3. Australian Practice

(i) Tracing

The two-stage planning of the Great North Road illustrates contrasting approaches to road-tracing practised in N.S.W. during the 1820's. The first attempt to trace the line, as discussed in Section III/1, indicates the pragmatic, haphazard nature of early road tracing, while Mitchell's resurvey of most of the line in 1829 reflects his attempt to introduce the modern "scientific" methods of his contemporaries in Britain.

Finch's efforts to find a feasible line of road apparently did not involve the location of the "best" route. Several alternatives had been found by settlers, and in his original survey he for the main part selected and incorporated one of these with existing tracks. The line (see Map 4), although rough, was practicable for horse and cart traffic after the major obstacles at Wisemans Ferry had been overcome. This first North Road exemplifies the established manner of road tracing in N.S.W. before Mitchell's arrival in 1827. The general pattern was that major roads were usually discovered and established by settlers, then officially surveyed and finally constructed when and if resources were available. Both Dangar and Atkinson wrote that most roads originated as settlers' tracks to their grants, which were first marked, then beaten out by traffic, and eventually constructed. Dangar gave a detailed account of the early stage:

The method adopted in first pursuing a route into any distant country is this: the first settler or party of settlers ... keep two or three men following in carts and with axes mark the trees by fractures in the bark ... this done, the settlers' men can proceed back with the teams and get up their second loading ... and thus, in a short period, the tract is beaten ... as to be designated the road ...
Subsequently, if "traffic and commerce warranted further attention" the road was "scientifically laid ... off and properly formed and metalled". (2)

The arrival of Thomas Mitchell in 1827 brought a new emphasis on meticulous planning and the condemnation of the old informal and improvised methods. Mitchell insisted in the first place that the location of the "bush" road and the "made" road were not likely to and should not coincide. While the former was "the best that could be found on the surface in its natural state", the latter was located "in a direction in which distances should be shortened and obstacles removed or diminished by labour" (3) His resurveys of the Great North Road and numerous other roads were, nominally at least, based on the principle of carefully balancing various factors, as espoused by the English road makers, and usually resulted in completely new lines of road. In contrast to the old pattern of road establishment, these new lines were often not traversable in their natural state and heavy construction was necessary. At the same time, construction work completed or underway was rendered redundant. His uncompromising attitude infuriated Darling and bewildered his own subordinates.

The simple distinction between the early "unplanned" roads and Mitchell's "planned" roads does not fully explain the colonial experience and the dilemma of road-tracing which arose later. Although the theorists invariably stressed the balancing of a number of important factors, such as obligatory points, physical features, economy and so on, Mitchell's particularly idiosyncratic approach and concern with a military style of road planning prevented him from achieving this balance. This approach comprised a literal interpretation of the
concept of the "perfect line", together with a passion for straightness, symmetry and regularity. In his lengthy reports concerning his choice of new lines, he invariably included references to other factors, dutifully reciting the maxims of "scientific" road tracing and stressing particularly the need to actually survey the ground and to carefully compare the benefits and disadvantages of each alternative. But in the end Mitchell's choice was always the most direct line between the two or more destinations. Much of Finch's original line between Ten Mile Hollow and the Wollombi was thus abandoned for a shorter route (see Map 12); the Five Dock to Dural section linked the whole road more directly with Sydney (see Map 8); and the Hunter Valley roads were completely reorganised to form one neat, sweeping line (see Map 11). All these alterations involved additional and often heavy construction and the redundancy of work completed on older sections. The numerous reports with which Mitchell accompanied his selections usually disguised this fact by the inclusion of long lists of other factors favouring his choice and by the exclusion of less favourable aspects. His preoccupation with rectilinearity was betrayed by frequent references to the "least circuitous line", the roads "branching at equal angles", to "angles which ought to be cut off" in order to "render the perfect line" and so on. The problem with this approach was that he equated straightness and symmetry with the ideal of the "perfect line". Since he considered the latter the only proper alternative, Mitchell drew up new lines for nearly every major road in the colony, insisting that this was, in the long run, economical, as it would settle the matter of road location "once and for all". His defence of his Department's activities to the Secretary for War and the Colonies gave this rationale:
I marked these lines (of communication) with great care in order... to prevent... the means of the government from being frittered away in the construction of roads liable to be changed which until then had been the case. It was obvious that any two points being given between which a road was required, all intervening obstructions could be surveyed and a line finally selected in which the deviations from a straight line might be made precisely such as admitted of the most level and easily made road... and as this conclusion could be thus arrived at with a degree of certainty that admitted of no further questions. I spared neither pains nor personal exertions to determine these lines on this principle. What has been done will be useful to posterity. (5)

The report was accompanied by a sketch map depicting his grand scheme for the colony. The coast of N.S.W. was shown as a horizontal line and the three Great Roads to the west, north and south as perpendicular and diagonal lines respectively converging on the centre of Sydney (see Fig. 81). Mitchell could not have provided a more succinct summary of his whole perspective on road planning. Later in the century his radial plan was repeated in the construction of the railways. Sydney was again the centre of this "political octopus", drawing in and monopolising trade and commerce. (6)

In spite of his genuine concern and "personal exertions", Mitchell's approach was fraught with difficulties. In the first place, since straightness and symmetry were given priority in order that the colony's road system might appear aesthetically pleasing on a map, other aspects of road tracing inevitably suffered. As discussed in Section III/11, Mitchell's efforts on the Great North Road were partly predetermined by general destinations, by the extent of construction already complete in 1829 and by topographical constraints. When dealing with the more specific location of the line, he subjected all other considerations, wherever possible, to his own preference for rectilinearity. Thus, although his reports played down or ignored the construction necessitated by his choice of line, subsequent material and
written records illustrate the colossal work required to carry the road over Mt. Baxter, Sampson's Pass, Mt. Manning, Mt. McQuoid, Mt. Simpson and Mt. Finch. Regarding "obligatory points", or those places or settlements which were to be served by the road, Mitchell also to some extent subjugated this consideration to rectilinearity. Thus village reserves were usually marked where no village, or any settlement, existed (see Map 12) while established settlements, such as Singleton, were avoided (see Map 16). In the latter case, as Jeans writes:

The (subsequent) Singleton branch of the road was born of the persistence of travellers who avoided the Surveyor General's planned road crossing of the Hunter at Jerry's Plains. (7)

Thus, while the official roads were straight, they were not necessarily direct in terms of the travellers' destinations.

In 1831 Mitchell was ordered to limit his road tracing activity to the Great Roads, since the numerous lines he had already marked out were considered by Darling "... of so extensive a nature that they are quite beyond the means of the government". The latter eventually wrote to Murray in exasperation:

Major Mitchell's plans are as extravagant as they are numerous. His object appears to be his own fame, that everything should originate or be improved by him. New roads are recommended almost every time he goes into the country without any consideration of the means of accomplishing his projects or the necessity of their adoption. (8)

The problems with Mitchell's plans thus hinged upon the lack of funds and labour to complete the roads, even considering the resources provided by the convict road gang system. Therein lay the dilemma of colonial road planning. On one hand, his obsession with directness aside, Mitchell was to
some extent justified in advocating roads which were carefully and properly planned with a view to long-term usage by an ever-growing colony. On the other hand, it seemed only sensible to complete and retain the old lines, since, owing to insufficient resources, there was no way such roads could be opened, particularly as they usually required considerable work to render them practicable. Thus, when Lockyer received Mitchell’s directives concerning a whole new road system for the Hunter Valley (Map 18) where gangs had already spent three years on the old, (see Figs. 2,3,4) he ventured to suggest:

... whether it would not be better to complete that which is already in progress and avail myself of the means I may find at my disposal without scattering the gangs and road parties on new lines which cannot possibly avail until the main Great road is open. (9)

S.A. Perry, the Deputy Surveyor-General, expressed the same dilemma some years later with regard to construction. In considering the proposed road along the coast to Newcastle he concluded that:

There is ... (a) great objection to the mere marking out of lines of this description if not to be immediately opened and that is that the best direction for a road to be made is not infrequently the most impractical as a road so long as the surface remains in a natural state, and thus what may be the result of elaborate surveys and much study and attention may drag only from the people of the country censure ... (10)

Mitchell’s plans, apart from those for the Great North Road, were jeopardised by the lack of resources to overcome both the heightened construction requirements and the vast distances. An anonymous colonial writer commented in 1850 that:

We affirm that there is a vast difference between the duties of a road engineer in England and in the
colonies. In England, the duties of such an officer seldom extend beyond the amendment of a single line, but in the colonies, it embraces the selection of not one new line, but many of them, with their connection and bearing on each other; and thus not within a radius of a few miles, but extending over vast tracts of land ... (11)

The other specific colonial difficulty in devising a large scale road system was that the colony itself was in a constant state of flux with rapid economic, demographic and technological development. Thus, while Mitchell deduced his lines of road from a "set of rules" to a "degree of certainty", the colony for which they were planned could by no means provide an equally "certain" or permanent rationale for their location. The result was a grand and permanent road which was abandoned before it was ever used.

In terms of construction, Mitchell's plans for the Great North Road were for the main part realised. The following sections will examine its original and subsequent tracing in more detail.

**Tracing the Great North Road**

**Obligatory Points and Physical Features**

During the early 1820's it was intended that the new North Road should link the capital Sydney with the more densely populated areas around Wallis Plains and Newcastle in the lower region of the Hunter Valley. In the absence of existing settlement and practicable routes directly north of Sydney, and in view of the major obstacle of Brokes Bay, Finch first travelled west to Parramatta and Baulkham Hills and thence north along the established tracks to Castle Hill and Dural. A continuous ridge was followed towards confluence of the Hawkesbury and MacDonald (the First Franch)
Rivers to a relatively suitable crossing place at Lower Portland Head where Solomon Wiseman had already established a farm. Finch adopted Richard Wiseman's recently discovered line crossing the ridges and valleys towards the Wollombi Brook. There he turned north-east over relatively easy terrain towards Wallis Plains (see Map 4). The first survey was thus completed according more to convenience and expediency than to deliberate planning. The fact that some areas through which the line passed were suitable for settlement, while others were barren and inhospitable was entirely incidental. There were no additional obligatory points of settlement governing the direction of the road, although Dumasiez, in retrospect, claimed that the Hawkesbury, MacDonald and Wollombi valleys were all to be served and made accessible by the great thoroughfare. (12)

By contrast, Mitchell in 1829 attempted to give his resurvey of the line a much more "scientific" basis. Although he could not practically have selected an entirely different line, such as one of the more direct tracks already in existence at the time (see Section III/11), he in any case re-evaluated the general location of the partly constructed road and concluded that it was, indeed, the best line. He first assessed the physical features of N.S.W. between Sydney and the Funter Valley generally:

That portion of the colony ... is much indented towards the coast by inlets of the sea and lagoons and intersected further inland by ravines descending to the Hawkesbury which intersects the country. The upper surface is elevated above the sea from 500 to 1000 feet, prescribing an even horizon but this horizon, apparently unbroken, consists of narrow crests of ridges separating ravines of great depth, whose sides are covered with rocks and impending cliffs. (13)

In spite of the fact that other lines to the north had been located by 1829, Mitchell maintained that, considering the
"direction of the ravines and ridges", the existing line was the only practicable one and there was "little room for selection elsewhere", since:

... to the eastward they (ravines and ridges) are bolder, and the mountains many of them would traverse any line northward from Sydney, and to the westward there the hills also rise towards the Blue Mountains there is no continuous ridge of equal extent with that to this point from the Hawkesbury northward; and it is plain that any direction further to the westward would be a more circuitous route ... (14)

Having thus settled the matter beyond any doubt, he enumerated the obligatory points which, by 1829, had been considerably augmented, with the emphasis shifting to the needs of the upper Hunter Valley:

The principal object of the road northward appear to be:
1st A most-direct communication by land to the upper districts of Hunters River (including the Goulburn River).
2nd The most-direct communication by land to the township of Maitland or Lower district of Hunter River.
3rd The continuation of the road further northward, in the direction most eligible under these various circumstances. (15)

As discussed in Section II/2, Mitchell's attention was given to the "numerous and influential class of settler" in the central and upper parts of the Hunter Valley, and he planned entirely new official branches of the Great North Road accordingly (see Map 11). In addition, he envisioned the section between Sydney and the Hunter as only the first stage of a far more extensive road traversing the entire continent towards Port Essington and ultimately providing a great trade route linking Sydney with Asia. (16) Regarding the more immediate destinations, however, he proposed that:

Sydney being one point, the next to be determined is that at which the road should reach Hunter's River District so as to admit branch roads at equal
angles, right and left to the points of ultimate destination. [47]

The latter point, which was "obvious from the map", was the head of the Wollombi Brook, the present-day site of Wollombi. There the made road branched north-east to Maitland, as Finch had earlier marked it, while the new line continued due north. Again, the Wollombi Valley was not an "obligatory point" which the road was intended to serve, but rather the most convenient junction point for the two branches to the upper and lower Hunter. Likewise, the Village Reserve of Broke was the best location for the road to branch again neatly towards the upper and middle Hunter. At the latter points the two branches joined Mitchell's proposed Hunter Valley road, which he devised at the same time (see Map 11). The original winding line was transformed into a thoroughfare serving the entire valley, which, more importantly, appeared pleasingly symmetrical and direct on a map.

Directness

Finch apparently paid little attention to the straightness of the line he laid out, or to the directness of the route as a whole. Both the original ascent from and descent to the Hawkesbury at Wisemans Ferry wound precariously around the cliff sides, lengthening the journey considerably (see Fig. 82, 92 and Map 6). Where the line was not strictly confined to the ridges it meandered to and fro in the sections between Ten Mile Hollow and the Wollombi (see Maps 4 and 12).

Mitchell's approach swung to the opposite extreme. Every possible saving of distance was made, often at the expense of construction considerations and an immediately practicable route. He planned large scale alterations to "two angles which ought to be cut off" on the original line to "render it
a very perfect one", one avoiding Wisemans Ferry and the other avoiding Parramatta as discussed in Sections III/6 and III/9 (see Map 11).

Economy

Dobson's advice for new roads in pioneer countries was to select a line which could be opened immediately and improved gradually in accordance with available resources. (18) The Great North Road was originally traced in this fashion and a cart track was rapidly established and used for some years without any construction at all. Where road making was essential, as at Wisemans Ferry, it was initially completed quickly, with only rudimentary structures. The result was a steep road with difficult turns (see Fig. 92).

The convict labour force in the form of road gangs was used from the early period, and this factor no doubt encouraged Mitchell to plan a road which would require such heavy construction. The consideration given to economy in road building was thus even more subject to the pursuit of directness than it otherwise might have been. As discussed, Mitchell realigned many early roads apparently without, as Darling wrote, "any consideration of the means of accomplishing his projects". (19) Mitchell claimed that he was sensible of the economic aspects of road construction. He pointed out that his plan for new branches of the Great North Road in fact involved "a considerable saving of road making ... between these points" by "carrying one road for a certain distance in an intermediate direction, so as to describe the letter Y rather than V". (20) On a still broader level, he considered the old-style unplanned road-system uneconomical and a waste of money, while his own roads, because they were properly planned, would endure and
be "useful to posterity" (21) The benefits of a permanent road system would thus be more economical in the long term than the early haphazard roads. The fact that there was insufficient labour to build these grand roads in the first place apparently did not occur to him.

Nature of Traffic

Most theorists stressed that consideration be given to the type and extent of traffic which would use the new road, so that the width, gradient and construction could be adjusted accordingly. As discussed in Section III, in the early period of the road's survey and construction little consideration appears to have been given to whether herds of cattle, heavy drays or coaches and four would be driven along the road. The steep zig-zag ascent from the north bank of the Hawkesbury certainly made passage for large vehicles very difficult. This approach changed radically, beginning with Dumaresq's enthusiastic account of 1827 and culminating in Mitchell's grand scheme and Simpson's impressive structures. The line came to be seen as a future great "artery" for trade and transport like the Great Roads in England. There was no doubt that the traffic between Sydney and the Hunter Valley would be heavy both in terms of volume and weight. The structures therefore became durable and impressive in anticipation of this flow. Mitchell seems to have given priority to the swiftness of the journey by making the line as direct as possible, but he failed to see that the steep gradients usually necessitated by this practice actually slowed the traffic. In most cases, however, the Assistant Surveyors applied the convict gangs to such difficult areas for long periods in order to achieve a manageable gradient (see Figs. 3-7).
Mountains and Valleys

In N.S.W. the problems of laying out a road in mountainous territory were particularly severe and could only be practically avoided by the location and following of continuous ridges wherever possible, a principle which was discovered with the first crossing of the Blue Mountains. (22) The ridges and ravines played a vital role in the tracing of the Great North Road. The topography between Sydney and the Hawkesbury River is described thus by Starling:

The Hornsby Plateau has been in places so deeply eroded that relatively little of the original plateau level actually remains. The major streams draining the southern Hornsby Plateau, the Hawkesbury and its tributaries, the MacDonald, Mangrove and Berowra Creeks have excavated a labyrinth of narrow steep sided valleys and gorges. The broken landscape is virtually impassable except across the levels of the original plateau which remain as continuous watersheds between the other major streams. (23)

Finch for the main part followed such a watershed almost directly to Wisemans Ferry and then traced the line along another ridge which Mitchell described as "also continuous although more broken" towards the Wollombi Valley. Mitchell also contrasted the Wollombi and Hawkesbury Valleys - while a road was "practicable along the valley of the Wollombi ... with its grassy flats", it was "necessary to keep to the ridges on the Hawkesbury side" since "the ravines are so deep and rocky that no road could be made in them". (24)

Where the selected ridges were interrupted, however, the surveyors had to deal with ascents and descents. The most difficult of these were the approaches to the Hawkesbury River. Finch's original line of descent, as shown on his map, plunged almost directly down the ravine towards the river, south west of the present descent, and then rounded
the head along the rivers edge towards the original crossing place. This plan apparently proved impractical and was, in any case, extremely roundabout (see Fig. 82). The descent which was constructed was apparently laid out by Durrell during his period as Inspector of Roads and Bridges. He contoured the line along the rocky mountainside towards the spur and there marked an abrupt zig-zag descent comprising three turns (see Fig. 82). On the opposite side of the river, Finch had also marked a zig-zag formation as an ascent but in this case it comprised seven sharp turns, steep gradients and allowed only narrow widths of approximately 11–12 feet (about 3 m) (see Fig. 92 and Map 6). This line was constructed in 1828 and used until 1832 when it was replaced by Mitchell's new line further to the west, scaling Devine's Hill. Like much of the descent on the south side, the new ascent was contoured along the steep mountain sides, as was recommended in British theory, with several sharp curves, and was made practicable only by heavy retaining walls and massive embanking, deep cuttings and elaborate drainage system (see Map 6). Mitchell subsequently criticised and altered the remainder of Finch's line towards Wollombi, stating that it "crossed every hill". An undocumented example of this is "Mitchell's Loop", approximately 4 km north of Wisemans Ferry, where the old line scales a steep hill, running along its summit, while the new is located lower down the slope, supported by a continuous retaining wall (see Fig. 93). Similar contouring on a much larger scale occurs at Mt. Baxter, Mt. McQuoid (see Fig. 95) and Mt. Simpson, although the heavy construction required at all these points was scarcely mentioned by Mitchell in his report. At Mt. Simpson his proposed direct line was subsequently completely altered, probably by Finch, to the present contoured, heavily embanked descent (cf. Maps 12 and 14). The descent from Mt. Manning at one point also
required the construction of a large ramp to carry the road at an acceptable gradient across a deep hollow (see Fig. 94). Other such formations are located between Wisemans and Ten Mile Hollow (see Appendix 1, Section 3) but none are of comparable scale.

River Crossings

The selection of crossing places also varied according to circumstance and the approach of the surveyor. The crossing of the Hawkesbury River was a major obstacle governing the overall survey, the "... key to the rest of the work" as Dobson put it. Its relative narrowness at Lower Portland Head, when compared with the vast expanse at Peat's property, near the mouth of the river, was one reason for the location of the road so far inland; another was the existence of the continuous ridge towards Wisemans, making that point a logical crossing place for the ferry. When the ascent from the north bank of the Hawkesbury was retraced, however, the crossing place was also relocated about a mile further north (see Map 6). Since the river was uniform in that area in terms of width and depth, no special care was taken in this relocation - the crossing was simply the most direct in relation to the road.

Another major crossing place was incorporated into the Great North Road when Mitchell added the branch via Bedlam Point on the Parramatta River to Dural. In this case, several alternatives were available and Mitchell went to great lengths in his report to give the impression of a "scientific" basis for his final choice. He accordingly examined the factors of breadth and depth of the river at the various points (see Map 7), the character of the connecting approaches and the general lines of road, the distance from Sydney, the
ownership of the land on either side and the relative directness of the roads. Not surprisingly, he concluded that the shortest and most direct route was the most favourable, reducing the distance to Wisemans by four miles and cutting off the angle formed by the road passing through Parramatta (see Maps 7 and 8). (25)

In spite of the general directives given by contemporary road builders in Britain, there is little evidence of the line of road being altered in order to incorporate a more convenient crossing place. Finch probably located practicable rock fords and shallow places in streams which could be crossed without bridging in his first survey. Mitchell's line did not veer from its course at the Wollombi Brook at Wollombi, at Cockfighter Creek at Warkworth or at his proposed river crossing of the Hunter at the planned centre of Leamington (see Maps 15 and 16). The bridges at Sampson's Pass, Circuit Flat and Mt. McQuoid also lie in the direct line. The only exception to this rule is a pronounced deviation just north of Ten Mile Hollow, where the largest surviving bridge (Bridge 4) spans a deep gully. The deviation was not intended by Mitchell, as evidenced by his map (see Map 12 and Fig. 83), but was probably made by Simpson in response to engineering difficulties. Another alteration was made by Finch, apparently with Mitchell's consent, to the crossing place selected for Watagan Creek just south of Wollombi. Finch respectfully pointed out that Mitchell's choice was "easily flooded" and would have required a long and high bridge. He suggested a crossing "a little lower down" where the "high land approaches much nearer and the channel is much more capacious". This selection, however, made the original line of road more circuitous, and so the latter was altered to form a direct route (see Map 13). (26)
Construction Considerations and Materials

Finch's original line, as discussed, was for the main part traversable without major construction, and the work which was necessary was executed by Warner in a most economical manner. Warner himself, when tracing another line (Simpsons Line, see Map 11) east of Ten Mile Hollow showed the same methods of tracing in his long and detailed report. (27)

Mitchell maintained that he had duly considered the constructional aspects of his new line:

... having endeavoured throughout to combine the straightest ... direction with that of the least declivity according to which principle, of course, the hills and rocky points are to be avoided. (28)

His "Reports on the Road between Young Wisemans ... and ... Twelve Mile Hollow", however invariably gave directness priority over construction costs. The importance of the former was heavily stressed while the latter was de-emphasised or not mentioned. The fact that he was himself not an engineer was probably a major reason for this - he was in fact somewhat disdainful of the occupation, writing in 1831 that he "... never condescended hitherto to make or repair roads". (29)

The location of suitable road-making materials was similarly incidental to his choice of line, as it tended to be for earlier surveys. Dumaresq had mentioned the existing hard surface of Finch's line south of Wisemans, along with the "abundance of stone at hand", (30) while Warner, on his survey, frequently mentioned the "immense large trees near the creeks" which, he maintained, would form excellent bridges if felled in the right direction. (31) Likewise, Mitchell mentioned the presence of ironstone gravel, "the best
material for making roads" near Mt. Manning. (32) The occurrence of such road building materials could not, however, be said to have affected the choice of line. Apart from the fact that in most areas they were abundant anyway, Mitchell generally ignored such matters, while Finch simply limited his work to finding any practicable line as quickly as possible.

Conclusion

The principles of the road building revolution with regard to the tracing of new lines should have replaced the older, unplanned haphazard procedure exemplified by Finch's original survey when Mitchell arrived in Sydney in 1827. Mitchell was apparently closely conversant with the new principles. He listed them and expounded on their merits endlessly. His judgement was, however, unduly and invariably affected by his desire, as a military man, to see the road system in N.S.W. in the form of a radial pattern of perfectly straight lines, and he went to great lengths to achieve this. Although he espoused the principles of balancing the factors of obligatory points, physical features, directness, construction considerations and so on, his idiosyncratic approach prevented him from actually practising this. As a result, many of his roads were never commenced, never finished or never used. In the actual construction of the Great North Road, several alterations were made to his line by engineers supervising the work (see Fig. 83). His purpose in providing "perfect" straight roads, economical because they "admitted of no further questions", was therefore self-defeating.
SECTION IV/3/1

AUSTRALIAN PRACTICE : TRACING

Notes


2. Ibid.; James Atkinson gives a similar account of road development in An Account of the State of Agriculture and Grazing in N.S.W., 1828, p. 136.


4. Mitchell to Macleay, 8 October 1829, "Report on the Road Northward from Sydney", A.O.N.S.W., S.G. to C.S.

5. Mitchell to Macleay, 2 September 1834, "Report to the Secretary of State for War and the Colonies", A.O.N.S.W., S.G. to C.S.


7. Dennis Jeans, An Historical Geography of N.S.W. to 1901, 1972, p. 128.


9. Lockyer to Macleay, 30 November 1829, A.O.N.S.W., C.S.I.L.

10. Perry to Macleay, 10 November 1834, A.O.N.S.W., C.S.I.L.


14. Ibid.

15. Ibid.


17. Mitchell to Macleay, 8 October 1829, "Report on the Road Northward from Sydney", A.O.N.S.W., S.G. to C.S.


20. Mitchell to Macleay, 8 October 1829, "Report on the Road Northward from Sydney", A.O.N.S.W., S.G. to C.S.
21. Mitchell to Macleay, 2 September 1834, "Report to the Secretary of State for War and the Colonies", A.O.N.S.W., S.G. to C.S.


24. Mitchell to Macleay, 8 October 1829, "Report on the Road Northward from Sydney", A.O.N.S.W., S.G. to C.S.


26. Finch to Mitchell, 13 October 1830, A.O.N.S.W., S. to S.G.

27. Warner to Dumaresq, 7 May 1828, "Description of the Line of road from Wiseman's to Wallis Plains (McDonald's Line) ...", A.O.N.S.W., C.S.I.L.


31. Warner to Dumaresq, 7 May 1828, "Description of the Line of road from Wiseman's to Wallis Plains (McDonald’s Line) ...", A.O.N.S.W., C.S.I.L.

32. Mitchell to Macleay, 8 October 1829, "Report on the Road between Young Wiseman's ... and the Twelve Mile Hollow", A.O.N.S.W., C.S.I.L.
(ii) Surveying

The record of surveying in N.S.W. during the early nineteenth century parallels that of road tracing, and the contrast between the nature of and conditions for surveying during the earlier period, and the new approaches prevailing after the arrival of Darling and Mitchell is again reflected in the two surveys made of the Great North Road in 1825 and 1829.

The numerous difficulties of surveying in the colony were compounded in the first place by the nature of the territory – it presented "higher mountains, deeper gorges, rougher bush and longer distances between sources of food and equipment". (1) In addition there was the fact that:

Of all the differences between surveying in Britain and N.S.W., the one most consistently ignored in Britain was the difference between surveying land long occupied and long used with established towns, roads and farms compared with surveying tractsless unsettled territory. (2)

In the same sense, instructions such as Crocker's, directing that boundaries, gates and stiles be painstakingly included in a survey (cf. Plates 1 and 2), appear ludicrous in the colonial context. (3)

The Surveyor General's Department was, in any case, hopelessly understaffed and poorly equipped. Oxley himself had been trained in the navy and lacked sufficient land surveying skills for large-scale projects such as the general survey of the colony. In 1819 his Department comprised only himself and a deputy "with occasional assistance in the office from convicts who happened to have any knowledge that qualified them for its duties" (4) By 1825, when the Great North Road was first surveyed, the number had increased to seven surveyors and one draughtsman, but two of these were
incapable of active duty, and there was a general ignorance of the technique of triangulation. Convicts were recruited to assist them but this practice was apparently also unsatisfactory. (5) In 1830 Finch still objected to the employment of certain types of convicts in surveying work:

We do not find the men chosen from the barracks at Sydney as fit for the service ... they appear to be the refuse of the prisoners, quite unused to work and unfit to be trusted, even under the fear of punishment such men we are obliged to send in charge of valuable property and articles essential to the performance of our duty ... (6)

The instruments were limited to circumferentors, a compass with sighting vanes for measuring angles (see Plate 2), later replaced by the theodolite (see Fig. 137); perambulators, measuring wheels held in the hand and rolled along the ground; gunter's chains and arrows (see Plate 2), the simple compass, and barometers for measuring height. (7) In 1815 George Evans' equipment for a survey in Tasmania comprised:

Two circumferentors with sights complete
Six spare needles for ditto
Two pocket compasses
One case of mathematical instruments, complete
One case of mathematical instruments, for the pocket
Spare compasses of sizes
Beam compasses
Parallel Rulers of sizes
Plotting scales and brass rulers
Two gunter's chains
One box colours
One small tent, complete
Large elephant paper, writing paper, memorandum book
Quills and Pencils (see Figs. 138 and 139) (8)

Orders for adequate and suitable equipment were ignored - Oxley in 1823 requested a list of supplies which was reordered by Darling in 1826, including the circumferentors, three 10-mile perambulators, 13 compasses, six 100-foot chains, 6 barometers, 12 thermometers, 3 sextants, 24 measuring tape lines, 2 theodolites, 2 iron measuring rods of two toises (6 feet each toise) in length and 2 cylinders.
The latter were "... presumably to make a base from which trigonometrical calculations could be made". (9) Yeaman maintains that, with regard to the accuracy of the early surveys using circumferentor and chain:

... it can be accepted that this would be accurate to at least half a degree in angle and at least 1 in 1,000 in measurement of length ... (10)

Finch's first survey of the North Road was therefore most likely to have been made with a circumferentor, chain and compass and in the shortest possible time. Although he was, unlike some members of the Department, a well-qualified surveyor, "... the first of a number of trained surveyors sent to K.S.W.", (11) the map he produced in this case was crude and poorly detailed (see Map 4). Private individuals such as John Howe, John Blaxland and Richard Wiseman, whose routes were sometimes officially adopted, used nothing more than a "watch and a pocket compass", estimating distances by time. (12) James Atkinson included illustrations of such "exploring parties" in his The Present State of Agriculture, depicting their modes of travel and shelter, the latter being formed of strips of bark lain across poles suspended horizontally (see Plates 3 and 4).

Darling's arrival proved to be a turning point for colonial administration and particularly for the Surveyor General's Department. He carefully examined the machinery of each department, improving efficiency generally, and devoted much attention to improving the facilities for surveying which appeared especially inadequate in view of the proposed general survey of the colony. The latter project was essential for the establishment of proper administration, especially in view of the chaotic state of land grants and sales which had arisen over the years because of neglected or
inaccurate surveys. Darling subsequently ordered the necessary equipment and requested that more skilled surveyors be sent, and in 1827 Thomas Mitchell was approved to fill the position of Deputy Surveyor General. (13)

Mitchell had acquired his considerable skills as a surveyor and draughtsman while serving in the 95th Regiment, one of the most famous of the Peninsular Army. His duties included the survey of the country over which the army moved, sketching, reporting on roads and bridges, resources and facilities. His skills were soon recognised and after the war he was selected by General George Murray, who became his patron, to make a full plan of the Peninsular battlefields. Although the approval for the project was later withdrawn, Mitchell completed the plans at the Military College at Sandhurst and having no prospects in England, accepted the post as Deputy Surveyor General in N.S.W. (14) He brought with him his zealous enthusiasm for exploration and mapping unsurveyed and uninhabited territory, and his knowledge of triangulation. In his opinion:

The form and direction of mountain ranges, the courses of rivers and the outlines of the coast and harbours require the earliest attention in taking up new countries. (15)

Again, it was the prospect of establishing "roads or public works" to a high degree of certainty through detailed and proper surveys which attracted him and he stated that his "confidence ... in plans ... devised in this colony" was based on "correct data". (16) He was interested in civilising the wilderness, bringing order and regularity to what he saw as chaos.
In *The Australian Geography* Mitchell he enumerated three approaches to surveying and map-making - maps could be based on astronomical observation, which showed the true place on the globe; trigonometrical measurement, which revealed the "true position of the elevated points"; and/or chain measurements, which showed the "direction of the sinuous line". (17) It was the second of these, triangulation, which was employed for the general survey of N.S.W., commenced in 1828 when he selected the three principle points of Mt. Jellioe in the south, Mt. Warrewolong in the north and Mt. Hay in the west, forming a triangle, the longest side of which was almost 100 miles. In 1834 the first map of the Nineteen Counties was produced and the triangulation was subsequently extended "southward to the mouth of the Glemelg, and northward to Capricornia". (18) Mitchell claimed that he also used triangulation in surveying "the smallest portion of ground" including roads such as the Great North Road:

... sites for towns, harbours, quays, bridges, wharves and the general direction of Great Roads have all been examined by him (Mitchell) under angular measurements by his own hand ... (19)

While theodolites were unavailable, broken or simply not used in surveys before 1827, they were certainly essential for Mitchell’s surveys. He reported the continual lack of equipment in 1828, referring to the:

... very serious want of almost every description of surveying instrument. Not a servicable theodolite was to be found in the department when I arrived; that which I used on any late survey was bought at a high price from a gentleman lately arrived ... I have succeeded in clumsily repairing others from the debris of instruments but there are now only three spare chains in the office and the general business must soon be seriously impeded. (20)
In contrast to Finch's first survey of the Great North Road, Mitchell in his survey abandoned the practice of selecting previously discovered settlers' tracks and applied modern techniques of triangulation using the theodolite. He spent three weeks in "a general survey of the country ... becoming thus satisfied ... as to the most eligible and direct line" and a further two weeks in making "a minute examination of the hills and marking the trees along the whole extent". (21) His map of the new line between Ten Mile Hollow and Laguna thus included much more information about the position of the road in relation to natural features than Finch's plan (see Map 12). A relevant sketch by S.T. Gill dating from the mid-1800's depicts a surveying party of five men at work in N.S.W., using a gunter's chain, theodolite and marking the trees with an axe.

Darling and Mitchell were responsible for the rapid improvement of surveys and surveying methods in N.S.W. in the 1820's and the contrast between the two surveys made of the Great North Road is indicative of this progress.
SECTION IV/3/11
AUSTRALIAN PRACTICE : SURVEYING

Notes

2. Ibid.
6. Finch to Mitchell, 6 October 1829, A.O.N.S.W., S. to S.G.
7. Oppenheimer, p. 105; See also John Fryer (ed.), Surveying the Hunter, Newcastle, 1980, pp. 53-54.
9. Cited in Oppenheimer, p. 121.
10. Yeaman, "Footsteps in Time".
16. Ibid.
19. Ibid.
20. Oppenheimer, p. 121.
21. Mitchell to Macleay, 8 October 1829, "Report on the Road between Young Wiseman's ... and the Twelve Mile Hollow", A.O.N.S.W., C.S.I.L.
(iii) Clearing

The initial operation in opening a new road, as for agricultural activity, was the clearing of timber and other vegetation from the line. Occasionally, when formations or cuttings were considered unnecessary or too expensive, clearing was the only road making undertaken, and often this path-breaking work provided a serviceable, if rough, "horse track" preceding more elaborate construction. Thus, in August 1827, Wilford reported that the Great North Road between Castle Hill and the Dural area was "... at present merely proposed to (be opened) by felling the timber one chain in width and stumping one half that space in the centre". (1) The stumps of the felled trees were to be removed from the centre portion of the line, but left in place on either side (see Fig. 84).

Maclehose gave a detailed description of the clearing work done by convicts at Victoria Pass in the Blue Mountains:

The first task for the poor creatures, who were here employed both in "summers heat and winters cold" was to fell, roll off or clear by burning, through the wood, of the projecting line of road, under the direction of their overseer, worked, too in fetters connecting from one ankle to the other, weighing seven to ten pounds ... The apportion of ground to be cleared by any given number of men per day was found impractical, the quantity to be performed was therefore a matter of necessity ... (see Plate 9). (2)

Irroned gangs on the Great North Road were not assigned such "task work", that is, particular or limited sections of ground to clear, either. The road gang reports show that the individuals were given one or another of the various tasks associated with clearing. Early in the construction period, Warner discovered that the methods the men had been using until then were slow and tedious:
Having observed that the making of the road from Beat's (vicinity of Dural) through the forest is retarded very much owing to the long time it takes to burn off all the timber that is felled 2 poles (22 yards) wide. (3)

Thus the initial practice was to fell, stump and burn off all the timber on the width of the road. Warner recommended, however, that to save time, "... the timber may be felled four poles wide and cleared two poles (11 yards) only", and, in addition:

... in lieu of burning the whole of the two poles of timber in the line of road it will be more expeditious to roll it (it?) in on each side where the stumps will only have to be burned and a few hands will answer to that duty when at present 12 (men) are employed who could roll the timber off the road during the time they lay it in piles to burn". (4)

He further pointed out that "in felling timber to be rolled clear off for two poles wide", the men could "throw the trees so as to fall with their heads off the line of road and will then only have to roll (sic) away the trunks and cut a few of them to burn stumps" (see Fig. 84). These suggestions appear to have been adopted immediately as Wilford's August 1827 report, cited above, indicates. Dumaresq described the convicts rolling the logs off the road with large spikes in the same month:

 Riding through the silent and thickly wooded forest of Dural the sudden crash of an enormous tree (ironbark) notified our near approach to the iron gangs making the road. About 50 men, all with chains around their legs were employed ... under an overseer from the prisoners barracks, some in felling, some in burning off; while others, with large handspikes were rolling the trunks of the prostrate trees to the side of the road; it was a black and busy scene in the midst of solitude. (5)

The first task in clearing, the felling of trees, was done with either a broad or felling axes or a cross-cut saw - both are listed in requisitions for tools (see Figs. 140, 141), and the trees were cut in such a way as to fall off the line of
road, as Warner described. Oliff and Crosthwaite give details of the procedure:

The trees were felled with heavy axes or cross-cut saws drawn backwards and forwards by two men. Often a wedge was placed in the cut to ensure that the tree fell in the desired direction. When the tree fell, convicts lopped off the boughs ... (8)

A similar description was given by Atkinson in 1826, including the dimensions of a suitable axe:

Felling is done with an axe, the edge of which is 2½ inches, with a large eye and weighing about 6 lbs; the trees were cut through with this at about 3 feet from the ground. (9)

A list of store requisitions of 1832 from the Commissariat specified that felling axes "should have large eyes and be tempered for the hard woods of the colony". (8) Atkinson also gave instructions for burning the trunks, as practised on the Great North Road before Warners' changes were made:

... they then lop off the branches and pile them around the middle of the trunk so as to burn it in two pieces; these are afterwards rolled around so as to form one fire. The smaller trees are also cut up and rolled to the large one. (9)

The convicts did, in fact, continue to lop off the branches, presumably with axes, so that the logs could be rolled. Burning off also continued, in order to clear the undergrowth and "rubbish" from the line. (10)

While settlers often simply left the stumps in their fields in place, ploughing around them, much of the efforts of clearing roads was spent in grubbing up and removing stumps. Tasks associated with this included "opening" stumps, "sapping" them, "grubbing up" and filling in the stump holes. The stump was first split open, the roots dug out and "grubbed up" with "grubbing axes" or "grubbing hoes" (11) (see Photos 80, 81).
Late in the construction period stumps were burnt out. Ogilvie reported that:

... extracting the stumps when all the timber has been burned off the line is work which takes a considerable time, as the timber has to be brought from off adjoining land to the stumps for the purpose of burning them out. (12)

Thus, nine years after Warner's time-saving recommendations, convicts had returned to the former system of burning off all the timber rather than simply removing it. The gathering of timber from "adjoining land" to burn out the stumps rather than the use of the freshly felled timber is unexplained.

After the stumps were finally removed, men were employed to fill the holes and to rake the road to provide a reasonably smooth surface. Tools for the clearing operation thus also included shovels and rakes (see Fig. 152). (13)

The Weekly Reports submitted by the Overseers and Assistant Surveyor provide information about the distribution of work and the gangs' rate of progress. For example, the report dated May 1827 of No. 8 Iron Gang, which was employed in clearing the dense timber around Dural, shows that the men were allotted tasks (as shown in Table 5). The largest proportion of the men, 12, were "making fires" and "burning off the trunks and brush" during that week, while most of the remainder were, until the Friday, removing the stumps and logs from the trees felled dug the previous week. Only four men felled more trees during one day only, presumably generating enough work for the following week. On Saturday nearly half the gang was filling in stump holes, while the rest were still employed grubbing stumps out. Burning the timber and stumping were thus, as Warner reported, the most time-consuming tasks. (14)
<table>
<thead>
<tr>
<th>Number of Men and Employment</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asst. Overseers</td>
<td>2</td>
</tr>
<tr>
<td>Hut Keeper</td>
<td>1</td>
</tr>
<tr>
<td>Bullock Dr.</td>
<td>1</td>
</tr>
<tr>
<td>Messenger</td>
<td>1</td>
</tr>
<tr>
<td>At Work</td>
<td>35</td>
</tr>
<tr>
<td>TOTAL</td>
<td>40</td>
</tr>
<tr>
<td>Falling Timber</td>
<td></td>
</tr>
<tr>
<td>Opening Stumps</td>
<td>2</td>
</tr>
<tr>
<td>Sapping Stumps</td>
<td>4</td>
</tr>
<tr>
<td>Grubbing up Stumps</td>
<td></td>
</tr>
<tr>
<td>Lopping Heads of Trees</td>
<td>6</td>
</tr>
<tr>
<td>Cutting Logs</td>
<td>6</td>
</tr>
<tr>
<td>Making Fires and Burning Off</td>
<td>12</td>
</tr>
<tr>
<td>Water Carrier</td>
<td>1</td>
</tr>
<tr>
<td>Handling Tools</td>
<td>1</td>
</tr>
<tr>
<td>Making the Road</td>
<td>2</td>
</tr>
<tr>
<td>Filling in Stumpholes</td>
<td></td>
</tr>
<tr>
<td>To Wisemans with Cart</td>
<td></td>
</tr>
<tr>
<td>In Hospital</td>
<td>1</td>
</tr>
</tbody>
</table>
### TABLE 6: PART OF WEEKLY REPORT OF NO. 8 IRON GANG

**R. McManus, Overseer, From 2nd to 8th March, 1828**

<table>
<thead>
<tr>
<th>Employment</th>
<th>M</th>
<th>T</th>
<th>W</th>
<th>T</th>
<th>F</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falling Timber</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Opening Stumps</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sapping Stumps</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Grubbing up Stumps</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Lopping Heads off Trees</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Crosscutting Logs</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Making Fires and Burning Off</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Grubbing Saplings &amp; Brush</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Supplying Water</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Keeping Tools in Repair</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Making the Road</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Quarrying Stone</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Assisting Cart ... with Rations</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Reports for No. 8 Iron Gang in the same area a year later indicated that the distribution of work by then was more regularly organised and much less erratic (see Table 6). Roughly the same number of men were employed in the same jobs each day during March. A large proportion was still involved in removing stumps, but fewer men were burning off, in accordance with Warner's changes, and two men each day were crosscutting logs in order to roll them away. (15)

Many gangs on the Great North Road were not employed solely in clearing. Frequently, clearing was undertaken simultaneously with the construction of formations and drainage structures. In other cases, the gang spent part of the week in forming the road, and the remainder in clearing the next section of road.
The gangs' progress depended mainly on the type and density of the vegetation that they encountered. At one extreme, No. 27 Road Party, comprising 31-35 men, cleared 5120 rod (25.7 km) of brush around Parson's Hill near Maitland in February 1829. By contrast, No. 8 Iron Gang, comprising around 40 men felled trees on only 100 rod (502 m) of the line during a week in March 1828, and only part of this was stumped.

Clearing a new line of road was a tedious and laborious operation. Alterations to the established method such as those suggested by Warner were quickly adopted in an attempt to reduce time and labour expended on it. Clearing was also an important, though not a conspicuous aspect of road building, since it often provided the first usable track for travellers.
SECTION IV/1/11

AUSTRALIAN PRACTICE : CLEARING

Notes

1. Wilford to Macleay, 4 August 1827, A.O.N.S.W., C.S.L.L.


3. Road Gang Reports, May 1827.

4. Ibid.


8. "Annual Demand of Stores Required for the Commissariat Department at N.S.W. for the year 1834", A.O.N.S.W., Commissariat Records, Copies of Store Requisitions and Abstracts.


10. Road Gang Reports.

11. Ibid.

12. Ogilvie to Mitchell, 9 April 1835, A.O.N.S.W., S. to S.G.

13. Road Gang Reports; Dulhunty to Mitchell, 7 June 1833, "Estimate of the Quantities of Tools, Implements and Stores that will be Required for the use of the Dept. of Roads Wollombi District for the year 1834", A.O.N.S.W., S. to S.G.

14. Road Gang Reports.

15. Ibid.

16. Ibid.

17. Ibid.
(iv) Formation - Excavation and Embanking

Topography

(a) Hollows and Points

The achievement of a manageable gradient involved the two basic operations of cutting the natural surface down to the level of the road, and filling over it to the required height, as circumstance dictated (see Fig. 86). Like their British counterparts, colonial road builders referred to such irregularities as "hollows and points". Maclehose provided a detailed description of such cutting and filling employed to level Brickfield Hill on the Parramatta Road near Sydney in the 1820's:

Up to the middle of last year, the ascent of Brickfield Hill was ... steep ... difficult (and) dangerous ... during the last nine months the ascent has been rendered completely safe and easy ... The inclined place of the ascent has been considerably lengthened by cutting and paring off the higher part of the road and the material from the top being conveyed to the ... lower extremity have there been successfully employed raising that compartment by as great a quantity as the other extremity was deepened by their removal. (1)

Similarly, a diagram of 1827 of a proposed alteration to the Bulga Road shows the high points "thrown down" or simply cut off, and one hollow, in this case a creek bed, filled by the construction of an "American Bridge" of log cribwork, thus forming a level line of road (see Fig. 85). (2) On the Great North Road, the filling of large hollows was often accompanied by the construction of stone retaining walls on both sides which both reduced the necessary size and slope of the embankments and strengthened them. Lockyer reported in 1829 that the line between Wisemans Ferry and Ten Mile Hollow required only the "filling in of two narrow necks on the ridge
and walls built up to enable any description of vehicle to travel. (3) One of these "necks" was probably near the 7 mile post (11.8 km) where No. 8 iron gang were employed during January 1830 in "filling an extensive hollow" and building side walls there (see Appendix 1, Section 3 and Photo 210). (4) The largest surviving example of the same type of construction is the ramp near Mt. Manning (0.65 km/0.4 m north of Mt. Manning junction) where battered walls up to 14 courses high bear the road over a deep hollow (see Appendix 1, Section 4a, Photos 284-292 and Fig. 94). A good example of road levelling by excavating a natural rock shelf is found at Sampson's Pass, 35.2 km/21.8 m south of the Mt. Manning junction, as shown in Photo 240. The road was excavated on both sides at 37.3 km north of Wisemans Ferry, where the cuttings are 1.5 m high and 7 m long.

(b) Sloping Ground

Wherever the natural terrain sloped from one side of the road to the other, the lower side was embanked and/or the higher side cut down. A gentle slope was often slightly embanked (see Fig. 87) with a side wall of one or two courses as shown in Photos 187 and 189. The latter also shows a shallow earth cutting on the high side. A large example of embanking only on a slope occurs at 51 km/31.2 m north of Baulkham Hills, where a substantial and well-built retaining wall supports the formation (see Appendix 1, Section 1b, Photos 26 and 27 and Fig. 91). Both cutting and filling were required on very steep slopes and the operations were usually simultaneous, the material from the cutting forming the embankment; (see Fig. 88). Good examples of both cutting and filling are shown in Photos 194 (Mitchell's Loop) and 224 (ascent of Mt. Baxter) (see Appendix 1, Sections 3n and 3m) while the descent to Wisemans Ferry, Devine's Hill, Mt. Simpson and Mt.
Finch sections exhibit the two operations on a very large scale. At Mt. McQuoid the second half of the abandoned section of road is generally built above the surrounding surface except for a short section of cut and fill (see Fig. 95).

(c) Flat Land and Ridges

Parnell's recommendation that any road should be elevated at least 2 feet was apparently adopted in N.S.W. in many instances. Macquarie's specifications for roads in 1810 instructed that:

Roads to be two rods wide; side drains to be three feet wide and two feet deep and pavement to be elevated and made of lasting material. (5)

The road to the Hawkesbury this acquired an "air of permanency", having changed from a track cut through the bush to one "32 feet wide, sunk 18 inches on each side and raised proportionally in the middle". (6)

Where land was naturally level on the Great North Road, however, it appears that no formation was made at all. The line was simply cleared, and a broken stone pavement laid (see Photo 186 for example). This occurs particularly on the barren ridge tops where the soil was hard and rocky and the ground sloped away on either side, providing natural drainage. Wilford described the first twelve miles from Baulkham Hills, which had only been cleared and raked as "thus completed and ... an excellent road for all purposes". (7) Photos 250 and 256 show similar unformed sections on the flat rocky ridge north of Wiseman's Ferry. The edge of the carriageway is defined by a slight chiselled ridge.
Cutting

Convicts employed in cutting the line of road were variously described as "moving and splitting rocks", "quarrying", "widening", "picking the side of hill", "picking the bank" and "excavating". (8) Generally, where a stone cutting was required up to approximately 1.5 m/4 feet in height, it was hand cut with chisels or rock picks and the face was vertical (see Fig. 89). Larger stone cuttings were usually blasted out, and where retaining walls were required, the exposed rock faces were quarried both to provide stone and to widen the road.

The numerous small cuttings extant on the road are fairly similar in detail. The marks of the chisels or picks slope to left or right often varying in direction on the same face (Photos 2 and 25). A large, fairly blunt tool was used for the cuttings shown in Photos 2, 8, 231, and 257 and the broad marks are widely spaced on coarse, crumbly rockface. Thinner, more closely spaced marks are shown in Photos 25, 223, 234, 243 and 251 while the much shorter finer strokes of a sharper tool are shown in Photos 122, 200 and 272. These marks are very dense and sometimes end in a small hole. In the upper part of Photo 65, the strokes have been weathered away, leaving only the holes. Photo 200 shows graffiti possibly etched by one labourer bored by his tedious task. Where a large platform of rock occurred, the side cuttings were combined with stone side drains and surfaces as shown in Photos 184 and 298, making the profile of the road completely of stone.

Blasting was employed mainly where the requisite width had to be cut from massive cliffs or rock faces, although occasional
jumper marks (the holes formed by the boring tool, the jumper) are found on lesser cuttings. No. 9 Iron Gang, when stationed at Mt. Baxter in March 1830 was employed in "considerable excavation in order to maintain a level base throughout this part of the road". (9) On the rocky approaches to the Hawkesbury, and at Mt. Baxter and Mt. Simpson, the faces are covered in jumper marks of all lengths (see Photos 66, 133, 224 and 314). Photo 265, a cutting on the 1828 ascent, shows a combination of both hand cutting and blasting - chisel marks occur at the top of the face and a single drill hole below indicates that the remainder was blasted out. Although a slope was recommended even for a solid rock cutting by the British road-builders, the rock cuttings generally have vertical faces, while quarries are stepped and benched. Photos 162 and 163 indicate the massive amount of stone which was removed for the ascent of Devine's Hill.

The gangs' progress in excavation again varied with the soil and stone types. There are several reports of extremely hard stone encountered on the line. On the descent to Wisemans, the gangs had great difficulty in "moving and splitting the rocks and mixed clay and smaller rocks". (10) At Geber Gums, just north of Ten Mile Hollow, their work was slowed by "extreme rocky substances requiring a good deal of blasting and quarrying ... to render the road safe and in some places passable". (11) The Judge Dowling Ranges were described as:

One of the worst situations on which (the) operations will have to be brought into action perhaps throughout the whole line of North Road, being formed of mountainous ironstone and rocky withall. (12)

Finch likewise described problems in the Wollombi valley, where "immense and irregular masses of rock have hitherto
formed an almost impassable barrier. (13) The amount of cutting which could be accomplished in a week varied between approximately 70 and 165 (cubic yards) by 12-14 men. (14)

**Filling**

No. 25 Road Party, in filling the road towards Devine's Hill were reducing the "activities of which line to a scale of 1 foot in 30". (15) The height of an embankment over a hollow or on sloping ground thus depended on the gradient planned. Mitchell's initial directions to Finch in early '830 stressed that care should be taken in ensuring "that the inclination never exceeds 5 degrees, four being as much as can well be admitted". (16) Embankments on the Great North Road vary between approximately 30 cm/1 foot and, where retaining walls enclosed them, approximately 7 metres/20 feet in height. The overseers and surveyors used terms such as "making the road", "raising the line" and "filling in hollows" to describe this operation, (17) and Nicholson in one of his sets of Instructions referred to the "width of the road" which has been measured and traced out with two lines marked in the soil or stumps driven in". The latter method of laying out the road is thus a simple version of the one described by Law. A requisition for 24 road lines for the Wollombi district suggests that these were used for the measurement of the new road. (18) A bench mark on the cutting at Ramsay's Leap (Photo 315) suggests a height indicator. There is no evidence of either the formation of concave strata (Gillespie) or of filling from outside to inside (Parnell). The embankment was simply kept filled to the height of the retaining wall as it was constructed. Thus in 1830 No. 4 Iron Gang was employed:
... quarrying and erecting a side wall 100 yards, 3 feet high, cutting into side rock to widen and forming the road corresponding with the transverse wall on the outside thereof. (19)

No. 3 Iron Gang was, similarly, "building a wall 300 feet long 12 feet high ... kept made up with quarried stone 12 feet wide". (20) The formation and pavements were to be compacted by natural settling and evenly distributed traffic - Lockyer instructed in 1828 that:

Where the roads are newly made or put in repairs by new stoning the sides should be logged to prevent cart and carriages, etc. from cutting up the sides of the road, thereby soon causing the road itself to give before it becomes properly settled and whole. (21)

As the abovementioned road gang reports indicate, the gangs' work was not usually limited to formation, or any other single aspect of construction. After the line had been cleared, and sometimes as clearing was still in progress, the men were simultaneously employed in cutting, quarrying, blasting, forming, wall-building and drain-making on one section of road. Hand carts and wagons drawn by bullocks were used to transport both fill material and stone for pavements from their source to the embankment. (22) Sometimes material was stockpiled along the road side - invalids and "exempted men" were employed in breaking stone in 1830 "to serve for forming the road at a future period across low places". (23) Warner described the major formation at Wisemans as having two stages of construction, reporting in 1827 that it was "impossible to state the actual progress of the road until we complete it a second time". (24) The gangs stationed on the descent to Wisemans presumably first cleared and excavated the massive rocky slope and subsequently commenced the construction of embankments, walls, drains and pavements.
The material used for fill was apparently not strictly standard - it varied with the location. While No. 3 Iron Gang on Devine's Hill kept the road "made up" with "quarried stone", as cited above, No. 4 Iron Gang on the opposite side of the river transported "upwards of 4,000 loads of earth by hand cart" to the formation there. Each load weighed between 15 cwt and 1 ton. (25) Some physical evidence of fill material is exposed by erosion. In Photos 118 and 166, the fill is predominantly of closely packed broken stone between approximately 5 cm and 25 cm/ 2-10 inches diameter. The height of the top course of the retaining wall in Photo 141 indicates the original level of the road's surface and the amount of formation material which has washed away. Photo 109 at the base of Devine's Hill shows the incorporation of natural jagged rocky outcrops in the formation. At Bridge 5, Sampson's Pass, both the interior abutments have been destroyed and the span recently filled in with earth. However, where the modern fill has eroded, as shown in Photo 246, the closely packed broken stone forming the embankment which would have backed the abutment is visible.

Zig-Zags

The construction of the Great North Road originally included the formation of two zig-zag approaches to the Hawkesbury River at Wisemans Ferry (see Map 6 and Figs. 16, 82 and 92). The first, the descent to Wiseman's on the south side of the river, was commenced under Warner's supervision (1827-28), but the bulk of the work was completed under Simpson between 1828 and 1832. The second, the original ascent of the north bank, was completed during Warner's period of supervision and later superseded by the Devine's Hill ascent and abandoned. The two zig-zag formations physically encapsulate the contrasting approaches of the two men.
The descent to Wisemans, which later in the century inspired several painters and photographers to depict it in their work (Plates 16, 18 and 25), was originally laid out by Dumesque in 1826 while he was Inspector of Roads and Bridges. (26) Finch's original line was entirely different, as discussed (see Fig. 82). Dumesque later described the descent during its construction:

> The abrupt and precipitous termination of the ridge at Wisemans presented to the Inspector of Roads (Dumesque) a very formidable difficulty which is now overcome, a zig-zag road having been quarried out to the bottom of a very easy descent, evidently the result of great skill and perseverance on the part of the engineer. (27)

By about August 1827, therefore, it appears that much of the cutting was well under way or complete. At the same time, however, it was officially reported that:

> The descent from the bold steep hill bordering the river Hawkesbury at Wisemans has required a great deal of labour and much will yet be necessary to perfect it, though there are no obstacles by any means to prevent it being made easily traversable. (28)

The Road Gang Reports invariably described the difficulty of "moving and splitting rocks" and the blasting and quarrying which was "unavoidable in its formation". Some rough although extremely high wall-building near the first turn and on the first stretch was completed by Warner during 1828 (see Photos 53 and 63), but Simpson's arrival in August 1828 resulted in far more substantial and extensive construction (see Photos 85, 47, 89). The present-day descent comprising two turns extending for 960 m, was cut mainly from rock and has large retaining walls supporting the embankments up to approximately 6 m/20 feet high. A small bridge (Bridge 2) and fourteen culverts set either obliquely or perpendicular
to the alignment provided drainage, along with an originally continuous side drain at the base of the cutting. The reach between the turns measures 153 m and the turning circle (see Photo 62) has a radius of 16 m/48 feet (see Appendix 1, Sections 1d and 1e and Photos 37-68).

It is apparent from the discussion of the first and second construction periods that Simpson's extravagant, large-scale and time-consuming style of construction contrasts sharply with Warner's economical, rough methods. When reporting on the construction of the first ascent from the north bank of the Hawkesbury (1828 ascent), Warner described the first section, stating that it "scarcely looks like going up a hill now it is made 4 yards wide" and the following section, which had "looked a very steep side of a hill", as an "excellent road" with the highest wall, he wrote proudly, "not more than four feet". He had, he wrote "kept in by the winding of the hill to avoid all high wall building in future as much as possible". (29) In spite of his efforts, a few high walls were necessary, such as the downhill retaining wall at the first turn (see Photo 263), but generally the narrowness of the road and its steep gradients allowed the construction of low, loosely built rubble walls (see Photos 258-262). The ascent is approximately 1.3 km in length, comprising three sharp corners and four hairpin turns, with the gradient unbroken and steep. The turning circles measure 7.6 m/25 feet, 10 m/30 feet and 8 m/25 feet in radius for the first three turns respectively, while none is now discernable for the fourth. The reaches between the four turns measure 151 m, 112 m and 100 m respectively (see Fig. 92). There are a few extant culverts near the base and at the top of the ridge, but none were located on the zig-zagged section itself, and while an earthen side drain may well have been dug and since been obliterated, no evidence of store side
Browne's recommendations for zig-zags, including adequate drainage to "throw off water" at each turn, and for turning circles of at least 50 feet radius were thus applied in the case of the descent to the Hawkesbury, but are not evident on the far more precipitous ascent on the north side laid out by Finch and constructed by Warner. While the former is still in use, the latter was in 1829 considered unsuitable, no doubt because of its steepness, narrowness and the large number of sharp turns, and was subsequently replaced by the Devine's Hill ascent.

The engineers who designed the Great North Road thus faced a multitude of topographical conditions which were frequently extreme in extent and ruggedness. Some measures, such as the avoidance of any formation whatsoever on flat, rocky, naturally well-drained ridges, were taken for economy. Others, such as the formation of continuous cuttings, drains and surfaces wherever expanses of solid rock shelves coursed on the line illustrate the utilisation of available material in a very simple and convenient fashion, rather than the construction of standard, more expensive formations. While the finer points of the recommended methods, as discussed, were apparently not applied in cutting and filling, the formations from the second and third period in particular were in the end highly successful and remain to a large extent, intact today.
SECTION IV/3/iv

AUSTRALIAN PRACTICE : FORMATION - EXCAVATION AND EMBANKING

Notes

1. Maclehose, p. 69.

2. Bell (Magistrate of Police, Windsor) to Macleay, letter 27/4924, A.O.N.S.W., C.S.I.L.

3. Lockyer to Macleay, 30 November 1829, A.O.N.S.W., C.S.I.L.


5. Sydney Gazette, 28 April 1810.


7. Wilford to Macleay, 4 August 1827, A.O.N.S.W., C.S.I.L.

8. Road Gang Reports.


10. Road Gang Reports, May 1827.

11. Simpson to Mitchell, January 1830, "The Assistant Surveyor of Roads ... Report ... for January 1830", in Road Gang Reports, A.O.N.S.W.

12. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March 1830", in Road Gang Reports, A.O.N.S.W.

13. Finch to Mitchell, 23 June 1830, A.O.N.S.W., S. to S.G.

14. Weekly figures include, for example, No. 8 Iron Gang of 10-12 men "picking a bank" of 70 yards; A Bridge Party of 23 men "cut down" 100 yards of hill; No. 42 Road Party of 24 men completed 35 rod/202 yards; No. 42 Road Party of 14 men completed 30 rod/165 yards; Road Gang Reports; see also J. Nicholson, 8 February 1830, "Instructions for the measurement of the different sorts of work which may occur in Road and Bridge making, with as much accuracy as the circumstances will permit", Surveyor-General, Misc. Papers c1820-1862, (hereafter S.G.M.P.), A.O.N.S.W.

15. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March, 1830", in Road Gang Reports, A.O.N.S.W.

16. Mitchell to Finch, 19 February 1830, A.O.N.S.W., S.G. to S.

17. Road Gang Reports.
18. J. Nicholson, 8 February 1830, "Instructions for the measurements of the different sorts of work which may occur in Road and Bridge making ...", A.O.N.S.W., S.G.M.P.; Dulhunty to Mitchell, 7 June 1833, "Estimate of the Quantities of Tools, Implements and Stores that will be Required for the use of the Department of Roads Wollombi District for the Year 1834", A.O.N.S.W., S. to S.G.

19. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March 1830", in Road Gang Reports, A.O.N.S.W.

20. Ibid.

21. Lockyer to Macleay, 25 June 1828, "Code of Regulations for the guidance and conduct of the Road Department" (draft), A.O.N.S.W., C.S.I.L. Although there is no other evidence of companion methods, it is interesting to note that heavy cylindrical stone road rollers were used for this purpose during the 1830's on the Hobart-Launceston Road (also known as the Great North Road). See G. Hawley Stancombe, *Highway in Van Diemen's Land*, 1974, map section.

22. Road Gang Reports.

23. Finch to Mitchell, 11 September 1830, A.O.N.S.W., S. to S.G.

24. Road Gang Reports, May 1827.

25. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March 1830", in Road Gang Reports, A.O.N.S.W.; J. Nicholson, 8 February 1830, "Instructions for the measurement of the different sorts of work which may occur in Road and Bridge making ...", A.O.N.S.W., S.G.M.P.


27. Ibid.

28. Wilford to Macleay, 4 August 1827, A.O.N.S.W., C.S.I.L.

29. Warner to Dumaresq, 7 May 1828, "Description of the line of road from Wiseman's to Wallis Plains (McDonald's Line) ...", A.O.N.S.W., C.S.I.L.
(v) Blasting and Quarrying

The use of gunpowder was essential in opening the difficult parts of the line to the north and blasting was undertaken from the earliest construction period. Without it, the sheer volume of solid rock at locations such as Wisemans Ferry, Geber Gunha, Sampson's Pass, Mt. Simpson and Mt. Finch in particular would have precluded the construction of a road on this scale. Thus, Assistant Surveyor Hughes, who briefly replaced Warner before Simpson's arrival at Wisemans Ferry, stressed the necessity of blasting operations for the work in progress in July 1828:

Overseer Barker's gang (No. 4 on the descent to Wisemans) is quite at a standstill for want of mauls and gunpowder. The road which they are about was made through solid rock principally and it would therefore require a greater quantity of powder than any other party. I should say that five pounds could be expended daily in the blasting of rocks. (1)

Similarly, the ascent of Devine's Hill required the "blasting and removing (of) some extensive overhanging rocks wherefrom the requisite width of road must be taken". (2) As a result of its scarcity in the colony, the frequent requests for gunpowder were usually apologetic in tone, and accompanied by justifications of its use:

Those at work on the Road have been engaged widening and forming the same leading from bear (sic) to the Flat Rock on the descent to Wisemans where some blasting and quarrying has been unavoidable in its formation. (3)

The abundance of stone thus dislodged no doubt encouraged the construction of the numerous and extensive retaining walls. Stone drains, stone blocks and slabs of suitable dimensions were cut from the loosened mass or quarried from the rock face exposed by the blast. Such stone structures are thus
generally more numerous in the vicinity of rocky outcrops which required blasting. The operation also provided the stone fill for the embankments and stone which was broken to form the pavements.

Gunpowder

Gunpowder was constantly both in great demand and short supply during the construction of the Great North Road. Wilford reported that stocks had not been received in June 1827, not long after Warner's arrival. (4) By 1828 No. 4 Iron Gang was "at a standstill" for want of it, and after Macleay informed Lockyer in March 1829 that there was no gunpowder in the colony to spare for the roads, there were continual reports of the slowness of the work. (5) Most of Simpson's reports concluded that "the work proceeds as well as can be expected in the absence of gunpowder". (6) Eventually he redistributed the work, reporting that "those men usually employed in the task of jumping and blasting have been engaged sinking for foundations". (7) When stores of gunpowder finally arrived in March 1830, Simpson assured the Colonial Secretary of his intention to exercise the utmost frugality and care in its use:

Five barrels of gunpowder were received on the 28th, but owing to the inclement state of the weather none has been issued nor do I intend any powder to be used but in my presence and have issued orders to the overseers to get the holes jumped and upon my weekly visits to inspect the charging and exploding where blasting is absolutely necessary. (8)

A "Return of Gunpowder in Government Magazines", dated March 1830 as shown in Table 7 included both large and fine grained powder, and it was presumably the former which was used for blasting out roads. (9) A collation of the various reports on the distribution and rate of use of gunpowder indicates
that each gang on the Great North Road used between 10 lbs and 30 lbs per month, while in September 1830 No. 3 Iron Gang alone used 75 lbs or over two thirds of a barrel. (10) A return supplied by Simpson in 1830 showed that the five gangs under his superintendence had used five barrels allotted to the area in only two months, in spite of his intentions. (11) A continued use of powder at this rate, which does not appear to have been unlikely, would have resulted in 30 barrels a year being expended on the Great North Road alone, forming a considerable proportion of the total powder in stock in the colony, as shown in Table 7.

<table>
<thead>
<tr>
<th>TABLE 7: RETURN OF GUNPOWDER IN GOVERNMENT MAGAZINES, MARCH 1830</th>
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<tbody>
<tr>
<td>Large Grain</td>
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<td>-------------</td>
</tr>
<tr>
<td>barrels</td>
</tr>
<tr>
<td>90 lb each</td>
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After its delivery to a central road station such as Wisemans Ferry, the powder was stored in a magazine, as shown on the sketch map of Lower Portland Head in c.1830 (see Fig. 42) and subsequently distributed to the gangs at the various locations two or three times a month. Huts were built for storage at the latter points and natural caves common along the road were probably also utilised. As discussed in Appendix 1, Section 3d, the cave on the Devine's Hill ascent ("Hangman's Cave") which features cut steps, a stone bench and pits suggesting some type of enclosing wooden structure, was most likely used for this purpose. Such a storage room was secure and at a safe distance from the stockade in case
of an accident, but conveniently located in the section requiring the heaviest blasting. (12)

The existence of large quantities of gunpowder at construction sites also provided continual problems regarding its security. Lookyer was instructed in 1828 to take "great care ... in its expenditure as it is an article which will otherwise be stolen" and Mitchell was similarly directed in 1830. (13) When Simpson applied for reinforcements to the constabulary at Wisemans Ferry in an effort to combat bushrangers, he cited the urgent need to protect both "travellers and the powder magazine at this station". (14)

Blasting

As blasting techniques were apparently traditional and fairly simple it is likely that those convicts involved in "jumping and blasting" employed basically the same methods as described by nineteenth century writers generally. However, the material evidence of blasting activity indicates slightly different methods. While there are some jumper marks which are half-round or bear the imprint of a faceted tool, the majority are triangular in cross-section, as shown clearly in Photos 161 and 314 (see Fig. 96). Photo 117 shows the triangular imprint made by the end of the tool in the rock at the base of a jumper hole. These jumpers therefore could not have been turned as they were driven into the rock, in contrast to the method described universally in technical manuals. A few examples of jumper holes particularly near the buttresses on Devine's Hill have faint vertical lines running their length, indicating that the jumper was faceted and, again, that it was not turned during drilling. There are numerous examples of these different types of marks along the length of the road, and particularly in the rocky
sections between Wisemans and Mt. Manning. Most measure 1\"/3.8 cm wide at top, decreasing in width towards the bottom.

The jumpers used were thus not particularly large, although not always strictly vertical and rarely found in a parallel series, the marks are usually upright, sloping to left or right at various angles. This signifies that the powder could be poured in and that scrapers, scoops and cartridges for inserting blasting powder were unnecessary. However, scrapers, needles and the various devices for clearing sludge from the hole and drying it would seem to have been indispensable.

Blasting activity was widely dispersed where cuttings of moderate height were required, but highly concentrated in areas where the road was cut from solid rock. In the first case, shot holes of between about 30 cm-60 cm in length occur frequently along the line of road but there are rarely more than 2 or 3 together. Often only a single blasting mark is located on a lengthy cutting. In the second case, however, several hundred blasting marks of various lengths are scattered at random all over the rocky cuttings of the approaches to the Hawkesbury River. Photograph 133 illustrates the considerable amount of blasting required to open the area near the buttressed section of the road on Devine's Hill. Gunpowder was also heavily used on the descent to Wisemans - Photo 66 shows a moderately sized stepped quarry near the base of the hill with numerous jumper holes of various sizes. This early blasting activity is usually easily distinguishable from modern machine drilled shot holes. The latter occur in parallel series, are generally wider (up to 6.3 cm/2.5 inches), more shallow and less weathered than the early work. Examples of modern blasting work are shown in Photos 24 and 42.
The convicts evidently drove the jumpers into the natural rock surface on the uphill side of the road, successively blasting out one layer of rock after another until the required depth was achieved. This was combined with quarrying and chiselling. Photo 130 illustrates this process on a cutting on Devine's Hill. At the top of the cutting are chisel marks (left) and one short jumper mark; in the level below are two additional short jumper marks and, lower, more chiselling. Three long jumper marks completed the cutting to near the level of the drain at its base. A single wedge pit on the left at this level suggests an abandoned attempt at quarrying. Photo 133 shows the same process on a larger scale, with more blasting and quarrying marks. The location of graffiti, cut with a chisel or pick, high up on the cutting also illustrates the face that the men worked a series of layers in blasting out the cutting (Photo 135). Often the jagged projecting points of rock left by the explosion were trimmed and smoothed with chisels, particularly near the road's edge, as shown in Photos 130 and 146.

Although specific written references to tools and techniques are rare, a number of points may be drawn from the road gang reports and other reports. It appears that two men rather than one or three were employed in drilling each hole. The reports invariably list even numbers of convicts for the task of "jumping". (15) It is most likely, therefore, that the jumper was used in conjunction with a hammer or sledge rather than alone, in the "double handed" fashion described by Andre. One man held, but did not turn, the jumper while the other wielded the hammer. As a result of the scarcity and irregular supply of gunpowder, the functions of jumping (boring the hole) and blasting (charging and firing) were often divided, the former being undertaken well in advance,
while the latter was performed when powder was available. Simpson reported in 1830 that "there are a great many holes prepared for blasting and in the month of February a great expenditure of powder will be necessary". (16) The holes were probably covered in some way to prevent them being filled with water or vegetable matter in the intervening period. Third, it appears that clay was the material used for tamping the holes, as recommended by Burgoyne and Andre. When John Onions escaped from a gang on the Great North Road in 1831, he had been "in charge of an overseer, employed in blasting and was sent to seek clay for the purpose of ramming". (17)

Whether the gangs were properly equipped for blasting operations is unclear. The Commissariat records list a requisition for "1 set blasting tools" in 1833, indicating that items such as scrapers, needles and tamping bars comprising the set were used in N.S.W. (18)

Quarrying

Simpson unwittingly summed up the nature of much of the road's construction when he reported that: "Some lofty and massive side walls will be necessary and are constructed on this road from stone quarried by force of maul and wedge". (19) The huge, ambitious structures were executed with only basic tools and primitive methods. The three simple techniques described in Section IV/7/iv, including quarrying by wedge pits, guttering, and plug and feathers, may possibly all have been employed on the road, but the evidence available only supports the first of these. Besides the frequent references in written reports to mauls and wedges, there are numerous examples of abandoned wedge pits or "pool holes" cut into rock faces with chisels or picks. The wedges were driven
into these with maul in order to split the rock. A good material example of the actual process is located at the top of the large cutting near the buttresses, Devines Hill (Photo 160). These pits measuring 19 cm, 13 cm and 18 cm are spaced at 19 cm intervals and are 9 cm, 8 cm and 2.5 cm deep respectively. As shown in the photo, the rock had already partly split near the deepest hole roughly along the line of the pits. Many other unsplit examples are located nearby, comprising 3 and 4 pits (see Photo 159), while near the summit, 1520 m from lower gate, a row of 10 pits in a low cutting indicates an attempt at quarrying a longer block (Photo 179). In these cases there is no evidence of the channel or chase having been cut between the pits as Tomlinson and Greenwell describe — this practice may have been dispensed with as a result of the hardness of the stone or simply because the process was quicker without it. Another interesting example occurs on the 1828 ascent where a large rounded boulder close to the edge of the road has two pits chiselled in this case into the horizontal face rather than the vertical (Photo 266). The removal and/or quarrying of the boulder was probably abandoned when construction ceased on this branch in late 1828. An early example of quarrying activity is located 48 km north of Baulkham Hills — in this case the pits are very weathered (Photo 21) and appear to have been irregularly spaced. Photographs included in Greenwell’s book depict quarrymen employed in driving rows of wedges into the stone with sledge hammers both on severed sections of rock and on a large rock face (see Figs. 149 and 150). These are illustrative of the work as it was done by the convicts on the Great North Road.

The use of the plug and feathers to split stone dislodged by a blast does not appear likely. In the first place there is no reference to the tools necessary for this operation; second,
there is no evidence of the type of holes described by Tomlinson and Greenwell, that is, 5 or 6 inches deep, drilled six inches apart, parallel in a row; and third, the task of jumping holes was a tedious and slow process, and it is unlikely that, particularly in view of the large quantity of rock to be quarried, it was undertaken for any other purpose than necessary blasting.

After the stone was hewn from the quarry it was removed to the construction site and, in the case of the better quality walls, dressed to the required shape and finished there (see Fig. 151). The Road Gang Reports referred to this aspect of the work variously as "carrying stone" "removing stone", "rolling stone" and "clearing quarry". (20) It appears that these blocks or slabs, some of them the size shown in Photo 156, were moved manually, while material such as broken stone for fill and surfacing were transported by handcart. A painting by Charles Rodius entitled "Convicts building the road over the Blue Mountains" shows two convicts pushing a very large stone towards the side of the road (see Plate 7). The quarry depicted in this painting is also very similar to the benchcut and stepped quarries lining the sides of the Great North Road, implying that the methods of the period were similar for all the Great Roads. Photos 52, 66 and 153 illustrate such quarries. Jumper marks are scattered over them where large masses were first loosened and removed, and the exposed faces subsequently cut. (21)

The disposal of stone not used in construction in the constricted areas involved throwing it over the edge of the road into the gully below. On the descent to Wisemans, tons of rubble and blocks are spread all over the steep slopes below the foot of the retaining wall (Photo 69) forming a type of boulder pitching (see Fig. 50).
Work on the road was apparently often slowed or delayed because of lack of tools which wore out quickly in cutting the hard stone. In July 1828 Hughes reported a want of mauls, while in January 1830, Simpson, as a result of the lack of quarrying tools, removed 24 members of No. 3 Iron Gang to No. 8 Iron Gang, "where they could be more advantageously employed". (22) Although each major road station was equipped with a blacksmith to keep such tools in repair, Finot complained in 1830 that there was no iron or steel to do so, and, consequently, the "wedges have become useless" and the picks were worn "down to the helve". (23) The nature of the mauls, which were frequently mentioned, is not clear. Although a maul is generally made of wood, they were also referred to as "iron mauls" suggesting that they more resembled a sledge hammer. The latter would have been more suitable for quarrying operations.

**Progress and Distribution of Work**

Relatively few men in the gangs were involved in jumping and blasting. At the most, four out of a gang of forty to fifty men were employed in this aspect of construction, and usually only two men per gang per month were recorded as either jumping or blasting or both. These operations were often listed with quarrying, although quarrying was frequently undertaken without blasting. The number of men quarrying in each gang varied between four and fourteen - again a relatively small proportion of the gang. An additional two or more men were generally employed in removing stone and rubble from the quarry site. On the difficult sections near Wisemans, No. 4 Iron Gang completed only 26 yards of road in a week, including blasting and quarrying, with a total of 36 of their number employed in the various aspects of these
operations. No. 3 Iron Gang, posted on a less difficult stretch completed the same amount of quarrying and blasting in a week with only twelve men. The quantity of stone removed was also estimated in monthly reports, and varied considerably with the amount of powder available and the number of men employed. No. 4 Iron Gang removed 20 tons of rock by quarrying only in one month, while No. 3 Iron Gang with 75 lbs of gunpowder blasted out 180 tons of rock and quarried 300 tons in the same time. (24)

In sections where massive rocky outcrops required blasting to open a practicable line of road, a small minority of the men in the gangs, in spite of the irregular and short supply of powder, managed to remove these vast quantities of stone. This provided abundant material for embankments, pavements, drains, and encouraged the extensive use of retaining walls. In both blasting and quarrying the stone, the gangs employed the simplest and quickest techniques possible, which nevertheless produced massive, well-formed blocks for the "lofty and massive side walls" supporting the embankments.
SECTION IV/3/iv

AUSTRALIAN PRACTICE : BLASTING AND QUARRYING

Notes

1. Hughes to Lockyer, 7 July 1828, A.O.N.S.W., C.S.I.L.

2. Simpson to Mitchell, January 1830, "The Assistant Surveyor of Roads Report ... for January 1830", in Road Gang Reports, A.O.N.S.W.

3. Ibid.

4. Wilford to Macleay 14 June 1827, A.O.N.S.W., C.S.I.L.

5. Hughes to Lockyer, 7 July 1828, A.O.N.S.W., C.S.I.L.; Simpson to Lockyer, 10 March 1829, A.O.N.S.W., C.S.I.L.; Macleay to Lockyer, 19 March 1829, A.O.N.S.W., C.S. to S.R.B.

6. Road Gang Reports.

7. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March 1830", in Road Gang Reports, A.O.N.S.W.

8. Ibid.


10. Road Gang Reports.

11. Simpson to Mitchell, 18 February 1830, A.O.N.S.W., S. to S.G.

12. A cave at Bull's camp, an 1840's road station site at Woodford in the Blue Mountains, has a hewn path and door frame and was also probably used for the storage of gunpowder. See Photos 334 and 335.


14. Simpson to Macleay, 10 August 1830, A.O.N.S.W., C.S.I.L.

15. Road Gang Reports.


17. Ensign Reynolds to Macleay, 6 May 1831, A.O.N.S.W., C.S.I.L.

18. Record of Stores Issued for Military and Convict Works, Ledger, Convict and Military, Clerk of Works, 1833, A.O.N.S.W., Commissariat records.

19. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March 1830", in Road Gang Reports, A.O.N.S.W.
20. Road Gang Reports.

21. Entirely different quarries are located on the descent to Wisemans at 93 m and 127 m from the summit. In these quarries the faces are vertical rather than stepped, and both have some blasting marks near the top, with the first featuring these in regular, parallel formation (see Photos 52-44). There are horizontal lines, also parallel, running across both examples, indicating the height of the blocks quarried. The totally different method suggested by this evidence indicates that these are later nineteenth century quarries, and the fact that the faces are not as weathered as the original benched quarries reinforces this.

22. Simpson to Mitchell, January 1830, "The Assistant Surveyor of Roads Report ... for January 1830", in Road Gang Reports, A.O.N.S.W.


24. Road Gang Reports.
(vi) Drainage

Although the need for effective drainage systems to remove and divert water from roads had been recognised in the colony since Macquarie's time, the details of construction were left to the engineers, and few written descriptions or instructions concerning their construction were provided. Macquarie had instructed in 1810 that side drains were to be dug on either side of the road, 3 feet wide and two feet deep. (1) In his 1828 "Draft of Instructions to Assistant Surveyors", Lockyer reiterated the importance of such drains, but failed to give directions on their actual construction:

It is also to be observed that one mode of keeping roads in good order is to keep them dry, that is that the water must not lodge on them or against them. The drains cut at the sides already prove the great good of them. (2)

He thus understood MacAdam's maxim that the maintenance of the road in a dry state was crucial to its preservation. In 1830, Nicholson gave specifications for the side drains, or ditches, together with instructions for their measurements:

This work (drainage) is measured in running yards and set against the time of the men who are cutting and throwing it up on the bank side, a regular ditch may be reckoned 2 feet 2 ins at top 1 foot 1 in at bottom and 1 foot 10 in deep which will be very nearly a cubio yard of soil per three yards running of ditch; deeper or wider ditches must be measured in cubio yards. (3)

Lockyer had earlier directed that drains be regularly cleared:

The season having arrived where heavy rains may be expected, you will particularly examine the watercourses on either side of the roads and overseers to remove any obstruction to the free egress of the water from off the main road. (4)
A record of both the damage which occurred and the corrective measures taken was to be noted by the Assistant Surveyors in the Monthly Journals. Frequent reports of the poor condition of many main roads, particularly the Parramatta Road, (4) in subsequent years indicate that such regular maintenance was probably not carried out, and eighteen years later, the superintendent of the Great Western Highway at Blackheath, Captain J.E.N. Bull, commented that:

The portion of road would be better at once placed under some charge while good, and not allowed to go to ruin, as former portions have, by drains filling up and small holes neglected. (5)

Men such as Lockyer and Nicholson thus grasped the principles of road drainage, but for the main part left the details of the actual construction of different types of drains to the discretion of the Assistant Surveyors. The road gang reports provided by the latter are similarly lacking in detail. No distinction was made between side and cross drains - the convicts were simply described as either "making" or "digging" a drain, with measurements given in yards as instructed by Nicholson. Where the more complex types were built, they were described as "flagged in bottom and top", "flagged and top'd" or "walled both sides". For example, No. 25 Road Party in September 1830 completed a drain "...excavated 15 yards long, walled both sides, flagged at top and bottom and covered in 2 feet in the clear". In another case, part of the stone side drain connected to the culvert inlet was apparently included in the dimensions given for the culvert = No. 4 Iron Gang cut a drain "80 feet through solid rock, flagged at top". (7)

The length of side drains (also occasionally referred to as "water tables") completed usually kept pace with the formation of the road generally. No 42 Road Party dug 20 rods
of side drain in a week, the same length of the road completed. An exception to this practice occurred in at least one area, however, when No. 34 Road Party on the Bedlam Point to Dural branch in 1830 appears to have cut drains while clearing but prior to forming the road, since 37 chains of road had been formed, 50 chains drained and 17 chains cleared in a month. (8) The construction of drains involved a relatively small number of men in the workforce. Usually three or four men from a gang of 40 or 50 were employed in forming both side and cross drains, although between five and eleven men in the gangs were digging drains near Cockfighter's Creek in 1833. (9)

Fortunately, this relatively scant documentation is supplemented by a wide and apparently comprehensive range of physical evidence, which illustrates the location, construction and dimensions of various types of drains on the Great North Road.

The Drainage System of the Great North Road

In 1835, towards the end of the road's construction period, Assistant Surveyor Ogilvie informed his superiors that, if a road were to be permanently completed "... it will be necessary to ditch on either side and also to drain by diagonal cuts across the road at the most convenient distance". (10) This was, in fact, a summary of the drainage system employed on the entire line of road. It basically comprised side channels or ditches, and, wherever necessary, culverts which passed water under the road (see Figs. 98 and 99). Some evidence of an unusual centre drain under the surface has also been located, as will be discussed, but this appears to be exceptional. Although limited in type in relation to the range of structures employed in Britain, the
drainage represents an extremely wide range of alternatives in construction, positioning, dimensions and detailing. This range not only reflects adaptation to the various requirements of the terrain and the materials available, but also indicates the large number of builders involved in construction.

Side drains would have originally lined the entire road on both sides in the case of flat land and descents, and on the uphill side where the road was built on a slope. They were excavated from earth or out from rock where it intervened and, in the latter case, frequently combined with cuttings and sheet stone surfaces. Occasionally the stone side drain was curved up to 90 degrees to pass water into culvert inlets at the side of the road (see Photo 58). Culverts were either perpendicular to the road alignment or set obliquely across it at intervals according to the gradient. Where the gradient was steep, they were slanted across the road to aid the flow of water from the side drain; where the surface was flat, they were usually perpendicular to the road, and occasionally took water directly from the slope (see Fig. 99). Culvert 30 on Devine's Hill is set in a curve and has a water race on the uphill side which is both unusually wide (90 cm) and extends approximately 5 metres back from the edge of the road in order to divert the water from the steep slope into the culvert and thence down the gully (see Photos 164 and 165). In other cases, culverts which are perpendicular to the road occasionally have double inlets to direct water from side channels in both directions into the culvert (see Photos 116 and 191). The length of the culvert depended on the gradient and the variable width of the road. In the case of oblique culverts the length varies between approximately 7.7 m/8.5 yards and 13.8 m/15 yards for sections of road 6.3 m/7 yards and 7.5 m/8.1 yards wide respectively. The angles
at which most of these culverts are set in relation to the road alignment vary between 130 and 145 degrees, thus generally conforming with Browne's recommendation of "about 135 degrees". The inverts of the most sophisticated culverts were also often sloped to assist the flow of water, as directed by Telford and Parnell. For example, Culvert 8 on the Devine's Hill ascent is 30"/77 cm wide, the inlet 20" high (52 cm) while the outlet is 29.9"/76 cm high. The level of the base thus drops 10" over 10 yards or about one inch in every three feet, steeper than the slope of 1 in 10 recommended by Telford and Parnell. However, another example, Culvert 33 on Devine's Hill, accords more closely, with a drop of 2" over 7 yards (see Appendix 1, Section 3c).

The frequency of culverts was again dependent on the steepness of the area. Telford recommended one culvert every 220 yards/201 m on flat ground, while for hilly ground, Parnell recommended one every 50-100 yards/45-91 m, and Browne one every 40 yards/36.5 m. Since many of the culverts on the road have been destroyed it is difficult to ascertain accurately their distribution, but, in the case of both the descent to Wisemans and the ascent of Devine's Hill, most appear to have survived and the distances between them are set out below in Table 8. On Devine's Hill, apart from the reach between the sharp curves near the summit, the culverts are nowhere further apart than 74 metres and most are between 18 and 30 metres apart, according to the incline. They are particularly regularly spaced where they occur in the four (originally five) buttresses. At that point, the first two are 21 m/23 yds apart and 21 m from the culvert preceding, while the following three are exactly 24 metres/25 yards apart. They become more widely spaced (74.5-66.5 m apart) as the road reaches the less steeply inclined area close to the summit. The pattern on the descent to Wisemans on the
opposite bank of the river is very similar (see Table 9). Apart from a gap of 161 metres on fairly steep ground, where the retaining wall, and presumably the culverts with it, have been destroyed, the fourteen extant culverts are spaced between 13 m and 104 m apart; several are only 15-17 m apart - this mainly occurs where the retaining wall is very high (up to 7 m/20 feet) and the grades very steep. A small bridge (Bridge 2) also forms part of the drainage system, passing water from a small stream near the summit under the road.

### TABLE 8

**Distribution of Culverts on the Descent to Wisemans Ferry**

<table>
<thead>
<tr>
<th>Culvert No.</th>
<th>Distance from Summit (in metres)</th>
<th>Distance from last Culvert (in metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>77</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>132</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>236</td>
<td>104</td>
</tr>
<tr>
<td>5</td>
<td>311</td>
<td>75</td>
</tr>
<tr>
<td>6</td>
<td>350</td>
<td>39</td>
</tr>
<tr>
<td>7</td>
<td>367</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>401</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>416</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>470</td>
<td>54</td>
</tr>
<tr>
<td>11</td>
<td>485</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>533</td>
<td>48</td>
</tr>
<tr>
<td>13</td>
<td>546</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>559</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>720</td>
<td>161*</td>
</tr>
</tbody>
</table>

* A large section of retaining wall in this section has collapsed, presumably destroying additional culverts.

** See also Appendix 1, Section 1d.
### TABLE 9

**Distribution of Culverts on Devine's Hill Ascent**

<table>
<thead>
<tr>
<th>Culvert No.</th>
<th>Distance from Base of Devine's Hill (in metres)</th>
<th>Distance from last Culvert (in metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>128.6</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>158.8</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>180</td>
<td>21.4</td>
</tr>
<tr>
<td>4</td>
<td>199</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>217</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>235</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>278.8</td>
<td>43.8</td>
</tr>
<tr>
<td>8</td>
<td>315</td>
<td>36.2</td>
</tr>
<tr>
<td>9</td>
<td>356.5</td>
<td>41.5</td>
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<tr>
<td>10</td>
<td>376</td>
<td>19.5</td>
</tr>
<tr>
<td>11</td>
<td>428</td>
<td>52</td>
</tr>
<tr>
<td>12</td>
<td>448</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td>466</td>
<td>21</td>
</tr>
<tr>
<td>14</td>
<td>496</td>
<td>27</td>
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<td>15</td>
<td>559</td>
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<td>16</td>
<td>599</td>
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<td>17</td>
<td>607</td>
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<td>18</td>
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<td>20</td>
<td>671</td>
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<tr>
<td>21</td>
<td>720</td>
<td>49</td>
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<tr>
<td>22</td>
<td>738</td>
<td>18</td>
</tr>
<tr>
<td>23</td>
<td>756</td>
<td>18</td>
</tr>
<tr>
<td>24</td>
<td>774</td>
<td>18</td>
</tr>
<tr>
<td>25 (Buttress 1)</td>
<td>795</td>
<td>19</td>
</tr>
<tr>
<td>26 (Buttress 2)</td>
<td>816</td>
<td>21</td>
</tr>
<tr>
<td>27 (Buttress 3)</td>
<td>840</td>
<td>24</td>
</tr>
<tr>
<td>28 (former Buttress)</td>
<td>864</td>
<td>24</td>
</tr>
<tr>
<td>Buttress 4 now destroyed)</td>
<td>29 (Buttress 5)</td>
<td>888</td>
</tr>
<tr>
<td>30</td>
<td>911</td>
<td>53</td>
</tr>
<tr>
<td>31</td>
<td>959</td>
<td>28</td>
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<td>32</td>
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<td>1108</td>
<td>52</td>
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<td>34</td>
<td>1144</td>
<td>36</td>
</tr>
<tr>
<td>35</td>
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<td>70</td>
</tr>
<tr>
<td>36</td>
<td>1650</td>
<td>43.5</td>
</tr>
<tr>
<td>37</td>
<td>1724.5</td>
<td>74.5</td>
</tr>
<tr>
<td>38</td>
<td>1791</td>
<td>66.5</td>
</tr>
</tbody>
</table>

* See also Appendix 1, Section 3a.
Construction Types

(a) Side Drains

Side drains were by far the most common drainage device provided to keep water off the surfaces and embankments. The original features are in many cases difficult to assess because of erosion, overgrowth and deposits of earth and vegetable matter. A large proportion are no doubt completely obscured for the same reasons — recent clearing and maintenance work on the Devine's Hill section unearthed considerable lengths of side drain previously invisible, as well as allowing a much better examination of culvert inlets. The problems related to surveying the structures are illustrated in Photos 292 (showing the effects of erosion on a stone side drain), 202 (showing dense undergrowth in a particularly wide side drain) and Photos 116, 171 and 236 (showing the drains completely choked with rubbish). In Photo 272 evidence of the side drain has completely disappeared, while in Photos 109, 118 and 166 the effects of the non-functioning drainage system are obvious in the deeply eroded channels cut over the surface.

There are still numerous and extensive examples of side drains, particularly between Wisemans Ferry and Mt. Manning, as listed in Appendix 1, Section 3. These present evidence of a wide variety of constructional approaches. First, the size of rock drains varies considerably — the shallowest are only 50 mm/2 inches deep (see Photo 184), while others reach 60-90 cm/2-3 feet in depth (see Photos 235, 236 and 292). Widths range between 30 cm/1 foot (Photo 131) and 120 cm/4 feet (Photo 202). Generally the shallower, narrower drains occur in sections on sloping ground, accompanied by culverts, as Burgoyne advised, while the deeper, wider examples are
located in sections which descend the hollows directly and are not equipped with culverts, for example, at Ten Mile Hollow, Sampson's Pass and Mt. Manning. Occasionally the junction between the side cutting and solid surface (invariably a right angle) was considered sufficient to direct water away from the road, and no additional drain was cut (see Photos 223 and 230). In other cases, where a solid rock platform was incorporated into the road's surface, a small ridge of between 2.5-5 cm/1-2 inches was cut. Photos 232 and 256 illustrate this method - in the latter example the ridge curves away from the alignment to disperse the water.

Where a distinct shape was given to stone drains, they were either square or rounded, again in various widths and heights according to the location and flow of water (see Fig. 97a and b). A neatly cut square side drain is shown in Photo 184, while Photo 297 illustrates a drain with one side and the base cut from stone while the outer side is overlaid with gravel from the road shoulder. The rounded drains vary in convexity between semi-circular and semi-elliptical, and many bear chisel and pick marks as shown in Photos 46, 128 and 131. Photo 128 shows the typical connection of the drain with the culvert inlet. A more irregular example of a stone drain is shown in Photo 212.

The most sophisticated side drain construction included low walls or edging of 1-2 courses of dressed or partly dressed stone on the alignment side (see Fig. 97c). These prevented material from the formation washing into the drains, as illustrated in Photos 202 and 235. Photo 116 shows the stone edge with one block missing and the attached culvert inlet.
Another example shown in Photo 236 has a curious zig-zagged cutting above the drain, a result of the jagged angled surface of the rock from which it was cut.

(b) Culverts

Culverts of diverse design and widely varying degrees of sophistication are located either alone or clustered in groups between Maroota and Wollombi. The most southerly is located at the base of a rough retaining wall in the abandoned section of road 40.4 km/25.1 m north of Baulkham Hills (see Appendix 1, Section 1a; Photos 14 and 15 and Fig. 90). It was most likely built under Warner’s supervision, and its small dimensions and primitive style contrast with the much larger, better constructed culvert set in the retaining wall 51 km/31.2 m north of Baulkham Hills (see Appendix 1, Section 1b, Photos 28 and 29 and Fig. 91). The zig-zag descent to Wisemans Ferry was supplied with numerous culverts, fourteen of which survive, with those located near the base of the hill most likely dating from the early period (see Appendix 1, Section 1d). On the opposite side of the river, Bridge 3 originally had two culverts set into the abutments on the uphill side opening into the stream. An additional culvert is located in the adjoining retaining wall lower down the slope (see Appendix 1, Section 3b, Photos 106–107 and Fig. 128). The ascent of Devine’s Hill presents the most intact record of the road’s drainage system, with 38 stone box culverts set at various intervals over the 2 km section (see Appendix 1, Section 3c). The original 1828 ascent to the ridge, by contrast, had four culverts and only two stone examples were located (see Appendix 1, Section 3f). A few stone culverts survive between Devine’s Hill and Mt. Manning, no doubt the remainder of a much larger number. Many have been recently replaced by concrete pipes. Between Mitchell’s Loop and Ten
Mile Hollow, the remains of five wooden culverts provide examples of an alternative construction type (see Appendix 1, Section 3h). Recent records suggest that these were common in the whole section until the 1960s, but most have been destroyed by upgrading, bushfires and the road's use by large numbers of four-wheel-drive vehicles. North of Mt. Manning two culverts of different construction occur in the abandoned section at Mt. McQuoid (Bucketty). The first is damaged but very large, while the second is smaller but intact and in excellent condition (see Appendix 1, Section 4b). At Sammay's Leap on the descent of Mt. Simpson, the curved retaining wall with buttressing flume incorporates a square culvert with a cantilever slab spillway at its mouth (see Appendix 1, Section 4d). Near the base of the same descent a fragment of similar retaining wall with the remains of a smaller culvert suggest that the structures were originally far more extensive, perhaps even continuous. In the vicinity of Mt. Finch and Fernance's Crossing, a large culvert with an arched lintel is located in a small curved retaining wall (see Appendix 1, Section 4f). A similarly proportioned culvert, also set in a retaining wall, just north of the Kulnura turnoff, has an arch of shaped voussoir stones (see Appendix 1, Section 4h). Between the two, at the junction with Murray's Run Road, a shallow, wide culvert of stone and wood spans a small swampy creek crossing the road obliquely (see Appendix 1, Section 4i).

While these are probably a small proportion of the total number of culverts originally constructed, they do illustrate the wide variety of styles employed by the convicts who built them. Although the range is complex, two basic types may be discerned for this discussion, while more specific details are shown in Table 10.
The most common surviving type is the stone box culvert in which the inlet and four sides of the lining and outlet comprise stone blocks and/or slabs. The shape varies greatly between shallow and wide, and narrow and tall, while many are square. Generally the earlier and/or more primitive examples are composed entirely of roughly cut rectangular stones (see Photos 14, 15, 261 and 267) and are usually relatively small (30 cm x 30-60 cm or 1 ft x 1-2 ft). The culverts constructed during the second and third periods under Simpson and Finch often comprise evenly shaped slabs of stone (or "flags") of up to one square metre in size for the invert and often for the covers, with large stone blocks forming the walls (see Photos 29, 299-301 and Fig. 102). The later culverts are also generally larger (60 cm x 60 cm to 1 m x 1 m or 2 ft x 2 ft to 3 ft x 3 ft) and of more even construction, with neatly shaped inlets and outlets. As for side drains, bedrock was often carved to form the base and/or side(s) of the lining (see Photos 121, 129, 137 and 146) and the outlets were often located in retaining walls. In the latter case, blocks were sometimes specially shaped to fit around the mouth of the culvert and to keep the surrounding courses even as shown in Photos 115 and 172, while in the case of culvert 34 on Devine's Hill, a wedge-shaped stone was used above the outlet to match the slope of the top of the retaining wall. Since many stone box culverts were constructed obliquely, the stones of the lining just adjacent to the outlet were often also carefully shaped to fit the culvert mouth in relation to the angle of the retaining wall (see Photos 38 and 113). Many of the better constructed culverts have curved soffits at both inlet and outlet, purely for decorative purposes. More elaborate versions of the stone box culvert occur at 12.35 km and 13.95 km north of the Mt. Manning junction. These are rectangular in shape and have arched outlets, the first carved in the lintel for
decorative effect (see Photo 319), the second formed of shaped voussoir stones which support the retaining wall above (see Photos 322-324). Behind the arches, large rectangular stone slabs form the lintels of the culverts in both cases (see Appendix 1, Sections 4f and 4h and Fig. 106).

One of the culverts located comprises stone and timber. It stands at the junction with Murray's Run Road 13.7 cm north of the Mt. Manning junction. This culvert has stone walls of two courses 75 cm high surmounted logs 30 cm high and decked with timber planks 12.5 cm thick (see Appendix 1, Section 4g, Photos 320 and 321 and Fig. 107). The culvert is skewed, spanning shallow, swampy creek which runs obliquely across the road. While the decking is most likely a recent addition, the logs could be original.

The second type of culvert was constructed entirely of timber as described by Dobson. This method was employed where stone was not plentiful, or if the gang lacked the skill or time to complete stone structures. Logs were either roughly squared or left round and the examples which survive illustrate the ways in which they could be arranged. Photo 206 shows the invert of beams laid parallel to the road alignment, surmounted by two logs left round, forming the sides. A bolt was used on one side to secure the log. The deck was formed of squared timber and covered over with fill material (see Fig. 101b). The culvert shown in Photo 207 does not have a timber floor - the round logs forming the sides were simply placed in an earthen-based trench (see Fig. 101a). Photos 195 and 196 illustrate the addition of two logs above the deck, presumably to keep the latter more firmly in place (see Fig. 101c). The culverts were originally completely covered.
in by fill material. These photographs also indicate the
damage caused by bushfires and the extent to which the
original shoulder of the road has been eroded.

In many cases the more elaborate culverts had several
additional features to aid in the speedy removal of water
from the road. Inlets were often provided with carefully
cut, sloped concave side drains (see Photos 121, 128, 175 and
313), drop entries (Photo 173), and in one case, a large slab
to prevent erosion (Photo 301). At the outlets, cantilever
slab spillways are common where the culvert would otherwise
discharge water onto the face of a retaining wall (Photos
126, 134 and 164). Where the outlet is at the base of a wall
or embankment, aprons of stone blocks, slabs or natural stone
formations were provided or utilised (see Photos 129, 132,
164 and 268 and Fig. 100). In the case of the second culvert
in the abandoned section at Mt. McQuoid, large uncut stones
have been placed on the slope at the outlet to dissipate the
water (see Photo 299). The same function is performed by the
natural rock bed beneath the culvert at Ramsay’s Leap. The
four (originally five) buttresses incorporating culverts on
Devine’s Hill were provided with spillways below the outlets
directing water into steeply inclined water races constructed
of stone slabs and blocks (see Photos 145, 158 and Figs.
119–122). Each race was shorter than the last as the slope
came steeper, and much of the third and fifth have been
washed away. At Ramsay’s Leap a cantilever spillway is
combined with an additional spillway in the buttressing flume
(see Photos 310–312 and Figs. 103–105).

Culverts were thus incorporated into large structures such as
retaining walls and buttresses and in one case provide
additional drainage for a bridge. Bridge 3 had two culverts
located near the top of the abutments on the upstream side.
Only part of the northern one survives, although the southern is intact and retains its own paved water race directing additional water from the steep slopes into the stream (see Photos 106 and 107 and Fig. 128). Another culvert is located in the retaining wall adjacent to the south side of the bridge.

In some aspects of culvert construction, therefore, the work of colonial road builders is in accordance with the recommendations of nineteenth-century theorists generally. They were set obliquely where the road climbed; the floors were inclined, as shown in Fig. 96; the descriptions of simple, cheap wooden culverts as given by Dobson and Spalding, and of the large arched culverts as given by Browne are very similar to those built on the Great North Road (cf. Figs. 58 and 101), and versions of the recommendations given for paving at inlets and outlets were also devised. The culverts on the whole are generally larger than those described by the earlier writers such as Telford and Parnell, according more with instructions given by subsequent writers, who were more concerned with future maintenance. One obvious departure from recommended practice was the omission of concave floors for culverts, although some side drains were shaped this way. It can be seen that since most inverts were constructed of stone slabs or timber beams rather than paving stones or bricks referred to by English roadmakers, such a practice would have been impractical. Other methods were adopted to achieve the same ends. Generally the size and shape of the culverts vary more with the demands of location than adhering to standard sizes such as those specified by Telford, Parnell and Browne.
(c) Central Drains

An example of a small channel cut from rock along the centre-line of the road has been located 150 m beyond the abandoned section at Mt. McQuoid, occurring in another section of the original alignment, about 100 m in length, which veers to the west of and below the present road. This drain has been exposed by recent roadworks (see Fig. 108). It is too close to the road shoulder on the west side to be side drain, and after running for approximately 10 m is obscured by the section of embankment still intact, indicating its original position. This example is anomalous and possibly an experimental technique. Such drains may have been filled with gravel and formed a type of underdrainage similar in principle to the mitre drains and trenches, and resembling the drain shown in Dobson's illustration (see Fig. 60).

Conclusion

The colonial engineers selected a simple road drainage system, suitable to the conditions and the workforce available, but then went to considerable lengths to ensure that it was adequate and sometimes even extravagant. The structures and their layout reflect a grasp of the principles of road drainage and its importance in preserving a road, but do not accord with detailed English specifications such as those of Telford, since these would, for the main part, have been unsuitable for colonial conditions. In the context of the road itself, the drains are not of standard proportions or design either. Rather, they vary with the requirements of each particular section - thus a low, wide culvert with a natural floor was provided for a small, swampy creek, while tall, spacious culverts with stone floors conveyed mountain torrents. In very steep locations, several methods not
described by the British roadmakers were devised to prevent the rush of water from cutting the slopes and walls at inlets and outlets.

The contrasting stages of the road's construction as discussed in Section 3 are also illustrated by the variations in design and standard and this is a direct result of the fact that the construction was left completely to the discretion of the Assistant Surveyors. Warner's structures are sparsely located, smaller and more primitive than most of those built under the direction of Simpson and Finch. It appears also that each individual gang to some extent practised certain methods and adhered to certain standards. The gangs who built the massive approaches to the Hawkesbury at Wiseman's undertook the purely decorative carving of curved soffits for many culvert inlets and outlets. These aesthetic considerations were not within the capabilities of less skilled gangs, such as No. 8 Iron Gang, which put up both crude stone culverts and simple timber ones on the stretch between Devine's Hill and Ten Mile Hollow. The work of the many individuals employed on the road is illustrated by the fact that no two structures are exactly alike, and few appear to meet particular standard specifications. Individuals from No. 3 Iron Gang carved representations of arched voussoir stones in the culvert lintels on Devine's Hill (Photos 136 and 139). One of them added a broad arrow to the centre of what was obviously his own work.
### TABLE 10

**Features of Culverts on the Great North Road**

#### 1. Inlets

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Construction Types Located</th>
<th>Fig. Ref.</th>
<th>Photo Refs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>parallel to road alignment</td>
<td>99</td>
<td>16, 172, 313</td>
</tr>
<tr>
<td></td>
<td>perpendicular to road alignment</td>
<td>99</td>
<td>121, 123, 136, 165, 162, 192</td>
</tr>
<tr>
<td></td>
<td>oblique</td>
<td>99</td>
<td>110, 114, 132, 146</td>
</tr>
<tr>
<td>Spillway Type</td>
<td>level entry</td>
<td></td>
<td>110, 114, 121, 123, 128, 146, 155, 175, 191</td>
</tr>
<tr>
<td></td>
<td>drop entry</td>
<td></td>
<td>173, 313</td>
</tr>
<tr>
<td></td>
<td>inclined entry</td>
<td></td>
<td>313</td>
</tr>
<tr>
<td></td>
<td>double entry</td>
<td>99</td>
<td>191</td>
</tr>
<tr>
<td>Materials and Construction - Lintels</td>
<td>rectangular stone block</td>
<td>16, 191, 146, 191</td>
<td></td>
</tr>
<tr>
<td></td>
<td>stone block, curved soffit</td>
<td>110, 114, 121, 128, 136</td>
<td></td>
</tr>
<tr>
<td></td>
<td>stone slab (single)</td>
<td>165, 175</td>
<td></td>
</tr>
<tr>
<td></td>
<td>stone slab (double)</td>
<td>123</td>
<td></td>
</tr>
<tr>
<td></td>
<td>single stone for lintel and sides timber beam</td>
<td>182</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 10 (Cont.)

2. Lining

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Construction Types Located</th>
<th>Fig. Ref.</th>
<th>Photo Refs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Position</strong></td>
<td>perpendicular to road alignment</td>
<td>99</td>
<td>176, 183</td>
</tr>
<tr>
<td></td>
<td>oblique - straight</td>
<td></td>
<td>175</td>
</tr>
<tr>
<td></td>
<td>oblique - curved</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td><strong>Materials and Construction - invert</strong></td>
<td>hewn from solid rock</td>
<td></td>
<td>124, 142, 146, 268</td>
</tr>
<tr>
<td></td>
<td>stone flags/slabs</td>
<td>98</td>
<td>28, 172</td>
</tr>
<tr>
<td></td>
<td>solid rock and slabs</td>
<td></td>
<td>132, 137</td>
</tr>
<tr>
<td></td>
<td>earthern</td>
<td>101</td>
<td>191, 207</td>
</tr>
<tr>
<td></td>
<td>timber beams</td>
<td>101</td>
<td>206</td>
</tr>
<tr>
<td><strong>Materials and Construction - walls</strong></td>
<td>hewn from solid rock</td>
<td></td>
<td>175</td>
</tr>
<tr>
<td></td>
<td>stone blocks</td>
<td></td>
<td>137, 155, 183</td>
</tr>
<tr>
<td></td>
<td>timber beams</td>
<td>101</td>
<td>206, 237, 195</td>
</tr>
<tr>
<td><strong>Materials and Construction - lintels</strong></td>
<td>stone blocks</td>
<td></td>
<td>15, 28, 183, 268</td>
</tr>
<tr>
<td></td>
<td>stone slabs</td>
<td></td>
<td>142</td>
</tr>
<tr>
<td></td>
<td>timber beams</td>
<td></td>
<td>175</td>
</tr>
</tbody>
</table>
TABLE 10 (Cont.)

3. Outlets

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Construction Types Located</th>
<th>Fig. Ref.</th>
<th>Photo Refs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lintel Materials and Construction</td>
<td>stone block, rectangular</td>
<td>14, 190, 143, 267, 268</td>
<td></td>
</tr>
<tr>
<td></td>
<td>stone block, curved soffit</td>
<td></td>
<td>115, 164</td>
</tr>
<tr>
<td></td>
<td>stone block, arched soffit</td>
<td>106</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>stone slab</td>
<td></td>
<td>129</td>
</tr>
<tr>
<td></td>
<td>arched voussoir stones</td>
<td></td>
<td>322-324</td>
</tr>
<tr>
<td></td>
<td>timber beams</td>
<td>101</td>
<td>205, 207, 195, 196</td>
</tr>
</tbody>
</table>

| Spillway Types | cantilever | 100 | 126, 134, 164, 172, 310 |
|               | stone slab | 100 |                         |
|               | stone slab apron (ground level) | 100 |                     |
|               | stone block step | 100 | 113, 132, 320 |
|               | broken stone  | 100 |                         |
|               | natural stone surface | 100 | 129, 268 |
|               | races - stone block and slab | 103-105, 119-122 | 143, 144, 145, 158, 310, 312 |
SECTION IV/3/VI

AUSTRALIAN PRACTICE: DRAINAGE

Notes

1. Sydney Gazette, 28 April 1810.

2. Lockyer to Macleay, 25 June 1828, "Code of Regulations for the guidance and conduct of the Road Department" (Draft), A.O.N.S.W., C.S.I.L.

3. J. Nicholson, 8 February 1830, "Instructions for the measurement of the different sorts of work which may occur in Road and Bridge making . . .", A.O.N.S.W., S.G.M.P.

4. Lockyer, "Circular to the Assistant Surveyors", 1 May 1829, A.O.N.S.W., C.S.I.L.

5. Newell, p. 45; Sydney Gazette, 6 April 1837; Sydney Morning Herald, 23 June 1857.


7. Road Gang Reports.

8. Ibid.

9. Ibid.

10. Ogilvie to Mitchell, 16 August 1835, A.O.N.S.W., S. to S.G.
(vii) Pavements

Contemporary Descriptions

The controversy in England over the merits of the rival theories of Telford and MacAdam apparently did not concern the early nineteenth century road engineers in New South Wales - at least they never bothered to voice opinions they may have held on the use of a solid foundation of packed stone, or the theory that it was the "native soil" which actually supported the road. The interest in constructing strong, durable road pavements had been present since Macquarie ordered that they be "made of lasting materials" in 1810. (1) The vagueness of this directive was characteristic of most subsequent descriptions. Later, writers used MacAdam's name to give the impression of their knowledge or familiarity with the recently devised methods. In 1826 Atkinson drew the distinction between the old earthen roads of the colony and those built according to the newly introduced techniques:

The leading roads from the capital in all directions are now very good; at first they were made in an imperfect manner, being nothing more than new earth thrown up into the form of a road. Of course they possessed very little durability and the traffic upon them in wet weather cut them up entirely; of late large portions of them have been covered with good durable materials on Mr. MacAdam's principle and the leading roads from Sydney to all the most considerable places in the interior are now as good as any in England. (2)

The "old roads" and their attendant problems were thus very similar to the "old crooked horsetracks" in England described by Law later in the century (see Fig. 64). Atkinson's boast was countered by a complaint in the Australian in the same year:
... the ruinous and very dangerous state of the (Parramatta) road in the vicinity of Sydney has risen chiefly from the disregard of Mr. MacAdam's instructions, that the road should be lifted previously to laying the new road. (3)

In this case the writer displays slightly more knowledge of the details of MacAdam's work, but for the main part, while the latter's name was obviously well-known and widely used, it appears that most colonial observers were not really conversant with the distinguishing features of MacAdam's theories and techniques. Thus Peter Cunningham advised in 1827 that for certain types of roads it was necessary to "level and macadamize" (4), and Henry Dangar attributed the introduction of MacAdam's theory to Brisbane:

General Sir Thomas Brisbane also used a considerable force in the improvement of the roads on the MacAdam system which had been before but imperfectly made. (5)

It is likely that the term "macadamize" applied in these cases simply to any surface of broken stone, rather than specifically to a pavement of carefully graded 2" stones at least 10" thick arranged in thin layers over a natural surface (see Fig. 71).

The men more closely connected with the actual building of roads occasionally provided further details of pavement construction. Dumaresq prepared specifications for roads in Van Diemen's Land in 1825 which were actually based on "MacAdam's experience in metalling and mending roads". (6)

In his "Draft Instruction to Assistant Surveyors", Lockyer, as Surveyor of Roads and Bridges, instructed that:

It is necessary that Assistant Surveyors should be particular in the selection of the material for laying on the road. The best in the colony is the whinstone or the ironstone. There is also a hard blue-coloured stone which broken to the size of one inch and a half or two inches diameter and laid
about 6 inches in depth and 21 feet wide with a coat of iron stone gravel over, first passing it with a screen to let the soil pass through, makes an almost imperishable road. (7)

In some ways, this description is a hybrid of MacAdam's and Telford's directives. It is almost identical to those of Telford for the Holyhead Road, except that the expensive foundation of large stones has been omitted. The inclusion of a top layer of fine gravel and the specified thickness of only 6" clearly distinguishes these instructions from those of MacAdam, although the absence of the heavy base accords with them. Nicholson later again ordered that the pavement "should never be less than six inches". (8) Mitchell also referred to iron-stone gravel as "the best material for making roads" and pointed out in his Report that it was "easily found where Iron Bark Forest or scrub is seen or met with". (9) The screening of gravel to remove any water-retain ing material such as earth had also been stressed by both theorists. Lockyer had thus imbibed MacAdam's particular concern with drainage, continual maintenance and even wear and compaction by traffic:

It is also to be observed that one mode of keeping roads in good order is to keep them dry, that is the water must not lodge on or against them. ... where there is a rut or opening in the road an immediate attention to it will save the whole from becoming bad and where the roads are newly made or put in repairs by new stoning, the sides should be logged to prevent oarts and carriages etc. from cutting up the sides of the roads, thereby soon causing the road itself to give before it becomes properly settled and made. (10)

Further evidence of attention to such matters was provided by Assistant Surveyor Ogilvie, reporting in 1835 that:

The men out of irons, 5 in numbers, are employed with rakes to fill up any ruts that might from time to time be formed by carriages and also in placing logs across the road to prevent too frequent traffic upon the smoothest part. (11)
As discussed in Section IV/1, the latter method was not actually mentioned in English textbooks until Tomlinson's *Cyclopaedia* appeared some decades later. Ogilvie's approach to the shape of the pavement appears to have been more out-of-date. In a long report on the proposed work for the Hunter Valley Road he recommended that:

> From this station (Cockfighters Creek/Warkworth) to the old station of No. 13 Road Party there are two miles ... that must be trunked or rounded up with stone ... between Black Creek and Anvil Creek the road requires raising considerably in the centre ... and ... must be thickly coated with broken stone. (12)

Unfortunately there is no other documentary evidence to indicate that other Assistant Surveyors adhered to the generally condemned practice of making the pavement of a pronounced convex shape - the subject does not appear to have been considered in reports and instructions. There is no physical evidence illustrating Ogilvie's technique of "rounding up" with stone, and the examples which are available cannot provide information on the finer distinction between the slight curve provided by Telford's foundation and the two inclined planes joined by a crown at the apex recommended by MacAdam.

Ogilvie's copious reports also include references to some experimentation with regard to metalling the road. He left it unmetsalled altogether in some sections "... that I might be enabled to ascertain how the road at different places would wear without being metalled". (13) In other areas, particularly along the lines of rocky ridges, it is likely that convicts simply raked some available gravel and broken stone onto the natural surface after the line had been cleared. Wilford described the section to twelve miles north
of Castle Hill as being hard, with an "abundance of iron stone to keep it in good order". (14)

For swampy or subsiding ground, plank or log roads such as those devised by Metcalfe and described later by Gillespie were also employed. In 1829 Lockyer recommended one for the road near Newcastle:

... the last three miles in approaching Newcastle which is owing entirely to the bad material, a very heavy sand, to remedy which I propose on a supply of bullocks obtained to log it across and place clay and gravel on it (see Plate 12). (15)

A similar surface was built on the approach to the Long Bridge at Maitland. Dulhunty reported in 1832 that he had:

... commenced in laying down a logged platform over the remaining part of the flat, to be connected with the pier (of the bridge), the whole of the flat being impassable after much rain. (16)

Ogilvie included a layer of metal in his recommendations for a corduroy road through Winder’s property on the Hunter Valley Road. Logs were to be placed "across the road and then a thick coat of stones (well-broken) to be placed over the logs". (17)

The road gang reports indicate that a large proportion of men in each gang were involved in forming the pavement, and the tasks connected with it were described variously as "breaking stone", "picking gravel", "shovelling gravel" and "raking the road" (see Plates 5 and 7). In March 1828, 14 to 18 men from No. 3 Iron Gang were employed in "picking gravel" only, while in January 1829, 4 to 5 men in No. 4 Iron Gang were "picking gravel" while another 4 to 5 men shovelled it into handcart or bullock carts for removal to the road. The quantity was given in cartloads of 15 cwt to 1 ton each. No. 4 Iron Gang
broke and shovelled 55 loads of stone in one week, and during April 1829 had stoned 40 yards of road in a week. Numerous references were made in 1830 to "cartloads of gravel" being "spread on the road" or "removed on the road" and also onto bridges, and the quantity varied greatly between 64 and 940 cartloads per week. Some men were also assigned the maintenance of the road, in one instance filling "1000 rod of holes" in a week in February 1830. As discussed in Section IV/3/iv, invalids were employed breaking stone which was stockpiled at the side of the road for future use. (13)

It is clear from the written records that broken stone was commonly used for constructing the pavements of the Great North Road and other colonial roads in the 1820's and 1830's. Engineers for the main part constructed pavements which were modified versions of those of Telford and MacAdam. They were sensitive to the problems of uneven wear and the formation of ruts, and to the necessity for proper screening, compaction and drainage. More detailed information concerning the pavements themselves is provided by their material remains.

Physical Evidence

There are a few small sections of pavement scattered at various locations on the Great North Road which, by their strong resemblance to descriptions and instructions from the construction period, appear to be original. These remnants occur exclusively in sections which have been long abandoned and are thus more likely to have been safe from both extensive wear and from maintenance. The problems connected with examining and assessing such physical evidence are obvious. This aspect of the road's construction is the most transient, having been subject to more wear, damage and alteration than any other. The apparent lack of maintenance
in some sections, while in one sense preserving the pavements, has also resulted in rapid disintegration both through vegetation growth and erosion, and a century and a half of traffic of varying heaviness has worn away much of the pavement. Further, since ongoing renewal through maintenance is a necessary part of road surfacing, the occasional 20th century gradings and addition of more material by local councils has also substantially altered the original pavements. Much of the recently graded earth surfaces on the section between Mt. Manning and Wollombi and beyond shows little evidence of the original pavement, while several other sections have been severely eroded. Keeping in mind the methodological difficulties, the details of the early pavements will be examined and provisional conclusions drawn.

Most of the unsealed road in the abandoned section between Devine's Hill and the Mt. Manning junction resembles the deeply eroded, rocky and sandy surfaces shown in Photos 109 (base of Devine's Hill) and 243 (Sampson's Pass). No evidence of the original pavement occurs on the present road between Baulkham Hills and Wisemans Ferry, since the line is sealed, and from Mt. Manning to Wollombi and thence to the Hunter Valley it alternates between a fairly recently graded earthen surface and a modern sealed surface. The 1828 ascent of the north bank of the Hawkesbury is mainly obliterated by thick vegetation (see Photo 258).

(a) Broken Stone Pavements

The method of pavement construction commonly described in early documents involved, basically, the placing of at least 6" of stone broken to about 1"-2" gauge. There are four areas where fragments of such pavements occur, each varying slightly from the written instructions. A fifth example, the causeway
at the base of Mt. Simpson, illustrates a contrasting style of broken stone construction.

The most southerly example of a possibly original section of pavement occurs in the abandoned section 41.3 km north of Baulkham Hills. The road here was realigned in 1943 and the abandoned section runs to the west of the present road (see Fig. 90). At 332 m from the southern junction, a pavement of fairly evenly graded compacted broken stone of 2-2.5"/50-65 mm diameter extends for 9 metres and is up to 7 metres wide. As shown in Photo 12, part of this pavement on the west side of the road has been washed away, revealing its thickness of approximately 6 inches/15 cm. Photo 19 shows the pavement made up to the level of the top of the rough retaining wall, indicating that it has not been eroded and is probably at its original level. Another small example of the same pavement occurs in the same section 452 m from the southern junction. The gauge of the stone is, like the first example, approximately 2-2.5 inches/50-65 mm, but it is only partly visible through deposits of sandy earth.

The two kilometre section scaling Devine's Hill north of Wisemans Ferry is much more severely eroded and illustrates several features of both formation and pavements. Photos 118 and 119, at around 300 m from the base of the hill, show a section where the passage of water across the road has cut a channel through the formation. In Photo 118, the fill of large broken stones is exposed, and above this, remnants of an upper layer of compacted broken stone of about 3-1/4"/75-100 mm gauge form a central strip. Photo 119 shows this layer (on the right) and indicates the fairly even grading of the stones. Almost continuously along the outer edge of the road near the top course of the retaining wall is a layer of fine ironstone gravel about 1 cm gauge and finer. The two layers
are illustrated in Photos 124 and 125, the latter showing the 
gravel in more detail. There are several other examples of 
similar pavements in this section in various stages of 
disintegration (see Fig. 109). Closer to the buttressed 
section the gauge becomes finer - averaging more about 
2-2.5"/50-65 mm. The stones are generally angular in shape. 
In Photo 170, at 1114 m from the base of the hill, the 
pavement of 2.5-4"/65-100 mm gauge stones is similar but less 
compact, and in Photo 131, near a square cut side drain 
537-540 m from the base of the hill, it is still looser. It 
thus appears that Lookyer's instructions, including a 6" 
layer of broken stone topped by fine gravel, were followed in 
these areas, the only variation being the larger gauged 
stones on Devine's Hill. Another abandoned section at 
Mt. McQuoid also illustrates variations of Lookyer's 
instructions. Two sections of broken stone pavement are 
intact; the first, 51 m from the southern junction is 6-7 m 
wide and comprises compacted stones up to 100 mm/4 inches in 
diameter. An earthen table drain on the east side reveals 
the thickness to be approximately 150 mm/6 inches (see Photo 
296). A similar section, approximately 8 m long and 7 m wide 
occurs at 312-328 m from the southern junction (see Photos 
302-304). Again the gauge ranges between 10-100 mm/0.5 inch 
and 4 inches and the stone is compacted to form a solid 
surface. (19)

An entirely different broken stone pavement is located near 
the base of Mt. Simpson, 9.3 km north of Mt. Manning. The 
original road veers to the east of the present alignment in a 
low swampy area where a gully creek joins the main creek. 
The road is built up above the surrounding flat to 
approximately 60 cm in height and the formation is 
approximately 8 metres wide. The pavement is constructed of 
hand-knapped sandstone of angular shapes, packed, rather than
shovelled, closely together to form a hard, even, solid causeway (see Photo 316 and Fig. 110). Towards the southern end, where the surface is not so subject to the flow of water, the stones are clearly defined, as shown in Photo 317, some up to 40 cm across, but most about 15-20 cm across, with the interstices packed with smaller chips. Further towards the creek the individual stones are more broken up, but their original shapes and sizes can be discerned by their colour (see Photo 318). While gangs were reported as "building a road over the swamp" in these areas and it may have been the ready availability of so much labour which allowed such elaborate and time consuming pavement construction, this item cannot be verified as original work. It differs radically from all other pavement work, although its swampy location is also unusual. The design does not resemble any described by the nineteenth century writers, although Forbes' article includes a diagram of an eighteenth century French road which is similar (see Fig. 65). (20) In any case, irrespective of its origin, the causeway is an interesting and unusual example of pavement construction.

The wharf at Bedlam Point, Gladesville, which was probably built on the new branch of the road in 1832 has been deeply eroded and provides a complete cross section of the material used to fill it. As shown in Photo 96 and Fig. 112, the lowest layer comprises large stones up to 12"-17"/30-40 cm diameter thrown at random to form a base. The dressed stones visible have been dislodged from the walls of the wharf. The next layer is of smaller broken stone, between 2" and 5"/4 and 10 cm gauge. Both the lower layer and the one above have a thin covering of sandy silt. The bank intact at the back of the wharf (see Photos 94 and 96) comprises a layer of compacted smaller stones, 1"-3"/25-75 mm gauge, which is covered by asphalt, then a mixture of clay, large stones and
bricks, and finally by a covering of grass. Since asphalting was not introduced in the Ryde Municipality until 1887, (21) the layer of smallest stones must have formed the wearing surface at or until that time. This formation is thus reminiscent of the method of laying successively smaller stones in strata as described by Telford and the eighteenth century French road builders before him. The base course is, however, not hand packed, and the stones used in the next two layers are larger than those recommended by Telford.

(b) Sheet Stone Pavements

Where rock platforms or shelves were encountered on the line of road, they were usually incorporated into the roadway by simply smoothing any projection with picks or chisels, cutting the requisite width and filling any gaps with broken stone to level it (see Fig. 111). Side drains, as discussed in Section IV/3/vi, were also often cut from the rock at the same time. Examples of such sheet stone pavements are numerous and often extensive, and it appears likely that, given the vast masses of rock occurring in some locations, the road was frequently aligned and levels arranged to take advantage of the virtually imperishable surface they provided. Photo 184 shows the cutting, square cut drain and pavement hewn from a single outcrop near the summit of Devine's Hill. The same excavation technique was used on the more extensive platform at Mt. McQuoid where both cutting and side drain curve gently on the ascent and the adjoining rock shelf extends the full width of the road. The shallow parallel channels visible on the surface in Photo 298 were most likely gouged out by the tynes of road making machinery (similar marks are found at the side of the road in the vicinity of Sampson's Pass, see Photo 229). Both the Mt. McQuoid and Sampson's Pass areas were probably selected
because they provided such convenient platforms to accommodate the road. Mitchell actually mentioned the latter shelf in his report. Photo 230 is an example of the omission of a channel as a side drain, and also one case where a rock platform, which adjoins the road, was not incorporated as a pavement. Instead, the alignment was neatly picked out and the small portion of rock extending on to the roadway cut down. A much deeper cutting was made 20.6 km north of Wisemans Ferry (Photo 223) and the attached pavement picked flat, again omitting a side drain. Other good examples of sheet stone pavements are located in the Circuit Flat area, 37-39 km north of Wisemans Ferry. Photo 243 shows the shallow cutting curved away from the road to direct water—again the stone forms the main part of the road's width, while in Photo 250, 37.8 km north of Wisemans Ferry, the platform is more intermittent. Gaps were probably filled with compacted broken stone as described above, and it is possible that the broken stones of various sizes, such as those visible in the foreground of Photos 249 and 250 are remnants of the pavement which originally levelled the present earth/sand surface with the rock platforms. The section shown in Photo 256 on the approach to Bridge 6 bears no trace of the stone pavement which would have been necessary to make up the sandy road beyond the sheet rock to the necessary height.

Although the controversy over the methods of Telford and MacAdam was certainly clear cut in England, in N.S.W. it was obscured by such pragmatic concerns as vast distances, the perceived urgency of road building and the lack of engineers familiar with such details. MacAdam's name was vaguely attached to any pavement of broken stone by several observers
eager to equate the colonial roads to those of England in quality. Lockyer, while prescribing a variation of Telford's specification, omitting the expensive, impractical base, also reiterated MacAdam's concerns with the screening of the metal, good drainage, even compaction and wear, and ongoing maintenance. The physical evidence suggests a range of four alternative construction types and, together with the documentary material, indicates that much of the Great North Road was made 7 yards wide and metalled over the whole width, rather than incorporating earthen shoulders. What also emerges from both sources is that several of the most important strands from the new theories were drawn out, transferred and applied in N.S.W., resulting in a range of hybrid constructions featuring characteristics of both Telford's and MacAdam's approaches, interspersed with the totally practical use of natural rock platforms. The variation present is also, again, indicative of the individual training and approach of the Assistant Surveyors and reflects the complete discretion given to them, posted at their isolated road stations, for the construction of the road.
SECTION IV/3/vii

AUSTRALIAN PRACTICE: PAVEMENTS

Notes

1. Sydney Gazette, 28 April 1810.
3. Australian, 20 May 1826.
4. Peter Cunningham, Two Years in N.S.W., p. 222.
7. Lookyer to Macleay, 25 June 1828, "Code of Regulations for the guidance and conduct of the Roads Department" (Draft), A.O.N.S.W., C.S.I.L.
8. J. Nicholson, 8 February 1830, "Instructions for the measurement of the different sorts of work which may occur in Road and Bridge making ...", A.O.N.S.W., S.G.M.P.
9. Mitchell to Macleay, 8 October 1829, "Report on the Road between Young Wiseman's ... and the Twelve Mile Hollow", A.O.N.S.W., C.S.I.L.
11. Ogilvie to Mitchell, 26 July 1835, A.O.N.S.W., S. to S.G.
12. Ogilvie to Mitchell, 24 July 1835, A.O.N.S.W., S. to S.G.
13. Ogilvie to Mitchell, 24 July 1836, A.O.N.S.W., S. to S.G.
14. Wilford to Macleay, 4 August 1827, A.O.N.S.W., C.S.I.L.
15. Lookyer to Macleay, 30 November 1829, A.J.M.S.W., C.S.I.L.
16. Dulhunty to Mitchell, 9 May 1832, A.O.N.S.W., S. to S.G.
17. Ogilvie to Mitchell, 24 July 1836, A.O.N.S.W., S. to S.G.
18. Road Gang Reports.
(wii) Retaining Walls

As the most visible aspect of the road's construction, the retaining walls have commanded most attention from both nineteenth and twentieth century observers, and it is the sections which feature the heaviest construction, such as the approaches to the Hawkesbury River, which elicit most admiration. One anonymous artist of the early 1830s took special care to include the zig-zag road and its supporting stonework in much detail in his primitive painting "Last View of Mr. Wisemans Villa" (see Plates 16 and 18). Later in the nineteenth century Conrad Martens sketched the romantic scenery around Wisemans Ferry again and again, often integrating views of the road winding majestically down into the distant mists or plunging down a steep ravine (see Plate 25). As in his paintings of the Viaduct and the Zig-Zag Railway at Lithgow, it was the "engineering feat in its wild, natural setting that caught Martens' imagination". (1) In the 1880's other travelling artists such as James I. Willis sketched the retaining walls, again in the midst of highly romanticised landscapes (see Plates 23 and 24). The Willis' depiction of the buttressed walls on Devine's Hill is totally inaccurate is not important - the simple fact that he was inspired to sketch them testifies to the impressiveness of the massive work.

In 1927 Robinson's N.S.W. Motorists Road Guide informed its readers that, north of the Hawkesbury River, the road "... goes around a series of steep turns, from which the stonework of the old convict gangs may be noted". (2) Today it is the size and weight of the stone blocks and the extent of the walls which likewise interests observers, accompanied by visions of hundreds of unskilled, unwilling convicts swarming over the walls with their legs chained, working under
constant fear of the lash or the noose. The Road Gang Reports reveal, however, that this skilled work was actually undertaken by a very small proportion of the convicts - most laboured on the much more mundane aspects of road building such as clearing, formation and breaking stone. The documentary evidence generally indicates that responsibility for design and construction of the retaining walls was left largely to the Assistant Surveyors, and possibly to the Overseers. The progress reports they provided contain, for the main part, only passing reference to the walls, with occasional mention of dimensions. Much more emphasis was laid on the division of labour and the amount of work completed. While the actual construction techniques are far better recorded by the physical evidence, the road gang reports do provide an insight into the way in which the labour force was organised and applied to the tasks related to wall building.

(a) Labour

Given the scarcity of skilled men in the colony it is unlikely that any of the men in the Road Parties or Iron Gangs already had such useful skills as stonemasonry. (3) Further, Lockyer in 1828 ordered that any available "rough carpenters, quarrymen and stone masons" were to be recruited for the Bridge Parties, which performed more specialised work. (4) Nevertheless, gangs in several areas managed to erect walls of a high standard, immense proportions and great durability. In each of the Iron Gangs (Nos. 3, 4 and 8) at Wisemans Ferry, between two and six men out of 40 to 50 were listed as "building walls" and in No. 7 Iron Gang on the Wollemi, the number was no more than four. More men were involved in the related operations of quarrying and removing the stone, as discussed in Section IV/3/v. (5) It thus appears that a few
men at least must have acquired skills in stone masonry during their assignment to the road gang, possibly from an overseer or Assistant Surveyor and also through experience. These men were then allotted all the wall-building necessary for the road. They were probably prized by ambitious superintendents such as Simpson and Pinch, who no doubt attempted to dissuade such men from absconding by favourable treatment and extra incentives.

Work proceeded at a variable rate. Warner frequently gave actual dimensions of complete works, reporting in 1827 that No. 25 Road Party had "raised a wall 22 yards long, 3 feet high by three feet wide" in a week, while in the following year, No. 3 Iron Gang erected a wall "74 yards long, 4 feet high and 9 feet wide" in a week. Work was slower under Simpson's supervision as a result of the improved quality of the work - two men in No. 4 Iron Gang completed 25 yards of wall only 2 feet high during a week in January 1829. (5) Simpson frequently included vague references to walls in his accounts of the formation of the road, such as "... filling in an extensive hollow near the 7 mile post and building side walls thereon", although more detail was given in his account of No. 9 Iron Gang at Mt. Baxter which during March 1830 completed "300 feet of wall six feet high" and "100 yards of road made 10 feet wide". The references to the thickness of the walls ranges between 1 foot and 3 feet, with the latter being most common. (6) The walls thus concurred with or exceeded the minimum thickness recommended by Telford and Browne.

**Physical Evidence**

Although decay and damage have altered almost all the retaining walls to some extent, in some cases obliterating
them entirely, the considerable amount of stonework which survives does provide an apparently comprehensive range of the methods and styles employed on the Great North Road. Often the original nature of sections which have collapsed can be conjectured by the standard of stone, by reference to adjoining intact sections or by other work known to have been completed by the same gang. The poorly constructed walls have not survived as well as more sophisticated structures and are therefore likely to have disappeared without a trace at some points. This means that the proportion of better quality masonry is probably much higher now than it was originally. Rubblework masonry is, however, still much more plentiful on the road, and it is, in any case, the qualitative rather than the quantitative differences which are useful to examine here.

**General Features and Techniques**

The construction of the road over a ten-year period by numerous gangs under different supervisors resulted in an extremely diverse range of retaining walls, varying broadly in every possible aspect, as will be discussed in detail. The dimensions vary according to the functions, from between less than 30 cm to over 9.5 m in height and between 30 cm and 1 m in thickness. In some cases a single course of stone was required to enclose a slight embankment elevating and levelling uneven ground, while in other cases over twenty heavy courses were necessary to support massive formations on precipitous slopes.

The common factor is that all the walls are dry laid. Even walls comprising the smallest and most ill-shaped blocks were not mortared, contrary to Law's suggestion. The time consuming, much more expensive use of mortar would have
complicated the works greatly and delayed progress even further because of the period necessary for the mortar to set. While the depth to which the foundations of walls were sunk below the natural surface is not known, the men invariably utilised rocky outcrops as foundations (for example, at Devine's Hill, the descent to Wisemans, Mitchells Loop and Sampson's Pass) wherever they occurred, usually constructing the wall neatly on and around them.

As Law and Dobson later pointed out, the need for mortar was usually obviated by the battering of the face of the wall, forming the triangular shape prescribed by Dobson (see Fig. 78). Three basic techniques were used to achieve the batter - the first was to incline the beds slightly so that the faces were also sloped (see Fig. 118a). Often the beds were made gradually horizontal towards the top of the wall so that the coping course was level; the second was to increase the thickness of the wall towards the base and to cut each of the outer stones with a sloped face, clearly illustrated by the buttresses on Devine's Hill (see Fig. 118b); the third method, used in the context of more primitive walls, was simply to recess the superior over the inferior courses about 5 cm, so creating a stepped profile (see Fig. 118c). In some cases two of these techniques were combined to achieve the batter, while in the case of most primitive walls, no attempt was made to slope the rough and uneven face at all.

Most of the more carefully prepared blocks have random-tooled faces and bear evidence of the use of pointed, blunt, broad or flat edged chisels or gads, while for cruder walls, stones were knocked into shape with a hammer or stone axe.

Although cross-sections revealing the fill used to back the retaining walls occur infrequently, it appears that either
broken stone, or a mixture of earth and stones was employed at different points. At Devine's Hill the walls were apparently principally backed with broken stone and boulders, of which Browne would have approved. Fill comprising mainly earth is in direct contact with the back of the retaining wall connected with Bridge 5 at Sampson's Pass (see Photo 246).

The coping courses were usually of the same design as the rest of the wall, although sometimes slightly thinner - the retaining wall attached to the former bridge at Mt. McGuoid (Bridge 7) has a coping course 150 mm thick while the course below is 200 mm and all courses below that 225 mm (see Photo 307). At 761 m from the base of Devine's Hill, the blocks forming the coping are perpendicular to the wall and are irregular in length (see Photo 141). It is likely that ironstone gravel originally covered these irregularities. Occasionally the coping course was carefully tapered in height to maintain horizontal coursing while also matching the slope of the road surface. The retaining wall at Ramsay's Leap (Photo 309) and on the descent to Wisemans Ferry illustrate this practice (Photo 51) (see Fig. 117).

The descent to Wisemans Ferry is particularly interesting, as it features two distinct types of stonemasonry, reflecting the work supervised by men of diverse approaches and skills. At the base of the hill, where the gangs began in 1827, the work is roughly executed, with loose joints on both beds and perpends (see Photos 61, 63 and 64). Much of this section of wall has collapsed. At around 311 m from the summit, the style changes dramatically and closely resembles the much better work near Little Maroota Forest (51 km north of Baulkham Hills) and at Devine's Hill, the work completed under Percy Simpson after 1828. The coursing, while not consistently horizontal, is at least regular and continuous,
with the joints much tighter and the face relatively smooth (see Photos 39, 45, 47, 49 and 51). A curious feature of the earlier, lower section occurs at about 700 m from the summit, where the location of the wall abruptly changes to 1.5 m further into the roadway, the intervening span simply filled with rubble and earth (see Photo 61). The lower wall continues to the first hairpin bend and this, together with the lack of evidence of a continuous "outer wall" such as foundations or dislodged stones, suggests that the break is an original feature. This is reinforced by a second example, occurring in the next reach 766 m from the summit. Again the walls are separated by a 1.5 m gap, both continuing uphill and downhill respectively. It is possible that these anomalies were caused by the assignment of different gangs, or different men, to either end of the reaches to work towards each other. A lack of careful measurement and calculation may have caused the gap when the work of the two groups met.

On the opposite side of the river it is, ironically, a massive slip in the retaining wall which provides important and otherwise inaccessible information about the construction of walls on the steepest sites. The damaged section occurs between the third and fifth buttresses, 840-888 m from the base of Devine's Hill. The wall was torn close to the north side of the third buttress and the whole of the retaining wall, including the fourth buttress and part of the south side of the fifth was dislodged, slipping, to some extent in one piece, down the slope. The fourth buttress lies, partly intact, on the slope below, along with mounds of enormous dressed blocks (see Photo 152 and Figs. 119 and 120). As shown, the removal of the outer retaining wall and much of the fill behind it has exposed another retaining wall of lesser quality, though still quite solid, which was
originally located about 3 m behind the outer wall. This wall, shown in Photos 150 and 151, has also collapsed at the original location of the fourth buttress, but continues intact towards the fifth, where it is reconnected with the outer wall (see Fig. 119) by another wall set at right angles between the two. It is probably similarly connected with the outer wall at Buttress 3, and would have accommodated the culvert incorporated into Buttress 4 (151 m from base of Devine's Hill). Since the outer walls and the fill remain relatively intact near the first and second buttresses, it is possible that the inner wall continues further downhill, reinforcing the entire section. Further north, at 1114 m in from the base of the hill, in another steep section, the coping course of another inner wall is exposed for 22.5 m surrounded by the rocky fill, close to the centre of the road, about 3 m from the outer wall (see Photo 170). Again the extent of this wall is not known, since more coping could be covered, as was originally intended, by the formation materials.

The five buttresses themselves comprise some of the most massive work undertaken on the whole road (see Photos 143-149, 156-158). Each was equipped with a large culvert, with the outlet in the centre of the front face. A 27-30 cm deep race below the mouth conveyed water down to the face onto an apron and thence into a substantial stone block and slab spillway. At the end of this, stones and slabs were positioned at random to disperse the water into the valley below. Each buttress is successively taller as the road ascends (the first is 3.97 m, the fifth 9.5 m tall) and the final spillway grows progressively shorter, apparently both by intention and by subsequent damage, while the quality of workmanship also decreases slightly (see Figs. 119 and 120). The top of the buttresses are paved with stone slabs - these
are almost all missing from the fifth, while some are also missing from the third. The buttresses are battered at the same rate as the retaining wall they reinforce, with each block on the front faces having a sloped face to achieve this, while the course beds remain horizontal. They form an interesting contrast with the buttressed work at Mt. Victoria, completed in the same period. The two buttresses there have inclined beds to achieve the batter and also increase significantly in depth towards the base (see Photos 332 and 333).

Some of the blocks comprising the buttresses and walls are of such massive proportions and positioned in such precipitous locations, that it is difficult to see how this could have been accomplished without some system of primitive craneage using hoists, levers and/or pulleys. A requisition for "6 treble blocks" in 1830 (blocks with three sheaves) suggest that this was indeed the case, although the details of such methods are not documented at all. (8)

(b) Typology of Retaining Walls

As discussed in Section IV/2/vii, British writers sometimes provided typologies to describe the different classes of stonework. Dobson set out the basic categories - ashlar, block in course, and rubble-work - which was similar to Tomlinson's definitions of ashlar work, coursed work and rubble work (see Fig. 76). Such a system is very useful in organising and assessing the numerous and extensive walls of diverse styles found on the Great North Road. A typology has accordingly been devised based on the schemes given by Dobson and Tomlinson, with the addition of further divisions of each type in order to classify the walls more accurately. One departure from the British typology is the inclusion of some
relatively high-quality work, which would be described as "coursed" by Dobson and Tomlinson, within the Type 3 category, which otherwise corresponds with the "ashlar" class. In the following typology, the three types are each split into two categories according to the standards of dressing, jointing and coursing of the work.

Type 1a: Rubble work of the most primitive quality. The stones are not dressed but merely picked or broken, sometimes sorted into similar sizes and stacked. There is thus no attempt at coursing or jointing the stone.

Type 1b: Rubble work in which the stones are roughly shaped (the "sharp corners knocked off", as Dobson writes) and are again stacked with no attempt at coursing or jointing.

Type 2a: The stones have been roughly squared with an axe or hammer, and there are vague attempts at coursing and jointing in the masonry.

Type 2b: The stones are again roughly squared, but there is definite, though often irregular, coursing, and rough jointing.

Type 3a: The stones are much more regularly dressed, with fairly smooth, often random tooled faces, but not always strictly of the same dimensions. Coursing is fairly regular although frequently not consistently horizontal, while jointing is evident although still slightly open.

Type 3b: The stones are mainly dressed to given dimensions. Coursing is regular and consistently horizontal and the jointing is tight.

Detailed Discussion

Type 1a

Examples of the most primitive attempts at wall building are rare partly as a result of poor construction, but also probably because such low quality work was not considered suitable for the road, even by Warner. In the abandoned section 40.4 km/ 25.1 m north of Baulkham Hills, the retaining wall is generally rough and sections of it shown in Photos 18 and 19 are Type 1a, comprising relatively small
stones (varying around 20-30 cm in length). Just north of the summit of Devine's Hill, a row of irregular broken boulders lines the edge of the shallow embankment, forming a striking contrast with the fine work on the adjacent ascent to the ridge. These stones are larger, averaging 40-60 cm diameter (see Photos 187 and 188). At Sampson's Pass, while most of the work is Types 2a and 2b, at 35.2-35.5 km/21.8-22 m north of Wisemans Ferry, the wall simply comprises broken stone of various sizes (see Photo 241). Part of this example has collapsed, so the original arrangement is not clear (Photo 242). In all cases, the embankment is slight and the walls no more than 60 cm high. The lack of any shaping and, in some cases grading, of the stones, precludes attempts at coursing, jointing and bonding.

Type 1b

In this category, wall construction is slightly less haphazard than Type 1a - the stones are at least given a face, and are sometimes roughly shaped. Although they occur more frequently, such walls are in poor condition. The most southerly example occurs, again, in the abandoned section 40.4 m/21.1 m north of Baulkham Hills, and comprises both square and rectangular shaped stones up to approximately 1.5 m high. In another example, 4.8 km north of Wisemans Ferry, the stones forming the wall have no particular shape, but are roughly faced. Two or three of the upper courses are obviously missing (see Photo 193). A similar example is located near a culvert (3.6 km north of Wisemans Ferry) and, while the culvert stones are more regularly shaped, those comprising the wall around the outlet are not (see Photo 190). Further north, the same style is repeated at 8.1 km from Wisemans. Photo 199 shows fairly large, uncoursed, roughly shaped blocks around the culvert outlet, with smaller
even less shaped blocks forming the adjoining wall. In the Sampson's Pass area 35.2 km north of Wisemans the stones are better shaped (generally rectangular) but irregular in size, allowing some stack bonding but no coursing (see Photo 237). The work has a very rough face as the profile in Photo 233 indicates, although there is in this case some evidence of the stepping of courses to provide something of a batter.

All the walls on the first ascent from the Hawkesbury, built in 1828 under Warner's supervision, are Type 1b. While the stones vary a great deal in dimension, they are all roughly shaped, usually flat and rectangular, and stacked as closely as their shape allows. Photo 258 shows the top and side of the wall near the base of the hill as it climbs the steep ascent, and this is similar to the fairly low (up to 1 m) walls supporting the subsequent reaches of the zig-zag (shown in Photos 259-262). These blocks are up to approximately 40 cm in length but vary a great deal. At the first turn, however, much larger, vaguely square blocks were used on the downhill side of the road and a greater height of the wall (approximately 3 metres) was thus achieved (see Photo 263). At the beginning of the reach above, an attempt was made at neater rubble work, although uncoursed, with a consistently sloping top course providing a rough coping (Photo 264). Very large square blocks (up to 1 m across) were used on an extremely steep section near the summit (Photo 269). Near the junction with the Devine's Hill ascent, the masonry work improves dramatically, as will be discussed in the following section. The 1828 ascent thus features the best and most intact range of Type 1b rubble work, and this is a direct result of its abandonment in 1832.
Type 2a

A few of the walls comprise stones which are more carefully prepared and regularly shaped, thus allowing closer jointing, but attempts at coursing are minimal and discontinuous. The abandoned section 40.4 km/25.1 m north of Baulkham Hills, probably built under Warner's supervision during 1827-28, also features such a style, particularly around the culvert outlet at 369 m from the southern end, shown in Photo 15. Any attempted coursing is interrupted by irregularly shaped and sized blocks, although the work as a whole is more substantial than Type 1b.

The retaining wall which supports much of the section of road at Mitchells Loop (5.7-6.0 km north of Wisemans Ferry) is a well-preserved example of Type 2a stone masonry (see Photo 194). The blocks are roughly rectangular in shape, of similar proportions and some coursing is attempted, although it is intermittent. As with other examples, the stones are packed as closely as their shape allows. Very similar examples occur further north, 7.6 m and 9.9 km north of Wisemans Ferry (see Photo 204).

Type 2b

Walls of better prepared stones, with more consistent coursing, closer jointing and sometimes tooled faces, occur more frequently on the road and are occasionally quite substantial. The retaining wall supporting an embankment approximately 1-1.5 m in height near the junction of the two ascents north of the Hawkesbury is shown in Photo 273. Although the stones in this case are by no means of standard size and shape, their faces are tooled fairly smooth and some effort has been made to fit the shapes together as closely as
possible. Thus the courses are frequently interrupted by snecking, of which there are several examples shown in Photo 273. The wall further along the old road has collapsed, as shown in the background and in more detail in Photo 274. This whole section contrasts both in style and quality with the much rougher Type 1b work undertaken by the same gang on the zig-zag section further south.

Very similar work is found 11.1 km and 12.4 km north of Wisemans Ferry (Photos 210 and 211). In both cases, courting is definite though broken, the faces are chiselled flat and the walls are battered by regular recessing of the superior over the inferior courses. The top of the wall is level and snecking is again evident in Photo 210.

Another section supported by Type 2b walls is the ascent of Mt. Baxter. In this case a substantial wall, up to approximately 2.5-3 m in height, comprises up to 9 courses of fairly regularly shaped stones. As shown in Photos 225 and 226, courting is attempted and is, in the lower section, almost consistently horizontal, but further up it is interrupted by snecking and unevenly matched blocks. The jointing approaches the standard of Type 3 work, while a batter is achieved by inclining the bedding planes. Small stones are used to fill interstices between unevenly matched stones on the north side.

Type 3a

These walls are rough approximations of ashlar work. The stones are evenly dressed, faced and matched; the courting is continuous and usually of even height, although often not consistently horizontal; and the joints are fairly tight. The walls are battered and mainly in consistent random
bonding. Like Type 3b walls, this type was mainly employed for individual, more ambitious projects such as a short section of retaining wall, a bridge or a ramp, rather than for lengthy sections. A good example is located 51 km/31.2 m north of Baulkham Hills. This substantial retaining wall carrying the road over a hollow on the slope is of evenly matched, neatly finished stones with a smooth, battered face. The courses, although of regular heights, dip to some extent, as shown in Photos 26 and 27, as do those in a similar section on the descent to Wisemans (Photo 47). In the latter case small stones were occasionally fitted into the interstices between large rectangular blocks. Similar walls of slightly better quality are also found extensively on Devine's Hill (see Photo 178). Most of the bridges on the road (Bridges 1, 2, 3, 5 and 6) are executed in this style of masonry. Bridge 3, just north of the Hawkesbury River, features the use of massive blocks as foundation stones for walls over 6 m in height (Photo 103), while Bridge 6, at Circuit Flat, features well-prepared stones, even coursing and close jointing (Photos 252 and 255). The ramp at Mt. Manning (0.65 km north of the Mt. Manning junction) comprises mainly square stones with well-prepared bed joints, although the perpends are rough, (Photos 288 and 289). Sneaking is employed to correct the occasionally uneven and unlevel coursing (Photo 287). There are also some instances of stack bonding. Two other examples of this type of stonework are the retaining walls surrounding the arched culverts at 11.55 km and 12.35 km north of Mt. Manning junction respectively. The first is rougher in both dressing and construction, with the jointing more open and uneven and the coursing interrupted by the use of stones of different sizes (Photo 319). The second retaining wall has a more smoothly finished face and closer jointing, although the courses in this case are also interrupted (see Photo 322).
Type 3b

This most sophisticated style of work answers the description of ashlar work given by Dobson and Tomlinson. The stones are dressed to given dimensions, providing a perfectly smooth face and tight bedding and perpend joints with coursing even and consistently horizontal. The heavily buttressed sections on Devine's Hill is constructed in this fashion, as shown in Photos 143-145, 147-148. Photos 156 and 157 show that the massive stones used to form the buttresses were dressed on the outside, while the unexposed sides were left rough. The large bridge at Ten Mile Hollow (Bridge 4) is also constructed of ashlar masonry, with the addition of specially shaped stones to form the v-shaped ends of the central pier (see Photos 215-218). Mt. McQuoid was another area where the best quality masonry was employed for the road. Although the wing walls of the culvert and the former bridge there are damaged and overgrown, the surviving walls still feature well-prepared stones, tight bedding and perpend joints, smooth faces and even battering and coursing (see Photos 293, 305-308). At Ramsay's Leap, 7.3 km/4.5 m north of the Mt. Manning Junction, the retaining wall was constructed in an identical fashion on a much larger scale - a curved retaining wall, fitted with a culvert and flume, runs for 100 metres and is up to 4.5 m high (Photos 309-312). The coping course is carefully tapered to match the gradient of the road way. Near the base of Mt. Simpson, 8.9 km/5.5 m from the Mt. Manning Junction, a small (13 m long) remnant of a similar wall suggests that much of the whole descent may have originally been supported by such work. Recent roadwork has, however, obliterated any further evidence.
The Walls and their Builders

The contrasting approaches of successive Assistant Surveyors superintending the construction of the Great North Road have been described in Section 3 and are best illustrated by the types of walls which were built under their direction. Warner's emphasis on quick, economical and consequently rough road building, with walls "only 4 feet high" (9), is directly reflected in the crude quality of the stone work on the first ascent of the north bank of the Hawkesbury (Type 1b). In spite of his assurances, however, some of the walls were, of necessity, up to approximately 3 m/10 feet high to support the narrow, steeply graded road. Likewise, the retaining walls near the base of the descent to Wisemans Ferry are roughly built, unevenly coursed rubble work, and they form a striking contrast to the "lofty and massive side walls" (10), as Simpson described the work proceeding under his supervision further up the slope (Type 3a). On the new ascent of Devine's Hill the walls were almost all of Types 3a and 3b quality. Bridges of masonry, avoided at all cost by Warner, were built under Simpson's direction, some of extravagant proportions and sophisticated design. Further north, the gangs under Finch constructed some very fine sections of masonry in the latter's effort to make his area "equally secure with the other part". (11)

This neat framework, while throwing light on the significance of the wide variety of styles of stone work, does not fully explain it. It cannot for instance be said that all work completed under Simpson's and Finch's direction was of a Type 3a or 3b standard. Some of the work which is known to have been done under Simpson's supervision is of the poorest quality found on the whole road - for example, the Type 1a work shown in Photo 187. To explain this anomaly,
documentary evidence must be collated with material remains. If the distribution of the gangs (see Figs. 2-7) between 1827 and 1832 is compared with the location of different styles of stone work (see Appendix 1, Sections 1, 3 and 4), it may be seen that certain gangs are generally associated with particular styles of masonry work. Thus Nos 3 and 4 Iron Gangs, confined during the construction period to the area approaching the Hawkesbury at Wisemans Ferry, were responsible for the high quality work located there. No. 8 Iron Gang, however, was consistently stationed in areas which today feature only poor quality stonework - the area around Maroota, the section between Devine's Hill and 7 Mile Hollow, and the vicinity of Hungry Flat and Sampson's Pass. Meanwhile, the men in No. 9 Iron Gang were likely to have been the builders of the fine retaining wall in the Little Maroota Forest area (Type 3a), for the ascent of Mt. Baxter (Type 2b) and probably for the stone ramp at Mt. Manning (Type 3a). It appears therefore that the gangs were organised according to skills - the least skilled or unskilled men allotted the task of wall-building were placed in No. 8 Iron Gang and assigned the construction of large stretches of road; men with more skills were placed in No's 4 and 9 Iron Gangs; and the best masons available were recruited into No. 3 Iron Gang and No. 25 Road Party for the construction of the Devine's Hill ascent. The latter was later divided to form Clare's Bridge Party, which constructed Bridge 4 at 10 Mile Hollow in 1830, and probably Bridges 5 and 6 (Sampson's Pass and Circuit Flat) in subsequent years. The work of No. 25 Road Party between 1828 and 1831 forms the most interesting range of styles. The same gang which put up the rough rubble walls (Type 1b) on Warners first zig-zag ascent in 1828, in the next two years constructed the Type 3a bridge and retaining wall on the approach to Devine's Hill, and subsequently joined No. 3 Iron Gang in the construction
of the remarkable walls of the ascent itself. The poor
workmen must have either been replaced by men with more
skills after Simpson's arrival, or they were somehow
persuaded to attain skills in the stone masonry and
encouraged to practise and perfect them.

Conclusion

A broad spectrum of stone masonry styles was employed on the
Great North Road, encompassing extremely diverse standards.
On one hand the massive and thus highly visible ashlar work
at Wisemans Ferry and Mt. Simpson are remarkable
achievements, especially in view of the scarcity of skilled
labour, the vast distances and isolation, and the scale of
work necessitated by the rugged topography. At the other
extreme, the simple broken stone walls are of the crudest
standard possible and, while still abundant, many have
already collapsed. While drainage structures were adapted to
a large extent to their location and function, the same
cannot generally be said of retaining walls. Neatly coursed
work, and sometimes fine ashlar are found in walls of modest
height and extent, while in other cases, extremely poor
quality masonry was employed for walls up to 5-6 m high. The
style of construction was apparently more closely connected
with the availability of skills in a particular gang, and
more generally, with the approach and technical knowledge of
the supervising Assistant Surveyor. With reference to the
latter point, it is obvious that Warner knew little of and
had no interest in building expensive, durable and
aesthetically pleasing walls, while the best work constructed
by Simpson and Finch features buttressing, evenly battered
faces, solid foundations and careful drainage as recommended
by the British engineers of the nineteenth century generally.
The theories of these men, translated through the mediums of
the colonial terrain, the engineers' approaches and the
distribution and skills of the convict gangs, are looked into
the shape and arrangement of the stones forming the retaining
walls.
SECTION IV/3/AIII

AUSTRALIAN PRACTICE : RETAINING WALLS

Notes

1. James Gleeson, Colonial Painters 1788-1880. Dee Why, 1979, p. 112. Some of Martens' other views of Wiseman's Ferry include "View at Wiseman's 1838" (pencil, unsigned, August 6 1838, Mitchell Library); "Wiseman's from the MacDonald River" (pencil, 1838, Dixon Library); "Wisemans Ferry" (m.d. sepia wash, unsigned, in his Album of Sketches and Wash drawings of Sydney ... f.30).


4. Lockyer to Macleay, 25 November 1826, A.O.N.S.W., C.S.I.L.

5. Road Gang Reports.

6. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March 1830", in Road Gang Reports.

7. Frank Walker wrote that this slip occurred during the flood of 1857; see his article, "The Great North Road" in J.B.A.H.E., Vol. 3, 59-79.

8. Harrington to Nicholson, 18 March 1831, A.O.N.S.W., C.S. to S.R.B. Conrad Martens. "Sketch of Victoria Pass" shows a series of crude timber cranes of a type which may have been used on the Great North Road. See Plate 8.

9. Warner to Dumaresq, 28 April 1828, A.O.N.S.W., C.S.I.L.

10. Simpson to Mitchell, March 1830, "Report of the Assistant Surveyor ... for March 1830", in Road Gang Reports.

11. Finch to Mitchell, 23 June 1830, A.O.N.S.W., S. to S.G.
(ix) Bridges

The surviving bridges constructed on the Great North Road comprise an excellent collection of evidence about bridge building technology in N.S.W. before the appointment of David Lennox in 1832. The latter, who had worked with Telford, was the first "scientific" bridge builder in the colony, and his work is well-documented. (1) Relatively little has been written about the simple bridges preceding his work, and primary written sources are vague and scattered. On the Great North Road, however, seven bridges, or remains of bridges survive, each with different constructional features, forming an interesting range of styles indicative of the state of engineering skills in N.S.W. at that time.

The Bridge Parties

The formation of Bridge Parties was ordered by Lockyer in November 1828 in response to the growing number of necessary bridges:

The number of bridges required to be kept in repair it is necessary to have from four to five bridge parties to consist of one overseer and twenty-five men who should be rough carpenters, quarry men and stone masons. (2)

In an earlier draft of these instructions, however, he had suggested that "a rough carpenter and a smith with a small forge would be all that is necessary". (3) When Farmer's Creek and Cox's River on the Bathurst Road required bridging, Mitchell proposed in 1830 that:

...a party of stone cutters with one or two good setters should ... be employed on this road (Bathurst Road) and that good blocks of granite should be cut from neighbouring rock. (4)
This was, according to Mitchell, to be only an interim measure "until mechanics can be spared from this department for the construction of arches". Given the scarcity of such skilled labour in the colony generally, this proposal appears overly optimistic. The bridge parties were formed of whatever skilled men could be found in the road parties, but their numbers must have been small. As Hirat comments, the convicts generally were treated "not according to their crimes, but to their usefulness for private gain and comfort or public works and services" (5), a factor which ensured that most skilled convicts arriving in N.S.W. were valued and sought after by both government and populace. They were thus much less likely to end up as the hardened second and third offenders who were banished to the road gangs.

Dulhunty had particular problems with the shortage of skilled labour in his efforts to construct the bridges near Wollombi. In December 1833 he reported that:

The bridge over the Wollombi at this station is finished with the exception of the handrailings on one side which I am prevented completing, the sawyers having absconded from the bridge party. (6)

Apparently there were no other men able to replace the sawyers. Dulhunty had earlier requested these men, along with "two carpenters and a stone mason" to form a gang totalling 25 men - the remainder were taken from the road parties. Assuming he did receive these men, only five out of twenty-five were skilled, although by 1830 he had received an additional sawyer and another carpenter. (7)

The fact remains that these "unskilled" builders did manage to produce several impressive and substantial stone bridges, albeit based on simple design. As discussed in the previous section, some convicts at least appear to have taken the
trouble to acquire skills in stone masonry during their time in the gangs. They practised these in the construction of bridges which, to some extent, became more sophisticated as the work progressed. In the case of Clare's Bridge Party, under Simpson's supervision between 1830 and 1832, thirty men were selected from No. 25 Road Party and posted near Ten Mile Hollow to build a large bridge there. (8) No. 25 Road Party had in 1827 and 1828 been employed building the first approaches to the Hawkesbury and during 1829 was stationed on the heavy works near Devine's Hill. It thus appears that by 1830 the men had learnt enough about stone masonry to enable them to build impressive bridges. The remainder of the party was also assigned the construction of a bridge, Bridge 3 near the base of Devine's Hill.

The overseers of Bridge Parties quickly earned reputations as bridge-builders and were valued as such. Most of the parties were known by the names of their overseers and were listed as Clare's Bridge Party, Byrn's Bridge Party, Hawkin's Bridge Party and so on. In 1832 Dulhunty particularly requested that Overseer Hawkins be removed from his station at Jerry's Plains to the Bridge Party working on the Long Bridge at Maitland, since "... Hawkins having always been employed in erecting bridges ... consequently is more fitted to take charge there". (9) At Jerry's Plains he had no doubt been employed in work other than bridge-building. The tasks of both the Bridge Parties and the other road gangs were thus not strictly delineated. The skilled men in Bridge Parties were often employed in the construction of huts and barracks for soldiers, veterans' houses and buildings associated with establishing road stations. (10) Occasionally they undertook more mundane tasks, such as "forming a bridle road" and building walls. At the same time, the Road Parties were often employed in bridge building, though these were on a small
scale. No.4 Iron Gang constructed Bridges 1 and 2 (descent to Wisemans), No. 25 Road Party commenced Bridge 3. in January 1830, and No. 7 Iron Gang was reported to have completed a number of bridges in the Wollombi Valley, including two bridges in December 1829, two bridges in January 1830, one in February and two more in September that year. (11)

The Bridges on the Great North Road

The compilation of a comprehensive, totally accurate list of bridges built on the road is hindered by the vagueness of the Assistant Surveyors' reports and by the absence of physical remains at many sites. The reports never included the location of bridges in terms of actual distance from the stations; the names of places where the gangs were stationed are often ambiguous (such as "the Wollombi"); and, since most minor creeks had not yet been named, their location is also unknown. In spite of these problems, the nature and extent of bridge building activities on the road over its 30-year construction period can be ascertained to a large degree by the collation of numerous references to bridges and the juxtaposing of this material with physical remains. In the following list, the bridges are ordered according to their location from south to north, for ease of reference. Table 11 is a condensation of this list and Fig. 124(A) shows the location of the bridges.

1. Abbotsford to Dural Branch

Two Bridges between Pennant Hills and Dural

The N.S.W. Calendar and Directory for 1832 included in its Itinerary of this branch of the Great North Road two bridges over small creeks, both 17 miles north of Sydney in the
vicinity of Pennant Hills, and mentions two creeks at 19.5 and 20.25 miles from Sydney respectively. This description concurs with a survey drawn up in 1869 of this part of the road (see R882 1603 "Plan of Road from Pennant Hills to (the) Dural (Road)"), which shows the bridges spanning two unnamed creeks, the first near the intersection with New Farm Road, and the second near the Wesleyan Chapel. The two creeks are Pye's and George's Creeks in Portions 245 and 70, Parish of South Colah, respectively. A Bridge Party was stationed in this area during January, February and March 1830 and was reported simply as "building bridges". (12) No information about their construction or design has been located.

2. Baulkham Hills to Wollombi

Bridge 1, 51 km/31.2 m north of Baulkham Hills

In January 1830 Simpson reported that No. 4 Iron Gang had been employed during that month "procurring timber for a bridge over a gully which is now covered in and completed" (13) on the south side of the Hawkesbury River. It is assumed that he was referring to the small bridge (Bridge 1) in the Little Maroota Forest area, which is of modest proportions and simple design. References to another bridge on the descent to Wisemans Ferry are more likely related to Bridge 2. Wilford had written in 1827 that "it does not appear that more than one small bridge will be necessary on the whole road" (14) - that is, the section between Castle Hill and Wisemans Ferry. It is unclear to which of the two bridges he was referring. In any case, Simpson saw fit to provide another. No bridges were mentioned at all during Warner's supervising period.
Bridge 2 on the descent to Wisemans Ferry, 52.9 km north of Baulkham Hills

This bridge was also constructed by No. 4 Iron Gang during and probably after September 1830. Simpson reported that the men had completed "... wall building for bridge ... 10 yards in length, 4 feet high; 130 slabs split for covering in bridge ... sawing posts and rails for bridge, 400 feet". (15) Bridge 2 spans a fast-flowing creek on the precipitous mountain side above the river and is of more sophisticated design than Bridge 1.

Bridge 3, near the base of Devine's Hill, 0.57 km north of Wisemans Ferry

This larger bridge was also built in 1830 to span a mountain torrent over a deep gully. The approach was excavated in January by No. 25 Road Party and wall-building was in progress in September. Simpson's Monthly Report states that the side walls "... 20 yards length, 2 feet high, 3 feet thick" had been completed by then, but the actual completion date is unknown. (16) The bridge appears on G.B. White's map "Survey of the New North Road from the Hawkesbury River to the Reserve of Wollombi", dated April 1831 (see Map 14).

Bridge 4, near Ten Mile Hollow, 17.3 km/10.7 m north of Wisemans Ferry

Clare's Bridge Party, recruited from No. 25 Road Party, was stationed at Snodgrass Valley in January 1830. where, as Simpson reported, a "log Bridge must be constructed". (17) The result was somewhat more impressive. It is the largest surviving bridge on the road, built in ashlar masonry with a large central stone cutwater pier, corbels on each abutment
to support deck bracing, and attached curved retaining wall. By May 1830 the 34 men in this party had built 12 chains (241.3 m) of wall 6 feet high, and by September the bridge was complete and half the men had already been moved on to Sampson's Pass. (18) This bridge also appears on G.B. White's 1831 map (see Map 18).

Two or more Bridges between Hungry Flat and Sampson's Pass

No. 8 Iron Gang finished "2 bridges between Hungry Flat and Sampson's Pass, one 16, the other 12 feet in width by 21 feet" in September 1830. (19) Given the extremely poor quality of stonework generally produced by this gang, it is likely that these were simply small timber slab bridges of the type shown in Figs. 123 and 124. G.B. White marked five bridges in this area on his 1831 map, two south and three north of Hungry Flat (Map 14). The site of the present-day remains of Bridge 5 at Sampson's Pass (see below), however, is not marked as a bridge, suggesting both that the latter bridge had not been commenced when White made his survey in 1830 and that No. 8 Iron Gang were not responsible for its construction. The latter point is reinforced by the quality of work evident in the remnants.

Bridge 5, Sampson's Pass, 35.9 km/22.3 m north of Wisemans Ferry

Since part of Clare's Bridge Party was removed to Sampson's Pass in September 1830, the remainder of the gang presumably following, it is likely that these men built the small stone 12-foot (3.6 m) span bridge in the subsequent months, although there is no documentary record of its actual construction.
Bridge 6, Circuit Flat, 36.6 km/24 m north of Wisemans Ferry

This is perhaps the most refined bridge design on the road, and is second only to Bridge 4 in size. Ironically, its construction date and builders are not recorded either, although the similarities in design to Bridge 4 and the high standard of workmanship strongly indicate that Clare's Bridge Party was again responsible. This also fits neatly into the gang's known movements - by the end of 1830 they were at Sampson's Pass while in 1832, a Bridge Party, most likely Clare's, was listed at Mt. Manning nearby. Further, White's 1831 map omits this bridge, although it shows Little Mogo Creek, which it spans, suggesting once more that the bridge had not yet been built when White made his actual survey the previous year. The absence of documentary evidence is due mainly to the lack of records for 1831 as a result of the transfer of the Roads and Bridges Department to the Surveyor General's Department in that year.

Bridge north of Mt. Manning

White's 1831 map (Map 14) shows this bridge just north of the Mt. Manning Junction. While there is no specific documentary or physical evidence, it is likely that this bridge was constructed by No. 9 Iron Gang under Simpson's supervision. The gang was posted at Mt. Manning between May and December 1830.

Bridge 7 at Mt. McQuoid, 4.7 km/2.9 m north of Mt. Manning Junction

The remains of this moderately sized bridge are located in the abandoned section of the original road below the present intersection at Bucketty. It is included in White's map, just
north of the road station at Dennis' Dog Kennel, and the Road Gang Reports show that the Mt. McQuoid area was constructed by No. 29 Road Party between April 1830 and January 1831. The bridge is therefore most likely to date from mid-1830.

Bridge 8 - Thompson's Bridge, Townsends Creek, 14.7 km/9.2 m north of the Mt. Manning Junction

This bridge has recent deck surmounting coursed rubble abutments and wing walls. In this case it is difficult to ascertain whether it was part of the original construction work of the road. Although its location suggests that it may have been built by No. 7 Iron Gang between July and September 1830, it does not appear on White's 1831 map, although the stream does. The stonework contrasts markedly with other structures in the area in both stone size and dressing and in quality as shown in Photo 325, which suggests that it is likely to be a later construction. It is possible that later additions were built on the site of an original bridge, and could even have utilised the stones from an earlier structure.

Hawkins Bridge over Watagan Creek, at southern entrance to Wollombi

In June 1830 this large creek was still being forded by travellers following the original track. Finch reported to Mitchell in that month:

I hope (the gang) will be ready to commence another bridge over Watagan Creek when you arrive and point out where the road is to cross. (20)

By September the crossing place had still not been selected, but Mitchell must have made a visit shortly after, since in
October, Finch, in a letter ventured some criticism of the official choice. Both the crossing place and its approaches were accordingly altered as shown on Finch's 1830 map of the road (see Map 13). Hawkins' Bridge Party was most likely responsible for the construction of the bridge in 1831, since Finch had intended this. Moreover, both the County Northumberland and Parish of Yengo maps mark this bridge as "Hawkins Bridge", the name very likely a tribute to its builder (see Fig. 15). These maps thus predate the modern steel and concrete Gleghorns Bridge which spans the creek today. Unfortunately, there is no physical or documentary record of the nature of the original bridge's construction.

3. North Western Arm: Wollombi to Warkworth (Cockfighter's Creek)

Wollombi Bridge/"First Crossing Place", Wollombi Brook at the North entrance to Wollombi

This was another substantial bridge of which there is no physical trace today. It was constructed between January and December 1833 during Dulhunty's period of superintendence. He usually referred to it as "the bridge opposite this station", since it was close to his cottage and the convicts' huts at Wollombi (see Fig. 15). The crossing place was selected by Mitchell in 1832 and is shown on his 1833 survey map of the line of road towards Broke (see Map 15). Dulhunty was informed in January 1833 that he was not to be removed from Wollombi until the bridge was complete, and he accordingly requested mechanics and bullocks for the job, as discussed above. The gang was formed mainly of men from No. 7 Iron Gang which had already built at least seven other bridges, and was headed by its overseer, MacDougall. The progress of the work was reported several times in 1833 and in December it was
complete apart from the handrailings. (22)

Second Crossing Place - Wollombi Brook, northwest of Wollombi

Major Mitchell's line continued north-west of Wollombi in an almost direct line which, because of the meandering of the Wollombi Brook, resulted in no less than nine crossings between Wollombi and Payne's Crossing (see Map 15). These were simply referred to as the "second crossing place" and the "third crossing place", and so on. After the completion of the Wollombi Bridge (First Crossing Place) in December 1833, MacDougall's Bridge Party was removed to the second crossing place, and in September 1834, Dulhunty reported that they had "nearly completed the ... bridge over the second crossing place from my old station (Wollombi)". (23)

Third Crossing Place - Wollombi Brook north west of Wollombi

Construction of the bridge at this crossing (see Map 15) was underway in March 1835 by Byrn's Bridge Party, but it appears that it was never finished. Ogilvie reported in that month that the work was "retarded for want of timber carriage". The party was removed to Maitland soon after, leaving the bridge incomplete. (24)

The remaining six crossings were apparently left unbridged, since work on the Great North Road ceased seven months later.

Cockfighter's Creek Bridge - Warkworth

This substantial bridge was often mentioned by both Dulhunty and Ogilvie during its construction between July 1834 and February 1836. Hawkin's Bridge Party was moved to Cockfighter's Creek to commence the bridge after the
completion of the Long Bridge at Maitland. In April 1835 Ogilvie reported that the new bridge had not yet been braced, while in August he stated that it was to be finished the following week, and that Hawkin's Bridge Party was to be removed to Loder's Creek on Mitchell's new Hunter Valley Road. However a pair of sawyers was requested in January 1836 and the bridge was not finally finished until February that year. (25)

4. North-Eastern Arm to Maitland and Newcastle

Bridge over Narrone Creek, north-east entrance to Wollombi

Finch referred to Narrone Creek as "a deep creek in the Reserve of Coroboeare" and reported that Hawkin's Bridge Party was working there in June 1830. It was probably finished by September that year, since by then he had "... no ... work to employ them upon, except putting up handrails to two bridges and slabling a small platform". The party was, however, still stationed at Narrone Creek in November, and were employed bridging small creeks further north. (26)

Several small bridges beyond Narrone Creek

The Monthly Report for September 1830 shows that Hawkin's Bridge Party was "erecting bridges across small courses a short distance beyond Narrone Creek and building huts". (27) The names, number and locations of these creeks were not given, and no material evidence of them has been found to date. The party probably worked on them until at least November 1830.
Bridge over Stoney Creek, at present-day Farley, near Maitland

No other bridges are mentioned between Wollombi and Maitland until Stoney Creek (also spelt Storey Creek) not far from Maitland. No. 42 Road Party was stationed there between January and February 1830 while Hawkin's Bridge Party was also working on it during March that year. (28)

The Long Bridge, Maitland

The Long Bridge spanned a swamp at the entrance to Maitland and appears to have been a most elaborate and time-consuming structure. Thirty-two men were employed on it in May 1830 (and possibly before then), building stone piers and log platforms. By June 18 Dulhunty needed two carts and ten more bullocks to "carry on more expeditiously the bridge erecting at Maitland". The bridge was not finished until July 1834 and even then 10 men were retained for further wall building "... to prop up the earth so as to fill up a hollow immediately adjoining the bridge". (29)

Victoria Bridge, Wallis Creek, Maitland

The original bridge spanning Wallis Creek was probably constructed in the 1820's by one of Campbell's gangs. By June 1833 it had collapsed and Hawkin's Bridge Party was erecting and handrailling a temporary replacement. (30) The bridge is shown as "Victoria Bridge" on G.B. White's 1834 Map, "Plan of Road from Maitland to Newcastle" (Lands Dept. Map 81.697).
Nineteen Small Bridges on the Maitland-Newcastle Road

The road between Newcastle and Wallis Plains had been established as a track since the 1810's and the original bridges over the numerous creeks probably dated from that period. Mitchell's 1833 map of the road marks 16 bridges ("Plan Showing Old Made Roads and New Lines of Road as marked by Major Mitchell, 1833", A.O. Map 5090), while White's 1834 map (R1.697 as cited above) notes nineteen, and the Lands Department's County of Northumberland map shows some of the creeks' names as "one mile", "two mile" and "four mile" creeks. The bridges were in constant need of repair and certainly encouraged travellers to use water transport between Newcastle and Morpeth. Finch reported in 1830 that the road was "nearly impassable" and by February, No. 29 Road Party was employed exclusively in repairing them. In March 1835 they were again out of repair - Ogilvie reported that only five were passable. (31)

Ironbark Bridge, Ironbark Creek, near Newcastle

This bridge required repair in May 1830 and had been built around July 1827 by No. 27 Road Party under Campbell's supervision. Finch in 1830 employed gangs stationed at Maitland in repairing the platform leading to it. (32) This bridge also appears on White's 1834 map (R1.697).
Design and Construction

Documentary Evidence

A brief survey of pre-arch bridge construction in N.S.W. reveals three basic approaches - the slab or log bridge; cribwork, also known as the "American Bridge"; and the stone conduit bridge.

The slab or log bridge was the simplest and earliest form of bridge building. A Road Committee formed in 1805 called for tenders to build ten bridges on the Parramatta Road in September that year. The specifications for the bridges were given as:

16 feet wide with four sleepers of at least a foot and a half diameter either of ironbark or of blue gum, bedded on timber of the like dimensions to be covered with three inch plank 16 feet long and properly secured by tree nails of 1/4 inch diameter (see Figs. 123 and 124). (33)

The bridge was simply a wooden platform spanning the stretch. Jonathon Warner prescribed such simple bridges in 1828 when he submitted his report on "Simpson's Line". He stressed the ease of construction and lack of skills required for these "slab" bridges and asserted several times that they could "easily be made" across both small creeks and larger water courses:

... a large creek ... about 6 or 7 yards wide and about 8 feet deep, water running gently ... and carries a heavy flush of water in rainy weather but having many flooded gums and other trees growing close to the creek a good slab bridge can be easily made across it. (34)
He reiterated the ready availability of natural materials for such bridges:

As there are immense large trees near all the creeks and more particularly near the largest; very strong slab bridges could be made over any of them with labouring men and without the assistance of mechanics, as many of the trees ..... 70 feet in the barrel without a limb and could be placed across the largest creeks as supporting the slabs of the bridge. (35)

It was exactly this method which had been used in 1814 for some of the bridges on Cox's Road over the Blue Mountains. Cox recorded in his diary that:

(the men ...) got one of the side pieces 45 feet long about 100 yards down the river and fixed it in its place without accident. The outside piece we got by falling a tree across the river about 50 feet long and that also fixed. (36)

The latter "side piece" was elsewhere described as "an oak tree with girth of 9 feet at least 6 feet above where it had fallen". Cox in this case also had a causeway constructed on each side of this bridge which was "filled up with stones and covered with earth". (37)

Timber logs were also exclusively used for the "American Bridge", similar to the cribwork described by Dobson. A diagram of proposed alterations to the Bulga Road in 1827 depicts such a bridge (see Fig. 85). Rather than being bridged by a platform, the whole gully was filled with layers of logs laid alternatively parallel and perpendicular to the road alignment and spaced to allow the flow of water. (38)

Cox was probably referring to the use of this method in his diary:

This bridge required great labour to fill it in with timber at the ends before the earth was put on, as the ground was swampy from springs. (39)
Both these types of simple timber bridges were probably constructed at various points on the Great North Road. The perishable nature of timber is no doubt the reason that no physical evidence of such structures have been located as yet. It is likely that the five bridges around Hungry Flat marked on White's 1831 survey (see Map 14) were either slab or cribs. They were built by a gang unskilled in masonry and have left no trace. The road gangs generally were often recorded as "building platforms" and "splitting slabs" for bridges. (42)

A more substantial style of construction had been introduced by 1808. The Sydney Gazette in October reported that:

The old method of levelling the road by forming log bridges over the difficult watercourses has been abandoned for the much more durable plan of a stone conduit several feet below the surface. These, when covered in and completed will give ease and safety. (46)

This system was also employed by Cox's men in 1814. In September he wrote that the "bridge rises very fast and the three quarrymen (are) well on with the stonework". By September 12 they had:

... completed all but the handrails and battening the planks ... The bridge we have completed is 80 feet long, 15 feet wide at one end, 12 at the other, 35 feet of it is planked, the remainder filled up with stone ... (47)

The bridge over the Fish River was constructed in January 1815, and also had "a pier at each end of 25 feet, which is well filled up with stones". Fifteen years later, Mitchell described a similar design for Farmer's Creek and Cox's River on the newly aligned Great West Road, which superseded Cox's line. While "... on the Lett (River) it will be most convenient to avail ourselves of wooden materials which have
been prepared", in the case of Farmer’s Creek and Cox’s River he proposed that:

... substantial stone piers at least should be erected so that wooden beams may be laid across ... The more immediate object I have in view in proposing stone piers being security of the bridges from the drift. (42)

On the Great North Road the stone conduit bridge in various forms was used in all cases where the bridges have survived (see Fig. 125). The details of their design will be dealt within the next section.

As Tomlinson pointed out, the piers were required simply to provide a permanent foundation for the deck. The suitability of the earth for these foundations was the first consideration. Ogilvie dutifully reported in 1836 that while "the black sand at Black Creek is not suitable for stone foundations", at Anvil Creek the banks were of "strong clay which make good foundations". (43) The piers/abutments were usually cut from whatever stone was available. The surviving bridges, however, indicate that the variable amount of stone at hand did not appear to affect the quality or scale of the bridges.

Most reports concerning bridge building dealt mainly with the construction of the timber decks. They included the number of logs felled, drawn and sawn, and this total varied a great deal. In November 1829 the Newcastle Bridge Party at Stoney Creek felled only two logs for the sawyers in a week, while in September 1830 Hawkin’s Bridge Party felled 51 during the month. These were cut up by the sawyers, usually numbering a pair to each gang, into various sizes including beams, sleepers, battens, cills, caps, uprights and seams. Logs
were also split into slabs for decks (see Plate 11). A typical report provided information such as:

29 beams laid and bedded; 29 sleepers laid and bedded; 64 feet of bridge slabbed 10 feet wide; 53 beams rolled and drawn; 1 cap and 4 uprights squared. (44)

The term "bedded" appears to have been interchangeable with "bolted", and "cills" (sills spanning the stretch) with "beams" - thus the Newcastle Bridge Party in 1829 completed "... 100 feet of cills laid and bolted". This gang also installed and panelled "20 feet of handrails". All the stone and timber bridges were provided with handrails most likely similar to those shown in the illustration of simple timber bridges in Rees' Encyclopaedia (1820). (45) The above report is, however, the only instance of panelled handrailimg. The posts and rails being prepared by No. 4 Iron Gang in September 1830 were no doubt for the handrails for Bridge 2. Ogilvie suggested in August 1835 that the handrailimg be given some protection from the weather:

... the handrails should either be painted or tarred as the timber constructing the same however well-slooted requires some compact coating to protect it from the weather. (46)

Whether or not his advice was implemented is not clear.

The larger bridges were braced from below by wooden beams (struts) as described by Gillespie. Although this is only mentioned once in written records - Ogilvie reported in April 1835 that the Cockfighter's Creek Bridge was "not yet braced" (47) - the large projecting corbels lining the abutments of Bridges 4 and 6 are evidence of this construction, forming foundations for the struts.

The decks of the bridges were finally surfaced with earth
and/or gravel. While Cox recorded that his gang spread earth over the slabs, except where the bridge was liable to be flooded (48), most of the gangs employed on the Great North Road drew gravel to the bridges and spread it on the decks. The approaches to the bridges varied with the natural features — swamps were covered in with Metcalfe-style log or plank platforms; steep gullies were embanked with broken stone supported by retaining walls; rocky outcrops and steep slopes were excavated by cutting and blasting.

Physical Evidence

Seven stone conduit bridges or parts of bridges have been located on the Great North Road. Of these, four are in use, two are intact but without decks, one has been drastically altered and another stands in ruins. The original design of each may nevertheless be ascertained.

Bridge 1, located off the present alignment, 51 km/31.2 m north of Baulkham Hills is an example of the simplest stone conduit bridge design (see Figs. 91 and 126). It comprises two battered stone walls forming abutments which support the creek bank, spanned by five round beams. A sixth lies at the uphill end of the bridge (see Photos 32 and 33). The walls are 711 cm/23'4" long, although damage at the eastern end suggests that they originally measured 732 cm/24', three feet wider than the usual 21-foot wide roadway. The bridge has a span of 167 cm/5.5' and is 190 cm/6'3" high at its highest point. Since there is no trace of any disturbance to the stonework where the beams are fitted into the top courses, it is possible that they are original. The beams are squared at the ends and bevelled on the underside to joint tightly into the stonework, while the upper sides across the stretch are hewn flat to receive the slabbing of the deck. Photo 36
shows the perpendicular marks on them, indicating the original position of the slabs. There are also several large, square handwrought nails lodged in the upper faces of most of the beams (see Photos 35 and 36). Part of the layer of mixed earth and stones which originally covered the deck is visible at the top of the walls (see Photos 33 and 36 and also Appendix 1, Section 1c).

Bridge 2 (52.9 km/32.8 m north of Baulkham Hills) is a more elaborate version of Bridge 1. It is incorporated into the retaining wall which originally ran continuously down to Wisemans Ferry (see Fig. 16), although the latter has been damaged near the bridge. This bridge has slightly tapered buttresses standing 25 cm/10" proud of the retaining wall flanking the outlet (see Photo 40 and Fig. 12”). These buttresses are battered at the same rate as the retaining wall and are of well-finished stonework, capped with very large stones. The interior of the bridge, by contrast, is less well-finished, with uneven course heights and beds and the faces left fairly rough. The upper courses have been altered for the insertion of new beams and the joints there have been mortared (see Photo 41). This bridge measures 223.5 cm/7'4" high at the downhill side, with a span of 260 cm/8' 6.5" at the base of the abutment, and is 115 cm/3' 7" long. It thus probably originally extended uphill beyond the road's edge, the modern deck being wider than the original (see also Appendix 1, Section 1e). This bridge is almost identical in design to the remains of Bridge 5 at Sampson’s Pass (see Figs. 133 and 134), forming a useful illustration of the latter's original appearance.

A similar bridge on a larger scale was constructed over a deep gully on the opposite side of the river some months earlier. Bridge 3, 0.57 km/0.36 m north of Wisemans Ferry,
measures 6.05 m / 20' in height, having flared walls 15 m / 49' long and spanning a 5 m / 16' 6" stretch (see Photo 104 and Fig. 129). The present recent deck (Photos 103, 104 and 108) appears to be in approximately the same position as the original, although damage to the corners of the abutment on the downhill side prevent it from extending to the edge. The walls thus extend 10 metres / 32' 9" beyond the deck upstream and each has a large culvert opening out into the gully (see Fig. 128). On the western wall the culvert has collapsed (see Photo 107) but on the eastern side it is intact, complete with a large, partly covered stone flagged race of substantial stone blocks (see Photo 105). Thus water coursed not only directly off the steep mountain slope but was also caught from the sides of the gully and passed into the channel of the bridge. The invert of the bridge comprises rocky outcrops, large broken stones and some paving at the outlet, and the water below the bridge is dissipated by broken stone (see Photo 105). The bridge is flanked by retaining walls extending 5 m on the west side and 30 m of curved stonework on the east. The outlet and inlet of an additional culvert are located 28 m and 25 m from the bridge respectively. This culvert has a cantilever slab spillway, throwing the water away from the wall (see also Appendix 1, Section 4b).

Near Ten Mile Hollow, a much larger bridge (Bridge 4) of more sophisticated design was built, as Simpson reported, "24 feet wide and 130 feet in length", (7.3 m and 39.6 m respectively). (49) The principle of the stone conduit bridge was here elaborated by the addition of a massive central outwater, a pier with v-shaped ends, providing two channels for the stream, and also by the addition of large stone corbels projecting from each face of the abutments, numbering 28 in all (see Photos 215-218 and Figs. 130-132). These
supported the bracing of the original deck, but with the new steel and timber replacement, they are now out of use. The original stonework is particularly fine, tightly jointed, with many stones given angled faces for the batter (see Photo 217) and curiously shaped blocks forming the "nose" of the central pier (see Photo 218). Part of the northern abutment was reinforced and rebuilt in 1965 and the difference in the quality of the work is obvious (see Photos 216 and 217, and Appendix 1, Section 3k).

The remains of a small bridge (Bridge 5) at Sampson's Pass (35.9 km/22.3 m north of Wisemans Ferry) are related in design and scale both to Bridge 2 and Bridge 7 (Mt. McQuoid), although almost the entire inner walling is buried and much of the northern buttress has been destroyed (see Photo 246), the dimensions and nature of this bridge are still ascertainable (see Figs. 130 and 131). Again the abutments on the downhill side were flanked by buttresses projecting from the adjoining retaining walls (see Photos 244 and 247). In this case, however, the buttresses are flared on their outer sides towards the base, rather than being tapered as a whole (see Fig. 131). The bridge was originally approximately 3 m/9 feet high and had a span of approximately 3.3 m/11 feet. Natural rocky shelving at the discharge end acts as a dissipator for the water (see Photo 245, see also Appendix 1, Section 3o).

The bridge at Circuit Flat (Bridge 6, 38.6 km/24 m north of Wisemans Ferry) is perhaps the most refined of all the bridges on the Great North Road. In this case, the stone abutments extending about 12.2 m/40 feet each to north and south level the approach to the gully on the flat, rising to 1.8 m/6 feet in height at Little Mogo Creek. The outer ends of the abutments curve outwards gently, and the walls feature the
remains of carefully constructed projecting coping (see Photo 252 and Figs. 135 and 136). In this case all four corners of the abutments are buttressed, and the buttresses (30 cm x 30 cm) project from both the outer and inner sides (see Photos 252-254). Six corbels were provided on each side of the interior to support the bracing of the deck (see also Appendix 1, Section 3p).

Bridge 7, spanning a creek on the slopes of Mt. McQuoid, 4.7 km/2.9 m north of Mt. Manning junction, has been substantially altered by the addition of a large circular concrete pipe (see Photo 306). The area in the waterway between the pipe and the abutments has been filled and faced on the discharge end with mortar jointed stones of smaller proportions and rougher shaping than those in the abutment. Once more, the nature of the downstream end is discernable in spite of these additions. The 20 m long ashlar wing walls on either side (see Photos 307 and 308), and the battered abutments with no buttressing (see Photo 305), make this bridge most similar in style to Bridge 3 (see Fig. 125). Its span was 3.06 m/10 feet and the height of the abutments 2.2 m/7 feet. (50) (See also Appendix 1, Section 4c).

**Conclusion**

At least 22 bridges were built between Sydney and the Hunter Valley, and a further 22 were erected between Maitland and Newcastle. Of these, many were apparently primitive slab bridges, others large braced timber bridges, some comprised a simple stone conduit covered in with slabs and a few were sophisticated interpretations of the latter form, with refined detailing and executed in handsome ashlar masonry (see Fig. 125).
During 1830, both Simpson and Finch directed that stone bridges were to be built, rather than the cheap, makeshift log and slab bridges favoured and no doubt utilised by Warner. All of the bridges which survive thus date from 1830 and 1831, making them the oldest on the Australian mainland. They once more reflect the materialisation of the ambition of the Assistant Surveyors in this period. Simpson in particular took the opportunity to display his considerable skills in stonemasonry. While the simple technology of stone conduit bridges was obviously common knowledge in Britain and had been employed in the colony since 1808, by 1831 bridge builders exploited the design as far as possible to provide handsome, durable bridges spanning deep rocky gullies. Tapered buttresses were added to the corners of the abutments, additional drainage structures such as culverts and races were provided, stone flagging formed platforms for the flow which was dissipated by appropriately placed broken stone. The ashlar worked masonry rose to 6 m/20 ft in height and extended up to 39 m/130 feet back from the span. On large bridges, square corbels were neatly inserted to support bracing for the deck. Finally, purely aesthetic details were added, such as the curiously shaped ends of the central pier of Bridge 4, and the elegant coping and the flared ends of the abutments of Bridge 6. Somehow Simpson and Finch found ways to coax a group of originally unskilled and probably unwilling men to apply the simple and rather limited technology available, extrapolating it to produce a range of bridges which probably represent the most sophisticated bridge building in N.S.W. before the appointment of David Lennox initiated the next stage of development.
### TABLE 11: Bridges originally built on the Great North Road

* denotes bridge is extant

<table>
<thead>
<tr>
<th>Location</th>
<th>Construction Date</th>
<th>Construction Type</th>
<th>Builders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbotsford-Dural Branch (New Line Road) 19.5 km north of Sydney</td>
<td>Jan-March 1830</td>
<td>unknown</td>
<td>unknown Bridge Party supervised by John Nicholson</td>
</tr>
<tr>
<td>Abbotsford-Dural Branch (New Line Road) 20.25 km north of Sydney</td>
<td>Jan-March 1830</td>
<td>unknown</td>
<td>unknown Bridge Party supervised by John Nicholson</td>
</tr>
<tr>
<td>Bridge 1.* (Old Northern Road) 51 km north of Baulkham Hills</td>
<td>Jan?-1830</td>
<td>stone conduit</td>
<td>No. 4 Iron Gang supervised by Percy Simpson</td>
</tr>
<tr>
<td>Bridge 2.* (Old Northern Road) 52.9 km north of Baulkham Hills</td>
<td>September 1830</td>
<td>stone conduit</td>
<td>No. 4 Iron Gang supervised by Percy Simpson</td>
</tr>
<tr>
<td>Bridge 3.* (Settlers Road) 0.57 km north of Wisemans Ferry</td>
<td>September 1830</td>
<td>stone conduit</td>
<td>No. 25 Road Party supervised by Percy Simpson</td>
</tr>
<tr>
<td>Wisemans Ferry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge 4.*</td>
<td>Jan-Sept 1830</td>
<td>stone conduit, 2 span, braced timber deck</td>
<td>Clare's Bridge Party supervised by Percy Simpson</td>
</tr>
<tr>
<td>17.3 km north of Wisemans Ferry, near Ten Mile Hollow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two or more bridges between Hungry Flat and Sampson's Pass, 29.8-35.1 km north of Wisemans Ferry</td>
<td>September 1830</td>
<td>probably slab</td>
<td>Probably no. 8 Iron Gang supervised by Percy Simpson</td>
</tr>
<tr>
<td>Bridge 5.*</td>
<td>After September 1830</td>
<td>stone conduit</td>
<td>Clare's Bridge Party supervised by Percy Simpson</td>
</tr>
<tr>
<td>Sampson's Pass, 35.9 km north of Wisemans Ferry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Construction Date</td>
<td>Construction Type</td>
<td>Builders</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Bridge 6.* Little Mogo Creek, Circuit Flat, 38.6 km north of Wisemans Ferry</td>
<td>Probably 1831</td>
<td>stone conduit, braced timber deck</td>
<td>Probably Clare’s Bridge Party supervised by Percy Simpson</td>
</tr>
<tr>
<td>Bridge just north of Mt. Manning Junction</td>
<td>unknown, shown on White’s map, 1831</td>
<td>unknown</td>
<td>unknown</td>
</tr>
<tr>
<td>Bridge 7.* Mt. McQuoid, 4.7 km north of Mt. Manning Junction</td>
<td>April 1830-January 1831</td>
<td>stone conduit</td>
<td>No. 29 Road Party supervised by Heneage Finch</td>
</tr>
<tr>
<td>Bridge 8.* Thompson’s Bridge over Townsends Creek, 14.7 km north of Mt. Manning Junction</td>
<td>Possibly 1830, but more likely a more recent structure</td>
<td>stone conduit</td>
<td>Possibly No. 7 Iron Gang supervised by Heneage Finch; more likely more recent</td>
</tr>
<tr>
<td>Hawking's Bridge over Watagan Creek at southern entrance to Wollombi</td>
<td>1831</td>
<td>unknown</td>
<td>Probably Hawkin's Bridge Party supervised by Heneage Finch</td>
</tr>
<tr>
<td>Wollombi Bridge, over Wollombi Brook at the north entrance to Wollombi</td>
<td>Jan-Dec 1833</td>
<td>unknown</td>
<td>MacDougall's Bridge Party supervised by L.V. Duhunty</td>
</tr>
<tr>
<td>Second Crossing Place of Wollombi Brook northwest of Wollombi</td>
<td>Dec 1833-Sept. 1834</td>
<td>unknown</td>
<td>MacDougall's Bridge Party supervised by L.V. Duhunty</td>
</tr>
<tr>
<td>Third Crossing Place of Wollombi Brook northwest of Wollombi</td>
<td>March 1835</td>
<td>unknown</td>
<td>Byrn's Bridge Party supervised by Peter Ogilvie</td>
</tr>
<tr>
<td></td>
<td>left unfinished</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Construction Date</td>
<td>Construction Type</td>
<td>Builders</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------</td>
<td>----------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Cooks Bridge, Crock Creek, Warkworth</td>
<td>July 1834-February 1836</td>
<td>large braced timber beam bridge</td>
<td>Hawkins's Bridge Party supervised by Peter Ogilvie</td>
</tr>
<tr>
<td>Bridge over Narrope Creek, north-east entrance to Wollombi</td>
<td>June-November 1830</td>
<td>unknown</td>
<td>Hawkins's Bridge Party supervised by Heneage Finch</td>
</tr>
<tr>
<td>Several small bridges beyond Narrope Creek, north-east of Wollombi</td>
<td>about September 1830</td>
<td>probably slab</td>
<td>Hawkins's Bridge Party supervised by Heneage Finch</td>
</tr>
<tr>
<td>Bridge over Stoney Creek, at present-day Parley, near Maitland</td>
<td>Jan-March 1830</td>
<td>unknown</td>
<td>No. 42 Road Party, Hawkins's Bridge Party supervised by Heneage Finch</td>
</tr>
<tr>
<td>The Long Bridge, Maitland</td>
<td>May 1830-June 1834</td>
<td>timber beams, + stone abutments</td>
<td>Hawkins's Bridge Party and others, supervised by Heneage Finch and L.V. Dilhunty</td>
</tr>
<tr>
<td>Victoria Bridge, Wallis Creek, Maitland</td>
<td>Originally probably 1820's, Replaced June 1833</td>
<td>unknown</td>
<td>Replacement, Hawkins's Bridge Party supervised by L.V. Dilhunty</td>
</tr>
<tr>
<td>Nineteen small bridges on Maitland-Newcastle Road</td>
<td>originally probably 1810's, repaired 1830, 1835</td>
<td>unknown; probably slab</td>
<td>Repaired No. 29 Road Party, 1830 supervised by Heneage Finch</td>
</tr>
<tr>
<td>Ironbark Bridge, Ironbark Creek, near Newcastle</td>
<td>July 1827, repaired May 1830</td>
<td>unknown</td>
<td>Originally built No. 27 Read Party supervised by Patrick Campbell</td>
</tr>
</tbody>
</table>
SECTION IV/3

AUSTRALIAN PRACTICE : BRIDGES

Notes


2. Lockyer to Macleay, 25 November 1828, A.O.N.S.W., C.S.I.L.

3. Lockyer to Macleay, 25 June 1828, "Code of Regulations for the guidance and conduct of the Roads Department" (Draft), A.O.N.S.W., C.S.I.L.


5. Hirst, pp. 83, 92.

6. Dulhunty to Mitchell, 30 December 1833, A.O.N.S.W., S. to S.G.

7. Dulhunty to Mitchell, 5 January 1833, A.O.N.S.W., S. to S.G.


9. Dulhunty to Mitchell, 9 May 1832, A.O.N.S.W., S. to S.G.

10. Road Gang Reports; Finch to Mitchell, 25 September 1830, A.O.N.S.W., S. to S.G.; Dulhunty to Mitchell, 15 June 1833, A.O.N.S.W., S. to S.G.

11. Road Gang Reports.

12. N.S.W. Calendar and General Post Office Directory, (comp. by J. Raymond), 1833; Road Gang Reports.


14. Wilford to Macleay, 4 August 1827, A.O.N.S.W., C.S.I.L.

15. Simpson to Mitchell, September 1830, "Assistant Surveyor Simpson's Report ... for September 1830", in Road Gang Reports.

16. Ibid.

17. Simpson to Mitchell, January 1830, "The Assistant Surveyor of Roads Report ... for January 1830", in Road Gang Reports.
18. "Monthly return of Clare's Bridge Party at Snodgrass Valley, May 1830", in Road Gang Reports; Simpson to Mitchell, September 1830, "Assistant Surveyor Simpson's Report ... for September 1830", in Road Gang Reports.

19. Simpson to Mitchell, September 1830, "Assistant Surveyor Simpson's Report ... for September 1830", in Road Gang Reports.

20. Finch to Mitchell, 23 June 1830, A.O.N.S.W., S. to S.G.

21. Finch to Mitchell, 13 October 1830, A.O.N.S.W., S. to S.G.

22. Dulhunty to Mitchell, 5 January 1833, A.O.N.S.W., S. to S.G.; Dulhunty to Mitchell, 30 December 1833, A.O.N.S.W., S. to S.G.

23. Dulhunty to Mitchell, 30 December 1833, A.O.N.S.W., S. to S.G.; Dulhunty to Mitchell, 20 September 1834, A.O.N.S.W., S. to S.G.

24. Ogilvie to Mitchell, 5 March 1835, A.O.N.S.W., S. to S.G.; Ogilvie to Mitchell, 25 July 1835, A.O.N.S.W., S. to S.G.


27. Road Gang Reports, September 1830.

28. Road Gang Reports.

29. Dulhunty to Mitchell, 9 May 1832, A.O.N.S.W., S. to S.G.; Dulhunty to Mitchell, 26 June 1832, A.O.N.S.W., S. to S.G.; Dulhunty to Mitchell, 17 July 1834, A.O.N.S.W., S. to S.G.

30. Dulhunty to Mitchell, June 1833, "Newcastle Road Department Journal mentioning all occurrences in any of the Road Parties from the 1st to 31st June 1833", A.O.N.S.W., S. to S.G.

31. Road Gang Reports; Lockyer to Macleay, 8 April 1829, A.O.N.S.W., C.S.I.L.; Finch to Mitchell, 17 July 1834, A.O.N.S.W., S. to S.G.; Ogilvie to Mitchell, 19 March 1835, A.O.N.S.W., S. to S.G.

32. Wilford to Macleay, 19 July 1827, A.O.N.S.W., C.S.I.L.; Finch to Mitchell, 19 May 1830, A.O.N.S.W., S. to S.G.

33. Cited in The Roadmakers, p. 7; See also Newell, p. 95.

34. Warner to Dumaresq, 7 May 1828, "Description of the line of road from Wiseman's to Wallis Plains (McDonald's Line) ...", A.O.N.S.W., C.S.I.L.

35. Ibid.

37. Ibid, p. 92.

38. Bell (Magistrate of Police, Windsor) to Macleay, letter 27/4927, *A.O.N.S.W., C.S.I.L.*


41. Cox, pp. 66, 93.


43. Ogilvie to Mitchell, 24 July 1836, *A.O.N.S.W., S. to S.G.*

44. Road Gang Reports.


46. Ogilvie to Mitchell, 16 August 1835, *A.O.N.S.W., S. to S.G.*

47. Ogilvie to Mitchell, 9 April 1835, *A.O.N.S.W., S. to S.G.*

48. Cox, pp. 92-93.

49. Simpson to Mitchell, September 1830, "Assistant Surveyor Simpson's Report ... for September 1830", in Road Gang Reports.

50. For report, see MoBean and Crisp, p. 6.
Conclusion

The Great North Road was for a few years of obsessive personal interest to men such as Mitchell, Simpson and Finch. It was for them a perfect opportunity to display their skills in road surveying and engineering in a highly visible manner, and to fulfill their ambitions for wealth, recognition and fame. Fortunately for Mitchell, there were other avenues to such goals - the road itself was more or less abandoned even before it was completed and soon became an object of popular censure. Like Simpson and Finch, it sank into obscurity.

It was largely because of this early abandonment that the material evidence of the strivings of these men survive today. The road is record of the technology they and their contemporaries imported and the way in which this technology was translated through the colonial conditions they encountered. The most significant of these conditions included the large but unskilled convict labour force harnessed for road building, the limited and simple tools available, the natural materials with which they worked, and the rugged, isolated terrain of immense distances which demanded that technology, tools and labour be applied to their fullest capacity.

Certain features of colonial road building have been revealed by the examination of its separate aspects against the background of British road-building theory. The initial operations of tracing and surveying improved remarkably over the short period between 1825 and 1829, from the badly equipped, crude, haphazard surveys practised since the early days, to the introduction and application of Mitchell's far more exact knowledge of road-tracing and triangulation, which necessitated proper instruments and care in surveys. The
pattern of the road's tracing also highlights the problems which Mitchell's idiosyncratic approach created in the unfixed and ever-expanding colony. The hard wood and the expanses of thickly-timbered ridges ensured that new methods for the labourious task of clearing the line were quickly adopted in an effort to reduce the time expended on this first, and occasionally only, stage of construction.

The gangs blasted out rocky cliffs, constructed massive embankments, cut down points and filled hollows wherever necessary, but also often left the terrain as it was, taking advantage of the natural drainage, flatness and hardness of some parts of the line, adding at most only small road edges and gravel surfacing. According to the material evidence, the most basic techniques of blasting and quarrying were even further simplified in N.S.W. Triangular, round and facetted jumpers were simply driven into the rock, without being turned. Labour was reorganised to accommodate the constant shortage of gunpowder. Similarly, huge blocks of stone were hewn by the simplest and most expedient method - wedges were driven in until the rock cracked, and the stone was removed manually and shaped.

The utilisation of the stone, by contrast, was often highly sophisticated. Neatly dressed, dry laid ashlar up to 12 m high, suitably battered and reinforced, climbed the steep slopes to the ridges. At the same time gangs of lesser skills in other areas produced the crudest broken stone walls possible. Similarly, the drainage structures vary considerably in quality from area to area and from period to period. Different gangs apparently had differing methods and standards, while their successive superintendents also
adhered to contrasting approaches and techniques. In many cases simple ideas reveal a basic grasp of road drainage system. Channels, carefully cut from solid rock, water races, and spillways often embellished the culverts and side drains, and occasionally the efforts of the workmen ran to providing purely aesthetic details. The structures in no way met given proportions such as those provided by Telford and Parnell (which in my case would have proven unsuitable), or, indeed, strictly to any given proportions at all, but did provide excellent drainage along the lines suggested by these men.

With regard to pavements, the colonial road-builders espoused the same concern with durability, maintenance and proper preparation and compaction of materials as MacAdam and Telford. The style of pavements they actually built, however, was a hybrid of the techniques of both men, and, of necessity, did not accord strictly with either. In both drainage and surfacing, the natural rock was utilised extensively as it occurred, by paring it down wherever necessary to serve the required purpose. Finally, in building the stone bridges which are extant today, the gangs and their supervisors found ways to apply the limited technology available to them to provide bridges which probably represent the most sophisticated achievements in the colony before 1832.

The end of the Napoleonic Wars meant that the colony in N.S.W. received not only large numbers of convicts and free settlers, but also a group of military men and civilians with much-needed engineering and surveying skills. They were, for the main part, ambitious for the success and
recognition possible in the new colony, and they approached their staggering tasks with enthusiasm and determination. Some happened to have better and more up-to-date technical knowledge than others, and it is a measure of the complete discretion allowed them, and the isolated fashion in which they worked, that their contrasting approaches are stamped so clearly or the physical remains. The difficult conditions and lack of skills and adequate tools meant that the new methods had to be simplified, altered and adapted in the various ways discussed. Primitive means were employed to ambitious ends - they adhered to the basic principles of contemporary road building but dispensed with the details. The technology was thus, paradoxically, highly simplified while it was simultaneously applied to its fullest capacity, resulting in the best road engineering possible in N.S.W. at that time.
SECTION V

Afterword

James Atkinson and Henry Dangar boasted that, by 1826, roads in N.S.W. were built in accordance with the most modern English specifications - those of John Loudon MacAdam. Dumaresq's description of the Great North Road in 1827 assures us that the work then underway was of impressively high quality. In 1858 the new Commissioner for Railways, Captain B.M. Mortindale, dismissed all the early roads in N.S.W. as "originally ill-laid out, ill-drained ... and never sufficiently metalled". (1) Several primary and secondary accounts of the convict road gang system lead us to assume that all the men in the gangs were totally unskilled, unwilling and continually absconding, that their overseers were invariably brutal, lax or both, and that their superintendents lacked incentive and motivation.

The examination of the material records, however, disproves all these assertions. I have argued in the preceding chapters that it was not possible to apply MacAdam's or Telford's instructions to the letter in N.S.W. - simplified versions were used instead; as a result of Warner's approach and lack of expertise, the standard of workmanship on the road was comparatively low in 1827, despite Dumaresq's claim; the survival of the massive formations, extensive drainage systems and fragments of pavement refute Mortindale's charges; and the grand buttressed walls rising majestically along the mountainsides belie the assumption that there were no skilled, interested or motivated men involved in the construction of the Great North Road.
Conversely, of course, to examine the physical remains in isolation is equally misleading, leaving a very flat picture of the road and its construction. The sources of the methods used would be unknown, the reasons for its shape and destinations explained, the vast variation in the quality, style and detail of the structures a mystery, and the vision which the road actualised remote. It is thus equally important to know that Atkinson, Dangar and Dumaresq and so many others made such extravagant claims about the colony's roads and why they did so.

The methodology of historical archaeology is thus vital for a full understanding of the Great North Road and its significance in its historical context. The dichotomy discussed in Section 1, concerning the fusion of the written with the material, the theory with the practice, is particularly fruitful. The juxtaposition of British theory with colonial practice in road building provides a picture of the process of transferral of the relevant technology. The methods were translated and transformed by various mediums, resulting in simplified techniques. Yet, at the same time, they produced structures which impressed and inspired people, reassured them of their "civilisation" and prompted them to bestow upon the road a grand English name, boasting that it was "as good as any in England". It was thus a practical, tangible symbol of European victory over the fearful wilderness, of the colony's rapid progress and of the firm contemporary expectation that New South Wales would prosper and grow. Such a grand and permanent thoroughfare was only fitting for a colony with such a future.
SECTION IV/3

AFTERWORD

Note