MARSHALLS CREEK NEAR BRUNSWICK HEADS, NORTHERN NEW SOUTH WALES: A PRELIMINARY STUDY OF BED SEDIMENTS AND STABILITY

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1. INTRODUCTION

Information on the sources of present channel-bed material for the lower (tidal) part of Marshalls Creek (formerly known as the North Arm of the Brunswick River) was required to assess the feasibility of dredging to alleviate flood impacts at New Brighton. It was also necessary to have some idea of the age and stability of the channel-floor deposits.

This report addresses the problems of sources and stability mainly (there is no indication of age without more work and the costs of dating). It includes sections on the methods used, the sources of material, their relative stability at present, in the immediate past, and in the future (without and with dredging), and finally it presents some discussion of the problems likely to be encountered as conclusions.

2. METHODS

Fieldwork was carried out on 10th July 1988. This consisted mainly of a boat trip from near Grassy Point in the lower estuary to the Pacific Highway bridge and back, and then a shorter traverse to the lower estuary north training wall and back. During these 23 bed samples were collected (Fig.1) and observations were made on channel bedforms, banks, other channels and the estuarine environment generally.

The samples were dried and examined without magnification, prior to being passed on to Darren Skene. He examined all samples under the mircoscope to determine lithology, colour, general grain size, sorting, angularity/ roundness, shell content, iron-oxide staining and estimates of percentages of mud, quartz and lithics. His general comments and table are presented as Appendix A.

Old surveys were examined at the NSW Department of Public Works. It was possible to obtain some details of earlier conditions in the lower estuary. Air photomaps revealed some information on bedforms. Present and past sinuosity was computed from this source. Topographic maps were examined to assess catchment changes and areas.

3. SOURCES OF BED MATERIAL

As indicated in Appendix A, three sources of bed material were revealed in the samples. These were: fluvial sediments, reworked coastal sands and marine sands.

3.1 Fluvial Sediments

The upper part of the estuary, between the Pacific Highway bridge and the entrance to the lake, east of Gooloo Close, revealed fluvial sediments at sample sites 19, 18 and 20. These had a lithic content of about 90% derived from the transport of bedrock fragments from the upstream catchment. Sample 17, with only 5% lithics, was obviously a marginal location for the influence of river-transported bedload. These samples have been described as sandy gravel because of the inclusion of river-

An exception was noted at site 13 where, as well as reworked marine sand, the bed was floored with well-rounded coarse gravel and boulders of local metamorphic rocks. This deposit covers the channel's floor and extends over 20 to 30m of channel length. While the finer reworked sands may pass through this site, the other materials represent some kind of lag deposit, the origins of which are not easily explained. It could represent a basal deposit of some much older flood plain or terrace grading to some lower sea level of the past. It might perhaps be part of a boulder beach but there are no nearby obvious fossil cliffs, which might have provided the source, but the orientation was right in pre-barrier times.

More important perhaps is the fact that this may create some problems for dredging and it may form some sort of long-profile control. This could not be revealed without survey.

3.3 Marine Sand

Although the marine sand is similar to the reworked material in terms of composition and texture, it is different. It is pale orange (iron staining) and contains more shell fragments (both marine and estuarine). Such sands are found downstream of Orana Bridge where they have been deposited in what might be regarded as a flood-tide delta.

Much of the sand in the lower estuary and even up to New Brighton is very mobile in the upper layers, as is evident from low amplitude, ebb-dominated dunes (0.3m high and up to 10m long) and ripples which can be influenced by both flood and ebb currents. Much of the marine sand has probably been introduced since the near closure of the estuary by the north training wall in 1969-1970. Breaks at western and eastern ends allow sea water and sediments in and out at higher velocities than are found elsewhere in the very wide channel. They do not facilitate much scour or removal, except in the immediate vicinity of the openings.

4. STABILITY OF MATERIAL

Sand-sized material in estuaries is seldom stable. Estuaries accommodate the coarse fluvial load being added from the inland catchment and they also allow the accumulation of marine materials coming through the heads or being reworked from the barriers. In between in the low-energy environments, there may be a mud basin floored by fines and reworked materials.

rolled coarser sediments. They represent the limits of estuary penetration by purely alluvial material of bedload size. They are located in a nearly straight channel (sinuosity P= 1.1) which is narrow (less than 10m) and whose banks are 1 - 2m high. In a sense it is a confined reach where probably gradient and flow velocities are higher than in the highly sinuous reach downstream of the entrance to the lake.

3.2 Reworked Coastal Sand

Downstream from the lake to about the Orana Bridge, the bed material has been described as reworked coastal sand. This material has been derived from eroded barriers systems and dunes associated with post-transgression Holocene deposition.

When sea level returned to near its present level about 6500 yr BP from low Pleistocene stages, lower estuaries were flooded by the sea. Barrier sands were moved onshore by marine processes to form the extensive sand barriers which dammed smaller rivers from reaching the sea directly. Frequently their lower courses were either directed south (Marshalls Creek) or north (Simpsons Creek) to join more powerful rivers (Brunswick River) maintaining a seaward outlet. This exits to the sea just south of what would have been a rocky island near the present Heads.

So the bed material for much of Marshalls Creek has been derived from a sandy barrier system post-dating 6500 yr BP. Weathering processes in these sand bodies accounts for the paler fawn-grey colour of this well-sorted, well-rounded material. Textures are mainly very fine to medium-grained sands which have been well rounded by marine processes. Their size makes them the least difficult to move by flowing water.

These problems are being addressed by Webb McKeown and need no further comment here.

5. CONCLUSIONS

Samples have revealed that the main source of bed material in Marshalls Creek is reworked coastal sand. This has been derived by erosion of Holocene barriers deposited by marine and aeolian processes since the transgression. At present bed deposits seem to be fairly stable in the shallow, very low gradient, low energy, tight meandering environment west of New Brighton, where floods spread out over the wetlands and into adjacent settled areas. Tidal penetration to this area is presently less important than in the lower estuary (PWD, 1984).

The reworked coastal sand and the more iron-stained, shell-rich marine sands south of New Brighton are much more mobile in a straighter channel, with somewhat lower overbank storage and a steeper tidal gradient. Mobility is evident from ripples and low amplitude dunes. There were no obvious differences in material recovered from 1m below a sand bar near the village. It is probable that floods up to 2m deep may scour the bed for up to 1m but it is still necessary to prove this.

Riverine bed material is limited to the uppermost part of the tidal reach in a confined, high-bank, nearly straight channel east of the Pacific Highway bridge. On the limited observations made, this material appears to be advancing only slowly into the main estuary. There is insufficient energy to move material of gravel size except in some of the larger floods.

6. REFERENCES

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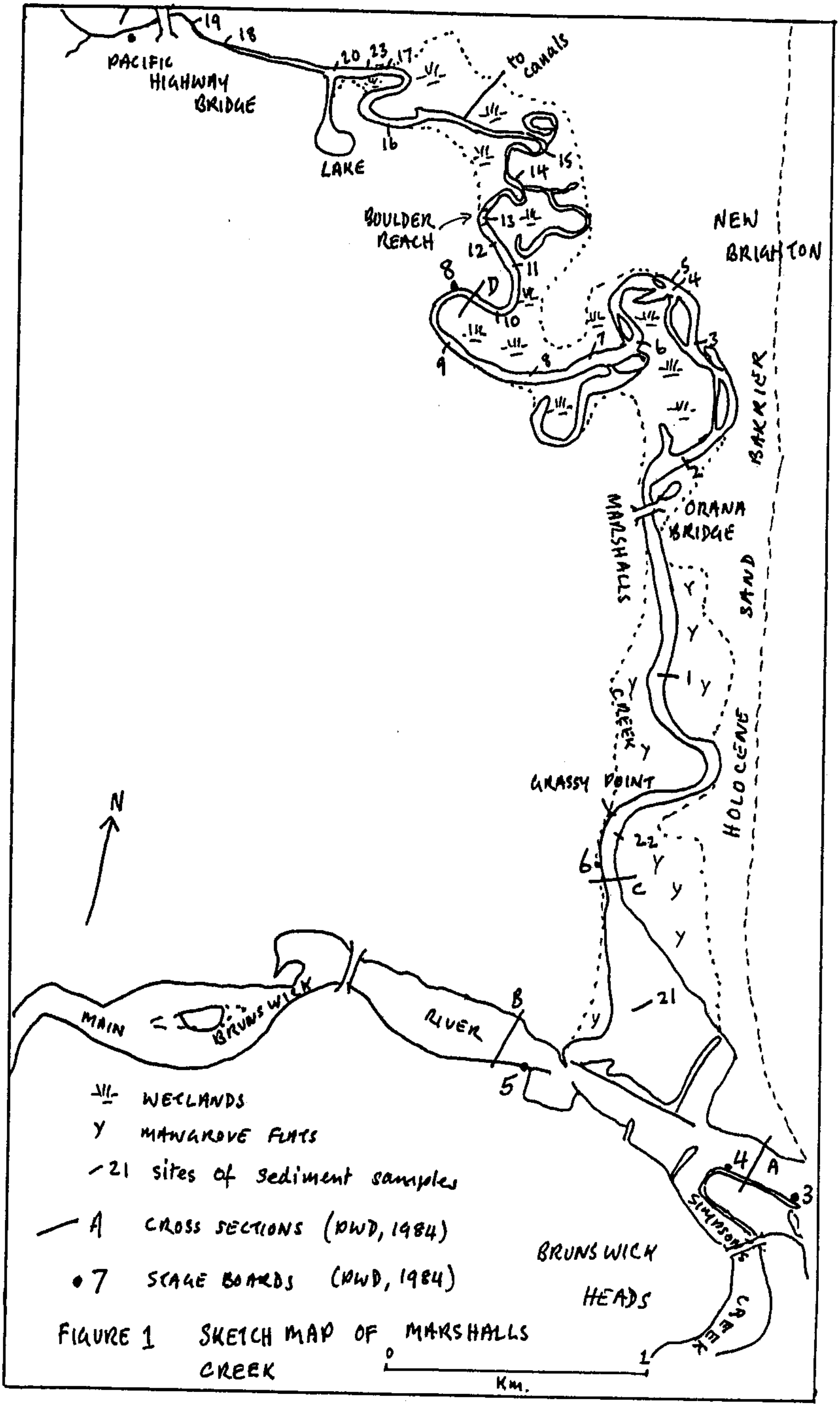

FIGURE 1 SKETCH MAP OF MARSHALLS CREEK

APPENDIX A

ANALYSIS OF RIVER SAMPLES FROM MARSHALLS CREEK, BRUNSWICK HEADS, NORTHERN NEW SOUTH WALES.

Darren Skene

A total of 23 samples collected from the channel of Marshalls Creek were analysed using a binocular microscope. The results are summarised below and detailed analyses are given in Table 1.

Three distinct sediment types are recognised:
(a) fluvial sediment
(b) reworked coastal sand
(c) marine sand

Fluvial Sediment

This is derived from terrestrial erosion of the country rocks in the hinterland and, as a result, they are rich in lithics. The sediment is grey to dark grey, very fine to very coarse, poorly sorted, subangular to angular and contains no shell. The sediment composition reflects the rock types in the river catchment. In Marshalls Creek these are Palaeozoic metasediments.

Reworked Coastal Sand

These sands are reworked from coastal barrier/dune systems intersected by the creek. They are predominantly quartzose in composition with a trace of lithics. The sand is typically pale fawn grey to pale grey, very fine to fine grained, well to very well sorted and subrounded to subangular. Larger fragments of esturaine shell occur occasionally.

Marine Sand

This is texturally and compositionally similar to the reworked coastal sand, but it can be distinguished from the latter mainly by its pale orange-fawn colour and the occurrence of marine (as well as estuarine) shell fragments. The distinctive colouring is due to iron staining of the sand grains. These sands are transported and deposited by ocean waves and tidal currents.

This pattern of mixing or transition from fluvial to marine has been described by Roy and Crawford (1977) in their attempt to explain a sediment deficiency at the coast.Because currently rivers are not supplying coarse loads to beaches, they claimed that there was a sediment budget deficiency and coastal degradation. They also thought that North Coast rivers could be seen to be in Stage 3 of a four-stage model proposed by Davies (1974). The final stage corrects this negative balance of coastal recession as rivers provide a more continuous load to the shore line.

This seems to be the case in this very small estuary. Only suspended fluvial loads reach the ocean. The coarser sands and gravels are held up some 7.2km channel distance from the training wall. So estuaries are slowly being filled in by various kinds of material. This is essentially the geological view of progressive sedimentation into the sink created by the transgression and the subsequent barriers. Apparent stability involves a shorter (engineering) span of time and this may be examined in three ways: the present, the immediate past and the future (without or with modifications).

Present-day stability seems to be indicated by a comparison of 1983 and 1988 cross-section surveys. This work has already been carried out by Webb McKeown. However, the stability noted in just two surveys six years apart may be more apparent than real. For instance, in a 12.5 month period 1970-71, just south of the north training wall in the Brunswick River, vertical variations were recorded along 5 traverses some 2000m long in five surveys. Maximum scour was up to 2.5m and, in some cases, the end survey was not greatly different from the first. Given the smaller estuary of Marshalls Creek and a more protected location with lower flows, the variations may well be much lower but they could still perhaps involve 1m or more. Much depends on duration and magnitudes of above threshold velocities, as well as the general state of the tides, in high runoff events leaving the flatter wetland environments west of New Brighton.

Immmediate-past stability is harder to understand without survey evidence. Three things have operated through the last 100 or so years to affect stability: changing catchment conditions, changing channel conditions and changing natural regimes.

Changing catchments conditions have probably increased runoff and suspended sediment loads, following eforestation, farming and the creation of some urban areas. ny bedload increases would have resulted mainly from hannel erosion and reworking of coarse bank materials.

Changing channel conditions have resulted from human ction and natural events. The addition of training walls, nitially near the Heads in the late 19th Century and then n the north wall to improve navigation in the Brunswick iver, has certainly altered the lower estuary (PWD charts).

The latter work has undoubtedly increased accretion with much sand having been added to the lower estuary since the late 1960s. Not all the PWD sources have yet been found and examined.

Channel changes may also have occurred as a result of variations in the natural regime. The late 19th Century is known to have been flood dominant; the first five decades of this century were much drier with few big floods and the period from 1949 onwards has again been flood dominant. Frequent floods of high magnitude in flood-dominated regimes (FDRs) have increased channel dimensions and have caused channel location changes. There is some evidence for this perhaps in the cutoff meanders in the wetlands area between the lake and New Brighton. For instance, at some earlier stage (probably not that long ago), the inclusion of the old meanders would have made the channel length from Site 20 to the Orana Bridge 5.8km. Sinuosity (channel length/valley length) was then very high at 2.3. Now the distance is 4.7km and the sinuosity has been reduced to 1.9. The loss of more than 1km has been effected by greater discharge (the former meanders are smaller in wavelength and channels were narrower) and some coarsening of the load. When this occurred is not evident as yet (may have been post-1949 but perhaps it was in the later half of the 19th Century). Below the Orana Bridge the channel length is 2.5km and sinuosity much lower at 1.2, indicating a coarser sand-perimeter channel and perhaps higher energy.

Future changes in stability may be of two kinds: those associated with no modification to the present channel and those with dredging for flood mitigation (or navigation as in PWD, 1984). In the former there would probably be a slow loss of capacity with the addition of lithics from the catchment and more marine material in the lower estuary. Some kind of channel would be maintained for the evacuation of water and fine sediments. Such slow changes might be accelerated by more catchment development and the maintenance of a flood-dominated regime.

The latter case cannot really be commented on in detail because data on location, size, shape and so on for the dredged channel are not available. The following speculations are apparent:-

(a) much of the lower part of any dredged channel will be cut in mobile sands, which are subject to reworking at fairly low velocities;

(b) west of New Brighton the tidal range will be increased, as will the prism volume (these are to be offset by increases in cross-section area);

(c) boundaries upstream and downstream of dredged reaches will need careful attention (NB PWD 1969 plan for western entrance through training wall);

(d) upstream there will be some potential for rejuvenation of more confined reaches of undredged channel.

SUMMARY

1. Three distinct channel types occur in Marshalls Creek estuary: an upper, straight, high-bank fluvially-dominant reach (900m); a tightly-meandering, low-gradient, low-energy, flanked by wetlands, reach, dominated by reworked marine-sand bedload (4000m); and a straighter, mangrove-flanked, sandbed channel, with steeper tidal gradients (more tidally dominant) (3200m). The latter is characterised by more mobile marine sand and reworked marine sand.

2. With the exception of fluvial materials and the lag gravels at site 13, both of which contain lithics derived from the catchment, all the bedload is potentially very mobile. Most of it is very fine to medium sand from marine sand and reworked marine sand.

3. Present stability is evident west of New Brighton from the wide plane bed, mud and bioturbation.

4. Present instability south of New Brighton is seen in micro and meso bedforms, due both to higher tidal energy and to more confined flood runout.

5. Dredging will modify both stable and unstable environments through the increased hydraulic efficiency of a deeper channel, a higher tidal range and a larger tidal prism, as well as more effective flood drainage.

6. In such potentially unstable bed sediments, there will be stability problems which will need to be carefully considered in the planning and design stages of any proposed works.

7. With more time and resources, more detailed work could be undertaken on sediment ages, the depth of scour and fill and problems associated with transient changes.