

Riparian Cadastral Boundaries: A Step Toward Reform

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ABSTRACT

The subject of riparian cadastral boundaries would, on initial examinations, appear to be well understood by surveyors in New South Wales. Surveyors have been undertaking such boundary definition for hundreds of years so you would think they have it down pat by now. But look a little closer and you will soon discover the truth is far different, as in some instances practice and subsequent determination do not comply with the definition for the boundary. Within just the proceedings of the last 20 years of APAS conferences there have been a number of papers presented that bring into question not only the methodologies used by surveyors to determine a riparian cadastral boundary but also the very definitions that form the basis of those boundaries. Through the avenue of the conference papers, reforms, or at the least review, have been called for. To date there appears to have been little movement toward undertaking those reforms. Now is the time to put something forward on which to make a basis for reform. From previous papers the misinterpretations of both tidal and non-tidal riparian cadastral boundaries have been brought forward into this one place. Alternatives are then offered that could form the basis of reform. Even the doctrine of accretion and erosion is dealt with. No conclusions are drawn as that is not the purpose of this paper. This is just the basis upon which to formulate future dialogue.

KEYWORDS: *Cadastral surveying, riparian cadastral boundaries, reform.*

1 INTRODUCTION

The definitions for the various riparian cadastral boundaries have been handed down to surveyors to interpret from legal deliberations, interpretations and precedence, some from more than 100 years ago. The definitions are complex, difficult to understand, and in some instances without adequate explanation to positively identify all necessary components. Over time, surveyors have applied their own interpretations and practices that do not necessarily comply with the strict wording of the definitions. Some riparian boundary practices that have evolved are not compliant with the legislated requirements. The fault for non-compliance does not necessarily lay solely with the surveyor. The legal representatives that tried to define a complicated natural phenomenon did not necessarily fully comprehend the complexities of what they were undertaking. Their interpretational choices sometimes result in ambiguous and contradictory results that do not satisfy what they envisaged (Blume, 1995; Songberg, 2015).

Investigations within the literature listed have shown that there are disparities between the happenstance of the riparian boundaries, the legal interpretation and definitions intended to define the natural phenomenon that creates the riparian boundaries, and the practical methodologies of surveyors to undertake the physical determination of the boundaries. Today there is a greater understanding of the natural phenomenon that creates these boundaries than was available during the first attempts at definition by legal professionals. The reason why the

disparities exist today is that we are still trying to use, inappropriately, those inadequate definitions. The only way in which the situation can be rectified is for something to change. The easiest way forward is to change the legislation by changing the definitions so that they better represent the riparian boundary and make it clear and practical as to what is required. Such a change is only likely to be effected if the legal precedence is abandoned and a more physical practical approach taken.

2 TIDAL BOUNDARIES: MEAN HIGH WATER MARK

The definition of the Mean High Water Mark (MHWM) boundary requires the determination of the tidal plane Mean High Water (MHW). The current definition, contained in the Surveying and Spatial Information Regulation 2012 (NSW Legislation, 2016a), is “*Mean High-Water Mark means the line of mean high tide between the ordinary high-water spring and ordinary high-water neap tides.*” The original definition, with no reference to ordinary, was handed down from an 1854 court case in England, *Attorney General v. Chambers*. It was later modified in 1907 by another court case *Tracey Elliot v. Morley (Earl)* which added in the ordinary, resulting in a definition that may be impossible to comply with. Unfortunately neither party fully comprehended the complexity of the tidal regime and their attempts at definition result in highly fluctuating determinations of MHW (Songberg, 2015).

The definition itself is lacking in both meaning and reliable direction for surveyors to positively establish the tidal land boundary. Figure 1 shows that the MHW is actually the line along the foreshore that the MHW surface traces across the land. When comparing Figure 1 to the definition, the shortcomings of the definition wording become clear. The definition does not define the line along the foreshore, which is the MHWM, as there is no reference to the foreshore or to the land. The definition instead is an attempt to define the MHW surface. The two parts of the definition do not equate.

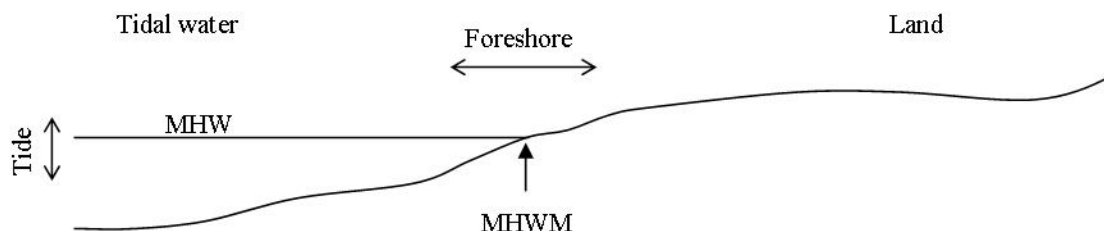


Figure 1: MHW and MHWM.

The shortcomings of the definition are further compounded by the lack of positive identification of both spring and neap tides. There is no clear or exacting definition of either (Songberg, 2015). About all that can be determined is the spring tides occur around the time the earth, sun and moon align and the neap tides occur around the time when the moon is perpendicular to the sun-earth alignment. The interval in time between these two events is approximately 7 days. Add to this the uncertainty of ordinary and the surveyor is left with no guidance at all.

Adding to the uncertainty was the Manual of the NSW Integrated Survey Grid (ISG) (Lands, 1976) in which an alternate definition was given that was in contravention to the legislated definition: “*Mean High Water ... is the mean of all high tides (including both spring and neap tides) taken over a long period.*” At least in this definition both parts equate in that the definition is for MHW. Although the MHWM is the subject of this part of the publication, and

often mentioned, there is no definition of it in the manual. The manual goes through a number of processes of defining the MHW surface (and sometimes confuses MHW with MHW) but does not give any direction that the intersection of that surface with the land is the MHW. It is left to the surveyor's interpolation to arrive at that conclusion.

Recognised survey practice methods to determine MHW have evolved as a consequence of the ISG manual publication. Even so the surveying practices that have evolved do not comply with the strict wording of either the manual or the regulation definition. Both definitions require an observation to be undertaken of high tides between the neap and spring. No surveyor does such. Most determinations undertaken over the last few decades use the published tidal plane analysis of MHW that is a result of mathematical modelling, which is not compliant with the legislation definition. As a consequence, every boundary determination undertaken using such data does not comply with the Surveying and Spatial Information Regulations of the time, potentially making all invalid (Songberg, 2015). Further investigations into the practices postulated in the ISG manual have also shown that they produce inconsistently accurate results so that considerably different answers will result from the different methods. Even using the same method over time produces similar fluctuating results (Songberg, 2005). Should an attempt be made to fully comply with the regulation definition, the 7-day observation period required will produce widely fluctuating results (Figure 2). That is, if it is even possible to comply as positively identifying the end points which measurements need to be taken between is virtually impossible (Songberg, 2015). If surveyors produced MHW determinations based on these MHW surface levels, it is likely that litigation occurrences would escalate.

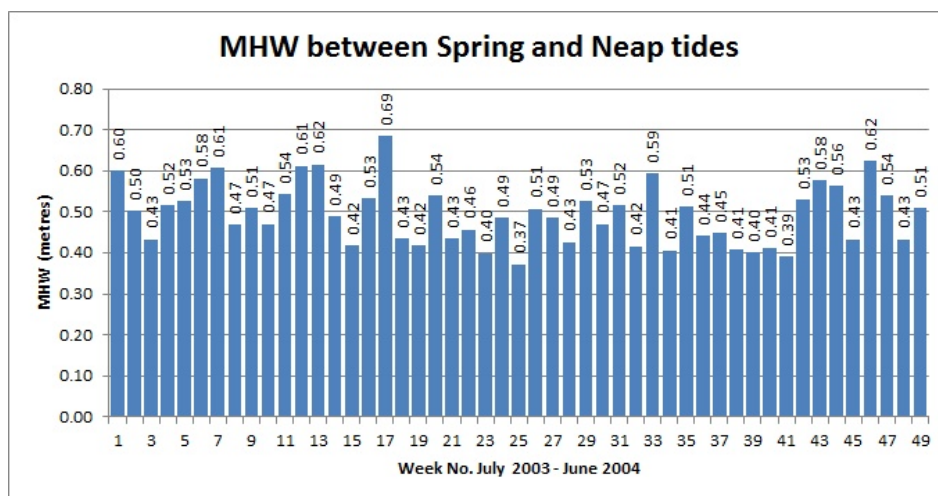


Figure 2: MHW observation using 7-day period neap-spring tides.

Neither the Surveying and Spatial Information Regulation, the ISG manual definitions or current determination practice recognise changes in sea level. Within present climatic changes there is a sea level rise, around NSW of about 3 mm per annum. The Surveying and Spatial Information Regulation definition cannot deal with the phenomenon due to its limited (7-day) observation period, which the definition wording requires. The ISG manual definition, despite requiring the observation to be taken over a long period, also cannot deal with sea level rise because the phenomenon limits the period in which a mean can be determined. The study of 20-year datasets for MHW, from the Public Works Manly Hydraulics Laboratory publication OEH NSW tidal planes analysis 1990-2010 harmonic analysis (Couriel et al., 2012), shows sea level change is detectable within that period (Figure 3). The MHW values used today (2016) are mostly a product of the mean for the 1990-2010 period. As a consequence, they are

already out of date and, when compared with the overall trend in sea level change, will result in determinations of MHW being made too low. Further study is required to determine the time limit for which a MHW value can be held constant and not significantly differ from the trend before a definitive answer can be given. The limited study over the 20-year datasets produced some mixed results which require further investigation (Songberg, 2015).

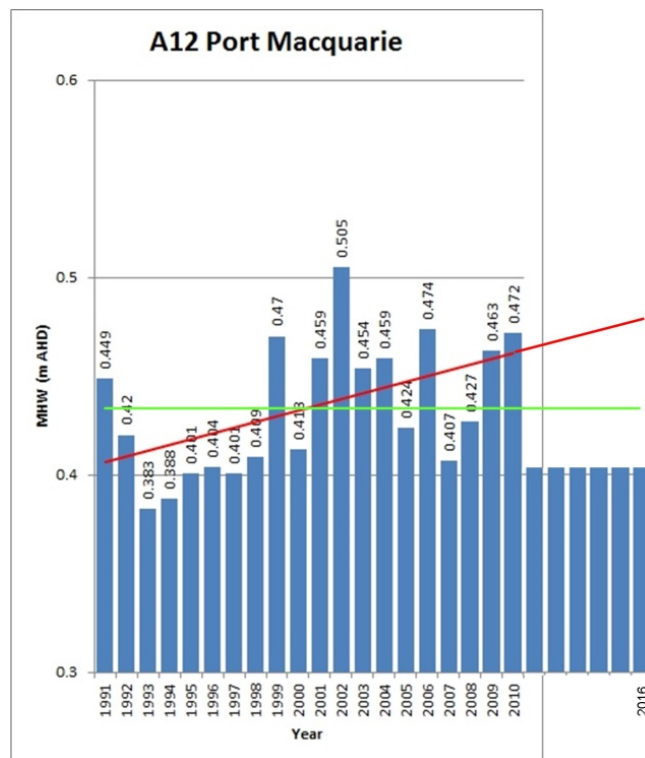


Figure 3: Mean high water trend v. mean from 20-year dataset extrapolated to present day, illustrating the consequence of not considering sea level rise.

Community expectations require the MHW boundary to be determined with reasonable accuracy and consistency over time. The community, including land titling, has yet to come to terms with sea level rise, although it is detectable and measurable. Highly fluctuating determinations from week to week as required by the regulations (Figure 2), month to month or year to year from tidal analysis (Figure 3) would not be acceptable nor would they be tolerated. There would be considerable litigation if one surveyor determined the MHW boundary tens of metres different to the neighbour or changed the location significantly from a previous but recent definition as a consequence of the variability in determination methods.

Assuming the MHW is to be retained as a tidal boundary, it of course does not have to be, the definition must consider sea level rise and produce reasonably consistent results over time. Of the methods of determination available to surveyors, only the use of long-term tide gauge data and tidal planes combined with the trend in change over time due to sea level rise is able to provide some uniformity and consistency in results.

2.1 MHW: A New Definition

There is a fundamental difference between MHW and MHW. The Mean High Water *Mark* is just that, the mark that the *plane* of mean high water makes against the shore. This fundamental difference is often misused or simply not considered and sometimes incorrectly interposed. The Surveying and Spatial Information Regulation 2012 is the most classic case of

misuse. There is no mention of the shore so the definition actually refers to MHW and not MHWM. The definition of MHWM should be *the line which the plane of mean high water makes against the shore*. There should be a separate but companion definition of MHW.

2.2 MHW: A New Definition

The definition in the Surveying and Spatial Information Regulation could simply have the header changed to mean high water and leave out the mark. The issue with that is the inconsistencies and uncertainties within that definition make it impossible to use. In order to allow current determination practice to comply, the new definition should be related to the established tide gauges. There is also a need to recognise sea level change to a new definition by the application of the trend in values calculated by harmonic analysis over the entire record length of the gauge and extrapolated to a maximum of 2 (or other appropriate period) years after the last published value. Such a definition for MHW could be *the trend value of MHW determined from year to year by harmonic analysis of an established tide gauge (for the full length of record) as determined for the date of survey extrapolated a maximum of 2 years after the last yearly determination of MHW*.

Alternative methods must also be available for use in areas where the tide gauge network does not extend. Such methods could be environmentally based, and range-ratio methods might also be applicable. Simple immediate on-site estimation is most likely in the more remote areas. Experience has shown that the tide gauge method will be applied in areas of greater population where more accurate results are expected and other methods used in more rural and sparser populated areas. The adoption of such a definition will first require the complete revision of all tidal data as well as the review of all tide gauges.

2.3 MHWM: Definition Limits

The current upstream limit to which MHWM determinations extend is the tidal limit, the location of which is usually recorded on the parish maps. That limit, however, is mostly based on the maximum reach of the tide. The difference between MHW and the highest tide, which determines the tidal limit, could be more than 0.5 m. There could be a significant difference in the distance upstream, which MHW will reach compared to the current tidal limit. A lot will depend on the nature of the individual stream profile. Any differences are not currently determinable. However, there could be an impact on what titles have tidal or non-tidal boundaries, especially around the changeover point.

2.4 An Alternative Tidal Boundary

The use of MHW to define the tidal boundary is entrenched in history. The tidal boundary does not have to be limited so. The recognised tidal limits are not based on MHW so that some MHWM boundaries near the tidal limits, under a MHW regime, may not actually be such. An alternative tidal boundary is to adopt the full reach of the tide as the indicator of the boundary. Such is already likely to occur in areas where tide gauge readings are not used and the boundary is determined by the surveyor's instantaneous observation of the environment. MHW is somewhere within the tidal environment, and use of MHW does result in some of that tidal environment being held within the land-based title. Use of environmental indicators coupled with a fuller tide than MHW to indicate the boundary would separate tidal and land-based environments. For example, the location of the MHWM in Figure 4 is uncertain and would depend on the method used. The division between land and tidal environments is clear,

located between the mangroves and oak trees to the right of the picture. To place the boundary at this point has some merit. Such a boundary would simply be labelled as the *tidal boundary*.



Figure 4: Tidal flats.

3 NON-TIDAL BOUNDARIES: THE BANK

It is unknown where the definition of the bank of a non-tidal stream originates or whether it has changed, but it comes to us in the present from section 172 of the Crown Lands Act 1989 (NSW Legislation, 2016b). The definition is, however, convoluted and also includes the definition of a lake. The application of the same definition to both lake and stream is not necessarily compatible.

The definition states “*bank means the limit of the bed of a lake or river*”. At first, this sounds simple but the definition depends on firstly defining the bed and therein lay the complications that cause grief to surveyors and are the cause of varied results.

It is stated that “*bed means the whole of the soil of a lake or river including that portion:*

- (a) *which is alternately covered and left bare with an increase or diminution in the supply of water, and*
- (b) *which is adequate to contain the lake or river at its average or mean stage without reference to extraordinary freshets in time of flood or to extreme droughts.”*

3.1 Stream Banks

Surveyors historically have had difficulties coming to grips with exactly what constitutes the bed of a stream and therefore the bank. Some will go to the water’s edge as it existed during the time of survey, while others will extend to the low bank often found located beside the water or channel, while others extended their interpretation to the major bank at the far extremity of the river gravel beds. Some have even interpreted the definition to be the usual stage rather than the average or mean stage. The usual stage is closer to the low flow than the average and is contained in a smaller channel within the bed and does not extend to the banks (Songberg, 2012). As a consequence of the varying interpretations, the position of the bank as defined can vary considerably and still not equate to the definition as worded. The main issue that clouds the definition process is the qualitative nature of the surveyor’s interpretation. Different people will view the same stretch of stream and choose differing locations as to what they consider the bank. Factors, other than stream flow, such as vegetation, soil structure

and the existence or lack of water influence the determining process. The definition, however, makes no mention of these other factors but relies solely on stream flow and an analysis of which quantum of stream flow is required to determine the average stage. Somewhere in Figure 5 is the cadastral bank. It is not likely to be at the edge of the water or at the high bank to the rear of the river flats. Only through stream flow analysis and cross section data can a reasonably reliable assessment of the mean flow, and thus the cadastral bank, be made.



Figure 5: A non-tidal stream.

Mathematical analysis of stream flow data from long-term stream gauges has found that it is possible to remove the qualitative nature of bank determinations and replace it with a purely quantitative mathematical determination (Songberg, 2012). The mathematics indicate that the mean stage, without reference to extraordinary freshets in time of flood or to extreme droughts, is little different, if any, to the simpler, mean of all stages (Figure 6). The usual flow is closer to the mean annual low flow than the cadastral or total mean.

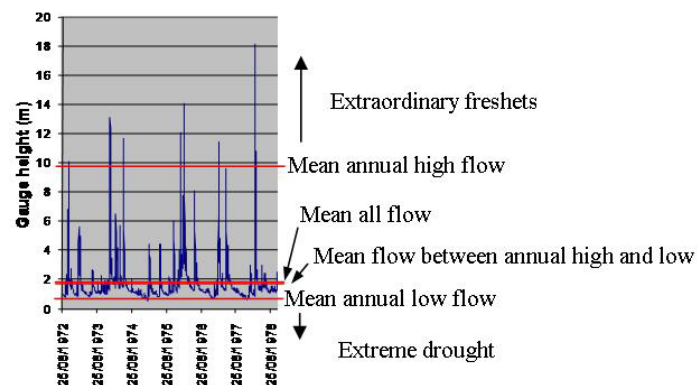


Figure 6: Flow relationships in a typical river regime.

What the mathematics also found was that the resultant cadastral bank is approximately the rear of the lower level gravel beds that sometimes lay close to the low flow water channel. Also the mean flow is only around 0.5% to 3% of the stream's maximum capacity. As a consequence, the cadastral extent of the bed will only be a small percentage of the entire riverine geological structure. The resulting bank is also considerably lower than the geological bank, which is often associated with the term bank full discharge. As a consequence, there will be a disparity between the cadastral land title bank and the geological bank.

From time to time reference to the high bank also forms part of the land title. Surveyors have also found that upon remeasure of the land the chosen bank by the early surveyors was indeed the high bank. It may be that the early choice of the bank was given as the dividing line between the riverine environment and that which the farmer could fully utilise. This high bank is also likely to be synonymous with the geological bank. Such a choice in some ways may be the wiser choice as it becomes clear which is land and which is river. Having the cadastral boundary somewhere down in the gravel flats causes considerable confusion and without reliable stream flow data any assessment is purely qualitative, open to a variety of interpolations with none likely to be correct.

3.2 Stream Bank: A New Definition

With the variety of banks available within and about the riverine environment, there are any number of choices which could substitute the existing definition. Maintaining the status quo as much as possible, the existing definition could be simplified to *the bank of a non-tidal stream is the outer extent of the bed sufficient to contain the stream at its average or mean stage*. It is then left to the surveyor to determine the likely average or mean stage with reference to the whole extent of the river dynamics, something which would be extremely difficult without stream flow data. Another possibility is to entirely separate the riverine environment from the land environment. In Figure 7, the extent of the river environment becomes a little clearer when compared to Figure 5. From this aerial vantage point, it would be a valid consideration that the river extended to the high bank which was seen in Figure 5. This aerial view and other landform characteristics are likely to be factors in locating the stream extent, as is a reference to the geological bank. The surveyor, using such factors, would be tasked with locating the bank by separating the stream and land components.



Figure 7: Aerial view of a non-tidal stream bank consideration.

What should be stressed is that the water's edge does not form the limit of the stream and never has. It is a common misconception that is even used by some surveyors. The water's edge is usually the much diminished low flow and is found in a much smaller channel within the confines of the much larger riverine structure. As with tidal boundaries, the non-tidal could also be defined by environmental considerations. Whether the high bank or the geological bank defines the limit of the stream is yet to be determined. Some non-tidal stream titles already exist that are defined as "the high bank" and even "the extreme margin of the

river”, so extending the extent of the bed to include the wider river structure could be acceptable. Describing such a boundary may not necessarily be the called bank but could simply be called the “river (or creek or stream) boundary”.

3.3 Lake Banks

The bank, through the definition from the Crown Lands Act, also provides the limit of a lake. Lakes, however, are not subject to the same influence as streams. Many lakes, especially inland, are either dry or full. Coastal lakes are periodically tidal whenever the seaward sand barrier is breached, naturally or artificially. Determining the shoreline on the basis of the average stage does not reflect the extent of the lake environment. Inland the average stage might be a considerable distance out from the edge of what is environmentally, obvious to all, the edge of the lake.

The use of the average stage as part of the definition, however, does not extend to an artificial lake as such a lake is expressly excluded from the definition of a lake in the Crown Lands Act. It has been left up to a court case in 1895, *Yeomans v. Peter*, to determine that the top water level of an artificial lake, usually the top water level of a dam, forms the bounds of the lake, something that is not mentioned in the Regulation. As a consequence of this, different lakes have different methods of how their boundaries are determined. Some inland lakes are partially natural and partially artificial as a consequence of irrigation schemes. Whether natural or artificial, lakes tend to produce a naturally occurring division between the lake environment and the land. This natural environmental division will likely to be in contradiction to the result of the average stage being determined. In Figure 8, both a low water level and a high water level (the line across the face of the reeds) can be seen, but what is the bank of the lake? Is it the middle line in between or is it near the edge of the trees? Without long-term lake height data any assessment is purely guess work with each surveyor offering a different choice with potentially none being correct. Such is the failing of trying to find the average or mean stage by purely visual assessment. The environmental extent of the lake, however, is more easily identified. The average or mean stage and the environmental extent of this lake are also not likely to be the same.



Figure 8: Consideration of a lake boundary.

3.4 Lake Bank: A New Definition

The determination of the extent of a lake needs to be made consistent with all types of lakes. A reference to a bank determined by an average or mean stage does not do that. The extent of a lake must include the whole of the lake, not just part. An environmental style assessment as to what is lake and what is land is more likely to provide a meaningful interpretation of the

limit of a lake. Thus any definition should reflect such a scenario. In part, the determination of the extent of an artificial lake meets such criteria. Similar to the determination for a stream, “lake boundary” would be the alternative description.

4 THE DOCTRINE OF ACCRETION AND EROSION

Quite simply, the doctrine should be abandoned. It should be replaced with the premise that if nature moves the physical boundary of the stream, lake or shoreline, then so too does the boundary of the land move. Artificial right line boundaries should not be a barrier to this premise. Nature does not recognise such boundaries. Conversely, if man moves the physical boundary, then the title boundaries associated do not move. In Figure 9, the physical river and the river defined by old cadastral boundaries, centred on the blue line, are for the most part separate entities. Land occupation and land tenure may also be two differing entities. The changes have not been by gradual means and the river is likely to change again at the next major stream flow event.

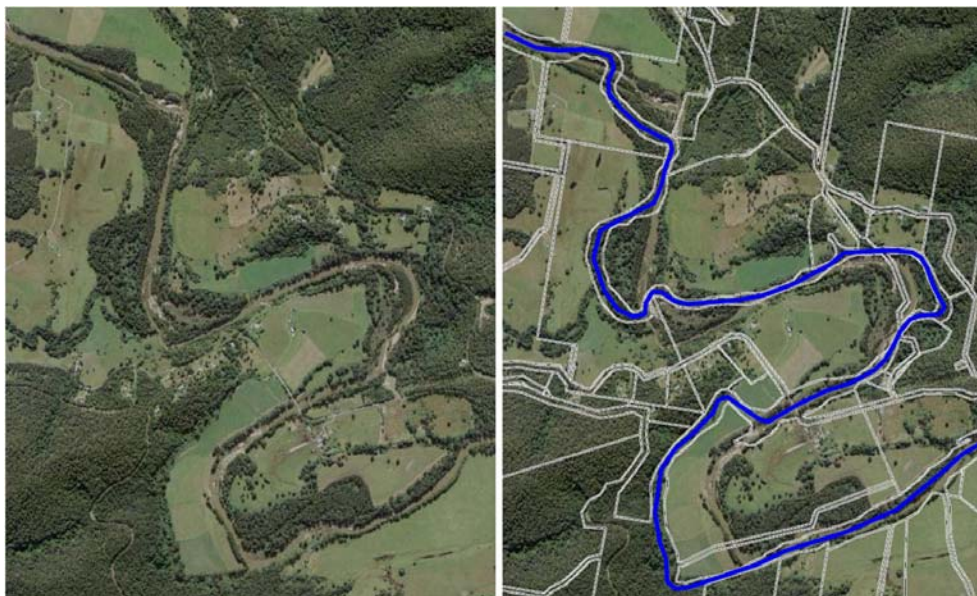


Figure 9: River changes.

The doctrine was formulated in a bygone era in environments that differ considerably to Australia. Environmental conditions in Australia that physically control the position of the riparian bounds are more known for their extremes than their consistency. It is those extremes, which occur in a random series of events entirely dependent on the vagaries of the weather, that shape the banks of streams and our shoreline (Songberg, 2002; 2004). The doctrine does not help the land owners in Figure 9 in determining the extent of their land. The river does, however, determine the extent of land which is occupied.

The normal day-to-day flow of a non-tidal stream is the low flow which does not have sufficient capacity in both force and volume to touch the banks let alone erode or add to them. It takes a flow event that statistically is only likely to occur every 1 or 2 years to even reach the bank. In the case of *Boyle Concessions Ltd v. Yukon Gold Co 1917* (unfortunately not an Australian case but it shows how the legal mind works), a yearly monsoon induced flow was not considered as one that would cause gradual change. What then does that mean for Australia where statistically such bank-reaching and potentially change-causing flows only

occur once every year but in reality happen randomly? Such an event could occur 2 or 3 times in a single year or not occur for 10 years (Songberg, 2002; 2004; 2012). What does that mean for gradual change?

In tidal streams, islands tend to migrate downstream and bank bars or spits habitually point downstream (Figure 10). If the ebb and flow of the tide were the contributing factor in shaping the streams then these two phenomenon would not occur. In contrast, down around the estuary mouth sand is constantly being draw into the estuary from off the coast suggesting that it is the inflowing tide that has the greater strength despite extra water being theoretically available to the outgoing tide. If the outflow tide were the greater then materials would constantly be pushed out to sea rather than there be continual calls for dredging from the community. Unless there is physical intervention, it is the major flow events that push materials back out to sea and at times unplug the bar that sometimes builds up preventing any ingress or egress of water.



Figure 10: Downstream pointing bars and migrating islands in tidal estuary.

The doctrine does not work in Australia and never has. Trying to comply with it results in uncertainty and disappearing rivers in a titling sense, not physically. As a consequence, we can lose the integrity of the river and have it subject to individual manipulation to the detriment of the wider community. The title extent of the land either side of the river in Figure 9 is a mess. It would be even worse if the changes had been gradual. If there are instances where gradual change does take place, more extreme forces tend to come along randomly and completely remove or significantly alter those smaller changes, negating all that was done. There are many instances along the coast where storm events erode the beaches, taking away the sand that was gradually built up, pushing the beaches inland and threatening property.

Although it has been happening since the last ice age, the new awareness of climate change and the accompanying sea level rise must also be incorporated in a new doctrine. It should be noted that these two phenomena are fact, something that has so far been ignored in formulating tidal boundaries. The influence that man's actions have on these events is, however, still subject to debate and does not form part of this discussion. If the land is to make way for the sea, and only the erection of a dyke, being continually raised higher, around the country will prevent this happening, then so too must the land title make way for the commonly held title of the sea, irrespective of whether the boundary is right line or ambulatory. Inland the land must also make way for the movement of a river. Physically the

two environments cannot coexist. Title should reflect the physical state and not overlap the boundaries between the two entities. There is, however, nothing stopping title being issued in either entity. There will, however, need to be different criteria in how such title would operate in the riverine or marine environment. The present doctrine of accretion and erosion cannot cope with such a fundamental change in approach in dealing with riparian cadastral boundaries.

5 CONCLUDING REMARKS

At this point, there is no conclusion to what has been put forward in this step to reform of riparian boundaries. As the title implies this is just a step toward an unknown conclusion. The issues that have been raised in the preceding papers and the options expressed here might not even move forward. What should be, according to legislation, and what is, according to survey practice, are at times two different things. That needs to change. Changing survey practice to conform to current legislation is likely to create uncertainty in land title which is unacceptable due to the inadequacies of the legislation. Changing legislation to more align with survey practice would create greater certainty and consistency. But in saying such, there also needs to be some change in survey practice as well. Survey practice is not always consistent as surveyors, like everyone else, have differing perspectives to the same scene. Changing both legislation and survey practice to align with the natural environment also makes a world of sense. What will happen in the future is unknown. It is possible that nothing will happen but it is hoped that this will not be the case.

ACKNOWLEDGEMENTS

I would like to thank, or maybe not, Peter Blume for presenting his paper at the first APAS conference in 1995. It was possibly his questioning of mean high water more than anything else that set me on the course of 20 years studying, rather closely at times, the intricacies of riparian boundaries. Much of the opinions expressed in this and previous papers come from direct observations and through many case investigations. This paper is perhaps the evolution of all those that precede it.

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