



Bowen Collinsville Enterprise

Don River Sand and Flooding

Briefing Report

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Bowen Collinsville Enterprise

Briefing Report on Don River

1. The Don River

1.1 Preliminary Information

The Don River has a long and well documented history of major floods which results in serious damage as they traverse the river's delta to the sea. Queens Beach is particularly vulnerable as it lies immediately east of the existing river mouth and in the path of a major overflow distributory channel. If there is any eastward migration of the present mouth or major flooding then there will much damage to dwellings at Queens Beach.

Queens Beach is particularly vulnerable to a major flood as a result of

- The uncontrolled nature of the river as traverses the lower flood plain and delta.
- The very high bed load carried by the river in full flood.
- The propensity of the flood outflow channels to become blocked. The importance of the outflow channels cannot be overstated. In the 1980 flood it is estimated that only 18% of the total river discharge was conveyed by the "old mouth".
- The location of Queens Beach in relation to the Old Mouth and the Bells Creek and Webster Brown outflows
- The erodible sediments underlying Queens Beach.

It is important in any flood management strategy for the lower Don River that the existing distributory channels are maintained in respect to both conveyance and position within the flood plain.

The river is characterised by a series of distributory channels which convey a major proportion of the total flow as it passes through the delta to the sea. Some of the more important of these channels with estimated percentage of total discharge for the 1980 flood are:

Old Mouth	14.1%
1946 Mouth	17.5%
Bells Gully	1.7%
Webster Brown Outflow	18.6%
Russells Crossing	4.5%

River Protection works have been undertaken at various parts of the river aimed at stabilising and enhancing the operation of the river.

1.2 Catchment Description

The Don River catchment forms part of the Don River Basin and comprises of an area of approximately 1100km². Most of the upper reaches of the catchment have remnant vegetation however the lower reach has been extensively cleared for agricultural and urban land uses.

A copy of the catchment area is contained in Appendix A.

1.3 Reports Undertaken

There have been a number of studies focusing upon the catchment and floodplain:

- Don River Floodplain Management Study (1993)
- Fluvial supply of sediments to the Queensland Coast
- Queensland Riverine Sediment Transport Rates
- Queens Beach Flood Study (Ulman and Nolan 1998)
- Euri Creek Catchment Flood Study and Don River Sand Depth Study (2005)
- Don River Engineering Works Risk Management Assessment (Ulman and Nolan 2001)
- Don River Sand Study Don River Catchment Study (2011)

Extracts from these reports are included in this brief.

2. Don River Sand Management

The following information in relation to creation of a low flow channel and sand matters has been extracted from the Euri Creek Catchment Flood Study and Don River Sand Depth Study (2005) and the Don River Sand Study Don River Catchment Study (2011)

2.1 Don River Sediment Study Key Outcomes from Investigations

An extract from the Euri Creek Catchment Flood Study and Don River Sand Depth Study with reference to the Don River Sediment Study outlines the outcomes of the investigation.

2.1.1 Don River Sediment Study

The key aim of the Don River Sediment Study was to undertake a sand depth survey to assess sediment transport and storage in the Don River Channel.

The Executive Summary from the Don River Sediment Study Report prepared by Hydrobiology Pty Ltd for Connell Wagner In September 2005 states:

- The Don River bed is aggrading.
- The current rate of catchment sediment erosion is estimated to be approximately 11 times the pre-European value.
- Sediment delivery ratio (i.e. the proportion of eroded catchment sediment that actually reaches the stream network prior to being re-deposited) is generally high at 55% (i.e. the sediment “conveyor belt” is quite efficient at the start of the process).
- Most eroded sediment is derived from hillslope erosion (86%) compared to gully erosion (11%) and streambank erosion (3%). The hillslope erosion value is relatively high compared to Australia-wide values.
- The rate of sediment supplied to the river network appear to be greater than the ability of the river to discharge it to the coast.

- The current sand slug below the Pott's Line (approximately Walsh's Crossing) consists of approximately 8 – 9 million m³ of high grade quartzo-feldspathic medium to coarse sand.
- Thicknesses of this sand slug range from 0 – 9 m with an average value of 5 – 7 m.
- Approximately 40 – 60% of this may have been deposited in the last 15 years and has added in places up to 3 – 4 m depth of sand.
- Above the Pott's Line there is approximately 1.5 million m³ of sand as a slug in the channel awaiting downstream transport. This is supplemented by at least as much again awaiting transport to the river channel from adjacent slopes.
- If no flushing of the lower reaches occurs, then movement of additional sand may add approximately another 1 m to levels currently found in the lower reaches of the Don River Channel. This might be expected to occur over 10's of years (rather than 100's) depending on flood frequency.
- Predicted general scour depths for 20-year and 100-year ARI design flow events range between 2 m and 11 m at various locations in the river system.
- A mean general scour value of 5 to 6 m may be appropriate. This predicted value is supported by anecdotal evidence.
- Commercial sand extraction may be a suitable management option to reduce the volume of sand in the river.

In the lower parts of the river channel (Cheffin's Line/Richmond Road Line in the vicinity of Inverdon Road) sand depths are in the order of 5 – 6 m above the surface of Pleistocene/Holocene river bed boundary. From borehole evidence, augerhole evidence, field assessment, textural interpretation and allegorical evidence it is probable that approximately 3 m of this has been added in the last 15 years since the last moderate/major flood event of 1991 and the moderate flood events of 1993, 1999 and 2000.

In the middle sections of the river channel (Russell's Crossing Line, Bruce Highway Line and Webster's Line) sand depths are of the order of 6 – 8 m depth with approximately one half of this likely being of relatively recent (15 years) origin.

2.2 Estimate of sand volumes

A estimated volumes are shown in Appendix B.

The depth of sand in the channel of the Don River was estimated from borehole data, cross sectional data, geophysical data and field observational data. The transient nature of the depths of sand in the river channel means that the error in these estimates is high (approximately -50%, +200% relative).

The estimated volumes are show in Figure 2-3. It was estimated that there is 5.5 million m³ of sand below Potts Line.

The current rate of extraction is around 60,000m³ per year. Based on the estimate of 5.5 million m³ in the lower reaches with a further 1.5 million awaiting transport (Connell Wagner 2005) it would take over a 100 years to exhaust the supply.

2.3 Sand extraction regimes

Five different sand extraction regimes were applied to the revised flood model. The area of extraction was mapped in a GIS with a specified depth of removal. This was then applied to the flood model, the model rerun and the results were mapped. The extraction regimes were based on extraction relative to the current surface level rather than extraction to a defined surface level. This allows for a relative comparison of the flooding impacts. Sand extraction cannot occur within 50m of the banks of the river and this was taken into account when developing the regimes.

The volume of sediment which is transported during flood events in the Don River is quite significant when compared to other rivers along the Queensland coast. A comparison of the bed material load for various Queensland rivers. Based on the Bureau of Meteorology flood hydrograph for the February 2008 event and the bed material transport rates derived by Horn et al (1998) the volume of bed material transport was approximately 75,000 tonnes (47,000m³).

2.3.1 Sand extraction regime 4

The results of sand extraction regime 4 shows that an increase in flood levels is concentrated around the Inverdon Road crossing, with elevated flood levels all the way to both the old and new Don River mouths. Only a small section of the north-east of town appears to be affected, with reduced flood levels apparent in the both the main Bowen township and to the west of the town. Flood levels in the Don River are also reduced with significant improvements around the Aerodrome to Bell's Gully areas. These reductions are also found in the Doughty's Creek region of Bowen.

Sand extraction regime 4 is the most favourable in terms of limiting flood level increases to the rural area surrounding the Don River mouth, while reducing flood levels around the township of Bowen.

2.4 Discussion

The volume of sand transported along the Don River during high flow events is of a similar magnitude to the current rate of extraction. Issues are arising because the sand being transported during flood flows is not being discharged out the river mouth where it could be transported by coastal process. It is instead being deposited in the lower reaches of the river.

Sediment from flood flows is deposited in the lower reaches (that is, below the Bruce Highway crossing) as breakouts in the middle reaches reducing the volume (and velocity) of water in the river channel. As most of the sediment is medium to coarse sand it remains in the river channel rather than being carried in suspension with the flood flows. This process is a positive feedback loop as the increased sediment deposited increases the volume of flows directed through breakouts, which in turn increases the sedimentation of the channel. The current slug of sand in the river mouth is an example of this process at work.

Modelling of various extraction regimes has demonstrated that removal of sand from the river could reduce the severity of flooding in Bowen township. In particular the removal of sand to form a channel below the railway line could reduce flood levels in most of the urban areas. However the modelling has also shown that if sand is only removed from above the railway line then flood levels could increase. Regime 4 appears to be the best option as it requires the least volume of sand extraction while reducing the flood levels through the urban areas of Bowen township. A type cross section has been developed based on the profile modelled.

The volume of sand extraction modelled far exceeds the current extraction rates (approximately 60,000 m³ per year) from the river and is also above the current removal rate cap set by DERM. (DNRW 2008) However it is unlikely that this volume of sand would have to be removed on an annual basis. Any moderate to large event in the river would result in the accumulation of sediment in the channel however current bed transport rates (as discussed in Section 4.1) are much lower than the modelled extraction volume.

2.5 Profile and Concept Design of Low Flow Channel

The recommended profile for the Don River between the crossing of the Bruce Highway and the river mouth is shown in Appendix C. The intention of this profile is to provide a low flow channel which will ensure that sediment does not accumulate during small events and during large events it will create an area of flow with sufficient velocity to move some of the sediment which has accumulated in the lower reaches out of the river mouth. At either end of low flow channel the profile needs to be graded to blend back into the current profile. The bed profile which has been developed is based on a survey of the river conducted in 2009 and the recommended profile is shown relative to the surface level at that time. This profile was run through the MIKE 21 model to ensure that it was comparable to what was previously modelled and it was found that peak discharge under the Bruce Highway Bridge was 3239m³/s (as compared to 3,500m³/s as predicted in the 1993 Ulman & Nolan report).

The recommended profile has also allowed for the removal of a significant sand bank which has developed where the river branches between the current mouth and the 1946 mouth. The intention of the profile in this area is to ensure during high flow events the flow is not restricted however during low flow events the preferred outlet is still the existing mouth. By maintaining the low flow channel on the inside of the bend it is expected that high flow events will mobilise much of the material which is remaining in this area.

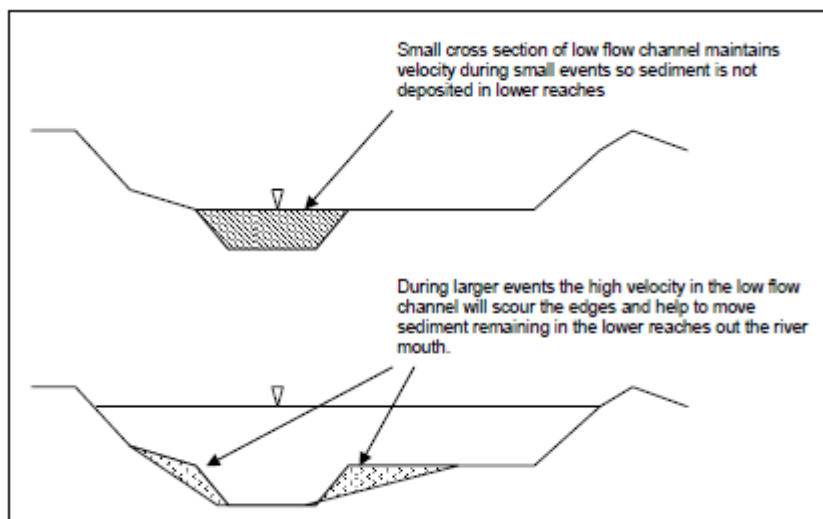


Figure 5-1 Concept design of low flow channel

Figure 5-1 Concept design of low flow channel

Due to the dynamic nature of the Don River bed it is difficult to define an absolute bed profile. For this reason, the recommended bed profile is based on a channel centreline, base width and bed level. Future extraction from the river should be based on these cross-sections but allowance needs to be made for variation from these exact profiles to ensure the actual profile of the river at the time of extraction is practical.

To this end, all extraction from the river should be based on the following rules:

- The minimum width of the low flow channel should be 50m at the base. This should be 25m on either side of the centreline as designed.
- Extraction should not occur within 50m of the defined high banks
- The base of the channel should be graded back into the existing profile at a slope no greater than 1 on 4
- Where the creation of the low flow channel results in sand banks between other areas of a similar level the channel should be widened to remove the sand banks (refer Figure 5-2)
- At either end of the extraction area the low flow channel should be graded back into the existing profile

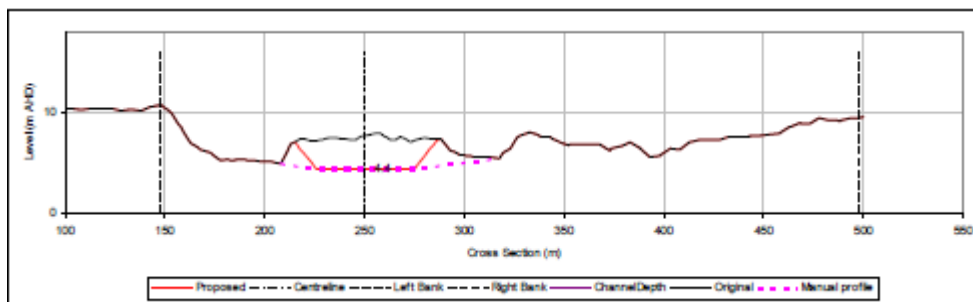


Figure 5-2 Example of profile correction to remove sand banks

2.6 Conclusions and recommendations

2.6.1 Conclusions

During flood events significant volumes of sediment (namely moderate to coarse sands) are transported downstream in the Don River which changes bed levels in the lower reaches. The level of sediment in the lower reaches needs to be reduced so that natural flushing of accumulated sediment during flood events can occur.

Modelling of the impact of sand removal in the Don River has demonstrated that removal of sand from the lower reaches (that is below the rail line) would reduce the flood levels through Bowen township.

The volume of sand extraction modelled far exceeds the current volume of extraction however it is unlikely that this would need to be removed on an annual basis.

2.6.2 Recommendations

As a result of this study the following recommendations are made:

- Sand extraction should be limited to the area downstream of the rail line. Extraction should be as per the recommended profile.
- A business case should be undertaken to determine if the channel can be constructed immediately. This would be dependent on approval from DERM.
- Additional flood monitoring should be carried out to improve the accuracy of the sediment transport formula developed by Horn et al (1998)
- A standard set of flood monitoring points should be adopted and peak heights recorded at each location for all events.
- Cross-section monitoring points should be established to monitor on-going changes to the bed levels and to determine if extraction regimes are effective in reducing sedimentation of the lower reaches.
- Measures should be investigated to reduce the level of erosion from the upper reaches of the catchment thus reducing the sedimentation of the lower reaches

3. 1946 Mouth

The 1946 mouth is an important distributory ranking in importance only behind Webster Brown in respect to flood conveyance. Deposition resulting from the number of small to medium floods that have occurred since 1980 is progressively closing off this channel. These smaller events have resulted in the building up of a sand island which are being stabilised by vegetation.

Concerns are that the progressive closure of this channel will direct additional flow to the old mouth and Webster Brown Breakaway. This in turn would increase the risk of catastrophic damage to the Queens Beach Township.

On this basis there would be a sound case for the construction of a pilot channel to re-establish and encourage small to medium discharges along the 1946 mouth.

The 1946 mouth is located completely within freehold land. It is not a boundary watercourse and as such, is not State land. Consent of the land owners would be required before any riverine quarry operation proposal could be considered.

4. Old Mouth

The mouth is characterised by shallow wide channels with a bar formation in the active wave zone. The mouth is prone to siltation. In the 1980 flood the upstream inlet to the old mouth was blocked by deposition. This propensity towards deposition in the old mouth is important in that any loss of conveyance could direct additional discharges along the Webster Brown outflow. Any increase in discharge would result in an increase in flood risk to Queens Beach.

The island at the mouth needs to be monitored and works undertaken to maintain a clear distributory channel and discharge for the river to mitigate against increased flows traversing the eastern flow channel which abuts the Queensbeach Township.

5. Approval Process and DNRM

Mr Gary Luck has prepared a Briefing Note in relation to the matters outlined above. The briefing note outlines information and matters that need to be addressed in the consideration and assessment of potential works. An extract of the briefing note is as follows:

4) Proposed future works for the River, including the '46 mouth

There are a number of considerations that are required to be investigated further before deciding the best way forward in relation to flood mitigation in the Don River.

Average Material Transport Rate

The Whitsunday Region Riverine Quarry Material Management Plan (the WRRQM Management Plan) developed by the department and the Whitsunday Rivers Improvement Trust in 1999 identified the Average Material Transport Rate (AMTR) for the Don River (as a whole system) being a maximum 70 000 cubic metres. The Riverine Quarry Material Management Plan for the Don Basin drafted in 2008 maintains that 70 000 cubic metres remains the AMTR for the Don River.

Whilst the WRRQM Management Plan recognised that there is considerable potential for sand extraction in the Don River to have positive flood mitigation benefits, it highlighted that implementing a high level of extraction would have potential environmental and river instability impacts that must be identified in order to be managed. Recommendations in the WRRQM stated that excavation of material should generally be restricted to material above the stream's low flow water level, such as material situated in the tops of bars and islands.

Existing Riverine Quarry allocation

At present, the level of commitment to sand extraction within the non-tidal reach of the Don River (issued through QMANs under the *Water Act 2000*) is at approximately 70 000 cubic metres, equal to the AMTR, and the **maximum** annual allocation for the system that is considered sustainable.

Analysis of monthly returns submitted by the existing operators on the Don River indicate that over the past 5 years less than half the volume allocated from the Don River (i.e. <35,000 cubic metres) is being extracted each year, with the total volume often much less than this. Allocating a larger volume under the *Water Act 2000* through the issue of QMANs is not likely to ensure the volume of material will be removed, as the extraction is largely restricted by market demand and end user requirements.

Don River Sand Study- Aurecon

The sand study on the Don River by Aurecon was undertaken to identify the issues associated with major flood events (100 year ARI flood) to develop management strategies to deal with the problems. The study area covered the Don River and Euri Creek catchments. The study examined the effectiveness of sand extraction as a means of mitigating flooding impacts along the Don River.

Whilst the sand study provides guidance as to where there are reserves of sand available for extraction, and identified potential volumes of material in situ. It does not deal with the potential adverse impacts on other land holders, the surrounding groundwater levels and quality.

There is no evidence at present that the proposal for a pilot channel will have the desired impact, of reducing the threat to property in the Queens Beach area without having other, unintended impacts in surrounding areas.

The '46 mouth

The '46 mouth is located completely within freehold land. It is not a boundary watercourse and as such, is not State land. Consent of the land owners would be required before any riverine quarry operation proposal could be considered. All land owners along this old channel would need to be consulted in relation to any proposal to extract sand or create a low flow channel through to the '46 mouth.

Any proposal to open up the '46 mouth, and/or create a permanent low flow channel in the Don River downstream of the Highway Bridge could only be investigated with an assessment the potential flow on impacts of the proposal, such as increased or targeted erosion of surrounding land and changes to water levels and quality of groundwater.

Don River Low flow Channel

The proposal to create a low flow channel downstream of the Bruce Highway crossing at AMTD 6.2km on the Don River requires further investigation and consideration of how the channel would be constructed (i.e. detailed design) and the potential impacts on:

- Erosion of surrounding land;
- changes to the tidal influence within the River. i.e. potential to extend tidal influence upstream considerably, effectively moving the downstream limit (and jurisdictional boundaries),
- the water quality of surrounding groundwater through increase sea water intrusion; and in particular, impact on stock and domestic and production bores from changing the reach of the tidal influence upstream; and
- the potential the lower water tables by deepening the in stream channel.

Sufficient buffers and bank protection is required to ensure that during high flow events the proposed works do not cause increased erosion and result in large quantities of material that would have otherwise been stable, move downstream towards the mouth and still impact Queens beach.

Stockpiling of sand

Extraction of significant amounts of sand from the Don River would require stockpiling and there is concern over the location and management of stockpiles to minimise environmental impacts. The physical size of such stockpile/s, would prohibit the ability to locate it/them within a floodplain area. Transport and storage of such large volumes of material has logistic and cost implications that may rule the exercise prohibitive to the small commercial operators in the area and has historically limited the use of material from the Don River and concrete production.

Alternative solution

An alternative to creating a pilot channel (or more appropriate solution) may be to strengthen right bank protection works in the Don River and invest in a levee bank system (similar to the downstream area of the Pioneer Estuary).

6. Commercial Sand Activities

If approved and the removal of sand and the formation of a low flow channel is part of the total strategy then the removal of the sand and the formation of the channel will be a significant cost.

If Regime 4 was approved an estimate of 350,000 m³ of sand would be removed. Currently there is not the local market demand for this quantity of sand and as such stockpiling of the sand and onselling of the sand when there is a market need could be an option. This would need an investment of \$1.4 to \$1.75 million if the rates of the work were say \$4 to \$5 per m³.

Further investigations regarding the market demand and viability to other regional areas such as Mackay can be investigated pending DNRM approvals for the sand removal.

Another proposal that has been presented is the dredging /pumping of the sand onto private property which would also be subject to DNRM approvals.

It is recommended that if DNRM approve a quantity of sand to be removed in excess of the current approvals that further investigations including Expressions of Interest for the sand be undertaken.

7. Conclusion

From the Briefing Note prepared by Mr Gary Luck, further studies and reports are required before any further works as mentioned in the Briefing Paper can proceed.

A collaborative open approach by all parties and stakeholders is required into the formation of a fully integrated strategy in the interests of the Bowen community.

Recommendations:

1. That DNRM provide a detailed terms of reference for the required studies in relation to sand removal and other associated works for the Don River to enable tenders to be invited for the reports. The reports are to provide estimated costs of the works to enable further submissions for funding to be sought.
2. That due to the potential devastation and damage losses of the Queens Beach Area and Bowen Town Areas as a result of a major flood that the Federal, State and Local Government provide funds to the Don River Improvement Trust for the costs of the reports.
3. If the outcomes of the reports provide strategies which either result in sand removal and the construction of low flow channels or other structural works:
 - a report on the sand removal be undertaken addressing matters including costs, commercial opportunities, regional market demand and subsidies and stockpiling,
 - funding be sought from the Federal and State Governments for the improvement works.
4. That a management plan for vegetation management and other minor river maintenance works be prepared and is costed and funded from the precept from Whitsunday Regional Council.
5. That the Bowen Collinsville Enterprise be regularly updated on matters pertaining to the Don River to ensure the progression of strategies for the Don River.

Appendix A
Don River and Euri Creek Catchments

Appendix B
Estimate of Sand Volumes

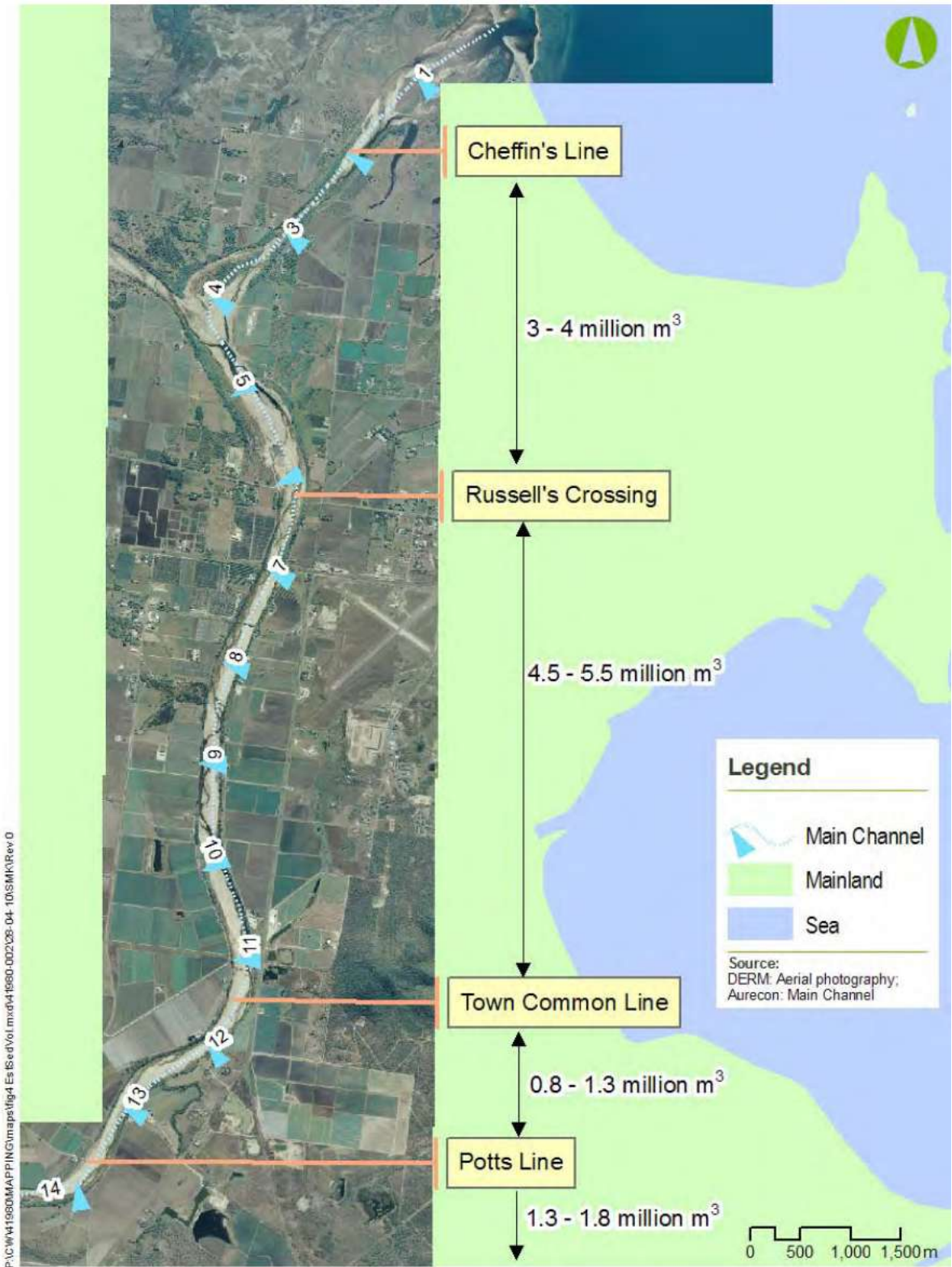


Figure 2-3 Estimate of sand volumes in the lower reaches (Connell Wagner 2005)

Appendix C

Sediment Removal and River Bed Reprofilng Layout Plan

