Preliminary Report on Bed load Transport in the Victoria River.

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Introduction

The Department of Planning and Infrastructure Road's section is undertaking a major upgrade of the Victoria Highway. This involves raising the level of several sections of road and upgrading bridges to reduce the proneness to flooding.
DPI requires sand and gravel material during construction of the road and bridge upgrade and some material may be sourced from the bed of the Victoria River. Surveys were undertaken on the 3rd – 5th February during a flood event to determine the bed load transport rate of the river and to collect data for the calibration of a bed load transport model.

Methods

An Acoustic Doppler Current Profiler (ADCP) was used to measure water velocities and the rate of bed load movement during high flow conditions during the wet season of early February 2006. The acoustic technique offers a non intrusive way of sampling bed movement. Acoustic pulses are transmitted from a boat mounted sensor and the return signals are processed within the sensor electronics. The Acoustic Doppler Current Profiler (ADCP) gives data on bottom depth, water velocities throughout the water column, bottom track velocities and navigation data. Techniques have been developed and field tested that allow a combination of these acoustic signal returns to determine bed load movement. The ADCP data was combined with a dual frequency survey depth sounder that allowed the depth of mobile sediment to be determined. Combining data from the ADCP and the survey sounder the total bed load transport was evaluated.

Twenty five cross sections were surveyed from Coolibah Homestead to upstream of the Victoria River Highway Inn. Survey sections (figure 1) were spaced along the river to represent pool riffle sequences along with more closely spaced cross sections over known gravel deposits as previously identified by the Roads group. The data was used to determine the bed load transport during the event and then compared with four separate bed load transport modeling techniques so that average annual bed load rates could be determined.

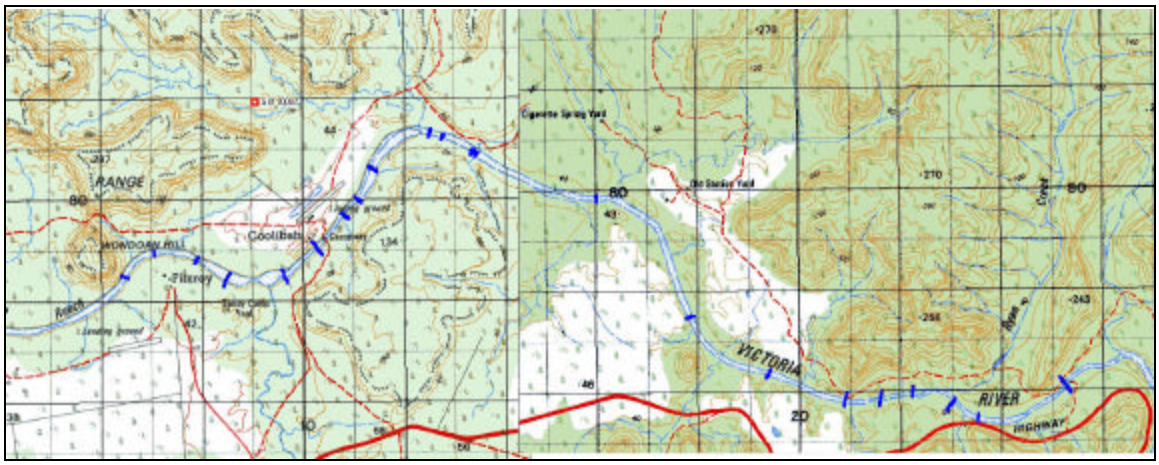

Figure 1 ADCP transects along the Victoria River from Coolibah upstream to the Victoria River roadhouse.

Results

The results of the field measured transport rate compared with bed load transport models are given in table 1. These results are the average bed load transport rate as determined over all the cross sections surveyed from the Victoria River Roadhouse down to Coolibah Homestead.

Table 1 Bed load transport rates (based on median sediment diameter of 20 mm).

ADCP	Bed load transport models			
Field measurements	Meyer-Peter	$Einstein_{42}$	$Einstein_{50}$	Ackers White
Rates are given in cubic meters per second				
0.284	0.371	0.228	0.437	0.197

Each cross section was measured by traversing a boat across the channel at the lowest safe speed to ensure maximum sampling time. The boat started from a known position and traversed across the channel and then returned back to the starting point. Each cross section was measured from left bank to right bank and back to the left bank and then the sequence was reversed. Typical transect times were 20 minutes giving a total of 40 minutes sampling interval for each section.

The bed load equations were selected as they are the most common cited in the literature and they have been designed to evaluate bed load within the range of sediment sizes published in the recent report for the Victoria River.

The bed load modeling methods calculate material transport potential and the fact that field measurements are in approximate agreement suggests that there is sufficient available material moving down the river during flood events.

Initiation of motion of sediments with a median grain size of 20mm will occur in the Victoria River reach from the Roadhouse Bridge Crossing to Coolibah Station when depths of flow are 6 metres or greater. This corresponds to a river flow rate of 1200 cubic metres per second.

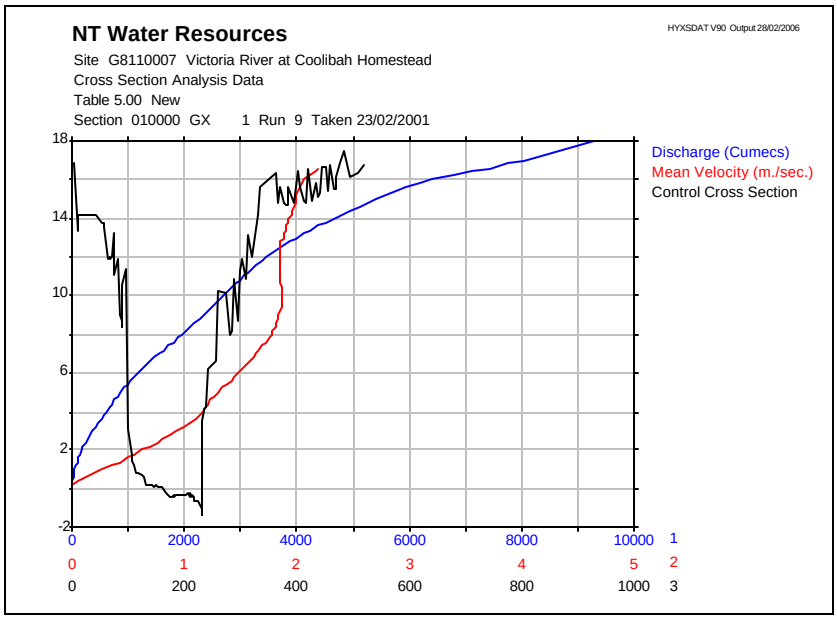

Figure 2 Cross section parameters at Victoria River.

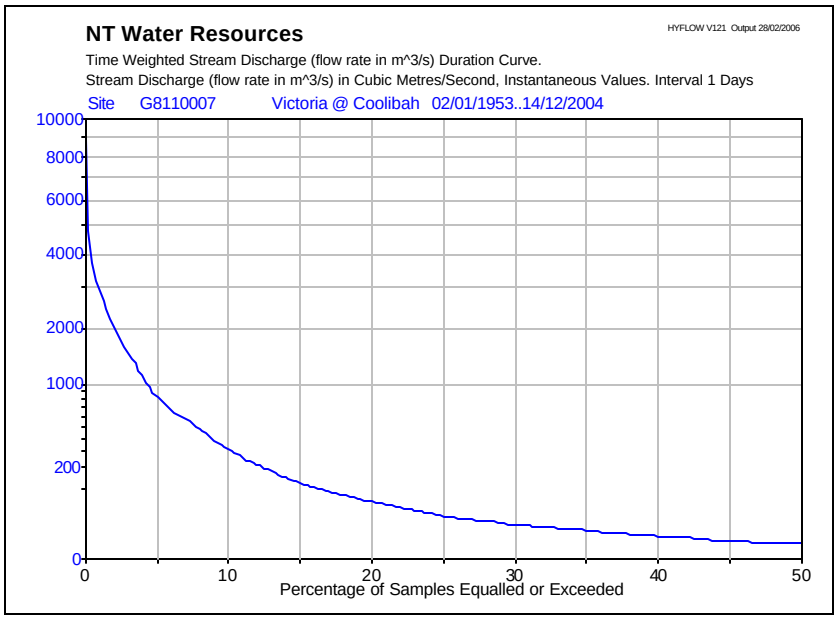

Figure 3 Flow durations for the Victoria River at Coolibah. Flows in excess of 1000 cubic meters per second will initiate bed load movement.

Based on flow duration data for the period of record for the Victoria River (1953 to date) a river flow rate of 1500 cubic metres per second will be equaled or exceeded ~4% of the time. This equates to a mean time of 15 days per year where bed loads with sediments of a median diameter of 20mm will be mobile. Figure 2 shows that above a depth of 6 metres the channel mean velocities stay fairly constant so bed load transport will also stay constant. For the bed load transport calculations a mean depth over the cross section has been used.

Given that the transport of material is 0.284 m3/s this then equates to an annual bed load transport rate of 360,000 cubic meters per year.

The sediment transport models range from 250,000 – 560,000 cubic metres per year.

Conclusions and Recommendations

- Field measurements on the Victoria River from the Victoria River Roadhouse to Coolibah Station indicate bedload transport movement volume of in the order of 360,000 cubic metres per year. These rates determined by using Acoustic Doppler techniques are also in the range of four commonly used bedload transport models based on median sediment sizes of 20 millimetres.
- The proposed amount of gravel to be extracted of 30,000 cubic metres would be replenished during the following wet season by new material moving down the river during flood flows.
- Gravel extraction from the river bed, in accordance with gravel extraction guidelines, will not cause river bed or river bank erosion or changes to riverbed geomorphology in the long term.

Guidelines for sand and gravel extraction from the bed of the Victoria River

River bed material should be extracted in accordance with accepted standards and published guidelines.
Extraction of river bed material will only be conducted in the dry season and extraction will not be within 20m of river banks.
The maximum depth of excavation will not be greater than 1 metre, will follow natural river bed contours and batter slopes on excavation will not to be steeper than 4:1 (H/V).
Extraction techniques should not create deep depressions that induce turbulent eddies when the river flows and compromise river bend stability.
Material should be extracted following natural contours so that river stability is not adversely affected. Impacts to outer bends of the river should be minimized so that natural flow lines are preserved.