ACTEW Water

Murrumbidgee Ecological Monitoring Program
Burra Creek geomorphology and vegetation assessment

March 2014

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Executive summary

This report has been prepared as a component of the Murrumbidgee Ecological Monitoring Program to satisfy the requirements of the Murrumbidgee to Googong Water Transfer - Geomorphologic Monitoring Sub Plan (Dec 2010), which sits under the M2G Operation Environmental Management Plan (OEMP, 2012).

It also includes an associated riverine vegetation assessment for Burra Creek undertaken in 2012. A second assessment of weed infestation along Burra Creek is being undertaken in May and June 2014.

The objective of this component of the program is to monitor the potential impact of the Murrumbidgee to Googong transfer pipeline (M2G) operation on the geomorphology and vegetation of Burra Creek below the discharge point, as well as the abstraction point on the Murrumbidgee River.

Geomorphology monitoring also included sites upstream of the abstraction point and at the discharge point for reference. Monitoring activities included surveying transects, a trial of 3D differential GPS mapping, sediment sampling, and regular reach observation.

Results have not identified any significant geomorphological changes as a direct result of pumping activities to date. However M2G is currently in standby mode where the pumps are only run for a short period every 2 months for maintenance purposes. Therefore any impacts from continuous operation of M2G cannot be determined at this point in time.

There have been small increases in turbidity during the initial phase of a maintenance pump run which is from remobilisation of some fine sediment deposited from small naturally occurring rainfall events.

The site at BUR2C, approximately 10 km downstream of the discharge and 400m upstream of London Bridge, has been identified as having a high erosion potential. When under continuous operation at 100ML/d, the flows from M2G discharge will exacerbate the natural erosion occurring at this site.

Recommendations:

1) Continue the ongoing monitoring of Burra Creek to determine the changes occurring as a result of natural flow events as well as from M2G maintenance runs, especially those that could be exacerbated by continuous discharge from M2G;
2) Consider options for whether BUR2C is to be left to natural ongoing erosion, or mitigated to reduce sediment transfer to Googong Reservoir.
3) Undertake monitoring of macrophyte beds along Burra Creek to Googong Reservoir to assess encroachment of vegetation into the central channel to determine potential impacts from M2G operating in a continuous mode.

1. Introduction

ACTEW Water has undertaken the Murrumbidgee to Googong Water Transfer (M2G) project as a means of increasing future water security for the Australian Capital Territory (ACT) and surrounding region. The transfer involves the pumping of up to 100 ML/day from the Murrumbidgee River at Angle Crossing (southern border of the ACT) via a 12 km long buried pipeline discharging into Burra Creek (immediately upstream of Williamsdale Road) that flows to Googong Reservoir via run of river.

This report covers the Geomorphologic Monitoring and Riverine Vegetation components of the Murrumbidgee Ecological Monitoring Program (MEMP).

The M2G pipeline construction was completed in August 2012 at which time the commissioning phase was undertaken over an approximate one month period. During that time the various pumps were tested which provided various flow rates up to full capacity.

An initial geomorphic assessment of Burra Creek was undertaken in June 2009 during the approval phase of the M2G project which focused on describing the conditions of Burra Creek and Angle Crossing on the Murrumbidgee River at that time.

This report serves as an update to what has previously been reported due to the changes which Burra Creek has undergone since then. The influencing factors over these changes have been the breaking of the drought period and the multiple large storm events. These alterations to the system have led to the previous data no longer being representative at key locations with a more recent assessment of the geomorphology of Burra Creek required.

There have been several significant storm events which have had an influencing factor upon the geomorphology of the creek and the catchment as a whole. The most significant storm event occurred on 9 December 2010, which was approximately a 1 in 70 year Average Recurrence Interval event. This event occurred at the end of the drought following two smaller events (1 in 2 year to 1 in 5 year ARI events) and dramatically altered the geomorphology of the creek through the large scale removal of macrophyte beds and sediment movement which had built up over many years.

Geomorphological impact from this scale of event significantly dominates any impact by a flow of 100 ML/d which represents a natural recurrence interval of less than once in 3 months on average.

2. Methodology

The methodology used in this report is based on the Geomorphological Monitoring Sub Plan of the M2G Operation Environment Management Plan (OEMP, 2012). Monitoring has been modified due to the change in operational expectation of the M2G pipeline to reflect that only maintenance pumping is occurring. It was expected that once the pipeline was commissioned that water transfer would commence almost immediately.

A reduced sampling frequency during the current standby period of maintenance only is understood to be as follows:

- 6 monthly visual inspections at key sites during a pump maintenance run where the maximum maintenance flow is approximately 50 ML/d; and
- Visual inspection at key sites during each pump maintenance run of 90 ML/d or above.
- Visual inspection at key sites after a 1 in 3 month ARI event or greater (950ML/d) to distinguish between natural event caused erosion and possible water transfer erosion;
- Prior to the pipeline commencing a continuous operational mode, surveyed transects and site observations as per the Geomorphologic Monitoring Sub Plan should be undertaken to re-establish and confirm baseline condition.

Due to Googong Reservoir currently being at full supply level there is no requirement to operate the M2G pipeline in continuous mode.

2.1 Creek observations and photogrammetry

Prior to the initial commissioning phase, the length of Burra Creek was walked from the M2G discharge structure downstream to London Bridge. This was done to evaluate the areas of potential bank erosion and riffle zone adjustment during the operation of the M2G pipeline. This initial walk was completed on the 24th and 25th July 2012 with the daily flows at Burra weir at 7.9 and 7.8 ML/d respectively. Photos were taken along the length of the creek of pools and riffle zones for future reference for a comparison of change over time. Pools were identified by the numbers given to them in the original geomorphic assessment (ACTEW, 2009).

All riffle zones were given an adjustment potential rating of high, moderate or low, while banks were assessed for erosion potential on each side of the creek individually and given an erosion potential of high, moderate or low. These assessments are consistent with the method employed in the previous geomorphic assessment completed during the EIS phase of the M2G project (ACTEW, 2009).

2.1.1 Sediment Transport & Deposition

Samples of sediments were taken from BUR1 and BUR2C, including topsoil, edge, gully and stream bed. These samples were put through sieve analysis to determine particle size distribution.

Sediment transportation samples were collected by placing sample containers into the substrate at pools. The sample containers were left with lids removed in-stream for a period of approximately 1 week and then removed by placing the lid back onto the sample container before extraction from the sediment bed.

2.2 Burra Creek & Murrumbidgee River Geomorphological Surveys

Sites were surveyed along Burra Creek consisting of 2 sites upstream of the discharge structure, at the discharge location itself, and at 4 sites downstream. The number of survey sections taken at each site ranged from 2 to 4 and are indicated in Table 2.1 with survey dates. The two sites (D/S Pool 51 &

D/S Pool 29) were surveyed after being identified as having a riffle zone adjustment potential of moderate during the walk of Burra Creek given in section 2.1.

Table 2.1. Number of Burra Ck survey sections collected pre-commissioning at each site

Site	Number of Survey Sections	Date Surveyed
BUR1	3	10/7/2012
BUR1C	4	6/7/2012
BUR2	3	1/8/2012
BUR2A	4	9/7/2012
D/S Pool 51	3	2/8/2012
D/S Pool 29	2	2/8/2012
BUR2C	4	5/7/2012

Sites surveyed on the Murrumbidgee included two cross sections upstream and two cross sections downstream of Angle Crossing causeway.

Survey sections pre-commissioning of M2G were measured using a dumpy level and graduated staff, where height measurements were recorded at intervals across each transect. Each height was also recorded against a distance along the length of the transect. GPS co-ordinates were collected for the beginning and end points for each transect to return to transect locations across the creek for later surveys. Transect locations were chosen with specific reference to potential erosion and/or scour points at each site.

Survey sections post-commissioning of M2G were undertaken using a differential GPS unit (DGPS) or using the Dumpy level where necessary (some sites have limited DGPS signal). At some sites both DGPS and Dumpy were used post-commissioning to ascertain the accuracy and validity of the DGPS method.

The state of accuracy of the DGPS is generally indicated as ± 15mm horizontally, and ± 20mm vertically. This accuracy is dependent on the real time kinetic correction factor as received from the closest CORSNET repeater via an internet link.

Table 2.2 - Murrumbidgee survey sections pre-commissioning

Location	Number of Survey Sections	Date Surveyed
Upstream	2	10/1/2010
Downstream	2	10/1/2010

2.3 Water Quality samples and streamflow

Grab samples were collected along Burra Creek at sites both upstream and downstream of the discharge structure. Burra Creek sites consisted of two upstream sites and four downstream sites, while one site was located on the Murrumbidgee River downstream of the abstraction point. Not all sites were sampled during each run and details of site locations can be found in Table 2.3.

Table 2.3 Grab sample site details

Site Code	Site name	Location in relation to M2G discharge structure	Latitude	Longitude
BUR1	Burra Creek, upstream of Cassidy Creek confluence	Upstream	-35.598461	149.228868
BUR1C	Burra Creek, upstream of Williamsdale Road	Upstream	-35.556511	149.221238
BUR2	Burra Creek at Williamsdale Road	Downstream	-35.555796	149.222977
BUR2A	Burra Creek, downstream of Williamsdale Road	Downstream	-35.554345	149.224477
410774	Burra Creek at Burra Weir	Downstream	-35.542639	149.228139
BUR2C	Burra Creek, upstream of London Bridge	Downstream	-35.517894	149.261452
MUR19	Murrumbidgee River, downstream of Angle Crossing	Downstream (intake structure)	-35.583161	149.109111

These grab samples were analysed at the ALS (Australian Laboratory Services) Canberra Laboratory. Samples were collected at a range of flows with collections at baseflow rates, at ~50 ML/d, ~70 ML/d and ~ 100 ML/d to cover various rates of pumping. The flow rates and collection dates are shown in Table 2.4. Historic flow from 2009 to 2013 is shown in Figure 1, with 8 events exceeding 1000 ML/d (~1 in 1 yr ARI).

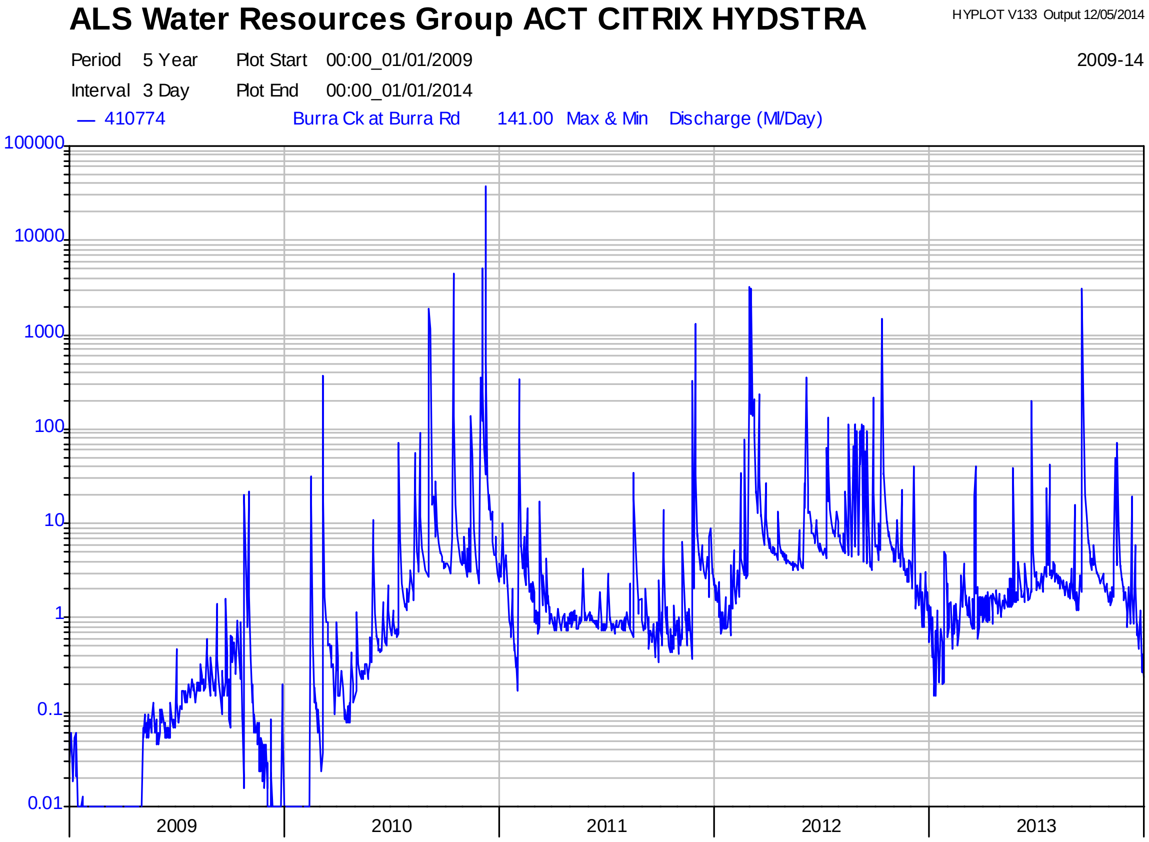


Figure 1 - Burra Weir (410774) flow data 2009-2013

The majority of the samples collected were at baseflow levels as many samples were collected prior to operation of the pumps and post pump operation in an attempt to detect any changes to the physico-chemical parameters of the creek as a result of the pumping schedule.

All samples collected were sampled for pH, electrical conductivity (EC), turbidity, alkalinity, dissolved aluminium and total aluminium. In addition to these base parameters, selected samples were also tested for NO_x, total phosphorus (TP), total nitrogen (TN), suspended solids, total dissolved solids (TDS), dissolved organic carbon (DOC), dissolved iron, total iron, dissolved manganese and total manganese. All water quality results can be found in Appendix M and are also available to ACTEW via their water quality database.

Table 2.4. Grab sample collection dates during M2G commissioning

Flow	Baseflow (< 5 ML/d)	~ 50 ML/d	~ 70 ML/d	~ 100 ML/d
Date Sampled	3/8/12, 8/8/12, 9/8/12*, 10/8/12, 14/8/12, 27/8/12, 10/9/12	22/8/12	14/9/12	17/8/12, 28/8/12, 7/9/12

** initial trickle release from the pipe, resulting in flow remaining below 10 ML/d*

Flow during the commissioning period is shown in Figure 2. During this period there is only one standard pump test to 109 ML/d from the 5th to the 9th of September 2012 as indicated by the stepping up and down of the pumps. During this time there were also 3 pump runs above 100 ML/d (27th, 28th Aug & 10th Sept), indicated by peaks without rainfall.

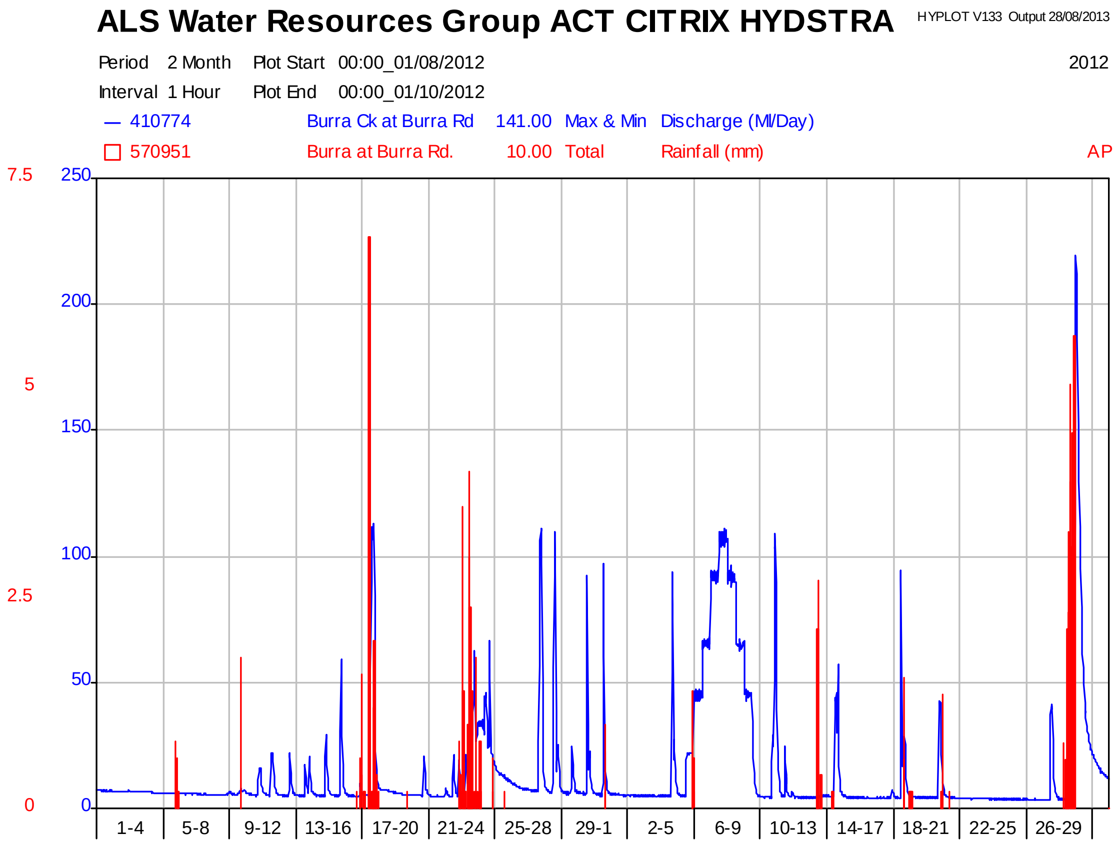


Figure 2. Burra Creek hydrograph during the M2G commissioning period

2.4 Vegetation Assessment

For the purpose of this study, the riparian zone is defined as the area of terrestrial land immediately adjacent to the creek, including the stream bank and depressions alongside the stream that are affected by periodic inundation and hydraulic disturbances.

This zone contains varying landforms, steep or gently-sloping banks, alluvial deposits and groups of associated moisture-loving or moisture-tolerant vegetation that is different to those occupying the broader, adjacent, terrestrial (upland) habitat.

The assessment composed of 4 sites, focusing on approximately 600 m reaches of the creek at each site location and is discussed in detail in Section 4.

In these reaches, the species composition and relative abundance (cover) were obtained from walk-through surveys and transects, which extended across the stream channel from one bank to the other, covering the typical riparian zones.

Transects covered the range of geomorphic features in the stream channel (sand beds, pools, bedrock shelves, cascades, cobble bars and riffles), types of riparian vegetation and variations.

The vegetation monitoring at each site qualitatively assessed the following:

- Current ‘condition’ of riparian and ‘in-stream’ aquatic vegetation with regard to taxon richness (species composition), abundance, distribution of dominant species, and nativeness; and the occurrence of rare and threatened species;
- Distribution and relative abundance of native and exotic vegetation;
- Abundance of different growth forms and functional groups, associated with the creek environment; and
- Capacity of the vegetation to persist, through recruitment; and contribute to the functioning of the system.

Transects were complemented by scouting and random meanders across the sites up to the upper riparian margin to develop a comprehensive species list at each site. Scouting, in no set pattern also allowed the habitat quality, seedling recruitment and regeneration (juveniles) of different species within the reaches to be assessed, and recorded.

The flora list generated by the survey for each reach/section examined in the Burra Creek is given in Appendix L.

3. Observations & Discussion

3.1 Creek Observations and photogrammetry

The creek observations were undertaken by walking the creek from the M2G discharge point to the London Bridge karst formation. This provided assessments of the riffle zone adjustment potential and the bank erosion potential. The assessments from the observations are presented on the maps found in Appendix A.

3.1.1 Sediment erosion observations

The riffle zone adjustment potential has reduced throughout the creek since the previous geomorphic report, with no areas assessed as high risk for potential adjustment. However there were nine areas which showed moderate potential for adjustment. As a result of this three of these riffle zones were surveyed. The remaining riffle zones were all assessed as having a low adjustment potential. Photos of pools were taken for future comparisons of pool movement and size changes under altered flow conditions and are presented in Appendix B.

There is the potential for one channel area (a small step, assessed as moderate) located immediately downstream of Williamsdale Road to be adjusted as a result of continuous increased flows from pumping. Plate 1 shows this section of creek at a flow of < 5 ML/d and at 109 ML/d.

Plate 1. Step with moderate adjustment potential immediately downstream of Williamsdale Road, left at <5 ML/d, right at 100 ML/d

With the exception of this location, the flow from the M2G discharge is unlikely to create erosion of the central channel section. Sediment bars are unlikely to be eroded by normal pumping flows. This may change with further adjustments to the system from natural large events.

3.1.2 Bank erosion assessments

The bank erosion assessment identified some new areas of erosion which have been exposed by the storm events since the original geomorphic assessment (Appendix A). Six high potential erosion areas were identified, with many of these being small in scale.

The bank area which was assessed as having the highest potential for substantial erosion was a section of steep bank just downstream of Pool 5, immediately upstream of the BUR2C macroinvertebrate sampling site. This bank area has been made vulnerable by the high flow events which have scoured the bank and undercut sections over time. Photos of the bank in 2012 are shown in Photo 1 and Photo 2, indicating erosion potential along the bottom of the bank which will increase the undercutting of the bank, resulting in bank collapse into the creek.

Photo 1 - High erosion potential area downstream of Pool 5 during July (left) and August (right) 2012

Photo 2 - High erosion potential area downstream of Pool 5 during September (left) and October (right) 2012

The other bank areas along Burra Creek assessed as having a high erosion potential are also vulnerable to a continued elevated flow from the M2G pipeline, however not to the same extent. Natural events have a much larger impact potential upon the geomorphology than the pump maintenance releases from M2G. However, if the pumps are run for a prolonged period (greater than 1 week), this may have additional impact due to saturation of the creek embankment from continued elevated water levels.

3.1.3 Sediment Transport & Deposition

Sediment samples of the sand bars from BUR2 and BUR2C show that the majority of sediment being deposited within stream is between 0.5 and 2mm in size as seen in Figure 3. This size corresponds to coarse sand. The sample taken from Angle Crossing has a majority of sediment in the 0.25-1mm range, which corresponds to medium and coarse sand.

Individual sieve analysis results can be found in Appendix D. The sediment analysis indicates that the very fine sediments are being transported through to Googong Reservoir in major and minor events and not captured within Burra Creek. This may change as macrophyte beds gradually re-establish with the creek after being significantly removed by the major 2010 event.

The base of the pool at BUR2C contained minimal sediment as it has been eroded to bedrock. Most of the fine sediment along this flatter section of Burra Creek has also been transported downstream into Googong Reservoir, with only a fine covering over the streambed remaining. This sediment is silt/clay as it is predominately below sand size (<63µm).

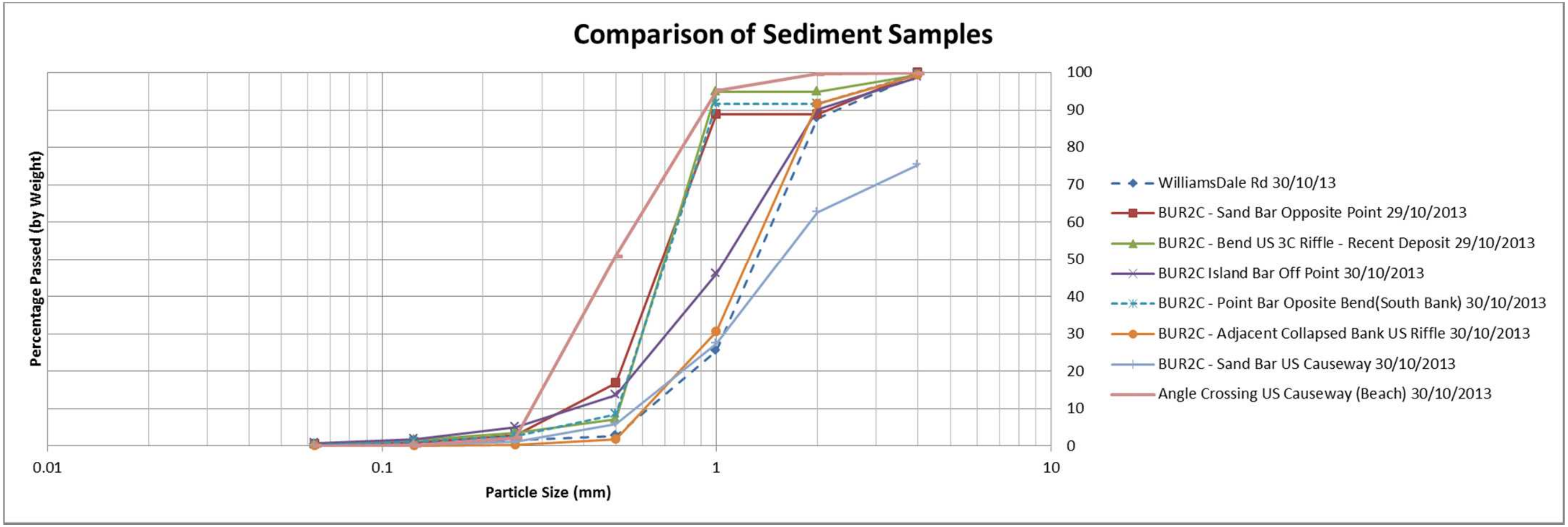


Figure 3 - Comparison of Sediment Sieve samples

3.2 Creek Surveys

Creek surveys were undertaken on Burra Creek (2 upstream, 4 downstream and at the discharge structure) and Angle Crossing (upstream and downstream). Surveys included transects, and 3D DGPS for selected locations.

The DGPS survey is a deviation from the proposal, however will provide much more detail of the area for future referencing of the sites. This was chosen as an experimental additional method as changes occurring at the exact cross section location may not be indicative of overall geomorphological change at that channel reach.

3.2.1 Channel Units

The channel units present at each location are shown below. Samples of sand bar sediments have been taken for more detailed analysis if required.

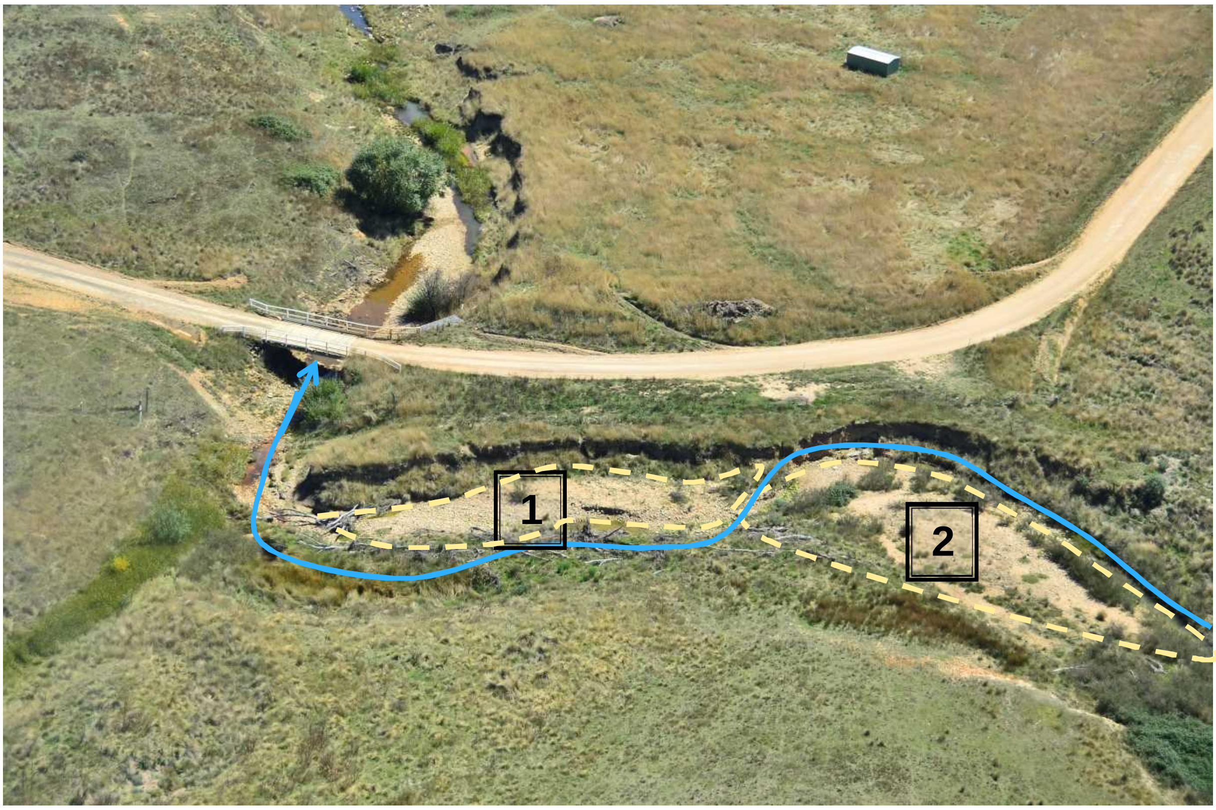


Figure 4 - BUR1 Channel Units 10/3/2013

Table 3.1 - BUR1 Channel Units

Identifier	Fluvial Environment	Comments
1	Sand Bar	Sand/gravel
2	Sand Bar	Sand/cobble
	Ephemeral Channel	Minor Run/Riffle/Pools

Figure 5 - BUR1C Channel Units 10/3/2013

Table 3.2 - BUR1C Channel Units

Identifier	Fluvial Environment	Comments
1	Sand Bar	Sand/gravel
	Ephemeral Channel	Minor Run/Riffle

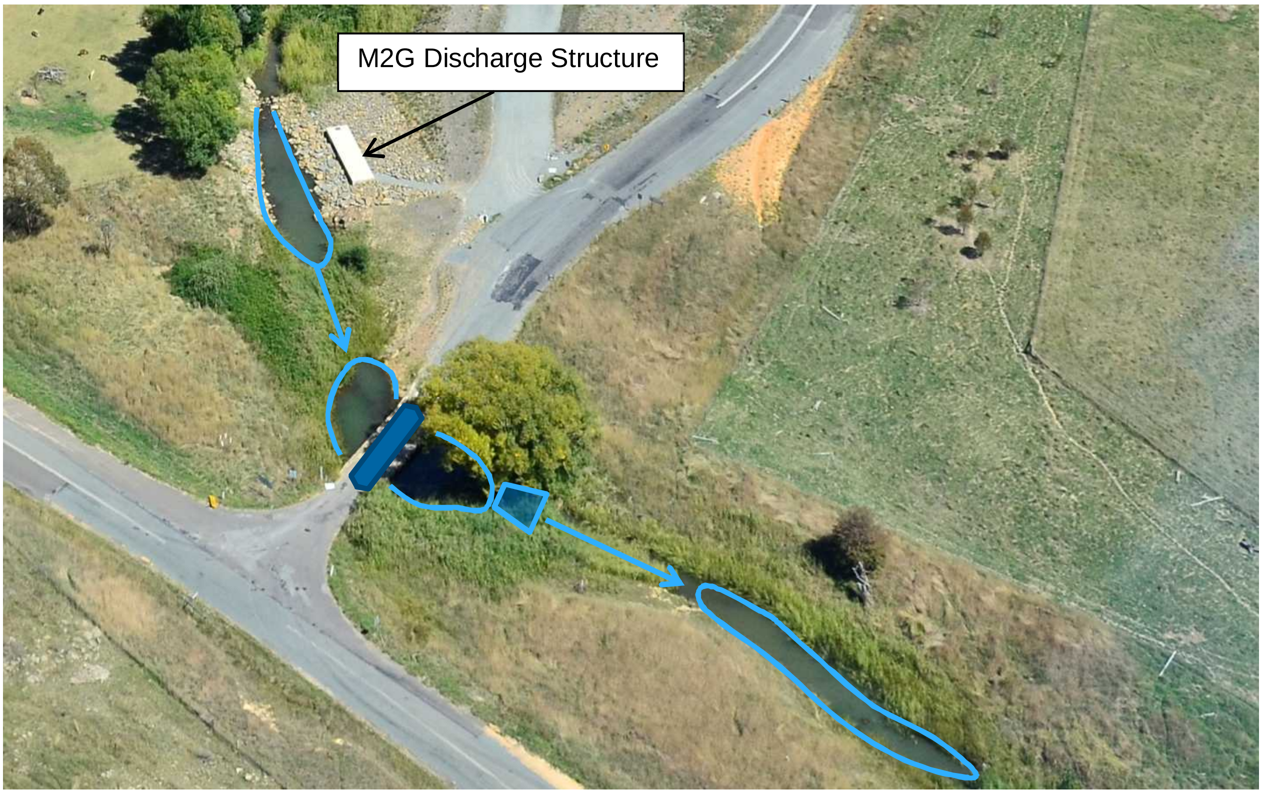


Figure 6 - BUR2 Channel Units 10/3/2013

Table 3.3 - BUR2 Channel Units

Identifier	Fluvial Environment	Comments
	Channel	Minor Run
	Pool	
	Step	Approximately 30cm
	Creek Crossing	Pipe Culvert Crossing Multiple 600mm diameter culverts

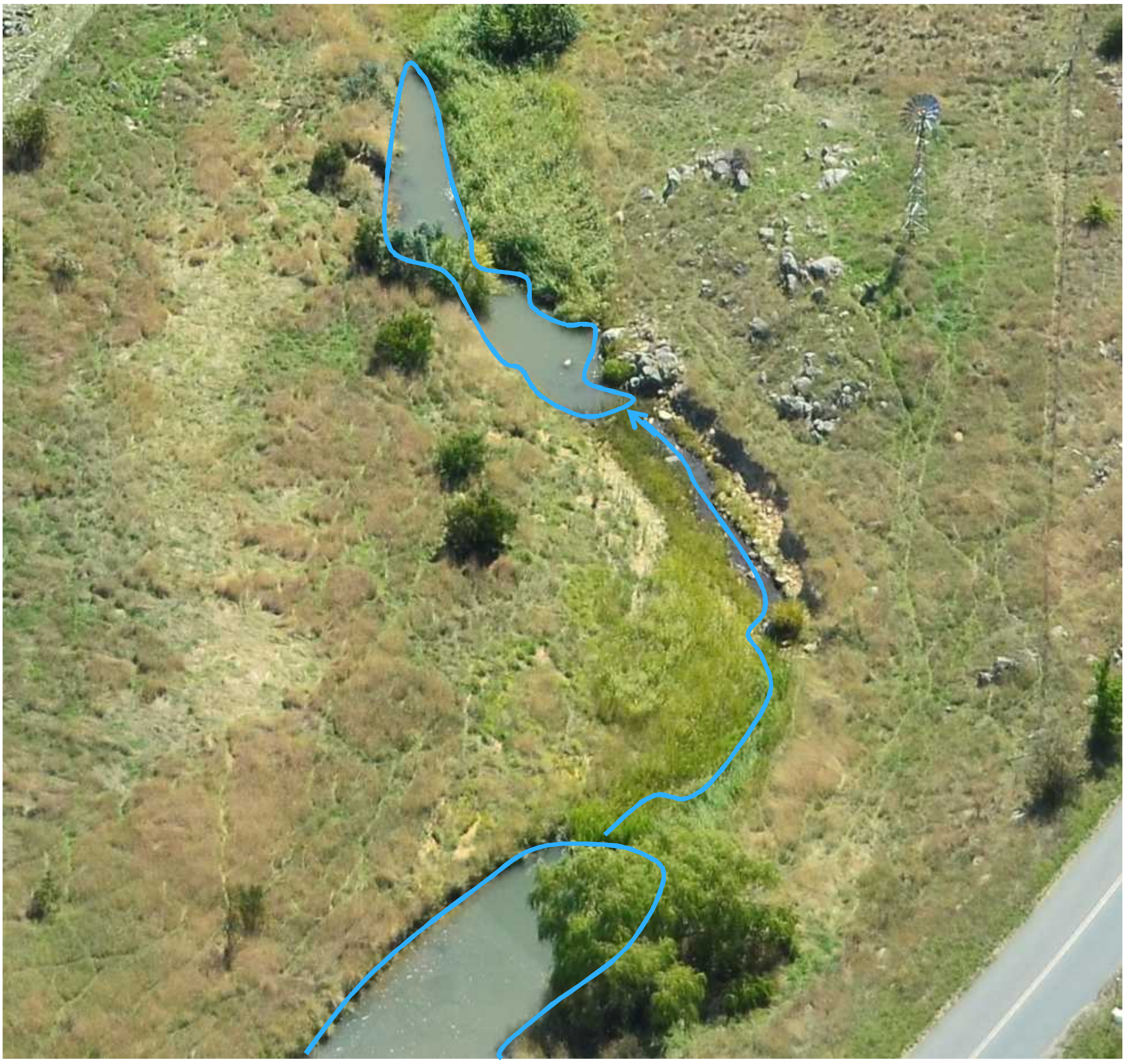


Figure 7 – BUR2A Channel Units 10/3/2013

Table 3.4 – BUR2A Channel Units

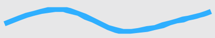
Identifier	Fluvial Environment	Comments
	Channel	Run/Riffle
	Pool	

Figure 8 – Pool 29 Channel Units 10/3/2013

Table 3.5 - Pool 29 Channel Units

Identifier	Fluvial Environment	Comments
	Channel	Run/Riffle
	Pool	

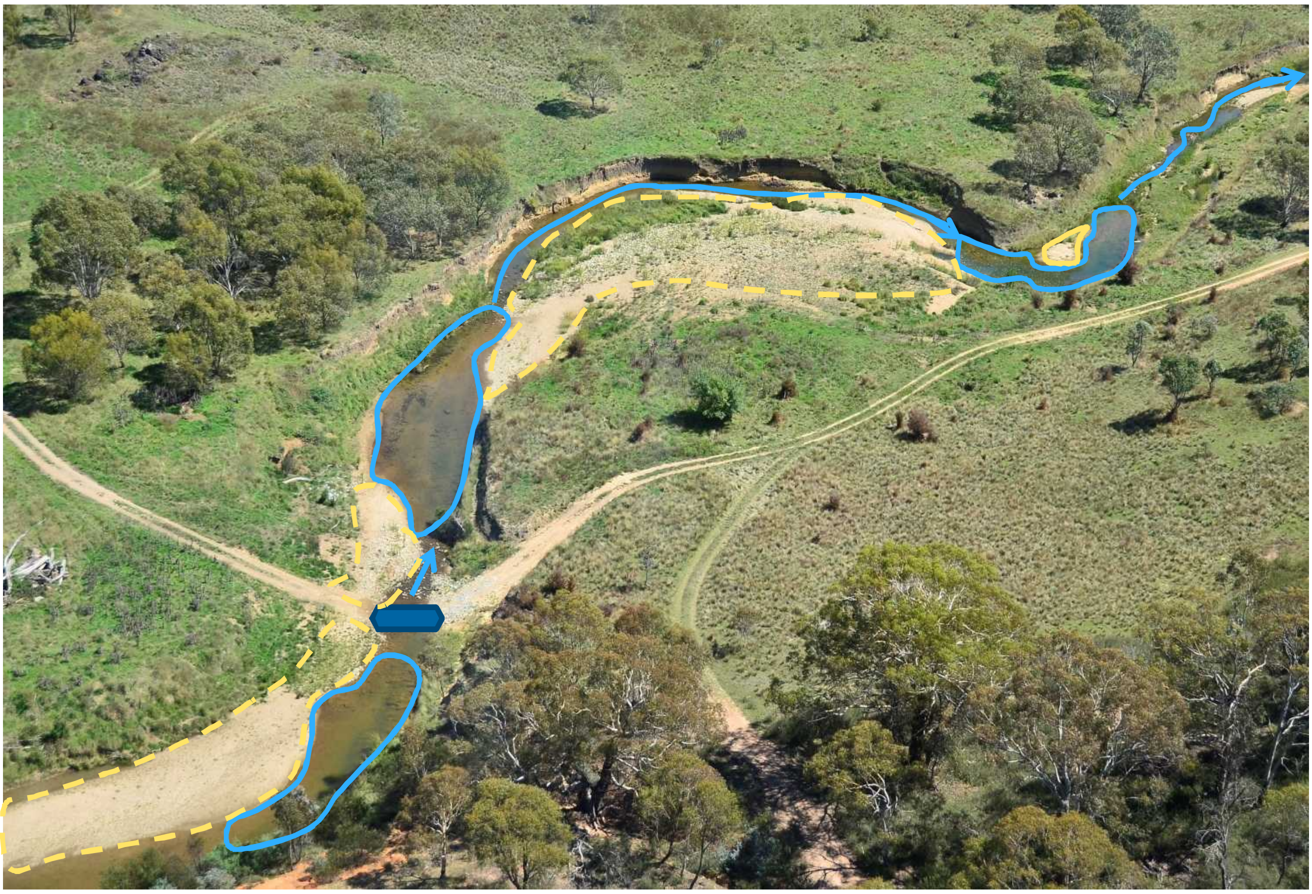


Figure 9 – BUR 2C Channel Units 10/3/2013

Table 3.6 – BUR 2C Channel Units

Identifier	Fluvial Environment	Comments
	Channel	Run/Riffle
	Pool	
	Crossing	Cobble
	Sand Bar/Deposit	Sand/Gravel

Figure 10 - Angle Crossing Channel Units 10/3/2013

Table 3.7 - Angle Crossing Channel Units

Identifier	Fluvial Environment	Comments
	Channel	Run
	Pool	
	Causeway	Cement
	Major Riffle	Cobble

3.2.2 Survey Transects

Surveys of the Murrumbidgee and Burra site locations are in Appendices as follows:

- Appendix E – BUR1
- Appendix F – BUR1C
- Appendix G – BUR2
- Appendix H – BUR2A
- Appendix I – Pool 50
- Appendix J – BUR2C
- Appendix K – Angle Crossing

BUR2C is the only site where a significant geomorphological change has occurred during the monitoring period. Cross-section 3 at this site (on the bend U/S of sampling riffle) shows there has been approximately 1m of slumping off the left hand side bank (as looking downstream). The removal of this material from the bank is a result of some of the high flow flood events that have occurred between the survey times.

There is also likely to be further undercutting and slumping occurring at this site from future moderate flood events.

3.3 Water Quality

Water grab samples were collected during commissioning phase of the M2G pipeline.

Sample results can be found in Appendix M.

The only detectable change in water quality was slight in turbidity at commencement of the initial pump runs. This was indicative of fine silts being re-mobilised along the creek. The change in turbidity decreased after several pump runs. Other changes noted from grab sample water quality data (collected below discharge) were a reduction in EC and pH in relation to upstream site (BUR1C) when water was being pumped. The change in EC was representative of the water being pumped from Angle Crossing and is also shown in the continuous water quality plots.

4. Riverine Vegetation Assessment

A list of plant species recorded within the four sites surveyed is presented in Table 6.1 in Appendix L. The species recorded from transect data, extended to individual reaches examined, are provided in Appendix L with notes on abundance.

A total of 54 plant species were recorded within the four sites sampled for aquatic and riparian vegetation, comprising 29 (54%) locally indigenous, native species; and 25 (46%) exotic and introduced, weed species.

The descriptions below refer to the right or left bank of the creek, looking downstream (d/s).

4.1 BUR 2 (U/S and D/S Williamsdale Bridge)

BUR2 is immediately downstream of the Williamsdale Bridge where the M2G transfer pipeline connects with the Burra Creek. In this section, the creek is comprised of pool and riffle sequences and its width varied between 2-10 m.

Several large pools, located u/s and d/s of the Williamsdale Bridge, varied in depth from 0.5 to 1.8 m; and the substrate in the short riffle zones were predominantly silt and bedrock with some cobbles and coarse sands.

In-stream habitat consisted of some woody debris and branches with large vegetation patches consisting primarily of the emergent macrophytes: Common Reed (*Phragmites australis*) and Cumbungi (*Typha orientalis*).

The upper riparian zone was dominated by pasture grasses - mainly *Phalaris aquatica* and *Eragrostis curvula*, interspersed with native Poa tussock (*Poa labillardieri).* There was no significant shrub vegetation at this site, except for a few, isolated individuals of *Acacia dealbata*.

Trees were limited to significant infestations of Poplars (*Populus* spp.) on the right bank (looking d/s) and Willows (*Salix* spp.), with many large trees and regrowing juveniles along the stream bank. A few juvenile Willow trees were present in the upper riparian zones. These sections were considered to be highly disturbed and in poor to moderate condition.

Blackberry infestations were heavy in the lower riparian areas immediately upstream of the bridge, below the patches of native plantings on either side. The most common aquatic species recorded was Common Reed (*Phragmites australis*), which occurred in dense patches upstream of the bridge. A few clumps of *Carex appresa* occurred in the upper riparian areas.

Downstream of the bridge, on both left and right banks of the pool-riffle-stream configuration, infestations of pasture grasses were present. Small infestations of Blackberry also occurred adjacent to the creek. Introduced weeds (such as *Avena fatua*; *Plantago lanceolata*; *Verbena bonariensis*; *Conyza* sp.) were also relatively common amongst the pasture grass cover. Some upper riparian areas on the right bank had patches of native Kangaroo Grass (*Themeda australis*), as well as infestations of Thistle (*Cirsium vulgare*) and St. John's Wort (*Hypericum perforatum*).

Aquatic species were strongly present in this reach, mostly distributed along the shallower areas of the creek. The most common species were: *Phragmites australis*, which formed several large stands along the riffles and stream habitat, and *Isolepis habra*, which formed patches of low-lying mats along the creek bed. Small patches of *Paspalum distichum*, *Eleocharis acuta* and *E. atricha* also occurred along the stream. Less abundant species recorded from the site, included *Typha* sp., *Carex* sp., *Cyperus eragrostis* and *Juncus usitatus.* The aquatic moss *Rosulabryum subfasciculatum* was growing in-stream, on crevices among the alluvial gravel and rocks.

All species recorded were common in the region, and had been previously recorded in the Burra Creek surveys conducted in November 2011 (ALS, 2012). No rare or threatened species or populations were found.

4.2 U/S and D/S Pool 51 (Homestead Road)

At the Burra Creek, above London Bridge Homestead, a 300 m long reach upstream of the gauged pool (up to the series of bedrock cascades and rock pools), and a 200 m section downstream, were surveyed.

Sections of the channel in this reach have relatively steep banks, many rocky outcrops; and no distinct alluvial benches; or floodplain. The creek consisted of several large, deep pools and interconnecting, shallow, bedrock riffles. Many of the pools were up to 10-12 m wide and about 1.5 m deep. The substrate in the pools was primarily silt and bedrock, with some sand and cobbles found in the tail of pools and riffles. In-stream habitats consisted of small amounts of woody debris and coarse organic matter.

The upper riparian zone was dominated by grasses, mainly African Love Grass (*Eragrostis curvula*) and Phalaris (*Phalaris aquatica*). These grassed banks were infested with introduced weeds, such as thistles (*Cirsium vulgare*), St. John's Wort (*Hypericum perforatum*), Twiggy Mullein (*Verbascum virgatum*), Plantain (*Plantago lanceolata*), Purpletop (*Verbena bonariensis*) and fleabane (*Conyza bonariensis*).

Occasional clumps of Blackberry (*Rubus fruiticosus*) occurred among the grasses, but not as abundantly as downstream of the Williamsdale Bridge. Although the riparian banks were interspersed with native Poa tussock (*Poa labillardieri*), as a result of pasture-grass and weed-dominated riparian zones, the area was considered to be disturbed and in poor condition.

There was no significant shrub vegetation in this site, except for a few, isolated individuals of *Acacia dealbata*. Trees were limited to sporadic infestations of adult and juvenile Willows (*Salix* spp.) and a few saplings of Poplars (*Populus* spp.), which had colonised the lower riparian zones. Some large and medium-sized Willow trees were particularly common in the downstream stretch, above the Homestead Road causeway.

Aquatic species were moderately abundant in this reach, mostly distributed along the shallower areas of the creek. The most common aquatic species recorded in-stream were common sedges: *Eleocharis* spp., *Isolepis habra*; *Juncus usitatus*; and *Carex* sp. Stands of *Eleocharis* formed narrow fringes along the lengths of the pools, approximately 30 m in length. Mats of *Isolepis habra* were common in the shallow, alluvial deposits all along the creek.

Other aquatic species: Cumbungi (*Typha orientalis*), Common Reed (*Phragmites australis*) and Water Couch (*Paspalum distichum*) were also present within the reach, only as sporadic small patches. A few clumps of *Carex appresa* also occurred in the upper riparian areas.

There were no submerged aquatic species in this reach, except for minor clumps of epiphytic, filamentous green algae – *Zygnema*, found attached to rocks and culms of sedges.

All species recorded within the reach were common in the region, and had been previously recorded (ALS, 2012). No rare or threatened species were found.

4.3 U/S and D/S Pool 29

The third reach assessed was a downstream site, located u/s and d/s of Pool 29. The creek at this location was a deeply incised, relatively broad channel (about 20-30 m wide) dominated by bedrock. The banks on both sides were steep, almost vertical, approximately 40-50 m in height in some places. Over the 300 m long reach that was examined, the channel comprised a series of large and elongated pools and riffle zones. Riffles were dominated by bedrock and cobbles overlaid with coarse gravel and sands.

A few isolated individuals of *Callistemon citrinus* and *Acacia dealbata* comprised the shrub vegetation in the riparian zone at this site. Trees were limited to a few large *Eucalyptus* trees. A few saplings of Willows (*Salix* spp.) and Poplars (*Populus* spp.) also colonised the lower riparian zones. Blackberry infestations were sporadic in the lower riparian areas. Various pasture weeds (i.e. Fuzzweed – *Vittadinia cuneata,* St. John's Wort – *Hypericum perforatum*) and pasture grasses - mainly *Phalaris aquatica* and *Eragrostis curvula*, dominated upper riparian zones, interspersed with native Poa tussock (*Poa labillardieri*). Other introduced weeds, such as *Avena fatua*; *Plantago lanceolata*; *Verbena bonariensis*; *Conyza* sp., were also relatively common amongst the pasture grass cover.

Aquatic species were not strongly present in the bedrock-dominated areas and large pools upstream of the gauged location in this reach, except for small clumps of *Isolepis habra*, *Cyperus eragrostis*, *Juncus usitatus* and *Carex* sp.

As in the upstream sections of the Burra Creek, *Isolepis habra* was observed, forming low-lying mats along the creek bed where sand and sediment had accumulated. Patches of *Paspalum distichum*, *Schoenoplectus validus*, *Eleocharis acuta* and *E. atricha* also occurred along the stream on the alluvial, gravelly and sandy deposits among the riffles.

Less abundant species recorded from the site, up to 300 m downstream of the gauged location, included *Phragmites australis*, *Typha orientalis*, *Carex* sp., *Cyperus eragrostis*, *Juncus usitatus, Rumex crispus, Persicaria prostrata* and *Mentha piperata.* A few individuals of an introduced aquatic weed - Purple Loosestrife (*Lythrum salicaria*) were recorded from the site. However, no submerged aquatic species occurred in this reach.

All species recorded within the reach were common in the region, and had been previously recorded (ALS, 2012). No rare or threatened species were found.

4.4 BUR 2C (U/S London Bridge)

BUR 2C is immediately upstream of the London Bridge and the 600 m section examined consisted of several large pools up to 1.8 m deep and up to 6 m in width, interspersed by narrow and shallow (300-400 mm) flowing sections.

The channel substrates were primarily a mix of alluvial silt, sand and coarse gravel, and significant amounts of cobble and partially-embedded boulders. Some sections with steep banks (up to 6 m in height) appeared subject to under-cutting and severe bank erosion. In-stream habitat consisted of relatively small stands of aquatic vegetation, mainly on the sand beds and along the edges of the pools.

There was no significant shrub or tree vegetation in this reach. Aquatic and riparian vegetation was also generally sparse in the reach, compared with the upstream reaches. The most common aquatic species recorded was the sedge: *Schoenoplectus validus*, which formed small, but significant stands along about 30% of the length of the reach, distributed along the shallower areas of the creek.

Other aquatic species present were: *Isolepis habra*, *Paspalum distichum*, *Eleocharis acuta* and *E. atricha*; Common Reed (*Phragmites australis*), and Cumbungi (*Typha orientalis*). Isolated clumps of *Carex* sp., *Juncus usitatus*, *Cyperus polystachyos* and *C. eragrostis* also occurred in the lower and upper riparian areas.

In the survey conducted in November 2011, large beds of the green algae *Chara* sp. (Stonewort) and Milfoil (*Myriophyllum crispatum*) were recorded in this reach. However these species and other submerged aquatic species were not recorded in the current survey. Small amounts of the aquatic moss *Rosulabryum subfasciculatum* were found growing in-stream, in crevices among the gravel and rocks.

On both left and right banks of the creek, infestations of pasture grasses - mainly *Phalaris aquatica* and *Eragrostis curvula*, dominated upper riparian zones, interspersed with native Poa tussock (*Poa labillardieri*). Small infestations of Blackberry also occurred adjacent to the creek. Introduced weeds, such as *Avena fatua*, *Plantago lanceolata*, *Verbena bonariensis*, *Conyza* sp., *Cirsium vulgare*, *Verbascum* spp. and *Hypericum perforatum,* were relatively common on upper riparian areas, mainly on the right bank (looking d/s).

As in the upstream reaches, all species recorded within this downstream reach were common in the region, and had been previously recorded (ALS, 2012). No rare or threatened species were found.

4.5 Native Vegetation

Riparian and fringing vegetation within shallow, in-stream sections of Burra Creek comprised of *Isolepis-Schoenoplectus-Carex* and *Juncus* sedge associations in shallow areas, and stands of large macrophytes: *Typha orientalis* and *Phragmites australis* in standing water. These sedgelands and reed beds perform several important ecological functions, providing habitat for aquatic fauna, trapping sediment and reducing the exposure of banks and stream beds to erosion.

Long-term stability is expected to be restored as newly formed low flow channel margins are recolonised by fringing vegetation and a new equilibrium is established within the system.

Above London Bridge Homestead (where bedrock dominates the channel), the changes as a result of transfer flow discharges are expected to be limited to the establishment of a more defined low flow channel connecting pools .

The formation of a continuous channel will result in the erosion and transport of sediment, since increased flow over riffle zones will inundate and destabilise fringing vegetation. However, the impact of this increased turbidity is expected to be short-lived and reduce as fringing vegetation re-establishes and expands, particularly during summer months, and particles settle out under low-flow conditions.

Pools in the lower reaches of Burra Creek above and below London Bridge are likely to be subject to deposition of sediment from the low flow channel within the riffle zones. The increase in the level and width of flow within pools may reduce the distribution of the existing fringing vegetation further. This may expose sediments to erosion, potentially increasing pool width. There may be a reduction in pool levels during low flow periods when transfer flows are not being discharged. Deep pools are important habitat for aquatic species and any loss of pool habitats would be a significant change in the availability of aquatic habitat along Burra Creek.

The most common large macrophytes in the Burra Creek are *Phragmites australis* and *Typha orientalis.* These two, and other common species: *Eleocharis* spp. and *Schoenoplectus validus*, are all perennials, but seasonal species, which dieback over winter and regrow from rhizomes in spring. Given the seasonality of these plants, their capacity to respond to larger flows also varies with season. During winter, reed beds senesce and tend to flatten or detach stems in response to strong flows. This behaviour greatly reduces shear stress and scouring effects, thus ensuring that root systems and surrounding sediments stay intact.

During spring, young shoots and stolons of sedges and reeds are produced, and these grow quickly during warm conditions and long days (extended sunlight hours) in summer. New roots, mostly adventitious roots, are also produced at this time. There is a possibility that high flows (both volume and velocity) could have an adverse impact at this time. For instance, young shoots could drown, or be poorly established through prolonged submersion; or fast flows could dislodge them out, before the roots have had the opportunity to properly establish. As previously identified (Bulk Water Alliance, 2009), the distribution and re-colonisation ability of the fringe beds of smaller macrophytes, as well as the larger stands of *Typha* and *Phragmites* will be important factors in the degree of morphological adjustments that would follow the transfer discharges.

Most of the predicted morphological adjustments are likely to occur within the first one to two years of operations (Bulk Water Alliance 2009). If the macrophytes are able to recolonise low flow channel areas, the impacts on water quality and pool sedimentation as a result of the proposed works are considered to be short-lived.

4.6 Introduced Species and Exotic Vegetation

Degraded riparian vegetation is common along Burra Creek between Williamsdale Road and Burra Road. Most significant are the populations of exotic trees: Willows (*Salix* spp.) and Poplars (*Populus* spp.) and infestations of Blackberry (*Rubus fruiticosus*). These could easily be incrementally controlled over 2-3 years, and native riparian vegetation re-established, within the framework of a vegetation management plan (see below).

A variety of non-native pasture and weed-affected areas occur along the Burra Creek, and are associated with the past history of land use (agricultural activities), poor weed management practices and other disturbances, such as erosion. A combination of these activities has led to sedimentation in Burra Creek.

4.7 Vegetation Recommendations:

A vegetation management plan, including implementation of a riparian rehabilitation and weed management is recommended. Areas to be focused on include those identified as having the potential to be undercut by transfer flows within Burra Creek; and immediate construction sites for the intake and discharge points.

Macrophytes should be monitored and mapped, to identify and manage any significant changes in biomass above the low flow channel. This will ensure that species are not lost, and re-colonisation of the existing species could be qualitatively assessed.

It will also assist in planning appropriate mitigation measures, which can be implemented if macrophytes are not re-establishing in the low flow channel marginal areas. Maintaining strong macrophyte communities along Burra Creek will ensure habitat quality is maintained and water quality and pool sedimentation impacts of the discharge flows are short-lived.

A program to monitor the extent of change to macrophyte beds as the increased flow is likely to reduce the area of occupancy via scouring, changed substrate and microhabitat availability.

As a result of the finding from this report it is recommended that ongoing monitoring is undertaken of the high risk areas which have been identified after large storm events resulting in flows greater than 1 in 1 yr ARI or prolonged operation of the pipeline (≥ 1 week continuous at 100 ML/d). This will ensure that any reduction in the quality of the geomorphology of the creek can be identified and managed efficiently and effectively.

5. Conclusions and Recommendations

During the commissioning, there was no observed erosion from the banks as a direct result of M2G discharge flows. There was also no evidence that the commissioning flows initiated any channel or riffle zone adjustment, and no movement of sediment deposits except for remobilisation of very fine sediment that temporarily increased turbidity.

Pool 5 above BUR 2C was identified as having a high erosion potential. When in operation, prolonged flows around 100ML/d will exacerbate the natural erosion occurring along the base of the western embankment.

Results from water quality samples show an increase in turbidity with initial pumping that tapers off as pumping continues. The duration and magnitude of this turbidity increase is not of concern environmentally.

Water quality results also show a reduction in EC and pH levels below the discharge in relation to samples taken above the discharge point. This reduction is consistent with what is expected from water out of the Murrumbidgee and is also not of environmental concern to Burra Creek.

The aquatic and riparian vegetation in Burra Creek are adapted to the flash event characteristics of the catchment. This allows them to recover quickly following inundation for short periods during events. This will allow the recovery of the vegetation after M2G maintenance releases which are short in duration. However when the pipeline is operational for extended periods of time, this will potentially have a negative impact on the fringing vegetation, as extended inundation will prevent recovery and less hardy species will subsequently retreat further from the creek bed.

To date it has not been possible to monitor long term pumping.

Recommendations:

1) Continue the ongoing monitoring of Burra Creek to determine the changes occurring as a result of natural flow events, especially those that could be exacerbated by a continuous discharge from M2G;
2) Consider options for BUR 2C to either be left to natural erosion, or mitigated to reduce sediment transfer to Googong Reservoir, be investigated further.
3) Undertake monitoring of macrophyte beds and encroachment of vegetation into the central channel to determine potential impacts from M2G operating in a continuous mode.

6. References

ACTEW Corporation (2009) *Murrumbidgee to Googong Water Transfer: Environmental Impact Statement*

ACTEW Corporation (2010a). *Murrumbidgee to Googong Water Transfer. Aquatic Ecology Management Plan.*

ACTEW Corporation (2010b). *Murrumbidgee to Googong Water Transfer: Geomorphologic Monitoring Sub Plan.*

ACTEW Corporation (2011). *Murrumbidgee to Googong Water Transfer: Burra Creek Environmental Management Plan.*

ACTEW Corporation (2012). *Murrumbidgee to Googong Water Transfer: Operation Environmental Management Plan.*

Appendices

Appendix A Creek Maps

Appendix B - Pre Commissioning Pool & Riffle Photos

Pool photos were taken on the 24th and 25th July 2012 when the average daily flow at Burra weir (gauging station 410774) was 7.9 and 7.8 ML/day respectively. Pool numbering is consistent with that of the previous geomorphic assessment completed during the EIS phase of the M2G project for ease when comparing changes over time.

Pool 1

Pool 2

Pool 3

Pool 4

Pool 5

Pool 6

Pool 7

Pool 8

Pool 9

Pool 10

Pool 11

Pool 12

Pool 13

Pool 14

Pool 15

Pool 16

Pool 17

Pool 18

Pool 19

Pool 20

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Pool 57

Pool 58

Pool 59

Pool 60

Pool 61

Pool 62

Pool 63

Pool 64

Pool 65

Pool 66

Pool 67

Pool 68

Pool 69

Pool 70

Pool 71

Appendix C - Post Commissioning Photos (19-21 March 2013): Key Sites


Step D/S Williamsdale Rd Looking U/S

BUR2A Riffle Looking D/S

BUR2A Riffle Looking U/S

Middle of Riffle U/S Pool 50 Looking U/S

Bottom of Riffle U/S Pool 50

Pool 28 Looking U/S

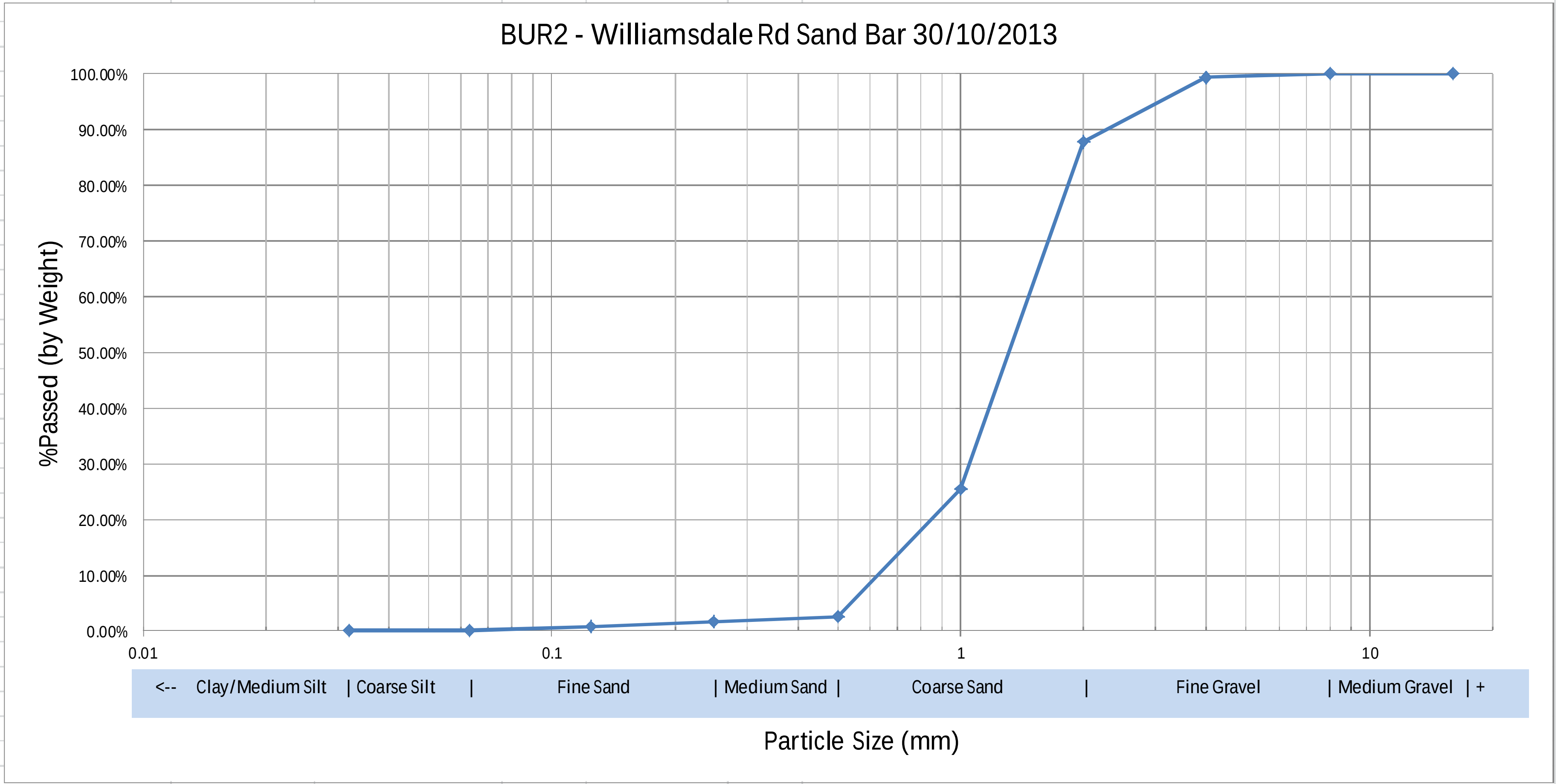
Pool 28 Looking D/S

Bend U/S BUR2C Riffle

There was no visually detectable change at sites except for the embankment at bend U/S BUR2C riffle where erosion had occurred.

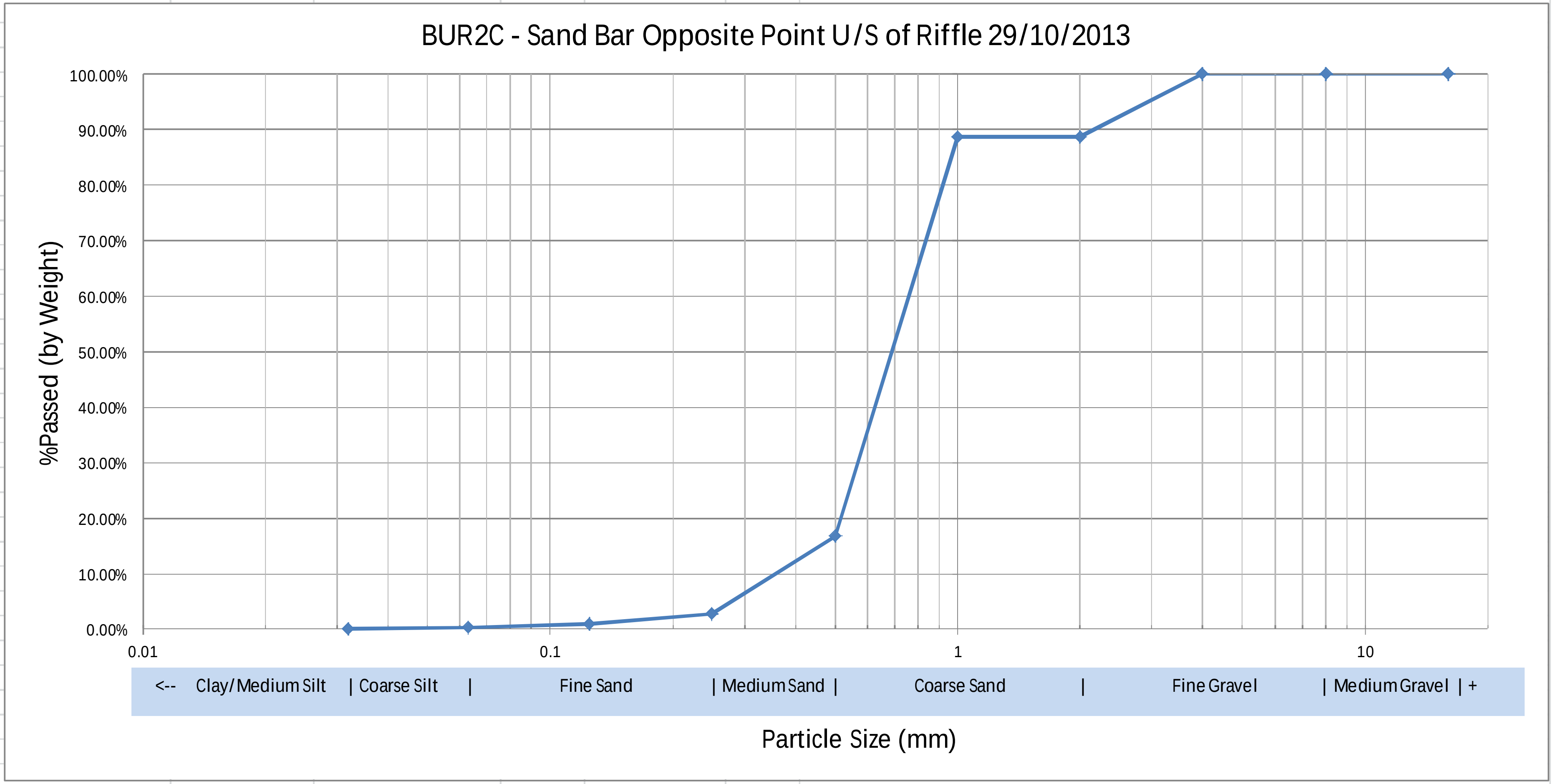
Appendix D - Sieve Analysis Results

	Sediment Sieve Analysis					
	Sample ID:	BUR2 - Williamsdale Rd Sand Bar				
	Sample Date:	30/10/2013				
	Container Weight	83.2				
	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16	0	0	0.00%	100.00%	
Medium Gravel	8	0	0	0.00%	100.00%	
Fine Gravel	4	88.12	4.92	0.67%	99.33%	
Fine Gravel	2	168.11	84.91	11.56%	87.77%	
Coarse Sand	1	541.41	458.21	62.38%	25.39%	
Coarse Sand	0.5	250.51	167.31	22.78%	2.61%	
Medium Sand	0.25	90.9	7.7	1.05%	1.57%	
Fine Sand	0.125	88.28	5.08	0.69%	0.87%	
Fine Sand	0.063	88.23	5.03	0.68%	0.19%	
Coarse Silt	0.032	84.59	1.39	0.19%	0.00%	
	Total Weight (g)		734.55	100.00%		

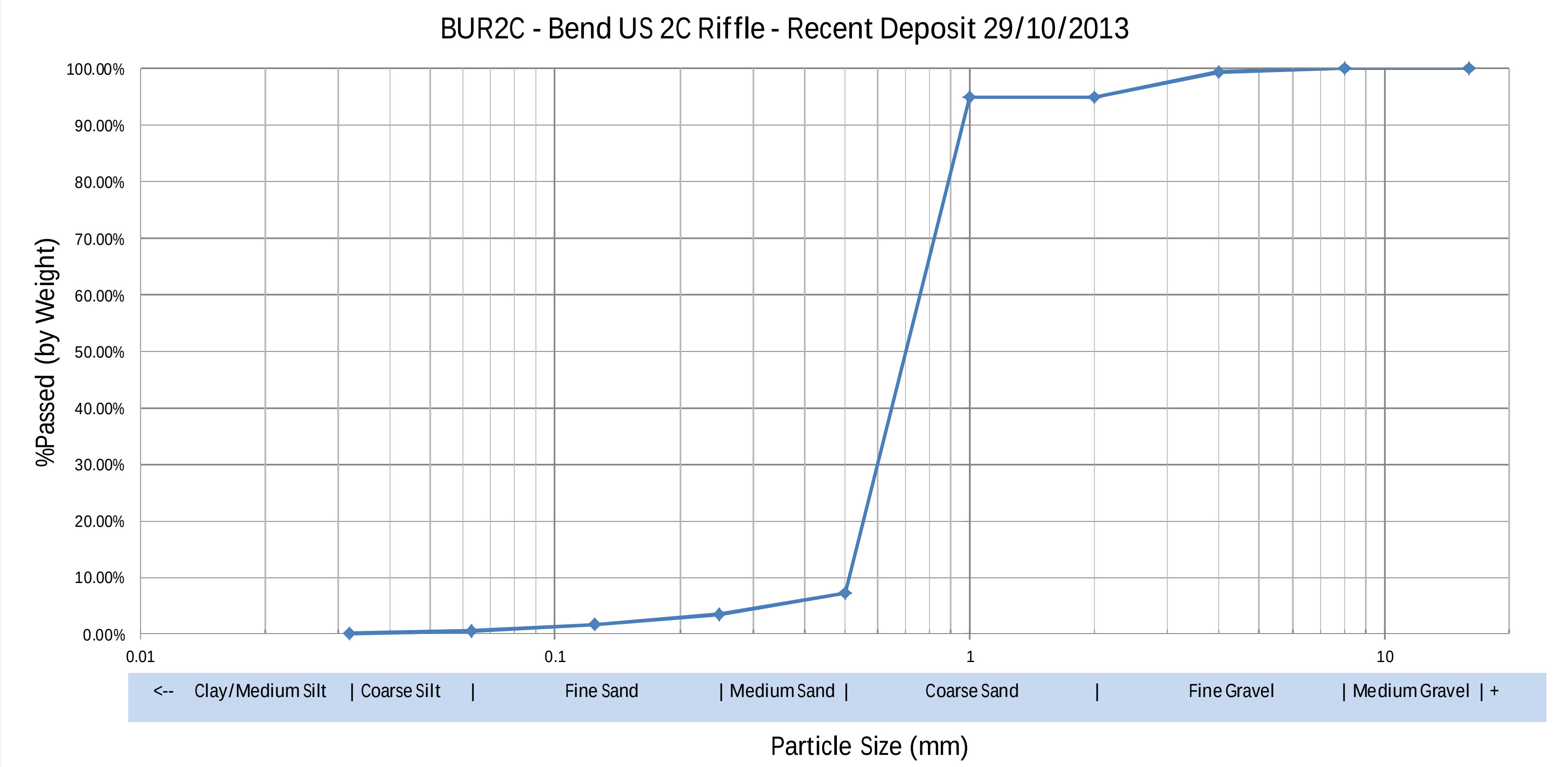


Sediment Sieve Analysis

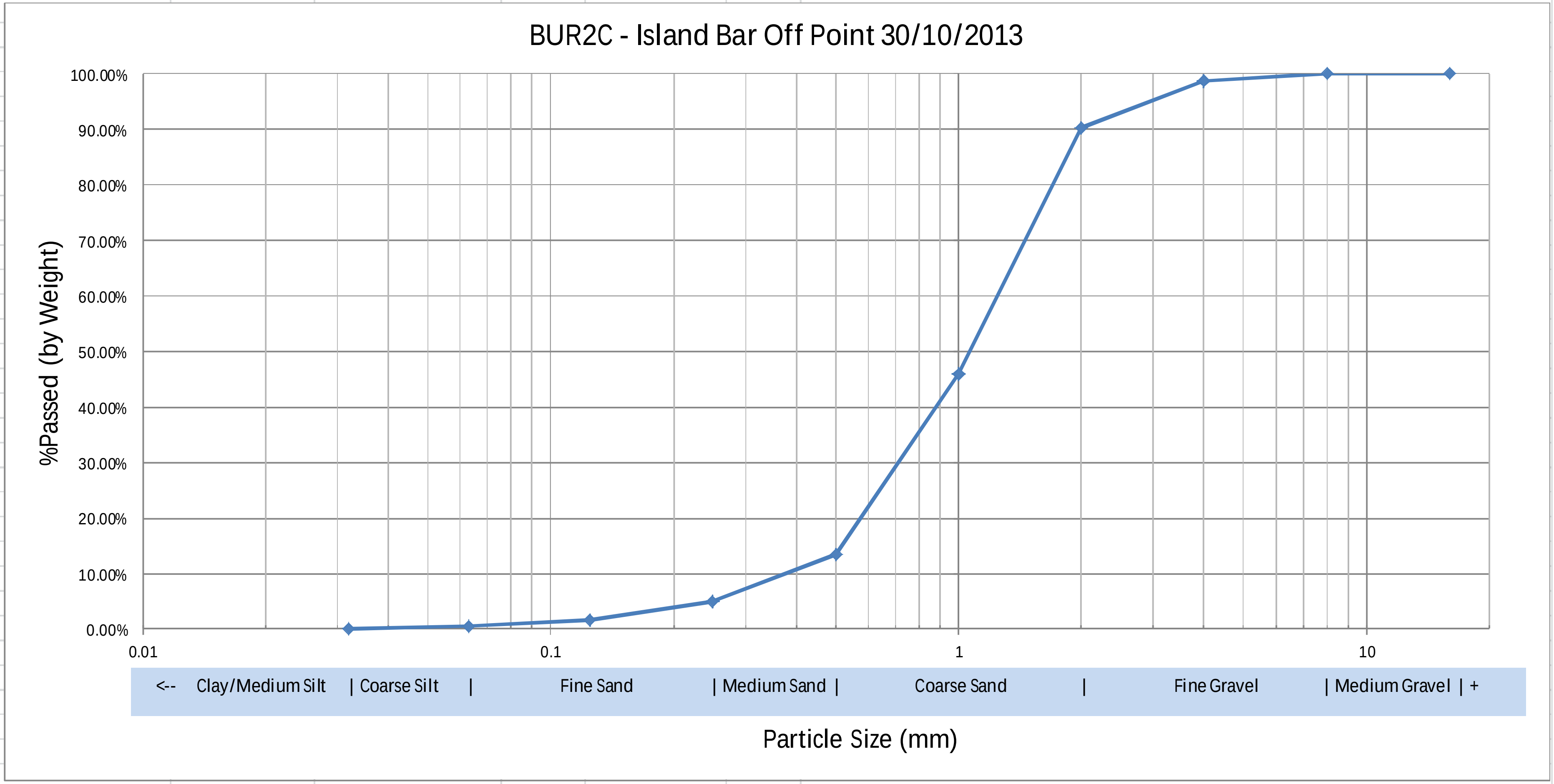
	Sample ID:	BUR2C - Sand Bar Opposite Point U/S of Riffle				
	Sample Date:	29/10/2013				
	Container Weight	83.2				
	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16		0	0.00%	100.00%	
Medium Gravel	8		0	0.00%	100.00%	
Fine Gravel	4		0	0.00%	100.00%	
Fine Gravel	2	139.2	56	11.24%	88.76%	
Coarse Sand	1		0	0.00%	88.76%	
Coarse Sand	0.5	441.2	358	71.89%	16.87%	
Medium Sand	0.25	153.2	70	14.06%	2.81%	
Fine Sand	0.125	92.2	9	1.81%	1.00%	
Fine Sand	0.063	86.2	3	0.60%	0.40%	
Coarse Silt	0.032	85.2	2	0.40%	0.00%	
	Total Weight (g)		498	100.00%		



	Sediment Sieve Analysis					
	Sample ID:	BUR2C - Bend US 2C Riffle - Recent Deposit				
	Sample Date:	29/10/2013				
	Container Weight	83.2				
	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16		0	0.00%	100.00%	
Medium Gravel	8		0	0.00%	100.00%	
Fine Gravel	4	86.2	3	0.61%	99.39%	
Fine Gravel	2	105.2	22	4.48%	94.91%	
Coarse Sand	1		0	0.00%	94.91%	
Coarse Sand	0.5	514.2	431	87.78%	7.13%	
Medium Sand	0.25	101.2	18	3.67%	3.46%	
Fine Sand	0.125	92.2	9	1.83%	1.63%	
Fine Sand	0.063	88.2	5	1.02%	0.61%	
Coarse Silt	0.032	86.2	3	0.61%	0.00%	
	Total Weight (g)		491	100.00%		



	Sediment Sieve Analysis					
	Sample ID:	BUR2C - Island Bar Off Point				
	Sample Date:	30/10/2013				
	Container Weight	83.2				
	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16		0	0.00%	100.00%	
Medium Gravel	8		0	0.00%	100.00%	
Fine Gravel	4	89	5.8	1.31%	98.69%	
Fine Gravel	2	120.7	37.5	8.49%	90.20%	
Coarse Sand	1	278.1	194.9	44.12%	46.08%	
Coarse Sand	0.5	226.87	143.67	32.52%	13.56%	
Medium Sand	0.25	120.5	37.3	8.44%	5.11%	
Fine Sand	0.125	98.09	14.89	3.37%	1.74%	
Fine Sand	0.063	88.09	4.89	1.11%	0.63%	
Coarse Silt	0.032	86	2.8	0.63%	0.00%	
	Total Weight (g)		441.75	100.00%		



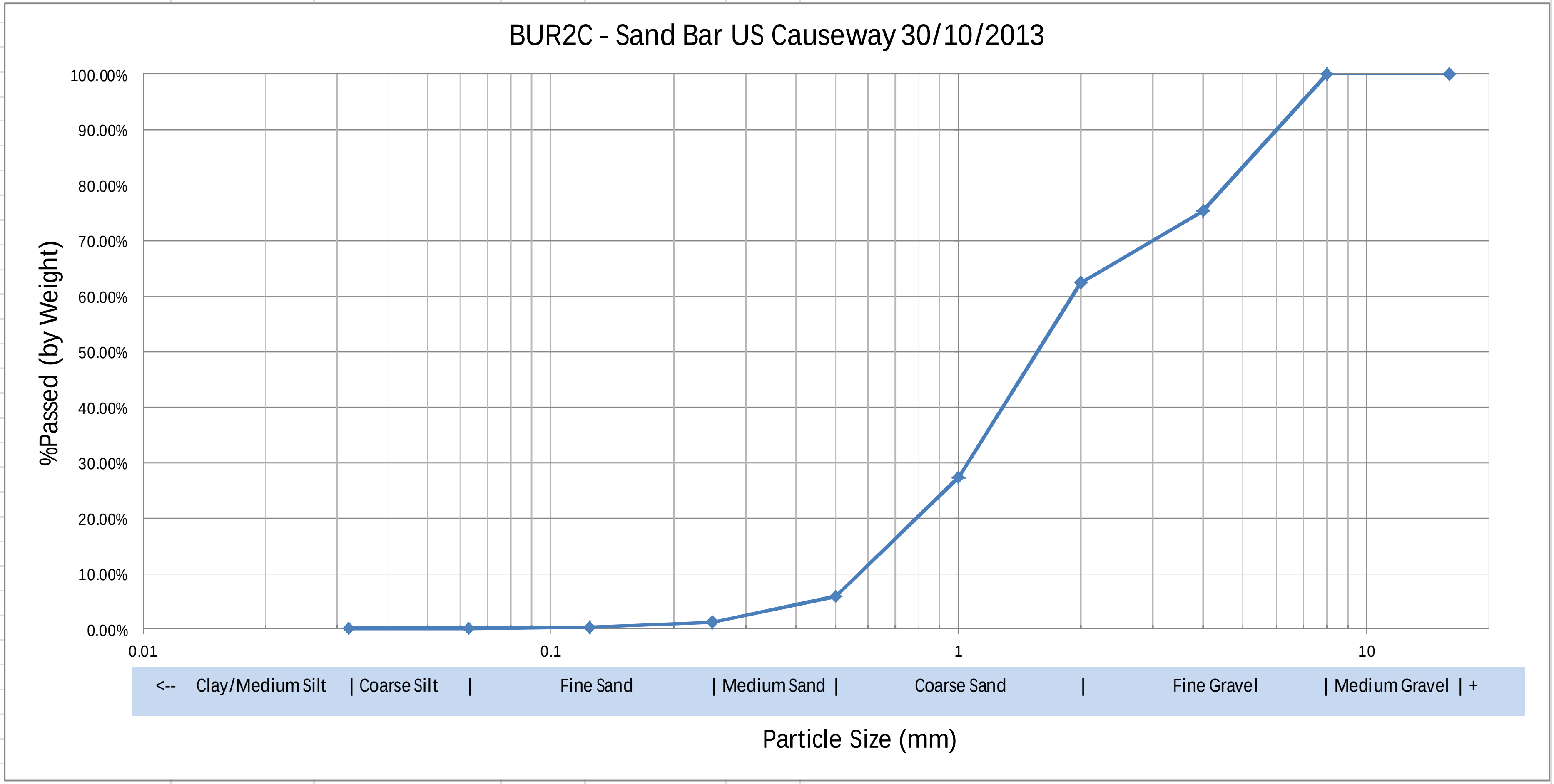
Sediment Sieve Analysis

Sample ID: BUR2C - Sand Bar US Causeway

Sample Date: 30/10/2013

Container Weight 83.2

	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16		0	0.00%	100.00%	
Medium Gravel	8		0	0.00%	100.00%	
Fine Gravel	4	332.05	248.85	24.65%	75.35%	
Fine Gravel	2	212.51	129.31	12.81%	62.54%	
Coarse Sand	1	438.71	355.51	35.21%	27.33%	
Coarse Sand	0.5	299.26	216.06	21.40%	5.93%	
Medium Sand	0.25	131.73	48.53	4.81%	1.12%	
Fine Sand	0.125	91.58	8.38	0.83%	0.29%	
Fine Sand	0.063	85.13	1.93	0.19%	0.10%	
Coarse Silt	0.032	84.23	1.03	0.10%	0.00%	
	Total Weight (g)		1009.6	100.00%		



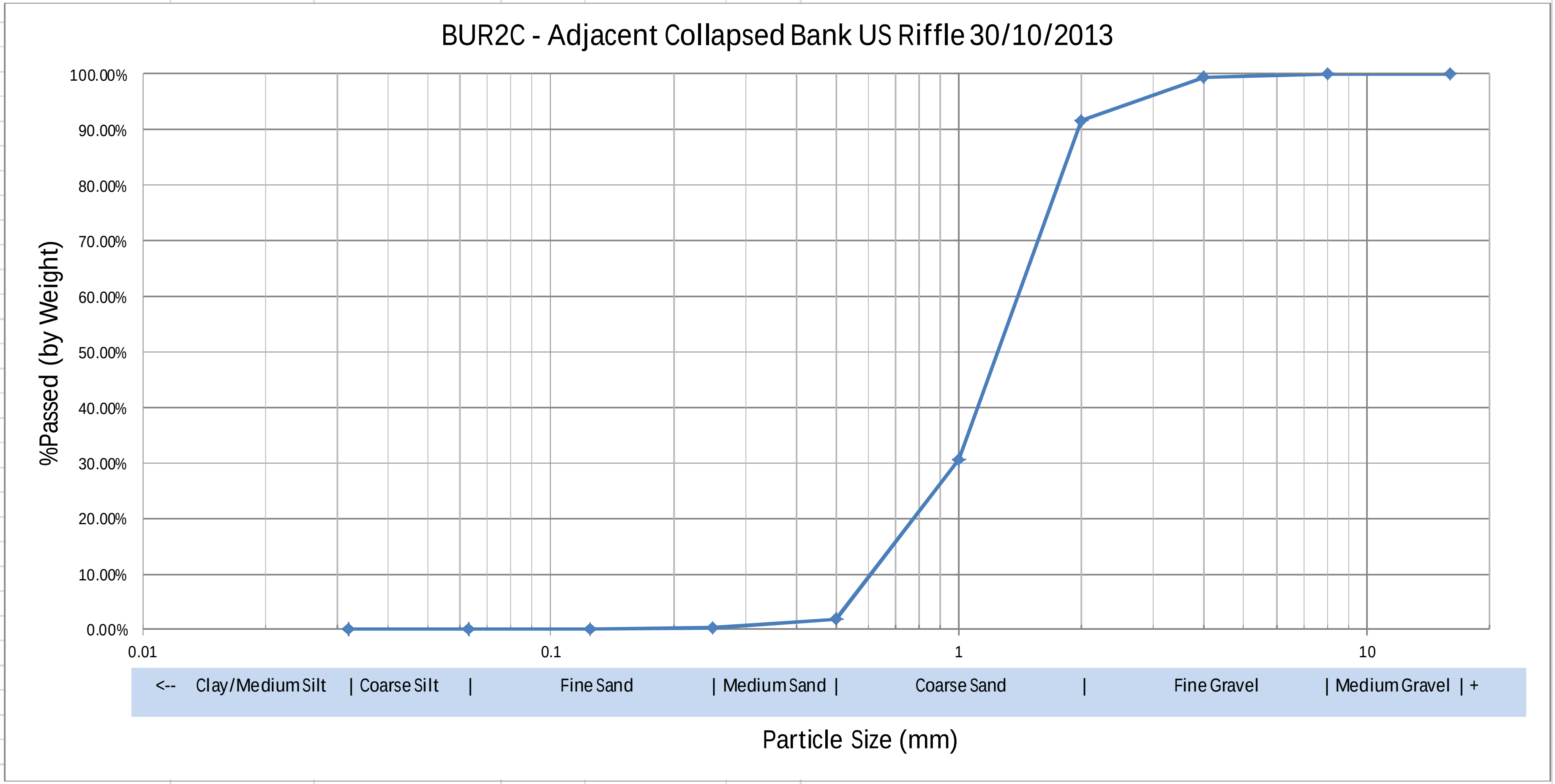
Sediment Sieve Analysis

Sample ID: BUR2C - Adjacent Collapsed Bank US Riffle

Sample Date: 30/10/2013

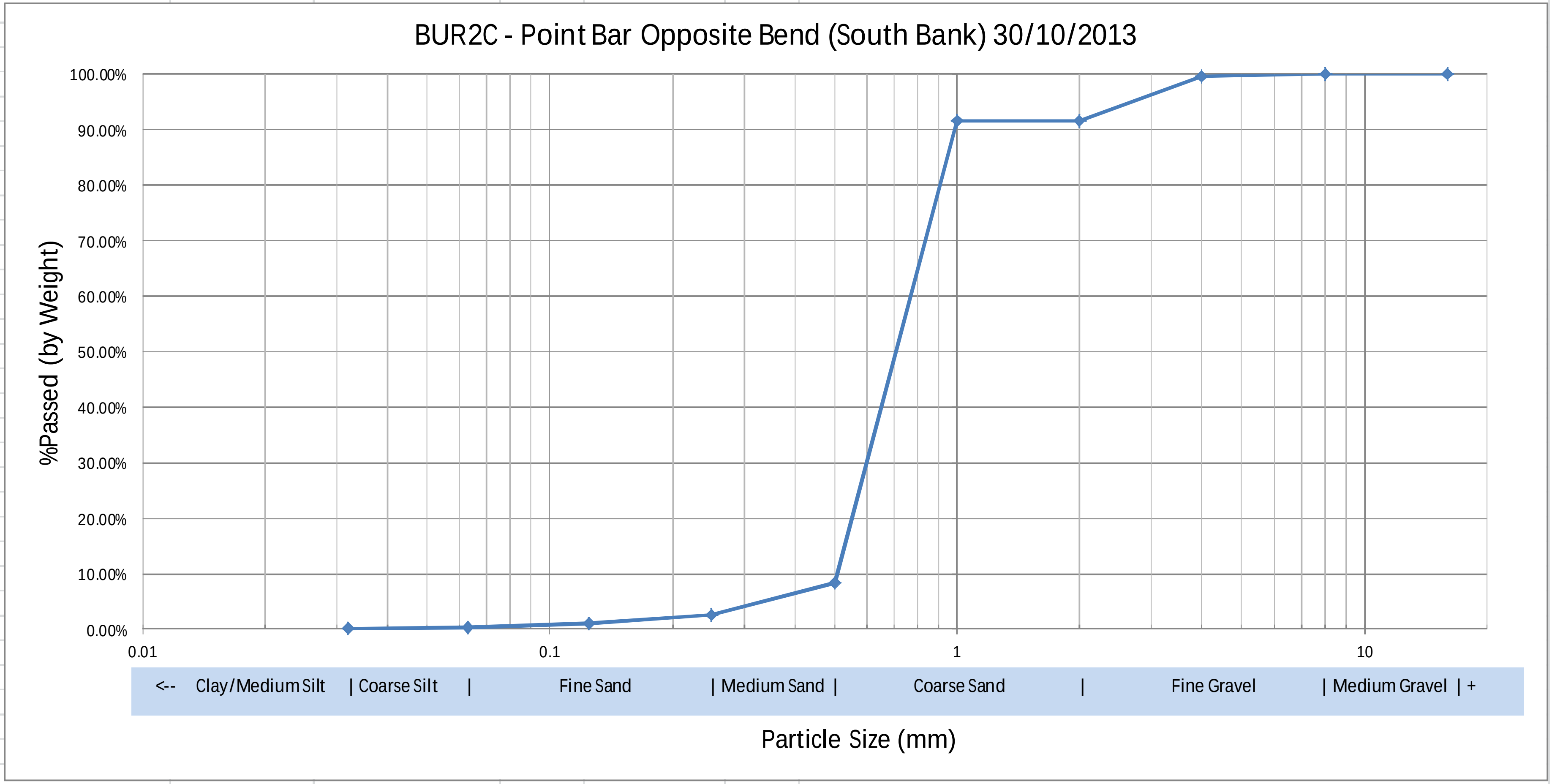
Container Weight 83.2

	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16		0	0.00%	100.00%	
Medium Gravel	8		0	0.00%	100.00%	
Fine Gravel	4	87.3	4.1	0.65%	99.35%	
Fine Gravel	2	131	47.8	7.62%	91.73%	
Coarse Sand	1	466.5	383.3	61.06%	30.67%	
Coarse Sand	0.5	264.1	180.9	28.82%	1.85%	
Medium Sand	0.25	93.05	9.85	1.57%	0.28%	
Fine Sand	0.125	84.4	1.2	0.19%	0.09%	
Fine Sand	0.063	83.75	0.55	0.09%	0.00%	
Coarse Silt	0.032		0	0.00%	0.00%	
	Total Weight (g)		627.7	100.00%		



Sediment Sieve Analysis

	Sample ID:	BUR2C - Point Bar Opposite Bend (South Bank)				
	Sample Date:	30/10/2013				
	Container Weight	83.2				
	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16		0	0.00%	100.00%	
Medium Gravel	8		0	0.00%	100.00%	
Fine Gravel	4	85.2	2	0.44%	99.56%	
Fine Gravel	2	119.8	36.6	7.97%	91.60%	
Coarse Sand	1		0	0.00%	91.60%	
Coarse Sand	0.5	465.2	382	83.17%	8.43%	
Medium Sand	0.25	110.2	27	5.88%	2.55%	
Fine Sand	0.125	90	6.8	1.48%	1.07%	
Fine Sand	0.063	86.6	3.4	0.74%	0.33%	
Coarse Silt	0.032	84.7	1.5	0.33%	0.00%	
	Total Weight (g)		459.3	100.00%		



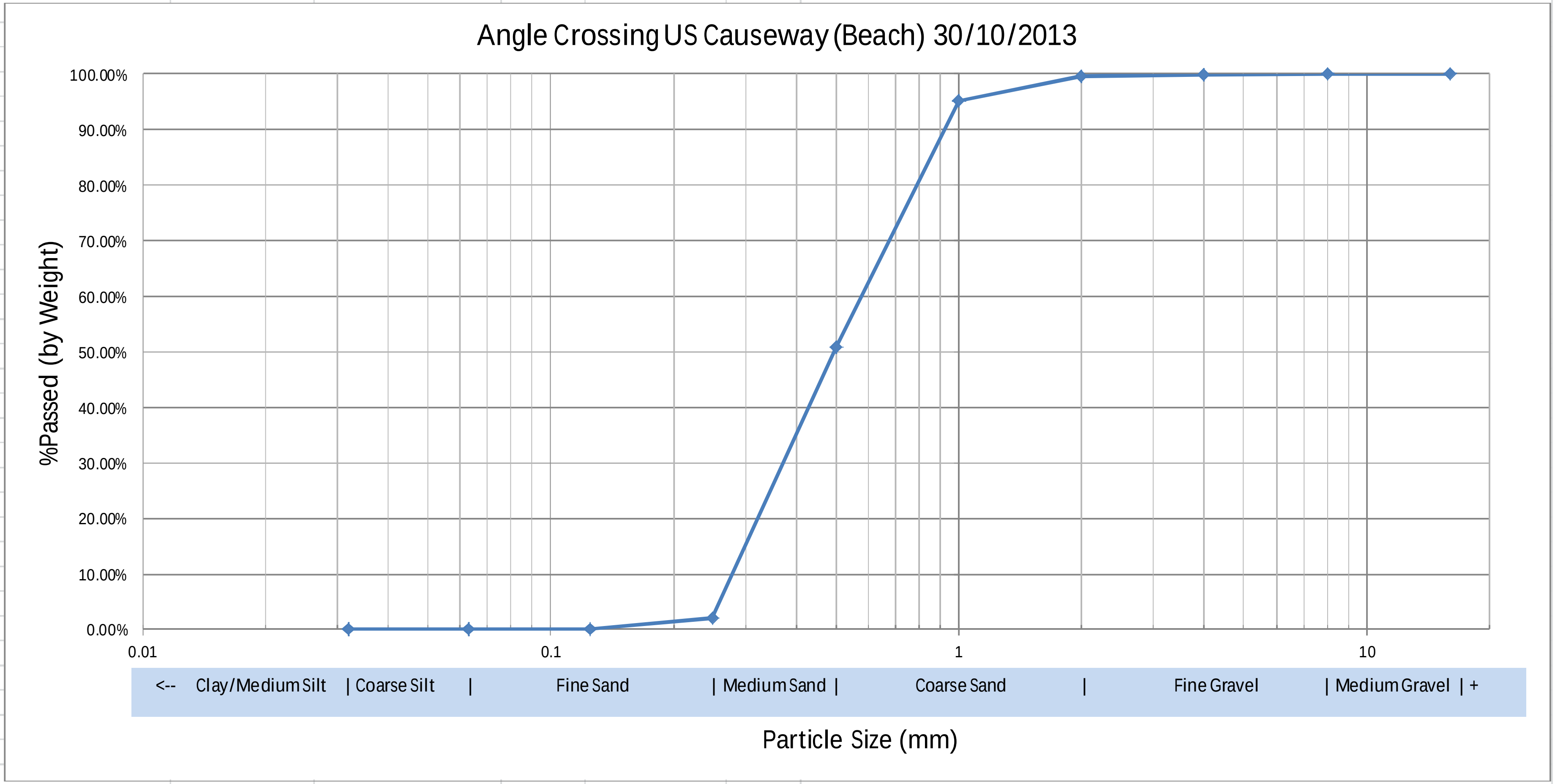
Sediment Sieve Analysis

Sample ID: Angle Crossing US Causeway (Beach)

Sample Date: 30/10/2013

Container Weight 83.2

	Sieve Size (mm)	Weight w/Container (g)	Weight (g)	% Sample (by Wt)	%Passed	Additional Comments
Medium Gravel/Cobble	16	0	0	0.00%	100.00%	
Medium Gravel	8	0	0	0.00%	100.00%	
Fine Gravel	4	83.88	0.68	0.08%	99.92%	
Fine Gravel	2	85.81	2.61	0.31%	99.61%	
Coarse Sand	1	120.1	36.9	4.38%	95.23%	
Coarse Sand	0.5	457.25	374.05	44.41%	50.82%	
Medium Sand	0.25	492.57	409.37	48.60%	2.22%	
Fine Sand	0.125	100.81	17.61	2.09%	0.12%	
Fine Sand	0.063	84.18	0.98	0.12%	0.01%	
Coarse Silt	0.032	83.27	0.07	0.01%	0.00%	
	Total Weight (g)		842.27	100.00%		



Appendix E - BUR 1: Site Survey

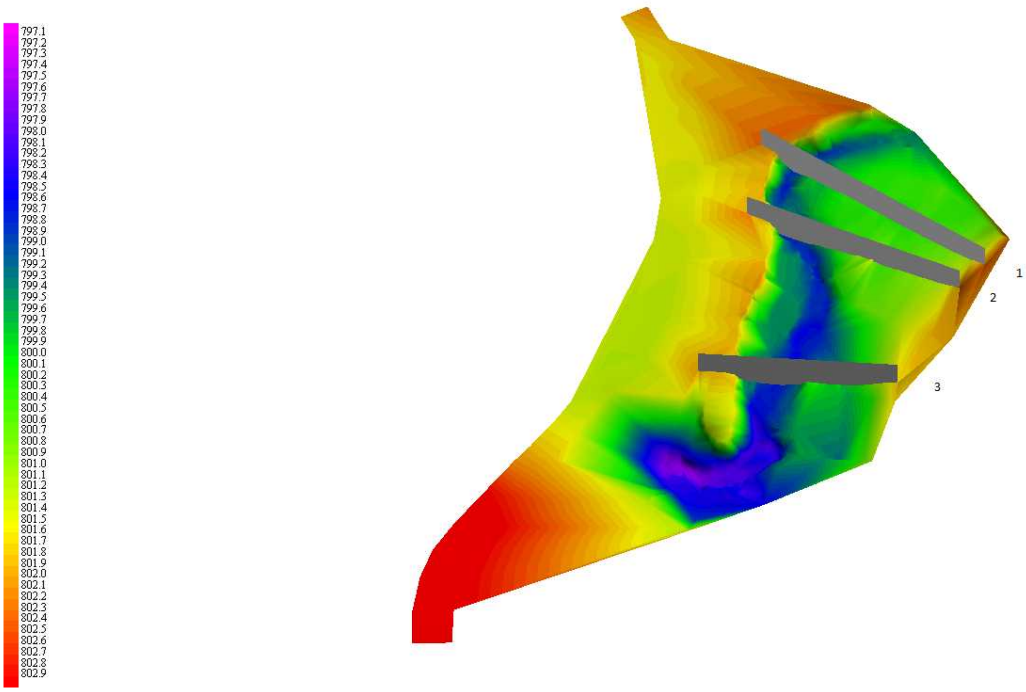


Figure 11 - BUR 1 3D DGPS Model (July 2013)

		2012		3D Model	
Section	Bank Side*	Latitude	Longitude	Latitude	Longitude
1	LHS	35.59797 S	149.22783 E	35.59799 S	149.22784 E
	RHS	35.59758 S	149.2277 E	35.59759 S	149.22771 E
2	LHS	35.59797 S	149.22777 E	35.59773 S	149.22777 E
	RHS	35.59768 S	149.22758 E	35.59767 S	149.22759 E
3	LHS	35.59803 S	149.22755 E	35.59806 S	149.22754 E
	RHS	35.59785 S	149.22728 E	35.59783 S	149.22728 E

* As seen looking Downstream (flow direction is top right to bottom left in 3D model, LHS closest to section numbers)

Cross-Section

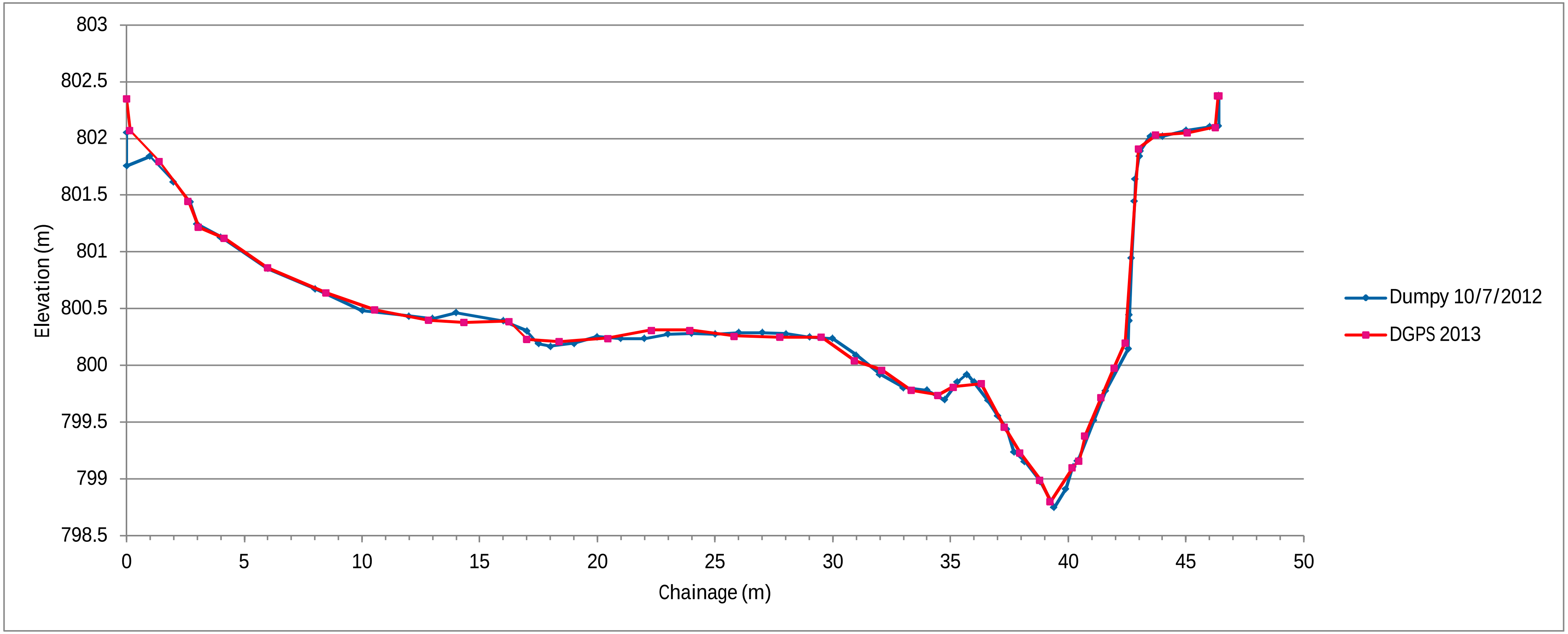


Figure 12 – BUR1 XS-1

- The cross section taken using a DGPS unit (Red) closely matches the cross section recorded by dumpy (Blue)

Cross-Section

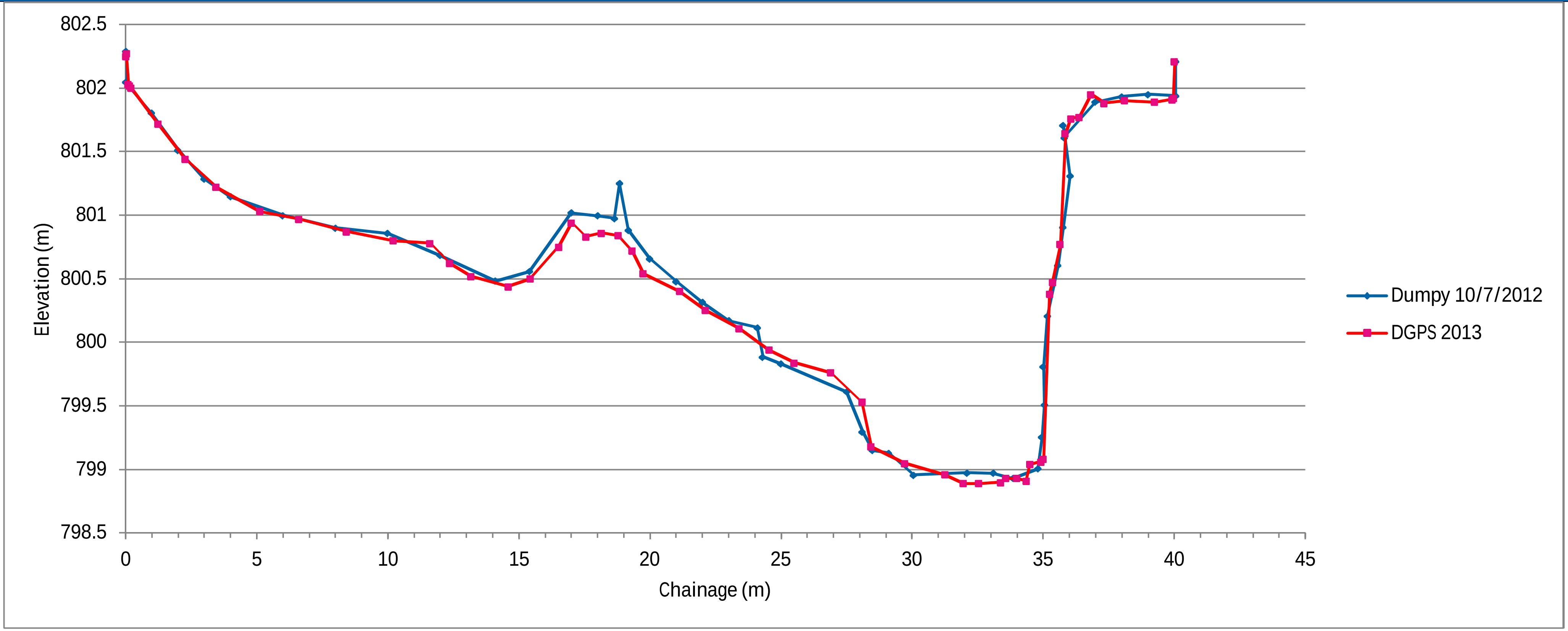


Figure 13 – BUR1 XS-2

- The cross section taken using the DGPS unit (Red) closely matches the cross section recorded by dumpy (Blue)
- Difference at CH16-20m due to flood debris that has moved or eroded away. Peak point ~CH19m on top of log.
-

Cross-Section

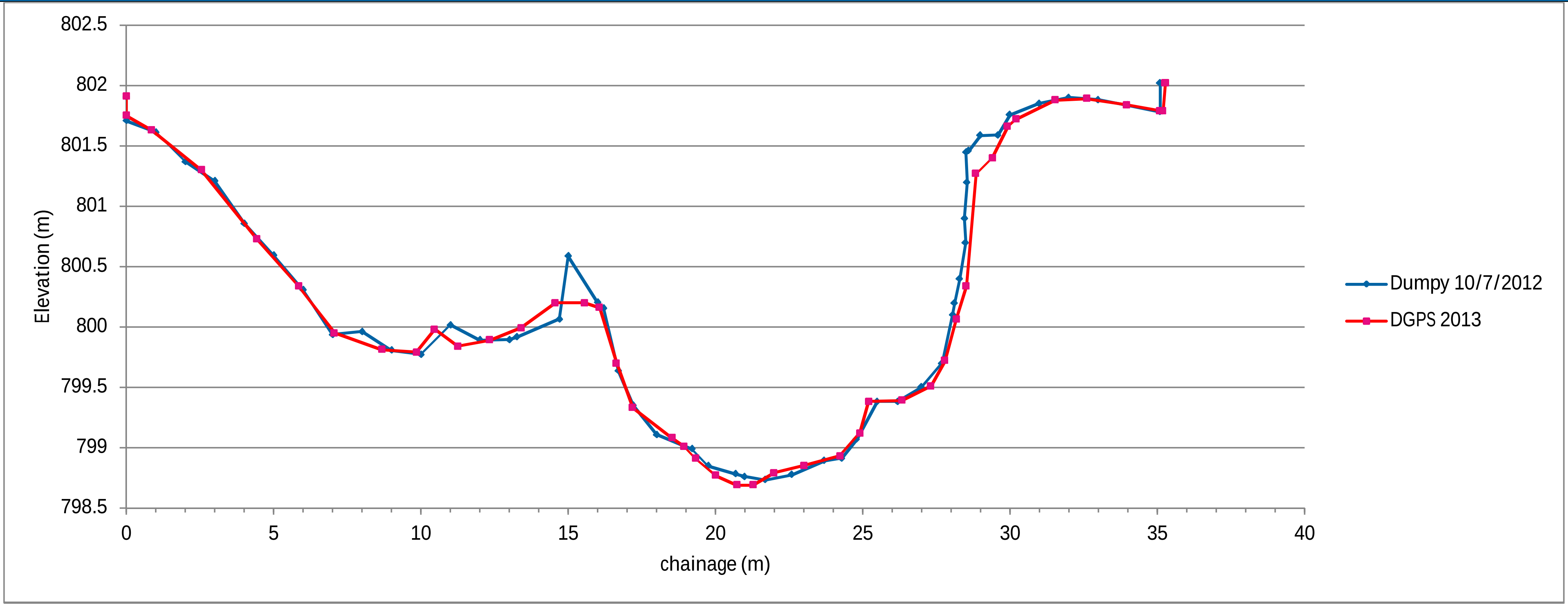


Figure 14 – BUR1 XS-3

- The cross section taken using the DGPS unit (Red) closely matches the cross section recorded by dumpy (Blue)
- Some erosion from top of bank at ~CH29m
- Spike at ~CH15m difference due to flood debris, top of branch.

Photo	Comment
 Photo 3 - BUR1 24/10/2009	- First photo on record for BUR1 - Evidence of erosion outside of bend. - Stable vegetation on 60%-80% of visible stream banks. - Sediment deposits within channel. - Creek channel dry.
 Photo 4 - BUR1 17/3/2010	- Water flow present in centre channel.

Photo	Comment
 Photo 5 - BUR1 12/8/2010	
 Photo 6 - BUR1 20/10/2010	

<table>
<tr><th>Photo</th><th>Comment</th></tr>
<tr><td>
Photo 7 - BUR1 9/12/2010</td><td>- DS of BUR1 sample area at Cassidy's Crk confluence.
- Turbid Burra Creek flowing left to right bottom of photo.
- Less suspended material entering through Cassidy's Ck, due to less bank erosion and highly vegetated channel.</td></tr>
<tr><td>
Photo 8 - BUR1 9/12/2010</td><td>- Tail end of severe flood event. Peak of event went over the RHS bank.
- Scouring of banks and channel
- Vegetation removal
- Highly turbid water indicates significant sediment transport.
- Heavy debris load deposited by flood waters including tree on RHS bank.</td></tr>
</table>

Photo	Comment
 Photo 9 - BUR1 17/12/2010	- About a week after event. Evidence of bank undercutting as result of flood waters. - Large riparian vegetation removed with significant new debris and sediment deposited. - Banks unstable after vegetation revmoval.
 Photo 10 - BUR1 3/5/2011	- Shrub vegetation showng evidence of dying, possibly as a result of previous flood damage. - Undercut banks slumped.

Photo	Comment
 Photo 11 - BUR1 26/11/2011	- Grass re-established on banks - Native Shrubs re-re-establishing in riparian zone.
 Photo 12 - BUR1 30/11/2011	- Med flow event

Photo	Comment
 Photo 13 - BUR1 19/12/2011	- No obvious signs of habitat detorioration from high flow event.
 Photo 14 - BUR1 3/2/2012	- Healthy grasses and shrubs stabilising banks.

Photo	Comment
 Photo 15 - BUR1 21/2/2012	- Base flow with high turbidity
 Photo 16 - BUR1 1/3/2012	- High flow event - High turbidity from native reserve upstream

Photo	Comment
 Photo 17 - BUR1 8/3/2012	- Evidence of additional bank erosion on outside of bend - Bankside grass vegetationon LHS flattened by previous flow.
 Photo 18 - BUR1 20/3/2012	- Bankside vegetation recovering.

Photo	Comment
 Photo 19 - BUR1 6/7/2012	• Winter vegetation die off • Low flow
 Photo 20 - BUR1 13/7/2012	• After minor rainfall, not a large increase in turbidity or flow

<table>
<tr><th>Photo</th><th>Comment</th></tr>
<tr><td>
Photo 21 - BUR1 3/8/2012</td><td>End of winter photo</td></tr>
<tr><td>
Photo 22 - BUR1 10/9/2012</td><td>Vegetation just commencing spring growth
baseflow maintained through winter</td></tr>
</table>

Photo	Comment
 Photo 23 - BUR1 3/10/2012	• Increase in springtime temperature starts to increase in-stream algal growth
 Photo 24 - BUR1 12/10/2012	- Medium flow event - Spring vegetation growth apparent

Photo	Comment
 Photo 25 - BUR1 20/11/2012	- Bank shows signs of minor erosion from October '12 event - Bankside vegetation recovered And growing strongly after decent rainfall
 Photo 26 - BUR1 24/1/2013	• Summer die off of grasses • Increased vegetation recovery from previous year • Surface flow has ceased but sub surface remains moist

Photo	Comment
 Photo 27 – BUR1 29/4/2013	• Lack of autumn rainfall means creek still not flowing • Vegetation encroachment into central channel

Appendix F - BUR 1C: Site Survey

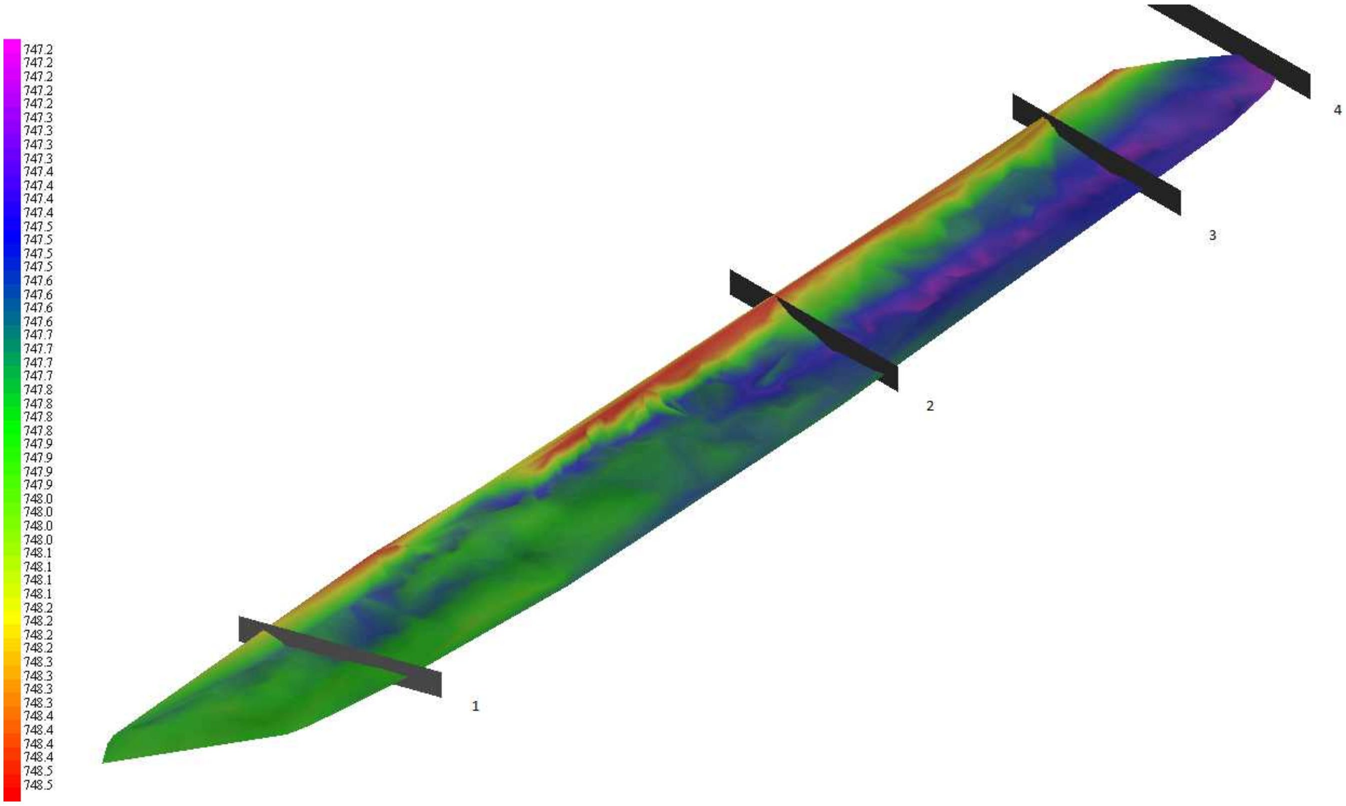


Figure 15 - Burra 1C 3D DGPS Model (July 2013)

		2012		3D Model	
Section	Bank Side*	Latitude	Longitude	Latitude	Longitude
1	LHS	35.55682 S	149.221 E	35.55682 S	149.22099 E
	RHS	35.55682 S	149.22112 E	35.55679 S	149.22111 E
2	LHS	35.5565 S	149.2211 E	35.55650 S	149.22110 E
	RHS	35.55653 S	149.22122 E	35.55653 S	149.22122 E
3	LHS	35.55633 S	149.22117 E	35.55633 S	149.22117 E
	RHS	35.55637 S	149.22128 E	35.55637 S	149.22128 E
4	LHS	35.55623 S	149.22118 E	35.55623 S	149.22118 E
	RHS	35.55627 S	149.22093 E	35.55627 S	149.22130 E

* As seen looking downstream (flow direction bottom left to top right in 3D image)

DGPS Survey equipment experiencing signal difficulties at this site, resulting in DGPS cross-sections not matching dumpy sections.

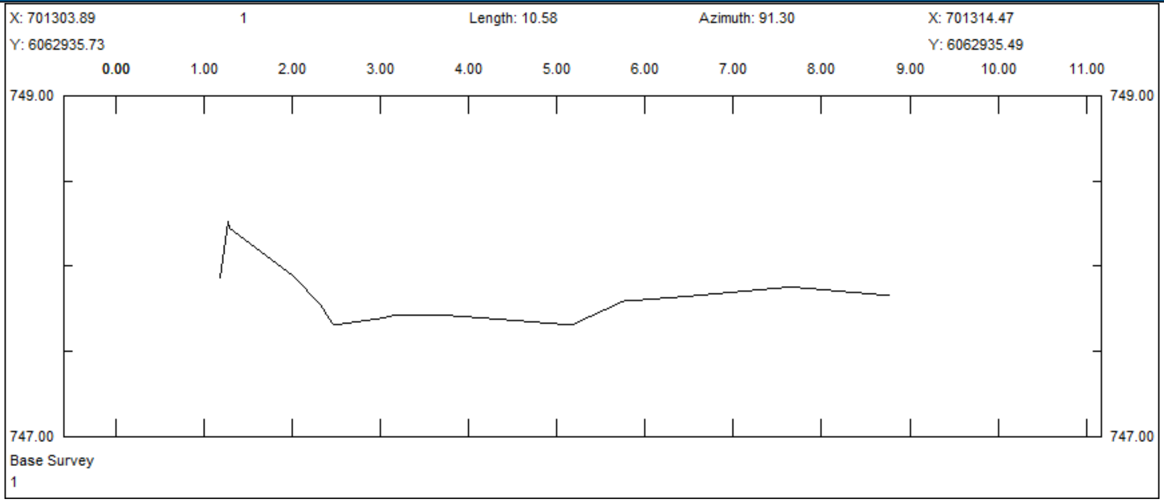
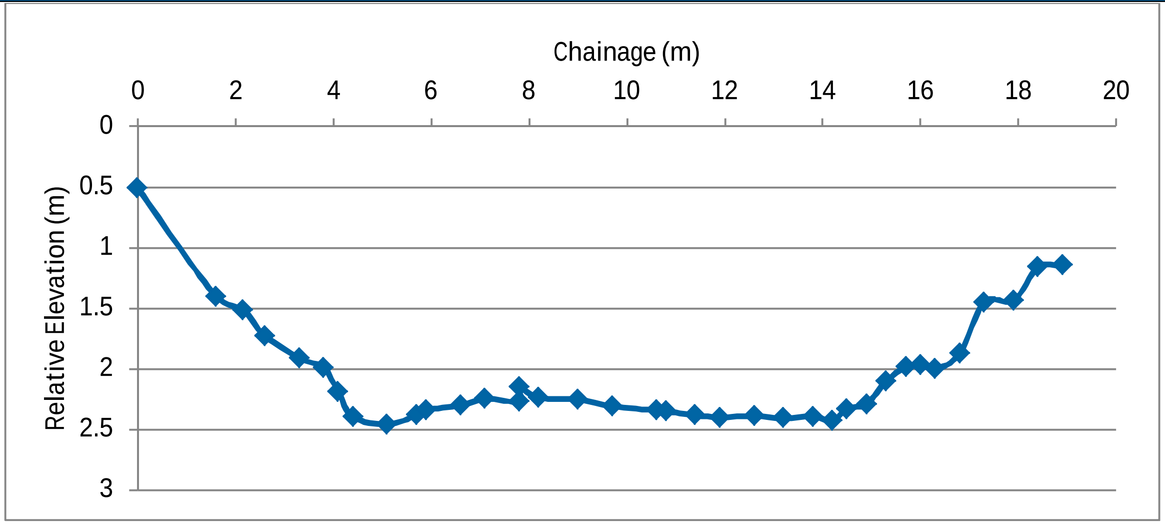
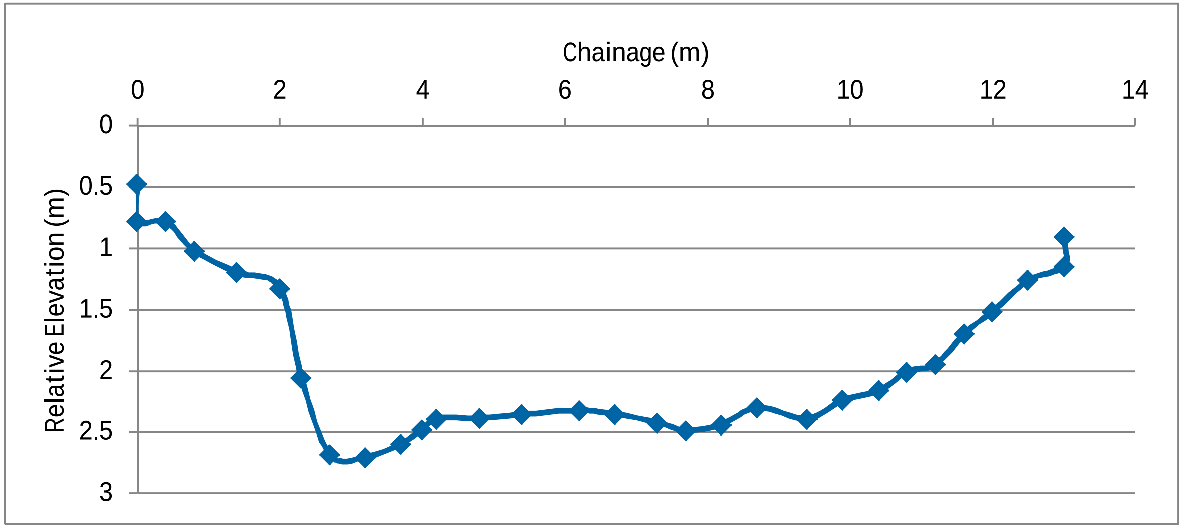
<table>
<tr><th>Cross-Section</th><th>Comment</th></tr>
<tr><td>


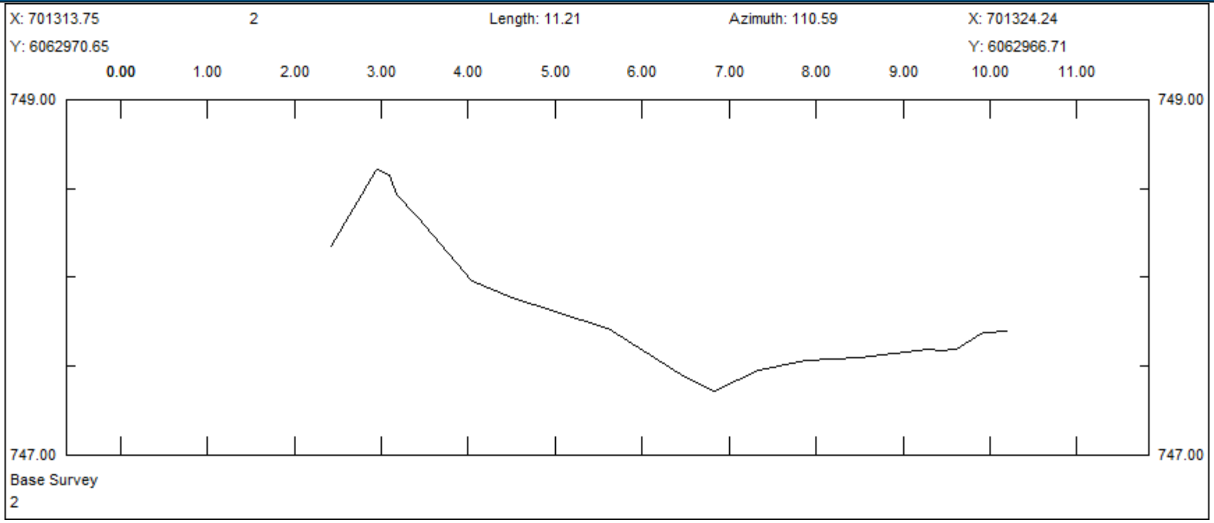
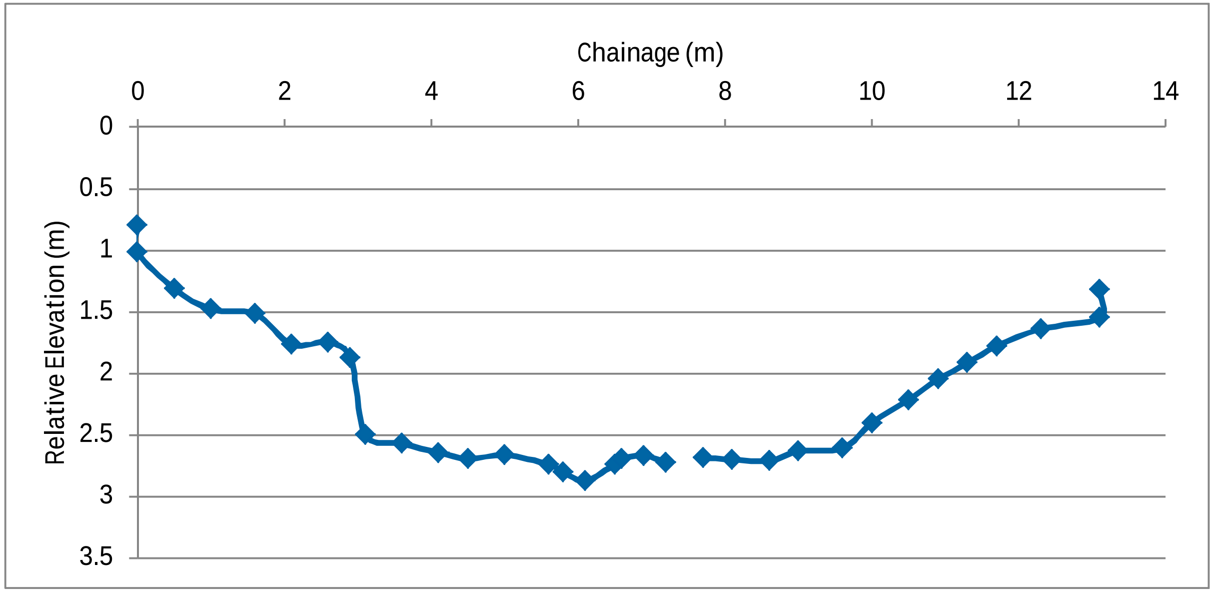
Figure 16 - BUR1C 3D GPS XS-1

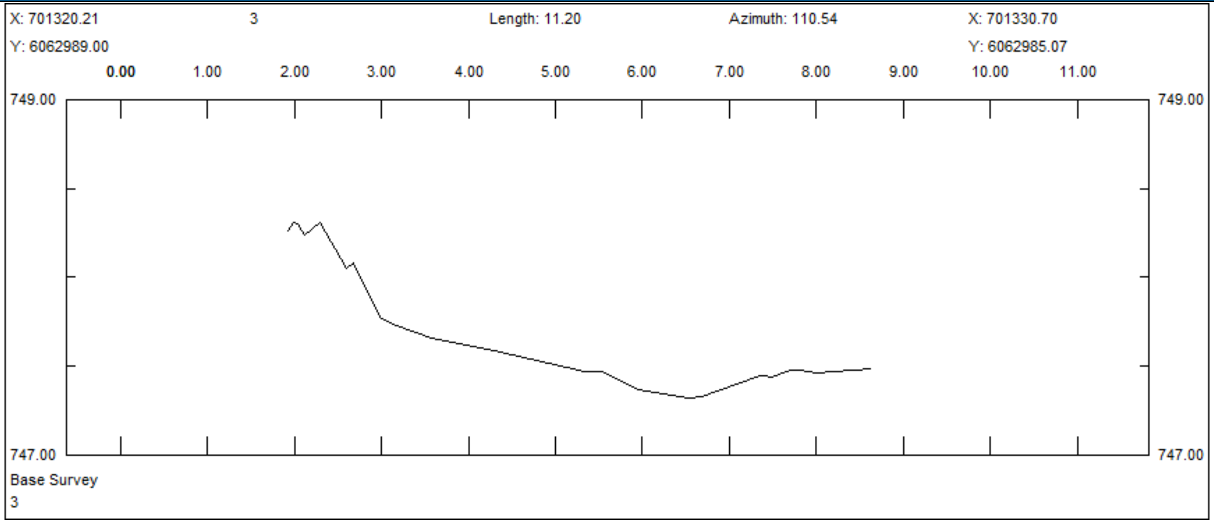
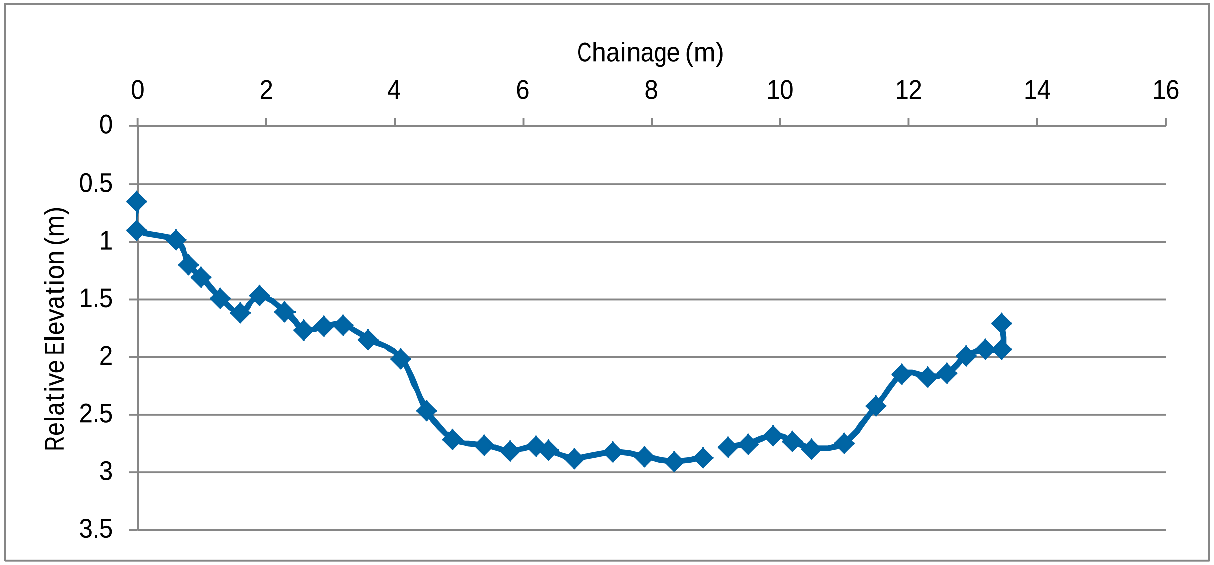
*All GPS sections shown in elevation (m) and chainage (m).
</td><td>

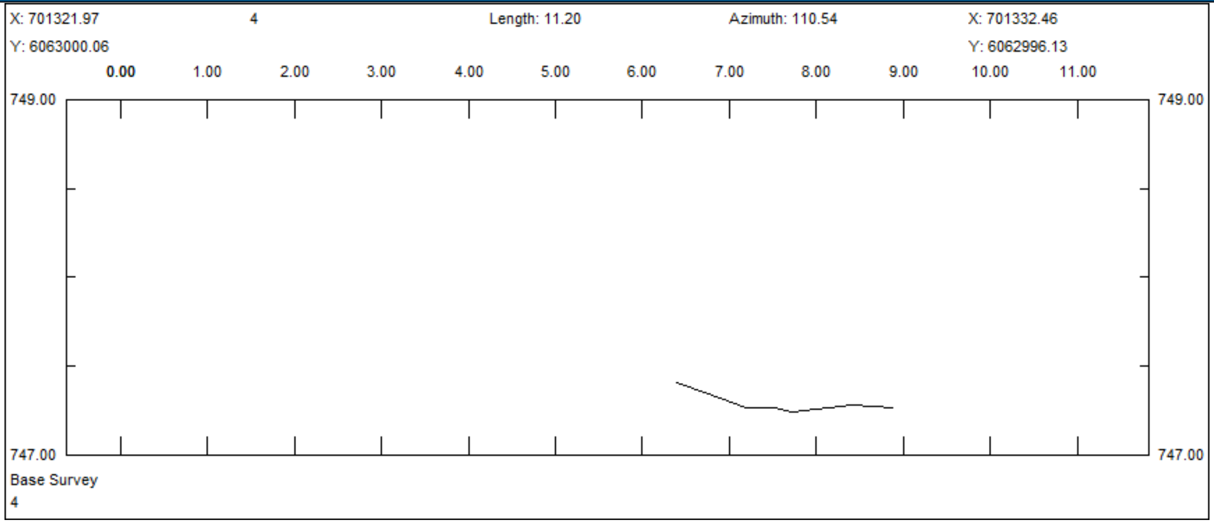
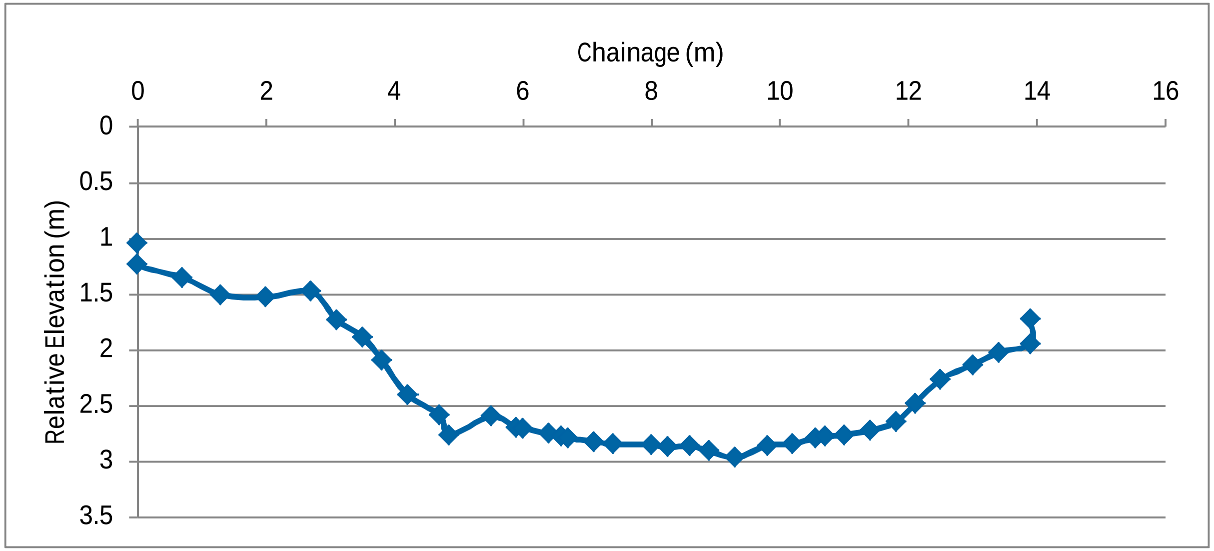
- Section from DGPS does not match actual cross section, therefore re-survey required to match previous survey.

*Highlights a concern that DGPS reception is causing an erroneous accuracy reading in surveyed points, resulting in recorded points misrepresenting actual XYZ points.
</td></tr>
</table>

Cross-Section	Comment
 Figure 17 - BUR1C XS-1A _ 2012  Figure 18 - BUR1C XS-1B _ 2012	- XS-1B lies perpendicular to the channel while XS-1A starts at the same point but runs at an angle to the channel to a different end point DS..

Cross-Section	Comment
 Figure 19 - BUR1C 3D GPS XS-2  Figure 20 - BUR1C XS-2 _ 2012	- Requires post commission survey for accurate comparison, no change noted during commissioning flow site inspections - Resurvey of actual cross section with DGPS required to complete/append to DGPS model

Cross-Section	Comment
 Figure 21 - BUR1C 3D GPS XS-3  Figure 22 - BUR1C XS-3 _ 2012	- Requires post commission survey for accurate comparison, no change noted during commissioning flow site inspections - Resurvey of actual cross section with DGPS required to complete/append to DGPS model

Cross-Section	Comment
 Figure 23 - BUR1C 3D GPS XS-4  Figure 24 - BUR1C XS-4 _ 2012	- Requires post commission survey for accurate comparison, no change noted during commissioning flow site inspections - Resurvey of actual cross section with DGPS required to complete/append to DGPS model

Appendix G - BUR 2 (Discharge Location): Site Survey

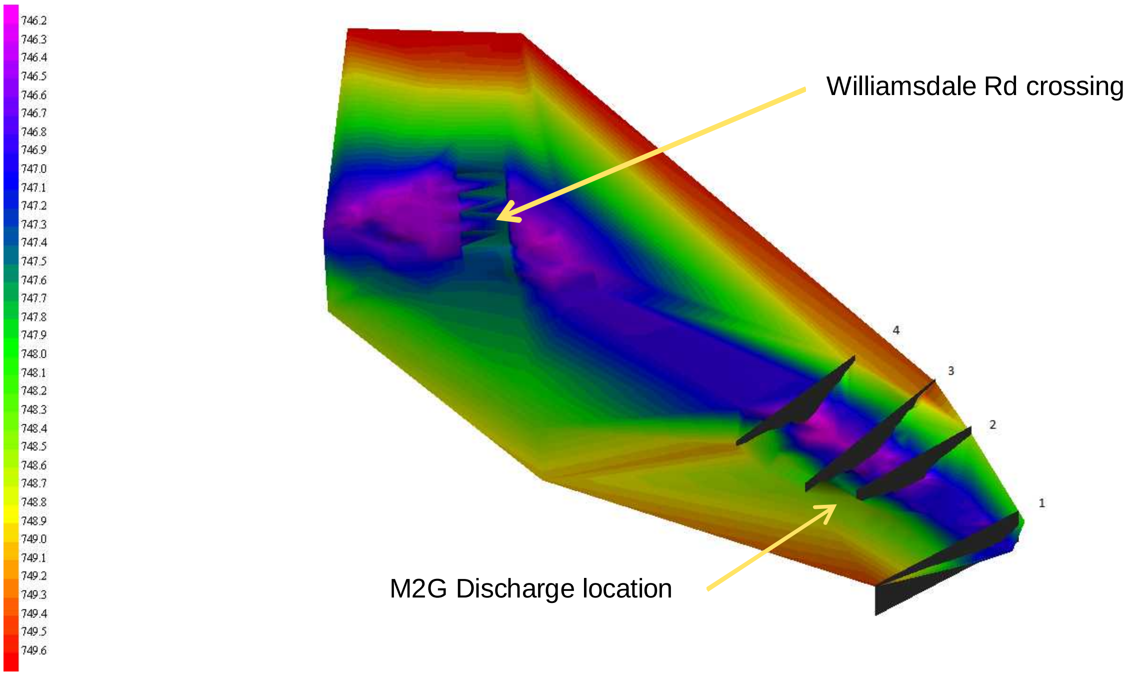


Figure 25 - BUR Discharge 3D DGPS Model (July 2013)

		3D Model	
Section	Bank Side*	Latitude	Longitude
1	LHS	35.55585 S	149.22228 E
	RHS	35.55601 S	149.22233 E
2	LHS	35.55589 S	149.22243 E
	RHS	35.55602 S	149.22248 E
3	LHS	35.55585 S	149.22247 E
	RHS	35.55602 S	149.22257 E
4	LHS	35.55582 S	149.22256 E
	RHS	35.55597 S	149.22264 E

* As seen looking downstream (flow direction from bottom right to top left in 3D image)

Cross-Section	Comments

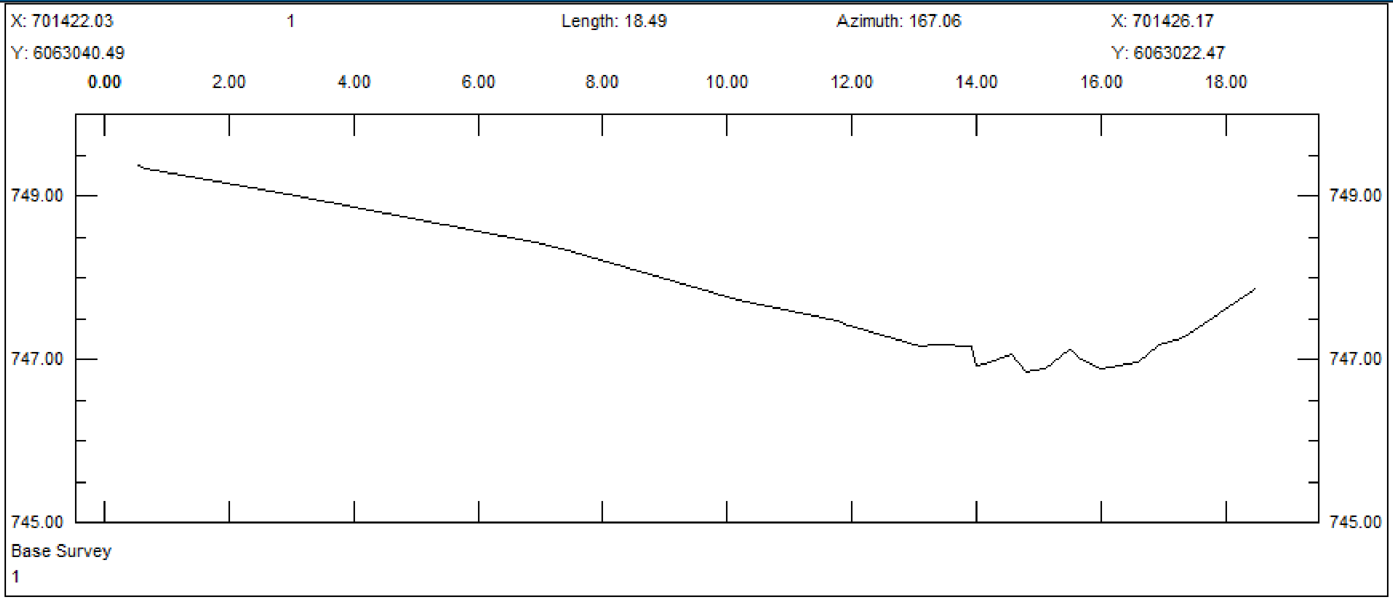


Figure 26 - BUR Discharge 3D GPS XS-1

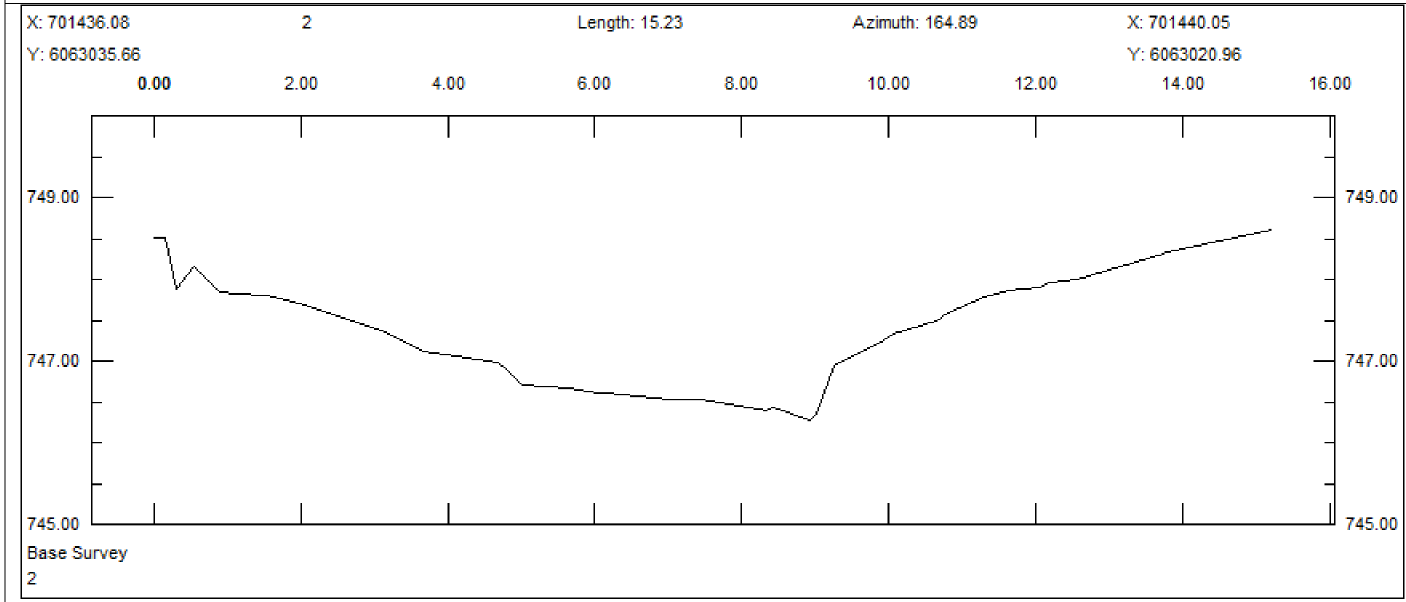


Figure 27 - BUR Discharge 3D GPS XS-2

Cross-Section	Comments

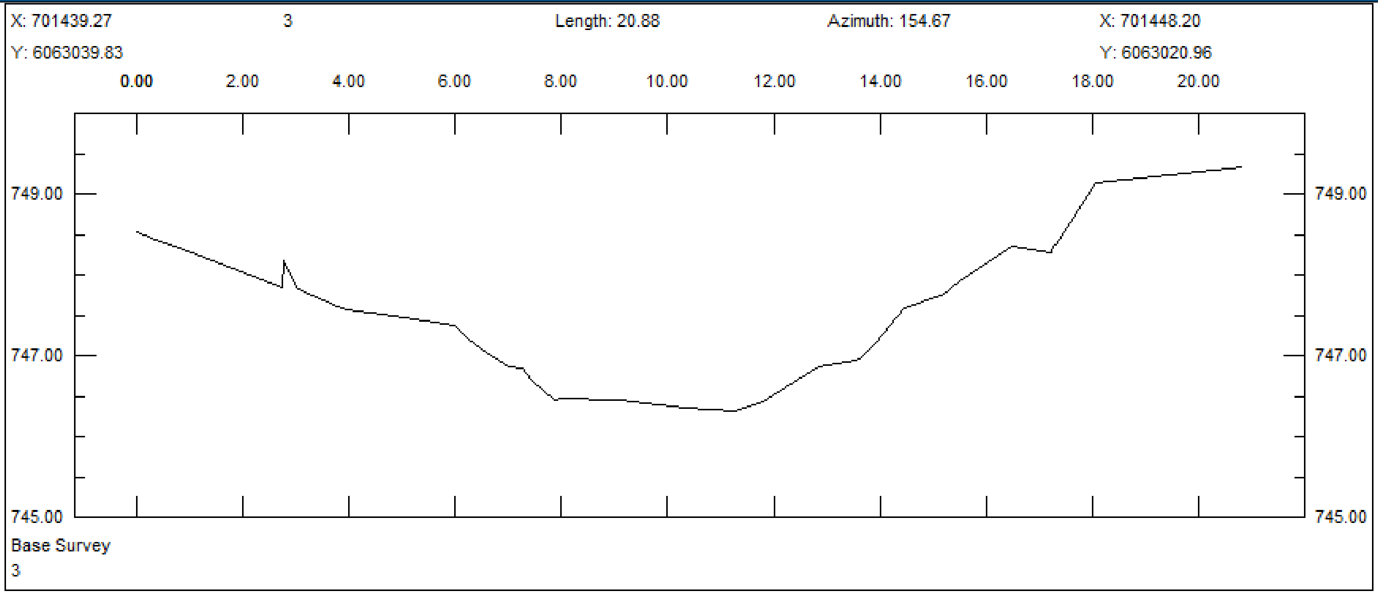


Figure 28 - BUR Discharge 3D GPS XS-3

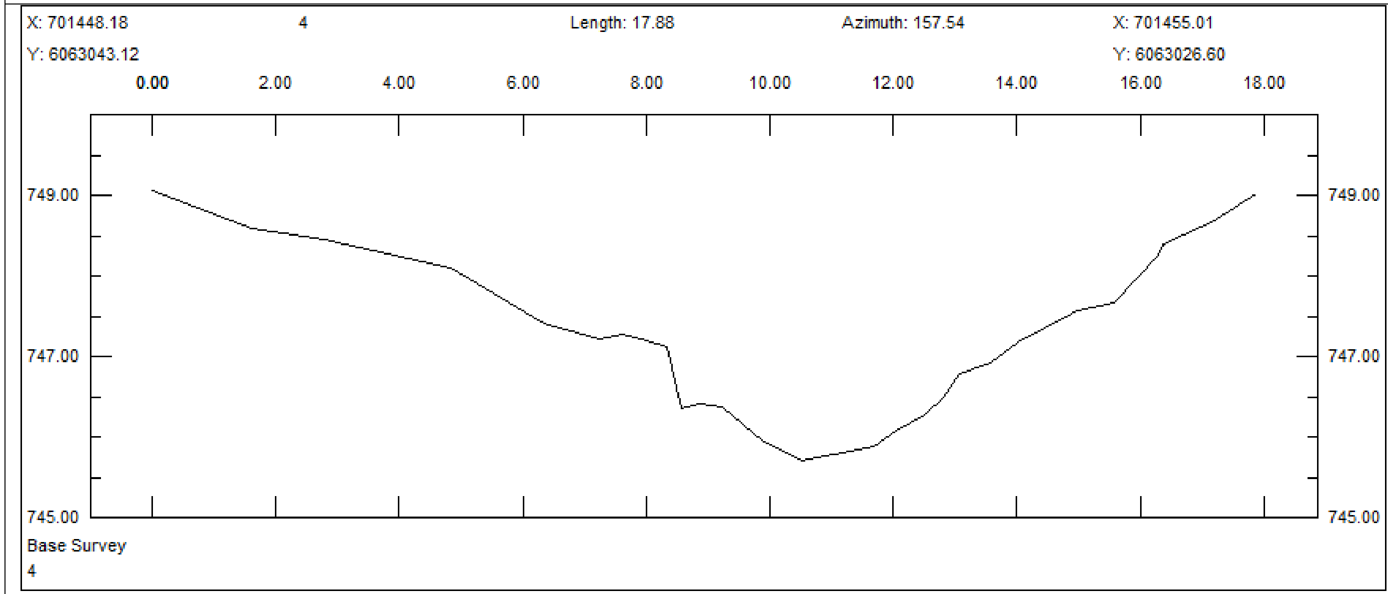
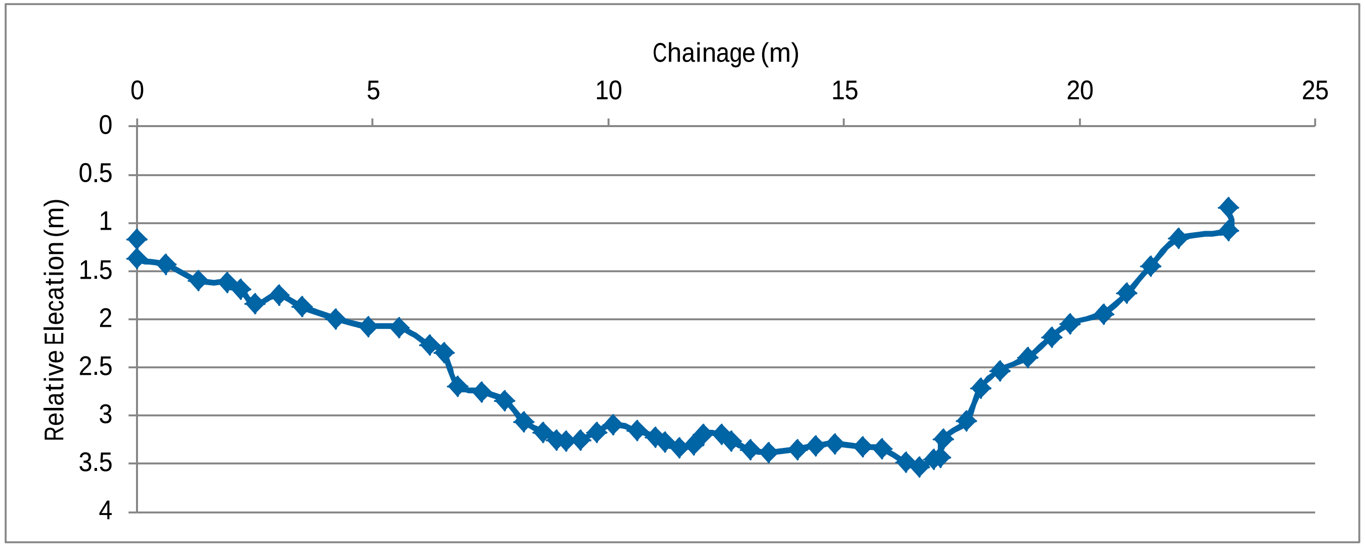
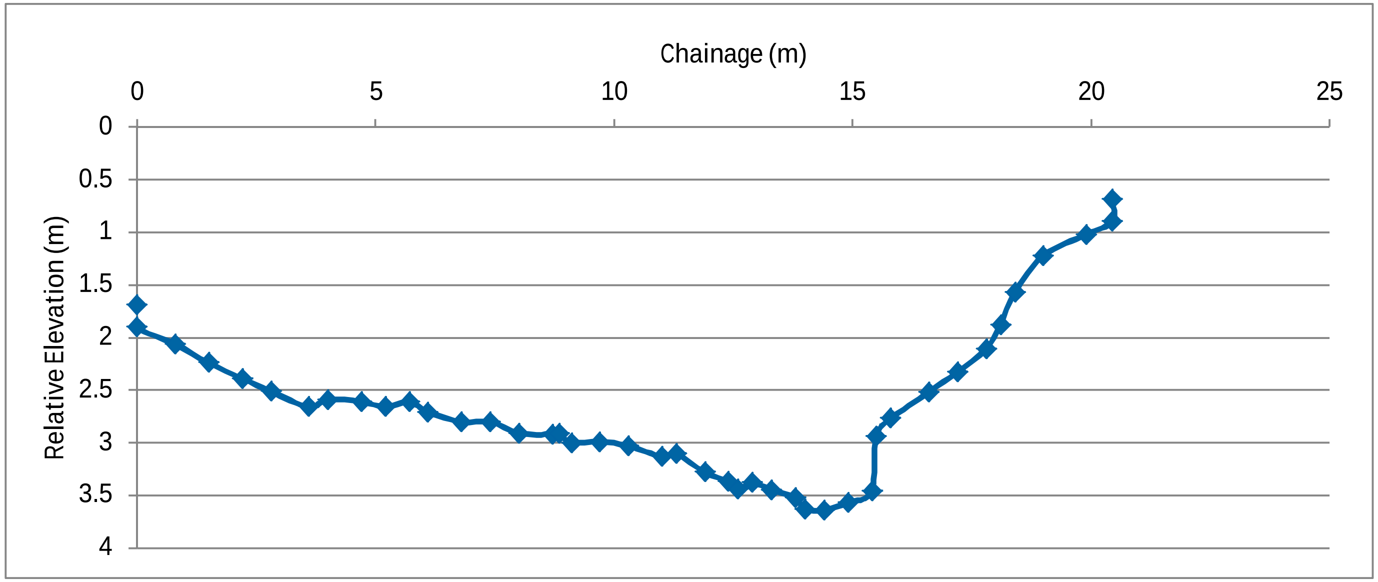


Figure 29 - BUR Discharge 3D GPS XS-4

Appendix H - BUR 2A: Site Survey

Figure 30 - BUR2A Aerial Photograph (2012 NSW SIX MAPS)

		2012	
Section	Bank Side*	Latitude	Longitude
1	LHS	35.55372 S	149.22492 E
	RHS	35.55382 S	149.22525 E
2	LHS	35.55362 S	149.22512 E
	RHS	35.55373 S	149.22528 E
3	LHS	35.55357 S	149.22513 E
	RHS	35.55353 S	149.22528 E
4	LHS	35.55348 S	149.22517 E
	RHS	35.55343 S	149.22527 E

Cross-Section	Comments
 Figure 31 - BUR2A XS-1 _ 2012	- Requires post commission survey for accurate comparison, no change noted during commissioning flow site inspections
 Figure 32 - BUR2A XS-2 _ 2012	- Requires post commission survey for accurate comparison, no change noted during commissioning flow site inspections

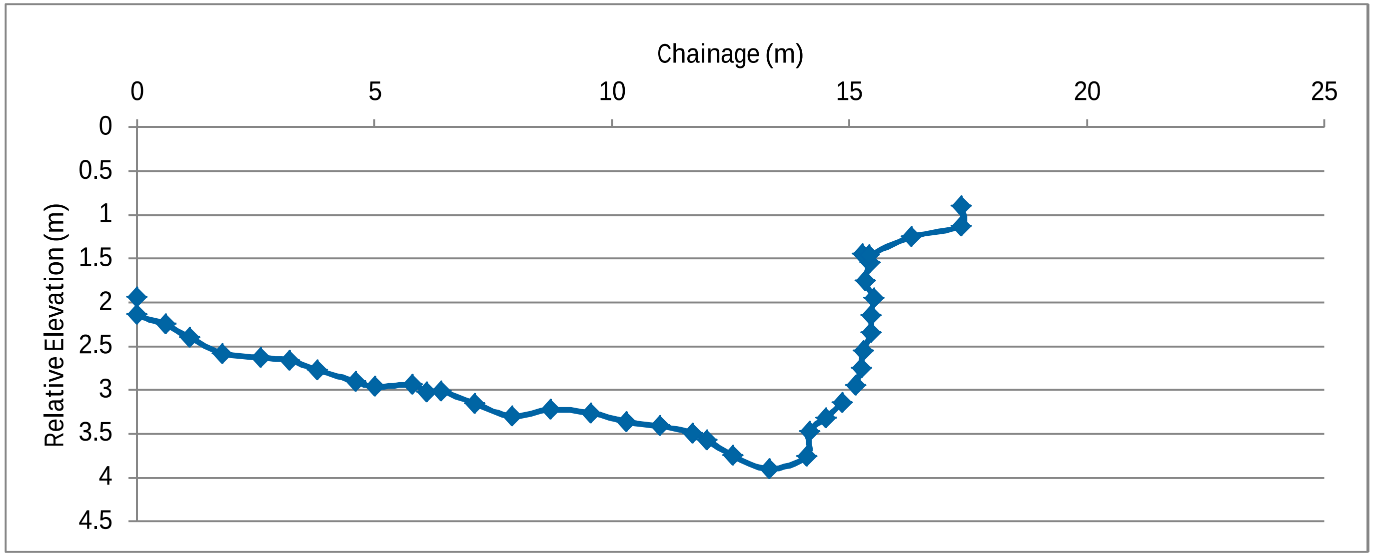
<table>
<tr><th>Cross-Section</th><th>Comments</th></tr>
<tr><td>


Figure 33 - BUR2A XS-3 _ 2012
</td><td>

- Requires post commission survey for accurate comparison, no change noted during commissioning flow site inspections

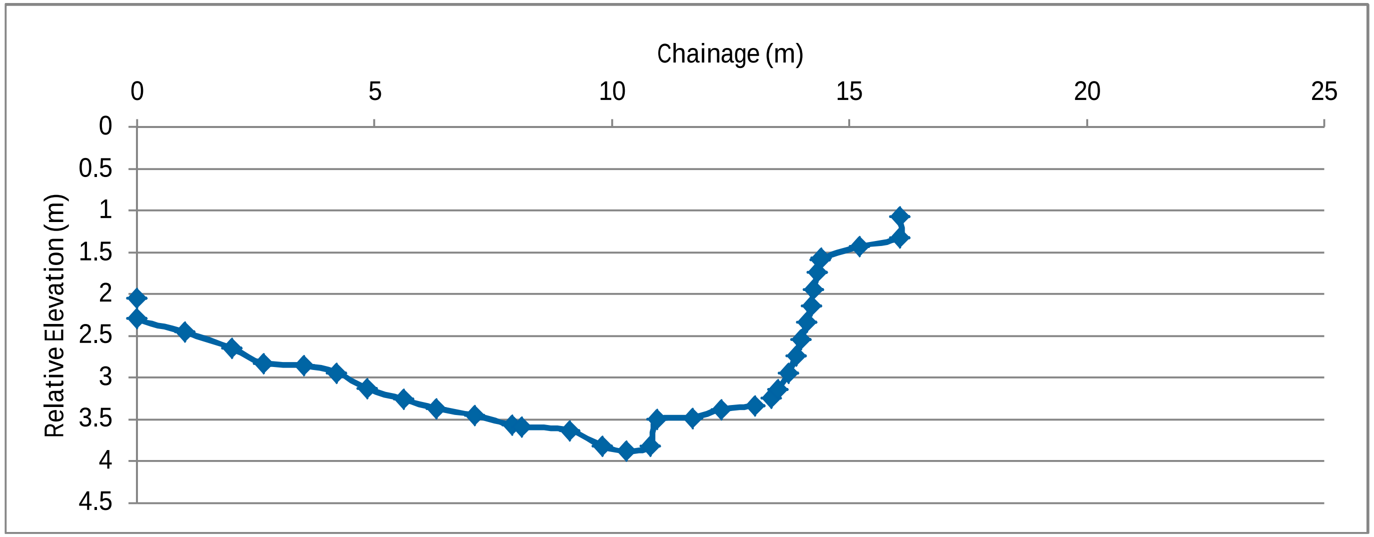
</td></tr>
<tr><td>


Figure 34 - BUR2A XS-4 _ 2012
</td><td>

- Requires post commission survey for accurate comparison, no change noted during commissioning flow site inspections

</td></tr>
</table>

Photo	Comments
 Photo 28 - BUR2A 14/2/2012	- Looking upstream - Stable riparian vegetation present
 Photo 29 - BUR2A 8/3/2012	- Flow event ~ 100 ML/d - Evidence of higher waters pushing vegetation over - No evidence of erosion

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 30 - BUR2A 20/3/2012</td><td>- Continued elevated flows
- Vegetation still showing signs of being pushed over by higher flows.</td></tr>
<tr><td>
Photo 31 - BUR2A 4/5/2012</td><td>- Normal water levels
- Low turbidity
- Increased clarity and available nutrients allow algal and periphyton growth on substrate</td></tr>
</table>

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 32 - BUR2A 5/7/2012</td><td>- Normal water levels
- Evidence of vegetation die off during winter months for emergent macrophytes</td></tr>
<tr><td>
Photo 33 - BUR2A 5/7/2012</td><td>- Stream condition at time of 2012 winter sampling</td></tr>
</table>

Photo	Comments
 Photo 34 - BUR2A 13/7/2012	- Med flow event - ~110ML/d
 Photo 35 - BUR2A 10/9/2012	- Med flow event (This includes an M2G pump maintenance run ~20ML/d +~5ML/d baseflow) - No evidence of new bank erosion from pumped flow - Turbidity low

Photo	Comments
 Photo 36 - BUR2A 29/10/2012	- Vegetation returning for spring - Algal growth evident in-stream

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 37 - BUR2A 22/11/2012</td><td></td></tr>
<tr><td>
Photo 38 - BUR2A 24/1/2013</td><td>• Noticeable increase in reed growth along left side of stream</td></tr>
</table>

Photo	Comments
 Photo 39 – BUR2A 29/4/2013	• Macrophyte die-off at onset of cold weather. Macrophytes have not fully encroached into the central channel

Appendix I - BUR U/S Pool 50: Site Survey

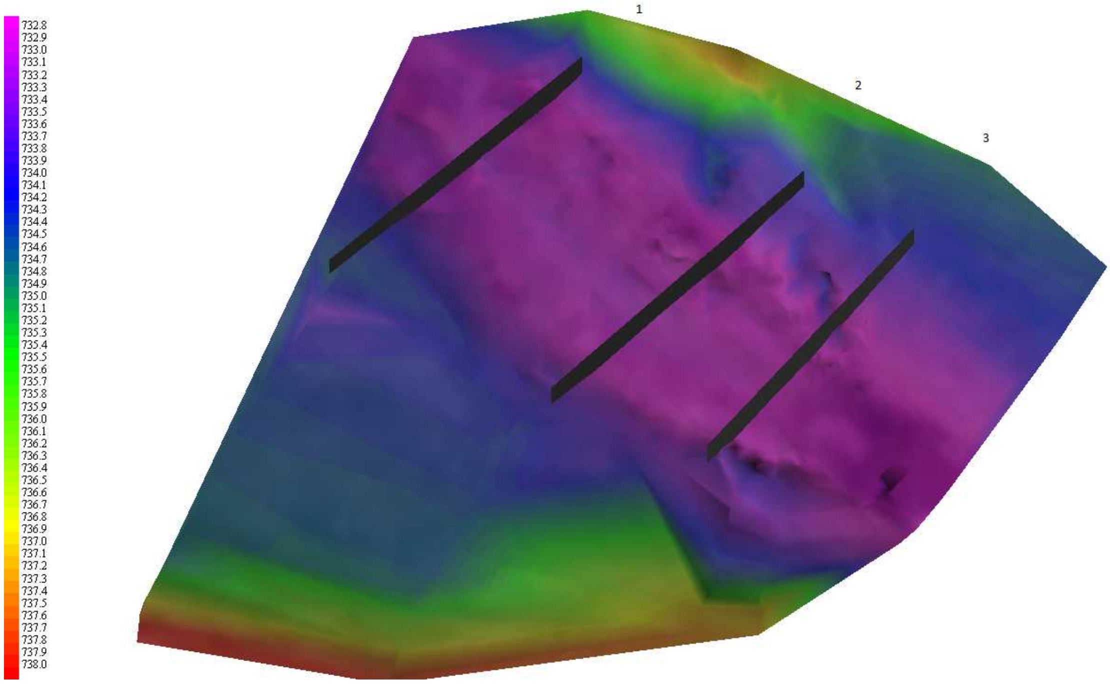
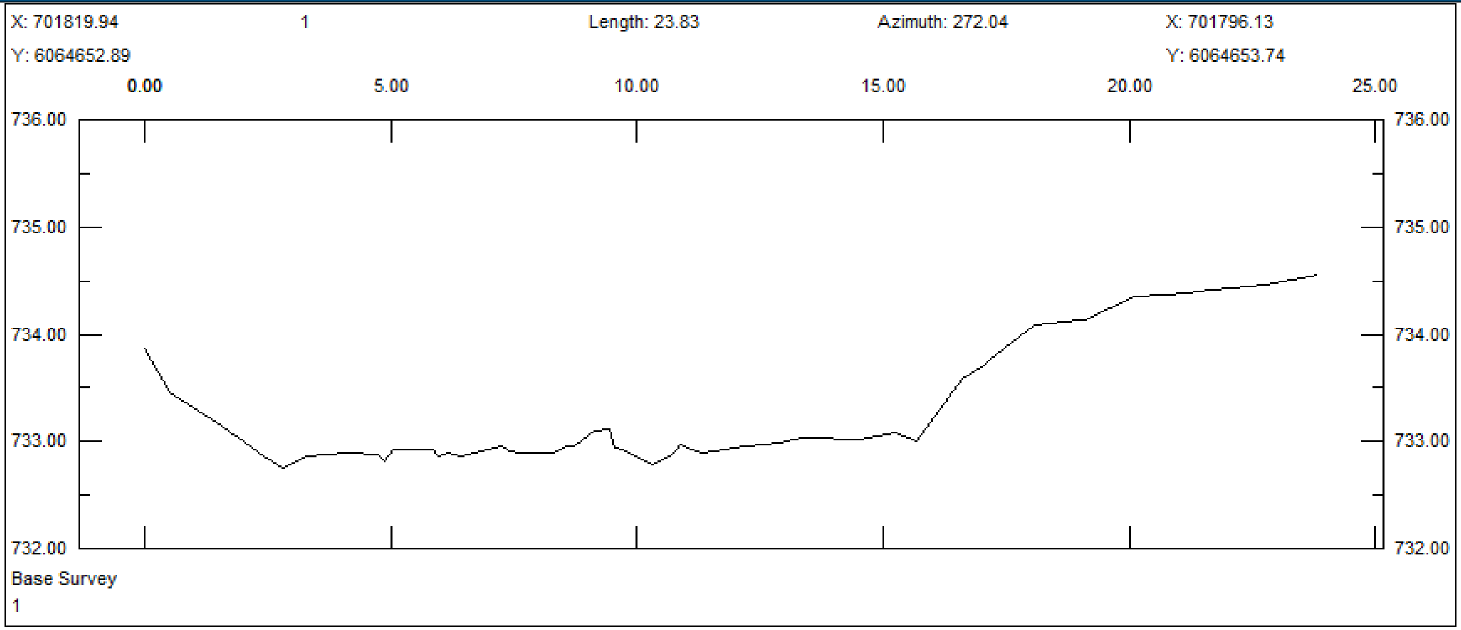
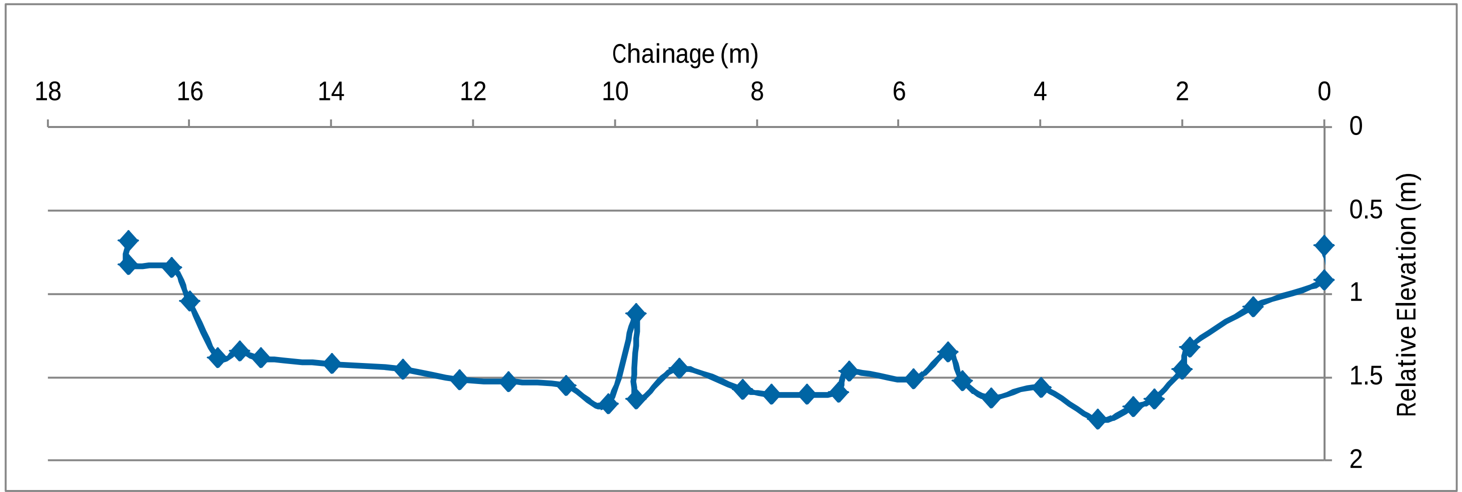
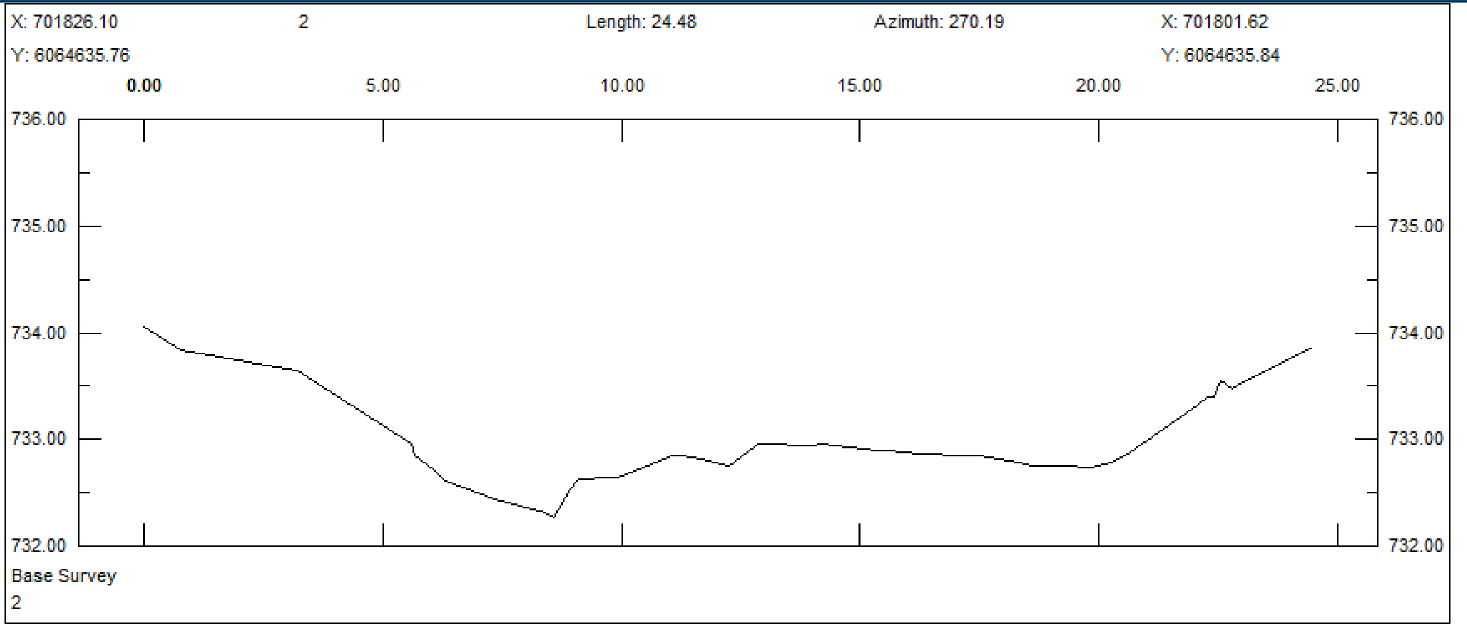
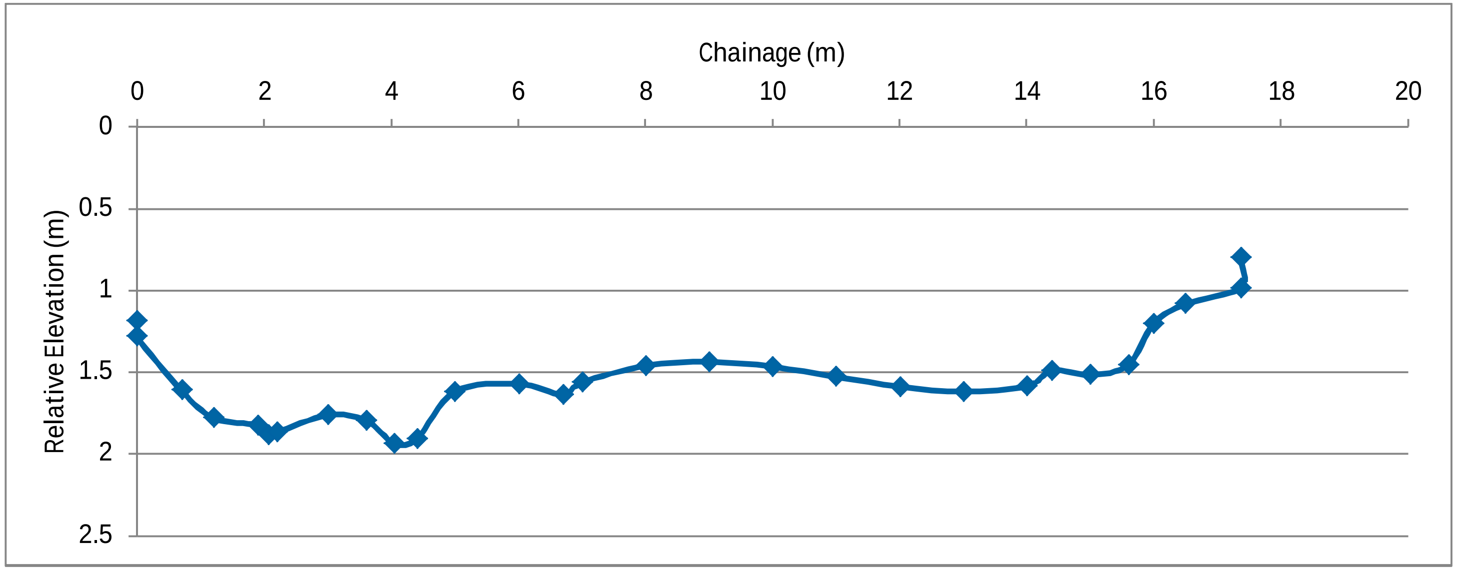


Figure 35 - Burra U/S Pool 50 DGPS 3D Model (July 2013)

		2012		3D Model	
Section	Bank Side*	Latitude	Longitude	Latitude	Longitude
1	LHS	35.54125 S	149.22625 E	35.54124 S	149.22626 E
	RHS	35.54123 S	149.22607 E	35.54124 S	149.22600 E
2	LHS	35.54138 S	149.22627 E	35.54139 S	149.22633 E
	RHS	35.5414 S	149.2261 E	35.54140 S	149.22606 E
3	LHS	35.54147 S	149.22628 E	35.54147 S	149.22637 E
	RHS	35.54148 S	149.22615 E	35.54149 S	149.22613 E

* As seen looking downstream (flow direction from left to right in 3D image)

Cross-Section	Comments
 Figure 36 - BUR U/S Pool 50 3D GPS XS-1  Figure 37 - BUR U/S Pool 50 XS-1 _ 2012	- DGPS survey longer than Dumpy cross section to accommodate 3D profiling - Original survey pegs could not be found at time of 3D survey. - Channel sections indicate similar profile, accurate survey needed to re-establish section

Cross-Section	Comments
 Figure 38 - BUR U/S Pool 50 3D GPS XS-2  Figure 39 - BUR U/S Pool 50 XS-2 _ 2012	- DGPS survey longer than Dumpy cross section to accommodate 3D profiling - Original survey pegs could not be found at time of 3D survey. - Channel sections indicate similar profile, accurate survey needed to re-establish section

Cross-Section	Comments

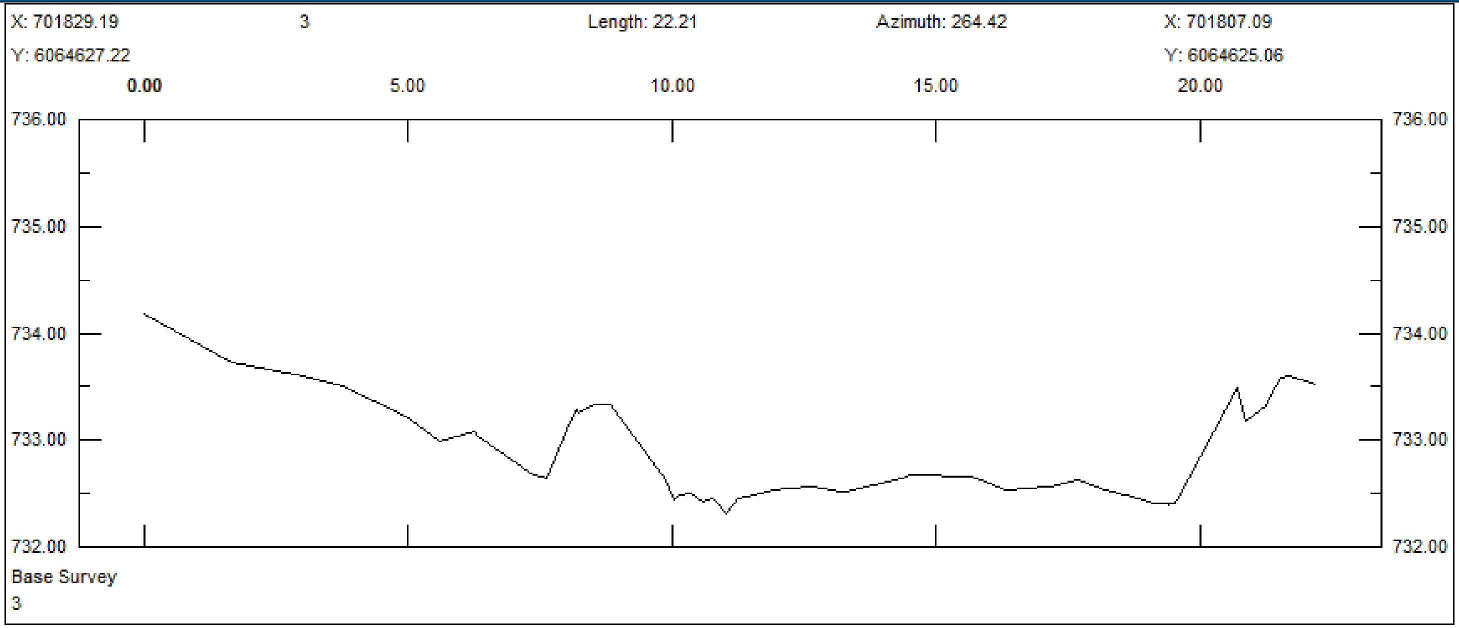


Figure 40 - BUR U/S Pool 50 3D GPS XS-3

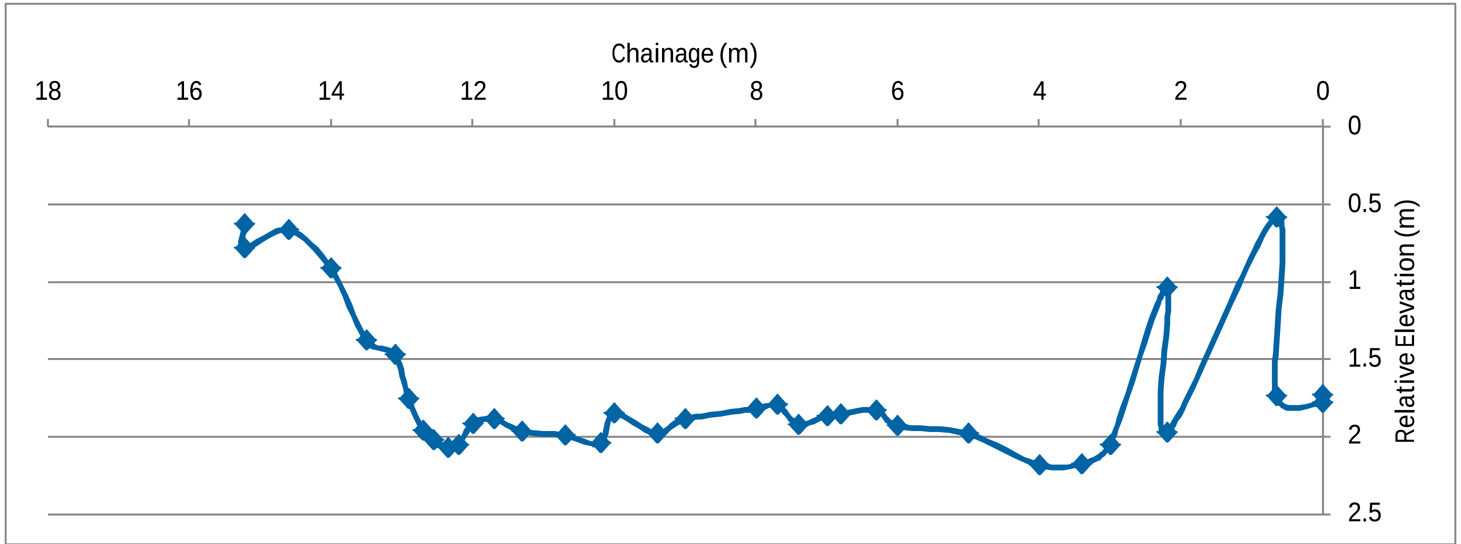


Figure 41 - BUR U/S Pool 50 XS-3 _ 2012

- DGPS survey longer than Dumpy cross section to accommodate 3D profiling
- Original survey pegs could not be found at time of 3D survey.
- Channel sections indicate similar profile, accurate survey needed to re-establish section
- Differences due to rock outcrops picked up in ~1m misalignment of cross sections

Appendix J - BUR 2C: Site Survey

Figure 42 - BUR2C Aerial Photo (2012 NSW SIX Maps)

Yellow lines indicate location of cross-sections at BUR2C.

Some original cross-section pegs have moved due to erosion effects or earthwork impact from moving of the creek crossing.

Locations to be confirmed

		2010		2012 & 2013	
Section	Bank Side*	Latitude	Longitude	Latitude	Longitude
D/S – XS4	LHS	35.51774 S	149.26123 E	35.51768 S	149.26128 E
	RHS	35.51758 S	149.26156 E	35.51758 S	149.2615 E
@ Bend – XS3	LHS	35.51808 S	149.26141 E	35.51815 S	149.26148 E
	RHS	35.51835 S	149.26154 E	35.51832 S	149.26157 E
XS2	LHS			35.51816 S	149.26114 E
	RHS			35.51831 S	149.26131 E
@ Old Road Xing – XS1	LHS	35.51880 S	149.26135 E	35.51883 S	149.26125 E
	RHS	35.51867 S	149.26154 E	35.51862 S	149.2616 E

* As seen looking downstream (flow direction is bottom to top in the adjacent figure)

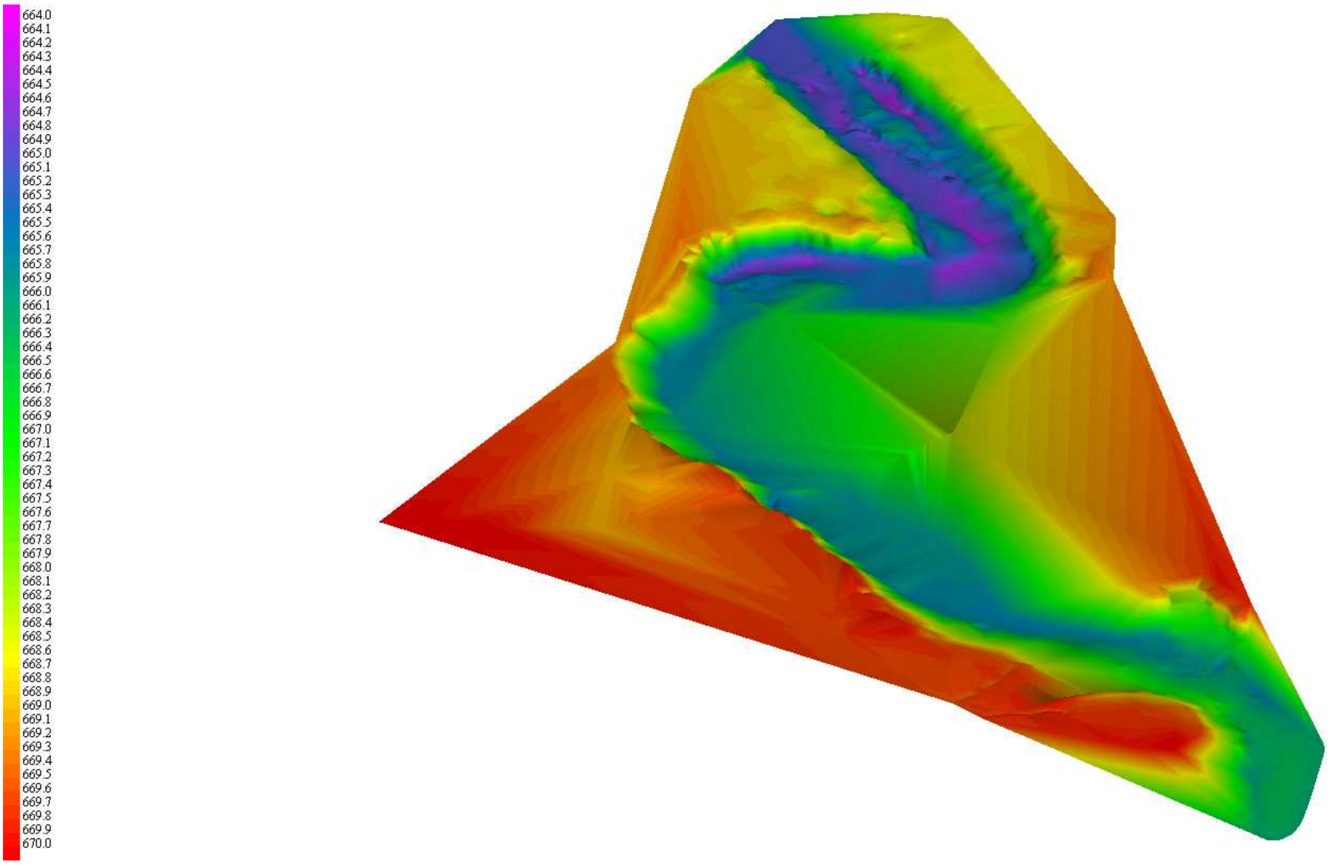
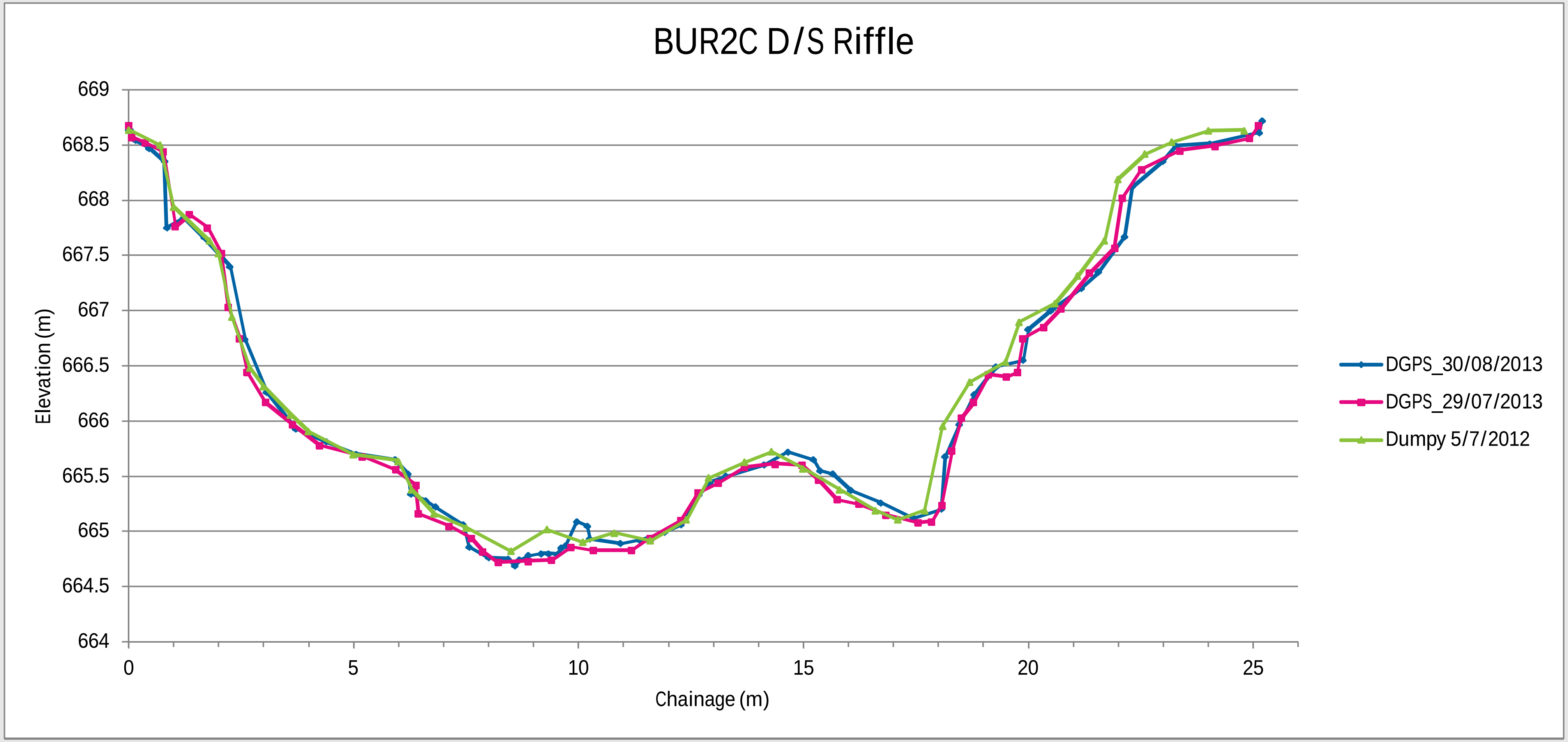
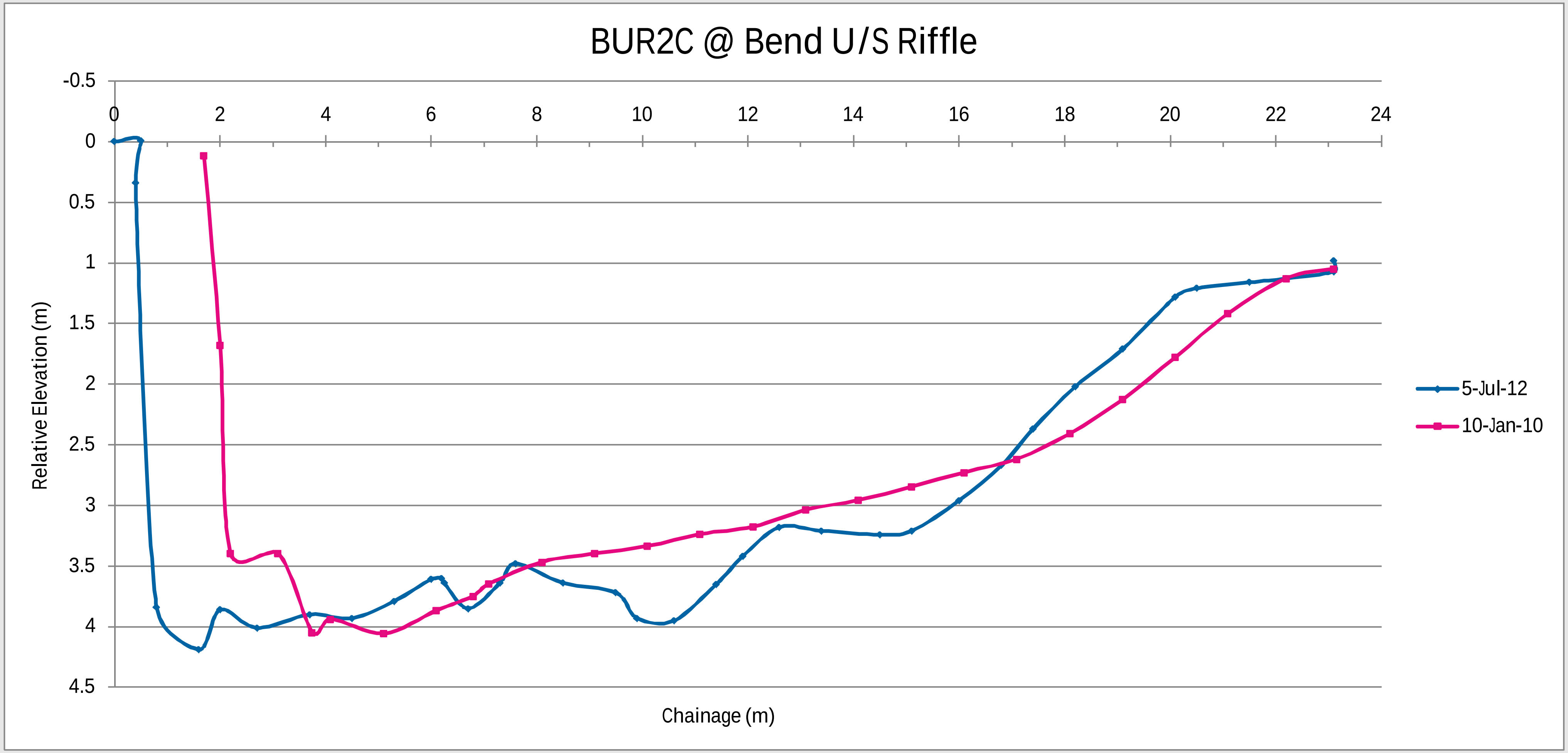


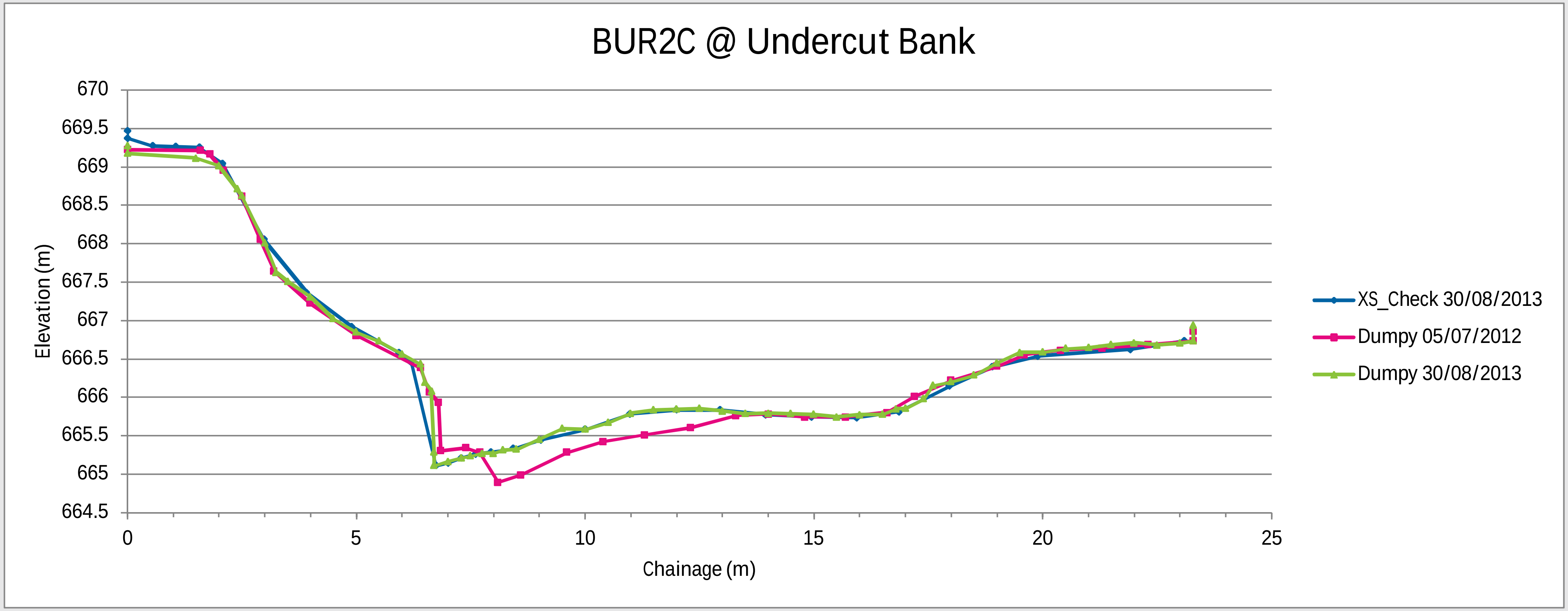
Figure 43 - BUR2C DGPS 3D Model (July 2013)

- In-stream points U/S of Riffle absent due to water level or loss of DGPS correction signal at base of embankment during survey.

Sect	2010 Survey (Red Sections)	2012 Survey (Yellow Sections)
D/S Site 2C XS-4		
comments		Some erosion from central channel

U/S 2C @ Bend XS-3		
Comments	Both sections by Dumpy	Left hand side of section shows ~1m of horizontal erosion or collapse from bank. Cross-sections were adjusted to the level of the peg on the right hand bank (right of graph) as this peg was used in both surveys. Peg on left hand bank was replaced due to loss by erosion.

BUR2C @ Undercut Bank XS-2



Comments

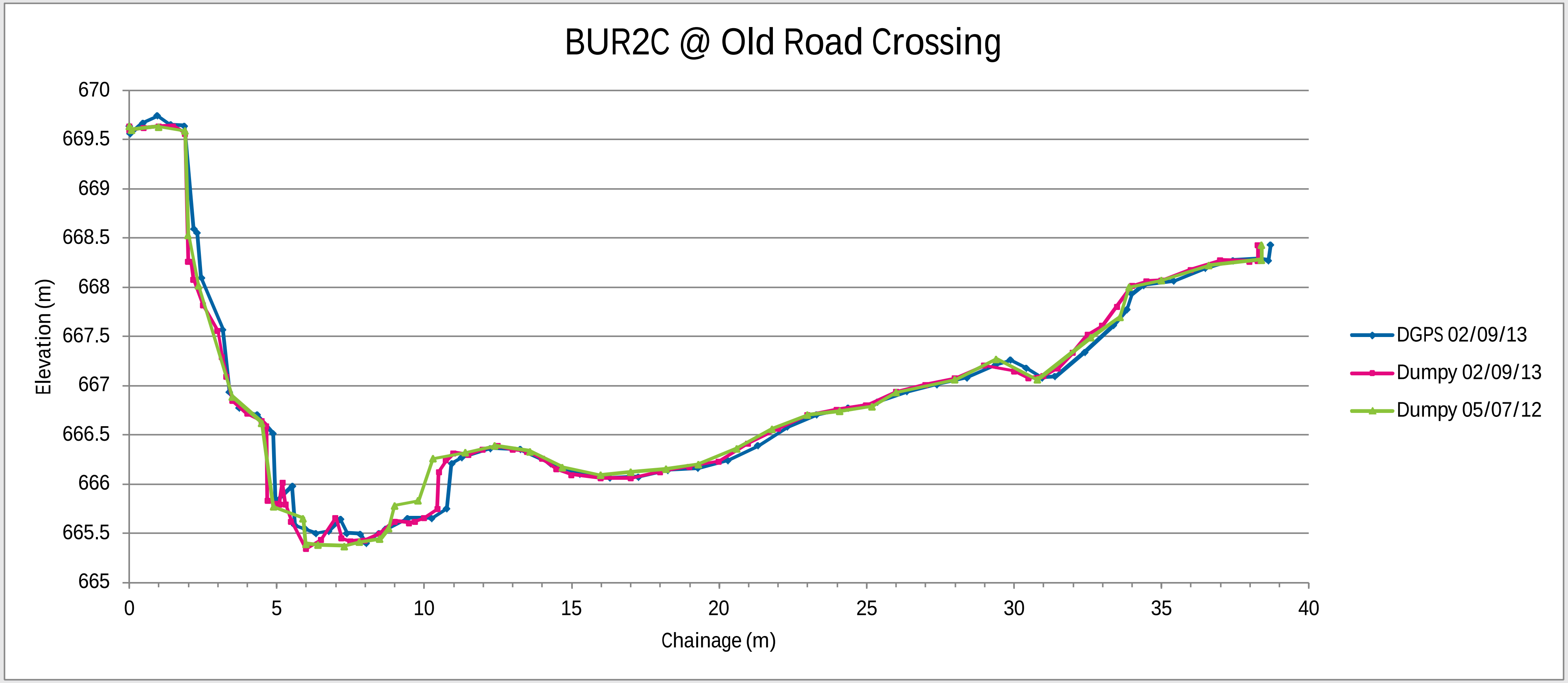
Sediment deposition on inside of bend (CH 8-13m)

Channel shift from CH 7m to 8m

Some erosion central channel

Dumpy Section taken at beginning of hydrograph shown left while DGPS data taken two months after end of hydrograph. Commissioning flows follow date of Dumpy Section with a 1000 Ml/d event occuring in Oct 2012. It is likely that the large event caused the changes in channel profile.

U/S @ Old Road Crossing XS-1



Comments

Erosion from right hand bank at ~CH 10m

Some deposition in central channel

Slump shown at ~CH 5m

Photo	Comments
 Photo 40 – BUR2C 22/10/2009	- Earliest photo on project record for BUR2C - Taken upstream of BUR2C riffle - Some grass coverage on banks
 Photo 41 - BUR2C 22/10/2009	• Region of dense macrophyte growth above BUR2C prior to 2010 events which scoured the whole channel to bedrock

Photo	Comments
 Photo 42 - BUR2C 15/2/2010	- Secondary flow on inside of bend resulting from elevated flow
 Photo 43 - BUR2C 15/2/2010	

Photo	Comments
 Photo 44 - BUR2C 15/10/2010	- Flood event sampling
 Photo 45 - BUR2C 17/10/2010	- Evidence of flood debris - Vegetation pushed over by high flows - Water levels still elevated

Photo	Comments
 Photo 46 - BUR2C 17/10/2010	• Evidence of peak water level from debris mark on side of channel
 Photo 47 - BUR2C 17/10/2010	- no obvious signs of bank erosion as a result of this flood event - new additional flow channel as a result of secondary flow on the inside bend due to the elevated water levels from the flood

Photo	Comments
 Photo 48 - BUR2C 20/10/2010	- location of old creek crossing
 Photo 49 - BUR2C 7/1/2011	• Creek crossing no longer serviceable from Dec 2010 event. Some rock placed for stabilisation but crossing moved upstream

Photo	Comments
 Photo 50 - BUR2C 3/8/2011	- looking upstream at dog-leg upstream of BUR 2C riffle site. - Bedrock visible in pool with algal growth - Significant sediment and cobble deposit on inside of bend as a result of December 2010 flood event
 Photo 51 - BUR2C 3/8/2011	- Evidence of bank erosion - Site of XS-3 - High algal growth due to elevated nutrient levels and warmer water temperature as vegetation previously shading the creek was washed out during flood

Photo	Comments
 Photo 52 - BUR2C 19/10/2011	- Bed rock exposed in majority of pool
 Photo 53 - BUR2C 26/11/2011	- med flow event - Grass and reed vegetation around banks re-establishing

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 54 - BUR2C 26/11/2011</td><td>- Med flow event
- Evidence of bank undercutting and erosion
- High turbidity</td></tr>
<tr><td>
Photo 55- BUR2C 20/3/2012</td><td>- Evidence of bank erosion caused by recent flood
- Little bank vegetation remaining.
- XS-2 located at the downstream end of the eroded embankment
- XS-3 in foreground location</td></tr>
</table>

Photo	Comments
 Photo 56 - BUR2C 20/3/2012	- Further bank erosion downstream of bend.
 Photo 57 - BUR2C 5/7/2012	- Entire bank on outside of bend eroding - No vegetation recovery during winter evident

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 58 - BUR2C 13/7/2012</td><td>Elevated flows
Turbid flows indicate suspended sediment transport</td></tr>
<tr><td>
Photo 59 - BUR2C 13/7/2012</td><td></td></tr>
</table>

Photo	Comments
 Photo 60 - BUR2C 13/7/2012	• Embankment erosion further upstream from BUR2C
 Photo 61 - BUR2C 13/7/2012	• Flow over new road crossing

Photo	Comments
 Photo 62 - BUR2C 3/9/2012	- Sediment deposition evident on outside of bend.
 Photo 63 - BUR2C 10/9/2012	- Evidence of new sediment deposition in pool - Algal growth continues

Photo	Comments
 Photo 64 - BUR2C 10/9/2012	- Woody debris present in channel - Fine Sediment deposit evident - Eroded banks too steep to allow easy vegetation regrowth for stability
 Photo 65 - BUR2C 3/10/2012	

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 66 - BUR2C 3/10/2012</td><td></td></tr>
<tr><td>
Photo 67 - BUR2C 18/10/2012</td><td></td></tr>
</table>

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 68 - BUR2C 23/1/2013</td><td>- Sloping banks show signs of vegetation recovery</td></tr>
<tr><td>
Photo 69 - BUR2C 23/1/2013</td><td></td></tr>
</table>

Photo	Comments
 Photo 70 - BUR2C 29/4/2013	- Section of bank has slumped into channel.
 Photo 71 - BUR2C 30/10/2013	- Significant section of embankment scoured after Sept event

<table>
<tr><th>Photo</th><th>Comments</th></tr>
<tr><td>
Photo 72 - BUR2C 30/10/2013</td><td>- significant slumping of embankment following Sept 2013 storm event</td></tr>
<tr><td>
Photo 73 - BUR2C 30/10/2013</td><td>- Bank Scour from Sept event
- Reforming of point island bar following Sept event.</td></tr>
</table>

Photo	Comments
 Photo 74 - BUR2C 30/10/2013	-

Appendix K - Angle Crossing – Site Survey

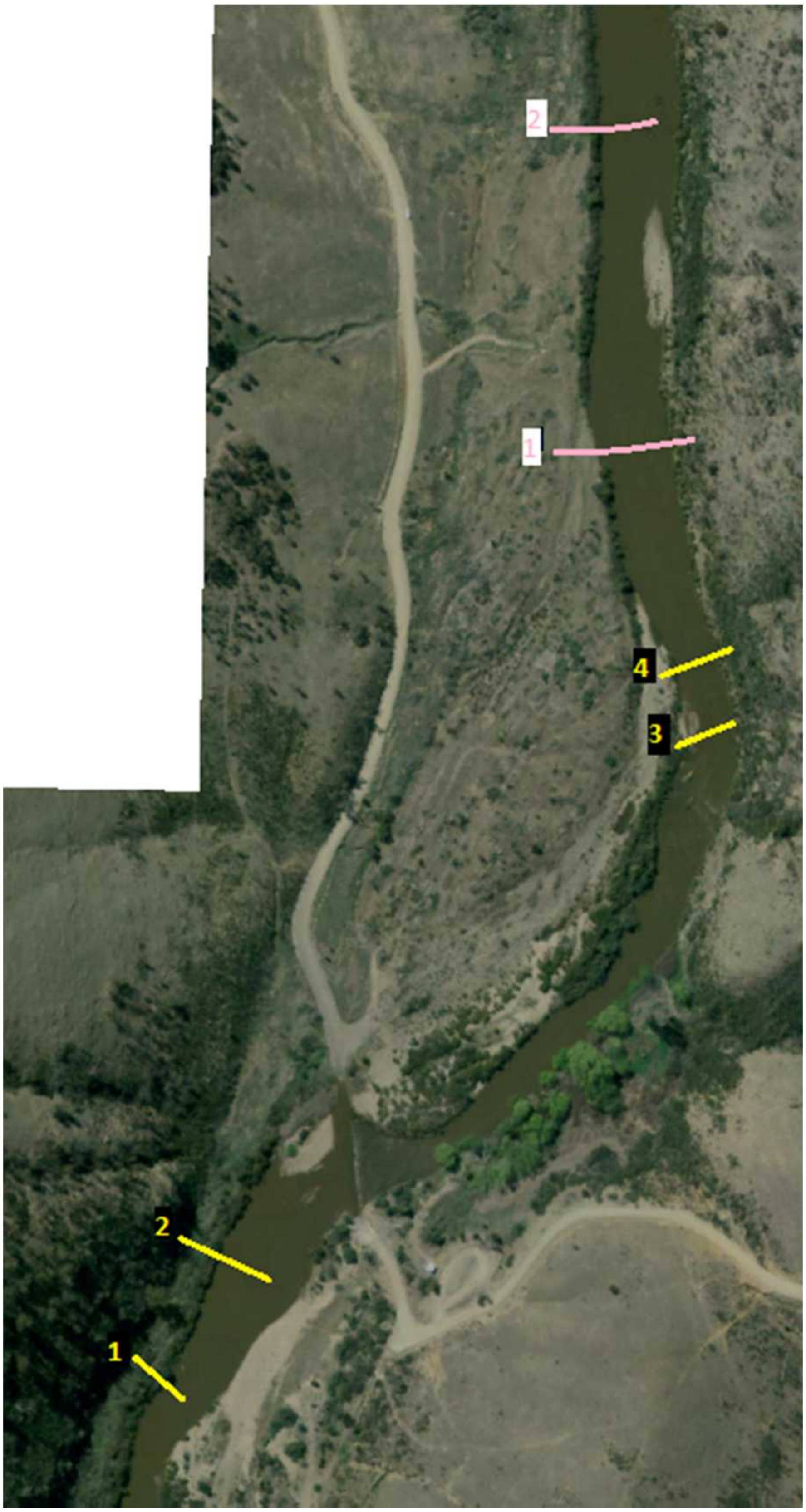


Figure 44 - Angle Crossing Aerial Photo (2012 NSW SIX Maps)

Original cross section locations in yellow (10th jan 2010). US Cross Section 2 not accessible during M2G construction.

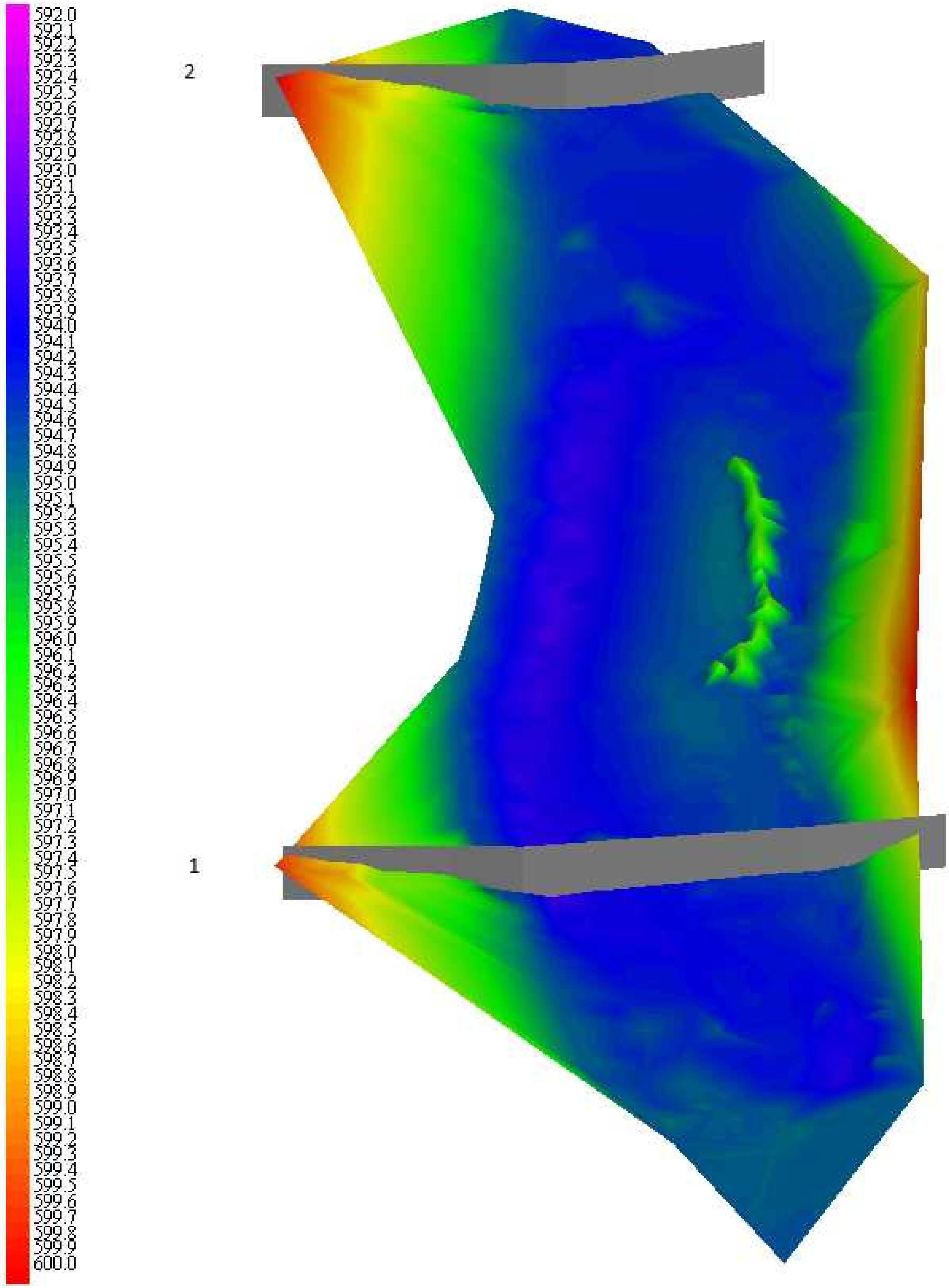
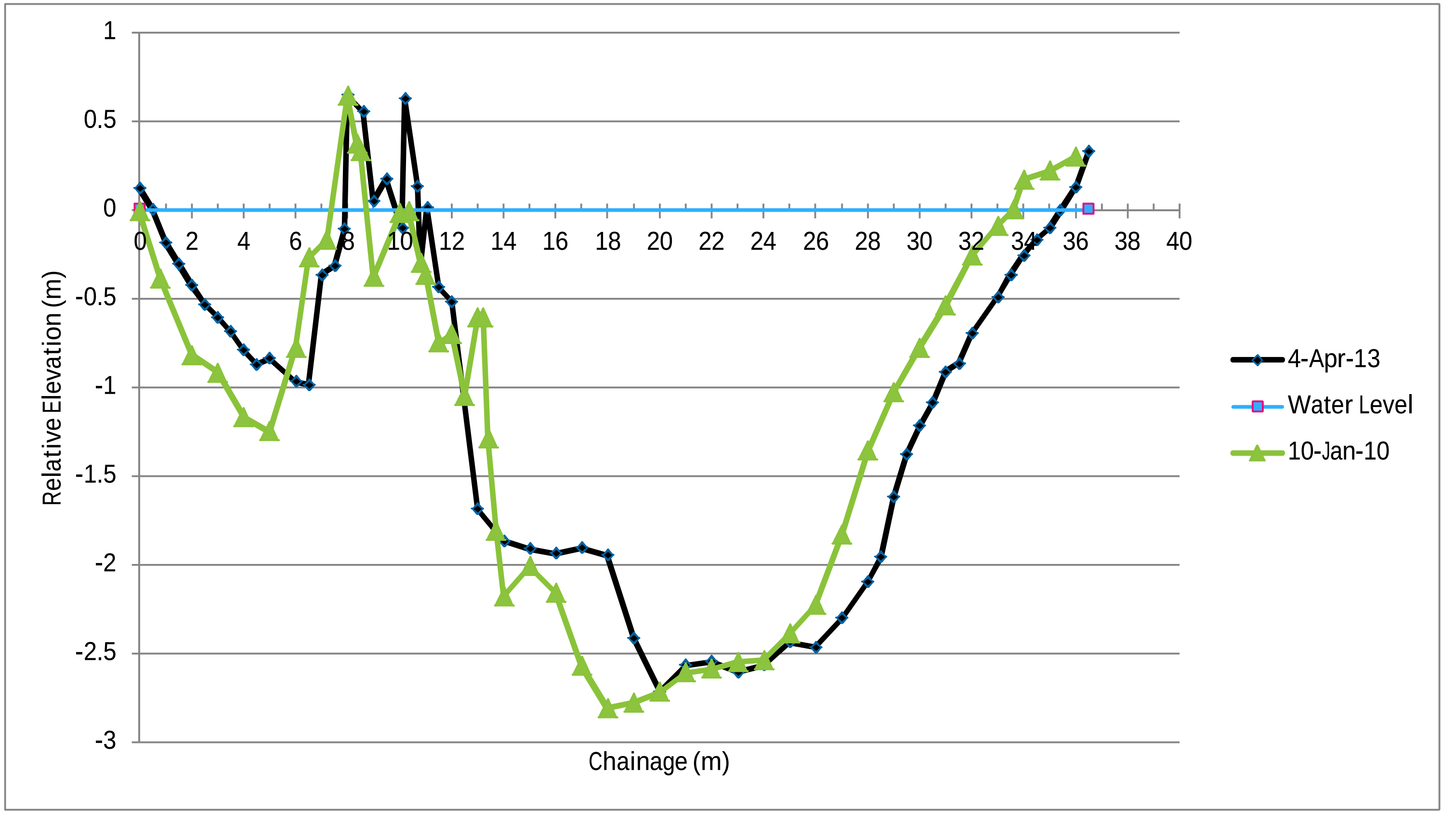


Figure 45 - Angle Crossing D/S DGPS Model (Jan 2013)

*DGPS Model corresponds to the pink cross-sections in Figure 44. This change in downstream sandbar due to the 2010-2012 flood events

		2010		GPS Model		2013	
Section	Bank Side*	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
1	LHS	35.58403 S	149.10779 E	35.57947 S	149.11024 E	35.58403 S	149.10779 E
	RHS	35.58423 S	149.10810 E	35.57940 S	149.11107 E	35.58423 S	149.10810 E
2	LHS	35.58343 S	149.10806 E	35.57787 S	149.11017 E		
	RHS	35.58363 S	149.10862 E	35.57781 S	149.11080 E		
3	LHS	35.58092 S	149.11102 E				
	RHS	35.58081 S	149.11136 E				
4	LHS	35.58057 S	149.11091 E				
	RHS	35.58044 S	149.11134 E				

Cross Section	Comments
 Figure 46 - Angle Crossing U/S 2010 - XS 1	- Differences due to taking a slightly different line through the rock outcrop - Minor sand deposition near rocky outcrop (13-18m) - Minor erosion on right hand bank - Movement of sand bed consistent with storm events during interim period - Cross sections adjusted to 0m height at water level

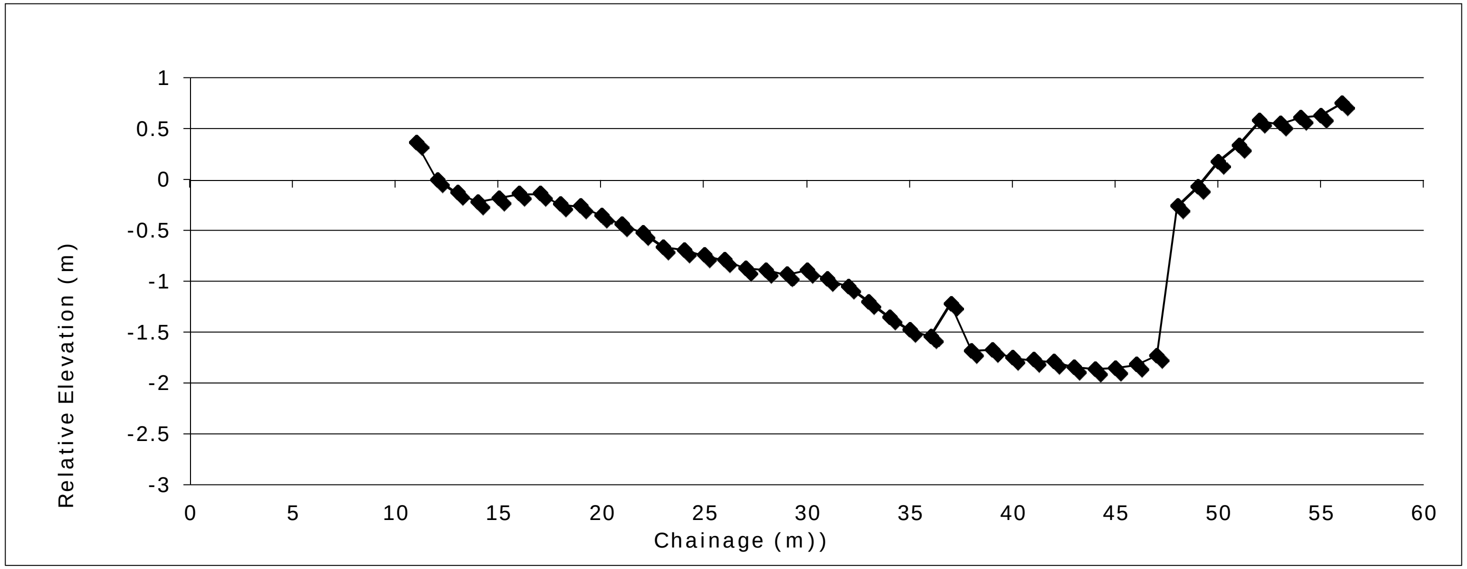


Figure 47 - Angle Crossing U/S 2010 - XS 2

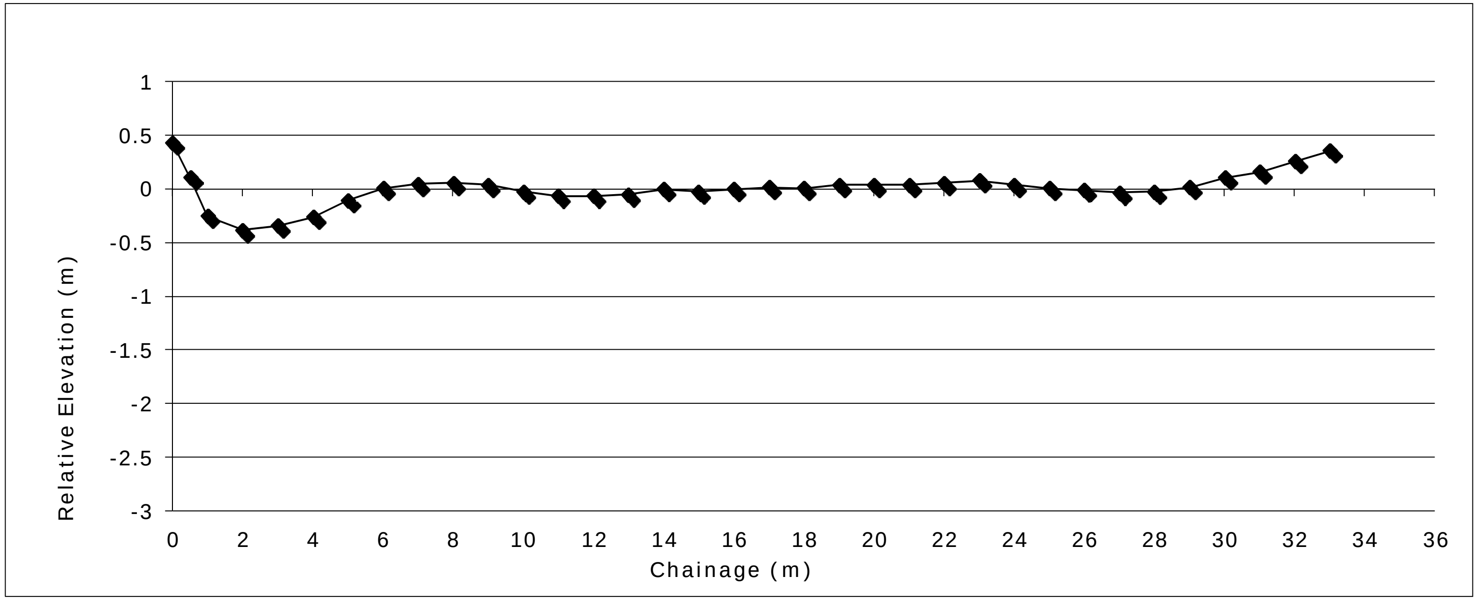


Figure 48 - Angle Crossing D/S 2010 - XS 3

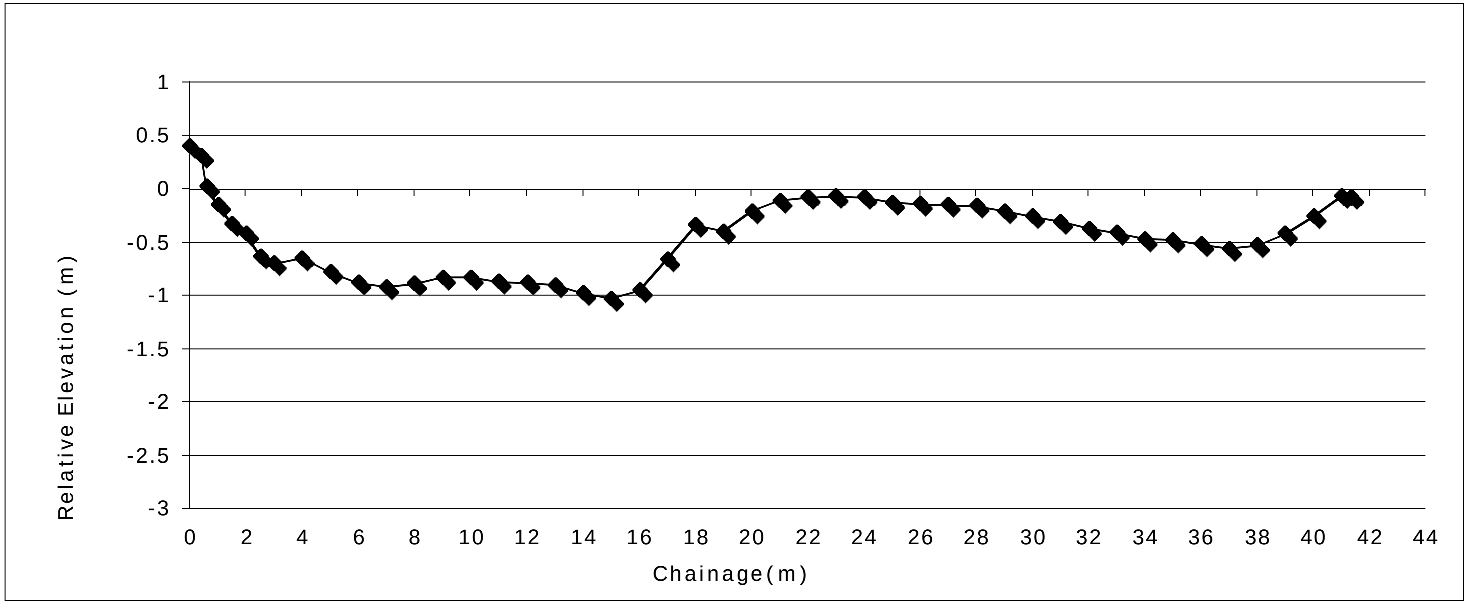


Figure 49 - Angle Crossing D/S 2010 - XS 4

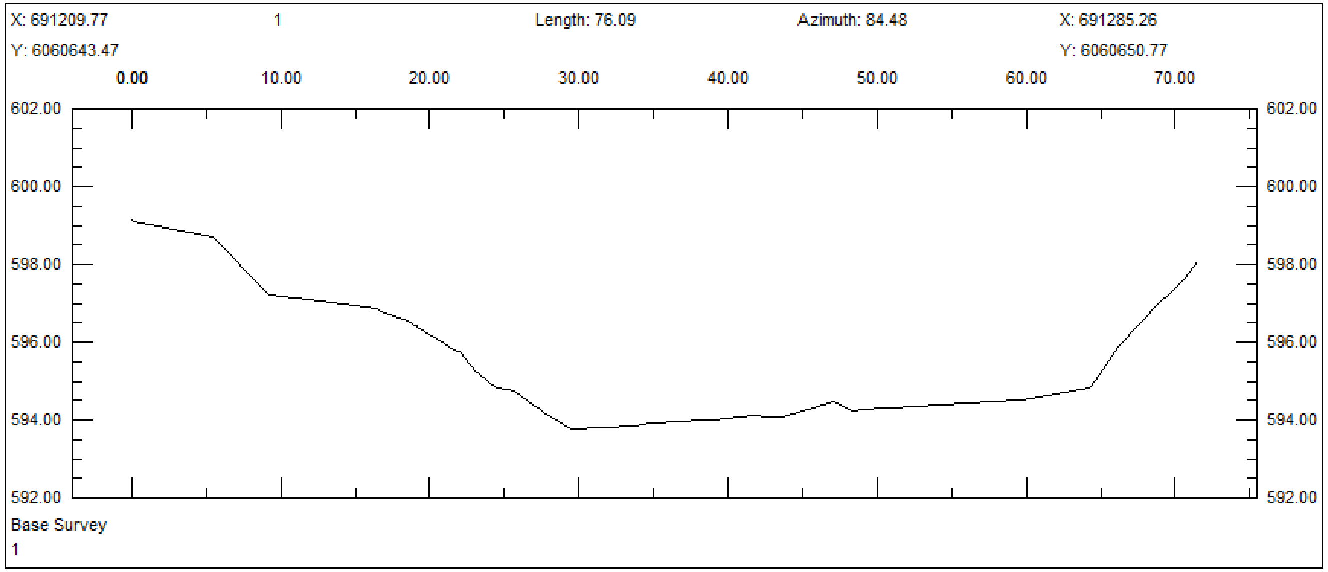


Figure 50 - Angle Crossing D/S 3D GPS XS-1

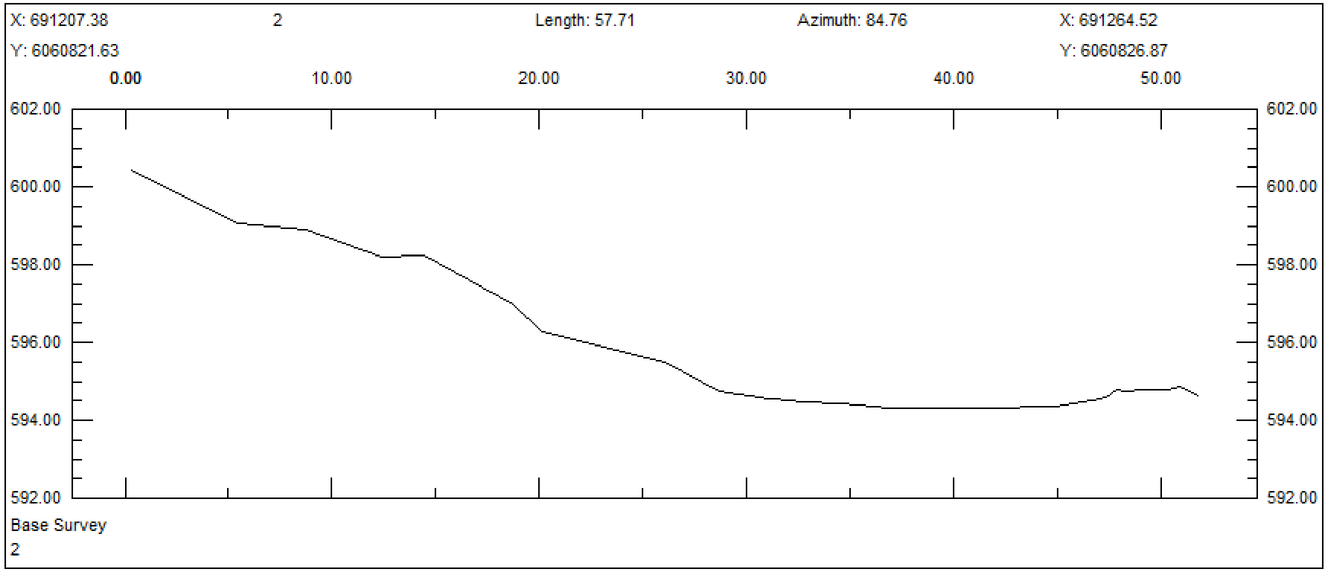


Figure 51 - Angle Crossing D/S 3D GPS XS-2

- DGPS cross section ends in-stream due to water level and vegetation not allowing access to opposite bank at time of survey

Appendix L - Vegetation Species Lists

Table 6.1. List of plants recorded in the Burra Creek Vegetation Surveys, August 2012

Family	Taxon	Common Name	Plant Form	Native/ Introduced
Asteraceae	*Carduus pycnocephalus*	Slender Thistle	Forb	Introduced
	Cirsium vulgare	Spear Thistle	Forb	Introduced
	Conyza bonariensis	Fleabane	Forb	Introduced
	Hypochoeris radicata	Catsear	Forb	Introduced
	Sonchus oleraceus	Sowthistle	Forb	Introduced
	Taraxacum officinale	Dandelion	Forb	Introduced
	Vittadinia cuneata	Fuzzweed	Forb	Introduced
Brassicaceae	*Rorippa nasturtium-aquatica*	Watercress	Forb	Native
Clusiaceae	*Hypericum perforatum*	St John's Wort	Forb	Introduced
Cyperaceae	*Bolboschoenus fluviatilis*	Marsh Club-Rush	Sedge	Native
	Carex appresa	Sedge	Sedge	Native
	Carex incomitata	Sedge	Sedge	Native
	Carex sp.	Sedge	Sedge	Native
	Cyperus eragrostis	Umbrella Sedge	Sedge	Native
	Cyperus polystachyos	Bunchy Flat Sedge	Sedge	Native
	Eleocharis acuta	Spike Rush	Sedge	Native
	Eleocharis atricha	Spike Rush	Sedge	Native
	Eleocharis sp.	Spike Rush	Sedge	Native
	Isolepis habra	Sedge	Sedge	Native
	Schoenoplectus validus	Sedge	Sedge	Native
Fabaceae	*Acacia dealbata*	Silver Wattle	Shrub	Native
	Trifolium sp.	Clover	Forb	Introduced
Juncaceae	*Juncus articulatus*	Common Rush	Sedge	Native
	Juncus usitatus	Common Rush	Sedge	Native
Lamiaceae	*Mentha piperata*	Mint	Forb	Introduced
Lythraceae	*Lythrum salicaria*	Purple Loosestrife	Forb	Native
Myrsinaceae	*Anagallis arvensis*	Scarlet pimpernel	Forb	Native
Myrtaceae	*Callistemon citrinus*	Bottlebrush	Shrub	Native
	Eucalyptus sp.	Gum Trees	Tree	Native
	Kunzea ericoides	Burgan	Shrub	Native
Plantaginaceae	*Plantago major*	Greater Plantain	Forb	Introduced
Poaceae	*Avena fatua*	Wild Oat	Grass	Introduced
	Echinopogon ovatus	Hedgehog Grass	Grass	Native
	Eragrostis curvula	African Love Grass	Grass	Introduced
	Lolium perenne	Ryegrass	Grass	Introduced
	Paspalum distichum	Water Couch	Grass	Native
	Phalaris aquatica	Phalaris	Grass	Introduced
	Poa labillardieri	Poa Tussock	Grass	Native
	Poa sp.	Poa	Grass	Introduced
	Phragmites australis	Common Reed	Grass	Native
Polygonaceae	*Acetosella vulgaris*	Sheep Sorrel	Forb	Introduced
	Persicaria prostrata	Creeping Knotweed	Forb	Native
	Rumex crispus	Curly Dock	Forb	Introduced
Ranunculaceae	*Ranunculus inundatus*	River Buttercup	Forb	Native

Table 6.1 (cont.). List of plants recorded in the Burra Creek Vegetation Surveys, August 2012

Family	Taxon	Common Name	Plant Form	Native/ Introduced
Rosaceae	*Acaena ovina*	Sheep's Burr	Forb	Native
	Rosa rubiginosa	Sweet Briar	Shrub	Introduced
	Rubus fruiticosus	Blackberry	Shrub	Introduced
Salicaceae	*Populus sp.*	Poplar	Tree	Introduced
	Salix spp.	Willow	Tree	Introduced
Scrophulariaceae	*Verbascum thapsus*	Common Mullein	Forb	Introduced
	Verbascum virgatum	Twiggy Mullein	Forb	Introduced
	Veronica anagallis-aquatica	Water Speedwell	Forb	Native
Typhaceae	*Typha orientalis*	Cumbungi	Sedge	Native
Verbenaceae	*Verbena bonariensis*	Purpletop	Forb	Introduced

Note: In addition to the above species, an aquatic moss - *Rosulabryum subfasciculatum* (Bryophyta) was common, growing in-stream, on crevices, sand and cobbles/rocks.

Burra Site 1 (U/S and D/S Williamsdale Bridge)

Table A6.2. Flora list from Burra Site 1*

Family	Taxon	Common Name	Plant Form	Native/ Introduced	Abundance in Creek/ Riparian Zone
Asteraceae	*Carduus pycnocephalus*	Slender Thistle	Forb	Introduced	Minor
	Cirsium vulgare	Spear Thistle	Forb	Introduced	Minor
	Conyza bonariensis	Fleabane	Forb	Introduced	Minor
	Sonchus oleraceus	Sowthistle	Forb	Introduced	Minor
	Taraxacum officinale	Dandelion	Forb	Introduced	Minor
Brassicaceae	*Rorippa nasturtium-aquatica*	Watercress	Forb	Native	Minor
Clusiaceae	*Hypercium perforatum*	St John's Wort	Forb	Introduced	Minor
Cyperaceae	*Carex appresa*	Carex sedge	Sedge	Native	Minor
	Carex incomitata	Fen Sedge	Sedge	Native	Minor
	Cyperus eragrostis	Umbrella Sedge	Sedge	Native	Minor
	Eleocharis acuta	Spike Rush	Sedge	Native	Common
	Eleocharis atricha	Spike Rush	Sedge	Native	Common
	Isolepis habra	Wispy Clubsedge	Sedge	Native	Very Common
Fabaceae	*Acacia dealbata*	Wattle	Shrub	Native	Minor
Juncaceae	*Juncus articulatus*	Jointed Rush	Sedge	Native	Minor
	Juncus usitatus	Common Rush	Sedge	Native	Common
Lythraceae	*Lythrum salicaria*	Purple Loosestrife	Forb	Native	Minor
Plantaginaceae	*Plantago major*	Greater Plantain	Forb	Introduced	Common
Poaceae	*Avena fatua*	Wild Oat	Grass	Introduced	Common
	Eragrostis curvula	African Lovegrass	Grass	Introduced	Dominant
	Lolium perenne	Ryegrass	Grass	Introduced	Common
	Paspalum distichum	Water Couch	Grass	Native	Common
	Phalaris aquatica	Phalaris	Grass	Introduced	Dominant
	Poa labillardieri	Poa Tussock	Grass	Native	Dominant
	Phragmites australis	Common Reed	Grass	Native	Dominant in patches
Polygonaceae	*Acetosella vulgaris*	Sheep Sorrel	Forb	Introduced	Common
	Persicaria prostrata	Creeping Knotweed	Forb	Native	Common
	Rumex crispus	Curly Dock	Forb	Introduced	Minor
Rosaceae	*Acaena ovina*	Sheep's Burr	Forb	Native	Minor
	Rosa rubiginosa	Sweet Briar	Shrub	Introduced	Minor
	Rubus fruiticosus	Blackberry	Shrub	Introduced	Common
Salicaceae	*Populus sp.*	Poplar	Tree	Introduced	Dominant
	Salix spp.	Willow	Tree	Introduced	Dominant
Scrophulariaceae	*Verbascum virgatum*	Twiggy Mullein	Forb	Introduced	Minor
Typhaceae	*Typha orientalis*	Cumbungi	Sedge	Native	Minor
Verbenaceae	*Verbena bonariensis*	Purpletop	Forb	Introduced	Minor

*Includes species in the vicinity of the Transects

Note: In addition to the above species, an aquatic moss - *Rosulabryum subfasciculatum* (Bryophyta) was common, growing in-stream, on crevices, sand and cobbles/rocks.

Burra Site 2 (U/S and D/S of Pool 51; Near Burra Road Homestead)

Table A6.3. Flora list from Burra Site 2*

Family	Taxon	Common Name	Plant Form	Native/ Introduced	Abundance in Creek/ Riparian Zone
Asteraceae	*Cirsium vulgare*	Nodding Thistle	Forb	Introduced	Common
	Conyza bonariensis	Fleabane	Forb	Introduced	Minor
	Hypochoeris radicata	Catsear	Forb	Introduced	Minor
Brassicaceae	*Rorippa nasturtium-aquatica*	Watercress	Forb	Native	Minor
Clusiaceae	*Hypericum perforatum*	St John's Wort	Forb	Introduced	Minor
Cyperaceae	*Carex appresa*	Carex sedge	Sedge	Native	Minor
	Carex sp.	Fen Sedge	Sedge	Native	Common
	Eleocharis acuta	Spike Rush	Sedge	Native	Common
	Eleocharis atricha	Spike Rush	Sedge	Native	Common
	Isolepis habra	Wispy Clubsedge	Sedge	Native	Very Common
Juncaceae	*Juncus usitatus*	Common Rush	Sedge	Native	Common
Plantaginaceae	*Plantago major*	Greater Plantain	Forb	Introduced	Common
Poaceae	*Eragrostis curvula*	African Lovegrass	Grass	Introduced	Dominant
	Paspalum distichum	Water Couch	Grass	Native	Common
	Phalaris aquatica	Phalaris	Grass	Introduced	Dominant
	Poa labillardieri	Poa Tussock	Grass	Native	Dominant
	Phragmites australis	Common Reed	Grass	Native	Dominant in patches
Polygonaceae	*Persicaria prostrata*	Creeping Knotweed	Forb	Native	Common
	Rumex crispus	Curly Dock	Forb	Introduced	Minor
Ranunculaceae	*Ranunculus inundatus*	River Buttercup	Forb	Native	Minor
Rosaceae	*Rubus fruiticosus*	Blackberry	Shrub	Introduced	Minor
Salicaceae	*Populus sp.*	Poplar	Tree	Introduced	Common
	Salix spp.	Willow	Tree	Introduced	Common
Scrophulariaceae	*Verbascum virgatum*	Twiggy Mullein	Forb	Introduced	Minor
	Veronica anagallis-aquatica	Water Speedwell	Forb	Native	Minor
Typhaceae	*Typha orientalis*	Cumbungi	Sedge	Native	Common
Verbenaceae	*Verbena bonariensis*	Purpletop	Forb	Introduced	Minor

*Includes species in the vicinity of the Transects

Note: In addition to the above species, filamentous green algae –*Zygnema* were found, growing attached to snags in the stream, and on cobbles/rocks.

Burra Site 3 – U/S and D/S of Pool 29

Table A6.4. Flora list from Burra Site 3*

Family	Taxon	Common Name	Plant Form	Native/ Introduced	Abundance in Creek/ Riparian Zone
Asteraceae	*Conyza bonariensis*	Fleabane	Forb	Introduced	Common
	Sonchus oleraceus	Sowthistle	Forb	Introduced	Minor
	Taraxacum officinale	Dandelion	Forb	Introduced	Minor
	Vittadinia cuneata	Fuzzweed	Forb	Introduced	Minor
Clusiaceae	*Hypericum perforatum*	St John's Wort	Forb	Introduced	Common
Cyperaceae	*Carex* sp.	Carex sedge	Sedge	Native	Minor
	Cyperus eragrostis	Umbrella Sedge	Sedge	Native	Minor
	Eleocharis acuta	Spike Rush	Sedge	Native	Common
	Eleocharis sp.	Spike Rush	Sedge	Native	Common
	Isolepis habra	Wispy Clubsedge	Sedge	Native	Dominant in patches
	Schoenoplectus validus	Sedge	Sedge	Native	Dominant in patches
Fabaceae	*Acacia dealbata*	Wattle	Shrub	Native	Minor
Juncaceae	*Juncus usitatus*	Common Rush	Sedge	Native	Common
Lamiaceae	*Mentha piperata*	Mint	Forb	Introduced	Minor
Myrtaceae	*Callistemon citrinus*	Bottlebrush	Shrub	Native	Common
	Eucalyptus sp.	Gum	Tree	Native	Minor
Plantaginaceae	*Plantago major*	Greater Plantain	Forb	Introduced	Common
Poaceae	*Echinopogon ovatus*	Hedgehog Grass	Grass	Native	Minor
	Eragrostis curvula	African Lovegrass	Grass	Introduced	Dominant in patches
	Paspalum distichum	Water Couch	Grass	Native	Common
	Phalaris aquatica	Phalaris	Grass	Introduced	Minor
	Poa labillardieri	Poa Tussock	Grass	Native	Dominant
	Poa sp.	Poa	Grass	Introduced	Minor
	Phragmites australis	Common Reed	Grass	Native	Common
Polygonaceae	*Persicaria prostrata*	Creeping Knotweed	Forb	Native	Common
	Rumex crispus	Curly Dock	Forb	Introduced	Common
Rosaceae	*Rubus fruiticosus*	Blackberry	Shrub	Introduced	Common
Salicaceae	*Populus sp.*	Poplar	Tree	Introduced	Minor
	Salix spp.	Willow	Tree	Introduced	Minor
Scrophulariaceae	*Verbascum virgatum*	Twiggy Mullein	Forb	Introduced	Minor
Typhaceae	*Typha orientalis*	Cumbungi	Sedge	Native	Dominant in patches
Verbenaceae	*Verbena bonariensis*	Purpletop	Forb	Introduced	Minor

*Includes species in the vicinity of the Transects
No submerged plants were found

Burra Site 4 (U/S London Bridge)

Table A6.5. Flora list from Burra Site 4*

Family	Taxon	Common Name	Plant Form	Native/ Introduced	Abundance in Creek/ Riparian Zone
Asteraceae	*Carduus pycnocephalus*	Slender Thistle	Forb	Introduced	Minor
	Conyza bonariensis	Fleabane	Forb	Introduced	Common
	Sonchus oleraceus	Sowthistle	Forb	Introduced	Minor
	Taraxacum officinale	Dandelion	Forb	Introduced	Minor
Clusiaceae	*Hypericum perforatum*	St John's Wort	Forb	Introduced	Common
Cyperaceae	*Bolboschoenus fluviatilis*	Marsh Club-Rush	Sedge	Native	Minor
	Carex sp.	Carex sedge	Sedge	Native	Minor
	Cyperus eragrostis	Umbrella Sedge	Sedge	Native	Minor
	Cyperus polystachyos	Bunchy Flat Sedge	Sedge	Native	Minor
	Eleocharis acuta	Spike Rush	Sedge	Native	Common
	Eleocharis atricha	Spike Rush	Sedge	Native	Common
	Isolepis habra	Wispy Clubsedge	Sedge	Native	Common
	Schoenoplectus validus	Sedge	Sedge	Native	Dominant in patches
Fabaceae	*Acacia dealbata*	Wattle	Shrub	Native	Common
	Trifolium sp.	Clover	Forb	Native	Minor
Juncaceae	*Juncus usitatus*	Common Rush	Sedge	Native	Minor
Lamiaceae	*Mentha piperata*	Mint	Forb	Introduced	Minor
Lythraceae	*Lythrum salicaria*	Purple Loosestrife	Forb	Native	Common
Myrtaceae	*Callistemon citrinus*	Bottlebrush	Shrub	Native	Common
	Eucalyptus sp.	Gum Trees	Tree	Native	Minor
Plantaginaceae	*Plantago major*	Greater Plantain	Forb	Introduced	Common
Poaceae	*Eragrostis curvula*	African Lovegrass	Grass	Introduced	Common in patches
	Paspalum distichum	Water Couch	Grass	Native	Common
	Phalaris aquatica	Phalaris	Grass	Introduced	Dominant
	Poa labillardieri	Poa Tussock	Grass	Native	Dominant
	Phragmites australis	Common Reed	Grass	Native	Common
Polygonaceae	*Persicaria prostrata*	Creeping Knotweed	Forb	Native	Common
	Rumex crispus	Curly Dock	Forb	Introduced	Common
Ranunculaceae	*Ranunculus inundatus*	River Buttercup	Forb	Native	Minor
Rosaceae	*Rubus fruiticosus*	Blackberry	Shrub	Introduced	Minor
Salicaceae	*Populus sp.*	Poplar	Tree	Introduced	Common
	Salix spp.	Willow	Tree	Introduced	Minor
Scrophulariaceae	*Verbascum thapsus*	Common Mullein	Forb	Introduced	
	Verbascum virgatum	Twiggy Mullein	Forb	Introduced	Minor
Typhaceae	*Typha orientalis*	Cumbungi	Sedge	Native	Minor
Verbenaceae	*Verbena bonariensis*	Purpletop	Forb	Introduced	Common in patches

*Includes species in the vicinity of the Transects;
Note: In addition to the above species, an aquatic moss - *Rosulabryum subfasciculatum* (Bryophyta) was common, growing in-stream, on crevices, sand and cobbles/rocks.

Appendix M - Water Quality Results

Water quality grab sample results for M2G commissioning

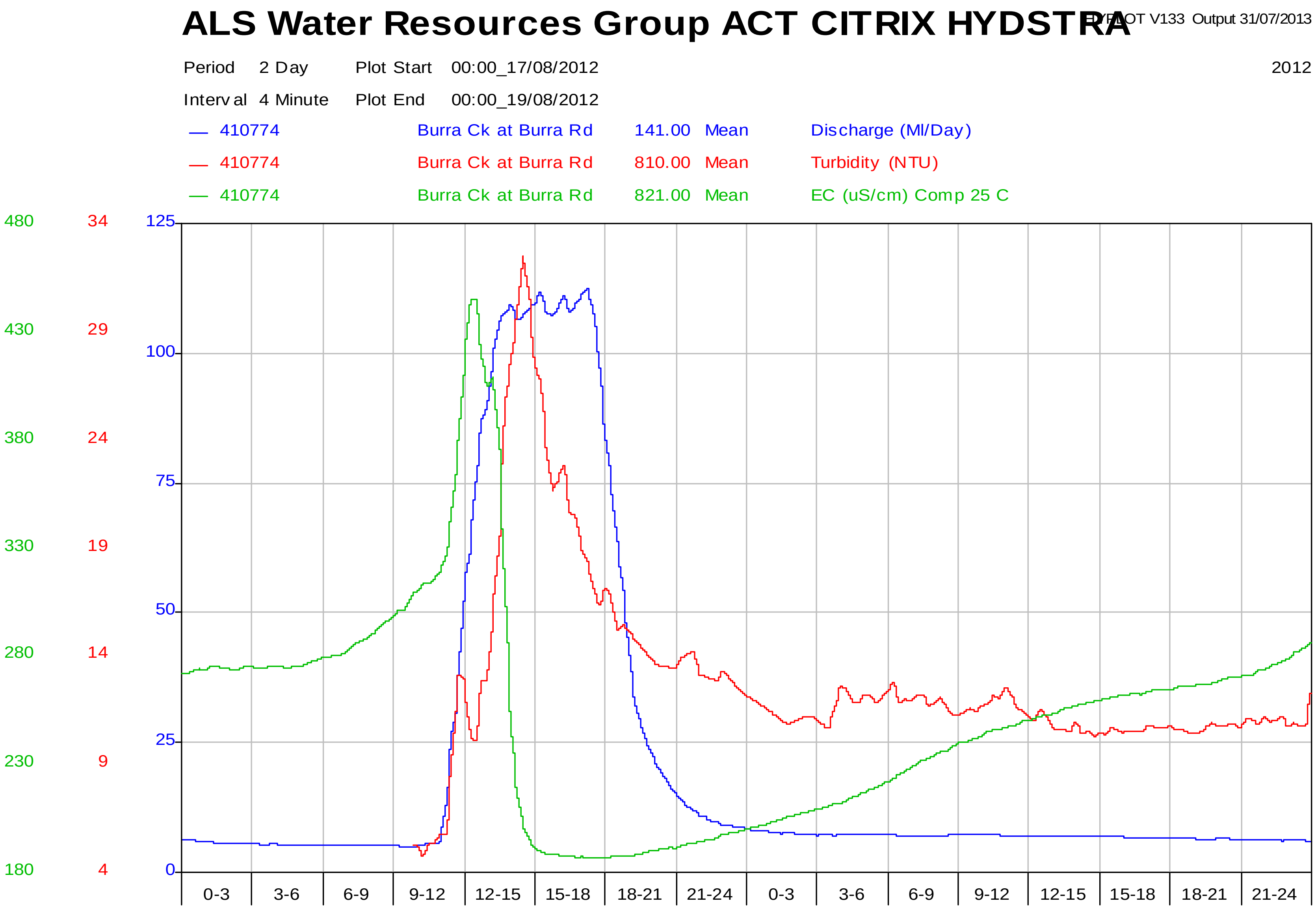
Yellows cells indicate values outside the ANZECC guidelines, orange cells indicate values on the cusp of the ANZECC guidelines

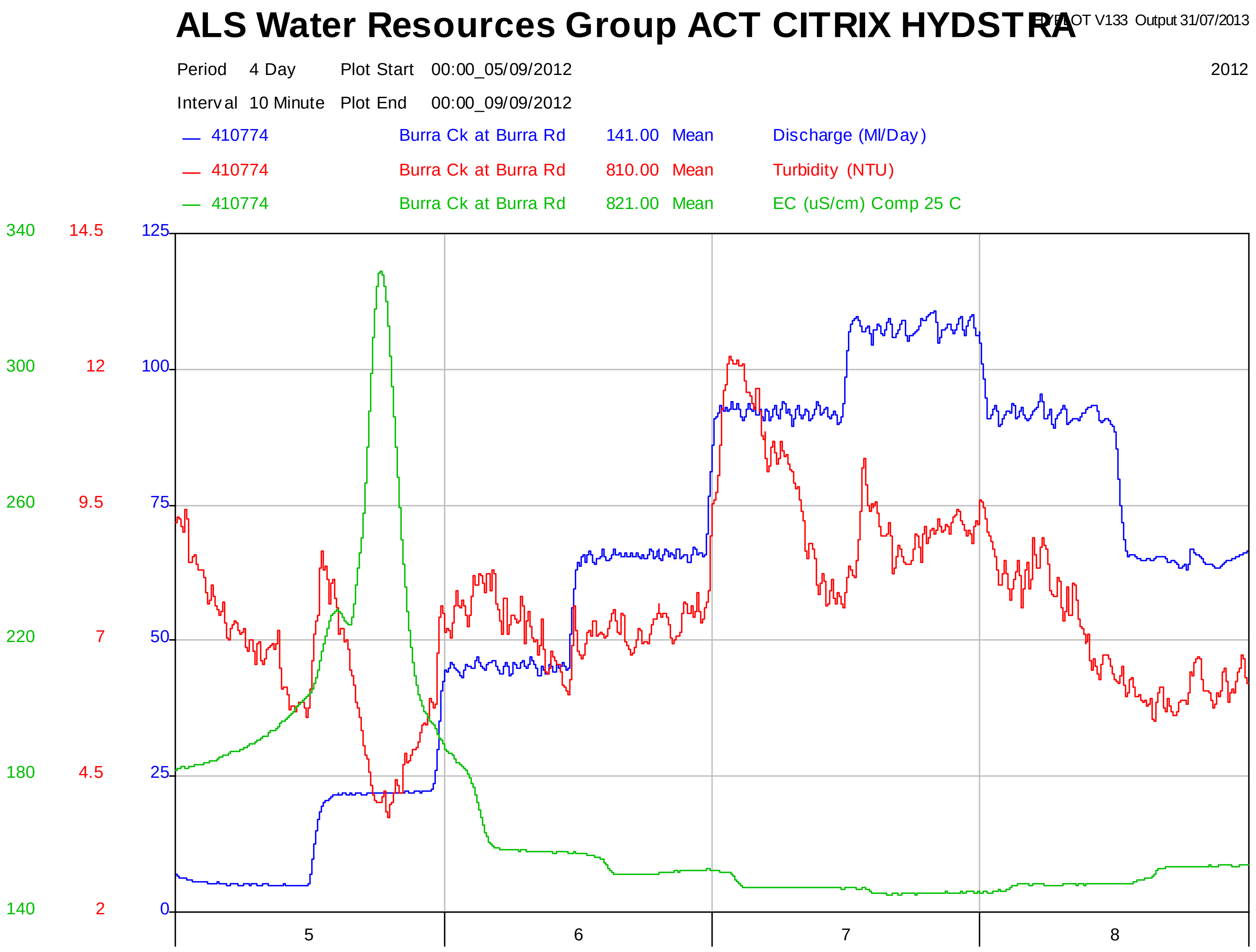
Site	Date	Time	Flow Category	Alkalinity (mg/L)	Electrical Conductivity (uS/cm)	Dissolved Aluminium (mg/L)	Dissolved Iron (mg/L)	Dissolved Manganese (mg/L)	Dissolved Organic Carbon (mg/L)	pH	Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	NO_X (mg/L)	Total Phosphorus (mg/L)	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Total Nitrogen (mg/L)	Turbidity (NTU)
ANZECC Guidelines				-	30 - 350	-	-	-	-	6.5 - 8.0	-	-	< 0.02	< 0.02	0.055	-	1.9	< 0.25	2 - 25
BUR1	3/08/12	14:00	< 10 ML/d	23	110	4.1	2.0	0.019		7.4	2	120	0.003	0.028	1.7			0.49	24
BUR1C	3/08/12	14:10	< 10 ML/d	137	360	0.34	0.41	0.044		7.9	2	190	0.052	0.010	0.38			0.38	7.8
BUR2	3/08/12	14:15	< 10 ML/d	167	420	0.17	0.27	0.071		8.0	2	210	0.28	0.008	0.32			0.55	6.5
410774	3/08/12	14:25	< 10 ML/d	173	430	0.09	0.18	0.059		8.1	3	240	0.18	0.007	0.25			0.45	6.4
MUR19	3/08/12	14:45	< 10 ML/d	54	140	0.10	0.32	0.018		7.8	5	84	<0.002	0.015	0.25			0.21	6.4
BUR1C	8/08/12	16:35	< 10 ML/d	154	390	0.11				8.2					0.29				5.3
BUR2A	8/08/12	16:45	< 10 ML/d	177	450	0.09				8.2					0.86				22
410774	8/08/12	17:00	< 10 ML/d	188	460	0.03				8.3					0.12				4.1
BUR1	9/08/12	13:20	< 10 ML/d	24	110	2.7				7.4					8.2				17
BUR1C	9/08/12	13:50	< 10 ML/d	154	390	0.10				8.2					0.29				5.0
BUR2	9/08/12	14:20	< 10 ML/d*	179	450	0.11				8.3					0.28				5.9
BUR2A	9/08/12	14:30	< 10 ML/d*	161	440	0.17				8.2					0.73				14
410774	9/08/12	15:00	< 10 ML/d*	188	450	0.03				8.3					0.10				4.1
BUR2C	9/08/12	12:20	< 10 ML/d*	191	450	0.04				8.4					0.08				2.2
BUR1C	10/08/12	12:10	< 10 ML/d	159	400	0.08				8.2					0.26				5.4
BUR2	10/08/12	12:15	< 10 ML/d	150	410	0.60				8.2					1.5				10
410774	10/08/12	12:25	< 10 ML/d	184	460	0.03				8.2					0.14				4.8
BUR2C	10/08/12	12:40	< 10 ML/d	203	460	0.03				8.2					0.07				2.5
BUR1C	14/08/12	11:40	< 10 ML/d	158	410	0.07				8.2					0.19				4.3
BUR2	14/08/12	11:45	< 10 ML/d	185	470	0.04				8.2					0.13				4.2
410774	14/08/12	11:55	< 10 ML/d	142	370	0.04				8.3					0.14				3.6
BUR2C	14/08/12	11:10	< 10 ML/d	159	410	0.04				8.3					0.12				2.2

** initial trickle release from the pipe, resulting in flow remaining below 10 ML/d*

Water quality grab sample results for M2G commissioning

Site	Date	Time	Flow Category	Alkalinity (mg/L)	Electrical Conductivity (uS/cm)	Dissolved Aluminium (mg/L)	Dissolved Iron (mg/L)	Dissolved Manganese (mg/L)	Dissolved Organic Carbon (mg/L)	pH	Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	NO_X (mg/L)	Total Phosphorus (mg/L)	Total Aluminium (mg/L)	Total Iron (mg/L)	Total Manganese (mg/L)	Total Nitrogen (mg/L)	Turbidity (NTU)
ANZECC Guidelines				-	30 - 350	-	-	-	-	6.5 - 8.0	-	-	< 0.02	< 0.02	-	0.055	1.9	< 0.25	2 - 25
BUR1C	17/08/12	13:15	< 10 ML/d	153	410	0.07	0.19	0.044	6	8.2	4	230		0.009	0.16	0.49	0.054	0.29	3.9
BUR2	17/08/12	09:15	< 50 ML/d	80	210	0.06	0.23	0.017	4	7.9	28	120		0.026	1.1	1.1	0.048	0.27	22
BUR2	17/08/12	09:40	< 80 ML/d	67	170	0.07	0.26	0.011	4	8.0	30	96		0.025	0.67	1.0	0.045	0.24	16
BUR2	17/08/12	12:30	~ 100 ML/d	60	160	0.06	0.22	0.011	4	7.9	24	96		0.024	0.56	0.95	0.052	0.23	11
BUR2A	17/08/12	13:00	~ 100 ML/d	61	160	0.07	0.28	0.011	4	8.0	27	94		0.022	0.64	0.90	0.053	0.23	13
410774	17/08/12	09:03	< 10 ML/d	115	290	0.03	0.16	0.023	5	8.2	6	170		0.013	0.29	0.56	0.046	0.29	5.0
410774	17/08/12	11:40	< 80 ML/d	149	370	0.03	0.09	0.020	5	8.3	11	200		0.015	0.46	0.64	0.061	0.38	7.8
410774	17/08/12	14:20	~ 100 ML/d	74	190	0.07	0.25	0.008	4	8.1	29	110		0.024	1.0	0.94	0.046	0.28	17
BUR2B	17/08/12	14:35	~ 100 ML/d	90	230	0.07	0.23	0.011	4	8.2	21	130		0.022	1.0	1.0	0.065	0.32	14
BUR2C	17/08/12	16:30	~ 100 ML/d	150	370	0.04	0.10	0.004	5	8.4	27	210		0.015	0.59	0.71	0.036	0.30	10
BUR1C	22/08/12	14:20	< 10 ML/d	160	420	0.06	0.19	0.018	7	8.3	6	240		0.008	0.13	0.55	0.046	0.31	4.2
BUR2	22/08/12	14:10	< 50 ML/d	189	470	0.03	0.13	0.042	7	8.3	4	260		0.008	0.09	0.55	0.070	0.56	3.9
410774	22/08/12	11:05	< 50 ML/d	143	360	0.04	0.23	0.024	6	8.3	4	190		0.010	0.11	0.54	0.058	0.37	3.8
BUR2C	22/08/12	15:00	< 50 ML/d	185	440	0.03	0.11	0.013	6	8.4	<2	250		0.006	0.06	0.21	0.020	0.30	1.8
BUR1	27/08/12	11:40	< 10 ML/d	24	120	3.4	1.7	0.014		7.3	2	130	0.003	0.025	1.4	1.1	0.018	0.45	22
BUR1C	27/08/12	11:25	< 10 ML/d	119	320	0.51	0.59	0.028		8.0	7	210	0.017	0.032	0.55	1.1	0.056	0.72	16
BUR2	27/08/12	10:50	< 10 ML/d	150	390	0.20	0.35	0.047		8.2	5	230	0.24	0.024	0.38	0.92	0.075	0.76	12
BUR2A	27/08/12	11:05	< 10 ML/d	148	380	0.33	0.45	0.050		8.1	6	230	0.21	0.024	2.1	1.6	0.073	0.76	12
410774	27/08/12	11:58	< 10 ML/d	144	370	0.34	0.48	0.030		8.1	6	230	0.13	0.026	0.49	1.0	0.057	0.73	12
BUR2C	27/08/12	12:20	< 10 ML/d	145	360	0.30	0.38	0.012		8.2	5	230	0.048	0.025	0.47	0.82	0.025	0.66	11
BUR1	28/08/12	14:35	< 10 ML/d	24	120	2.7	1.4	0.015		7.3	3	130	0.004	0.023	6.4	2.8	0.018	0.42	20
BUR1C	28/08/12	14:15	< 10 ML/d	128	340	0.36	0.50	0.039		8.2	6	210	0.018	0.025	1.3	1.3	0.057	0.60	13
BUR2	28/08/12	13:35	~ 100 ML/d	49	130	0.12	0.28	0.010		7.8	16	78	0.007	0.024	0.63	0.83	0.038	0.25	9.0
410774	28/08/12	15:00	~ 100 ML/d	77	200	0.14	0.31	0.019		8.1	12	120	0.042	0.022	0.29	0.80	0.062	0.35	8.0
BUR2C	28/08/12	17:35	~ 100 ML/d	88	220	0.16	0.29	0.009		8.2	11	130	0.013	0.019	0.53	0.80	0.037	0.31	8.8
BUR1	7/09/12	11:10	< 10 ML/d	25	130	0.79	0.53	0.013		7.4	6	120	0.003	0.016	1.2			0.34	12
BUR1C	7/09/12	10:40	< 10 ML/d	160	410	0.05	0.16	0.060		8.3	3	240	0.013	0.010	0.20			0.30	6.8
BUR2	7/09/12	10:30	~ 100 ML/d	51	130	0.07	0.25	0.014		7.8	7	85	0.011	0.020	0.28			0.20	7.0
410774	7/09/12	11:20	~ 100 ML/d	53	140	0.07	0.24	0.013		7.9	7	89	0.009	0.019	0.35			0.21	6.6
BUR2C	7/09/12	11:50	~ 100 ML/d	60	150	0.08	0.22	0.007		8.1	8	99	0.009	0.017	0.28			0.22	7.0
MUR19	7/09/12	13:45	~ 100 ML/d	45	120	0.07	0.25	0.016		7.9	12	71	0.002	0.022	0.45			0.20	9.2
BUR1	10/09/12	14:20	< 10 ML/d	25	130	0.64	0.45	0.005		7.6	<2	110	<0.002	0.013	1.5			0.32	7.8
BUR1C	10/09/12	14:50	< 10 ML/d	165	420	0.04	0.17	0.064		8.4	4	240	0.009	0.011	0.15			0.30	4.2
BUR2	10/09/12	15:20	< 10 ML/d	56	150	0.07	0.25	0.008		8.2	8	84	0.014	0.020	0.26			0.22	5.5
410774	10/09/12	13:50	< 10 ML/d	88	220	0.05	0.23	0.049		8.3	5	130	0.036	0.016	0.19			0.27	4.4
BUR2C	10/09/12	13:05	< 10 ML/d	91	230	0.04	0.15	0.011		8.3	<2	130	0.042	0.011	0.18			0.23	3.2
MUR19	10/09/12	16:25	< 10 ML/d	47	120	0.06	0.23	0.010		8.2	23	73	<0.002	0.029	0.45			0.22	12
BUR1C	14/09/12	14:50	< 10 ML/d	172	440	0.04	0.18	0.058		8.3	3	240	0.017	0.008	0.11			0.31	3.9
BUR2	14/09/12	14:55	< 50 ML/d	53	140	0.08	0.19	0.003		7.9	10	84	0.010	0.021	0.29			0.27	6.9
410774	14/09/12	15:00	< 50 ML/d	115	290	0.04	0.18	0.027		8.1	5	160	0.085	0.011	0.22			0.32	4.8
BUR2C	14/09/12	15:20	< 50 ML/d	123	300	0.03	0.10	0.015		8.1	<2	150	0.049	0.008	0.14			0.27	2.6


ALS Water Resources Group ACT CITRIX HYDSTRA
HYPLOT V133 Output 31/07/2013
Period 2 Day
Plot Start 00:00_17/08/2012
2012
Interv al 4 Minute
Plot End 00:00_19/08/2012
410774 Burra Ck at Burra Rd 141.00 Mean Discharge (Ml/Day)
410774 Burra Ck at Burra Rd 810.00 Mean Turbidity (NTU)
410774 Burra Ck at Burra Rd 821.00 Mean EC (uS/cm) Comp 25 C
480 430 380 330 280 230 180
34 29 24 19 14 9 4
125 100 75 50 25 0
0-3 3-6 6-9 9-12 12-15 15-18 18-21 21-24 0-3 3-6 6-9 9-12 12-15 15-18 18-21 21-24



ALS Water Resources Group ACT CITRIX HYDSTRA
HYPLOT V133 Output 31/07/2013
Period 4 Day Plot Start 00:00_05/09/2012
2012
Interval 10 Minute Plot End 00:00_09/09/2012
410774 Burra Ck at Burra Rd 141.00 Mean Discharge (Ml/Day)
410774 Burra Ck at Burra Rd 810.00 Mean Turbidity (NTU)
410774 Burra Ck at Burra Rd 821.00 Mean EC (uS/cm) Comp 25 C
340 14.5 125
300 12 100
260 9.5 75
220 7 50
180 4.5 25
140 2 0
5
6
7
8

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