6 DATA COLLECTION AND REVIEW

6.1 Topographic, GIS and Other Relevant Data Sets

As part of the data submission for the project, Bega Valley Shire Council provided the following GIS data for use in the flood study:

- Aerial photograph within the Bega and Brogo Rivers catchment, dated 2010
- Ortho-photography, dated 1980
- Aerial photographs, dated 1959
- Cadastre map showing property boundaries and lot number
- Major roads and street names, and other transport roads such as vehicular tracks
- 2m and 10m topographic contours for overall catchment
- Map of flood extent (frequency unknown)
- Land zoning map – draft LEP2012
- Bridge location map with attribute data such as type, creek, traffic surface, number of spans, width, width between kerbs, bed to deck, deck area, year of construction, description
- Layout of rivers and creeks
- Sub-catchments without detailed delineation

Other Council data supplied as part of the current study included:

- LIDAR survey data in various forms such as point data, DEM and contours
- CivilCAD survey data in a local datum for three locations, namely Jauncey Bridge, Sandy Creek, and Slaters Bridge
- Scanned bridge design plans
- Flood and damage photos (flood events of 2010, 2011, 2007 and 2005)
- Flood video at Bega bridge and Mogareeka
- 2011 map of floodmarks within the Bega township
- Summary tables from the community questionnaire
- RTA bypass plans issued for construction and dated 21/10/2011
- Plots of estuary heights at daily increments (Feb 2007, Feb 2010, Mar 2011 events)
- The Bega River entrance closure and opening patterns dating from 2000 to 2012
- Water surface profiles (from previous modelling) near the town of Bega, including the 10, 20, 50, 100 year ARI design events and February 1971 historic event
- Photographs
- Flood inundation map of Bega and Brogo Rivers at Bega (by WRC, 1979)
- Various reports relating to issues of flooding and river behaviour (refer to Section 7-Previous Reports)

The projection of the submitted GIS data was MGA 1994, Zone 55. The data was imported into MapInfo and comprehensively assessed for consistency, forming the basis for further investigation, modelling and mapping.

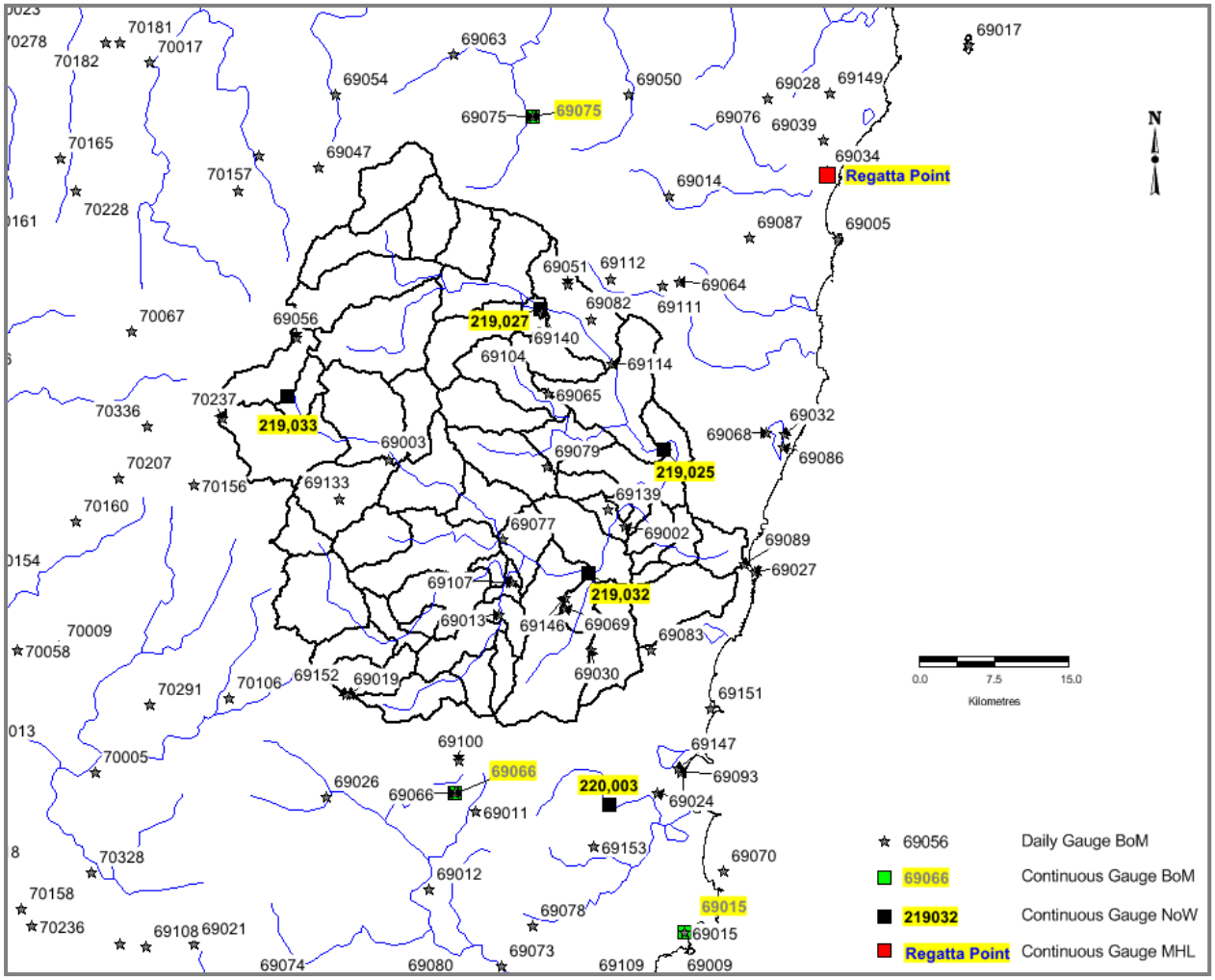
Landsat images showing the historic aerial photography were also available from NASA, dated 1972, 1980, 1989, 2000, 2004, 2005.

Data relevant for hydrologic modelling of Brogo Dam was sourced from NSW Office of Water Pinneena DVD and included daily rainfall, continuous pluviograph records, continuous water level measurements, and continuous streamflow records. Cochrane Dam is operated by Eraring Energy who provided information for the hydrologic modelling relevant for this dam. Some additional information on historic water levels for Cochrane Dam was also obtained from the NSW Office of Water Pinneena DVD. State Water was contacted directly during this data collection phase of obtaining relevant data for the modelling of Brogo and Cochrane Dams. Data obtained from State Water included construction dates for Brogo Dam and environmental and low flow release rules (refer Section 6.6.1). OEH also provided historic aerial photos near Mogareeka, bathymetric data dated 2002, and ocean tide and water level data near Tathra bridge (obtained from Manly Hydraulics Laboratory).

6.2 Rainfall and Pluviograph Stations

Locations of daily rainfall and pluviograph records were obtained from the Bureau of Meteorology and NSW Office of Water's Pinneena DVD and are shown in Figure 6.1. While there are several daily rainfall stations situated throughout the catchment the number is still limited particularly in the mid to upper parts of the catchment where there can be significant orographic effects impacting on rainfall. Many of these stations were not operational for all of the events used during the calibration.

Figure 6.1: Locations of Rainfall Stations



Orographic impacts often occur near the upper reaches of the catchment, causing clouds and water vapour to suddenly rise due to the topography of the mountain ranges. The rise in water vapour causes an increased potential of rainfall in the vicinity of the ranges and may significantly vary the spatial and temporal distribution of rainfall in that localised area, which is difficult to confirm without sufficient data.

The pluviograph stations were very sparse with some historic events requiring data sourced from far outside of the catchment area. Pluviograph stations from the NSW Office of Water's Pinneena DVD were only available in the more recent events, namely the Feb 2010 and Feb 2011 events. Detailed information on rainfall patterns and pluviograph data for specific events used to calibrate the hydrologic and hydraulic models can be found in Section 14.

6.3 Streamflow Gauging Stations

The locations of the streamflow gauging stations were obtained from the NSW Office of Water based on records held in their database (Pinneena DVD). In addition to flow gauging sites, water level measuring sites at Brogo Dam, Cochrane Dam, the North Bega site in the town of Bega, and Bega (Live) site at Mogareeka were also used. The Bega (Live) site at Mogareeka is sourced from OEH data obtained from the Manly Hydraulics Laboratory. The locations of these gauging sites are shown in Figure 6.2.

The gauging stations shown in Figure 6.2 were chosen for modelling to provide a level of detail and maximise the reliability of the calibration. Lower gauging station sites with larger cumulative flows were supplemented with additional gauges upstream to enhance the level of detail in the calibration by representing variations in hydrology throughout the catchment. Not all of the gauging stations were operating for all flood events modelled.

Figure 6.2: Flow and Water Level Gauges Map

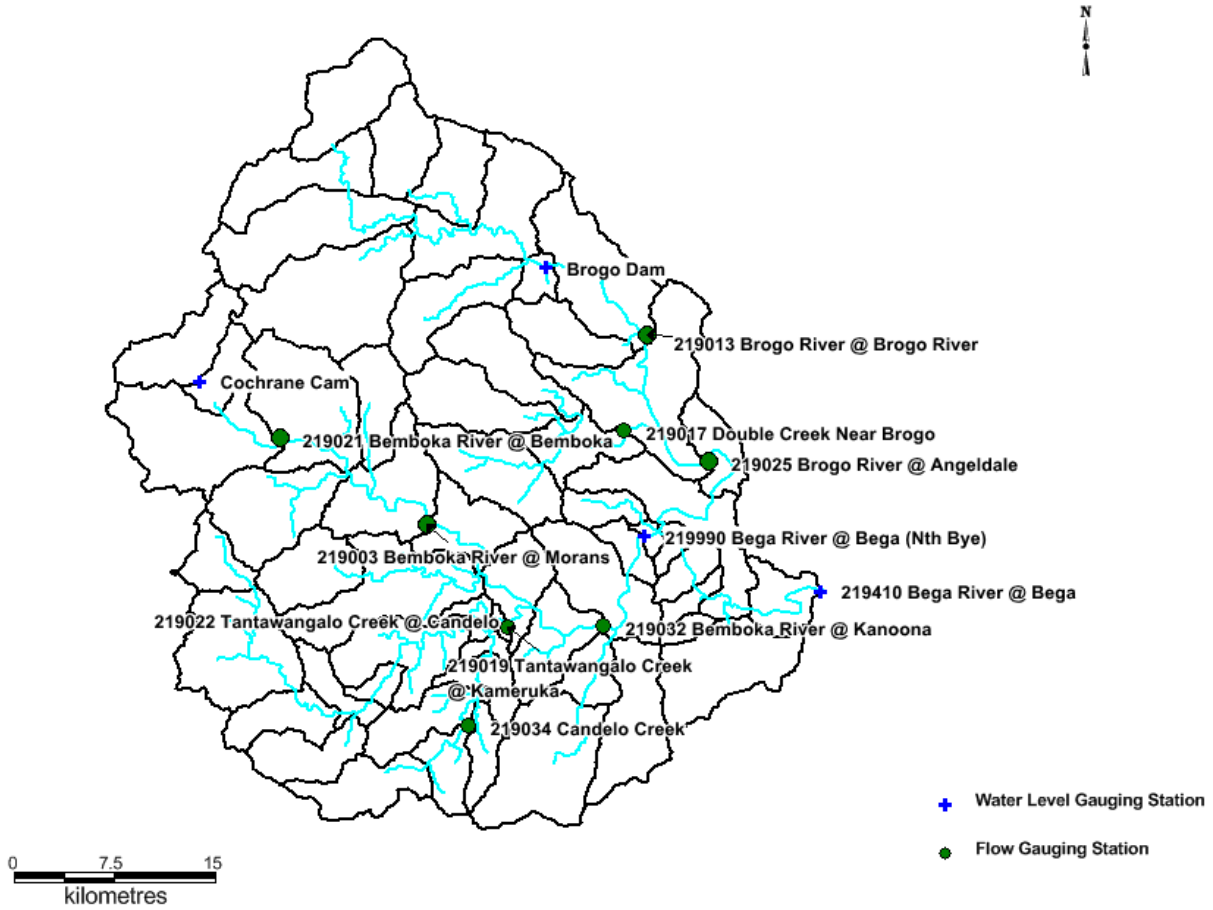


Table 6.1 shows the years of continuous water level records at the abovementioned gauging stations. The levels at Brogo and Cochrane Dams are used to record reservoir water levels and storage volumes. The other stations convert the water levels to observed streamflow discharges, using developed rating curves specific to each site.

Table 6.1: Years of Continuous Water level Records

Station No	Station Name	Operational Record		Comments
		From	To	
Reservoir Water level	Brogo Dam	Jan 1976	current	
219013	Brogo River at Brogo River	Nov 1961	current	Some missing data
219025	Brogo River at Angeldale	Nov 1976	current	
219017	Double Creek near Brogo	Jul 1966	current	
Reservoir Water level	Cochrane Dam	Dec 1960	current	Some missing data
219021	Bemboka River at Bemboka	Jul 1966	Feb 1983	
219003	Bemboka River at Morans Crossing	Apr 1943	current	Includes some daily records
219022	Tantawangalo Creek at Candelo	Nov 1971	current	
219034	Candelo Creek at Greenmount	Jun 2002	current	
219014	Candelo Creek at Yuramme	Jul 1963	Apr 1978	Some missing data
219019	Tantawangalo Creek at Kameruka	Jul 1966	Mar 1978	
219032	Bemboka River at Kanoona	Dec 1997	current	

6.4 Site Inspection

A site inspection of the study area was undertaken in April 2012 by SMEC to:

- gain an appreciation of the study area and floodplain characteristics,
- confirm the relevant hydraulic structures,
- obtain a photographic record of the study area,
- establish the survey requirements in preparation of a survey brief.

The findings of site inspection were fully incorporated in further assessment and development of the model.

6.5 Topographic and Survey Data

6.5.1 General Catchment and Modelling Area Topography

Topographic Data from NASA's Shuttle Radar Topography Mission (SRTM) was used to develop an electronic surface (Digital Elevation Model - DEM) of the entire catchment that was subsequently used in the catchment delineation. The SRTM data was obtained at a spacing of about 1 second or approximately 30m which provided a detailed topographic surface for the purposes of the hydrologic model setup. The perspective view of the catchment topography is shown in Figure 5.2 above.

For the purpose of the detailed hydraulic modelling from Bega to Mogareeka, Council's detailed LIDAR survey was used. Digital Elevation Models (DEM) were produced by Terranean Mapping Technologies using the LIDAR data flown at 800m above sea level, at a point density of approximately 1.5 points per square metre. The data was captured between January and March 2008 and has an accuracy at the 95% confidence level of 0.33m.

Figure 6.3: DTM Representation of the Confluence of Brogo and Bega Rivers North of Bega Based on the Council's LIDAR Survey Data

6.5.2 Additional Survey

Additional ground/bathymetric survey was arranged through a local survey firm, Caddey Searle & Jarman Consulting Surveyors. The survey along Bega and Brogo Rivers was undertaken to review and validate cross sections formed from the LIDAR data. Survey also included the geometry of relevant bridges.

Bridge survey included 5 locations (Princes Highway bridge, both the river and anabranch bridges at Tarraganda Lane, Tathra-Bermagui Road bridge and Candelo town bridge) and provided the following details to supplement the existing bridge design drawings:

- Top of the deck or road level above the structure (whichever was higher). For the bridge decks that were not horizontal, levels at both ends and at the high point were surveyed,
- Deck soffit level,
- Height of railing/safety barriers, and
- Cross-section at the bridge.

In addition to these bridges, survey also included Jellat Jellat weir. The Jellat Jellat weir (also known as Russells Creek Weir) prevents migration of tidal salt water up the creek into Jellat Jellat Flats when the gates are closed.

As Council's LIDAR survey did not extend to Candelo, the topographic survey of the Candelo Creek was undertaken by Caddey Searle & Jarman Consulting Surveyors and included the creek bed and floodplain area. Generally, the survey provided a high level of detail to adequately supplement the existing survey data and define the topography of the study area and hydraulic structures required for modelling. Figures 6.4 and 6.5 show the locations of cross sections surveyed by ground survey at both project locations.

Figure 6.4: Surveyed Control Cross-Sections Along Bega and Brogo Rivers

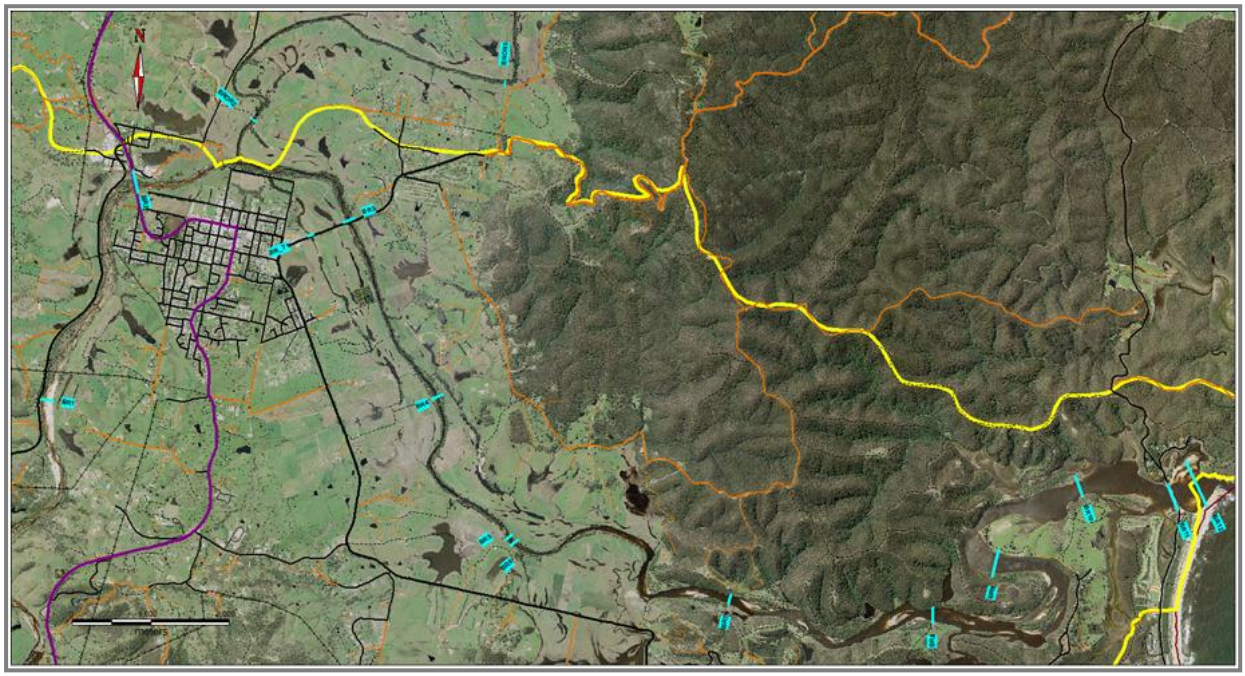
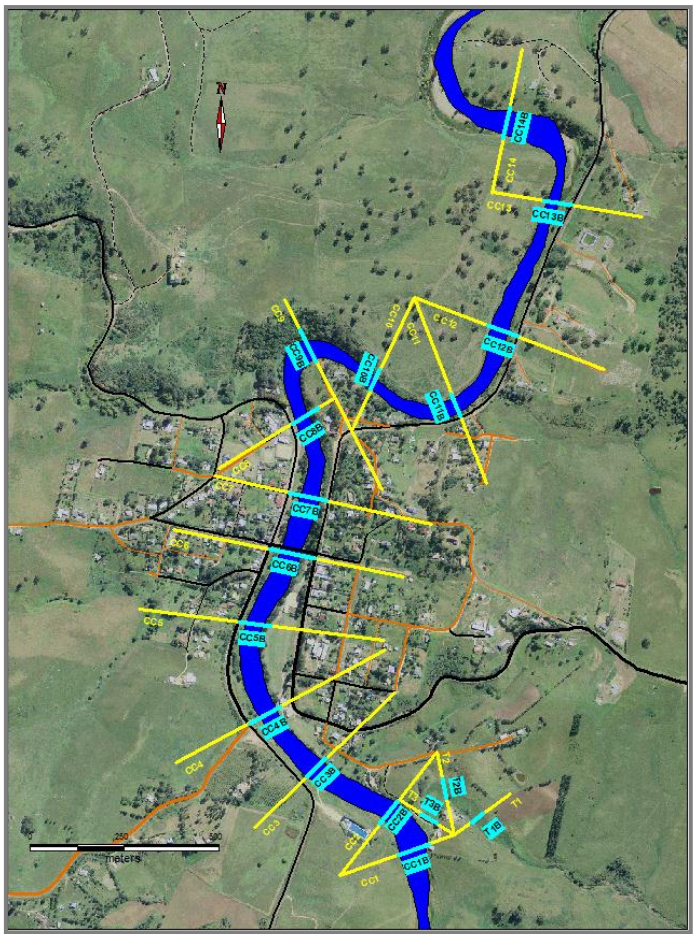


Figure 6.5: Candelo Creek Surveyed Cross Sections

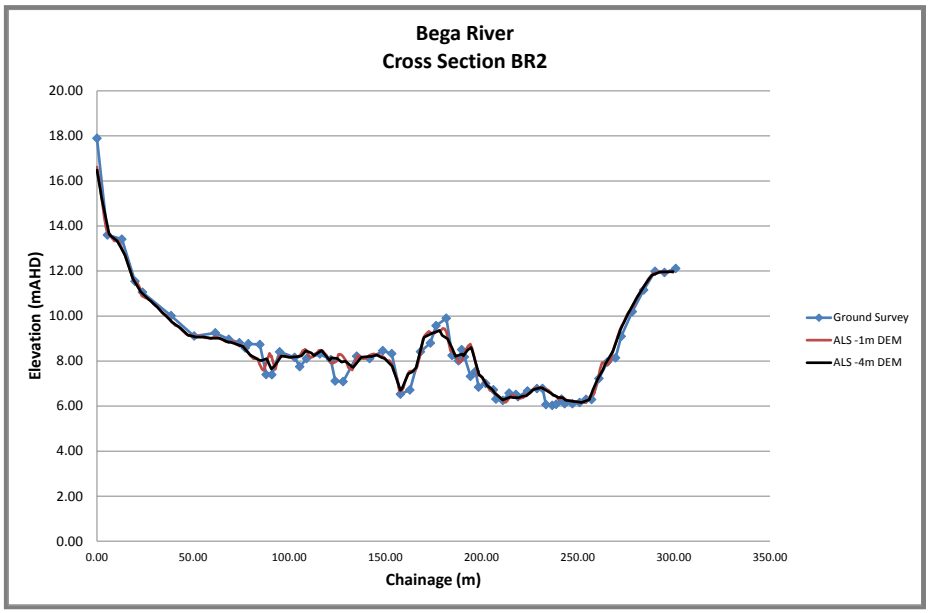


The review of cross sections along Bega River indicated that the LIDAR data adequately represented the topography of the channel in the upper parts of the hydraulic modelling area from Jellat Jellat to the upstream end, but did not register the channel within the banks downstream of Jellat Jellat flats to Mogareeka. The

inconsistencies in lower reaches originate from LIDAR registering the water surface rather than the bottom of the channel.

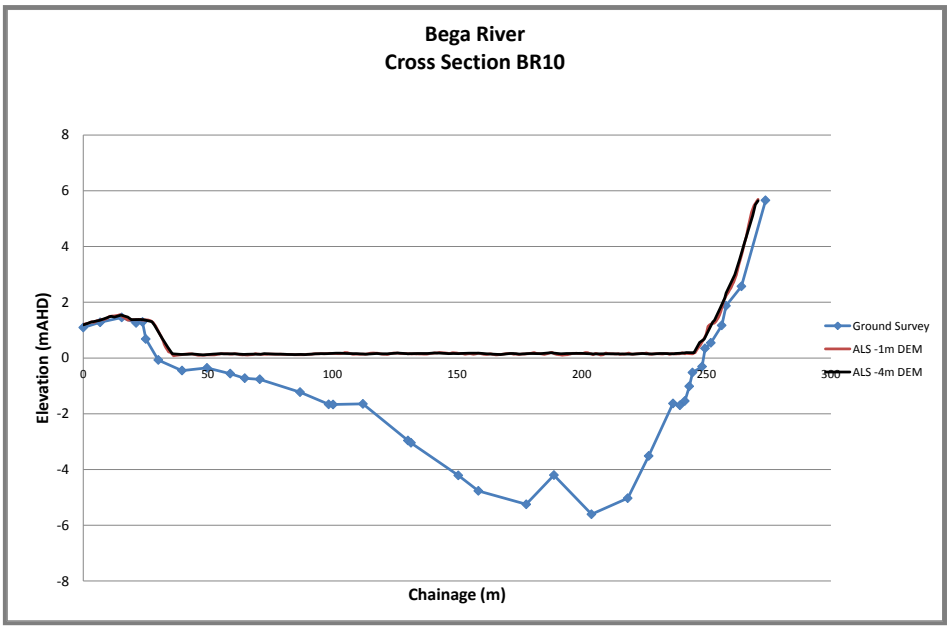
An example of a review of the surveyed cross section where the LIDAR adequately represented the channel as typical in the upper reaches is shown in Figure 6.6 below.

Figure 6.6: Example where LIDAR Adequately Represented Channel



An example of a review where the LIDAR did not adequately represent the channel, typical in the lower reaches, is presented in Figure 6.7 below. In such cases the ground/bathymetric survey was used in preference to the LIDAR data.

Figure 6.7: Example where LIDAR did not Adequately Represent Channel



In addition to the topographic survey, the survey of floodmarks was carried out, upon obtaining the flood information through the flood questionnaire.

6.6 Data for Hydrologic Modelling of Dams

6.6.1 Brogo Dam

Brogo Dam is a concrete lined dam with compacted rockfill and a height of 43m, with maximum water depth of 25m. The dam has a storage capacity of 8980ML at the spillway level of 102.60 mAHD. The dam crest level is at 118.10 mAHD while the Full Supply Level coincides with the spillway level. The construction of Brogo Dam commenced in late 1973 while the construction of the main wall did not start until 1975.

Data was requested for Brogo Dam from State Water and NSW Office of Water for the following information:

- Stage-discharge relationships (refer Appendix A)
- Stage-storage relationships (refer Appendix A)
- Historic event flow releases including any environmental flows or low flows
- Operating rules for storage levels for large events
- Operating rules for use in the modelling of design events

Stage-discharge and stage-storage relationships were provided by State Water, and observed water levels obtained from NOW's Pinneena DVD.

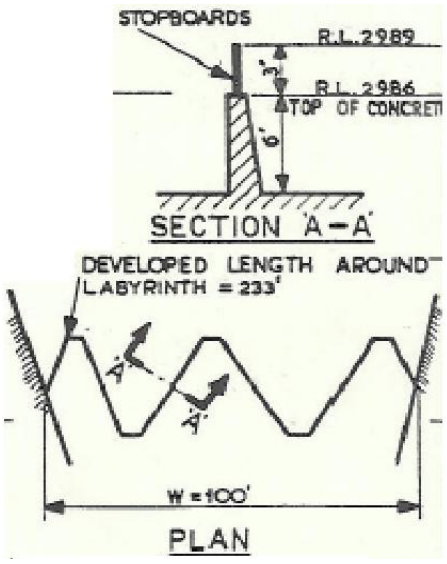
A "transparent flow release" information provided by State Water noted that:

"The Approval Holder must ensure that when the volume of water in Brogo Dam water storage is equal to or greater than 50 per cent of full capacity, all inflows into Brogo Dam up to 15 megalitres per day (ML/day) must be released from Brogo Dam." For the purposes of this flood study this release (15 ML/day i.e. 0.2m^3/s) is considered to be negligible.

6.6.2 Cochrane Dam

Cochrane dam is situated in the upper reaches of the Bega River catchment between Bemboka and Nimitabel. The dam is used for both power generation and supplying water to the village of Bemboka. Cochrane dam is an earth filled dam with a central concrete core and with a labyrinth type spillway leading to a concrete lined chute with hydraulic jump dissipator. The weir includes approximately 910mm (3 ft) high stopboards as shown in Figure 6.8 below.

Figure 6.8: Schematic of Cochrane Dam Weir – Plan and Section Views



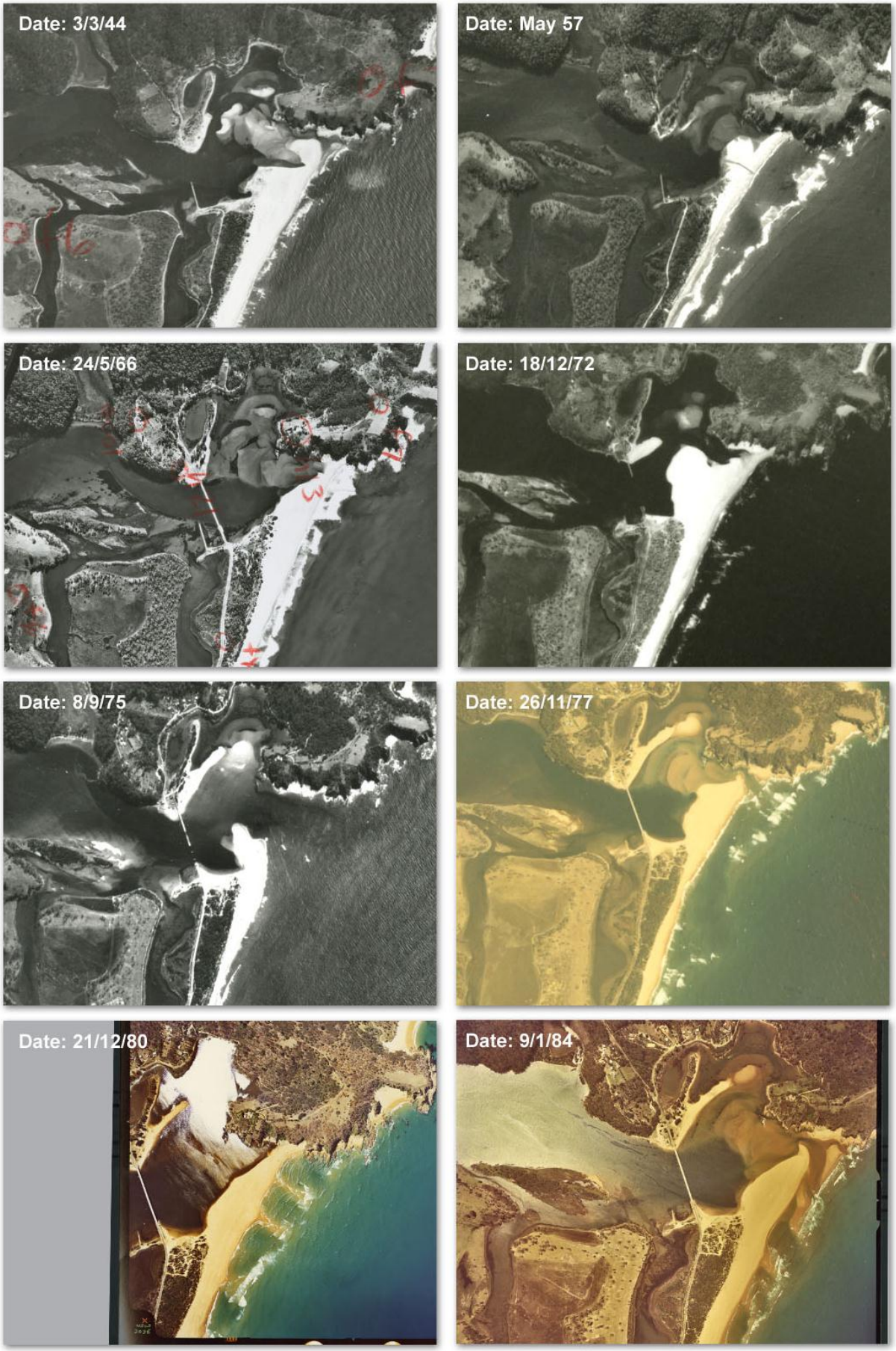
At the top of the labyrinth weir at a level of 910.13 mRL (2986 ftRL) the spillway length along the labyrinth weir is approximately 71m, while the width from abutment to abutment is 31m – refer Figure 6.8 plan view. (Connell Wagner PPI, December 2007). The dam crest level is noted as 915.1 mRL with a Full Supply Level (FSL) at 910.13 mRL, i.e. at the invert level of the stopboards. (Connell Wagner PPI, December 2007).

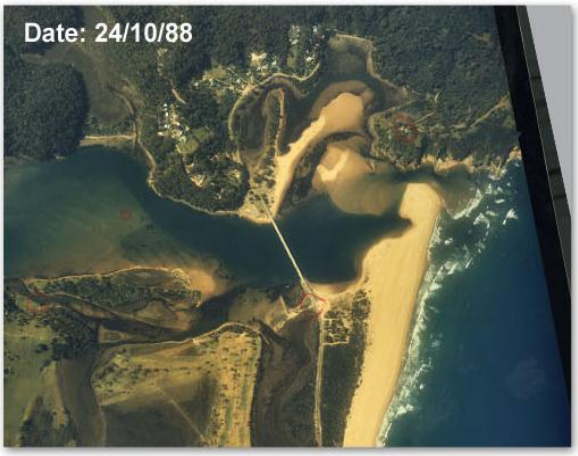
Eraring Energy provided a stage-discharge and stage-storage relationship for Cochrane Dam (refer Appendix A). Any environmental or low flows during flood events were assumed to be negligible. The rating curve supplied indicates that flows begin to spill at the spillway crest level of 911.05 mRL (2989 ftRL), equivalent to 110%FSL, while the stopboards collapse at a level of 911.96 mRL (2992 ftRL).

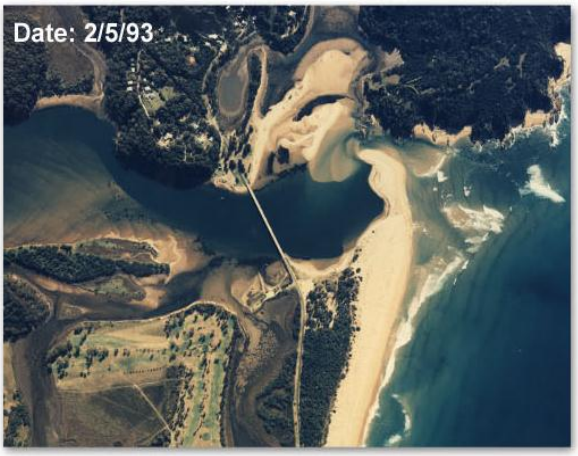
6.7 Mogareeka Inlet Historic Aerial Photos

Aerial photography of the outlet at Mogareeka was provided by OEH and indicated that the berm changes over time. There were significant changes in location and shape at the outlet.. Fifteen aerial photos of the inlet were provided, dating back to March 1944 to May 2011. These aerial photos are shown in Figure 6.9 below.

Figure 6.9: Historic Aerial Photographs near Mogareeka (Source OEH)




Date: 24/10/88


Date: 2/5/93


Date: 19/2/98


Date: 26/1/99


Date: 1/4/01


Date: 6/3/05


Date: 15/5/11

Changes noted in the aerial photos include:

- The width and shape of the berm
- The width of the opening
- The location of the opening
- Sediment build up between Tathra Bridge and the berm
- Changes to the Tathra bridge with part of the bridge being removed/ washed away (also noted in bridge drawings)
- Relatively minor changes to bathymetry upstream of the Tathra bridge (although difficult to associate from the plan views alone)
- Changes to development in the area
- Changes to the alignment of the road leading to Tathra bridge since May 1957
- Changes to the location of Tathra bridge since May 1957.
- Generally the opening of Bega River is situated at the northern end of the berm, however in the case of the Feb 1998, Jan 1999 and May 2011 photos the opening is situated more centrally between the berm's northern and southern ends.

Figure 6.10 shows an image of the opening from the aerial photograph supplied by Council (dated 2010).

Figure 6.10: 2010 Aerial Photograph near Mogareeka (Source Council)