Department for Environment and Heritage

Katfish Reach Modelling

Data Review and Modelling Framework

February 2009

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WATER TECHNOLOGY

WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

DOCUMENT STATUS

Version	Doc type	Reviewed by	Approved by	Date issued
v01	Draft	Ben Tate	Ben Tate	6-Mar-09

PROJECT DETAILS

Project Name	Katfish Reach Modelling
Client	Department for Environment and Heritage
Client project manager	Mike Harper
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Job number	J874
Report number	R01
Document Name	R01_Katfish_DataReview.doc

Cover Photo: from www.katfish.org.au (Stone crossing on waterway within Katfish Reach)

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1. INTRODUCTION

Department for Environment and Heritage (DEH) commissioned Water Technology to develop a hydraulic model for the Eckert Island section of Katfish Reach to assist decision makers in the development of a number of waterway management options.

This report reviews previous studies and all available data , outlines the proposed hydraulic modelling framework, and scopes the additional topographic field survey required.

The structure of this report is as follows:

- Section 2 – review of previous studies
- Section 3 – review of available data
- Section 4 – proposed hydraulic modelling framework
- Section 5 – required additional survey

2. PREVIOUS STUDIES

Two major studies have been made available to the study team:

- Katfish Reach Implementation Plan (2008)
- Katfish Reach Investment Proposal (2008)

These documents highlight a number of issues for the Katfish Reach study area and provide a vision for the future "A healthier and more productive aquatic and floodplain ecosystem that everyone can enjoy".

This hydraulic modelling study has arisen from a number of the key objectives highlighted in these reports, including:

- Improving connectivity between river, creek, wetland and floodplain environments
- Improving environmental flow management

In order to achieve these objectives it has been recognised that a hydraulic model of the study area is required to firstly enable a detailed understanding of the hydrodynamics of the floodplain/wetland system and secondly enable a better understanding of the likely impacts of various management options.

These documents summarises the knowledge to date of the system and propose a number of preferred management options. These documents are a valuable resource to the hydraulic modelling study.

3. AVAILABLE DATA

This section identifies and briefly reviews relevant available data and information collated. Sources of background data and information collated include:

- Observed flood extents
- Hydrologic data
- Topographic data
- Register of Structures

3.1 Observed Flood Extents

Observed flood extents are required if a thorough calibration of the hydraulic model is to be undertaken. It is our experience with calibrating similar hydraulic models that the more recent events tend to make the best calibration events as there is less likelihood that the floodplain has had structural changes, and there is greater confidence in the operating regime of regulating structures. There is generally more gauged data to calibrate to also. Table 3-1 indicates a number of recent flood events that may be suitable for calibration. It is unknown if observed flood extents exist for these events, and if it is available to DEH. Water Technology could arrange an investigation into satellite imagery for these events, this is not included in the current scope, but is not a large task, however the cost of the imagery itself may be around $1,000 per image.

Table 3-1 Possible flood events for calibration

Date	Peak Flow at Lock 5 (ML/day)
July to December 1996	60000
September to December 1998	33000
August to December 2000	45600
September to October 2003	14000
September to November 2005	15200

3.2 Hydrologic data

Hydrologic gauged data is available for Lock 5, Lock 4 and Lock 3 as well as for another ten gauges along the Murray River through the Katfish model reach as shown in Figure 3-1, and listed in Table 3-2. Figure 3-2 and Figure 3-3 show flow and level data for the three Locks.

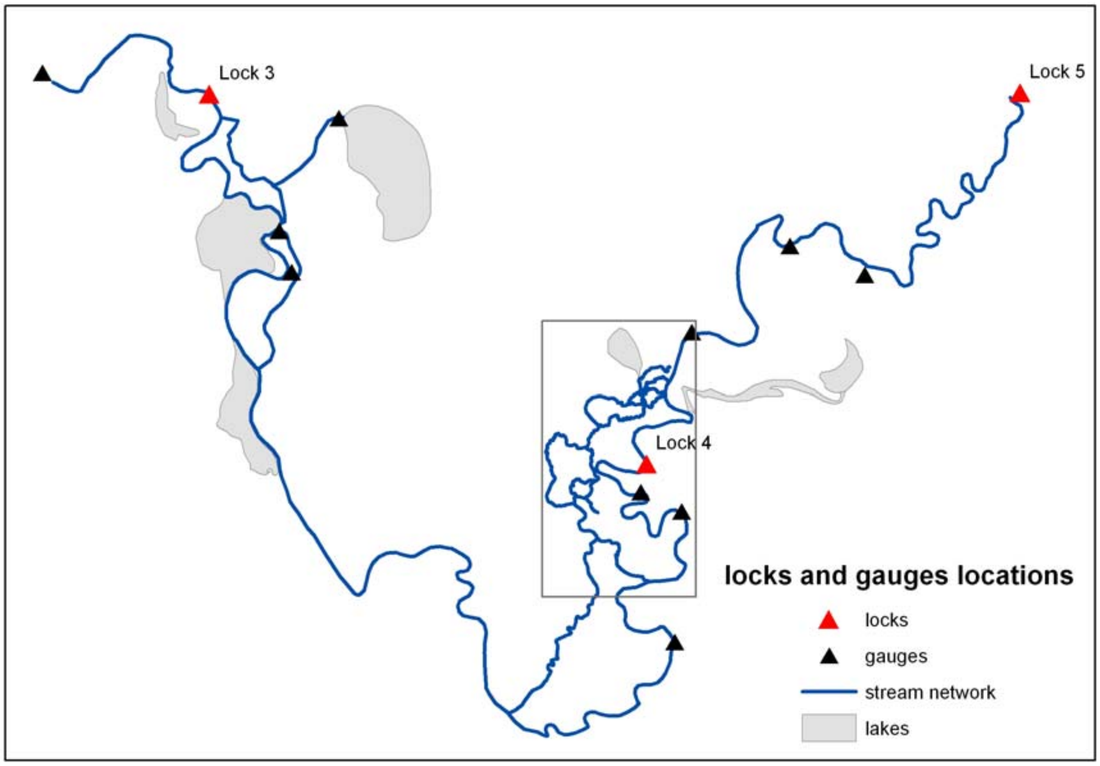

Figure 3-1 Locations of Locks and Gauges

Flow data at lock 5 has gaps for discharges greater 2500 ML/day prior to 1994. From 1994 onwards there are continues flow records at Lock 3, Lock 4 and Lock 5. Water level data for these locks and the ten additional locations within the 1D stream network are available. This gauged data will be utilised in the hydrologic and hydraulic model calibration.

Table 3-2 Summary of discharge and water level records

Gauge Station (No.)	River/Creek, Location	Parameter measured	Period of Observation
A4260513	Murray at Lock 5	WL Flow	1924 - 2009 1981-2009
A4260514	Murray U/S Lock 4	WL	1927 - 2009
A4260515	Murray D/S Lock 4	WL Flow	1927 - 2009 1994 - 2009
A4260516	Murray U/S Lock 3	WL	1921 - 2009
A4260517	Murray d/S Lock 3	WL Flow	1921 - 2009 1994 - 2009
A4260537	Berri IPS / Murray RV	WL	1974 - 2009
A4260550	Loxton IPS / Murray RV	WL	1998 - 2009
A4260596	Lake Bonney at Jetty	WL	1997 - 2009
A4260597	Chambers CK / Nappers	WL	1997 - 2009
A4260624	Loveday IPS / Murray r	WL	1986 - 2009
A4260645	Pike RD Picnic Ground	WL	2003 - 2009
A4260663	Lyrup PS / Murray RV	WL	1993 - 2009
A4261065	Solora Pumping Station	WL	2000 - 2009
A4261083	Booky Bank	WL	2005 - 2009
A4261086	Northern Inlet	WL	2006 - 2009

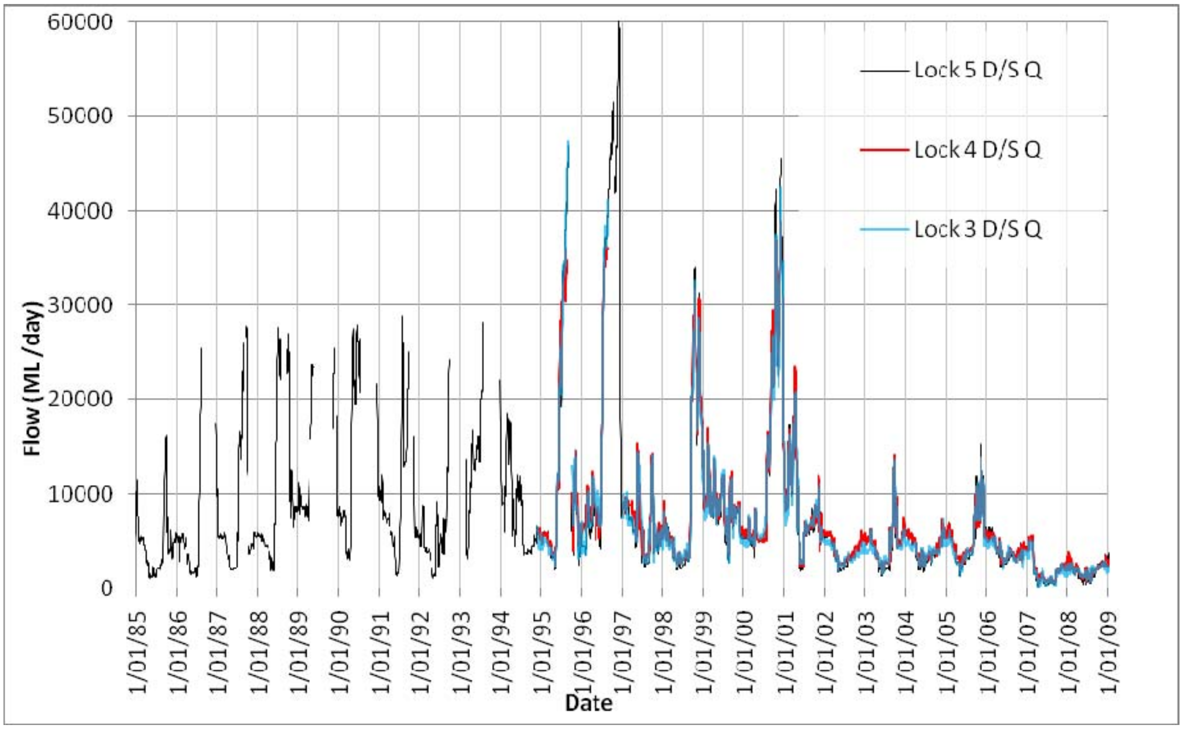

Figure 3-2 Flow data for Lock 5, Lock 4 and Lock 3

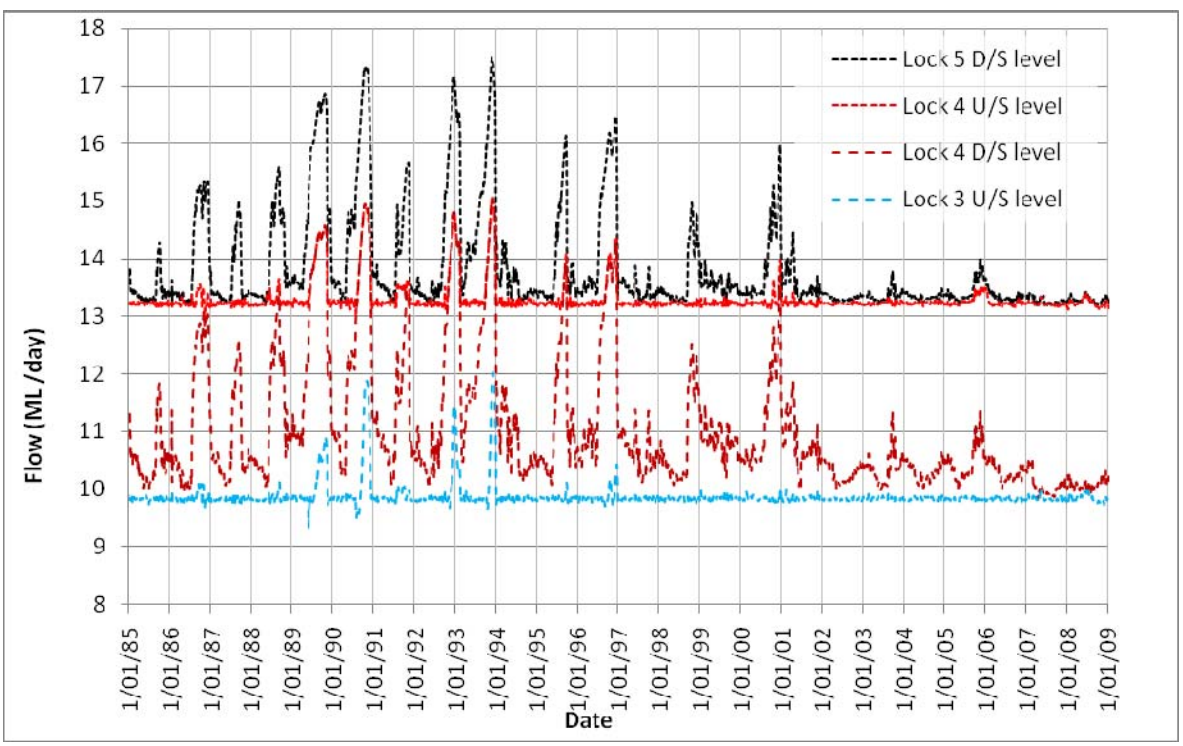

Figure 3-3 Level data for Lock 5, Lock 4 and Lock 3

3.3 Topographic Data

The base topographic data for the study area is Airborne Laser Scanning (ALS) supplied by DEH for the study area. This ALS data has a vertical accuracy of 0.15 m along the Katfish Reach.

The ALS data is available in two formats, all ground strikes with a point density less than 2 m, and gridded data with 2 m and 10 m spacing. The 2m ALS has been used to create the model grid as described in Section 4.

In addition to the ALS data, bathymetry for major waterways is also available, Figure 3-4.

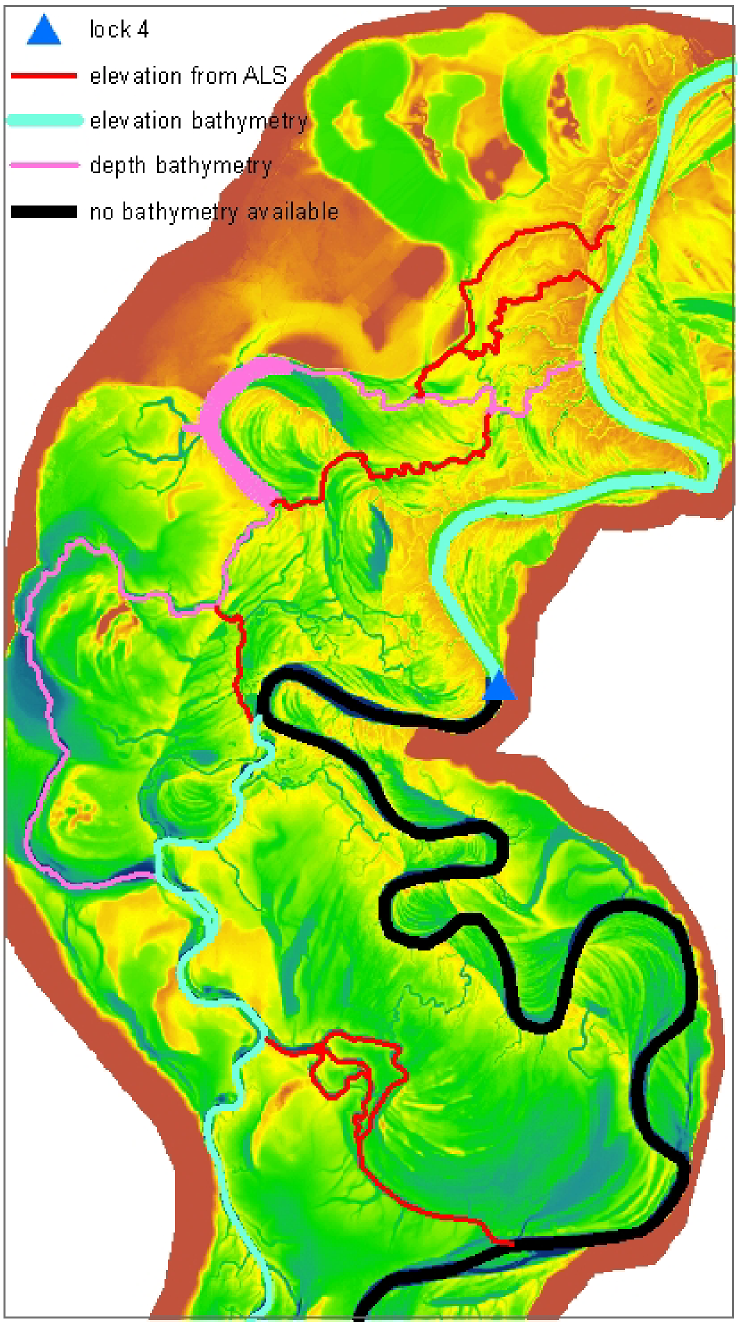

Figure 3-4 Available topographic data

The ALS data gives a good representation of the floodplain topography, and minor creeks dry at the time of survey. However for flowing streams and inundated wetlands additional bathymetry is required as the ALS survey does not penetrate water. A number of bathymetric data sets are available as shown in Figure 3-4. Unfortunately some bathymetry datasets have only recorded depth not elevation, so can't be currently utilised as a topographic dataset. It is recommended that DEH investigate if it is possible to get these depth bathymetric datasets levelled in to elevation AHD. A bathymetric dataset for the Murray River between Lock 5 and Lock 4 is available, however it is currently unknown as to whether a similar dataset exists between Lock 4 and Lock 3 for the Murray River.

The bathymetric elevation point data has been tinned and gridded and merged with the 2m ALS grid to create a continuous surface. This will be repeated for the depth bathymetry if DEH can convert them to elevations.

It is understood that the bathymetry was measured by driving along the creek in a boat, taking soundings every few seconds. No metadata is available for these bathymetric datasets so it is difficult to gauge accuracy as the instrumentation used is unknown. Sections of Eckert Creek and The Splash only recorded depth without converting to elevation. Unless these depths can be converted to elevation additional survey will be required along these reaches.

3.4 Register of structures

The Katfish Reach Register of Flow & Fish Barriers (DEH, 2008), is a comprehensive document detailing the majority of structures in the floodplain. Table 3-3 below summarises major structures, contained in the report. The report generally lists inverts of culverts, rock weirs etc, as well as levels of top of road crossings etc. This report will be fully utilised to ensure the hydraulic structures are represented accurately in the hydraulic model.

Table 3-3 Summary of Flow and Fish Barriers in the study area

Report ID	Barrier	Stream/ Wetland	Barrier Type
2.1	Eckert Creek North Arm Inlet (Bank N)	Eckert Creek	Bank & Pipe
2.2	Main Eckert Creek Inlet (Bank J)	Eckert Creek	Bank & Pipe
2.3	Eckert Creek North Arm Bridge	Eckert Creek	Concrete Bridge
2.4	Main Eckert Creek Bridge	Eckert Creek	Concrete Bridge
2.5	Eckert Creek South Arm Road Crossing	Eckert Creek	Bank & Pipes
2.6	Eckert Wide-water North Arm Road Crossing	Eckert Creek	Bank & Pipes
2.7	Eckert Wide-water Flood Runner Road Crossing	Eckert Creek	Bank & Pipes
2.8	Eckert Creek Log Crossing	Eckert Creek	Wooden logs
3.1	Bank D	Eckert Island	Bank

3.2	Bank C Flow Path Lock 4 Road Crossing	Eckert Island	Bank & Pipe
4.1	Ngak Indau Wetland Inlet Structure (Bank C)	Ngak Indau	Bank & Pipes
4.2	Ngak Indau Wetland Inlet Channel Road Crossing	Ngak Indau	Bank, Pipes & Box Culvert
4.3	Ngak Indau Wetland Outlet Structure	Ngak Indau	Bank & Weir
5.1	Katarapko Creek Stone Weir	Katarapko Creek	Rock Bank
6.1	Piggy Creek Inlet North Arm Road Crossing	Piggy Creek	Bank
6.2	Piggy Creek Inlet North Arm Old Road Crossing	Piggy Creek	Bank
6.3	Piggy Creek Inlet South Arm Road Crossing	Piggy Creek	Bank
6.4	Piggy Creek Outlet Bank	Piggy Creek	Bank
6.5	Piggy Creek Western Outlet Bank	Piggy Creek	Bank
6.6	Piggy Creek Western Track	Piggy Creek	Bank
6.7	Piggy Creek Cutting & Channels	Piggy Creek	Trench
7.1	Carpark Lagoons Inlet	Katarapko Floodplain	Bank & Pipe
7.2	Carpark Lagoons Outlet	Katarapko Floodplain	Bank & Pipe
7.3	Kat Creek South Lagoon Inlet	Katarapko Floodplain	Bank
7.4	Kat Creek South Lagoon Cutting	Katarapko Floodplain	Channel
7.5	Kat Creek South Floodrunner Inlet	Katarapko Floodplain	Bank
7.6	Kat Creek South Floodrunner Outlet	Katarapko Floodplain	Bank

4. MODELLING FRAMEWORK

This section summarises the initial thoughts on the proposed modelling framework for the hydraulic modelling.

As outlined in the proposal, the hydraulic modelling approach employs a dynamic, combined one and two-dimensional flood model. This allows the application of full two-dimensional grids in areas where hydraulic results for flood mapping are required, and the use of one-dimensional hydraulic model elements to provide reliable simulation of in-bank stream flows for environmental flow management.

- The one dimensional (1D) hydraulic model simulates up to bankfull flows for streams
- The two dimensional (2D) model simulates flow across the floodplain. The 2D grid resolution is estimated to be in the order of 10 m to 15 m.
- Linkage between the 1D and 2D components of the model allows flow in the channel to spill onto the floodplain once channel flow capacity is exceeded.

The linked 1D/2D hydraulic model framework is provided in Figure 4-1. Lock 5 will be the upstream flow boundary and the lock 3 weir pool level will be the downstream boundary. The proposed schematisation may be revised in consultation with DEH.

4.1 Model development

The MIKE FLOOD modelling system from DHI Water and Environment will be employed as the platform for this study. The 1D hydraulic model (MIKE11) will simulate up to bankfull flows in key streams. Where stream flows exceed bankfull the 2D model (MIKE21) simulates the flow across the floodplain.

Figure 4-1 shows the channels to be modelled as 1D model branches and the 2D model grid for the floodplain. A number of structures exist on the floodplain as described in Section 3.4, some of the major structures are also shown in Figure 4-1.

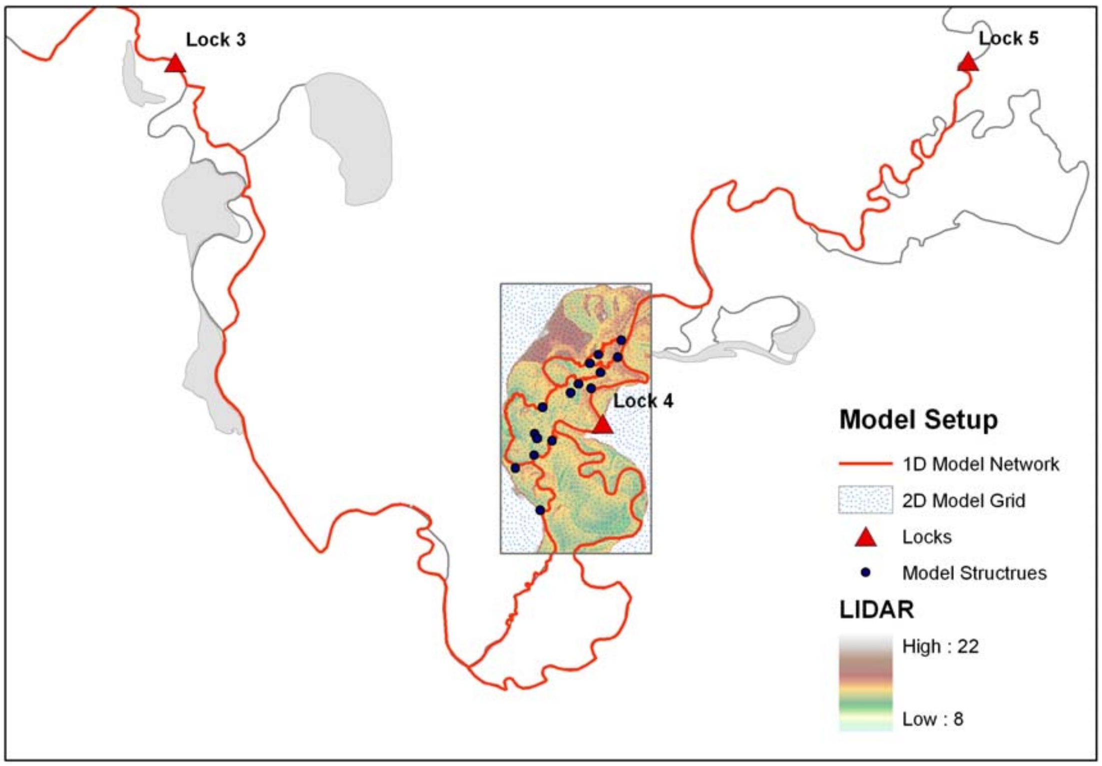

Figure 4-1 Detailed 1D and 2D hydraulic model setup

To simulate in channel flows in the 1D model, cross section geometry is required. Criteria for the location of modelled cross sections along the model branches include:

- Hydraulic controls (contraction in channel width & sills in channel bed)
- In-channel storage (ponds & back waters)
- Immediately upstream and downstream of all waterway junctions.

As discussed in Section 3.3, limited channel cross section data is available. Efficient use of ALS data with targeted field survey for below water level is considered appropriate. Section 4.3 outlines the required field survey required to provide adequate topographic information to develop the hydraulic model. All structures on the floodplain will also be modelled in 1D, allowing for regulating structures to be operated dynamically throughout a flood event as they would be operated in reality.

The 2D model grid has been created from the 2 m ALS grid. The model grid size has currently been set at 10 m. This provides a very high resolution grid of the floodplain and wetlands. The creeks that are modelled in 1D will be filled in, in the 2D grid so as not to represent the storage of the waterways twice.

4.2 Hydraulic model calibration and verification

For the calibration of the model hydrological data for a range of flood flows is required. Section 3.1 and 3.2 outline a number of historic events that may be suitable for calibration. Historic flood extents and gauged levels/flows are required for the study area to enable a good calibration is achieved.

Water Technology can assist DEH in identifying available satellite imagery and getting quotes, however this task was not allowed for in the proposal and would require a fee variation. No data other than the Murray River data is currently available to the study team. If DEH is aware of the existence of any data this should be retrieved as a matter of priority.

4.3 Additional survey requirements

Additional field survey is required to supplement the ALS data, particularly to resolve in-channel geometry of flowing streams. The field survey will provide further verification points for the ALS data.

Figure 3-4 shows the reaches where depth bathymetry has been collected. If this can't be converted to elevation then additional cross-sections will be required to be collected. This reach is just under 15 km long and may require approximately 15 cross-sections. Locations for these cross-sections will be supplied if it is found that the depth bathymetry can't be utilised.

The other section of waterway that currently has no bathymetry data available is the Murray River from Lock 4 to Lock 3. SA Water should have survey through this reach, be it cross-sections or bathymetry data similar to the section upstream of Lock 4 (this was sourced for a separate study).

If both of these sections of missing data can be filled using the depth bathymetry and SA Water data, then no additional survey will be required at this stage.

5. CONCLUSIONS

A number of key datasets are required for the development of the Katfish Reach hydraulic model. As a first step it is suggested that DEH investigate if this data is available:

- Observed flood extents (Water Technology can assist in investigating the availability of satellite imagery)
- Observed flow/level data throughout the study area (only have data for Murray River at this stage)
- Conversion of depth bathymetry to elevation AHD for Eckert Creek and The Splash
- Obtain cross-section survey or bathymetry for Murray River from Lock 4 to Lock 3 (SA Water should be able to assist with this)

If the above survey/bathymetry data is not available then Water Technology will scope up a survey brief.