SARFIIP – Pike Floodplain hydraulic modelling

Managed inundation options assessment scenarios – 2015–16

DEWNR Technical note 2016/12

Government of South Australia
Department of Environment, Water and Natural Resources

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June, 2016

DEWNR Technical note 2016/12

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ISBN 978-1-925369-67-0

Preferred way to cite this publication

McCullough DP, Montazeri, M and Esprey, L, 2016, *SARFIIP – Pike Floodplain hydraulic modelling – Managed inundation options assessment scenarios – 2015-16,* DEWNR Technical note 2016/12, Government of South Australia, through the Department of Environment, Water and Natural Resources, Adelaide

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Acknowledgements

SARFIIP is a $155 million investment program funded by the Australian Government and implemented by the Government of South Australia to improve the watering and management of River Murray floodplains in South Australia's Riverland.

The authors wish to acknowledge the project support provided by Major Projects Branch, Department of Environment, Water and Natural Resources, in particular Brad Hollis, Manager – Pike Floodplain and Roger Ebsary, Project Manager – Pike Floodplain.

The authors wish to acknowledge the peer reviewers for their input into the report Matt Gibbs and David McInerney of the Department of Environment, Water and Natural Resources, and Keiko Yamagata of DHI Water and Environment.

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Summary

Pike Floodplain is an anabranch of the River Murray located in the vicinity of Renmark, South Australia. Its main inlets are located upstream of Lock 5, with return flows re-entering the River Murray on the downstream side of Lock 5. A number of structures and banks have been constructed over the years, both internal and external to the floodplain, which have modified the natural hydraulics of the system and resulted in a general degradation of the ecological condition of the floodplain and associated wetlands. Owing to this general degradation of floodplain condition, the South Australian Riverland Floodplains Integrated Infrastructure Program (SARFIIP) has been initiated to improve the flexibility of managing the system via new infrastructure and operational solutions.

A number of hydraulic modelling scenarios were conducted in 2014–15 to provide hydraulic data for further assessment of proposed infrastructure options that allow managed inundation to be conducted within the floodplain (McCullough et al, 2016). Hydraulic modelling of the Pike Floodplain, using a 1-D/2-D coupled model, was conducted with specific scenarios designed to provide insights into a range of important management decisions, including the siting of infrastructure, design of infrastructure, and potential benefits and risks associated with various managed and natural hydraulic scenarios.

Following the hydraulic modelling conducted in 2014–15, the MIKE FLOOD model was requested to be refined to match the requirements of the design process, such as updating the blocking alignment with minor changes to the previous Alternative 2 alignment specified in the scenarios conducted in 2014–15 (McCullough et al, 2016), and also including additional ancillary structures along the finalised blocking alignment.

In addition to these refinements, the MIKE FLOOD model was found to contain erroneous cross-sections within the Tanyaca Creek reach between Mundic Creek and the horseshoe area of Tanyaca Creek, resulting in an overestimation of minimum bed levels in the reach immediately downstream of the Tanyaca regulator. These erroneous cross-sections resulted in water levels downstream of the Tanyaca regulator to be overestimated for certain hydraulic conditions, particularly at lower River Murray flows, and hence impacted on initial modelling conducted for assessment of tailwater conditions at the regulator for the purposes of fishway design. Further inspection of the model configuration indicated that this cross-section issue was unique to this reach due to apparent limitations in the original cross-sectional survey data collected for input into the model. These issues did therefore not impact other parts of the model, including downstream of the Pike River environmental regulator. Cross-sections were corrected with data from more recent cross-sectional surveys of the reach.

Scenario 10 was conducted to complement previous modelling for assessing the potential for local water level raising in Mundic Creek during a Spring Fresh event through the use of complementary regulators on Mundic Creek outlets to Pike River. The modelled outputs indicated that raising the Pike River regulator upstream level to 14.85 m AHD (when closing the Mundic Creek southern outlet and Snake Creek inlet regulators) has the effect of raising Mundic Creek water level by approximately 0.1 m, and hence increasing Mundic Creek inundation extent, when compared to operating Pike regulator at normal operating levels (i.e. 14.35 m AHD). There is also an inundation benefit downstream of Mundic Creek as a result of raising the Pike River regulator upstream water level, achieving almost 100 ha of overbank inundation in addition to the local Mundic Creek inundation.

Scenario 11 investigated the tailwater levels at Pike River and Tanyaca Creek environmental regulators over a range of steady state flow conditions, with the overall purpose to provide data for structure designs and decision making. The results indicated that tailwater levels at Pike River regulator are relatively insensitive to flow splits between Pike River and Tanyaca Creek, indicating the greater influence in tailwater being the level in the River Murray. The tailwater level at Tanyaca Creek regulator however is found to vary with flow split, at least under controlled conditions – once the regulator is removed, flow splits are uncontrolled and hence there is no difference between the scenarios in terms of tailwater levels at either structure.

Scenario 12 investigated the impact of lowering Lock 4 weir pool on tailwater levels at the environmental regulators, with the aim of ensuring that weir pool lowering operational exercises are considered in infrastructure designs. Additionally, mid-pool lowering is also considered within the scenarios conducted.

Scenario 13 was conducted to provide data to assist with the design and placement of ancillary structures in the blocking alignment. The functional requirements of these ancillary structures include reducing barriers to flow under overbank flow conditions (e.g. culverts) while also allowing for control of bank overtopping during high flow or managed inundation conditions to safeguard against bank erosion (e.g. spillways). Ancillaries were tested against dynamic flood limbs, using the fastest rising

and falling historical flood limbs on record as the basis for each scenario iteration. The results indicate that flow through both Tanyaca Creek and Pike River regulators is always positive (i.e. from floodplain to river) under both rising and receding flood limbs. For 6-bay configurations of both Tanyaca Creek and Pike River regulators, the maximum flow through each structure is modelled during the receding limb, at approximately 3200 ML/d for both Pike River and Tanyaca Creek regulators.

Note that an external (to DEWNR) peer review of the MIKE FLOOD model and 2014–15 modelling was conducted in parallel to the modelling presented in this Technical Note. The overall outcomes of the review, which are also applicable to the 2015–16 modelling, indicated the model and scenarios were fit for purpose, with no critical errors impacting on results. The context of any issues in the modelling raised through the peer review are presented in Appendix B of this Technical Note for reference.

1 Hydraulic modelling summary

1.1 Hydraulic model

The Pike floodplain hydraulic model is a 1-D/2-D coupled model designed in the MIKE FLOOD software package by DHI Water and Environment. The details of the base model used for these scenarios is detailed in McCullough (2013). Updates implemented for this work on the MIKE FLOOD model are listed in McCullough (2016).

Hydraulic modelling scenarios contained in this report utilise the MIKE FLOOD 1-D/2-D coupled model as used in modelling exercises conducted in 2014–15 (McCullough et al, 2016), with modifications and updates made as appropriate to each scenario. Any such changes are listed in the respective scenario chapters.

1.2 Model refinements

The MIKE FLOOD model was refined as required to match the requirements of the design process, including:

- Update of the blocking alignment involving minor changes to the previous 'Alternative 2' alignment specified in the scenarios conducted in 2014–15 (McCullough et al, 2016)
- Addition of ancillary structures, including spillways and culverts, along the finalised blocking alignment.

Figure 1.1 indicates the latest (finalised) alignment at the time of writing and the locations of all structures (including ancillary) within the blocking alignment. Note that the ancillary structures indicated are part of an iterative modelling process, and as such some of those shown may be excluded from final plans for ancillary structure placement, while other ancillary structures may potentially be added in future.

In addition to these refinements, the MIKE FLOOD model was found to contain erroneous cross-sections within the Tanyaca Creek reach between Mundic Creek and the horseshoe area of Tanyaca Creek, resulting in an overestimation of minimum bed levels in the reach immediately downstream of the Tanyaca regulator. These erroneous cross-sections resulted in water levels downstream of the Tanyaca regulator to be overestimated for certain hydraulic conditions, particularly at lower River Murray flows, and hence impacted on initial modelling conducted for assessment of tailwater conditions at the regulator for the purposes of fishway design. Further inspection of the model configuration indicated that this cross-section issue was unique to this reach due to apparent limitations in the original cross-sectional survey data collected for input into the model. These issues did therefore not impact other parts of the model, including downstream of the Pike River environmental regulator.

Cross-sections were corrected with data from more recent cross-sectional surveys of the reach, and also a boat-mounted depth survey (adjusted to elevation) commissioned for addressing the issue. These surveys indicated that a layer of silt was present in this reach, of which the recent cross-sectional surveys located the approximate bottom of this layer, while the boat-mounted survey located the approximate top of the silt layer. Due to some uncertainty in the extent to which the silt layer may be affected by an increase in flow through Tanyaca Creek, modelling was conducted in the relevant scenarios using minimum elevation estimates assuming a silt layer is present and in the absence of a silt layer, providing an indication of sensitivity of water levels downstream of the Tanyaca Creek regulator to the adjusted minimum channel depths.

Note that an external (to DEWNR) peer review of the MIKE FLOOD model and 2014–15 modelling was conducted in parallel to the modelling presented in this report, as indicated in Yamagata (2016). The overall outcomes of the review indicated the model and scenarios were fit for purpose, even prior to the scenarios presented in this Technical Note, with no critical errors impacting on results. The context of potential issues raised in the peer review are presented in Appendix B for reference.

1.3 Hydraulic scenarios

Scenarios were defined to investigate a number of aspects required for the structure design process and other decision making requirements, including modelling for:

- Localised Mundic Creek water level raising during Spring Fresh[1] events
- Water levels at environmental regulators under a range of hydraulic conditions up to high flow to assist with structure concept designs
- Water levels at environmental regulators at weir pool and mid-pool lowering conditions, to complement the modelling conducted in the previous scenario and assist with structure concept designs
- Addition of ancillary structures into the final blocking alignment for structure concept designs.

More detailed descriptions of these scenarios and results are contained in the following sections of this report.

[1] Spring Fresh flow scenarios are described in Table 2.3 in McCullough et al (2016).

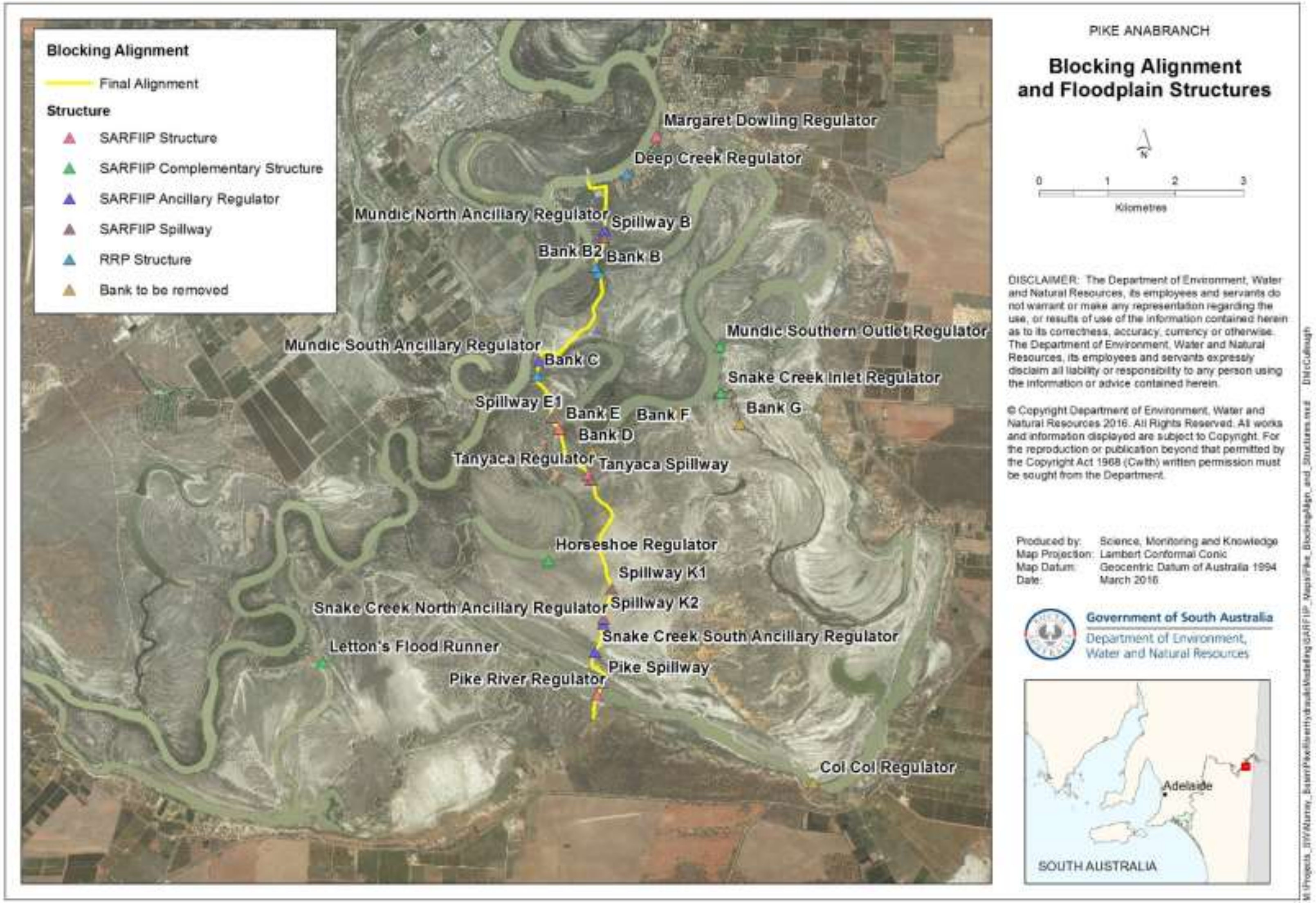


Figure 1.1 Pike Floodplain final blocking alignment and floodplain structures (proposed and current)

2 Scenario 10 – Mundic Creek level raising during spring fresh event

2.1 Summary

Simulations were conducted to complement previous modelling for assessing the potential for local water level raising in Mundic Creek during a Spring Fresh event through the use of complementary regulators on Mundic Creek outlets to Pike River. Modelling of the current proposed solution of regulators on Mundic Creek northern and southern outlets, and on Snake Creek inlet, was presented in Scenario 3 in McCullough et al (2016). Note that Scenario 3 considered infrastructure designed a facilitate a maximum raising to 15.5 m AHD, however this was subsequently modified to 15.6 m AHD based on additional factors external to the modelling exercise. The current modelling scenarios were conducted to assess the potential extent of Mundic Creek water level raising with the exclusion of the proposed Mundic Creek northern outlet regulator.

The simulation configurations used are indicated in Table 2.1, with a comparison to the base case configuration (i.e. Scenario 3 modified to the 15.6 m AHD maximum raising). In each of these scenarios the model was updated to incorporate the finalised blocking alignment as in Figure 1.1. All current scenarios (excluding the base case) assume full closure of complementary regulators on Mundic Creek southern outlet and Snake Creek inlet in order to maximise the level within Mundic Creek, with only manipulation of Tanyaca Creek environmental regulator flow, and the remaining flow passing through the Mundic Creek northern outlet (note that this does not necessarily represent optimised operations). Comparisons of the steady state levels achieved are made with the following modelling assumptions and configurations:

- River Murray flow of 10 000 ML/d above Lock 5, and Lock 4 upstream level of 13.2 m AHD
- Total inlet flow from Deep Creek and Margaret Dowling Creek of 1200 ML/d
- Varying Pike River regulator upstream water level between typical current levels of approximately 14.35 m AHD, and operating at +0.5 m higher than normal operating level, to 14.85 m AHD
- Tanyaca Creek regulator flow controlled between 0 and 400 ML/d, with the remainder flowing to Pike River.

Table 2.1 Model configurations for analysis of Mundic Creek water level raising operations

Scenario	Infrastructure	River Murray flow ML/d	Total inlet flow ML/d	Tanyaca Creek regulator water level m AHD	Pike River regulator water level m AHD	Tanyaca Ck flow ML/d	Pike Ck flow ML/d
Base	Regulators on Mundic Creek northern/southern outlets, Snake Creek inlet.	10 000	1200	15.60	14.35	400	Remaining
10a	Regulators on Mundic Creek southern outlet and Snake Creek inlet fully closed. No structure on Mundic Creek northern outlet.	10 000	1200	TBA*	14.35	0	Remaining
10b		10 000	1200	TBA*	14.35	400	Remaining
10c		10 000	1200	TBA*	14.85	0	Remaining
10d		10 000	1200	TBA*	14.85	400	Remaining

* To be assessed via each scenario

2.2 Results

Table 2.2 shows the results of the Mundic Creek water level raising scenarios for the defined hydraulic configurations. The inundation extent for each scenario, in comparison to the base case, is also presented in Figure 2.1, while velocity and bed shear stress profiles for Mundic Creek northern outlet are shown in Figure 2.2.

Table 2.2 Mundic Creek water level raising scenario results at 10 000 ML/d River Murray flow

Scenario	Total inlet flow ML/d	Tanyaca Ck regulator water level m AHD	Pike River regulator water level m AHD	Tanyaca Ck flow ML/d	Mundic Creek localised inundated area* ha	Total inundated area U/S blocking alignment* ha	Max. bed shear stress (Mundic northern outlet) N/m^2	Max mean velocity (Mundic northern outlet) m/s
Base	1200	15.60	14.35	400	235	249	4.3	0.30
10a	1200	15.40	14.35	0	165	189	9.5	0.50
10b	1200	15.15	14.35	400	83	90	8.8	0.46
10c	1200	15.49	14.85	0	197	293	6.9	0.44
10d	1200	15.26	14.85	400	105	185	5.0	0.36

* Inundated area excludes all permanently inundated waterways upstream of Tanyaca Creek and Pike River environmental regulators under normal operational conditions

For the base case scenario with regulators on Mundic Creek northern, southern outlets and Snake Creek inlet, the target level in Mundic Creek of 15.6 m results in an inundated area of the Mundic Creek fringes modelled at approximately 235 ha (excluding permanently inundated waterways). With regulators on all Mundic Creek outlets, flow splits through each outlet can be controlled, and thus velocity and shear stress values in Mundic Creek northern outlet are variable, however with a flow of 400 ML/d directed through this outlet the maximum velocity downstream of the regulator is approximately 0.3 m/s, and maximum bed shear stress is modelled at approximately 4.3 N/m^2.

With the Mundic Creek northern outlet regulator removed (Scenario 10b), a Mundic Creek level of approximately 15.4 m AHD was modelled where Tanyaca Creek, Mundic Creek southern outlet and Snake Creek inlet regulators are closed, and all flow was diverted through the Mundic Creek northern outlet. A modelled inundation extent of almost 170 ha within the Mundic Creek fringes was calculated at this level. Maximum velocity and bed shear stress values through Mundic Creek northern outlet in this case were modelled at approximately 0.5 m/s and 9.5 N/m^2, respectively.

When using the same configuration as above, but passing 400 ML/d through Tanyaca Creek environmental regulator and the remainder through Mundic Creek northern outlet (Scenario 10b), a Mundic Creek level of approximately 15.15 m AHD was modelled. This resulted in a calculated inundated area in the Mundic Creek fringes of approximately 80 ha, with maximum velocity and bed shear stress values through Mundic Creek northern outlet of 0.46 m/s and 8.8 N/m^2, respectively.

The modelled outputs indicate that raising the Pike River regulator upstream level to 14.85 m AHD (when closing the Mundic Creek southern outlet and Snake Creek inlet regulators) has the effect of raising Mundic Creek water level by approximately 0.1 m, and hence increasing Mundic Creek inundation extent, when compared to operating Pike regulator at normal operating levels (i.e. 14.35 m AHD) i.e. Scenario 10c compared with 10a, and Scenario 10d compared with 10b. Operating at raised Pike river level also results in a reduction of maximum velocities and bed shear stresses through Mundic Creek northern outlet (when compared to operation at normal Pike River level) due to the increased tailwater level, thereby potentially reducing the risk of erosion through this channel. For instance, a maximum Mundic Creek level of almost 15.5 m AHD is achieved with all flow directed through Mundic Creek northern outlet and Pike River regulator raised to 14.85 m AHD, resulting in an inundated area of the Mundic Creek fringes of almost 200 ha. There is also an inundation benefit downstream of Mundic Creek as a result of raising the Pike River regulator upstream water level, achieving almost 100 ha of overbank inundation in addition to the local Mundic Creek inundation. The maximum bed shear stress and mean velocity in the Mundic Creek northern outlet in this case is approximately 7 N/m^2 and 0.44 m/s, respectively, which are both reduced when compared to operating at normal Pike River levels. Note however that further analysis is required to determine the erosion potential that this may present in the northern outlet.

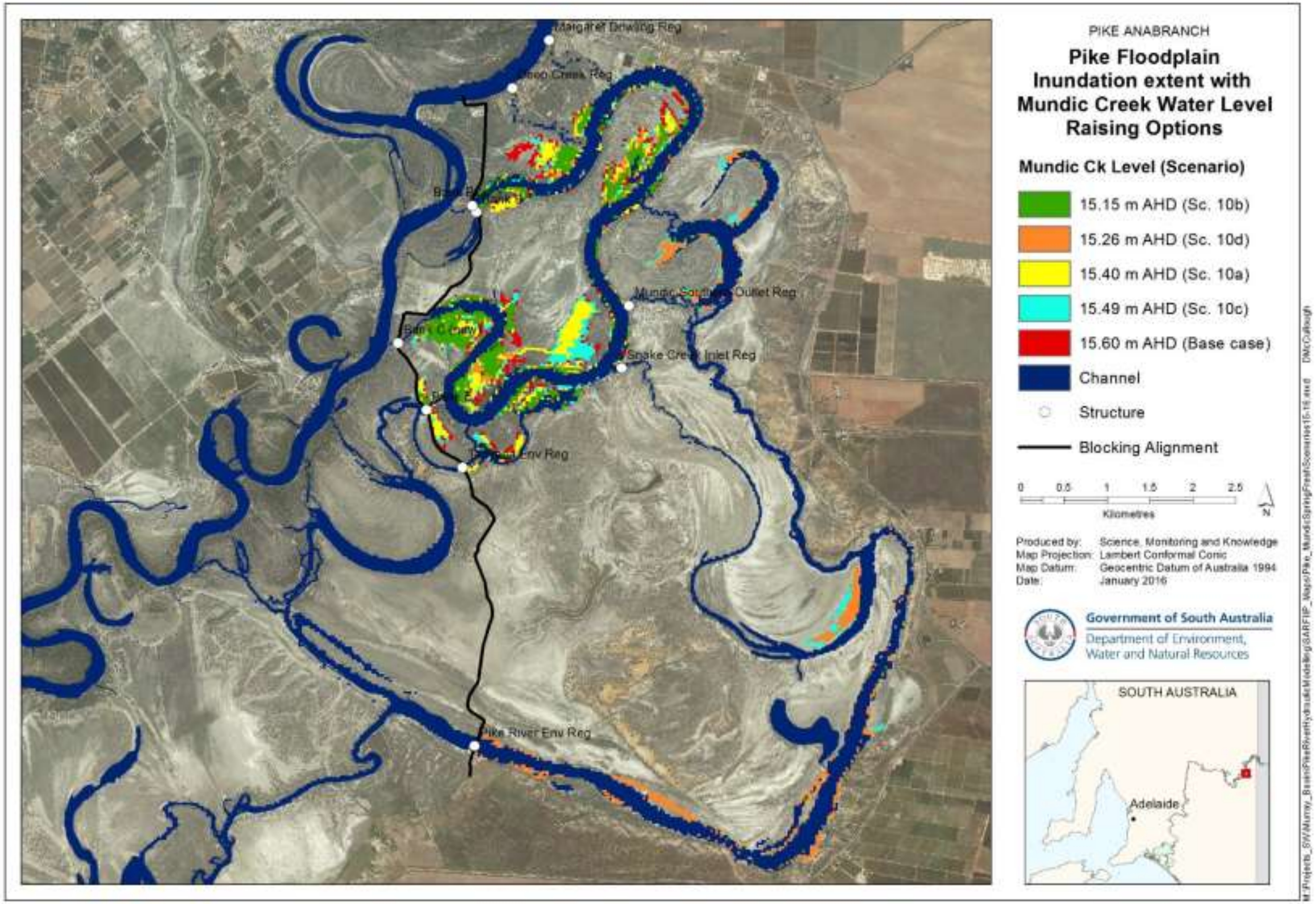


Figure 2.1 Inundation extents for various Mundic Creek water level raisings, with level defined upstream of Tanyaca Creek regulator

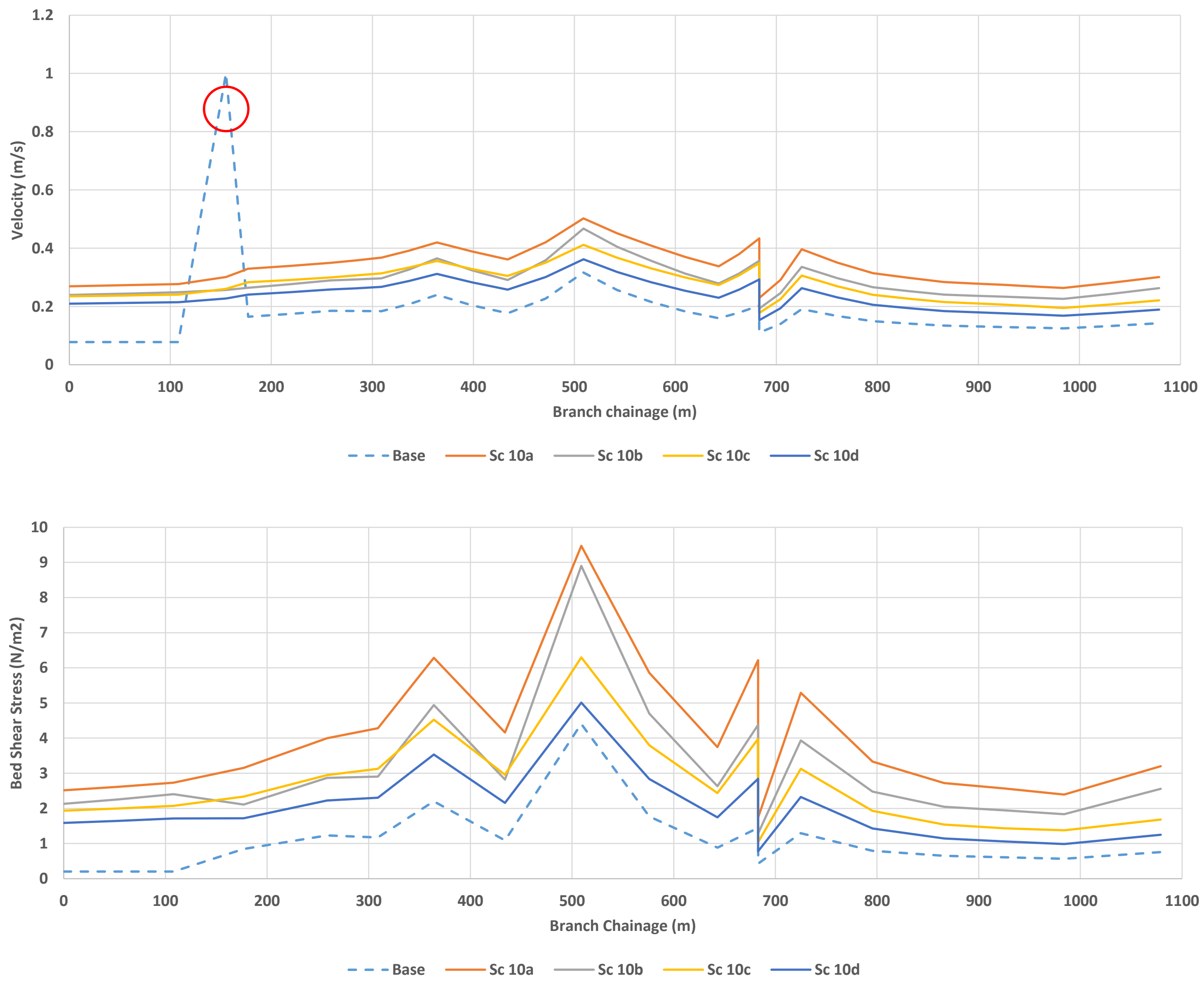


Figure 2.2 Velocity and bed shear stress profiles in Mundic northern outlet for each operating scenario. Structure location for base case-only circled in red.

3 Scenario 11 – Environmental regulator tailwater levels under River Murray flows up to 100 000 ML/d

3.1 Summary

A suite of scenarios were developed to investigate the tailwater levels at Pike River and Tanyaca Creek environmental regulators over a range of steady state flow conditions, with the overall purpose to provide data for structure designs and decision making. Normal operating conditions were considered for the flow range tested, assuming no managed inundation operation.

Table 3.1 shows the general hydraulic characteristics used in each set of scenarios. Common parameters used for each scenario set include:

- River Murray inflows, and corresponding levels at Locks 5 and 4, were stepped up for each scenario in various increments depending on the flow magnitude, and allowed to reach steady state at each increment. The following inflows were modelled:
    - Low flow at 500 ML/d
    - From 5000 to 60 000 ML/d in 5000 ML/d increments
    - From 60 000 to 100 000 ML/d in 10 000 ML/d increments.
- Total combined inflow throughout flow range tested was set to a constant 1200 ML/d
- Banks B, B2 and C were set to closed at low flows that result in a head difference over the structures (i.e. up to approximately 30 000 to 35 000 ML/d) and open when no head difference is present
- Pike River regulator set to control upstream level to typical level of 14.35 m AHD at low flows, but opened when head difference across the structure becomes negligible under higher flows (at approximately 40 000 to 45 000 ML/d)
- Tanyaca Creek regulator set to control upstream level to typical level of 14.75 m AHD at low flows, but opened when head difference across the structure becomes negligible under higher flows (at approximately 40 000 to 45 000 ML/d).

Table 3.1 Operating parameters of scenarios conducted for tailwater level analysis

Scenario	River Murray flow ML/d	Lock 4 level m AHD	Total inflow ML/d	Outflow split ML/d	Banks B, B2, C operation	Pike River U/S level m AHD	Tanyaca Creek U/S level m AHD
11a	500 to 100 000	Linked to flow^		Pike ~ 400 ML/d controlled flow, open high flow			
11b	500 to 100 000	Linked to flow^	1200	Tanyaca ~ 400 ML/d controlled flow, open high flow	Closed controlled flow, open at high flow	14.35 controlled flow, open at high flow	14.75 controlled flow, open at high flow
11c	500 to 40 000	14.34		Tanyaca ~ 400 ML/d controlled flow, open high flow			

^ Lock 4 levels set using historical water level record at lock linked to corresponding River Murray flow

The main variations between scenarios include changing the flow split between Tanyaca Creek and Pike River, with Tanyaca Creek regulator set to pass flows of 800 ML/d (scenario 11a) and 400 ML/d (Scenario 11b and c); and Lock 4 upstream water level varied from normal pool level of 13.2 m AHD (Scenarios 11a and b) to top of piers level of 14.34 m AHD (Scenario 11c). Note that the latter Lock 4 weir pool level raising scenario was only extended up to 40 000 ML/d as it was assumed that this flow exceeds the maximum flow at which Lock 4 weir pool would be manually raised, and thus hydraulics at higher flows will match those under Scenarios 11a or b. Each of the scenarios were conducted in duplicate to provide an indication of tailwater levels in Tanyaca Creek with and without a layer of silt present in the creek.

3.2 Results

Prior to modelling tailwater levels at each structure, an additional check was made by comparing water levels in the river upstream and downstream of the environmental regulators, Modelled results of Lock 5 downstream level and Lyrup pump station level against flow at Lock 5 were compared to observed values, as shown in Figure 3.1. This comparison indicates a reasonable correlation of modelled and observed water levels at Lock 5 downstream and Lyrup pump station through the measured range up to a maximum rated flow at Lock 5 of approximately 60 000 ML/d, indicating that impacts of River Murray levels on structure tailwater levels are being appropriately accounted for.

Note that at a glance there appears to be a reduction in the quality of correlation in modelled to observed levels above approximately 50 000 ML/d. However, this difference can be attributed to lock operations, the differences in levels between a rising and falling flood limb for a given flow, and the availability of rated flow data above certain river flows. Prior to 1995, the rated flow was only recorded up to approximately 30 000 ML/d for any given event, with subsequent gaps in the record above these flows. Since 1995, rated flow has extended further up to approximately 60 000 ML/d, but with only two events (i.e. 1996 and 2010–11) exceeding this flow. For the latest flow event in 2010–11, rated flow on the rising limb reached a maximum of approximately 53 000 ML/d before the rating was invalidated by lock operations, which corresponded to a level of approximately 15.75 m AHD, approximately matching the modelled results in Figure 3.1. On the receding flood limb however, flow was recaptured at approximately 60 000 ML/d, providing more data above 50 000 ML/d for a falling flood limb rather than rising limb, and hence contributing to the apparent discrepancy between modelled and observed results in this range.

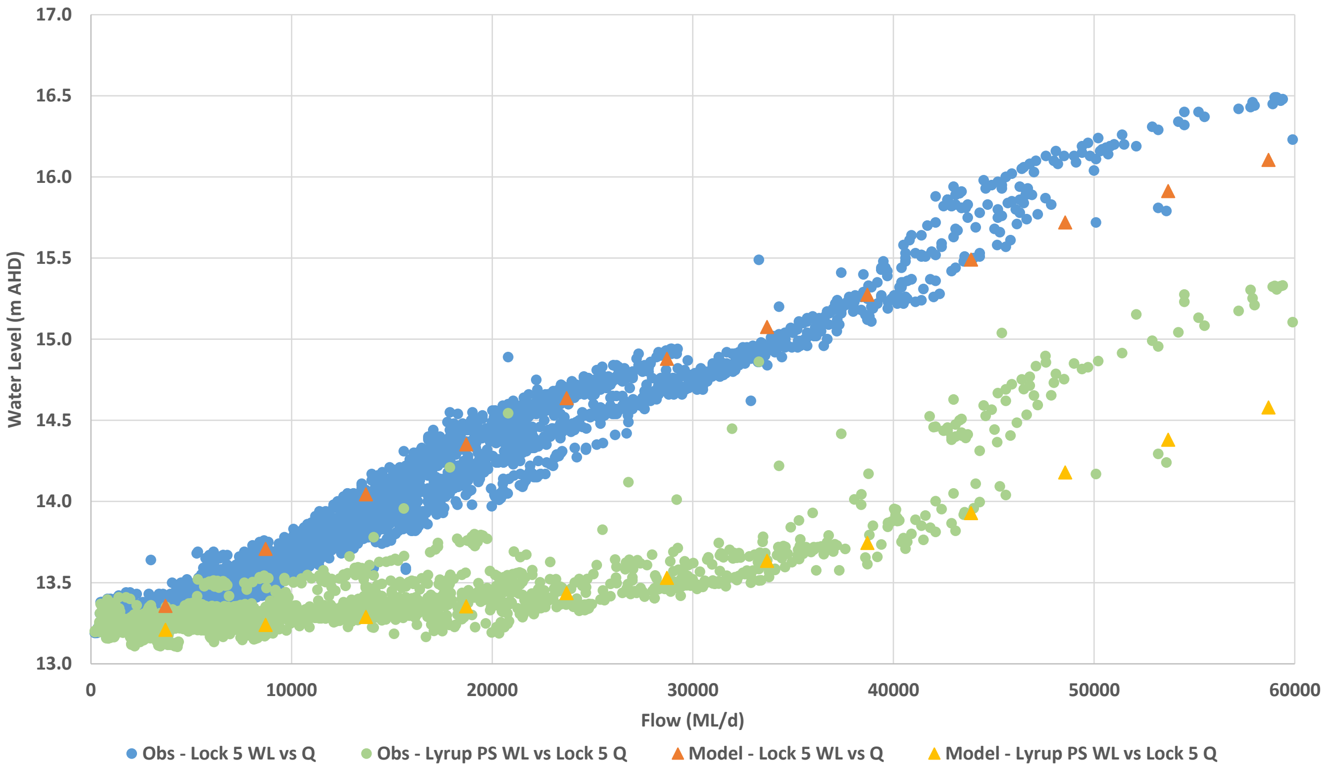


Figure 3.1 Comparison of modelled to observed data for Lock 5 downstream water level and Lyrup pump station water level versus flow at Lock 5

Plots of tailwater level variation with Lock 5 flow are shown in Figure 3.2, with results distinguished by variations in flow splits between Pike and Tanyaca regulators, and between normal Lock 4 pool level (13.2 m AHD) and pool level raised to top of piers (14.34 m AHD). Distinction is made between tailwater levels at Tanyaca Creek regulator based assumptions of no silt layer and a silt layer present in the reach downstream of the regulator, which impact on the minimum elevations of the cross-sections based on separate investigations in the reach. Tabulated results for the tailwater level analyses are also presented in Appendix A.

The results indicate that tailwater levels at Pike River regulator are relatively insensitive to flow splits between Pike River and Tanyaca Creek, indicating the greater influence in tailwater being the level in the River Murray. The tailwater level at Tanyaca Creek regulator however is found to vary with flow split, at least under controlled conditions – once the regulator is removed, flow splits are uncontrolled and hence there is no difference between the scenarios in terms of tailwater levels at either structure.

The impact of a silt layer in Tanyaca Creek is observed to create a difference in tailwater level (compared to no silt layer) only up to approximately 25 000 to 30 000 ML/d, above which the differences between these levels become negligible.

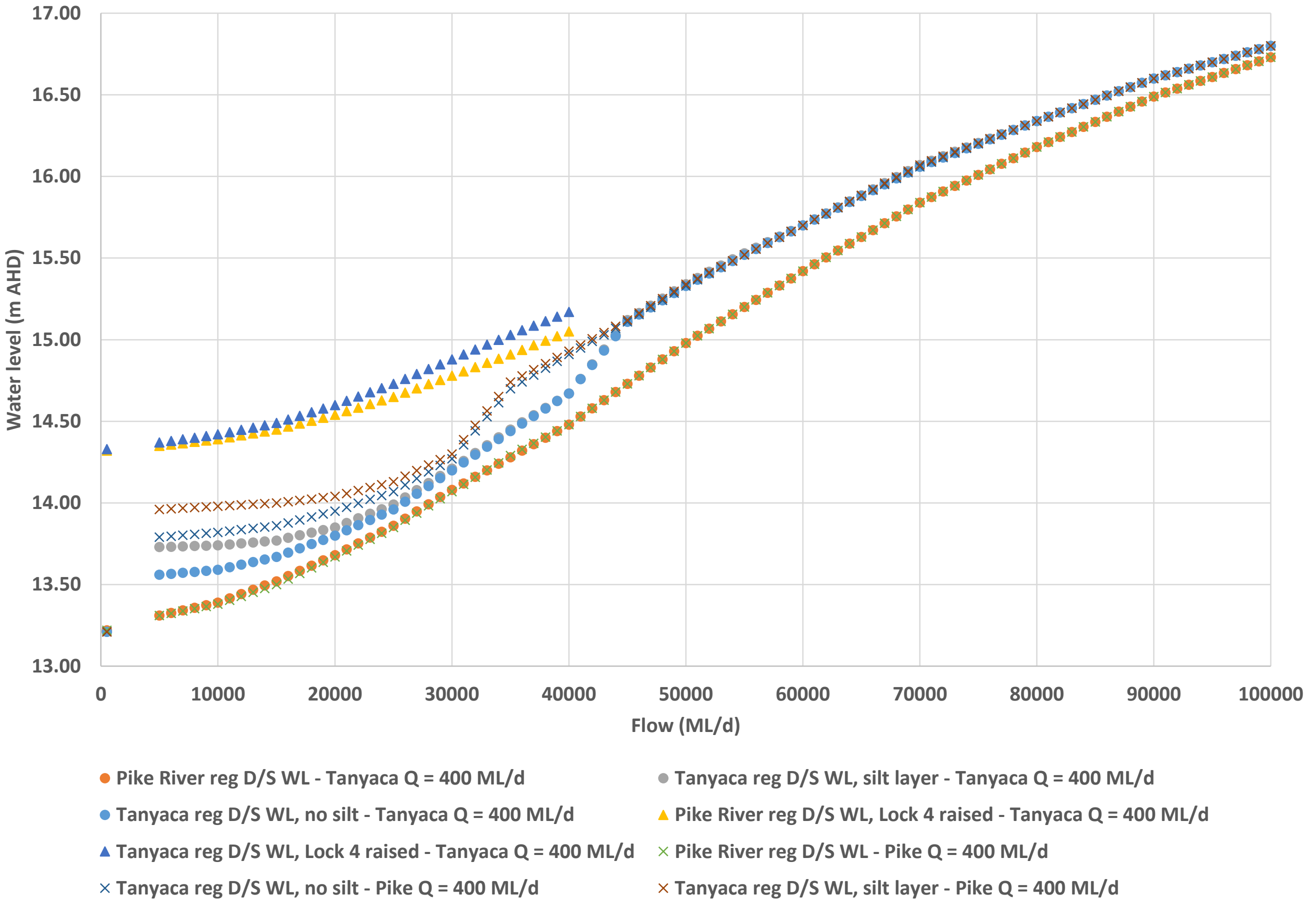


Figure 3.2 Tailwater level variation with model inflow at Pike River and Tanyaca Creek regulators, including: ● – Scenario for Tanyaca Creek flow of 400 ML/d (under controlled conditions only); ▲ – for Lock 4 raised to 14.34 m AHD and Tanyaca Creek flows of 400 ML/d; and × – for Pike River flow of 400 ML/d (under controlled conditions only).

4 Scenario 12 – Environmental regulator tailwater levels under weir pool lowering operations

4.1 Summary

A number of scenarios were conducted to complement the tailwater level analysis scenarios presented in Scenario 11, indicating the impact of lowering Lock 4 weir pool on tailwater levels at the environmental regulators, with the aim of ensuring that weir pool lowering operational exercises are considered in infrastructure designs. Additionally, mid-pool lowering (i.e. upstream of the blocking alignment) is also considered within the scenarios conducted. Table 4.1 presents the details of weir pool and mid-pool lowering scenarios conducted. Scenario details are as follows:

- All scenarios set flow to 3000 ML/d upstream of Lock 5, and Lock 4 weir pool lowered to 12.7 m AHD
- Lock 5 upstream level varied between lowered pool (15.8 m AHD) and normal pool (16.3 m AHD) levels
- Deep Creek flow set to 400 ML/d, and Margaret Dowling Creek flow set to 400 ML/d at normal Lock 5 pool or maximum possible flow under lowered Lock 5 pool level
- Pike River regulator upstream level varied between normal mid-pool level (14.35 m AHD) and lowered mid-pool level (13.85 m AHD)
- Tanyaca Creek flow set to between 200 and 400 ML/d and allowing the model to reach an equilibrium level in Mundic Creek, with the exception of one scenario in which Mundic Creek level was set to 14.7 m AHD and allowing the model to reach an equilibrium flow through Tanyaca Creek to maintain that level.

Table 4.1 Weir pool lowering scenario details

Scenario	River Murray flow ML/d	Lock 4 level m AHD	Lock 5 level m AHD	Deep Creek flow ML/d	Margaret Dowling Creek flow ML/d	Pike River reg U/S level m AHD	Tanyaca Ck flow ML/d	Tanyaca Ck reg U/S level m AHD
12a	3000	12.7	15.8	400	Max possible	14.35	400	Governed by flow
12b	3000	12.7	15.8	400	Max possible	14.35	200	Governed by flow
12c	3000	12.7	15.8	400	Max possible	13.85	400	Governed by flow
12d	3000	12.7	15.8	400	Max possible	13.85	200	Governed by flow
12e	3000	12.7	15.8	400	Max possible	14.35	Governed by level	14.7
12f	3000	12.7	16.3	400	400	14.35	400	Governed by flow
12g	3000	12.7	16.3	400	400	13.85	400	Governed by flow

4.2 Results

The modelled results of weir pool and mid-pool lowering scenarios are presented in Table 4.2. The results indicate that, where Lock 5 weir pool is lowered to 15.8 m AHD (Scenarios 12a to e), the maximum flow through Margaret Dowling Creek with the upgraded regulator is approximately 200 ML/d, providing a maximum total inflow of 600 ML/d under these weir pool lowering scenarios. Although this total inflow remains greater than the historical record of gauged inflows under pre-upgraded regulator conditions (i.e. approximately 300 ML/d), there is also a substantially greater outflow through Tanyaca Creek when compared with current flow conditions. This contributes to the Mundic Creek water level being modelled as lower than the current typical level of approximately 14.75 m AHD when using flow rather than level as the control target at Tanyaca Creek Regulator (i.e. Scenarios 12a to d). Conversely, when targeting a level of 14.7 m AHD in Mundic Creek under a lowered Lock 5 weir pool (Scenario 12e), the resultant flow modelled through Tanyaca Creek regulator is approximately 175 ML/d. This indicates that higher levels may be reached in Mundic Creek during a weir pool lowering scenario, but will be achieved with a further lowering of potential flow through Tanyaca Creek.

Under the scenarios pertaining to Locks 4 and 5 weir pool lowering (Scenarios 12a to e), tailwater levels at Tanyaca Creek regulator are shown to be dependent on the flow through Tanyaca Creek, modelled at approximately 13.2 m AHD under 175 ML/d Tanyaca Creek flow (Scenario 12e), approximately 13.3 m AHD under 200 ML/d flow (Scenarios b and d), and approximately 13.5 m AHD under 400 ML/d flow (Scenarios 12a and c). Tailwater levels at Pike River are modelled to be less sensitive to changes in flow through the structure however, maintaining at approximately 13.0 m AHD regardless of Pike River flow for a Lock 4 weir pool lowering. For the scenarios where Lock 5 is maintained at normal pool (Scenarios 12f and g), a slight raising of Pike Creek regulator tailwater level of approximately 0.1 m is modelled to occur – this can be attributed to the extra inflow and hence outflow possible under this condition, with flows through both Pike River and Tanyaca Creek combining to raise water levels slightly in the Rumpagunyah Creek reach.

Table 4.2 Results of weir pool and mid-pool lowering scenarios. Includes Tanyaca Creek regulator tailwater level assuming silt and no silt layer present in the reach downstream of the structure

Scenario	River Murray flow ML/d	Lock 4 level m AHD	Lock 5 level m AHD	Deep Creek flow ML/d	Margaret Dowling Creek flow ML/d	Pike River reg U/S level m AHD	Pike River reg D/S level m AHD	Pike River reg flow ML/d	Tanyaca Ck Flow ML/d	Tanyaca Ck reg U/S level m AHD	Tanyaca Ck reg D/S level – no silt m AHD	Tanyaca Ck reg D/S level – silt layer m AHD
12a	3000	12.7	15.8	400	209	14.35	13.02	181	400	14.50	13.50	13.72
12b	3000	12.7	15.8	400	209	14.35	13.05	372	200	14.68	13.27	13.52
12c	3000	12.7	15.8	400	209	13.85	13.03	197	400	14.43	13.50	13.72
12d	3000	12.7	15.8	400	209	13.85	13.06	377	200	14.63	13.27	13.52
12e	3000	12.7	15.8	400	209	14.35	13.05	397	175	14.70	13.23	13.49
12f	3000	12.7	16.3	400	400	14.35	13.14	364	400	14.67	13.51	13.72
12g	3000	12.7	16.3	400	400	13.85	13.14	367	400	14.61	13.51	13.72

5 Scenario 13 – Analysis of proposed ancillary structures in blocking alignment

5.1 Summary

Modelling was conducted to provide data to assist with the design and placement of ancillary structures in the blocking alignment, which involve two different structure types – culverts and spillways. The functional requirements of these ancillary structures include reducing barriers to flow under overbank flow conditions (e.g. culverts) while also allowing for control of bank overtopping during high flow or managed inundation conditions to safeguard against bank erosion (e.g. spillways).

Preliminary ancillary structures were added to the final blocking alignment as per Figure 1.1. Modelling was conducted on an iterative basis, involving minor changes to the ancillary structures on each iteration and also the number of bays simulated in each environmental regulator. The various modelling iterations used for appropriate sizing and placement of ancillary structures and environmental regulators, including structure characteristics, are shown in Table 5.1 for documentation purposes. The iterations presented are those completed at the time of writing, however further refinements may be necessary for design purposes – these refinements are only expected to result in incremental differences in the results to those presented however, provided the adjustments in structure sizing or location are incremental only. Note that not all ancillaries were included in the analysis across all iterations, with some being excluded or added as refinements were made externally to the ancillary designs. It should also be noted that the hydraulic behaviour over some of the ancillary structures represented in the model may be compromised to an extent by the 30 m grid size of the topography, which may not fully represent finer flow paths at which some of the ancillary structures are intended to be placed, such as Mundic North (Culvert B) and South (Culvert C1) Ancillary Regulators, which have flow paths under 30 m wide. This should be taken into account when assessing the modelling data at each of the ancillaries.

Ancillaries were tested against dynamic flood limbs, using the fastest rising and falling historical flood limbs on record as the basis for each scenario iteration. General model configurations were as follows:

- Model inflow and Lock 4 and 5 upstream water levels were governed by historical flow event data, using the 1981 high flow event as the basis for the fastest rising limb, increasing up to approximately 100 000 ML/d, and the 1993 event as the basis for the fastest flood recession on record, reducing from approximately 100 000 ML/d (see Figure 5.1 for hydrographs developed for each scenario)
- Margaret Dowling Creek and Deep Creek regulators set as fully open for the entire simulation
- Banks B, B2 and C set to fully closed below approximately 35 000 ML/d and fully open above this flow
- Tanyaca Creek regulator set to control upstream level to 14.75 m AHD at low flows and fully open at higher flows when head difference across structure is minimal
- Pike River regulator set to control upstream level to 14.35 m AHD at low flows and fully open at higher flows when head difference across structure is minimal
- All spillways were configured with a crest level of 16.4 m AHD (i.e. maximum inundation height), transitioning to the blocking bank height of 16.6 m AHD in a stepped arrangement, with the spillway length set as listed in Table 5.1.

These hydraulic conditions and operating configurations were consistently applied across every iteration tested, with only ancillary details being altered as appropriate. Water levels upstream and downstream, flows and velocities from the 1-D section of model were presented for each culvert and spillway.

Due to the iterative nature of the scenarios, and the minor changes to hydraulic results at each structure that these iterations produce, the results presented in the following section are limited to only one of the latest iterative scenarios (Iteration 3a) to provide an indication of the type of data generated. The data is presented graphically, and limited to upstream and downstream water levels and discharge through each structure for simplicity. The results consider positive flow direction as being from the floodplain side to river side of the blocking alignment.

Table 5.1 Modelling iterations of ancillary structures included in Pike Floodplain blocking alignment. Highlighted fields indicate changes implemented between iterations

Structure name	Iteration 1	Iteration 2	Iteration 3a	Iteration 3b
Tanyaca Creek regulator	6 bays x 2 m	6 bays x 2 m	6 bays x 2 m	8 bays x 2 m
Pike River regulator	6 bays x 2 m	6 bays x 2 m	6 bays x 2 m	8 bays x 2 m
Mundic north ancillary regulator (Culvert B)	1.8 x 0.9 m x 1 cell Invert = 15.3 m AHD	1.8 x 0.9 m x 3 cells Invert = 15.3 m AHD	1.8 x 0.9 m x 1 cell Invert = 15.3 m AHD	1.8 x 0.9 m x 1 cell Invert = 15.3 m AHD
Mundic south ancillary regulator (Culvert C1)	1.8 x 1.5 m x 1 cell Invert = 14.95 m AHD	1.8 x 1.5 m x 1 cell Invert = 14.95 m AHD	1.8 x 1.5 m x 1 cell Invert = 14.95 m AHD	1.8 x 1.5 m x 1 cell Invert = 14.95 m AHD
Culvert C2	1.8 x 1.8 m x 1 cell Invert = 14.35 m AHD	Not included	Not included	Not included
Spillway E1 (~200 m north-west of Bank E)	50 m	50 m	50 m	50 m
Bank E spillway	100 m	100 m	100 m	100 m
Tanyaca spillway (adjacent Tanyaca Ck regulator)	80 m	80 m	80 m	80 m
Spillway K1 (~500 m north of Snake Ck north ancillary regulator)	20 m	20 m	20 m	20 m
Snake Ck north ancillary regulator (Culvert K)	1.8 x 0.9 m x 1 cell Invert = 15.6 m AHD	1.8 x 0.9 m x 2 cells Invert = 15.6 m AHD	1.8 x 0.9 m x 1 cell Invert = 15.6 m AHD	1.8 x 0.9 m x 1 cell Invert = 15.6 m AHD
Spillway K2 (adjacent Snake Ck north ancillary regulator)	20 m	20 m	20 m	20 m
Snake Ck south ancillary regulator (Culvert L)	1.8 x 1.5 m x 1 cell Invert = 14.8 m AHD	1.8 x 1.5 m x 1 cell Invert = 14.8 m AHD	1.8 x 1.5 m x 1 cell Invert = 14.8 m AHD	1.8 x 1.5 m x 1 cell Invert = 14.8 m AHD
Culvert N	1.8 x 1.8 m x 1 cell Invert = 14.4 m AHD	Not included	Not included	Not included
Pike spillway (adjacent Pike River regulator)	80 m	80 m	80 m	80 m
Spillway B (~100 m south of Mundic North ancillary regulator)	Not included	Not included	150 m	150 m

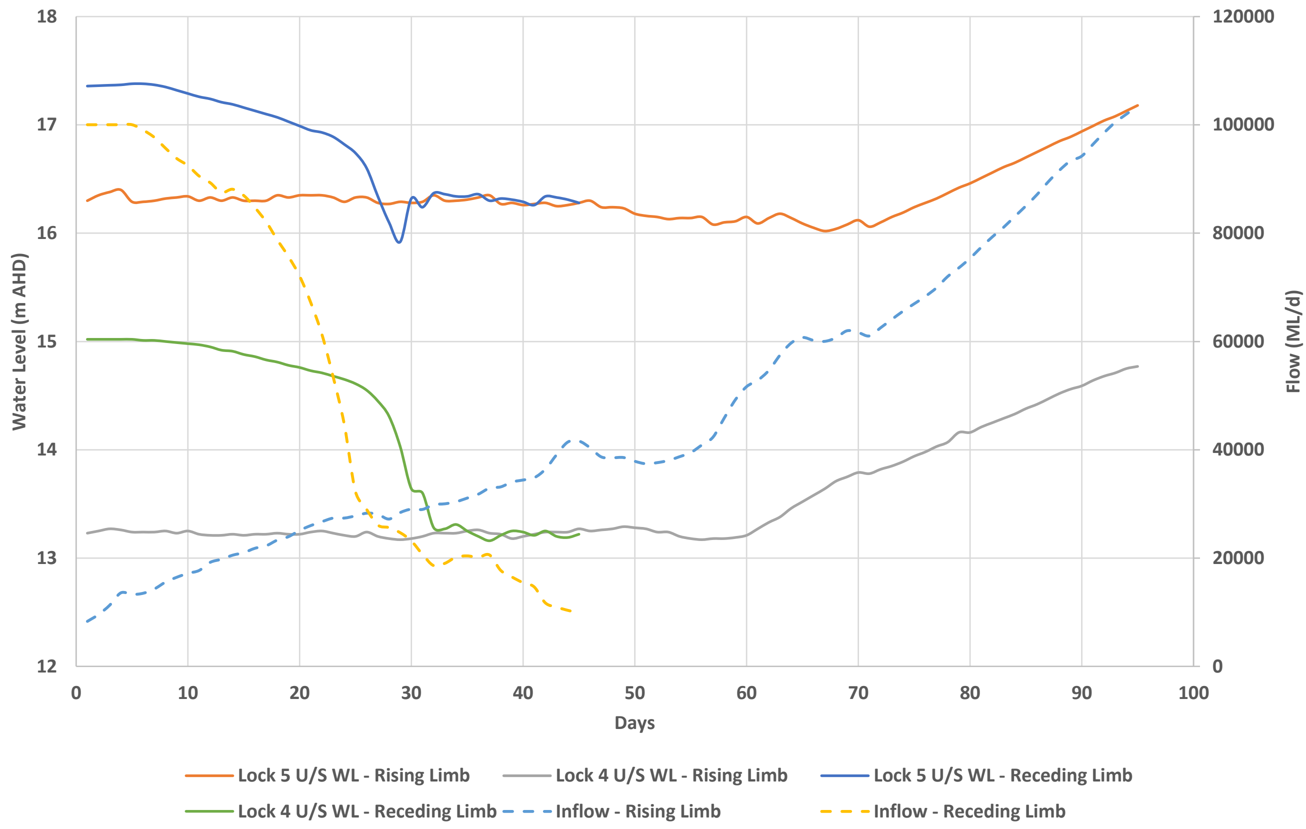


Figure 5.1 Scenario hydrographs used for rising and receding flood limb simulations

5.2 Results

Figure 5.2 to Figure 5.14 show water level (upstream and downstream of each structure) and flow through the structure as they vary with rising and receding flood limbs. Results are shown at the ancillary culverts, spillways, and the main regulators in Tanyaca Creek and Pike River.

The results indicate that flow through both Tanyaca Creek and Pike River regulators is always positive (i.e. from floodplain to river) under both rising and receding flood limbs. For 6-bay configurations of both Tanyaca Creek and Pike River regulators, the maximum flow through each structure is modelled during the receding limb, at approximately 3200 ML/d for both Pike River and Tanyaca Creek regulators.

In general, ancillary culverts on the floodplain are modelled to only become active (i.e. water present at structure) in the order of approximately 50 000 to 60 000 ML/d River Murray flow on the rising flood limb. The direction of flow through the structure varies depending on location; for example, at Culvert B (Mundic North Ancillary Regulator), the flow is modelled to enter the floodplain from the river under both rising and receding flood limbs as indicated by a negative flow through the structure, whereas at Culvert L (Snake Creek south ancillary regulator) the flow is mainly positive, exiting from the floodplain to the river side of the blocking bank. Culvert C1 indicates no flow through the structure with rising or falling water levels, which, as indicated in the preceding section, may be a result of the coarseness of the topographic grid not adequately capturing the detail of a minor flow path in this area. This result highlights the issues associated with assessing the hydraulics of smaller structures at a sub-floodplain scale against the 30 m grid, which may introduce a higher level of uncertainty in the results. Further refinements to the model in the Culvert C1 area may be required to more effectively model this specific ancillary structure, either through an additional 1-D branch to model the minor flow path or modelling using the more detailed flexible mesh model currently under development.

Due to the nature of the spillways, flow is only apparent through these structures at levels above the minimum crest level of 16.4 m AHD. Bank E, which is placed at an existing major flow path into Tanyaca Creek, is modelled to carry the highest flow from floodplain to river side of the blocking bank, at a maximum of approximately 1400 ML/d. Conversely, Spillway B, located to the north of the floodplain, indicates the highest modelled flow from river to floodplain, carrying a maximum flow of 1500 to 1600 ML/d.

Tanyaca Spillway, adjacent to the Tanyaca Creek regulator, indicates little to no modelled flow across the structure during either rising or receding flood limbs, despite the rising or falling water levels. Similar to the Culvert C1 case, this may again be a result of the topographic grid in the area of this spillway being excessively coarse for adequately representing the hydraulics across the structure, and similarly may require some modification to the 1-D section of model to more effectively connect the spillway to the Tanyaca Creek branch.

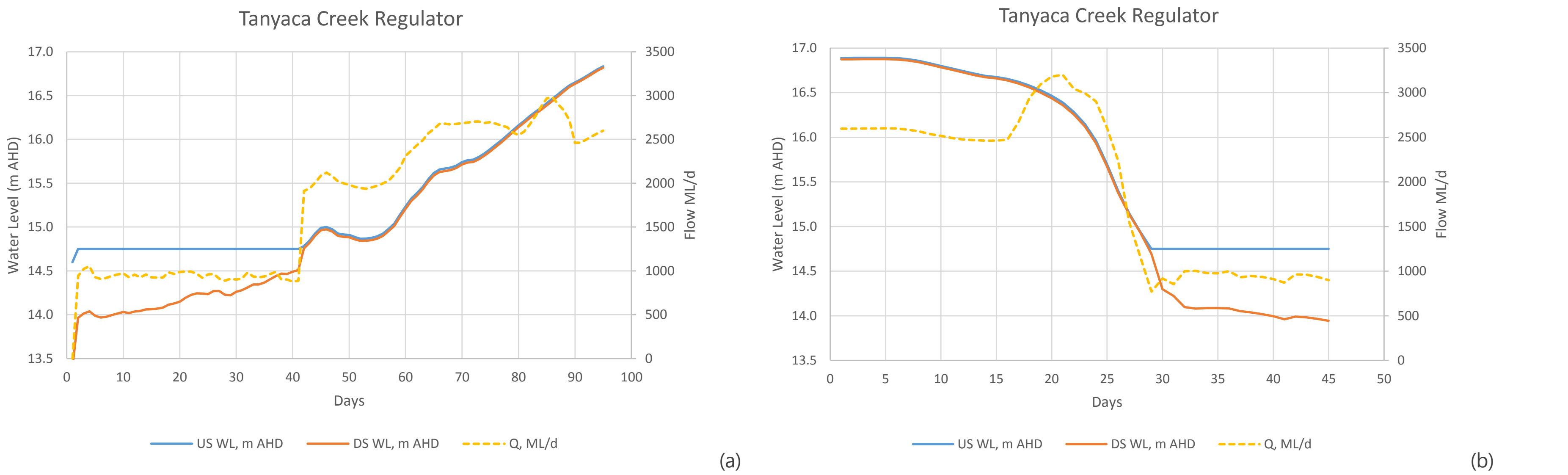


Figure 5.2 Tanyaca Creek regulator water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

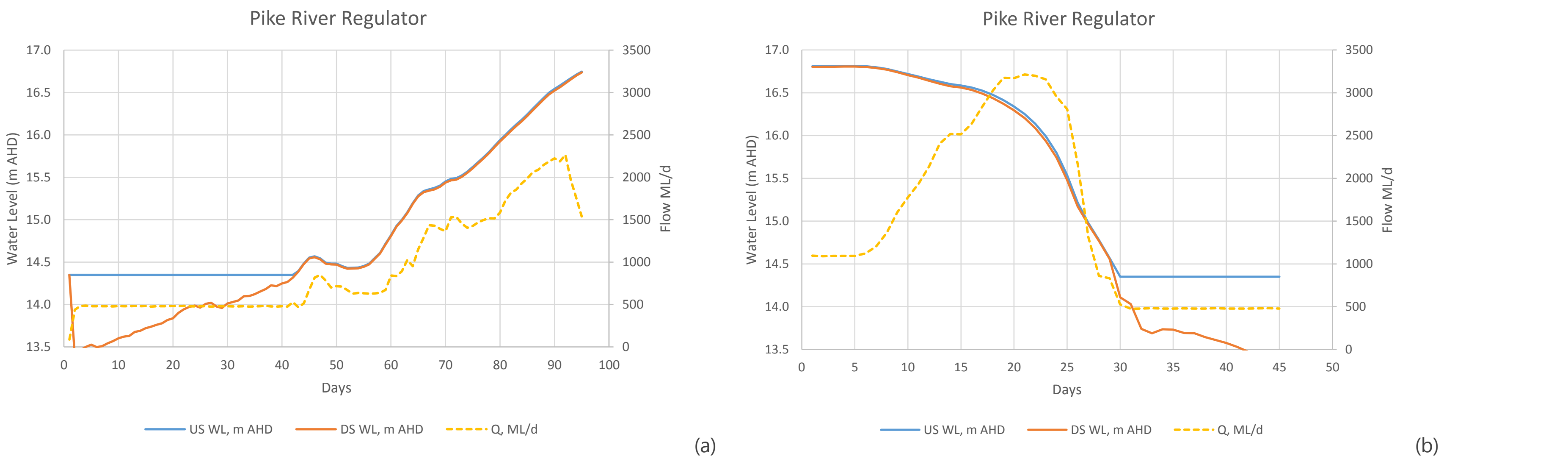


Figure 5.3 Pike River regulator water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

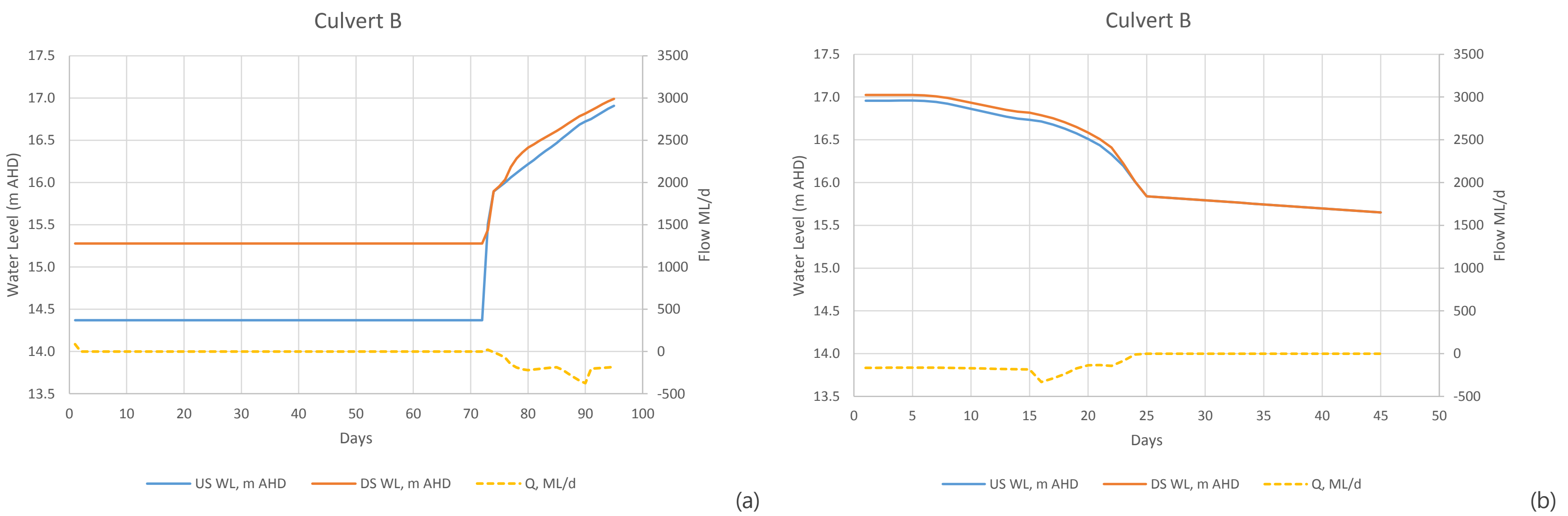


Figure 5.4 Culvert B water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

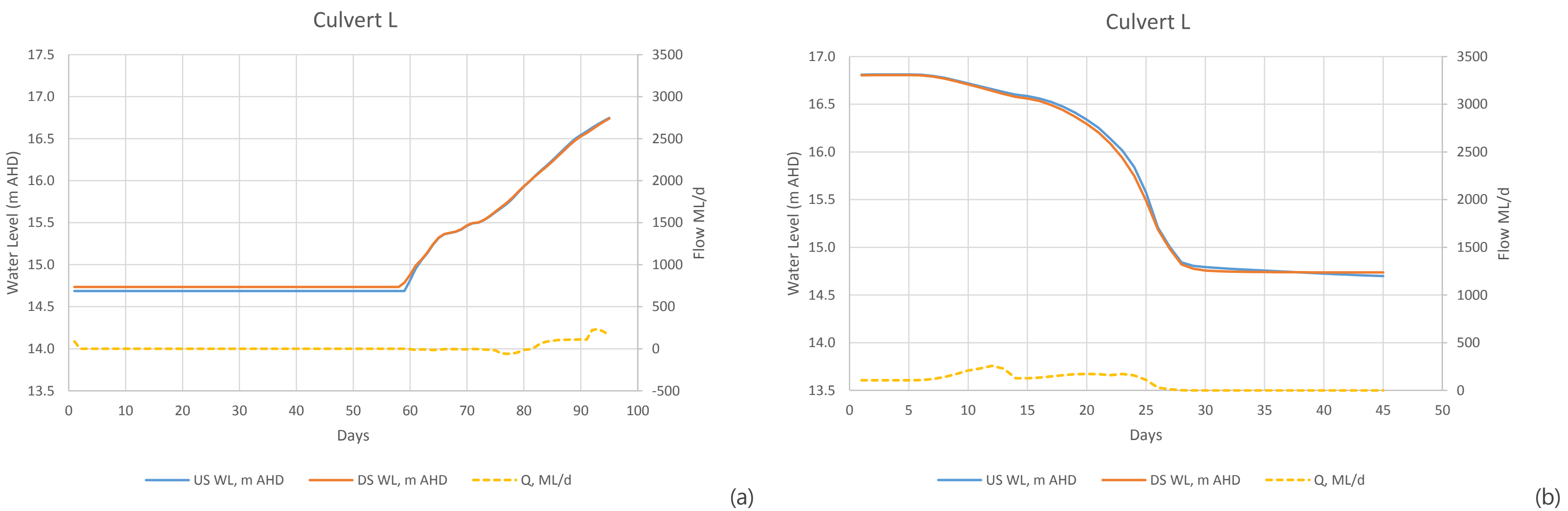
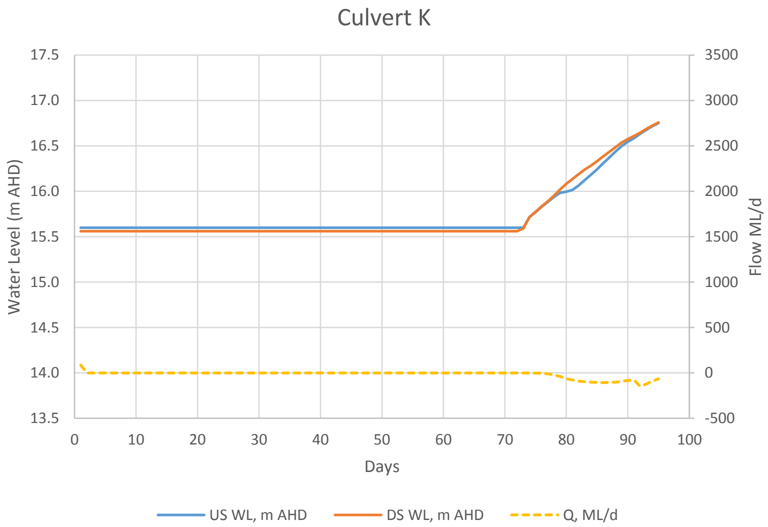
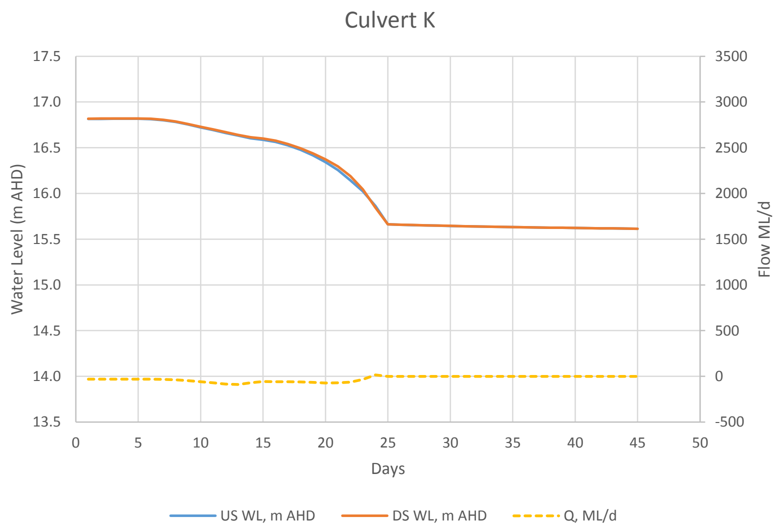


Figure 5.5 Culvert L water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

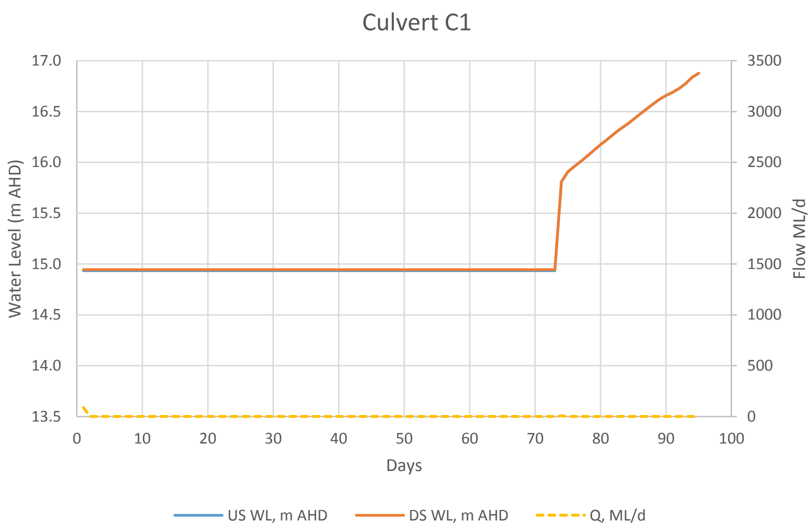


(a)

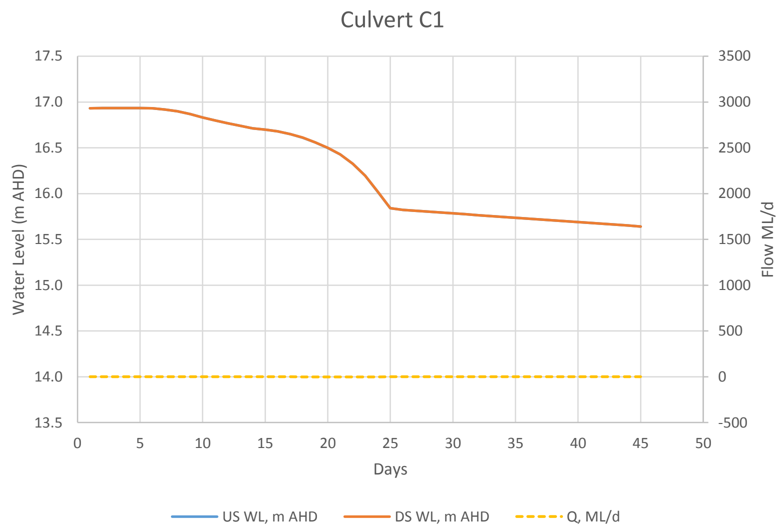


(b)

Figure 5.6 Culvert K water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs



(a)



(b)

Figure 5.7 Culvert C1 water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

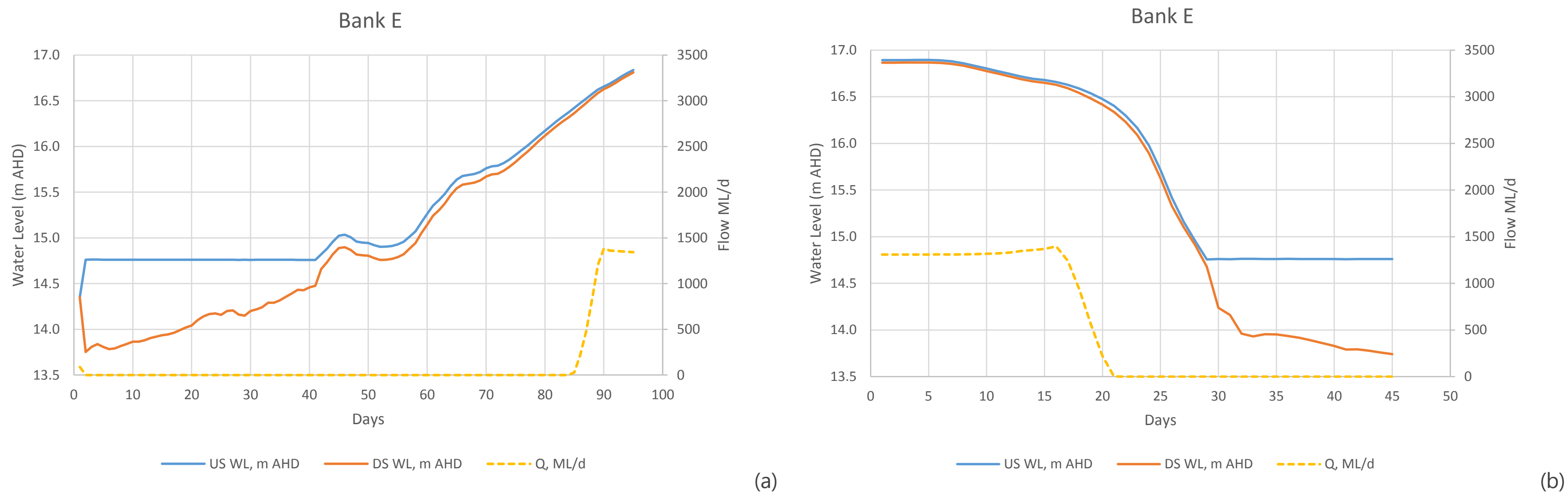


Figure 5.8 **Bank E water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs**

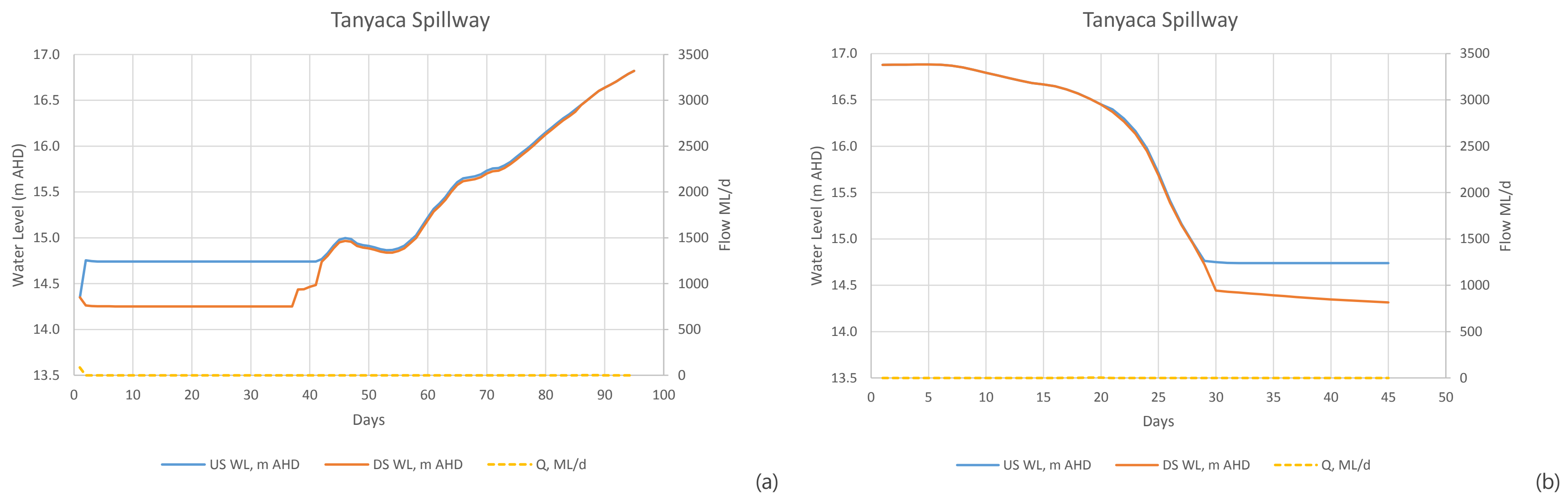


Figure 5.9 **Tanyaca spillway water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs**

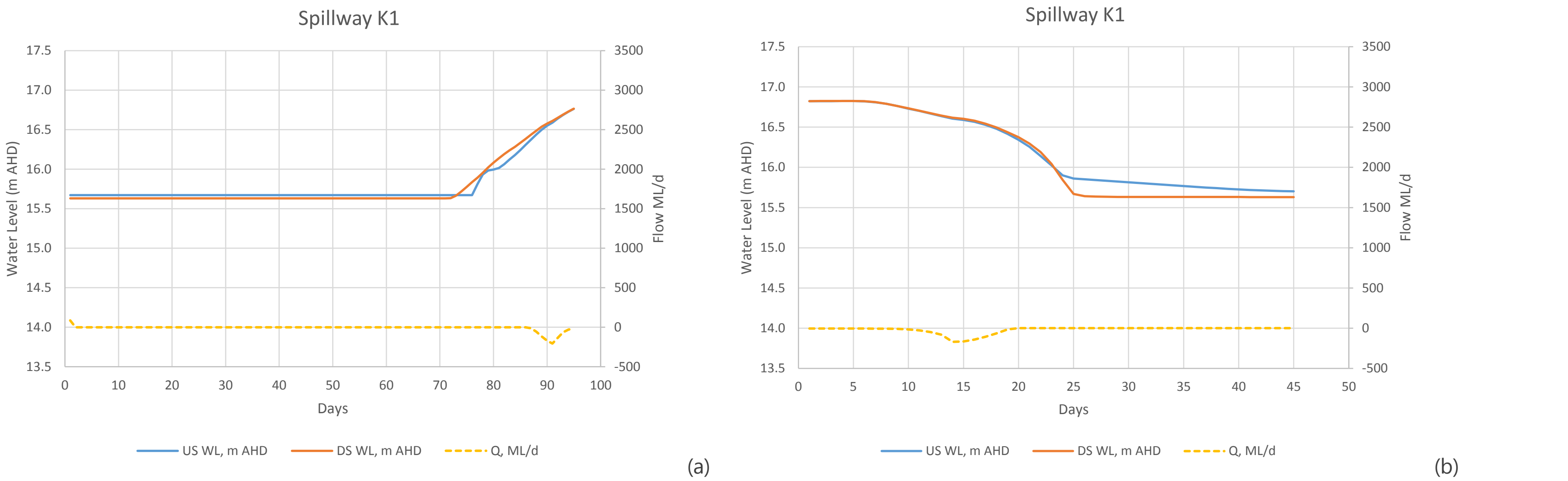


Figure 5.10 Spillway K1 water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

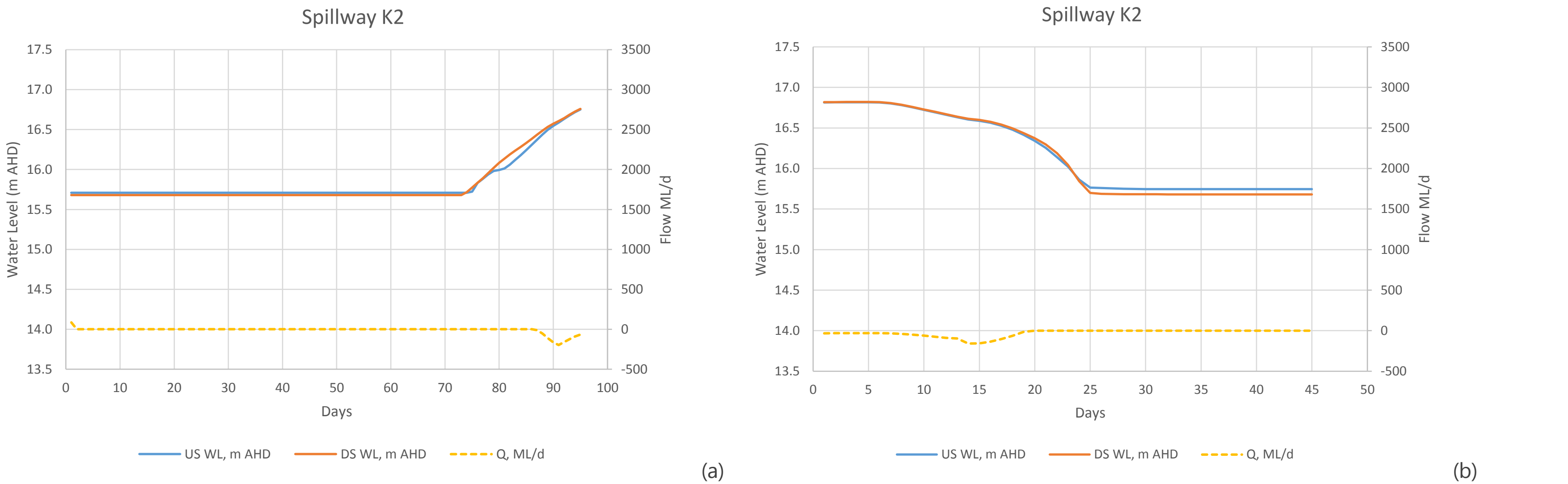


Figure 5.11 Spillway K2 water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

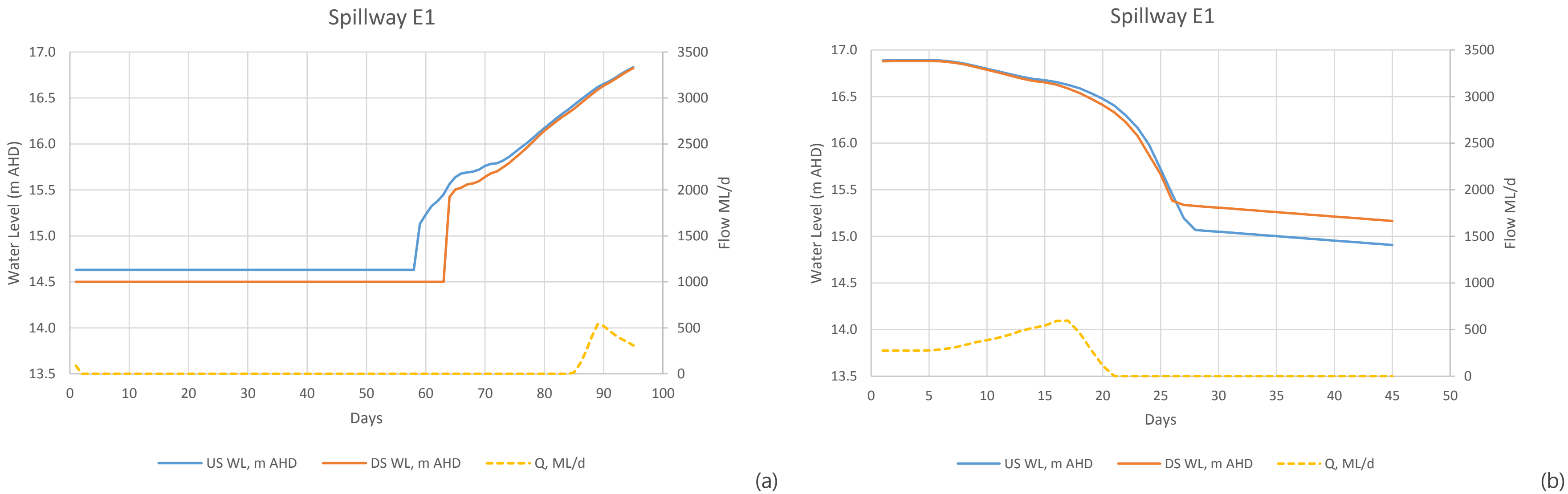


Figure 5.12 Spillway E1 water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

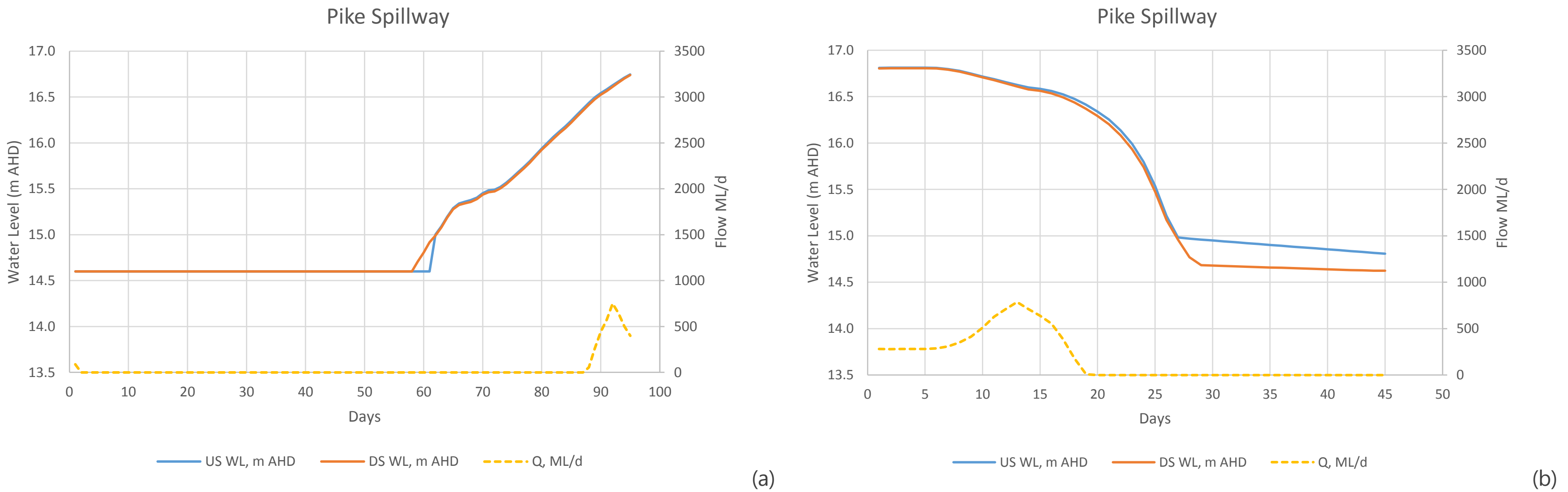


Figure 5.13 Pike spillway water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

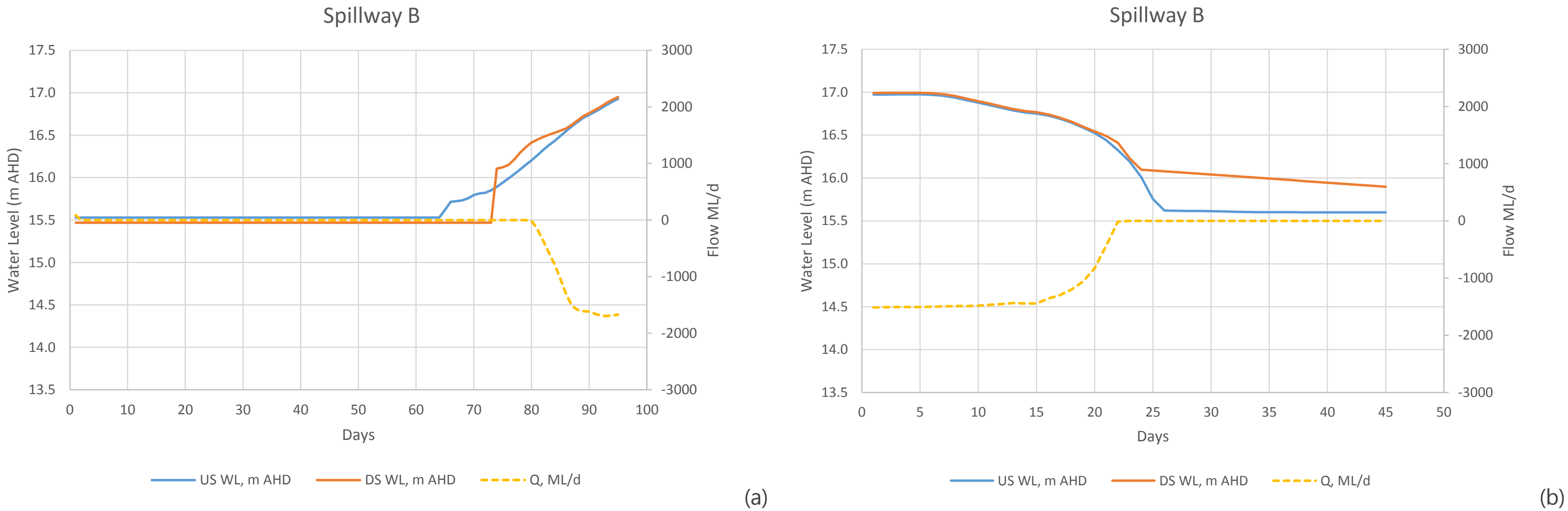


Figure 5.14 Spillway B water levels (upstream and downstream of structure) and discharge for (a) rising and (b) receding flood limbs

6 References

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McCullough DP, 2016, *SARFIIP – Preliminary Investigations – Pike Floodplain hydraulic model setup and review,* DEWNR Technical Note 2016/04, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide

McCullough DP, Montazeri, M and Gibbs, M, 2016, *SARFIIP – Pike Floodplain hydraulic modelling: Managed inundation options assessments scenarios – 2014–15,* DEWNR Technical note 2016/05, Government of South Australia, through the Department of Environment, Water and Natural Resources, Adelaide

Yamagata, K, 2016, *Review of the Pike Floodplain MIKE FLOOD models*, Reference no. 43802214, DHI Water and Environment, Sydney

Appendix A – Tabulated data from Scenario 11

Table A.1 Tailwater levels at Pike River and Tanyaca Creek environmental regulators for a Tanyaca Creek flow of approximately 400 ML/d under controlled flows

River Murray, D/S Lock 6 ML/d	River Murray, D/S Lock 5 ML/d	MD and DC combined inflow ML/d	Bank B complex ML/d	Bank C ML/d	Pike River regulator ML/d	Tanyaca Ck regulator (no silt) ML/d	Tanyaca Ck regulator (silt) ML/d	Tanyaca Ck U/S m AHD	Tanyaca Ck D/S (no silt) m AHD	Tanyaca Ck D/S (silt) m AHD	Pike River U/S m AHD	Pike River D/S m AHD
500	<100	399	0	0	362	0	0	14.67	13.21	13.21	14.35	13.22
5000	3724	1200	0	0	635	410	403	14.99	13.56	13.73	14.59	13.31
10 000	8718	1200	0	0	724	410	393	15.04	13.59	13.74	14.66	13.39
15 000	13 716	1200	0	0	744	406	393	15.05	13.67	13.77	14.68	13.52
20 000	18 715	1200	0	0	749	407	398	15.06	13.80	13.85	14.68	13.68
25 000	23 713	1200	0	0	751	397	400	15.06	13.96	13.99	14.68	13.86
30 000	28 712	1200	0	0	752	409	397	15.06	14.20	14.21	14.68	14.08
35 000[a]	33 709	1200	-1	-100	657	404	393	14.97	14.44	14.45	14.61	14.28
40 000	38 706	1200	84	32	849	404	392	15.14	14.67	14.67	14.76	14.48
45 000[b]	43 868	1200	760	1280	879	2300	2201	15.12	15.11	15.12	14.74	14.73
50 000	48 566	1200	982	1563	1104	2538	2441	15.34	15.33	15.34	15.01	14.98
55 000	53 693	1200	1208	1820	1328	2791	2695	15.53	15.52	15.53	15.23	15.20
60 000	58 689	1200	1405	2035	1426	2937	2846	15.71	15.70	15.70	15.45	15.42
70 000	68 684	1200	1712	2023	1735	2837	2761	16.07	16.06	16.07	15.87	15.84
80 000	78 682	1200	2194	2002	2023	2907	2838	16.35	16.34	16.34	16.21	16.18
90 000	88 677	1200	2519	1771	2371	3578	3455	16.61	16.60	16.60	16.53	16.49
100 000	98 664	1200	3078	1960	1402	3310	3210	16.81	16.80	16.80	16.74	16.73

[a] Banks B, B2 and C fully opened at or above 35 000 ML/d

[b] Tanyaca Creek and Pike River regulators fully opened at or above 45 000 ML/d

Table A.2 Tailwater levels at Pike River and Tanyaca Creek environmental regulators for a Pike River flow of approximately 400 ML/d under controlled flows

River Murray, D/S Lock 6 ML/d	River Murray, D/S Lock 5 ML/d	MD and DC combined inflow ML/d	Bank B complex ML/d	Bank C ML/d	Pike River regulator ML/d	Tanyaca Ck regulator (no silt) ML/d	Tanyaca Ck regulator (silt) ML/d	Tanyaca Ck U/S m AHD	Tanyaca Ck D/S (no silt) m AHD	Tanyaca Ck D/S (silt) m AHD	Pike River U/S m AHD	Pike River D/S m AHD
500	<100	399	0	0	362	0	0	14.67	13.21	13.21	14.35	13.22
5000	3724	1200	0	0	398	743	743	14.75	13.79	13.96	14.46	13.31
10 000	8718	1200	0	0	402	764	764	14.75	13.82	13.98	14.5	13.38
15 000	13 716	1200	0	0	398	768	768	14.75	13.86	14.00	14.5	13.5
20 000	18 715	1200	0	0	398	768	768	14.75	13.95	14.04	14.5	13.67
25 000	23 713	1200	0	0	399	768	768	14.75	14.07	14.13	14.5	13.85
30 000	28 712	1200	0	0	400	768	768	14.75	14.27	14.30	14.5	14.07
35 000[a]	33 709	1200	347	762	400	1866	1833	14.75	14.70	14.74	14.56	14.29
40 000	38 706	1200	520	982	400	2181	2082	14.92	14.91	14.93	14.81	14.48
45 000[b]	43 868	1200	761	1280	877	2299	2201	15.12	15.11	15.12	14.74	14.73
50 000	48 566	1200	982	1560	1104	2537	2441	15.34	15.33	15.34	15.01	14.98
55 000	53 693	1200	1209	1820	1328	2791	2690	15.53	15.52	15.52	15.23	15.2
60 000	58 689	1200	1406	2035	1426	2937	2846	15.71	15.70	15.70	15.45	15.42
70 000	68 684	1200	1709	2019	1734	2835	2761	16.07	16.06	16.07	15.87	15.84
80 000	78 682	1200	2194	2002	2023	2906	2839	16.35	16.34	16.34	16.21	16.18
90 000	88 677	1200	2518	1769	2370	3575	3455	16.61	16.60	16.60	16.53	16.49
100 000	98 664	1200	3097	1981	1412	3314	3207	16.81	16.80	16.80	16.74	16.73

[a] Banks B, B2 and C fully opened at or above 35 000 ML/d

[b] Tanyaca Creek and Pike River regulators fully opened at or above 45 000 ML/d

Table A.3 Tailwater levels at Pike River and Tanyaca Creek environmental regulators for a Tanyaca Creek flow of approximately 400 ML/d under controlled conditions and raised Lock 4 upstream level of 14.34 m AHD

River Murray, D/S Lock 6 ML/d	River Murray, D/S Lock 5 ML/d	MD and DC combined inflow ML/d	Bank B complex ML/d	Bank C ML/d	Pike River regulator ML/d	Tanyaca Ck regulator (no silt) ML/d	Tanyaca Ck regulator (silt) ML/d	Tanyaca Ck U/S m AHD	Tanyaca Ck D/S (no silt) m AHD	Tanyaca Ck D/S (silt) m AHD	Pike River U/S m AHD	Pike River D/S m AHD
500	<100	399	0	0	361	0	0	14.67	14.33	14.33	14.35	14.32
5000	3724	1200	0	0	708	402	402	14.97	14.37	14.38	14.46	14.35
10 000	8718	1200	0	0	751	397	403	14.99	14.42	14.42	14.50	14.39
15 000	13 716	1200	0	0	751	392	400	15.01	14.49	14.50	14.55	14.45
20 000	18 715	1200	0	0	742	395	397	15.03	14.60	14.60	14.62	14.54
25 000	23 713	1200	0	0	734	404	408	15.07	14.73	14.73	14.71	14.65
30 000	28 712	1200	0	0	727	394	394	15.11	14.88	14.88	14.82	14.78
35 000[a]	33 709	1200	48	129	903	406	404	15.27	15.03	15.03	14.97	14.91
40 000	38 706	1200	186	270	1110	400	399	15.43	15.17	15.17	15.12	15.05

[a] Banks B, B2 and C fully opened at or above 35 000 ML/d

Appendix B – Comments and responses relating to external review of MIKE FLOOD model

Table B.1 Peer reviewer comments and context of impact on modelling

Review report section	Reviewer comment	Consequence on modelling	DEWNR response	Recommendation
Calibration - Overall model setup	'dx' parameter (i.e. spacing between calculation points) is ~ 500 m in some parts of M11 model	Causes water level averaging across multiple linked cells under the 20 m^2 grid cell size. May reduce accuracy of results via interpolation and averaging of 1D-2D linkages.	Main impact is with averaging of water levels through 1D–2D River Murray linkages. The impact is only relevant where overbank spills occur at high flows, and may only be a minimal impact on result accuracy, especially in the context of inherent model error.	For future modelling with the MIKE FLOOD model reduce maximum dx values to reduce averaging. Not an issue in FM model as River Murray represented in 2D domain.
	Total length of linked grids significantly different from the total length of linked M11 branch	Results in interpolation and averaging of water levels and flow along links. May reduce accuracy of results.	Likely to have similar impact to large dx spacing issue as in above comment, and may only be minimal impact on results. Investigation of model configuration suggests that the majority of linked cells are difficult to reduce in length owing to the coarseness of the 20 m^2 grid cells, and thus in many cases it is difficult to identify unnecessary cells to remove from the links.	For future modelling with the MIKE FLOOD model, refine linked cells wherever possible.
	In standard links, depth adjustment parameter was switched off for all standard links	Links standard links with only one cell to the M11 model. Generally not problematic to do this, however is recommended to switch them on to link to multiple cells.	Depth adjustment parameter is switched off by default when creating standard links, which is the reason behind all links being switched off. Not a major issue for results as identified by reviewer.	Switch on depth adjustment parameter for future modelling for best practice approach. FM model has already had this recommendation implemented as part of the model upgrade work.
	dx spacing (i.e. calculation points in 1D domain of model) is small in some M11 locations	Requires a small time step to avoid instabilities. Instabilities may arise if time step not sufficiently small.	Mainly an issue at higher flows to avoid model errors, but investigation of previous results indicate minimal impact on those scenarios conducted. Increasing dx value may allow higher flows to be modelled than currently (e.g. up to approximately 100,000 ML/d before errors occur).	For future modelling using the MIKE FLOOD model, ensure cross-sections, branch connections and structures are appropriately spaced to avoid small dx values.

Review report section	Reviewer comment	Consequence on modelling	DEWNR response	Recommendation
	Opening width of structures (i.e. weir specifications) is greater than U/S and/or D/S cross-sections i.e. Bank B track crossing, Bank G, Col Col Bank (existing structure), Bank C existing	Can lead to instability in M11. Potential impact on results e.g. erratic behaviour of hydraulics at relevant locations in the model.	All the listed structures (except for Bank B track crossing) have been removed from the upgraded version of the model as these are superseded structures, and thus do not impact on scenarios conducted for SARFIIP options. Inspection of scenario result files does not indicate any obvious model instability created by Bank B track crossing based on velocity and water level traces.	For future modelling with the MIKE FLOOD model, adjust cross-sections/weir dimensions as applicable to avoid instabilities.
	Delta in M11 is set to 1.0, greater than recommended value of 0.85.	Improves stability in model. May have impact on maximum inundation extent when dynamic modelling is considered.	In the majority of runs this is not an issue as they are typically operated to steady state rather than dynamically based. Value of delta can be reduced however if model stability is improved by implementing some of the model refinements as above.	Increase model stability by implementing measures in comments above, and reduce delta value to 0.85 if possible.
	Discharge through Lock 5 is adjusted (up or down) to a single value rather than a small gap between upper and lower thresholds	Operation of lock structure in model adjusts flow more rapidly than if a margin between upper and lower levels is used, resulting in a more erratic looking water level trace. Average upstream water level matches the target level, but varies more rapidly over time than would a margin-based water level control.	Inspection of result files indicates at steady state the water level around the set point upstream of Lock 5 varies by << 1 mm, and flow downstream varies by < +/- 0.07 m3/s, resulting in minimal impact on scenarios.	For future modelling with MIKE FLOOD model, operate Lock 5 to a target margin rather than a single value, to optimise model configuration.

Review report section	Reviewer comment	Consequence on modelling	DEWNR response	Recommendation
	Branches 'SL_1' to 'SL_5' specified in 1D model are not linked to 2D model (NB these are located around Snake Creek flood runner)	Branches are not included in model calculations. Flow at these locations is through 2D grid rather than 1D.	These branches were included in the original model as unlinked branches, presumably to act as ancillary structures along the original blocking alignment concept at low points in the terrain to allow exchange through the bank. These are irrelevant to current scenarios given they are no longer part of the blocking alignment.	No impact to modelling from these branches. Can remove from the model as they are not required.
Calibration – Cross-sections	In Branch 4_1 (Tanyaca Creek, between Mundic Creek and Tanyaca Horseshoe), the bank orientation (left and right banks) of cross-sections have been entered in reverse compared to the survey data	No impact on MIKE FLOOD model given the setup of the lateral spill links, however may be an issue with different coupling methods (e.g. as in flexible mesh (FM) model)	Present in the original model configuration, has no impact on MIKE FLOOD results given the way the linkages are defined.	Ensure that cross-sections at the Tanyaca Creek location in the FM model under development are correctly oriented.
Calibration performance	Depths in various water bodies on the right bank (western side) of the River Murray are estimated as no survey data is available, and flood runners associated with these water bodies are coarsely represented	Higher uncertainty of flood extent representation on right bank of river	Only areas on the left bank (floodplain side) of the river are considered reliable in the model configuration, given the estimation of depths on the right bank side. Therefore, these areas are not considered in the comparison between modelled to observed inundation extents. Note also that some of these identified areas have been 'filled in' within later options assessment scenarios, including for all of the 2015–16 scenarios, as it was identified that they created some instabilities in the model under certain hydraulic conditions in the river (e.g. medium river flows and some instances of Lock 4 raising), and were not required in model outputs.	No specific action required aside from indicating what parts of the model are not considered as reliable within the results.

Review report section	Reviewer comment	Consequence on modelling	DEWNR response	Recommendation
Scenarios	Momentum factor set to zero (i.e. default value) at standard links at Pike regulator	Neglects momentum from calculations, which has a stabilising effect on setups, but potentially impacts water levels and velocities immediately upstream of structure	Setting the momentum factor to 1.0 at the Pike regulator standard links, and comparing to results with a momentum factor of zero for an in-channel simulation, resulted in no difference to the upstream water level, given the level is controlled to a set point, and velocity with only a minor change of ~ 0.01 m/s against a velocity of ~0.30 m/s (i.e. ~ 3%), which is within the expected error of results.	Future modelling with the MIKE FLOOD model should utilise a momentum factor of 1.0 for the Pike regulator standard links to ensure that velocities upstream of the structure are being represented with the highest level of accuracy.

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