Source Rivers Beta release

Milestone 5

October 2010

Authors

eWater Cooperative Research Centre
eWater Limited ABN 4 7 115 422 903

Building 15, University of Canberra,
ACT 2601, Australia
Phone +61 2 6201 5168
Fax +61 2 6201 5038
www.ewatercrc.com.au

1 Executive summary

Key messages:

1. Source Rivers development has been accelerated as a result of additional federal funding. This includes tools for estimating groundwater surface-water interactions and catchment water yield.
2. Sound project management procedures have been implemented ensuring model development continues such that it will be able to support water resource planning.
3. The prototype and beta versions of the Source Rivers Trial Model have been released on schedule and are available for eWater partners.
4. User documentation, including User and Training Manuals, are distributed with the software.
5. A significant effort has gone into functional testing of the Trial Model to identify bugs, issues and future development requirements.
6. There is increasing partner confidence in the delivery of a modelling platform to support operations and water resource planning.
7. Testing larger more complex models is the next step in building partner confidence.

The eWater CRC is building a new modelling platform to support planning and operational aspects of river system management. This platform, known as Source Rivers, is being co-developed with eWater partners. Source Rivers simulates the physical and management aspects of river systems at a range of spatial and temporal scales. It allows users to answer questions such as:

- What is the best way of sharing water between environmental and irrigation demands?
- What impact will climate change have on water security?
- How much water to release from a storage today to meet downstream demands?

The National Water Commission and the Department of Water Environment, Heritage and Arts have invested in the ‘accelerated’ delivery of the Source Rivers Modelling platform. This report

outlines project progress, and also provides specific detail against the major project milestone 5, due 30th September 2010, of the River Systems project. *Viz.*

" Report on model performance and Beta release of Source Rivers software"

As scheduled, a prototype release of the 'Trial' Source Rivers model occurred in July, 2010. Rigorous testing of the Prototype model functionality was undertaken through the jurisdictions to assess if the platform works as specified, is fit for 'purpose' and to identify critical bugs and potential enhancements. These critical bugs were subsequently fixed and useability improvements were made, culminating in the Beta release of Source Rivers in October 2010. Overall, significant additions to model functionality, as well as improvements to usability, and stability have been achieved compared to the prototype 'Base' model delivered in July 2009. The overall result is solid progress towards a Planning model being available in late 2011.

The River Manager User Reference Group made the following observations of model development:

1. The evolution of model development from discrete builds associated with big milestones to a monthly development cycle has led to a continuously improving model development approach.
2. As directed by the River Manager User Reference Group, additional effort has gone into bug fixing and stabilising the model with a view towards building confidence in the modelling platform. This has resulted in a greater number of bugs being fixed, but the time taken to stabilise the code means that some trade-offs with new functionality was required.
3. There is increasing confidence in the model platform as a result of the continuously improving model development approach and significant progress made in testing the Beta.
4. The key next step in building confidence is to start building larger models to ensure the different model components interact correctly and the model can represent water sharing plans.

As above, development over the next 12 months will focus on delivering the Planning Model. The Planning Models aims to have the additional functionality, usability and stability required to

support water resource planning. The outstanding development tasks required to deliver the Planning Model have been prioritised by the jurisdictions and a schedule developed to track progress towards its release. The main risk to development of the Planning Model results from inadequate hydrology resources (ie personnel) being available to complete the hydrological design of new functionality.

Table of contents

2 Project Summary

2.1 Background

2.1.1 Private and public industry partners in eWater have expressed a desire for tools that will allow them to support whole of catchment integrated water resource management, in particular to:

2.1.1.1 predict the combined impacts of various drivers (e.g., climate, land use, farm dams, irrigation, water savings, water trade and groundwater development) on water resources and water allocation, to support river basin planning and policy decisions;

2.1.1.2 forecast runoff, reservoir storage volume, water demand and water allocation from days to months/seasons ahead, to support operations of regulated river systems;

2.1.1.3 estimate water availability (historical, present and future) across the whole of Australia using model(s) that are consistent at catchment, regional and continental scales; and

2.1.1.4 be used in conjunction with other tools for water quality, ecological response and socioeconomic indices to get the greatest benefit out of river flows.

2.1.2 The complexity of models required to support integrated water resource management is beyond the scope of any one organisation to develop alone. The eWater CRC provides a collaborative environment between partners to pool intellectual capacity and resources to create a suite of integrated water resource management models.

2.1.3 The eWater CRC River Systems project was initiated to build the next generation of integrated water management tools for Australia. The River Systems project will contribute to this objective through development of Source Rivers (River Manager and River Operator), which are designed to inform and support (as outlined in a-d above)

consistent operational decision making for river operators and managers to efficiently deliver water to all users.

2.1.4 The National Water Commission (NWC) and the Department of Environment, Water, Heritage and Arts (DEWHA) have invested in the delivery of the Source Rivers Platform. DEWHA funded the accelerated delivery of Source Rivers and the NWC has funded three separate projects to provided enhancements to the modelling platform, including:

2.1.4.1 The River System Modelling Tool project

2.1.4.2 The Groundwater-Surface Interactions Tool project

2.1.4.3 The Catchment Water Yield Estimation Tool project.

2.1.5 The project High Level Steering Committee (HLSC) recommended that we should attempt to manage the separate project agreements (with NWC, eWater CRC and DEWHA) as one coordinated project. This included developing an updated milestone schedule to:

2.1.5.1 Streamline project reporting,

2.1.5.2 Significantly reduce project management overheads, and

2.1.5.3 Ensure appropriate project review and governance.

2.1.6 An updated project schedule was formally agreed between DEWHA, NWC and eWater. This report summarised progress against this updated Milestone Schedule.

2.2 Project Objectives

2.2.1 The key objectives of the River Systems Project are to:

2.2.1.1 Develop the Source Rivers planning model: A planning tool designed to model the management of water in both regulated and unregulated river systems;

2.2.1.2 Develop the Source Rivers operations model – which provides the capacity to manage regulated and unregulated (with abstractions) river systems on a daily and seasonal basis;

2.2.1.3 Develop quality assurance procedures, user and technical documentation, in-line help and training materials that ensure the models are supported; and

2.2.1.4 Demonstrate that Source Rivers is fit for purpose.

3 Milestone 5

3.1.1 This Milestone Report corresponds to Milestone 5 of the River Systems project. Table 1 lists the actual deliverables and performance indicators associated with Milestone 5. A cross reference to the original NWC and DEWHA milestones are provided in Attachment A.

Table 1. Milestone 5 September 2010 – Trial application reports finalised and Beta Version 1 released.

Deliverable	Performance Indicator
Completed trial of the application of the larger River Systems modelling framework, including functionality in Prototype Version 1 and assessment of groundwater - surface water interaction[#1] and catchment water yield estimation[#2] tools, in the: • Namoi • Murray • McIntyre Brook • Goulburn Broken. Improvements made on the basis of feedback from trials. Evaluation of model useability and Functionality	Report on performance of model endorsed by High Level Steering Committee
Release of Beta Version 1	Endorsed by HLSC. Beta version 1 software made publicly available (free to eWater partners and public institutions as a minimum).

Notes [#1] Testing of the groundwater-surface water interaction tools is limited to the Namoi

[#2] Testing of the catchment water yield estimation tools was limited to catchments identified by the CWYET Technical Review Panel.

4 Report on model performance

4.1 Scope of Beta release of the Trial Model.

4.1.1 Expectations and scope relating to this milestone were discussed at RM URG Meeting (7 May 2010). At this meeting, the RM URG endorsed that:

4.1.1.1 It was not feasible to replicate current valley models with the functionality that will be available in the Beta Version of the Trial Model

4.1.1.2 The outcome sought from trial applications is confidence that the modelling platform will be suitable to support water management planning.

4.1.1.3 The focus is not to replicate existing models, rather

- test model components,
- prove the capabilities of Source Rivers, and
- identify where enhancements are required.

4.1.1.4 The specifications define the functionality required, which is based on the principle of being ‘fit for purpose’.

4.1.1.5 Any additional enhancements to Source Rivers beyond those currently in the specifications need to be prioritised in line with the available resources.

4.1.2 The development timeline of Source Rivers is outlined in Figure 1. This includes the functionality to be made available as part of the Base Model, the Trial Model and the Planning Model. A detailed list of new functionality added to support the Trial Model is provided in Attachment B.

Figure 1. The development timeline for Source Rivers, including the functionality being built into each version of the software, is shown below

4.2 Testing model useability and functionality

4.2.1 A process was agreed with the RM TUG and RM URG for building confidence in Source Rivers, with a view towards future implementation. This process involved:

4.2.1.1 Testing functional components of the Prototype release of the Trial Model.

4.2.1.2 Fixing critical bugs indentified the Prototype release of the Trial Model prior to the Beta release.

4.2.1.3 Identifying enhancements required in the prototype and bringing these enhancements to the RMURG for prioritisation relative to other development tasks.

4.2.1.4 Progressively building bigger models to test how the different functional components interact.

4.2.2 The testing procedure is based on the assumption that the software specifications are designed with the intention of being ‘fit for purpose’.

4.2.3 The high-level User Requirements (URs) relating to the functionality provided in the Trial Model were collated from the software specifications (Attachment C).

4.2.4 A traceability matrix was established that mapped hydrology tests against the URs.

4.2.5 Testing was undertaken by Trial Application staff and eWater staff to assess if functionality:

4.2.5.1 met the specification

4.2.5.2 requires enhancement to be used to support water resource planning

4.2.6 Extensive testing of the June 2010 prototype release has been undertaken. Through this process, a number of bugs, issues and suggested improvements were identified.

4.3 Testing results

4.3.1 A significant number of bugs and enhancements have been identified during the iterative design, develop and test cycle.

4.3.2 A total of 1158 bugs were identified since the release of the Base Model in July 2009, of which 919 have been resolved (Table 3). A detailed breakdown of these bugs is provided in Table 3.

Table 3. Bugs identified during the development and testing of the Prototype and Beta version of the Trial model.

Number of bugs Priority	Identified	Resolved	Ready test	Open
Blocker	93	92	1	1
Critical	233	193	21	19
Major	387	290	27	70
Minor	404	324	11	99
Trivial	24	20		4
Parked	17			
Total	1126	834	71	206

4.3.3 A total of 32 critical bugs were identified following the release of the Prototype Trial Model in July 2010 that were required to be fixed prior to the release of the Beta.

4.3.4 Bug resolution is clearly an ongoing and iterative process. At the time of writing, there were 11 of the 32 critical bugs still open. Software fixes for these bugs have been implemented and are included in the latest build. Closure of these bugs is pending hydrology review and testing. It is possible that some of these bugs may require an additional iteration to ensure the software works as required.

4.3.5 Model performance against the high-level User Requirements (URs) are provided in Attachment C. This includes identifying which of the functional requirements performs as required and any functional and useability enhancements required. Testing the

CWYET and GWSIT functionality has been incorporated as part of the normal Source Rivers testing procedures.

4.4 Suggested enhancements and new features

4.4.1 Table 4 summarises the suggested enhancements and new features identified during the building and testing of the Trial Model. This includes all issues generated post the release of the Base Model in the 2009.

4.4.2 A total of 614 potential improvements have been identified, of which 324 have been included into the model and a further 30 are ready for testing.

Table 4. Enhancements and new feature identified during the development and testing of the Prototype version of the Trial model.

Enhancement/New features	Identified	Resolved	Ready test	Open
Critical	48	23	7	18
Major	183	94	12	77
Minor	348	190	11	147
Trivial	21	16		5
Parked	14	1		13
	614	324	30	260

4.4.3 A number of suggested improvements required a significant coding resource (Table 5). As part of our project management processes, these improvements needed to be prioritised on the project schedule and traded-off against other planned new functionality. The River Manager User Reference Group prioritised these issues at Meeting 9 and they are now included in the project schedule.

Table 5. Identified enhancements that have been included onto project schedule.

Component	Description	Effort Days
Weir	Include downstream link rating table. Currently requires user to include in max outlet release which is not intuitive and makes configuration difficult	5
Weir-multiple outlets processing	Current approach does not work when a weir with multiple outlets is subject to drown out. This is a result of multiple outlet functionality being added after completion of the weir specification.	10
Environmental demand model	No persistence was provided with the environmental demand model. Some GUI changes and persistence are required to make it operational	5
Assigning costs in arc-node network	Required to support parallel flow paths in NetLP and other functionality. This will be achieved by allowing user to configure costs on a maximum flow node. The effort required depends on the required flexibility in specifying the cost of capacity and costs of arcs.	20 -60

4.4.4 The River Manager User Reference Group Meeting 9 (26th October) reviewed progress against this milestone. The key messages that the User Reference Group wished to be communicated to the High Level Steering Committee included:

- The evolution of model development from discrete builds associated with big milestones to a monthly build has let to a continuously improving development approach.
- The focus of the Beta release is on building confidence in the platform. Consequently there has been more effort gone into bug fixing, which was traded off against new functionality.
- The next step in building confidence is to start building larger models.

5 Release of Beta

5.1.1 River Manager User Reference Group Meeting 9 (26th October) endorsed that:

5.1.1.1 The Beta version contains all of the agreed functionality.

5.1.1.2 Rigorous testing of the available model functionality has been undertaken.

5.1.1.3 Considerable effort has gone into addressing critical bugs.

5.1.1.4 A number of enhancements have been identified by jurisdictions as being required to make the model 'fit for purpose'.

5.1.1.5 Overall, significant improvements in model functionality, usability, and stability have been achieved.

5.1.1.6 Ongoing testing continues to identify:

5.1.1.6.1 Bugs – where the software does not work as specified

5.1.1.6.2 Issues where the software works as specified, but does not work as required.

5.1.1.6.3 Enhancements required to improve usability and functionality of Source Rivers

5.1.1.7 A process is in place for addressing the identified bugs and issues and updating specifications. As expected the Beta is not bug free.

5.1.2 This Beta Trial Model is now available for eWater Partners to download for free.

5.1.3 A user guide and training material have been prepared. These are available separately or as part of the download of the Trial Model.

6 Summary and next steps

6.1.1 The Beta release provides significant advancements in model functionality.

6.1.2 The ongoing design, build and test process will mean that new model functionality progressively becomes available as part of the monthly model builds.

6.1.3 Ongoing testing of Source Rivers will occur as the monthly releases are made to ensure that the model is ‘fit for purpose’. Bugs will continue to be fixed as they arise. Identified improvements/enhancements will be brought to the RM URG for prioritisation if they require a significant coding effort to update (> 5 days).

6.1.4 The focus of testing will move to more complex systems to ensure that the model will have the capability to support operations and water resource planning into the future.

7 Attachments

Attachment A – Cross referencing of milestones with original NWC and DEWHA milestones.

Attachment B – List of new functionality included in the Beta release

Attachment C – Assessment of compliance with user requirements

Attachment A. Cross referencing of milestones with original NWC and DEWHA milestones.

Deliverable	Performance Indicator	Source/Contract
Completed trial of the application of the larger River Systems modelling framework, including functionality in Prototype Version 1 and assessment of groundwater - surface water interaction and catchment water yield estimation tools, in the: • Namoi • Murray • McIntyre Brook • Goulburn Broken. Improvements made on the basis of feedback from trials. Evaluation of model useability and Functionality	Report on performance of model endorsed by High Level Steering Committee	NWC CWYET Milestone 6 NWC RSMT Milestone 7 NWC GSWIT Milestone 7 DEWHA Milestone 5
Release of Beta Version 1	Endorsed by HLSC. Beta version 1 software made publicly available (free to eWater partners and public institutions as a minimum).	DEWHA Milestone 5 NWC GWSIT Milestone 8 NWC RSMT Milestone 7

Attachment B. List of new functionality added to the July 2009 'Base Model' to meet requirements of the Trial Model

Function	Purpose	Dependencies	Key Stakeholders
Trial Release			
Controlled splitter	To be able to model branches in both regulated and unregulated systems. These branches may be distributaries or anabranches. This includes combinations of: • Uncontrolled branches • Uncontrolled effluent and controlled main channel • Uncontrolled main channel and controlled effluent • Both branches controlled		All
Water User	A water user is a node in the model. It replaces the existing functionality provided by a time series demand and town water supply. It is required to generate orders, manage water extracted from the river model and provide drainage return flows. The water user is divided into three components which each have a specific function: 1. Demand, 2. Account holder, and 3. Water user storage.		All

Function	Purpose	Dependencies	Key Stakeholders
CropMod2	Irrigation demand model used in IQQM	Water User	NSW/QLD
Links	Routing of flow through a link, including lag routing, storage routing, and a combination of lag and storage routing will be available in RiverManager. The methods described cover most of the routing methods available in existing models.		All
Groundwater link model and floodplain model	The Groundwater module determines the exchange flux of water between a river and the underlying aquifer for each link of River Manager at any time step. The estimated flux accounts for all the interactions between groundwater (GW) and surface water (SW) along the entire length of the link. The direction of the flux can either be from the river to aquifer or vice versa, that is, the river either loses water to the groundwater or it gains water from the groundwater system. The Groundwater module also calculates salinity (as Total Dissolved Solids, TDS), which is generally a time-invariant constant for the link	Links	All
Optimised MSP (Stage 1 and 2)	An optimised solution to multiple supply modelling for RiverManager. NETLP solvers are used in the ordering phase to determine the optimum distribution of orders within the whole or part of the river system. The solvers will provide the flow phase with		DSE

Function	Purpose	Dependencies	Key Stakeholders
	information on how to distribute flow at regulators, constraints on demands and ownership of orders at each reservoir and routing reach		
General requirements for resource assessment	Addresses the user requirements common across the different resource assessment methods and the interface required to implement resource assessment in RiverManager. Separate specifications are being developed for each different type of resource assessment system		All
Continuous sharing resource assessment	The Continuous Share Resource Assessment Option implements the system that has been developed by SunWater in Queensland and has been introduced into the St George and Macintyre Brook schemes	General requirements for resource assessment	QLD
Multiple Storage outlets	Ability to connect more than one flow outlet path to a storage To model ana-branches that are driven by the head in a storage To provide more than one downstream reach To have town water supplies connected to a separate outlet path	Storages as a node	All

Function	Purpose	Dependencies	Key Stakeholders
	To be able to specify the priority of the different outlet paths (eg Yarrawonga weir)		
Storages as nodes	Storages are able to represent regulated on and off-stream dams, weirs and large unregulated farm dams and wetlands Controll releases to meet downstream orders Various and multiple outlet types (pipes, pump, valves, gated and ungated spillways) Allowance for spills when storage level exceeds full supply level Provision for flood mitigation Rainfall and evaporation from water surfaces. Seepage Expression editor for outlet relationships Storage operation rules (eg a target operating level) Ability to override simulated storage releases with observed releases to support calibration of RiverManager/RiverOperator. Ability to manually override forecast storage releases for RiverOperator to support river operations	Weirs, multiple storage outlets, overriding releases	All

Function	Purpose	Dependencies	Key Stakeholders
	Ownership (shares, internal spilling, ceding and sharing outlet capacity) Ability to specify ownership associated with observed releases Ability to override simulated storage levels and volumes with measured storage volumes and levels during a warm up period (RiverOperator)		
Upgrade graphing tool	To provide an efficient graphics package to support analysis of model results.		All
Weirs	Able to route flow in a storage that is subject to drown out from downstream water levels Provide the basis for the ability to route water quality constituents through the storage Able to control operation of the weir node through minimum and maximum operating targets.	Multiple outlets and storages as nodes	All
Expression editor – within	Expressions currently update at the start of the model timestep. This change allows expressions to be updated within the NETLP solution during the ordering phase.	Multiple supply paths - optimisation	Vic DSE

Function	Purpose	Dependencies	Key Stakeholders
timestep NETLP			
Groundwater extraction node	To enable the water user to extract water from a groundwater sources To enable the groundwater link model to connect to a groundwater extraction node.	Water User Node, Groundwater link model	NSW and QLD
Extraction node (over order, over bank flow harvesting)	To specify a minimum river flow rate that must be maintained at the extraction node To identify a threshold when flow in the river is overbank and is not subject to extraction pump and licence limits. Be able to increase orders at extraction nodes to model operational efficiency	Ordering system. Water User node	NSW and QLD
Water user node – update for local storage	Build a local storage (OFS) into the water user node that: maintains a water balance of the water user storage enables storage of: • unregulated flow/supplementary water	Water User Node, CropMod2	All

Function	Purpose	Dependencies	Key Stakeholders
	• unused order debit water • drainage return flow (include runoff harvesting) • overland flow • floodplain harvesting Generates demands to fill water user storages – this could occur when there is no carry over and there is unused allocated water that an irrigator wants to put into storage or to meet a reserve curve by filling using unused allocation at end of water year Provides an alternative water source to the demand model		
Hydropower	Enable the calculation of hydropower generation to storage nodes.	Storage as nodes, multiple outlets	All

Attachment C. Assessment of Compliance with User Requirements

Notes:

- *testing has not assessed ownership or constituents, as these functionalities are not fully implemented*
- *Testing of some functionality not required for the beta release has been reported in this report. E.g. daily modelling using network LP ordering*
- *Some test fails relate to useability issues rather than functionality failures (e.g. inconsistent naming conventions within expression editor)*
- *User Requirements which required re-testing following testing of the Prototype release are identified in the final column.*
- *Tests of some User Requirements which previously passed have been re-assessed as fails. These have not been addressed in the Beta release as the issues were not previously identified, nevertheless the reports are included below. The issues will be subsequently addressed.*

Function	No	Requirement	Rank	QC Id	Meets planned requirements as per specification	Enhance-ments delivered	Additional enhancements required	Retest October 2010
Loss	1.	To be able to model losses in both regulated and unregulated systems.		303	Ownership off – functionality complete		Specification required for case of restrictions on orders (see RM 1452)	
Loss	1.1	Losses may be shared according to downstream orders, specified ratio or expression.		304	shared according to downstream orders- meets requirements specified ratio or expression - does not work as required		Software needs to properly implement option of "Ownership of excess based on defined ratio"	
Splitter	1	To be able to model branches in both regulated and unregulated systems. These branches may be		305	Testing based on splitter specification V1.1: Ownership off - functionality complete except for use of expression editor		Updates to the specification have been drafted to address problems with Expression Editor and with ownership.	

		distributaries or anabranches.					Methodology for distribution of allocated flow requires clarification	
Splitter	1.1	Combinations of: • Uncontrolled branches • Uncontrolled effluent and controlled main channel • Uncontrolled main channel and controlled effluent • Both branches controlled		306	As above for Uncontrolled branches and controlled effluent case. See "Multiple storage outlets" for cases with controls on main channel.		As above	
Splitter	2.	Flow should be delivered to maximise the amount of regulated water delivered down both branches while minimizing the losses on the effluent		307	Testing based on splitter specification V1.1: Distribution of total flow correct for ownership off and on Requirement for distribution of allocated flow is unclear		Methodology for distribution of allocated flow requires clarification (waiting for completion of ordering specification)	
Splitter	3.	In systems with ownership, borrow and payback will exist. The borrow will be based on a priority hierarchy between owners.		308	Borrow and payback has not been implemented		Borrow and payback specification to be finalised before implemented	
Water user	1.	Ability to specify the type of water user (e.g. irrigation, urban, environmental)	E	311	RM performs satisfactorily, there is a slight specification adjustment required.	-	Enhancement to specification: Slight changes necessary in description of water user configuration. The feature editor and setup of the water user in RM is slightly different from the node	

							description in the specification (page 50 & 66). Instead of selecting the type of water user (i.e. urban, industrial, environmental, irrigator), options exist for 'Available Models'. The models available include monthly pattern, adjust demand, CropMod2 demand, environmental demand and time series demand. The system response should be the same, however the setup varies from the specification.	
Water user	2.	Ability to select different demand models, including scope for new models in the future	E	312	RM performs satisfactorily, there is a slight specification adjustment required. Most of the CropModel functionality is implemented however there are some outstanding bugs and testing is only about 50% complete (LH).	- OFS and accounting is implemented separately to Crop Model	<u>Enhancement to specification:</u> As described in QC 311, the feature editor and setup of the water user in RM is slightly different from the node description in the specification (page 66-7). The modeller selects one of the five available models (monthly pattern, adjust demand, CropMod2 demand, environmental demand or time series demand) to configure the water user. Once the model is selected, a file of demand can be imported or loaded. This varies from the process described in the specification (page 66-7).	

Water user	3.	Ability to edit demand model (Note: the demand model is required to generate demand for current/future time steps. A separate specification is required for each demand model.)	E	313	RM performs satisfactorily	-	-	
Water user	4.	Choice of different demand water quality models.	HD	314	Water quality not implemented yet			
Water user	5.	Ability to edit demand water quality model	HD	315	Water quality not implemented yet			
Water user	6.	Choice of storage models to be used by water user. A separate water user storage specification is required to describe how the following user requirements are addressed: • maintain a water balance of the water user storage (317) • enable storage of: 1) unregulated flow/supplementary water (318)	E	316 (see sub requirements also)	Functionality has been implemented since the prototype. A specification is required to test against. RM performs to a certain extent, but further functionality is required.	-	Enhancement to RM: Further functionality is required.	Re-tested.

		2) unused order water (319) 3) drainage return flow (include rainfall runoff) (320) 4) unused allocated water (321) 5) overland flow (322) 6) floodplain harvesting (323) • Generate demands to fill water user storages – this could occur when there is no carry over and there is unused allocated water that an irrigator wants to put into storage or to meet a reserve curve by filling using unused allocation at end of water year. (324)						
Water user	7.	Ability to edit water user storage model.	E	326	RM performs satisfactorily (must develop new project though)	Changes can now be undone by selecting the 'Cancel' function in the Water User feature editor. All changes are undone and initial parameters are		Re-tested.

						reinstated.		
Water user	8	Ability to select a storage water quality model Note. The ability to model constituent concentration is not implemented yet.	HD	327	Functionality not implemented yet			
Water user	9	Ability to edit storage water quality model	HD	328	Functionality not implemented yet			
Water user	10	Enable management of return flows from water user	E	329	Implemented in crop model but functionality not tested			Test following beta release
Water user	11	Ability to specify the fate of return flows	E	330	Implemented but functionality not tested			Test following beta release
Links	1.	To be able to do hydrologic flow routing in a similar manner to existing models	E	275	See QC Id 276-283			
Links	1.1	Lag routing	E	276	Ownership On- not tested as ownership is not yet enabled on links			
Links	1.2	Linear routing	E	277	Ownership off - functionality complete	Na	Na	
Links	1.3	Non-linear routing	E	278	Ownership off - functionality complete			
Links	1.4	Non-linear routing with lag	D	279	Pass.		Length is not used in routing - k is for each division in a reach, regardless of number of divisions. Guidance for stability criteria discussed in Jira issues RM-2653 and RM-2674a.	
Links	1.5	Multi-stage linear routing Note. This functionality as envisaged is now considered unsound. The	NH	280	This functionality as originally envisaged is now considered unsound. The objective will be satisfied by use of the piecewise			

		objective will be satisfied by use of the piecewise routing function.			routing function.			
Links	1.6	Multi-stage non-linear routing Note. This functionality as envisaged is now considered unsound. The objective will be satisfied by use of the piecewise routing function.	NH	281	This functionality as originally envisaged is now considered unsound. The objective will be satisfied by use of the piecewise routing function.			
Links	1.7	Piecewise routing function	E	282	Ownership off - functionality complete		Output for multiple sub-reaches requires some enhancements. Can not be selected, and is recorded by default. Can only open sub reach reporting individually(for a single output) at this stage. Also, total evap on reach is not recordable yet.	
Links	2.0	Consider net evaporation losses on reaches	E	283	Most tests pass. Two loose ends need fixing. Lag reaches not tested as fluxes no longer implemented in them.			Re-tested.
				283	Re-test report: Waiting acceptance of resolution of issue with multiple rating tables. Other tests pass.		Output total reach net evaporation in ML	
Links	3.0	Consider groundwater losses	E	284	Yes, groundwater flux for link is passed back to River Manager	Nil	Nil	
Links	3.1	Flux as a function of flow/head	HD	285	Yes, groundwater flux derived from the river heads and groundwater heads derived from sources outside of River Manager (i.e. measured data) is passed back to River Manager	Nil	Nil	

Links	3.2	Time series flux	HD	286	Yes, time series of groundwater flux derived from sources outside of River Manager (i.e. a MODFLOW groundwater model) is passed back to River Manager	Nil	Nil	
Links	3.3	Surface-groundwater interaction model	HD	287	Yes, model is implemented as per specification but model still undergoing testing in Namoi trial	Ability to read in groundwater pumping schedules from a file	Unsure, depending on how testing in Namoi trial proceeds	
Links	4.0	Consider time series diversions along the routing reach	NH	288	Testing failed for all routing with additional sub-reaches.		Implementation appears to be incorrect. This method still needs to be implemented in conjunction with ownership on links and the associated water accounting.	Re-test required – pending availability of tester.
Groundwater	1.	To be able to model losses of river water to an underlying groundwater system and gains of groundwater from an underlying groundwater system.		365	Tested under QC Id 287			
Groundwater	2	To be able to model both saturated or unsaturated connections between the river and the groundwater as the flux estimation method and the relevant processes are different for each of those two connection types.		366	Tested under QC Id 287			
Groundwat	3.	Depending on the type of		367	Tested under QC Id 287			

er		connection, the exchange flux can be attributed to one or more of the following relevant processes: (1) natural exchanges between the river and the aquifer as driven by the difference in river and water table levels during and outside flood events; (2) return of overbank flow into wetlands through the groundwater system; (3) exchange due to groundwater pumping; and (4) exchange due to evapotranspiration.						
Catchment water yield	1.	To be able to model catchment runoff for a river system model node given climate data.		513	Prototype works as required. Needs testing in RiverManager after implementation completed.			
Optimised NetLP: Timestep	1.	To be able to model a system at a monthly timestep.		427	• Broad objective and requires interaction between different functional components of the software • No specific test performed since it can be undertaken only after majority of functional components are bug-free and reasonably complicated model can be built			
	2.	To be able to model a system at a daily timestep.		428	• Refer to QC ID 427			

	3.	To be able to read in data with units appropriate to the modelling timestep.		429	• Meets the requirement of inputting and outputting data at inflow and water user nodes for monthly and daily timesteps in version 2.0.2 • No tests performed for other components and timesteps		• Should be possible to use ML/month rather than ML for input and output in monthly timestep (RM-804)	
Optimised NetLP: Diagnostics	1.	To be able to view the details of the total network, including hidden arcs and nodes, costs and capacities at the time of a crash.		430	Ownership off - The details of the total network, including hidden arcs and nodes, costs and capacities can be viewed. The addition of extra arcs for trapping crashes has not been implemented as it has not been required.			
Cost setting	1.	The user will be able to define costs to set priorities. Note. The ability to assign costs for the minimum flow node has not yet been implemented.		431	• Ability to define costs for setting priorities between different components (e.g. minimum flow requirement, demands etc.) has not yet been implemented in version 2.3.1 • Requirements as specified in the specification: - Ability to assign costs to minimum flow nodes and/or links (RM-2834/ RM-2811) -Ability to assign costs to expressions in max flow node to emulate parallel links (similar to that in REALM) (RM-2836).		The ability to specify costs and capacities for multiple parallel arcs is proposed for the maximum flow node. The ability to determine capacities, and possibly costs, for these arcs with expression editor is desirable, but expensive to implement. Priorities for this work need to be established.	Method for implementing additional functionality has been determined. Not yet implemented. Priorities agreed at URG meeting no. 9.
Optimised NetLP: Expression Editor	1.	Be able to flexibly define values for features, attributes or quantities such as capacities, demands and		432	• Partially meets the requirement in version 2.3.1 given Item (a) and subject to Items (b) to (f)		• Design of expression editor should be improved such that - Last Iteration in date range	This issue is still being

		losses as functions of modelled or external quantities.			- (a) Modelled source variables referred to flow out other downstream reach of splitter or downstream system variables failed due to zero value for these variables (RM-2870) - (b) All tests conducted are in NetLP mode, monthly timestep and using expression editor in minimum flow node - (c) Modelled source variables referred to are only from upstream inflow and storage nodes - (d) Only date range tested while referring to the modelled source variables is last timestep - (e) Tests do not include ownership - (f) Not all units available in expression editor while referring to modelled source variables are tested.		referencing and ordering network referencing for source variables should not be available (and therefore greyed) for simulation in rules-based mode (RM-2840) - - Last iteration in date range referencing should not be available (therefore greyed) if ordering network referencing for source variables is not selected (RM-2840) - Duplication to choose units in expression editor should be avoided and simplified to avoid confusions for users, specially for global expressions (RM-2134)	investigated.
	1.1	To be able to refer to quantities modelled within the current timestep.		433	• Partially meets the requirement in version 2.3.1 given Item (a) to (c) and subject to Items (d) to (g) - (a) If forecast from previous timestep is selected in daily models, tests failed by using the forecasted inflows not the actual inflows to calculate the system variables of “Last Iteration”, which gives different meaning of last iteration in			Was re-tested. The issues affecting monthly models are being investigated. The issues affecting daily models will

					Expression Editor in daily models (RM-2056) - (b) If selecting last iteration of system variables in expression editor in timeseries demand nodes, tests failed by giving the same results as selecting last timestep in date range since demand is not updated on each iteration (RM-2056) - (c) Modelled source variables referred to downstream system variables of last iteration failed due to zero values for these variables (RM-2870) - (d) All tests conducted are in NetLP mode, monthly timestep and using expression editor in minimum flow node - (e) Modelled source variables referred to are only from upstream inflow and storage nodes - (f) Increase in number of minimum iterations required - (g) Not all units available in expression editor while referring to modelled source variables are tested. • Improvement required for Victorian trial catchment model are: - Different flow rate units (e.g. ML/d,			be addressed after issues affecting monthly models are resolved.

					ML/month, ML/year etc.) should be available when ordering network referencing for source variables is selected (RM-2292) - Ability to refer to storage level of storage ordering network in expression editor in NetLP mode (RM-2839) - Referencing to downstream system variables including last time step, last iteration etc. in expression editor should be available (RM-2870) Referencing to last iteration system variables in expression editor in daily time step models should be the same as in monthly models (i.e. being able to refer to last iteration of current time step system variables) (RM-2056).			
Optimised NetLP: Storages	1.	To apportion storage of water and releases from storage according to user defined target rules for: • Storages in series • Storages in parallel • Combinations of storages in series and parallel.		434	• Storages in series or combination of storages in series and parallel and monthly timestep - Partially meets the requirement in version 2.3.1 given Items (a) to (b) and subject to Item (c) - (a) In case of tests using RELAX IV or PPRN Without Side-Constraints, water can now be released from upstream storages to supply downstream demands once the downstream storage reaches dead storage when there is enough water in the upstream storages, However, as a dead storage carryover arc is now		• Users should have flexibility to define variable increments for the costs of storage carryover arcs rather than just assigning fixed increment.	Re-tested. The issues affecting monthly models are being investigated. The issues affecting daily models will be addressed after issues affecting

					included in arc-node network the other carry-over arcs and cost functions should be based on active storage (i.e.full supply - dead storage), and the user interface to define the cost functions for storages should also changed to be consistent with this (RM-2980, RM-2442, RM-2371) - (b) In case of tests using PPRN With Side-Constraints, demand shortfalls are not assigned according to user defined demand priorities and the same dead storage issue in cost functions as addressed for RELAX IV or PPRN Without Side-Constraints above (RM-2980, RM-3194) - (c) Test included only 3 storages in series or 2 upstream storages in parallel linked to 1 downstream storage in series • Storages in series or combination of storages in series and parallel and daily time step - Fails to meet the requirement in version 2.3.1 since NetLP does not apportion storage of water and releases from storage according to the user-defined storage cost functions (RM-2784) and travel time in daily NetLP models is still being implemented and debugged (RM-2494). • Storages in parallel and monthly timestep - Meets the requirement in			monthly models are resolved.

					version 2.3.1 subject to: - Test included only 2 storages in parallel. • Storages in parallel and daily timestep - Fails to meet the requirement in version 2.3.1, since travel time in daily NetLP models is still being implemented and debugged (RM-2494). • Improvements required for Victorian trial catchment model are: - Storage targets (defined by storage carryover arcs/cost functions) should only be used to decide preferences for releases or storing water such that user can define required distribution of water within different storages in the system. However there should be flexibility for storages going above or below the targets if required for satisfying demands. The NetLP solvers should ensure that supply of demands has higher priority than meeting storage targets In case of system with storages in parallel / series and different travel times to the extraction node, ambiguity in specifying order/travel times should be avoided if users have to specify order/travel times at extraction point nodes (RM-2494)...			
	1.1	Be able to group storages into different sub-systems		435	• Grouping storages into different sub-systems has not yet been implemented in			

		and specify target rules for different sub-systems. Note. The storage carry-over scheme implemented in River Manager means that there is no technical advantage to implementing storage groups in River Manager.			version 2.3.1, thus unable to be tested. Note that ability to assign reservoirs in sub-groups is required for useability and resource assessment (RM-2832).			
	2.	Be able to select different outlet paths from a storage.		436	Ownership off - functionality complete. Passes for Relax1v and PPRN without side constraints. PPRN with side constraints needs more work.			
	3.	Be able to select multiple outlets for each outlet path.		437	As for QC ID 436			
Optimised NetLP: Inflow	1.	Be able to: • model a timeseries of inflow read from a data file • utilize inflow from the current timestep for supplying demands.		438	• Monthly timestep, single storage system: - Meets requirement in version 2.3.1 if inflow forecast based on current timestep and additional enhancement required (refers to comments on Additional enhancement required) - In version 2.3.1 if inflow forecast based on previous timestep in monthly models, River Manager calculates the forecast inflow volume based on last month mean daily flow rate and the number of days of this month (RM-2016). An alternative approach would be to use last month flow volume for forecasting purpose. Therefore, this method needs to be discussed further to agree on the best		If forecast inflow is based on current timestep (i.e. travel time of 0 units), the recession parameter K does not affect the results. Therefore for such situation, the input box for parameter K should be greyed/inactivated to avoid confusion for users	Re-tested. Need to resolve basis of calculating monthly recession flows.

					approach - Tests performed with no ownerships. • Daily timestep, single storage system: - Meets the requirement if inflow forecast based on previous timestep and current timestep in version 2.2.4 except titles of outputs reported by recording manager are not correct (RM-2575) - Tests performed with no ownerships. • Multi-storages system: - Not tested in version 2.3.1 since travel time in daily NetLP models is still being implemented and debugged (RM-2494).			
Optimised NetLP: Demand	1.	Be able to model a timeseries of restricted demand read from a data file.		439	• Meets the requirement in monthly timestep in version 2.3.1 subject to - Tests do not include ownership. • Meets the requirement for single storage system in daily timestep in version 2.3.1 subject to - To account for travel/order time in the system, a warm up period (i.e. run model for n time steps lag before the actual simulation period) is required to ensure that demands can be supplied at the first			Re-tested. Debugging daily net_LP functionality has a lower priority than monthly functionality.

					n time steps - Tests do not include ownership. • Multi-storage system (two parallel storages) in daily timestep: - Unable to retest in version 2.3.1 since travel time in daily NetLP models is still being implemented and debugged (RM-2494). • Improvements required for Victorian trial catchment model are: - In case of system with storages in parallel / series and different travel times to the extraction node, if users have to specify order/travel times at extraction point nodes, ambiguity in specifying order/travel times should be avoided (RM-2494) Functionality for predicting orders based on travel/order time should exist in water user node, at least when timeseries input in expression editor is used to define the demand (RM-1727).			
	1.1	Be able to specify priorities of supply for demands.		440	• Fails to meet the requirement in monthly timestep in version 2.3.1 given that - Demand shortfalls are not assigned according to the user-defined demand priorities in the use of RELAX IV and		• Users should have flexibility to define variable numbers of shortfall arcs for each demand rather than just assigning a fixed number of shortfall arcs for all demands (RM-2845).	A method for fixing the problem with RELAX1V

					PPRN Without Side-Constraints with losses in the systems (RM-3194) - Demand shortfalls are not assigned according to the user-defined demand priorities in the use of PPRN with side-constraints in storages in series (RM-3194). • Unable to test in daily timestep in version 2.3.1 since travel time in daily NetLP models is still being implemented and debugged (RM-2494). • Improvements required for Victorian trial catchment model are: - Supplying demands should have higher priority than meeting storage targets - Capability to assign demands in groups (RM-2833) - Demand shortfalls should be distributed according to user defined demand priorities irrespective optimisation algorithm selected (RM-3194).			and PPRN without side constraints has been agreed. A fix for PPRN with side constraints is being considered. Supplying demands has a higher priority than meeting reservoir targets,
Optimised NetLP: Flow Constraints	1.	Be able to: • specify a minimum flow rate for a link which the system must try to meet, and which has a higher priority of		441	• Meets the requirement for ability to specify minimum flow rate in version 2.3.1 subject to - All tests were with single storage system			

		supply than demands • specify a maximum flow rate for a link.			- Specification of minimum flow rate by fixed monthly pattern and monthly requirement through expression editor were tested - Not all options available in expression editor to specify minimum flow requirement were tested. • Meets the requirement for ability to specify maximum flow rate in version 2.3.1 subject to - All tests were with single storage system - Specification of maximum flow rate by fixed flow rate and fixed flow rate through expression editor were tested - Not all options available in expression editor to specify max rate were tested. • Improvements required for Victorian trial catchment model are: - If users have to specify order/travel times at min flow requirement nodes, ambiguity in specifying order/travel times should be avoided in systems with storages in parallel / series and different travel times (RM-2494) - Functionality for predicting orders based on travel/order time should exist in			

					minimum flow node, at least when timeseries option of expression editor is used to define the minimum flow rate (RM-1727).			
Optimised NetLP: Loss	1.	Be able to specify loss functions for links.		442	• Partially meets the requirement in version 2.3.1 given Item (a) and subject to Items (b) to (c) - (a) If the NetLP algorithm "RELAX IV", "PPRN Without Side-Constraints" or "PPRN With Side-Constraints" is used, tests failed by distributing demand shortfalls different to user-defined priorities (note that "RELAX IV", "PPRN Without Side-Constraints" used to work correctly in version 2.1.2) (RM-3194, RM-2372) - (b) Increase in number of minimum iterations required when NetLP algorithms "RELAX IV" or "PPRN Without Side-Constraints" are used - (c) Loss relationship is monotonically increasing		• In many instances, losses are modelled as complex functions of combination of different modelled system variables (other than just upstream inflows) and external inputs. Therefore expression editor utility should be included in loss nodes such that complex losses can be modelled as functions of combination of different modelled system variables (not just upstream inflows) and external inputs.	PPRN with side constraints needs further attention.
Optimised NetLP: Effluents	1.	Be able to define a bifurcation.		443	• Tests for QC ID 445 cover this requirement also. Therefore refer to QC ID 445.			
	1.1	Be able to specify constraints on flow out an		444	• Meets the requirement in version 2.0.2 subject to			

		effluent.			- Tests undertaken in monthly timestep for a single storage system with one or two controlled splitters - NetLP algorithms tested were RELAX IV, PPRN Without Side-Constraints and PPRN With Side-Constraints.			
	1.2	Be able to specify the apportionment of flow down an effluent.		445	• Fails to meet the requirement in case of a single storage system in version 2.3.1 given that - Different modelling results were obtained between RELAX IV, PPRN Without Side-Constraints and PPRN With Side-Constraints when there is insufficient water in the system in the ordering phase / flow phase,(RM-2576). • Fails to meet the requirement in case of system of 2 storages in series and splitter between the storages in version 2.3.1 given that - Storages targets are not met and unexpected releases from storages at some timesteps in the use of PPRN With Side-Constraints (RM-2715). • Further improvements: - Clear solutions are required for NetLP to apportion order / flow at controlled splitters if there is insufficient water in			Re-tested.

					the system in the ordering phase or flow phase, meanwhile, meeting the supply priorities as required (RM-2576).			
Optimised NetLP: Confluences	1.	Be able to define a confluence.		446	• Meets the requirement in version 2.0.2 subject to - No travel time, lags or routing included in daily timestep tests - The NetLP algorithms tested are RELAX IV, PPRN Without Side-Constraints and PPRN With Side-Constraints.			
	1.1	Be able to utilise inflows from each tributary at a confluence.		447	• Meets the requirement in case of monthly / daily timestep in version 2.2.4 subject to - It is required to select either "Both Inflows Regulated" or "Unregulated Inflows" configuration at confluence, and selection of "Single Inflow Regulated" produces wrong results due to unexpected releases from storage and shortfall of min flow requirement in preference to demands (RM-2196) - The NetLP algorithms tested are RELAX IV, PPRN Without Side-Constraints and PPRN With Side-Constraints. • Further improvements: - It is required that selection of "Single Inflow Regulated" configuration at			Re-tested.

					confluence is available and works correctly. Otherwise, it will be confusing for users in the selection of appropriate configuration at confluence when it is used to link inflow from a tributary and releases from upstream storage.			
Optimised NetLP: Anabranch	1.	Be able to allow alternative flow paths, and unambiguously solve for flow.		448	• Monthly timestep test in version 2.0.2: - Manual calculation of expected results not possible due to complexity of the test model - Results assessed based on supply to min flow requirement and demands, demand shortfalls, and storage targets - Although these criteria were met, different optimisation algorithms may give different solutions for ambiguous flow paths (RM-2811). The implementation for adding costs to max flow nodes (RM-2836) is expected to resolve this issue. • Daily timestep test: - Unable to undertake the test in version 2.3.1 since travel time in daily NetLP models is still being implemented and debugged (RM-2494).			
Optimised	1.	Have the option of lagging		449	• Fails to meet the requirement for system			Re-tested.

NetLP: Routing		flow by a set number of timesteps.			with storages in parallel / series and different travel times in version 2.3.1, given that - NetLP does not apportion storage of water and releases from storage according to the user-defined storage cost functions in daily models (RM-2784) - Travel time in daily NetLP models is still being implemented and debugged (RM-2494). - There is a model stability issue, that is, different model results are obtained when the same models are built on different River Manager versions. • Improvements required for Victorian trial catchment model are: - In case of system with storages in parallel / series and different travel times to the extraction node, ambiguity in specifying order/travel times should be avoided if users have to specify order/travel times at extraction point nodes (RM-2494).			This is related to travel time and will be fixed when that is implemented
Optimised NetLP: Ownership	1.	Be able to support multiple owners: • internal spilling and		450	• Ownership not fully implemented in NetLP mode. Therefore, tests not undertaken in version 2.3.1.			

		ceding in storages • capacity sharing in storages • capacity sharing in links • sharing demand shortfalls .						
RA – General requirements	1	Users must be able to configure one or more resource allocation systems for a RiverManager scenario.	E	238	RM performs according to specification	-	-	
RA – General requirements	2	Users must be able to view and change configuration details for each resource allocation system.	E	239	RM performs according to specification	-	-	
RA – General requirements	3	Users must be able to delete an existing resource allocation system from a RiverManager scenario.	E	240	RM performs satisfactorily	Deletions can now be undone by selecting the 'Cancel' function in the Resource Assessment explorer. All changes are undone and the	Possible improvement to RM: It would be great (but not necessary) to have a warning when deleting any part of the resources assessment - i.e. "are you sure you want to delete resource assessment system?"	Re-tested.

						deleted resources assessment system is reinstated.		
RA – General requirements	4	Users should be able to link water users to resource allocation systems.	E	241	RM performs satisfactorily, but slightly differently from the specification. The process of linking a water user as described in the specification (page 22, actor actions 1-4) varies from the process followed in the software. (A problem here is that the process is slightly different to the Spec, otherwise it works fine.)	-	Enhancement to specification (page 22): The process of linking a water user to a resource allocation system as explained in the specification is as follows: Right-click on Resource Assessment system → select 'Add Water User' function → then use the 'Add Water User Account' function. The actual process in RM is as follows: Right-click on Resource Assessment system → select 'Add Account Type' function → right-click on the account type → select the 'Add Account' function → configure the account (a valid water user will be selected as the account holder)	Re-tested.
RA – General requirements	4.1	Users should be able to add/modify/delete a water user's resource allocation system membership.	E	242	RM does not perform according to specification but performs satisfactorily, and the specification requires change.	-	Enhancement to specification: Same section and enhancement as mentioned above. The use cases describe processes which are not the same as the process followed in the modelling platform.	
RA – General requirements	4.2	Users should be able to link water users to more than one resource allocation system.	E	243	RM does not perform according to specification but performs satisfactorily, and the specification requires change (see QC Id 241 - this test refers to same process (page 22, actor actions 1-4) therefore, same changes).	-	Enhancement to specification (page 22): Same section and enhancement as above. Enhancement to RM: The 'Originating Allocation System' option in the 'Account Type' form should default to the allocation system is actually falls within.	
RA –	5	Users must be able to	E	244	RM performs according to specification, in	-	-	

General requirements		configure/modify the shares of water users within a resource assessment system.			terms of configuring and modifying.			
RA – General requirements	6	The system must keep track of the allocation as calculated by the resource allocation system.	E	245	RM performs satisfactorily, but with restrictions. If simple resource assessment is used, ensure there is not more than one scenario with the same water users and accounting (update provided by Rhett 13/08/2010).	The system is able to keep track of allocations.	Enhancement to RM: Other resource assessment types implemented in RM will probably override the need for this to be fixed in the short term, but multiple scenarios with water users and simple resource assessment should be able to be recorded (RM-2498).	Re-tested.
RA – General requirements	7	The system must provide a report on resource allocation assessment calculations (i.e. the resource assessment procedure produces a trace of the calculations).	E	246	RM does not perform satisfactorily, no report of the resource assessment calculations is provided. The issue of whether to provide calculations is still under discussion. There is still no consesus about this issue. So it is not so much a fail, more that it has not been implemented yet.	-	Enhancement to RM: A trace of the resource assessment calculations to be added if still deemed necessary.	Re-tested.
RA – Continuous sharing	1	To be able to model and simulate the Continuous Share Resource Assessment System.	E	309	Further in-depth testing of this functionality and checking of JIRA issues is required and currently underway.	Continuous Sharing functionality has been implemented in RM. One round of testing (and resulting enhancements and fixes) has been completed, further testing is being undertaken now.	Feedback has already been provided once, further testing is now being completed to determine whether further enhancements are required.	Re-tested

Storages		Storages able to represent regulated on and off-stream dams, weirs and large unregulated farm dams	E	363	Specification for storages has not been finalised, this has limited complete testing of storages. Ownership on – incomplete, also need more detail in specification on ownership		Review required for storage specification – physical operation, and changes required for ownership at nodes. Changes also required to software.	
Storages		Controlled releases to meet downstream orders	E	345	Ownership off – testing incomplete, basic functionality operational but incorrect behaviour when extrapolating (RM-842).		Software needs to be updated to correct when extrapolating.	Jira issue RM-842 has been fixed.
Storages		Various and multiple outlet types (pipes, pump, valves, gated and ungated spillways)	E	346	The functionality adequately models the behaviour of the following outlet types from a storage both individually and in combination on an outlet path: Ungated Spillway Gated Spillway Valve Hydropower Valve Culvert Pump		On one outlet path with multiple outlet types it could be beneficial to prescribe which outlet has priority e.g. Hydropower valve is used where possible despite the outlet also having a gated spillway, to ensure accurate calculation of hydropower generation. On a storage for a level of zero a surface area greater than 0 should be able to be specified.	
Storages		Ability to control outlets separately (refer to multiple outlets function)	E	347	Existing functionality in the model can be used to meet the requirements		Potentially desirable to prioritise outlets on the outlet path as well as prioritising outlet paths. It is currently possible to model each outlet separately and direct a downstream order to the appropriate path using expression editor function. Proposed ordering methodology could	Re-assessed.

							probably replicate this methodology as well.	
Storages		Allowance for spills when storage level exceeds full supply level	E	348	Ownership off – testing incomplete, basic functionality operational but incorrect behaviour when extrapolating (RM-842)		Software needs to be updated to correct when extrapolating.	Jira issue RM-842 has been fixed.
Storages		Provision for flood mitigation (provided using a minimum flow node)	E	349	Minimum flow node functionality complete for ownership off and ownership on.		Adequacy of expression editor to define operational rules (e.g. restrictions to rate of change in release) needs some further consideration.	
Storages		Rainfall and evaporation from water surfaces	E	350	Ownership off – testing complete except for testing of extrapolation using rainfall.		Does not include groundwater flux in user requirements.	
Storages		Expression editor for outlet relationships	NH	351	Not implemented.			
Storages		Head driven connections between storages and rivers (refer to wetlands function)	HD	352	Not implemented.			
Storages		Routing through weirs (refer to weir function)	E	353	This requirement is covered by QC Id 267			
Storages		Storage operation rules	HD	354	Operational rules for storage will be controlled by either one of two ordering methodologies: Net LP Rules based and also resource assessments. The NetLP solutions is being tested elsewhere. The rules-based solution is not yet adequate to test properly			
Storages		Multiple downstream	E	355	This requirement is addressed in the tests			

		links(refer to multiple outlets function)			265, 270, 271, 272, 273			
Storages		Ability to pump from inactive storage	D	356	Pumping was allowed to occur below the specified dead storage level. User needs to ensure that outlet relationships for other outlet types do not allow the storage to go below dead storage level.			Re-assessed.
Storages		Hydropower release (through turbine) (refer to hydropower function)	D	357	Testing based on Power Generation Component of Hydropower Specification Version 0.5: Ownership off - functionality complete			
Storages		Ability to override simulated storage releases with observed releases to support calibration of RiverManager/RiverOperator.	E	358	Functionality complete.			
Storages		Ability to manually override forecast storage releases for RiverOperator to support river operations	E	359	Not really. Can only do it one cell at a time in the Tabular Editor. Need to be able to set within the individual Feature Editor with a 'forecast tab' so seasonal plans etc for storage releases can be uploaded for the forecast period. (Shorter term scenarios and analysis for immediate operational decisions can then be undertaken in the Tabular Editor).		Need to be able to set within Feature Editor in a forecast tab so seasonal plans, expressions (e.g. an expression that matches the forecast release to the forecast inflows to maintain a pool level instead of just filling the storage) etc can be uploaded or implemented for the forecast period. This may already be possible if the storage is ticked as a weir but the River Operator currently crashes when I do this (i.e. in V 2.0.2).	To be re-tested in the Beta release
Storages		Ability to specify ownership associated with observed releases	HD	360	Not assessed. Ownership on links not yet implemented,			

Storages		Ability to override simulated storage levels and volumes with measured storage volumes and levels during a warm up period (RiverOperator)	E	361	Functionality as described is basically in place but there is a bug that seems to stop it working properly. (JIRA SR-3)		Need to be able override the calculated forecast releases to maintain a pool level – see the enhancement described for QC Id 359	To be re-tested in the Beta release
Storages		Ownership	E	362	Not tested.			
Multiple storage outlets	1.	Ability to connect more than one flow outlet path to a storage	E	265	Functionality complete multiple downstream links were able to be connected to a storage node			
Multiple storage outlets	1.1	To model anabranches that are driven by the head in a storage	E	269	Not separately assessed.			
Multiple storage outlets	1.2	To provide more than one downstream reach	E	270	Functionality complete multiple downstream reaches were able to be connected to a storage node			
Multiple storage outlets	1.3	To have town water supplies connected to a separate outlet path	E	271	Functionality complete The user is able to specify a town water demand from a storage via the water user node and extraction node		A separate urban demand model available to the water user node	
Multiple storage outlets	2.	To be able to associate different outlets with different outlet paths	E	272	Functionality complete 15 outlets were assigned to 10 different outlet paths from a single storage.			
Multiple storage outlets	3.	To be able to specify the priority of the different outlet paths	E	273	Functionality complete with the exception of one minor bug			
Weirs	1	Able to route flow in a storage that is subject to drown out from downstream water levels	E	264	Testing based on Weir Specification 2.1 The proposed methodology does not handle a weir that is subject to downstream drown		The storage calculation need s to have an exception for weirs that are flooded that is able to set the weir storage based on the downstream flow and set the	

					out		storage outflow to the calculated routing outflow The program develops an exception after running the model and crashes	
Weirs	2	Able to have multiple effluents (either regulated or un-regulated)	E	265	Pass. Issues with the stability of the weir node have been resolved in subsequent debugging			Re-tested.
Weirs	3	Provide the basis for the ability to route water quality constituents through the storage	E	267	Not yet implemented.			
Weirs	4	Able to control operation of the weir node through minimum and maximum operating targets	E	268	Passes under normal conditions. A solution has been developed for operation during floods.			Re-tested.
Hydropower	1	Ability to include a turbine on a valve outlet to determine the power generated over time.	D	332	Testing based on Power Generation Component of Hydropower Specification Version 0.5: Ownership off - functionality complete			
Hydropower	2	Ability for the user to view power generated over time	D	333	As for QC ID 332			
Hydropower	3	Ability to specify which power units are used for output.	D	334	As for QC ID 332			
Extraction node	1.	To be able to specify the upstream reservoir or combination of reservoirs (using a confluence) that an order is directed to.		336	RM does not perform according to the specification. Extraction points can be configured satisfactorily, but there are a number of differences to the use case described in the specification (page 21). At this stage, orders cannot be sent to a confluence or a combination of storages.	-	Enhancement to specification (page 21): Slight changes necessary in description of extraction point configuration. Enhancement to RM: The ability to specify and configure a combination of reservoirs that an order is directed to.	Ordering specification is currently being re-written.

					Configuring one storage as the supply reservoir works as expected.			
Extraction node	2.	To allow for the delivery time (order time) between the most upstream storage used to deliver the order and the extraction node.		337	RM performs satisfactorily, there is little mention of this feature in the specification.	-	-	
Extraction node	3.	To be able to extract water from regulated and unregulated river systems and groundwater sources		338	RM performs satisfactorily, water is able to be extracted from both regulated and unregulated river systems. Configuring an unregulated extraction point/water user is slightly different to the process explained in the specification (page 22). (The only problem now is that the process is slightly different to the Spec, otherwise it works fine.)	For unregulated water users, water is now extracted from run of river only, as opposed to forcing releases from the storage as it was previously.	Enhancement to specification (page 22): It is not possible to 'check' the unregulated water source option, only to 'uncheck' both regulated and groundwater sources (page 22).	Re-tested.
Extraction node	4.	To be able to limit the extraction to a specified capacity		339	RM performs satisfactorily, there is possibility of an output enhancement.	-	Enhancement to RM: In the scenario results it would be ideal if there was an output (either in the extraction point or water user) which reflects the actual volume the water user wants to order, instead of just the constrained extraction point volume.	
Extraction node	5.	To specify a minimum river flow rate that must be exceeded for the extraction node pump to work		340	RM does not perform according to the specification, there is currently no option available to specify a minimum flow rate above which extractions may begin	-	Enhancement to RM: That the functionality to specify a minimum flow rate is added to the modelling platform.	
Extraction node	6.	To identify a threshold when flow in the river is overbank and is not subject to extraction and licence limits.		341	UI implemented, but functionality not yet implemented.			

Extraction node	7.	Be able to increase orders at extraction nodes to model operational efficiency		342	RM performs satisfactorily, there is possibility of an output enhancement.	-	Enhancement to RM: In the scenario results in the recording manager, the ordered volume (that is the RM 'Volume Ordered' output for the extraction point) should reflect the actual volume the extraction point wants to order (that is, including the over order factor), as opposed to the volume required by the water user.	
Water user – local storage		Refer to water user node requirements						