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|  Revision of Long-Term Diversion Limit Equivalent Factors for Victoria’s Basin Plan Water Recoveries Technical Report Nov 2019 |

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Executive Summary

To achieve the Sustainable Diversion Limit (SDL) under the Basin Plan, the Commonwealth Government (the Commonwealth) commits to recover water through purchases and water savings. At the basin level, the amount of water to be recovered to meet the SDL is 2,075 GL with SDL offsets and Northern Basin amendments. To allow the Murray-Darling Basin Authority (MDBA) to report on water recovery in a way that is consistent and accurate across the Basin, each valley's entitlement classes are given a conversion factor to translate through to average use, so they can be counted on equal terms.

This conversion factor is commonly called the 'Cap Factor', but the formal Basin Plan term is long-term diversion limit equivalence (LTDLE) factor. LTDLE factors represent the long-term average annual usage of an entitlement by taking into account the average availability and utilisation of the entitlement. The Commonwealth uses LTDLE factors to calculate the long-term average annual yield (LTAAY) of water entitlements that it purchases for the environment.

LTDLE factors are values ranging from 0.0 to 1.0 and are assigned to each entitlement class that reflects estimates of long-term average actual water use. This is different to the reliability of an entitlement, which considers water availability. The factors are also focused on historical patterns and are not a prediction or a guide of future water use. The factors have no impact on entitlements or water availability.

LTDLE factors are being revised because existing published factors are based on out of date information and are not consistent with baseline diversion limits (BDL). The revised factors presented in this report provide a better representation of the usage of entitlements in Victoria’s water resource plan (WRP) areas. The revision also aims to protect existing entitlement holders from any third-party impacts that might arise from Basin Plan recoveries made through purchases by using Victoria’s best available data on long-term average annual yields of entitlements. The revised LTDLE factors can be used to estimate Basin Plan recoveries in the absence of water resource models that represent those recoveries explicitly in the model configuration. If such a model currently exists, recovery estimates obtained directly from the model will take precedence over any estimates obtained using LTDLE factors.

The methodology used to calculate the revised factors is documented in this report to ensure the process is repeatable, transparent and auditable. In summary, the revised LTDLE factors are developed using either of the following equations (both yielding the same result):

$$LTDLE Factor=Average Availability Factor\*Average Utilisation Factor=\frac{Average Diversion}{Entitlement}$$

Modelled utilisation is sourced from the BDL models sumbitted to the MDBA as part of the WRP submission. The revised LTDLE factors used for Basin Plan water recovery are listed in the table below, along with the version used previously.

|  |  |  |
| --- | --- | --- |
| System | Entitlement class | LTDLE Factor Versions |
| **v2.05** | **Revised** |
| Broken | High reliability | 0.950 | 0.570 |
| Low reliability | 0.767 | 0.083 |
| Campaspe | High reliability | 0.950 | 0.950 |
| Low reliability | 0.490 | 0.571 |
| Coliban Urban and Rural | 0.900 | 0.797 |
| Goulburn | High reliability | 0.950 | 0.967 |
| Low reliability | 0.350 | 0.583 |
| Loddon | High reliability | 0.950 | 0.624 |
| Low reliability | 0.270 | 0.050 |
| VIC Murray | High reliability | 0.950 | 0.974 |
| Low reliability | 0.240 | 0.543 |
| Wimmera-Mallee | Irrigation Product including Losses | 0.806 | 0.828 |
| Ovens | Regulated irrigation | 0.950 | 0.450 |

Additionally, some entitlements obtained for Basin Plan water recovery have no equivalent entitlement present and modelled under BDL. Alternate methods based on best available information have been used to convert these to an estimated recovery volume for the purpose of calculating the extent in which the gap between BDL and SDL has been bridged as specified in the Murray Darling Basin Plan 2012.

|  |  |  |
| --- | --- | --- |
| System | Entitlement class | Factor |
| Campaspe | Very high reliability entitlement from Campaspe Irrigation Area decommissioning | 1.000 |
| Loddon | Very high reliability entitlement from East Loddon Waterworks District decommissioning | *See footnote1* |
| Wimmera-Mallee Pipeline Savings Entitlement in the Loddon system | 1.000 |
| VIC Murray | Unregulated entitlements associated with Green’s Lake decommissioning | *See footnote2* |

*1Entitlement resulting from the decommissioning of East Loddon Waterworks District has unique rules / conditions that do not make it equivalent to a Loddon high reliability water share. The water savings volume of 1.478 GL is a modelled outcome and the resulting entitlement was determined as 1.480 GL*

*2The entitlement resulting from the decommissioning of Greens Lake has no equivalent modelled under BDL. The water savings volume is a modelled outcome resulting from an increase of 7.1 GL and 1.2 GL in end-of-valley flows from Goulburn and Loddon respectively. The resulting VIC Murray unregulated entitlement of 9.0 GL is calculated using an agreed method between DELWP and MDBA.*

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# Introduction

## Basin Plan recoveries

In 2012 the Murray-Darling Basin Plan was introduced to ensure sustainable management of the Basin’s water resources. Modelled long-term average surface water diversions as at 30 June 2009, were determined and defined as the baseline diversion limit (BDL). The Basin Plan sets out a long-term average sustainable diversion limit (SDL) for the Basin that will come into effect in 2019. At the basin level, the amount of water to be recovered to meet the SDL is 2,075 GL excluding SDL offsets of 605 GL. The actions taken to ‘bridge the gap’ between the BDL and SDL include purchases by the Commonwealth and investments in improved infrastructure in addition to SDL offset projects.

## What are LTDLE factors?

LTDLE factors represent the long-term average annual usage of an entitlement by taking into account the average allocation and utilisation of the entitlement. The Commonwealth uses LTDLE factors to calculate the long-term average annual yield (LTAAY) of water entitlements that it purchases for the environment.

Table 1 shows an illustrative example of how LTDLE factors can be used to determine the basin value of different entitlement classes in two catchments. In this example, the High Reliability Water Share (HRWS) entitlement in catchment A, offers the Commonwealth the highest LTAAY value in water recovery towards reaching the SDL target.

High reliability entitlements will always have much greater LTAAYs than low reliability entitlements as they have a higher rate of allocation. The difference between the value of HRWS in Catchment A compared with Catchment B, could be due to a number of factors impacting use and allocation. For example, differences in irrigator behaviour or catchment water availability.

Table 1‑1 Illustrative example of using LTDLE factors to calculate recoveries from purchases of different entitlements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SDL resource unit | Entitlement Type | Entitlement Volume | LTDLE factor(illustrative only) | Long-Term Average Annual Yield (LTAAY) |
| A | HRWS | 1000 ML | **0.950** | 950 ML |
| A | LRWS | 1000 ML | **0.350** | 350 ML |
| B | HRWS | 1000 ML | **0.813** | 813 ML |

## LTDLE factor versions and their usage

Prior to the implementation of the Basin Plan, limits or ‘caps’ on diversions were in place under the Murray-Darling Basin Agreement. Under cap accounting a set of factors were developed by Basin States for trade and to calculate environmental water recovered as a result of The Living Murray (TLM) program. These factors were termed ‘Cap Factors’ but are now known as LTDLE factors under Basin Plan reporting. The factors have since been updated by MDBA and Basin States. A key version is version 2.05 (v2.05), which was published by Department of Sustainability, Environment, Water, Population and Communities was used in Victoria to calculate recoveries from purchases. V2.05 factors has several technical issues, including that they do not reflect the Basin Plan 2012 BDL definition. There are subsequent LTDLE factor versions following V2.05 but they have no formal status under the Basin Plan.

## Review of LTDLE factors

The LTDLE factors currently used by Victoria to calculate Basin Plan recoveries contain some technical issues. In particular, v2.05 contains significant technical problems including the inaccurate reflection of BDL definitions. These errors have compelled MDBA and other basin states to review their LTDLE factors.

Victoria has now developed a revised set of LTDLE factors which provides an improved representation of the entitlement values in Victoria’s water resource plan areas compared to previous versions. The purpose of the revision was to avoid third party impacts of Basin Plan recoveries by preventing Basin Plan recoveries, made through purchases, from adversely affecting the reliability of exisiting entitlements.

This report presents the revised factors and the methodology used to derive them. The revised factors represent Victoria’s best available data on the long-term usage of entitlements, and therefore, the best available estimate of the long-term yield for the Commonwealth, if those entitlements are purchased to recover water in the absence of water resource models where those recoveries are directly configured in the model.

The methodology documented in this report was endorsed by the MDBA commissioned independent review panel (IRP) in March 2019. The water resource models used to derive the factors have been further updated following IRP endorsement to satisfy MDBA requirements.

## Using the revised LTDLE factors

The revised LTDLE factors can be used to estimate Basin Plan recoveries in the absence of water resource models which represent those recoveries explicitly in the model configuration. If such a model currently exists, recovery estimates obtained directly from the model will take precedence over any estimates obtained using LTDLE factors.

Additionally, LTDLE factors presented in this document and accompanying spreadsheets, are rounded to the third decimal point and should be used accordingly, to maintain consistency with previous LTDLE factor versions which were also rounded to the third decimal point.

# Methodology

## Principles

When developing the methodology used for the LTDLE factor revision the following key principles were applied:

* LTDLE factors assumes BDL conditions, and are developed using the best available models which represents those conditions
* Models and other aspects of the methodology utilises the best available data. Where data is not available, assumptions are made using the best understanding of the systems in question
* The process is repeatable, transparent and auditable
* All entitlements for each type are treated equitably and consistently (i.e. no different approaches for different entitlements or valleys)
* Entitlements with highly uncertain availability and usage data (e.g. unregulated) are not considered if LTDLE factors for them are not needed to calculate water recovery
* Environmental entitlements already present under BDL conditions (e.g. TLM) are not considered as as this revision is not intended to reassess their value.

## Categorisation of LTDLE factors

LTDLE factors are published for each of the entitlement categories, which are illustrated in the following sections. The categories represent different types of consumptive entitlements present under baseline conditions and contribute to the overall take from regulated systems (except for Ovens and Kiewa). Note that some categories consist of several subcategories. The subcategories are combined together as they can be considered as legally the same and once purchased to recover water, they are undistinguishable from one another. The published LTDLE factor for those categories is the weighted average of the unpublished LTDLE factor of the comprising subcategories.

### Northern Victoria Water Resource Plan Area

### Wimmera-Mallee Water Resource Plan Area

### Victorian Murray Water Resource Plan Area

## Input data

There are three external data types that are used to calculate LTDLE factors:

* Entitlements;
* Allocation (Seasonal Determination): To calculate *Average Availability Factor*, and
* Diversions: To calculate *Average Utilisation Factor.*

For the regulated component of LTDLE factors, the information above are obtained from outputs and parameters from hydrologic models wherever possible. As with the models used to calculate previous LTDLE versions, the models selected are the best available models which represent BDL conditions (30 June 2009 for Northern Victoria and Victorian Murray, 31 October 2010 for Wimmera-Mallee) that form part of Victoria’s Water Resource Plans submitted for acreditation. The models were run from 1895 to the latest available date, but long-term averages used in LTDLE factor calculations were calculated over the Basin Plan climate baseline period (1895 – 2009). Nodes and carriers representing each entitlement type are listed in Appendix A.

Table 2‑1 Hydrologic models used

|  |  |  |  |
| --- | --- | --- | --- |
| Water Resource Plan Area | Model | Platform | Run number |
| Northern Victoria | Goulburn Simulation Model (GSM) | REALM | 0935 |
| Wimmera-Mallee | Wimmera-Mallee REALM Model | REALM | BDL2 |
| Victorian Murray | Source Murray Model | Source | River Murray Model 4.8.1.rsproj |

For some unregulated components, particularly for Ovens and Kiewa, entitlements and diversions were obtained from data used in published Water Audit Monitoring (WAM) reports.

### Entitlements

The following sections outline how entitlement volumes are compiled from various data sources. For entitlement categories that represent or include losses, this also covers the relevant loss allowances. Entitlement volumes for each entitlement type are shown along with other parts of the LTDLE factor calculation in Appendix D.

#### Northern Victoria Water Resource Plan Area

Entitlement volumes for the Northern Victoria WRP Area were obtained from the GSM model where available. The entitlements within the model reflects the thorough verification and review of baseline conditions and entitlements documented in DELWP (2017a). For entitlement volumes that were not explicitly specified within the model, they are obtained directly from the Bulk Entitlement document or DELWP (2017a).

##### Rural (Irrigation areas, private diverters), Broken Creek Supplement, Tagged Trade

Entitlements are obtained from parameters within the hydrologic models. In the GSM, entitlements are obtained from limit curves within the demand nodes. For a given demand node, High Reliability Water Share entitlements are equal to the annual limit where allocation is at 100%. Low Reliability Water Share entitlements are equal to the annual limit when allocation is at 200%, less the High Reliability Water Share.

##### Urban & Coliban Water

Urban and Coliban Water demands are mostly obtained from parameters within the hydrologic models. Some urban and Coliban Water entitlements were obtained from limit curves within the demand nodes. Because there is no split between High and Low Reliability, the entitlements of those nodes are taken as the highest annual limit in the limit curve. In some cases, the demand node is not restricted using limit curves. In these cases, entitlement volumes are taken directly from Bulk Entitlements documents as compiled in DELWP (2017a).

#### Wimmera-Mallee Water Resource Plan Area

Entitlement volumes for the Wimmera-Mallee WRP area are obtained from the Wimmera-Mallee REALM model, specifically from the carrier ‘ENTITLEMENT’ where entitlement volumes from various entitlement groups are recorded. Entitlement volumes recorded in this carrier and used for LTDLE calculations are shown in Appendix A.2.

#### Victorian-Murray Water Resource Plan Area

##### In model / regulated entitlements

Entitlement volumes modelled in the Source Murray Model (SMM) are summarised in MDBA (2019) and shown in Appendix A.3.

The loss allowances associated with extra Torrumbarry and Broken Creek losses are not explicitly considered as separate entitlement categories. This is because according to the Bulk Entitlement, over the long-term, they form part of the normal loss allowances.

##### Kiewa and Ovens

Murray unregulated, Kiewa, and Ovens entitlements are obtained from the 2008/2009 Water Audit Monitoring reports, to reflect baseline entitlements like in regulated systems.

### Allocation

#### Northern Victoria Water Resource Plan Area

##### Rural (HRWS/LRWS)

Allocation of rural entitlements are obtained from the allocation outputs (RLVS in REALM) from the REALM demand nodes representing those entitlements. For rural demands modelled in GSM, allocation ranges from 0 to 200%, with 0 to 100% representing allocation of HRWS, and 101-200% representing allocation of LRWS.

For a given water year (1 July to 30 June), availability of each entitlement class is calculated by extracting the maximum allocation of each water year (i.e. June allocation) and splitting the total volume between HRWS and LRWS as described in Equation 2‑1. Average availability for each entitlement class is then obtained by averaging the availability for every water year as calculated in Equation 2‑1 over the baseline period (1895-2009).

Equation 2‑1 HRWS and LRWS availability factors for a given water year

$$\left(a\right) Availability\_{HRWS}=\frac{Min\left(100\%, Percent Allocation\_{June}\right)}{100\%}$$

$$\left(b\right) Availability\_{LRWS}=\frac{Max\left(0, Percent Allocation\_{June}-100\%\right)}{100\%}$$

##### Urban & Coliban Water

Due to the way urban demands are modelled in the GSM, there is no robust method to calculate average availability. Therefore, it is assumed that average allocation is equal to the modelled average diversion. In other words, the utilisation factor is assumed to be 1.00.

#### Wimmera-Mallee Water Resource Plan Area

The Wimmera-Mallee REALM model calculates volumetric allocation for various entitlement groups directly in accounting carriers. Therefore, in calculating the average annual availability, the capacity (CAPC in REALM) outputs were extracted from those accounting carriers, averaged for every water year in the baseline period (1895-2009), and aggregated to the entitlement classes considered in the LTDLE calculations. The average annual allocation of each of those accounting carriers, and the entitlement classes that each of those carriers belong to are shown in Appendix A.2

Because the model outpus volumetric allocation directly, the average annual availability factor is calculated as the ratio of the allocation and the entitlement.

#### Victorian Murray Water Resource Plan Area

##### Victorian Murray

Availability of entitlements are modelled through the annual accounting functionality in the Source Murray Model. As a result, the model records volumetric allocation outputs for each entitlement class in the Victorian Murray where LTDLE factors are calculated for. The output paths are summarised in Appendix A.3.

The volumetric allocation outputs include both consumptive and environmental (i.e. Snowy, TLM) components. LTDLE factors are calculated only for consumptive entitlement classes. To obtain the consumptive allocation outputs, the allocation outputs from the SMM are scaled down based on the proportion of consumptive entitlements in the total entitlement volume also included in Appendix A.3.

The extra losses (Torrumbarry loss allowance, and Broken Creek loss allowance) are considered to be part of the normal loss allowances over the long-term and therefore assumed to increase the availability of variable losses.

Initial loss allocation is a direct output rom the model. Consumptive (HRWS and LRWS), variable loss, and extra loss allocation are also obtained from the model but summed (combined) together. The reason for combining them is because the diversion outputs used from the SMM combines them also (see Section 2.3.3.2).

Equation 2‑2 can then be used to split the combined volumetric allocation into separate HRWS and LRWS volumetric availability.

Equation 2‑2 Calculation of a) HRWS and b) LRWS volumetric availability from combined volumetric availability

$$\left(a\right) Allocation\_{HRWS}=Min\left(Entitlement\_{HRWS}, Allocation\_{Combined}\right)$$

$$\left(b\right) Allocation\_{LRWS}=Allocation\_{Combined}-Allocation\_{HRWS}$$

Average availability is obtained by averaging the volumetric availability for every water year in the baseline period (1895-2009). The average availability factor is the ratio of this volumetric availability and entitlement volume.

##### Ovens, and Kiewa

Availability factors are not calculated for this entitlement class because they are unregulated. Volumetric availability is assumed to equal the volume diverted (see Section 2.3.3.2.3).

### Diversions

#### Northern Victoria Water Resource Plan Area

##### Rural (HRWS/LRWS)

Combined HRWS and LRWS diversions are obtained from the supplied demand outputs (SUPP in REALM) from the hydrological model demand nodes representing those entitlements (see Appendix A.1).

Because the supplied demand outputs do not distinguish between demands from the HRWS or LRWS, a method is needed to split those demands into each entitlement class.

The first step of the method is determining the breakpoint in the combined annual diversion. The breakpoint represents the maximum possible annual diversion against HRWS. Diversions above the breakpoint in a given water year can confidently be assumed to be diversions against LRWS.

The breakpoint can be calculated by finding the maximum annual diversion in years where allocation is at 100% (i.e. full HRWS allocation, no LRWS allocation). However, not every entitlement class has sufficient years where such allocation occurs. Therefore, to ensure that breakpoints can be determined for every entitlement class, the following method is used:

1. *Subtract the combined annual diversions by the maximum low reliability annual limit (LALL in REALM) in the same year, and*
2. *Find the maximum in the resulting annual series*

The low reliability annual limit (LALL) variable in REALM represents the low reliability water share annual usage volume limit (i.e. volumetric allocation including carryover) of any demand nodes with carryover configured.

After the breakpoint is identified, Equation 2‑3 can be used to calculate HRWS and LRWS diversions separately using the combined annual diversions produced by the model.

Equation 2‑3 Calculation of a) HRWS and b) LRWS diversions from combined diversions

$$\left(a\right) Diversion\_{HRWS}=Min\left(Breakpoint, Diversion\_{Combined}\right)$$

$$\left(b\right) Diversion\_{LRWS}=Diversion\_{Combined}-Diversion\_{HRWS}$$

The separated diversions are then aggregated to annual and averaged over the baseline period (1895-2009) to obtain the average annual diversions.

This is done on a demand node scale. Average annual diversion for each entitlement category is calculated by aggregating the average annual diversion from the demand nodes representing those entitlements (see Appendix A.1).

##### Urban & Coliban Water

Diversions for urban and Coliban Water entitlements are obtained from the supplied demand outputs from the hydrological model demand nodes which represent those entitlements (see Appendix A). The outputs are aggregated to annual and averaged over the baseline period (1895-2009) to obtain the average annual diversions.

#### Wimmera-Mallee Water Resource Plan Area

Diversions for the in-model / regulated entitlements were obtained directly from the Wimmera Mallee REALM outputs of the carriers which represent deliveries to the demand nodes representing those entitlements. In most cases the outputs extracted are flow outputs (FLOW in REALM), except one accounting carrier where the capacity output (CAPC in REALM) was extracted. In calculating the average annual availability, the capacity (CAPC in REALM) outputs were extracted from those carriers, averaged for every water year in the baseline period (1895-2009), and aggregated to the entitlement classes considered in the LTDLE calculations. The average annual diversion of each of those cariers, and the entitlement classes that each of those carriers belong to are shown in Appendix A.2

#### Victorian Murray Water Resource Plan Area

Diversion data used to calculate LTDLE factors for the Victorian Murray was obtained from the total Victorian diversion output. This represents consumptive (irrigation areas, private diverter, and urban) diversions, and diversions associated with Victorian Flora and Fauna Exchange entitlements and variable loss allowance. The SMM does offer diversion outputs for each individual entitlement class, however, due to the priority ordering configuration in the model, this data requires thorough verification before deemed suitable for use.

##### Initial losses

Due to the nature of initial losses and information available from the model, it is assumed that the average annual diversion equals the average annual availability. In other words, it is assumed that the loss allowances for those particular losses will be fully utilised.

##### Consumptive (HRWS/LRWS) (incl. VIC Flora Fauna, variable losses)

As the combined diversion output do not distinguish between demands from the HRWS or LRWS, a method is needed to split those demands to each of those entitlement classes. For the Victorian Murray, the breakpoint is assumed to be equal to the HRWS entitlement volume.

Using this breakpoint, Equation 2‑3 can again be used to calculate HRWS and LRWS diversions separately using the combined annual diversions produced by the model, less the initial loss.

The diversions are then aggregated to annual and averaged over the baseline period (1895-2009) to obtain the average annual diversions.

##### Ovens, and Kiewa

Diversions from the Ovens and Kiewa, both regulated and unregulated, are obtained from the regression equations used in the SMM. The total diversions are distributed to the different entitlement classes in those systems based on the average annual diversions of those entitlement classes reported in the Water Audit Monitoring (WAM) spreadsheets which are within the baseline period (1895-2009). The diversion data are available are only available in WAM spreadsheets from 1999/2000 onwards. Therefore, average annual unregulated diversions for each of the entitlement classes are calculated from 1999-2009.

## Calculating LTDLE

The following sections outline the steps involved in calculating LTDLE factors.

### Step 1: Calculate the Average Allocation (ML)

The Average Allocation is the average volumetric allocation of an entitlement class under BDL conditions. It is the product of the average availability factor (see Section 2.3.2), and the entitlement volume (see Section 2.3.1).

Equation 2‑4 Average Allocation (ML)

$$Average Allocation=Entitlement\*Average Availability Factor$$

### Step 2: Calculate the Average Utilisation Factor (-)

The Average Utilisation Factor represents how much of the Average Allocation is utilised. It is calculated as the ratio of the Average Diversion (see Section 2.3.3) and the Average Allocation. Although LTDLE factors can be calculated without this information, the AverageUtilisation Factor is still useful as it can be compared with observed utilisation to ensure that the utilisation modelled by the BDL model is reasonable and to confirm that out-of-model adjustment to utilisation is not required. This analysis is available in Appendix B.

Equation 2‑5 Average Utilisation Factor (-)

$$Average Utilisation Factor=\frac{Average Diversion}{Average Allocation}$$

### Step 3: Calculate the LTDLE factor

There are two ways to calculate LTDLE factors. One approach is to multiply availability and utilisation calculated in Step 1 and Step 2 respectively. Another is simply dividing the average diversion to the entitlement of each category. Both approaches will produce the same result.

Equation 2‑6 LTDLE factor (-)

$$LTDLE Factor=Average Availability Factor\*Average Utilisation Factor=\frac{Average Diversion}{Entitlement}$$

# Reconciliation with BDL

## Northern Victoria Water Resource Plan Area

The Baseline Diversion Limit (BDL) for the Northern Victoria WRP area will be provided to the MDBA as part of the submission of the revised Northern Victoria WRP area BDL model. The diversions calculated for the purpose of LTDLE factor calculations will contain differences to the BDL. The differences in volume are caused by differences in the way the diversions are calculated, with the BDL calculating them at the key diversion points (top-down approach) whereas the LTDLE calculations recognises them where they are being utilised (bottom-up approach). The key reasons for the differences are outlined in the following sections.

### Supplements to Waranga Western Channel

BDL accounts for supplements as diversions from the SDL resource unit that supplies them. Because diversions in LTDLE calculations are used to calculate utilisation, it recognises supplements as usage by the end users which receives them. In other words, supplements from Loddon and Campaspe will be counted towards utilisation in the Goulburn system. Therefore, to reconcile the modelled diversions in LTDLE calculations to the reported BDL numbers, supplements needs to be added back to Loddon and Campapse and subtracted from the Goulburn diversion in the LTDLE calculations.

Supplements from Campaspe were obtained using the flow output (FLOW in REALM) of carriers ‘CAMP SUPL TO WWC’ and ‘CIVTE ACTUAL VOL’. Supplements from the Loddon were obtained using the flow outputs of carriers ‘LOD TO WWC’.

### Serpentine Creek to Dingee

In the bottom-up LTDLE methodology, usage in Dingee counts towards utilisation in the Goulburn even though some of the supply comes from the Loddon through Serpentine Creek. To reconcile with the BDL, this supply and associated losses needs to be subtracted from the total modelled diversion in the Goulburn and added back to the total modelled diversion in the Loddon. Those are accounted in the FLOW and LOSS outputs of carrier ‘SERP CK TO DING FLOW’.

### Waranga Basin to Rochester Urban demand

In the bottom-up LTDLE methodology, Rochester urban demand counts towards utilisation in the Campaspe. However, some of the supply comes from the Waranga Western channel which is part of the Goulburn system. To reconcile with the BDL, this supply needs to be subtracted from the total modelled diversion in the Campaspe and added back to the total modelled diversion in the Goulburn. Those are accounted in the FLOW output of carrier ‘WWC TO ROCHESTER’

### Irrigation area losses

Irrigation area losses in the Northern Victoria WRP area are assumed to be the estimated physical distribution losses as modelled in GSM. LTDLE factors are not calculated for these losses as the corresponding loss provisions are not modelled in the GSM.

For irrigation areas in the Goulburn SDL resource unit, those modelled losses are recorded as a capacity output (CAPC in REALM) in the accounting carrier ‘GOULB TOTAL’, as well as the loss output (LOSS in REALM) in the carrier ‘SERP CK TO DING LOSS’ which represents losses from the supply to Dingee from Serpentine Creek. Total modelled loss is assumed to be the sum of the two outputs.

Modelled losses in the Campaspe Irrigation Area represented by the loss output (LOSS in REALM) of the carrier to the supplying irrigation area demand node (carrier TO CAMP IRRIG).

### Other diversions/use which doesn’t have an associated entitlement

Some diversions and use are excluded in the LTDLE calculation process, because they can’t be assigned to an entitlement class. Table 3‑1 summarises these demands and the demand nodes that represent them.

Table 3‑1 Diversions/use with no associated entitlement

|  |  |  |  |
| --- | --- | --- | --- |
| SDL resource unit | Diversion | Node / carrier | Output type |
| Goulburn | Supply to Wimmera Mallee | WIM MAL | SUPP |
| Broken | Tungamah losses | TUNGAMAH ETC. | SUPP |
| Private diverter losses | TO L/BROK PD | LOSS |
| TO SHEP WWD | LOSS |
| Campaspe | Unregulated Coliban demands | UNREG COLIBAN R DEM | FLOW |
| Upstream Campaspe river PD demand | TO U/S CAMP PD | FLOW |
| Loddon | Private diverter losses | SERP CK TO SERP | LOSS |

### Supply from Centenary Creek to Maryborough

Centenary Creek is outside of the Murray-Darling Basin and therefore, excluded from the BDL. However, it supplies water to Maryborough which is also supplied by the Loddon system. To calculate the utilisation of Loddon urban demands, those diversions from Centenary Creek to Maryborough are included in the LTDLE calculations. The REALM carrier where this supply is measured is ‘TALB-EVANS-CENT’.

### Water balance of storages downstream of diversion points

The net storage level difference between model initialisation and end of model run, as well as the losses/gains and evaporation/rainfall within this period is not considered in the BDL but will affect the usage and utilisation of water users supplied by those storages.

Net storage level difference is calculated by subtracting the end of run storage level with the initial storage level for each storage located downstream of a diversion point. In GSM, those storage nodes are ‘WARANGA BASIN’, ‘GREENS LAKE’, ‘MCCAY RES’, ‘S/HURST RES’, ‘S/GULLY RES’, ‘SHEP LOSS STORAGE’, ‘CG LOSS STORAGE’, ‘PB&R LOSS STORAGE’. Other water balance components and the GSM outputs used to quantify them are shown in Table 3‑2.

Table 3‑2 Water balance components and associated model outputs of storages downstream of diversion points

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SDL resource unit | Storage | Water balance component | Model node/carrier | Output type |
| Goulburn | Waranga Basin | Net evaporation | WARANGA BASIN | EVAP |
| Inflow | WARANGA BASIN | INFW |
| Waranga Basin net loss (loss - gain) | TO WARANGA B LOSS  | FLOW |
| TO WARANGA B GAIN | FLOW |
| Greens Lake | Net evaporation | GREENS LAKE | EVAP |
| Campaspe | Upper Coliban storages | Net evaporation | MCCAY RES | EVAP |
| S/HURST RES | EVAP |
| S/GULLY RES | EVAP |

### Reconciliation tables

The following tables contain the comparison of diversions in the LTDLE calculation and the BDL, and the balancing terms used to reconcile them. With all of the above differences accounted for, 387 ML remains unaccounted. This minor difference is likely due to rounding and other modelling artefacts.

Table 3‑3 Goulburn BDL reconciliation

|  |  |
| --- | --- |
| **Goulburn** | **Volume (ML)** |
| **Diversion (LTDLE)**  | **1,260,308** |
| **BDL** | **1,552,652** |
| **Difference** | **-292,344** |
| **Corrective Terms** | Less supplements from Loddon and Campaspe | -86,446 |
| Goulburn Irrigation area losses | 333,984 |
| Net evaporation in Waranga Western Channel storages | 41,855 |
| Waranga Basin net loss | 2,919 |
| Supply from Waranga Western Channel to Rochester urban demand | 932 |
| Supply to Wimmera-Mallee | 6,177 |
| Less Waranga Basin inflow | -4,455 |
| Less modelled storage drawdown in WWC | -1,967 |
| Less Supply from Serpentine Creek to Dingee (incl. losses) | -1,179 |
| **Total Corrective Terms** | **291,820** |
| **Unaccounted difference** | **-523** |

Table 3‑4 Broken BDL reconciliation

|  |  |
| --- | --- |
| **Broken** | **Volume (ML)** |
| **Diversion (LTDLE)**  | **11,405** |
| **BDL** | **13,245** |
| **Difference** | **-1,840** |
| **Corrective Terms** | Private diverter losses | 144 |
| Tungamah losses | 1,696 |
| **Total Corrective Terms** | **1,840** |
| **Unaccounted difference** | **0** |

Table 3‑5 Campaspe BDL reconciliation

|  |  |
| --- | --- |
| **Campaspe** | **Volume (ML)** |
| **Diversion (LTDLE)**  | **86,518** |
| **BDL** | **115,825** |
| **Difference** | **-29,307** |
| **Corrective Terms** | Supplement to Waranga Western Channel | 21,743 |
| Campaspe Irrigation area losses | 7,908 |
| Coliban Storage net evaporation | 355 |
| Unregulated Coliban river demand | 210 |
| Upstream Campaspe river PD demand | 82 |
| Less modelled Coliban storage drawdown | -47 |
| Less supply from Waranga Western Channel to Rochester urban demand | -932 |
| **Total Corrective Terms** | **29,319** |
| **Unaccounted difference** | **12** |

Table 3‑6 Loddon BDL reconciliation

|  |  |
| --- | --- |
| **Loddon** | **Volume (ML)** |
| **Diversion (LTDLE)**  | **18,131** |
| **BDL** | **85,770** |
| **Difference** | **-67,639** |
| **Corrective Terms** | Supplement to Waranga Western Channel | 64,702 |
| Private Diverter Losses | 3,375 |
| Serpentine Creek Supply to Dingee (incl. loss) | 1,179 |
| Less supply from Centenary Creek to Maryborough | -1,493 |
| **Total Corrective Terms** | **67,764** |
| **Unaccounted difference** | **125** |

## Wimmera-Mallee Water Resource Plan Area

As shown in Appendix D.2, the total modelled diversion of 67 GL matches the revised BDL documented in the draft Wimmera-Mallee Water Resource Plan (DELWP, 2017b).

## Victorian Murray Water Resource Plan Area

For Victorian Murray WRP Area, diversion data were obtained from the model at the diversion points, similar to the way the BDL is calculated. Therefore, the total diversions used in the LTDLE calculations will be consistent with Basin Plan (2012).

# Conversion method for other entitlement classes

LTDLE factors were prepared for entitlement classes which are present and modelled under BDL and is also applicable to new entitlements generated from water savings projects which are subject to the same rules as those entitlement classes. Some water savings projects generate entitlements which has no equivalent present under BDL. Alternate methods are proposed to convert these to an estimated recovery volume for the purpose of calculating the extent in which the gap between BDL and SDL has been bridged as specified in the Murray Darling Basin Plan 2012.

These new entitlement classes and the proposed conversion method are further explained in the following subsections.

## Very high reliability entitlement from Campaspe Irrigation Area decommissioning

As part of the Campaspe Irrigation Area decommissioning, a very high reliability entitlement of 1,656 ML was created and incorporated into the Campaspe River Environmental Entitlement 2013. The bulk entitlement document specifies that the full volume of entitlement is available at 1 July of every year. The entitlement volume is a direct representation of 1,656 ML fixed loss calculated during the water savings project. The calculation was based on a relationship of historical loss and deliveries.

As this class of entitlement is fully available every year, it is highly likely it will be fully utilised, hence it is proposed that a conversion factor of 1.00 be applied to this entitlement volume to estimate the resulting recovery volume for the purpose of calculating the extent in which the gap between BDL and SDL has been bridged as specified in the Murray Darling Basin Plan 2012.

## Wimmera-Mallee Pipeline Savings Entitlement in the Loddon system

As part of the Wimmera-Mallee pipeline project 7,490 ML of entitlement was created and incorporated into the Loddon River - Environmental Reserve Bulk Entitlement Order 2005 (Consolidated Version as at 10 April 2014). This entitlement volume was not converted from a long-term average annual savings and was expressed directly as an entitlement volume.

The bulk entitlement document specifies that the full volume of entitlement is available at 1 July if there is at least 1% allocation of HRWS in the Goulburn system in April of the previous water year. The BDL model indicates that this condition is met in every year of the model run. This entitlement can also be supplied from the Goulburn system through the Waranga Western Channel during periods where flows in the Loddon is insufficient. Therefore, it is extremely likely that this entitlement will be fully available, and also highly likely to be fully utilised. Therefore, it is also proposed that a conversion factor of 1.00 be applied to this entitlement volume to estimate the resulting recovery volume for the purpose of calculating the extent in which the gap between BDL and SDL has been bridged as specified in the Murray Darling Basin Plan 2012.

## Very high reliability entitlement from East Loddon Waterworks District decommissioning

As part of the decommissioning of East Loddon Waterworks District, 1,480 ML of entitlement was created and incorporated into the Loddon River - Environmental Reserve Bulk Entitlement Order 2005 (Consolidated Version as at 13 June 2019). This entitlement volume was a rounding up of the 1,478 ML water savings volume which was a modelled outcome.

This entitlement is subject to the restrictions specified in Clause 2 Schedule 6 of the Loddon River - Environmental Reserve Bulk Entitlement Order 2005 (Consolidated Version as at 13 June 2019).

## Unregulated entitlements associated with Greens Lake decommissioning

As part of the decommissioning of Greens Lake, 9,000 ML of unregulated entitlement was created and incorporated into environmental entitlements in the Victorian Murray.

This unregulated entitlement has no equivalent modelled under BDL. The water savings volume of 8.3 GL is a modelled outcome and the resulting entitlements are calculated using an agreed method between DELWP and MDBA, where an 8.3 GL/yr average increase in end-of-valley flows (comprising of 7.1 GL from the Goulburn, and 1.2 GL from the Loddon) was identified upon decommissioning of Greens Lake (see GMW and Jacobs (2018) and associated addendum).

# Summary of LTDLE factors

Table 5‑1 shows a comparison of the revised LTDLE factors with previous versions, for entitlement classes relevant to Basin Plan recoveries. A complete set of LTDLE factors from the previously adopted V2.05 is available in Appendix C to this report, whereas the revised LTDLE factors are available in Appendix D.

Table 5‑1 Comparison of revised LTDLE Factors with previous versions

|  |  |  |
| --- | --- | --- |
| System | Entitlement class | LTDLE Factor Versions |
| **v2.05** | **Revised** |
| Broken | High reliability | 0.950 | 0.570 |
| Low reliability | 0.767 | 0.083 |
| Campaspe | High reliability | 0.950 | 0.950 |
| Low reliability | 0.490 | 0.571 |
| Coliban Urban and Rural | 0.900 | 0.797 |
| Goulburn | High reliability | 0.950 | 0.967 |
| Low reliability | 0.350 | 0.583 |
| Loddon | High reliability | 0.950 | 0.624 |
| Low reliability | 0.270 | 0.050 |
| VIC Murray | High reliability | 0.950 | 0.974 |
| Low reliability | 0.240 | 0.543 |
| Wimmera-Mallee | Irrigation Product including Losses | 0.806 | 0.828 |
| Ovens | Regulated irrigation | 0.950 | 0.450 |

Conversion methods for entitlements obtained for Basin Plan water recovery which have no equivalent entitlement present under BDL are summarised in Table 5‑2.

Table 5‑2 Conversion method for other entitlement classes

|  |  |  |
| --- | --- | --- |
| System | Entitlement class | Factor |
| Campaspe | Very high reliability entitlement from Campaspe Irrigation Area decommissioning | 1.000 |
| Loddon | Very high reliability entitlement from East Loddon Waterworks District decommissioning | *See footnote1* |
| Wimmera-Mallee Pipeline Savings Entitlement in the Loddon system | 1.000 |
| VIC Murray | Unregulated entitlements associated with Green’s Lake decommissioning | *See footnote2* |

*1Entitlement resulting from the decommissioning of East Loddon Waterworks District has unique rules / conditions that do not make it equivalent to a Loddon high reliability water share. The water savings volume of 1.478 GL is a modelled outcome and the resulting entitlement was determined as 1.480 GL*

*2The entitlement resulting from the decommissioning of Greens Lake has no equivalent modelled under BDL. The water savings volume is a modelled outcome resulting from an increase of 7.1 GL and 1.2 GL in end-of-valley flows from Goulburn and Loddon respectively. The resulting VIC Murray unregulated entitlement of 9.0 GL is calculated using an agreed method between DELWP and MDBA.*

# References

DELWP. (2016). *Water Market Trends - Trends in Northern Victorian Water Trade 2001-2015.* The State of Victoria Department of Environment, Land, Water and Planning.

DELWP. (2017a). *Verification of Entitlements in the GSM Baseline Diversion Limit Model - Final Report Version 2.* Victoria: The State of Victoria Department of Environment, Land, Water and Planning .

DELWP. (2017b). *Draft Wimmera-Mallee Water Resource Plan Comprehensive Report.* Melbourne: The State of Victoria Department of Environment, Land, Water and Planning.

GMW and Jacobs. (2018). *Greens Lake Water Savings Project - Irrigation System Reliability, Constraints and Rainfall Rejection Modelling.* Goulburn Murray Water and Jacobs Australia Pty Limited.

MDBA. (2014). *Derivation of version 10.8 Long Term Diversion Limit Equivalence Factors – a companion document to the history of LTDLE factors.* Canberra: Commonwealth of Australia (Murray-Darling Basin Authority).

MDBA. (2019). *Source Murray Model - Method for determining permitted take in the Victorian Murray, Kiewa and Ovens SDL resource units: Technical Report No. 2018/16.* Canberra: Murray Darling Basin Authority.

1. Hydrological model nodes, carriers used in LTDLE factor calculations
	1. Northern Victoria WRP Area

**Diversion data for each entitlement category were obtained from the SUPP (supplied demand) outputs from the following demand nodes**

| SDL resource unit | Category | Demand node |
| --- | --- | --- |
| Goulburn | Rural  | Irrigation Areas | RODNEY |
| TONGALA |
| ROCH E |
| ROCH W |
| TANDARA |
| BOORT |
| DEAKIN |
| DINGEE |
| SHEP.2 |
| SHEP.8 |
| Private Diverters | WL,BL,N |
| U/GOULB PD |
| L/GOULB PD |
| D/S MCCOYS PD |
| MID GOULB PD |
| TUNGAMAH D&S |
| Broken Creek Supplement | M VALLEY |
| Tagged Trade | TAGGED\_2MURRAY |
| Urban | L/GOULB URB |
| U/GOULB URB |
| CHANL\_URB |
| Broken | Rural | Private Diverters | UP BROKEN PD1 |
| UP BROKEN PD2 |
| LOW BROKEN PD |
| LK MOKOAN PD |
| MAJOR CK PD |
| BROKEN CK PD |
| SHEPPARTON WWD |
| Urban | TUNGAMAH URB |
| Campaspe | Rural | Irrigation Area | CAMPASPE IRR |
| Private Diverters | CAMPASPE PD1 |

|  |  |  |
| --- | --- | --- |
| SDL resource unit | Category | Demand node |
| Campaspe(cont’d) | Rural (cont’d) | Private Diverters (cont’d) | CAMPASPE PD2 |
| CAMPASPE PD3 |
| Coliban Water | RUR POV GULLY |
| RUR HARCOURT |
| RUR E/VALLEY |
| RUR S/GULLY |
| RUR S/HILL & LOCK |
| RURAL 3 |
| RUR COL MAIN DEM |
| TYLDEN |
| KYNETON |
| URB MALM |
| URB CASTLEMAIN |
| URB S/GULLY |
| URB CRUSOE |
| URB S/HURST |
| URB AXE/GOOR |
| URB ROCHESTER |
| HEATHCOTE DEMAND |
| CAMPRES WOODEND |
| FALLS CK WOODEN |
| Loddon | Rural | Private Diverters | SERP |
| CC-LAAN PD |
| TULL-LAAN PD |
| LAAN-WEIR PD |
| Urban | E LOD WT |
| MARYB WT |
| BRING |
| BDLT |

* 1. Wimmera-Mallee WRP Area
		1. Entitlements

|  |  |
| --- | --- |
| ‘ENTITLEMENT’ carrier subequation | Entitlement categorisation for LTDLE |
| Pipeline & balancing storage losses entitlement | Pipeline Losses |
| Recreation entitlement | Recreation |
| Urban off pipeline and headworks entitlement | Consumptive Wimmera Mallee Pipeline Product |
| Rural D&S off pipeline entitlement | Consumptive Wimmera Mallee Pipeline Product |
| Supply by Agreement off pipeline entitlement | Consumptive Wimmera Mallee Pipeline Product |
| Growth water off headworks entitlement | Consumptive Wimmera Mallee Pipeline Product |
| Growth water off pipeline entitlement | Consumptive Wimmera Mallee Pipeline Product |
| Coliban Water entitlement | Coliban Water (Coliban) |
| Wetlands entitlement | Wetlands |
| Commonwealth Environmental Water Holder entitlement | Irrigation Product including Losses |

* + 1. Allocation

|  |  |
| --- | --- |
| Accounting carrier | Entitlement categorisation for LTDLE |
| LOSS ALLOCATION | Pipeline Losses |
| RECN ALLOCATION | Recreation |
| URBHW ALLOCATION | Consumptive Wimmera Mallee Pipeline Product |
| D&SPL ALLOCATION | Consumptive Wimmera Mallee Pipeline Product |
| SBAPL ALLOCATION | Consumptive Wimmera Mallee Pipeline Product |
| DEVHW ALLOCATION | Consumptive Wimmera Mallee Pipeline Product |
| DEVPL ALLOCATION | Consumptive Wimmera Mallee Pipeline Product |
| COLBN ALLOCATION | Coliban Water (Coliban) |
| WETLD ALLOCATION | Wetlands |
| IRRIG ALLOCATION | Irrigation Product including Losses |

* + 1. Diversion

|  |  |  |
| --- | --- | --- |
| Carrier | Output Type | Entitlement categorisation for LTDLE |
| LOSS ACTUAL VOL | FLOW | Pipeline Losses |
| 6 PIPE LOSS | FLOW | Pipeline Losses |
| RECN ACTUAL VOL | FLOW | Recreation |
| 30-47 UNRES RECDEM | FLOW | Recreation |
| MACKENZIE FIXED FLOW | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| EX HW URBANS | CAPC | Consumptive Wimmera Mallee Pipeline Product |
| 10-25 UNRES URBDEM | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| 30-47 UNRES URBDEM | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| 60 UNRES URBDEM | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| D&SPL ACTUAL VOL | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| 30-47 UNRES DSDEM | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| 60 UNRES DSDEM | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| SBAPL ACTUAL VOL | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| STAWELL PDS PIPE | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| TO PIPE DEMAND | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| TO SEPPELTS | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| TO PIPELINE DEM | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| DEVHW ACTUAL VOL | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| DEVPL ACTUAL VOL | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| 3&4 GROWTH SUP | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| 6 GROWTH SUP | FLOW | Consumptive Wimmera Mallee Pipeline Product |
| COLBN ACTUAL VOL | FLOW | Coliban Water (Coliban) |
| WETLD ACTUAL VOL | FLOW | Wetlands |
| 30-47 UNRES WETDEM | FLOW | Wetlands |
| IRRIG ACTUAL VOL | FLOW | Irrigation Product including Losses |

* 1. Victorian Murray WRP Area
		1. VIC Murray BDL entitlement volumes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Entitlement Type** | **Total Entitlement at Baseline** | **TLM** | **Water for Rivers - Snowy** | **Consumptive Entitlement** | **Proportion of consumptive** |
| Initial Loss | 230932 | 0 | 0 | 230932 | 100% |
| HRWS | 1283761 | 16146 | 44465 | 1223150 | 95.28% |
| HRWS with extended carryover | 5710 | 5710 | 0 | 0 | 0% |
| HRWS Variable Loss | 38179 | 0 | 0 | 38179 | 100% |
| LRWS | 285589 | 0 | 6423 | 279166 | 97.75% |
| LRWS with extended carryover | 101850 | 101850 | 0 | 0 | 0% |
| LRWS Variable Loss | 104431 | 0 | 0 | 104431 | 100%  |

* + 1. Source Murray Model availability outputs

|  |  |
| --- | --- |
| **Entitlement Type** | **Output path** |
| HRWS | **Resource Assessment>Victoria>Annual Accounting Recorder>Recorder>Account Types>High Reliability Water Share>Allocation** |
| HRWS Variable Loss | **Resource Assessment>Victoria>Annual Accounting Recorder>Recorder>Account Types>HRWS Loss>Allocation** |
| LRWS | **Resource Assessment>Victoria>Annual Accounting Recorder>Recorder>Account Types>Low Reliability Water Share>Allocation** |
| LRWS Variable Loss | **Resource Assessment>Victoria>Annual Accounting Recorder>Recorder>Account Types>LRWS Loss>Allocation** |
| Initial loss | **Resource Assessment>Victoria>Annual Accounting Recorder>Recorder>Account Types>Initial Loss>Allocation** |
| Broken Creek Supplement | **Resource Assessment>Victoria>Annual Accounting Recorder>Recorder>Account Types>Broken Creek Supplement>Allocation** |
| Extra Torrumbarry Loss | **Resource Assessment>Victoria>Annual Accounting Recorder>Recorder>Account Types>Extra Torrumbarry Loss>Allocation** |

* + 1. VIC Murray Source Murray Model diversion outputs

|  |  |
| --- | --- |
| **Entitlement Type** | **Output path** |
| Total Victorian Murray Diversions | **DemandModel>Output>$f\_VicTotalDiversions** |

1. Validation of modelled utilisation
	1. Introduction

The purpose of this appendix item is to present a validation of utilisation modelled using the BDL model and calculated using the method developed for Victoria’s revision of LTDLE factors. The modelled utilisation is compared against observed utilisation from several data sources. The comparison is to identify any significant differences between them that may warrant out-of-model adjustments to utilisation (e.g. global ultimate utilisation method) similar to what was done in previous LTDLE factor versions. This comparison also provides verification on whether modelled utilisation is able to be achieved in reality.

* 1. Method
		1. Modelled utilisation

The method to calculate modelled utilisation from the BDL model is outlined in the main body of the report (Section 2.4.2). This includes splitting HRWS and LRWS diversions outlined in Section 2.3.3.

* + 1. Observed utilisation

Corresponding observed utilisation are obtained from two sources, the Water Market Trends report (DELWP, 2016) the other is usage and water availability data from the Victorian Water Register.

To calculate the average observed utilisation, the equation below is used, where *m* represents the first water year available for the data source, and *n* represents the last water year.

$$Utilisation\_{Average}=\frac{\sum\_{i=m}^{n}Usage\_{i}}{\sum\_{j=m}^{n}(Available Water\_{j})}$$

To calculate the year-on-year utilisation, the equation above cannot be used for individual years, as it will result in multiple recognition of unused water and above 100% utilisation in years where carryover was utilised. To work around this, the equation below is used, with *y* representing the water year index (e.g. water year index for 2008/09 is 2009, 2009/10 is 2010 etc).

$$Utilisation\_{y}=\frac{min⁡(Available Water\_{y}, Usage\_{y}+\sum\_{i=y+1}^{n}Usage\_{i}-\sum\_{j=y+1}^{n}(Utilisation\_{j}\* Available Water\_{j}))}{Available Water\_{y}}$$

This equation essentially considers utilisation in year *y* as utilisation of all allocation and net trade in year *y* including utilisation of any unused water from year *y* in future years (carryover). This utilisation however, does not recognise usage in year *y* against carryover from previous years, as that usage will be recognised in the year where the carryover was initially generated.

The data sources available are further described below.

* + - 1. Water Market Trends report

The Water Market Trends report contains water availability, usage and trade data from 2008/09 – 2014/15 water years. Available water from this report can be considered as *allocation + net trade*. Based on the period of record, *m* and *n* can be taken as 2009 and 2015 respectively.

The report categorises this data based on the type of use, either irrigation area or private diverters, and the water authority that supplies them either GMW or LMW. It doesn’t distinguish between different valleys, so usage in the Goulburn, Broken, Campaspe, Loddon, and some parts of Victorian Murray, all are combined into G-MW. There is also no distinction between HRWS and LRWS. Considering that diversions in the Goulburn and Victorian Murray forms the vast majority of the usage, and that in the period of record there has been no allocation announced for LRWS, the utilisation calculated from this data source is only compared to modelled utilisation for Goulburn HRWS and Murray HRWS.

* + - 1. Victorian Water Register

The Victorian Water Register contains water availability (allocation, carryover), usage, trade data, evaporation and other adjustments from 2009/10 – 2017/18 water years. Available water from this data source can be considered as *allocation + net trade + adjustments + evaporation*. Based on the period of record, *m* and *n* can be taken as 2010 and 2018 respectively.

The data obtained from the Water Register categories the usage and water availability based on valleys and type of usage (environmental, irrigation, and water corporations). As this data is compared with rural HRWS and LRWS modelled utilisation, only irrigation is considered. Note that because utilisation for regulated irrigation cannot be calculated for the Ovens, the observed utilisation is compared against the corresponding LTDLE factor instead.

* 1. Result
		1. Comparison with Water Market Trends report

|  |  |  |
| --- | --- | --- |
| Entitlement class | Modelled average utilisation | Observed (GMW) utilisation (2008/09 – 2014/15) |
| Min | Average | Max |
| Goulburn HRWS | 0.981 | 0.628 | 0.899 | 1.000 |
| Murray HRWS | 0.981 |

* + 1. Comparison with Victorian Water Register
			1. Goulburn

|  |  |  |
| --- | --- | --- |
| Entitlement class | Modelled average utilisation | Observed utilisation (2009/10 – 2017/18) |
| **Min** | **Average** | **Max** |
| Goulburn HRWS | 0.981 | 0.652 | 0.934 | 1.000 |
| Goulburn LRWS | 0.927 |

Context: No years with >100% end of season utilisation in 2009/10 – 2017/18

* + - 1. Broken

|  |  |  |
| --- | --- | --- |
| Entitlement class | Modelled average utilisation | Observed utilisation (2009/10 – 2017/18) |
| **Min** | **Average** | **Max** |
| Broken HRWS | 0.601 | 0.029 | 0.417 | 1.000 |
| Broken LRWS | 0.094 |

Context: 5 years with 200% end of season utilisation in 2009/10 – 2017/18

* + - 1. Campaspe

|  |  |  |
| --- | --- | --- |
| Entitlement class | Modelled average utilisation | Observed utilisation (2009/10 – 2017/18) |
| **Min** | **Average** | **Max** |
| Campaspe HRWS | 0.984 | 0.409 | 0.784 | 1.000 |
| Campaspe LRWS | 0.674 |

Context: 4 years with 200% end of season utilisation in 2009/10 – 2017/18

* + - 1. Loddon

|  |  |  |
| --- | --- | --- |
| Entitlement class | Modelled average utilisation | Observed utilisation (2009/10 – 2017/18) |
| **Min** | **Average** | **Max** |
| Loddon HRWS | 0.634 | 0.037 | 0.706 | 1.000 |
| Loddon LRWS | 0.079 |

Context: No years with >100% end of season utilisation in 2009/10 – 2017/18

* + - 1. Ovens

|  |  |  |
| --- | --- | --- |
| Entitlement class | LTDLE factor | Observed utilisation (2009/10 – 2017/18) |
| **Min** | **Average** | **Max** |
| Ovens Regulated Irrigation | 0.450 | 0.045 | 0.210 | 0.299 |

Context: modelled utilisation unavailable, compare against LTDLE factor instead

* + - 1. VIC Murray

|  |  |  |
| --- | --- | --- |
| Entitlement class | Modelled average utilisation | Observed utilisation (2009/10 – 2017/18) |
| **Min** | **Average** | **Max** |
| VIC Murray HRWS | 0.981  | 0.684 | 0.960 | 1.000 |
| VIC Murray LRWS |  0.627  |

Context: No years with >100% end of season utilisation in 2009/10 – 2017/18

* 1. Conclusion

From the comparison it is evident that modelled average utilisation for the larger systems (i.e. Goulburn and Murray) are higher than observed average utilisation. This is expected as post millennium drought utilisation is lower than pre-drought conditions, as irrigators use their water more conservatively to manage their risk. Similar behaviour is also evident in the smaller valleys. The only exception to this is Loddon where observed utilisation is slightly higher than modelled.

Year-on-year observed utilisation across all valleys can exceed modelled average utilisation as irrigators utilise carryover. Based on this comparison, the models appear to provide a reasonable representation of observed utilisation. The average modelled utilisation appears to be achievable in reality. Out-of-model adjustments to utilisation is therefore not conducted to maintain a consistent and transparent approach throughout all valleys.

1. Previous LTDLE factors (V2.05)

| SDL Resource Unit | Entitlement Type | LTDLE Factor |
| --- | --- | --- |
| Goulburn / Broken / Loddon / Campaspe | East Loddon Waterworks District | 0.91 |
| Goulburn / Broken / Loddon / Campaspe | Coliban Urban and Rural | 0.90 |
| Goulburn / Broken / Loddon/ Campaspe | Goulburn HRWS – Districts & PDs | 0.95 |
| Goulburn / Broken / Loddon / Campaspe | Broken High Reliability Water Share | 0.95 |
| Goulburn / Broken / Loddon / Campaspe | Loddon High Reliability Water Share | 0.95 |
| Goulburn / Broken / Loddon / Campaspe | Campaspe HRWS – Districts & PDs | 0.95 |
| Goulburn / Broken / Loddon / Campaspe | Broken Low Reliability Water Share | 0.767 |
| Goulburn / Broken / Loddon / Campaspe | Loddon Low Reliability Water Share | 0.27 |
| Goulburn / Broken / Loddon / Campaspe | Goulburn LRWS – Districts & PDs | 0.35 |
| Goulburn / Broken / Loddon / Campaspe | Campaspe LRWS – Districts & PDs | 0.49 |
| Goulburn / Broken / Loddon / Campaspe | Goulburn unregulated entitlement | 0.723 |
| Goulburn / Broken / Loddon / Campaspe | Broken unregulated entitlement | 0.05 |
| Goulburn / Broken / Loddon / Campaspe | Loddon unregulated entitlement | 0.053 |
| Goulburn / Broken / Loddon / Campaspe | Campaspe unregulated entitlement | 0.322 |
| Goulburn / Broken / Loddon / Campaspe | Goulburn HRWS - for NVIRP Stage 2 package only | 0.939 |
| Goulburn / Broken / Loddon / Campaspe | Goulburn LRWS - for NVIRP Stage 2 package only | 0.488 |
| Kiewa / Ovens / Vic Murray | Vic Murray HRWS - for NVIRP Stage 2 package only | 0.957 |
| Kiewa / Ovens / Vic Murray | Vic Murray LRWS - for NVIRP Stage 2 package only | 0.519 |
| Kiewa / Ovens / Vic Murray | Vic Murray HRWS – Districts & PDs | 0.95 |
| Kiewa / Ovens / Vic Murray | Ovens Regulated Irrigation | 0.95 |
| Kiewa / Ovens / Vic Murray | Vic Murray LRWS – Districts & PDs | 0.24 |
| Kiewa / Ovens / Vic Murray | Upper Murray Unregulated Entitlement | 0.201 |
| Kiewa / Ovens / Vic Murray | Kiewa Unregulated Entitlement | 0.58 |
| Kiewa / Ovens / Vic Murray | Ovens Unregulated Entitlement | 0.40 |
| Wimmera / Mallee | Wimmera Mallee Pipeline Product | 0.943 |
| Wimmera / Mallee | Irrigation Product including Losses | 0.806 |
| Wimmera / Mallee | Unregulated Entitlement | 0.149 |

*Note that for LTDLE factor V2.05, the term “Irrigation District/s” was used instead of “Irrigation Area/s”*

1. Revised LTDLE Factors
	1. Northern Victoria Water Resource Plan Area









* 1. Wimmera-Mallee Water Resource Plan Area



* 1. Victorian Murray Water Resource Plan Area



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