A comparative analysis of GIS dams data in the SA Murray Region Water Resource Plan Area (SDL unit SS10)

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December 2016

DEWNR Internal technical report

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Preferred way to cite this publication

Herpich D, 2016, A comparative analysis of GIS dams data in the Murray Region Water Resource Plan Area (SDL unit SS10), DEWNR Internal technical report 2016, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide

Foreword

The Department of Environment, Water and Natural Resources (DEWNR) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEWNR's strong partnerships with educational and research institutions, industries, government agencies, Natural Resources Management Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

Sandy Pitcher CHIEF EXECUTIVE DEPARTMENT OF ENVIRONMENT, WATER AND NATURAL RESOURCES

Acknowledgements

This project is part of a broader project focussed on delivering elements of Action 12, *Develop and Implement Water Resource Plans that are consistent with the Basin Plan,* of the Basin Plan Implementation Strategy.

The following people are gratefully acknowledged for assistance with this project:

- Lisa Stribley, Ingrid Franssen, Theresa Heneker, Mardi van der Wielen, Lissa Arcoverde, Kumar Savadamuthu, Matthew Miles and Matthew Royal for advice and assistance with refining the project scope.
- Samantha Lucas from MDBA for supplying the original Geoscience Australia Farm Dams spatial information.
- Matthew Miles, Matthew Royal and Mardi van der Wielen for internal technical peer review.

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Summary

The State and National Water Policy unit of the Department of Environment, Water and Natural Resources (DEWNR) commissioned this project to undertake a comparative analysis of the DEWNR Topo Waterbodies (TW) dataset against the Geoscience Australia (GA) dams data set provided by the Murray-Darling Basin Authority (MDBA). The project aimed at improving knowledge and understanding on the frequency and surface area of farm dams within the South Australian Non-prescribed Areas SDL resource unit (SS10) of the SA Murray Region Water Resource Plan (WRP) area to underpin renegotiation of the baseline diversion limit (BDL).

The work undertaken in this project identified the DEWNR TW spatial layer to be a more accurate dataset in relation to actual farm dams (frequency and area). More importantly, this dataset is maintained as a result of regional updates associated with aerial imagery updates, emergency services map book updates and future reconciliation of dams from permitting processes. Consequently, it is recommended that the DEWNR TW data is the "point of truth" dataset for the review and negotiation of the baseline diversion limit (BDL) and future reporting against the sustainable diversion limit (SDL) within the SA non-prescribed area (SS10).

The SA Murray Region WRP area contains parts of the South Australian Murray-Darling Basin (SAMDB), South Australian Arid Lands (SAAL) and South East (SE) natural resources management regions (NRM) (Figure 1.1). The SAMDB NRM region contains the non-prescribed Burra and Rangelands catchments and sub-catchments which have dam capacity limits under the SAMDB regional NRM plan, together within a non-designated area (the remaining non-prescribed area within SAMDB) that doesn't have specific dam capacity limits. External to SAMDB, but within SS10, there are also the non-prescribed SAAL NRM region and the SE NRM region. These areas are referred to as non-designated areas within the context of this report.

Excluded from SS10 but still within the SAMDB are the South Australian Murray (SS11), Marne Saunders (SS12) and the Eastern Mt Lofty Ranges (SS13) surface water SDL resource units.

The objectives of this study were to:

- Assess the accuracy of the GA data (which was used to set the initial BDL) in comparison to the DEWNR corporate TW feature class.
- Calculate dam surface area and volume in defined sub-catchments of the SAMDB NRM Region and non-designated areas within SS10.

The results of the study indicate that with the exception of the SAAL non-designated area of SS10, the DEWNR TW feature class is more accurate in terms of farm dam count and surface area than the Geoscience Australia data. In a defined data deficient area of the SAAL and northern SAMDB non-designated areas, GA farm dam data was extracted and incorporated into TW. Moreover, additional polygons were digitised utilising a DEWNR point feature dataset for the pastoral areas in association with satellite imagery.

Dam volumes were calculated using McMurray (2004) equations and the dataset archived as at March 2016 to enable future comparisons and change assessments. The frequency, surface area and volume over the SS10 region is detailed in Table 1.1.

The non-designated catchments of SS10 contain 4950 farm dams compared to 2283 and 687 for the Rangelands and Burra catchments, respectively. The non-designated catchments have a combined volume of 18 058 ML compared to 2121 and 1012 ML for the Rangelands and Burra catchments. The total developed volume for the non-prescribed SS10 area is 21.19 GL.

Surface Water Policy Area	NRM Region	Catchment	Dam Count	Dam Area (ha)	Dam Volume ML
SS10	SAMDB	Burra	687	76.2	1012.6
SS10	SAMDB	Rangelands	2283	175.9	2121.4
SS10	SAMDB	non-designated	4041	840.3	13161.6
SS10	SAAL	non-designated	622	259.0	4415.6
SS10	SE	non-designated	291	35.9	481.0
Total			7924	1387.3	21192.2

Table 1.1 Farm dam summary statistics within the non-prescribed surface water area of SS10

Time and budgetary constraints did not permit a full spatial revision of farm dam boundaries within SS10. Instead accuracy assessments were undertaken on case study areas within each catchment or non-designated area. These case studies have indicated that a full visual review with amendments to the TW feature class for the 6 197 181 ha SS10 area would take 195 days, which is a large investment for a region with low water demand. The data improvement undertaken in the SAAL and northern SAMDB NRM regions as part of this project, and the reasonable accuracy of the TW layer in the remainder of the SS10 region, means that the revised TW dataset is considered an appropriate, fit-for-purpose dataset for identifying water interception by dams in this region.

This study was necessary to determine the most accurate feature class in terms of dam frequency and surface area prior to volumetric calculations. It was also necessary as a precursor to discussions with the MDBA to negotiate a new BDL for SS10, and internal discussions on options for managing spare dam development capacity across three NRM regions.



 Figure 1.1
 Non-Prescribed Surface Water Study Area – SS10

1 Introduction

The Basin Plan, introduced in November 2012, divides the Murray-Darling Basin into Water Resource Plan (WRP) areas. Within the South Australian Murray-Darling Basin, there are three water resource plans:

- South Australian (SA) Murray Region
- Eastern Mount Lofty Ranges (including the Marne Saunders Prescribed Water Resources Area)
- SA River Murray

For each of the water resources within a WRP area, the MDBA were required to determine a baseline diversion limit (BDL) for each of the SDL resource units. For the South Australian Non-Prescribed Areas (SS10) SDL resource unit within the SA Murray Region WRP area, the BDL estimate of 3.5 GL was made using information from Sinclair Knight Merz, CSIRO & Bureau of Rural Sciences (2010) on surface water interception activities commissioned by the National Water Commission (NWC). This estimate was based on assumed long-term average water use from existing farm dams in the area. For the South Australian Non-prescribed Areas the BDL.

The development process for the SA Murray Region Water Resource Plan included state analysis of SDL compliance requirements. This analysis identified that the BDL for SS10 needed to be re-calculated to include the effect of state water management law i.e. dam capacity limits that were in the 2009 SAMDB regional NRM plan, which were not included in the original calculation.

Subsequent analysis of the NWC surface water interception activities report has also shown that the BDL of 3.5 GL for SS10 based on assumed use from existing dams was calculated using an underestimate of existing dam numbers and capacity. The BDL was calculated as the sum of the farm dam impacts for five of the Surface Water Management Areas (SWMAs) listed in Table 33 of the report. A number of other SWMAs, whose areas lie within South Australian Non-Prescribed Areas, are listed in Table 33 of the interception activities report but do not appear to have been included in the BDL estimate. Additionally, the map of the geographic boundaries of the SWMAs for the South Australian Non-Prescribed Areas (provided by the MDBA) indicates an additional SWMA (Mallee), that covers a large area north of the River Murray within the South Australian Non-Prescribed Areas, is not listed in Table 33 of interception activities report. It is known that this is an area with a significant number of farm dams.

A GIS analysis project was established to undertake a detailed analysis and comparison of the Geoscience Australia dams dataset, considered to provide an improved estimate of farm dam locations and surface areas than that used in the NWC report, to the South Australian corporate dataset (DEWNR TW). This information could then be used to determine an improved estimate of existing interception across the entire SS10 area. This improved information on dam capacity supports re-negotiation of the BDL for the area, and also allows an updated calculation of existing development within the areas with dam capacity limits under state water management law (in the SAMDB regional NRM plan) so that spare dam development capacity could be identified.

The remainder of this document details the steps undertaken as part of the GIS analysis project to compare the GA dataset to the DEWNR TW dataset and calculate new interception values to guide re-negotiation of the BDL for SS10.

The objectives for this project focused on defining the SS10 project area, identifying the frequency and surface area of farm dams within SS10 sub-catchments, catchments and non-designated areas and the subsequent determination of volume. Specific aims are detailed below.

1.1 SS10 within the Murray Region WRP Area

• Define the area of SS10 study area incorporating exclusions and interactions with other surface water policy zones.

1.2 Accuracy assessment

• Assess the accuracy of the GA data in each sub-catchment or non-designated area by comparing GA data with all other data. All other data includes dam construction data from NRM regions and data listed in Section 2.

1.3 Farm dams within SS10 and Regional Zone f

- Define the area of intersection between SS10 and the South East Regional Zone f surface water policy area.
- Compare the area of dams between the Geoscience Australia (GA) spatial layer used to initially determine BDL and the
 DEWNR Topo Waterbodies (TW) spatial layer. This area was included within the focus for this project because the
 South East Regional Zone f has dam capacity limits assigned under state water management law as part of the South
 East regional NRM plan. Although the dam capacity limits for the South East came into effect after 30 June 2009, it
 was considered important to improve understanding of dam development in Regional Zone f to include as part of the
 BDL and to assist the South East region to manage their dam capacity limits within the SE regional NRM plan.

1.4 Additional data capture

• Time permitting improve the digitised farm dams layer in non-designated areas. Recommend methods for improvement if time is limited.

1.5 Farm dam surface area and volume

- Calculate dam surface area and volume for the areas with existing dam capacity limits (Burra and Rangeland catchments in the SAMDB NRM region), as well as areas without existing dam capacity limits ('non-designated areas').
- Calculate the dam surface area and volume in each of the NRM regions.

2 Data and methods

Datasets used in this study are listed below:

- South East local dataset for Regional Zone f surface water policy area
- Admin.NRM regions
- ADMIN.SurfaceWaterSDLResourceUnits
- ADMIN.MDBWaterResourcePlanAreasSW
- Sub-catchment Boundaries from SAMDB NRM Plan
- GA Large Farm Dam Non-prescribed (polygon)
- GA Small Farm Dam Non-prescribed (point)
- Topo Waterbodies (definition query = dams)
- Admin.Pastoral Waterpoint
- WOfS Water Summary Filtered (Geo web server) from Geoscience Australia (http://eos.ga.gov.au/geoserver/NFRIP-WOfS/wms)
- SE 2 m Digital Elevation Model (DEM)
- South East 2013 Aerial Ortho imagery
- Western Murraylands 2013 Aerial Ortho imagery
- Google Imagery (web service to QGIS)
- ALOS Agri 2010 250 cm Satellite Image

Efforts were made to source the original SA Government Department for Water farm dam spatial layer which was used by Savadamuthu (2007), with no success. Consequently the DEWNR corporate Topo Waterbodies layer was used for analysis.

The Geoscience Australia (GA) farm dam information comprises a Large Farm Dam polygon feature class and a Small Farm Dam point feature class. The point feature class contains volume but no supporting area information. Moreover, surface area could not be sourced from the Topo Waterbodies feature class due to poor spatial correlation. To compensate for this a mean area (derived from area of TW farm dams within a catchment) was identified and used to buffer the Small Dam point features and merge the data into the Large Dam (GA) polygon feature class. Therefore, surface area for the GA Small Farm Dam feature class is derived from the mean area of TW farm dams within a sub-catchment or non-designated area. The proportion of the dataset generated using this method was 4, 6 and 16 per cent for the Burra, Rangelands and non-designated areas (refer to Table 3.8).

Details of the spatial process involved:

Step 1

- Select from TW, dams that intersect a specified catchment
- Select from this selection TW that intersect GA Small Farm dams
- Generate statistics on area within tables. Obtain the mean area, calculate the radius of a circle required to generate this area and use this figure to buffer GA Small Farm Dams point data.

Step 2

- Select GA Large farm dams within a specified catchment and export to a new feature class
- Append results of Step 1 to this dataset

Step 3

• Intersect outputs of Step 2 with specified catchment feature class

Step 4

• Dissolve based on key fields (e.g. sub-catchment name, area of catchment) and calculate statistics (Count, Sum Area, Sum Volume)

Step 5

- Complete for all catchments
- The TW feature class was intersected with specific catchments and dissolved based on key fields
- Spatial analyses were then undertaken to calculate count and dam areas within a sub-catchment or non-designated area. The area was summed to form a total dam surface area for the non-prescribed areas of SS10.
- Compile information in Excel spreadsheet

2.1 SS10 within the Murray Region WRP Area

Spatial overlays and selection queries resulted in division of SS10 into areas displayed in Figure 1.1. The SS10 boundary within the SE NRM region does not fully extend to the SA Murray Region WRP (surface water) boundary. This is due to the surface water areas above both the Tatiara Prescribed Wells area to the east and the Lower Limestone Coast Prescribed Wells to the west being intentionally excluded from the description of Basin water resources by a regulation made under the *Water Act 2007.*

2.2 Accuracy assessment

The purpose of this task was to assess the accuracy of the GA data in each sub-catchment or non-designated area by comparing GA data with other datasets. This was undertaken for the whole SS10 area using TW for comparison, as well as in case study areas within each NRM region using TW and various types of imagery. Improved datasets were created for five case study areas (Figure 2.6) by comparison with available imagery, as described below.

2.2.1 Comparison of Area by Sub-catchment and/or NRM Region

Information from Section 2.4 relating to frequency and surface area of dams was extracted and tabulated in Microsoft Excel for each sub-catchment or non-designated area within SS10.

2.2.2 Case studies

For all case studies a new dataset was created containing a revised surface area. The TW feature class was copied and used as a base to add, subtract and revise farm dam boundaries as deemed appropriate from visual inspection of aerial and/or satellite imagery. The new dataset is a local dataset and is referred to as the '2015 revision'.

A 500 m polygon fishnet layer was generated for the complete Murray-Darling Basin SS10 area to assist tracking of progress in reviewing aerial imagery and farm dam datasets.

The sections below describe the work undertaken in each of the case study areas.

2.2.2.1 Intersection of SS10 and SE Regional Zone f

The study area was identified that is the intersection between SS10 and the South East Regional Zone f surface water policy area. The count and area of farm dams from TW, GA Farm Dams and the 2015 farm dam revision undertaken in Section 2.3 was summarised. The study area is illustrated in Figure 2.1. The GA Large Farm Dams feature class is illustrated in Figure 2.1. No GA small dams are present.





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2.2.2.2 SA Arid Lands (SAAL) NRM region

A section of 500 m tiles comprising 72 100 ha within the SAAL region was selected for review (Figure 2.2).

QGIS was used with a Google Imagery web service. The Admin.Pastoral Waterpoints, TW and GA farm dams feature classes were compared. During the review a revised farm dam dataset was digitised. Information on count and area of farm dams was summarised.



Figure 2.2 SS10 Assessment Area within SAAL NRM Region using Google Imagery. Red indicates location of 500 m polygon tiles used for review. Red bar is 100 km in length.

2.2.2.3 Non-designated area of SAMDB NRM region

A section of 500 m tiles was randomly selected over the 2013 Western Murraylands aerial orthoimagery. The test area (8400 ha) north-east of Tailem Bend is illustrated in Figure 2.3. ESRI ArcGIS was used with the 2013 Western Murraylands aerial orthoimage. The existing farm dam layers were reviewed against imagery and a revised Farm Dam feature class generated for the non-designated area. All three features are compared in terms of count and area.

2.2.2.4 SAMDB - Sedan sub-catchment – Rangelands Catchment

The *Sedan* sub-catchment (16 825 ha) was selected for accuracy testing within the Rangelands catchment (Figure 2.4). The 500 m tile grid was intersected with the sub-catchment and GA Farm Dams and TW features selected within that area. ESRI ArcGIS was used with the 2013 Western Murraylands aerial orthoimage. The existing farm dam layers were reviewed against imagery and a revised Farm Dam feature class generated for the sub-catchment. All three features are compared in terms of count and area.

2.2.2.5 SAMDB - Razorback sub-catchment – Burra Catchment

The *Razorback* sub-catchment (6350 ha) was selected for accuracy testing within the Burra Catchment (Figure 2.5). The 500m tile grid was intersected with the sub-catchment and GA and TW features selected within that area. QGIS was used with Google imagery. The existing farm dam layers were reviewed against imagery and a revised farm dam feature class generated for the sub-catchment. All three features are compared in terms of count and area.







Figure 2.4 SS10 assessment area within Sedan sub-catchment



Figure 2.5 SS10 assessment area within Razorback sub-catchment

2.3 Farm dams within SS10 and Regional Zone f

Regional Zone f was intersected with the SS10 area (Figure 2.1).

Due to the small size of this area, each 500m tile within the intersection of Regional Zone f and SS10 was inspected utilising the South East 2013 aerial orthoimagery. Google Earth imagery was also consulted for areas of doubt. Comparisons were made to the TW layer, GA Farm Dams, WOfS and the DEM. A new feature class was generated which incorporates the revised dam boundaries for the intersection of Regional Zone f and SS10.

Boundaries of dams were digitised (new) or modified (from TW) according to the procedures within DEWNR (2011). Comparisons were made between TW, GA Farm Dams and the derived Farm Dam dataset.

2.4 Surface area of dams and volume calculation

The results from the accuracy assessment (section 2.2) identified the TW feature class to be the most accurate. However a data deficient area was identified in the SAAL and northern SAMDB regions. In this area the corporate TW data was edited to include GA large farm dams. In addition, farm dam polygons were captured where visible utilising the Admin. Pastoral Water Point feature class and the ALOS 2010 250cm satellite image. Future maintenance will be enhanced by using higher resolution and more recent satellite or aerial imagery. The area of data improvement comprised the area above the yellow line in Figure 2.6.

The volume of farm dams was then calculated using McMurray (2004) equations i.e.

- For surface area less than 15 000m², Volume = 0.0002*(Surface Area)^{1.25}
- For surface area greater than 15 000m², Volume = 0.0022*Surface Area





3 Results

3.1 SS10 within SA Murray Region WRP area

Figure 1.1 illustrates the SS10 project area within the SA Murray Region water resource plan area. Figure 3.2 shows additional sub-catchment features.

As shown in these figures, the SA Murray Region water resource plan area contains parts of the South Australian Murray-Darling Basin, South Australian Arid Lands and South East NRM regions. The SAMDB NRM region contains the non-prescribed Burra and Rangelands catchments and sub-catchments which have dam capacity limits under the SAMDB regional NRM plan, together within a non-designated area (the remaining non-prescribed area within SAMDB) that doesn't have specific dam capacity limits. External to SAMDB, but within SS10, there are also the non-prescribed SAAL NRM region and the SE NRM region. These areas are referred to as non-designated areas within the context of this report.

Excluded from SS10 but still within the SAMDB are the South Australian River Murray (SS11), Marne Saunders (SS12) and the Eastern Mt Lofty Ranges (SS13) surface water SDL resource units.

3.2 Accuracy assessment

3.2.1 Previous accuracy assessments

In 2011, the former SA Department for Water (DFW) compared the GA dataset with the DFW digitised farms dams dataset of that time (DFW 2011). This report found that within the prescribed areas the total number of farm dams were generally underreported in the GA dataset and that total volumes were over-estimated due to a different surface area – volume relationship. Moreover, the review identified that in the non – prescribed SS10 area, GA was a more complete dataset of farm dams than the then DFW data (this was prior to the integration of respective surface water datasets from the former SA Department of Environment and Natural Resources and DFW to create a single authoritative dataset, Topo Waterbodies).

Within the Burra Catchment the number of farm dams was estimated to be 580 and 760 for the GA and DFW farm dam datasets, respectively. Whilst GA had fewer dams, the estimation of dam capacity was 2000ML for the GA dataset as opposed to 1400ML for the DFW dataset. This was due to the GA data generally having larger surface areas resulting in significantly greater dam capacity volumes.

Within the remainder of the non-prescribed areas, the GA dataset was found to be the best available information for dam locations and surface areas.

3.2.2 Current accuracy assessment - overall comparison

A comparison of count and surface area between GA Farm Dams and TW (pre data improvement) by sub-catchment, catchment and region is provided in Table 3.1. The analysis does not incorporate spatial autocorrelation, it is only a summary of frequency of dams and cumulative surface area.

Within the SAAL NRM region of SS10 the GA farm dam feature class has 237 more dams captured compared to the TW data. The TW area is 106.2ha less than the GA data, which is the largest difference for all of the SS10 study area.

For the SAMDB NRM Region of SS10 the TW farm dam feature class has 584 more dams than the GA dataset. The surface area is 66ha less, largely due to an overestimation in boundaries of farm dams with the GA feature class.

In total the non-designated area has <mark>425</mark> more digitised farm dams in the TW dataset compared to GA, yet the surface area is 165ha less. Fluctuations in surface area and frequency occur within each sub-catchment of the Rangelands and Burra catchments. The Rangelands catchment has 685 more digitised dams within the TW dataset, but the surface area is 123ha less. The Burra catchment has 67 more farm dams within TW and again the surface area is less by 47ha.

Within the overall SS10 non-prescribed region the TW feature class has 1177 more farm dams and the surface area is 336ha less than the GA dataset.

Table 3.1: Count and surface area comparison between GA Farm Dams and TW (before revision).Sub-catchments are shown in Figure 3.2.

SDL Resource Unit	Catchment	NRM region or Sub- catchment of SS10	Area of Sub- catchment (ha)	Number of Dams			Total Surface Area of dams (ha)		Area of dams ha)
				GA	TW	Difference (GA-TW)	GA	тw	Difference (GA-TW)
SS10	Not designated	SAAL	1 155 900	349	112	237	157.426	51.225	106.201
SS10	Not designated	SAMDB	4 427 600	2901	3485	-584	747.004	681.173	65.831
SS10	Not designated	SE	162 809	122	200	-78	20.793	27.687	-6.894
sub total			5 718 700	3372	3797	-425	925.22	760.08	165.14
SS10	Rangelands	BA	9914	38	34	4	8.075	3.454	4.621
SS10	Rangelands	CA	1912	1	1	0	0.171	0.083	0.088
SS10	Rangelands	СР	14 544	49	104	-55	6.796	3.987	2.809
SS10	Rangelands	KP	46 760	258	405	-147	53.659	34.246	19.413
SS10	Rangelands	LC	9045	61	147	-86	10.181	7.304	2.877
SS10	Rangelands	ND	24 769	115	259	-144	18.041	14.750	3.291
SS10	Rangelands	NE	24 792	115	99	16	23.032	7.443	15.589
SS10	Rangelands	PC	1025	4	3	100	0.546	0.230	0.316
SS10	Rangelands	PN	5838	81	125	-44	13.424	10.880	2.543
SS10	Rangelands	RC	13 543	37	50	-13	7.427	4.871	2.556
SS10	Rangelands	RL	10 716	74	118	-44	10.807	9.542	1.265
SS10	Rangelands	SC	5144	27	34	-7	5.750	2.459	3.291
SS10	Rangelands	SE	15 190	29	74	-45	4.245	3.696	0.549
SS10	Rangelands	SH	27 996	178	227	-49	30.672	19.974	10.698
SS10	Rangelands	ST	11 870	67	94	-27	8.821	6.918	1.903
SS10	Rangelands	TC	9436	26	29	-3	2.583	1.201	1.381
SS10	Rangelands	TR	19 384	182	232	-50	31.300	23.246	8.053
SS10	Rangelands	WA	47 394	55	66	-11	13.387	5.888	7.499
SS10	Rangelands	WC	32 922	137	130	7	33.196	9.424	23.772
SS10	Rangelands	WD	2582	19	21	-2	2.654	2.151	0.503
SS10	Rangelands	WI	17 126	52	38	14	14.357	4.563	9.793
SS10	Rangelands	WR	2197	3	3	0	0.766	0.278	0.488
sub total			354 099	1608	2293	-685	299.89	176.59	123.30
SS10	Burra	BU1	5297	44	51	-7	8.875	3.626	5.249
SS10	Burra	BU2	6351	74	81	-7	17.594	8.662	8.932
SS10	Burra	BU3	9904	75	71	4	12.551	6.080	6.471
SS10	Burra	BU4	3997	49	45	4	12.191	5.469	6.722
SS10	Burra	BU5	8999	42	73	-31	9.803	7.175	2.628
SS10	Burra	BU6	6559	43	38	5	7.931	3.090	4.841
SS10	Burra	BU7	4777	89	102	-13	14.998	7.097	7.901
SS10	Burra	BU8	8256	62	64	-2	11.967	3.903	8.064
SS10	Burra	BU9	6101	23	21	2	3.881	1.200	2.681
SS10	Burra	BU10	33 532	108	130	-22	24.098	30.023	-5.925
sub total			93 773	609	676	-67	123.89	76.33	47.56
Total			6 166 572	5589	6766	-1177	1349	1013	336

3.2.3 Case studies

3.2.3.1 Intersection SS10 and SE Regional Zone f

In comparison to the 2015 revision (digitised farm dams using 2013 Aerial Imagery) the DEWNR TW Waterbody overestimated the number of farm dams by 5 (**Table 3.2**) whereas GA farm dams underestimated by 8. Both GA and TW were similar in total area, however they were both identified to overestimate actual farm dam surface area by 212%. Further detail on methods used to refine data is provided in section 3.3.

Table 3.2: Summary statistics – SS10 and SE Regional Zone f

Feature Class	Number of Dams	Surface Area (ha)
Topo Waterbodies	57	3.85
GA Farm Dams	44	3.88
2015 revision	52	1.58

3.2.3.2 SAAL test area

No farm dams were captured in the TW data for the case study area and this is the case for the majority of SAAL region within SS10 with the exception of a 20 km strip at the western side of the SAAL non-designated area. Five GA farm dams were discounted as dams, resulting in only 11 dams (21%) that intersect the revised 2015 farm dam layer. The GA surface area is 51% of the total revised surface area.

42 Pastoral Waterpoints (selection of Feature Codes 4812 and 4409) intersected the test area, with 4 locations identified as not reflecting farm dams.

For the SAAL area the Pastoral Water Points feature class is the best source of information for farm dam locations. These locations together with the GA dataset should be used as a guide to assist digitisation of farm dams into the corporate TW data within the SAAL area.

The majority of dams in this region were connected to watercourses or drainage systems.

Table 3.3: Summary statistics – SAAL NRM Region test area of SS10

Feature Class	Number of Dams	Surface Area (ha)
Topo Waterbodies	0	0
GA Farm Dams	11	5.14
Pastoral Water Points	38	NA
2015 revision	52	10.16

3.2.3.3 SAMDB NRM Region

The GA farm dam dataset identified one dam compared to 13 for TW. Both the number and area of farm dams are under estimated (Table 3.4).

One (6%) GA farm dam and 13 (87%) TW features intersect the revised 2015 farm dam layer.

Seven dams from TW were identified not to be dams. Two new dams were digitised whilst 8 dam boundaries were revised.

Feature Class	Number of Dams	Surface Area (ha)
Topo Waterbodies	20	1.24
GA Farm Dams	1	0.04
2015 revision	15	1.3

Table 3.4: Summary statistics – SAMDB test area (non-designated)

3.2.3.4 Sedan sub-catchment – Rangelands Catchment

The GA farm dataset identified 30 dams compared to 85 for TW (Table 3.5) with similar surface areas indicating overestimation of dam boundaries within the GA dataset.

Twenty three GA farm dams intersected TW farm dams. Twenty five (28%) GA farm dams and 84 (94%) TW features intersected the revised 2015 farm dam feature class for the Sedan sub-catchment.

Ten TW features were identified not to be dams. 14 new dams were digitised. 24 of the 89 dam boundaries were revised.

Table 3.5: Summary statistics – Sedan sub-catchment

Feature Class	Number of Dams	Surface Area (ha)
Topo Waterbodies	85	4.7
GA Farm Dams	30	4.3
2015 revision	89	3.88

3.2.3.5 Razorback sub-catchment – Burra Catchment

The GA farm dataset identified 48 dams compared to 59 for TW (Table 3.6) however the area was overestimated i.e. double that of TW.

Thirty six GA farm dams intersected TW. Forty three (57%) GA farm dams and 56 (75%) intersected the revised 2015 farm dam feature class for the Razorback sub-catchment.

Sixteen new farm dams were digitised. 52 of the 59 TW features were revised. Five GA farm dam features were identified not to be dams.

Table 3.6: Summary statistics – Razorback sub-catchment

Feature Class	Number of Dams	Surface Area (ha)
Topo Waterbodies	59	4.45
GA Farm Dams	48	10.48
2015 revision	75	5.12

3.2.4 Timing

Time required to review and digitise datasets for the case studies are detailed below.

In summary 3.8 days was required to review a total area of 120 657 ha:

- SE 16 982 ha 7.5 hours
- SAAL 72 100 ha 5 hours
- SAMDB 8400 ha 3 hours
- Rangelands sub-catchment 16 825 ha 11.5 hours
- Burra sub-catchment 6350 ha 3 hours

3.3 Farm dams within SS10 and Regional Zone f

The extent of Regional Zone f within the Murray Region WRP area is detailed in Figure 2.1. The area comprises 16 982ha.

Generally, the Geoscience Australia (GA) farm dam dataset only identified the larger dams and were greater in surface area than that of TW. The TW feature class required modification to boundaries in accordance with DEWNR (2011) to reduce the spatial footprint of dams to the waterbody feature. An example of a GA, TW and a 2015 digitised farm dam is illustrated in Figure 3.1.

Some dams within the TW feature class were identified to be bulldozer scrapes or were borrow pits at the time of the last spatial capture (2008). Some of these features were able to be confirmed or denied dam attribution using the DEM and the image history functionality within Google Earth.

WOfS was only useful in dam detection on one occasion in identifying a dam, however, this had previously been digitised by TW and GA Farm Dams (Figure 3.1). The size of dams in regional zone f is most likely the limiting factor for detectability.

The TW feature class had 57 farm dams (Table 3.7) compared to 44 and 52 for the GA farm dams and 2015 revision, respectively. However, GA farm dams had a total surface area of 3.88ha compared to 3.85 and 1.58ha for the TW and 2015 revision, respectively.

The 2015 revised surface area is 40% of the GA farm dams estimated area.

13 new dams were digitised. 39 TW boundaries were revised whilst 10 features attributed as farm dams were deleted.

One GA farm dam was determined not to be a dam feature as at 2015. It appeared to be a borrow pit during 2008 which may have influenced dam categorisation at that time.

Table 3.7	Summary statist	tics – Topo Waterbo	odies (dams), GA F	arm Dams and 2015	digitised dams
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Feature Class	Number of Dams	Min Surface Area (ha)	Max Surface Area (ha)	Mean Surface Area (ha)	Sum Surface Area (ha)
Topo Waterbodies	57	0.005	0.2	0.07	3.85
GA Farm Dams	44	0.003	0.13	0.09	3.88
2015 revision	52	0.002	0.05	0.03	1.58



Figure 3.1 Example of WOfS, Topo Waterbodies, GA Farm Dams and 2015 digitised boundary

3.4 Surface area of dams and volume

3.4.1 Count and surface area of dams in the non-prescribed SAMDB NRM Region – Pre data improvement

The location of catchments, sub-catchments and non-designated areas within the SS10 portion of the Murray Basin are shown in Figure 3.2.

Summary statistics for number of farm dams, area and volumes between the GA dataset and TW for the Burra and Rangelands catchments, and the non-designated areas of SS10 are detailed in Table 3.8. In this instance the number and area of GA Farm dams is itemised and not summarised to one figure in order to demonstrate the minor influence of small dams. Small dams comprise 16, 6 and 4% of total GA dams for the SAMDB non-designated area, Rangelands and Burra catchments, respectively.

For each catchment or zone the TW feature class has more farm dams and less surface area than the GA data. The reason for a large discrepancy in the maximum surface area between TW and GA farm dams (i.e. 30ha to 5.47ha) is predominantly due to differing dam extents at Nunnyah Dam i.e. 30ha compared to 1ha.

Catchment	Feature Class	GA Туре	Number	Smallest (ha)	Largest (ha)	Average (ha)	Total (ha)
Burra	Topo Waterbodies		676	0.0007	1.3	0.11	76
	GA Farm Dams	small dams	27			0.085	2.3
		large dams	582	0.002	1.58	0.21	121.5
Rangelands	Topo Waterbodies		2293	0.002	1.51	0.07	176
	GA Farm Dams	small dams	98			0.059	5.58
		large dams	1510	0.0002	1.71	0.195	294
Non-designated area	Topo Waterbodies		3797	0.002	30	0.2	761
	GA Farm Dams	small dams	478			0.043	20.96
		large dams	2423	0.008	5.47	0.29	726

Table 3.8 Summary statistics – Count and area for Topo Waterbodies (dams) and GA farm dams (by type)

3.4.2 Count and surface area of dams in the non-prescribed SAMDB NRM Region – Post data improvement (March 2016 TW feature class)

The total number of dams within non-prescribed SAMDB NRM Region of SS10 is 7011. The total area and volume is 1092 ha and 16 295 ML, respectively.

The non-designated area has the largest number of dams (4041), area (840 ha) and volume (13 161 ML) followed by the Rangelands and Burra Catchments.

Table 3.9	Summary	v statistics – Coun	t, area and volum	e for non-pres	scribed SAMDB	NRM Region of SS10
			-			

Catchment	Feature Class	Number	Smallest (ha)	Largest (ha)	Average (ha)	Total (ha)	Volume (ML)
Burra	Topo Waterbodies	687	0.009	1.029	0.113	76.2	1012.62
Rangelands	Topo Waterbodies	2283	0.002	1.509	0.077	175.9	2121
Non-designated area	Topo Waterbodies	4041	0.002	5.07	0.21	840	13 161
Total		7011				1092	16 295

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Figure 3.2 Catchments and non-designated areas within SS10

3.4.3 Surface area of dams and volume across SS10

Table 3.10 shows summary statistics for total dam surface area and calculated volume based on the GA dataset and the revised TW dataset, split by NRM region and further splitting the SAMDB region into the Burra, rangelands and non-designated components.

Overall, the GA dataset has a smaller total surface area of dams than TW (1349 vs 1387 ha), but a larger total dam capacity (27 018 vs 21 192 ML). However, the trend is different within NRM regions and catchments within regions. For example, total surface area and dam capacity is higher in the GA dataset than TW across the Burra and Rangelands catchments in the SAMDB NRM region, but both are lower in the GA dataset than TW for the SAAL NRM region.

Table 3.10	Surface area and volume – G/	A 2010 dataset and DEWNR To	po Waterbodies (March 2016).	Sub-catchment codes are shown in Figure 3.2
			po	

SWSDLID	Catchment	NRM region or Sub-catch of SS10	Area of Sub- catchment (ha)	Geoscience Australia Farm Dams Topo Wate Feature Class 2010		b- Geoscience Australia Farm Dams it Feature Class 2010 March 2016		
				Dam Area (ha)	GA Volume [#] (ML)	Dam Area (ha)	Volume ** (ML)	
SS10	Not designated	SAAL	1 155 900	157	3466.95	259	4415.62	
SS10	Not designated	SAMDB	4 427 600	747	15 849.98	840.3	13 161.61	
SS10	Not designated	SE	165 809	20.7	352.89	35.9	481.00	
sub total			5 749 309	925	19 669.82	1135.2	18 058.23	
SS10	Rangelands	BA	914	8.1	135.78	3.4	40.08	
SS10	Rangelands	CA	1912	0.2	2.56	0.1	0.88	
SS10	Rangelands	СР	14 544	6.8	111.76	4	38.98	
SS10	Rangelands	KP	46 760	53.7	957.4	34.2	421.99	
SS10	Rangelands	LC	9045	10.2	169.62	7.3	76.66	
SS10	Rangelands	ND	24 769	18	299.81	14.7	164.09	
SS10	Rangelands	NE	24 792	23	396.07	7.4	83.96	
SS10	Rangelands	PC	1025	0.5	8.2	0.2	2.66	
SS10	Rangelands	PN	5838	13.4	218.32	10.8	130.56	
SS10	Rangelands	RC	13 543	7.4	134.43	4.8	63.89	
SS10	Rangelands	RL	10 716	10.8	161.35	9.5	121.87	
SS10	Rangelands	SC	5144	5.7	99.28	2.4	26.70	
SS10	Rangelands	SE	15 190	4.2	67.45	3.5	38.91	
SS10	Rangelands	SH	27 996	30.7	511.42	19.9	252.70	
SS10	Rangelands	ST	11 870	8.8	140.61	6.9	78.20	
SS10	Rangelands	TC	9436	2.6	43.27	1.2	11.72	
SS10	Rangelands	TR	19 384	31.3	532.95	23.2	297.71	
SS10	Rangelands	WA	47 394	13.4	257.31	5.9	74.02	

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SWSDLID	Catchment	NRM region or Sub-catch of SS10	Area of Sub- catchment (ha)	Geoscience Australia Farm Dams Feature Class 2010		Topo Waterbodies (Farm Dams) Feature Class March 2016		
				Dam Area (ha)	GA Volume [#] (ML)	Dam Area (ha)	Volume ** (ML)	
SS10	Rangelands	WC	32 922	33.2	629.81	9.4	107.51	
SS10	Rangelands	WD	2582	2.7	40.64	2.1	25.01	
SS10	Rangelands	WI	17 126	14.4	265.39	4.5	60.19	
SS10	Rangelands	WR	2197	0.8	13.29	0.3	3.07	
sub total			354 099	299.9	5196.72	175.9	2121.35	
SS10	Burra	BU1	5297	8.9	155.04	3.6	40.31	
SS10	Burra	BU2	6351	17.6	311.61	8.6	106.97	
SS10	Burra	BU3	9904	12.6	209.67	6.1	70.11	
SS10	Burra	BU4	3997	12.2	237.41	5.6	74.89	
SS10	Burra	BU5	8999	9.8 -	183.32	7.1	88.54	
SS10	Burra	BU6	6559	7.9	129.41	3.1	35.53	
SS10	Burra	BU7	4777	15	241.55	7.1	77.44	
SS10	Burra	BU8	8256	12	196.71	3.9	40.45	
SS10	Burra	BU9	6101	3.9	59.02	1.2	12.83	
SS10	Burra	BU10	33 532	24	428.41	29.9	465.56	
sub total			93 773	123.9	2152.15	76.2	1012.62	
Total			6 197 181	1348.8	27 018	1387.30	21 192.20	

** Volume based on McMurray (2004) equations

#Volume derived from GA 2010 data

4 Discussion

4.1 Accuracy assessment

Within the SS10 non-prescribed area, the TW farm dam data had 6766 features compared to 5589 for the GA data, a difference of 1177. The GA farm dam surface area was 1349 ha compared to 1013 ha for the TW data, a difference of 336 ha (all TW data given in this section is pre-data improvement).

With the exception of the SAAL NRM case study area, the GA data had the lowest percentage accuracy compared to the TW data (Table 4.1). The SAAL case study area had no TW features and the GA data still only had an accuracy of 21% compared to actual digitised farm dams. The pastoral water points feature class had an accuracy of 73% (refer to Table 3.3). This data should be used in conjunction with GA to capture farm dam polygons in the future. The SAAL region should be a priority in terms of any future data capture programs for farm dams.

The GA data was least accurate for the SAMDB non-designated case study area with a 6% and 3% accuracy for count and surface area, respectively.

The percentage accuracy for the number of overall dams was 41.8% and 83.4% for the GA and TW datasets respectively, compared to revised 2015 dams identified from imagery as part of the case studies. However, both the GA and TW farm dam boundaries had a greater surface area than the boundaries digitised for this review.

Source	SE		SA	AL	SAMDE desigr	3 non- nated	RANGE	LANDS	BUR	RA	AL	L
	Count	AREA	Count	AREA	Count	AREA	Count	AREA	Count	AREA	Count	AREA
	%	%	%	%	%	%	%	%	%	%	%	%
GA	84	245	21	50	6	3	34	110	64	204	41.8	122.4
TW	109	243	0	0	133	95	96	121	79	86	83.4	109

Table 4.1: Percentage accuracy of GA and TW farm dams to 2015 revised data, based on visual inspection

During the review process it was harder within the SAMDB and SE portion of SS10 to distinguish between borrow pits and farm dams.

4.2 Farm Dams within SS10 and Regional Zone f

The intersection of SS10 and SE surface water policy area Regional Zone f was defined (Figure 2.1) and a complete visual review undertaken to digitise farm dam boundaries. Initially this work was perceived important to determine if any of the allowable dam volume under surface water policy in the SE regional NRM plan needs to be incorporated in the revised BDL. During the course of this work it was identified that the dam capacity limits for Regional Zone f in the SE regional NRM plan did not come into effect until 2010, post determination of BDL limits for SS10 (2009). Consequently, the contribution to the SS10 BDL from this zone will be limited to existing dam capacity / interception.

This review identified the GA data underestimated the number of dams whilst TW overestimated dams before data improvement. Both datasets significantly overestimated surface area.

4.3 Additional data capture

The time consumed to review and digitise farm dams for case study areas is detailed in section 3.2.4. Given the SS10 region is 6 202 766 ha, a complete review is estimated to require 195 days.

Future reviews should use the DEWNR Topo Waterbodies layer as the base. This project has improved the TW dataset in the case study areas, and also in the SAAL and northern SAMDB NRM regions by incorporating relevant data from the GA dataset and the Admin. Pastoral Water Point feature class and the ALOS 2010 250cm satellite image, as described in section 2.4.

Future reviews could undertake a complete visual review of aerial photography (or Google imagery where photography is dated) using the TW and GA data as guides. This could be a staged approach for catchments and non-designated areas. The SE Regional Zone f is complete.

Consideration also needs to be given to how DEWNR manages its datasets in relation to external policy settings (i.e. BDL). For this study the original DFW farm dams layer used for initial analysis of surface area and volume against the GA dataset could not be located in a timely fashion. Moreover, the corporate DEWNR TW data is routinely updated. Should datasets be used for future BDL or SDL settings it is recommended the data at that time be specifically time stamped or segregated as a new feature class to enable 'like' with 'like' comparisons in future reviews. To this end, the improved dams dataset created by this project has been archived as at March 2016 to enable future comparisons and change assessments.

4.4 Dam surface area and volume – Pre and post data improvement – SAMDB NRM Region

4.4.1 Pre-data improvement

For each catchment or zone within the SAMDB NRM region the TW feature class had more dams and less surface area than the GA data. Overall the TW data had 1177 more dams with a surface area 336 ha less than the GA data.

The total dam area for the Burra catchment was 124 ha and 76 ha for the GA and TW data, respectively. The total dam area for the Rangelands catchment was 299 and 176 ha for the GA and TW data, respectively.

The total dam area for the non-designated areas of SAMDB NRM Region was 747 and 681 ha for the GA and TW data, respectively.

4.4.2 Post-data improvement

The revised TW feature class (March 2016) has 7011 farm dams comprising 1092.4 ha and a calculated volume of 16 295.6 ML. The non-designated area of SS10 has the most dams (4041), largest area (840 ha) and volume (13 161.61 ML) followed by the Rangelands and Burra catchments.

4.5 Dam surface area and volume – Non-designated, catchments and sub-catchments

Surface areas and volumes for sub-catchments, catchments and non-designated areas have been assimilated or derived for the March 2016 TW feature class.

In total there are 7924 farm dams with a total area of 1390 ha and a total volume of 21 221 ML

4.6 Recommendations

- 1. The most accurate and therefore preferred layer for analysis of location and surface area information in addition to calculation of volume is DEWNR Topo Waterbodies.
- 2. The new, deleted and revised polygon boundaries captured during the accuracy assessments be reconciled with DEWNR Edit. AHGF Waterbody layer and attributed accordingly.

- 3. Consideration needs to be given to storage and date stamping (archiving) of data sets and metadata within DEWNR used for policy setting such that routine updates don't affect base data.
- 4. A procedure should be formulated to reconcile farm dam applications received from the Water Affecting Activities permits with on ground construction and subsequent digitisation within Topo Waterbodies.

5 Conclusions

With the exception of SAAL area, the Topo Waterbodies feature class was more accurate than the GA data for both dam locations and surface area. For the SAAL area, a DEWNR waterpoint feature class (associated with ALIS) was the most accurate farm dam dataset (73% accurate).

The limitations of the DEWNR Topo Waterbodies feature class in portions of the SAAL and northern SAMDB regions resulted in undertaking a data improvement phase during this project. The improvements incorporated additions to the dataset through incorporation of GA large farm dam polygons or digitisation of features from the DEWNR Admin.Pastoral Waterpoint dataset. These improvements have been included into the live topo waterbodies dataset and an archived version, referred to as the *March 2016 dataset* within this report, and stored on DEWNRs network (Location SA metadata system dataset number 1937).

This work has provided a baseline dataset of dam frequency, area and volume within the non-prescribed areas of SS10 within the Murray Basin.

The case studies identified that a full visual review and attribution of farm dams within SS10 may take 195 days for one FTE, which is a large investment for a region with low water demand. The data improvement undertaken in the SAAL and northern SAMDB NRM regions as part of this project, and the reasonable accuracy of the TW layer in the remainder of the SS10 region, means that the revised TW dataset is considered an appropriate, fit-for-purpose dataset for identifying water interception by dams in this region.

6 Appendix – Data

As per Recommendation 3, a copy of the TW data checked out and edited for volume calculations and allocation of catchments, will be archived within DEWNR corporate systems. It is called "SAMDB non-prescribed farm dams – March 2016". The metadata id for this record is 1937 on the SA Location Metadata System (http://sdsidata.sa.gov.au/LMS).

A zip file containing the following elements accompanies this report and is stored in DEWNR archives:

- GIS shapefile of "SAMDB non-prescribed farm dams March 2016"
- Metadata report for "SAMDB non-prescribed farm dams March 2016"

7 Glossary

Act (the) — In this document, refers to the Natural Resources Management (SA) Act 2004, which supersedes the Water Resources (SA) Act 1997

Basin Plan — Murray–Darling Basin Plan

- **BDL** Base diversion limit
- DEWNR Department of Environment, Water and Natural Resources

GA — Geoscience Australia

MDBA — Murray–Darling Basin Authority

NRM — Natural Resources Management; all activities that involve the use or development of natural resources and/or that impact on the state and condition of natural resources, whether positively or negatively

- SAAL South Australian Arid Lands
- SAMDB South Australian Murray-Darling Basin
- **SDL** Sustainable diversion limit
- **SE** South East
- SS10 South Australian Non-Prescribed Areas Surface Water SDL Unit
- \mathbf{TW} Topo_Waterbodies feature class maintained by DEWNR
- WOfS Water Observations from Space spatial dataset from Geoscience Australia
- WRP Water Resource Plan

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