APPENDIX A – SURFACE WATER QUALITY MONITORING RESULTS

	Site D Monitoring Results											
	pH	Dissolved Oxygen	Electrical Conductivity	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	Chloride	Sodium	Arsenic	Manganese	Dissolved Iron	Total Nitrogen	Total Phosphorus
Unit		mg/L	µS/cm k 25.00C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Limit of Reporting	0.1		1	< 2	1	1	1	0.001	0.001	0.05	0.1	0.01
ANZECC Trigger Values for physical & chemical stressors for south-east Australia for slightly disturbed ecosystems (Upland River)	6.5 - 8		30 - 350								0.25	0.02
ANZECC Trigger Values - Freshwater Ecosystems												
99% Level of Species Protection								< LOR	1.2			
95% Level of Species Protection								0.013	1.9			
90% Level of Species Protection								0.042	2.5			
80% Level of Species Protection								0.14	3.6			
Australian Drinking Water Guidelines												
Health								0.01	0.5			
Aesthetic	6.5 - 8.5	> 85%			600	250	180		0.1	0.3		
14/02/2007	6.4		69		111	4.8	4	< 0.001	0.111	1.54	4.2	3.15
27/02/2007	6.3		62		112	4.4	2	< 0.001	0.433	1.49	2.3	0.15
22/03/2007	6.6		84		77	3.9	4	< 0.001	0.417	1.93	2.9	0.22
26/04/2007	6.7		109		128	4.2	3	0.004	0.972	4.74	3.7	0.26
28/05/2007	7		115		118	4.4	4	0.002	0.94	7.82	6.3	0.46
18/06/2007	6.2		87		149	19.2	9	< 0.001	0.105	1.77	1.5	0.04
16/07/2007	6.1		138		129	23.4	13	< 0.001	0.257	1.57	2.4	0.2
13/02/2008	6.2		83		130	9	6	< 0.001	0.112	2.22	2	0.1
12/03/2008	6.4		230		79	16.3	7	< 0.001	0.156	1.94	1.7	0.16
14/04/2008	6.9		98		107	17.2	7	< 0.001	0.143	1.69	2	0.07
14/05/2008	6.5		103		86	6.1	7	0.002	0.125	1.67	3.4	0.18
11/07/2008	7.1		104		99	16.6	7	< 0.001	0.082	1.83	2.8	0.27
11/09/2008	6.7		124		120	17		0.001	0.296	2.59	2.7	0.17
14/10/2008	6.5		158		128	7	4	0.001	0.161	3.29	1.8	0.2
6/03/2009	6.7	8.2	98		116.4	9.7	7.2	< 0.001	0.066	0.69		
11/06/2009	6.3	10.4	66		117	12	6.6	< 0.001	0.058	0.95		
9/07/2009	6.1	8.8	83		110	12	6.5	< 0.001	0.031	0.76		
18/08/2009	6.8	10.7	87		120	13	6.9	< 0.001	0.097	0.79		
14/09/2009	7.1	10.2	96		130	14	6.8	< 0.001	0.21	1.1		
14/10/2009	8.3	10.8	110		130	15	7.9	0.001	0.47	2.1		
12/11/2009	7.5	6.4	130		120	18	8.7	0.001	0.12	1.4		
10/12/2009	8.3	10.8	200		160	23	10	0.001	0.061	0.26		
8/01/2010	5.9	5.8	110		220	12	5.9	0.001	0.56	2.1		
4/02/2010	6	8.9	76		450	6.6	4.1	0.001	0.12	0.72		
4/03/2010	6.9	7.9	52		80	7	3.6	0.001	0.11	0.97		
16/04/2010	10	9.1	53		58	7.7	3.8	0.001	0.009	0.41		
14/05/2010	6		50	26	66		4	0.001	0.033	0.27	1.9	0.14
16/06/2010	5.1	11.8	63		100	9	4.5	0.001	0.016	0.4		
20/07/2010	6.9	7.3	71		77	9.2	4.9	0.001	0.052	0.61		
13/08/2010	6.7		70	11								
13/09/2010	7.2		72	5								
8/10/2010	7.1		82	5								
8/11/2010	6.6		51	23							1.6	0.14
15/12/2010	6.7		100	10								
13/01/2011	7.1		110	16								
11/04/2011	6.7		110	19							1.7	0.09
13/07/2011	7.3		110	6				0.001	0.011	0.43	1.6	0.04
17/02/2012	6.2		100	36							2.5	0.18
14/05/2012	7		160	13							2.6	0.1
14/11/2012	6.8		190	5							2.1	0.07
12/02/2013	7.1		280	55							4.1	0.18
16/05/2013	7.5		270	41							1.9	0.09
16/08/2013	7.3		190	26							2.8	0.08
14/11/2013	7.9		290	100							2.7	0.15
14/02/2014	9.2		520	21							3	0.12
21/05/2014	7.4		340	20							2.3	0.13
20/11/2014	8		600	4							4.1	0.03
20/02/2015	8.2		1300	6							9.9	0.02

Site O Monitoring Results												
	pH	Dissolved Oxygen	Electrical Conductivity	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	Chloride	Sodium	Arsenic	Manganese	Dissolved Iron	Total Nitrogen	Total Phosphorus
Unit		mg/L	µS/cm k 25.00C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Limit of Reporting	0.1		1	< 2	1	1	1	0.001	0.001	0.05	0.1	0.01
ANZECC Trigger Values for physical & chemical stressors for south-east Australia for slightly disturbed ecosystems (Upland River)	6.5 - 8		30 - 350								0.25	0.02
ANZECC Trigger Values - Freshwater Ecosystems												
99% Level of Species Protection								< LOR	1.2			
95% Level of Species Protection								0.013	1.9			
90% Level of Species Protection								0.042	2.5			
80% Level of Species Protection								0.14	3.6			
Australian Drinking Water Guidelines												
Health								0.01	0.5			
Aesthetic	6.5 - 8.5	> 85%			600	250	180		0.1	0.3		
14/02/2007	6.5		279		207	51.2	22	< 0.001	0.03	1.76	4.1	0.26
27/02/2007	7.7		253		190	34.1	14	0.002	0.044	0.91	2.5	0.1
22/03/2007	7.5		400		252	47.6	26	0.002	0.104	0.91	1.7	0.07
26/04/2007	8.1		542		364	82.1	42	< 0.001	0.08	0.44	1.7	0.05
28/05/2007	8		611		332	90.2	47	< 0.001	0.164	0.36	1.9	0.12
18/06/2007	7		240		193	42.5	20	< 0.001	0.025	1.43	3.6	0.22
16/07/2007	7.2		855		480	183	66	< 0.001	0.028	0.34	1.2	0.07
13/02/2008	7.2		552		446	91.2	43	< 0.001	0.094	1.17	1.6	0.01
12/03/2008	7.7		1372		894	401	118	< 0.001	0.103	0.32	1.2	0.03
14/04/2008	8.2		3960		2780	1220	357	< 0.001	0.071	1.02	0.8	0.01
14/05/2008	8.2		4260		2360	1180	430	0.001	0.013	0.05	0.8	0.01
11/07/2008	8.2		1329		808	373	112	< 0.001	0.011	0.19	0.9	0.37
11/09/2008	8.3		2280		1350	641		< 0.001	0.034	0.27	0.8	0.01
14/10/2008	7.6		686		468	144	61	< 0.001	0.062	2.08	0.7	0.08
6/03/2009	8.3	9.5	560		340	87	38	< 0.001	0.004	0.2		
11/06/2009	7.8	10.3	350		241	62	31	< 0.001	0.003	0.19		
9/07/2009	6.6	6.7	190		330	35	16	< 0.001	0.004	0.79		
18/08/2009	6.9	8.8	210		380	36	18	< 0.001	0.017	0.7		
14/09/2009	6.5	3	190		1100	28	16	< 0.001	0.011	0.62		
14/10/2009	7.3	9.7	150		1400	19	30	0.001	0.007	1.5		
12/11/2009	7.5	3.3	200		920	23	24	0.001	0.086	0.85		
10/12/2009	6	1.3	170		940	23	17	0.001	0.19	0.54		
8/01/2010	6.9	7.2	380		260	55	25	0.001	0.08	0.39		
4/02/2010	6.3	1.4	370		370	56	26	0.002	0.53	0.7		
4/03/2010	8	8	470		320	73	39	0.001	0.003	0.13		
16/04/2010	8.5	9.3	540		340	87	46	0.001	0.003	0.06		
14/05/2010	8.5		550		350		49	0.001	0.004	0.03	1.3	0.05
16/06/2010	5.8	8.4	420		520	80	42	0.001	0.013	0.29		
20/07/2010	7.4	9.3	520		350	110	50	0.001	0.008	0.1		
13/08/2010	7.7		340	470								
13/09/2010	8.3		1200	22								
8/10/2010	8.5		1200	8								
8/11/2010	7.9		360	150							1.5	0.16
15/12/2010	7.8		430	49								
13/01/2011	8.4		950	4								
11/04/2011	8		550	10							1.3	0.05
13/07/2011	8.3		1300	11				0.001	0.012	0.05	0.8	0.02
17/02/2012	6.6		240	23							2.2	0.10
14/05/2012	8.3		1500	4							0.8	0.01
14/11/2012	8.1		2900	8							0.7	0.02
12/02/2013	7.8		1100	19							1.5	0.08
16/05/2013	8.3		1200	7							0.8	0.02
16/08/2013	8.1		1700	3							0.8	0.01
14/11/2013	8.1		1200	13							0.6	0.02
14/02/2014												
21/05/2014	8.5		1200	7							1.8	0.06
20/11/2014												
20/02/2015	8.2		930	14							0.94	0.02
14/05/2015	8.5		2000	2							0.57	0.01

Site I Monitoring Results												
	pH	Dissolved Oxygen	Electrical Conductivity	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	Chloride	Sodium	Arsenic	Manganese	Dissolved Iron	Total Nitrogen	Total Phosphorus
Unit		mg/L	µS/cm k 25.00C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Limit of Reporting	0.1		1	< 2	1	1	1	0.001	0.001	0.05	0.1	0.01
ANZECC Trigger Values for physical & chemical stressors for south-east Australia for slightly disturbed ecosystems (Upland River)	6.5 - 8		30 - 350								0.25	0.02
ANZECC Trigger Values - Freshwater Ecosystems												
99% Level of Species Protection								< LOR	1.2			
95% Level of Species Protection								0.013	1.9			
90% Level of Species Protection								0.042	2.5			
80% Level of Species Protection								0.14	3.6			
Australian Drinking Water Guidelines												
Health								0.01	0.5			
Aesthetic	6.5 - 8.5	> 85%			600	250	180		0.1	0.3		
14/02/2007	6.8		111		110	17.5	11	< 0.001	0.189	8.8	4.7	5.55
27/02/2007	6.2		114		209	11.5	7	< 0.001	0.062	4.09	2.1	0.22
22/03/2007	6.6		142		213	7.3	8	0.003	0.832	5.57	2.5	0.12
26/04/2007	7		205		800	20.4	14	0.007	1.7	28.6	8.8	1.22
28/05/2007	6.5		61		91	6.2	9	< 0.001	0.023	2.52	1.6	0.04
18/06/2007	6.2		96		167	22.3	11	< 0.001	0.032	1.69	1.2	0.03
16/07/2007	5.9		143		142	25.7	14	0.001	0.128	0.98	2	0.13
13/02/2008	6.3		105		282	10.3	10	0.001	0.232	4.68	2	0.08
12/03/2008	6.4		132		286	19.8	8	0.003	0.682	18.6	3.3	0.3
14/04/2008	5.9		96		147	20.8	8	< 0.001	0.26	2.97	2.2	0.21
14/05/2008	8.2		3640		1950	846	376	< 0.001	0.025	0.08	1.8	0.91
11/07/2008	8.3		3230		2060	822	306	0.002	0.012	0.05	1.4	0.13
11/09/2008	5.7		149		398	27		< 0.001	0.312	6.21	0.9	0.18
14/10/2008	6.2		123		407	19	11	0.002	0.52	12.6	1.4	0.06
6/03/2009												
11/06/2009												
9/07/2009												
18/08/2009												
14/09/2009												
14/10/2009												
12/11/2009												
10/12/2009												
8/01/2010												
4/02/2010												
4/03/2010												
16/04/2010												
14/05/2010												
16/06/2010												
20/07/2010												
13/08/2010	6.4		97	21								
13/09/2010												
8/10/2010												
8/11/2010												
15/12/2010	6.3		140	6								
13/01/2011												
11/04/2011												
13/07/2011												
17/02/2012												
14/05/2012												
14/11/2012												
12/02/2013												
16/05/2013												
16/08/2013	8		1800	5							0.55	0.01
14/11/2013												
14/02/2014												
21/05/2014												
20/11/2014												
20/02/2015												
14/05/2015												

APPENDIX B – WATER BALANCE SUMMARY SHEETS

Gunlake Quarry: Site Water Balance
Model Assumptions: Approved Operation (0.75 Mtpa)

Storage Assumptions

Storage Name	Surface Area (m^2)	Average Depth (m)	Volume (ML)	Contributing Catchments	Overflows	Function
Process Water Dam	*4500*	*2.2*	*10*	*DW -1 (19ha)*	*to Chapmans Creek*	*Captures runoff from DW-1 for process water use*
Pit Sump	*1500*	*3*	*5 plus flood storage*	*Pit (14ha)*	*no overflows*	*Captures runoff from the pit for process water use*
Clean Water Dam 1	*3500*	*2*	*7*	*CW -1 (70ha)*	*to Chapmans Creek*	*Captures runoff from CW-1 for process water use*
Clean Water Dam 2	*6000*	*2.5*	*15*	*CW -2 (62ha)*	*to Chapmans Creek*	*Captures runoff from CW-2 for process water use*

Note: Storage volumes have been estimated using available information and have not been confirmed by survey

Demand Assumptions

Haul Road Dust Suppression

Water use for haul road dust suppression is calculated as a function of the haul road area and prevailing climatic conditions using the following formulae

$$DSupp(t) = Max(0, ((Evap(t) \times PanCoeff) - Rain(t)) \times HRArea \times 0.01)$$

Where:

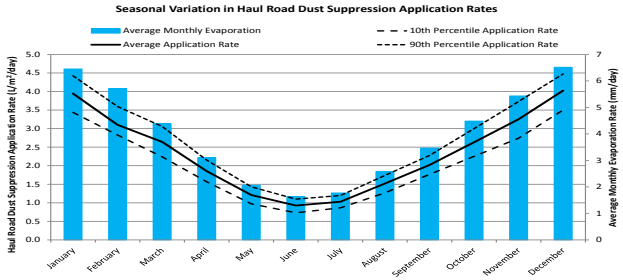
DSupp(t) = Daily water use for haul road dust suppression (ML/day)

Evap(t) = Daily pan evaporation (mm/day)

PanCoeff = Evaporation adjustment coefficient

Rain(t) = Daily rainfall (mm/day)

HRArea = Area of active haul road (ha)



The following haul road area and Pan Coeff were adopted

Haul Road Area	5ha	
Pan Coeff	0.72	*(This equates to an average annual application rate of 3L/m^2 per day)*

The calculated annual demand varies between **41** to **45 ML/year**, depending on rainfall over the year.
The demand varies seasonally inline with evaporation rates as shown in the above chart.

Plant Water Use

Plant water use is calculated as a function of the plant throughput and a water use rate

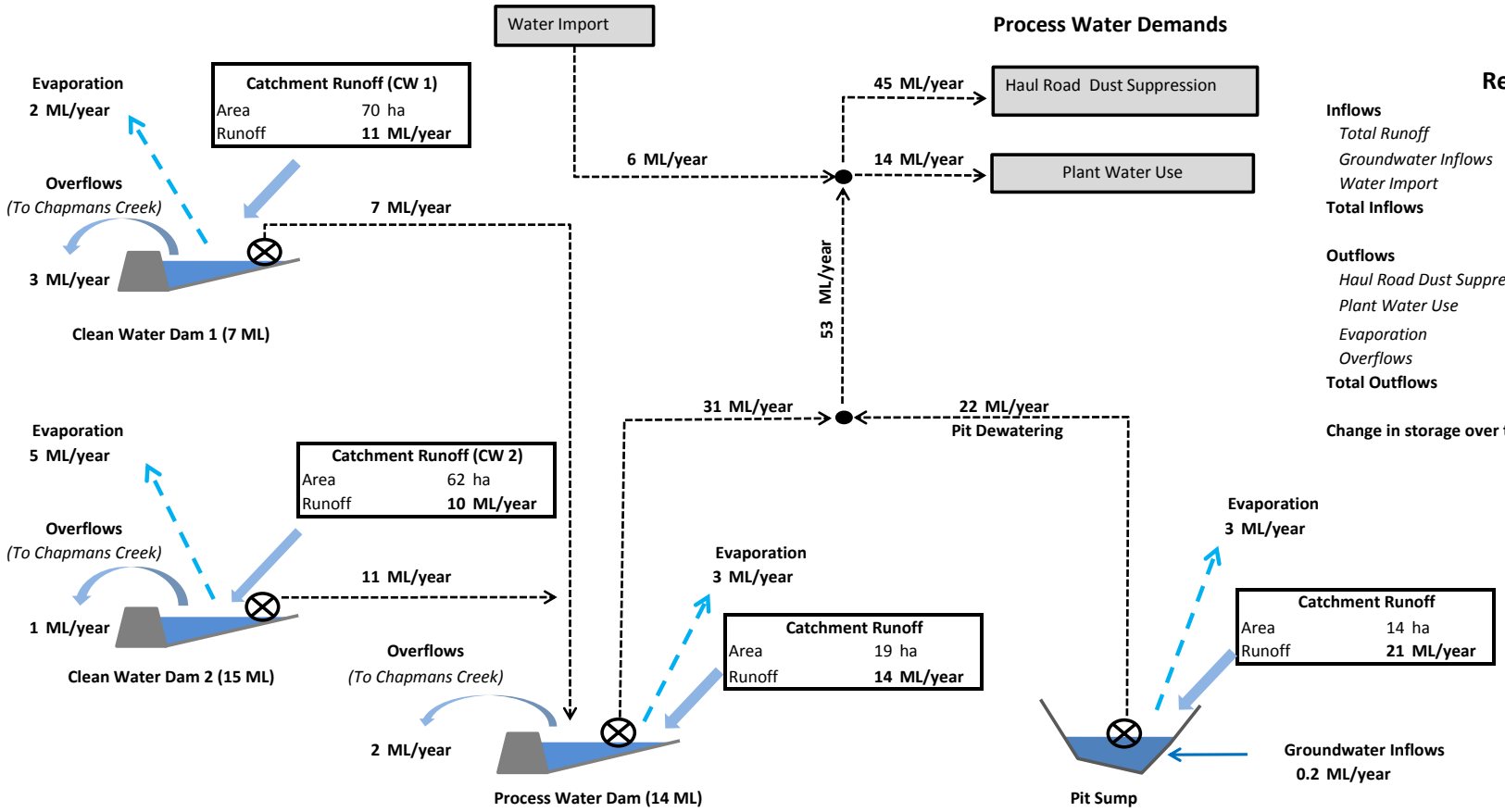
Plant Throughput	0.75 Mtpa	
Water use rate	18.2 L/t	*(Calculated from metered data provided by Gunlake)*
Annual Water Use	**13.7 ML/year**	

Process Water Use Order of Preference

The water balance model preferentially sources water to meet process water demands as follows:

1st preference: *Water stored in the pit*
2st preference: *Water stored in the process water dam*
3rd preference: *Water stored in Clean water dams*
4th preference: *Water imported to site via tankers*

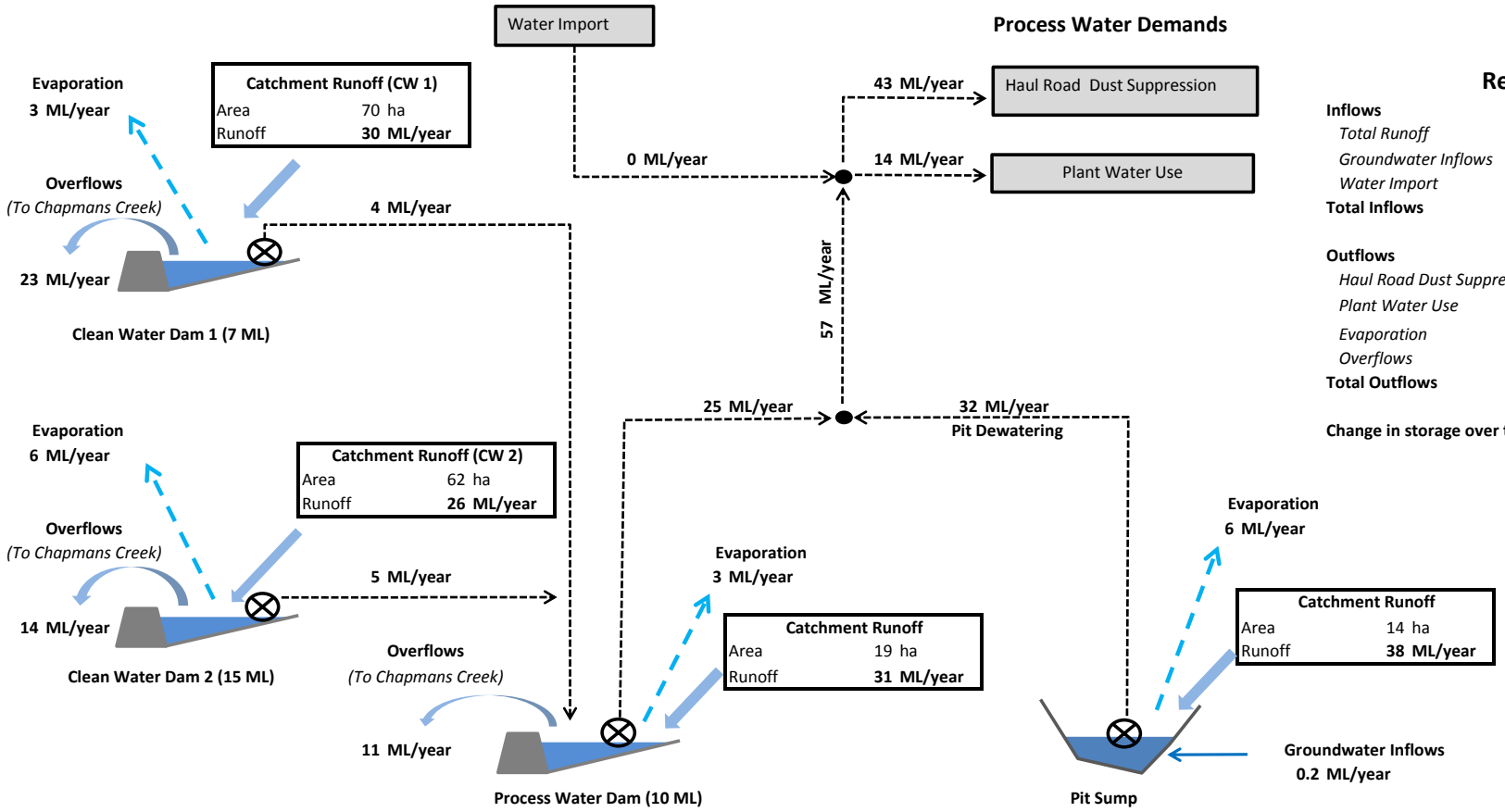
Gunlake Quarry: Site Water Balance: Approved Operation: Surface Water Management Plan
Typical Dry (10th Percentile) Rainfall Year
Annual Rainfall *451 mm/year*



Results Summary

Inflows	
Total Runoff	57 ML/year
Groundwater Inflows	0.2 ML/year
Water Import	6 ML/year
Total Inflows	**63 ML/year**
Outflows	
Haul Road Dust Suppression	*45 ML/year*
Plant Water Use	*14 ML/year*
Evaporation	*14 ML/year*
Overflows	*6 ML/year*
Total Outflows	**79 ML/year**
Change in storage over the year	**-16 ML/year**

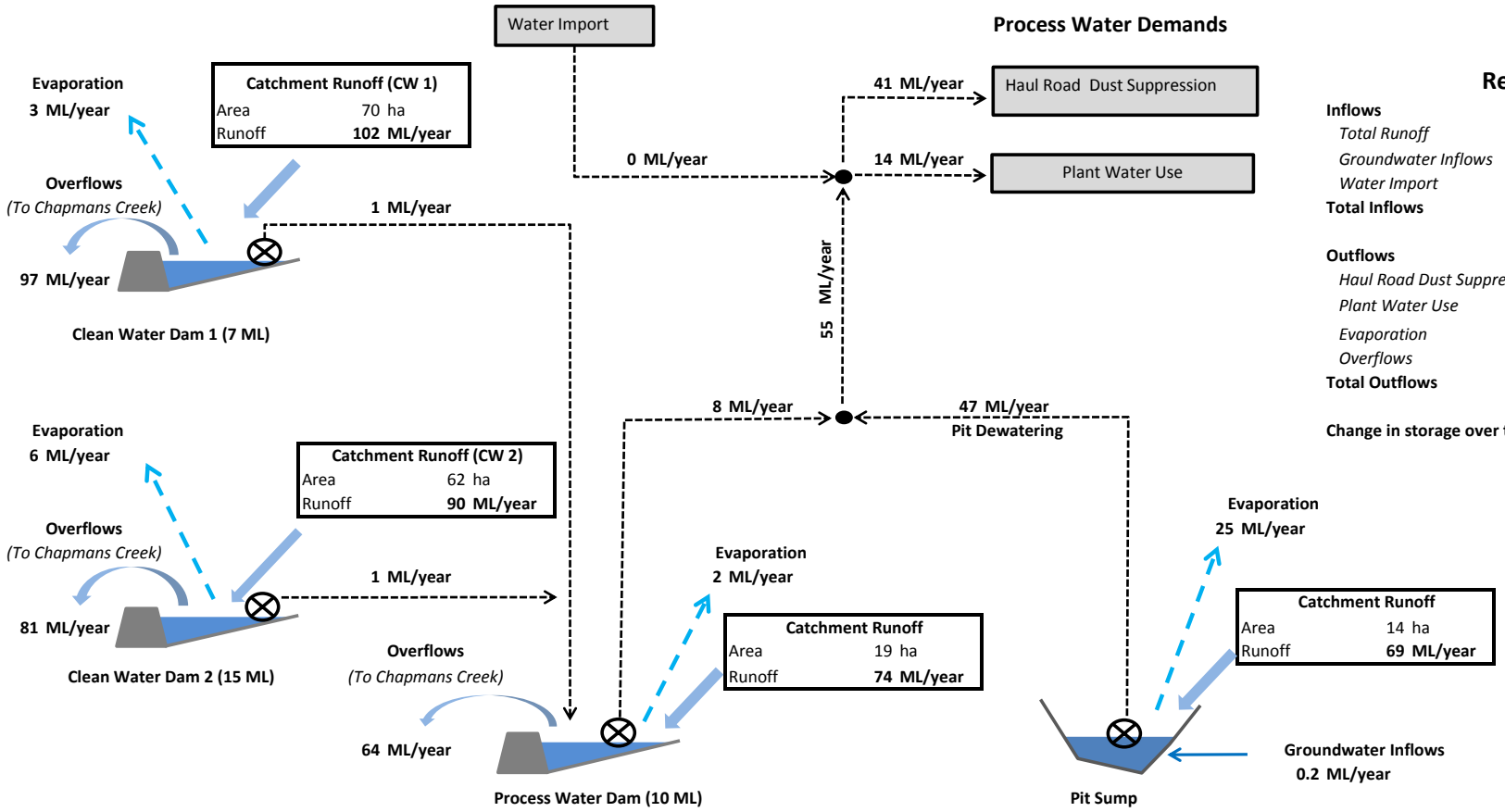
Gunlake Quarry: Site Water Balance: Approved Operation: Surface Water Management Plan
Typical Median (50th Percentile) Rainfall Year
Annual Rainfall *695 mm/year*



Results Summary

Inflows	
Total Runoff	125 ML/year
Groundwater Inflows	0.2 ML/year
Water Import	0 ML/year
Total Inflows	**125 ML/year**
Outflows	
Haul Road Dust Suppression	*43 ML/year*
Plant Water Use	*14 ML/year*
Evaporation	*18 ML/year*
Overflows	*47 ML/year*
Total Outflows	**121 ML/year**
Change in storage over the year	**4 ML/year**

Gunlake Quarry: Site Water Balance: Approved Operation: Surface Water Management Plan
Typical Wet (90th Percentile) Rainfall Year
Annual Rainfall *982 mm/year*



Results Summary

Inflows	
Total Runoff	335 ML/year
Groundwater Inflows	0.2 ML/year
Water Import	0 ML/year
Total Inflows	**335 ML/year**
Outflows	
Haul Road Dust Suppression	*41 ML/year*
Plant Water Use	*14 ML/year*
Evaporation	*37 ML/year*
Overflows	*242 ML/year*
Total Outflows	**333 ML/year**
Change in storage over the year	**2 ML/year**

Gunlake Quarry: Site Water Balance
Model Assumptions: Quarry Year 1: Surface Water Management Plan

Storage Assumptions

Storage Name	Surface Area (m^2)	Average Depth (m)	Volume (ML)	Contributing Catchments	Overflows	Function
Process Water Dam	*7500*	*5*	*35*	*DW -4 (19ha)*	*to Chapmans Creek*	*Captures runoff from DW-4 for process water use*
Pit Sump	*+7000*	*+3*	*20 plus flood storage*	*Pit (29ha)*	*no overflows*	*Captures runoff from the pit*
Clean Water Dam 2	*6500*	*2.3*	*15*	*CW -2 (48ha) + DW-2 (5ha)*	*to Chapmans Creek*	*Sedimentation dam for emplacement area. Water stored for process water use*
Pit Dewatering Dam	*10000*	*3*	*30*	*DW 5 (16ha)*	*to Chapmans Creek*	*Treats water dewatered from the pit. Water stored for process water use*

Demand Assumptions

Haul Road Dust Suppression

Water use for haul road dust suppression is calculated as a function of the haul road area and prevailing climatic conditions using the following formulae

$$DSupp(t) = Max(0, ((Evap(t) \times PanCoeff) - Rain(t)) \times HRArea \times 0.01)$$

Where:

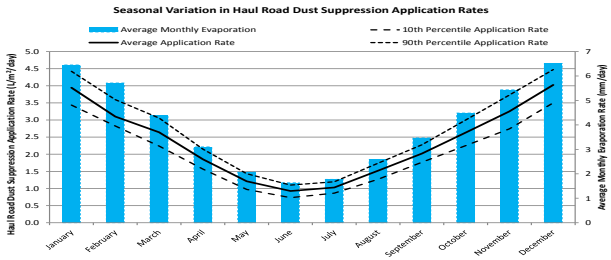
DSupp(t) = Daily water use for haul road dust suppression (ML/day)

Evap(t) = Daily pan evaporation (mm/day)

PanCoeff = Evaporation adjustment coefficient

Rain(t) = Daily rainfall (mm/day)

HRArea = Area of active haul road (ha)



The following haul road area and Pan Coeff were adopted

Haul Road Area	8ha	
Pan Coeff	0.72	*(This equates to an average annual application rate of 2.3L/m^2 per day)*

The calculated annual demand varies between **66** to **74 ML/year**, depending on rainfall over the year.
The demand varies seasonally inline with evaporation rates as shown in the above chart.

Plant Water Use

Plant water use is calculated as a function of the plant throughput and a water use rate

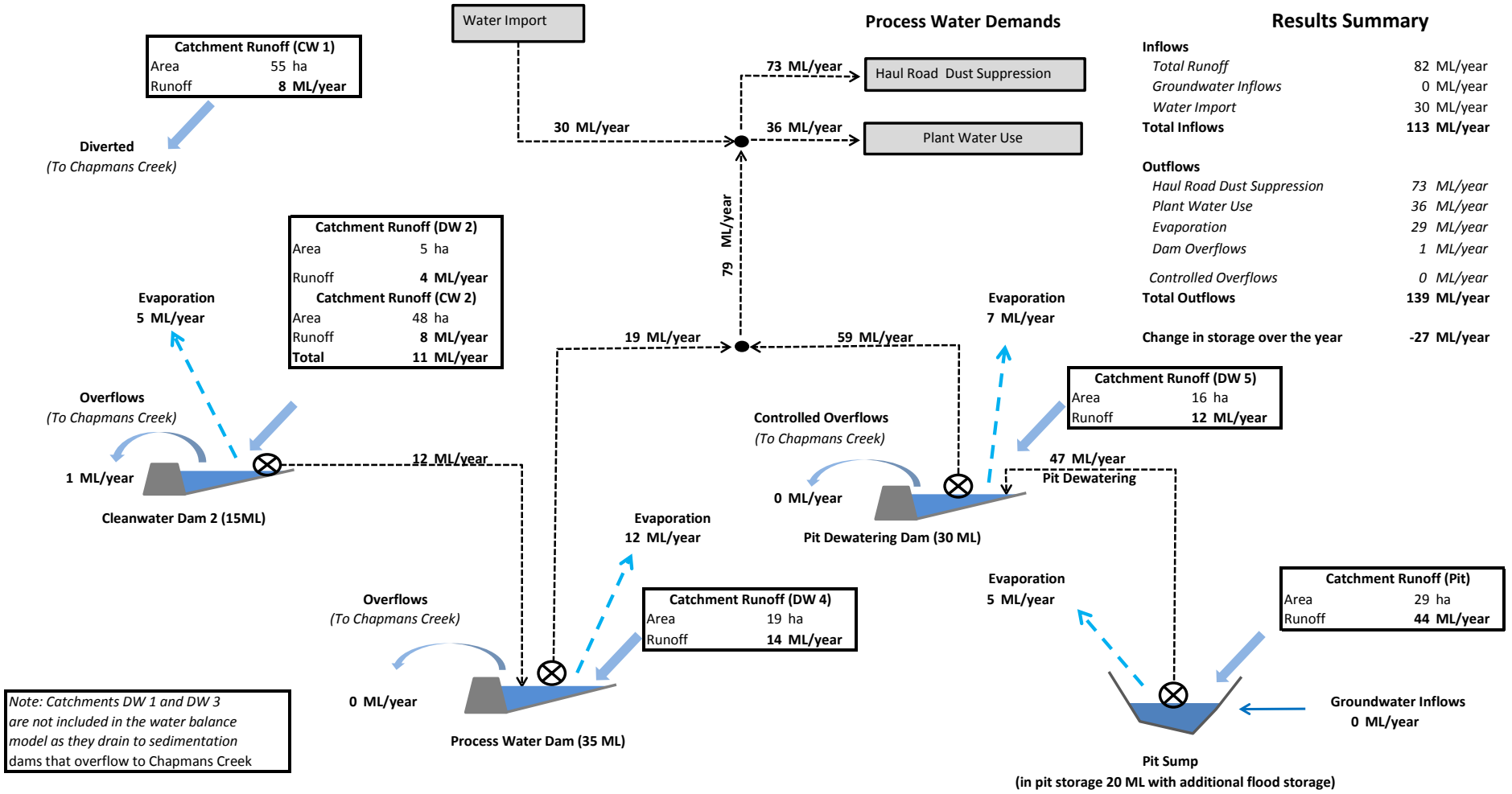
Plant Throughput	2.0	Mtpa	
Water use rate	18.2	L/t	*(Calculated from metered data provided by Gunlake)*
Annual Water Use	**36.4**	**ML/year**	

Process Water Use Order of Preference

The water balance model preferentially sources water to meet process water demands as follows:

1st preference: *Water stored in the process water dam*
2st preference: *Water stored in the Pit Dewatering Dam*
3rd preference: *Water stored in the Sed Dam 2*
4th preference: *Water imported to site via tankers*

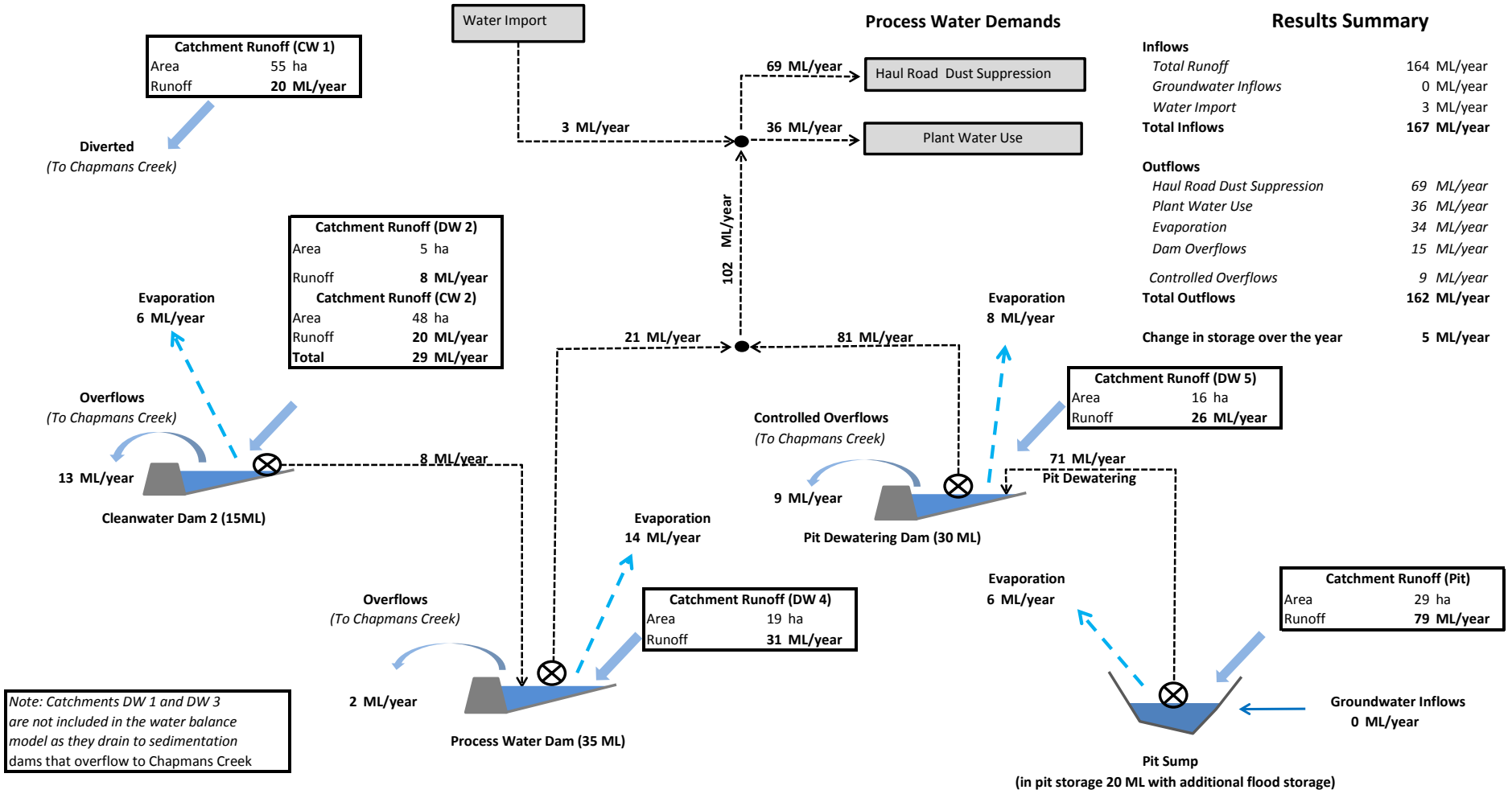
Gunlake Quarry: Site Water Balance: Quarry Year 1: Surface Water Management Plan
Typical Dry (10th Percentile) Rainfall Year
Annual Rainfall *451 mm/year*



Results Summary

Inflows	
Total Runoff	82 ML/year
Groundwater Inflows	0 ML/year
Water Import	30 ML/year
Total Inflows	**113 ML/year**
Outflows	
Haul Road Dust Suppression	*73 ML/year*
Plant Water Use	*36 ML/year*
Evaporation	*29 ML/year*
Dam Overflows	*1 ML/year*
Controlled Overflows	*0 ML/year*
Total Outflows	**139 ML/year**
Change in storage over the year	**-27 ML/year**

Gunlake Quarry: Site Water Balance: Quarry Year 1: Surface Water Management Plan
Typical Median (50th Percentile) Rainfall Year
Annual Rainfall *695 mm/year*

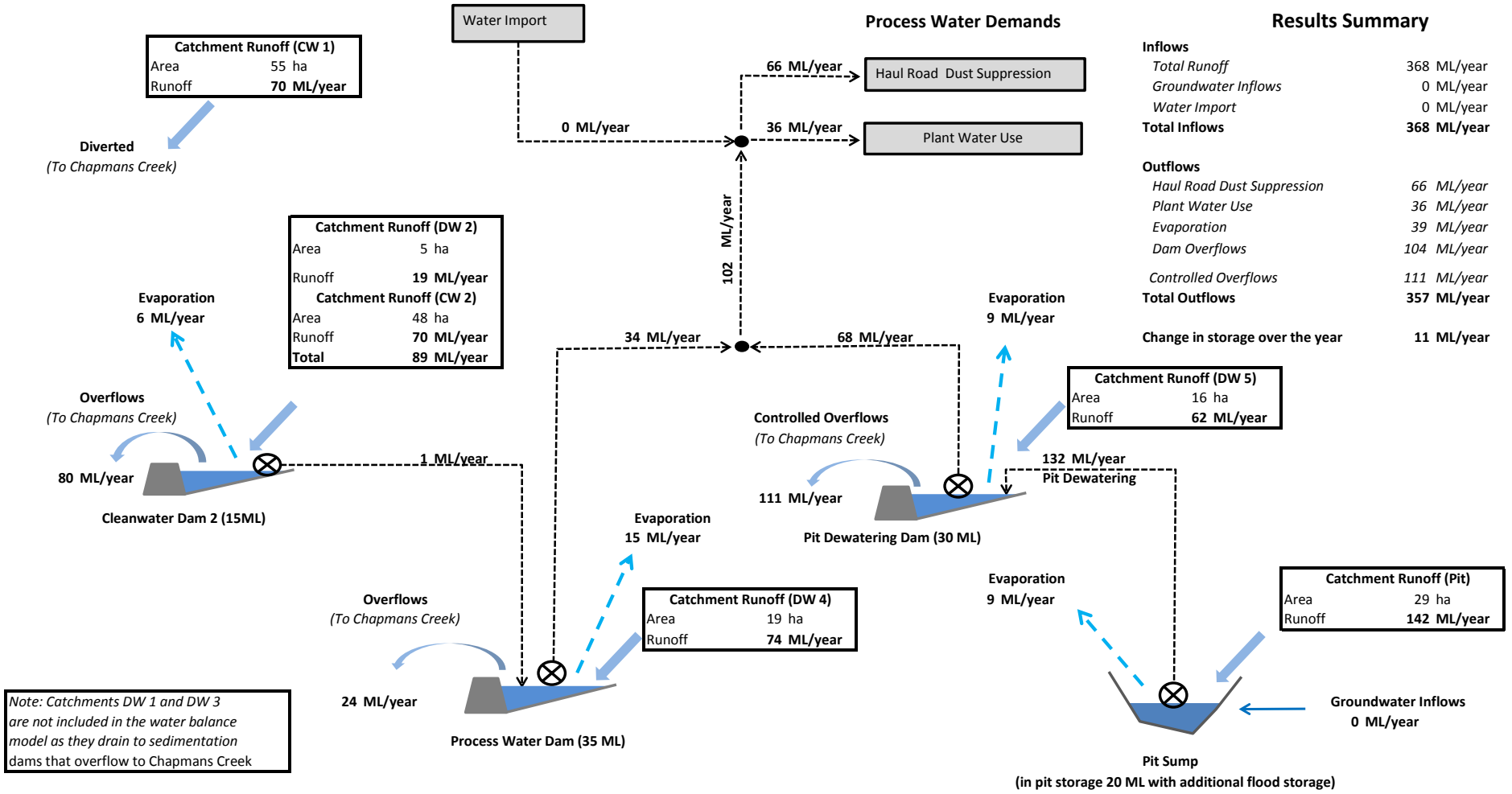


Note: Catchments DW 1 and DW 3 are not included in the water balance model as they drain to sedimentation dams that overflow to Chapmans Creek

Results Summary

Inflows		
Total Runoff	164	ML/year
Groundwater Inflows	0	ML/year
Water Import	3	ML/year
Total Inflows	**167**	**ML/year**
Outflows		
Haul Road Dust Suppression	*69*	*ML/year*
Plant Water Use	*36*	*ML/year*
Evaporation	*34*	*ML/year*
Dam Overflows	*15*	*ML/year*
Controlled Overflows	*9*	*ML/year*
Total Outflows	**162**	**ML/year**
Change in storage over the year	**5**	**ML/year**

Gunlake Quarry: Site Water Balance: Quarry Year 1: Surface Water Management Plan
Typical Wet (90th Percentile) Rainfall Year
Annual Rainfall *982 mm/year*



Results Summary

Inflows	
Total Runoff	368 ML/year
Groundwater Inflows	0 ML/year
Water Import	0 ML/year
Total Inflows	**368 ML/year**
Outflows	
Haul Road Dust Suppression	*66 ML/year*
Plant Water Use	*36 ML/year*
Evaporation	*39 ML/year*
Dam Overflows	*104 ML/year*
Controlled Overflows	*111 ML/year*
Total Outflows	**357 ML/year**
Change in storage over the year	**11 ML/year**

Gunlake Quarry: Sedimentation Dam Calculations
Model Assumptions: Quarry Year 1: Surface Water Management Plan

Calculation Assumptions

Sedimentation dam volumes have been calculated in accordance with the methods provided in *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries* (DECC, 2008). The following sizing methods have been adopted:

- The sedimentation dam sizing method for Type F and D soils has been adopted.
- Treatment volumes have been calculated based on the 90th Percentile 5 day rainfall event. This is in accordance with Table 6.1 *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries* (DECC, 2008) for a dam that operates form more than 3 years and overflows to a non-sensitive receiving water.
- A sediment storage volume equivalent to 50% of the treatment volume has been adopted.

Key assumptions are provided in the following table.

Assumption	Adopted Value	Source
90th Percentile Rainfall Depth	28.6 mm	Table 6.3a Vol. 1 (Location Goulburn)
Soil Hydrologic Group	D high runoff potential	Appendix F Vol. 1

Calculated Dam Sizes

	Units	Dam Name				
		Process Water Dam	Sed Dam 1	Sed Dam 2	Sed Dam 3	Pit Dewatering Dam
Catchment Area (ha)	*(ha)*	19	10	5	6	16
5 day Rainfall Depth	*(mm)*	28.6	28.6	28.6	28.6	28.6
Runoff Coefficient (Cv)[1]	-	0.56	0.56	0.56	0.56	0.56
Sedimentation Dam Volume	*(ML)*	3.0	1.6	0.8	1.0	2.6
Calculated Sediment Storage	*(ML)*	1.5	0.8	0.4	0.5	1.3
Total Dam Volume	*(ML)*	4.6	2.4	1.2	1.4	3.8
Proposed Dam Volume[2]	*(ML)*	35.0	2.4	1.2	1.4	30
Exceeds Minimum Requirements	-	Yes	Yes	Yes	Yes	Yes

Note 1: From Table F2 Vol. 1
Note 2: Some dam volumes exceed minimum requirement as they are sized to store water for process water use

Gunlake Quarry: Site Water Balance
Model Assumptions: Quarry Year 5: Surface Water Management Plan

Storage Assumptions

Storage Name	Surface Area (m^2)	Average Depth (m)	Volume (ML)	Contributing Catchments	Overflows	Function
Process Water Dam	*7500*	*5*	*35*	*DW -4 (19ha)*	*to Chapmans Creek*	*Captures runoff from DW-4 for process water use*
Pit Sump	*+7000*	*+3*	*20 plus flood storage*	*Pit (29ha)*	*no overflows*	*Captures runoff from the pit*
Clean Water Dam 2	*6500*	*2.3*	*15*	*CW -2 (48ha) + DW-2 (5ha)*	*to Chapmans Creek*	*Sedimentation dam for emplacement area. Water stored for process water use*
Pit Dewatering Dam	*10000*	*3*	*30*	*DW 5 (6ha)*	*to Chapmans Creek*	*Treats water dewatered from the pit. Water stored for process water use*

Demand Assumptions

Haul Road Dust Suppression

Water use for haul road dust suppression is calculated as a function of the haul road area and prevailing climatic conditions using the following formulae

$$DSupp(t) = Max(0, ((Evap(t) \times PanCoeff) - Rain(t)) \times HRArea \times 0.01)$$

Where:

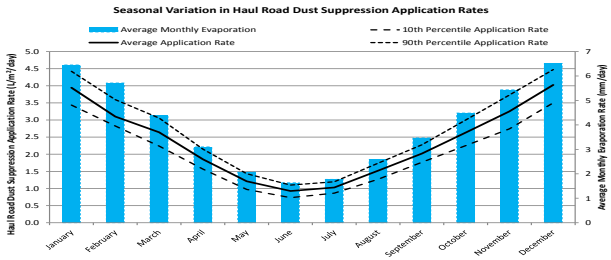
DSupp(t) = Daily water use for haul road dust suppression (ML/day)

Evap(t) = Daily pan evaporation (mm/day)

PanCoeff = Evaporation adjustment coefficient

Rain(t) = Daily rainfall (mm/day)

HRArea = Area of active haul road (ha)



The following haul road area and Pan Coeff were adopted

Haul Road Area	8ha	
Pan Coeff	0.72	*(This equates to an average annual application rate of 2.3L/m^2 per day)*

The calculated annual demand varies between **66** to **74 ML/year**, depending on rainfall over the year.
The demand varies seasonally inline with evaporation rates as shown in the above chart.

Plant Water Use

Plant water use is calculated as a function of the plant throughput and a water use rate

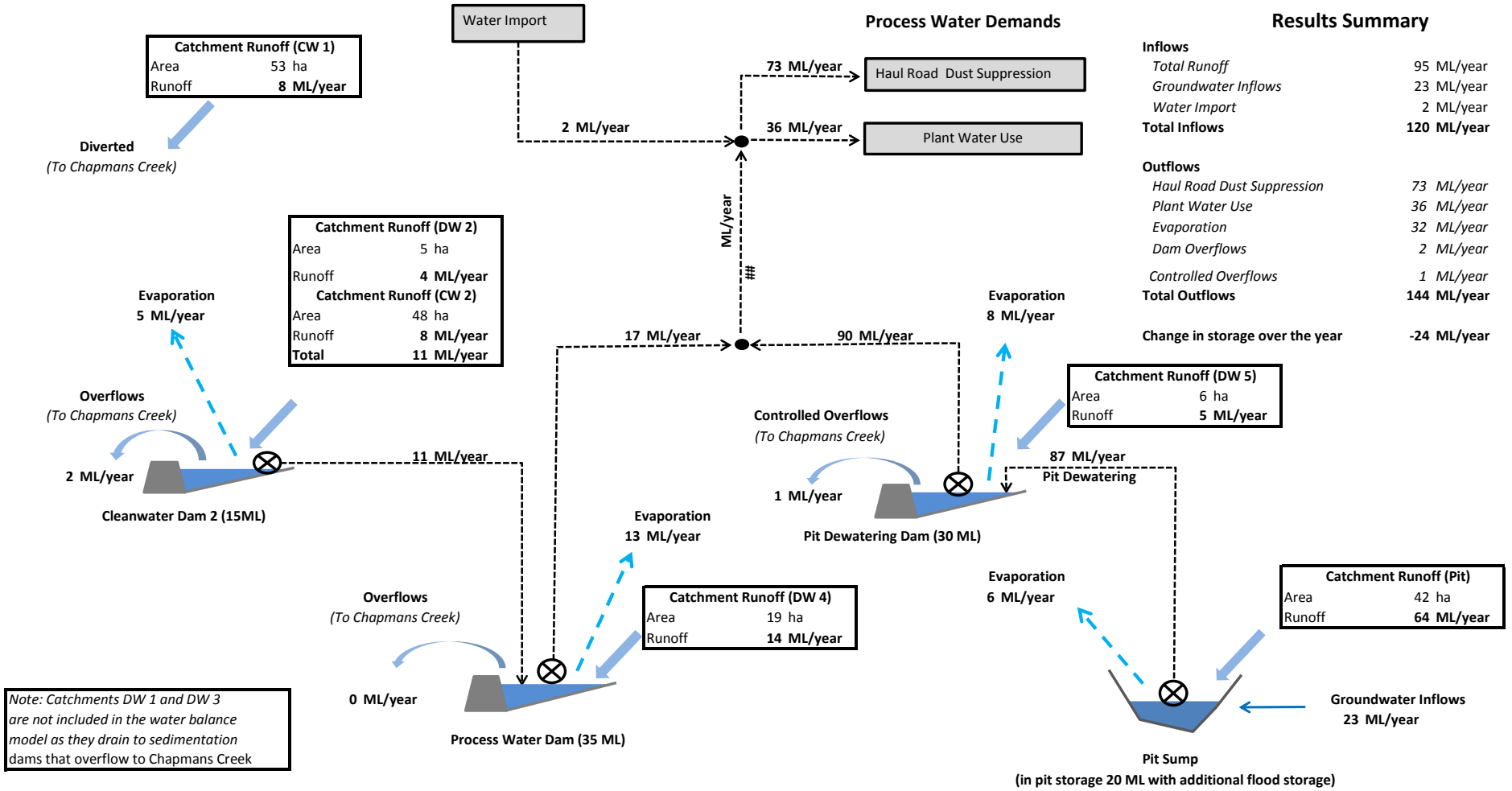
Plant Throughput	2.0	Mtpa	
Water use rate	18.2	L/t	*(Calculated from metered data provided by Gunlake)*
Annual Water Use	**36.4**	**ML/year**	

Process Water Use Order of Preference

The water balance model preferentially sources water to meet process water demands as follows:

1st preference: *Water stored in the process water dam*
2st preference: *Water stored in the Pit Dewatering Dam*
3rd preference: *Water stored in the Sed Dam 2*
4th preference: *Water imported to site via tankers*

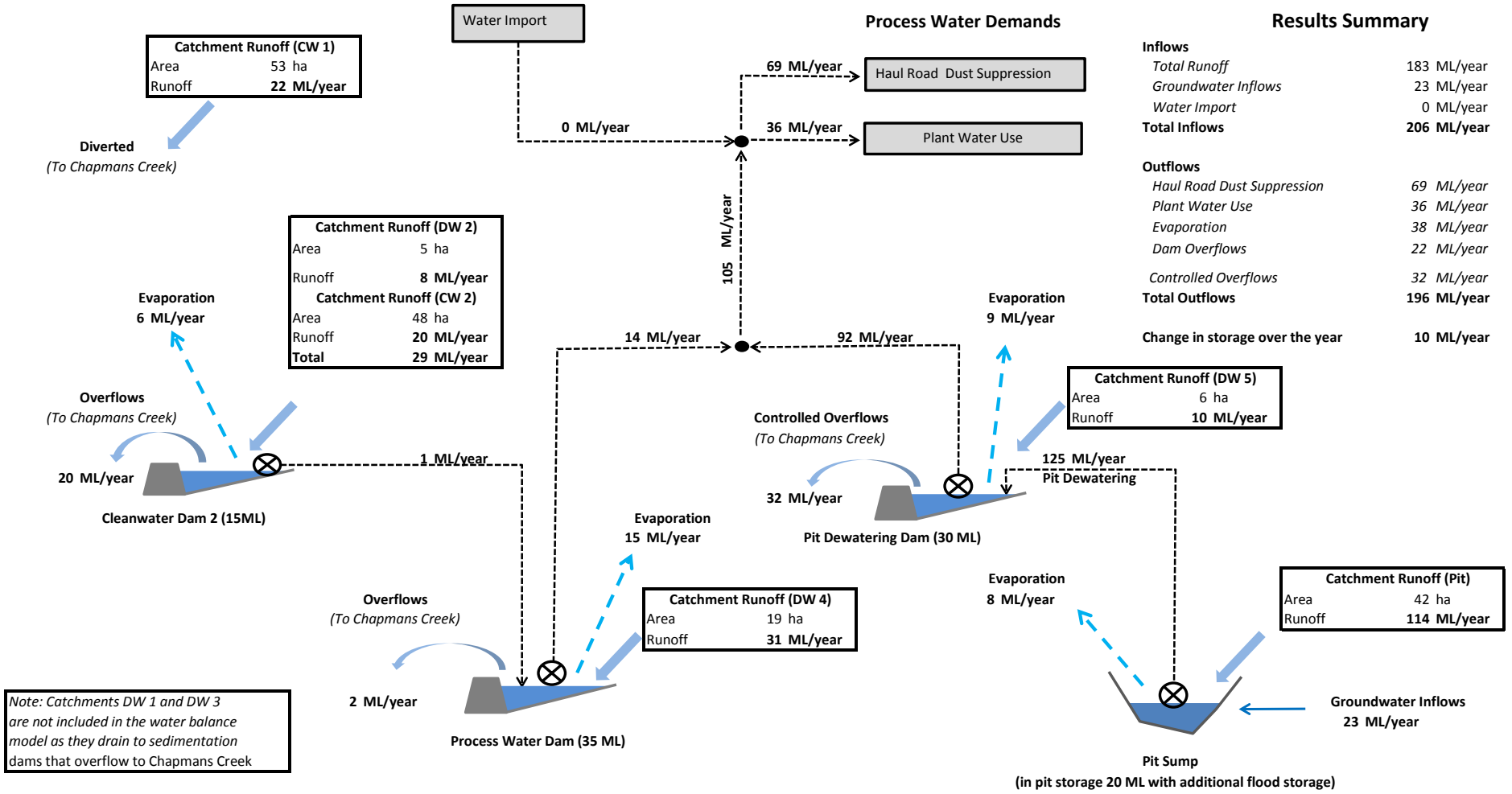
Gunlake Quarry: Site Water Balance: Quarry Year 5: Surface Water Management Plan
Typical Dry (10th Percentile) Rainfall Year
Annual Rainfall *451 mm/year*



Results Summary

Inflows		
Total Runoff	95	ML/year
Groundwater Inflows	23	ML/year
Water Import	2	ML/year
Total Inflows	**120**	**ML/year**
Outflows		
Haul Road Dust Suppression	*73*	*ML/year*
Plant Water Use	*36*	*ML/year*
Evaporation	*32*	*ML/year*
Dam Overflows	*2*	*ML/year*
Controlled Overflows	*1*	*ML/year*
Total Outflows	**144**	**ML/year**
Change in storage over the year	**-24**	**ML/year**

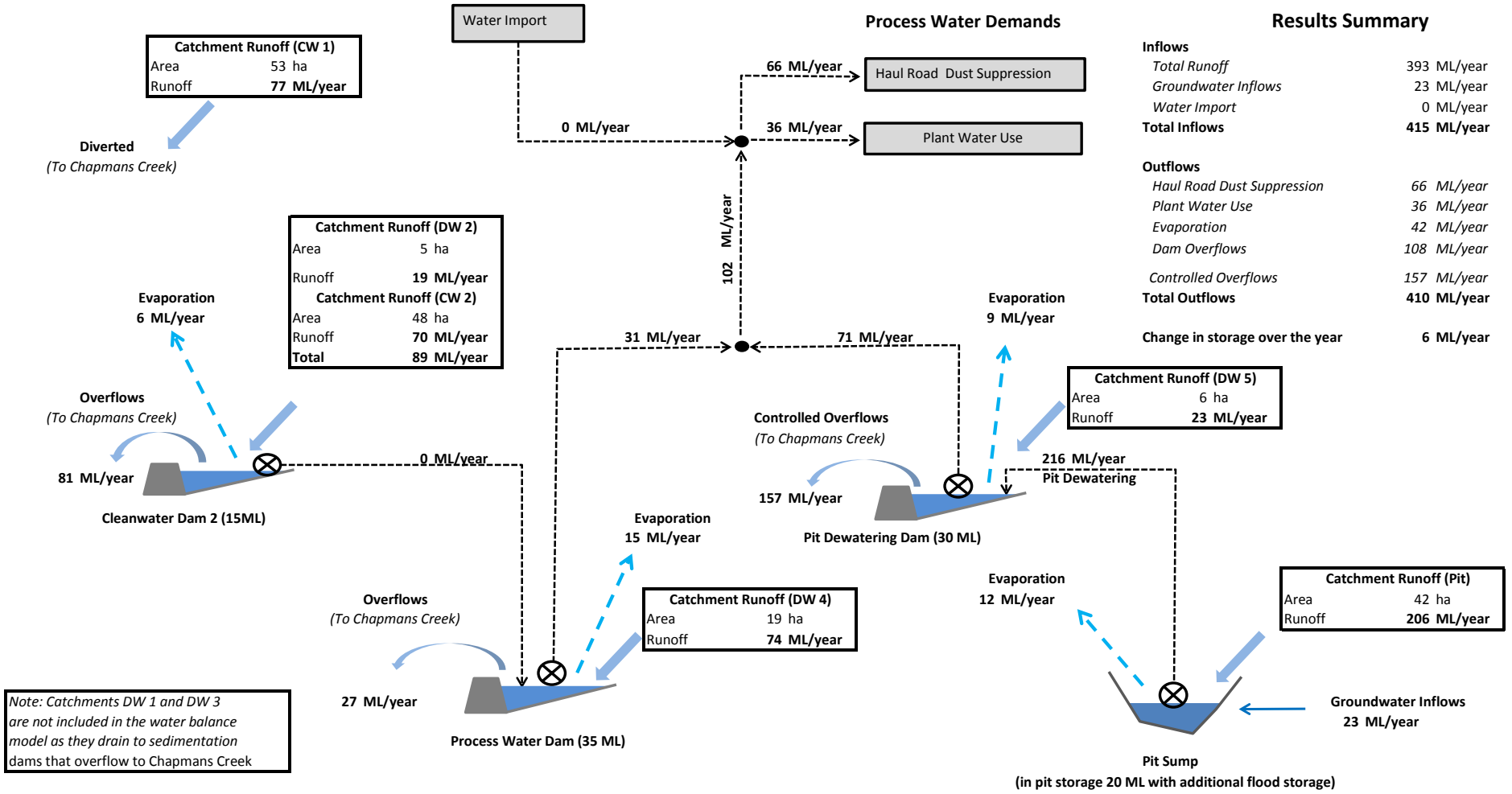
Gunlake Quarry: Site Water Balance: Quarry Year 5: Surface Water Management Plan
Typical Median (50th Percentile) Rainfall Year
Annual Rainfall *695 mm/year*



Results Summary

Inflows		
Total Runoff	183	ML/year
Groundwater Inflows	23	ML/year
Water Import	0	ML/year
Total Inflows	**206**	**ML/year**
Outflows		
Haul Road Dust Suppression	*69*	*ML/year*
Plant Water Use	*36*	*ML/year*
Evaporation	*38*	*ML/year*
Dam Overflows	*22*	*ML/year*
Controlled Overflows	*32*	*ML/year*
Total Outflows	**196**	**ML/year**
Change in storage over the year	**10**	**ML/year**

Gunlake Quarry: Site Water Balance: Quarry Year 5: Surface Water Management Plan
Typical Wet (90th Percentile) Rainfall Year
Annual Rainfall *982 mm/year*



Results Summary

Inflows	
Total Runoff	393 ML/year
Groundwater Inflows	23 ML/year
Water Import	0 ML/year
Total Inflows	**415 ML/year**
Outflows	
Haul Road Dust Suppression	*66 ML/year*
Plant Water Use	*36 ML/year*
Evaporation	*42 ML/year*
Dam Overflows	*108 ML/year*
Controlled Overflows	*157 ML/year*
Total Outflows	**410 ML/year**
Change in storage over the year	**6 ML/year**

Gunlake Quarry: Sedimentation Dam Calculations
Model Assumptions: Quarry Year 5: Surface Water Management Plan

Calculation Assumptions

Sedimentation dam volumes have been calculated in accordance with the methods provided in *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries* (DECC, 2008). The following sizing methods have been adopted:

- The sedimentation dam sizing method for Type F and D soils has been adopted.
- Treatment volumes have been calculated based on the 90th Percentile 5 day rainfall event. This is in accordance with Table 6.1 *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries* (DECC, 2008) for a dam that operates form more than 3 years and overflows to a non-sensitive receiving water.
- A sediment storage volume equivalent to 50% of the treatment volume has been adopted.

Key assumptions are provided in the following table.

Assumption	Adopted Value	Source
90th Percentile Rainfall Depth	28.6 mm	Table 6.3a Vol. 1 (Location Goulburn)
Soil Hydrologic Group	D high runoff potential	Appendix F Vol. 1

Calculated Dam Sizes

	Units	Dam Name				
		Process Water Dam	Sed Dam 1	Sed Dam 2	Sed Dam 3	Pit Dewatering Dam
Catchment Area (ha)	*(ha)*	19	10	5	6	5
5 day Rainfall Depth	*(mm)*	28.6	28.6	28.6	28.6	28.6
Runoff Coefficient (Cv)[1]	-	0.56	0.56	0.56	0.56	0.56
Sedimentation Dam Volume	*(ML)*	3.0	1.6	0.8	1.0	0.8
Calculated Sediment Storage	*(ML)*	1.5	0.8	0.4	0.5	0.4
Total Dam Volume	*(ML)*	4.6	2.4	1.2	1.4	1.2
Proposed Dam Volume[2]	*(ML)*	35.0	2.4	1.2	1.4	30
Exceeds Minimum Requirements	-	Yes	Yes	Yes	Yes	Yes

Note 1: From Table F2 Vol. 1
Note 2: Some dam volumes exceed minimum requirement as they are sized to store water for process water use

Gunlake Quarry: Site Water Balance
Model Assumptions: Quarry Years 10 to 30: Surface Water Management Plan

Storage Assumptions

Storage Name	Surface Area (m^2)	Average Depth (m)	Volume (ML)	Contributing Catchments	Overflows	Function
Process Water Dam	*7500*	*5*	*35*	*DW -4 (19ha)*	*to Chapmans Creek*	*Captures runoff from DW-4 for process water use*
Pit Sump	*+7000*	*+3*	*20 plus flood storage*	*Pit (53ha)*	*no overflows*	*Captures runoff from the pit*
Clean Water Dam 2	*6500*	*2.3*	*15*	*CW -2 (48ha) + DW-2 (5ha)*	*to Chapmans Creek*	*Sedimentation dam for emplacement area. Water stored for process water use*
Pit Dewatering Dam	*10000*	*3*	*30*	*DW - 5 (2ha)*	*to Chapmans Creek*	*Treats water dewatered from the pit. Water stored for process water use*

Demand Assumptions

Haul Road Dust Suppression

Water use for haul road dust suppression is calculated as a function of the haul road area and prevailing climatic conditions using the following formulae

$$DSupp(t) = Max(0, ((Evap(t) \times PanCoeff) - Rain(t)) \times HRArea \times 0.01)$$

Where:

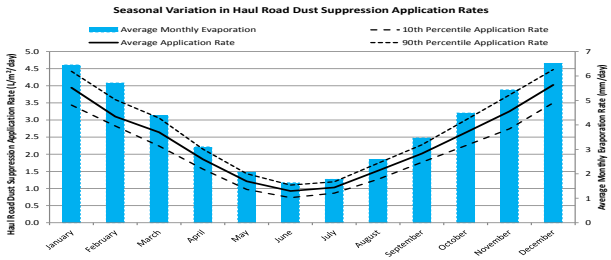
DSupp(t) = Daily water use for haul road dust suppression (ML/day)

Evap(t) = Daily pan evaporation (mm/day)

PanCoeff = Evaporation adjustment coefficient

Rain(t) = Daily rainfall (mm/day)

HRArea = Area of active haul road (ha)



The following haul road area and Pan Coeff were adopted

Haul Road Area	8ha	
Pan Coeff	0.72	*(This equates to an average annual application rate of 2.3L/m^2 per day)*

The calculated annual demand varies between **66** to **74 ML/year**, depending on rainfall over the year.
The demand varies seasonally inline with evaporation rates as shown in the above chart.

Plant Water Use

Plant water use is calculated as a function of the plant throughput and a water use rate

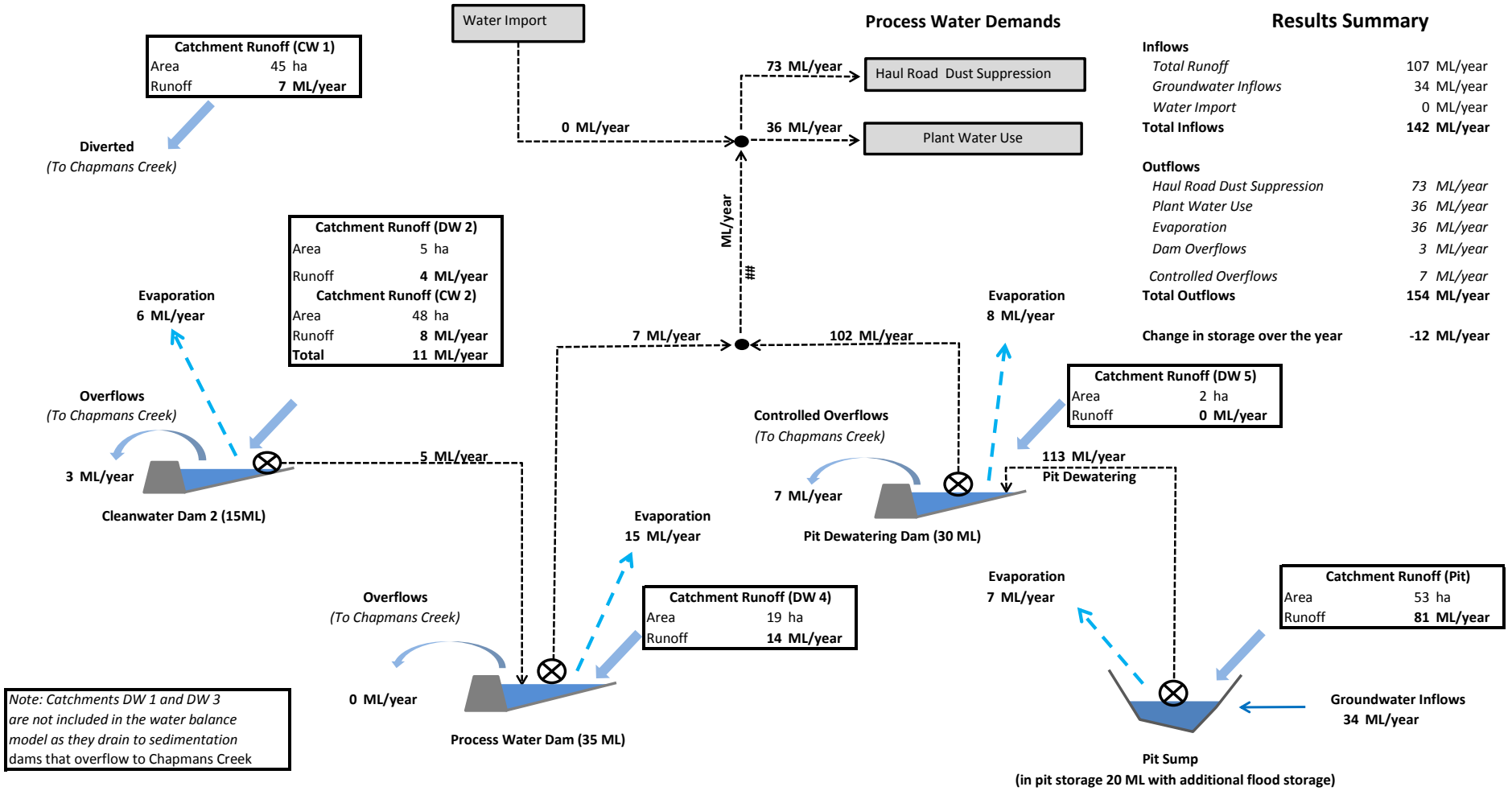
Plant Throughput	2.0 Mtpa	
Water use rate	18.2 L/t	*(Calculated from metered data provided by Gunlake)*
Annual Water Use	**36.4 ML/year**	

Process Water Use Order of Preference

The water balance model preferentially sources water to meet process water demands as follows:

1st preference: *Water stored in the process water dam*
2st preference: *Water stored in the Pit Dewatering Dam*
3rd preference: *Water stored in the Sed Dam 2*
4th preference: *Water imported to site via tankers*

Gunlake Quarry: Site Water Balance: Quarry Years 10 to 30: Surface Water Management Plan
Typical Dry (10th Percentile) Rainfall Year
Annual Rainfall *451 mm/year*

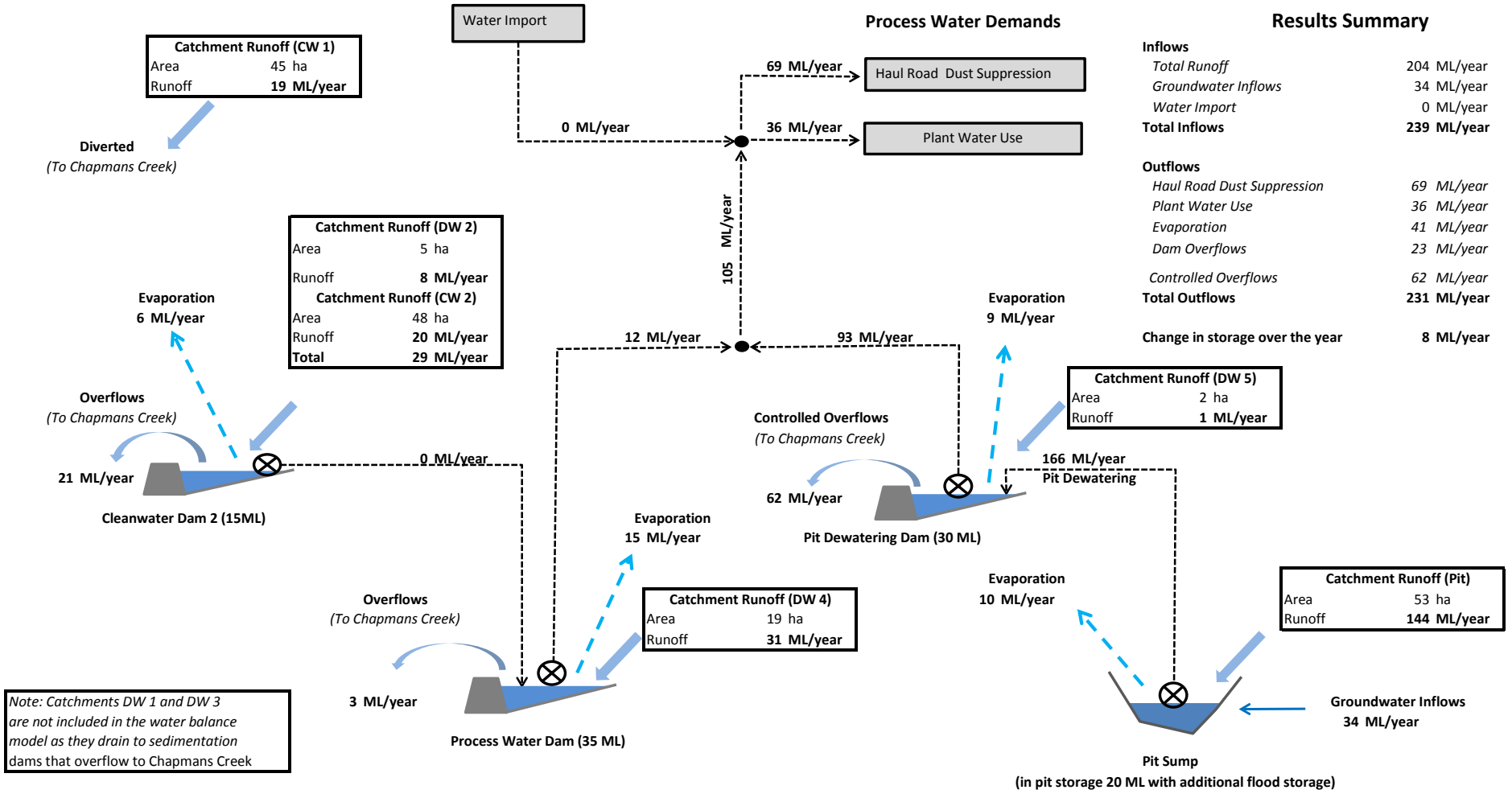


Note: Catchments DW 1 and DW 3 are not included in the water balance model as they drain to sedimentation dams that overflow to Chapmans Creek

Results Summary

Inflows		
Total Runoff	107	ML/year
Groundwater Inflows	34	ML/year
Water Import	0	ML/year
Total Inflows	**142**	**ML/year**
Outflows		
Haul Road Dust Suppression	*73*	*ML/year*
Plant Water Use	*36*	*ML/year*
Evaporation	*36*	*ML/year*
Dam Overflows	*3*	*ML/year*
Controlled Overflows	*7*	*ML/year*
Total Outflows	**154**	**ML/year**
Change in storage over the year	**-12**	**ML/year**

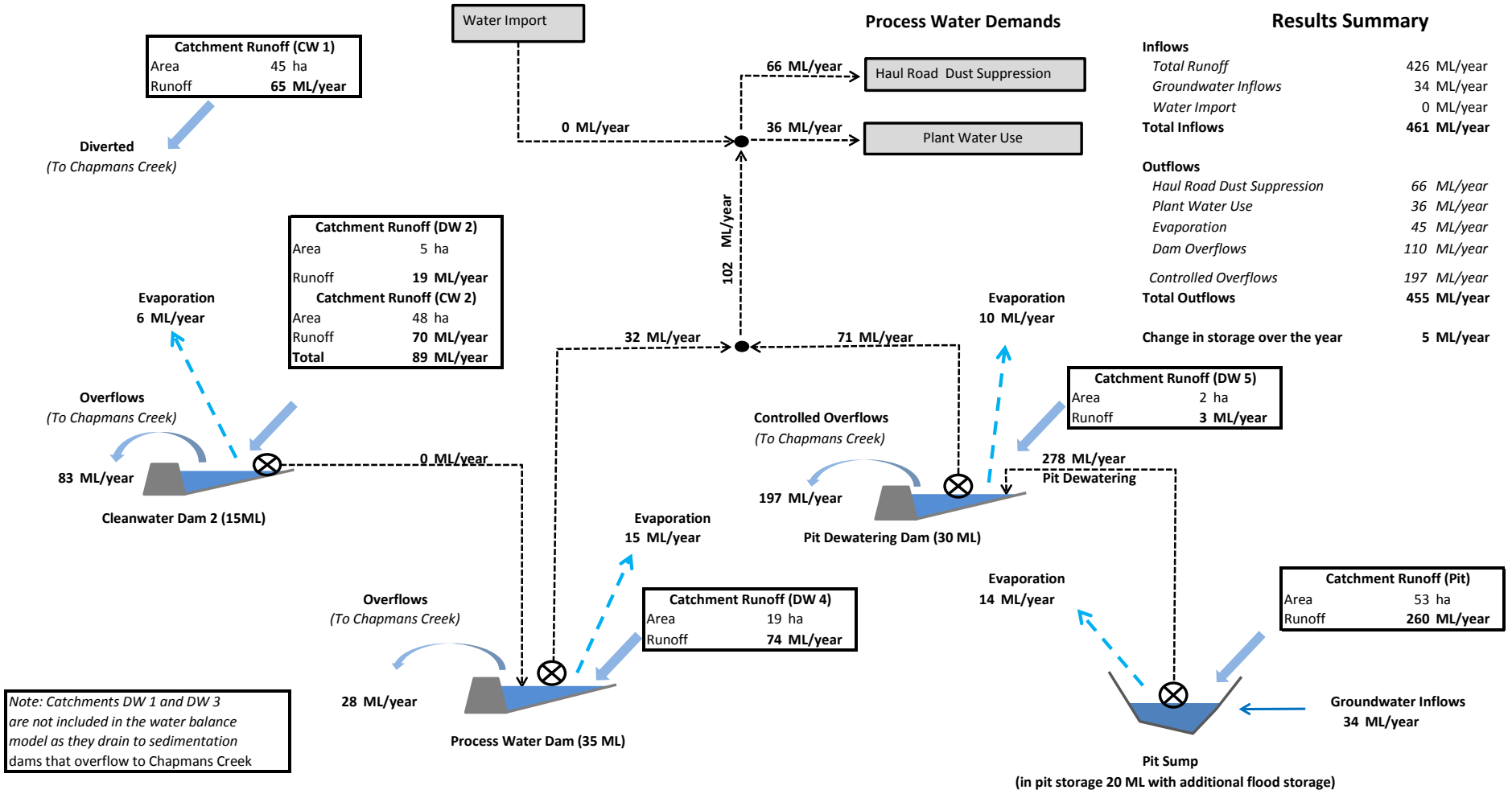
Gunlake Quarry: Site Water Balance: Quarry Years 10 to 30: Surface Water Management Plan
Typical Median (50th Percentile) Rainfall Year
Annual Rainfall *695 mm/year*



Results Summary

Inflows		
Total Runoff	204	ML/year
Groundwater Inflows	34	ML/year
Water Import	0	ML/year
Total Inflows	**239**	**ML/year**
Outflows		
Haul Road Dust Suppression	*69*	*ML/year*
Plant Water Use	*36*	*ML/year*
Evaporation	*41*	*ML/year*
Dam Overflows	*23*	*ML/year*
Controlled Overflows	*62*	*ML/year*
Total Outflows	**231**	**ML/year**
Change in storage over the year	**8**	**ML/year**

Gunlake Quarry: Site Water Balance: Quarry Years 10 to 30: Surface Water Management Plan
Typical Wet (90th Percentile) Rainfall Year
Annual Rainfall *982 mm/year*



Results Summary

Inflows		
Total Runoff	426	ML/year
Groundwater Inflows	34	ML/year
Water Import	0	ML/year
Total Inflows	**461**	**ML/year**
Outflows		
Haul Road Dust Suppression	*66*	*ML/year*
Plant Water Use	*36*	*ML/year*
Evaporation	*45*	*ML/year*
Dam Overflows	*110*	*ML/year*
Controlled Overflows	*197*	*ML/year*
Total Outflows	**455**	**ML/year**
Change in storage over the year	**5**	**ML/year**

Gunlake Quarry: Sedimentation Dam Calculations
Model Assumptions: Quarry Years 10 to 30: Surface Water Management Plan

Calculation Assumptions

Sedimentation dam volumes have been calculated in accordance with the methods provided in *Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and Quarries* (DECC, 2008). The following sizing methods have been adopted:

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- A sediment storage volume equivalent to 50% of the treatment volume has been adopted.

Key assumptions are provided in the following table.

Assumption	Adopted Value	Source
90th Percentile Rainfall Depth	28.6 mm	Table 6.3a Vol. 1 (Location Goulburn)
Soil Hydrologic Group	D – high runoff potential	Appendix F Vol. 1

Calculated Dam Sizes

	Units	Dam Name				
		Process Water Dam	Sed Dam 1	Sed Dam 2	Sed Dam 3	Pit Dewatering Dam
Catchment Area (ha)	*(ha)*	19	10	5	6	2
5 day Rainfall Depth	*(mm)*	28.6	28.6	28.6	28.6	28.6
Runoff Coefficient (Cv)[1]	-	0.56	0.56	0.56	0.56	0.56
Sedimentation Dam Volume	*(ML)*	3.0	1.6	0.8	1.0	0.3
Calculated Sediment Storage	*(ML)*	1.5	0.8	0.4	0.5	0.2
Total Dam Volume	*(ML)*	4.6	2.4	1.2	1.4	0.5
Proposed Dam Volume[2]	*(ML)*	35.0	2.4	1.2	1.4	30
Exceeds Minimum Requirements	-	Yes	Yes	Yes	Yes	Yes

Note 1: From Table F2 Vol. 1
Note 2: Some dam volumes exceed minimum requirement as they are sized to store water for process water use