

Supplementary material

Water, Water Everywhere, nor Any Drop to Drink? Options for Improving the Resilience of a Subtropical Island to Drought and the Sensitivity of Their Yield under a Projected Drier Future Climate

Table S1. Capital costs for a skid-mounted 2.3 m³/hour fastRO plant (A50). All costs in 2019 AUD.

ITEM	QUAN- TITY	UNIT RATE (\$)	COST (\$)	COMMENT
Containerised desalinisation plant	-	-	-	
Preparation of site for desalinisa- tion plant	-	LS†	12,500	
Supply containerised desalinisa- tion plant	1	80,000	80,000	Delivery to mainland Australia. Does not include delivery to Norfolk Island.
Transport desalinisation plant to Norfolk Island and site		LS	13,000	Shipping and transport to site.
Corrosion-resistant and tamper- proof housing	1	10,000	10,000	
Electrical connection to plant	-	LS	12,500	Includes cabling and switchboards.
Monitoring equipment	-	LS	17,500	Pressure transmitters, flow meters, and water quality monitoring devices, data loggers.
Commission desalinisation plant	-	LS	40,000	
Seawater intake system	-	-	-	
Supply seawater pump	2	4000	8,000	Quote from AC Hargreaves Brisbane agents.
Supply and install inlet cage	-	LS	10,000	
Electrical connection	-	LS	5,000	
Install seawater pump	-	LS	15,000	Installation of seawater pump on jetty.
Seawater delivery pipeline	-	-	-	
Supply seawater delivery pipeline	160	12	1,920	90-mm diameter HDPE Class 4.
Install seawater delivery pipeline	160	35	5,600	
Brine outlet system	-	-	-	
Supply brine discharge pipeline	150	12	1,800	90 mm diameter HDPE Class 4.
Supply brine discharge pipeline weights	-	LS	3,000	
Install brine discharge pipeline	150	35	5,250	
Freshwater delivery system	-	-	-	

ITEM	QUAN- TITY	UNIT RATE (\$)	COST (\$)	COMMENT
Balancing storage supplied to site and connection into system	1	12,500	12,500	Nominally a 20,000-L tank.
Supply freshwater pump to site	2	3,200	6,400	Vertical multi-stage centrifugal pump and backup pump. 110 m head requirement.
Install freshwater pumps	-	LS	5,000	
Electrical connection	-	LS	5,000	
Supply freshwater delivery pipe-line to storage tanks	280	12	3,360	50-mm HDPE pipe.
Install freshwater delivery pipe-line to storage tanks	280	35	9800	
Freshwater storage system	-	-	-	
Prepare site for freshwater storage tanks	-	LS	12,500	
Supply to two 92,500-L tanks	2	13,000	26,000	Pioneer GT90 water tank.
Construct concrete slabs	2	8,000	16,000	Assumes continuous slab for easy identification of leaks and a concrete cost of \$700/m ³ (not including placement).
Erect tanks on-site	2	3,250	6,500	
Direct costs	-	-	344,130	
Overheads	-	15%	51,620	
Total	-	-	395,750	
Contingency	-	30%	118,725	
Total project cost	-	-	514,474	Say \$515,000
Expected range of total project costs	-	±30%	Say \$360,000 to \$670,000	

Table S2. Cost of potential Cockpit Falls dam at FSL of 36 mASL.

ITEM	UNIT COST (\$)	UNITS	COST (\$)	COMMENT
Diversion costs	-	-	-	
Excavation for diversion	15	52	790	
Diversion pipeline	500	8.72	4,360	
Outlet valve	-	LS†	2,000	
Upstream coffer dams	5,000	1	5,000	
Remove coffer dam	3,000	1	3,000	
Dewatering	5,000	1	5,000	
Dam construction costs	-	-	-	

ITEM	UNIT COST (\$)	UNITS	COST (\$)	COMMENT
Access road to dam site	10,000	LS	10,000	
Reservoir area clearing and root excavation	10,000	0.66	6,630	
Foundation excavation	30	529.00	15,870	
Treatment of seams	LS	-	15,000	
Excavation across streambed	20	3	60	
Excavation of abutments	5	808	4,040	
Key trench excavation	10	80	800	
Key trench backfill	20	50	1,000	
Embankment fill (supply and placement and compaction)	10	6,624	66,240	
Downstream topsoil and grassing	10	614	6,140	
Excavate trench for liner	9	50	450	
Backfill anchor trench for liner	9	100	900	
Reservoir lining, transport and installation	35	16,114	563,990	
Fencing	20	1,623	32,450	
Spillway #	84,000	1	84,000	
Relocate existing infrastructure and maintain access	10,000	1	10,000	
Water treatment and storage	-	-	-	
Pre-filter, UV unit and protective housing	-	-	20,000	
Electrical connection	-	-	20,000	
Treated water storage tank (50 kL)	-	-	17,000	
Total direct costs (TDC)	-	-	894,720	
Contractor overheads	-	-	-	
Mobilisation/demobilisation	5% TDC	-	44,740	
Site overheads (accommodation)	10% TDC	-	89,470	
Contingencies	30% TDC	-	268,420	
Total contractor overheads (TCO)	-	-	402,630	
Total construction cost (TCC)	-	-	1,297,350	
Design costs, approvals and acquisition	-	-	-	
Design costs and approvals	10% TDC	-	89,470	
Land acquisition (ha)	-	-	-	
Total design costs (TDC)	-	-	89,470	
Total cost (TC)	-	-	1,386,820	

ITEM	UNIT COST (\$)	UNITS	COST (\$)	COMMENT
Upper estimate (+50%)	-	-	2,080,230	
Lower estimate (−30%)	-	-	970,770	
Total cost (without lining)	-	-	457,390	
Upper estimate (+50%)	-	-	686,090	
Upper estimate (−30%)	-	-	320,170	

Table S3. indicative capital costs of cluster-scale RHRWS of Option 1.

ITEM	QUAN- TITY	UNIT RATE (\$)	COST (\$)	COMMENT
Total direct costs	-	-	-	
Roofing and piping to site	-	-	-	
Piping to connect building #1	-	-	3,000	
Piping to connect building #2	-	-	3,000	
Piping to connect building #3	-	-	3,000	
Trunk pipe to storage area	-	-	32,500	300-mm PVC pipe (including \$10,000 for fittings and installation).
Overflow piping to Broken Bridge Creek	-	-	22,500	Including trenching and outlet works at creek.
Total	-	-	64,000	
Site preparation and tank construction	-	-	-	
Water carter access road and turning circle to water delivery area	-	LS†	5,000	
Earthworks excavation and leveling	6,750	15	101,250	Higher unit cost due to confined working space. Assumes 1.5 m depth of excavation.
Supply and construction of 0.5-ML tanks	15	65,000	975,000	No including plumbing.
Security fencing	400	110	44,000	Unit cost per metre.
Total	-	-	1,125,250	
Inter-tank connection and pumps	LS	-	-	
Electrical connection to site	50	20,000	20,000	
Piping and plumbing to water treatment	3	70	7,900	50-mm pressure pipe to enable pumping from any tank, including labour for trenching and plumbing.
Pumps and installation and electrical connection	-	5,000	15,000	Redistributing water between tanks.

ITEM	QUAN- TITY	UNIT RATE (\$)	COST (\$)	COMMENT
Piping interconnecting tanks and overflow interconnections and plumbing	-	-	20,000	
Electronic monitoring of water levels	-	LS	10,000	
Total	-	-	72,900	
Water treatment	-	-	-	
50,000-L tank	1	14000	14,000	Minus plumbing and electrical connection.
Standpipes and piping to trucks	2	2500	5,000	
Housing	-	LS	5,000	
In-line filter	1	1400	1,400	Scheme design and treatment would need a targeted water quality study to evaluate risks and ensure the treatment train is appropriate.
Commercial grade UV treatment (50,000 L/day capacity) and housing	1	7000	7,000	50,000 L/day capacity.
Electrical connection to site	LS	5000	5,000	
Total	-	-	37,400	
Total direct cost (TDC)	-	-	1,299,550	
Contractor overheads	-	-	-	
Mobilisation/demobilisation	5%	-	64,978	
Site overheads	5%	-	64,978	On basis that main unit is modular.
Contingencies	30%	-	389,865	
Total	-	-	519,820	
Design costs, approvals and acquisition	10%	-	-	
Design costs, approvals and project management	-	-	129,955	Includes detailed surveying.
Land acquisition	-	-	0	
Total	-	-	129,955	
Total cost	-	-	1,949,325	Say \$1.95 million

Table S4. Cost of potential rainwater tank farm.

ITEM	UNIT COST (\$)	UNITS	COST (\$)	COMMENT
Total direct costs	-	-	-	
Site preparation and tank construction		-		

ITEM	UNIT COST (\$)	UNITS	COST (\$)	COMMENT
Access to site	5,000	LS†	5,000	Nominal amount for dirt road construction and ensure landholder access to their property is maintained.
0.247-ML rainwater tanks	39,938	9	359,442	Tanks 3.23 m height and 14 m diameter. Cost includes site preparation, concrete ring, construction, installation pumps and plumbing tank into pressure pipe.
Security fencing	110	200	22,000	
Total	-	-	386,442	
Water treatment system	-	-	-	
25,000-L tank for storing treated water	1	12,200	12,200	
Pressure piping from tank farms to water treatment system	100	13	1,300	50-mm pressure pipe plus \$5000 labour for trenching (also containing power cables) and \$1500 extra fittings.
Diesel generators	5,000	2	10,000	
Electrical connections	10,000	LS	10,000	
High volume pumps to supply water from treated tank to water carting trucks	5,000	2	10,000	Includes piping and hosing.
Housing for water treatment system	5,000	LS	10,000	
In-line cartridge filter	700	LS	700	
Commercial grade UV	6,000	1	6,000	
Smart water savers	700	2	1,400	
Total	-	-	61,600	
Total direct cost (TDC)	-	-	711,633	
Contractor overheads	-	-	-	
Mobilisation/demobilisation	5%	-	22,402	
Site overheads	5%	-	22,402	
Contingencies	20%	-	89,608	
Total (TCO)	-	-	134,413	
Design costs, approvals and acquisition	-	-	-	
Design costs and approvals	10%	-	44,804	Includes project management and surveying.
Land acquisition (ha)		0	60,500	Nominal value. Will vary between locations. Area includes enclosure and allowance for access road.
Total (TDCAA)	-	-	105,304	
Total cost (TC = TDC + TCO + TDCAA)	-	-	687,759	

Table S5. Indicative cost of twelve new deep groundwater bores.

ITEM	UNIT COST (\$)	UNITS	COST (\$)	COMMENT
Exploratory holes	500	2100	1,050,000	14 holes at an average of 75 m
Production bores	1000	900	900,000	6 holes at an average of 75 m
Water storage tanks	39,938	12	479,256	1 x 290 kL tank per bore location
Access road	6,000	12	72,000	An associated infrastructure (e.g. turning circle, standpipes etc)
Commercial grade UV treatment and housing	6,000	12	72,000	
Total direct costs (TDC)			2,573,256	
Contractor overheads				
Mobilisation of operators	3000	2	6,000	
Mobilisation of equipment and operation	LS		350,000	Assumes 160,000 C-17 cost each way and mobilisation costs on mainland Australia and Norfolk Island.
Operator rates	4000	120	480,000	2 operators for 60 days
Incidentals	500	120	60,000	
Total			896,000	
Design costs, approvals				
Design costs, approvals, legal and logistics	10% TDC		257,326	
Land acquisition (ha)			60,500	Nominal value will vary between locations. May be zero if bores can be sited on land owned by the NIRC (e.g. road verge)
Contingency	30% TCC		771,977	
Total			1,089,802	
Total cost (TC)			4,559,058	Say 4.56 million with estimated uncertainty of -25% to +75%.

Table S6. Costs associated with removal of woody weeds. Costs are indicative and will vary between locations depending upon a range of factors such as access and topography. Note cost of hand clearing dense infestations of wood weeds is prohibitive.

SERVICE	COST (\$/ha)	COMMENT
Mechanical clearing of small to medium height woody vegetation, remove roots and burn on-site	6000 to 10,000	Desiree Boudan (BC Excavations), 2020, pers. comm.
Mechanical clearing small to medium height woody vegetation, remove roots and burn on-site and rotary hoe	10,000	Jim Tavener (Norfolk Industries), 2020, pers. comm.

SERVICE	COST (\$/ha)	COMMENT
Hand clearing woody weeds from salvageable native vegetation	7000	Informed by correspondence with Parks Australia. 1.15 ha took a ranger staff (~\$45/hour) 149 hours. Plus misc. costs (e.g. herbicide) of approximately \$1200/ha.
Purchase grass seed and spread	500	Jim Tavener (Norfolk Industries), 2020, pers. comm.
Follow-up slashing and other maintenance in first year	1000 to 1500	Jim Tavener (Norfolk Industries), 2020, pers. comm.
Annual maintenance in subsequent years	500 to 1000	Jim Tavener (Norfolk Industries), 2020, pers. comm.