To: Commissioner Dr Jane Doolan, Associate Commissioner Drew Collins

Productivity Commission
National Water Reform 2020

Submission by John F Kell   BE (SYD), M App Sc (UNSW), MIEAust, MICE
Date: 25 March 2021
Revision: 3

Summary of Contents

Attachments

Units

L	litres
KL	kilolitres
ML	Megalitres
GL	Gigalitres (Sydney Harbour ~ 500GL)
GL/a	Gigalitres / annum
RL	Relative Level - above sea level (m)
m	metre
TEL	Townsville Enterprise Limited
SMEC	Snowy Mountains Engineering Corporation
MDBA	Murray Darling Basin Authority

1.0 Introduction

This submission is to present a practical solution to restore balance in the Murray Daring Basin (MDB) with a significant regular inflow of water from the Burdekin and Herbert Rivers in Queensland.

My background is civil/structural engineering (BE Sydney Uni - 1973).
As a fresh graduate, I worked in South Africa and UK for ~6 years, including a stint with a water consulting practice in Johannesburg, including relieving Mafeking as a site engineer on a water canal project. Attained the MICE (UK) in Manchester in 1979.
In 1980 returning to Sydney, I joined Connell Wagner (now Aurecon), designing large scale industrial projects.
Since 1990, I have headed a manufacturing company in the specialised field of investment casting (www.hycast.com.au) at Smithfield, NSW.
In 1995, I graduated in Masters of Applied Science at UNSW.
I've had my fair share of time in the bush. I walked the Thorsborne Trail on Hinchinbrook Is, twice (not in February). I've been bitten by a bug - the Burdekin Bug.
I have maintained a strong interest in water engineering throughout my career.

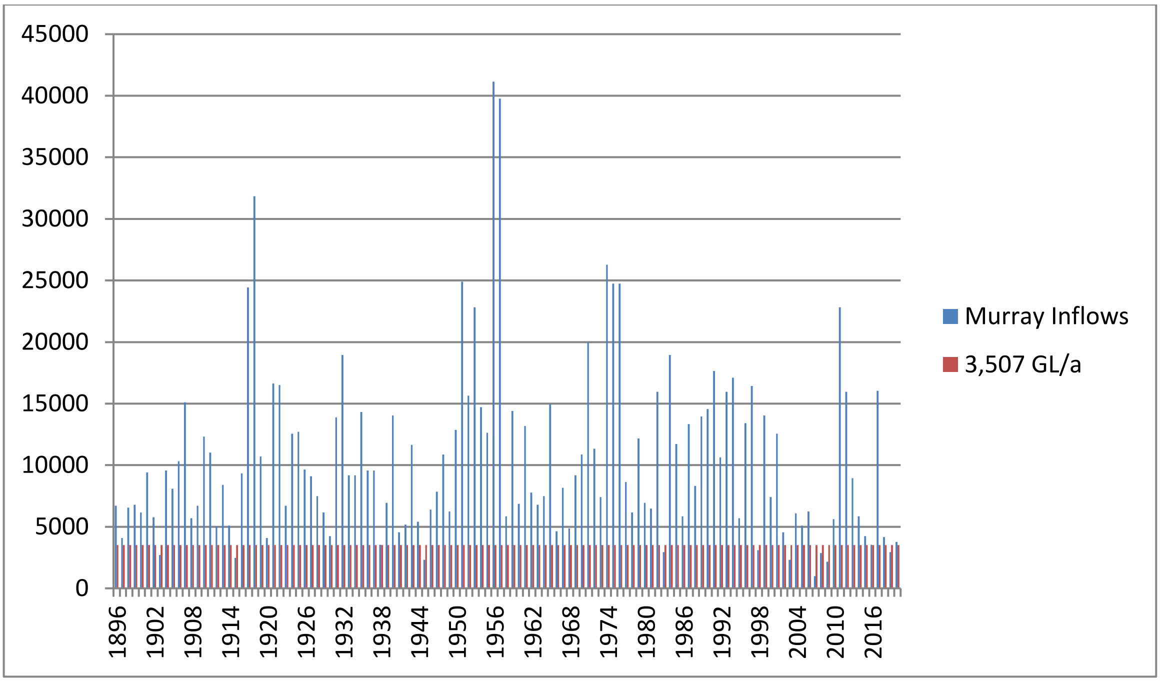
2.0 Current Situation / Problem

The current situation is that the MDB is in a **very** distressed state. The inflow variability has been well documented and the average inflow has dropped from ~10,000 GL/a 1896-1995 to ~6,000 GL/a in the last 25 years. This 6,000 GL/a average is similar to the 1920-1950 period but with far less demand. Refer to MDBA data Graph 1.

Water demand has increased and that will continue. Water has been pumped since 2018 from Wentworth on the Murray to Broken Hill as the Darling River is dying. Towns are being forced to truck in water. The situation is dire and depressing for all concerned Australians.

A stark realisation, is the significant variation in inflows and how large and small quantities are often grouped together, possibly mirroring the Indian Ocean dipole effect.

Indications are that conditions will only get worse.



Graph 1 Murray River Inflows 1896-2020
(3,507 GL/a added to the bottom line – see later)
Reference MDBA

Meanwhile, in Queensland, 12,500 GL/a is discharged into the Coral Sea, from the Herbert and Burdekin Rivers, being excess to Queensland requirements. The current proposal of building the 2,100 GL Hells Gate Dam for Queensland, will reduce this excess to 10,400 GL/a. Compared to the ~10,000 GL/a averages in Graph 1, this is a significant quantity being discarded.

The construction of this Hells Gate dam would forever negate the only chance we have to address the MDB problem and Queensland could still be serviced in another way, with excess water.

In many minds, Section 100 of our Constitution prohibits water being transferred from one state to another.

The current situation is approaching catastrophic …… and yet there is a solution.

3.0 The Solution

There have been many proposals offering a solution to solve the MDB problem to bring the Burdekin and Herbert northern rivers into action. Each solution has been discarded with:

“heard it all before”, or
“pumping is so expensive” or
“it’s my water and I’m not sharing” or
“it’s Queensland water, we can’t take it from them”.

However all authorities and schemes do agree on one thing - that there **is** excess water in the Burdekin River system in northern Queensland.

3.1 The Solution - Five Key Points

Elevation Gravity channel to the MDB from an upper Burdekin Dam ,

Inflow 3,507 GL/a available – a significant volume (see Graph 1).

Storage ~9,000 GL water storage possible in the Burdekin River gorge. This volume is effective to service the MDB

Evaporation A dam in the Burdekin gorge minimises this Queensland evaporation curse.

Section 100 As there is sufficient water to share, our Constitution, Section 100 allows the Federal Govt to request the Qld Govt to share its water to the nation or, Queensland can offer the water for the benefit of the nation, as there is excess to Queensland’s needs.

3.2 Summary of the Preferred Solution

Step 1 Capture average 3,507 GL/a, inflow from Burdekin River and the Herbert River with a 25km tunnel from Glen Eagle RL555 on the Herbert to Wairuna RL 530 on the Burdekin.

Step 2 Build storage dam on the Burdekin River Gorge at Mt Foxton. Its capacity of 9,000 GL provides a buffer for the dry years and at a minimum water level of RL 350m...

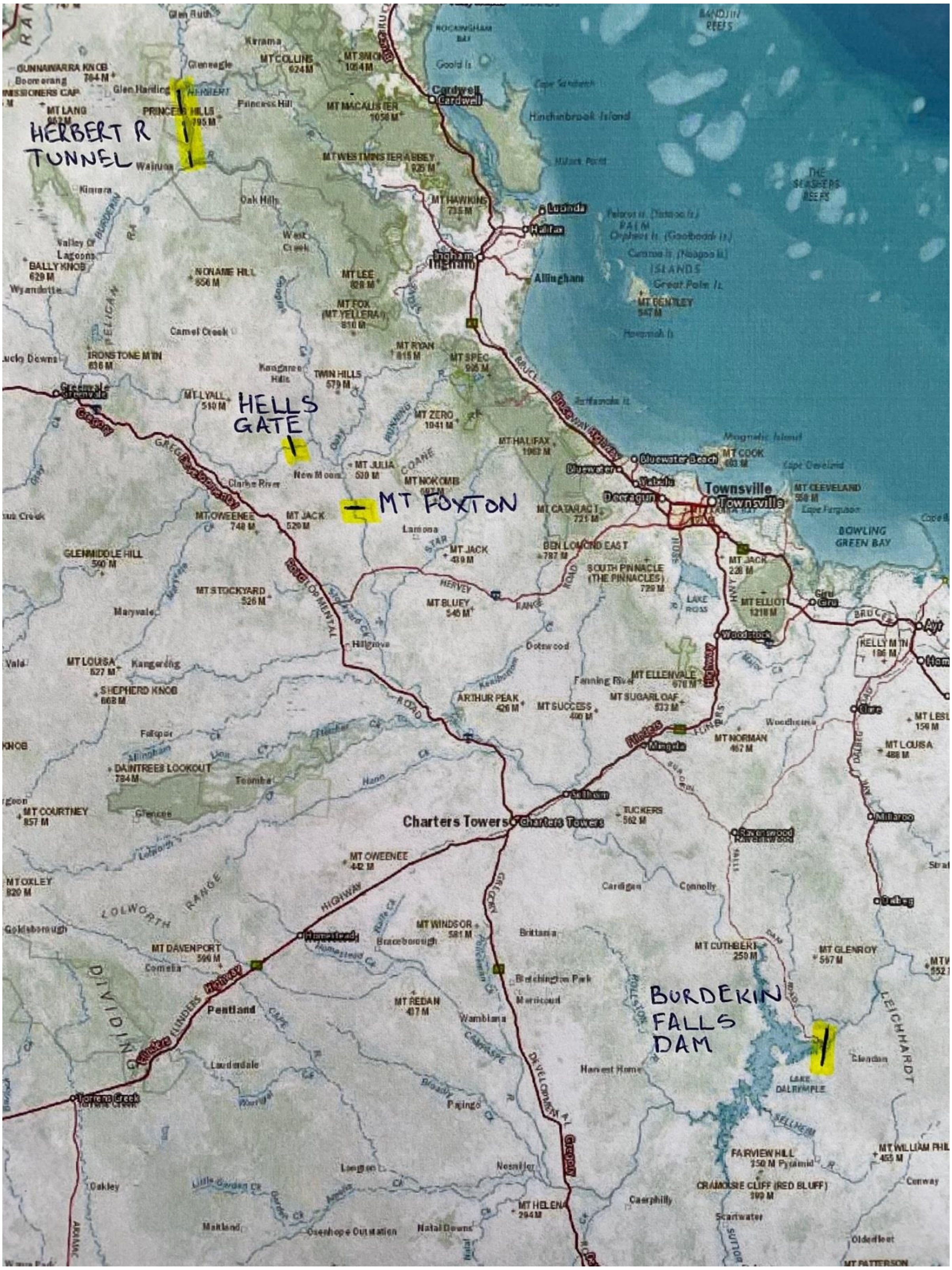
Step 3 Transfer this 3,507 GL annually, via a gravity channel, located just inland of the Great Dividing Range, to the MDB and Great Artesian Basin (GAB), a distance ~2,500km, with take-offs on the way.

Step 4 Ensure Queensland has “*reasonable use of the water of rivers for conservation or irrigation*” (Section 100), after the 3,507 GL/a is sent to the MDB and 2,100GL/a has been allocated for the Charters Towers / Townsville regions.

4.0 Dam Location

Dam Location – choice of three:

New dam the Burdekin gorge at Hells Gate or
New dam in the Burdekin gorge at Mt Foxton or
Raising the existing Burdekin Falls Dam.



Map 1
Mt Foxton, Hells Gate and Burdekin Falls Dam Locations, with Herbert River Tunnel

4.1 Hells Gate Dam. Dam Water RL 372m

This Hells Gate site was Dr JJC Bradfield's choice of 1930s and has recently been the subject of Snowy Mountains Engineering Corporation (SMEC) Study of 14/09/2018. This recommendation is impressive; however, each entity was aiming at different targets, with no regard to the MDB.
This site has three major limitations – inflow, future extensions and suitability for MDB:

The inflow to the Hells Gate site is just 1,817 GL/a (ref Mt Fullstop 120110A). Deducting evaporation and there is even less (refer Table 3)
To extend capacity of this dam, the gorge advantage is lost and evaporation is significant upstream, away from the gorge.
This site **would be** suitable for storage on the basis of dam level, as the level allows for gravity channel to the MDB.
However, this site **is not** suitable for storage for the MDB, as the inflows are not maximised.

4.2 Mt Foxton – 30km downstream from Hells Gate. Dam Water Level RL380

Mt Foxton - (Referred in CSIRO *Northern Rivers and Dams*, 5/12/2014 Fig 4-14), has additional inflow from Douglas Creek, Oaky Creek and Running River (~600 GL/a).
This site has the following features:
Mt Foxton has an inflow of ~2,400 GL/a. (result of the three additional rivers inflow)
To extend capacity of this dam, the gorge is used, absorbing the proposed Hells Gate dam site. Evaporation is minimised.
This site **is** suitable for storage for the MDB, as the inflows are maximised (with 3,507GL/a).
This site **is also** suitable for storage on the basis of RL380 dam level as the level allows for gravity channel to the MDB from 350m

4.3 Burdekin Falls Dam – 220km downstream from Mt Foxton. Dam Water Level RL 154

The dam level is being raised from existing RL154 to either RL156-RL160.
Downstream from the Burdekin Falls Dam, there is a current outflow of 6,657 GL/a. (at hydro site)
The existing capacity of 1,850 GL is being increased by raising the dam wall to either 2,010GL or 2,435 GL, depending on the wall increase.
This site **is not** suitable for storage (even if wall is raised further) for the MDB on the basis of dam level, as the level of the dam would require pumping, which is not feasible with current technology and considering the volume involved.
The dam **is** suitable to be extended to service the TEL requirements, pumping with either Solar or Hydro (possibly from Mt Foxton discharge hydropower to MDB).

4.4 Summary of inflows for dams

Item	Hells Gate	Mt Foxton	Burdekin Falls Dam
Inflow (Burdekin R only)	1,817 GL/a	2,400 GL/a	6,657 GL/a

Table 1 Dam Water Inflows

Item	Hells Gate	Mt Foxton	Burdekin Falls Dam
Inflow (additional Herbert R)	1,817 + **1,107** = 2,924 GL/a	2,400 + **1,107** = **3,507 GL/a**	6,657 GL/a

Table 2 Dam Water Inflows with Herbert River

Table 2 provides flow meter data, demonstrating the inflows when the Herbert River 1,107 GL/a is added.

4.5 Evaporation Loss

Evaporation losses vary over the nation. The losses are at extreme rates in Queensland. Evaporation creates a loss of ~3.0 m/a (Longreach 3.038 m/a, Charleville 2.621 m/a).
https://www.stateoftheenvironment.des.qld.gov.au/climate/climate-observations/evaporation-rate

Gorges are the preferred targets to build dams. The Burdekin Gorge is perfect.
The larger the dam's capacity related to surface area, the less evaporation loss.
Mt Foxton water level at 380m, would assist in the dry spells and evaporation losses.
Refer to Table 3.

Dam	**Surface Area**	**Capacity**	**Evapor'n Loss ***	**Evapor'n Loss**	**Evapor'n Loss**	**Available Annual Discharge**
	sq.km	**GL**	**m / a**	**GL**	**%**	**GL/a**
Mt Foxton RL350 (MDB takeoff level)	260 (est)	2,000	n/a	n/a	n/a	n/a
Mt Foxton RL380	360 (est)	9,000	2.6	900	10%	8,100
Mt Foxton RL380 effective discharge to MDB	360 (est)	7,000				8,100
Hells Gate	180 (est)	2,100	2.6	450	21%	1,650
Burdekin Falls (current) RL154m	286	1,860	2.6	700	37%	1,160
Burdekin Falls 2m extension RL156m	344	2,010	2.6	900	45%	1,110
Burdekin Falls 6m extension RL 160m	483	2,435	2.6	1250	51%	1,185
MDB Channel 2,400km x 18m	45	3,507 GL/a	2.6	120	3.4%	3,400
Warragamba (comparison)	75	2,030	0.85	64	3%	n/a

Table 3 Evaporation Impact

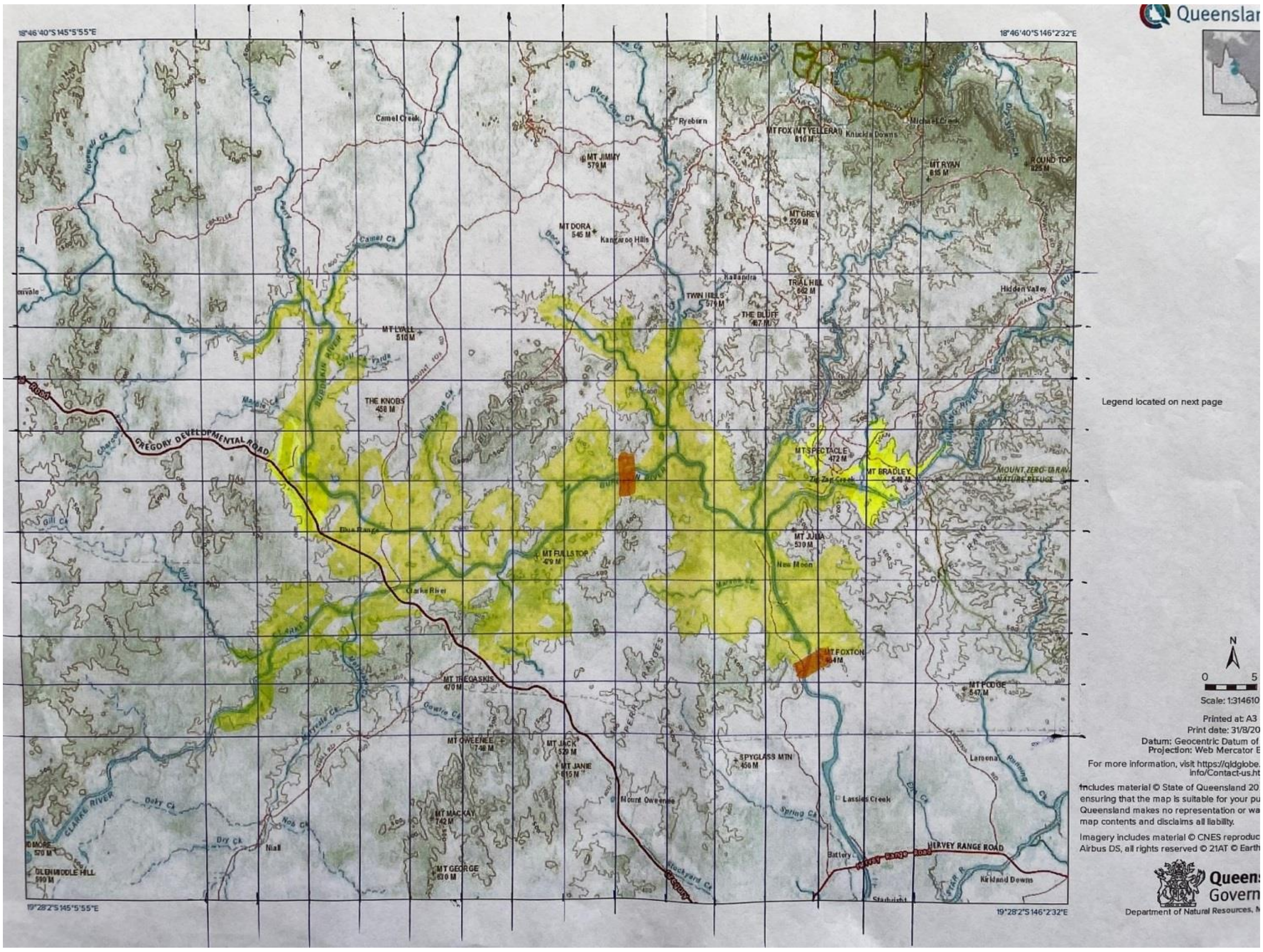
* Evaporation rates - Townsville Airport 2.588m, Charleville Airport 2.621m

4.6 Conclusion on dam site choice

1. Mt Foxton — Mt Foxton, with dam level at RL380 satisfies the three critical elements of water inflow, elevation and capacity to feed the MDB.

2. Hells Gate — Not suitable for MBD. The preliminary construction work being done on the Hells Gate site will **not** deliver the designed 2,100 GL/a… because of inflow and dam storage capacity are insufficient. The nett inflow for this dam is 1,650 GL/a after evaporation. (ref Table 3)

3. Burdekin Falls Dam — Extended dam can store the requirements for the TEL and SMEC for local irrigation with solar or hydro pumps for transfer above Charters Towers.



Map 2
Map of Upper Burdekin River, with Mt Foxton Dam site, merging the Hells Gate Site

4.7 Building Storage Dam at Mt Foxton

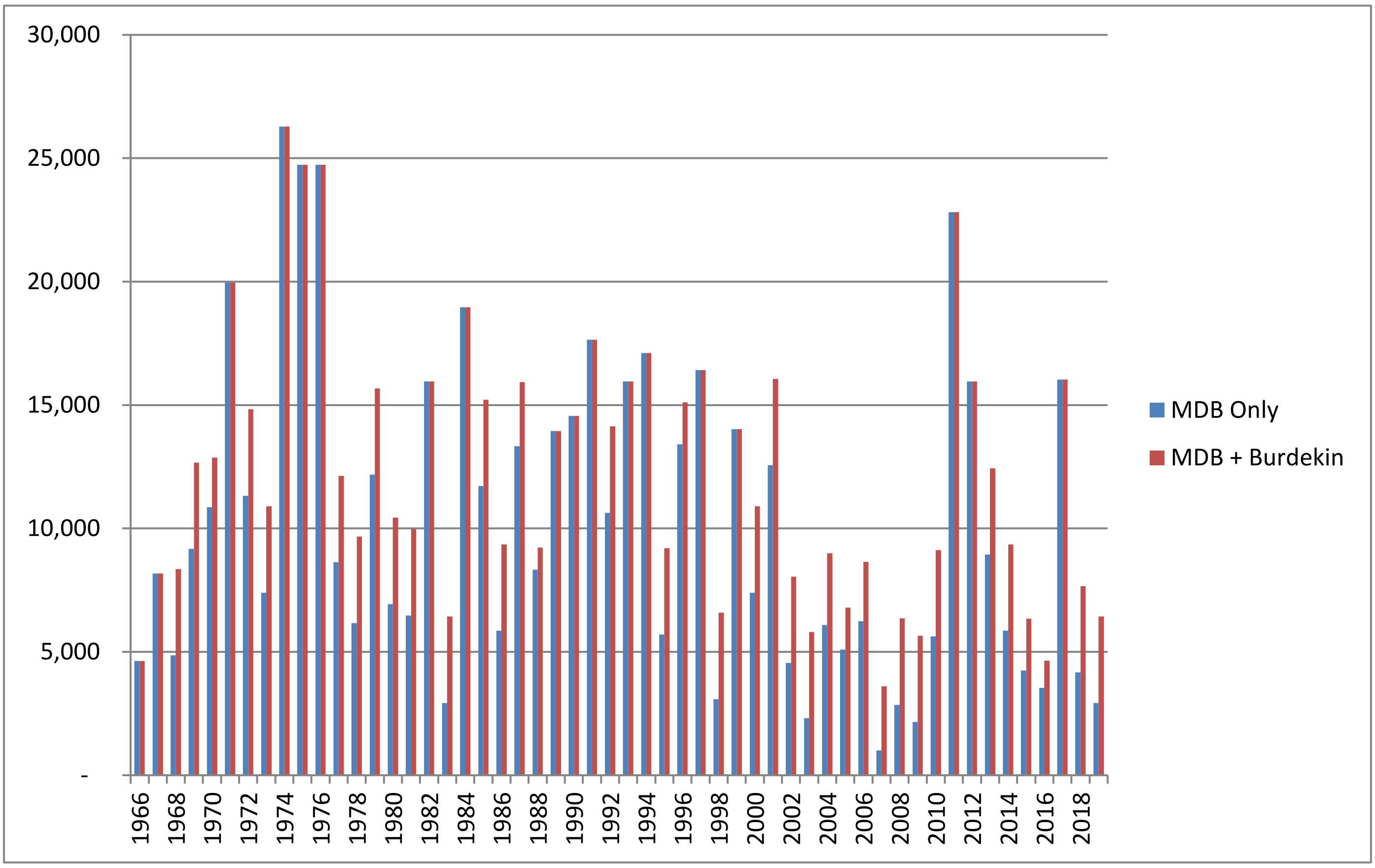
Referring to the SMEC Hells Gate Dam Feasibility Study dated 14/06/2018, the Mt Foxton dam site is compared with the Hells Gate site in Table 1.
Mt Foxton was rated as a possible dam site and has suitable construction materials nearby, based on an initial assessment of the geology.

The capacity of the dam is related to the consistency of flow deemed sufficient for the MBD.

4.8 Dam Capacity – determination for suitability

A dam capacity of 9,000 GL, with RL 380 is envisaged as being a practical size, with 2,000GL of this storage is redundant, as water would be discharged from RL380-RL350.
There will be times when water is not transferred, being excessive water levels in the MDB (no point in adding water to floods) and reduced from the optimum of 3,500 GL/a when inflow is not sufficient.

Graph 2 was obtained from Graph 1, adding the Burdekin water from 1966-2019.



Graph 2 Murray R Inflows + Burdekin Addition (when required)

Attachment 3 tabulates and Graph 2 shows:

- MDB water inflows, compared with
- the inflows of the Burdekin, from 1966 – 2019.

Please note that water has been tabulated **NOT** to be transferred from Mt Foxton Dam when the inflows in the MDB exceed:

- the average of 10,230 GL/a for the MDB + the average transfer of 3,500 GL/a from the Burdekin
- equating to 13,730 GL.

This effect is to allow the dam at Mt Foxton to take in additional inflow, when the MDB inflows are sufficient.

This table was generated with the aim of determining a suitable dam capacity.
Would it be 7,000 GL or 10,000 GL or 15,000 GL?

As a result of this exercise for a 7,000 GL capacity, **10 years** out of the 54 years were not able to send the 3,500 GL as hoped (averaged 1,270 GL instead of the 3,500).
The exercise was also carried out on a 15,000 GL storage dam and there were **4 years**.
In other words, the difference between a 7,000 GL and 15,000GL dam was negligible.

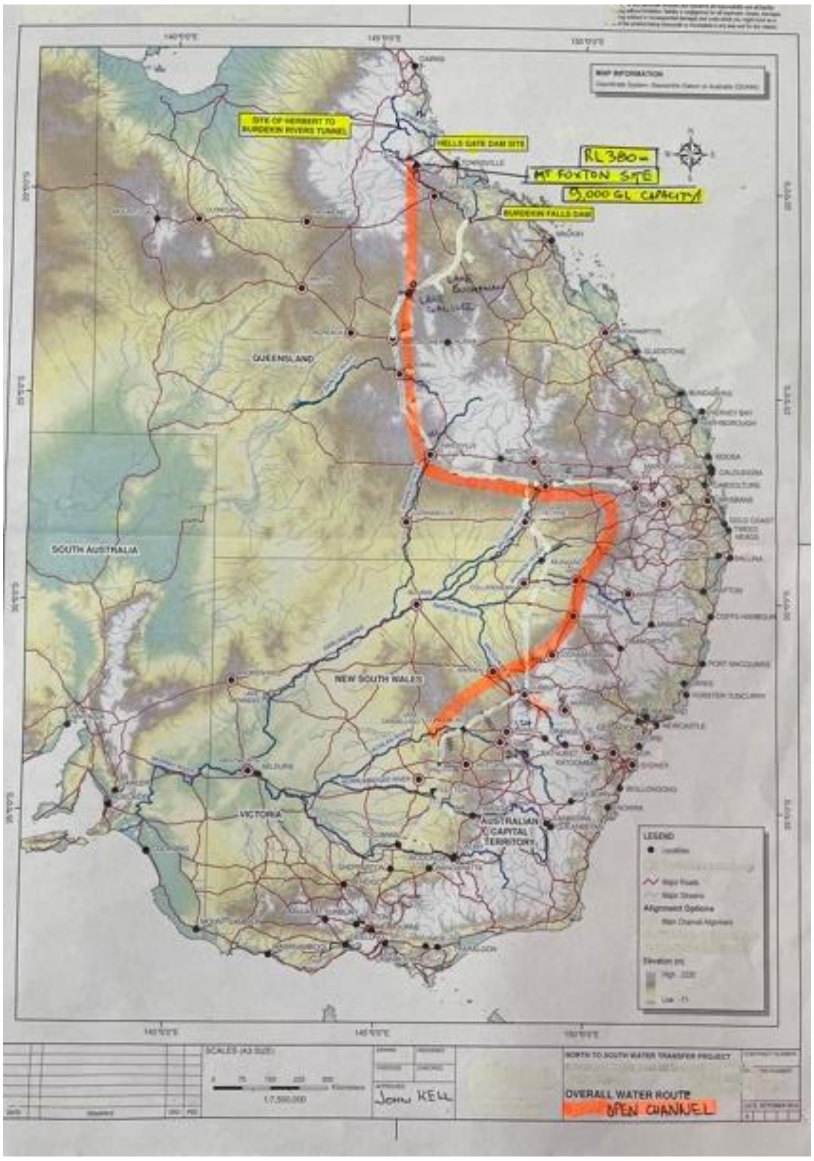
4.9 Conclusion on dam capacity

Choice is 9,000GL dam at Mt Foxton, with 2,000GL being unusable (below RL350m) for allowing gravity channel from RL350m.

The dam volume would need to be investigated thoroughly in the next phase.

5.0 Water Channel Design - Mt Foxton to MDB

My preliminary design for 3,500 GL/a to be transferred from the dam at Mt Foxton to take offs in Qld and the MDB is included in attachment 2A and 2B.
This 3,500 GL/a is a significant volume, and is sufficient proportion of the current total inflow to the Murray River of 10,000 GL/a – refer to Graph 1.
This 3,500 GL will not be discharged each year, for reasons mentioned in clause 4.8 above.



1. **Map of Overall Water Route, with Gravity Channel**

5.1 First Leg

The first leg is from Mt Foxton to the saddle at Lake Galilee which is a natural salt lake in the Barcaldine Region. The channel would go straight past this feature. It would not be used as a storage facility.
In a straight line the distance is 350km but 450km is assumed to allow for some twists and turns to follow the contour. The initial RL (Relative Level above sea level) at dam discharge is 350m. This height is to allow for the upper 30m below the RL 380 to be used for MDB requirements. The level at Lake Galilee is RL310, resulting in a 40m fall over 450km.

The water level of the Mt Foxton dam is preliminarily set at RL 380m.

5.2 Southern Extent of Gravity Channel

The open channel will then extend generally south, following and gradually falling with the contours on the western side of the Great Dividing Range, to the Qld/NSW border via Moree, and beyond into NSW, with discharges at the crossing of the various rivers of the MD catchment, including the Barwon Upper Darling River.
The open channel in these preliminary calculations will eventually finish up a Lake Cargelligo on the Lachlan River.

5.3 Wear of Channel

The velocity of the water is around 1.74 m/sec or 6.2 km/hr… so it takes just ~3 days for that 450km from Foxton Dam to Lake Galilee and a further 18 days to Lake Cargelligo. Reasonable low velocity reduces wear on the channel material, expected to be reinforced concrete.

5.4 Evaporation Losses

Evaporation losses during transfer related to the 18m channel top width and 2,400 km length, at a rate of 2.6 m/a is 3.4%. Refer to Table 3.

5.5 Possible take-offs

5.5.1 Toowoomba Take off

Toowoomba - to address a chronic water shortage problem in that city.

5.5.2 Tamworth Take off

Tamworth - to address the problems for that inland city.

5.5.3 Sydney Take off

The addition of solar pumps enables water to be sent up to the Burrendong Dam and eventually to the Coxs River (RL 400) to feed to the Warragamba Dam and the Sydney system. Burrendong Dam (1,678 GL) could be the backup Sydney so desperately requires by:

- building the 90 GL/a desalination plant in 2010 with,
- an additional desalination plant on the drawing board and
- plans to extend the Warragamba Dam capacity.

5.5.4 Longreach Take off

A gravity channel is included to service Longreach and that city’s environs and feeding into the Barcoo R and Great Artesian Basin.

5.6 Environmental Concerns

There are environmental concerns. The submission describes the engineering behind a scheme to save the MDB from extinction, which would be considered absolutely critical from an environmental viewpoint.

Our country has tropical rain water traversing the country when we have high rainfall in Far North Queensland (FNQ), so there is nothing new in this exercise.

The channel would need to have multiple and frequent crossings for the wildlife and landowners to have full access to their properties. Envisaged are cuttings at spurs and bridges over creeks in a way that life can cross over easily. Frequent water points to provide outside the security fences for wildlife.
The design of the channel would certainly consider local requirements. A central long column (not to reduce flow rates) could be inserted to reduce the roof span, when deemed necessary for crossings.
This channel could be designed as a centre piece in environmental engineering for generations of all species to benefit.
The channel will also require the highest level of high tech security.

6.0 Commonwealth of Australia Constitution Act – Section 100

There is plenty of water in coastal North Queensland; but we must use the precious resource wisely, by transferring to areas where it is desperately needed to address the National challenge, whilst not affecting the donating state of Queensland.

Table 4 outlines the excess water situation for the Burdekin and Herbert Rivers, after the MDB and Qld have removed required quantities.
It is clear with the excess flows detailed, the state of Queensland would not suffer with the MDB being rejuvenated with 2,400 (Burdekin R) + 1,107 (Herbert R) = 3,507 GL/a.

River	**Current Outflow**	**Deduct Take-off**	**Excess Outflow after take-off**
	Sea Level		
Burdekin River River Mouth	**8,574 GL/a** (Clare 120006B) Burdekin River Mouth	MDB 2,400 GL/a QLD 2,100 GL/a	**4,074 GL/a** at river mouth
	RL 130m		
Burdekin River At Burdekin Falls Dam Site	**6,657 GL/a** (Hydro Site 120015A) Just downstream from Burdekin Falls Dam Site	MDB 2,400 GL/a QLD 2,100 GL/a	**2,157 GL/a** at Hydro Site 120015A
	Sea Level		
Herbert River	**3,924 GL/a** (Ingham 116001F) Herbert River Mouth	MDB 1,107 GL/a	**2,817 GL/a** at river mouth

Table 4 Excess Water for "*reasonable use*"

This Section 100 is a single sentence:
"*The Commonwealth shall not, by any law or regulation of trade or commerce, abridge the right of a State or the residents therein to the reasonable use of the waters of rivers for conservation or irrigation*."

S100 Appraisal

With the Table 4 figures in mind, the following appraisal from legal Counsel was obtained.
"*S100 would not be infringed by a Commonwealth law or regulation (include 'direction', etc) which facilitated works to enable the passage of water from Queensland to NSW in circumstances where Queensland retained its existing water supplies and a generous buffer supply to cope with its reasonable requirements for the present and future needs of Queensland and its residents.*"
Christopher McEwen SC, Martin Place Chambers, Sydney

7.0 Federal and State Responses

I have been communicating with both the Federal Government though the Minister for Infrastructure and was referred to the state of Queensland's Minister for Infrastructure. The conclusion reached was:

- Federal Government says water is a State issue and
- Queensland does not comment.
- The Federal Government suggested that we get Queensland to ask to send water to the MDB. This request could come, but it never has in the past and we have an 80 year record of this not happening.

Now is the time to act everyone, as a team… for the sake of our nation's future generations.

8.0 Conclusion

Headline: If Hells Gate Dam is built, Australia will NEVER get another chance to save the MDB!!

8.1 There is ample flow, elevation and storage capacity to proceed with developing a proper design to provide security to the MDB and assistance to the GAB into the future, without S100 being compromised.

8.2 The current Hells Gate site work needs to be stopped **urgently** (I recognise this is a bold statement!) – as it prevents water **ever** flowing down to the MBD.

8.3 The Mt Foxton dam site needs to be **thoroughly** investigated.
The five key items have been covered:

- Elevation
- Inflow
- Storage
- Evaporation
- Section 100

I do hope that the Productivity Commission, through the National Water Reform 2020 is able to take on board, the critical national importance of the objectives of this scheme.

I shall be available to provide clarifications or additional details as may be required.

9.0 Acknowledgements
I wish to thank a number of agencies for their assistance in preparing this submission:

- Queensland DNRME (Dept of Natural Resources, Mines and Energy)
- Sunwater for Burdekin Falls Dam data
- Australian Bureau of Meteorology
- National Water Reform Feb 2021
- MDBA
- SMEC "Hells Gate Dam Feasibility Study" 14/09/2018
- Christopher McEwen SC

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Attachments

1. Referenced Data
2. Preliminary Design of Gravity Flow Channel Summary
3. 9,000 GL Dam Size and Effectiveness

Below is a table of average flows, storage capacities, excess water of the Burdekin and Herbert Rivers. There is also a comparison with Sydney Desalination Plant and the Wentworth-Broken Hill pipeline.

			Excess	**Reference**
River Flows		**GL/a**	**GL/a**	
Burdekin River	Outflow at mouth	8,574		Clare 120006B
Burdekin River	Dalrymple Dam	6,657		Hydro Site 120015A
Burdekin River	Hells Gate Site	**1,817**		Mt Fullstop 120110A
Burdekin River	Mt Foxton Site extra to Hells Gate	**~600**		Running R, Douglas Ck & Oxley Ck included (JFK estimate)
Herbert River	Tunnel to Burdekin	**1,107**		Glen Eagle 116004C
Herbert River	Mouth	3,924		Ingham 116001F
Tully River	Tully Gorge	77		Tully Gorge NP 113015A (irrelevant)
				(Broken Hill pipeline is 13.6 GL/a !)
Hells Gate Site	With Herbert R	2,914		To supply 2,100 Qld
Mt Foxton Site	With Herbert R	**3,507**		To supply 2,100 Qld + 3,500 MDB
Excess to Coral Sea		**GL/a**	**GL/a**	
Burdekin River	Current Flow	8,574		Clare 120006B
Burdekin River	Deduct MDB		6,174	8,574 – 2,400 = 6,174 GL/a
	Deduct QLD		4,074	6,174 – 2,100 =4,074 GL/a
Herbert River	Current	3,924		Ingham 116001F
Herbert River	Deduct MDB		2,817	3,924 -1,107 = 2,817 GL/a
Dams		**GL**		
Hells Gate Site		2,100		SMEC report 09/2018 (tbc)
Mt Foxton Site		9,000		JFK estimate, water level 380m
Burdekin Falls Dam		1,850		
	With extension 2m	2,010		
Warragamba Dam		2,030		
Sydney Harbour		500		
Eucumbene Dam	Snowy	4,798		
Burrendong Dam	Wellington	1,678		
Others		**GL/a**		
Sydney Desal Plant	Max capacity	90		
Wentworth -	Broken Hill Pipeline	13.6		
Great Artesian Basin		65mil	GL	estimate
Murray River Inflows*		10,000	GL/a	Estimates from 1896-2016

*3,500 GL/a would significantly increase, the Murray River inflows, by 35% in fact…

Please note that these average GL/a figures change annually and need to be taken as estimates only.

1. Referenced Data

	Gravity Feed			**Burdekin - Murray Darling Basin**				1 of 2	
	Volume of water	Mt Foxton		3,500	GL/a				
							Channel	**Design**	
Leg	**Point From**	***Town RL***	**Elev**	**Point To**	**Elev**	**River**	**Wide**	**Depth**	**Base**
		m	m		m		m	m	m
1	Mt Foxton	*n/a*	350	Lake Galilee	310	Great Dividing	18.4	4.7	9
2A	Lake Galilee	*n/a*	310	Longreach	190	Thomson R	6.0	1.5	3
2	Lake Galilee		310	Aramac-Jericho	303.5	Reedy Ck	18.4	4.7	9
3	Aramac-Jericho Rd		303.5	Charleville	270	Warrego R	18.4	4.7	9
4	Charleville	*295*	270	Surat	238.7	Condamine R	17.4	4.2	9
5	Surat	*246*	238.7	Goondiwindi	226.1	MacIntyre R	17.4	4.2	9
5A	Goondiwindi	226.1		**Toowoomba**	404	tba			
6	Goondiwindi	*217*	226.1	Moree	218.2	Gwydir R	17.0	4	9
7	Moree	*212*	218.2	Narrabri	211.8	Namoi R	16.2	3.6	9
7B	Narrabri	*211.8*	211.8	**Tamworth**	404	Peel R			
8	Narrabri	*216*	211.8	Coonamble	200	Castlereagh R	14.4	3.2	8
9	Coonamble	*183*	200	Warren	193	Macquarie R	13.0	3	7
10	Warren	*197*	193	Lake Cargelligo	168	Lachlan R	10.0	3	4
	Mt Foxton		350	Lake Cargelligo	168				
	Sydney			Warragamba Dam					
	Take Off		Elev	90 GL/a maximu	Elev	via			
1B	Warren	*197*	193	Burrendong	344	Macquarie R	solar pumped		
2B	Burrendong		344	Windamere	552	Cudgegong R	solar pumped		
3B	Windamere		552	Coxs R	400	Coxs R	tunnel		

Design Criteria

- Manning Formula for Uniform Trapezoidal Flow
- Manning Roughness coefficient 0.011 concrete construction, or steel formwork

2A. Preliminary Channel Design (1 of 2)

			Preliminary Design					2 of 2
						Design	Straight	Slope
Leg	Point From	Vol	Vol	Deduct	Ht diff	Length	Length	
		GL/a	kL/sec	GL/a	m	km	km	m/m
1	Mt Foxton	3500	111.0		40	450	350	0.000089
2A	Lake Galilee	500	15.9	500	120	150	150	0.000800
2	Lake Galilee	3000	95.1	0	6.5	100	100	0.000065
3	Aramac-Jericho Rd	3000	95.1	350	33.5	500	350	0.000067
4	Charleville	2650	84.0	350	31.3	400	350	0.000078
5	Surat	2300	72.9	350	12.6	200	200	0.000063
5A	Goondiwindi							
6	Goondiwindi	1950	61.8	350	7.9	150	125	0.000053
7	Moree	1600	50.7	350	6.4	125	100	0.000051
7B	Narrabri							
8	Narrabri	1250	39.6	350	11.8	185	200	0.000064
9	Coonamble	900	28.5	350	7	100	100	0.000070
10	Warren	550	17.4	550	25	350	250	0.000071
	Mt Foxton					2,560		
	Sydney	Vol	Vol	Deduct	Ht diff	Length		
	Take Off	GL/a	kL/sec	GL/a	m	km		
1B	Warren	100	3.2		-151	200		pump
2B	Burrendong	100	3.2		-208	100		pump
3B	Windamere	100	3.2	100	152	60		0.0025

2B. Preliminary Channel Design (2 of 2)

Dam Size Effectiveness

MDB and Burdekin Inflow s at Mt Foxton - Dam Capacities							9,000 GL Storage Dam			RL 380m
	System inflow s (GL)		Burdekin Mt Fullstop (GL/a)	Burdekin Mt Foxton (GL/a) additional	Herbert Glen Eagle (GL/a)	Mt Foxton (GL) total inflow	Transfer to MDB	Evap'tion 10%	Discharge to Coral Sea	**Max Storage effective 7,000 GL**
mean/a	MDB	10,230	1,817	600	1,107	3,524				2,000 GL
Add'n	Burdekin	3,500		0.33						at RL350
Total		13,730		(x Fullstop)						
1966	4,624	13,730	640	211	198	1,049	-			1,049
1967	8,170	13,730	604	199	2,959	3,762		105		4,707
1968	4,855	13,730	2,183	720	1,344	4,247	3,500	471		4,983
1969	9,171	13,730	139	46	298	483	3,500	498		1,468
1970	10,867	13,730	460	152	141	753	**2,000**	147		74
1971	19,961	13,730	1,124	371	1,342	2,837		7		2,903
1972	11,329	13,730	4,879	1,610	2,100	8,589	3,500	290	2,000	5,702
1973	7,399	13,730	1,129	373	1,719	3,221	3,500	570		4,852
1974	26,281	13,730	10,699	3,531	5,048	19,278		485	17,000	6,645
1975	24,740	13,730	1,537	507	1,333	3,377		664	3,000	6,358
1976	24,740	13,730	1,670	551	1,135	3,356		636	2,500	6,578
1977	8,632	13,730	1,463	483	3,432	5,378	3,500	658	1,000	6,798
1978	6,166	13,730	241	80	88	409	3,500	680		3,027
1979	12,177	13,730	4,142	1,367	2,829	8,338	3,500	303	1,000	6,562
1980	6,936	13,730	1,026	339	557	1,922	3,500	656		4,327
1981	6,474	13,730	5,595	1,846	1,529	8,970	3,500	433	3,000	6,365
1982	15,954	13,730	654	216	786	1,656		636	1,000	6,384
1983	2,929	13,730	865	285	264	1,414	3,500	638		3,660
1984	18,960	13,730	2,067	682	541	3,290		366		6,584
1985	11,715	13,730	362	119	390	871	3,500	658		3,297
1986	5,857	13,730	1,164	384	1,117	2,665	3,500	330		2,133
1987	13,333	13,730	344	114	224	682	**2,600**	213		1
1988	8,324	13,730	446	147	347	940	**900**	0		41
1989	13,950	13,730	926	306	1,260	2,492		4		2,529
1990	14,566	13,730	1,300	429	825	2,554		253		4,830
1991	17,649	13,730	7,935	2,619	3,011	13,565		483	11,000	6,911
1992	10,636	13,730	309	102	193	604	3,500	691		3,324
1993	15,954	13,730	154	51	151	356		332		3,348
1994	17,110	13,730	191	63	203	457		335		3,470
1995	5,703	13,730	417	138	269	824	3,500	347		446
1996	13,410	13,730	682	225	426	1,333	**1,700**	45		35
1997	16,416	13,730	1,293	427	672	2,392		3		2,423
1998	3,083	13,730	2,189	722	748	3,659	3,500	242		2,340
1999	14,027	13,730	1,041	344	2,022	3,407		234		5,513
2000	7,399	13,730	2,490	822	1,872	5,184	3,500	551		6,645
2001	12,563	13,730	3,230	1,066	1,092	5,388	3,500	665	1,000	6,868
2002	4,547	13,730	1,709	564	151	2,424	3,500	687		5,106
2003	2,312	13,730	387	128	277	792	3,500	511		1,887
2004	6,089	13,730	300	99	804	1,203	**2,900**	189		1
2005	5,087	13,730	1,059	349	332	1,740	**1,700**	0		41
2006	6,243	13,730	1,129	373	917	2,419	**2,400**	4		56
2007	1,002	13,730	1,288	425	936	2,649	**2,600**	6		99
2008	2,852	13,730	2,255	744	1,496	4,495	3,500	10		1,085
2009	2,158	13,730	8,442	2,786	3,325	14,553	3,500	108	5,500	6,529
2010	5,626	13,730	1,247	412	1,114	2,773	3,500	653		5,149
2011	22,813	13,730	6,218	2,052	4,054	12,324		515	10,000	6,958
2012	15,954	13,730	2,261	746	934	3,941		696	4,000	6,203
2013	8,940	13,730	481	159	673	1,313	3,500	620		3,395
2014	5,857	13,730	845	279	1,052	2,176	3,500	340		1,732
2015	4,239	13,730	138	46	405	589	**2,100**	173		47
2016	3,545	13,730	673	222	201	1,096	**1,100**	5		38
2017	16,031	13,730	879	290	721	1,890		4		1,925
2018	4,162	13,730	2,304	760	1,553	4,617	3,500	192		2,850
2019	2,929	13,730	4,456	1,470	971	6,897	3,500	285		5,962
mean*	10,230	13,730	1,883	621	1,155	3,659	-			

3.Effectiveness of Dam Design for period 1966-2019