EXPLORING BRADFIELD'S PROPOSALS 21 November 2021
Version 2

INTRODUCTION

Over the last twelve months, Covid has put a lid on a lot of activities. So, to keep the brain active, I decided to explore Bradfield's proposal to transport water from east flowing streams into the proposed Hells Gates Dam (HGD) on the Burdekin and across the Great Dividing Range (GDR) to the Thomson catchment. This activity was further advanced by the proposal for a 'New Bradfield Scheme' during the 2020 election campaign.

From a technical perspective, I needed a better understanding of the original proposal and the relevant topography. I also wanted to examine existing information on the internet, some of which seemed unreliable to me, but first I had to understand exactly what Bradfield was talking about. Only about 25% of the text in his initial report dated October 1938 discussed Qld rivers. The rest was about building dams in the deserts of Central Australia including a recommendation to plug Simpsons Gap and Standley Chasm etc in NT. Not likely these days.

All the imperial data had to be converted to metric and the task just expanded exponentially as it progressed. Wasn't interested in the hydrology of harvesting water from Herbert, Tully and Johnstone Rivers to HG Dam, someone else can do that. But remember, the Johnstone is in a world heritage area. Nor was I interested in economics, geology, agriculture etc. Just **water distribution** from east to west.

THE TOPOGRAPHY

I became more focused on the topography of this vast area of land from Greenvale in the north, south along the Burdekin to upper Lake Dalrymple, down the GDR to Mitchell, west to the south of Charleville and Quilpie to Cooper Creek at Thargomindah, north through the Diamantina around Richmond and the Flinders and back to Greenvale. This is an area of about 900km by 530km

I decided that I needed a topographic map of this area to understand the scope of Bradfield's proposal and I utilised Qtopo on the internet for this purpose. Qtopo is built in layers from 1:100,000 down to 1:10,000 (in areas of specific interest only) and is laid out in relation to latitudes and longitudes. Distances are scaled off the latitudes but not the converging longitudes. One degree of latitude equals 111.1km. The top and bottom of 1:100,000 sheets are 0.5 degrees of latitude apart. Qtopo is a Mercator projection.

Contours at 100m, roads, streams and towns were all traced off Qtopo at 1:50,000 level, to form a sheet 55.6 km north to south and approx 133 km east to west (depending on the latitude) to produce a plan of the area. These were much reduced, joined to their neighbours and saved as a pdf file. When printed on four sheets of A4 paper, trimmed and taped together, this plan is about 60cm by 30cm and will be finalised at a scale of 1:2,000,000

HELLS GATES DAM (shown as Hells Gates on Qtopo)
The Hells Gates Dam site is my starting point. I am trying to do a preliminary storage curve from the Burdekin River bed of 330m AHD, to my selected FSL of 400m, and up to LNP's desire of somewhere near 440m. Although LNP quoted a dam height of 440m, I have since discovered a preliminary drawing by SMEC that shows the spillway to be just below 410m. The top of wall is shown as being just below 440m (can't read figures clearly). A low saddle 6km north of the dam site becomes problematic above 400m as does another on Mount Fox Road about 3km SE of The Knobs (a small hill) above 400m.

Qtopo shows that the river bed at HGDam is exactly the same as most of Hughenden, 300km away on the contour. Additionally, the Neil Turner Weir at Mitchell on the Maranoa about 850km south of HGDam is also at this level.

BRADFIELDS INITIAL PROPOSAL: TUNNEL TO FLINDERS RIVER
In 1938, Bradfield proposed moving 170 m3/sec of water from the upper reaches of the Clarke River within the HGDam storage area, through a tunnel in a SSW direction under the GDR to the Flinders River at Blantyre, on the left bank of the Flinders.

Dr Nimmo mentioned in his 3/2/1947 report that this tunnel would commence at the junction of the Clarke and Broken Rivers where Nimmo says Dr Bradfield suggested the bed is RL 1400 feet (426m). Unfortunately, the bed level there is 460 AHD which by any comparison is 'high and dry'.

This tunnel would have been upwards of 200km long and 11.5m dia with a HGL slope of 0.0001m/m, a V of 1.77 m/sec requiring 20m of head if that is available. Alternatively, 200km long and 10m dia with a HGL slope of 0.0002m/m, a V of 2.28m/sec requiring 40m of head. (These figures are from calculations on an internet site and need verifying)

Blantyre homestead, 17km NE of Prairie, is itself more than 11km from the Flinders R. The river bed there is 420 AHD with top of bank 480. It is impossible to gravitate water 200km to this site from HG Dam wall where bed is 330 and a spillway 400. Bradfield and Nimmo didn’t have access to today’s

topographic information. One contribution to the internet suggest that water can be diverted from storages on the Flinders to Skeleton Ck, which flows south just west of Torrens Ck, need to have a closer look at the contours.

Others are still publishing questionable information including a submission in March 2021 by John Kell BE, to the Productivity Commission National Water Reform 2020, who says he can divert water from a dam at Mt Foxton over the GDR at Lake Buchanan, while giving up 40m of head, and then on to the Darling. A close look at the contours shows that this is not possible without tunnels or pumping.

BRADFIELDS ALTERNATIVE SCHEME: WATER DISTRIBUTION TO WEBB LAKE

In 1941 Bradfield reconsidered this difficult exercise and proposed an alternative twin 26 foot diameter pipeline system at ground level from HG Dam, SSE via somewhere between Charters Towers and Pentland, and then SSW on to Webb Lake where he had been told there was a low spot in the GDR and that water could then flow into Torrens Creek a tributary of the Thomson, and on to Cooper Creek and Lake Eyre. Nimmo calculated that these two 7.9m diameter pipes needed 61m of head to move the total of 170m3/sec at 1.7 m/sec to Webb Lake.

To take advantage of the total storage volume, you might expect these pipes to commence near the base of the dam, but the head would be massive. The engineering design of these pipelines would be critical. How do you put a flow control gates on these big pipes? A similar and much smaller single cast in situ pipe is utilised on the West Barron Main Channel downstream from Tinaroo Falls Dam.

Bradfield theorised that these two pipes would be constructed at a small gradient down to Webb Lake. However, Qtopo shows that there are many ridges and creek crossings to be negotiated requiring a constantly fluctuating pipe invert level which will require scour valves and large air valves. The country is rugged and one obstacle is the aptly named Great Basalt Wall, half of which is a NP.

Unfortunately, Webb Lake, at just below 340 AHD, is still on the eastern side of the GDR which is actually some 12km further west and 40m higher. The bed of the Torrens further west is higher than the bed at HGDam. At this stage, to me everything looks bad. So much for "It's all downhill". Worse still, it is over 20km to Torrens Ck from Webb Lake (tunnel or cut through the GDR?) which will eat up another 5m of head. Torrens Creek here is a mess

of channels, 10km wide, and includes Banty and Woura Creeks which are anna branches of the Torrens. This anna-branch system is about 50km long, north to south. From Qtopo and Qimagery, I would choose Banty Creek (330 AHD) at Tarella. The ground here is very flat falling only 1m every 6km to the south. The bed of the creek would be about 1 or 2 m below the surrounding countryside, if that.

TORRENS & THOMSON FLOW CONTROL

Even if water can be fed into the Torrens via the two large pipes through Webb Lake and the GDR, how do you regulate water flow in these conduits? Gates at the beginning of the pipes would be massive. And what about controls at the Webb Lake end to manage the volume of the 300km of water in those two pipes. Does anyone want to comment on the static head on this pipeline if closed at the downstream end? I have seen serious water hammer in a pipeline over 1m dia (caused by a sudden pump shutdown), and I wonder if these pipes could create something horrendous.

With this water free flowing within the Thomson catchment, many small weirs would have to be constructed over a multitude of channels to allow water extraction. That would be a challenge for water storage construction contractors as many weirs on normal rivers have already failed. A quick fierce storm would cause serious flooding if irrigation supplied water is already occupying the flat channel country. Have you seen how far the town of Longreach is above the Thomson bed? Not a lot of freeboard there. A weir on one of the Thomson channels supplies water to the town.

LNP's NEW BRADFIELD SCHEME

This proposal put out to the voting public last year was to irrigate 80,000km2 with a demand of 1m depth of irrigation water per annum. It is simple maths to convert this annual demand to m3 per annum and then to a m3/sec flow in an irrigation supply pipe or channel.

From here, an open channel cross sectional area with a V of 1m/sec and a tunnel diameter with a V of 4m/sec (if that is achievable) can be determined. I encourage you all to do this calculation to see how the size of these conduits has never been considered to achieve the proposal to irrigate 80,000km2. (Answer: open channel 2,500m2 cross sectional area, tunnel 28m diameter at 4m/sec, if that V can be achieved) The tunnel volume would be approx. 123,200,000 m3 which, for comparison, is 47 times larger than the Great Pyramid of Giza at 2,600,000 m3, height 138m. About the volume of 50,000 Olympic size swimming pools.

THE LABOR GOVT's EXPERT PANEL

Experts have been appointed to a Panel to conduct a comprehensive examination of the proposed Bradfield inland irrigation scheme. One can ask the question 'what is a Bradfield scheme'? What are the details of this scheme? I have seen a few irrigation schemes in my day, but none with such minimal detail.

The Terms of Reference for the panel include;
"The purpose of the Panel is to present a report to the Minister, outlining the results of an assessment of the financial, economic, environmental, social and technical viability of a Bradfield Scheme, or "Bradfield like" concepts, as well as a set of recommendations for any further assessment."
So, what is a Bradfield Scheme?

"While there is no defined project area, the project area that the Panel will focus on is the geographic area that allows for the diversion of flows from the Wet Tropics to the Burdekin and as far south as the Queensland Murray-Darling Basin."

So, there is no defined project area and no one has looked at the fact that you can't gravitate water to the Warrego or Maranoa. A quick look at the contour plan would have ruled this out. The Thomson catchment is separated from the Warrego catchment by ranges with various names, Grey, Gowan, Warrego and Enniskillen all with elevations over 400m. To get into the Maranoa, the big restriction is the Chesterton range at well over 500m. Any idea of moving water (without pumping) should be rejected. Again, so much for "It's all downhill". But then, I guess we will always have people who think the earth is flat. I suggest that the largest volume pumps in Queensland are those in the Burdekin River at Clare Weir Together, the double submersible pumps shift 14 m3/sec.

"The Panel will be guided by the Queensland Government's objectives for bulk water supply, which are to support development of bulk water infrastructure that provides a commercial return to bulk water providers."
So, the infrastructure on any Bradfield Scheme will be so vast that bulk water providers are unlikely to achieve a commercial return.

IRRIGATION AREA DESIGN

Bradfield stated that in the Windorah area, allowing 20 square miles (52km2) of dry country to every square mile (2.6km2) of irrigated land, about 60,000 square miles (155,400km2) could be heavily stocked, with the irrigated land (about 7,400km2) supplying all the fodder. This will irrigate an area 100 km

diameter, 0.72m deep/annum (less evaporation and seepage losses, less water led to the Diamantina River)

How does an irrigator pump water out of this ‘channel country’ area where the water might be here one season and 20km away the next? Even in the Torrens, your pumping equipment may not be able to be put in a position safe from flooding.

I do recognise that some water holes are permanent with the assistance of a small earth weir. I have seen the Longreach Waterhole where more than one boat operates a thriving tourist business. I have also seen the Diamantina at Dagworth Station near Kynuna with more than half a dozen channels, one of which contains the ‘Combo Waterhole’, of ‘Waltzing Matilda’ fame. We dragged that hole in a small rowing boat but didn’t find any trace of the swagman, the jumbuck nor any fish. These channels can be crossed on a 2km road which has neatly placed rocks on the downstream side of the gravel invert at each channel, said to be constructed by Chinese labourers for Cobb & Co coaches more than a century ago.

An alternative to Bradfield’s Windorah thoughts would be a specific irrigation area designated along the lines of the Emerald Irrigation Area (EIA) which could be located in the Hughenden Richmond area on the black soil plains. As stated before, I have seen a few irrigation areas in my time and if governments want to see concentrated agricultural activity in the Hughenden Richmond area and all the benefits that would bring, then the money needs to be put up.

These days, major infrastructure investments need a viable business plan. The EIA would not have passed a business plan enquiry as it was planned as an irrigated cattle fodder business, but magically in 1970 just as the 500 acre farms were being auctioned/balloted at around $30,000 Gordon Titmarsh from Pilot Farm No1 started selling his high value cotton to the St George cotton gin. Soon everyone was growing cotton and farm prices went to $80k then $500k (from memory), and the business plan would have gone out the window.

PUMPED SCHEME

If the Govt wants water at Hughenden. I would like the Panel to further assess a proposal to supply water to farms in a planned irrigation area at Hughenden by pumping from the Burdekin at CT Weir, up over GDR and down to Flinders River. Gravitate by open channel to farms in a developed irrigation area SW of Hughenden.

Water would be released to the Charters Towers Weir through a hydro at HG Dam. Another hydro would be located at the pipe end at Flinders River, with both connected to the proposed 'Copper String' project. A flow of 15.9 m3/s can be pumped through 2 x 1.6 m dia conc lined steel pipes at a velocity of 4m/s to irrigate 50,000 ha or 250 farms at 200 ha each. While the pipeline would be expensive, I see no other way of providing irrigation at Hughenden. It is envisaged that the electrical hydro input and pump output could be part of the 'Copper String' project and farmers would only pay for O & M of water supplied by gravity from the Flinders reservoir. This scheme can be duplicated at a later date if required. No hydro can be generated via the tunnel method from upper Clarke R.

While this proposal will provide regional economic benefits, it may not "support development of bulk water infrastructure that provides a commercial return to bulk water providers".

MYTHS TO DISPEL

Some information on the internet about the Bradfield scheme appears to be straight out of a Jules Verne novel and needs to be 'fact checked' properly.

1. TUNNEL. There is no economical method of constructing a tunnel at any size under the GDR. It is too long and a HGL slope must be considered in any calculations.
2. CLARKE RIVER. Taking water from the upper reaches of the Clarke allows only a small percentage of storage volume to be accessed. What happens when the seal is broken and huge volumes of air enter the gigantic chasm of the tunnel? This method also prevents the use of hydro.
3. WARREGO RIVER. Without pumping, there is no way of distributing water from the Thomson catchment to the Warrego, let alone the Maranoa.

CONCLUSION

Water distribution from east to west by any method is an expensive exercise. An organised irrigation area on the alluvial black soil between Hughenden and Richmond would certainly inject a lot into that area, but Governments need to provide the funding and not expect irrigators to pay for everything.

Bob McDonald

HELLS GATES DAM - PRELIMINARY STORAGE VOLUME 20 November 2021

(Indicated as Hells Gates on Qtopo and by the North Queensland Water Infrastructure Authority)

Selecting Full Supply Levels.

Following my previous contribution on Exploring Bradfield's Proposals, I have been working on a preliminary storage curve from the Burdekin River bed at 330m AHD, to my selected FSL of 400m, and up to LNP's desire of somewhere near 410m. Although LNP quoted a dam height of 440m, a preliminary drawing by SMEC that shows the spillway to be just below 410m. The top of wall is shown as being just below 440m (can't read figures clearly). A low saddle 6km north of the dam site becomes problematic above 400m as does another on Mount Fox Road about 3km SE of The Knobs (a small hill) above 400m. I wanted to see what higher FSLs produced and I have completed the areas that encompass volumes up to 410AHD (20,600GL). The areas that encompass volumes up to 440AHD (>64,000GL) have been almost completed. Water is backed up from HG Dam 83km to Hopewell Ck for FSLs at 400, 92km to near Greenvale for 410 and 122km for 440.

Qtopo Grid.

Scale is a big problem in that the Qtopo grid is drawn using latitudes and longitudes. The distance between latitudes is known but longitudes at 19 deg south are narrower. The mapping projection is Transverse Mercator, or Universal Transverse Mercator (UTM). I understand Mercator, but not sure of UTM. Elevation is a small factor that I haven't considered.

Some tech detail to establish scale.

LATITUDE				LONGITUDE (at 19deg S)			
1 deg	1	111.19km (earth calc on net)		1 deg	1	105.13km (earth calc on net)	
30min	0.5	55.60km	1:100,000	30min	0.5	52.57km	1:100,000
15min	0.25	27.80km	1:50,000	15min	0.25	26.28km	1:50,000
7.5min	0.125	13.90km	1:25,000	7.5min	0.125	13.14km	1:25,000
3.75min	0.0625	6.95km	1:10,000	3.75min	0.0625	6.57km	1:10,000

The latitude grids on Qtopo 1:10,000 plans are shown at 0.0625 degrees or 6.95km apart. The distance between the longitude grids at 19 deg south is debatable but I have used 6.57km.

Methodology.

I use a 'column' method to calculate volumes. A 10x10 grid is superimposed over each Qtopo 1:10,000 grid. NS levels were manually interpolated for each of the 100 squares. Each of my 10x10 grids are then 695mx657m and this area is multiplied by the depth from the desired FSL to obtain a volume for each column in m3, and then converted to GL. However, both latitude and longitude distances can be adjusted on my Excel storage spreadsheet as they are individual entries, in single cells, that are used in all the calculations. About 4,000 NS levels were interpolated up to 440 AHD.

For volume calculations, I use the ‘=IF’ formula in the spreadsheet cells to determine if each 10x10 ground level is above or below the desired FSL. If above, the cell is marked with a zero. If below, the cell formula multiplies the column area by the depth from desired FSL to NS. All 10x10 column cells are then summed to give a total FSL volume for that Qtopo grid, and then the whole storage.

For surface area calculations I use another ‘=IF’ formula to establish if the NS for each 10x10 column cell is below, equal to or above the desired FSL. I can then sum the number of submerged columns and then calculate the total surface area in square kilometres.

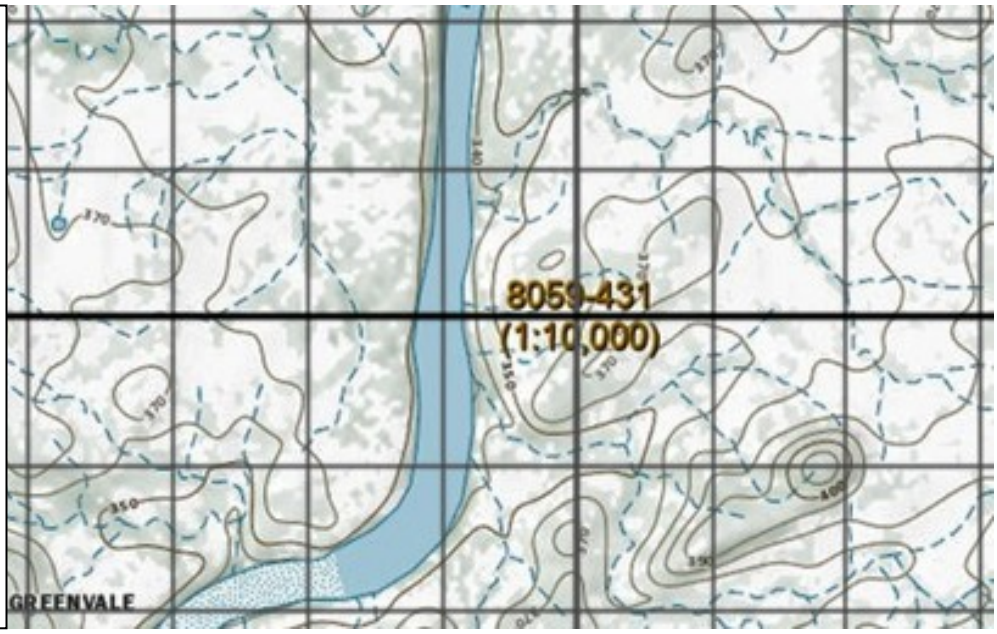
While this ‘column’ method is not the most accurate, it is the best I can do in the circumstances. To have the 10x10 grid any smaller would make it all too time consuming. I’m not paying for LiDAR.

Bob McDonald

Below are some figures to put storage volumes in perspective.

Tinaroo Falls	438 GL	Wivenhoe FSL	1,165 GL	Warragamba	2,000 GL
Peter Faust	491 GL	Fairbairn	1,301 GL	Gordon (Tas)	12,359 GL
Sydney Harbour	500 GL	Burdekin Falls	1,859 GL	Hells Gates 410AHD	20,600 GL
Fred Haigh	561 GL	Hells Gates 375AHD	1,884 GL	Hells Gates 440AHD	>64,000 GL

Part of a typical Qtopo 1:10,000 sheet shown overlain with part of my 10x10 grid. The river is flowing north here and is 7km above BF Dam. The bed here is 340 AHD and is some 70m below the 410 FSL.



Australian Height Datum AHD m

Volume GL