

## MODULE 6 POTENTIAL AUSTRALIAN ZINC PRODUCTION

As covered in Part 1 of this report, Australia has been a reliable source of 1.5 Mt a year of zinc in concentrate until recently and are now projected to provide in the range of 1 Mt a year going forward.. The question therefore is what would it take to get back to prior production levels? As discussed below, this appears to be unlikely under any circumstances apart from a concerted grassroots exploration program making significant new discoveries.

I will first cover the more advanced projects, those with a least a Preliminary Economic Assessment complete, then briefly discuss projects that could be considered to be in the advanced exploration stage.

### Advanced Projects

#### Stockman

Information concerning this project can be found [here](#). Independence Group plans to develop the Stockman project in Victoria once they have placed the Nova nickel project into production. They will likely want to review timing since studies to date have been based on higher copper and zinc prices than current. Indeed, a 2014 development schedule provided previously is already out of date. 2019 is likely the first opportunity for production. This project is located in Victoria and consists of two separate deposits, Currawong and Wilga. Some previous mining has occurred at Wilga. Deposits are roughly 30 km apart and a mill will be located in between both to treat 1 MT a year of ore. Recoveries will be somewhat low at 81.5% Cu and 76.4% Zn. Precious metal recoveries are very low. Both operations will use ramp access with blasthole stoping. Annual production is expected to average 15,000 T Cu and 26,000 T Zn.

Reserves are listed below. Commodity prices used to determine these reserves were \$2.99/lb. Cu, \$1.35/lb. Zn, \$20.17/oz Ag and \$1,146/oz Au. The exchange rate assumed was \$0.84 \$AU per \$US.

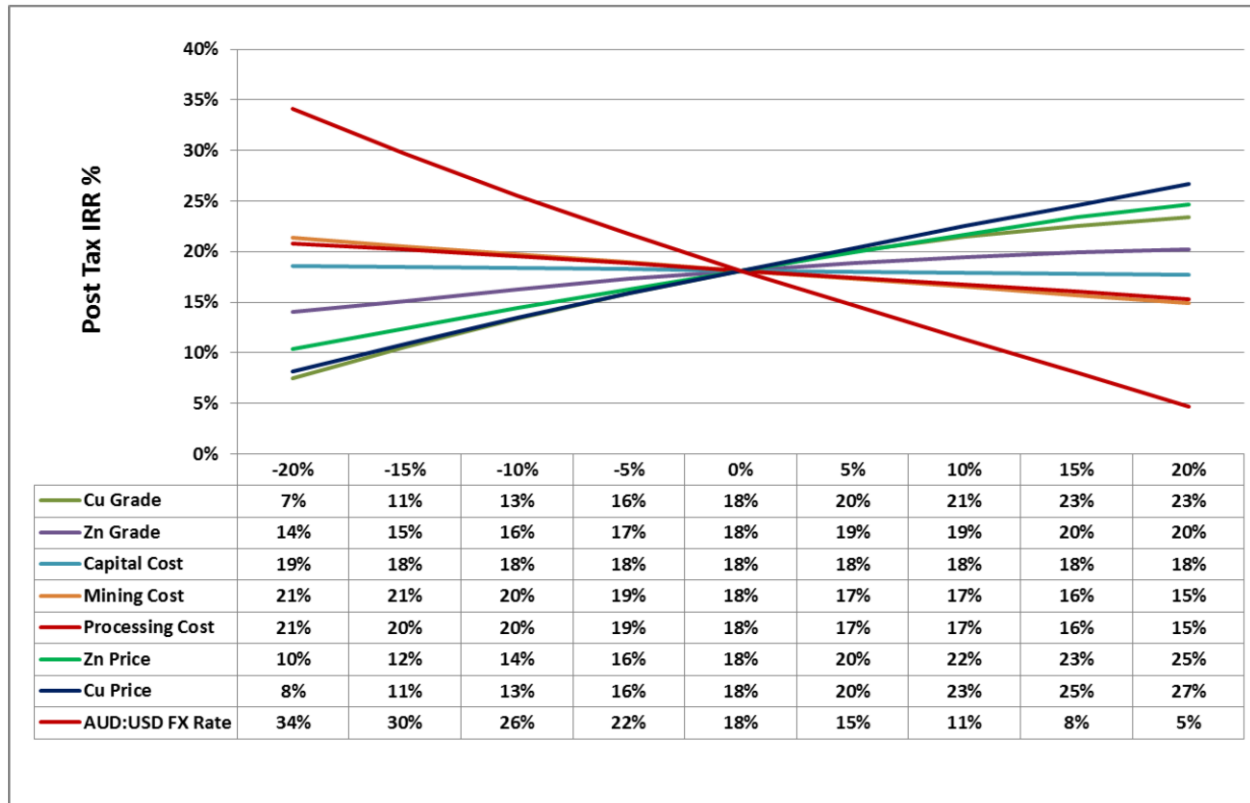
Deposit	Class	Ore Reserve 28 November 2014					Ore Reserve 30 June 2014				
		Tonnes (Mt)	Cu %	Zn %	Ag g/t	Au g/t	Tonnes (Mt)	Cu %	Zn %	Ag g/t	Au g/t
Currawong	Proved	-	-	-	-	-	-	-	-	-	-
	Probable	7.4	2.1	4.3	40	1.2	7.3	2.2	4.1	40	1.2
<b>sub total</b>		<b>7.4</b>	<b>2.1</b>	<b>4.3</b>	<b>40</b>	<b>1.2</b>	<b>7.3</b>	<b>2.2</b>	<b>4.1</b>	<b>40</b>	<b>1.2</b>
Wilga	Proved	-	-	-	-	-	-	-	-	-	-
	Probable	1.6	2.1	5.6	31	0.5 <sup>3</sup>	1.1	2.5	5.3	30	0.5 <sup>3</sup>
<b>Sub total</b>		<b>1.6</b>	<b>2.1</b>	<b>5.6</b>	<b>31</b>	<b>0.5<sup>3</sup></b>	<b>1.1</b>	<b>2.5</b>	<b>5.3</b>	<b>30</b>	<b>0.5<sup>3</sup></b>
<b>Grand Total</b>		<b>9.0</b>	<b>2.1</b>	<b>4.5</b>	<b>39</b>	<b>1.1<sup>3</sup></b>	<b>8.4</b>	<b>2.3</b>	<b>4.3</b>	<b>39</b>	<b>1.1<sup>3</sup></b>

Power will be generated on site. Water is a bit of a question mark. They state that there is sufficient water on site in a previous tailings storage facility but if this proves to not be the case there is a potential

bore field 33 km away. Any capital related to this worst case bore field option however is likely not factored into project capital costs.

Pre-production capital of \$A202 M is required along with an additional \$A31M in working capital for the start up. On site costs of \$A103/t are listed (mining- \$A49/t, milling \$A40/t and G&A of \$A14/t) with concentrate transport costs of \$A29/t and TC/RC's of \$A38/t. The cut-off grade NSR used was between \$A97 and \$A105/t which appears too low (see Table 21, Part 1).

Why Independence Group may hesitate with the development of this project is revealed in the spider diagram below. Copper prices are currently trending 30% below that used in the Optimization Study so the economic rationale has been somewhat destroyed. This is only partially countered by the exchange rate assumption. So I suspect this project will be repackaged as a zinc/copper mine, not copper/zinc mine, if zinc prices rise to above \$1.50/lb as I anticipate.



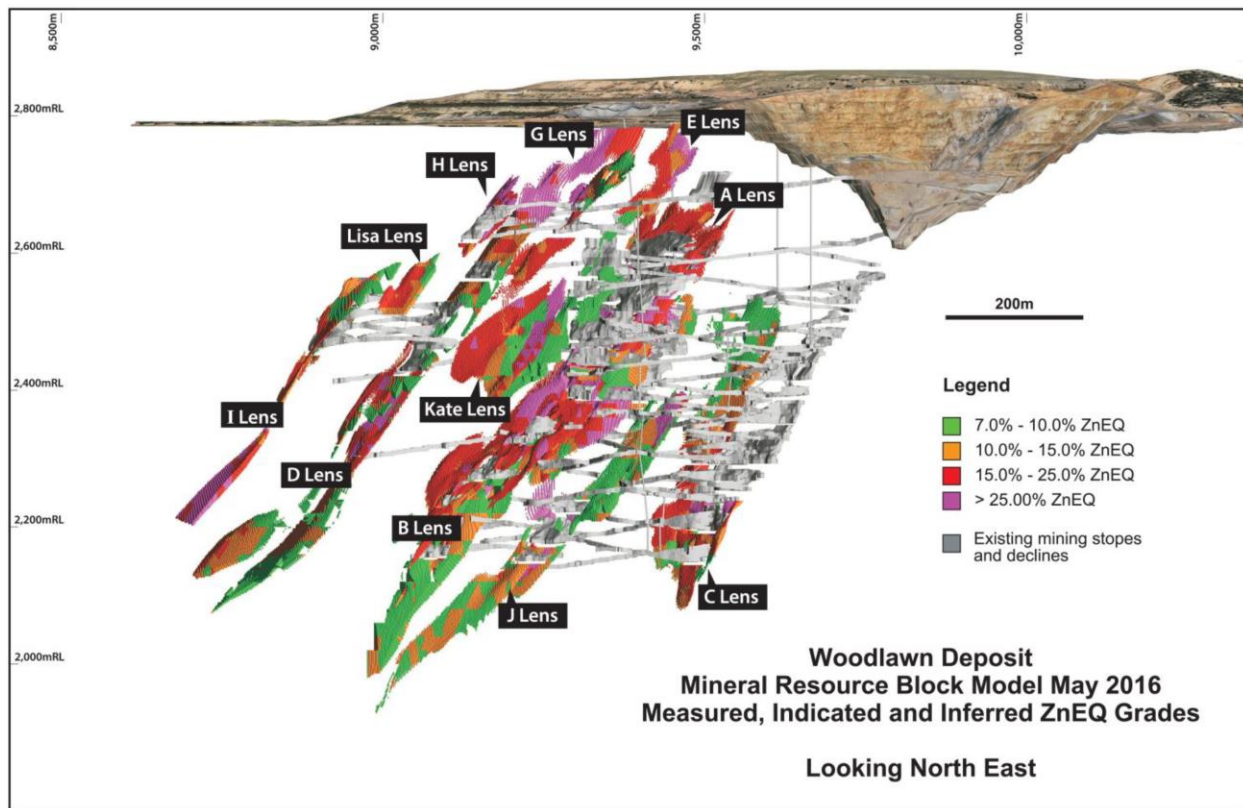
Independence Group has demonstrated their ability to finance and develop a number of mines with similar characteristics to this one so that provides me with some comfort, that when the economic conditions are right, they will proceed with this project here. They are not a single asset company so have some flexibility with respect to timing and financing.

But the real key take away here is that this is one of only a handful of near shovel ready projects in Australia but its zinc output will only be 26,000 T a year. This is a mere drop in the bucket compared to the 500,000 T a year of production that was lost recently.

**Woodlawn**

Heron recently released a very thorough assessment of their Woodlawn project and I thank them for the high degree of transparency. This study can be found [here](#). Woodlawn is a mine that previously produced base metals from 1978 to 1998. I never had the opportunity to visit the mine but I recall it was a struggle there for many years and this appears to be related to relatively poor mill performance combined with the ups and downs of commodity prices.

Similar to the Caribou mine in Canada, Heron intends to improve mill performance by introducing the ultra-fine grinding IsaMill that was developed for the McArthur River mine in the early 1990’s. The existing tailings piles will be retreated and this will be supplemented with underground ore. So this project strikes me as being a mix of Caribou, Endeavor and the previous Hellyer tailings retreatment project. The redeveloped mine will target a number of unmined lenses.



Not being a milling guy, I pretty much have to accept what they state about expected grades and recoveries. I note however that the Caribou mill is still pulling up a little short of expectations grade and recovery wise and indeed so is the McArthur River mine. So this is a word of caution likely related to scaling up pilot plant work to full production.

I have reviewed the production plan and it appears achievable. Underground production rates are quite modest and having the tailings stream available for milling when underground ore is not available takes the pressure off the mine so that they can do it right while keeping the miners safe. The mining of remnants adjacent to previous mined out areas, with unconsolidated fill in particular, is the wildcard but

this has been pushed out in the schedule so the potential to introduce inferred resources into the schedule as reserves instead is possible once they are better defined.

Heron plans to treat tailings at a 1.5 MT a year rate and underground ore at a 1.0 MT a year rate. Annual output will average roughly 40,000 T Zn, 10,000 T Pb and 5,000 T Cu with silver and gold credits for roughly eight years.

There are only two concerns that I had while reviewing the NI 43-101. Firstly, I was confused with the upfront capital required for the project. The breakout is provided below. Where is the capital for the mining portion?

<b>Cost to Peak Cash Draw</b>	<b>Total</b>
<b>Pre-Commissioning</b>	
Underground Development & Rehabilitation	0.8
Mining Services	3.2
Paste Plant	5.4
Treatment Plant and Services	95.4
Earthworks & Roads	2.7
Construction & Engineering	19.9
Tailings Storage (TSF4)	6.0
Commissioning, First Fills, Other	4.7
Owners Costs & Pre-operating Costs	6.0
<b>Subtotal</b>	<b>144.2</b>
<b>Post-Commissioning</b>	
Underground Development & Rehabilitation	8.5
TSF4 First Lift	2.4
Working Capital	7.6

After digging into it, the mine has been essentially costed in sustaining capital and the headline number of \$A144.2M therefore excludes it. This is a bit mischievous in my opinion since it does not portray an accurate picture of total project costs and is another example of a project in Australia attempting to “pay as you go”. In other words, early cash flows are expected to cover sustaining capital. But startups never go as planned and this is when undercapitalized projects are at their most vulnerable. Particularly for single asset companies. The clock is ticking with respect to cash burn and the owner then does a mad scramble to find more cash. Invariably shareholders always come out worse for wear in these situations. So the right approach is to ensure that funds are available for the upfront capital and also for

very healthy working capital to cover this vulnerable period. An example in Canada of a company continually having to go to the trough for more capital was Detour Gold and you can look at their share price during this period to see that shareholders took the brunt of it. Fortunately, that one turned out well in the end. It could equally turn out in Administration though if debt holders are not as gracious. In other situations such as Hudbay's new mine in Peru, they made sure they had an extra 10-20% capital available to see themselves through the vulnerable startup period.

The second concern I had was the use of the unit rate method for calculating the costs underground. In other words, a meter of tunnel costs \$x and a meter of blastholes costs \$y. Schedules such as Table 16-37 and 16-38 show activity levels underground bouncing all around from quarter to quarter. Contractors will be used and a manpower list is provided in Table 16-26. The way life works with a contractor is that you can expect to pay at least \$1,000/day per contract employee on site irrespective of whether they are doing unit rate work or not. The contractor is running a business and has to cover his costs. He will simply send you a delay or overhead bill for the difference between his costs and the revenue derived from the unit rate activities completed. Contractor manpower totals 87 in that list. Therefore, the unit rate charges derived from the activities listed should be reconciled with the daily bill expected to be received from the contractor to cover their manpower and equipment costs. Gut feel is that the costs used here are probably 30% light and are largely related to contractor overheads.

Other than those two items I am not going to quarrel with the rest of the work done. I can't argue with what it costs to build a mill in Australia since quite frankly I have no clue.

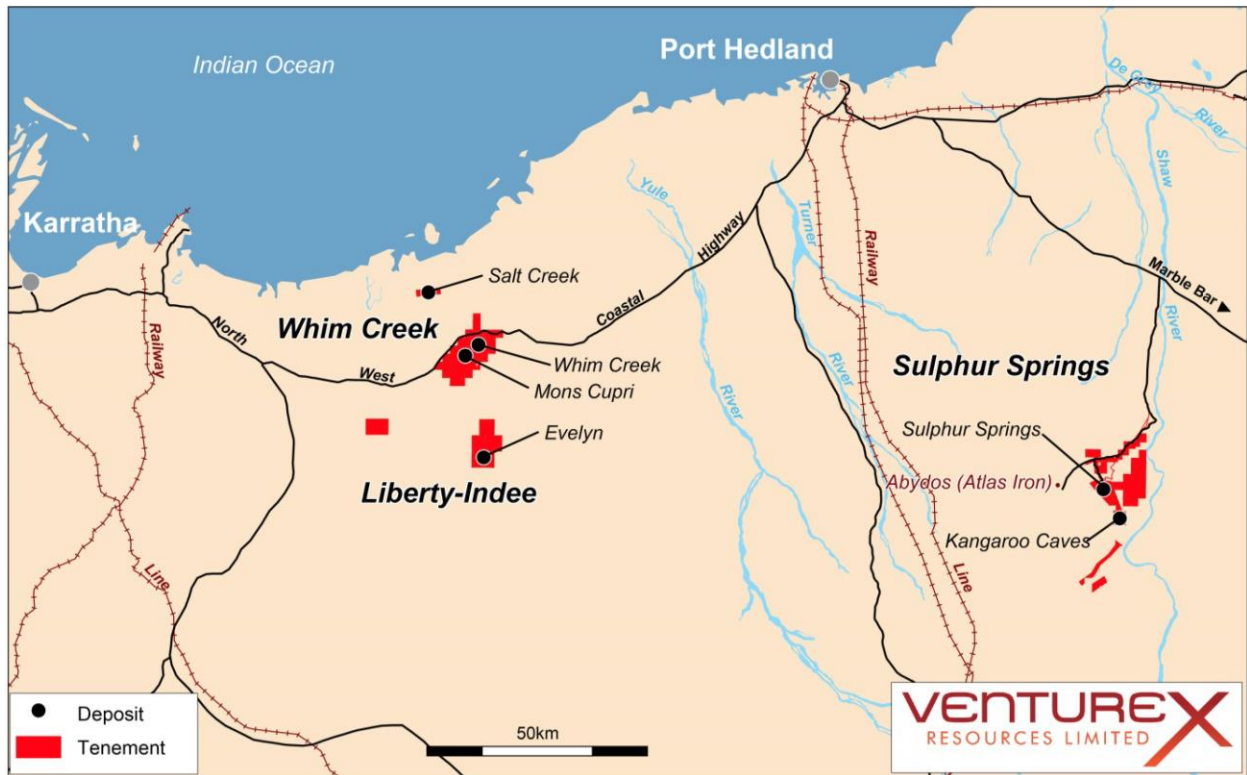
The good news is that this project is highly leveraged to the price of zinc and a zinc price of \$1.01/lb has been used in financial modelling. If you believe the price of zinc should rise to the \$1.50/lb range, this leaves a lot of upside. Unfortunately, projects also continue to use \$3.00/lb copper but the copper leverage here is considerably less than Stockman for instance.

It is important to note that Heron primarily trades on the ASX with only secondary volumes on the TSX. The market is made in Australia. Past experience tells me that the Aussies are usually much more conservative when it comes to valuing projects of this nature. They have a much longer memory of projects that did not turn out well. Canadian analysts however, tend to sweep these projects under the carpet quickly lest it upset retail investors (Rubicon anyone?). Like their crazy uncle, they don't want to talk about it.

Most mining stocks in Australia are penny stocks and they remain penny stocks due to high share counts. So don't be looking for any 10 baggers on the ASX. However, I do endorse this project and I will likely take a small position here. I look forward to seeing what financial arrangements they come up with and what it means for shareholders. The capital they need to raise is a multiple of their current market capitalization so this leaves current equity holders vulnerable to heavy dilution. I wish them all the best on the execution of this project though.

**Sulphur Springs/Whim Creek**

Venturex Resources has conducted a number of studies for the Sulphur Springs and Whim Creek deposits. Looks like zinc must be the flavor of the month since the Whim Creek copper project has now become the Whim Creek zinc/copper project with some additional drilling announced days ago. These deposits are located in the northern part of Western Australia not far from Port Hedland. Sulphur Springs appears to be the more promising deposit with updated reserves listed below. Project details can be found [here](#).

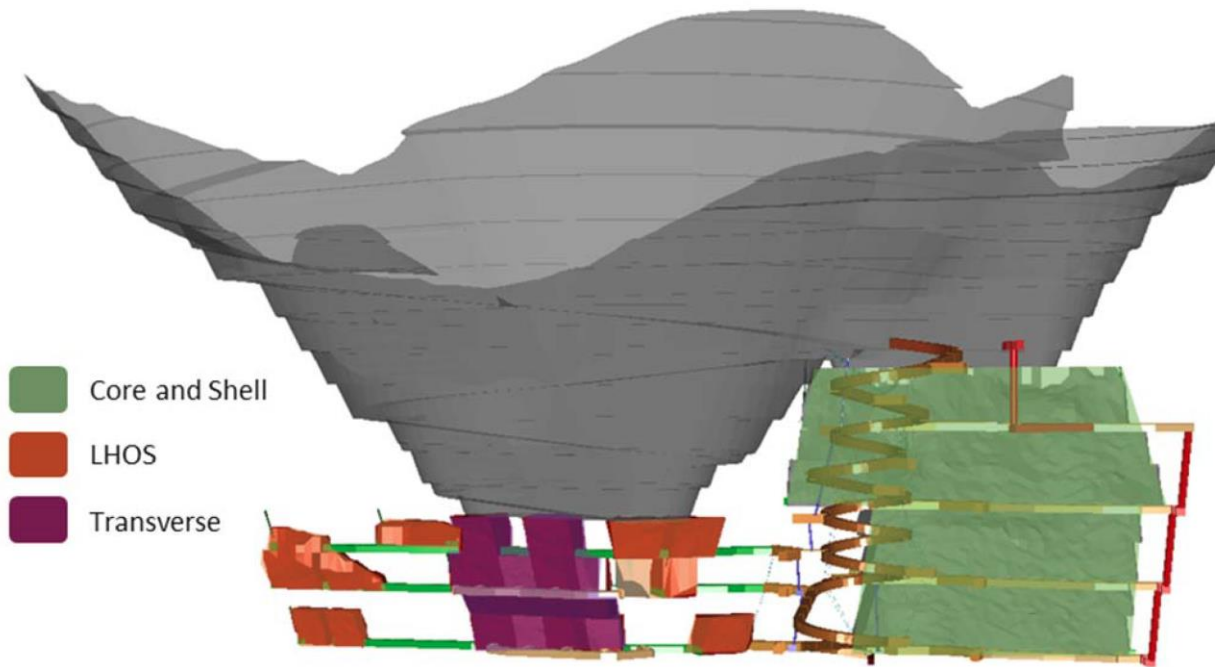


The deposit strikes me as an ideal candidate for the expression “mines are not found, they are made”. Further drilling and optimization combined with the right commodity price environment may finally put this project over the top. The capital (\$A244M) and operating cost estimates appear to be reasonable but the company states that they await higher commodity prices prior to development. Both open pit and underground mining are planned.

Annual production would be roughly 14,000 T Cu and 30,000-35,000 T Zn for eight years.



Description	Category	Tonnes '000	Cu (%)	Cu (t)	Zn (%)	Zn (t)	Ag(g/t)
Open pit	Proved	-	-	-	-	-	-
	Probable	2,930	1.3	39,000	4.2	122,000	15.8
	<b>Total<sup>1</sup></b>	<b>2,930</b>	<b>1.3</b>	<b>39,000</b>	<b>4.2</b>	<b>122,000</b>	<b>15.8</b>
Underground	Proved	-	-	-	-	-	-
	Probable	4,350	1.0	45,000	3.1	133,000	13.5
	<b>Total<sup>2</sup></b>	<b>4,350</b>	<b>1.0</b>	<b>45,000</b>	<b>3.1</b>	<b>133,000</b>	<b>13.5</b>
Total	Proved	-	-	-	-	-	-
	Probable	7,280	1.2	84,000	3.5	255,000	14.4
	<b>Total</b>	<b>7,280</b>	<b>1.2</b>	<b>84,000</b>	<b>3.5</b>	<b>255,000</b>	<b>14.4</b>



In 2015 the company attempted to sell this asset for \$A14M but the deal fell through. So their hearts may not be in mining this asset. Perhaps a JV or sale to Independence Group with the relocation and upgrading of Jaguar infrastructure once Bentley is exhausted could further enhance the project economics by reducing capital requirements.

So there you have it folks. This is about all Australia has to offer in the way of advanced new zinc projects. There is nothing here that is going to set the world abuzz.



**Brownfield Expansions**

There are only two mines in Australia that appear to have brownfield expansion potential: McArthur River and George Fisher. All other mines are fighting reserve exhaustion.

McArthur River could expand up to 5.5 MT a year with higher consequent output by both improving recoveries of zinc and making the bulk concentrate attractive for electrolytic smelters. Glencore is aware of technology that they can implement at their San Juan de Nieva and Nordenham smelters to be able to introduce this concentrate into their smelters. As far as I can tell, they have not committed to doing so (but I could be wrong). McArthur River was at one time touted as producing up to 800,000 T a year of bulk concentrate containing roughly 350,000 T of zinc. This is substantially above the output at the mine prior to the October 2015 announcement of curtailed production.

Mining at George Fisher will likely be constrained by hoisting capacity. An increase in hoisting from 4.5 MT to perhaps 5.0 MT may be possible to modestly increase output. Further improvements in the mill to raise zinc recoveries are also possible.

## Advanced Exploration

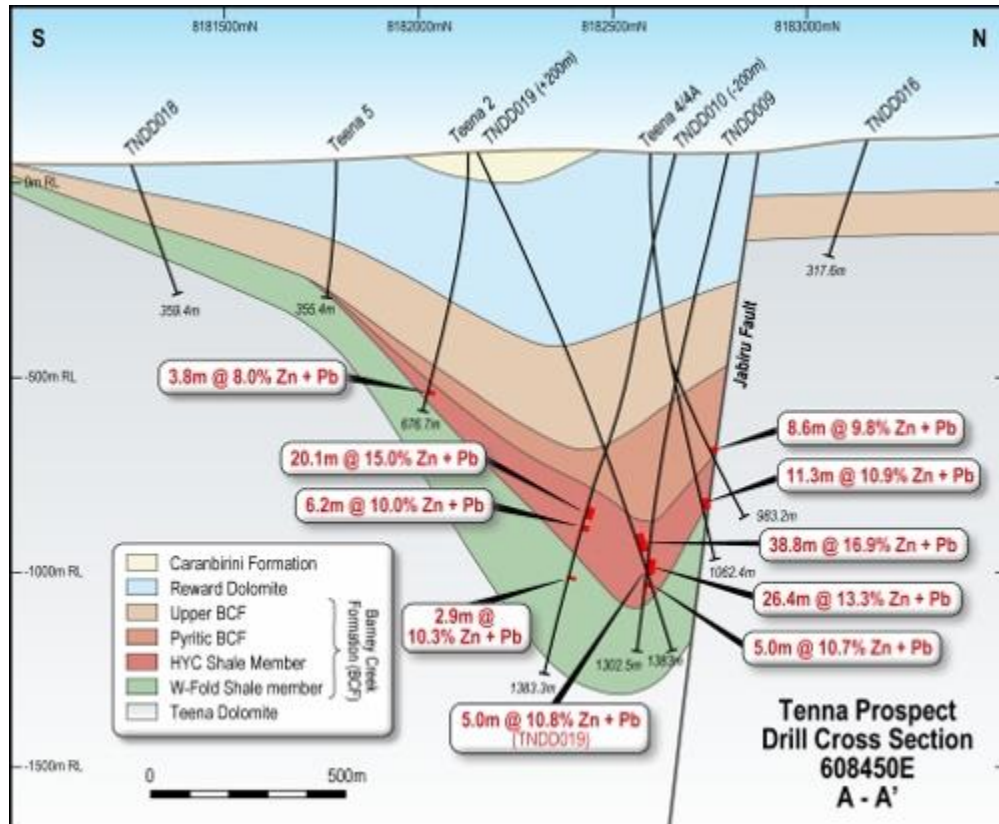
A good summary of ASX listed companies with zinc assets is provided by Rox Resources on page 25 of the presentation found [here](#).

## Teena

This deposit, adjacent to the McArthur River deposit in the Northern Territory, appears to have good potential for large scale zinc mine development. This could be a big mine, potentially a Tier 1 asset, unlike the slew of generally “ma and pa” small ramp operations prevalent in Australia today. A production rate in the order of 2 MT a year could produce in excess of 200,000 T a year of zinc for + 20 years if all the stars aligned correctly. (Remember, I’m the guy that designed the 150,000 T a year underground zinc mine 8 km away from this deposit so that statement is not promotional bullshit.) Inferred resources here are 58 MT @ 11.1% Zn and 1.6% Pb. This deposit reminds me of McArthur River or Tara in Ireland or perhaps even the Sullivan mine in BC Canada (minus the silver). With Red Dog slowly winding down, this could be Teck’s premier zinc asset with a bit of vision that they currently appear to be lacking.

Teck Resources is close to earning a 70% interest with Rox Resources holding the remaining 30%. However two weeks ago Marindi announced the acquisition of Rox’s portion for a mere \$8M [here](#). WTF? Teck are taking a very slow approach to this drilling and appraisal which is surprising for a company with a virtually empty cupboard of new projects. Has Teck lost their way and are in need of a bit of a shakeup? Most of the drilling is on wide spacing. The inferred resource drill spacing is as wide as 500 m. However, the continuity for this type of deposit is excellent as we witnessed at McArthur River. So I have no issues with the inferred resource at all.

Yes, this is a relatively deep deposit (500-1000 m) by Australian standards and would likely require a hoisting shaft to reach its full potential. The inclined conveying approach used by Newcrest in NSW and soon by Rio Tinto at Oyu Tolgoi (and indeed what I implemented for McArthur River in 1991) is another possibility. The depth is peanuts compared to most locations around the world but Australians seem to find it intimidating since they are not shaft sinkers and have become accustomed to their trucks.



If a mine plan were put together to target higher grades initially, let's call it 13% Zn and the mill can recover 80% of the zinc into a 50% grade zinc concentrate and the selling price of zinc is \$1.50/lb. in an \$A0.80 cent exchange rate environment, the revenue potential is:

T ore mined/T concentrate:  $50\% / (13\% \times 80\%) = 4.8 \text{ T}$

Revenue/T concentrate:

$50\% \times 85\% \text{ payable} \times 2204.5 \text{ lb/T} = 937 \text{ lb zinc payable}$

$937 \times \$1.50 = \$1,405 / \text{T conc.}$

Minus:

Treatment charge = \$200/ T conc.

Shipping= \$50/ T conc.

Net Smelter Return: \$1,155/T conc.

Equals \$288.75/T ore mined or \$A360/T or mined.

Site costs could be similar to Cannington at \$A120/ T ore mined leaving a healthy gross margin of \$A240/T or \$A480 M per year. What is there not to like about that?

Perhaps there is more than meets the eye here and we are not getting the full story. Could Teck and Rox be aware that there is a fatal flaw such as:

- No saleable zinc concentrate can be made?
- Excessively high rock temperatures necessitating air conditioning?

At the pace Teck is proceeding, we may never know. In my mind, if there is no fatal flaw, this is one of the best, if not the best, undeveloped zinc deposit in the world today.

Water in the area is abundant in bore fields. A natural gas pipeline is within a couple kilometers and may have the additional capacity required to use for power generation. An upgrade of this line or a parallel line (from the Alice Springs to Darwin pipe line 350 km away) is possible. Paved road access is available within a couple kilometers. A runway is available at the town of Borrolola about 50 km away or the use of the McArthur River airstrip 10 km away may be possible. Duplicating the McArthur River barging strategy from the Gulf of Carpentaria about 130 km away is possible in order to minimize concentrate haulage distance to port. In a nutshell, this one has the necessary infrastructure virtually in place.

### **Admiral Bay**

This Western Australia stratiform zinc deposit has roughly half the grade of Teena and is roughly 1 km deep. My understanding is that the rock temperature at the mining horizon is roughly 50 Celsius so an air conditioning strategy would be required here. Due to the lower grade and depth I am not going to discuss this one in any detail. This one will miss this business cycle and the next one most likely also. More information can be found [here](#) .

### **Thalanga**

This past producer still has a resource in place that could be a minor swing producer at the right commodity prices. More information can be found [here](#) .

### **Grassroots Exploration**

This is not an area of my expertise. I was however in Mt. Isa when the Century zinc, Cannington silver/lead/zinc and Ernest Henry copper/gold deposits were found in the area. These were all +100 MT deposits. It appeared to me that these deposits were discovered by using advances in geophysical exploration methods. The ability to look deeper into the rocks remotely seems to have been the key. So the question needs to be asked, what advances have been made in exploration methods in the past 25 years that can be used to look even deeper or better at the rock? If I was involved in grassroots zinc exploration in Australia, I would concentrate on the area from south of Mt. Isa through to Darwin since if you want to find tigers you look in tiger country.



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