From: [redacted]
Sent: Tuesday, 26 March 2019 1:53 PM
To: IPCN Enquiries Mailbox <ipcn@ipcn.nsw.gov.au>
Subject: RE: Vickery Extension Project: Whitehaven Coal response to IPC 5th and 7th March 2019

Dear Troy,

Thanks for that.
I understand that I can submit new material to the IPC Website in the Vickery Extension Project.
I will phone Diana later today.
In the interest of openness and transparency I would like to submit a summary paper which is very relevant to the Project. It is suitable for your website.
The article is attached.
It was published in Irrigation Australia Journal Spring 2018

Regards Ken Crawford

MANAGING THE IMPACTS OF CLIMATE CHANGE AND INFRASTRUCTURE ON THE NAMOI FLOODPLAIN: PART 2

In an article in the autumn 2018 edition of *Irrigation Australia* journal, Ken Crawford outlined the basic principles of floodplain management using the example of Gins Leap Gap on the Namoi floodplain near Gunnedah in NSW. In this article he takes this information further and examines key environmental risks to the floodplain posed by building new infrastructure such as bridges, roads and railway lines.

Gins Leap Gap railway viaduct bridge in the Boggabri area crosses at the major constriction in the Upper Namoi Valley on bedrock, which is the safest place to cross. Photo: Ken Crawford.

Balancing competing interests

This issue of development is not one that just affects the Namoi floodplain, rather there are other areas in Australia where the same risks could apply. The key message is that any proposal to build infrastructure should balance competing interests. Importantly, developing infrastructure is not just an engineering challenge, rather it must consider a range of environmental, social and economic impacts.

Development already completed in the Gins Leap Gap area illustrates this challenge well.

Gins Leap Gap, which is on the fertile Liverpool Plains, is a special area. It is recognised as a as the Seventh Wonder of the Hydrogeological World in Australia (Geoscience Australia 2015) and is an area is of national and international significance as well as being prime agricultural land. The Liverpool Plains is featured in the Australian National Museum in Canberra and has a worldwide reputation for high productivity and sustainable agriculture.

The northern area of the Liverpool Plains with the Namoi River in the foreground and Deadman's Gully carrying the main body of water in the centre. Mount Binalong in the background with its ridge running north south for photo orientation. Photo: Keith Harris.

Key risks of building infrastructure

There are three key environmental risks to the Namoi floodplain in building infrastructure, as follows:

- infrastructure location
- engineering design of the infrastructure
- impacts on groundwater recharge.

Infrastructure location. The evidence is difficult to dispute that the environmental implications of built infrastructure, such as major roads and railways, to the floodplain have been and continue to be poorly understood.

Unfortunately, shortcomings in location design often become obvious only after construction is complete. By then it may be too late. Simple considerations include the fact that railways and roads running with the flow have the least impact while those cutting across pose the greatest risk. Structures having diagonal sections and corners are problematic.

Planning can incorporate these considerations as shown by construction of the existing Gins Leap Gap railway viaduct bridge, which crosses at a narrow section of the valley. It has adequate hydraulic capacity in design and includes a safety valve in the system (see photo).

The lesson from this is that infrastructure proposals should be assessed together with all the risks. Location should not stand alone as the first step but be integrated with engineering structural design and hydraulic flood capacity. Sustainable floodplain management must include social, economic and environmental aspects. In other words, the assessment process must be holistic, integrated and multi-disciplined.

Engineering design. It is impossible to separate engineering structural design from the proposed location in any planning assessment. As an example, a proposed railway viaduct bridge of the same hydraulic capacity as the one at Gins Leap Gap but located across the main aquifer of groundwater zone 4 west has added risks, particularly to nearby irrigation bores.

As well as the risks of diversion of flow causing erosional flooding, streambank erosion and groundwater recharge affects, there is the very real risk of aquifer compaction and subsidence. The alluvial sediments are much deeper at this location and the aquifers host many high yielding irrigation bores (see figure). Compaction and subsidence results from not only the initial installation of piers using pile drivers, but also the continual vibration of heavy coal trains on the structure.

The lesson from this is that what is happening under the ground must be considered as well as what is happening at ground level.

In this area, pore space containing precious groundwater varies by about 60 to 65 per cent by volume. Infrastructure can interfere with these aquifers by reducing recharge and reducing the storage capacity of the pore space in the alluvial sediments. It happens imperceptibly over time. The continual vibration causes a 'preferred orientation' of the sediments so that they take up less space meaning that aquifers may not refill to the same extent.

Groundwater recharge. Major flooding and sideslope catchment are the two dominant sources of recharge in this area. One of the consequences of diverting flow caused by poorly located large infrastructure projects is interference with aquifer recharge. This happens because hillslope catchment runoff and deep drainage can be diverted away from intake beds on the floodplain.

As an example, the sideslope catchment of Collygra Creek has an area of 32,000 ha which incorporates more than 20 soil landscape slope and soil types and infinitely variable meteorological scenarios. Unpredictable summer storm cells in this area and complex soil landscape classifications make numerical modelling problematic. Storm cells over part or all the catchment produce unbelievable runoff events, the magnitude of which is often underestimated in models.

The lesson from this is that models cannot be the only tool relied on and that local knowledge is crucial. Local people understand the possibility of extreme flood events in the valley where they live and work. Eyewitness accounts over generations confirm that we should not be complacent. The limitations of transient numerical models must be acknowledged and the possibility of more extreme events in the future accepted.

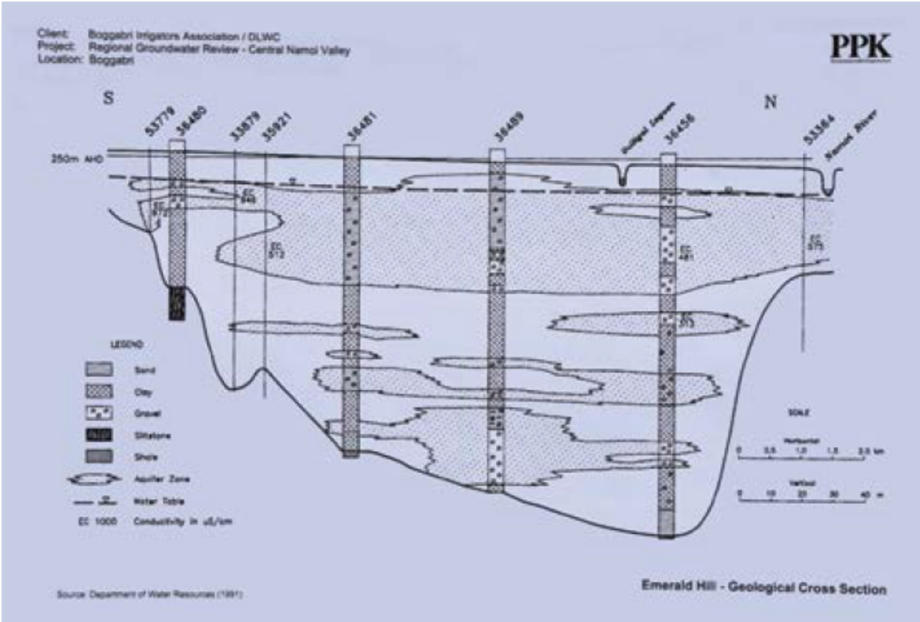

Figure. Emerald Hill geological cross-section. *Source: Boggabri Irrigators Association/DLWC Regional Groundwater Review-Central Namoi Valley PPK, Department of Water Resources (1991).*

What is the safest option?

The case study area described in this article is acknowledged as being a sensitive part of the floodplain where there is no consistent pattern of flooding. This is due to the large catchment, the variability of storm cell location and the many sources of floodwaters. Changes in flood behaviour have also been observed from flood to flood as the course of the riverbed is altered and changes occur to floodplain development.

Storm intensity and duration together with ill-defined catchments, e.g. Deadman's Gully, mean that transient numerical modelling has limitations and that cropping patterns and soil landscapes must also be considered. This makes prediction of future flood heights through modelling unreliable.

While modelling past floods can be helpful, what catchment communities are interested in is planning for the future. In this context, planning and assessment should proceed with caution with all involved being aware of possible unintended consequences after structures are built.

In this case, the safest option is to keep large infrastructure off the floodplain.

Information

Ken Crawford
[redacted]

Ken Crawford, retired hydrogeologist and former principal consultant, KLC Environmental Pty Ltd, Boggabri NSW