Impact of no flow on fish at the proposed hydro-power station site directly below Boegoeberg Dam

The project would consist of an off-take structure at the weir and a canal/ tunnel of up to 400m long (AURECON, 2013). The hydro scheme requires a flow of up to 120m^3/s when sufficient river flow is available after environmental releases. The off-take structure would consist of a predominantly concrete structure built into the riverbank 120m to 250m upstream of the existing weir wall. The tailrace canal would be approximately 100m long.

The impact of water abstraction for the proposed hydro-power station at Boegoeberg is, therefore, going to be 400m long, reaching from above the weir to below, with the tailrace and impacted area downstream of the weir expected to be 100m to 150m long.

The hydro scheme will require a flow, for operation, in excess of the current flows experienced during low flow season, implicating that the river channel directly below the weir will be dry during low flow seasons for a distance of 100-150m.

Unnatural zero flow conditions are generally undesirable for rivers as it will negatively affect the biotic integrity of the system. The biotic integrity of the area or site at Boegoeberg Weir is, however, already compromised due to the presence of the weir. The main impacts of large weirs such as at Boegoeberg are mainly flow regulation, upstream inundation, in-stream habitat loss, and the loss of migration of fish further upstream. The most important habitat which will be impacted below the weir is the rapid and riffle habitat with rocky substrate.

The rapids below the dam wall are, however, not unique to the reach and rapids and cobble beds also occur further downstream, but the loss of spawning habitat below the dam will have a negative impact on the spawning success of the fish in this reach, and these types of habitats need to be protected as they become less and less due to the impact of dams (inundation) and water abstraction from our rivers.

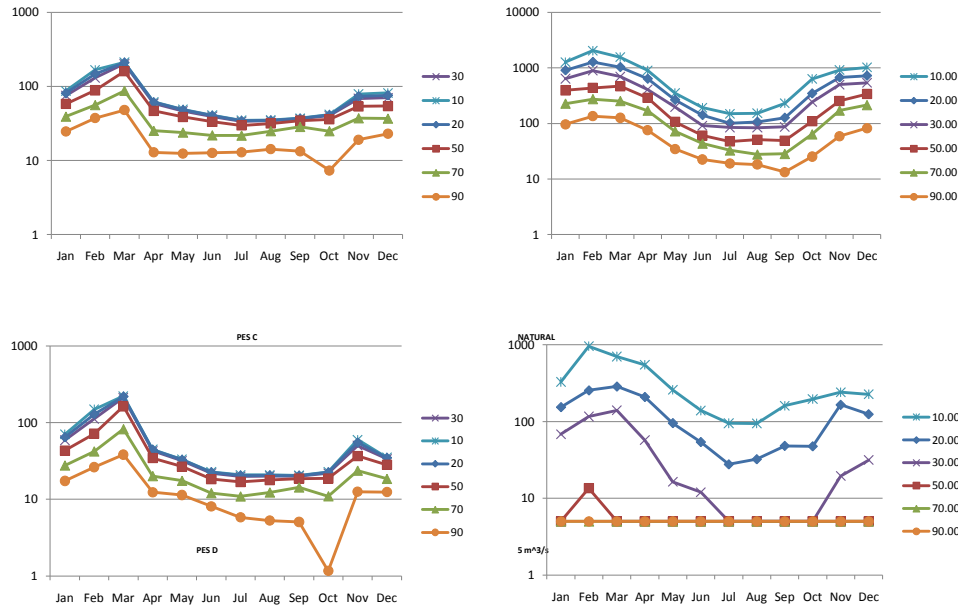
The area directly below the weir is, therefore, mainly of importance in terms of spawning for fish and habitat for stream loving aquatic species including fish species such as yellowfish.

The loss of flow in the rapids directly below the dam wall will, however, only be of high significance for the immediate site (i.e. at the dam wall), but of lower significance to the reach.

Other habitats that occur below the dam wall such as the slow deep channels with marginal vegetation in the mid- and right-hand sections of the river will also be affected, but is of lesser importance as it is utilised to a lesser extent by fish. These habitats are also more abundant throughout the system (Kotze and Koekemoer, 2010)

The impact of no flow at the site is considered to be low as a relatively short length of river (100-150m) will be affected, during low flow seasons/periods.

The main criterion for fish at the site is that there should be enough flow during high flow season over the weir to facilitate spawning in the rapid and rocky habitat below the weir (see box below for comparison of flow scenarios).



Box 1. Comparison of flow scenarios: top left – PES C; top right – Natural; bottom left – PES D; bottom right – 5m^3/s.

The river below the dam wall was divided into three channels during the survey: A right-hand channel which consisted mostly of slow deep and shallow habitat with sandy bottom substrate; and a middle and left-hand channel with rocky rapid and riffle habitat. The right-hand and middle channels are of less importance in terms of fish as the habitat diversity is low with minimal cover. The left-hand channel is of higher importance due to various flow depth classes being present as well as ample cover in terms of rocks and water column.

Figure 1 indicates the habitat in the left-hand channel downstream from the dam wall which will be affected by the proposed development. This habitat will be dry during low flow season.

Figure 1: Downstream view of dominant habitat of left-hand channel at and below the site.

Figure 2 shows the right-hand channel of the river below the dam wall consisting of slow shallow and slow deep sandy habitat. Very little cover is present at these habitats.

Figure 2: Dominant habitat of right-hand channel at site.

Figures 3 and 4 show the habitat directly below the dam wall on left of the main river channel that will be affected and laid dry during low flows.

Figure 3: Main habitat section below dam expected to be dry or lost during low flow periods.

Figure 4: Main section of habitat on left-hand of river below dam expected to be dry or lost.

The flow was measured to be 42m^3/s further downstream from the site at the time of the survey. There are, however, two channels within the reach between the Boegoeberg Weir and the gauging station, which supplement the flow in the Orange River from an irrigation channel that flows parallel to the river on the left bank. One of these channels (upper channel) delivers approximately 5m^3/s to the river. The outlet of this channel falls within the lower reaches of the affected area, which means that this additional inflow will help mitigate the effects of the proposed water abstraction. This channel should maintain fish and fish habitats in this area within the deeper sections of the main river and its deeper pools during low flow periods.

Both the channels from the irrigation channel have adequate and even fast flow with ample habitat and cover in terms of water column and rocky substrate. Overhanging vegetation is also abundant. These two channels are, therefore, of importance as they provide additional habitat for fish and flow to the main river.

When the above is taken into account it can be reasoned that the flow over the Boegoeberg Dam wall was approximately 30m^3/s at the time of the survey. If this flow is spread between the three channels identified within the main channel below the weir, it can be estimated that there was a flow of approximately 10m^3/s per channel. It was observed during the survey that half of the observed flow should be adequate to maintain the river during low flows. This calculates to 5m^3/s per channel (i.e. 15m^3/s for the three channels combined within the main

stream). The flow of the upper supplementing channel from the irrigation channel falling within the affected reach will, therefore, be of high importance to the site as it will provide flow to the left-hand channel which was identified as the most important section of the river within the development area.

Figure 5 indicates the upper channel falling within the development area. The channel has a fast deep flowing stream with ample cover for fish (water column, rocks, and vegetation overhang). These channels are important as they provide additional habitat for fish.

Figure 5: Fast flow from the upper irrigation canal to the main river in impacted area of site.

Figure 6: General habitat characteristics of the stream channels fed from the irrigation channel feeding into the Orange River.

Figure 6 shows the general habitat of the lower channel flowing from the irrigation canal into the Orange River. Rocky substrate (rocks, cobbles, and gravel) seems to be dominant (Figure 7), and is also the preferred habitat of the more sensitive species.

The additional habitat created by these side channels from the irrigation canal are important and will help with the mitigation of the upstream impacts from the proposed development.

Figure 7: Substrate in the side channels in area and downstream of site.

General Discussion:

The area below the Boegoeberg Weir is mainly important in terms of spawning for fish. It is, however, expected that there would be enough flow over the weir during floods (high flow season) to facilitate spawning.

The supplementing flows (two channels observed) from the irrigation canal will help mitigate effects (no flow) from the proposed development. These channels also provide the preferred habitat for the more sensitive species.

It will be preferable (and recommended) if the flows from the side channels from the irrigation canal can be maintained.

The affected reach (100m) is relatively short if the extent of the development and the size of the Orange River are taken into account. The impact can, therefore, be seen as low for the reach.

The advantages of the development seem to outweigh the disadvantages to the system, but it is important to note that from a conservation point of view the development and the effect of total loss of flow still remain undesirable to the natural area and ecosystem.

It is still recommended that some flow, if possible, is released to help maintain the area below the weir especially the left-hand channel in the mainstream.

The tailrace from the hydro power scheme may also provide new habitat for fish as it will most probably flush sand and sediment from the right-hand channel creating new rocky substrate for fish. In addition constructed cobble beds will provide additional fish habitat and serve to mitigate other losses.

It is highly likely the there will be reed encroachment is the impacted section.

References:

AURECON. 2013. Proposed hydropower station and associated infrastructure at Boegoeberg dam on the Orange River, near Groblershoop, Northern Cape: Final Scoping Report. Report No. 8182 /109626.

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