INSTALLATION AND COMMISSIONING OF THE AMANZIFLOW AUTOMATIC SCOUR GATE IN THE NECKARTAL ABSTRACTION WEIR ON THE FISH RIVER, NAMIBIA.

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ABSTRACT

The incorporation of automatic scour gates to remove sediment from abstraction points in dams and weirs has become even more important given the changes in rainfall intensity. It is important to scour abstraction points to protect pump impellers from damage due to suspended sediment. Offtake infrastructure must also be protected from sedimentation and it is important to allow sediment to pass through these structures across rivers in order to preserve the downstream ecology and prevent degradation of the riverbed directly downstream of weirs and dams.

The design of the offtake structure and scour channel at the Neckartal abstraction weir is suitable to allow for the efficient automatic operation of the Amanziflow scour gate. The scour gate installed at this abstraction weir will operate automatically during flood events when water is available for scouring of the abstraction channel. This is vital in an arid area with low rainfall where water is a valuable resource. The gate can be manually operated during periods when water is available for flushing of the abstraction channel and scour tunnel. This paper will explain the reasons why such scour gates should be installed to mitigate the effects of sedimentation of our dams, weirs and offtake points.

1. INTRODUCTION

The Neckartal dam is constructed on the Fish River in Namibia, approximately 35 km west of Keetmanshoop. It is an 80m high RCC dam. Water is released through electricity producing turbines to an abstraction weir some 21 km downstream, where water is to be abstracted and pumped for irrigation purpose for the Namibian Ministry of Agriculture,Water and Forestry. Being an arid country with little vegetation cover, sediment was a concern at the abstraction weir.

The designers of the project, Messrs Knight Piesold, Consulting Engineers required a scour gate that would effectively keep the entrance to the abstraction works essentially free of gravel and sand but also that it must be automatic without any electrical or mechanical means to operate it. Operator intervention could not be relied upon to open the gate when required and hence the automatic scour gate by Amanziflow Projects was specified based on previous recommendations of a large scour gate operating at Matsoku on the Lesotho Highlands Water scheme. The scour gate is effective in minimizing sediment accumulation because it opens automatically as the water level rises due to an incoming flood and passes the sediment, both in suspension and rolling on the river bed, though the scour tunnel and downstream. Once sediment is allowed to settle it consolidates and is then difficult to flush out with standard sluice gates. Once the water level recedes, the scour gate will close automatically to retain the full supply level (FSL) in the weir. The operation and advantages of the scour gate is given in more details in papers presented by PD Townshend[1] and JF von Holdt[2].

The scour gate comprises a radial closure plate which closes off a scour tunnel 4m wide and 2.3m high and under 6m head of water. The radial closure plate is fixed to a buoyancy tank which rotates about upstream axles with pivot arms. When the water level rises to a pre-set level, water flows into the gate chamber to open the gate and when the upstream water recedes, water stops flowing into the gate chamber and water is drained out of the chamber through outlet pipes to lower the water level in the gate chamber and the scour gate then closes slowly to retain the FSL. An animation of operation of the scour gate can be viewed on our website www.amanziflow.com.

The gate was fabricated and corrosion protected by Messrs VIC Engineering Group in Vereeniging. The gate weighs 15 tonnes. It was assembled complete in the workshop with the seal frame and tracked up and down to check for clearances. The fabrication was complete and transported to site in March 2017 but only installed in March 2018.

2. BASIC OVERVIEW OF AUTOMATIC SCOUR GATE

2.1 Design and hydraulic parameters

- Scour tunnel invert level D/stream 705.50 masl
- 1:15 sloped Gravel trap channel 707.01 masl
- Overflow weir level 708.60 masl
- Sand trap offtake level 708.84 masl
- FSL of abstraction weir 710.00 masl
- 6 baffled inlets invert level 710.90 masl
- 1:1 Year flood level Q=164 m3/s 711.00 masl
- 300 NB Emergency inlet level 712.50 masl
- 1:10 year Flood level, Q = 2433 m3/s 713.50 masl
- 1:100 year Design flood level, Q = 7167m3/s 717.30 masl

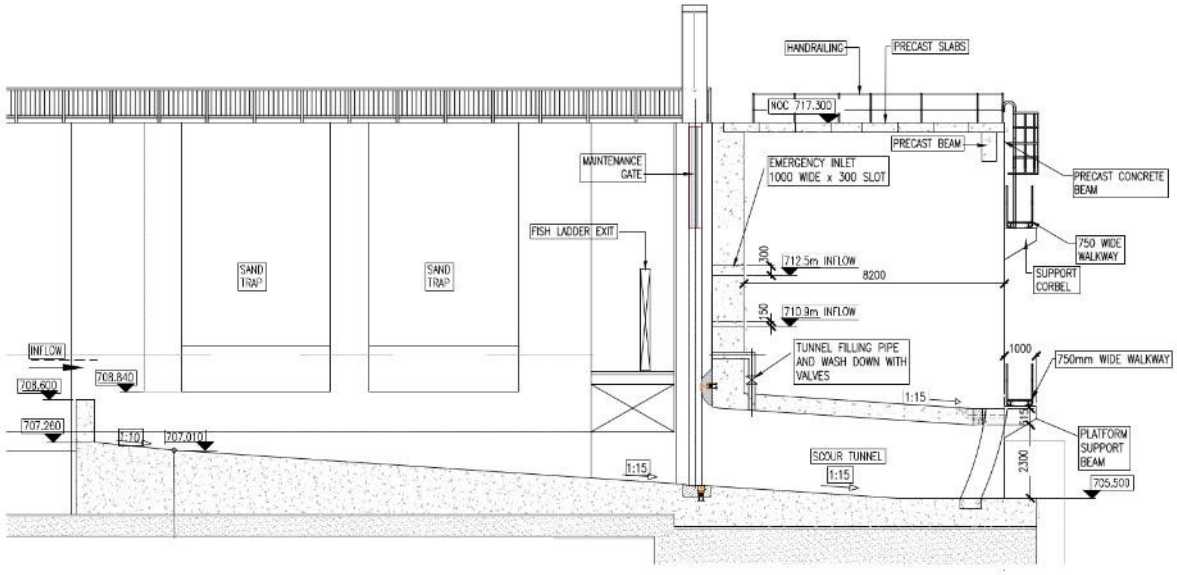

Figure 1. Section of overflow weir and scour channel

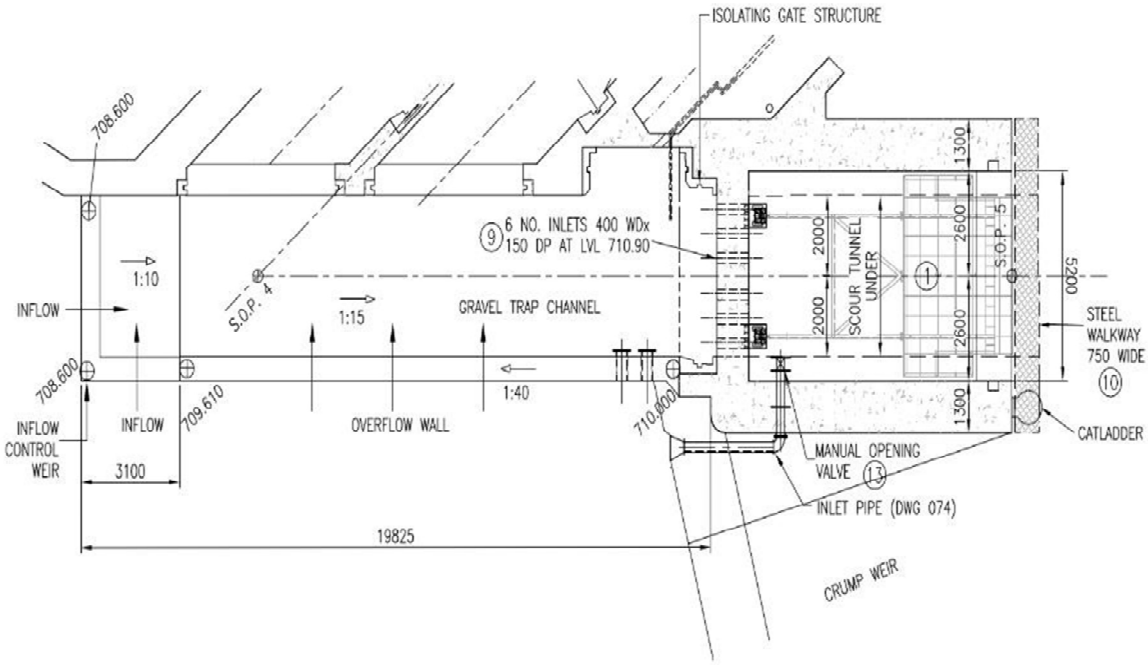

Figure 2. Plan view of overflow weir, scour channel and tunnel

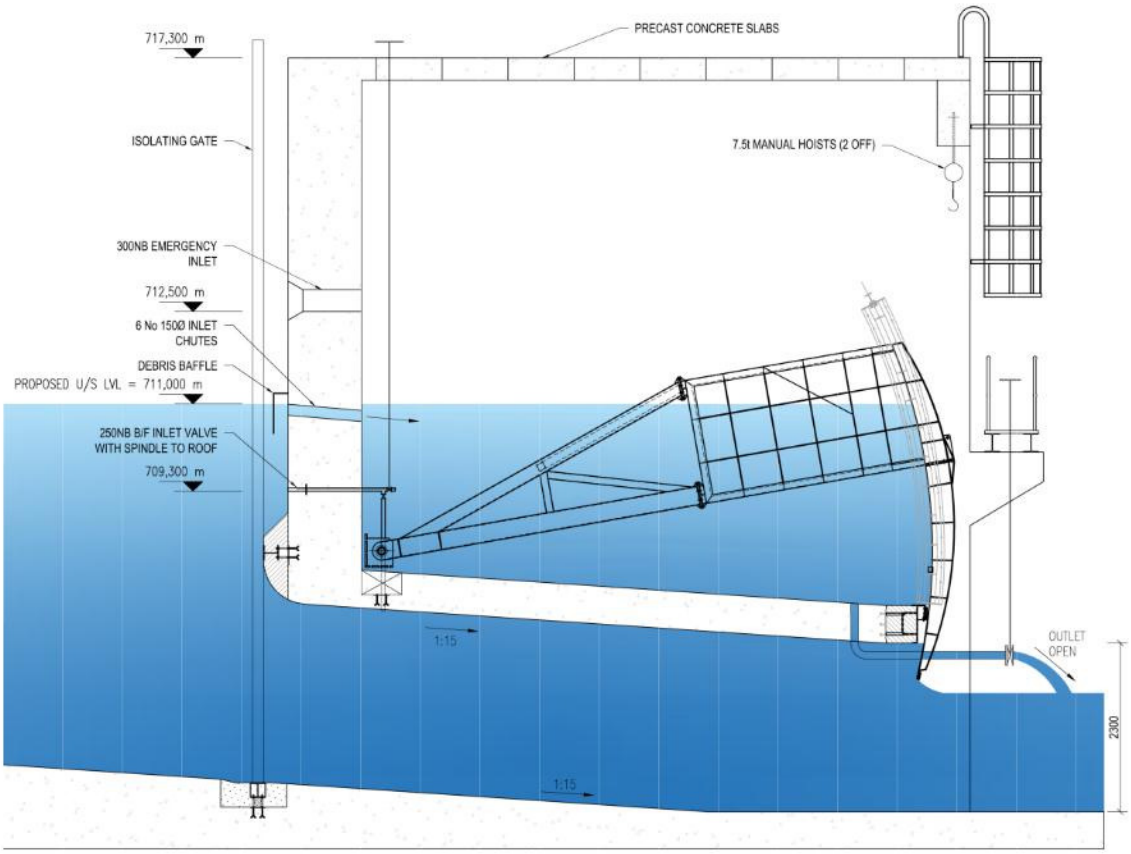

Figure 3. Gate opening automatically 1:1 Year flood

- The scour gate should open automatically when the upstream water level reaches the 1:1 year flood level of 711m when water flows through 6 baffled openings into the buoyancy chamber causing the fixed buoyancy tank of the gate to float into its open position and the gate closes automatically once the water level drops below this level and water drains from the buoyancy chamber via the two 100NB openings.
- During normal conditions the scour gate should remain closed as water is diverted into the scour channel over the inlet weir wall and through the trash screens into the sand trap channels to the pump abstraction point. The screens can be seen in Figure 5 below. Please bear in mind that this image was taken prior to completion and a temporary brick wall was used to raise the intake weir wall to prevent water damage to incomplete works on the fish ladder.
- The gate can be manually actuated if required from a safe position above the gate chamber to flush gravel and sediment from the scour channel and tunnel.
- The high velocity discharge from the scour tunnel induces a scouring action in the sloping approach channel and this removes the sediment and gravel from the intake forebay.
- The closure plate and seals must seal off the scour tunnel and the seals must not leak excessively in the closed position.
- The automatic scour gate must operate automatically without reliance on electric supply nor an operator and keep the scour channel free of gravel and silt build up.
- The scour channel is separated from the abstraction weir by a wall preventing the heavier sediment from entering the abstraction point.

Figure 4. Downstream view of scour gate and abstraction weir

Figure 5. View of upstream scour channel with sand trap offtakes

2.2 Components of the scour gate

Some of the components mentioned below can be seen in Figure 6 from a photo taken from the upper walkway:

Self-lubricating axle units cast into the buoyancy chamber floor.

- Pivot arms connected to the axle units and the fixed buoyancy tank.
- Side closure plates to retain water in buoyancy chamber.
- Fixed buoyancy tank supporting closure plate.
- Curved closure plate to close scour tunnel bolted to underside of buoyancy tank.
- Cast in tunnel filling pipe and tunnel vent pipe for filling the scour tunnel after maintenance.
- Manual weir inlet pipe with 250NB butterfly valve and spindle for manual operation.

The rest of the components are as follows:

- Lintel, side and sill seal frame with solid, hump and piano note seals.
- Access walkways, cat ladders and mechanical hoists.
- Baffle plates to inlet openings in upstream wall.
- Two drain pipes from buoyancy chamber fitted with 100NB b/fly valves with spindles.

Figure 6. View of buoyancy chamber during manual opening operation

Figure 7 below shows the scour gate on the shop floor at VIC Steel after fabrication during tracking.

Figure 7. Scour gate at VIC Steel during testing.

2.3 Materials

- The gate and side closure plates are fabricated in 3CR12, a material with good corrosion protection properties for exposed and occasional water submergence. The surface is coated with a good quality twin pack epoxy coating
- The water face of the scour tunnel closure plate is stainless steel grade 314 with a good corrosion protection system with strong abrasion resistance.
- The 3CR12 material was selected as it less expensive than stainless steel and because the 3CR12 components are accessible for recoating if necessary. The whole gate can be

isolated by and upstream isolating gate and the gate can be removed if absolutely necessary, although highly unlikely.

- All cast in items such as the seal frame and inlet puddle pipes are in stainless steel grade 316, as they are permanent and cannot be removed later.
- The seals are natural rubber shore hardness 60 with an applied layer of low friction PTFE to reduce the seal friction force required to open the gate.

2.4 Installation procedure

Figure 8 below shows the work site prior to the installation of the scour gate into the abstraction weir structure. The sequence of installation and completion is as follows:

- Main contractor to cast in plates and leave box outs in structure during primary concrete.
- Delivery of fabricated components onto site.
- Staged installation of components to suite main construction programme.
    - Install lower walkway for safe working platform
    - Install closure plate into box outs in tunnel walls and floor.
    - Align and weld adjustment brackets onto closure plate seal frame.
    - Install buoyancy tank and bolt onto closure plate.
    - Install pivot arms with axle units attached into box outs provided, bolt pivot arms to buoyancy tank.
    - Adjust axle unit adjustment brackets and align gate lintel, side and sill seals, release seal frame from closure plate.
    - Install overhead concrete beam to support manual hoists and upper walkway.
    - Use manual hoists to track gate open and closed in order to check alignment of seals. Once satisfied call for dry commissioning.
- Dry commissioning of gate to test alignment and tracking of gate against seals.
- Second stage concrete by main contractor. Cast concrete into all box outs and make good.
- Cleaning and preparation for wet commissioning of gate.
- Manual operation of gate under controlled conditions.

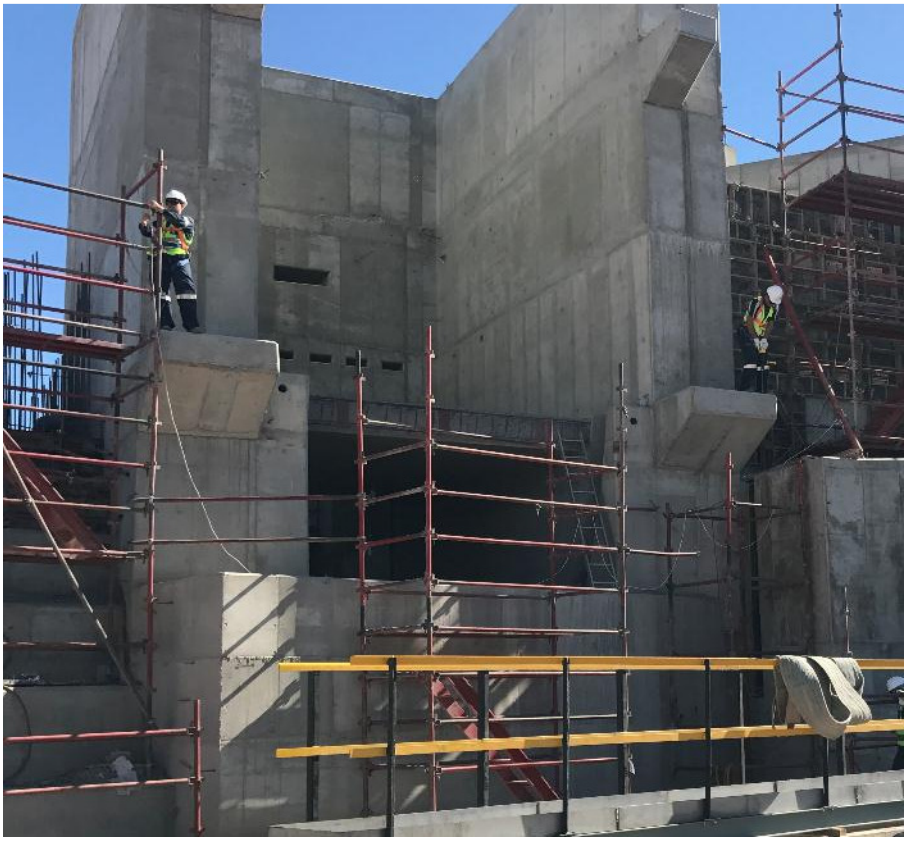

Figure 8. Structure prior to installation of gate components and access

3. IMPORTANT DETAILS FOR A SUCCESSFUL INSTALLATION

Table 1. Considerations for simple installation of scour gate

Cast in plates	Cast in plates for incorporation into primary structure should be the full length of the recess.	
Box outs	Box outs in primary structure should be generous, in order for access for welding and adjustment of brackets.	
Adjustment brackets	Should be of sound construction and large diameter coarse threaded bar used for ease of adjustment.	See above.
Bolt hole sizing	Paint thickness to be taken into account when sizing bolt holes and axle shafts.	

Seal frame and seals.	Seals to be shop fitted and seal frames to be fitted to closure plate to ensure no damage during transport and installation.	
Bolt schedules	Bolt schedules and lists of smaller items need to be double checked and packed prior to dispatch to site.	
Base plate drillings	Base plate and connection plate drillings to concrete should be suitably sized for fasteners. Most suitable concrete drills have bits larger than 12 mm.	
Fasteners	All fasteners must comply with material specifications.	

Table 2. Planning and communication with main contractor

Safe access	Prior to mobilisation to site, safe access should be provided for installation team.	
Crane reach and loading.	The individual component weights should be supplied to contractor in order to arrange correct crane size.	
Rigger	Experienced rigger required.	The correct and safe attachment and choice of slings and chains for each component is required.
Installation program.	Liase with main contractor.	The installation should suite the main contractor's construction program.
Work space.	Shaded space with table and chairs required on site.	

4. CASE STUDIES AND CONCLUSION

It is possible that where the approach to a weir is relatively flat that large debris could become tangled and jammed in the scour gate. For instance a log could become jammed under the sill seal as the gate closes automatically after a flood event. If this happens the gate can be raised to its fully open position using the two manual hoists kept in position above the scour gate. Once the gate is raised the log could be removed and the gate lowered again into its closed position. We have had a log jammed under a scour gate at the Tswasa weir on the Groot Marico river but this was flushed from under the gate by manually flooding the buoyancy chamber causing the scour gate to open sufficiently to flush the log out of the scour tunnel.

The Amanziflow automatic scour gate was specified because it was best suited for this application at the abstraction weir to effectively keep the abstraction points relatively free of gravel and sand. The gate is totally automatic to open and close when required and does not require operator intervention. An animation of operation of the scour gate can be viewed on our website www.amanziflow.com.

The gate was installed in a short space of time given correct planning and preparation prior to mobilization on site. But as with all installations challenges could arise. Inspections done during the fabrication phase on the shop floor which includes a full gate assembly and rotation in the workshop, testing at key hold points and clear communication with the main contractor are all key factors ensuring a neat and accurate installation. The scour gate is now fully operational to effectively keep the scour channel to the abstraction works free of gravel and sediment.

5. ACKNOWLEDGEMENTS

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- The Namibian Ministry Agriculture, Water and Forestry.
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- VIC Steel Vereeniging.

6. REFERENCES

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