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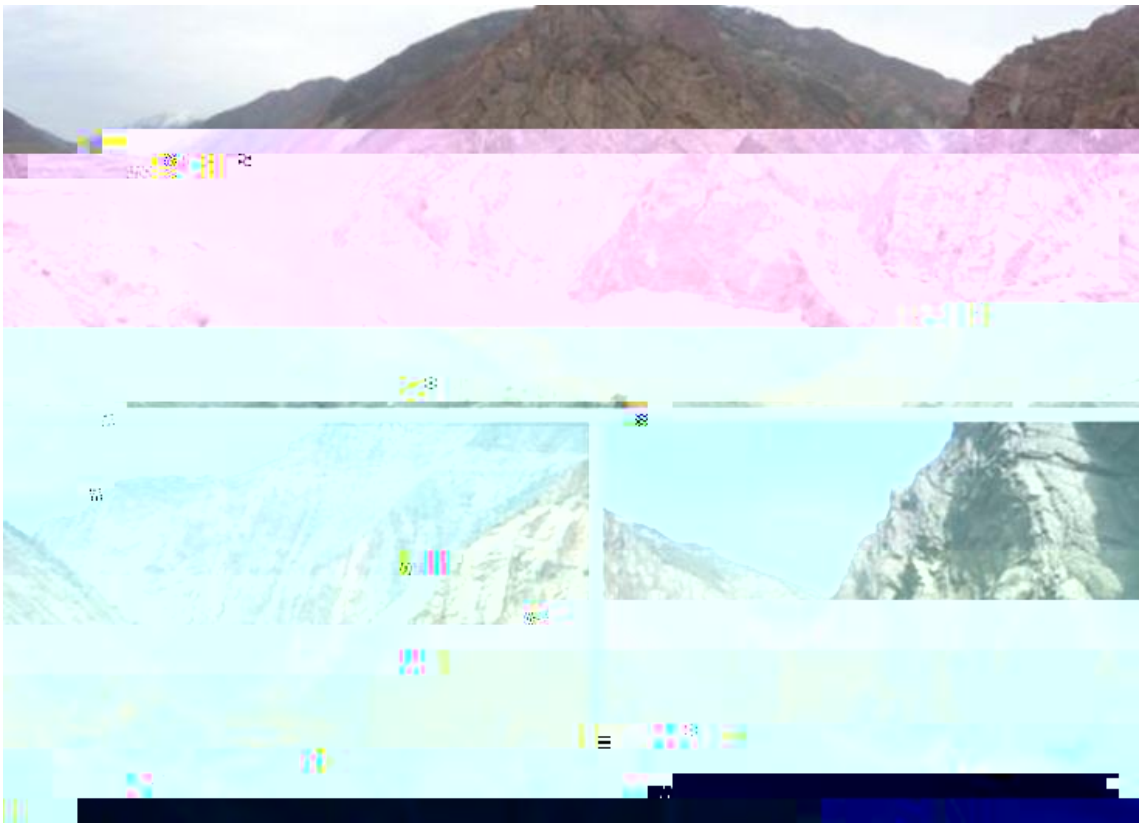

Phase 0 Report – Geological and Geotechnical Investigation of the Salt Wedge in the Dam Foundation and Reservoir

Summary

CONTENTS

1 OBJECTIVES OF THE REPORT

The Phase 0 Report examines the potential impact on dam safety of the wedge of salt that exists along the Ionakhsh Fault, which cuts across the Rogun dam site in a roughly NE-SW direction, in the upstream part of the dam axis (cf. Figure 1-1).

Figure 1-1: Dam site geological map with Ionakhsh Fault and other main faults; limits of Stage 1 dam are highlighted (in blue), limits of final dam (in black) for the El. 1290 Full Supply Level Alternative

The geometry of the salt body within the Ionakhsh Fault has been extensively investigated since the first studies were conducted on the proposed Rogun project. The investigations have shown that the salt body has a wedge shape, the top of which, at the maximum elevation, has a variable width from 1.5-2 m within the left bank to up to 12 m within the right bank. The thickness of the salt wedge increases with depth, with an average 15 m increase every 100 m depth.

2 SCOPE OF THE ANALYSES PERFORMED

A thorough analysis of the hydrogeological phenomena has been carried out, and the existing

4.2 Geometry and characteristics of Ionakhsh Fault

The model developed for the analysis is based on a thorough evaluation of all documentation available since the original 1978 design and up to 2012, when a new pumping dissolution test was conducted by the TEAS Consultants. This gives an accurate location and

- Implementation of a hydraulic barrier, which consists of a series of holes on the downstream side of the salt wedge to maintain the reservoir pressure, so as to minimise the water gradient between the two sides of the salt wedge.

The following scenarios were therefore analysed:

- Existing conditions prior to any mitigation work, for the model calibration based on an observed natural equilibrium between salt dissolution and salt wedge rising;

- The “No remedial measures” option after the construction of the Stage 1 dam, *i.e. no mitigation measures is implemented*.

- Each of the following mitigation measures implemented for the three different dam height alternatives:

  Grouting of the cap alone;

  Reduced efficiency of the grouting of the cap alone (i.e. long term loss of efficiency of grouting);

  Hydraulic barrier alone;

  Hydraulic barrier and cap grouting;

  Hydraulic barrier and reduced efficiency of the cap grouting.

In all cases, the size of the generated cavity is always less than 3 m, or the salt wedge penetrates the dam body.

The consequences of the salt wedge penetrating the dam body are negligible. The dam fill above the Ionakhsh Fault has a porosity of about 10%. The salt intrusion will happen very slowly; it will begin to fill the voids in the dam body and be dissolved by the impounded water in the upstream part of the dam fill until a new equilibrium is reached. In the worst case, this new equilibrium will be a return back to the initial conditions, which would be controlled by the proposed mitigation measures.
One specific “worst case” scenario has been studied: considering reduced hydraulic barrier efficiency, reduced efficiency of the grouting and loss of clay coating of the salt wedge, for a 40-year delay in construction after the Stage 1 dam. In this case, the cavity generation might exceed 5 m.

There is no significant groundwater gradient difference at the salt wedge for the three dam alternatives for Stage 2.

6 MAIN MODEL CONCLUSIONS

The conclusions arrived at from the various analysesBT1 0 0 1 91.224 204-3(i)5(n)13(g)-8( )-232((se)-3e

8 CONCLUSIONS

From these assumptions and the TEAS Consultants' models, it is clear that both efficient grouting and an efficient hydraulic barrier are necessary to prevent excessive salt dissolution. Both mitigation measures are required to cover the risk that one of the two mitigation measures might lose part of their effectiveness.

Even if the results of the analysis show that an efficient hydraulic barrier alone, or efficient grouting alone would be acceptable, both of these two mitigation measures should remain operational throughout the lifetime of the dam.

In order to check the efficiency of the design mitigation measures, adequate monitoring is required, so that timely remedial measures can be implemented as soon as possible. Detailed monitoring measures have been proposed.

With the implementation of the hydraulic and grouting barriers, the related monitoring system, and the design of feasible remedial works in case of the loss of efficiency of the mitigation measures, the Consultants conclude that these measures are sufficient to ensure that the dissolution potential of the salt wedge does not affect the safety of the proposed dam.