A Deep-Dive, Forensic Analysis into the Wells Dam East Embankment Design and Construction History to Address Ongoing Internal Erosion and Seismic Stability Concerns

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Wells Dam, owned and operated by the Douglas County PUD, is an 840 megawatt hydroelectric development on the Columbia River near Chelan, Washington. The dam consists of east and west embankments flanking a unique integrated spillway and powerhouse structure called a ‘hydrocombine’. The hydrocombine encompasses ten generating units and 11 leaf gates, alternating side-by-side across the river channel. The dam commenced commercial operation in 1967. The west embankment and the hydrocombine were completed entirely in the dry. In contrast, the east embankment was constructed partially in the Columbia River channel as an underwater hydraulic fill dam, and, once the river was successfully diverted through the hydrocombine unit, as a more conventional zoned embankment resting on the hydraulic fill foundation. A series of sinkholes developed along the crest following first filling and later, and, in 1990, a nearly 1000-foot long, 250-foot high concrete diaphragm wall was installed along the centerline of the embankment to forestall additional internal erosion. The wall effectively terminated further sinkhole development, although gaps along the base and at both ends of the wall still raise concerns with respect to internal erosion. With the recent better understanding of seismic risk in the Pacific Northwest, seismic stability concerns were raised at the project, especially with regard to liquefaction of the hydraulic fill foundation, leading to slumping and deformation of the dam shells, exposure and failure of the diaphragm wall, and overtopping of the structure. A deep-dive forensic analysis of the construction history and material properties of the hydraulic fill portion of the dam is ongoing, including field investigations, laboratory testing, and development of a detailed, electronic 3D model of the dam, which provides a visual and systematic re-construction of the history and sequence of river diversion and dam construction and performance, including material sources and gradations, placement techniques, sinkhole development, remedial activities and current investigation and instrumentation data. The 3D model was used extensively during recent activities, including a Part 12D Inspection, a PFMA workshop, a semi-quantitative risk assessment (SQRA), and, most recently, presentations and discussions with our expert Board of Consultants and the FERC. All participants lauded the value of the 3D model for effectively visualizing the important details of the complex design and construction history of the east embankment, as well as integrating results of more recent investigations and instrumentation data. The path forward includes a thorough assessment of liquefaction potentials, filter compatibility analyses, updated seismic risk and ground motion studies, and study of remedial alternatives.