= Disi Water Conveyance Project =

The Disi Water Conveyance Project is a water supply project in Jordan . It is designed to pump 100 @,@ 000 @,@ 000 cubic metres (2 @.@ 2 × 1010 imp gal) of water per year from the Disi aquifer , which lies beneath the desert in southern Jordan and northwestern Saudi Arabia . The water is piped to the capital , Amman , and other cities to meet increased demand . Construction began in 2009 and was mostly completed in July 2013 when the project was inaugurated by King Abdullah of Jordan . Its total cost was USD 1 @.@ 1 billion . An independent study revealed the water to be radioactive and potentially dangerous to drink , surrounding the project with controversy . Jordan 's Ministry of Water and Irrigation has stated that the radioactivity is not a problem because the water is to be diluted with an equal amount of water from other sources , although it remains disputed if this would be enough to bring the water up to standards . The Ministry said the independent study was inaccurate , as it did not test water from any of the wells that will be used in the project . The President of the Jordanian Geologists Association Bahjat Al Adwan stated that the radiation is present in the water in the form of Radon , and thus dissipates harmlessly when the water is exposed to air on the surface .

= = Background = =

The water in the Disi aquifer gathered 30 @,@ 000 years ago during the Pleistocene era . It is 320 kilometres (200 mi) long and located 500 metres (1 @,@ 600 ft) below ground inside of porous sandstone . The aquifer is classified as a fossil aquifer , meaning that the water is not replenished if it is removed . In fact , the aquifer has a recharge rate of 50 @,@ 000 @,@ 000 m3 (1 @.@ 1 × 1010 imp gal) of water per year . This recharge is dwarfed , however , by the current extraction rate of 90 @,@ 000 @,@ 000 m3 (2 @.@ 0 × 1010 imp gal) for agricultural and domestic needs , including 15 @,@ 000 @,@ 000 m3 (3 @.@ 3 × 109 imp gal) of water that is supplied to Aqaba , Jordan . The current extraction rate of 90 @,@ 000 @,@ 000 m3 (2 @.@ 0 × 1010 imp gal) , coupled with the future extraction rate of 100 @,@ 000 @,@ 000 m3 (2 @.@ 2 × 1010 imp gal) for the project , is expected to produce a total extraction rate of 190 @,@ 000 @,@ 000 m3 (4 @.@ 2 × 1010 imp gal) . At that rate , the water in the aquifer will last a minimum of 50 years , according to the Disi Water Company .

Only a small portion of the Disi aquifer lies beneath Jordan , while the majority lies beneath Saudi Arabia . Saudi Arabia also extracts water from the aquifer (called the Saq aquifer in Saudi Arabia) . The aquifer has created controversy between Saudi Arabia and Jordan , with each country demanding the other to use less of the shared water . There is no formal agreement between the countries regarding the water and the Disi Water Conveyance Project is being constructed without Saudi consultation or involvement .

Non @-@ revenue water is a serious problem in Amman . Currently , 40 % of water in Amman is lost as non @-@ revenue water . The city rations water , with individual residents averaging 36 hours of water access weekly . If the non @-@ revenue water problem remains , it is possible that a large portion of the water provided by the Disi Water Conveyance project will also be lost as it is piped through Amman .

The Disi Water Conveyance project was first proposed in the 1990s , but was initially regarded as too expensive . A feasibility study was completed in 1996 . But it was not until 2007 that the Jordanian Government was able to contract a firm to begin construction .

= = Design = =

The project proposed by the Jordanian government will pump 100 @,@ 000 @,@ 000 m3 (2 @.@ 2 × 1010 imp gal) of water per year from 55 wells in the aquifer . However , a total of 64 wells will be drilled , the extra wells to be used as piezometers to measure the elevation of the water . Nine of the 55 water producing wells will be used in emergencies only . The wells producing water will be drilled 600 ? 700 m (2 @,@ 000 ? 2 @,@ 300 ft) deep while the piezometers will be drilled to a

depth of 400 m (1 @,@ 300 ft) . The plan is to pump the piezometer wells for 25 years , according to the project leader .

After being pumped from the wells , water will then be transported to Amman , via a 325 km (202 mi) pipeline , passing through a pumping station , then flowing by gravity and being pumped up again . The reservoirs near Amman are only 200 m (660 ft) higher than the surface area where the pumping field is located . Nevertheless , the total elevation differential over which water needs to be lifted by both pumping stations is about 800 metres (2 @,@ 600 ft) . To pump the water through the proposed pipeline will require 4 kilowatt @-@ hours per cubic meter of water . The entire project would require approximately 4 percent of Jordan 's current electrical production . The project is expected to be completed by January 2017 and to run for 25 years or until the Two Seas Canal is built .

The 100 @,@ 000 @,@ 000 m3 (2 @.@ 2 × 1010 imp gal) of water will be divided between the Abu Alanda reservoir and the Dabouq reservoir . Approximately 40 @,@ 000 @,@ 000 m3 (8 @.@ 8 × 109 imp gal) of water will be sent to the Abu Alanda reservoir where it will be diluted with water from the Zara Ma ? en desalination plant as well as water from Wala . The remaining 60 @,@ 000 @,@ 000 m3 (1 @.@ 3 × 1010 imp gal) of water will be sent to the Dabouq reservoir where it will be diluted with water from the Zai Treatment Plant as well as water from Wala . It is estimated that the cost of one cubic meter of water from the project will be 0 @.@ 74 JOD ($ 1 @.@ 05 USD) .

= = Construction = =

In June 2009 , the Turkish firm GAMA began construction . By February 2011 , eight piezometer wells and two water producing wells have been completed . Twenty @-@ three other wells were to be drilled , and 85 km (53 mi) of pipe were to be installed . By April 2011 , 99 % of the 340 km (210 mi) of project 's piping had arrived from Turkey , an anonymous source told The Jordan Times . This source stated that the project was over 50 % completed and that it was ahead of schedule .

Construction was delayed by disgruntled members of a Bedouin tribe living in the area , who allegedly intimidated workers by shooting in the air and at construction equipment . All work was stopped for two weeks after two employees were killed in January 2011 ? allegedly murdered by a member of the Bedouin tribe . The tribe had been upset because GAMA did not rent its water tankers , according to Adnan Zu 'b , Assistant Secretary Genera at the Ministry of Water and Irrigation . To satisfy the tribe , GAMA then announced plans to rent tankers from the tribe . However , near the site of the killings , the town of Ma 'an had protests against the government 's failure to punish the killers . During October and November , 2011 the construction works have been suspended at southern part of the project from Hasa to Mudawarra due to security problems created by tribes , therefore there is delay in this part which will affect the completion date of the project .

= = Structure and funding = =

The project is funded on a build @-@ operate @-@ transfer concession contract between the Jordanian government and the Disi Water Company (Diwaco) , a subsidiary of the Turkish construction company GAMA Energy . GAMA Energy is a joint venture between the Turkish GAMA Holding and the US firm General Electric Energy Financial Services . Diwaco is responsible to build the project over a 4 @-@ year period and to operate it for another 25 years . At the end of the concession period the ownership will transfer to the Jordanian government . Diwaco will retain any profits and will bear the risk of losing its equity . Construction is undertaken by GAMA Power Systems , another subsidiary of GAMA Holding , under a turnkey engineering , procurement and construction contract with Diwaco . Operation will be undertaken by Disi Amman Operation Maintenance LLC , a fully owned subsidiary of the French water company Suez Environnement , under a separate operating contract with Diwaco .

The project is funded through an equity contribution of about USD 200m from Diwaco , a USD 300m grant and a USD 100m stand @-@ by facility from the Jordanian government , as well as USD 475m in foreign loans to Diwaco . The project 's total cost is expected to be $ 1 @.@ 1 billion

USD . The U.S. Overseas Private Investment Corporation has lent USD 250m to Diwaco to support U.S. foreign investment on the basis that General Electric partially owns GAMA Energy . The state @-@ owned French bank PROPARCO , which is the part of the French Development Agency (AFD) that supports private sector development , and the European Investment Bank (EIB) each lent about USD 100m to Diwaco . The loan package has been put together by the Arab Banking Corporation . Much of the government grant supporting the project comes from sovereign soft loans that the government of Jordan has borrowed from the EIB and AFD and passes on as a grant to the project . AFD provided USD 50m for the state grant and USD 48m for the stand @-@ by facility .

= = Radioactivity concerns = =

The project became controversial in 2009 when a study performed by Avner Vengosh of Duke University revealed the Disi water to be highly radioactive . Water was tested from 37 existing wells in the aquifer , and all but one had concentrations of radioactive radium @-@ 226 and radium @-@ 228 isotopes that exceeded international standards for drinking water . Some of the water tested exceeded standards by 2 @,@ 000 % . Drinking water with these isotopes has been linked to bone cancer and leukemia . Though expensive , the water could be purified of the radioactive isotopes through ion @-@ exchange purification .

Jordan 's Ministry of Water and Irrigation has stated that the radioactivity is not a problem because the water is to be diluted with an equal amount of water from other sources . This dilution would presumably halve the radioactivity of the water which , according to Vengosh 's data , would not be enough to bring the water up to standards . The Ministry of Water and Irrigation , however , has declared Vengosh 's data to be inaccurate , as his study did not test water from any of the wells that will be used in the project . As radiation varies from well to well , it is possible that the data Vengosh collected does not accurately reflect the water sources to be used in the project .

Although testing at the well sites that supply Aqaba reveals high radioactivity , testing performed using water from the tap in Aqaba shows the water to be safe . There is no confirmed explanation for this phenomenon , although it is hypothesized that the depth of the wells (the ones that supply Aqaba are relatively shallow) may play a role as the radiation varies greatly at shallow depths . In May , 2011 , the President of the Jordanian Geologists Association Bahjat Al Adwan stated that the radiation is present in the water in the form of Radon , and thus dissipates harmlessly when the water is exposed to air on the surface . This explanation has not been confirmed scientifically , however .

During the inauguration of the conveyor in July 2013 Minister of Water and Irrigation Hazim El @-@ Nasser said that after mixing Disi water radiation is less than 0 @.@ 5 millisievert per year . The worldwide average natural dose of human ? s exposure to radiation is about 2 @.@ 5 @-@ 3 millisievert per year . " Disi water is purer than bottled water and I take full responsibility for what I ? m saying , ? the Minister said during a press conference .