

NOT TO SCALE

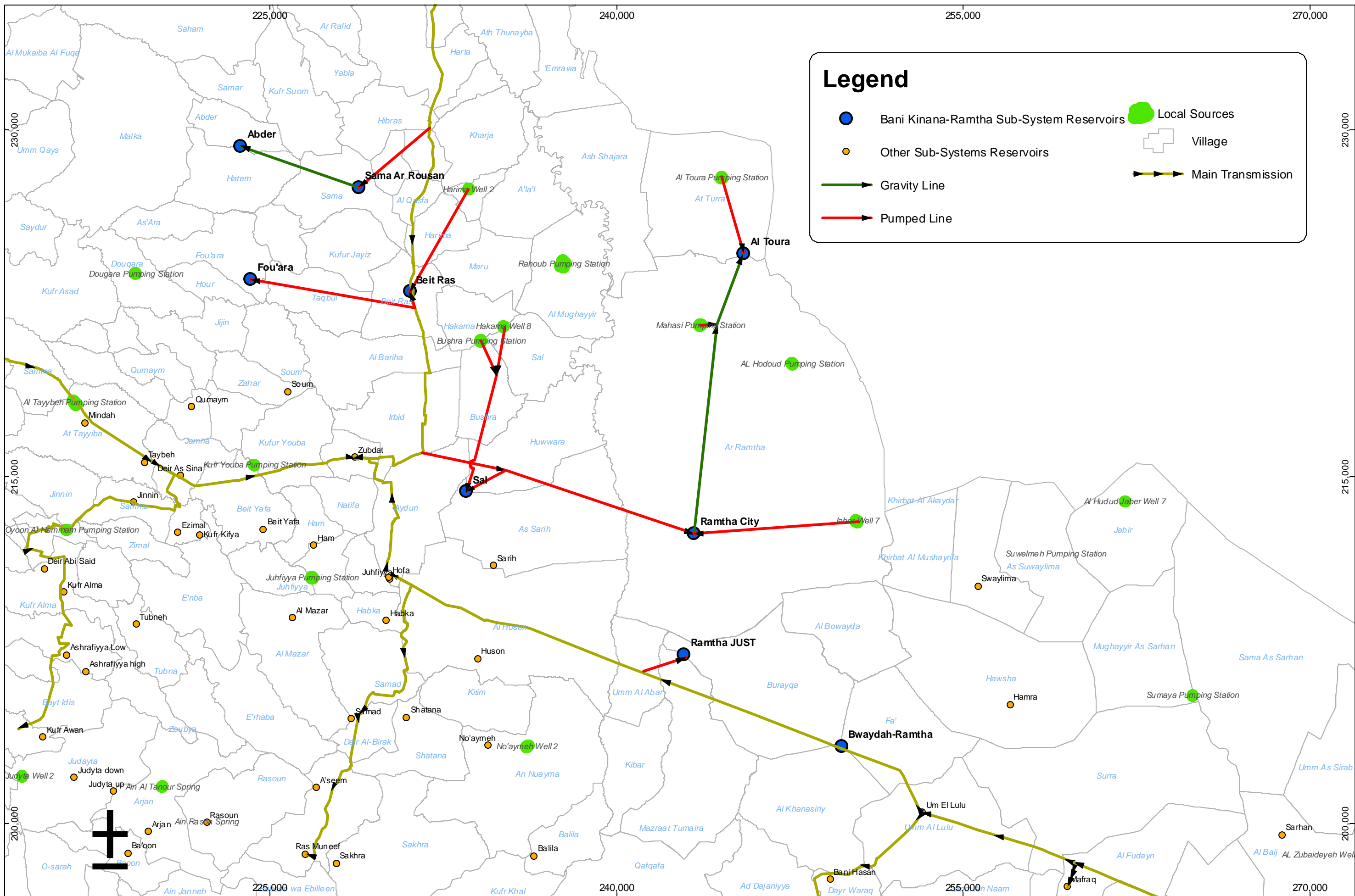
THE HASHEMITE KINGDOM OF JORDAN  
 MINISTRY OF WATER AND IRRIGATION  
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NORTHERN GOVERNORATES WATER  
 TRANSMISSION SYSTEM FEASIBILITY STUDY  
 SCHEMATIC PROFILE OF PROPOSED SYSTEM  
 HOFA SUB-SYSTEM

PROJECT NO.  
 3029-42324  
 FIGURE NO.  
 8-12



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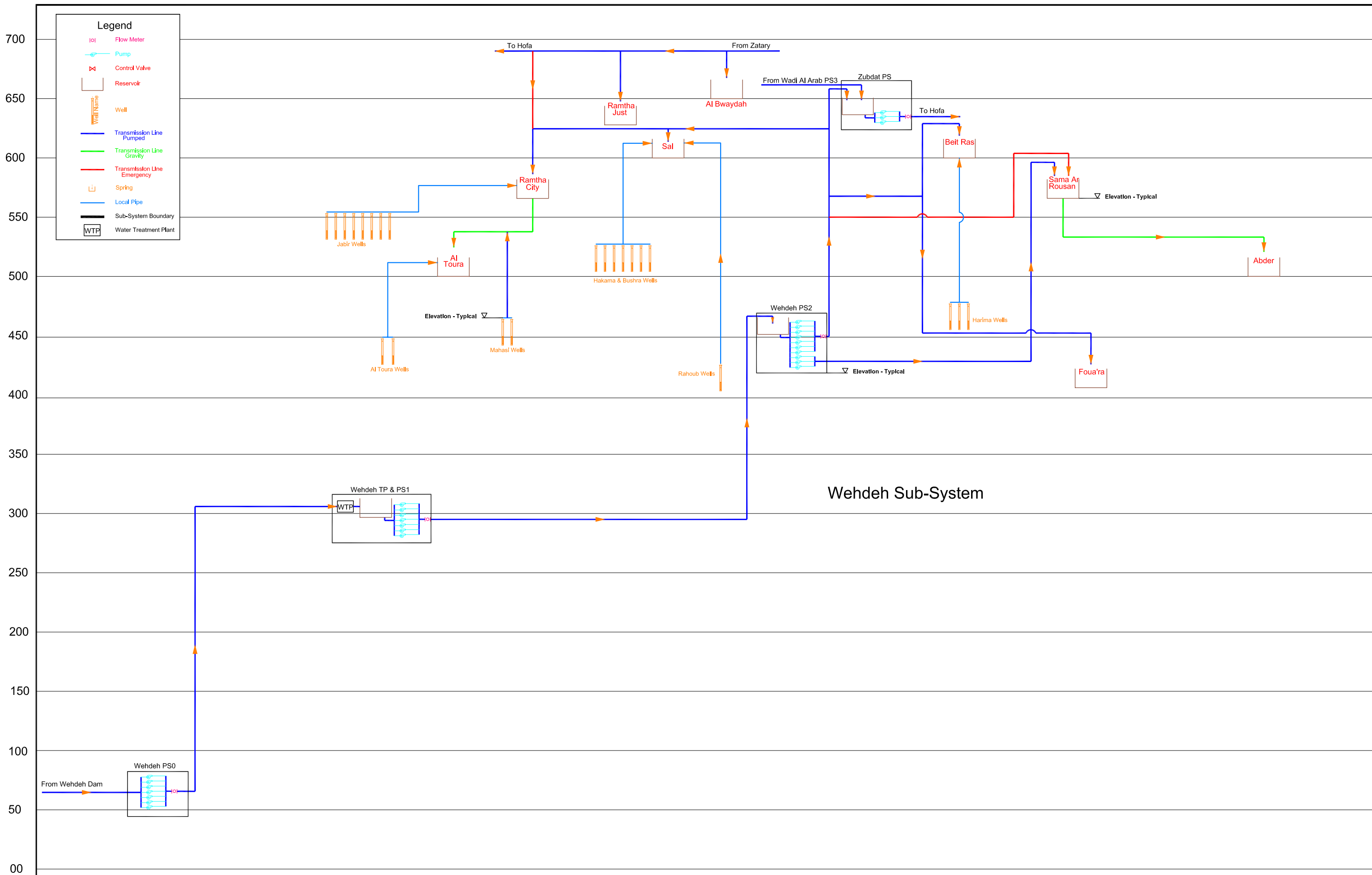
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 TRANSMISSION SYSTEM FEASIBILITY STUDY  
 Final Proposed System:  
 Wehdeh Sub-System Plan

PROJECT No.  
 3029-42324  
 FIGURE No.  
 8-13



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 TRANSMISSION SYSTEM FEASIBILITY STUDY  
 SCHEMATIC PROFILE OF PROPOSED SYSTEM  
 WEHDEH SUB-SYSTEM

PROJECT NO.  
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 FIGURE NO.  
 8-14

## 8.2.4 Potential Emergency Connections

The hydraulic modelling conducted under this feasibility study has encompassed the selection of pipe sizes that would handle one type of emergency situation; namely, that water can be delivered from the primary transmission system whenever the largest local well for a given reservoir (or group of reservoirs) is out of service. In addition, a number of potential emergency connections have been identified by NGWA during the feasibility studies, which will require further consideration during final design; these are discussed in this section.

**Figure 8-15** shows several pipelines that are considered as Emergency Connections, to be used in case of failure of the relevant local sources or the facilities usually supplying the areas in question. At the design stage, when detailed designs will be developed for these Potential Emergency Connections, the designer should thoroughly consider possible excessive pressures resulting from connecting high pressure zones to low pressure zones and should include in the detailed design the pressure reducing facilities on the Emergency Line to prevent excessive pressures in the transmission system benefiting from the Emergency Connection. The designer should also select appropriate emergency scenarios that will determine the required diameters for the new lines. These Potential Emergency (EM) Connections are:

- 1- Zatory-Hofa to Mafraq Reservoir: New Pipeline  
(See Line EM1 on **Figure 8-15**). This line connects the  $\Phi 1000\text{mm}$  to the Upper Aqeb line to make sure that the Upper Aqeb system receives its demands in case of any interruptions in the system.
- 2- Um El Lulu to Hamra Reservoir: Existing  $\Phi 200\text{mm}$  to Hosha Booster followed by a new pipeline  
(See Line EM2 on **Figure 8-15**). This line connects Um El Lulu system to parts of Sumaya system in case of any interruptions in the latter.
- 3- Qadam to Moammariyyeh reservoirs: Existing  $\Phi 150\text{mm}$   
(See Line EM3 on **Figure 8-15**). This line connects Um El Lulu system to the Upper Aqeb - Mafraq system to serve the latter in case of any failure.
- 4- Qafqafa to Nadira Reservoir: New Pipeline  
(See Line EM4 on **Figure 8-15**). In case of any interruption in the Um El Lulu - Nadira line, Qafqafa can serve Nadira Reservoir and the 'medium pressure zones' of Jerash by gravity.
- 5- Abu Eiat-Nadira and Moammariyyeh-Jerash Lines: New Pipeline  
(See Line EM5 on **Figure 8-15**). The two lines under study pass in the same road. A connection between them is suggested to be used in case of failure of the Moammariyyeh Hamama-Jerash line.
- 6- Ras Muneef to Ketta reservoir: New Pipeline  
(See Line EM6 on **Figure 8-15**). In case of failure of the Um El Lulu - Jerash line, this connection will allow the affected areas to receive water from Ras Muneef.

- 7- Anjarah Up and Anjarah Down: New Pipeline  
(See Line EM7 on **Figure 8-15**). In case of interruptions in the Samad – Aseem – Anjarah down line, the connection will allow water to be conveyed by gravity from the Ras Muneef – Anjarah Up line.
- 8- Ishtafina to Deir Smadiyyeh Pipeline: Existing  $\Phi$ 150mm  
(See Line EM8 on **Figure 8-15**). This line will be used to serve the lower parts of the Deir As Sina system in case of any interruption.
- 9- Transmission Line to Ba'oon and Arjan Reservoirs: 2 New lines  
(See LineS EM9-1 & EM9-2 on **Figure 8-15**). These lines will be used to serve the two reservoirs from the transmission in case of failure of Ain Tanour local source
- 10- Judyta Up to Judyta Down: Existing  $\Phi$ 150mm  
(See Line EM10 on **Figure 8-15**). This connection will be used to serve Deir As Sina system in case of any failure or interruptions in the mains/ facilities.
- 11- Kufr Kifya to Ezimal Reservoir: Existing  $\Phi$ 150mm  
(See Line EM11 on **Figure 8-15**). In case of failure in the Deir As Sina System (Jinnin Booster or Wadi Arab PS3) Kufr Kifya could transfer water to Ezimal and Jinnin by gravity.
- 12- Juhfiyya PS to Hofa-Habka Pipeline: The Same Line  
(See Line EM12 on **Figure 8-15**). In case of failure of the Juhfiyya wells and PS, the shortage will be overcome from Hofa PS by conveying the water in the opposite direction through the same proposed new line.
- 13- Zubdat to Soum: Existing 150mm  
(See Line EM13 on **Figure 8-15**). This line will be used in case of failure of the Wadi Al Arab PS3 – Qumaym lines or any other interruptions.
- 14- Zubdat to Sama Ar Rousan reservoirs: Existing  $\Phi$ 400mm  
(See Line EM14 on **Figure 8-15**). This connection will be used to return the water from Zubdat reservoir in case of any interruptions in the Wehdeh System.
- 15- Zatary-Hofa transmission main to Ramtha: Existing  $\Phi$ 300mm line  
(See Line EM15 on **Figure 8-15**). This connection will be used as an emergency line in case of any interruptions in the proposed Ramtha supply system from Wehdeh / Zubdat.
- 16- Hofa - Zubdat - Hofa: The Same Line  
(See Line EM16 on **Figure 8-15**). Being the connection between the terminal reservoirs of the Primary Systems (East, West and Wehdeh) it's important to use this pipe for any Emergency in the Primary Systems. This connection should be able to carry water both ways between the two terminals.



## 8.3 Phased Development of the Transmission System

### 8.3.1 Sources to be Developed

As identified in Section 5, the new water sources required over the planning period to year 2030 include:

1. An allowance of 500 m<sup>3</sup>/hour (4.4 MCM/year) to NGWA from the King Abdullah Canal (KAC), which is being developed as an urgent project by WAJ and NGWA, and should be in operation in 2006. Water treatment alternatives for the KAC source are included in Appendix G, and pipeline/pump station improvements are described in Appendix K.
2. Re-allocation to NGWA of the water exported from the Aqeb-Zatary well fields to Zarqa and Amman, which amounted to 11.7 MCM in 2003. It is expected that this water will be available in 2007, upon completion of Amman's Zara-Ma'in project.
3. An allocation of 30 MCM to NGWA from the Al Wehdeh Dam on the Yarmouk River, currently under construction. It is assumed that this water will be available by 2009. A detailed discussion of the development of this source is included in Appendix K, and treatment alternatives are discussed in Appendix G.
4. Re-allocation to NGWA of the water supplied from the Corridor wells to Zarqa and Amman, which amounted to 10 MCM in 2003. The NGWA system will need this water by about 2018, by which time it is expected that Amman and Zarqa will be receiving water from the Disi aquifer, to replace the water from the Corridor wells.
5. New local wells serving small local systems amounting to 5 MCM, to be developed over the period from 2005 to 2030, as allocated under the WLRP.
6. Four springs identified in Section 5 as potential new sources of water for NGWA, which could provide 4 MCM. These are not required until after 2027.

### 8.3.2 Selection of Water Transmission Projects

The improvements to the transmission system required by year 2030 have been divided into ten projects, named for portions of the primary transmission system or for geographic portions of the NGWA service area. Locations of the pipelines and reservoirs for the ten projects are shown on **Figure 8-16**, and the pump stations are shown on **Figure 8-17**.

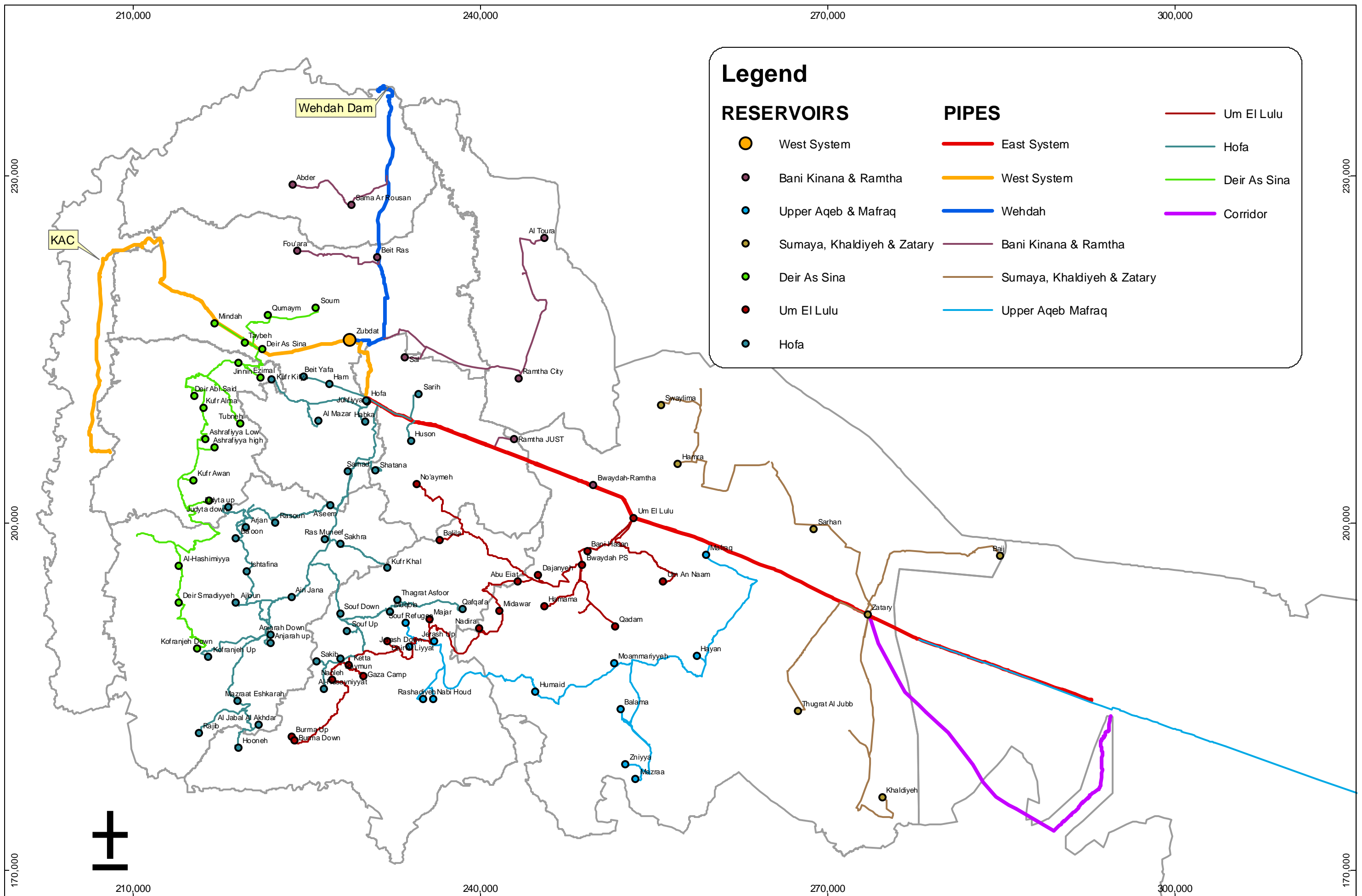
Four projects are concerned with expansion or additions to portions of the existing primary transmission system. These projects are designated as the East, West, Wehdeh and Corridor systems.

Six of the projects cover the pipelines, reservoirs and pump stations that serve geographic portions of the study area. These subsystems have been designated as follows: Sumaya/Khaldiyeh; Upper Aqeb/Mafraq; Um El Lulu/Jerash; Hofa; Bani Kinana/Ramtha; and Deir As Sina. The number of subsystems and grouping of areas have been selected on a trial basis, so as to give a reasonable size of project for financing.

The sequence or phasing of development of transmission/subsystem projects are not necessarily tied directly to the development of the new water sources. The linkages between development of water sources and the transmission projects are discussed below.

- Supply of 500 m<sup>3</sup>/h from KAC by 2006: the required facilities have been grouped under the West transmission project, including the treatment plant, PS0 booster pump, and a short length of pipeline. A distribution reservoir that is fed directly from the Wadi Al Arab transmission main has also been included in the West transmission project. It is expected that the additional supply from this project could be readily absorbed by Irbid and other areas. As a result, the timing of construction for the Deir As Sina subsystem is not necessarily tied to the new KAC supply.
- Re-allocation of Aqeb-Zatary wells by 2007: for this source, the improvements designated under the East transmission system project are essential, consisting of a 48-km pipeline (700mm to 1100mm diameter) from Zatary pump station to Hofa reservoir, and modification of Zatary pump station. This new Zatary-Hofa pipeline must be in place before work is completed on the following subsystems: Um El Lulu/Jerash; Upper Aqeb/Mafraq; and Sumaya/ Khaldiya; and Hofa. The work on these four subsystems can proceed simultaneously; there is no requirement that one subsystem be completed before the next subsystem can proceed.
- Supply from Al Wehdeh Dam by 2009: the Wehdeh transmission project (3 pump stations and large pipeline to Irbid) must be completed before work can proceed on the Bani Kinana/Ramtha subsystem.
- Supply from Corridor wells by 2018: the only requirement is the construction of a pipeline from the Corridor wells to the Zatary pump station.





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TRANSMISSION SYSTEM FEASIBILITY STUDY  
Proposed Pipeline and Reservoir Projects

PROJECT No.  
3029-42324  
FIGURE No.  
8-16