State of Palestine

Palestinian Water Authority

دولـــــة فلسطيـن

سـلطة المياه الفلسطينيـة

STRATEGIC WATER RESOURCES AND TRANSMISSION PLAN

(FINAL)

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1 Introduction & Objectives

1.1 Background

In 2013 the PWA finalised the Water Strategy including two phases; short term phase (2012-2017) and the long term phase (2017-2032). This document includes the estimated water demands for Public use, (domestic, commercial, municipal, industrial etc.) and agricultural for both Gaza and the West Bank and the proposed options to meet these demands including imported water quantity, ground water, surface water, desalination, rainwater harvesting and re-allocation of conventional water resources, currently used for agriculture, for public use in a direct reallocate for re-used wastewater to be used for agriculture.

Gaza is in a position to plan and implement its part of the strategy which is applicable to Gaza in that there is a clear direction and actions required to increase the required resource and deliver them to the population centres across the Gaza strip.

However in the West Bank this is less clear, since the proposed resources to meet the demands are not necessarily in the same region of the West Bank and the responsibility for the allocation of those resources, the staged implementation of the development of those resources and the planning and implementation of the inter-regional infrastructure required to deliver those bulk resources needs to be included as a national plan to ensure that the objectives of the strategy are met.

Therefore, further to the production of the Strategy it was decided to prepare a Strategic Water Resources and Transmission Plan for public water supply. This plan will be considered as a guidance document for any future master plans in the West Bank.

1.2 Objectives of the Plan

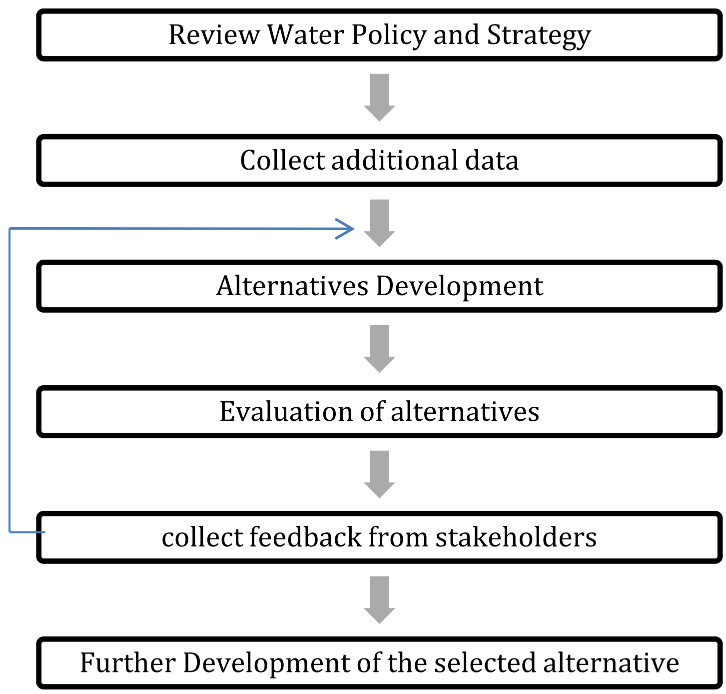
The objectives to be achieved in this Strategic Water Resources and Transmission plan to implement the national water strategy for public water supply for the West Bank include:

- Develop a stage development plan of the water resources included in the strategy over the lifetime of the plan showing their location and anticipated volumes.
- Development of an effective plan to develop the inter-Governorate transmission infrastructure required to deliver those bulk resources to a location where they would become the responsibility of a regional service provider to deliver supply to its customers.
- A sufficiently detailed transmission plan that can be taken to outline design by others.

2 Process Used to Develop the Plan

The transmission plan proposed here was based on the water policy and strategy document and the trans-boundary strategy developed by PWA. The process of plan preparation went through the steps as depicted in Figure 1 and summarized below:

1. The draft water policy and strategy document were reviewed and discussed with all water experts;
2. All data available and maps produced for developing the Water Sector Strategy were collected and reviewed.
3. Other needed information including the available information with TPAT Water Supply Expert concerning the Strategic Plan was collected.
4. Three alternatives were developed and agreed upon with PWA staff. These alternatives are described later in this report but they are a reallocate and reallocation scenario, a conveyance scenario and a combination of reallocating, reallocation and conveyance alternative.
5. Alternatives were evaluated against criteria that consider not only the economic value but also the practicality of both plan implementation and system operation in addition to flexibility of the plan.
6. The draft plan was presented to PWA senior management and key relevant Stakeholders focusing on the main considerations and decisions leading to the final contents of the document.
7. Based on received comments to the Strategic plan, a revised and final document was prepared in cooperation with PWA and International Expert.



3 Water Demands and Location

3.1 Water Demands - Public

Public water demands include domestic, commercial, industrial, municipal etc. i.e. any demands for water excluding agricultural demands. The expected public water demands are based on those included in the Water Strategy over the lifetime of the strategy and the location of those demands has been estimated pro-rata by population estimates from the Strategy by region.

The main strategic assumptions used to estimate the public water demand are taken from the national strategy and policy. These assumptions can be summarized in the following:

1. The population growth rate will remain very high over the coming years (3.5%), but is expected to slow down slightly as a result of changes in education and family structure, as has been observed in other Mediterranean countries. The Demographic trends For the purpose of the water sector strategy, includes a progressive decrease from the present growth rate to a more modest rate by 2032 of 120l/c/day and a dramatic inflow of Palestinian returnees as a consequence of a final agreement with Israel.

2. Improve customer satisfaction, providing customers with access to a reliable, permanent source of good quality tap water, at an affordable price. This means that there is likely to be an increase in domestic water consumption especially in areas with a very low consumption rates at present. Nevertheless, this increase will be constrained not only by the customers' affordability and willingness-to-pay for this service, but also by consumers' support of the national policy that aims to limit water wastage and over-abstraction of limited water resources.

The strategy has been developed with the objective that the public water consumption rate is 120 lcd in both regions (the Gaza Strip and the West Bank). Per capita public water consmption will increase from 72 lcd at present in the West Bank to 120 lcd by the year 2032. It should be mentioned that demand management practices are inherent in these demand rates.

3. Demand for water for industry will rise from 3% of urban water supply to 10% by 2032 and wherever possible, the treated wastewater will be a source to meet the demand for water.

4. The UFW will be reduced to a strategic level of 20%. Thus the strategy aims to reduce this UFW rate. Reducing UFW will require major investment in the transmission and distribution networks (leakage detection, illegal connection detection, pressure management, pressure districts, etc.), improving the service providers

performance and/or efficiency and at customer connection level and that will be reflected in both the investments and the action plans that would be prepared as a next step of water strategy.

Table 1 below shows the public water demand for the different locations in the West Bank and for the different Planning years. Annex 1 shows maps of the West Bank showing the public demands by region for each of the different planning years. It should be mentioned that Jerusalem Governorate includes east Jerusalem and all communities within the Jerusalem Governorate according to Palestinian division of Governorates adopted by Palestinian Central Bureau of Statistics (PCBS).

Table 1 Estimated Public Water Demands (MCM/year)

Governorate	2012	2017	2022	2027	2032
Jenin	11.4	15.9	23.9	32.9	42.9
Nablus	14.2	19.9	29.5	40.7	53.2
Tubas	2.3	3.2	4.8	6.6	8.7
Tulkarm	6.9	9.6	14.3	19.8	25.8
Qalqilia	4.1	5.7	8.5	11.7	15.3
Salfit	2.6	3.6	5.5	7.6	9.9
Jericho	1.9	2.6	4.0	5.5	7.1
Ramallah-Al-Bireh	12.6	17.6	26.3	36.3	47.4
Jerusalem	15.9	22.1	33.1	45.7	59.6
Hebron	25.2	35.1	52.6	72.6	94.7
Bethlehem	7.9	11.0	16.5	22.7	29.6
Total West Bank	**105.0**	**146**	**219**	**302**	**394**

3.2 Agricultural Water Demands

The expected agricultural water demands are based on those included in the Water Strategy over the lifetime of the strategy and the location of those demands has been assessed in agreement with the Ministry of Agriculture. The irrigable areas and the water demand per dunum for the different areas in the West Bank have been provided by the MoA based on their field data available for the different areas and the different cropping pattern for each area. This explains the difference in the growth in demand between the different areas and between the different planning periods.

The main strategic assumptions used to estimate the agricultural water demand are taken from the national strategy and policy. These assumptions can be summarized in the following points:

1. there are 611,000 dunum of irrigable land in the West Bank.

2. For overall planning purposes, Ministry of Agriculture (MoA) recommends using an average figure of 600 m3/dunum/year as the water requirements per dunum in West Bank. This figure has been calculated to take into account the recent and considerable development of drip irrigation.

3. Due to difficulties in accessing water resources, only 75% of the “normal” water demand (450 m3/dunum/year instead of 600 is been used based on recommendations from MoA. This is also explained by MoA with the fact that there is still a room for improvements in irrigation efficiency with an overall gain of 10% for the next 20 years (by the year 2032).

4. The resources available for irrigation will increase dramatically in the West Bank, as Palestinians will attain their water rights in the Jordan River and shared aquifers.

5. PWA and MoA will encourage the reuse of treated wastewater for agriculture, including the construction of facilities to store and transport this water.

Table 2 below shows the agricultural water demand for the different locations in the West Bank and for the different Planning years. Appendix 1 shows maps of the West Bank showing the agricultural demands by region for each of the different planning years.

Table 2 Estimated Agricultural Water Demands (MCM/year)

Governorate	2012	2017	2022	2027	2032
Jenin	19.6	28.0	33.6	40.3	55.0
Nablus	8.2	15.0	18.0	21.6	35.9
Tubas	9.8	25.0	30.0	36.0	43.2
Tulkarm	3.3	9.9	11.9	14.3	17.1
Qalqilia	2.1	8.0	9.6	11.5	13.8
Salfit	5.9	7.1	8.5	10.2	12.2
Jericho	5.4	30.0	36.0	43.2	60.0
Ramallah-Al-Bireh	4.2	5.0	6.0	7.3	8.7
Jerusalem	0.4	0.4	0.5	0.6	0.7
Hebron	13.2	19.8	23.8	28.5	45.0
Bethlehem	1.4	1.7	2.1	2.5	3.0
Total West Bank	**73**	**150**	**180**	**216**	**295**

4 Development Options of Water Resources

The proposed staged development of the water resources required to meet the demands included in the strategy has been based on the Water Strategy as a starting point. Further analysis has been completed during the completion of this plan so that the proposed development options of the resources over the life-time of the plan represent a plan that accommodates socio-economic, sectorial and national considerations. The sources to be developed first, represent a combination of the cheapest to abstract and easiest deliver to their point of use.

4.1 Public Water Resources

Tables 3 through 6 below show the proposed development of the water resources to be dedicated to public use. The tables show the additional quantities to be developed from the different future potential water resources for the different Governorates and for the different planning years. The numbers in the different tables indicate the additional quantity to be developed from a given source during that planning period. The additional quantities for the planning year 2017 are those quantities above the quantities existed in 2012. Based on these tables, the additional future resources to be developed are from four main sources namely the purchased water, the development of groundwater resources, water harvesting and desalination. It should be mentioned here that development of groundwater wells means both, drilling of new wells or rehabilitation of existing ones. It is worth mentioning that the negative numbers in a certain planning year means that this resource will be used less from the previous planning year which indicates a reallocation either between sectors or between governorates.

In addition, Tables 7 through 10 show the proposed development actions to achieve the additional supply for each of the planning periods and for the different Governorates. Finally, it should be mentioned that Annex 1 of this report includes Maps that show the total quantities of these resources developed for the different Governorates and for the different planning years. The Annex also includes Maps that show the location of these resources over the West Bank. In cases where there is no development in a certain planning year in a certain governorate, this means that no additional supply is needed by that planning year or no actions is recommended due to both natural and/or artificial constraints.

Table 3 Additional Supply by the year 2017 for Public Purposes (MCM/year)

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Harvesting	De-Salination
		Wells	Springs	Wells	Springs	Wells	Springs		
Jenin	2.0			5					
Nablus	0.4			3					
Tubas				1.6	0.11				
Tulkarm	0.5								
Qalqilyia									
Salfit	2.5		0.11						
Jericho	2.0					2			0.5
Ramallah -Al Bireh	1.5					0.2			
Jerusalem[1]	1.4								
Hebron	5.5	3				2			
Bethlehem	0.4					2			

Table 4 Additional Supply to be Developed Between 2017-2022 for Public Purposes (MCM/year)

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Harvesting	De-Salination
		Wells	Springs	Wells	Springs	Wells	Springs		
Jenin				2.0					
Nablus				0.5					
Tubas				0.4					0.5
Tulkarm		2.5							
Qalqilyia		2.5							
Salfit		1							
Jericho						0.5		0.3	
Ramallah -Al Bireh									
Jerusalem[1]									
Hebron		2					20		
Bethlehem		2				4	20		

Table 5 Additional Supply to be Developed Between 2022-2027 for Public Purposes (MCM/year)

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Harvesting	De-Salination
		Wells	Springs	Wells	Springs	Wells	Springs		
Jenin				5				0.5	
Nablus				4		5			
Tubas				5		5			
Tulkarm		10							
Qalqilyia		11							
Salfit		4	0.11						
Jericho						3		0.5	
Ramallah -Al Bireh		3						0.1	
Jerusalem[1]		2							
Hebron		5				1	10		
Bethlehem		3				5	-10		

Table 6 Additional Supply to be Developed Between 2027-2032 for Public Purposes (MCM/year)

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Harvesting	De-Salination
		Wells	Springs	Wells	Springs	Wells	Springs		
Jenin				15	4.5			0.5	
Nablus				11	0.15	5		0.5	
Tubas				6	1.9	15			
Tulkarm		20						0.5	
Qalqilyia		20						0.5	
Salfit		5							
Jericho						5		0.5	
Ramallah -Al Bireh		10					0.9	0.4	
Jerusalem[1]		3							
Hebron		10				3			
Bethlehem						5			

Table 7 Actions to be taken by the Year 2017 for Public Supply Purposes

Governorate	Resource Development Actions
Jenin	• Import of 2.0 MCM/year additional quantity. • Development of 5 MCM/year of groundwater wells from the North Eastern Aquifer Basin.
Nablus	• Import of 0.4 MCM/year additional quantity. • Development of 3 MCM/year of groundwater wells from the North Eastern Aquifer Basin.
Tubas	• Development of 1.6 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.11 MCM/year from the groundwater springs in the North Eastern Aquifer Basin.
Tulkarm	• Import of 0.5 MCM/year additional quantity.
Qalqilyia	•
Salfit	• Import of 2.5 MCM/year additional quantity. • Development of 0.11 MCM/year of groundwater springs from the Western Aquifer Basin.
Jericho	• Import of 2.0 MCM/year additional quantity. • Development of 2 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.5 MCM/year from brackish water desalination.
Ramallah -Al Bireh	• Import of 1.5 MCM/year additional quantity. • Development of 0.2 MCM/year of groundwater wells from the Eastern Aquifer Basin by rehabilitation of existing wells.
Jerusalem[1]	• Import of 1.4 MCM/year additional quantity.
Hebron	• Import of 5.5 MCM/year additional quantity. • Development of 3 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 2.0 MCM/year of groundwater from the Eastern Aquifer Basin.
Bethlehem	• Import of 0.4 MCM/year additional water quantity. • Development of 2.0 MCM/year of groundwater from the Eastern Aquifer Basin.

Table 8 Actions to be taken During the Period 2017 - 2022 for Public Supply Purposes

Governorate	Resource Development Actions
Jenin	• Development of 2 MCM/year of groundwater wells from the North Eastern Aquifer Basin.
Nablus	• Development of 0.5 MCM/year of groundwater wells from the North Eastern Aquifer Basin.
Tubas	• Development of 0.4 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.5 MCM/year from brackish water desalination.
Tulkarm	• Development of 2.5 MCM/year of groundwater wells from the Western Aquifer Basin.
Qalqilyia	• Development of 2.5 MCM/year of groundwater wells from the Western Aquifer Basin.
Salfit	• Development of 1 MCM/year of groundwater wells from the Western Aquifer Basin.

Jericho	• Development of 0.5 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.3 MCM/year from groundwater springs in the eastern Aquifer Basin.
Ramallah -Al Bireh	•
Jerusalem[1]	•
Hebron	• Development of 20 MCM/year from Al-Fashkha brackish water springs desalination. • Development of 2.0 MCM/year of groundwater wells from the Western Aquifer Basin.
Bethlehem	• Development of 20 MCM/year from Al-Fashkha brackish water springs desalination. • Development of 2.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 4.0 MCM/year of groundwater wells from the Eastern Aquifer Basin.

Table 9 Actions to be taken During the Period 2022 - 2027 for Public Supply Purposes

Governorate	Resource Development Actions
Jenin	• Development of 5 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.
Nablus	• Development of 4.0 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin.
Tubas	• Development of 5.0 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin.
Tulkarm	• Development of 10.0 MCM/year of groundwater wells from the Western Aquifer Basin.
Qalqilyia	• Development of 11.0 MCM/year of groundwater wells from the Western Aquifer Basin.
Salfit	• Development of 4.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.11 MCM/year of groundwater springs from the Western Aquifer Basin.
Jericho	• Development of 1.6 MCM/year of groundwater wells from the Eastern Aquifer Basin and relocate 1.4 from agricultural supply wells to public. • Development of 0.5MCM/year from rainwater harvesting.
Ramallah -Al Bireh	• Development of 3.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.1MCM/year from rainwater harvesting.
Jerusalem[1]	• Development of 2.0 MCM/year of groundwater wells from the Western Aquifer Basin.
Hebron	• Development of 5 MCM/year from groundwater wells in the Western Aquifer basin. • Development of 1.0 MCM/year of groundwater wells from the Eastern Aquifer Basin.

	• Convert 10 MCM/year of Al-Fashkha water from Bethlehem.
Bethlehem	• Development of 3 MCM/year from groundwater wells in the Western Aquifer basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin.

Table 10 Actions to be taken During the Period 2027 - 2032 for Public Supply Purposes

Governorate	Resource Development Actions
Jenin	• Development of 15 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 4.5 MCM/year of groundwater springs from the North Eastern Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.
Nablus	• Development of 11 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.15 MCM/year of groundwater springs from the North Eastern Aquifer Basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.
Tubas	• Development of 3 MCM/year of groundwater wells from the North Eastern Aquifer Basin and relocate of 3 MCM/year from agricultural groundwater wells. • Development of 1.9 MCM/year of groundwater springs from the North Eastern Aquifer Basin. • Development of 15 MCM/year of groundwater wells from the Eastern Aquifer Basin.
Tulkarm	• Development of 20.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.
Qalqilyia	• Development of 20.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.
Salfit	• Development of 5.0 MCM/year of groundwater wells from the Western Aquifer Basin.
Jericho	• Development of 5.0 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.5MCM/year from rainwater harvesting.
Ramallah -Al Bireh	• Development of 0.9 MCM/year of groundwater springs from the Eastern Aquifer Basin. • Development of 0.4 MCM/year from rainwater harvesting.
Jerusalem[1]	• Development of 3.0 MCM/year of groundwater wells from the Western Aquifer Basin.
Hebron	• Development of 10.0 MCM/year from groundwater wells in the Western Aquifer basin. • Development of 3.0 MCM/year from groundwater wells in the Eastern Aquifer Basin.
Bethlehem	• Development of 5 MCM/year from groundwater wells in the Eastern Aquifer basin.

It is worth to mention that the development of additional water quantities from springs in all districts is associated with a high uncertainty since this option depends on many complex factors such as: recharge areas, rainfall distribution, recharge rates, any nearby new wells and human activities.

4.2 Agricultural Water Resources

Tables 11 through 14 below show the proposed development of the water resources to be dedicated to agricultural use. The tables show the additional quantities to be developed from the different future potential water resources for the different Governorates and for the different planning years. The numbers in the different tables indicate the additional quantity to be developed from a given source during that planning period. Based on these tables, the additional future resources to be developed are from four main sources namely the purchased water, the development of groundwater resources, water harvesting and wastewater reuse.

It should be mentioned here that the utilization of the Jordan River Basin by the Palestinians might be through the construction of the West Ghor Canal. This option is being considered as a strategic option and is being considered by PWA for further analysis.

In addition, Tables 15 through 18 show the proposed development actions to achieve the additional supply for each of the planning periods and for the different Governorates for agricultural use. Finally, it should be mentioned that Annex 1 of this report includes Maps that show the total quantities of these resources developed for the different Governorates and for the different planning years. The Annex also includes Maps that show the location of these resources over the West Bank.

Table 11 Additional Supply by the year 2017 for Agricultural Purposes

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Jordan River	Harvesting	Reallocate / WWR
		Wells	Springs	Wells	Springs	Wells	Springs			
Jenin				1						1.2
Nablus						1			0.2	1
Tubas				2		1			0.2	0.3
Tulkarm										
Qalqilyia										
Salfit										
Jericho									1	0.5
Ramallah -Al Bireh										0.9
Jerusalem[1]										
Hebron									0.1	0.3
Bethlehem										

Table 12 Additional Supply by the year 2022 for Agricultural Purposes

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Jordan River	Harvesting	Reallocate / WWR
		Wells	Springs	Wells	Spring	Wells	Springs			
Jenin									0.5	3.8
Nablus				1					0.5	6
Tubas									0.5	2.2
Tulkarm									0.5	1
Qalqilyia									0.5	1.5
Salfit									0.5	1
Jericho										1
Ramallah - Al Bireh										2.3
Jerusalem[1]										
Hebron									0.9	7.7
Bethlehem									1	1

Table 13 Additional Supply by the year 2027 for Agricultural Purposes

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Jordan River	Harvesting	Reallocate/ WWR
		Wells	Springs	Wells	Springs	Wells	Springs			
Jenin								20	1	3
Nablus								10	1	3
Tubas	0.5							24	1	1.5
Tulkarm									1	2
Qalqilyia									2	1
Salfit									0.5	2
Jericho						-1.4		30	1	2.5
Ramallah -Al										1.3
Jerusalem[1]										2
Hebron									0.5	7.5
Bethlehem										1

Table 14 Additional Supply by the year 2032 for Agricultural Purposes

Governorate	Import/ Purchased	Western Aqf		N. East Aqf		East Aqf		Jordan River	Harvesting	Reallocate/ WWR
		Wells	Springs	Wells	Springs	Wells	Springs			
Jenin								50	2	2
Nablus								40	1	6
Tubas				-3				60	2	1
Tulkarm									2	2
Qalqilyia									2	1.5
Salfit									3	2
Jericho								70	5	2
Ramallah -Al									2	3.5
Jerusalem[1]									1	3
Hebron									1	7.5
Bethlehem			0.5						1.5	4

Table 15 Actions to be taken During the Period 2012 - 2017 for Agricultural Supply Purposes

Governorate	Resource Development Actions
Jenin	• Development of 1.0 MCM/year from groundwater wells in the North Eastern Aquifer Basin. • Development of 1.2 MCM/year from Wastewater Reuse.
Nablus	• Development of 1.0 MCM/year from groundwater wells in the Eastern Aquifer Basin. • Development of 0.2 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.
Tubas	• Development of 2.0 MCM/year from groundwater wells in the North Eastern Aquifer Basin. • Development of 1.0 MCM/year from groundwater wells in the Eastern Aquifer Basin. • Development of 0.2 MCM/year from rainwater harvesting. • Development of 0.3 MCM/year from Wastewater Reuse.
Tulkarm	
Qalqilyia	
Salfit	
Jericho	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 0.5 MCM/year from Wastewater Reuse.
Ramallah -Al Bireh	• Development of 0.9 MCM/year from Wastewater Reuse.
Jerusalem[1]	
Hebron	• Development of 0.1 MCM/year from rainwater harvesting. • Development of 0.3 MCM/year from Wastewater Reuse.
Bethlehem	

Table 16 Actions to be taken During the Period 2017 - 2022 for Agricultural Supply Purposes

Governorate	Resource Development Actions
Jenin	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 3.8 MCM/year from Wastewater Reuse.
Nablus	• Development of 1.0 MCM/year from groundwater wells in the North Eastern Aquifer Basin. • Development of 0.5 MCM/year from rainwater harvesting. • Development of 6.0 MCM/year from Wastewater Reuse.
Tubas	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 2.2 MCM/year from Wastewater Reuse.
Tulkarm	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.
Qalqilyia	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 1.5 MCM/year from Wastewater Reuse.
Salfit	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.
Jericho	• Development of 1.0 MCM/year from Wastewater Reuse.
Ramallah -Al Bireh	• Development of 2.3 MCM/year from Wastewater Reuse.
Jerusalem[1]	•
Hebron	• Development of 0.9 MCM/year from rainwater harvesting. • Development of 7.7 MCM/year from Wastewater Reuse.
Bethlehem	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.

Table 17 Actions to be taken During the Period 2022 - 2027 for Agricultural Supply Purposes

Governorate	Resource Development Actions
Jenin	• Development of 20 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 3.0 MCM/year from Wastewater Reuse.
Nablus	• Development of 10.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 3.0 MCM/year from Wastewater Reuse.
Tubas	• Development of 24.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 1.5 MCM/year from Wastewater Reuse.
Tulkarm	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.
Qalqilyia	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.
Salfit	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.
Jericho	• Reallocation of 1.4 MCM/year from groundwater wells in the Eastern aquifer Basin to Public Supply. • Development of 30.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 2.5 MCM/year from Wastewater Reuse.
Ramallah -Al Bireh	• Development of 1.3 MCM/year from Wastewater Reuse.
Jerusalem[1]	• Development of 2.0 MCM/year from Wastewater Reuse.
Hebron	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 7.5 MCM/year from Wastewater Reuse.
Bethlehem	• Development of 1.0 MCM/year from Wastewater Reuse.

Table 18 Actions to be taken During the Period 2027 - 2032 for Agricultural Supply Purposes

Governorate	Resource Development Actions
Jenin	• Development of 50 MCM/year from Jordan River Basin. • Development of 2.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.
Nablus	• Development of 40.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 6.0 MCM/year from Wastewater Reuse.
Tubas	• Reallocation of 3 MCM/year from groundwater wells in the North eastern aquifer Basin to public supply. • Development of 60.0 MCM/year from Jordan River Basin. • Development of 2.0 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.
Tulkarm	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.
Qalqilyia	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 1.5 MCM/year from Wastewater Reuse.
Salfit	• Development of 3.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.

Jericho	• Development of 70.0 MCM/year from Jordan River Basin. • Development of 5.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.
Ramallah -Al Bireh	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 3.5 MCM/year from Wastewater Reuse.
Jerusalem[1]	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 3.0 MCM/year from Wastewater Reuse.
Hebron	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 7.5 MCM/year from Wastewater Reuse.
Bethlehem	• Development of 0.5 MCM/year of groundwater springs in the Western Aquifer Basin • Development of 1.5 MCM/year from rainwater harvesting. • Development of 4.0 MCM/year from Wastewater Reuse.

5 Alternative Solutions

5.1 Introduction

Based on the development options presented above that represent the proposed water resources development plan, some Governorates in a certain planning year has available water resources exceeding targeted demands. On the other hand, other Governorates have a gap in meeting their targeted demands which means that the available water resources are less that the targeted demand quantities. This is true in different planning years and for the two different demand sectors, the public and the agricultural demands. Also, it is worth to mention here that due to the complex settings of Topograhy in West Bank (i.e. not flat area) and due to different aspects of groundwater aquifers with respect to depths, quality and quantity, there is a need to consider reallocateping and reallocation

The above mentioned fact recommends a reallocation of water resources between the districts with excess water supply and those with water deficit. This reallocation can be implemented through different strategic decisions which will form the different transmission alternatives. Nevertheless, the Strategic Decisions are limited to the following two main concepts:

- Development of a transmission system between the different Governorates.
- Reallocation of resources development between governorates.

The concept of reallocation means that PWA will reallocate a certain quantity from one sector, agriculture for example, to another. On the other hand, reallocation also means to reallocate water quantities from one resource to another or reallocate water resources development within the same resource but from one Governorate to another. For example, instead of drilling a 2 MCM/year groundwater well in the Western Aquifer in Tulkarem Governorate, a well of 2 MCM/year will be drilled in Nablus Governorate as a reallocate to that well which is called inter resource reallocation. It is important to mention that this of course will depend on the existing hydro-geological conditions

However, the combination of both concepts could be considered. In addition, and to ensure sustainable water supply services, the PWA vision under any selected alternative is based on a comprehensive interconnection among main water sources used for public water supply which includes wells and springs.

According to the proposed resources development program, Table 19 below shows the quantities that can be shifted from one governorate to another for the different planning years. This means that if in a certain planning year a surplus of water exists in a certain Governorate and a deficit exists in another Governorate then the option exists whether to develop the resources in the Governorate and then convey water to the other or reallocate that quantity to be developed in the Governorate with water deficit. The table shows that some conveyance is needed for a certain planning year but the same conveyance is not needed for later periods which recommend that some re-allocation is a better option than building a conveyance system since It is not feasible to invest with conveyance systems for certain years and then neglect them.

Table 19 Quantities Available for Reallocation or Conveyance Between Governorates (MCM/year)

<table>
<tr><th>Year</th><th>From</th><th>To</th><th>Quantity (MCM/year)</th></tr>
<tr><td>2017</td><td rowspan="4">Bethlehem</td><td rowspan="4">Jerusalem</td><td>3.5</td></tr>
<tr><td>2022</td><td>23.5</td></tr>
<tr><td>2027</td><td>15</td></tr>
<tr><td>2032</td><td>14</td></tr>
<tr><td>2017</td><td>Ramallah</td><td>Jerusalem</td><td>4</td></tr>
<tr><td>2017</td><td>Qalqilia</td><td>Salfit</td><td>1.5</td></tr>
<tr><td>2027</td><td rowspan="2">Qalqilia</td><td rowspan="2">Nablus</td><td>9</td></tr>
<tr><td>2032</td><td>9</td></tr>
<tr><td>2027</td><td rowspan="2">Jericho</td><td rowspan="2">Ramallah</td><td>9</td></tr>
<tr><td>2032</td><td>9</td></tr>
<tr><td>2027</td><td>Tubas</td><td>Jenin</td><td>8</td></tr>
<tr><td>2032</td><td>Salfit</td><td>Nablus</td><td>3</td></tr>
<tr><td>Year</td><td>From</td><td>To</td><td>Quantity (MCM/year)</td></tr>
<tr><td>2017</td><td>Tulkarm</td><td>Jenin</td><td>3.9</td></tr>
<tr><td>2032</td><td>Jericho</td><td>Hebron</td><td>20</td></tr>
<tr><td>2027</td><td rowspan="2">Jenin
(J.R.B)</td><td rowspan="2">Tubas
Nablus
Tulkarm
Salfit</td><td rowspan="2">50 from source</td></tr>
<tr><td>2032</td></tr>
</table>

Based on these facts, three separate solutions describing the infrastructure and location of that infrastructure for delivering water resources from the location of the source to the area of demand were developed and then compared. Each of these alternatives has its advantages and disadvantages over the other alternatives. The following three sections present these alternatives and highlight the main assumptions behind each alternative.

5.2 Alternative 1: Reallocation Alternative

5.2.1 Description

This alternative suggests the re-allocation between the different water resources development in order to minimize the conveyance between the different governorates. In other words, this alternative suggests the re-allocation whenever possible in terms of water resources development. Based on this, Table 20 below shows the needed action in terms of reallocation and conveyance systems to be taken under this alternative

Table 20 Conveyance and Re-allocation Actions for Alternative 1

Year	From	To	Quantity (MCM/year)
2017	Bethlehem	Jerusalem	Reallocation of 3.5 MCM/year of Mekorot water from Bethlehem to Jerusalem
2022			Construction of 20 MCM/year conveyance line with the needed storage and pumping to pump water from Bethlehem to Jerusalem.
2017	Ramallah	Jerusalem	Reallocate of 4 MCM/year of Mekorot water from Ramallah to Jerusalem.
2017	Qalqilia	Salfit	Reallocation of 1.5MCM/year of Western Aquifer groundwater well.
2027	Qalqilia	Nablus	Reallocate of 9 MCM/year of Western Aquifer groundwater wells to Nablus from Qalqilia.
2027	Jericho	Ramallah	Reallocate 9 MCM/year of Jordan River Basin water with the same amount from the Western Aquifer in Ramallah area
2027	Tubas	Jenin	Reallocation of 8 MCM/year of agricultural water in Jenin to public water in Jenin.
2032	Salfit	Nablus	Reallocate of 3 MCM/year of Western Aquifer groundwater wells to Nablus from Salfit.
2017	Tulkarm	Jenin	Irrigate additional area in Tulkarem (some 5000 dunum)
2032	Jericho	Hebron	Reallocation of 20 MCM/year of Jordan River Basin water with 20 MCM/year to Hebron from the Israeli NWC.
2027	Jenin (J.R.B)	Tubas Nablus Tulkarm Salfit	Reallocate of 50 MCM/year of Jordan river water to 4 locations from the Israeli national water carrier.
2032			

5.2.2 Cost Estimates

As part of the evaluation criteria, the cost associated with each alternative were calculated for Comparison purposes. The estimated costs here include the differential cost of this alternative over the other alternatives which means that it only include the costs of the actions needed under this alternative and not under the others. Neither the distribution cost nor the storage cost are included since they will be needed regardless of what alternative is selected and the difference in the storage and the distribution costs is minimal under the considered alternatives. In this alternative, the associated capital costs of the solution are included in Table 21 Below.

Table 21 Anticipated Costs Associated with Alternative 1

Year	From	To	Quantity (MCM/year)	Capital Cost US$
2017	Bethlehem	Jerusalem	Reallocate of 3.5 MCM/year of Mekorot water from Bethlehem to Jerusalem	350,000
2022			Construction of 20 MCM/year (20 km of 30'') of conveyance line with the needed storage and pumping to pump water from Bethlehem to Jerusalem.	6,000,000
2017	Ramallah	Jerusalem	Reallocate of 4 MCM/year of Mekorot water from Ramallah to Jerusalem.	400,000
2017	Qalqilia	Salfit	Reallocate of 1.5MCM/year of Western Aquifer groundwater well.	1,070,000
2027	Qalqilia	Nablus	Reallocate of 9 MCM/year of Western Aquifer groundwater wells to Nablus from Qalqilia.	2,140,000
2027	Jericho	Ramallah	Reallocate 9 MCM/year of Jordan River Basin water with the same amount from the Western Aquifer in Ramallah area	5,350,000
2027	Tubas	Jenin	Reallocation of 8 MCM/year of agricultural water in Jenin to public water in Jenin.	800,000
2032	Salfit	Nablus	Reallocate of 3 MCM/year of Western Aquifer groundwater wells to Nablus from Salfit.	535,000
2017	Tulkarm	Jenin	Irrigate additional area in Tulkarem (some 5000 dunum)	500,000
2032	Jericho	Hebron	REALLOCATE of 20 MCM/year of Jordan River Basin water with 20 MCM/year to Hebron from the Israeli NWC.	2,000,000
2027 2032	Jenin (J.R.B)	Tubas Nablus Tulkarm Salfit	Reallocate of 50 MCM/year of Jordan river water to 4 locations from the Israeli national water carrier.	5,000,000

5.3 Alternative 2: The Full Conveyance Alternative

5.3.1 Description

This alternative suggests the development of all needed conveyance between the different water resources development in order to maximize the freedom of conveying water between the different governorates. In other words, this alternative suggests building the conveyance lines that are needed all over the next 20 planning years assuming that no re-allocation is possible in terms of water resources development. Based on this, Table 22 below shows the needed action in terms of reallocation and conveyance systems to be taken under this alternative.

Table 22 Conveyance and Reallocation Actions for Alternative 2

Year	From	To	Quantity (MCM/year)
2017	Bethlehem	Jerusalem	Reallocate of 3.5 MCM/year of Mekorot water from Bethlehem to Jerusalem
2022			Construction of 20 MCM/year conveyance line with the needed storage and pumping to pump water from Bethlehem to Jerusalem.
2017	Ramallah	Jerusalem	Reallocate of 4 MCM/year of Mekorot water from Ramallah to Jerusalem.
2017	Qalqilia	Salfit	Reallocate of 1.5MCM/year of Western Aquifer groundwater well.
2027	Qalqilia	Nablus	Construction of 9 MCM/year conveyance line with the needed storage and pumping to pump water from Qalqilia to Nablus.
2027	Jericho	Ramallah	Construction of 9 MCM/year conveyance line with the needed storage and pumping to pump water from Jericho to Ramallah.
2027	Tubas	Jenin	Reallocate of 8 MCM/year of agricultural water in Jenin to public water in Jenin.
2032	Salfit	Nablus	Construction of 3 MCM/year conveyance line with the needed storage and pumping to pump water from Salfit to Nablus.
2017	Tulkarm	Jenin	Irrigate additional area in Tulkarem (some 5000 dunum)
2032	Jericho	Hebron	Construction of 20 MCM/year conveyance line of Jordan River Basin water from Jericho to Hebron.
2027	Jenin (J.R.B)	Tubas Nablus Tulkarm Salfit	Construction of 50 MCM/year conveyance system from Jenin to Nablus (9 MCM/year), Tubas (9 MCM/year), Tulkarem (4 MCM/year) and to Salfit (5 MCM/year).

5.3.2 Cost Estimates

Include a table showing the capital costs of the solution, the operational costs and an overall lifetime cost.

As mentioned above, the estimated costs here include the differential cost of this alternative over the other alternatives which means that it only include the costs of the actions needed under this alternative and not under the others. In this alternative, the associated capital cost of the solution is included in Table 23 Below.

Table 23 Anticipated Costs Associated with Alternative 2

Year	From	To	Quantity (MCM/year)	Capital Cost US$
2017	Bethlehem	Jerusalem	Reallocate of 3.5 MCM/year of Mekorot water from Bethlehem to Jerusalem	350,000
2022			Construction of 20 MCM/year conveyance line (20 km of 30") with the needed storage and pumping to pump water from Bethlehem to Jerusalem.	6,000,000
2017	Ramallah	Jerusalem	Reallocate of 4 MCM/year of Mekorot water from Ramallah to Jerusalem.	400,000
2017	Qalqilia	Salfit	Reallocate of 1.5MCM/year of Western Aquifer groundwater well.	1,070,000
2027	Qalqilia	Nablus	Construction of 9 MCM/year conveyance line (32 km of 20") with the needed storage and pumping to pump water from Qalqilia to Nablus.	5,872,000
2027	Jericho	Ramallah	Construction of 9 MCM/year conveyance line (30 km of 20") with the needed storage and pumping to pump water from Jericho to Ramallah.	5,505,000
2027	Tubas	Jenin	Reallocate of 8 MCM/year of agricultural water in Jenin to public water in Jenin.	800,000
2032	Salfit	Nablus	Construction of 3 MCM/year conveyance line (25 km of 20")with the needed storage and pumping to pump water from Salfit to Nablus.	2,750,000
2017	Tulkarm	Jenin	Irrigate additional area in Tulkarem (some 5000 dunum)	500,000
2032	Jericho	Hebron	Construction of 20 MCM/year conveyance line (55 km of 30") of Jordan River Basin water from Jericho to Hebron.	16,500,000
2027	Jenin (J.R.B)	Tubas Nablus Tulkarm Salfit	Construct of 50 MCM/year (10 km of 36" and 30 km of 30" and 15 km of 20" and 30 km of 16") conveyance system from Jenin to Nablus (9 MCM/year), Tubas (9 MCM/year), Tulkarem (4 MCM/year) and to Salfit (5 MCM/year).	20,457,500

5.4 Alternative 3: The Combination Alternative

5.4.1 Description

This alternative suggests the development of all needed conveyance between the different water resources development but also considers the potential to reallocate some resources that are seen reasonable. In other words, this alternative suggests building the conveyance lines that are needed all over the next 20 planning years assuming that a reasonable amount of re-allocation is possible in terms of water resources development. Based on this, Table 24 below shows the needed action in terms of reallocation and conveyance systems to be taken under this alternative.

Table 24 Conveyance and Re-allocating Actions for Alternative 3

Year	From	To	Quantity (MCM/year)
2017	Bethlehem	Jerusalem	Reallocate of 3.5 MCM/year of Mekorot water from Bethlehem to Jerusalem
2022			Construction of 20 MCM/year conveyance line with the needed storage and pumping to pump water from Bethlehem to Jerusalem.
2017	Ramallah	Jerusalem	Reallocate of 4 MCM/year of Mekorot water from Ramallah to Jerusalem.
2017	Qalqilia	Salfit	Reallocate of 1.5MCM/year of Western Aquifer groundwater well.
2027	Qalqilia	Nablus	Reallocate of 9 MCM/year from Western Aquifer Basin in Qalqilia to Nablus area.
2027	Jericho	Ramallah	Construction of 9 MCM/year conveyance line with the needed storage and pumping to pump water from Jericho to Ramallah.
2027	Tubas	Jenin	Reallocate of 8 MCM/year of agricultural water in Jenin to public water in Jenin.
2032	Salfit	Nablus	Reallocate of 3 MCM/year from Western Aquifer Basin in Salfit to Nablus area.
2017	Tulkarm	Jenin	Irrigate additional area in Tulkarem (some 5000 dunum)
2032	Jericho	Hebron	Reallocate of 20 MCM/year of Jordan River Basin water with 20 MCM/year to Hebron from the Western Aquifer
2027	Jenin (J.R.B)	Tubas Nablus Tulkarm Salfit	Construct of 50 MCM/year conveyance system from Jenin to Nablus (9 MCM/year), Tubas (9 MCM/year), Tulkarem (4 MCM/year) and to Salfit (5 MCM/year).

5.4.2 Cost Estimates

As mentioned above, the estimated costs here include the differential cost of this alternative over the other alternatives which means that it only include the costs of the actions needed under this alternative and not under the others. In this alternative, the associated capital cost of the solution is included in Table 25 Below.

Table 25 Anticipated Costs Associated with Alternative 3

Year	From	To	Quantity (MCM/year)	Capital Cost US$
2017	Bethlehem	Jerusalem	Reallocate of 3.5 MCM/year of Mekorot water from Bethlehem to Jerusalem	350,000
2022			Construction of 20 MCM/year conveyance line (20 km of 30") with the needed storage and pumping to pump water from Bethlehem to Jerusalem.	6,000,000
2017	Ramallah	Jerusalem	Reallocate of 4 MCM/year of Mekorot water from Ramallah to Jerusalem.	400,000
2017	Qalqilia	Salfit	Reallocate of 1.5MCM/year of Western Aquifer groundwater well.	1,070,000
2027	Qalqilia	Nablus	Reallocate of 9 MCM/year from Western Aquifer Basin in Qalqilia to Nablus area.	2,140,000
2027	Jericho	Ramallah	Construction of 9 MCM/year conveyance line (30 km of 20") with the needed storage and pumping to pump water from Jericho to Ramallah.	5,505,000
2027	Tubas	Jenin	Reallocate of 8 MCM/year of agricultural water in Jenin to public water in Jenin.	800,000
2032	Salfit	Nablus	Reallocate of 3 MCM/year from Western Aquifer Basin in Salfit to Nablus area.	535,000
2017	Tulkarm	Jenin	Irrigate additional area in Tulkarem (some 5000 dunum)	500,000
2032	Jericho	Hebron	Reallocate of 20 MCM/year of Jordan River Basin water with 20 MCM/year to Hebron from the Western Aquifer	2,000,000
2027	Jenin (J.R.B)	Tubas Nablus Tulkarm Salfit	Construct of 50 MCM/year (10 km of 36" and 30 km of 30" and 15 km of 20" and 30 km of 16") conveyance system from Jenin to Nablus (9 MCM/year), Tubas (9 MCM/year), Tulkarem (4 MCM/year) and to Salfit (5 MCM/year).	20,457,500

5.5 Comparison of Alternatives

To evaluate and compare the three alternatives discussed above, certain criteria were developed that includes the following four main elements:

- Costs (Capital Cost, Operational Cost & Life time Costs)
- Practicality of Plan Implementation
- Practicality of System Operation
- Flexibility of the Plan

This criterion is seen to be a preliminary one and additional variables ought to be included later in the master planning phase including national priorities. The multiple decision criteria analysis was used to reach to the optimal alternative among the three described alternatives. The weights given to each attribute of the criteria is shown below in Table 26.

Table 26 Weights Assigned to Different Elements of the Criteria

Element	Cost	Practicality of Plan implementation	Practicality of System operation	Flexibility of the plan
Weight	0.4	0.2	0.2	0.2

These attributes of the criteria are discussed below in the following two sub-sections.

5.5.1 Costs

Based on the above estimates of the differential costs, Table 27 shows the differential costs of the three alternatives. The score of an alternative is estimated by dividing the minimum cost of each category by the cost of that alternative and then multiply by 10 to get the score out of 10.

Table 27 Costs of Different Alternatives

Alternative	**Capital Cost US$**	**Score**
Alternative 1	24,145,000	10
Alternative 2	60,204,500	4
Alternative 3	39,757,500	6.1

5.5.2 Advantages and Disadvantages of Alternatives

Based on the different components of the alternatives, assumptions behind each alternative and the prevailing political and socio-economic conditions, the three alternatives have different advantages and disadvantages. These are summarized in Table 28 below for the different alternatives and for the different criteria elements.

Table 28 Advantages and Disadvantages of Alternatives

Alternative	Alternative 1	Alternative 2	Alternative 3
Practicality of Plan implementation	1. Uncertainty in the ability to develop groundwater resources in certain locations such as the 9 MCM/year from the Western Aquifer in Nablus instead of Qalqilia and 3 MCM/year also to Nablus from Salfit. 2. Uncertainty in the Israeli approval during the first planning years to reallocate 9 MCM/year of Jordan River Basin to Western Aquifer Basin or the reallocation of 20 MCM/year to Hebron from the Western Aquifer Basin instead of 20 MCM/year from Jordan River Basin. 3. The need to drill deeper wells or more wells in areas such as in Nablus western aquifer basin to reach the same quantities.	1. Less Uncertainty in the ability to develop groundwater resources in certain locations. 2. No need to drill deeper wells due to re-allocation of water sources options. 3. The implementation of the plan during the first planning years can be considered impractical if area C is considered since most of the conveyance system is within area C. 4. Some pipe diameters needed have not been installed before which creates a challenge for local experts to implement such plan.	1. The most relative certain alternative in terms of developing groundwater resources in certain locations. 2. Less reliance on Israeli approval to reallocation. 3. No need to drill deeper wells or more wells in areas such as in Nablus western aquifer basin to reach the same quantities. 4. Some pipe diameters needed have not been installed before which creates a challenge for local experts to implement such plan.

Practicality of System Operation	1. Minimum water transmission distance which will reduce the potential to pollution. 2. Minimum water transmission distances which will reduce the physical losses in the transmission lines. 3. This alternative has the highest practicality in operation given the minimum pumping and transmission efforts compared to other activities.	1. This alternative has the largest water transmission distance which will increase the potential to pollution. 2. The relatively large water transmission distances will increase the physical losses in the transmission lines. 3. This alternative has a moderate practicality in operation despite the large distances needed for water to be conveyed from one location to another.	1. This alternative has the highest practicality among the three alternatives. 2. Physical losses is moderate compared to alternative 2 but there is a higher potential for physical losses compared to alternative. 3. This alternative also has a high practicality in operation compared to alternative 2.
Flexibility of Plan	1. This alternative is less flexible compared to the other two alternatives since the reallocateping is only possible in certain locations within the different Governorates. Utilization zones are limited in some Governorates where water rights has been re-allocated	1. This alternative has the highest flexibility among the three alternatives. Possibility to reallocate quantities from one option to another is higher in this alternative since the proposed conveyance system can be used to allocate water quantities between the different Governorates in case of changes in planning options. The developed conveyance system will give the water providers to distribute water close to the optimal point	1. This alternative has moderate flexibility among the three alternatives. Both the proposed conveyance system and the Possibility to reallocate quantities from one option to another give this alternative a fair degree of flexibility.

Based on the above table of advantages and dis-advantages, the following Table 29shows the score of each alternative for the different attributes:

Table 29 Score of Each Alternative for the Different Attributes

Alternative	Alternative 1	Alternative 2	Alternative 3
Practicality of Plan implementation	5	9	8
Practicality of System Operation	7	5	9
Flexibility of Plan	5	6	9

Based on these scores and the proposed weight of each attribute, table 30 shows the final score of each alternative. The Table shows that alternative 3 has the highest score among the three alternatives which recommends the adaptation of alternative 3 which combines both reallocation and conveyance between different Governorates.

Table 30 Score of Each Alternative According to Weights Assigned

Element	Cost	Practicality of Plan implementation	Practicality of System operation	Flexibility of the plan	Total Score of Alternative
Alternative 1	4.0	1.0	1.4	1.0	**7.4**
Alternative 2	1.6	1.8	1.0	1.2	**5.6**
Alternative 3	2.44	1.6	1.8	1.8	**7.64**

5.6 Recommended Solution for Further Development

A short workshop was held with more than 15 stakeholders representing both governmental and non-governmental organizations on the 26th of December to explain and discuss the alternatives and the advantages and disadvantage of the alternative solutions. Based upon the discussions in the workshop and the comparisons included in the above sections, the combination of both reallocation and conveyance, Alternative 3, was proposed as the most reasonable solution to be developed into a more detailed solution. Two more points were mentioned to be considered for the master planning phase. Those are the possibility of building a national carrier that would connects all parts of the West Bank and the other was to create three loops conveyance system for the north, central and southern parts of the West Bank. It was also discussed that the three alternatives will be re-run using the capabilities of MYWAS-WEAP model. The above decision was based on many reasons including the following:

1. The most relative certain alternative in terms of developing groundwater resources in certain locations.
2. Less reliance on Israeli approval to reallocation and reallocation.
3. No need to drill deeper wells or more wells in areas such as in Nablus western aquifer basin to reach the same quantities.
4. The alternative has the highest practicality among the three alternatives.
5. This alternative has moderate flexibility among the three alternatives. Both the proposed conveyance system and the Possibility to reallocate quantities from one option to another give this alternative a fair degree of flexibility.

Finally it should be emphasized that this selection of alternative is only to give the master planning team the general vision and direction on how to proceed with the development of the master plans both on the regional and national levels. It is expected that further evaluation and analysis based on a more detailed criteria will be needed to evaluate the different developmental actions within the above agreed upon alternative.

6 Details of the Plan

6.1 Introduction

The transmission plan selected above, alternative 3, is further developed to include probable pipe routes and diameters and the locations of export and import points into a region. These are all developed based on the assumption that all water resources proposed in the prepared strategy and policy will be implemented as planned.

Based on the developed action, a staged implementation plan for the development of water transmission delivery infrastructure is prepared so that it is in place at the time it is required. Based on the staged implementation plan, a more detailed capital and operational cost estimate are prepared in the form of a cash flow forecast.

6.2 Water Resources Development

Based on the water strategy and policy, the following Table 31 and Table 32 present the time frame for the different water resources development actions for both public and agricultural resources respectively. This time frame shows the actions needed for water resources development in addition to all other needed actions to accompany the resources development actions such as storage, distribution and treatment. The transmission, reallocating and reallocation actions are separated in the next section in the form of a transmission plan.

Table 31 Strategic Water Resources Development Plan for Public Supply

Governorate	Resource Development Actions	Start Up Year	OperationYear
Jenin	• Import of 2.0 MCM/year additional quantity. • Development of 5 MCM/year of groundwater wells from the North Eastern Aquifer Basin.	2014 2016	2015 2017
Nablus	• Import of 0.4 MCM/year additional quantity. • Development of 3 MCM/year of groundwater wells from the North Eastern Aquifer Basin.	2015 2016	2016 2017
Tubas	• Development of 1.6 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.11 MCM/year from the groundwater springs in the North Eastern Aquifer Basin.	2015 2014	2016 2014
Tulkarm	• Import of 0.5 MCM/year additional quantity.	2015	2015
Salfit	• Import of 2.5 MCM/year additional quantity. • Development of 0.11 MCM/year of groundwater springs from the Western Aquifer Basin.	2015 2014	2016 2014
Jericho	• Import of 2.0 MCM/year additional quantity. • Development of 2 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.5 MCM/year from brackish water desalination.	2015 2016 2014	2016 2017 2015
Ramallah -Al Bireh	• Import of 1.5 MCM/year additional quantity. • Development of 0.2 MCM/year of groundwater wells from the Eastern Aquifer Basin by rehabilitation of existing wells.	2015 2015	2016 2015
Jerusalem[1]	• Import of 1.4 MCM/year additional quantity.	2015	2015
Hebron	• Import of 5.5 MCM/year additional quantity. • Development of 3 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 2.0 MCM/year of groundwater from the Eastern Aquifer Basin.	2014 2016 2015	2016 2017 2016
Bethlehem	• Import of 0.4 MCM/year additional water quantity. • Development of 2.0 MCM/year of groundwater from the Eastern Aquifer Basin.	2015 2016	2016 2017
Jenin	• Development of 2 MCM/year of groundwater wells from the North Eastern Aquifer Basin.	2018	2019
Nablus	• Development of 0.5 MCM/year of groundwater wells from the North Eastern Aquifer Basin.	2019	2019
Tubas	• Development of 0.4 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.5 MCM/year from brackish water desalination.	2019 2020	2019 2020
Tulkarm	• Development of 2.5 MCM/year of groundwater wells from the Western Aquifer Basin.	2020	2021
Qalqilyia	• Development of 2.5 MCM/year of groundwater wells from the Western Aquifer Basin.	2021	2022

Salfit	• Development of 1 MCM/year of groundwater wells from the Western Aquifer Basin.	2019	2020
Jericho	• Development of 0.5 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.3 MCM/year from groundwater springs in the eastern Aquifer Basin.	2018 2019	2018 2019
Hebron	• Development of 20 MCM/year from Al-Fashkha brackish water springs desalination. • Development of 2.0 MCM/year of groundwater wells from the Western Aquifer Basin.	2020 2019	2022 2020
Bethlehem	• Development of 20 MCM/year from Al-Fashkha brackish water springs desalination. • Development of 2.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 4.0 MCM/year of groundwater wells from the Eastern Aquifer Basin.	2020 2021 2018	2022 2022 2019
Jenin	• Development of 5 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.	2025 2023	2027 2024
Nablus	• Development of 4.0 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin.	2023 2026	2024 2027
Tubas	• Development of 5.0 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin.	2025 2023	2026 2024
Tulkarm	• Development of 10.0 MCM/year of groundwater wells from the Western Aquifer Basin.	2025	2027
Qalqilyia	• Development of 11.0 MCM/year of groundwater wells from the Western Aquifer Basin.	2025	2027
Salfit	• Development of 4.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.11 MCM/year of groundwater springs from the Western Aquifer Basin.	2024 2023	2025 2023
Jericho	• Development of 1.6 MCM/year of groundwater wells from the Eastern Aquifer Basin and relocate 1.4 from agricultural supply wells to public. • Development of 0.5MCM/year from rainwater harvesting.	2023 2025	2024 2026
Ramallah -Al Bireh	• Development of 3.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.1MCM/year from rainwater harvesting.	2024 2023	2025 2023
Jerusalem[1]	• Development of 2.0 MCM/year of groundwater wells from the Western Aquifer Basin.	2026	2027
Hebron	• Development of 5 MCM/year from groundwater wells in the Western Aquifer basin. • Development of 1.0 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Convert 10 MCM/year of Al-Fashkha water from Bethlehem.	2025 2023 2026	2027 2023 2027
Bethlehem	• Development of 3 MCM/year from groundwater wells in the Western Aquifer basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin.	2026 2024	2027 2025
Jenin	• Development of 15 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 4.5 MCM/year of groundwater springs from the North Eastern Aquifer Basin.	2028 2028	2032 2030

	• Development of 0.5 MCM/year from Rainwater Harvesting.	2028	2028
Nablus	• Development of 11 MCM/year of groundwater wells from the North Eastern Aquifer Basin. • Development of 0.15 MCM/year of groundwater springs from the North Eastern Aquifer Basin. • Development of 5 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.	2028 2028 2031 2028	2032 2028 2032 2028
Tubas	• Development of 3 MCM/year of groundwater wells from the North Eastern Aquifer Basin and relocate of 3 MCM/year from agricultural groundwater wells. • Development of 1.9 MCM/year of groundwater springs from the North Eastern Aquifer Basin. • Development of 15 MCM/year of groundwater wells from the Eastern Aquifer Basin.	2028 2030 2028	2029 2031 2032
Tulkarm	• Development of 20.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.	2028 2028	2032 2028
Qalqilyia	• Development of 20.0 MCM/year of groundwater wells from the Western Aquifer Basin. • Development of 0.5 MCM/year from Rainwater Harvesting.	2028 2028	2032 2028
Salfit	• Development of 5.0 MCM/year of groundwater wells from the Western Aquifer Basin.	2028	2032
Jericho	• Development of 5.0 MCM/year of groundwater wells from the Eastern Aquifer Basin. • Development of 0.5MCM/year from rainwater harvesting.	2028 2028	2030 2028
Ramallah -Al Bireh	• Development of 0.9 MCM/year of groundwater springs from the Eastern Aquifer Basin. • Development of 0.4 MCM/year from rainwater harvesting.	2028 2029	2028 2029
Jerusalem[1]	• Development of 3.0 MCM/year of groundwater wells from the Western Aquifer Basin.	2031	2031
Hebron	• Development of 10.0 MCM/year from groundwater wells in the Western Aquifer basin. • Development of 3.0 MCM/year from groundwater wells in the Eastern Aquifer Basin.	2028 2031	2032 2032
Bethlehem	• Development of 5 MCM/year from groundwater wells in the Eastern Aquifer basin.	2028	2030

Table 32 Strategic Water Resources Development Plan for Agricultural Supply

Governorate	Resource Development Actions	Start Up Year	Operation Year
Jenin	• Development of 1.0 MCM/year from groundwater wells in the North Eastern Aquifer Basin. • Development of 1.2 MCM/year from Wastewater Reuse.	2016 2015	2017 2016
Nablus	• Development of 1.0 MCM/year from groundwater wells in the Eastern Aquifer Basin. • Development of 0.2 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.	2015 2014 2014	2016 2014 2015
Tubas	• Development of 2.0 MCM/year from groundwater wells in the North Eastern Aquifer Basin. • Development of 1.0 MCM/year from groundwater wells in the Eastern Aquifer Basin. • Development of 0.2 MCM/year from rainwater harvesting. • Development of 0.3 MCM/year from Wastewater Reuse.	2016 2015 2014 2016	2017 2016 2014 2016
Jericho	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 0.5 MCM/year from Wastewater Reuse.	2015 2016	2016 2017
Ramallah -Al Bireh	• Development of 0.9 MCM/year from Wastewater Reuse.	2014	2014
Hebron	• Development of 0.1 MCM/year from rainwater harvesting. • Development of 0.3 MCM/year from Wastewater Reuse.	2014	2014
Jenin	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 4.0 MCM/year from Wastewater Reuse.	2018 2019	2018 2021
Nablus	• Development of 1.0 MCM/year from groundwater wells in the North Eastern Aquifer Basin. • Development of 0.5 MCM/year from rainwater harvesting. • Development of 6.0 MCM/year from Wastewater Reuse.	2018 2019 2020	2019 2019 2021
Tubas	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 2.2 MCM/year from Wastewater Reuse.	2019 2020	2019 2022
Tulkarm	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.	2018 2019	2018 2020
Qalqilyia	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 1.5 MCM/year from Wastewater Reuse.	2018 2020	2018 2022
Salfit	• Development of 0.5 MCM/year from rainwater harvesting.	2018	2018

	• Development of 1.0 MCM/year from Wastewater Reuse.	2020	2022
Jericho	• Development of 1.0 MCM/year from Wastewater Reuse.	2018	2019
Ramallah -Al Bireh	• Development of 2.3 MCM/year from Wastewater Reuse.	2018	2020
Hebron	• Development of 0.9 MCM/year from rainwater harvesting. • Development of 7.7 MCM/year from Wastewater Reuse.	2019 2018	2020 2022
Bethlehem	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.	2018 2020	2019 2021
Jenin	• Development of 20 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 3.0 MCM/year from Wastewater Reuse.	2024 2023 2025	2027 2024 2027
Nablus	• Development of 10.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 3.0 MCM/year from Wastewater Reuse.	2024 2023 2025	2027 2024 2027
Tubas	• Development of 20.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 1.5 MCM/year from Wastewater Reuse.	2024 2024 2025	2027 2024 2026
Tulkarm	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.	2024 2026	2025 2027
Qalqilyia	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.	2024 2026	2025 2027
Salfit	• Development of 0.5 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.	2024 2026	2025 2027
Jericho	• Reallocation of 1.4 MCM/year from groundwater wells in the Eastern aquifer Basin to Public Supply. • Development of 30.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 2.5 MCM/year from Wastewater Reuse.	2023 2024 2023 2025	2023 2027 2024 2027
Ramallah -Al Bireh	• Development of 1.3 MCM/year from Wastewater Reuse.	2024	2025
Jerusalem[1]	• Development of 2.0 MCM/year from Wastewater Reuse.	2026	2027
Hebron	• Development of 0.5 MCM/year from rainwater harvesting.	2023	2023

	• Development of 7.5 MCM/year from Wastewater Reuse.	2024	2027
Bethlehem	• Development of 1.0 MCM/year from Wastewater Reuse.	2026	2027
Jenin	• Development of 50 MCM/year from Jordan River Basin. • Development of 2.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.	2028 2028 2029	2032 2029 2030
Nablus	• Development of 40.0 MCM/year from Jordan River Basin. • Development of 1.0 MCM/year from rainwater harvesting. • Development of 6.0 MCM/year from Wastewater Reuse.	2028 2029 2031	2032 2030 2032
Tubas	• Reallocation of 3 MCM/year from groundwater wells in the North eastern aquifer Basin to public supply. • Development of 60.0 MCM/year from Jordan River Basin. • Development of 2.0 MCM/year from rainwater harvesting. • Development of 1.0 MCM/year from Wastewater Reuse.	2028 2028 2029 2031	2029 2032 2030 2032
Tulkarm	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.	2028 2030	2029 2031
Qalqilyia	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 1.5 MCM/year from Wastewater Reuse.	2030 2028	2031 2029
Salfit	• Development of 3.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.	2028 2030	2029 2031
Jericho	• Development of 70.0 MCM/year from Jordan River Basin. • Development of 5.0 MCM/year from rainwater harvesting. • Development of 2.0 MCM/year from Wastewater Reuse.	2028 2030 2028	2032 2031 2029
Ramallah -Al Bireh	• Development of 2.0 MCM/year from rainwater harvesting. • Development of 3.5 MCM/year from Wastewater Reuse.	2028 2030	2029 2031
Jerusalem[1]	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 3.0 MCM/year from Wastewater Reuse.	2030 2028	2031 2029
Hebron	• Development of 1.0 MCM/year from rainwater harvesting. • Development of 7.5 MCM/year from Wastewater Reuse.	2028 2030	2029 2031
Bethlehem	• Development of 0.5 MCM/year of groundwater springs in the Western Aquifer Basin • Development of 1.5 MCM/year from rainwater harvesting. • Development of 4.0 MCM/year from Wastewater Reuse.	2028 2020 2030	2028 2029 2031

6.3 The strategic Transmission Plan and Its Costs

The strategic plan has been developed based on the above assumptions and selected alternative and also based on the proposed water resources development program in the strategy and policy. Table 33 below shows the actions to be taken to develop the transmission plan in addition to the proposed starting and completion year for each action. These actions are also presented in Annex 2 Figures.

The total construction cost as shown in Table 33 below is 39,757,500 US$. This cost only includes the costs of construction of the transmission lines and the additional construction cost associated with re-allocation. Other costs including the development of the resources itself, the construction of the treatment plants and all storage costs are not included and will be estimated according to the master planning.

Concerning the cost of the transmission, reallocation and reallocateping actions, this cost is distributed over the next 20 years with a total value of 39,757,500 US$ as mentioned above.

Table 33 Strategic Transmission Plan of Action

Year	Description	Capital Cost US$	Start Up Year	Operation Year
2017	Reallocate of 3.5 MCM/year of Mekorot water from Bethlehem to Jerusalem	350,000	2017	2018
2022	Construction of 20 MCM/year conveyance line (20 km of 30") with the needed storage and pumping to pump water from Bethlehem to Jerusalem.	6,000,000	2020	2022
2017	Reallocate of 4 MCM/year of Mekorot water from Ramallah to Jerusalem.	400,000	2017	2018
2017	Reallocate of 1.5MCM/year of Western Aquifer groundwater well.	1,070,000	2015	2016
2027	Reallocate of 9 MCM/year from Western Aquifer Basin in Qalqilia to Nablus area.	2,140,000	2026	2027
2027	Construction of 9 MCM/year conveyance line (30 km of 20") with the needed storage and pumping to pump water from Jericho to Ramallah.	5,505,000	2025	2027
2027	Reallocate of 8 MCM/year of agricultural water in Jenin to public water in Jenin.	800,000	2024	2025
2032	Reallocate of 3 MCM/year from Western Aquifer Basin in Salfit to Nablus area.	535,000	2031	2032
2017	Irrigate additional area in Tulkarem (some 5000 dunum)	500,000	2015	2016
2032	REALLOCATE of 20 MCM/year of Jordan River Basin water with 20 MCM/year to Hebron from the Israeli NWC.	2,000,000	2031	2032
2027	Construct of 50 MCM/year (10 km of 36" and 30 km of 30" and 15 km of 20" and 30 km of 16") conveyance system from Jenin to Nablus (9 MCM/year), Tubas (9 MCM/year), Tulkarem (4 MCM/year) and to Salfit (5 MCM/year).	20,457,500	2023	2027

7 Summary and Recommendations

This transmission plan is based totally on the developed strategy and policy of the water sector in Palestine. All demand and supply values are taken from the strategy and policy. The plan did consider different alternatives for bridging the water gap on the Governorate level. These alternatives include the concepts of conveyance, reallocation and reallocating either within the same water resource or between two water resources.

Based on preliminary criteria and the feedback from PWA senior staff and other water sector stakeholders, the more preferable alternative has been selected. The investment cost of the transmission plan is 39,757,500 US$. This cost includes only the cost of the actions within the transmission plan and not the cost of developing the resource neither the storage cost.

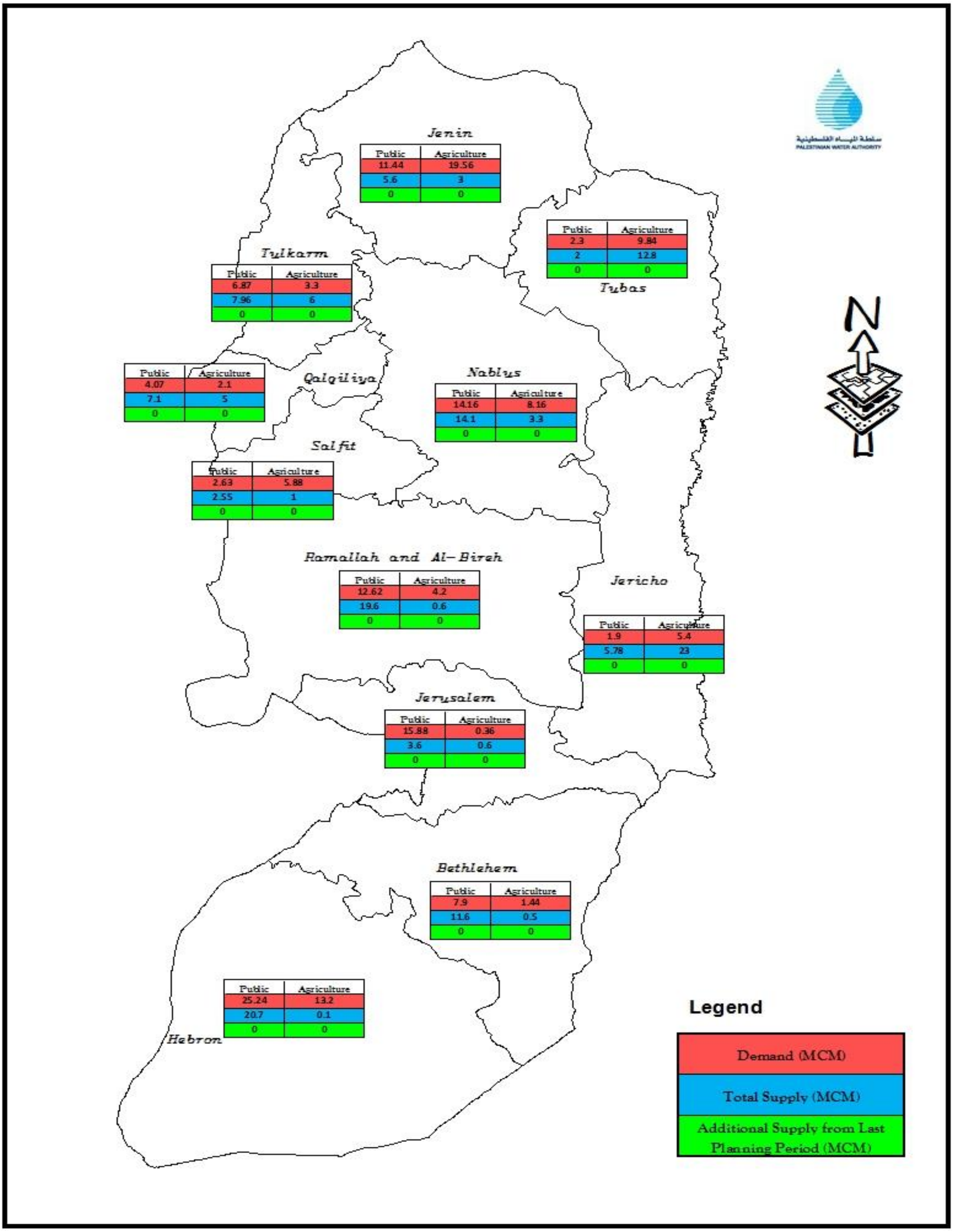
Based on the above, the following are the main recommendations and recommended future steps:

1. This transmission plan gives the framework that should be used together with the water strategy and policy to develop any future master plans.
2. The criteria used to evaluate the different alternatives should be further developed to be used for any future master planning exercises.
3. The unit costs included in the water strategy should form the basis for any future cost estimates.
4. According to the workshop outcome, the plan needs to be made more dynamic and be periodically tested through the utilization of the MYWAS-WEAP planning tool being developed at PWA at present.
5. The following are the main future steps to be considered:

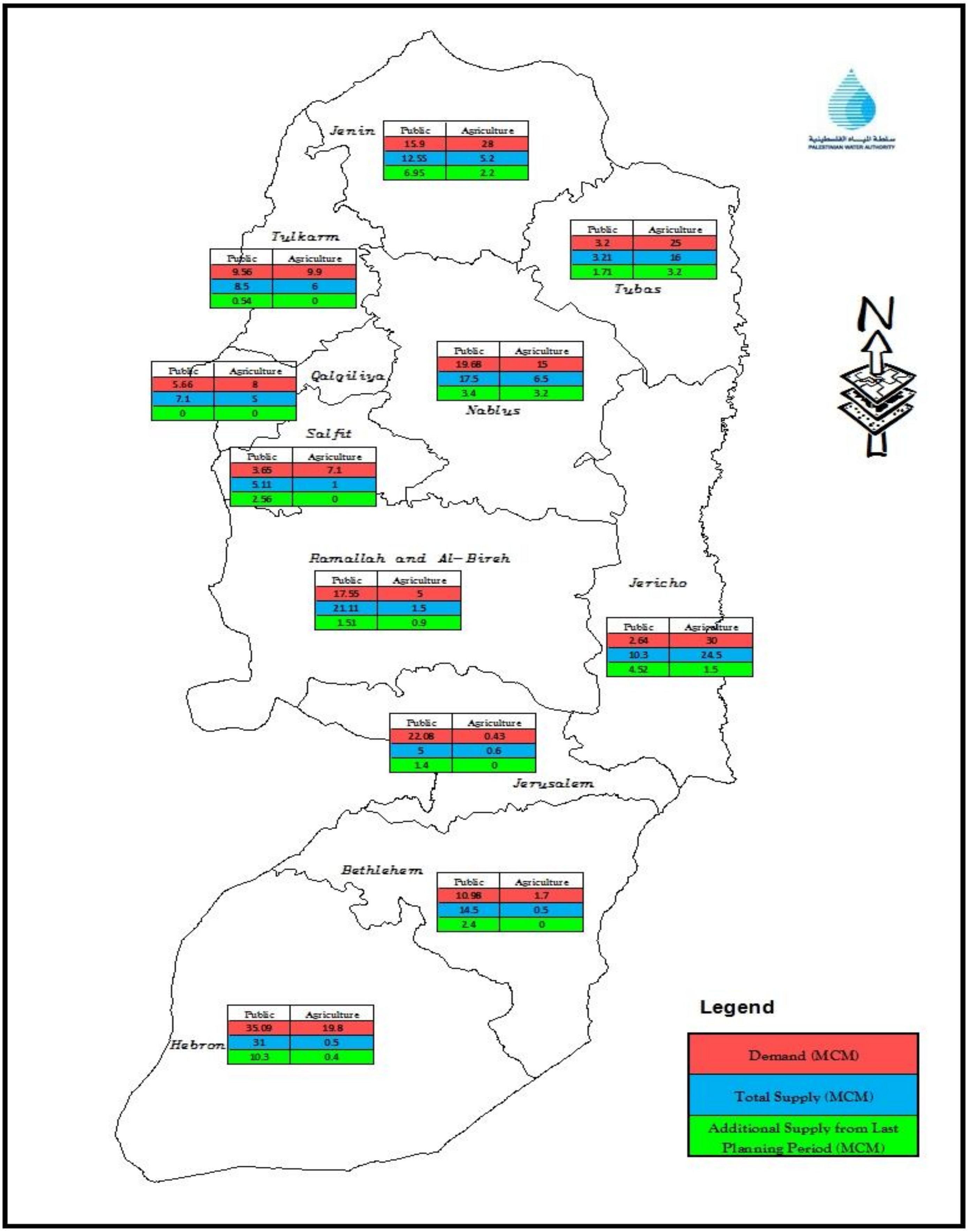
   - There is a need to conduct a feasibility study to evaluate in depth the possibility to consider a full conveyance system that connects all West Bank Governorates.
   - There is a need to develop a background document regarding the reallocation policy.
   - Using the prepared water strategy, policy and this transmission policy, there is a need to proceed with developing a master plan for the West Bank and Gaza.

Appendix 1 Maps of water Demand and Available Water Resources

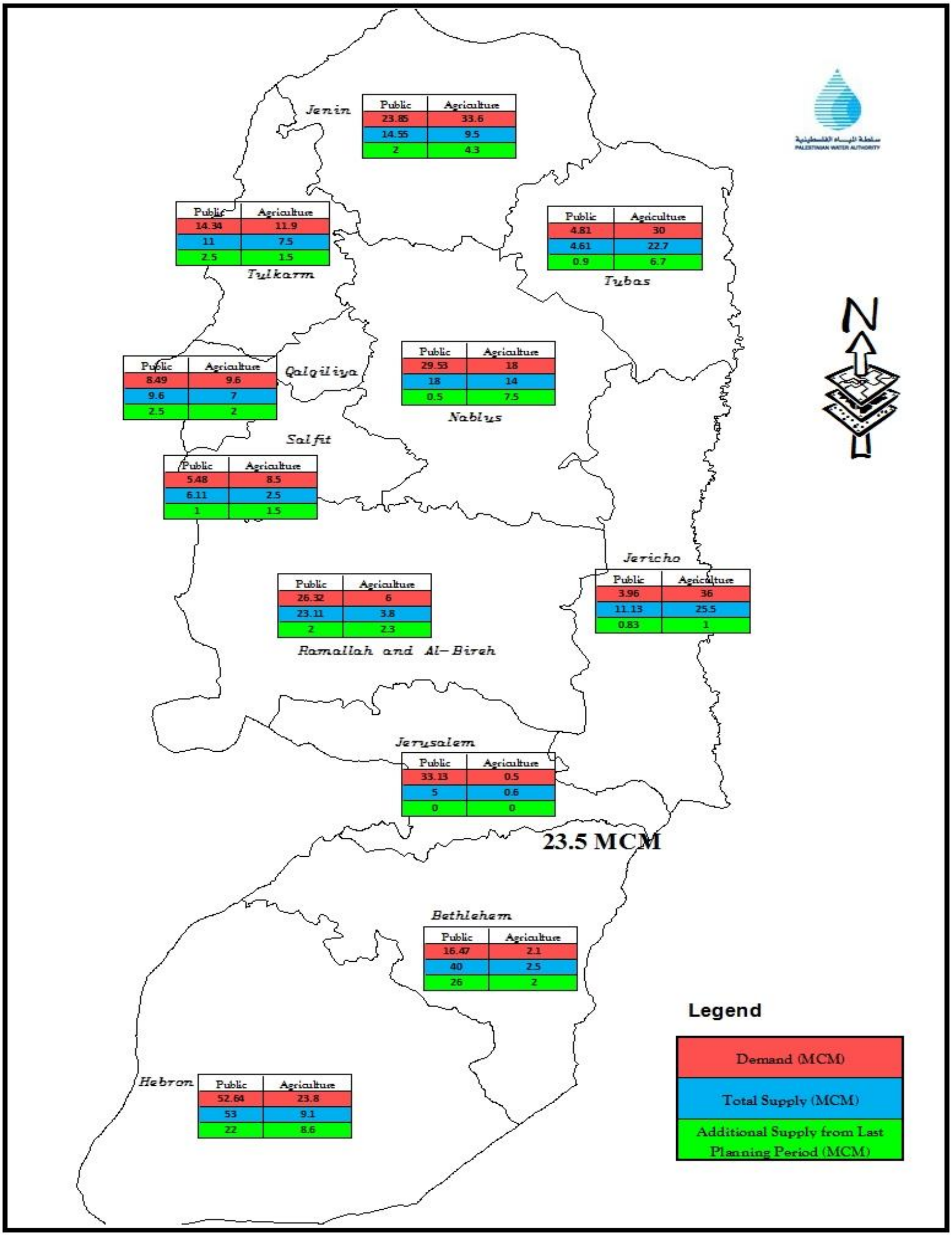
Water Demand, Supply and Additional Supply by the Palnning Year 2012



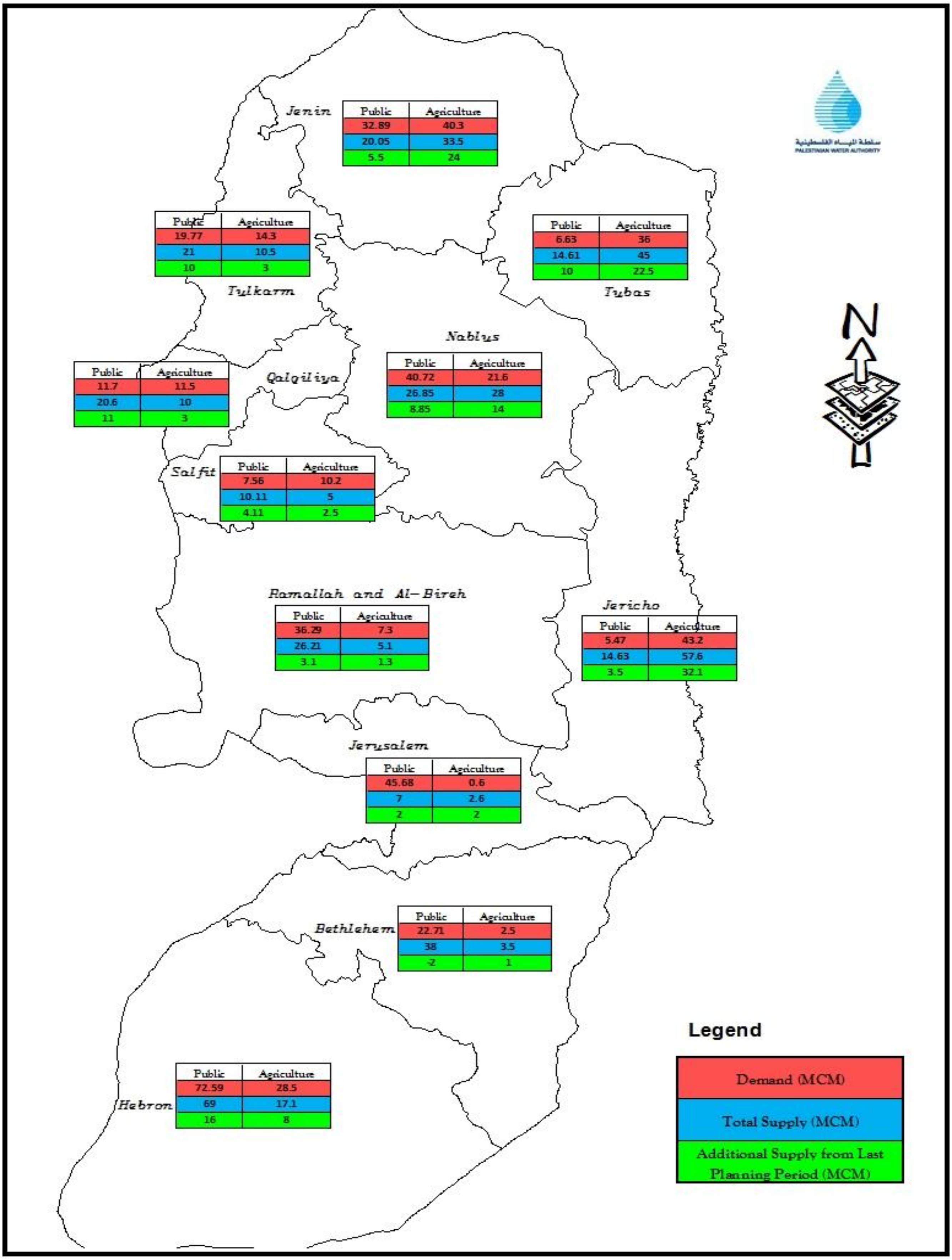
Water Demand, Supply and Additional Supply by the Palnning Year 2017



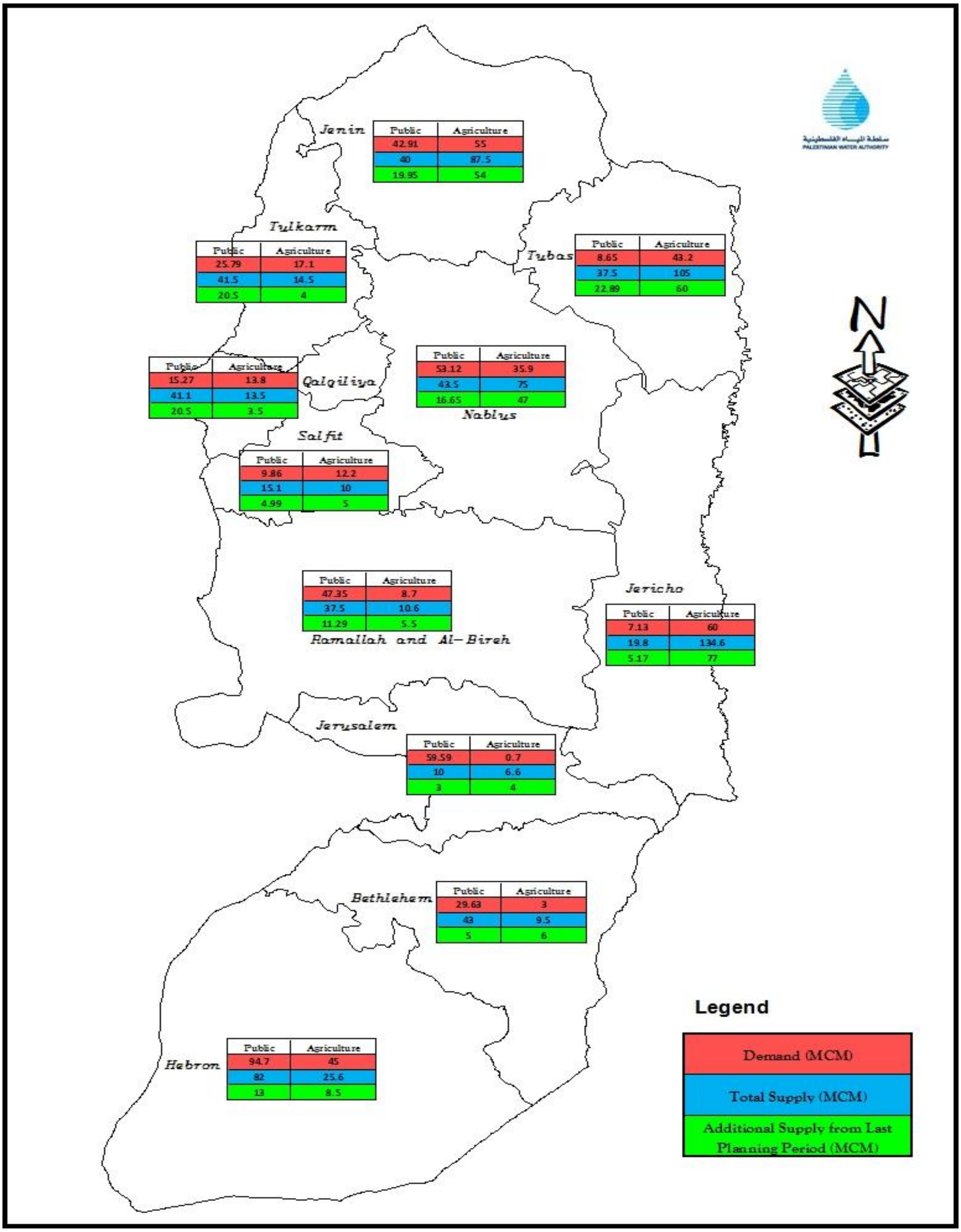
Water Demand, Supply and Additional Supply by the Palnning Year 2022



Water Demand, Supply and Additional Supply by the Palnning Year 2027

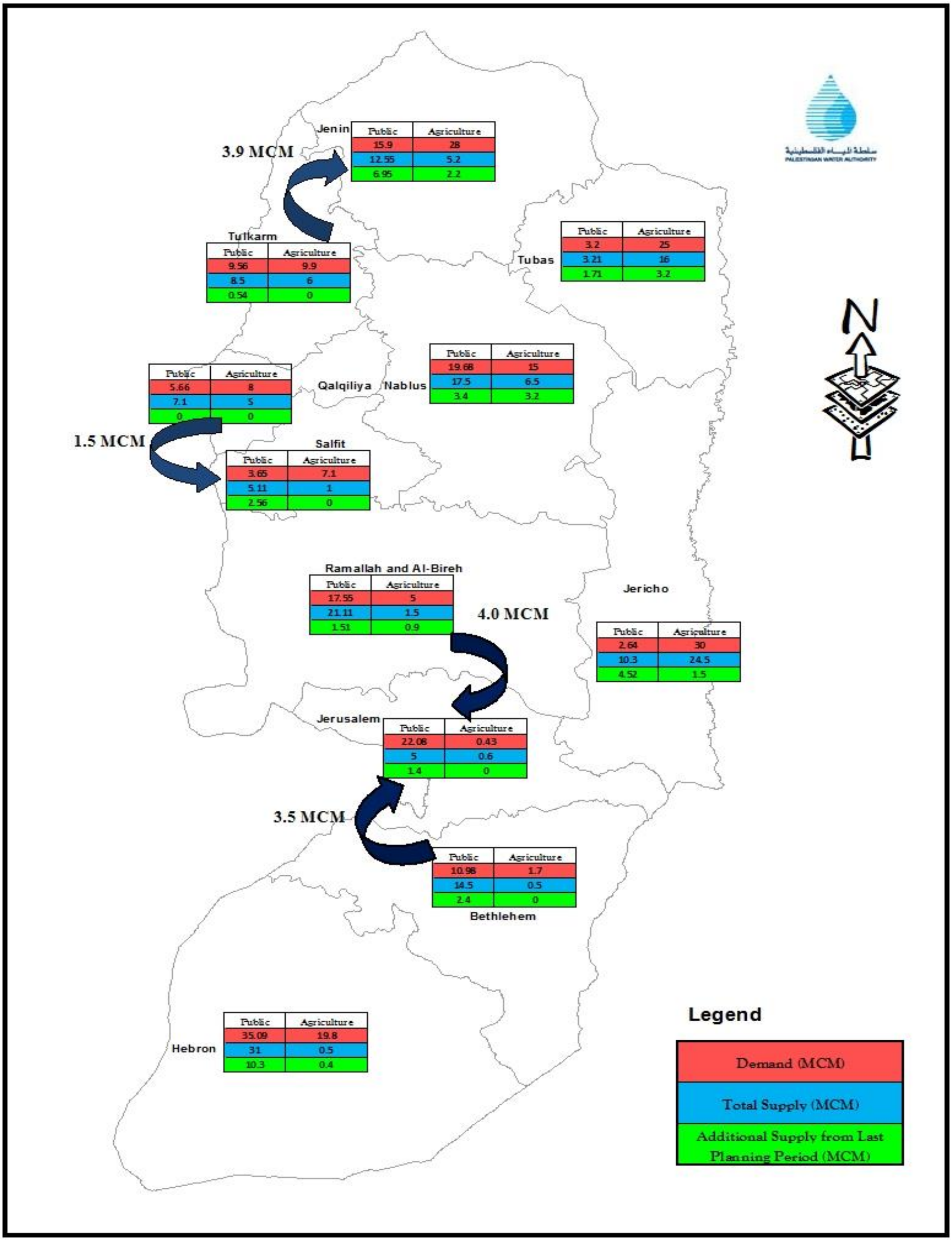


Water Demand, Supply and Additional Supply by the Palnning Year 2032

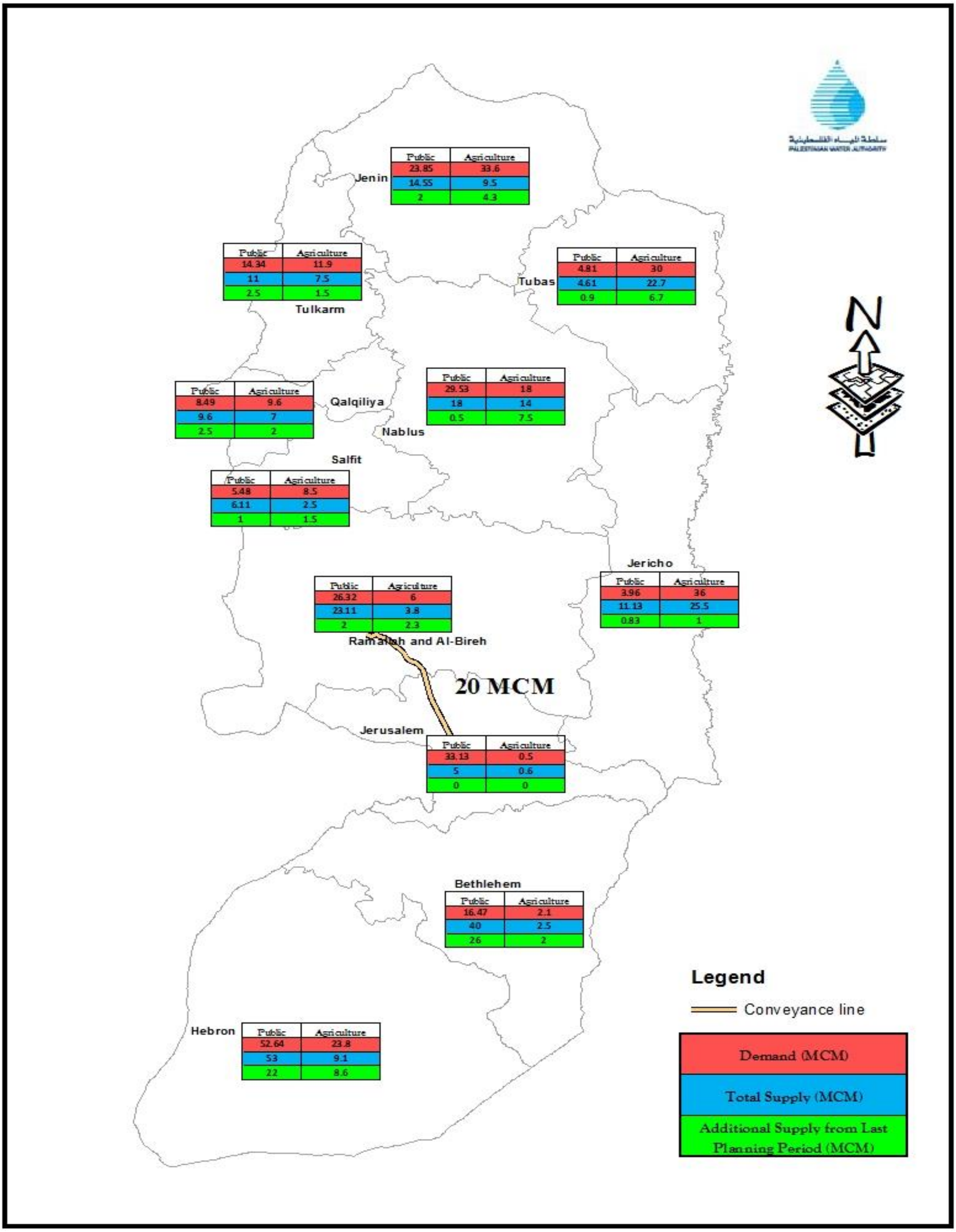


Appendix 2 Maps Showing the Proposed Reallocating and Transmission Actions

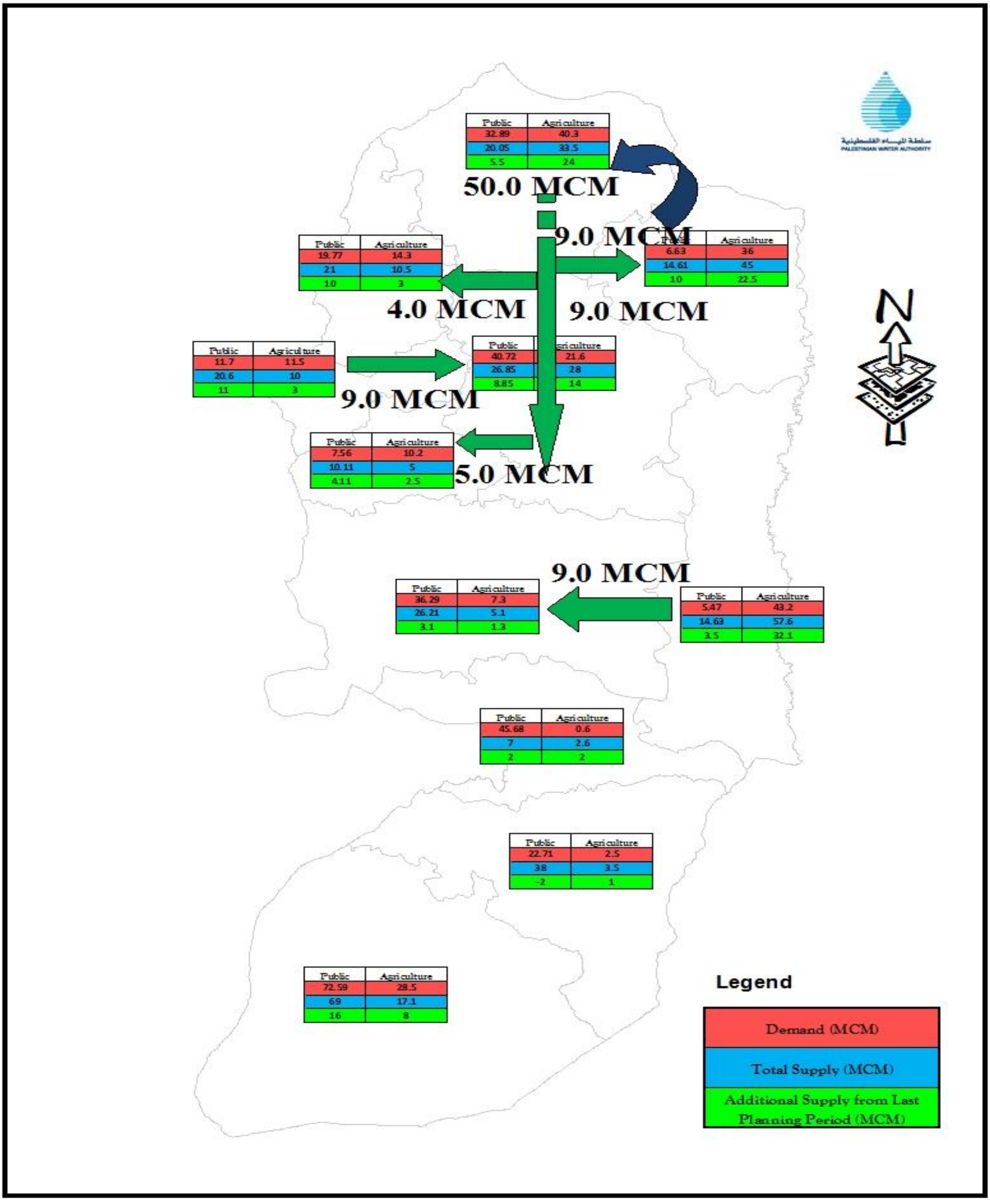
Reallocateping and Transmission Actions by the Year 2017



Reallocating and Transmission Actions by the Year 2022



reallocating and Transmission Actions by the Year 2027



Reallocating and Transmission Actions by the Year 2032