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NEW EDEN MASTER PLAN  
FOR INTEGRATED WATER RESOURCES  
MANAGEMENT IN THE MARSHLANDS AREA

Volume III  
Implementation Plans

Book 7  
Water and Sanitation assets  
Annex IV  
DETAILED INVESTMENT/O&M COSTS FOR THE  
WATER SUPPLY SECTOR

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# ***DETAILED INVESTMENT/O&M COSTS FOR THE WATER SUPPLY SECTOR***

## FOREWORD

Annex IV of Book 7 includes the detailed data related to the investment and O&M costs assessments developed for each scenario that were considered for the water supply sector.

Table 1 describes the different alternatives evaluated with the study for the water supply sector: the reference scenario (Scenario 5 for both centralized and decentralized options) is highlighted in green.

| Scenario | Scheme configuration | Water treatment plants | Per capita water provision (l/cap/d) | Water provision for pipes sizing (l/cap/d) | Treated water salinity (mg/l TDS) |
|----------|----------------------|------------------------|--------------------------------------|--|-----------------------------------|
| 1        | Decentralized        | Existing               | 50                                   | 50   | 1,000                             |
| 2        | Decentralized        | Existing\New           | 50                                   | 250/360/450                                | 1,000                             |
|          | Centralized          | Existing\New           | 50                                   | 250/360/450                                | 1,000                             |
| 3        | Decentralized        | Existing\New           | 200                                  | 250/360/450                                | 1,000                             |
|          | Centralized          | Existing\New           | 200                                  | 250/360/450                                | 1,000                             |
| 4        | Decentralized        | Existing\New           | 200                                  | 250/360/450                                | 800                               |
|          | Centralized          | Existing\New           | 200                                  | 250/360/450                                | 800                               |
| 5        | Decentralized        | Existing\New           | 250/360/450                          | 250/360/450                                | 800                               |
|          | Centralized          | Existing\New           | 250/360/450                          | 250/360/450                                | 800                               |
| 6        | Decentralized        | New                    | 250/360/450                          | 250/360/450                                | 800                               |
|          | Centralized          | New                    | 250/360/450                          | 250/360/450                                | 800                               |
| 7        | Decentralized        | Existing\New           | 250/360/450                          | 250/360/450                                | 500                               |
|          | Centralized          | Existing\New           | 250/360/450                          | 250/360/450                                | 500                               |
| 8        | Decentralized        | Existing\New           | 200/250                              | 200/250                                    | 800                               |
|          | Centralized          | Existing\New           | 200/250                              | 200/250                                    | 800                               |

Table 1: Basic characteristics of the scenarios evaluated for the water supply sector

The investment and O&M costs for each scenario were evaluated. Considering the large extent of the study area and the considerable number of settlements involved, in order to facilitate the evaluation of the different scenarios, the New Eden Team developed specific GIS procedures that can be used both for the sizing of the infrastructure assessed and the investment/O&M costs associated with each alternative being considered.

The procedure is a very flexible, user-friendly tool that will help the MoMPW staff with future updates/modifications to the evaluations supplied by the New Eden Team and for the

development of the final version of the water and sanitation Master Scheme for the southern governorates.

In particular the GIS procedure is very helpful in comparing different alternatives (as for example the centralized/decentralized configurations) and in performing quick assessments of the effect of the modification of basic planning criteria (population growth rate, per-capita water provision, treated water quality etc.) on the investment and O&M costs.

Moreover, in order to complete the analysis and identify the most cost-effective approach, the investment and O&M costs of the different scenarios were combined through the calculation of the capitalized cost at different capitalization rates.

A useful comparison between the two different approaches (centralized and decentralized systems) can be performed, considering that the intervention has to be carried out over a long term period of time. Consequently, the total cost of the facilities calculated at the present time can vary in the coming years.

The total cost that the relevant authorities have to consider is given by the sum of construction and O&M and these two parameters can vary independently from each other. They follow different economical and social aspects such as: building materials market price increase, availability of the building materials themselves on the local market, modification of the skilled and un-skilled manpower cost, exchange rate of the local currency, local life costs and so on.

Applying different capitalization rates to the construction and O&M costs, it is possible to simulate the variation trends of these parameters. This methodology allows decision-makers to understand how the investment and O&M costs can affect the cost-effectiveness of the decentralisation or centralisation approach.

In this study, capitalization rates ranging from 2% to 16% were applied. This wide range was adopted in order to enhance the variation of the investment and O&M costs and highlight the impact of the two parameter on the total cost of the intervention.

## GOVERNORATE OF BASRAH

Total investment and O&M costs for each scenario

The total investment and O&M costs for each scenario evaluated for the governorate of Basrah are included in Table 2:

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollars x 1000) | O&M costs* (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|---------------------------------------|-------------------------------------|---|---|
| Scenario 1         | 1.41                                   | 416,405                               | 8,791                               | 181   | 3.83                                      |
| Scenario 3C        | 12.51                                  | 1,610,819                             | 19,790                              | 316   | 3.88                                      |
| Scenario 3D        | 12.53                                  | 1,416,405                             | 28,494                              | 277   | 5.58                                      |
| <b>Scenario 5C</b> | 23.62                                  | 2,032,696                             | 29,557                              | 399   | 5.80                                      |
| <b>Scenario 5D</b> | 23.65                                  | 1,768,694                             | 39,705                              | 346   | 7.77                                      |
| Scenario 6C        | 23.62                                  | 2,037,720                             | 29,557                              | 400   | 5.80                                      |
| Scenario 6D        | 23.65                                  | 1,844,940                             | 39,705                              | 361   | 7.77                                      |
| Scenario 7C        | 23.62                                  | 2,058,336                             | 32,009                              | 404   | 6.28                                      |
| Scenario 7D        | 23.65                                  | 1,789,386                             | 42,543                              | 350   | 8.33                                      |
| Scenario 8C        | 14.90                                  | 1,635,569                             | 23,244                              | 321   | 4.56                                      |
| Scenario 8D        | 14.92                                  | 1,448,277                             | 32,228                              | 284   | 6.31                                      |

\* The costs associated to Basrah city distribution network are not included

Table 2: Investment and O&M cost for Basrah governorate.

As described in detail in the section “*Definition of the investments plan - Water sector*” of Book 7, the governorate of Basrah was divided into two main regions (Basrah North and Basrah South) for the development of the water supply schemes.

Considering separately the investment cost for Basrah North (Table 3) and Basrah South (Table 4) only for Scenario 5 is it clearly shown that in the northern area the total investment costs of the decentralized option are 1% lower than those of the centralized option.

The situation is considerably different for Basrah South area where investment costs for the decentralized schemes are almost 20% lower than the ones of the centralized regional system.

The higher investment costs in the Southern area are due mainly to the cost of the raw water pipe which connects the water intake from the Tigris River located close to Qurnah city to the centralized Basrah WTP and the presence of a double treatment station (one supplied with the

raw water coming from the Shatt Al Arab canal and the other one with raw water coming from the Tigris River through the above mentioned transmission pipe). As a matter of fact, for the Basrah South water supply system, a double source of raw water has been considered:

- the first one is located close to Basrah city and provides 60% of the total water demand (approximately 13,4 m<sup>3</sup>/s) with raw water taken from the Shatt Al Arab River (raw water pipe length = 7.90 Km, Ø = 3.2 m, raw water salinity = 2.5 g/l)
- the second one is located on the Tigris River, just north of Qurnah city, and provides the remaining 40% of the water demand (approximately 8,9 m<sup>3</sup>/s) to Basrah WTP (raw water pipe length = 64.7 Km, Ø = 2.9 m, raw water salinity = 1.1 mg/l).

Among the 1,590.68 US\$M needed for the construction of the centralized regional scheme in Basrah South, 186.6 US\$M are related to the construction of the raw water pipe from Qurnah to Basrah WTP (which represents almost 12% of the total investment costs).

On the other hand, the O&M costs of decentralized schemes are significantly higher than those of the centralized systems, due mainly to the high desalinization costs related to the operation of the eight (8) reverse osmosis plants considered for the decentralized alternative. This is compared to the costs of the single regional plant (Basrah WTP) which supplies the entire southern region in the centralized option.

Considering Scenario 5, as indicated in Table 2 the O&M costs for the entire governorate for the centralized option are 34 % lower than those of the decentralized alternative. This tendency is maintained also for Scenario 8 (which considers a lower per capita water provision, as indicated in Table 1): centralized O&M costs are about 39% lower than the decentralized ones.

As indicated in Table 3 and Table 4, considering Basrah North and South separately the O&M for centralized schemes are respectively 51% and 29% lower than those of the decentralized schemes.

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollars x 1000) | O&M costs* (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|---------------------------------------|-------------------------------------|---|---|
| Scenario 1         | 0.29                                   | 144,109                               | 4,136                               | 292   | 8.37                                      |
| Scenario 3C        | 0.60                                   | 346,105                               | 3,967                               | 335   | 3.84                                      |
| Scenario 3D        | 0.60                                   | 328,389                               | 5,141                               | 318   | 4.97                                      |
| <b>Scenario 5C</b> | 2.41                                   | 393,214                               | 4,847                               | 380   | 4.69                                      |
| <b>Scenario 5D</b> | 2.41                                   | 387,435                               | 7,306                               | 375   | 7.07                                      |
| Scenario 6C        | 2.41                                   | 396,742                               | 5,307                               | 384   | 5.13                                      |
| Scenario 6D        | 2.41                                   | 390,356                               | 7,898                               | 378   | 7.64                                      |

| Scenario    | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollars x 1000) | O&M costs* (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|-------------|--|---------------------------------------|-------------------------------------|---|---|
| Scenario 7C | 3.71                                   | 429,847                               | 5,994                               | 416   | 5.80                                      |
| Scenario 7D | 3.71                                   | 431,012                               | 9,203                               | 417   | 8.90                                      |
| Scenario 8C | 3.71                                   | 434,871                               | 5,994                               | 421   | 5.80                                      |
| Scenario 8D | 3.71                                   | 442,243                               | 9,203                               | 428   | 8.90                                      |

Table 3: Investment and O&amp;M cost for Basrah North

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollars x 1000) | O&M costs* (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|---------------------------------------|-------------------------------------|---|---|
| Scenario 1         | 1.12                                   | 272,297                               | 4,655                               | 151   | 2.58                                      |
| Scenario 3C        | 12.51                                  | 1,217,605                             | 14,943                              | 300   | 3.68                                      |
| Scenario 3D        | 10.12                                  | 1,028,970                             | 21,188                              | 253   | 5.20                                      |
| <b>Scenario 5C</b> | 23.62                                  | 1,602,849                             | 23,563                              | 394   | 5.80                                      |
| <b>Scenario 5D</b> | 19.94                                  | 1,337,682                             | 30,501                              | 328   | 7.49                                      |
| Scenario 6C        | 23.62                                  | 1,602,849                             | 23,563                              | 394   | 5.80                                      |
| Scenario 6D        | 19.94                                  | 1,402,697                             | 30,501                              | 344   | 7.49                                      |
| Scenario 7C        | 23.62                                  | 1,623,498                             | 25,439                              | 399   | 6.26                                      |
| Scenario 7D        | 19.94                                  | 1,353,556                             | 32,496                              | 332   | 7.98                                      |
| Scenario 8C        | 14.90                                  | 1,240,996                             | 17,764                              | 305   | 4.37                                      |
| Scenario 8D        | 12.20                                  | 1,052,830                             | 24,013                              | 258   | 5.90                                      |

\* The costs associated to Basrah city distribution network are not included

Table 4: Investment and O&amp;M cost for Basrah South.

As for Basrah South centralized system, an additional investigation (Table 5) was elaborated which considers two opposite alternatives. The first one foresees the total provision of water for Basrah South from the Tigris River (through the raw water main connecting Qurnah with Basrah) and the second one the provision of the same water quantity only from the Shatt Al Arab in Basrah town.

The results show a total investment cost amounting to 1,603 US\$M for the first option and to 1,587 US\$M for the second one. Comparing the three alternatives presented in Table 5, the most convenient in terms of investment costs would be the one that considers 100% of the raw water coming from the Shatt Al Arab River, despite the higher salinity of the raw water, which would require the desalination of 100% of the supplied raw water. The construction costs of the 65 km raw water main from Qurnah are very high and cannot be compensated by the reduction of the investment on the water treatment plant due to the increased quality of the raw water.

| Raw water source                        | Investment cost (US\$M) |
|---|-------------------------|
| 60 % Shatt Al Arab<br>40 % Tigris river | 1,603                   |
| 100 % Tigris river                      | 1,587                   |
| 100 % Shatt Al Arab canal               | 1,435                   |

Table 5: Raw water sources for Basrah south and related cost.

If the raw water pipe from Qurnah is the main factor influencing the investment cost, the main parameter characterizing the O&M costs is represented by the final salinity of the treated water against the initial one and the management cost of the two WTPs located in Basrah.

Moreover, it's also important to take into consideration all the monetary unquantifiable advantages given by a centralized water schemes with two independent water sources, especially in terms of the reliability of the entire system. The availability of an alternative water source from the Tigris River would allow for the handling of possible polluting events involving the Shatt Al Arab system (which is currently receiving the untreated discharges of all the main cities of the governorate of Basrah) and would also allow for the management of a temporary breakdown of any part of the transmission system.

Figure 1, Figure 2 and Figure 3 show the capitalized cost trends respectively for the entire governorate of Basrah, for Basrah North region and for Basrah South region.

The cost analysis at a governorate level (Figure 1) shows that the centralized option for the reference scenario (Scenario 5) has the highest capitalized costs for the entire range of capitalization rates that were considered. As already explained in the analysis of the different scenarios included in Book 7, the main reason for this is the high cost of the pipe connection from Qurnah to Basrah.

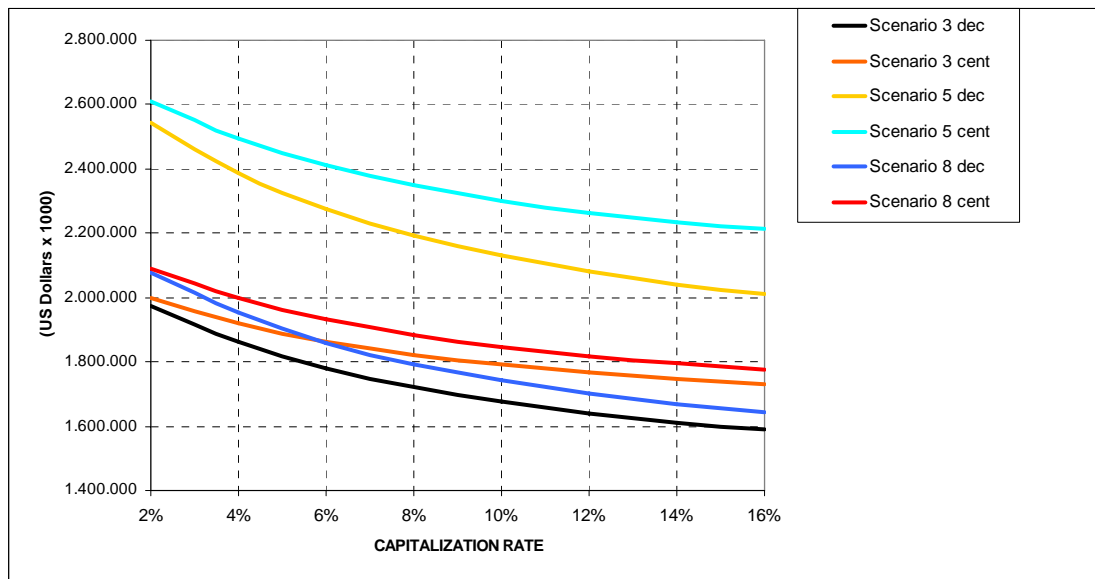


Figure 1: Capitalized costs for Basrah governorate

Apparently, the comparison between Basrah North and Basrah South cost analyses (Figure 2 and Figure 3) confirms that the decentralisation option may be the most cost-effective strategy in the southern part of the governorate while the centralisation approach would be preferable for the northern part.

It is important to take into consideration all the monetary unquantifiable advantages given by a centralised water scheme in Basrah South, which takes a part of the raw water from the Tigris River as the entire area lacks of suitable water sources which are in any case subject to a strong anthropic pressure.

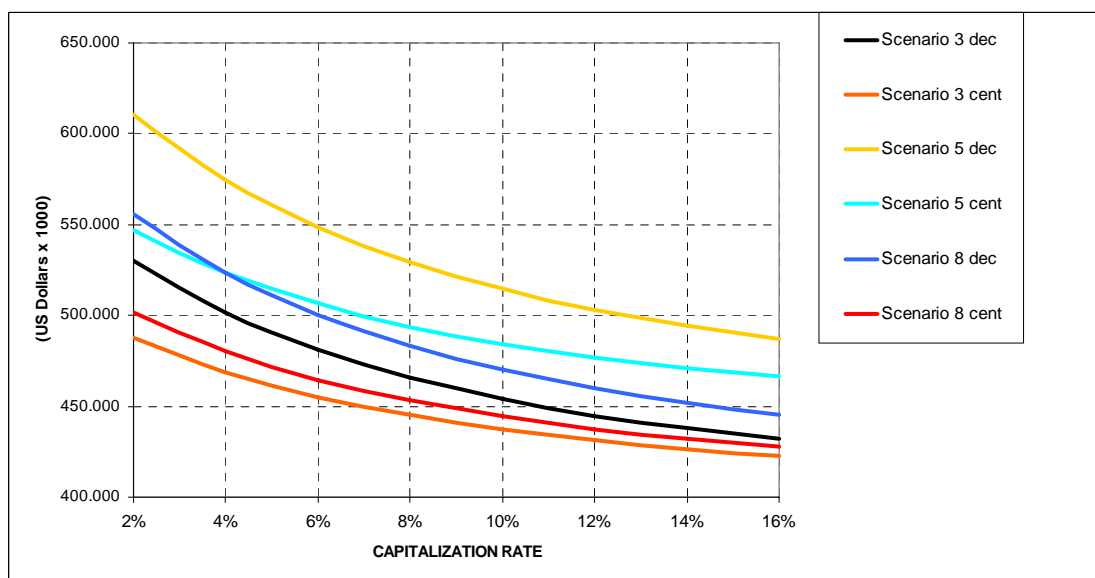


Figure 2: Capitalized costs for Basrah North

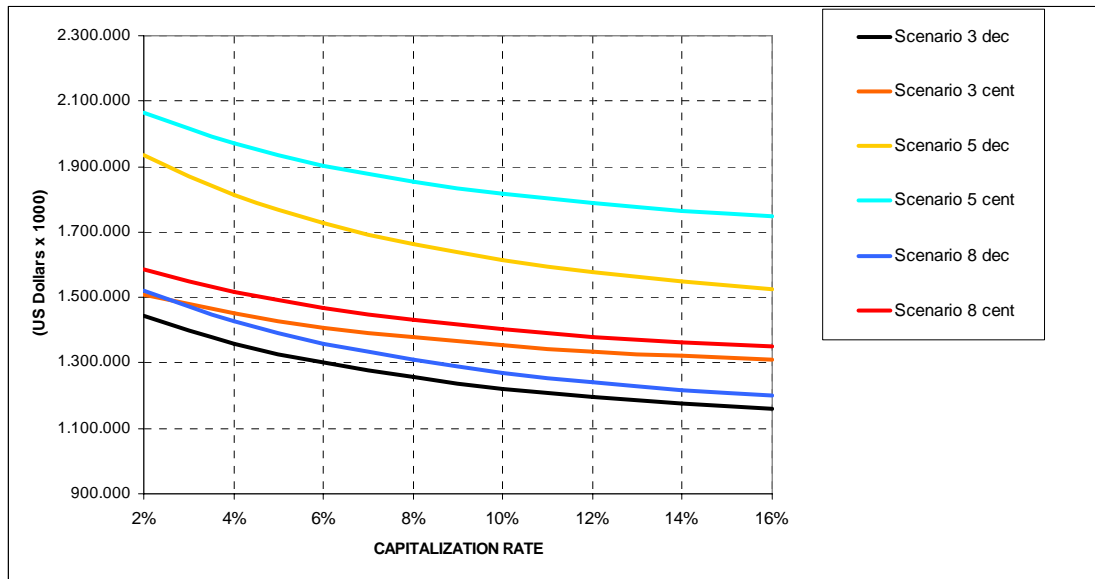


Figure 3: Capitalized costs for Basrah South

Examining the capitalization costs for the three alternatives considered for Basrah South centralized schemes (see Table 5), Figure 4 highlights that the most cost-effective alternative is the total provision of raw water from the Shatt Al Arab River despite the high salinity of the raw water. This is due mainly to the considerable reduction of the investment costs for the alternatives that do not include the construction of the raw water pipe from Qurnah city.

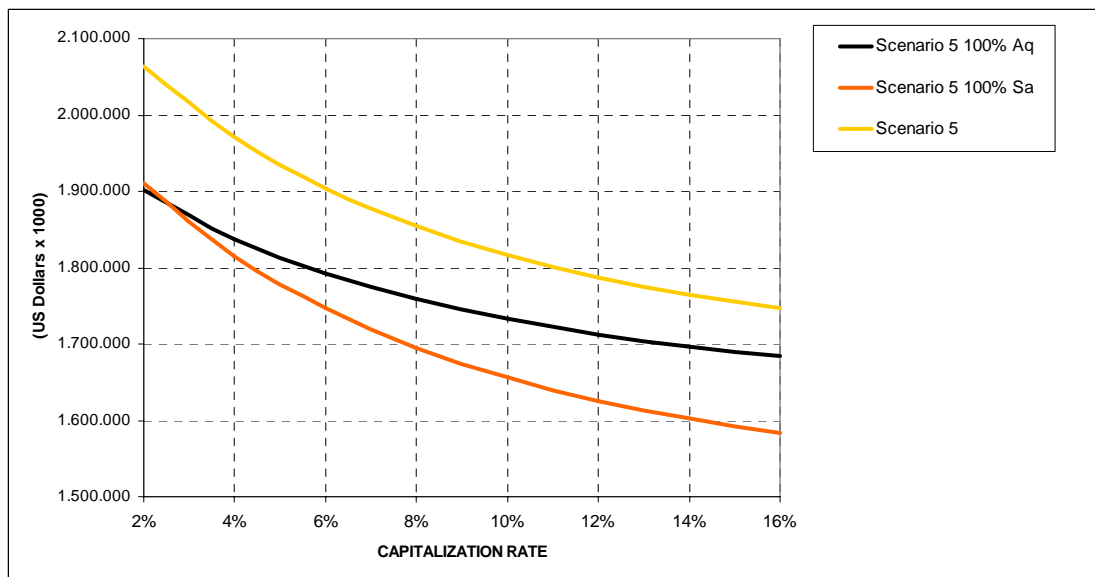


Figure 4: Capitalized costs for different raw water sources in Basrah South scheme

## GOVERNORATE OF THI QAR

### Total investment and O&M costs for each scenario

The total investment and O&M costs for each scenario evaluated for the governorate of Thi Qar are included in Table 6. The high initial investment and O&M costs for decentralised schemes is due to the huge number of WTPs and R.O. treatment plants necessary to cover all the villages and towns in the governorate. Moreover, in the decentralized schemes the raw water is not always taken from the Gharraf River (which has the lowest salinity in the area) but in many cases from minor water streams (sometimes irrigation channels) which show water salinities up to 2,000 mg/l. O&M costs are consequently affecting the cost-effectiveness of the decentralisation approach.

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollar x 1000) | O&M costs* (US Dollar/year x 1000) | Per-capita investment cost (US Dollar/cap) | Per-capita O&M cost (US Dollar/year/cap) |
|--------------------|--|--------------------------------------|------------------------------------|--|--|
| Scenario 1         | 1.04                                   | 410,505                              | 27,992                             | 252  | 17.21                                    |
| Scenario 2C        | 2.26                                   | 1,229,773                            | 25,271                             | 348  | 7.15                                     |
| Scenario 2D        | 2.26                                   | 879,486                              | 30,823                             | 249  | 8.71                                     |
| Scenario 3C        | 9.03                                   | 1,392,086                            | 27,288                             | 394  | 7.72                                     |
| Scenario 3D        | 9.03                                   | 1,079,454                            | 36,710                             | 305  | 10.37                                    |
| Scenario 4C        | 9.03                                   | 1,392,086                            | 27,288                             | 394  | 7.72                                     |
| Scenario 4D        | 8.98                                   | 1,079,962                            | 37,461                             | 305  | 10.59                                    |
| <b>Scenario 5C</b> | 15.98                                  | 1,544,748                            | 29,345                             | 437  | 8.30                                     |
| <b>Scenario 5D</b> | 15.98                                  | 1,263,144                            | 41,199                             | 357  | 11.64                                    |
| Scenario 6C        | 15.98                                  | 1,557,408                            | 29,345                             | 440  | 8.30                                     |
| Scenario 6D        | 15.98                                  | 1,309,226                            | 41,199                             | 370  | 11.64                                    |
| Scenario 7C        | 15.98                                  | 1,585,771                            | 34,063                             | 448  | 9.63                                     |
| Scenario 7D        | 15.99                                  | 1,311,190                            | 52,746                             | 371  | 14.90                                    |
| Scenario 8C        | 10.64                                  | 1,303,316                            | 27,766                             | 369  | 7.85                                     |
| Scenario 8D        | 10.58                                  | 1,107,282                            | 38,163                             | 313  | 10.79                                    |

\* The costs associated to Nasiriya city distribution network are not included

Table 6: Investment and O&M cost for Thi Qar governorate

Table 7 includes the detailed costs for the district of Rafai. All the other districts are involved in the large Nasiriya Unified Water Project and/or in the Islah/Chubayish Water Project and as a consequence a detailed cost analysis at a district level for the centralized scenarios is not feasible. The investment and O&M have therefore been represented at a water scheme level (see Table 8 for the Nasiriya Unified Water Project and Table 10 for the Islah/Chubayish Water Project).

The detailed description of the water schemes that were considered for the different areas is included in the section “*Definition of the investments plan - Water sector*” of Book 7

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs (US Dollar x 1000) | O&M costs (US Dollar/year x 1000) | Per-capita investment cost (US Dollar/cap) | Per-capita O&M cost (US Dollar/year/cap) |
|--------------------|--|-------------------------------------|-----------------------------------|--|--|
| Scenario 1         | 0.23                                   | 122,864                             | 7,527                             | 343  | 21.00                                    |
| Scenario 2C        | 0.51                                   | 271,916                             | 7,600                             | 353  | 9.87                                     |
| Scenario 2D        | 0.51                                   | 256,951                             | 8,501                             | 333  | 11.02                                    |
| Scenario 3C        | 2.04                                   | 313,910                             | 8,064                             | 408  | 10.47                                    |
| Scenario 3D        | 2.04                                   | 304,404                             | 9,169                             | 395  | 11.89                                    |
| Scenario 4C        | 2.04                                   | 313,910                             | 8,064                             | 408  | 10.47                                    |
| Scenario 4D        | 2.01                                   | 303,172                             | 9,149                             | 393  | 11.86                                    |
| <b>Scenario 5C</b> | 3.32                                   | 346,621                             | 8,446                             | 450  | 10.97                                    |
| <b>Scenario 5D</b> | 3.32                                   | 339,220                             | 9,584                             | 440  | 12.43                                    |
| Scenario 6C        | 3.32                                   | 348,852                             | 8,446                             | 453  | 10.97                                    |
| Scenario 6D        | 3.32                                   | 342,409                             | 9,584                             | 444  | 12.43                                    |
| Scenario 7C        | 3.32                                   | 357,635                             | 10,361                            | 464  | 13.45                                    |
| Scenario 7D        | 3.32                                   | 352,381                             | 13,567                            | 457  | 17.59                                    |
| Scenario 8C        | 2.39                                   | 319,461                             | 8,169                             | 415  | 10.61                                    |
| Scenario 8D        | 2.36                                   | 311,184                             | 9,254                             | 404  | 12.00                                    |

Table 7: Investment and O&M cost for Rafai district.

Considering only Rafai centralized water scheme, the total water demand for Scenario 5 amounts to 0.29 Mm<sup>3</sup>/d (3.32 m<sup>3</sup>/s). The total investment and O&M costs for the entire district are 346,621,000 US\$/8,446,000 US\$/y and 339,220,000 US\$/9,584,000 US\$/y respectively for the centralized and decentralized options.

As already indicated above, the costs evaluation for Shattrah, Nasiriya and Suq Ash Shuyukh districts has been performed at the water scheme level (Nasiriya Unified Water Project, including Batha'a, see Table 8)

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollar x 1000) | O&M costs* (US Dollar/year x 1000) | Per-capita investment cost (US Dollar/cap) | Per-capita O&M cost (US Dollar/year/cap) |
|--------------------|--|--------------------------------------|------------------------------------|--|--|
| Scenario 1         | 0.69                                   | 231,548                              | 15,452                             | 213  | 14.19                                    |
| Scenario 2C        | 1.54                                   | 817,686                              | 13,455                             | 338  | 5.57                                     |
| Scenario 2D        | 1.54                                   | 511,627                              | 16,843                             | 212  | 6.99                                     |
| Scenario 3C        | 6.16                                   | 921,440                              | 14,820                             | 381  | 6.13                                     |
| Scenario 3D        | 6.13                                   | 641,157                              | 21,010                             | 266  | 8.72                                     |
| Scenario 4C        | 6.16                                   | 921,440                              | 14,820                             | 381  | 6.13                                     |
| Scenario 4D        | 6.13                                   | 643,274                              | 21,640                             | 267  | 8.98                                     |
| <b>Scenario 5C</b> | 11.45                                  | 1,032,161                            | 16,384                             | 427  | 6.78                                     |
| <b>Scenario 5D</b> | 11.43                                  | 776,394                              | 24,423                             | 322  | 10.14                                    |
| Scenario 6C        | 11.45                                  | 1,042,591                            | 16,384                             | 431  | 6.78                                     |
| Scenario 6D        | 11.43                                  | 814,196                              | 24,423                             | 338  | 10.14                                    |
| Scenario 7C        | 11.45                                  | 1,058,334                            | 18,579                             | 438  | 7.69                                     |
| Scenario 7D        | 11.43                                  | 807,085                              | 30,390                             | 335  | 12.61                                    |
| Scenario 8C        | 7.34                                   | 832,755                              | 15,171                             | 344  | 6.28                                     |
| Scenario 8D        | 7.32                                   | 660,698                              | 22,126                             | 274  | 9.19                                     |

\* The costs associated to Nasiriya city distribution network are not included

Table 8: Investment and O&M cost for Nasiriya, Suq Ash Shuyukh, Al Gharraf, Shattrah, Al Dawaya and Batha'a towns (as per Nasiriya Unified Water Project).

Table 9 summarizes the water demand for the main towns involved in the Nasiriya Unified Water Project:

| Town            | Scenario 5                       | Scenario 5                       |
|-----------------|----------------------------------|----------------------------------|
|                 | Water demand (m <sup>3</sup> /s) | Water demand (m <sup>3</sup> /h) |
| Nasiriya        | 6.62                             | 23,814.22                        |
| Suq Ash Shuyukh | 1.08                             | 3,899.34                         |
| Al Gharraf      | 0.34                             | 1,240.70                         |
| Shattrah        | 1.59                             | 5,742.68                         |
| Al Dawaya       | 0.20                             | 708.98                           |
| Batha'a         | 0.28                             | 1,028.41                         |

Table 9: Water demand for the main cities included in the Nasiriya Unified Water Project.

The costs evaluation for Chubayish district (including the eastern section of Nasiriya district, Islah sub-district) was performed at a water scheme level (Islah - Chubayish Water Project, see Table 10).

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs (US Dollar x 1000) | O&M costs (US Dollar/year x 1000) | Per-capita investment cost (US Dollar/cap) | Per-capita O&M cost (US Dollar/year/cap) |
|--------------------|--|-------------------------------------|-----------------------------------|--|--|
| Scenario 1         | 0.11                                   | 56,093                              | 5,014                             | 313  | 27.93                                    |
| Scenario 2C        | 0.21                                   | 140,171                             | 4,216                             | 402  | 12.08                                    |
| Scenario 2D        | 0.21                                   | 110,908                             | 5,478                             | 310  | 15.30                                    |
| Scenario 3C        | 0.83                                   | 156,736                             | 4,404                             | 449  | 12.62                                    |
| Scenario 3D        | 0.86                                   | 133,893                             | 6,532                             | 374  | 18.24                                    |
| Scenario 4C        | 0.83                                   | 156,736                             | 4,404                             | 449  | 12.62                                    |
| Scenario 4D        | 0.83                                   | 133,516                             | 6,673                             | 373  | 18.64                                    |
| <b>Scenario 5C</b> | 1.21                                   | 165,966                             | 4,515                             | 476  | 12.94                                    |
| <b>Scenario 5D</b> | 1.23                                   | 147,529                             | 7,192                             | 412  | 20.09                                    |
| Scenario 6C        | 1.21                                   | 165,966                             | 4,515                             | 476  | 12.94                                    |
| Scenario 6D        | 1.23                                   | 152,621                             | 7,192                             | 426  | 20.09                                    |
| Scenario 7C        | 1.21                                   | 169,801                             | 5,123                             | 487  | 14.68                                    |
| Scenario 7D        | 1.23                                   | 151,724                             | 8,789                             | 424  | 24.55                                    |

| Scenario    | Total water demand (m <sup>3</sup> /s) | Investment costs (US Dollar x 1000) | O&M costs (US Dollar/year x 1000) | Per-capita investment cost (US Dollar/cap) | Per-capita O&M cost (US Dollar/year/cap) |
|-------------|--|-------------------------------------|-----------------------------------|--|--|
| Scenario 8C | 0.91                                   | 151,101                             | 4,426                             | 433  | 12.68                                    |
| Scenario 8D | 0.91                                   | 135,400                             | 6,783                             | 378  | 18.94                                    |

Table 10: Investment and O&M cost for Islah - Chubayish water scheme.

Figure 5, Figure 6 and Figure 7 show the capitalized cost trends respectively for the District of Rafai, for the regions served by the Nasiriya Unified and Islah-Chubayish water projects.

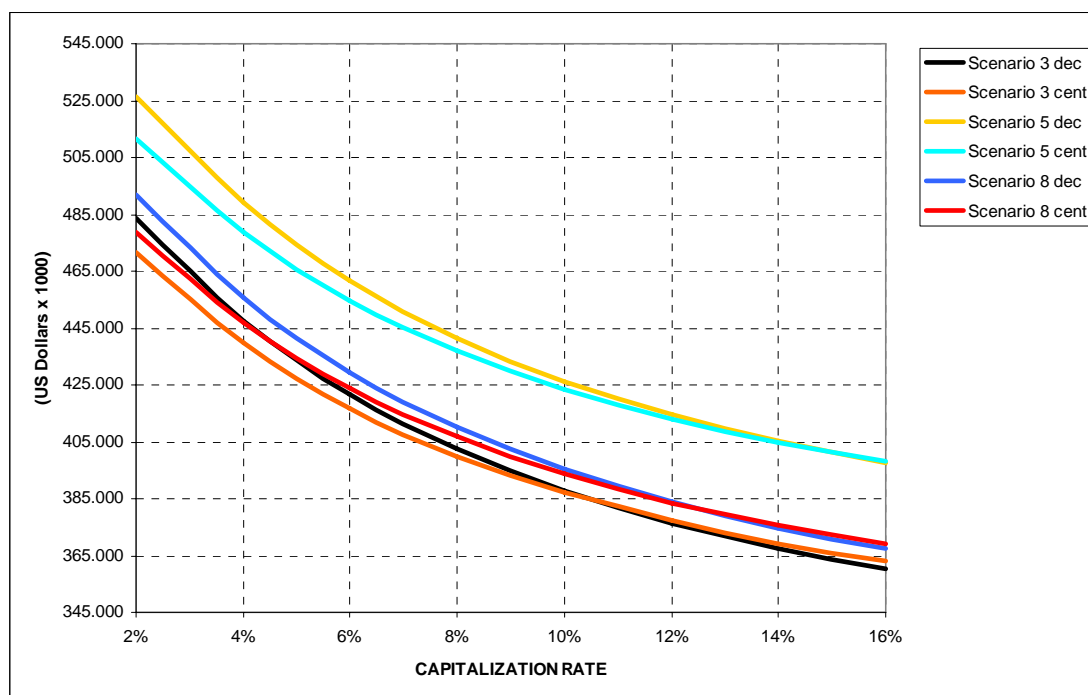


Figure 5: Capitalized costs for Rafai district.

In Figure 5 the cost analysis indicates the centralized scenarios as the most cost-effective approaches compared to the decentralized.

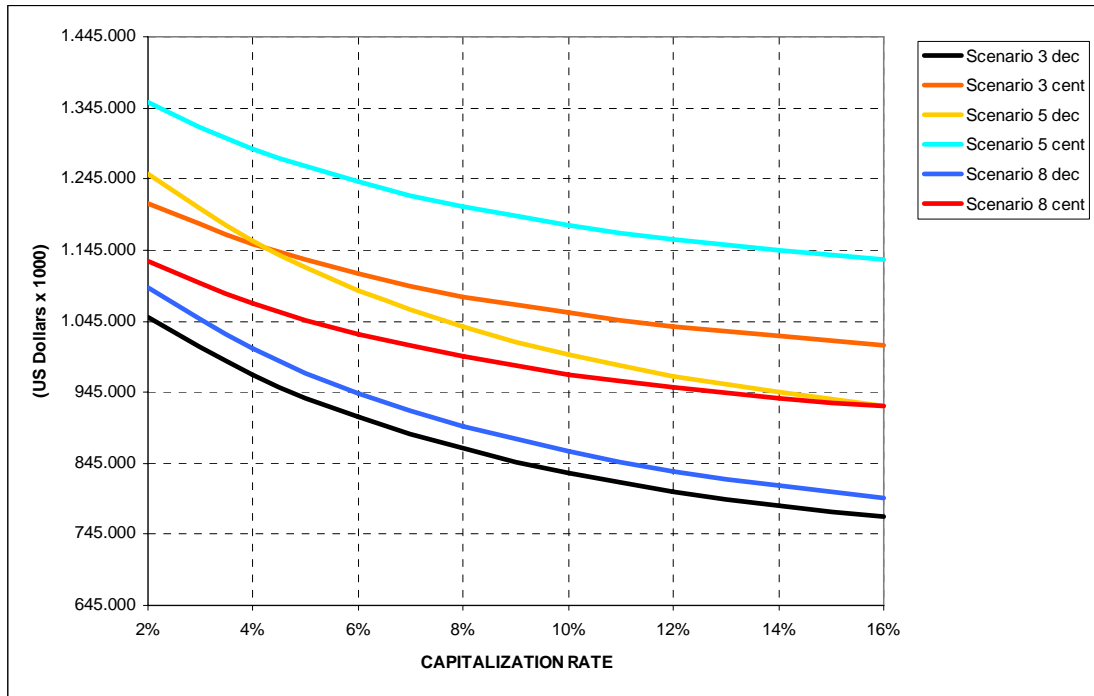


Figure 6: Capitalized costs for Nasiriya, Suq Ash Shuyukh, Al Gharraf, Shattrah, Al Dawaya and Batha'a towns (as per Nasiriya Unified Water Project) area

For urban and rural areas involved in the Nasiriya Unified Water Project, Figure 6 indicates the decentralization as the most cost-effective approach.

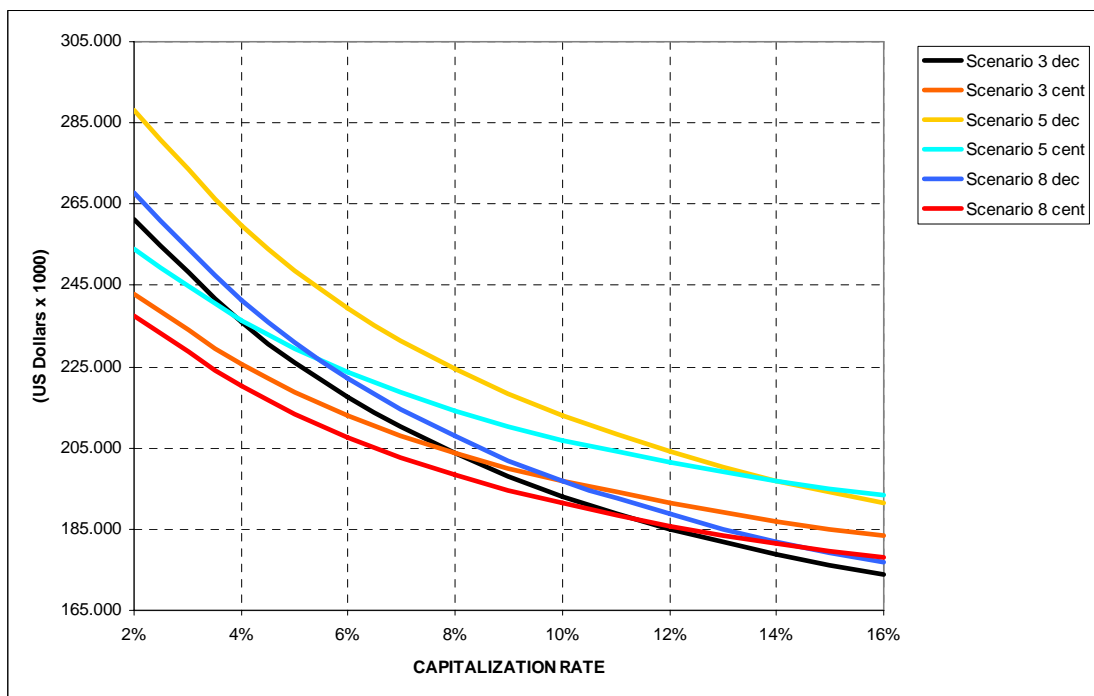


Figure 7: Capitalized costs for Islah - Chubayish area.

The cost analysis indicates the centralized approach as the most cost-effective for low capitalization rates. Along with increase of the capitalization rates the capitalized costs of centralized and the decentralized options get near. Scenario 3 indicates the decentralization as the most cost-effective approach for capitalization rates higher than 11%.

## GOVERNORATE OF MISSAN

Total investment and O&M costs for each scenario

The total investment and O&M costs for each scenario evaluated for the governorate of Missan are included in Table 11:

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollars x 1000) | O&M costs* (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|---------------------------------------|-------------------------------------|---|---|
| Scenario 1         | 0.76                                   | 228,016                               | 14,421                              | 216   | 13.66                                     |
| Scenario 2C        | 1.71                                   | 571,707                               | 14,531                              | 242   | 6.15                                      |
| Scenario 2D        | 1.71                                   | 517,861                               | 16,049                              | 220   | 6.80                                      |
| Scenario 3C        | 6.83                                   | 703,139                               | 16,292                              | 298   | 6.90                                      |
| Scenario 3D        | 6.83                                   | 657,229                               | 18,512                              | 279   | 7.85                                      |
| Scenario 4C        | 6.83                                   | 717,333                               | 18,780                              | 304   | 7.95                                      |
| Scenario 4D        | 6.83                                   | 675,348                               | 22,915                              | 286   | 9.71                                      |
| <b>Scenario 5C</b> | 13.13                                  | 873,817                               | 21,718                              | 370   | 9.20                                      |
| <b>Scenario 5D</b> | 13.12                                  | 838,642                               | 26,500                              | 355   | 11.23                                     |
| Scenario 6C        | 13.13                                  | 889,863                               | 21,718                              | 377   | 9.20                                      |
| Scenario 6D        | 13.12                                  | 862,900                               | 26,500                              | 366   | 11.23                                     |
| Scenario 7C        | 13.13                                  | 898,084                               | 25,163                              | 380   | 10.66                                     |
| Scenario 7D        | 13.12                                  | 862,905                               | 31,636                              | 366   | 13.41                                     |
| Scenario 8C        | 8.25                                   | 732,016                               | 19,484                              | 310   | 8.25                                      |
| Scenario 8D        | 8.25                                   | 703,185                               | 23,711                              | 298   | 10.05                                     |

\* The costs associated to Amarah city distribution network are not included

Table 11: Investment and O&M costs for Missan governorate.

The costs at a district level are summarised in Table 12 (Ali Al Gharbi district), Table 13 (Al Maimona district), Table 14 (Al Majar Al Kabeer district), Table 15 (Amarah and Al Kahla'a districts) and Table 16 (Qalat Saleh district).

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs (US Dollars x 1000) | O&M costs (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|--------------------------------------|------------------------------------|---|---|
| Scenario 1         | 0.03                                   | 17,224                               | 1,717                              | 377   | 37.59                                     |
| Scenario 2C        | 0.06                                   | 38,862                               | 1,640                              | 401   | 16.92                                     |
| Scenario 2D        | 0.07                                   | 35,114                               | 1,953                              | 348   | 19.34                                     |
| Scenario 3C        | 0.25                                   | 42,977                               | 1,713                              | 443   | 17.66                                     |
| Scenario 3D        | 0.26                                   | 40,163                               | 2,071                              | 398   | 20.51                                     |
| Scenario 4C        | 0.25                                   | 43,721                               | 1,949                              | 451   | 20.10                                     |
| Scenario 4D        | 0.26                                   | 40,878                               | 2,495                              | 405   | 24.70                                     |
| <b>Scenario 5C</b> | 0.42                                   | 48,869                               | 2,075                              | 504   | 21.40                                     |
| <b>Scenario 5D</b> | 0.43                                   | 45,765                               | 2,659                              | 453   | 26.33                                     |
| Scenario 6C        | 0.42                                   | 51,866                               | 2,075                              | 535   | 21.40                                     |
| Scenario 6D        | 0.43                                   | 49,869                               | 2,659                              | 494   | 26.33                                     |
| Scenario 7C        | 0.42                                   | 50,004                               | 2,385                              | 516   | 24.60                                     |
| Scenario 7D        | 0.43                                   | 47,099                               | 3,186                              | 466   | 31.55                                     |
| Scenario 8C        | 0.30                                   | 44,737                               | 1,985                              | 461   | 20.47                                     |
| Scenario 8D        | 0.31                                   | 41,817                               | 2,533                              | 414   | 25.09                                     |

Table 12: Investment and O&M cost for Ali Al Gharbi district

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs (US Dollars x 1000) | O&M costs (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|--------------------------------------|------------------------------------|---|---|
| Scenario 1         | 0.08                                   | 44,748                               | 3,974                              | 338   | 30.00                                     |
| Scenario 2C        | 0.18                                   | 97,969                               | 4,020                              | 355   | 14.57                                     |
| Scenario 2D        | 0.18                                   | 89,410                               | 4,347                              | 328   | 15.97                                     |
| Scenario 3C        | 0.72                                   | 113,302                              | 4,192                              | 411   | 15.19                                     |
| Scenario 3D        | 0.71                                   | 107,122                              | 4,713                              | 394   | 17.32                                     |
| Scenario 4C        | 0.72                                   | 115,107                              | 4,599                              | 417   | 16.67                                     |
| Scenario 4D        | 0.71                                   | 109,276                              | 5,561                              | 401   | 20.43                                     |
| <b>Scenario 5C</b> | 1.11                                   | 126,357                              | 4,832                              | 458   | 17.51                                     |
| <b>Scenario 5D</b> | 1.10                                   | 121,583                              | 5,911                              | 447   | 21.72                                     |
| Scenario 6C        | 1.11                                   | 127,843                              | 4,832                              | 463   | 17.51                                     |
| Scenario 6D        | 1.10                                   | 124,127                              | 5,911                              | 456   | 21.72                                     |
| Scenario 7C        | 1.11                                   | 128,972                              | 5,353                              | 467   | 19.40                                     |
| Scenario 7D        | 1.10                                   | 124,645                              | 6,942                              | 458   | 25.50                                     |
| Scenario 8C        | 0.81                                   | 116,418                              | 4,658                              | 422   | 16.88                                     |
| Scenario 8D        | 0.80                                   | 111,649                              | 5,629                              | 410   | 20.68                                     |

Table 13: Investment and O&amp;M costs for AI Maimona district

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs (US Dollars x 1000) | O&M costs (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|--------------------------------------|------------------------------------|---|---|
| Scenario 1         | 0.11                                   | 42,765                               | 1,574                              | 309   | 11.37                                     |
| Scenario 2C        | 0.25                                   | 104,967                              | 1,649                              | 334   | 5.25                                      |
| Scenario 2D        | 0.25                                   | 100,106                              | 1,823                              | 320   | 5.83                                      |
| Scenario 3C        | 1.00                                   | 124,634                              | 1,874                              | 397   | 5.97                                      |
| Scenario 3D        | 1.00                                   | 120,704                              | 2,122                              | 386   | 6.79                                      |
| Scenario 4C        | 1.00                                   | 126,804                              | 2,236                              | 404   | 7.12                                      |
| Scenario 4D        | 1.00                                   | 123,137                              | 2,763                              | 394   | 8.84                                      |
| <b>Scenario 5C</b> | 1.73                                   | 145,883                              | 2,586                              | 465   | 8.24                                      |
| <b>Scenario 5D</b> | 1.73                                   | 143,176                              | 3,186                              | 458   | 10.19                                     |
| Scenario 6C        | 1.73                                   | 147,538                              | 2,586                              | 470   | 8.24                                      |
| Scenario 6D        | 1.73                                   | 147,081                              | 3,186                              | 471   | 10.19                                     |
| Scenario 7C        | 1.73                                   | 149,342                              | 3,081                              | 476   | 9.81                                      |
| Scenario 7D        | 1.73                                   | 147,002                              | 4,015                              | 470   | 12.85                                     |
| Scenario 8C        | 1.22                                   | 131,622                              | 2,344                              | 419   | 7.47                                      |
| Scenario 8D        | 1.22                                   | 128,881                              | 2,882                              | 412   | 9.22                                      |

Table 14: Investment and O&amp;M costs for Al Majar Al Kabeer district

| Scenario  | Total water demand (m <sup>3</sup> /s) | Investment costs* (US Dollars x 1000) | O&M costs* (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|---|--|---------------------------------------|-------------------------------------|---|---|
| Scenario 1  | 0.47                                   | 91,835                                | 4,762                               | 147   | 7.61                                      |
| Scenario 2C   | 1.08                                   | 254,712                               | 4,776                               | 177   | 3.33                                      |
| Scenario 2D   | 1.08                                   | 222,485                               | 5,243                               | 155   | 3.65                                      |
| Scenario 3C   | 4.30                                   | 333,785                               | 5,742                               | 233   | 4.00                                      |
| Scenario 3D   | 4.30                                   | 304,219                               | 6,423                               | 212   | 4.48                                      |
| Scenario 4C   | 4.30                                   | 342,151                               | 6,960                               | 238   | 4.85                                      |
| Scenario 4D   | 4.30                                   | 315,739                               | 8,460                               | 220   | 5.90                                      |
| <b>Scenario 5C</b>  | 9.02                                   | 453,791                               | 8,925                               | 316   | 6.22                                      |
| <b>Scenario 5D</b>  | 9.02                                   | 431,898                               | 10,766                              | 301   | 7.50                                      |
| Scenario 6C   | 9.02                                   | 462,273                               | 8,925                               | 322   | 6.22                                      |
| Scenario 6D   | 9.02                                   | 442,765                               | 10,766                              | 309   | 7.50                                      |
| Scenario 7C   | 9.02                                   | 469,276                               | 10,714                              | 327   | 7.47                                      |
| Scenario 7D   | 9.02                                   | 446,136                               | 12,967                              | 311   | 9.04                                      |
| Scenario 8C   | 5.29                                   | 348,223                               | 7,394                               | 243   | 5.15                                      |
| Scenario 8D   | 5.29                                   | 332,499                               | 8,957                               | 232   | 6.24                                      |
| * The costs associated to Amarah city distribution network are not included |  |                                       |                                     |   |   |

Table 15: Investment and O&amp;M cost for Amarah+ Al Kahla'a districts

| Scenario           | Total water demand (m <sup>3</sup> /s) | Investment costs (US Dollars x 1000) | O&M costs (US Dollars/year x 1000) | Per-capita investment cost (US Dollars/cap) | Per-capita O&M cost (US Dollars/year/cap) |
|--------------------|--|--------------------------------------|------------------------------------|---|---|
| Scenario 1         | 0.07                                   | 31,444                               | 2,394                              | 276   | 21.03                                     |
| Scenario 2C        | 0.14                                   | 75,197                               | 2,445                              | 314   | 10.21                                     |
| Scenario 2D        | 0.14                                   | 70,745                               | 2,683                              | 297   | 11.25                                     |
| Scenario 3C        | 0.56                                   | 88,440                               | 2,772                              | 369   | 11.57                                     |
| Scenario 3D        | 0.55                                   | 85,022                               | 3,182                              | 357   | 13.34                                     |
| Scenario 4C        | 0.56                                   | 89,550                               | 3,035                              | 374   | 12.67                                     |
| Scenario 4D        | 0.55                                   | 86,318                               | 3,637                              | 362   | 15.25                                     |
| <b>Scenario 5C</b> | 0.86                                   | 98,918                               | 3,299                              | 413   | 13.77                                     |
| <b>Scenario 5D</b> | 0.85                                   | 96,221                               | 3,979                              | 403   | 16.68                                     |
| Scenario 6C        | 0.86                                   | 100,343                              | 3,299                              | 419   | 13.77                                     |
| Scenario 6D        | 0.85                                   | 99,057                               | 3,979                              | 415   | 16.68                                     |
| Scenario 7C        | 0.86                                   | 100,490                              | 3,629                              | 419   | 15.15                                     |
| Scenario 7D        | 0.85                                   | 98,024                               | 4,526                              | 411   | 18.98                                     |
| Scenario 8C        | 0.63                                   | 91,016                               | 3,103                              | 380   | 12.95                                     |
| Scenario 8D        | 0.63                                   | 88,339                               | 3,711                              | 370   | 15.56                                     |

Table 16: Investment and O&amp;M costs for Qalat Saleh district

Capitalized costs trends in the capitalization rates range 2%-16% are shown in Figure 8 (Ali Al Gharbi district), Figure 9 (Al Maimona district), Figure 10 (Al Majar Al Kabeer district), Figure 11 (Amarah and Al Kahla'a districts) and Figure 12 (Qalat Saleh district).

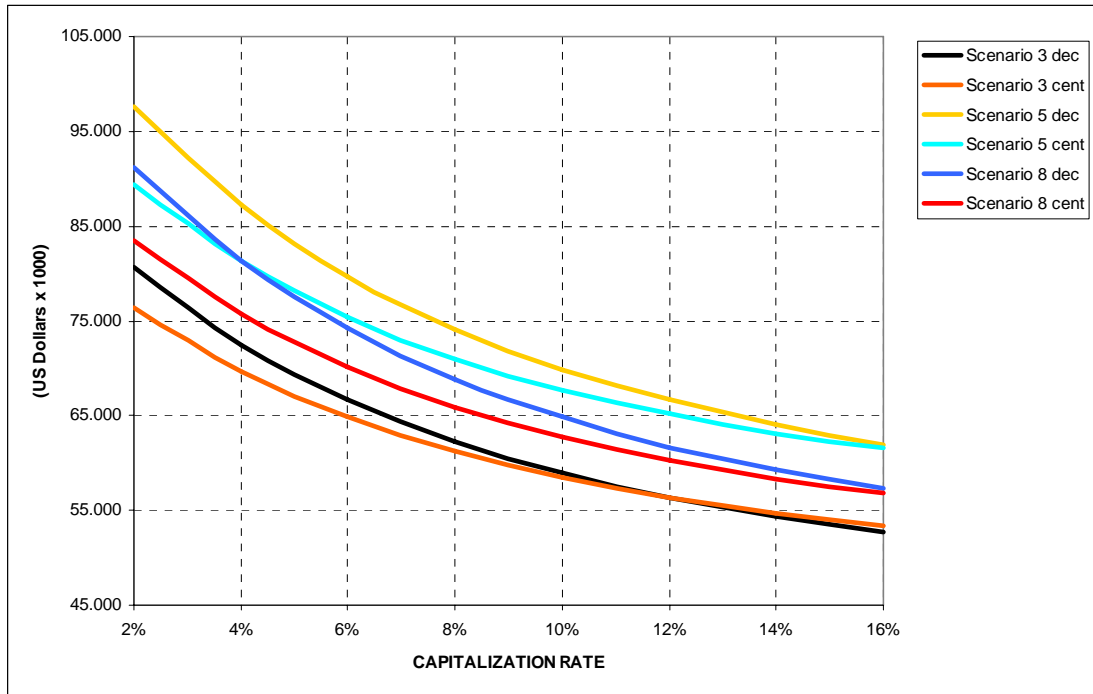


Figure 8: Investment and O&M cost capitalisation for Ali Al Gharbi district.

The cost analysis in Figure 8 indicates the decentralized options as the most cost-effective for high capitalization rates. With decreasing of the capitalization rates the costs of centralized and the decentralized options get near. The trend for Scenario 5 shows the centralization as the most cost-effective approach for capitalization rates lower than 6.5%. The trend for Scenario 8 shows the centralization as the most cost-effective approach for capitalization rates lower than 5.5%.

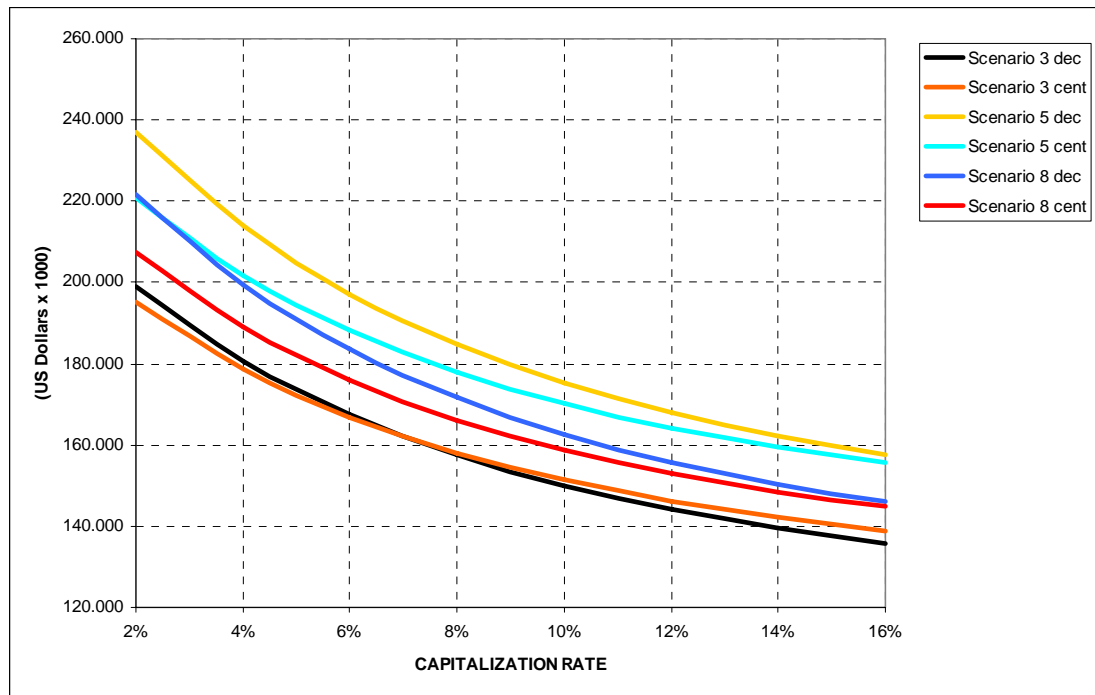


Figure 9: Investment and O&M cost capitalisation for AI Maimona district.

The cost analysis in Figure 9 indicates the centralized options as the most cost-effective for low capitalization rates. Along with increase of the capitalization rates the costs of centralized and the decentralized options get near. The trend for Scenario 3 shows the decentralization as the most cost-effective approach for capitalization rates higher than 12%.

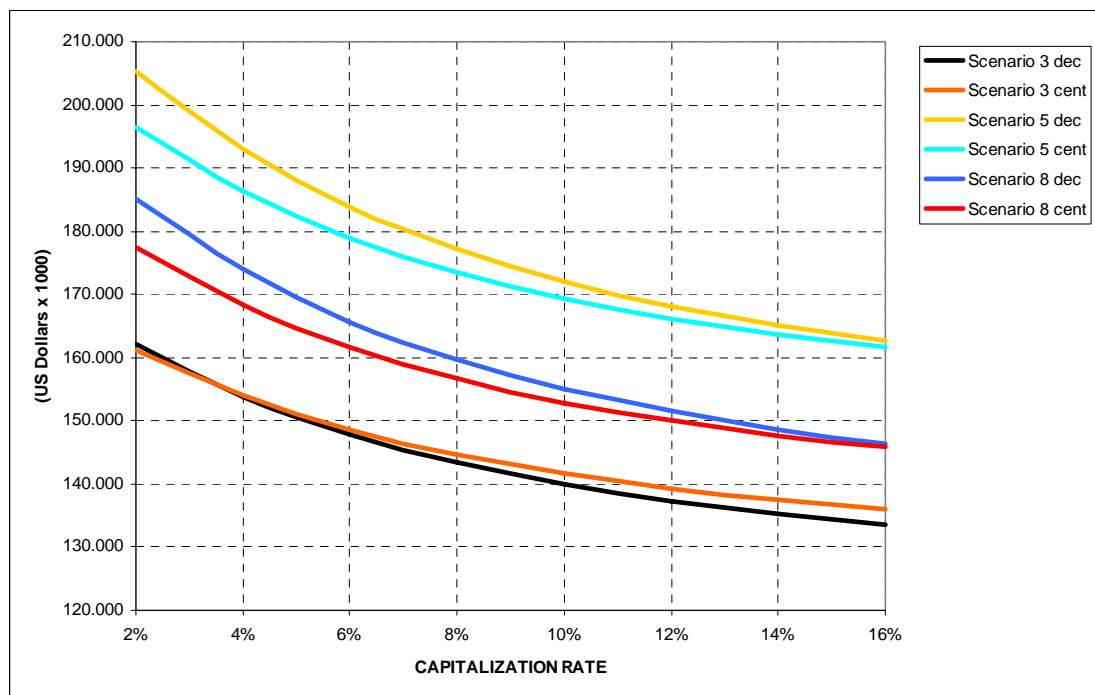


Figure 10: Investment and O&M cost capitalisation for AI Majar Al Kabeer district.

The cost analysis in Figure 10 indicates the centralized options for Scenarios 5 and 8 as the most cost-effective (if compared with the decentralized). Along with increase of the capitalization rates

the two curves (centralized/decentralized) for each scenario get near. Scenario 3 shows the decentralization as the most cost-effective approach for capitalization rates higher than 6%.

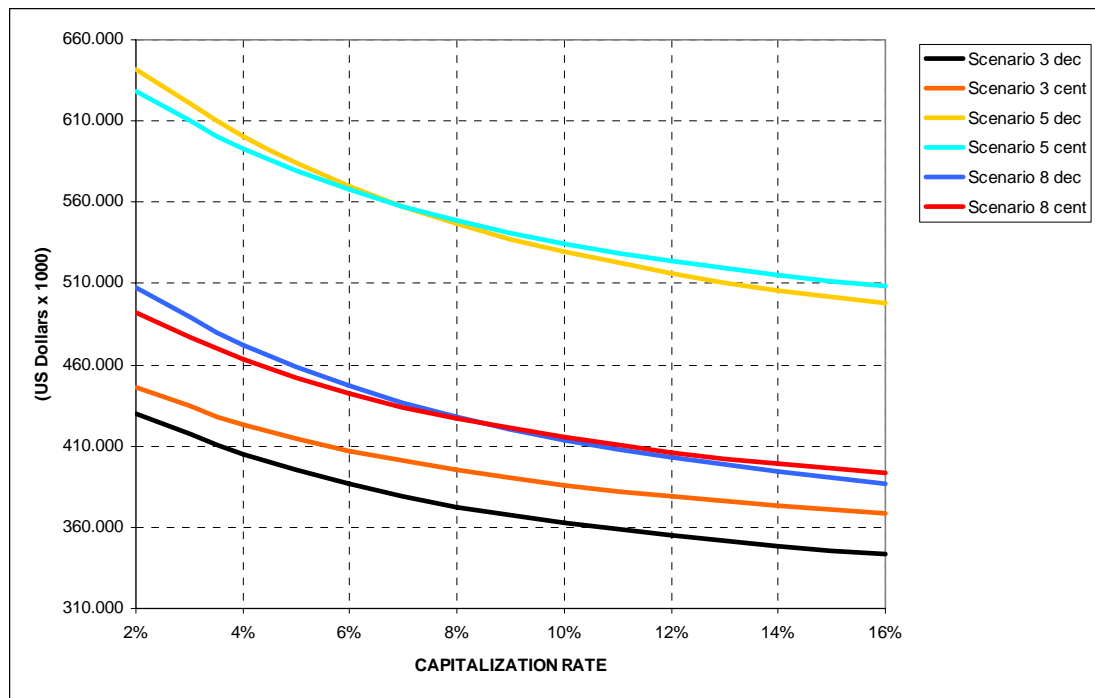


Figure 11: Investment and O&M cost capitalisation for Amarah+ Al Kahla'a district.

The cost analysis in Figure 11 indicates the centralized options for Scenarios 5 and 8 as the most cost-effective for capitalization rates lower than 7% and 8.5% respectively. Scenario 3 results, economically, the best option for the entire range of capitalization rates considered.

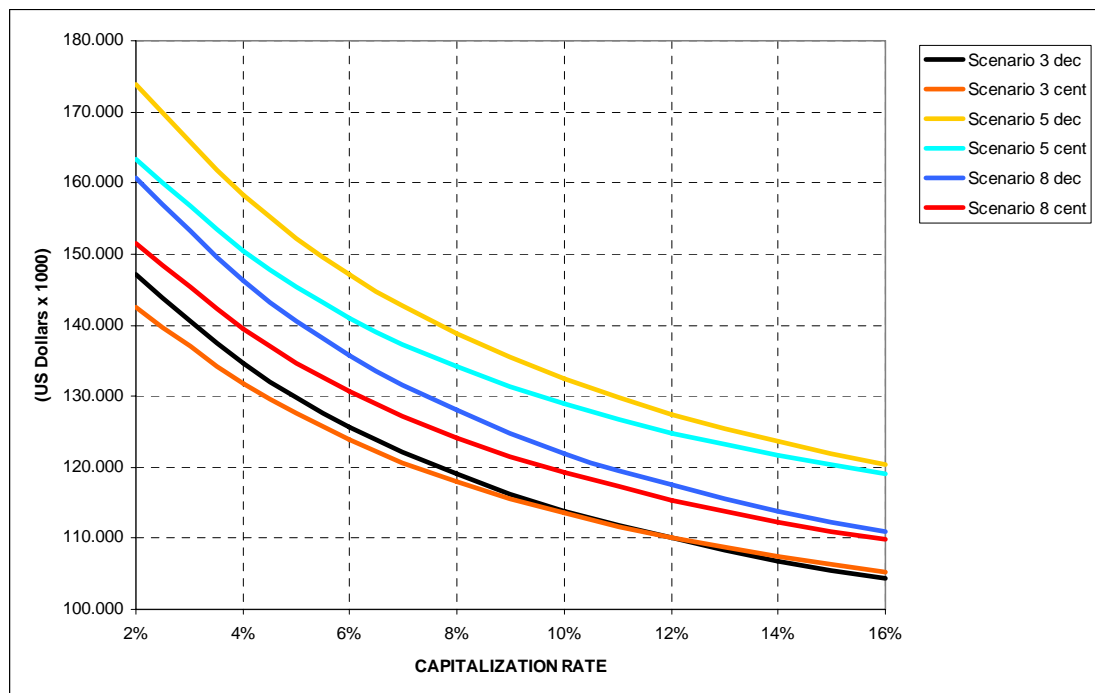


Figure 12: Investment and O&M cost capitalisation for Qalat Saleh district.

The cost analysis in Figure 12 shows the centralized options for Scenarios 5 and 8 as the most cost-effective (if compared with their respective decentralized options). Along with increase of the capitalization rates the two curves (centralized/decentralized) for each scenario get near. Scenario 3 shows the decentralization as the most cost-effective approach for capitalization rates higher than 12%.