

GLOBAL WASTEWATER REUSE MARKET WITH SPECIAL FOCUS ON KSA

PREPARED BY:

**Professor Walid Abderrahman
Managing Director, Miahona**



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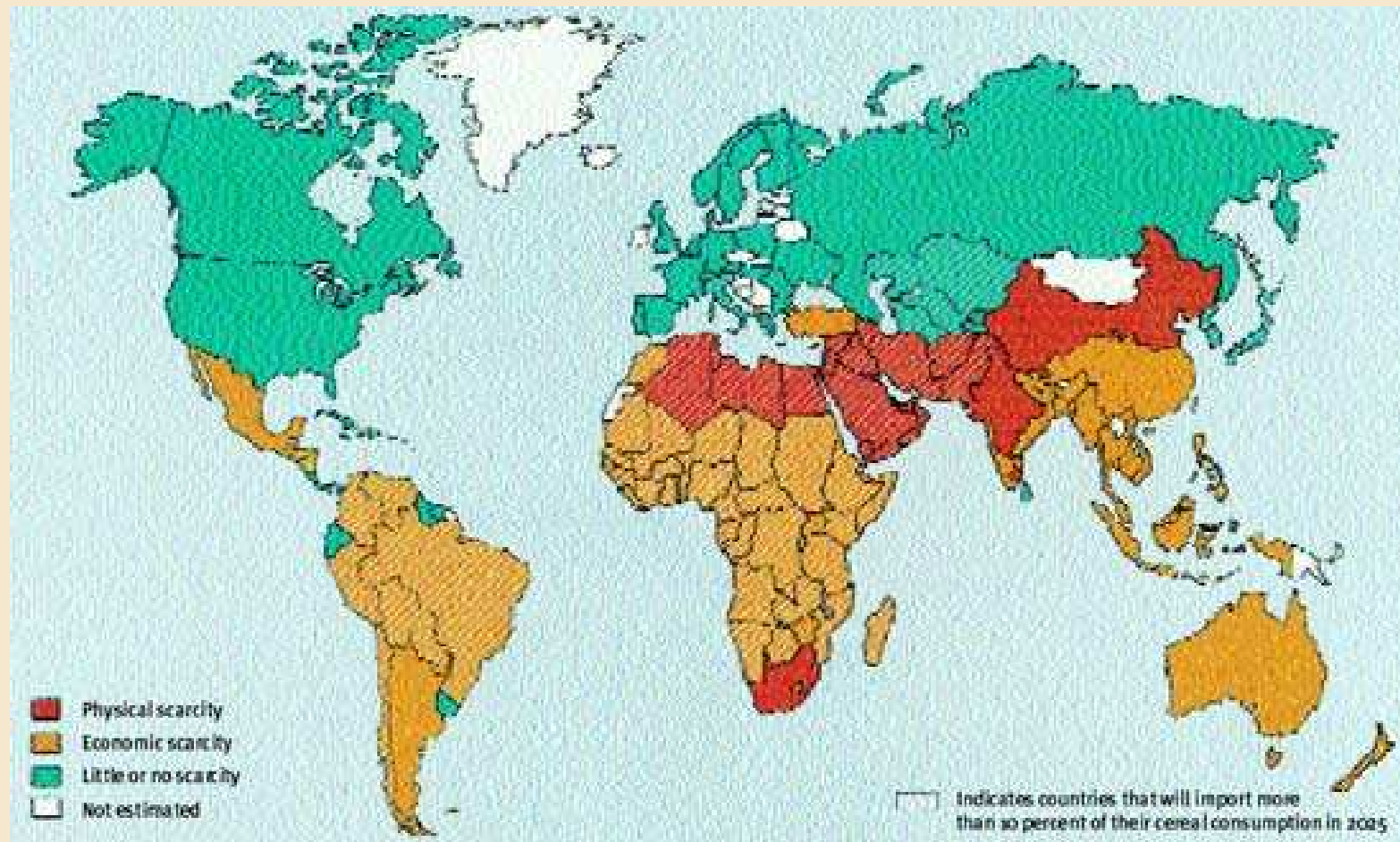
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**SECTION 2: MARKET DRIVERS OF WASTEWATER REUSE IN
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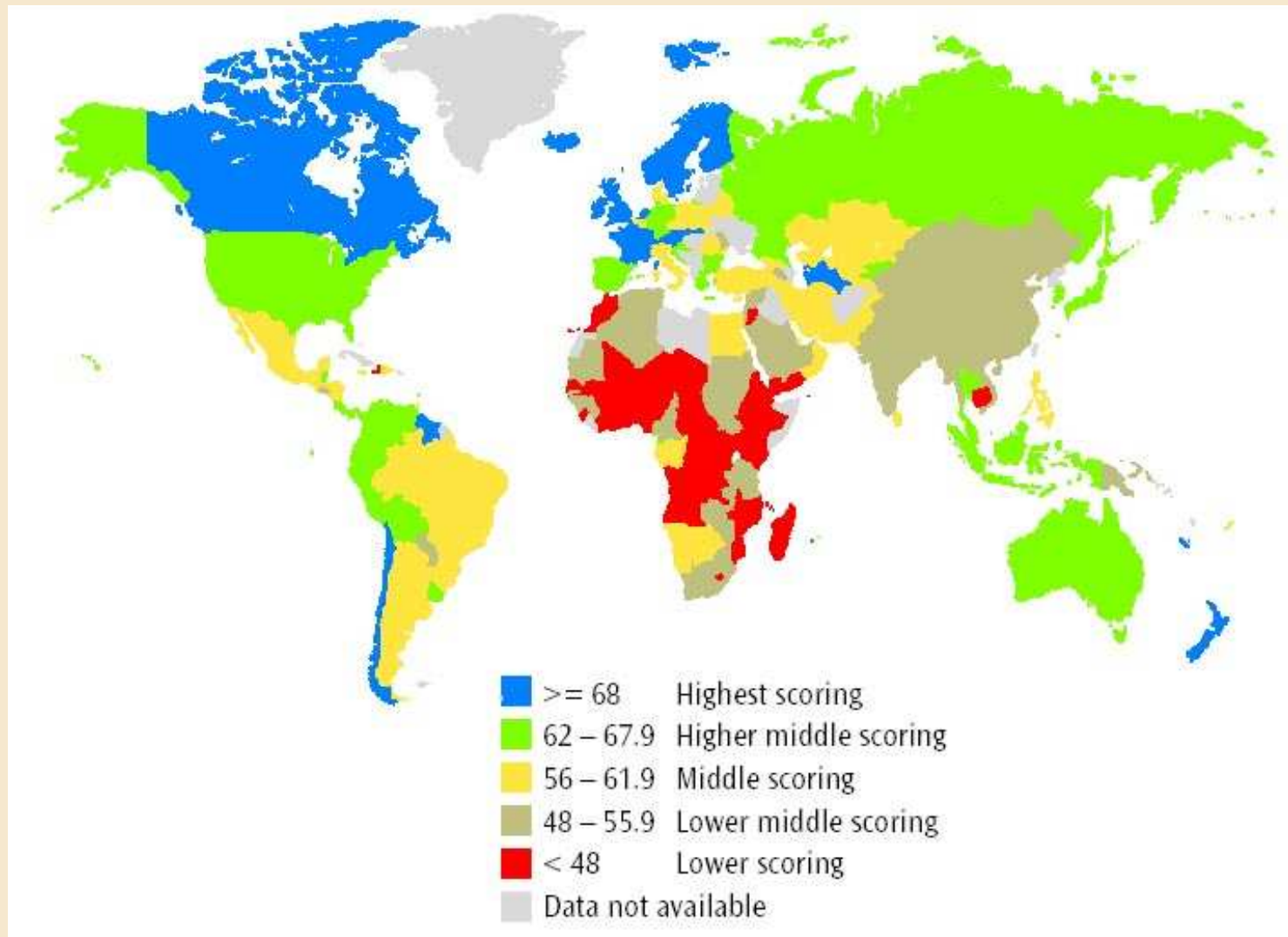
**SECTION 3: MARKET FORECAST FOR WASTEWATER REUSE IN
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SECTION 1: GLOBAL OVERVIEW ON WASTEWATER REUSE MARKETS

1.1: Global Water Scarcity- Water Thirst Map



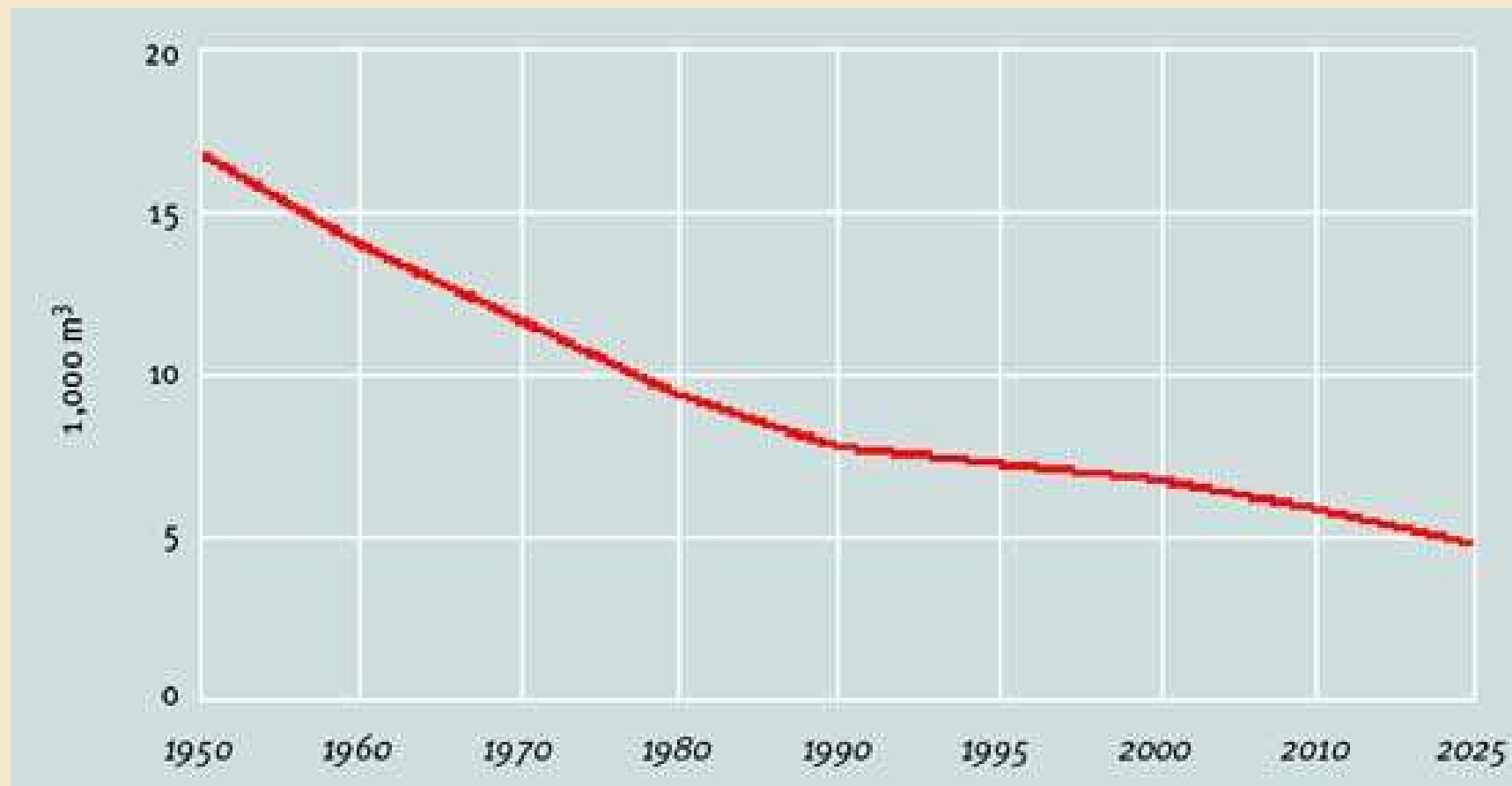
Water Poverty Index



Water Scarcity Among Global Population

Degree of Water Shortage	Definition (Annual Renewable Resources/Head)	% Global Population
Water scarcity	Fewer than 1,000 m ³	7.80%
Water stress	1,000 - 1,699 m ³	24.50%
Insufficient water	1,700 - 2,999 m ³	34.70%
Relatively sufficient	3,000 - 9,999 m ³	16.70%
Plentiful supply	More than 10,000 m ³	16.30%

World Available Water Use



Additional Non-traditional Supply Required In Water Scarce/Water Stressed Regions

	Non traditional supplies required by 2010	Non traditional supplies required by 2015
Americas		
USA	5,415	12,023
Rest of Americas	1,505	3,898
Americas total	6,920	15,921
Asia Pacific		
Japan	595	1,296
China	17,932	51,990
Singapore	296	350
Australia	472	1,089
Rest of Asia Pacific	17,665	58,050
Asia Pacific total	36,960	112,775
Europe, Middle East, Africa		
Western Europe	2,330	6,050
Eastern Europe/CIS	1,137	3,154
GCC	5,766	11,919
Israel	1,150	2,550
Rest of Middle East and North Africa	5,966	15,206
Namibia	20	46
South Africa	941	3,102
Rest of Africa	487	1,489
EMA total	17,797	43,516
World total	61,677	172,212

1.2: Drivers For Treated Wastewater Reuse

- It converts wastewater that potentially damages the environment into a resources that can improve the environment.
- Treated wastewater comes as a response to fresh water scarcity challenges .
- It is a sustainable and reliable resource regardless of weather patterns.
- It is available where the population is, and grows with the population increase.

1.2: Drivers For Treated Wastewater Reuse-Contd

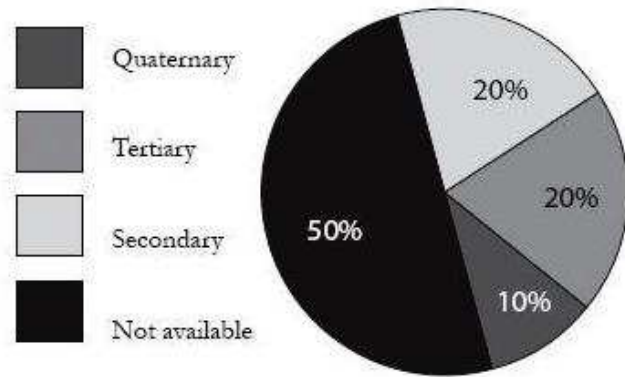
- It may be cheaper than other alternatives such as desalination, or long distance water transport.
- While it may not be acceptable for direct potable use, but it may reduce pressure on other raw water sources for potable uses.
- It is a local solution to water scarcity where it is difficult to find additional resources from elsewhere.
- Water reuse sectors such as district cooling and industry has demonstrated rapid returns on investment.
- The associated cost of wastewater treatment and reuse has proven to be feasible in many countries worldwide.

1.3: Potential Wastewater Reuse Sectors

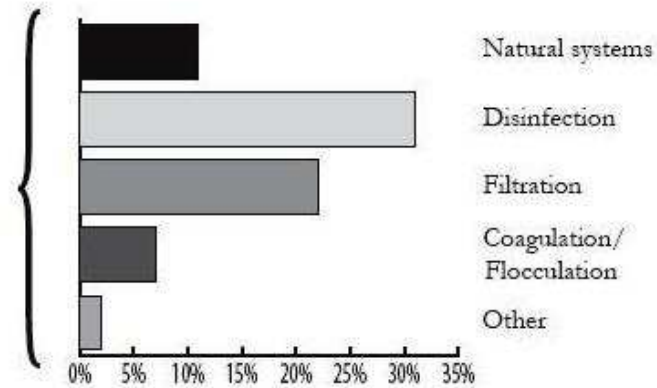
- Agriculture-farms irrigation.
- Industries-process, refineries, power plants.
- District cooling systems-big commercial buildings.
- Multi-story apartments, large housing units.
- Public parks-landscaping, public fountains.
- Groundwater and aquifer recharge.
- Non-potable use-fire hydrants, toilet flushing, car washing, gardening industries.

1.4: Present Wastewater Reuse Worldwide

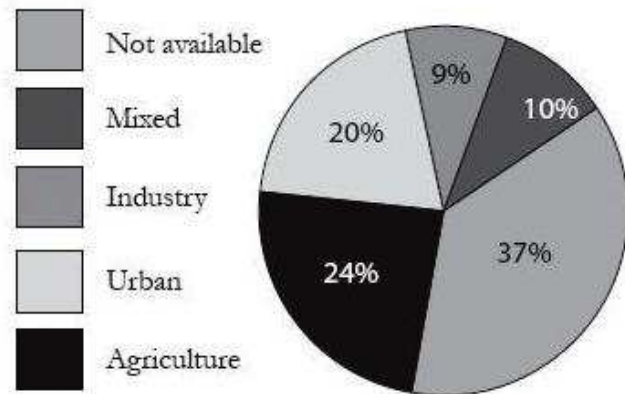
Global Water Reuse Volume By Level Of Treatment



Water Reuse by Treatment Level



Water Reuse by Type of Tertiary Treatment



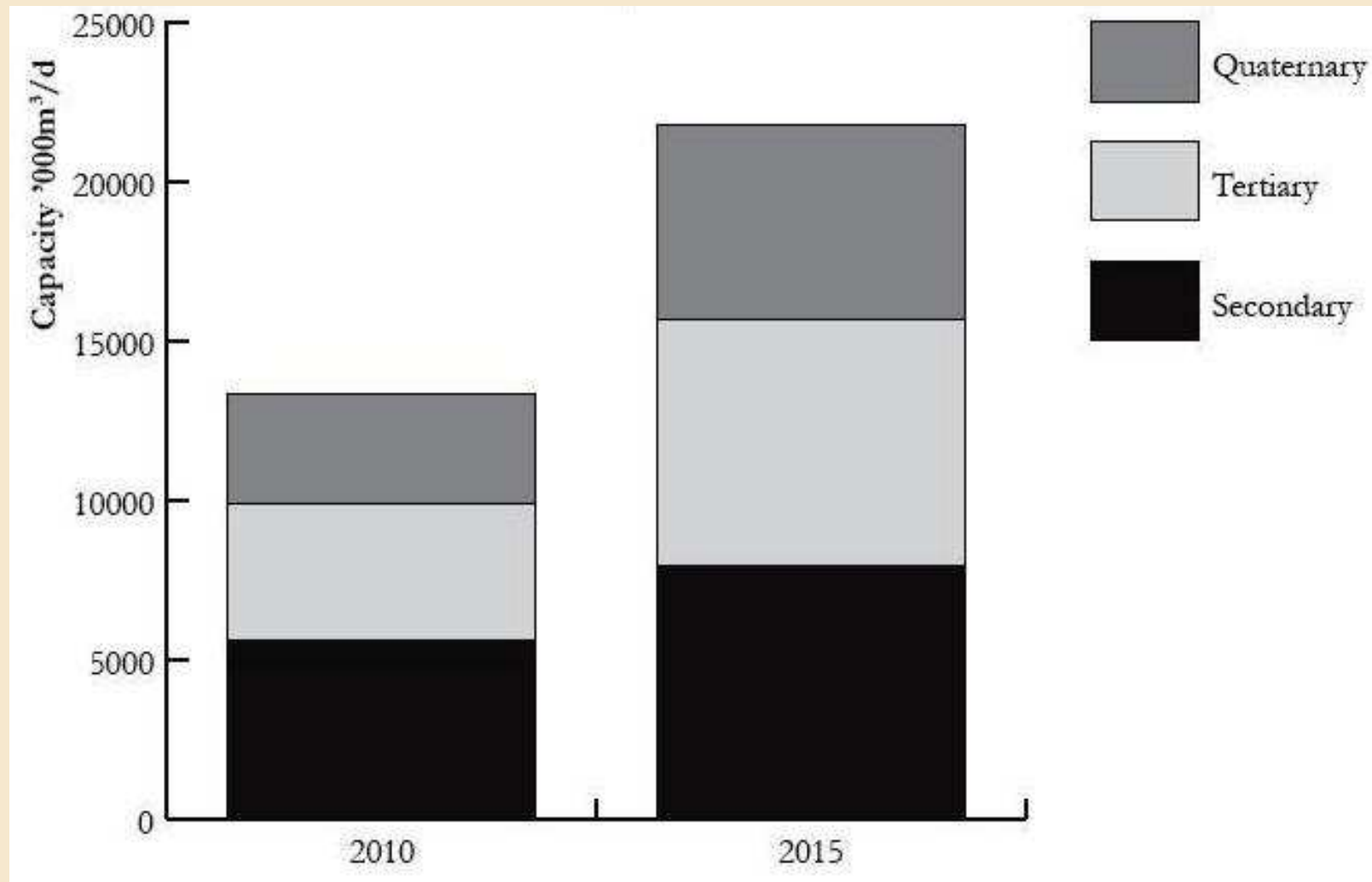
Water Reuse by Application

Global Water Reuse Volume By Field Of Application By Country/Region

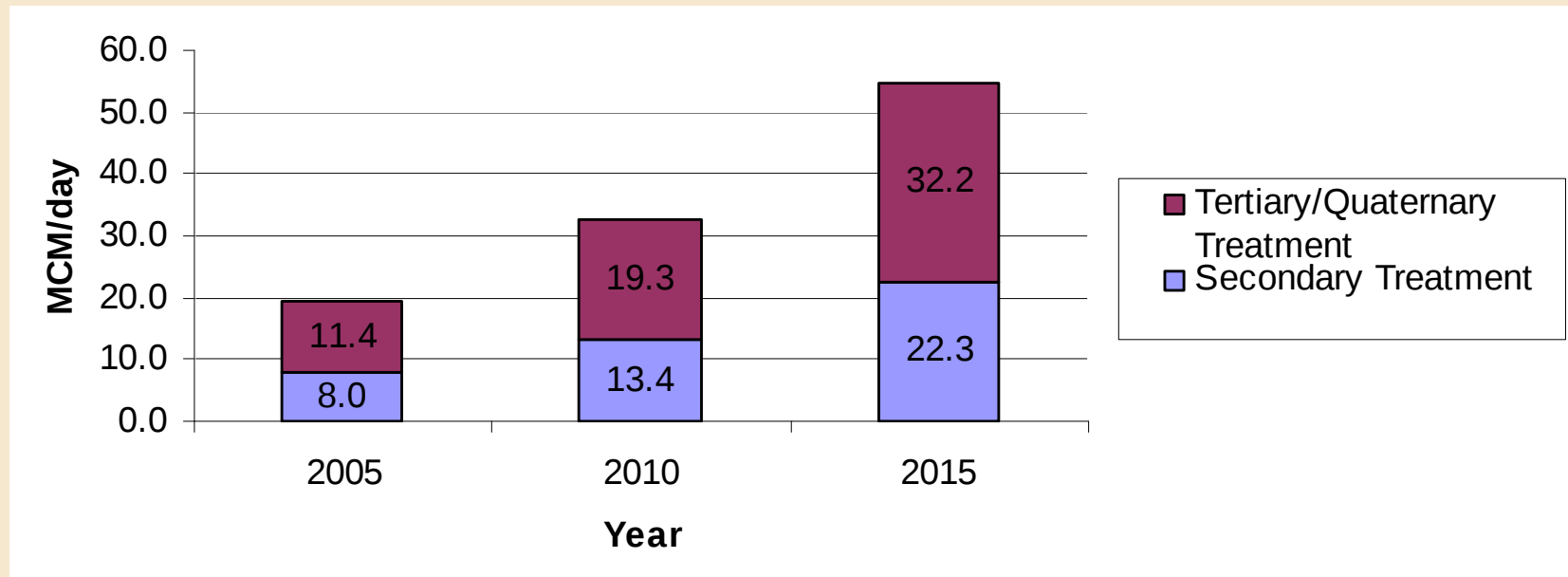
	Agriculture	Urban	Industry	Mixed	Not available
<u>Americas</u>					
USA	27.8%	46.9%	3.6%	10.8%	10.8%
Rest of Americas	78.6%	0.0%	7.1%	0.0%	14.3%
Americas total	39.8%	21.2%	22.9%	21.2%	24.6%
<u>Asia Pacific</u>					
Japan	5.0%	40.9%	9.0%	45.1%	0.0%
China	10.0%	40.0%	50.0%	0.0%	0.0%
Singapore	0.0%	100.0%	0.0%	0.0%	0.0%
Australia	42.4%	27.1%	4.9%	19.3%	6.2%
Rest of Asia Pacific	0.0%	0.0%	0.0%	0.0%	100.0%
Asia Pacific total	8.2%	21.3%	12.7%	10.0%	47.8%
<u>Europe, Middle East, Africa</u>					
Western Europe	24.9%	43.0%	18.5%	9.2%	4.3%
Eastern Europe/CIS	0.0%	0.0%	25.0%	0.0%	75.0%
GCC	13.6%	22.4%	2.1%	14.3%	47.6%
Israel	60.0%	0.0%	0.0%	40.0%	0.0%
Rest of Middle East and North Africa	39.0%	5.4%	2.8%	0.0%	52.9%
Namibia	0.0%	0.0%	0.0%	100.0%	0.0%
South Africa	5.3%	0.0%	15.8%	52.6%	26.3%
Rest of Africa	0.0%	0.0%	0.0%	0.0%	100.0%
EMEA total	24.1%	10.5%	9.3%	11.6%	44.5%
World total	25.1%	16.5%	14.1%	14.2%	41.3%

1.5: Global Wastewater Reuse Forecast Capacity 2005–2015

Additional Wastewater Reuse By Level Of Treatment 2005-2015



1.6: Summary Of Global Trend In Wastewater Reuse



1.7: Expected Largest Growth In Wastewater Reuse Volumes And Investments

Market increase	Expected additional capacity by 2015	% Annual increase in Capacity	Forecast capital expenditure (thousand million)
China	10,790	29%	\$3,615
MENA	5,589	12%	\$17.2
USA	4,473	12%	\$5,636
Western Europe	3,895	10%	\$5,534
Rest of Asia	3,750	14%	\$2,500

1.8: Factors Controlling The Ability To Pay For Wastewater Reuse

- The first is the actual price that water consumers pay for water.
- The second is the maximum price that they are likely to pay for water. The maximum price is generally a function of the GDP per head.
- If the average cost of water from a wastewater reuse project is greater than the maximum affordable price, the project will only go ahead if there is an industrial off-taker. A municipal off-taker would probably be unable to finance the project.

1.9: Global Obstacles For Wastewater Reuse

- Water reuse may be required from a demand point of view and affordable, but not locally practical. This is generally because of a mismatch between the supply of wastewater and the demand for reclaimed water due to various causes.
- Lack of wastewater collection and treatment facilities to supply a water reuse facility
- Lack of an economic distribution system to get the reclaimed water to where it is required. **Distribution is the major bottleneck for the water reuse market in North America, Europe, Australia and Japan.** This is particularly true of large scale urban projects: if an urban wastewater treatment plant is not located conveniently for industry, and there are no local leisure facilities requiring irrigation then heavy investment in distribution infrastructure is required.

1.10 National Public Policy And Wastewater Reuse

A) The public policy is a driver of water reuse both in terms of restricting wastewater discharges and in terms of incentivizing water reuse through grants and tax breaks.

The regulatory trend in the US is more static. On a state level however there are a number of initiatives to encourage reuse. State laws allow a 50% business tax credit for equipment or conveyance solely for the purpose of water reuse in an industrial process. The state also offers low-interest loans for reuse projects: 50% at zero interest and 50% at market interest rates.

1.11 National Public Policy And Wastewater Reuse-Contd

B) The impact of public policy on the market for wastewater reuse goes beyond the **direct incentives to reuse wastewater and restrictions on discharges**. Public policy also boosts water reuse indirectly through the **obstacles it creates for alternative new water sources** such as long distance water transfer and **fossil groundwater depletion**.

C) Wastewater reuse, along with leak reduction and demand management, is generally considered one of the most environmentally sustainable approaches to meeting future water resources requirements.

SECTION 2: MARKET DRIVERS FOR WASTEWATER REUSE IN SAUDI ARABIA

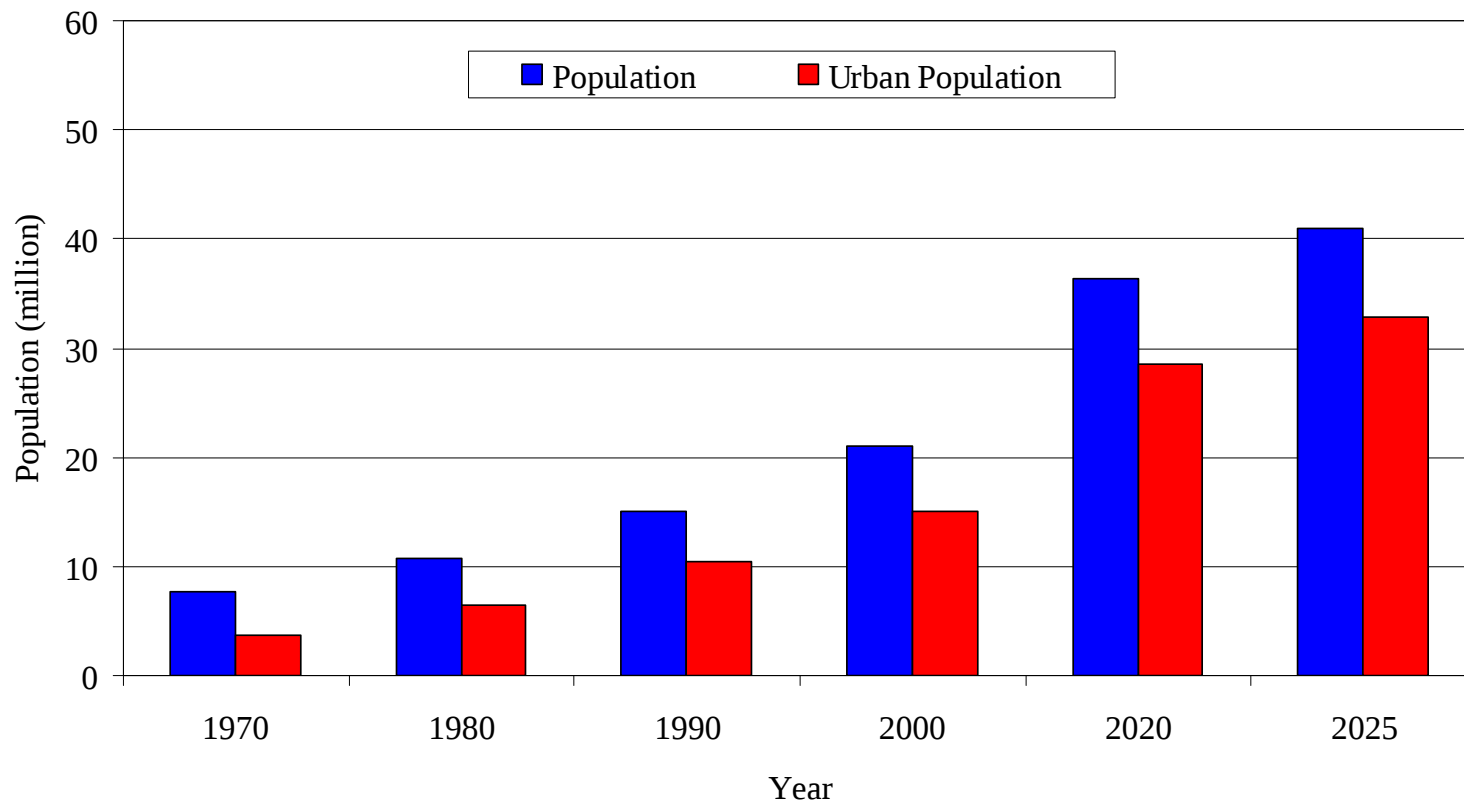
2.1: Background Information

- Saudi Arabia is located under extremely arid conditions where annual rainfall in most of the country is less than 150 mm/ year.
- During the past four decades, the Kingdom has witnessed rapid increase in population coupled with improvements in standard of living and comprehensive development in domestic, agricultural and industrial sectors.
- Consequently, the national water demand has increase immensely (from less than 6 Billion m³/year in 1970 to more that 20 billion m³/year in 2007).

2.1: Background Information-Contd

- The annual increase in domestic demand is about 6%.
- The demands have far exceeded the water supply quantities from limited resources (mainly non renewable groundwater) in addition to the costly desalination.
- The trend of water demand increase and water supply shortage will increase in future if non conventional water resources such as wastewater reuse is not widely and effectively adopted.
- The cost of water production and distribution is considered as one the highest in the world.

Population Growth In Saudi Arabia



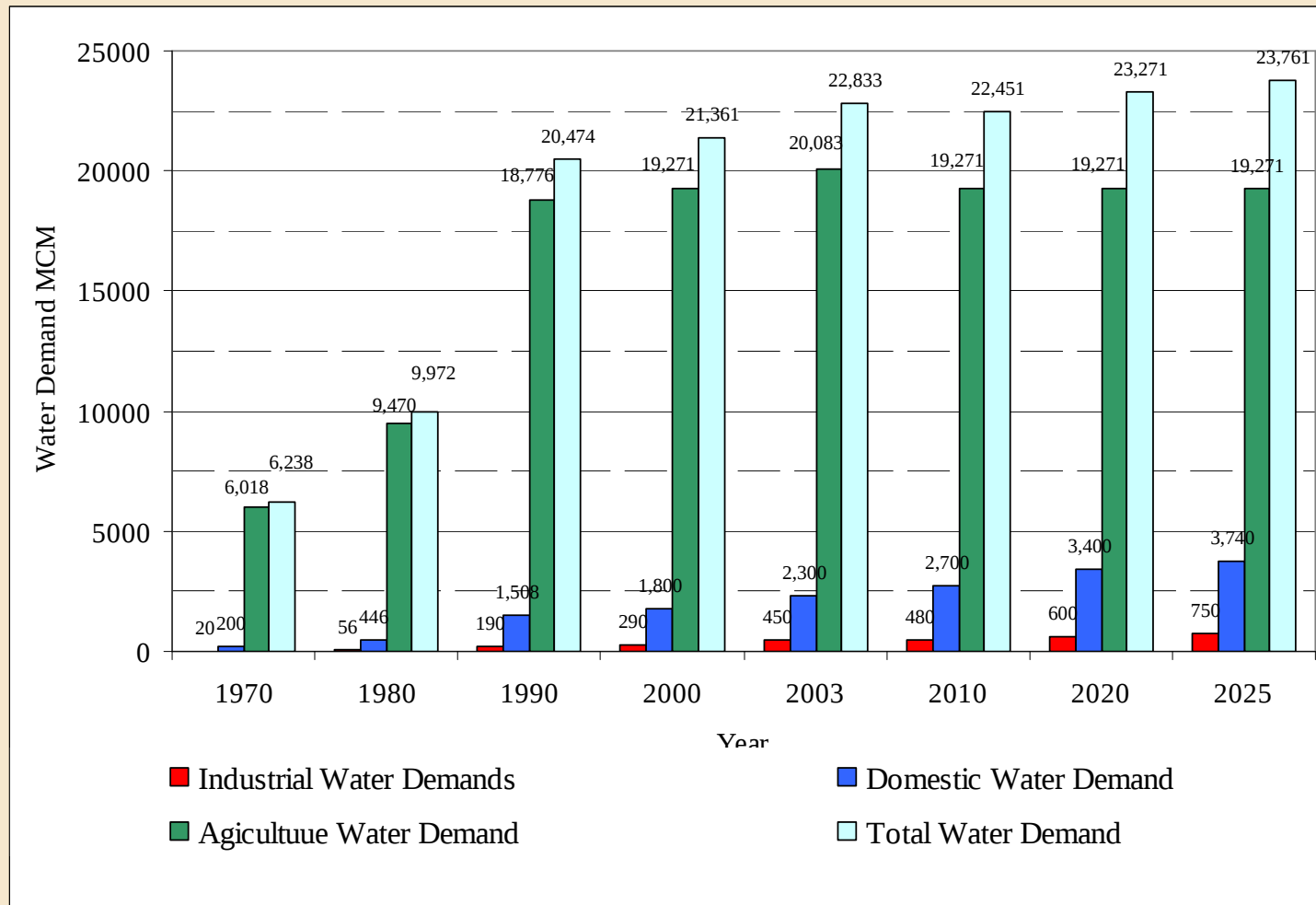
Growth Of Domestic Water Demand In Saudi Arabia In MCM/year

YEAR	Water Demands
1970	200
1980	446
1990	1,508
1997	1,563
2000	1,800
2010	2,700
2020	3,400**
2025	3,740

Growth of Industrial Water Demands In Saudi Arabia In MCM/year

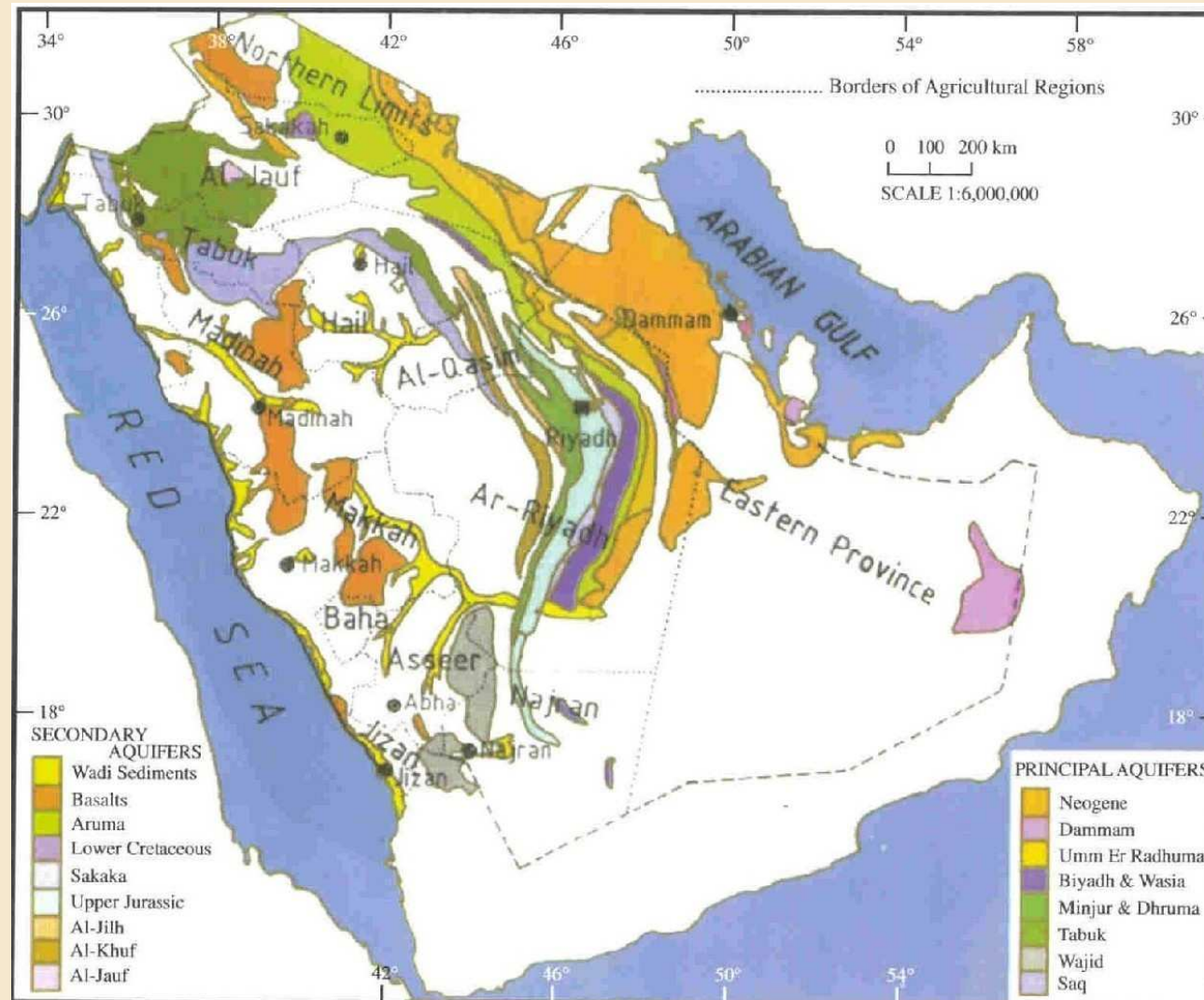
YEAR	Water Demands
1970	20
1980	56
1990	190
2000	290
2010	480
2020	600
2025	750

Growth In Industrial, Domestic, And Agricultural Water Demands In The Kingdom



2.2: Water Resources

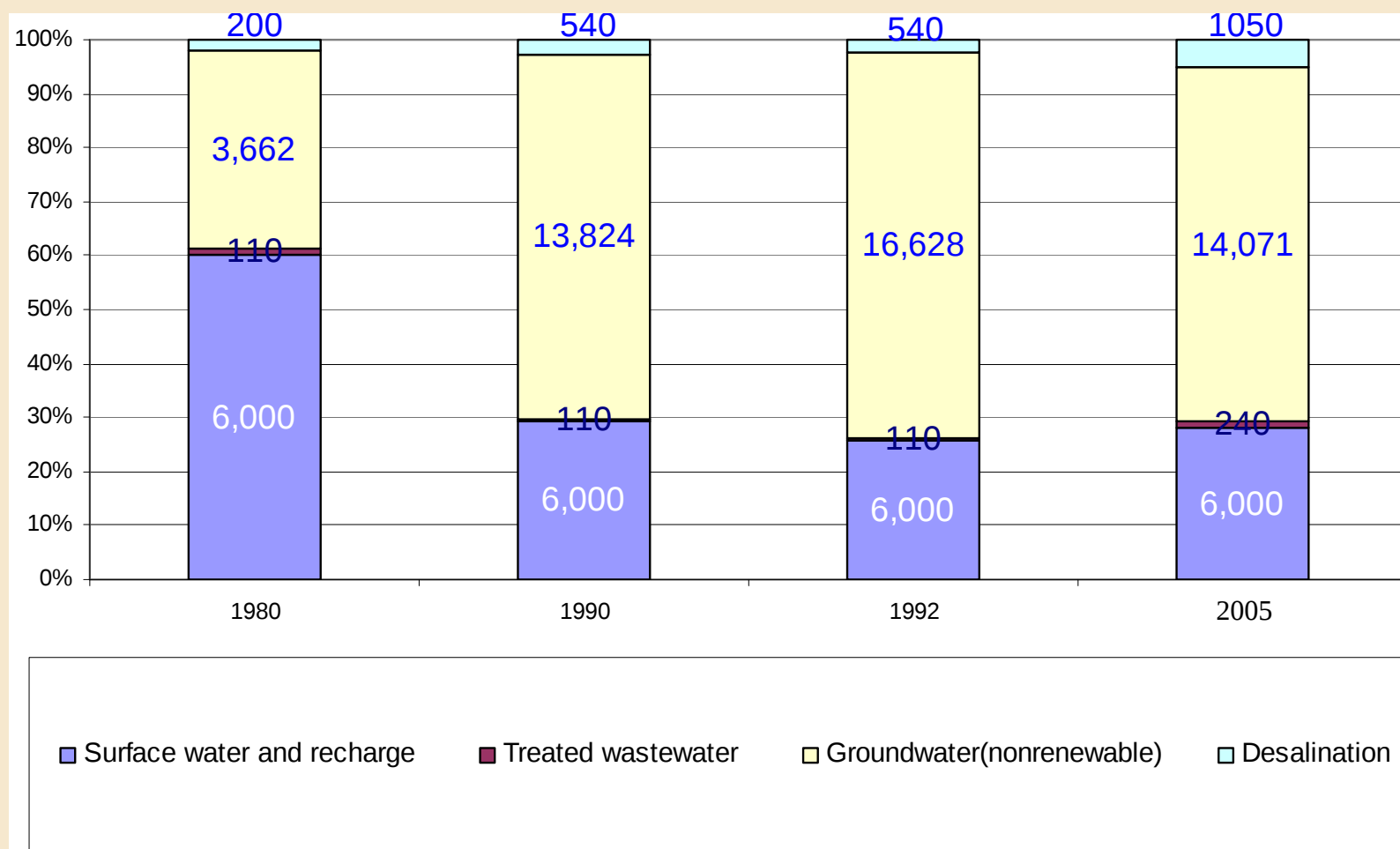
Challenges Of Water Resource Management In Saudi Arabia



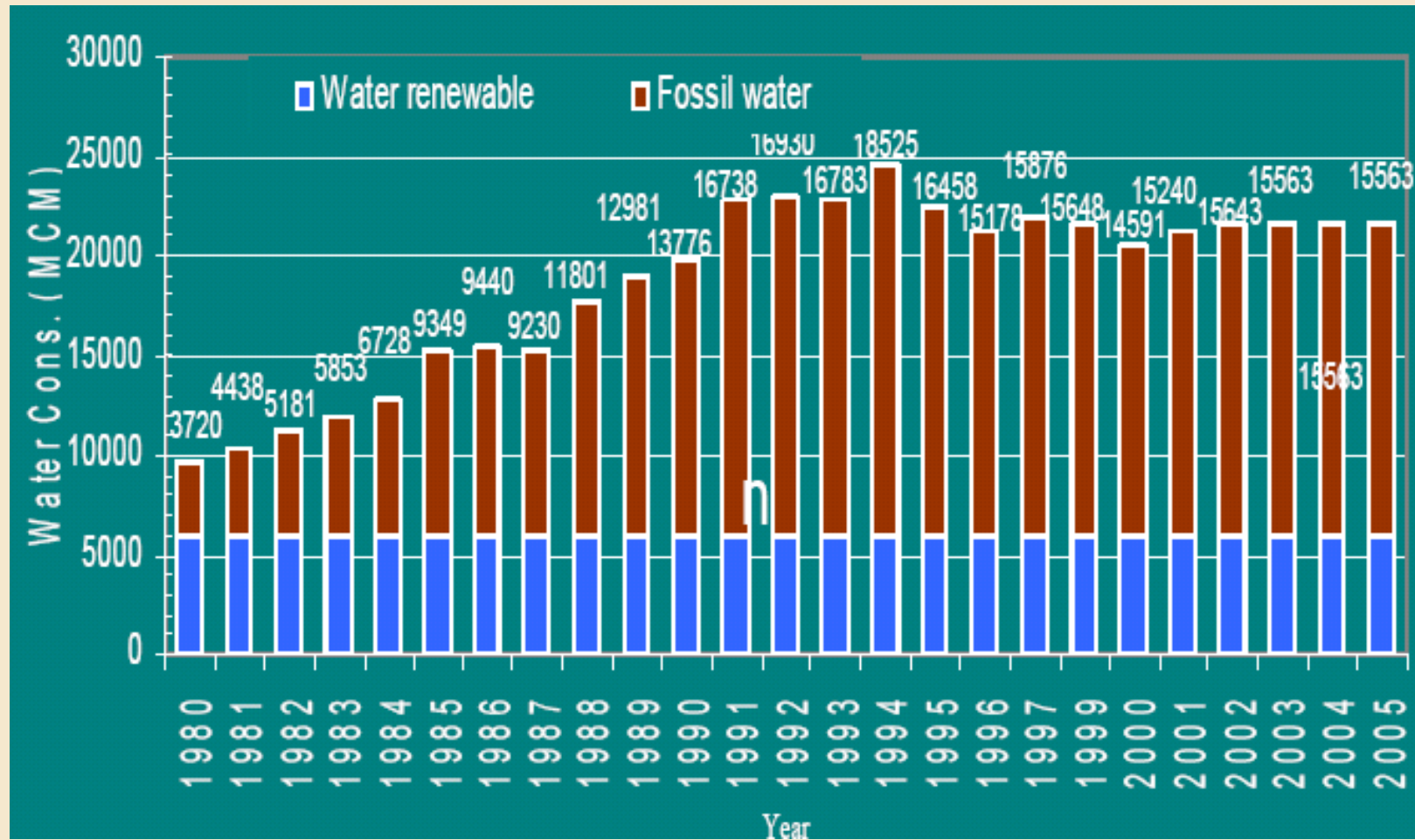
2.4: Average Water Share

The average water availability from renewable resources is about 260 cubic meters per person in 2009. According to the scarcity index the country is under extreme water shortages.

Water Supply In Saudi Arabia (MCM)



Groundwater Abstraction In Saudi Arabia



2.5: National Drivers For Wastewater Reuse Market In Saudi Arabia

- Saudi Arabia is a scarce water country and every additional drop of water including treated wastewater is considered precious.
- The use of treated sewage effluent (TSE) can be considered as an important augmentation to the available limited water resources in the Kingdom.
- Satisfying the non potable needs of the kingdom for irrigation, district cooling etc can be fulfilled by alternative such as treated sewage effluent.
- The rapid growth of industrial cities resulting in increasing water demand can be satisfied by treated sewage effluent.
- The dairy farms which consume large quantities of fossil groundwater for forage cultivation and dairy use can be replaced by treated sewage effluent.

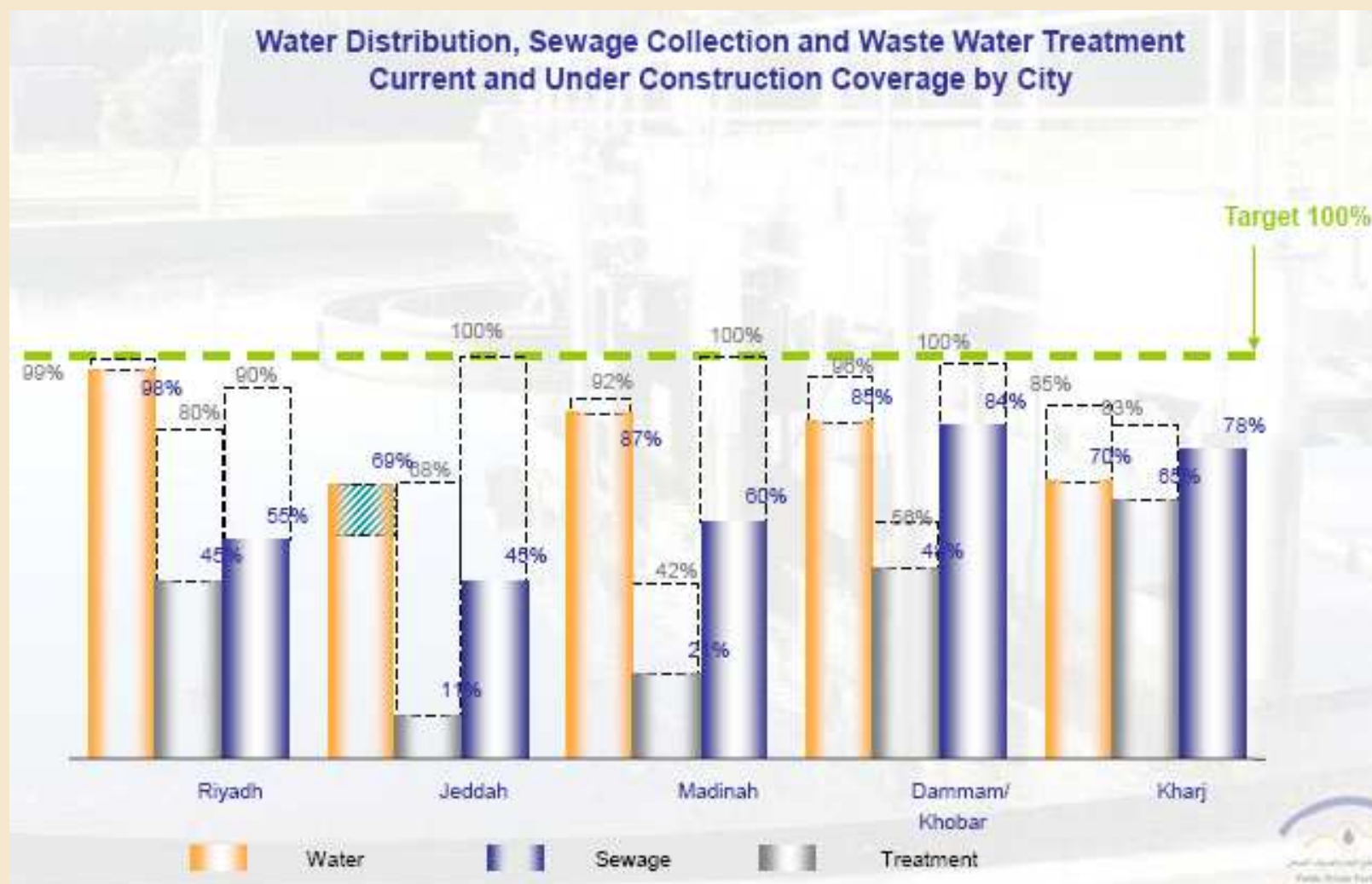
2.6: Specific Challenges for Creation of Wastewater Reuse Market in Saudi Arabia

- The present coverage of Kingdom's sewage collection is only 45%.
- The wastewater reuse in the Kingdom is less than 10% of total water supply.
- Huge capital investments are required for the collection systems and treatment of wastewater, and reuse infrastructure development in the kingdom. According to NWC about SR 85 billion is required in the next 20 years.

2.6: Specific Challenges for Creation of Wastewater Reuse Market in Saudi Arabia-Contd

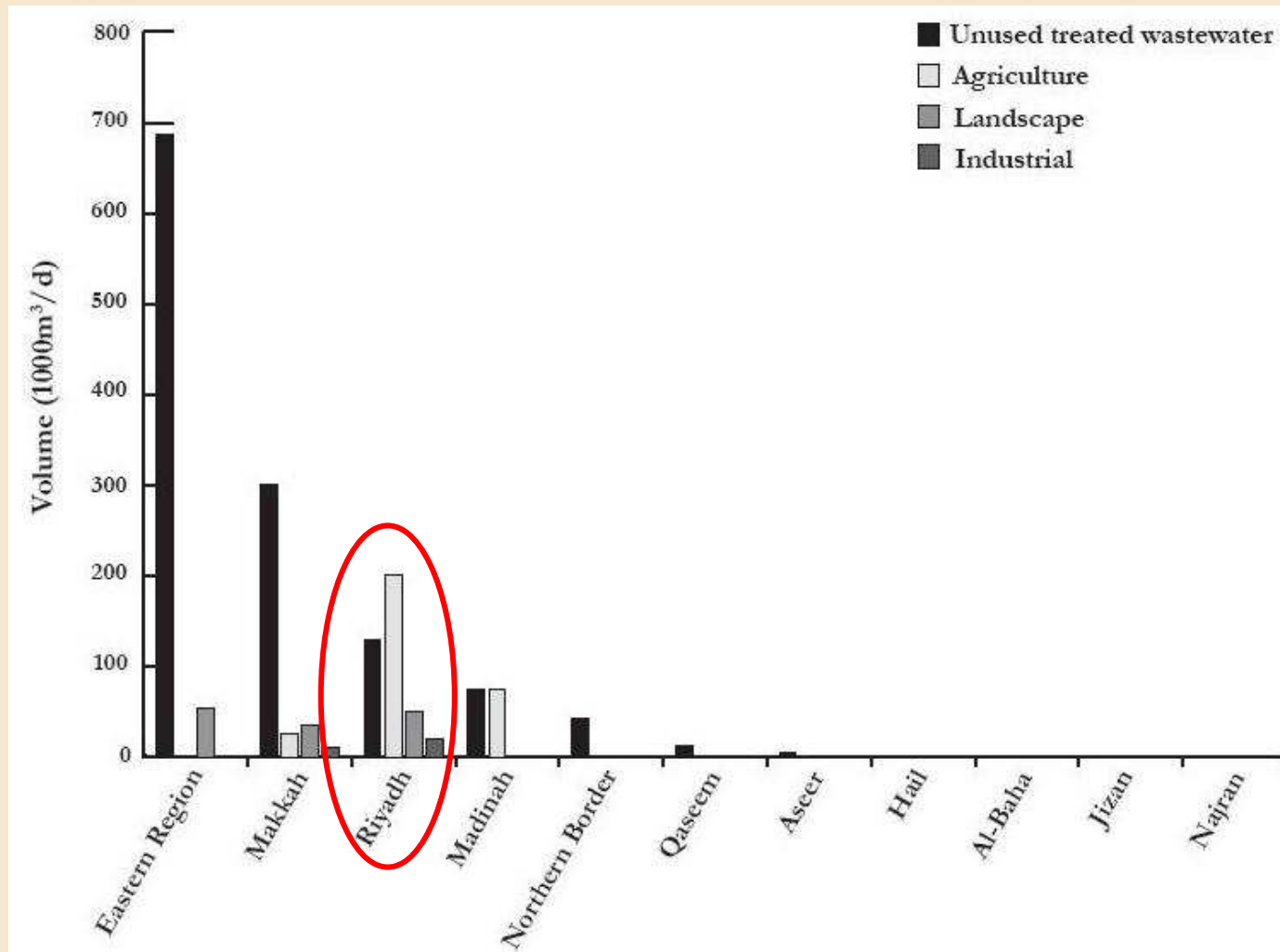
- Requirement for proper organizational and institutional structure for wastewater reuse market. The NWC is acting on this issue seriously.
- Although wastewater reuse legal act is announced, but additional frameworks are required to regulate and to enforce the implementation of the act.
- Additional legislation are required to enhance the wastewater reuse demands such as **banning the use fossil non-renewable ground water for dairy farms, forage crop production** and industry within and around cities.

Current Coverage percentage versus 100% coverage

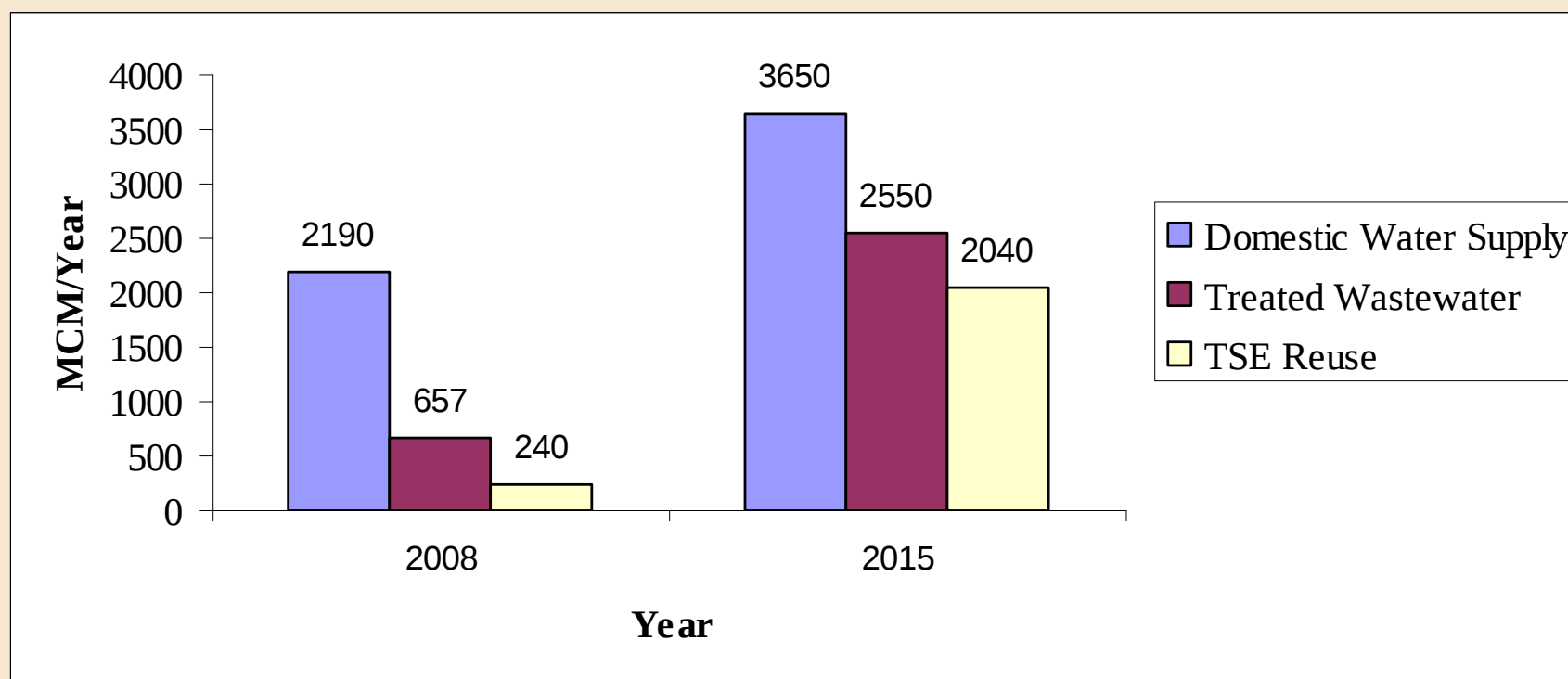


Source: NWC

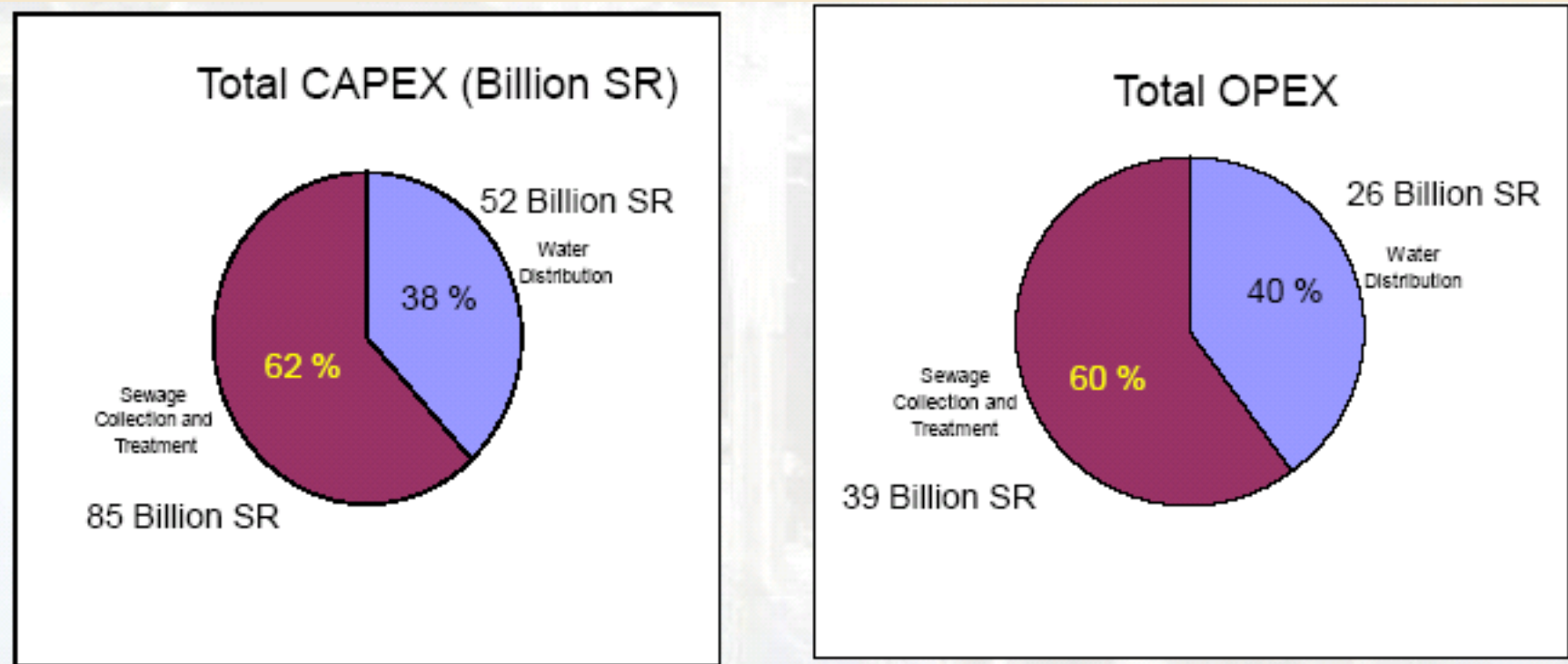
Current Wastewater Reuse Market By Volume And Sector In Saudi Arabia



Present And Future Size of Wastewater Reuse In Saudi Arabia



CAPEX and OPEX Expenditure On Wastewater Collection And Treatment In Saudi Arabia For Next 20 Years

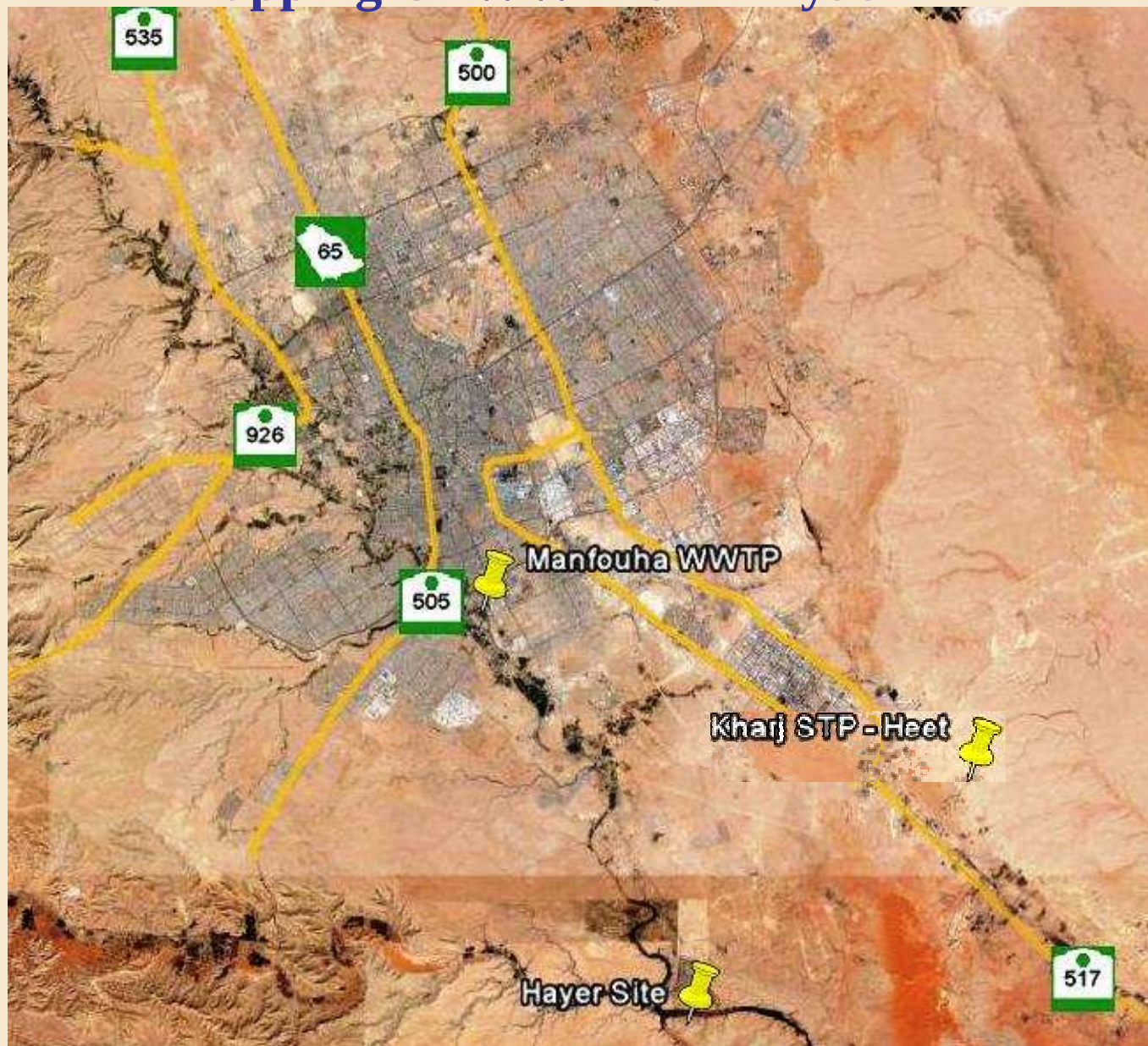


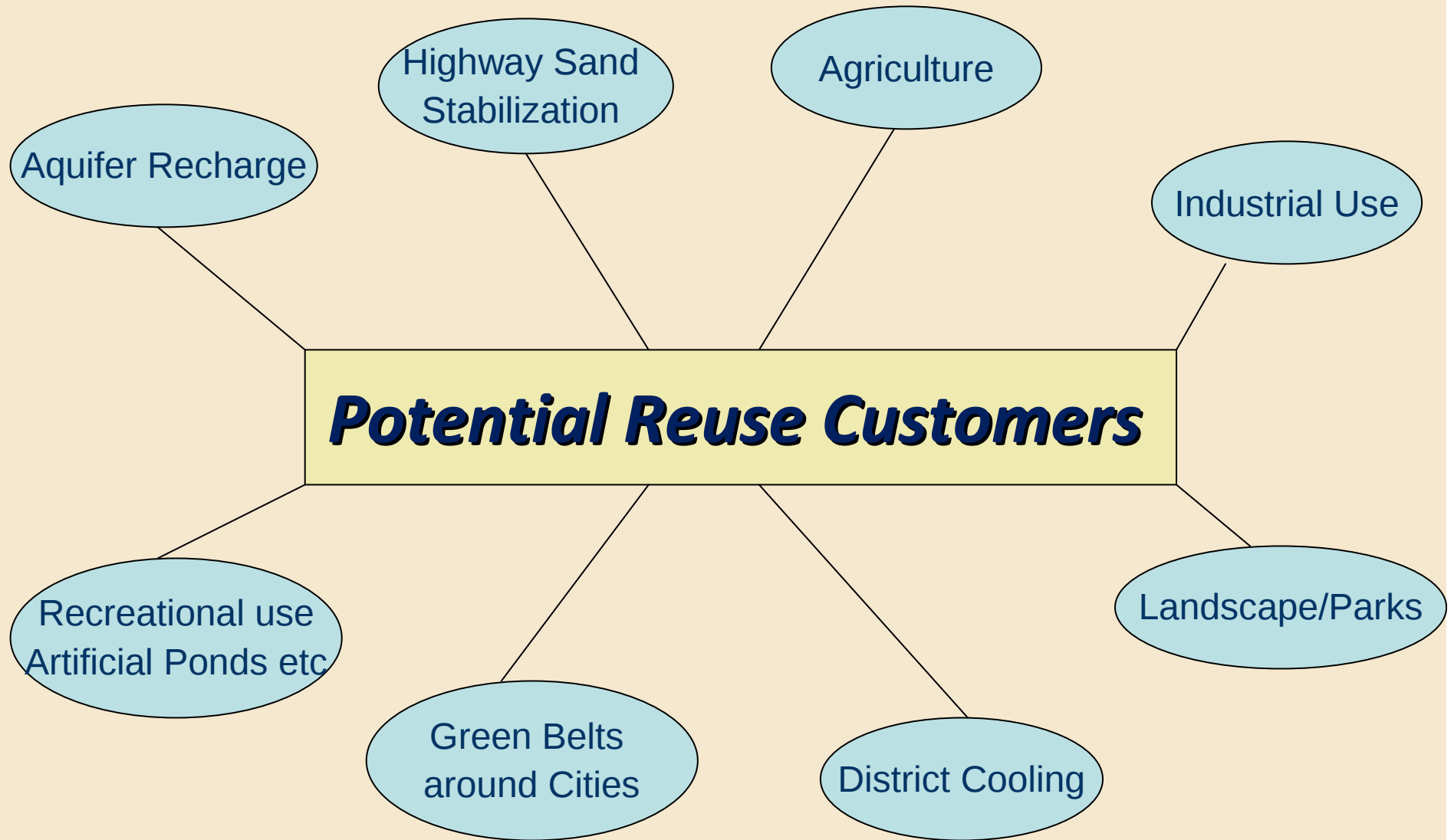
Source: NWC

SECTION 3: MARKET FORECAST FOR WASTEWATER

REUSE IN RIYADH

Mapping Of WWTPs In Riyadh





3.1: Present Wastewater Reuse Market By Level Of Treatment In Riyadh

Location	Plant	Design Capacity (M3/day)	Level of treatment	Suitable for
Manfouha	South C2	80,000	Presently Secondary- Upgrading to Tertiary	Restricted Re- use
	South C3	120,000	Presently Secondary- Upgrading to Tertiary	Restricted Re- use
	North	200,000	Presently Secondary- Upgrading to Tertiary	Restricted Re- use
	East	200,000	Presently Secondary- Upgrading to Tertiary	Restricted Re- use
Al-Kharj Road Phase-1		100,000	Presently Secondary- Upgrading to Tertiary	Restricted Re- use
Total Capacity		700,000		

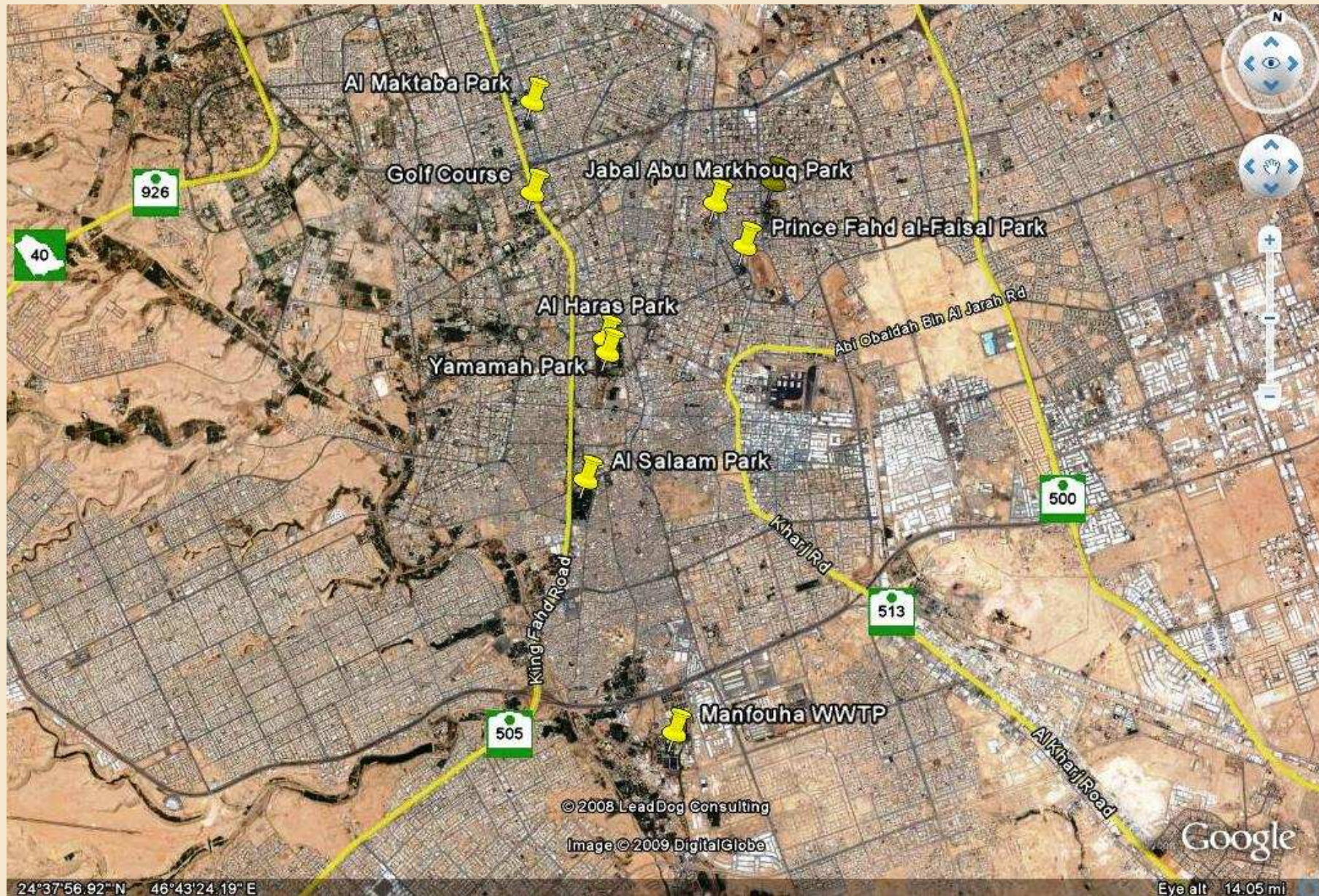
3.2: Present And Future Reuse Market In Riyadh

Location	Plant name	Year of commission	Design Capacity (M3/Day)
Manfouha	South plant C2	1975	80,000
	South plant C3	1981	120,000
	North Plant	1998	200,000
	East Plant	2005	200,000
Hayer	Phase-1	Under construction Expected Completion: 2010 / 2011	400,000
	Phase-2	Under Study	400,000
Al-Kharj	Phase-1	2006	100,000
	Phase-2	Under construction Expected : 2008 / 2009	100,000
	Phase-3	Under Study	100,000
Total Capacity			1,700,000

3.3: Present And Future Wastewater Reuse Market Sectors In Riyadh

Customer	Purpose of Re-use	Current Demand (M3/day)	Expected future daily Demand (M3/day) for 5 years
Aramco	Industrial	20,000	
Current Manfouha Reuse	Irrigation / Cooling Water	179,000	--
Muzaimiya & Dirab	Irrigation		280,000
Dareiya & Jebilla	Irrigation		120,000
Prince Turkey Bin Saud Al-Kabeer	Irrigation		50,000
Tabreed	Cooling Water		150,000
Other farms	Irrigation		25,000
Diary Farms	190,000 Milking Cows		22,000
Landscape/Parks	Irrigation of 50% area in Riyadh (5000Ha) by TSE		165,000
Green Belts	Irrigation of Green Belts around Riyadh		22,000
Diary Farms	Irrigation of Forage Crops mainly Alfalfa (10000 Ha)		1,000,000
Total		199,000	1,834,000

3.4: Mapping Of Major Parks In Riyadh



3.5: Area And Volume Of Water Required For Parks/Landscape In Saudi Arabia Including Riyadh

Region	%	Area (Ha)	Volume of Water (m3/day)
Riyadh	10.6	9228.45 *	303,401
Makkah	10.7	9292.93	305,521
Madinah	12.5	10903.40	358,468
Qaseem	13.3	11574.96	380,547
Eastern Region	4.8	4176.93	137,324
Aseer	16.5	14381.02	472,801
Tabouk	5.6	4920.75	161,778
Hail	6.7	5823.45	191,456
Northern Region	0.3	270.64	8,898
Jazan	11.4	9935.26	326,639
Najran	2.8	2454.02	80,680
Al-Baha	2.2	1916.00	62,992
Al-jouf	2.6	2314.20	76,083
Total	100	87192.01	2,866,587

* Assumption: 50% of the park area will be irrigated by TSE

3.6: Area And Volume Of Water Required For Green Belts In Saudi Arabia

Region	Forestation			Volume of Water (m3/day)
	No. of Trees	Area (Ha)	No. of Sites	
Riyadh-Khuraish-Al Hayseya-Khorem- Riyadh Streets	90019	545.7	6	22,426
Makkah-Taif	80607	90.8	3	3,732
Asir	145200	143.6	13	5,901
Bisha	77500	98.0	7	4,027
Baha	240062	264.8	19	10,882
Najran	-	-	-	-
Northern	5000	-	1	-
Total	638388	1142.9	49	46,968

3.7: Crop Irrigation By Treated Wastewater



3.8: Forage Crops Area And Volume For Water Required In Riyadh Area

Region	Area (Ha)	Water Requirement (m3/day)
Riyadh	41533*	4,412,284
Makkah	950	100,924
Madinah	2686	285,349
Qaseem	14247	1,513,539
Eastern Region	1873	198,979
Aseer	1189	126,314
Tabouk	7607	808,134
Hail	5766	612,555
Northern Region	10	1,062
Jazan	0	0
Najran	1635	173,695
Al-Baha	46	4,887
Al-jouf	9582	1,017,950
Total	87124	9,255,672

* Assumption: 10,000 Ha of Alfalfa in the dairy farms near Riyadh will be irrigated by TSE

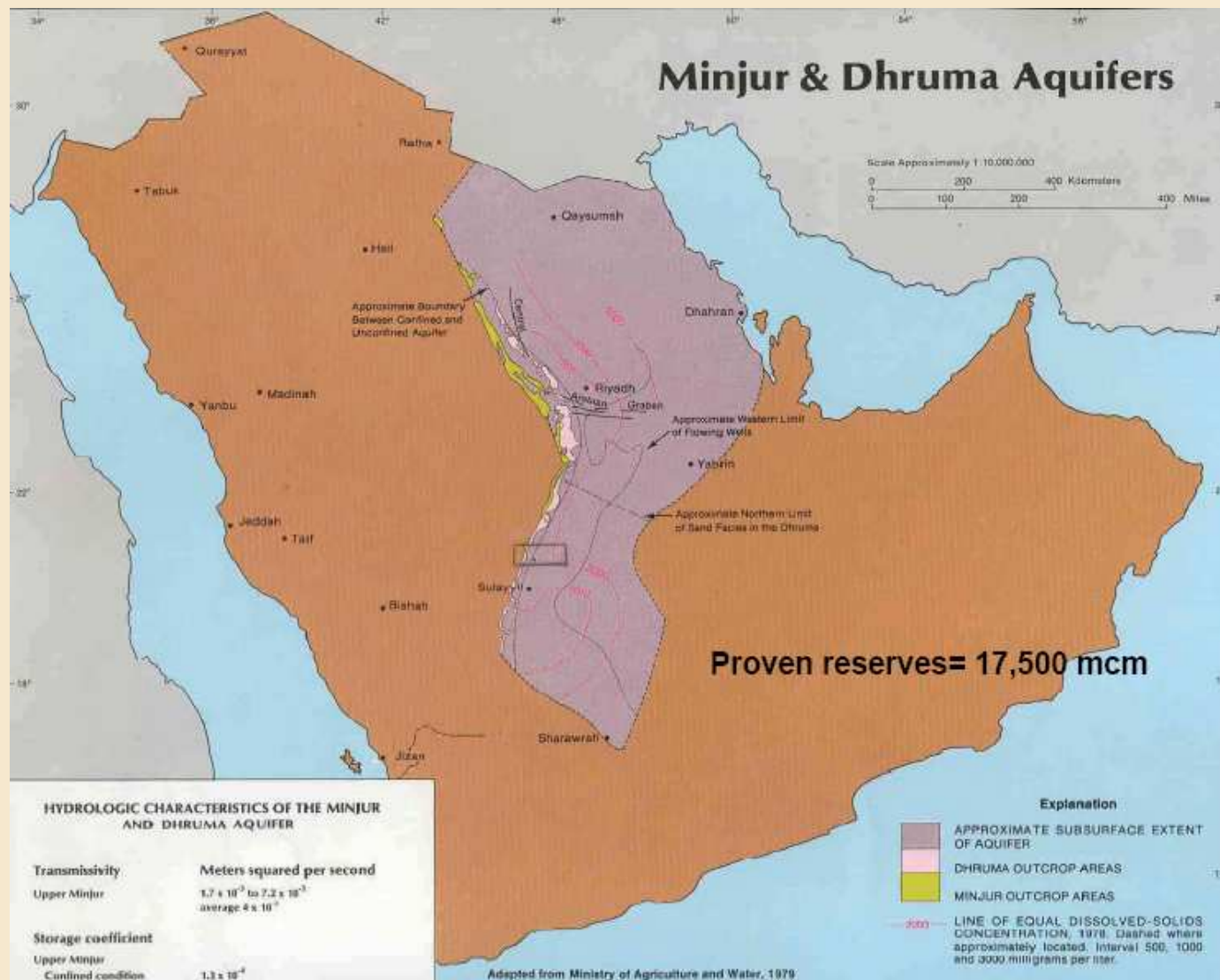
3.9: Wastewater Reuse For Dairy Cows

Region	No. of Cows	Water Requirement (m3/day)
Riyadh	190229	21,876
Makkah	10221	1,175
Madinah	2953	340
Qaseem	14717	1,692
Eastern Region	103803	11,937
Aseer	13600	1,564
Tabouk	3326	382
Hail	3817	439
Northern Region	7	1
Jazan	17900	2,059
Najran	2998	345
Al-Baha	2800	322
Al-jouf	2187	252
Total	368558	42,384

3.10: Aquifer Recharge

- Principal aquifers of the country contain large amounts of fossil water but have little recharge.
- It is well established that in many agricultural regions in the Kingdom of Saudi Arabia, the water table has been depleted dramatically.
- If the current level of agricultural production is to be maintained, other sources of agricultural water must be found.
- Utilization of Treated wastewater effluents to recharge groundwater aquifers and reuse them at least for agricultural purposes becomes a viable proposition.

Aquifers In Riyadh Region



3.11: Industrial Effluent Reuse

S.No.	Industrial City	Total Area (M ²)	No. of Factories	No. of Workers	Water Requirement
1	Riyadh 1st.	451,000	59	5080	Not available
2	Riyadh 2nd.	18,786,000	806	65256	Not available
3	Jeddah 1st.	12,807,000	988	78519	Not available
4	Dammam 1st.	2,704,000	126	14148	Not available
5	Dammam 2nd.	24,800,000	534	53877	Not Available
6	Makkah	730,117	57	3075	Not available
7	Qaseem	1,542,934	52	2762	Not available
8	Ahsa	1,543,000	93	7230	Not available
9	Madinah	9,949,000	44	3520	Not Available
10	Assir	2,663,000	84	8120	Not available
11	Al-Jouf	3,000,000	8	640	Not Available
12	Tabuk	4,000,000	12	960	Not Available
13	Hail	2,560,000	19	1520	Not Available
14	Najran	6,560,000	1	80	Not Available
	Total	92,096,051	2883	244787	

3.13: Wastewater Effluent Reuse For District Cooling

- The Gulf district cooling market has experienced rapid growth over the past decade, with current capacity at more than 1.8 million tonnes of refrigeration (TR).
- The demand is being boosted by the fact that district cooling is at least 40 per cent more efficient than conventional air conditioning.
- There is a demand for at least 150,000 m³/day of water for district cooling in Riyadh.

SECTION 4: WASTEWATER

REUSE IN RIYADH

4.1: Framework Assumptions For Wastewater Reuse Market

- Financial Assumptions
- Regulatory Assumptions
- Project Cost
- Financing Resources
- Off-take Assumptions

4.2 Pillars Of Wastewater Reuse Market

- Quantitative requirements for establishing demands for various industries.
- Qualitative requirements for various industries.
- Capex/Opex requirements for infrastructure development.
- Institutional requirements for establishing reuse market.
- Legislation Framework to regulate and maximize Wastewater reuse Such as introduction of reuse legislation - **Ban on the use of fossil groundwater for fodder cultivation in Diary Farms within 200 km from city boundaries.**
- Public-Partnership model for reuse market.
- Assessing the customer's willingness to pay.
- Feasible tariff development for wastewater reuse.

5. CONCLUSIONS

- **There is a global trend in increasing dependence on the reuse of wastewater as sustainable non conventional water resource for solving the rising global water stress especially in arid countries. The maximum utilization of the wastewater effluents for different purposes is inevitable through proper levels of treatment.**
- Water reuse has a number of attractions for water utilities and businesses considering alternatives to their existing water resources. It is a sustainable and reliable resource regardless of weather patterns. It is available where the population is, and grows with the population increase. The related costs are reasonable.
- **More investments are required on collection, treatment and distribution systems to maximize its use.**
- **Institutional, legal and financial reforms are needed to facilitate the creation of wastewater reuse markets.**
- **PPP can play a major role in investment, development and O&M of wastewater reuse markets such as KSA.**

THANK YOU