CHAPTER 8
UTILITIES INFRASTRUCTURE DEVELOPMENT PLAN

8.1 Water Resources & Irrigation

8.1.1 Existing Conditions

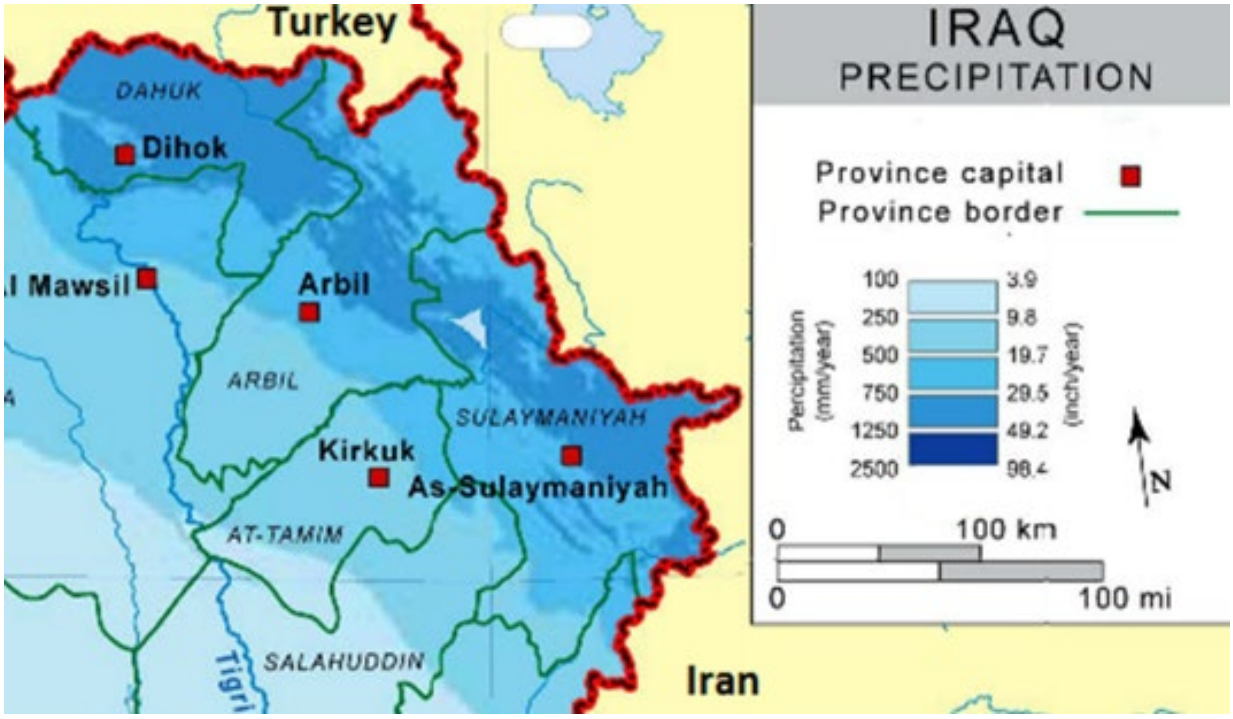
(1) Weather condition

1) Literature analysis

Literature[1] indicates annual precipitation in Erbil and surrounding areas varies from 1000 mm in the mountainous areas, 500 to 750 mm in the hilly to flat areas, including the urban area of Erbil, and 200 to 500 mm in the southwestern area of Erbil (see Figure 8.1.1).

Literature[2] shows trends in precipitation and evapotranspiration over the past several decades in Erbil (see Figure 8.1.2). Literature [2] presents "a decreasing trend in annual precipitation and an increasing trend in evapotranspiration, which suggests that water resources are decreasing and the amount of water in the soil is decreasing, which has an impact on agriculture."

However, this trend is not significant. Figure 8.1.2 can also be explained by the fact that “the annual changes in rainfall and evapotranspiration are highly variable”.

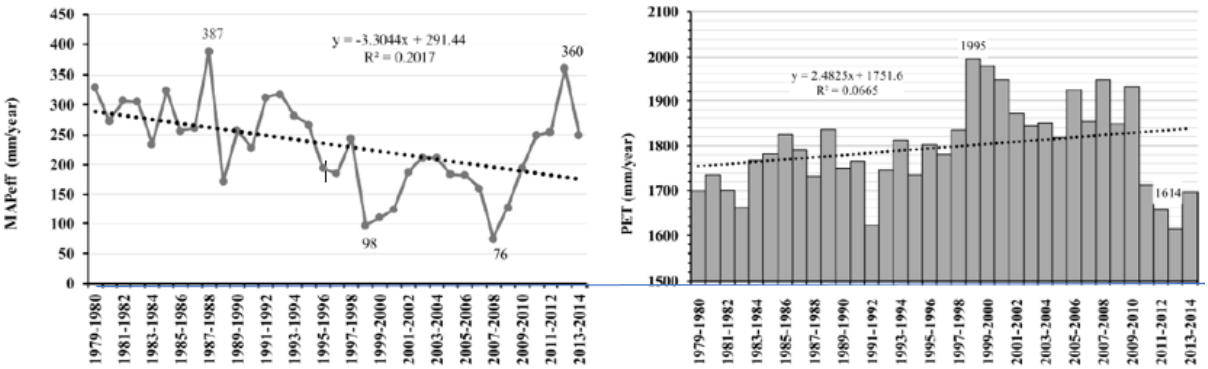


Source: Literature [1]

Figure 8.1.1 Distribution of Rainfall in Erbil

[1] Literature: Water harvesting in Erbil Governorate, Kurdistan region, Iraq Detection of suitable sites using Geographic Information System and Remote Sensing ; Hasan Mohammed Hameed 2013

[2] Literature2: Estimating Ground Water Balance in the Presence of Climate Change Impact: A Case Study of Semi-Arid Area; Mohammed Nanekely, Furat Al-Faraj1,and Miklas Scholz

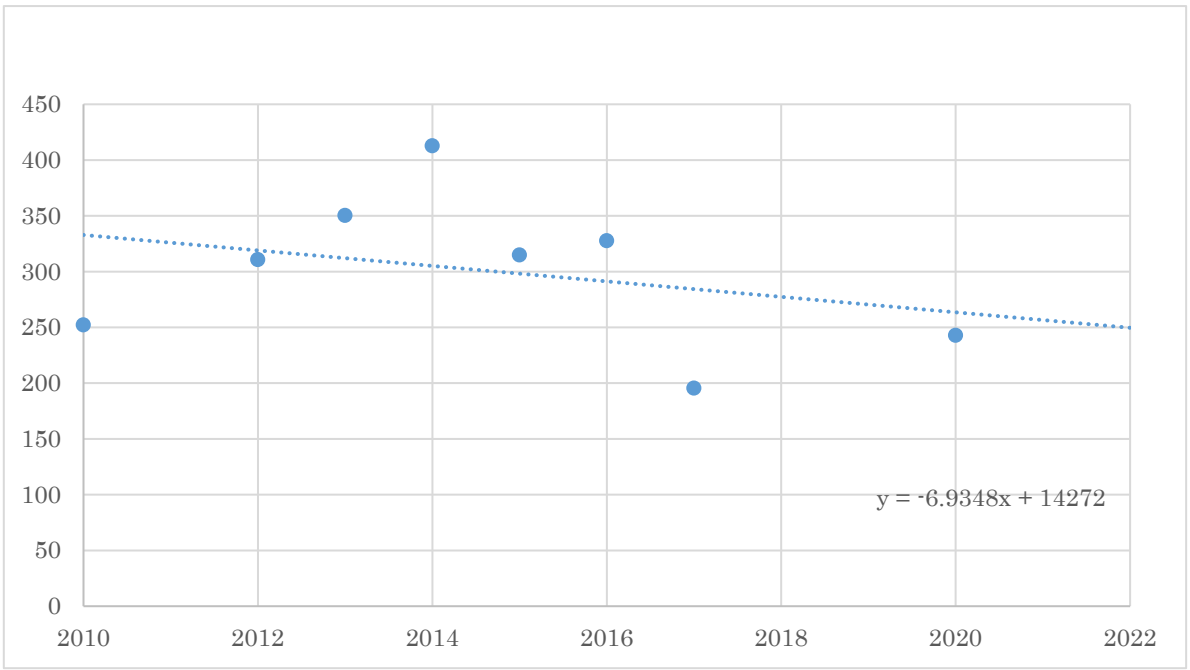


Source: Literature 2[3]
Note: MAPeff ; Mean Annual (effective)Precipitation PET; Potential Evapotranspiration

Figure 8.1.2 Long-term Annual Effective Rainfall Trend in Erbil (Left); Long-term Annual Evapotranspiration Trend in Erbil (Right)

2) GDWR meteorological data analysis

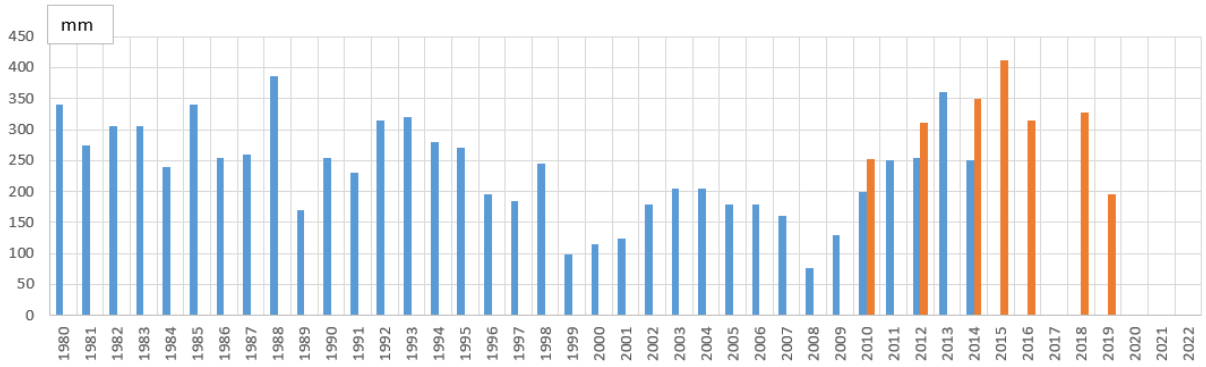
Figure 8.1.3 shows the rainfall data within the 150 Ring Road, with observation points taken at the Irrigation Directorate Office Site (hereafter referred to as 'Ir rainfall') since 2010. Figure 8.1.4 shows a graph overlaying Figure 8.1.3 with Figure8.1.2 (left). From this graph, the "decreasing trend of annual rainfall" shown in the literature (see Figure 8.1.2) is doubtful, and an explanation such as "a large difference between periods of high and low rainfall" is more appropriate. Global warming, which influences the rainfall patterns highly possibly causes this variation.



Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.3 Annual Rainfall Change from 2010-2022 in Urban Area

[3] Literature Estimating Ground Water Balance in the Presence of Climate Change Impact: A Case Study of Semi-Arid Area; Mohammed Nanekely, Furat Al-Faraj1,and Miklas Scholz



Source: Blue is based on literature2[4] Orange is the JICA Project Team, based on data provided by GDWR

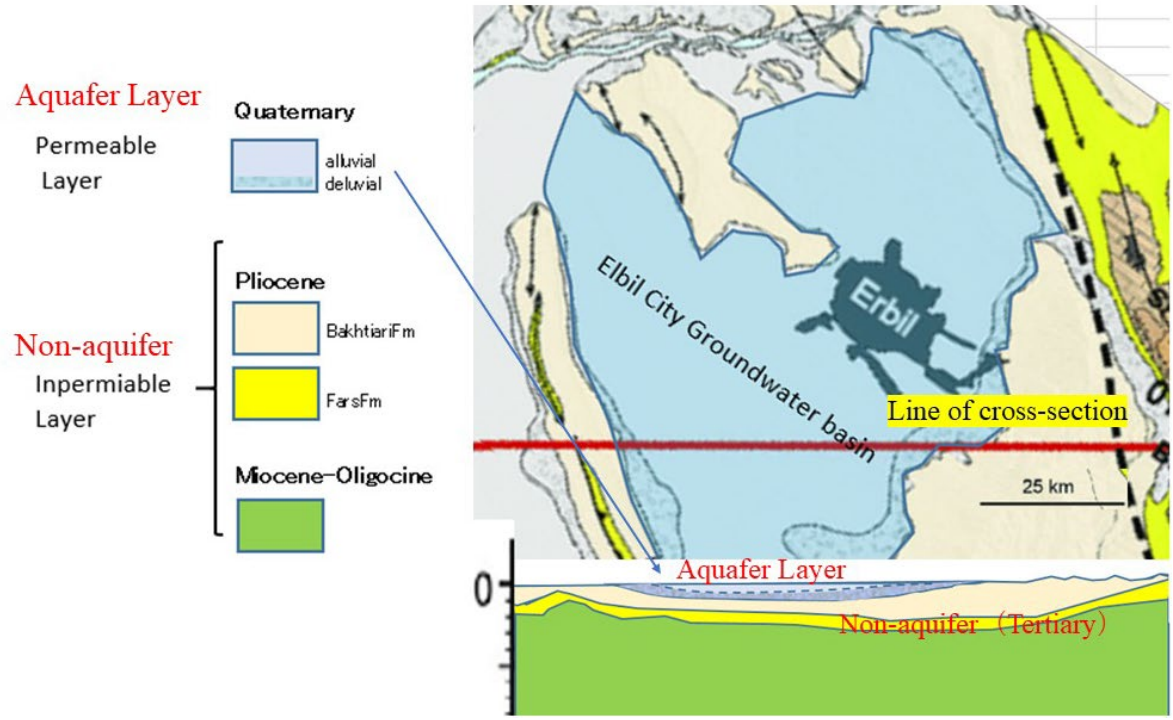
Figure 8.1.4 Overlay of Literature Rainfall and Ir Rainfall

Although it may not be appropriate to simply compare the literature-based rainfall data (blue) with the Ir rainfall data (orange) because the rainfall data (blue) is an average for Erbil province, the rainfall trends are similar.

Therefore, it is doubtful that climate change plays a major role in the decline of groundwater resources.

(2) Aquifer condition

Figure 8.1.5 shows an overview of the aquifer distribution in Erbil. According to the literature[5], the aquifer is approximately 2000km2 and 100-800 m depth. The aquifer consists of Alluvium and Deluvium (terrace deposits) distributed in the lower part. The basement of the aquifer is the tertiary layer.



Source: JICA Project Team

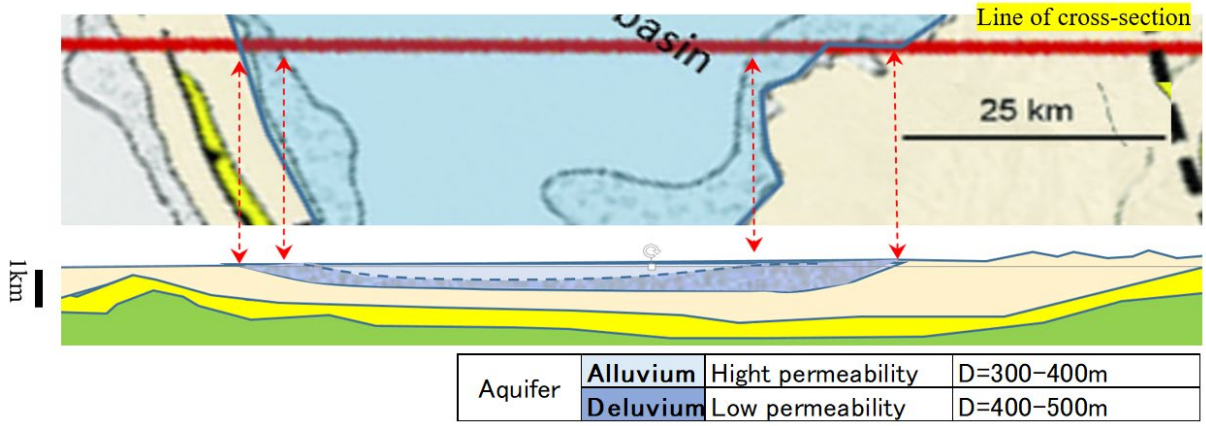
Figure 8.1.5 Aquifer of Erbil City (1)

[4] Literature Estimating Ground Water Balance in the Presence of Climate Change Impact: A Case Study of Semi-Arid Area; Mohammed Nanekely, Furat Al-Faraj1,and Miklas Scholz

[5] Literature Groundwater Degradation and Sustainability of the Erbil Basin, Erbil, Kurdistan Region, Iraq By RUBAR DIZAYEE Bachelor of Science, 2010 Salahaddin University Hawler, Kurdistan

Literature[6] said, "Aquifer layer is 800m depth including some thick clay Layers (semi-confined or confined aquifer)".

The lower part of this aquifer consists of diluvium with low permeability. In other words, the only effective aquifer is the upper alluvium.



Source: JICA Project Team

Figure 8.1.6 Aquifer of Erbil City (2)

Figure 8.1.6 displays an enlarged cross-section of Figure 8.1.5. The Quaternary layer assumed 800 meters thick, consists of the Diluvium in the lower part and the Alluvium in the upper part. An outcrop photograph of the Diluvium is illustrated in Figure 8.1.7. This layer is composed of gravel with a silty sandy substrate so compact and its permeability is estimated to be low (1～5X10-4 cm/sec). Therefore, the Diluvium is not an effective aquifer, and the Alluvium is an effective aquifer formation. The thickness of the Alluvial ranges from 300 to 400 meters, as shown in Figure 8.1.6.

On the other hand, Figure 8.1.8 indicates the change in groundwater levels in agricultural areas over time. The rate of decline of the groundwater level tends to accelerate at depths of 80 to 100 m and deeper. Groundwater intake for agricultural use has remained relatively constant since 2018, as indicated in Figure 8.1.8. The high rate of water level decline despite the constant water intake can be attributed to the low porosity (small storage coefficient) of the strata under 100 m depth. Possible factors contributing to the low porosity include consolidation and the distribution of fine-grained layers.

Based on the above consideration, the effective aquifer is 300～400m, and the upper 100m is the most effective aquifer area.

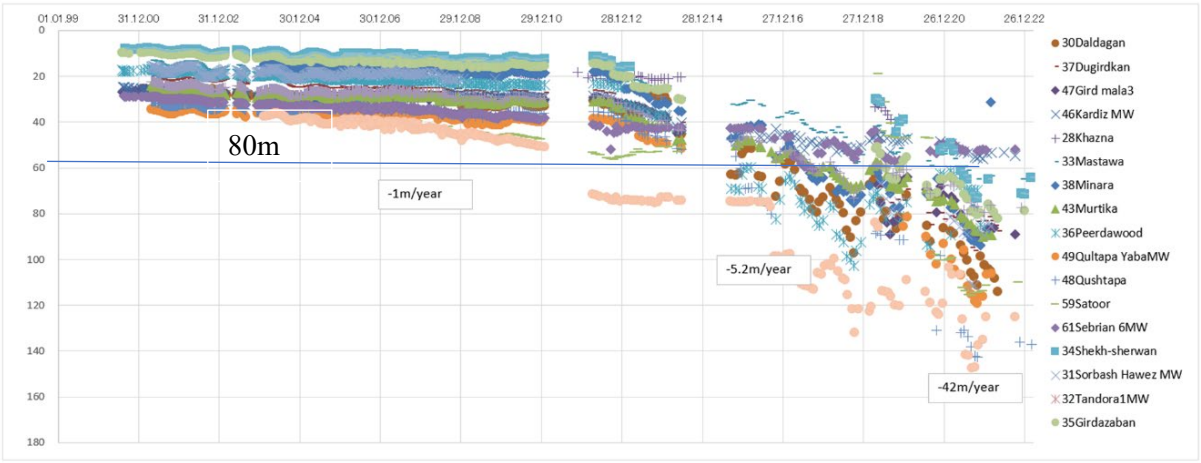
Source: JICA Project Team

Figure 8.1.7 Soil Conditions in Diluvium

[6] Literature3 Groundwater Degradation and Sustainability of the Erbil Basin, Erbil, Kurdistan Region, Iraq By RUBAR DIZAYEE Bachelor of Science, 2010 Salahaddin University Hawler, Kurdistan

Blue line indicates the groundwater area of the Erbil City, while the orange area represents the West-South Agricultural Area. The West-South Agricultural Area is supplied with groundwater passing through Erbil City.

The symbol ◉ indicates the location of monitoring wells. The graph below illustrates the change in the groundwater levels over time for the monitoring wells situated in the West-South Agricultural Area (orange area).



Source: JICA Project Team

Figure 8.1.8 Groundwater Fluctuations in Agricultural Areas

- [Area of the aquifer]

The area of the Quaternary formation, the aquifer in Erbil City indicated in Figure 8.1.9[7], is calculated to be approximately 2000 km².

- [Depth classification of the aquifer]

From Figures 8.1.6 and Figure 8.1.8, the aquifer, a Quaternary formation, can be divided into the following zones according to depth

0-80 m: Range where groundwater withdrawal is stable.

(Reason: From Figure 8.1.8, the depth at which the groundwater level slowly declines is in the range of 0 to 80 m.)

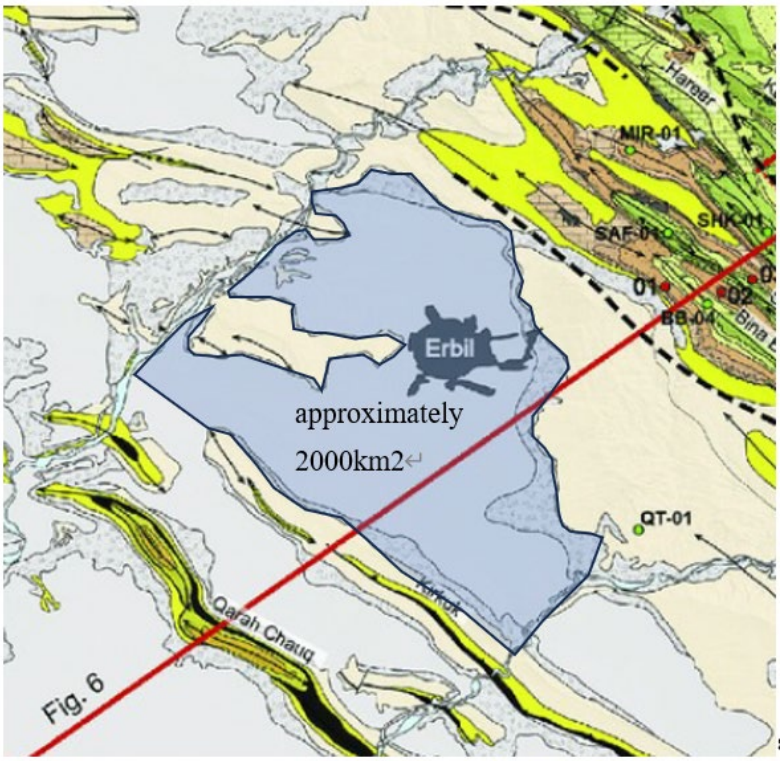
80-300m: Range where groundwater level declines rapidly due to groundwater extraction.

(Reason: The range where the water level in the well drops significantly from Figure 8.1.8, and the depth is 300m from Figure 8.1.6) This range may be subject to mixing, concretion, and consolidation of low permeable soil layers such as silt because of the wide distribution of alluvium with slightly low porosity throughout the area. Pumping groundwater at this depth could result in a significant drop in the water table in the well. Groundwater withdrawal is possible but inefficient.

300-800 m: Pleistocene deposits with low porosity are distributed.

(Reason: From Figure 8.1.6, Pleistocene layers are present at depths of 300m and deeper) This formation is likely to be unsuitable for groundwater use.

[7] Literature Groundwater Degradation and Sustainability of the Erbil Basin, Erbil, Kurdistan Region, Iraq By RUBAR DIZAYEE Bachelor of Science, 2010 Salahaddin University Hawler, Kurdistan



Source: JICA Project Team (addition to literature[7])

Figure 8.1.9 Watershed Area of the Groundwater Supply Area to Erbil City

Table 8.1.1 Aquifer Size for an Aquifer Area of 2000 km^3

Aquifer thickness	Aquifer volume(Mm3)	Assumed effective porosity	Water volume(Mm3)	Cumulative (Mm3)	Remarks
0-80 m	160,000	15%	24,000	24,000	- The effective porosity from 0 to 80 m depth was assumed to be 15%, which is a typical value for the Alluvium (Literature[8])
80-300 m	440,000	10%	44,000	68,000	- 80 to 300 m depth was assumed to be 10%, because this is the depth at which a sudden drop in the groundwater table occurs, which may be caused by a decrease in the effective porosity.
300-800m	1,000,000	5%	50,000	118,000	- The Diluvium distributed between 300 and 800 m is composed of well-compacted silty sandy sediment, so the effective porosity was assumed to be 5%.

Source: JICA Project Team

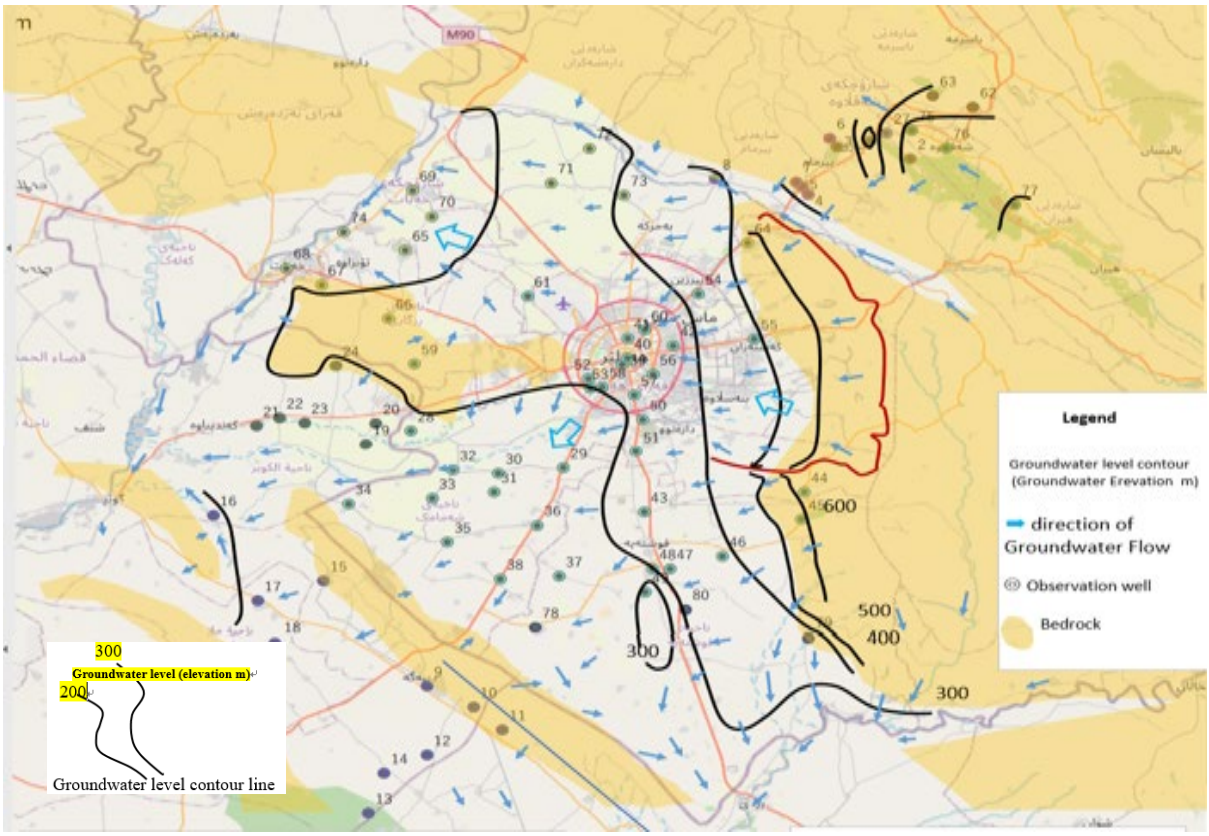
[8] Literature Collection of Hydraulic Formulae (Japan Society of Civil Engineer)

Based on the above postulations, the groundwater volume in the aquifer in Erbil city is calculated to be 118,000 Mm3 (Table 8.1.1). Moreover, aquifers suitable for groundwater intake are in the range shallower than 100 m depth, but most of this groundwater has already been consumed.

(3) Groundwater flow

A groundwater level contour map was created based on groundwater level monitoring data (provided by GDWR) for each well (Figure 8.1.10). The groundwater contour maps indicated in Figure 8.1.10 are at intervals of 100 m, with hydrodynamic gradients ranging from 0.005 to 0.01.

The groundwater contour map indicates the distribution of groundwater potential. Groundwater flows from higher potential to lower potential, so the groundwater contour map shows the direction of groundwater flow. Groundwater in this area is an unconfined groundwater layer and flows in the direction of the blue arrows (→,⇨) along the potential distribution. In other words, the groundwater provided to Erbil City is the result of rainfall on the hillsides, which seeps into the ground on its way to the plains and becomes groundwater in the Erbil City area, further siphoned off into deep wells, and the remaining groundwater flows to the agricultural area in the southwest. On the other hand, north of Erbil City, groundwater flows toward the Great Zab River.



Source: JICA Project Team, based on data provided by GDWR

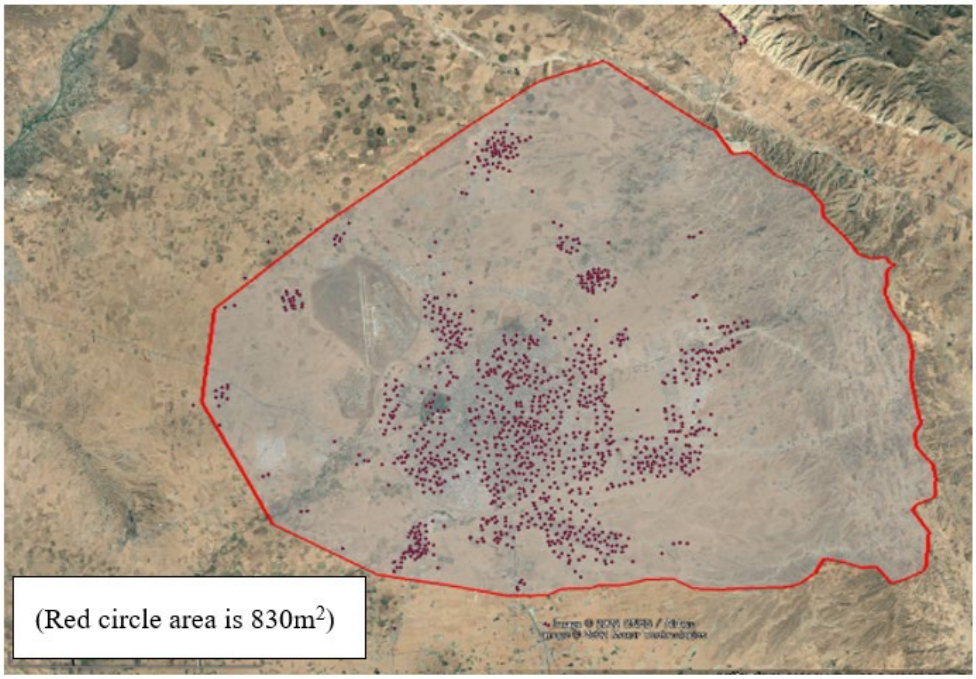
Figure 8.1.10 Groundwater Flow in Erbil

The orange areas in Figure 8.1.10 are hillsides where the basement rock is exposed. This area of exposed basement rock was transcribed from literature[9]. The basement rocks (hillsides) on the west and southwest sides of Erbil City limit groundwater flow and divide the groundwater basin.

[9] Literature Groundwater Degradation and Sustainability of the Erbil Basin, Erbil, Kurdistan Region, Iraq By RUBAR DIZAYEE Bachelor of Science, 2010 Salahaddin University Hawler, Kurdistan

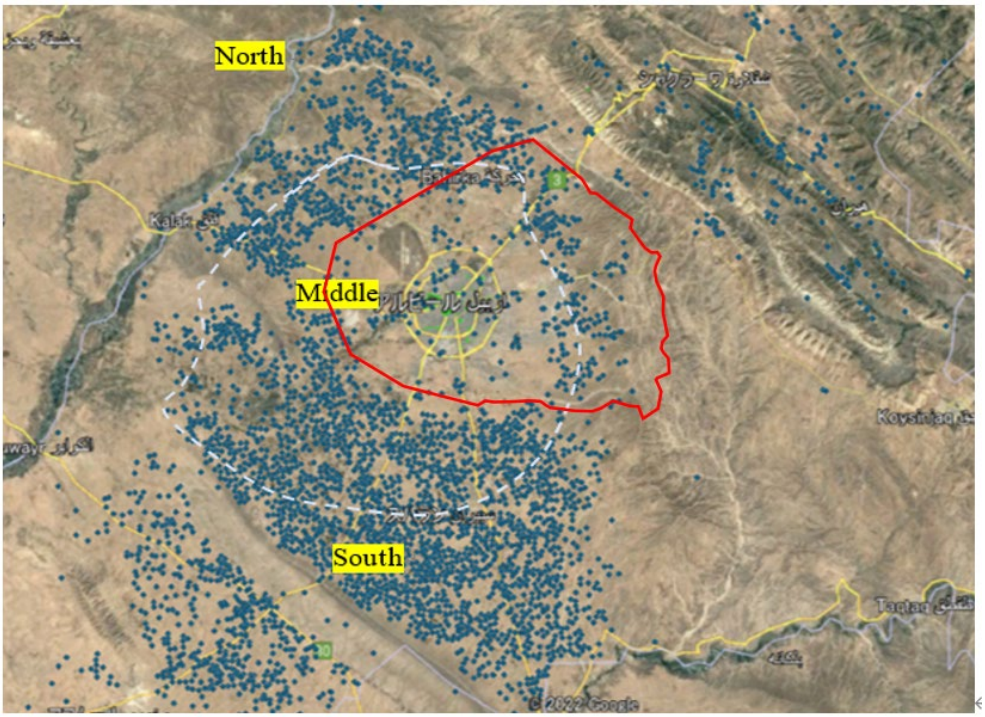
(4) Amount of groundwater resource condition

Figure 8.1.11 indicates the distribution of domestic wells, while Figure 8.1.12 shows the distribution of agricultural wells. The red circle in Figure 8.1.11 indicates the groundwater flow area within the Erbil city area. Its area is 830km3.



Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.11 Groundwater Catchment Area Small Dots are Domestic Wells



Source: JICA Project Team, based on data provided by GDWR
Note: North, Middle, and South are management name and does not indicate the groundwater district.

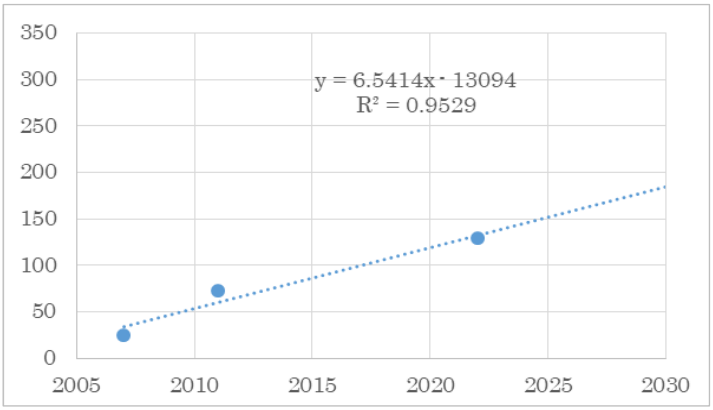
Figure 8.1.12 Distribution of Agricultural Wells

1) Domestic water intake from wells (deep wells)

The following data for domestic water intake from wells in 2007, 2011, and 2022 are shown below.

- Water intake in 2007 was 68,000 m³/day (≈25 Mm³/year) from deep wells (400 wells)
- Water intake in 2011 was 200,000 m³/day (≈73 Mm³/year) from deep wells (800 wells).
- Water intake in 2022 was 354,000m³/day (≈129Mm³/year) from deep wells (4157 wells).

The trend is indicated in Figure 8.1.13. The water volume has increased linearly over the years, with an increase rate of 6.5 to 7 Mm^3/year. This rate of increase is clearly greater than the effects of climate change and land use change on groundwater.

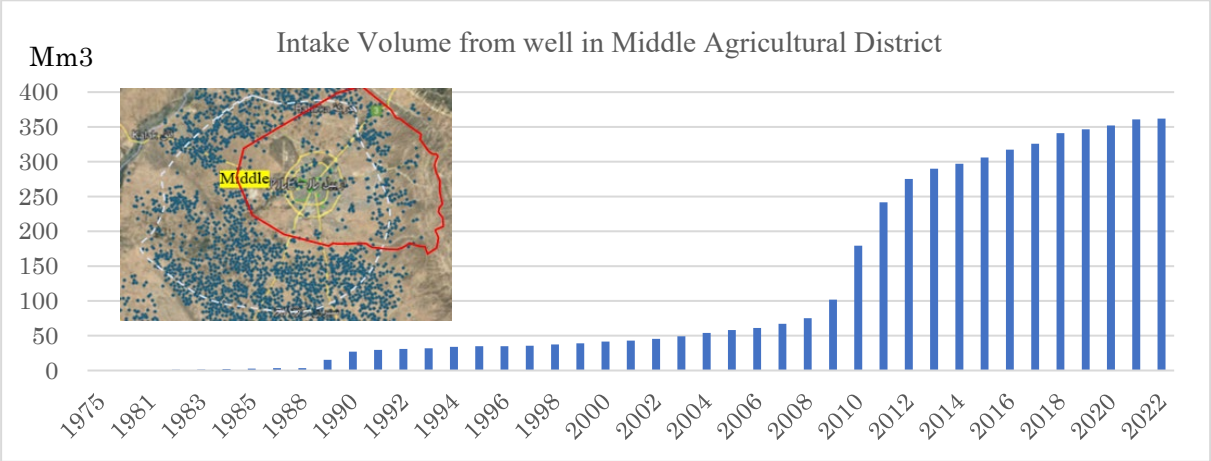


Source: JICA Project Team, graphical history of water intake based on JICA report 1 [10].

Figure 8.1.13 Trends in Water Intake for Domestic Use (deep wells)

2) Agricultural Well Water Intakes

Based on agricultural well water intake data obtained from GDWR, Figure 8.1.14 indicates the cumulative amount of well development over time in the "Middle; the white dashed line area in the figure" agricultural district where Erbil City is located.



Source: JICA Project Team, based on data provided by GDWR
Note: The daily water intake for each well is specified in the data provided by GDWR. Additionally, agricultural wells are operational for approximately 6 months per year as indicated by GDWR. Based on this, the annual water intake is calculated as the daily water intake for each well multiplied by 183 days.

Figure 8.1.14 Cumulative Change in Annual Water Intake of Middle Agriculture District

[10] JICA Report 1 Erbil Urban Development Master Plan Renewal Project for Sustainable Cities in Iraq

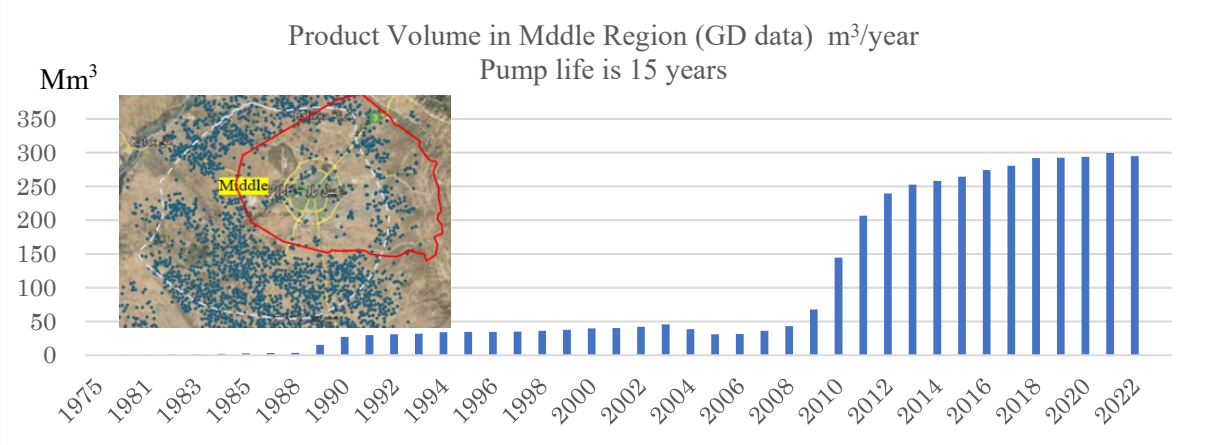
Based on water intake data obtained from GDWR for agricultural wells only (not including domestic wells), Figure 8.1.14 indicates the cumulative amount of well development over time in the "Central; white dashed line in the figure" agricultural area where Erbil City is located.

Figure 8.1.14 (Amount of water developed in agricultural wells) shows a rapid increase from 2009 to 2011, with little increase after that.

Figure 8.1.14 does not include data on closed wells, so the actual water intake should be less than this, but there is no data on the life of the wells.

Therefore, assuming a typical well life of 15 years and modifying the data, Figure 8.1.15 is shown. If the life of the well is estimated to be 20 years, this does not match the actual situation because water intake decreases over time.

Therefore, Figure 8.1.15 would reflect the actual change in water intake for agricultural wells only. The trend of increase since 2018 has been very slow.



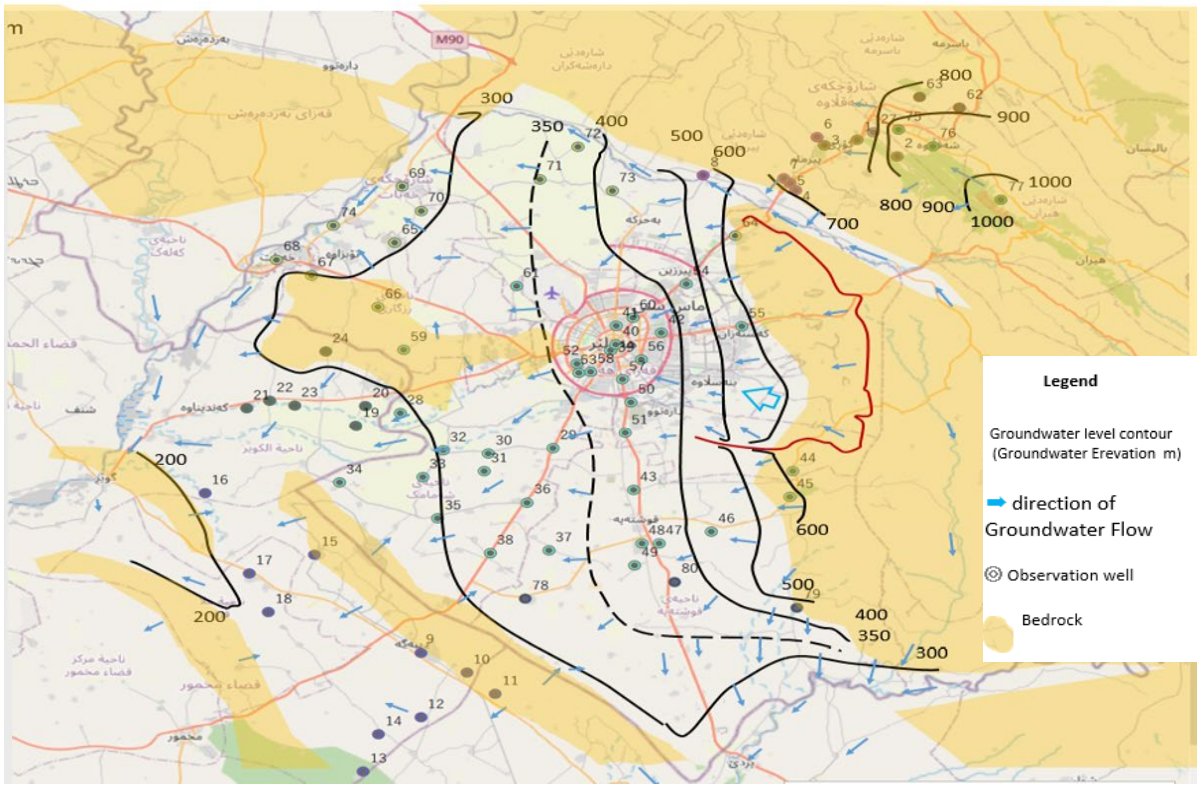
Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.15 Cumulative Change in Annual Water Intake (Assuming a well life of 15 years)

(5) Changes in groundwater levels over time

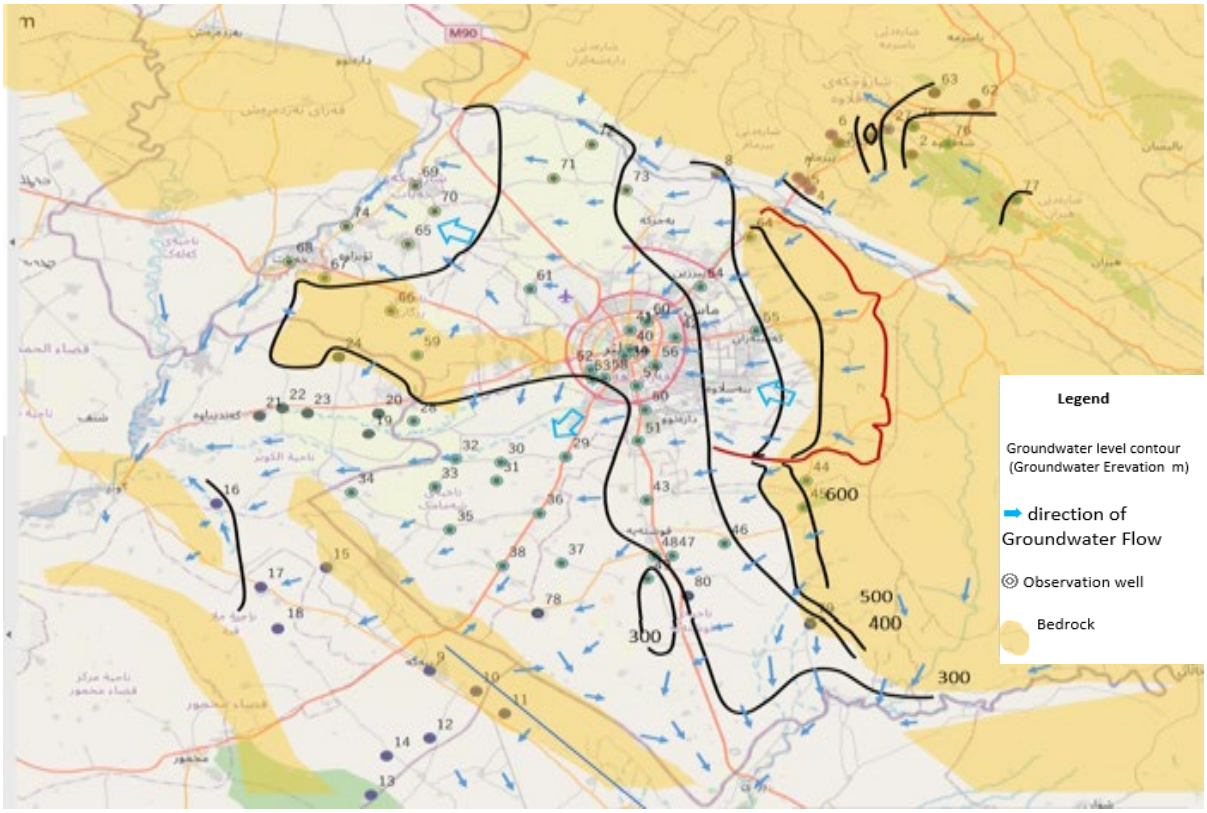
1) Change in the distribution of groundwater level in wide area

The groundwater level contour maps for 2000 and 2022 (and in some cases 2021) are indicated in Figures 8.1.16 and 8.1.17, respectively. A comparison of these two maps shows decline in groundwater levels across most areas, with notable regional variation in the amount of decrease. In particular, groundwater levels have dropped significantly on the west side of Erbil City; a map of groundwater level changes between 2000 and 2020 is indicated in Figure 8.1.18.



Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.16 Groundwater Level Contour Map (2000)



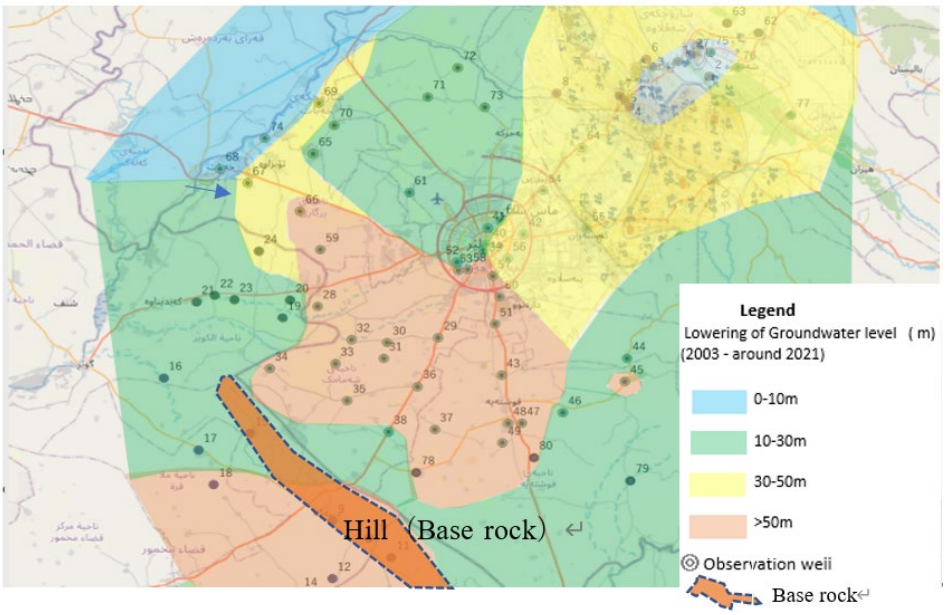
Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.17 Groundwater Level Contour Map (2021)

2) The Status of groundwater storage

The difference between Figures 8.1.16 and 8.1.17 shows the amount of decline in the groundwater level between 2000 and 2020. Figure 8.1.18 visualizes this difference, with the orange area indicating a drop of 50 to 80 meters, the green area a decline of 30 to 50 meters, and the blue area a drop of 10 to 30 meters. Because the available groundwater is in Quaternary formations, the areas of basement rock are indicated in brown. The distribution of basement rocks is indicated concerning the existing geologic and topographic maps.

Figure 8.1.18 shows that the areas where groundwater levels have declined the most over about 20 years are the rural areas southwest to south of the Erbil urban area.



Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.18 Groundwater Level Drop (Difference between 2000 and 2021)

(6) Changes in groundwater levels at each well

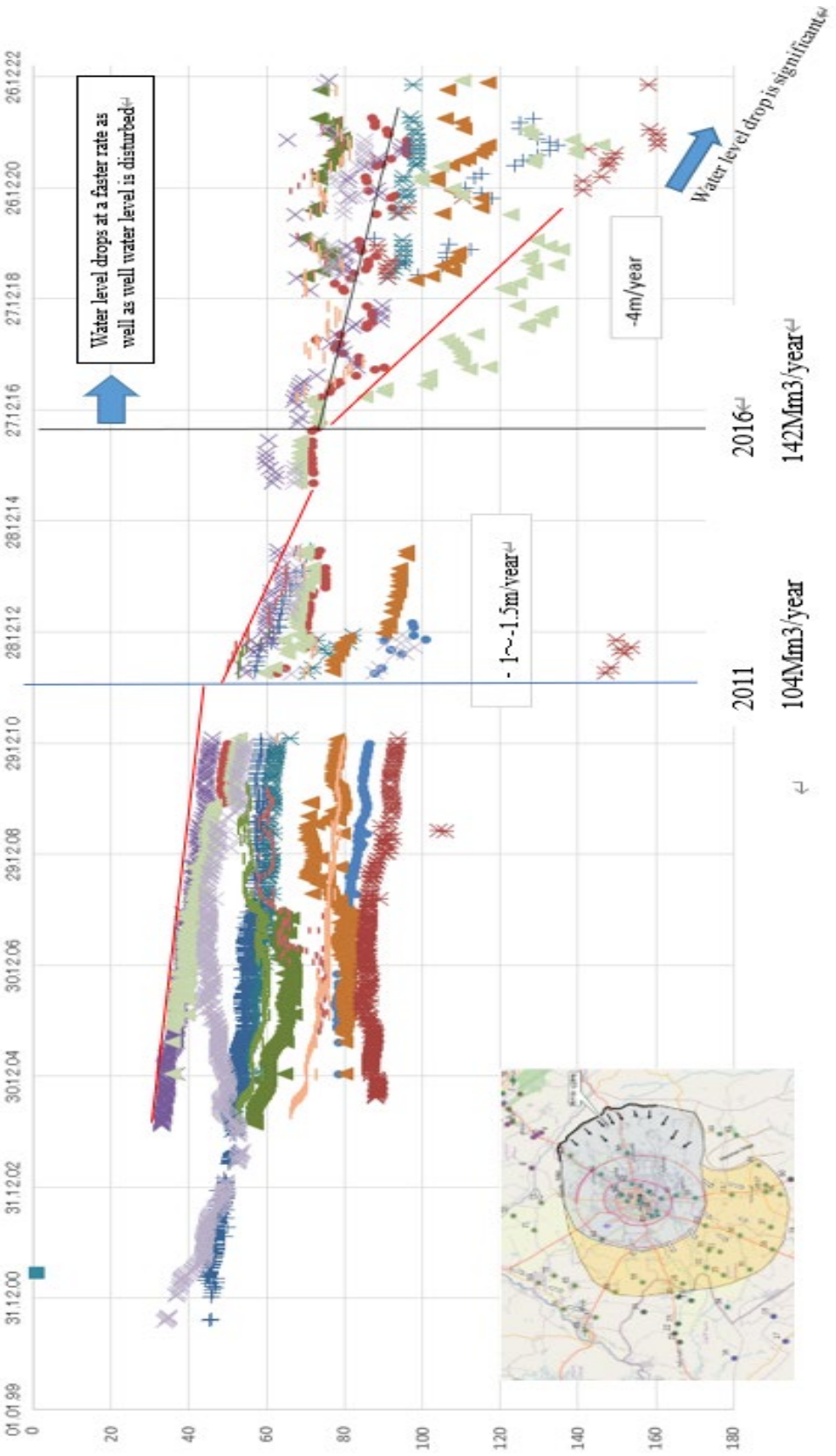
GDWR conducts annual observations of monitoring wells. Based on this monitoring data, changes in groundwater levels over time can be compiled for the urban area and the agricultural area located southwest of the urban area.

1) Change in groundwater level within the 150m Ring Road

The results are indicated in Figure 8.1.19. Characteristics of groundwater level changes in 150m Ring Road can be summarized below.

i) Between 2000 and 2016, water levels indicated a very gradual downward trend, with water level decline rate between 1 and 1.5 m/year.

ii) After 2016, variability increases, and the decline rate increases. The rate of decline after 2016 is approximately 4 m/year.



Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.19 Groundwater Level Changes in Deep Wells (water wells for domestic use) (blue area in the left figure)

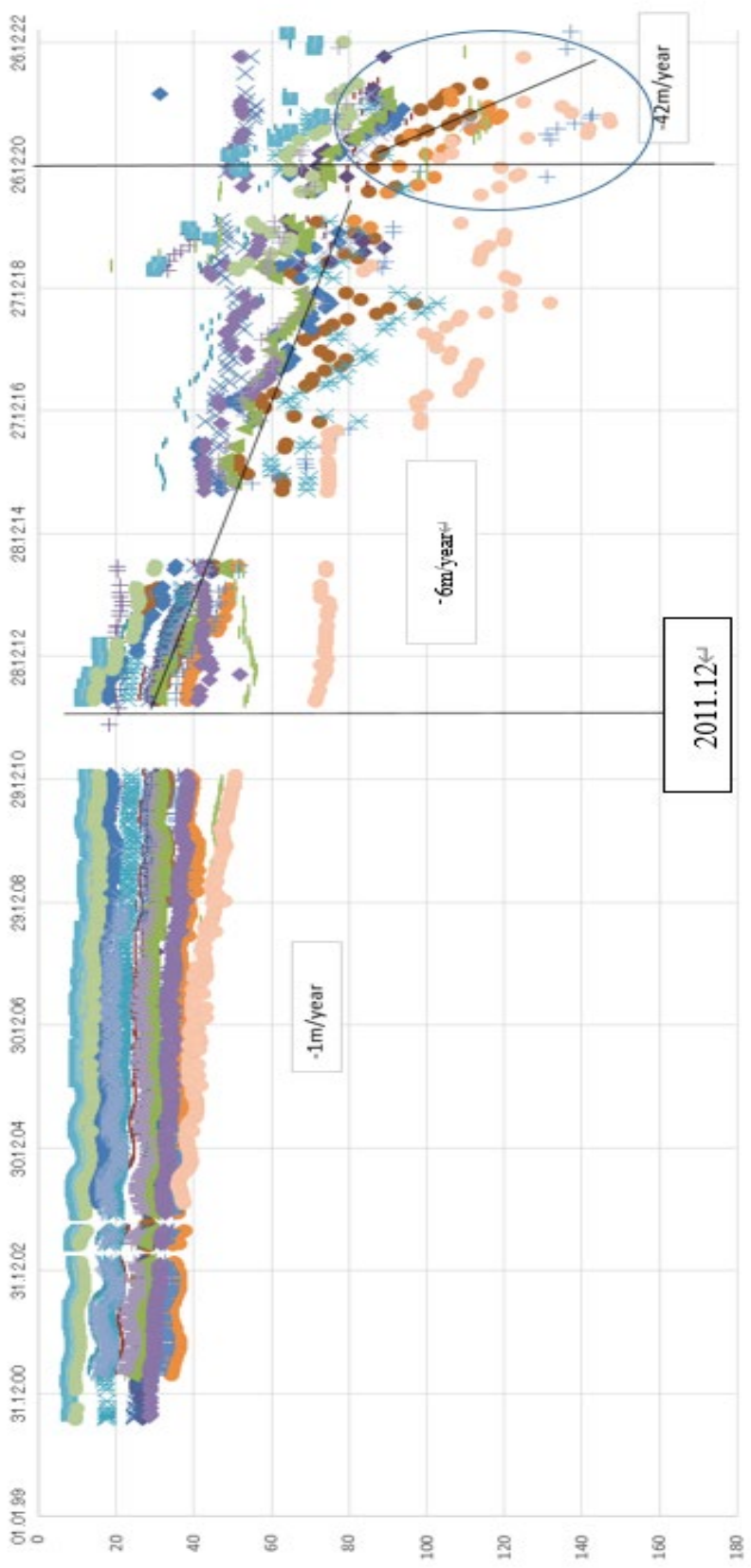
2) Groundwater level changes in the agricultural area

The groundwater changes are shown in Figure 8.1.20 and outlined below.

i) Water levels began to decline significantly in 2011, with a decline rate of approximately 6 m/year.

ii) The onset of the groundwater level decline occurred 5 years earlier than within the 150m Ring Road.

iii) After 2020, the rate of decline increases further, with some wells showing decline rates exceeding 40 m/year, as indicated by the circle in the lower right-hand corner of the graph.



Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.20 Groundwater Level Changes in the Agricultural Area, the West, and South Area from 150 Ring Road (Orange area in the left figure)

(7) Study of water balance

1) Analysis of meteorological data

GDWR provided urban precipitation and temperature data between 2010 and 2022. Calculation of evapotranspiration based on this data results in more evapotranspiration than precipitation in most months, which does not match reality. Since rainfall data from stations located in upstream areas (mountainous and hilly areas) are not available, a water balance analysis based on meteorological data cannot be conducted. Therefore, a water balance analysis based on sensitivity analysis was conducted.

2) Sensitivity Analysis

Sensitivity analysis in water balance is an approach that seeks to understand the truth by weighing the factors affecting the results of water balance analysis and examining the relationship between important factors.

Equation for water balance (factor organization)

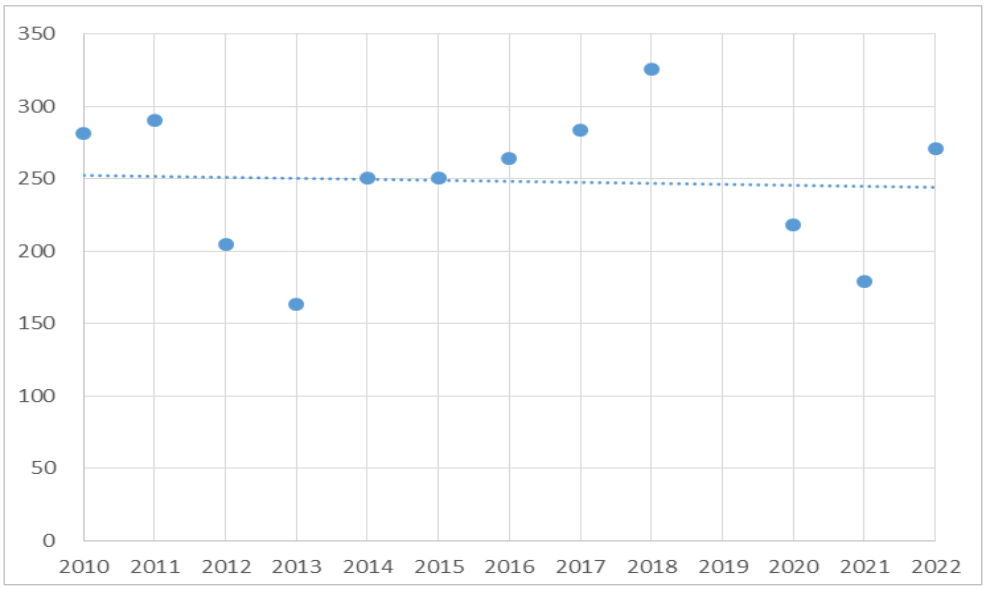
The following equation shows the water balance.

- (Q- E)-R-P=GW
- (Q: rainfall, E: evapotranspiration, R: runoff, P: water intake, GW: groundwater)
- (Q-E) is effective rainfall, (Q-E)-R is groundwater infiltration, and P is water intake from domestic wells + water intake from agricultural wells + water intake from industrial wells

The following assesses the impact of each factor (weather, runoff, and water intake) on annual changes in groundwater quantity.

Changes in weather conditions

As shown in "Chapter 8.1.1 (1)", some observers believe that rainfall has been decreasing over time, but this trend is not significant. The results of the Thorn Thwaite Method for evapotranspiration based on the meteorological data provided by GDWR for 2010-2022 (see Figure 8.1.21) also show no trend.



Source: JICA Project Team, based on data provided by GDWR

Figure 8.1.21 Annual Changes in Evapotranspiration

Decreased infiltration due to expansion of urban areas

Urban expansion increases the amount of rainwater runoff and decreases the amount of groundwater infiltration. Therefore, urban expansion is directly related to flooding and a decrease in rainwater infiltration. Calculating the infiltration rate reduction if 10% of the current field land were to be urbanized, results in approximately 3% decrease, as indicated in the table below.

Table 8.1.2 Change in Infiltration Rate due to Urbanization (if urban area increases by 10% and field area decreases by 10%）

Geographical classification	Area ratio Obtained on Google earth	Coefficient of Infiltration*	Infiltration rate
Uban area	0.6	0.3	Present
Farmland	0.4	0.7	0.45
Uban area	0.7	0.3	Uban area +10%
Farmland	0.3	0.7	0.42

Source: JICA Project Team

Note:*Coefficient of Infiltration is based on literature10 [11]

Assuming an annual precipitation rate of 400-700 mm in urban areas of Erbil (source: data provided by GDWR) and an infiltration rate of 30% of total precipitation, a 10% increase in urban areas would result in a 5-9 Mm^3/year decrease in infiltration volume. The reduced infiltration volume, when converted to groundwater level, is less than 1 m for an effective porosity of 15%. However, since 5-9 million m^3/year is not a small amount, infiltration facilities (infiltration ponds, riparian parks, rainwater infiltration facilities) are considered necessary.

Water intake from domestic wells and water intake from agricultural wells

Water intake from wells for domestic use will increase approximately 4 times between 2007 and 2022 (see Chapter 8.1.1 (4)- 1)).

Water intake from agricultural wells in the Middle region increased approximately 8 times from 2007 to 2022 (see Chapter 8.1.1 (4)- 2)).

In 2022, the annual water intake is estimated to be 129 Mm3 for domestic wells and 295 Mm3 for agricultural wells in the "Middle" region.

Water intake from industrial wells

Water intake from industrial water wells is 3500 m^3/day (1.3 Mm^3/year) as an actual result in 2021. This amount is very small compared to deep wells for domestic use and agricultural wells.

Based on the results of the studies (i) ~ (v), it can be concluded that the cause of the groundwater level decline is well water intake, which will be discussed later in this section.

In other words, the change in groundwater level over time can be expressed by the following formula.

- GW(dt) ≒ P(dt)

P(dt) is the water intake rate from domestic wells and agricultural wells, except for the water intake from industrial wells.

3) Annual intake volume change

Within the 150m Ring Road

“Chapter 8.1.1 (4)- 1)” indicates the domestic water intake for 2007, 2011, and 2022.

[11] Lecture10 : Road earthwork guidance (H21.6) P13

These changes over time are shown as a linear function, as shown in Figure 8.1.13 (Change in well water intake for domestic use (deep wells)). On the other hand, there are agricultural wells within the 150m Ring Road, and the number of wells is about 16% of the total number in the" Middle" agricultural district. Therefore, the total water intake was calculated as follows.

- Groundwater intake within the 150m Ring Road = (domestic well intake + agricultural well intake)
- Water intake from domestic wells each year can be calculated from Figure8. 1.13.
- Water intake from agricultural wells each year can be calculated from (Figure 8.1.15 × 16%).
- Based on the above, the estimated water intake for each year is shown in Table 8.1.3.

Table 8.1.3 Water Intakes within the 150 Ring Road

	Within Ring Road (Mm3/year)		
Year	Domestic	Agricultural	Total
2007	25	5.8	30.8
2008	37	6.9	42.9
2009	49	10.8	59.8
2010	61	23.1	84.1
2011	73	33.1	106.1
2012	78	38.3	116.4
2013	83	40.4	123.6
2014	88	41.3	129.6
2015	93	42.3	135.7
2016	98	43.9	142.3
2017	104	44.9	148.4
2018	109	46.7	155.3
2019	114	46.8	160.5
2020	119	47.0	165.8
2021	124	47.9	171.8
2022	129	47.2	176.2

Water level begins to drop (see Fig 8.1.19)

Source: JICA Project Team, based on data provided by report1 [12]

Outside the 150m Ring Road, agricultural intake volume in the west and south part of the Erbil city

The water intake for the "Middle" agricultural area, including those within the 150m ring road, was indicated in Figure 8.1.15. On the other hand, the percentage of agricultural wells outside of the 150 Ring Road is 84% of the total (100% - 16%). Based on the above, the agricultural water intake is indicated in Table 8.1.4 Groundwater began to decline in 2011.

[12] Report1 Erbil Urban Development Master Plan Renewal Project for Sustainable Citie121.3s in Iraq205.4

Table 8.1.4 Water Intake from the Middle Agricultural Area outside of the 150m Ring Road (added in Table 8.1.3)

	Within Ring Road (Mm3/year)			Outside of Ring	Total
Year	Domestic	Agricultural	A) Total	B) Agricultural	A)+B)
2007	25	5.8	30.8	30.4	61.2
2008	37	6.9	42.9	36.2	80.1
2009	49	10.8	59.8	56.9	116.8
2010	61	23.1	84.1	121.3	205.4
2011	73	33.1	106.1	173.6	279.6
2012	78	38.3	116.4	201.2	317.7
2013	83	40.4	123.6	212.1	335.7
2014	88	41.3	129.6	216.7	346.3
2015	93	42.3	135.7	222.1	357.8
2016	98	43.9	142.3	230.4	372.7
2017	104	44.9	148.4	235.6	384.1
2018	109	46.7	155.3	245.2	400.5
2019	114	46.8	160.5	245.7	406.3
2020	119	47.0	165.8	246.8	412.6
2021	124	47.9	171.8	251.6	423.5
2022	129	47.2	176.2	247.7	423.9

Water level in agricultural areas begin to decline (see Fig 8.1.20).

Water level in urban areas begin to decline (see Fig 8.1.19)

Source: JICA Project Team, based on data provided by report1 [13]

4) Assumed volume of groundwater supply.

In 2016, when the water level in the wells inside the 150m Ring Road began to drop, signaling the onset of a breakdown in the water balance, the total water intake was 142 Mm³. This can be considered groundwater recharge for the Erbil City watershed.

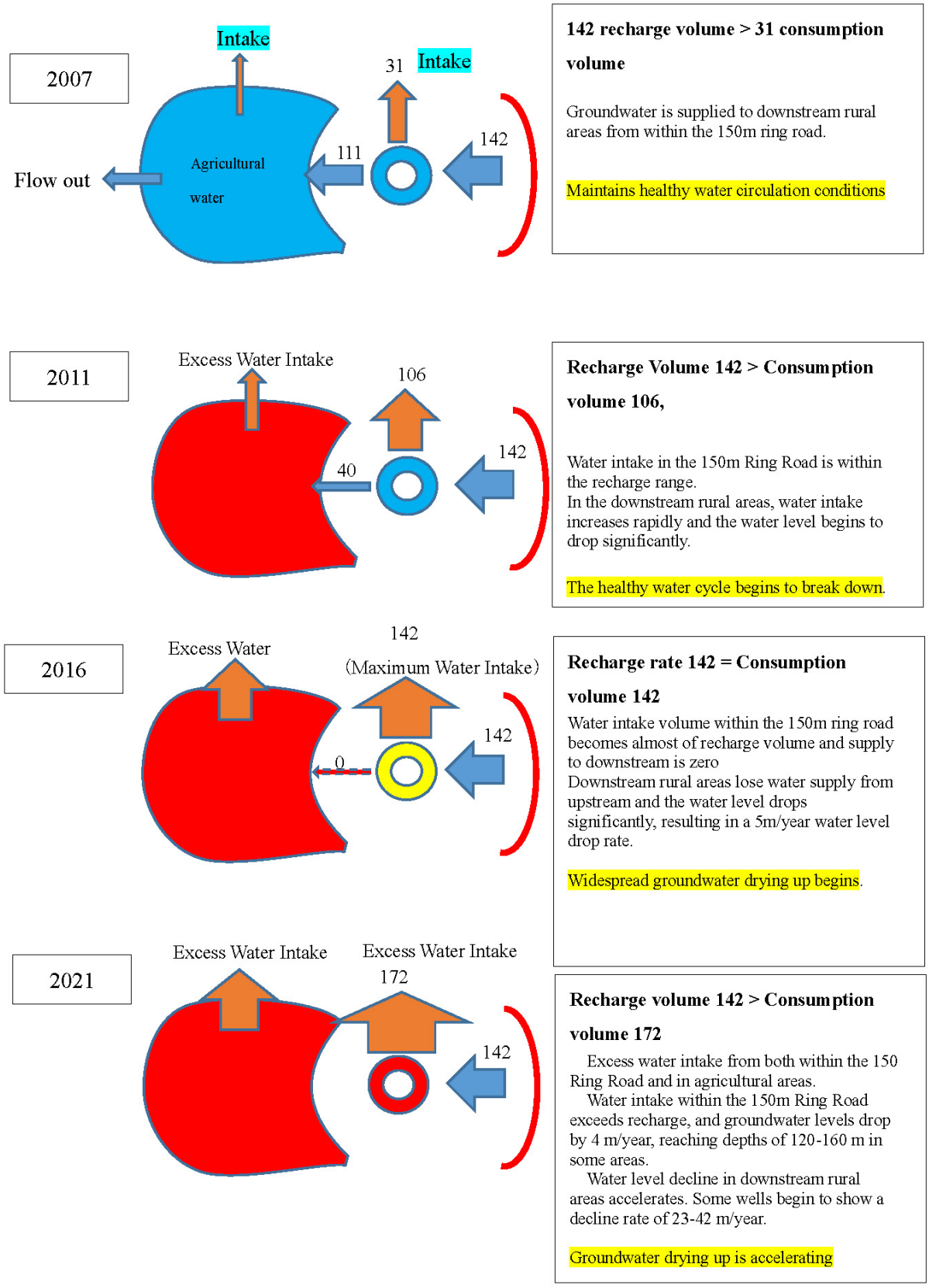
5) Water balance

In the following page, Figure 8.1.22 shows the change in the water balance over time.

After 2016, groundwater levels in and out of the 150m Ring Road have been declining progressively, with some wells now showing an annual decline rate of over 40 meters.

While the increase in well water intake almost remained relatively constant, the rate of groundwater decline has been accelerating. The main reason for the rapid decrease in groundwater levels in the wells is the substantial excess water intake over recharge. Another factor may be that the suitable depth for groundwater abstraction is approximately 80 m, and aquifers deeper than this have low permeability (i.e. low groundwater quantity) (see Chapter 8, Section 1.1.1 (2) Aquifer conditions for details).

[13] Report1 Erbil Urban Development Master Plan Renewal Project for Sustainable Cities in Iraq



Source: JICA Project Team

Figure 8.1.22 Change in Water Balance Over Time

8.1.2 Strategies & Policies (Consideration)

(1) The plan for future water supply

1) Water requirements due to population growth

As the population grows, so does the amount of water production required (see Table 8.1.5).

Table 8.1.5 Requirement Water Production

Item		2025	2030	2040	2050
Population		1,982,000	2,200,000	2,620,000	3,009,000
Water Demand	Unit Demand (Ipcd)	330	325	315	300
	Daily Demand (m3/d) (a)	654,100	715,000	825,300	902,700
Water Demand	Unit Discharge (%)	10%	10%	15%	20%
	Industrial & Commercial (m3/d) (b)	65,400	71,500	123,800	180,500
NRW	Ratio (%)	45	40	30	20
	Daily Demand (m3) (c)	153,700	163,400	171,300	141,000
Required Water Production (a)+(b)+(c)		873,200	949,900	1,120,400	1,224,200

Source: JICA Project Team

The population growth in Erbil will lead to a growing demand for water. On the other hand, groundwater supplies are being exhausted, and new water resources need to be developed.

The current groundwater recharge to the intake area is 142 million m3/year (≈ 380,000 m3/day). In order to continue using the deep wells, water intake would need to fall below the 2016 level of 142 million m3/year. Excessive groundwater intake would lead to damage to the well structure (irreversible reduction in water intake). For safety reasons, groundwater withdrawals should be reduced to 100Mm3/year, 100Mm3/year being the withdrawals rate in 2011 when groundwater levels were stable.

However, immediately restricting groundwater intake is not realistic because it would lead to a shortage of water for domestic use. Groundwater withdrawals should be maintained at current levels and gradually reduced in the future.

Source: JICA Project Team
Note: It indicates the critical situation of Erbil's water resources.

Figure 8.1.23 Water Supply Plan

2) Water intake from IFRAZ IV

The actual water intake from IFRAZ I, II, and III is 78% of the planned water intake (Table 8. 1.6). On the other hand, the planned water intake from IFRAZ IV is 600,000m3/day (219Mm3/year), so the actual water intake is 170.8 Mm3/year, which is 78% of the planned intake. However, the year in which IFRAZ IV will begin supplying water has not yet been determined.

Table 8.1.6 Planned and Actual Water Withdrawal from IFRAZ I ・II・ III・ IV

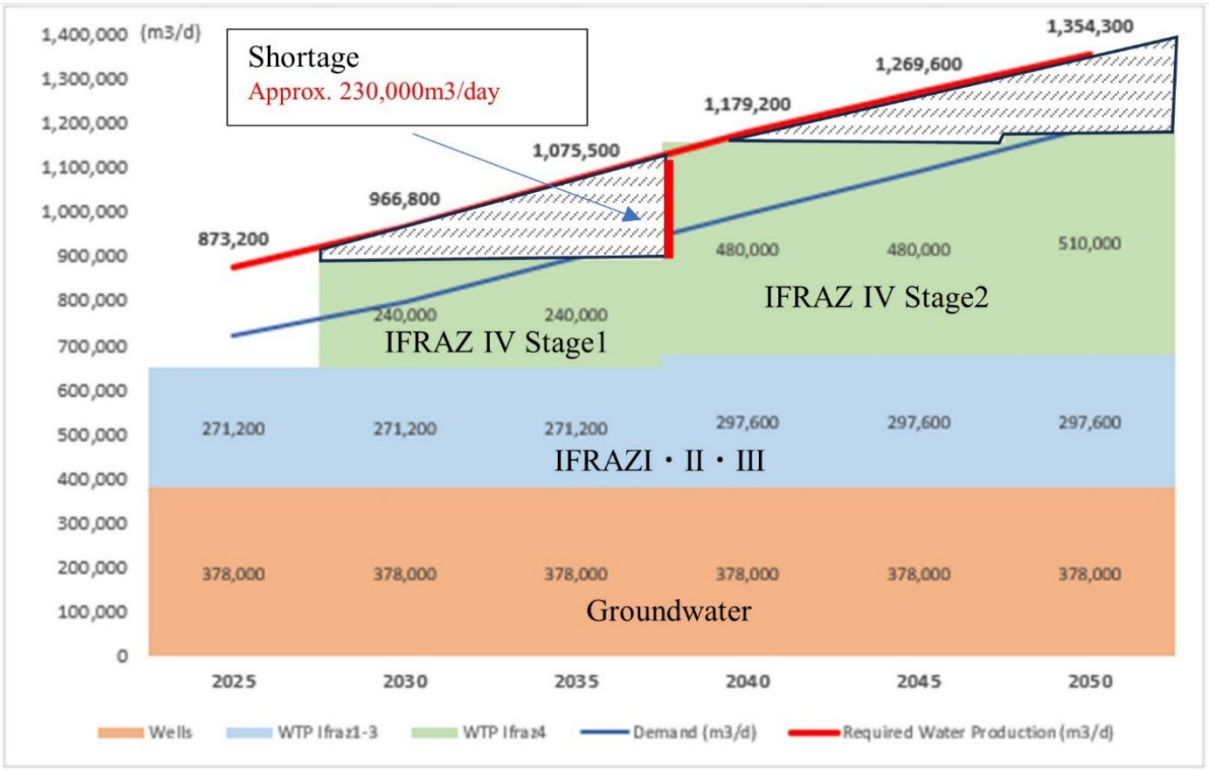
Water Source	Design		Current Operation (2023)		
	M3/hr	M3/d	M3/hr	M3/d	%
Ifraz 1	1,600	38,400	1,200	28,800	75%
Ifraz 2	2,880	69,120	2,100	50,400	73%
Ifraz 3	10,000	240,000	8,000	192,000	80%
Ifraz 4	25,000	600,000	-	-	-
WTP-Total	39,480	947,520	11,300	271,200	78%

Source: JICA Project Team

3) Relationship between water supply and demand

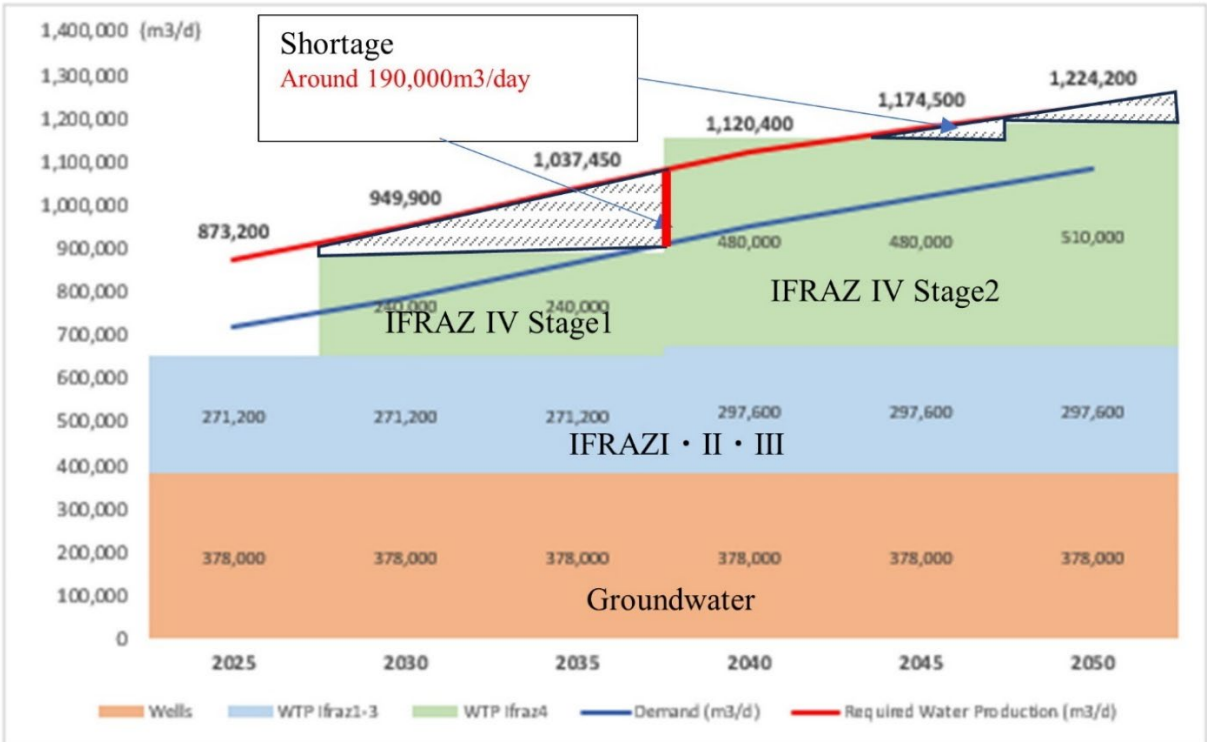
Figure 8.1.25 and 8.1.26 indicate water supply relative to water consumption.

Figure 8.1.25 indicates the water consumption at 330 ℓ/d/person, and Figure 8.1.25 indicates the plan to achieve 10% water savings by 2050 through gradual water conservation. (The 10% water savings can be achieved through water-saving habits such as not forgetting to turn off the faucet.)



Source: JICA Project Team

Figure 8.1.24 Water Supply Plan Assuming that Water Consumption 330 ℓ/d/person, (IFRAZ IV will start supplying water in 2030(IFRAZ IV is constructed in two stages)



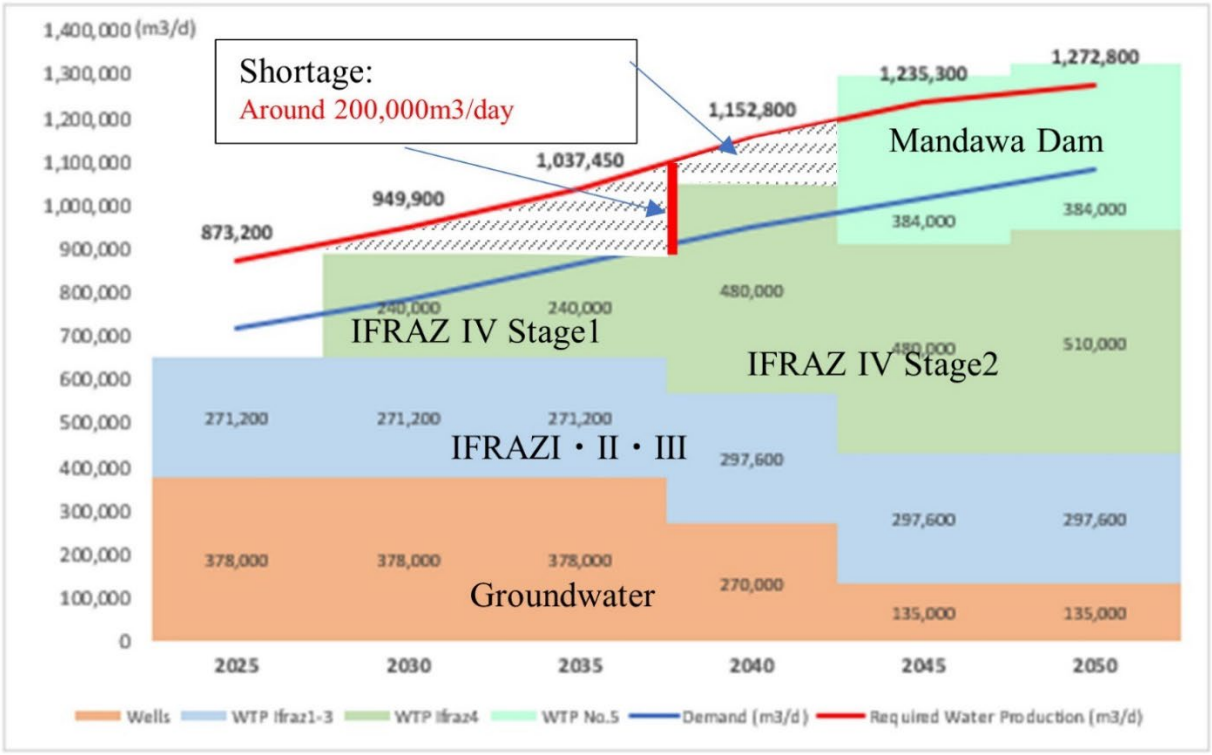
Source: JICA Project Team

Figure 8.1.25 Gradually Decreasing from 330 L/day in Figure 8.1.25 to 300ℓ/d/person.

Result

If excessive water intake continues at this rate, there is concern about the irreversible destruction of the well structure. Under these situations, groundwater use will have to be restricted. However, restrictions on groundwater intake should not result in a shortage of water supply.

The following is proposed as the most appropriate future plan at this stage. The water supply plan assumes that Ifraz IV will start supplying water in two phases in 2030 and that intake from Mandawa Dam will start supplying water in 2045. Water consumption is gradually reduced to 300 L/day/person in 2050.



Source: JICA Project Team

Figure 8.1.26 Water Supply Plan

The schedule（Figure 8.1.27） will significantly change depending on the operation of Ifraz IV and Mandawa Dams and other factors. What is clear, however, is that now is the time to start developing new water resources. A new water resource volume of 190,000～2,300,000m3/d (70-84 Mm3/year) is considered necessary for development planning. In addition, assuming that water withdrawals will be limited for unforeseen reasons, such as failure of existing facilities, reduction in the volume of the Great Zab River, and water contamination, new water development will not have to wait.

(2) New Water Resource Development

1) Menu of water resource development

Based on the above considerations, groundwater resources are nearing their limit and there is an urgent need to secure new water resources. In the following, groundwater recharge, dam, Great Zab River intake, groundwater and water conservation, etc. are indicated.

Table 8.1.7 Countermeasure Plan (policy)

Development Item	Comments and Remarks
1) Groundwater Recharge	The minutes of the **"Committee meeting for the scope of updating the identification of the groundwater recharge zone in the city of Erbil according to the development of the new master plan"** revealed the existence of a groundwater recharge protection area (Figure 8.1.28). It is estimated that this recharge area can provide approximately 29 Mm3/year of groundwater infiltration for domestic wells within the city of Erbil. Recharge is planned through the construction of flood control ponds within the groundwater recharge area (Figure 8.1.36). Some of these flood control ponds are also located in an area that overlaps with the alluvial plain and experiences relatively high rainfall (Figure 8.1.37). Strategic recharge measures are required, including groundwater recharge associated with the construction of dams in the upstream area, such as the Bastola Dam. Furthermore, groundwater recharge is also facilitated by agricultural irrigation.
2) The concept of an artificial river and lake in Erbil	President Masoud Barzani introduced the concept of constructing an artificial river to supply water from the Great Zab River to Erbil in early 2003. The Ministry of Water Resources has provided detailed information on this idea in a report entitled "Preliminary Report of Artificial Lake and River in Erbil (written by Ali Rashid Ahmad)". Although this idea faces several challenges, it is believed that direct water transfers from the Great Zab River will have a significant benefit in ensuring water resource security for Erbil.
3) Dam	The specifications for the Mandawa Dam have not yet been finalized. The dam site is being changed to increase water storage. The construction of this dam is of immense importance to Erbil's water resources. While its primary purpose is power generation and agricultural water supply, it is critical to consider domestic water supply in the planning process. Currently, the Gomaspan and Bastora dams are under construction. In addition, many other dams are planned for construction, as shown in Table 8.1.12.
4) Development of the Great Zab River and Groundwater Development around the River.	In IFRAZ IV, water intake from the Great Zab River is planned(480,000～510,000m3/day). In this section, it is proposed to study the possibility of developing water resources from the Great Zab River. In addition, the development of subsoil water is also proposed.

Source: JICA Project Team

Table 8.1.8 Countermeasure Plan (policy)

Development Item	Comments and Remarks
5) Water conservation	Water conservation is an efficient way to secure new water resources without spending money. However, due to Erbil climatic conditions and lifestyle, its introduction should be phased in with the consent of the citizens. A reduction from 330 L/person/day to 300 L/person/day would amount to 30-40 Mm3/year. This is equivalent to IFRAZ-II. It is possible to save 10% of water just by being careful not to forget to turn off the faucet, so it is essential to promote water awareness.

Development Item	Comments and Remarks
6) Non-Revenue Water	Non-revenue water is expected to account for 40-45% of the water supply. A survey should be conducted to determine the actual amount of non-revenue water.

Source: JICA Project Team

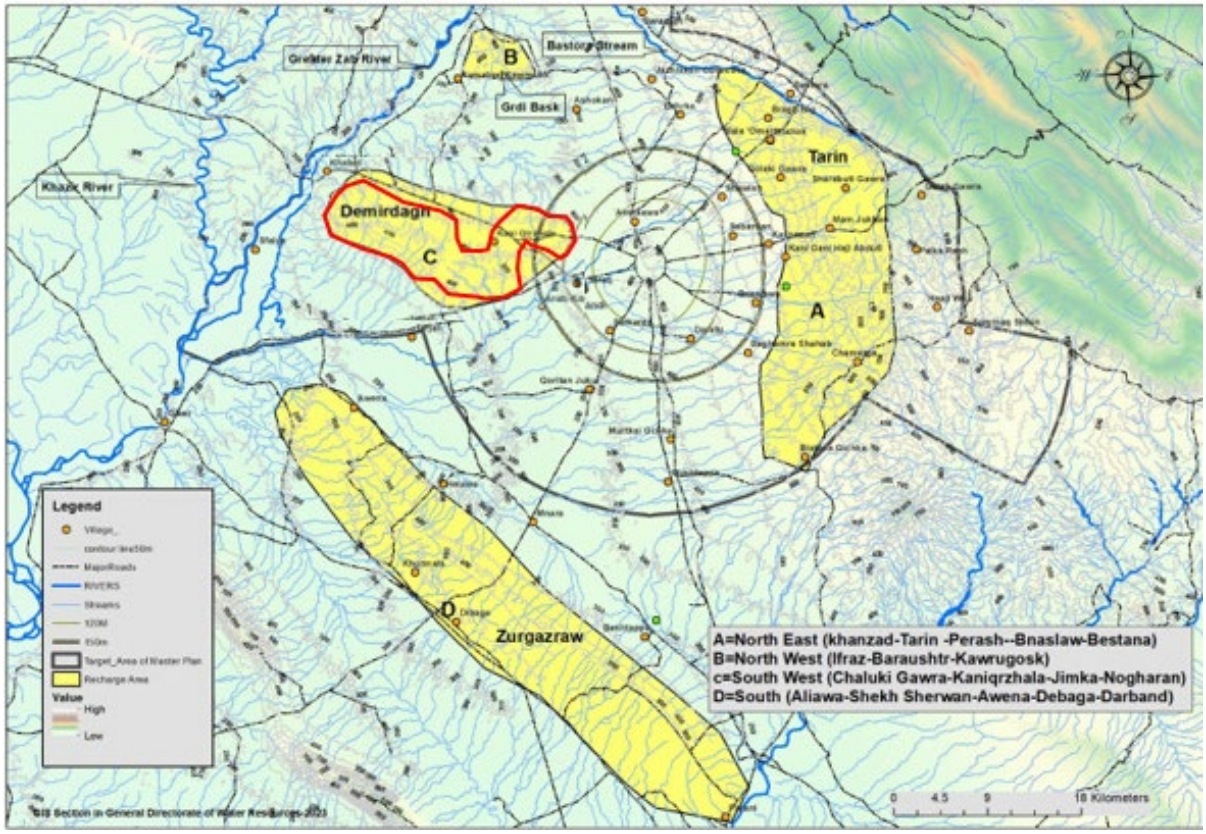
Below is an explanation of each category (1) -4)) in the table above.

(3) Discussion of proposed measure

1) Groundwater Recharge

Conservation and Utilization of Groundwater Recharge Areas

"Committee meeting Minutes for the scope of updating the identification of the groundwater recharge zone in Erbil city according to the development of the new master plan" (chaired by Salman Kareem Hamad, with Dr. Ali Abdullah, and Dr. Abdullah Ali Abdullah) provide details of the groundwater recharge zone, as shown in the figure below.



Source: Report[14] JICA project team added red line

Note :C area: groundwater recharge area indicated by MP2050 in red line

Figure 8.1.27 Groundwater Recharge Area

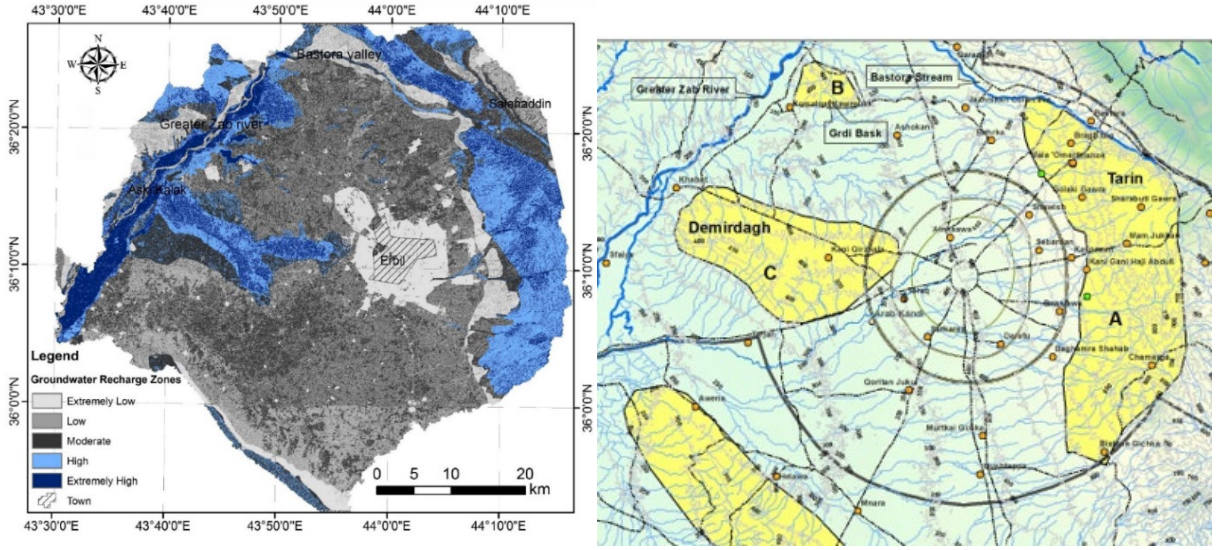
However, no scientific explanation was provided for the selection of these areas, nor were specific infiltration facilities presented. The concept behind this decision is based on the understanding that urban expansion into natural areas can impede groundwater recharge. This notion was confirmed during a workshop with the MoAWR, as there are numerous cases where urban development has led to a decrease

[14] Report: Committee meeting Minutes for the scope of updating the identification of the groundwater recharge zone in Erbil city according to the development of the new master plan" (chaired by Salman Kareem Hamad, with Dr. Ali Abdullah, and Dr. Abdullah Ali Abdullah)

in groundwater recharge. Therefore, the judgment of this committee is considered accurate.

i) Adequacy of the groundwater recharge area proposed by the committee

The most recent research on groundwater recharge in the city of Erbil (literature[17]) supports the recharge area identified by the committee. This study used ArcGIS to analyze the area around the city of Erbil based on factors such as "TPI, topography, lithology, land cover, slope, DD, and LD" and classified it into five categories: very low, low, moderate, high, and very high groundwater recharge effectiveness (Figure 8.1.29 left). Figure 8.1.29: The results support the recharge area identified by the Commission because the blue color on the left (height of recharge) is similar to the recharge area on the right figure.



Source: Literature[15] and Report[16]

Figure 8.1.28 Comparison of Suitable Groundwater Recharge Areas Identified by the Literature[15] and the Groundwater Recharge Area Identified by the Committee

ii) Estimates of groundwater recharge from the recharge area specified by the Committee

- Groundwater recharge from the entire area

The objective of this calculation was to roughly estimate the amount of groundwater recharge due to conservation in the recharge area and the extent of reduction in groundwater infiltration due to urbanization.

Calculation conditions:

- ✓ Annual rainfall: 500 mm
- ✓ Groundwater infiltration rate [rainfall- (surface runoff + evapotranspiration)] ÷ annual rainfall =15%. (Assuming a surface runoff rate of 0.7 and an evapotranspiration rate of 0.5).

The rainwater infiltration rate was assumed to be 15% because field testing was not permitted by the GDUP, but in reality, Area A2 consists of weathered rock or sandy soils that have high permeability and can have a permeability 10 times that of Areas A3 and A4. Area A1, where alluvium is distributed, consists of silty soils (low permeability) and sandy to gravelly soils (high permeability). Since there is a high probability that sandy to gravelly (high permeability) soil is the distributed riverbed, it needs to

[15] Literature; Identifying potential sites for artificial groundwater recharge using GIS and AHP techniques: A case study of Erbil basin, Iraq; Kuwait J.Sci., Vol.50, No.(1B), January.2023, pp(1-22)
Omeed H. Al-Kakey, Arsalan A. Othman, Broder J. Merkel

be investigated in the future. Therefore, it is necessary to conduct rainwater infiltration tests to account for these variations and classify the areas based on their specific rainwater infiltration rates. This is suggested as a future issue to be addressed.

If the shape of the MoAWR groundwater recharge zone is reduced to match the future urbanized areas (detailed plan, Ararat Industrial Zone, Gweru Road Industrial Zone, etc.), the red line in Figure 8.1.32 will be the extent of the recharge zone. This reduced size is defined as the groundwater recharge zone.

- Calculation result

The total groundwater recharge is expected to be 45 Mm^3/year.

Table 8.1.9 Estimated Groundwater Recharge Rates

Area	Subdivision	Area (km2)	Area (m2)	Annual rainfall (m/y)	Total Precipitation (m3/year)	Recharge Rate (%)	Recharge Volume (m3)	Recharge Volume (Mm3)
A	Total A	376	376,300,000	0.5	188,150,000	15%	28,222,500	28.2
B	Total B	202	201,700,000	0.5	100,850,000	15%	1,852,500	1.9
C	Total C	143	142,705,881	0.5	71,352,941	15%	10,702,941	10.7

Source: JICA Project Team

Note: Area C is the area within the red line in Figure 8.1.32

- Recharge to urban areas with high concentrations of domestic wells
  - ✓ Area A consists of strata of varying permeability.
  - ✓ Areas B and C contain groundwater flowing outside the urban area where domestic wells are concentrated.

To solve these problems, conditions such as infiltration rate and direction must be determined. This requires the collection and analysis of soil and groundwater information, but there is not enough data to analyze. The establishment of a database should be mentioned as a future task. An attempt has been made here to estimate groundwater recharge in urban areas with a high concentration of domestic wells by setting empirical conditions.

Table 8.1.10 Reclassification of Each Area and Estimation of Groundwater Recharge Rates

Area	Subdivision	Area (km2)	Area (m2)	Annual rainfall (m/y)	Total Precipitation (m3/year)	Recharge Rate (%)	Recharge Volume (m3)	Recharge Volume (Mm3)
A	A1	144	144,300,000	0.5	72,150,000	15%	10,822,500	10.8
	A2	112	111,800,000	0.5	55,900,000	15%	8,385,000	8.4
	A3	96	96,400,000	0.5	48,200,000	10%	4,820,000	4.8
	A4	24	23,800,000	0.5	11,900,000	5%	595,000	0.6
	Tota l A	376	376,300,000	0.5	188,150,000	15%	24,622,500	24.6
B	B1	10	9,700,000	0.5	4,850,000	15%	727,500	0.7
C	C1	24	22,549,687	0.5	11,274,844	15%	1,691,227	1.7
	C2	27	27,855,234	0.5	13,927,617	15%	2,089,143	2.1
	C1+C2	217	216,700,000	0.5	108,350,000	15%	3,780,369	3.8

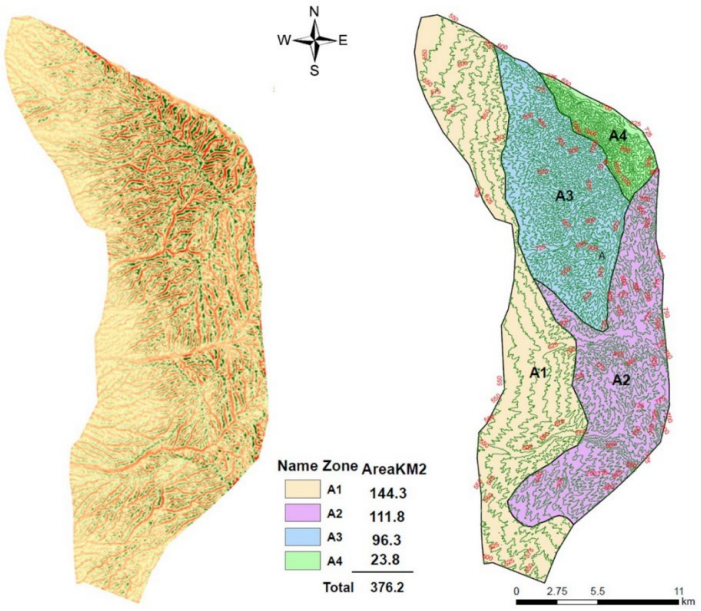
Source: JICA Project Team

Note: Area C is the area within the red line in Figure 8.1.32

(a) Area A classification

Groundwater infiltrating into areas A1, A2, A3, and A4 flows down towards Erbil urban area where domestic wells are concentrated.

- ✓ A1: Almost flat terrain (mixture of silt and sand)
- ✓ A2: Hilly (sandy soil and weathered rock)
- ✓ A3: Mountainous areas and hills (weakly weathered sedimentary to fresh rocks): field tests show that the hydraulic conductivity (k) is small, around 1 x 10-5 cm/s.
- ✓ A4: High mountainous region (hard base rock)

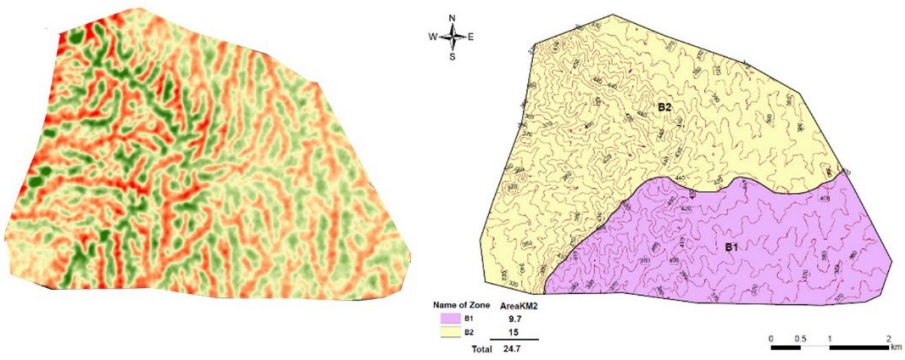


Source: JICA Project Team

Figure 8.1.29 Classification according to Topography (Area A)

(b) Area B classification

- ✓ B1：This area slopes towards the Erbil city side, resulting in groundwater flow towards the city. The soil in this area is a mixture of silt and sand, with high permeability.
- ✓ B2：This area slopes in the northwest direction, with groundwater flowing in the opposite direction to the city of Erbil. The soil in this area is a mixture of silty sand and silt, and it also has a high permeability.

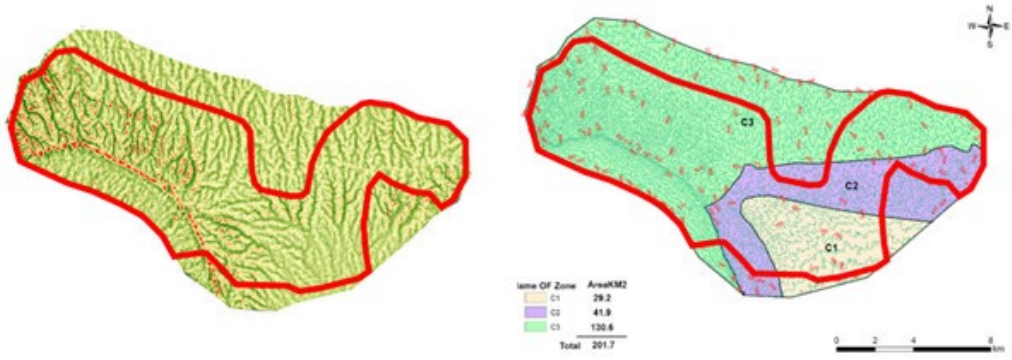


Source: JICA Project Team

Figure 8.1.30 Classification according to Topography (Area B)

(c) Area C classification（Within red line）

- ✓ C1: This area has an almost flat topography and the groundwater flows towards the city of Erbil. The rock type in this area is weathered conglomerate, and field test results indicate a permeability coefficient (k) of 1×10-4 cm/sec.
- ✓ C2: This area has a hilly topography and the groundwater flows towards the city of Erbil. The rock type in this area is the same as C1, which is a weathered conglomerate with a permeability coefficient (k) of 1×10-4 cm/sec.
- ✓ C3: This area has a hilly topography with groundwater flowing outside of urban areas (in the north, west, and south directions). The rock type in this area is coarse-grained sandstone to silty sandstone, which has lower permeability compared to weathered conglomerate.



Source: JICA Project Team
Note: Groundwater recharge area indicated by MP2050 in red line

Figure 8.1.31 Classification according to Topography (Area C)

(d) Result

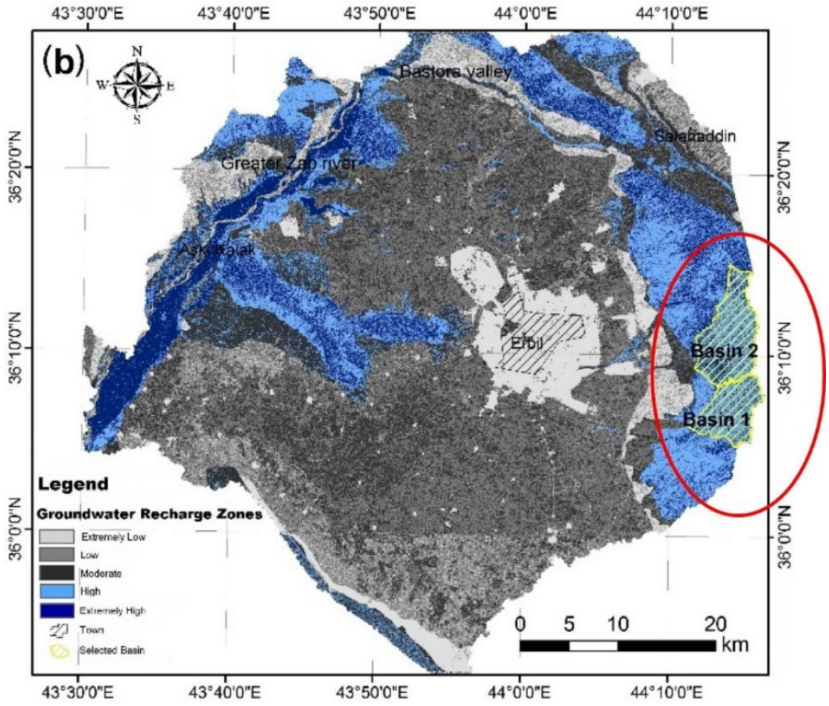
From the above classification, the amount of groundwater supplied to the urban area with a concentration of domestic wells in Erbil is the combined groundwater recharge from Area A and Areas B1 and C1. The total amount of groundwater recharge is 29 Mm3/year. If the entire recharge area is urbanized, the groundwater recharge rate will decrease to about 1/3 due to increased runoff from 0.7 to 0.9. In the case, 9 Mm3/year would be lost.

iii) Construction of groundwater recharge facilities

To further increase groundwater recharge, the construction of groundwater recharge facilities is proposed. The method is to store rainwater to reduce runoff. This can be achieved through the construction of surface and underground dams.

(a) Surface dams

Two dams in the recharge area are described in literature[16]. These dams are located within the groundwater recharge area and are considered an effective proposal.



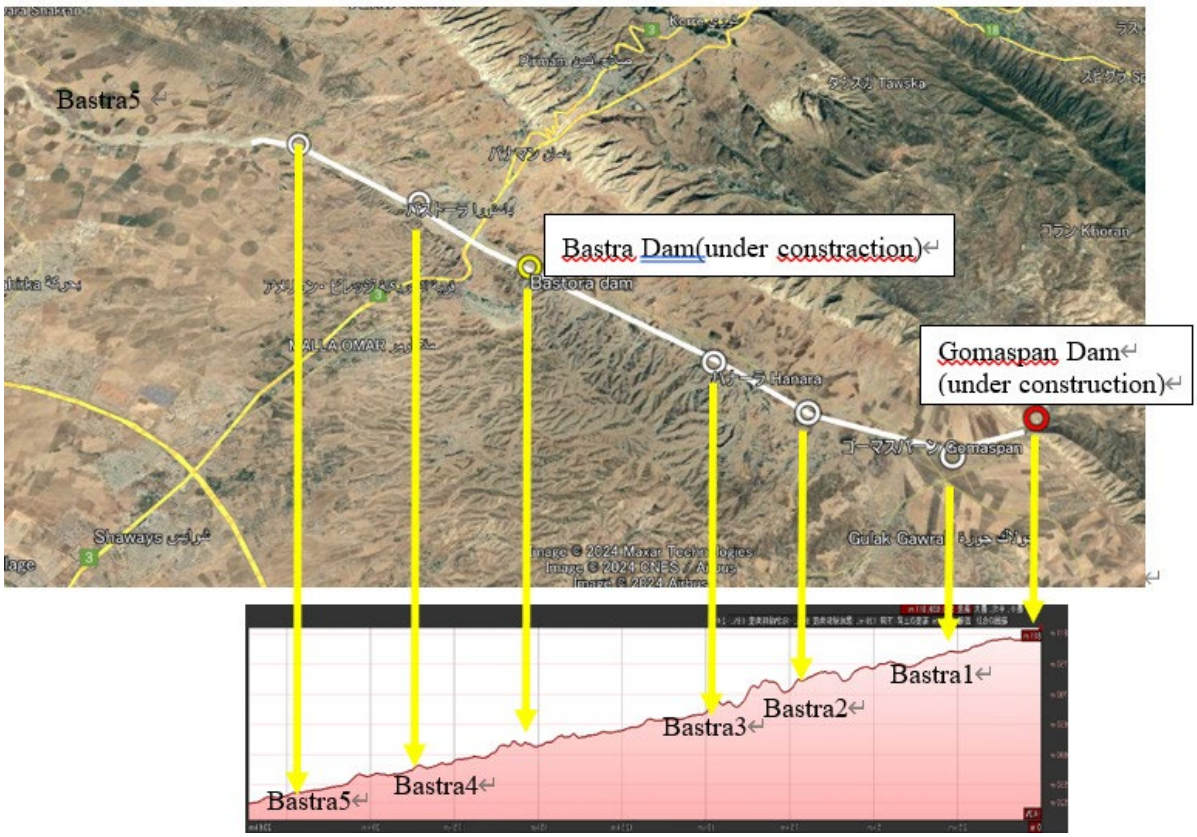
Source: Literature [16]

Figure 8.1.32 Plan of Dam Constructions (red circle)

The construction of Bastra Dam for groundwater recharge is currently underway, and the construction of Bastra Dams 1-5 (referred to as the Bastra Dam Group) is also planned.

- Bastora Dam Overview
  - ✓ Capacity: less than 20 million cubic meters.
  - ✓ Purpose: mainly for groundwater recharge and tourism, but could be used for irrigation
  - ✓ Dam height: 642 m AMSL. (~30 m above ground).
  - ✓ Length of dam: 640 m.

[16] Literature; Identifying potential sites for artificial groundwater recharge using GIS and AHP techniques, A case study of Erbil basin, Iraq, Omeed H. Al-Kakey1, Arsalan A. Othman, Broder J. Merkel



Source: Compiled by JICA based on dam locations provided by the Dam Directorate

Figure 8.1.33 Gomaspan Dam, Bastora Dam and Bastora 1-5 Planning Dams

Bastora Dams Group, including the Gomaspan Dam, are planned online that allow for gravity flow, which will be beneficial for the discussed irrigation systems.

(b) Underground Dam

Due to the location of the Bastora Dam (and its group of dams) in a sand and gravel supply area, it is expected to accumulate a significant amount of sediment over time. As a result, it is predicted that the dam will gradually be converted into an underground dam. Underground dams are highly effective for groundwater recharge because they experience minimal evapotranspiration.

In addition, large rivers have sand and gravel deposits with high porosity. Check dams and dikes have already been constructed to prevent sediment flow and small underground dams have also been implemented (information from the Groundwater Directorate). This combination of recharge and flood control measures is an effective construction method.

<u>Groundwater recharge from flood control dams</u>

Many flood control ponds are planned within the recharge (Area A). Because ponds are particularly effective for groundwater recharge, this study focuses on evaluating ponds with high groundwater recharge capacity.

Natural conditions suitable for groundwater recharge:

i) To be able to get relatively high precipitation.
ii) To be able to recharge the Erbil City underground.
iii) To have a high rainwater infiltration capacity.

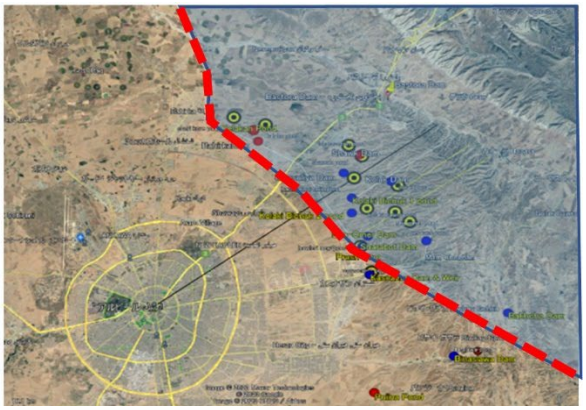
Areas where all three conditions apply are good recharge areas. (Field testing for infiltration rate

estimation was discontinued by the GDUP, so condition i) needs to be reviewed based on the results of the field survey. The field survey and reconsideration are proposed as a future task).

i) Relatively high precipitation.

Based on the rainfall distribution map shown in Figure 8.1.35 (left figure), the areas where annual rainfall is expected to be 700 mm or more are indicated with blue color in Figure 8.1.35 (right figure) below. Candidate sites are within or along rivers flowing down from this range.

Source: Precipitation map[17]

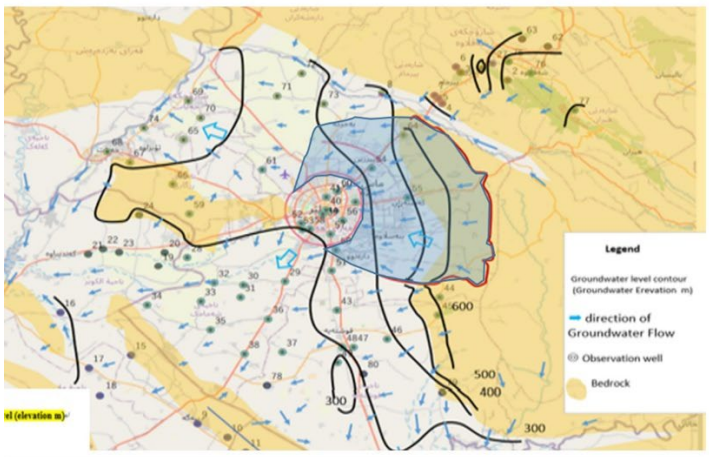


Source: JICA Project Team

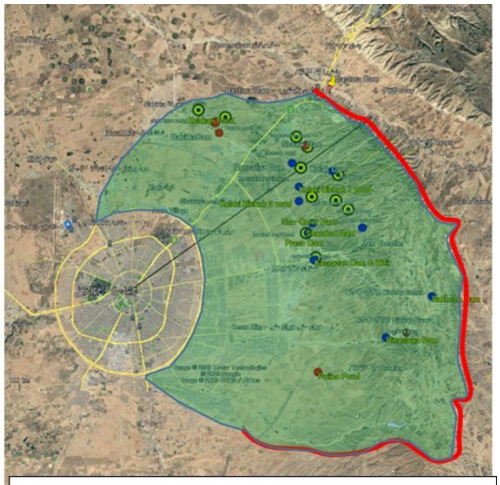
Figure 8.1.34 Area where Rainfall of 700 mm or More Per Year can be Expected

ii) Recharged groundwater is supplied to the underground in Erbil City.

The blue area is the groundwater flowing area that supplies the underground of Erbil City. The groundwater flows along the blue arrows (→ and ➡) from the ridge to the east to Erbil City to the west.



Groundwater contour map
Groundwater flows from high—elevation areas to urban areas in a direction perpendicular to this contour.



Areas where rainfall of 700 mm or more is expected. The dots in the figure indicate the flood planning control dams (ponds) .The red line is the

Source: JICA Project Team

Figure 8.1.35 Groundwater Basin Supplying into the Erbil City (blue (left Fig.) and green (right Fig.) represent groundwater flow into Erbil City)

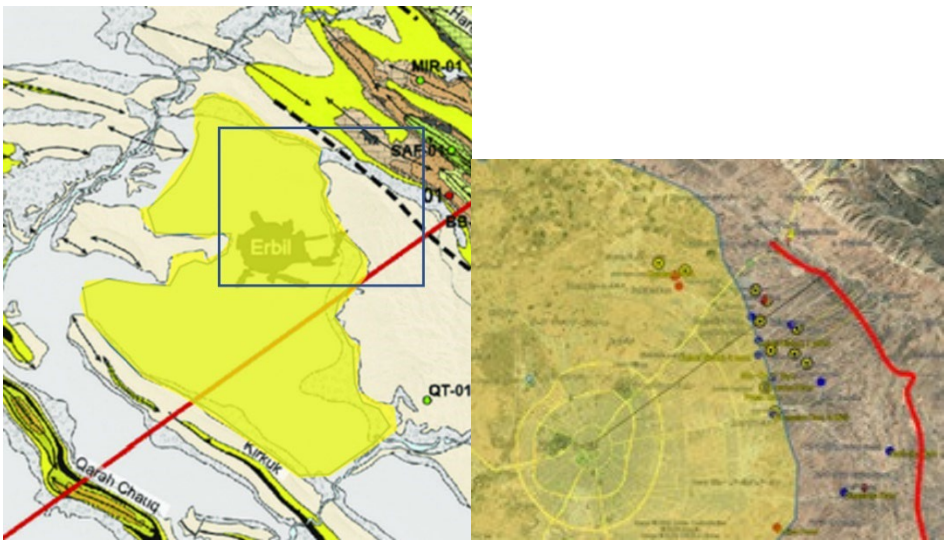
Based on the information presented in Figure 8.1.35, the proposed flood control dams are also effectively

[17] Literature1 Water harvesting in Erbil Governorate, Kurdistan region, Iraq Detection of suitable sites using Geographic Information System and Remote Sensing ; Hasan Mohammed Hameed 2013

located for groundwater recharge.

iii) Alluvium with good permeability is distributed

The aquifer in Erbil city is composed of Quaternary layers. The Quaternary layer has a higher infiltration capacity than the base rock and is more effective in rainwater infiltration. The left figure below shows the distribution of alluvium, the right figure is superimposed on the flood control reservoir distribution map.

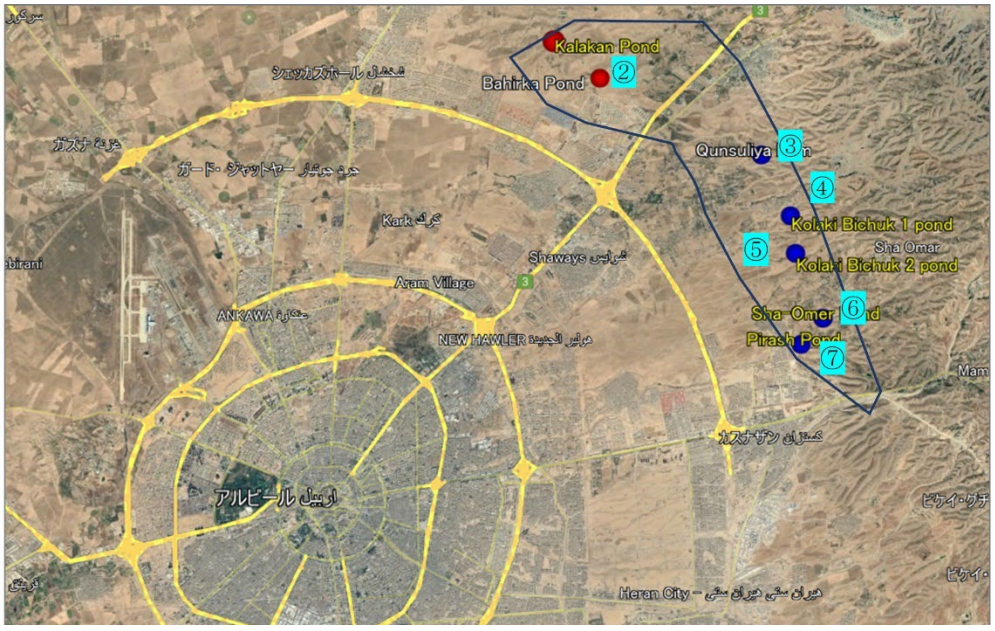


Source: JICA Project Team based on Geological Map[16]

Figure 8.1.36 Distribution Area of Quaternary Formations with High Infiltration Capacity

- Effective rainwater infiltration areas

The suitable areas for rainwater infiltration are those that combine these three conditions: the distribution of Quaternary formations with high rainwater infiltration capacity, relatively high precipitation, and the ability to recharge the Erbil City underground. Figure 8.1.38 indicates this specific area.



Note: Area in the blue circle is suitable for rainwater infiltration

Figure 8.1.37 Suitable Areas for Rainwater Infiltration and Location of Reservoirs

Table 8.1.11 List of Dams and Ponds Effective for Groundwater Recharge

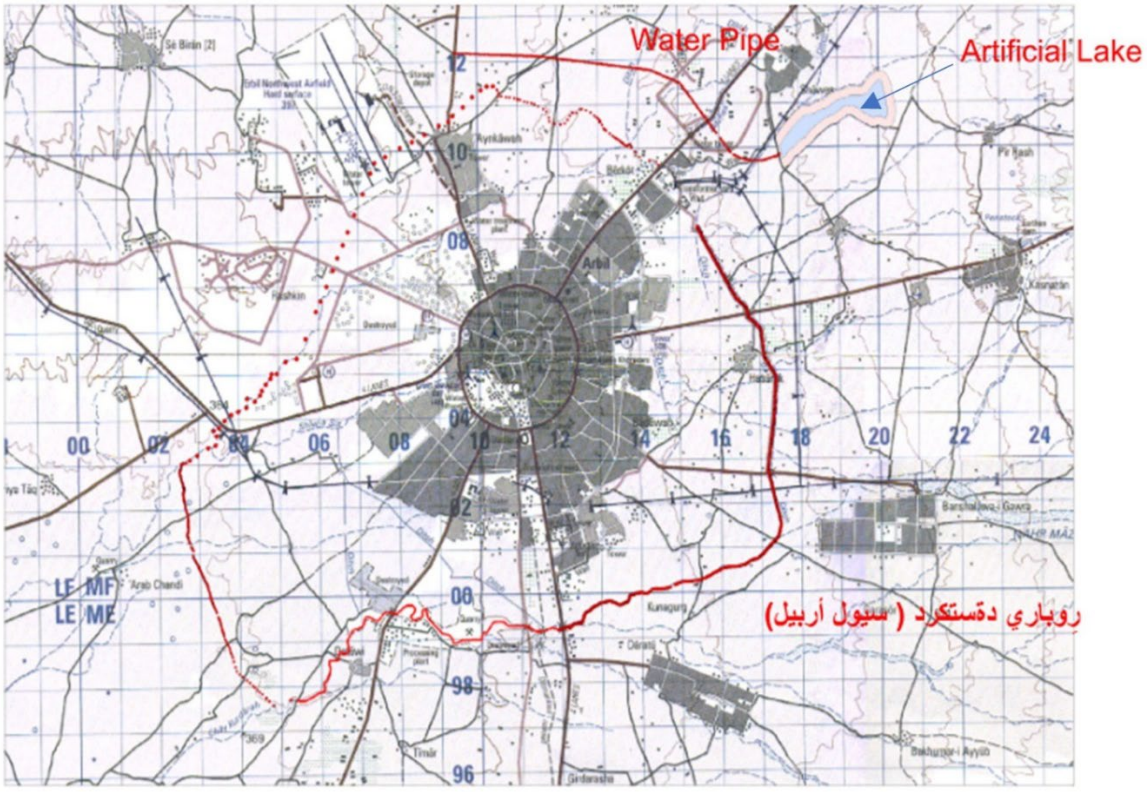
No.	Dam /Pond Name	Catchment Area(Km2)	Height (m)	Reservor Volume(m3)	RV/H※	Priority
① ◉	Kalakan Pond	4.24	10	500,000	50,000	1
② ◉	Bahika Pond	11.84	13	640,000	49,231	1
③ ◉	Qunsuliya Pond	3.04	13	120,000	9,231	3
④ ◉	Kolaki Bchuk 1 Pond	6.26	11	250,000	22,727	2
⑤ ◉	Kolaki Bchuk 2 Pond	1.11	10	225,000	22,500	2
⑥ ◉	Sha-Omer Pond	2.33	18	453,333	25,185	2
⑦ ◉	Pirash Pond	4.4	18	101,333	5,630	3

Source: JICA Project Team

Note: Circled points (◉) are planned as flood control dams (ponds) with recharge facility. Red dots indicate sites with high flood control capacity, high storage capacity (recharge capacity), and good cost-effectiveness.
※RV/H : Reservoir volume divided by dam height (approximate cost-effectiveness)

2) The Concept of an Artificial River and Lake in Erbil

In early 2003, President Masoud Barzani proposed the construction of an artificial river to supply water to Erbil by diverting water from the Great Zab River. The Ministry of Water Resources prepared a report entitled "Preliminary Report of Artificial Lake and River in Erbil" (written by Ali Rashid Ahmad), which outlined the specific details of this project.



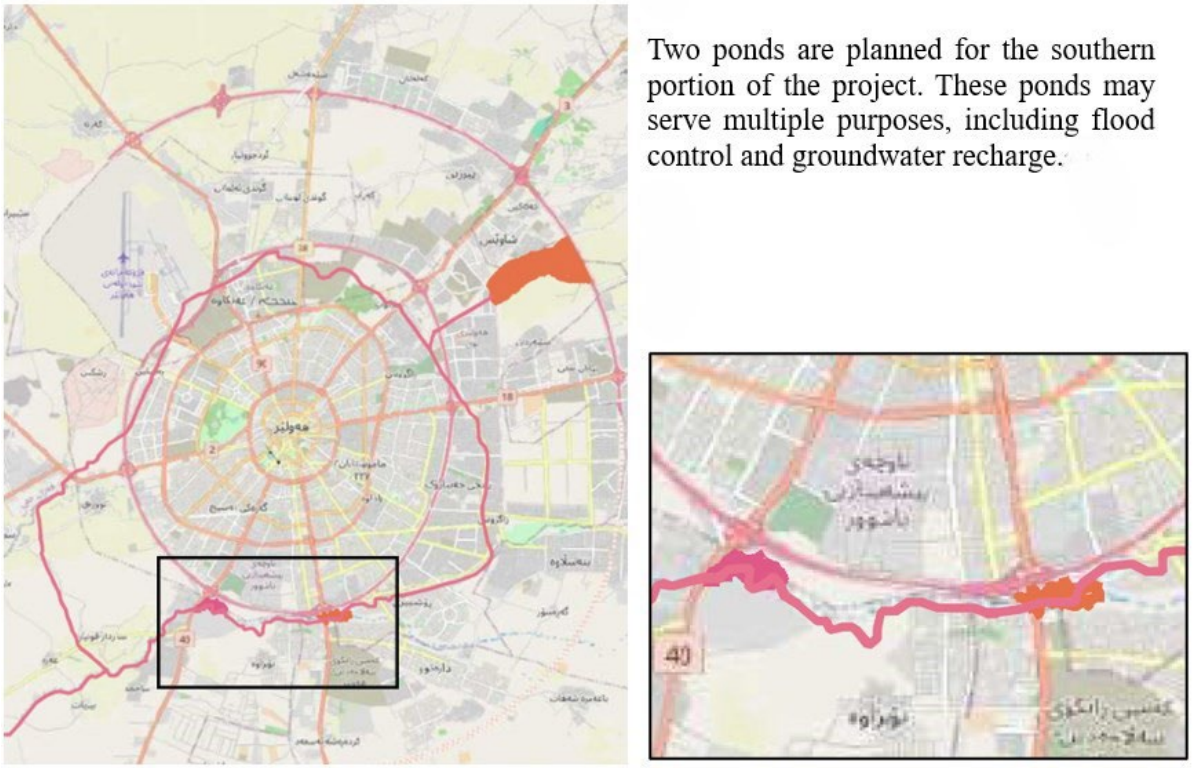
Source: "Preliminary Report of Artificial Lake and River in Erbil" (written by Ali Rashid Ahmad)

Figure 8.1.38 Concept of an Artificial River and Lake in Erbil

The concept is to construct one or more pumping stations to lift and pump 2 to 5 cubic meters of water from the Great Zab River. This water will be transported through a 30 km pipeline to the artificial lake in the northern region of Erbil. From there, an artificial canal will be constructed to transfer the water to Erbil. During a meeting of the KRG Water Resources Directorate on May 13, 2007, the following uses for this water were discussed:

- The area around the central basin can be used for tourism purposes (construction, gardens, parks, etc.).
- Water can be pumped from the three ponds for irrigation according to the amount of water in the lake
- Using the Siyol Erbil River for the artificial river that is now located inside the city of Erbil and building another river to protect Erbil from floods outside the city of Erbil.

Although there are many challenges associated with the implementation of this concept, it is strongly believed that the direct delivery of water from the Great Zab River will significantly contribute to the security of Erbil's water resources.



Source: MoAWR

Figure 8.1.39 Lake Project in the Southern Part of Erbil City

3) Dam

List of Dams

Table 8.1.12 lists the dams planned in Erbil. This list is currently being updated, but there is no doubt that many dams are planned. In addition, the Bastora Dam and the Gomaspan Dam are under construction. Even if these are not used for domestic purposes, they will be effective for groundwater recharge.

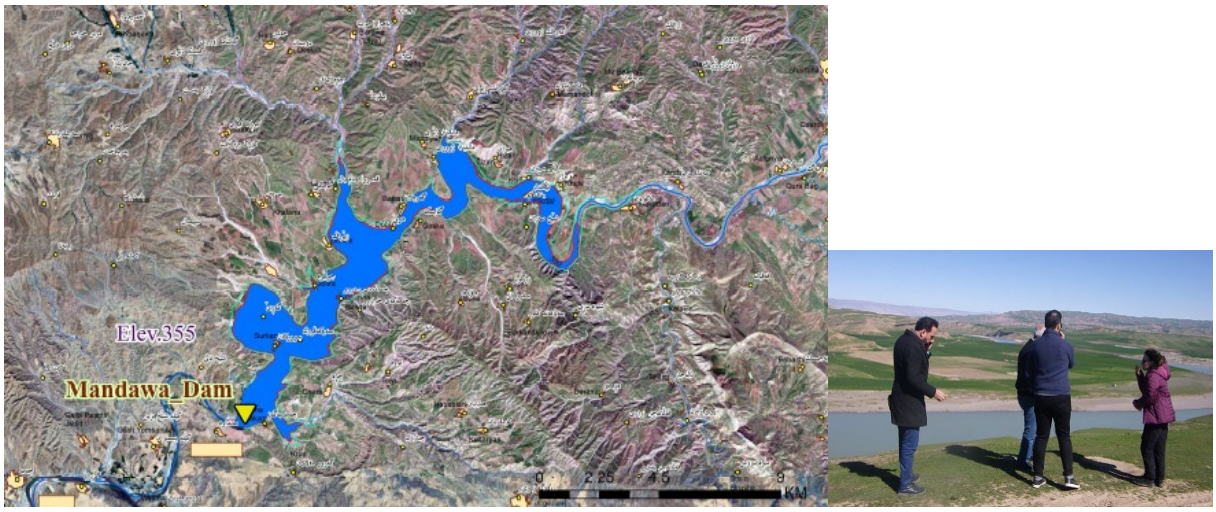
Table 8.1.12 Details of the Planning Dams- Erbil City（this table is being updated now）

Site Name	River Catchment	Type of Dam	Dam Height (m)
To Be Constructed			
Mandawa	Greater Zab	Earth fill	63.55
Taqtag	Lesser Zab	Earth fill with clay core	93
Sartik	Lesser Zab	Earth fill with clay core with a part of concrete spillway	40
Rawanduz 10	Greater Zab	Gravity Concrete Dam	75
Basty Sharga	Lesser Zab	Earth Fill Dam	20.5
Balayan	Greater Zab	Reinforced Concrete Weir	10.5
Gla Rash	Greater Zab	Gravity Concrete Dam	26
Shewarash	Greater Zab	Rockfill face concrete	42
Shqlawa	Greater Zab	Rockfill with Claycore	21
Sule	Greater Zab	Earth Fill Dam	41.5
Azyana	Lesser Zab	Earth Fill Dam	16.5
Merakan	Lesser Zab	Earth Fill Dam	20.5
Bestana	Greater Zab	Earth fill Dam	18
Bastora 1	Greater Zab	Gravity Concrete Dam	9.5
Bastora 2	Greater Zab	Gravity Concrete (R.Concrete)	10.5
Bastora 3	Greater Zab	Gravity Concrete Dam	12.5
Bastora 4	Greater Zab	Gravity Concrete Dam	11.5
Bastora 5	Greater Zab	Gravity Concrete Dam	9.5
Siktan	Lesser Zab	Rockfill Dam	21
Qapakian	Greater Zab	Earth Fill Dam	18
Darash	Greater Zab	Earth fill Embankment Dam	18
Letan	Greater Zab	Earth fill Embankment Dam	35
Under Construction			
Gomaspan	Greater Zab	RCC	70
Shawger	Lesser Zab	Earth fill Dam	23
Aqwban	Greater Zab	Earth fill Dam	28
Nazanin	Lesser Zab	Rock fill	21
Banue Talaban	Lesser Zab	Earth fill Dam	21

Source: GDUP

Mandawa Dam

A new design for the Mandawa Dam is currently being initiated. The specific details of the design and construction process are yet to be determined. The reason for changing the dam site is to increase the water capacity. The proposed new dam site, as shown in Figure 8.1.41, is subject to change and has not yet been finalized.



Source: General Directorate of Dams & Reservoirs. The dam change location is added by JICA Project Team on the hearing results (the new dam site is not finalized).

Figure 8.1.40 Location of the Dam Site（not finalized）

Gomaspan Dam

Table 8.1.13 shows the Gomaspan Dam specifications. This dam is currently under construction.

Table 8.1.13 Gomaspan Dam Specification

Site location	35 km far from Erbil center at the northeast of Erbił
Dam type	RCC
Coordinates	N 401045.521, E 440164.2 t9
Rainfall data	400-800mm/yr
Average capacity	47,839,000m3/yr
Irrigation area	14.75 km2
Catchment area	132.5 km2
Dam surface area	245 hectares
Fetch of the dam	4.4km
Dam Sedimentation	179,000m3/yr

Source: Information from GDUP

4) Development of the Great Zab River and Groundwater Development around the River

IFRAZ IV

The planned volume of IFRAZ IV is shown in Table 8.1.6.

The possibility of developing water resources from the Great Zab River

Proposal from KRG Environment Protection & Improvement Board for the development of the Great Zab River

"Construction of several dams on the Zey Gowra River to generate electricity, store water, and benefit from the establishment of advanced irrigation systems to reduce groundwater use. Irrigation systems will benefit livestock and irrigation of agricultural land, green belts and irrigation of parks and forests, etc."

The MoAWR requested a study based on flow data of the Great Zab River, and flow data was sent to us. Therefore, a rough estimate of the expected development volume is proposed on the base of this data here.

i) Study Method

A virtual dam operation simulation is assumed. Three years (2002,2004,2005) of flow data is used for the data. 2003data is nothing.

ii) Procedure

1) Set the virtual upper capacity of the dam as a temporary reservoir based on the H-V curve.
2) Set the capacity to be secured based on the flow conditions during the dry and rainy seasons.
3) If the dam is not depleted, it is considered a case where development is possible; if it is depleted, it is considered a case where development is impossible.
4) The above calculations are repeated in many cases.

iii) Calculation by 3 cases

Case 1: Dam capacity of 200 million tons (m3), developed water volume: 150 m3/s in wet season, 100 m3/s in dry season

Therefore, the amount of water to be developed is set and the dam operation calculations are performed. In the (three-year) calculations for Case 1, the minimum dam capacity occurs in December 2002 (57,613 m3), November 2004 (5,773 m3) and November 2005 (3,287 m3), and the dam is never empty. In this case, there is room.

- Case 2: Dam capacity set at 250 million tons (m3), developed water volume: 200 m3/s in rainy season, 100 m3/s in dry season

  In the (three-year) calculations for Case 2, the minimum dam capacity occurs in December 2002 (107,613 m3), November 2004 (55,773 m3) and November 2005 (53,267 m3), and the dam is never empty. The dam plan will be a dam plan where the development volume will be developable. In this case, there is still room.

- Case 3: Dam capacity set at 250 million tons (m3), developed water volume: 200 m3/s in rainy season, 150 m3/s in dry season

  In the (3-year) calculation of Case 3, the minimum dam capacity occurs in the dry season, and the 150 m3/s of water to be developed in the dry season is not developable.

iv) Result of calculation

In the above study, Case 3 is not developable, and Case 2 has a larger development use than Case 1. Therefore, the amount of development in Case 2 is about the amount of development possible for the Great Zab River. This result does not take into account the impact on downstream areas, financing of construction, impact on residents, environmental impact, etc.

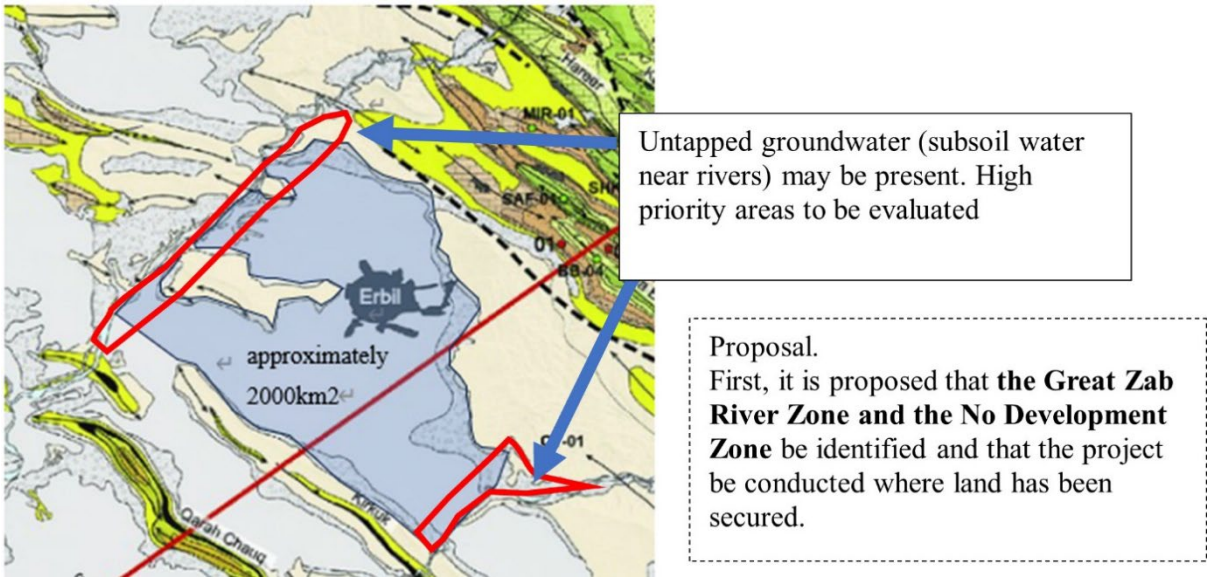
v) Policies for future studies

The accuracy of the calculation can be improved by measuring the flow rate of the Great Zab River on a daily basis and by setting the size of the hypothetical dam in detail. For various development, it is suggested that KRG engineers conduct a trial.

The development of subsoil water is also proposed

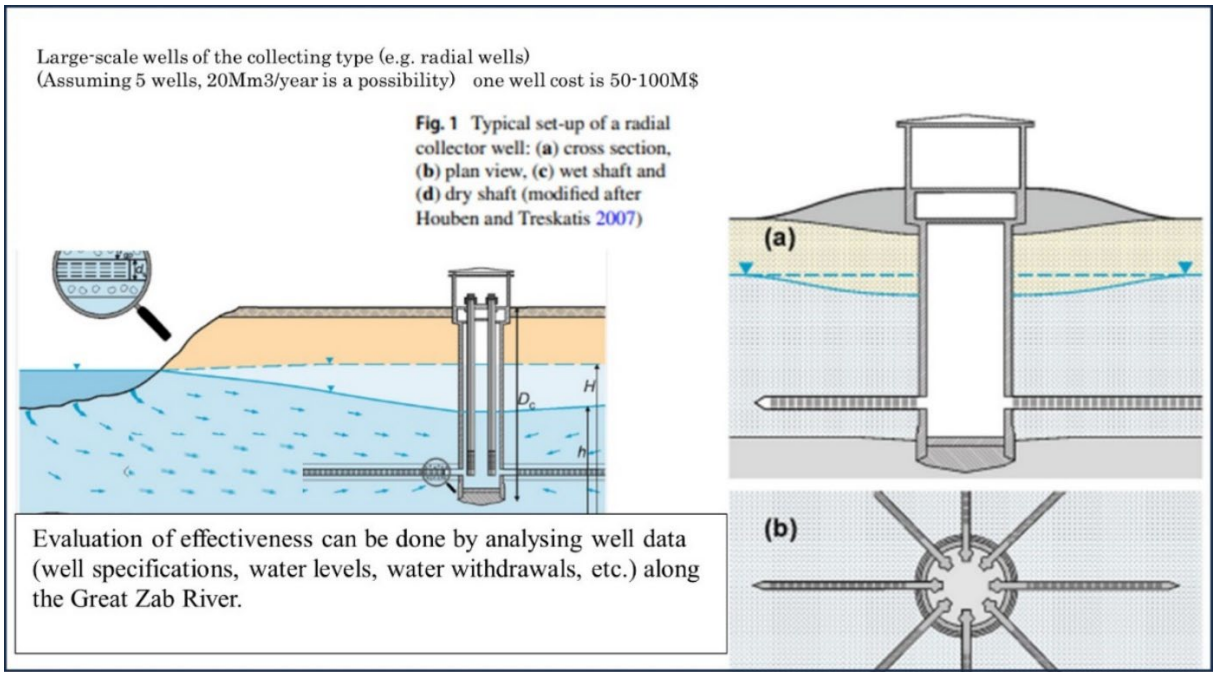
The average annual runoff of the Great Zabu River is about 400m3/sec, equivalent to 12614Mm3/year.

Typically, 20-50% of the flow is present as subsoil water (groundwater near the river). Withdrawal of 1% of this subsoil water would provide 25Mm3/year. This does not affect Erbil City's water resources and is a good quality water resource for drinking water.



Source: JICA Project Team

Figure 8.1.41 Undeveloped Groundwater (subsoil water near rivers)



Source: Compiled by JICA based on Reference[18]

Figure 8.1.42 Example of Groundwater Withdrawal Method near a River

[18] Horizontal, directionally drilled and radial collector wells Georg J. Houben1 · Sarah Collins2 · Mark Bakker3 · Thomas Dafner4 · Falk Triller5 · Anvar Kacimov6 Received: 1 April 2021 / Accepted: 4 November 2021 © The Author(s) 2022

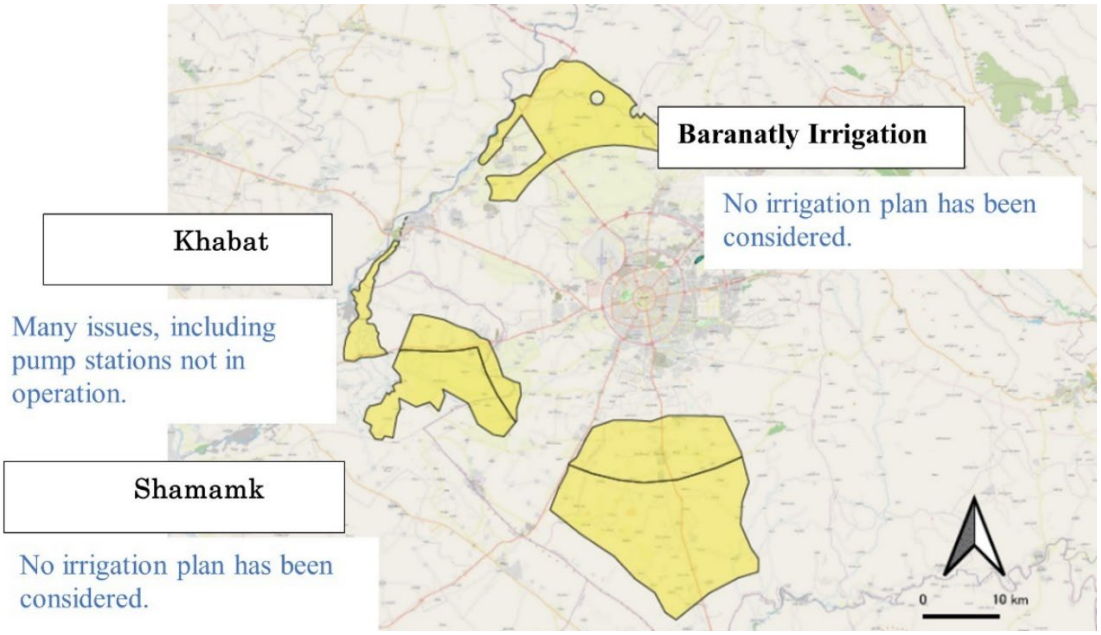
(4) Irrigation Plan for Agricultural Water

1) Basic Policy

After consultation with the MoAWR, it was decided that the use of groundwater would be a priority due to the significant drop in groundwater levels in the agricultural area.

2) Agriculture Plan

The three agricultural regions are shown again. Blue is the current status.



Source: MoAWR

Figure 8.1.43 Agriculture Plan

The following policy for each agriculture area is proposed to address these issues, based on the results of discussions with the MoAWR.

3) Baranatly Irrigation

According to the Dam List provided by GDUP, major irrigation water development is as follows

- Mandawa Dam: A plan for 108,000 donum is currently under design.
- Gomaspan Dam: Construction is underway for 14,400 donum (refer to Table 8.1.13).
- Bastora Dam: Construction is ongoing for groundwater recharge and irrigation purposes.

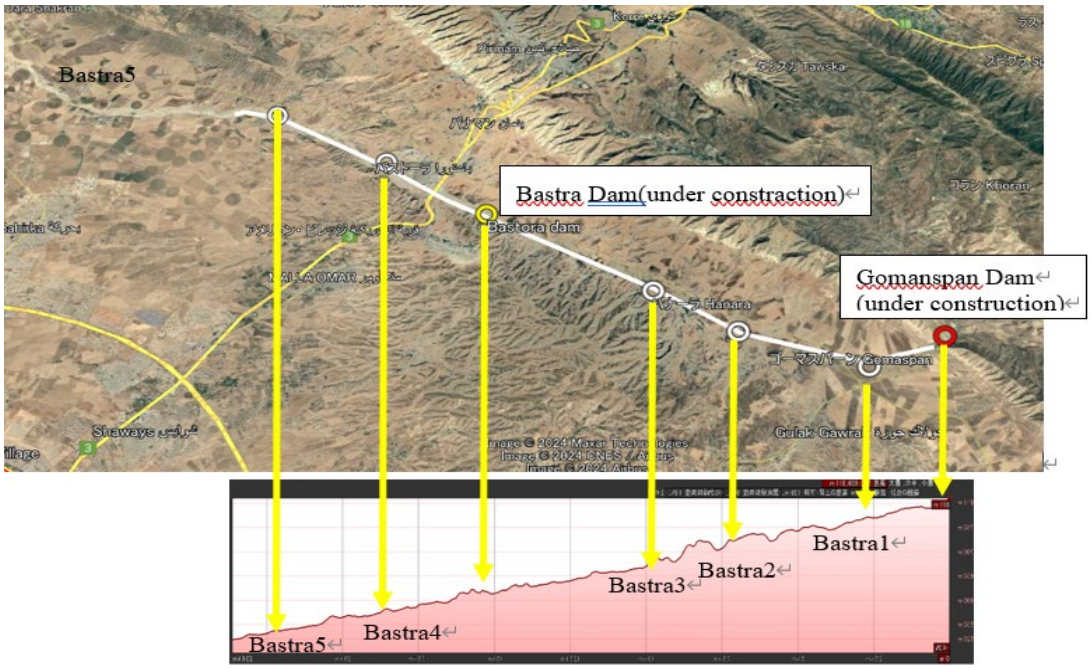
The above quantities may change in the future. The main water supply is expected to come from the Mandawa Dam, but two issues need to be addressed:

i) The water supply plan is uncertain due to the revision of the dam plan.
ii) There is a hilly area between the dam and the agricultural area, which requires the installation of a relay tank and relay pump.

Although the water supply plan for the reservoir water has not been decided yet, the design and construction plan should be started. This is considered to be the most effective irrigation plan among the three dam plans mentioned above.

At the workshop with the MoAWR, the proposal to supply water from the Great Zab River was presented. However, there is a significant altitude difference of more than 100 m between the agricultural area and the Great Zab River. Therefore, similar to the case of water supply from the Mandawa Dam, it will be necessary to install a water supply pipe, a relay tank and a relay pump. It is suggested that the irrigation design be studied taking into account the possible delay of the Mandawa Dam.

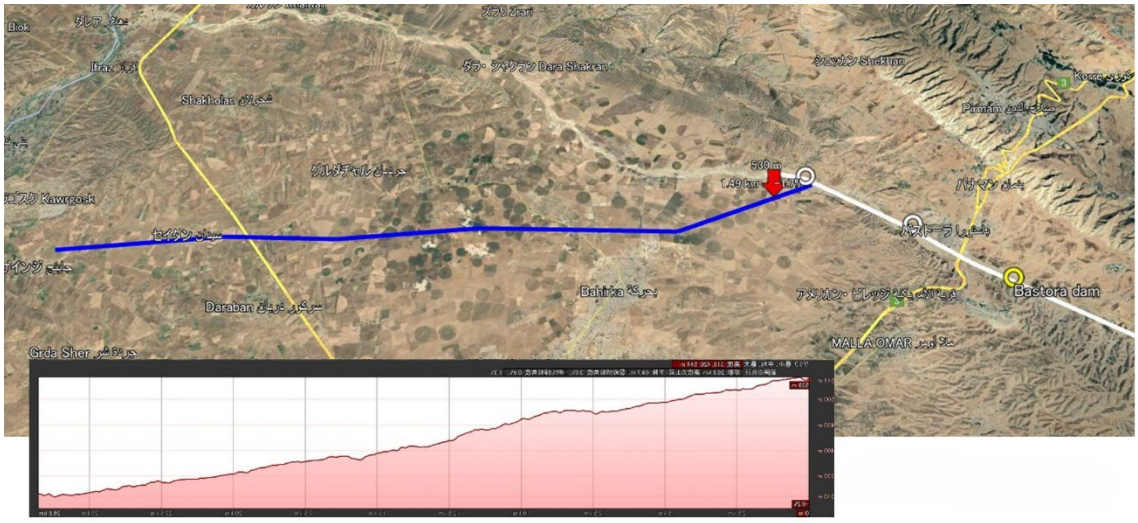
In addition, as a new proposal, it is suggested to consider a plan for water transfer from a group of dams connecting the Gomaspan Dam and the Bastra Dam. If these two dams are connected and an irrigation canal is constructed from the Bastra Dam, gravity flow irrigation would be feasible (Figure 8.1.45).



Source: JICA Project team (Dam location is provided by the Dam Directorate)

Figure 8.1.44 Irrigation System with Dam Group Linkage (Bastora Dam Group)

This proposal entails the construction of an irrigation canal that connects the Bastora Dams group. The irrigation canals can be designed to branch out from each dam and extend into the agricultural areas.

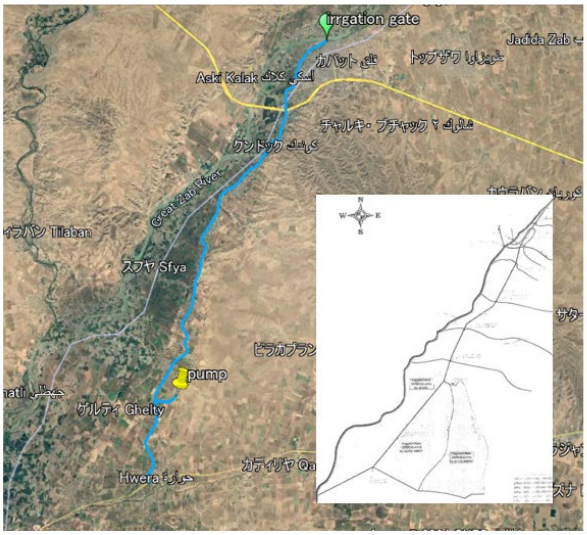


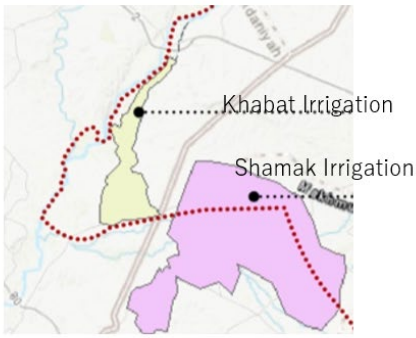
Source: JICA Project team

Figure 8.1.45 Irrigation Canal with Branches in Agricultural Areas (proposed)

4) Khabat Irrigation

Khabat irrigation water is from the Great Zab River and faces many issues. The issues related to the irrigation facilities in Khabat were explained to us by the site manager, and the site was checked together with him. These problems and other improvements are described in the "Detailed Report on Irrigation Projects in Khabat and Al-Kwir Districts". The rehabilitation of the pump and a portion of the canals is a matter of urgency. Furthermore, it is essential to implement sustainable maintenance systems, which will be presented as a priority project.

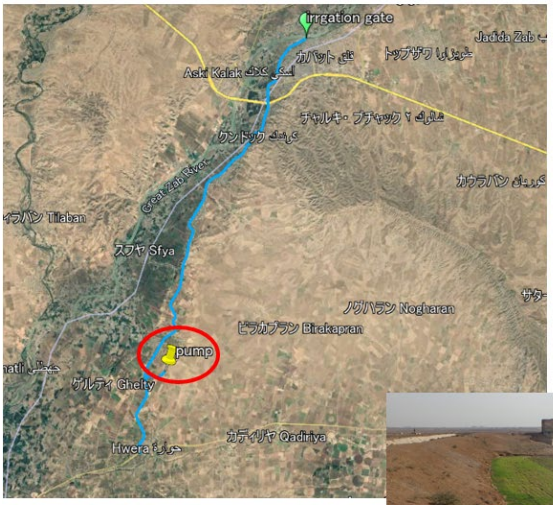




Issues

Main Issue 1:
The water intake fills with sediment during flooding. Currently, maintenance is performed each time this happens, but the labor involved is significant (interview with administrator).

Main Issue 2:
The pumping station is broken, and water is not being supplied to East area.



Khabat Irrigation

Main issue 2
The pumping station is broken, and water is not being supplied to the Shamak Irrigation area.
Proposed countermeasure1): Repair the pumping station.

Source: JICA Project Team

Figure 8.1.46 Issues with the Khabat Irrigation

5) Shamamk Irrigation

Currently, most water for agricultural use is groundwater. There are two ways to avoid relying on groundwater

i) Use water from the Great Zabu River. This method is to install a water pipeline from Khabat Irrigation to the east and then pump up the water. Since there is a difference in elevation of more than 50 m, a relay tank and a relay pump are necessary.

ii) The water collected at sewage treatment plants is reclaimed and purified, then discharged into rivers and pumped up to be used for agricultural purposes.

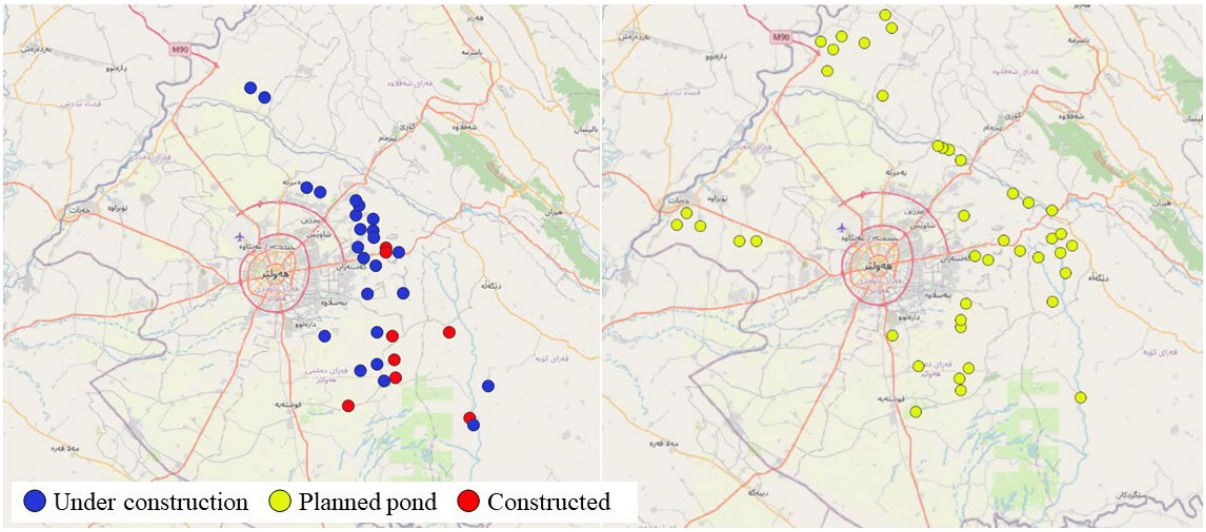
iii) The list of dams provided by GDUP shows the Kodara dam（Figure 8.1.48). A "similar small weir" would be useful. The treated water is discharged into the river and then taken up by a small pump.

Source: JICA Project team (Dam location is provided by the Dam Directorate)

Figure 8.1.47 Kodara Dam (height 6m)

(5) Ponds Plan

Many ponds have been constructed and many are under construction to provide water for agricultural lands and as flood control ponds (Figure 8.1.49 left). Plans for the construction of many more ponds have been indicated (Figure 8.1.49 right). These ponds are also effective for groundwater recharge. The policy is to proceed with construction in areas where land and budget can be secured.



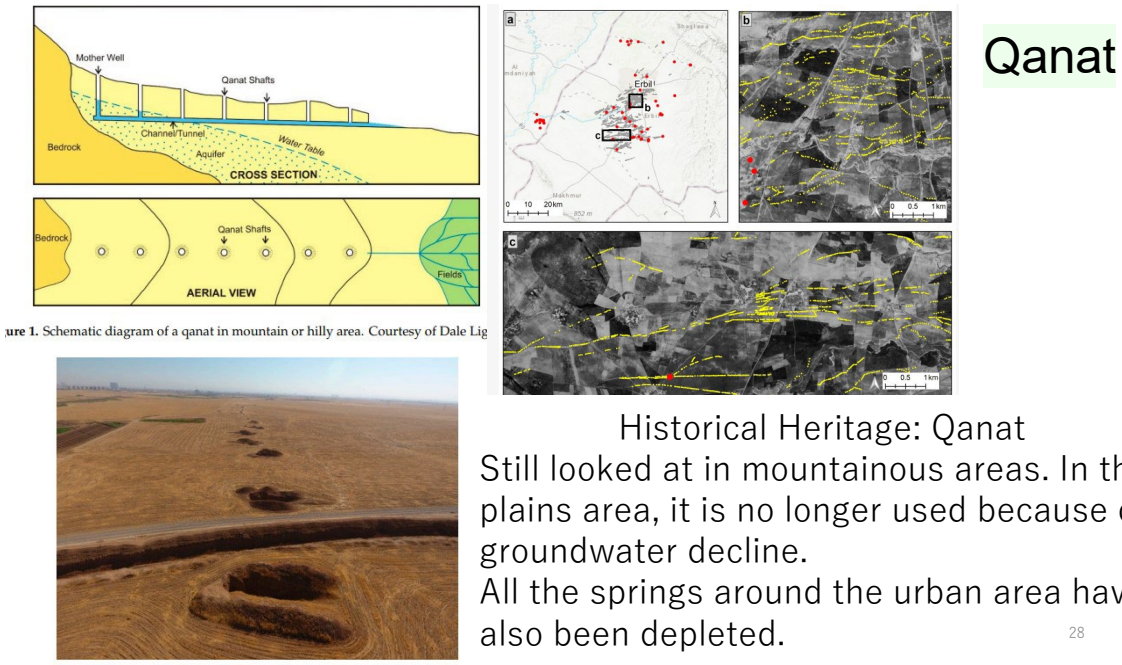
Source: MoAWR

Figure 8.1.48 Ponds Project

(6) Water-related heritage and conservation

1) Qanat

In Erbil Province, the Qanat ruins, which tell the history of water use, and the ruins of the water conduit leading to the Citadel (castle) are symbolic of the area. These sites show the great achievements of our predecessors regarding water.



Source: JICA Project Team compiled on the basis of Literature [19]

Figure 8.1.49 Qanat

[19] Deep Learning in Archaeological Remote Sensing: Automated Qanat Detection in the Kurdistan Region of Iraq; Mehrnoush Soroush, Alireza Mehrtash, Emad Khazraee, and Jason A. Ur

2) Spring

Springs near the city of Erbil were once identified as a source of clean water. However, they dried up as the water table dropped and are no longer confirmed. Currently, stable and clean spring water can only be found in the mountainous areas. Although the information about this spring in the mountainous area was not available, it is important information for evaluating the groundwater level in the mountainous area. For this reason, we propose to create a map of spring locations (including the quantity and quality of spring water). MP 2050 would like to see a water management program implementation on an entire province scale.

8.1.3 Sector Strategies & Policies

(1) Overall Goals of Water Resources & Irrigation Sector

The Overall Goals of the Water Resources & Irrigation Sector development in Erbil 2050 MP, contained in the latest policies of MoAWR and Water Resources, and which will realize the Long-term Development Visions, can be summarized as below.

- HYD-I: Ensure water security: a reliable and secure water supply for future domestic, agricultural, and industrial needs
- HYD-II: Implement sustainable practices such as water recycling and efficient agricultural water use for responsible water management
- HYD-III: Promote optimization of water distribution infrastructure, including dams and irrigation systems
- HYD-IV: Establish strategies for Climate Change adaptation
- HYD-V: Increase public awareness about water conservation and the impacts of water-related decisions through education campaigns

To implement those Overall Goals, the Water Resources & Irrigation Sector is adopting the following technical approaches.

- Assessment of groundwater balance: analysing existing monitoring data to illuminate current status and resource-related challenges
- Proposition of measures to compensate for the deficit in groundwater resources. This includes an evaluation of groundwater recharge methods and their effectiveness, an examination of the efficiency of water extraction from the Great Zab River (Mandawa Dam and Pump and Treat Station No. 4), and an assessment of water conservation practices. Ultimately, a policy for securing an adequate water resource supply for the future will be presented.

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Water Resources & Irrigation Sector mainly support the realization of the Strategic Orientations #1: Establish the foundations for urban sustainability, resilience and adaptation to climate change (see Section 5.4.1), which implements especially the Long-term Development Vision (see Section 4.2) of Water-Conscious City (WCC).

(3) Strategies & Policies of the Water Resources & Irrigation Sector

Table 8.1.14, provides a summary of the Strategies and Policies within the Water Resources and Irrigation Sector. These strategies and policies are strategically designed to address existing issues while working towards the realization of the long-term visions and overall sector goals set forth in the Erbil 2050 MP.

Table 8.1.14 Strategies & Policies of Water Resources & Irrigation Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Stable supply of water	**HYD-S1**: Identification of the groundwater structure and groundwater resources in Erbil City and to determine the current status	**HYD-S1-1:** Calculate groundwater resource quantities based on data and conduct scientific groundwater balance analysis **HYD-S1-2** : Understand the impact of climate change on groundwater levels based on historical precipitation.	**[HYD-I]** Visualize groundwater distribution, groundwater flow, and annual changes in groundwater levels to show the depletion of groundwater resources. **(See 8.1.1 (1))** **[HYD-I]** Presentation of groundwater balance considering climate change (annual changes in rainfall). **(See Figure 8.1.22)**
	HYD-S2: Create a water supply plan that limits groundwater abstraction	**HYD-S2-1**: Analysing the relationship between groundwater level fluctuations and water withdrawals to determine the appropriate amount of groundwater used. **HYD-S2-2**: Identification of actual water intakes of IFRZ- I, II, and III and planned water intakes of IV. **HYD-S2-3**: Discussion on water-saving settings suitable for Kurdistan's lifestyle.	**[HYD-I]** Develop a Water Supply Plan up to 2050 by adding water conservation, groundwater abstraction restrictions, and projected intakes from IFRAZ IV and Mandawa Dam to the existing water supply plan**. (See Figure 8.1.27)** **[HYD-Ⅳ]** Add water saving to the Water Supply Plan up to 2050. **(See Figure 8.1.27)**
	HYD-S3: Water Resources Development Plan	**HYD-S3-1**: The effectiveness of water resource development methods will be examined and development items will be narrowed down in consultation with the KRG, including groundwater recharge, dams, and conduits from the Great Zabu River.	**[HYD- I]** Estimates of the amount of each water resource that can be developed, and the effects of groundwater recharge. Indicates items for future study, such as monitoring. **(See 8.1.2 (2) & (3))**
River water development	**HYD-S4**: Sequential construction of planned dams	**HYD-S4-1**: Understanding the dam specifications and progress of the Gomaspan Dam / Bastora Dam to understand all dam projects	**[HYD-Ⅲ]** Arrange the current status of The Gomaspan Dam / Bastora Dam. Arrange the list of dam projects. **(See 8.1.2(3) 3) Dam)** **[HYD-Ⅲ]** Propose irrigation systems using dam projects such as The Gomaspan Dam / Bastora Dam. **(See 8.1.3(3) 3) Dam)**
		HYD-S4-2: Assess the progress of the dam specifications and design of the Mandawa Dam. Confirm the suitability of the modified design after checking the dam site.	**[HYD-III]** Develop a Water Supply Plan up to 2050 that assumes water abstraction from the Mandawa Dam. **(See Figure 8.1.27)**

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
	HYD-S5: Identify irrigation facility issues in each agricultural planning area and develop policies	**HYD-S5-1** : Discuss irrigation plans with THE MOAWR based on an understanding of geographical and hydrological conditions in each planned agricultural area	**[HYD-II]** Planning a draft irrigation plan for the three agricultural planning areas, its challenges, and future policy. **(See 8.1.2 (4))** For this purpose, proposing that the following should be implemented as a priority Irrigation Canal Rehabilitation Khabat Irrigation and New Construction Plan Shamamk Irrigation & Barnatiy Irrigation **(See8.1.4 (6) 1)Priority Strategic Implementation 1)**
Integrated Water Resources Development and Management	**HYD-S6:** Sustainable utilization of wide-area groundwater (including urban and agricultural areas)	**HYD-S6-1**: After understanding the actual situation of water resources management in Erbil, consult with THE MOAWR, GDUP, and others to develop a future policy.	**[HYD-I]** Planning a draft irrigation plan for the Integrated water resources management plan 【(agriculture + domestic water) & (groundwater + river water (surface water) **(See8.1.4 (6) 2)Priority Strategic Implementation 2)**

Source: JICA Project Team

8.1.4 Sector Plan

(1) Integrated water resources management plan

Priority Strategic Implementation 1: Integrated water resources management plan [(agriculture + domestic water) & (groundwater + river water (Implement [agriculture + domestic water], establish a water resources management system (industry-government-academia collaboration), legislation, an implementation plan for the legislation matter, and an establishment of water information system while strengthening the effectiveness of the new development plans listed below and conducting field surveys as necessary.

(2) New Water Resource Development See

See Table 8.1.7 Proposed Measures (Policies).

1) Groundwater Recharge

If the entire recharge area is urbanized, the groundwater recharge rate will decrease to about 1/3 due to increased runoff from 0.7 to 0.9.

Therefore, it is a prerequisite that the designated recharge areas be preserved. If this designated area becomes urbanized, the installation of artificial recharge facility construction will be promoted (Appendix: Infiltration Facilities in Urban Area).

The conservation of natural areas and the construction of ponds and dams are effective for groundwater recharge, and it is important to add groundwater recharge to multi-purpose peri-urban plans that also serve flood control and recreation. In the recharge area recommended by the committee, the PDCA cycle

should promote finding more effective methods of groundwater recharge. Of course, this process should also include the development of natural parks (green belts) that include the construction of ponds and dams.

The PDCA cycle involves constructing a dam or other groundwater recharge facility, monitoring its performance, evaluating the results, providing feedback to the committee, reviewing and implementing an improvement plan, and repeating the monitoring process.

Monitoring shall be long-term groundwater level observations using existing wells. If the wells are closed, this can be achieved by installing water level observation pipes or automatic measuring devices. At the same time, rainfall stations should be increased.

2) The Concept of an Artificial River and Lake in Erbil

The proposal has been under consideration for a long time and problems have been identified. The priority is to create an implementation design, although political and budgetary challenges to implementing the plan have been identified.

3) Dam

First of all, Table 8.1.12 The details of the planning dams - Erbil City needs to be updated and the schedule for each dam for construction (schematic design, implementation design, construction plan, construction and operation) needs to be expedited.

As for the Mandawa Dam, it is necessary to properly evaluate the adequacy of the reviewed design and make sure that it is a safe dam. Although the impermeability of the base rock was confirmed in the field, it should be noted that the strength of the spillway foundation needs to be carefully evaluated. Once the schedule for the Mandawa Dam is finalized, the water supply plan will be modified.

In conjunction with the construction of the Gomanspan and Bastora dams, we will proceed with the construction of Bastora dams 1, 2, 3, 4, and 5 to create a group of dams (dam-line) and plan for irrigation using this group of dams. This plan should be easy to set up according to the topographical conditions and farmland (crop) conditions.

4) Development of the Great Zab River and Groundwater Development around the River

<u>Establishment of the amount of water to be developed in the river</u>

A method was proposed to estimate the amount of development based solely on the flow of the Great Zab River by setting up a virtual dam. This is a simple Excel-based method that can be considered and implemented by KRG engineers. In addition, the flow observation of the Great Zab River should be changed from once a month to daily. However, this answer does not take into account downstream water use, etc.

Another problem is the lack of information on downstream water use. In order to calculate a normal flow rate that takes into account downstream water use, etc., it is necessary to understand the river ecological survey, landscape, water quality, fisheries, structures along the river (water intake locations), and groundwater use, in addition to the river channel network. Without establishing this normal flow rate, it is not possible to calculate the real amount of water intake that can be developed in the Great Zab River.

<u>Subsoil water development</u>

Subsoil water development is a common method in Japan, regardless of the size of the river. Since the amount of subsoil water in large and small Zab rivers cannot be ignored, it is worthwhile to construct one unit, even on a small scale, to verify its effectiveness.

(3) Irrigation Plan for Agricultural Water

Priority Strategy Implementation 2: "Irrigation Canal Rehabilitation (Khabat Irrigation) and New Construction Plan (Shamamk Irrigation Canal Rehabilitation (Khabat Irrigation) and New Construction Plan (Shamamk Irrigation & Barnatiy Irrigation)". This implementation should enable most of the irrigation planning in the three agricultural areas.

(4) Ponds Plan

As the shape design for almost all of the planning ponds has been completed construction will proceed in phases.

(5) Water-related heritage and conservation

1) Qanat

The method of preservation with utilization is good. The utilization includes tourism, education (environmental and historical), etc. It is suggested that a book or relief be prepared by a researcher that summarizes the scale, period of construction, characteristics, and utilization methods.

2) Spring

Organize the location map and characteristics (water quantity, water quality, and use), and propose utilization and conservation for the same as Qanat.

(6) Priority Strategic Implementation

There are two priority strategic implementation items for water resources and irrigation.

1) Priority Strategic Implementation 1

- Integrated water resources management plan【(agriculture + domestic water) & (groundwater + river water (surface water)】

Development of new water resources is a priority. However, it is necessary to determine the priority water resource development method after conducting a study of the effectiveness and method of groundwater recharge, the amount of river water intake that does not harm the river environment, and the feasibility of groundwater development along the river (large well near the river). In addition, river water and groundwater are interlinked, and water use in agricultural areas and water for domestic use in urban areas affect each other, so separate conservation is insufficient. Based on the above, it is proposed that effective and realistic water resource development methods be extracted in the process of developing an "Integrated Water Resources Management Plan".

- Main Implementation Items
  - i) Additional information collection
  - ii) Field survey (field check of soil and water environment, simple soil test, survey plan)
  - iii) Measurement of river water volume, groundwater level, and rainfall in the mountain (3 months during the rainy season)
  - iv) Water balance analysis
  - v) Identification of agricultural, industrial, and private groundwater intake volume. And calculation of groundwater resources
  - vi) Calculation of surface water resources in rivers, etc.

vii) Establishment of groundwater development areas and conservation areas.
viii) Setting of appropriate amounts of groundwater use
ix) River water development and its impact on the water environment
x) Cost-effectiveness & feasibility study of groundwater development
xi) Cost-effectiveness & feasibility study of rivers and surface water development
xii) Management of water demand (water conservation awareness)
xiii) Compilation as an integrated water resources management plan
xiv) Support for the establishment of a legal system and a strong management organization (references are listed below)

- Need for Legal System

Erbil2050 believes that the lack of a legal system and functional management organization for water resources management is a problem. Similar to Erbil, the Kumamoto region of Japan, which depends on groundwater, once had a similar problem. The following is a case study of the Kumamoto region for your reference.

i) Water situation in Kumamoto area

- Almost 100% of water resources depend on groundwater.
- Population of approximately 1 million
- Concerns about groundwater shortages and groundwater contamination due to population growth and urbanization grew in 1970.
- Starting with a fact-finding survey conducted in 1970, a system for groundwater conservation began to be established.

ii) History of Major Legal Systems

1978: Kumamoto Prefecture Groundwater Intake Ordinance
1986-1987: Groundwater Utilization Study
1988: Kumamoto Prefecture Groundwater Supply and Demand Plan
1990: 1990: Kumamoto Prefecture Groundwater Quality Preservation Ordinance
1992-1994: Kumamoto District Groundwater Comprehensive Survey
1994: 1st Kumamoto Prefecture Comprehensive Plan for Water Resources
2001: Kumamoto Prefecture Groundwater Conservation Ordinance
2008: Second Comprehensive Plan for Water Resources and Action Plan of Kumamoto Prefecture

iii) Water Management System

- Establishment of water administration divisions in prefectures and cities
- Establishment of a water management organization (Kumamoto Groundwater Foundation) that transcends administrative districts, industry, government, and academia

iv) What the government has done to ensure the continuous use of groundwater

(a) Promotion of local residents' understanding of water resource conservation and creation of a foundation for collaboration => {revision of groundwater conservation ordinances and water environment education}.
(b) Training and utilization of water policy advisors
(c) Collection and dissemination of information on groundwater and formation of research base ⇒ {revision of groundwater conservation ordinance and water environment education}
(d) Implementation of recharge measures to ensure groundwater balance
(e) Promotion of water use optimization (recharge and water conservation) with participation of all residents.
(f) Reinforcement of water environment monitoring and investigation to improve water quality.
(g) Establishment of a promotion organization and creation of a mechanism for sharing financial resources to strengthen the comprehensive groundwater conservation and management system.
(h) Entrepreneurship utilizing water resources {creation of a culture of water blessings}.
(i) Creation of a water-friendly environment.
(j) Rediscovering the attractiveness of water and creating new attractions {tourism, preservation of historical sites}.

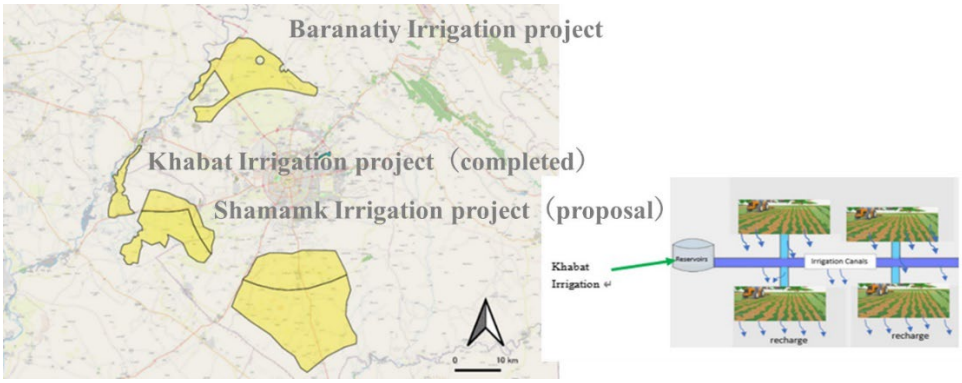
2) Priority Strategic Implementation 2

- Irrigation Canal Rehabilitation（Khabat Irrigation） and New Construction Plan （Shamamk Irrigation & Barnatiy Irrigation）

Currently, the groundwater level in the planned agricultural area is rapidly declining, and the policy is to use surface water in the future. The existing Khabat Irrigation project has many problems, especially sediment disposal at the intake from the Great Zab River, and facility damage that occurs with each flood makes maintenance difficult. The pumping facilities are also broken and not in operation.

The method of supplying agricultural water for the proposed the Baranatiy Irrigation project and the Shamamk Irrigation project has not yet been determined. Pumping up is required in these areas due to their higher elevation than the Great and Little Zab rivers. On the other hand, reservoirs and channels for waterway at the relay sites can contribute to the development of water resources such as groundwater recharge. The target agricultural areas are three locations.

- Khabat Irrigation project
- Baranatiy Irrigation project
- Shamamk Irrigation Project



Source: MoAWR and Water Resources

Figure 8.1.50 Agricultural Areas Covered by Master Plan 2050

- Main Implementation Items
  i) Information gathering (data collection, field surveys, interviews, etc.)
  ii) Repair plans for Khabat irrigation (intakes, pumps, canals)
  iii) Irrigation plan for Shamamk irrigation (pumping up 30-50m from Khabat irrigation is needed. A relay reservoir and drainage canal will be needed). Recycled treated water use plans and explanations to farmers
  iv) Irrigation plan for Baranati irrigation (close to the Great Zab River, but needs to raise the elevation up to 100 meters towards the farmland. Relay reservoirs and drainage channels will be needed). Plan of intake from Bastora Dams group.
  v) Basic irrigation design and costing in irrigating each agricultural area.

8.2 Water Supply

8.2.1 Existing Conditions

(1) Water Supply Infrastructure

1) Water source

The water source for the water supply system in Erbil municipality is surface water and groundwater.

Surface water is taken from the Great Zab River at all three existing water treatment plants (WTPs). The Great Zab River is located upstream of the Tigris River and is not affected by dam construction in Turkey and Iran, which are upstream countries of international rivers, but dams such as Bekme Dam and Mandawa Dam are being constructed within the Kurdistan Region which may affect the water flow of the Great Zab River in the future.

Groundwater sources are declining also in Erbil due to climate change and inadequate water resource management, with groundwater levels reported to have fallen by about 30-40 m over the past decade. Miscellaneous wastewater (grey water) is not recycled, and high proportion of groundwater is used for agriculture, industry and other industries in addition to water supply sources.

Table 8.2.1 Comparison of Water Resources Development in Erbil 2030 MP and Current Status

Water Resource		Situation/Proposal of Erbil 2030 MP	Situation as of 2021
Surface water	Great Zab River	Average flow: 313m^3/s、 Min/Max day flow: 118 – 2,439m^3/s、 Water quality is good	Average flow: 227m^3/s Min/Max day flow: 106 – 1,227m^3/s Water quality is good
Ground water	Boreholes	For drinking water: about 400 Pumping capacity per borehole: 240 - 480 m3/d Total pumping capacity: 68,000 m3/d About 25% of the water supply at the time	Boreholes for drinking water: approx. 4,157 Pumping capacity per well: 240 - 480 m3/d Total pumping capacity: 354,000 m3/d (12 hrs/d of operation) Agricultural boreholes: approx. 4,583 Total pumping capacity: 796,000m3/d (operated in one month per year) Industrial boreholes: approx. 164 Total pumping capacity: 3,500 m3/d (3 hrs/d operation)
Water resource develop-ment	Lesser Zab River	Average folw: 290m^3/s、 Min/Max flow: 82-1,265m^3/s No supply to the city in 2007	Flow in April 2021: 28 m^3/s
	Siwa Sur River, Naher Mazuran River	Flow rate cannot be assessed due to temporary water flow	Not suitable for water source
	Gomaspan Lake/Dam	Potential water sources. Specific capacity of water unknown.	**＜Dam under construction＞** Planned capacity: 80,800,000 m^3 Flow：2.11 m^3/s Dam type: Gravity concrete dam Construction period: 5 years Use: drinking water, electricity, irrigation, tourism
	Mandawa Lake/Dam	Potential water sources. Specific capacity of water supply unknown.	**＜Dam under construction＞** Planned capacity: 330*10^6m^3 ~ 520*10^6m^3 Flow: 300 m^3/s Dam type: Earth dam Construction period: 5 years Use: drinking water, electricity, irrigation, tourism

Water Resource		Situation/Proposal of Erbil 2030 MP	Situation as of 2021
	Bekhme Lake/Dam	Not included in the water source proposal due to the cost of water transmission and treatment	**＜Dam under construction ＞** Planned capacity: ：17*10^9 m^3 Dam type: Rock-fill dam Construction period: 6 years (25% built in 1988-1991) Use: drinking water, electricity, irrigation, tourism

Source: JICA Preliminary Survey on Erbil Urban Development Planning Project, 2021

2) Water treatment plant (WTP)

According to the Erbil Water and Sewerage Directorate (EWSD), the Erbil water supply system currently serves water to approx. 275,000 connections, 1,377,000 people and 737,500 m3/d in 2021.

The water is provided by three WTPs sourced from the Great Zab River, which flows approximately 25 km north-east of the city center, and 1,180 deep wells (average capacity of approximately 20-30 m3/h) located scattered throughout the city.

As shown in the table below, the total water production of the three WTPs is 362,000 m3/d, which does not meet the daily water demand of 737,520 m3/d. The shortfall from surface water is covered by groundwater extracted from deep wells, which contributes to declining groundwater levels.

Table 8.2.2 Table Water Supply Capacity in Erbil City

Classification	Source of river	Year built	Design Capacity	Water supply (2021)	
			(m^3 /d)	(m^3 /d)	(m^3/hr)
Surface water	WTP No.1 (Ifraz 1)	1968	38,400	36,000	1,500
	WTP No. 2 (Ifraz 2)	1983/2011	84,000	67,000	2,800
	WTP No. 3 (Ifraz 3)	2006/2015	240,000	170,000	7,000
	Subtotal		362,000	273,000	11,300
Groundwater	Deep wells (20-30 m3/h, 10-15 hours operation)			1,180 units, 464,500 (estimated)	
	Total			**737,500**	**30,700**

Source: JICA Project Team

WTP No.1 (Ifraz 1)

WTP Ifraz 1 intakes water from the Greater Zab River adjacent to the intake facility of Ifraz 2, and all facilities are built near the source. Constructed in 1968, it is the smallest of the Erbil water treatment plants, with a design capacity of 1,600m3/hr (38,400 m3/d).

There are five distribution pumps sending water from Ifraz 1 to the city, three of which are in operation. There are no drawings of Ifraz 1 available.

WTP No2 (Ifraz 2)

WTP Ifraz 2 also sourced by the Greater Zab River; in Ifraz 2, the intake and transmission pumps are located on the riverside adjacent to Ifraz 1 and treatment facilities such as clarifiers, sand filters and chlorination facility are in the town. The WTP was constructed in 1981 with a capacity of 2,000 m3/hr and expanded by 1,500 m3/hr in 2011 with KOICA support, giving it a total capacity of 3,500 m3/hr (84,000m3/d). Current water production is 2,800m3/hr (67,000m3/d).

There are six transmission pumps at the intake of Ifraz 2 and four pumps are in operation, and 5 distribution pumps at the WTP with the capacity of Q 500m3/h x H 210m.

Only hand drawings are available in Ifraz 2.

WTP No3 (Ifraz 3)

WTP Ifraz 3 is also taking water from the Great Zab River and all the facilities are located at river side.

This WTP was constructed in 2006 with the support of the US Army and expanded from 6,000 m3/hr to 10,000 m3/hr in 2015 under a JICA loan project (IQ P-11). Current water production is 7,900m3/hr (190,000 m3/d) in summer and 7,000m3/hr (170,000 m3/d) in winter (design 240,000 m3/d).

Seven water pumps (Q 2,000m3/hr x H 115m) deliver water from Ifraz 3 to the Maroda Pumping Station, about 20 km away, and from the Maroda PS to the terminal reservoir, Dawajin Terminal Reservoir (TR).

The drawings for the 2006 project are available in data, but the drawings for the 2015 expansion were not available.

Figure 8.2.1 Layout of WTPs Ifraz 1, Ifraz 2 and Ifraz 3

Outline of three WTPs are summarized in the table below.

Table 8.2.3 Outline of Three WTPs

	Ifraz 1	Ifraz 2	Ifraz 3
Completion Year	1968	1983 2011 expansion	2006 2015 expansion
Source	Great Zab River	Great Zab River	Great Zab River
Design Capacity	1,600 m3/hr, 38,400 m3/d	3,500 m3/hr, 84,000 m3/d	10,000 m3/hr, 240,000 m3/d
Intake Pump	Submersible Pump 4 units - 850m3/h x H30m Low Lift Pump 6 units - 850m3/h x H16.5m	High lift pump 6units - 720m3/h x H210m High lift pump 4units - 300m3/h x H220m	Intake low lift pump 7units - 2000m3/h x H36m
WTP			
Rapid Mixing Chamber	W3.0m x L2.85m x H2.85m x 2units	W5.60m x L3.50m x H5.88m x1unit	39sec retention time ×2units
Sedimentation Basin (Clarifier)	[Flocculation] D15m x H8.0m x 2 units [Sedimentation] D32.8m x H4.55 - 5.55m x 2 units	[Flocculation] D12m x H8.0m x 3units [Sedimentation] D38.8m x H4.55 - 5.55m x 3units	[Flocculation] 154m2 x H7.5m x 10units [Sedimentation] Sedimentation time 441min x 10units
Rapid Sand Filter	W3.0m x L4.0m x H2.15m x 28 units	W5.0m x L8.0m x 12units	W3.0m x L4.0m x H2.15m x 20unit
Clear Water Well	W30.75m x L42.77m x H3.25m x 1unit (divided into 2 compartment)	W30.75m x L42.77m x H3.25m x 1unit (divided into 2 compartment)	W15m x L31.5m x 2units
Transmission Pump	High lift pump - 426m3/h x H200m x 4 units - 300m3/h x H220m x 2 units	Saylo line pump - 690m3/h x H35m x 3 units Tayrawa line pump - 690m3/h x H30m x 3 units	High lift pump - 2000m3/h x H115m x 7 units
Transmission pipe	DN 700 DIP	DN 800 SP	DN 1500 GRP
Water Quality			
Water quality control	No laboratory Instruction from Ifraz 2 central laboratory.	Central Laboratory Analysis of raw & treated water, Jar-test, R-Cl at taps	WTP laboratory Analysis of raw & treated water, pH, turb., Cl, TDS, EC Jar-test

	Ifraz 1	Ifraz 2	Ifraz 3
Chemicals	Flocculant: Alum Disinfectant: Chlorine gas	Flocculant: Alum Disinfectant: Chlorine gas	Flocculant: Alum, polymer Disinfectant: Chlorine liquid
High turbidity	Stop intake (>3000NTU)	Stop intake (>3000NTU)	Using polymer (>100 NTU) Stop intake (>1500NTU)
O&M			
Number of staff	23 staff (also overseeing Ifraz 2 intake facility) 8 hrs x 3 shifts	20 staff 8 hrs x 3 shifts	57 staff (engineers, operators) + 1 temporary staff 24 hrs x 4 shifts
O&M process	(not interviewed)	Monitoring of flow, pressure, turbidity at Central monitoring room. Daily operation records are datamined and sent to EWSD.	Regular inspection of pumps (twice a year) Adding 10 cm filtration sand instead of replacing (every year). 20 filtration ponds are backwashed five times daily
Issues on O&M	(not interviewed)	Daily O&M is not particularly problematic, but the lack of special tools makes replacing/ repairing pumps time-consuming. Water intake is controlled when the turbidity of source is high, and water shortages become problem in summer when water demand increases.	Turbidity fluctuations in the Greater Zab River are high and can rise from 10 to 40 000 NTU after heavy rainfall. The system is shut down at turbidity levels of 1,250-1,500 NTU or higher and restarted after turbidity levels drop. Frequent breaks in the 16 Bar Φ1,500 mm x 11 km of GRP, laid in 2006, which cause water cuts lasting 2-3 days.

Source: EWSD

[Ifraz 2 WTP]

Water distribution plan for Ifraz 2

Sedimentation basin (clarifier)

Monitor in central monitoring room

[Ifraz 3 WTP]

Water source Greater Zab River

Booster pumping room

Sample of high turbidity raw water

3) Water reservoir and pumping station

As shown in the figure below, there are five service reservoirs, i.e., Dawajin, Hawlery, Kasnazan, Qala & Stadium Water Reservoirs in Erbil water supply system.

Dawajin Reservoir (74,000 m3)

Dawajin Reservoir is located in the east of Erbil city, supplied by Ifraz 3 WTP and supplying water to the east half of the city. It was constructed in 2006 with capacity of 24,000m3 and expanded in 2014 with the capacity of 50,000 m3, having total capacity of 74,000m3. The inlet pipe from Ifraz Intake is a Diameter Nominal (DN)1,500 GRP pipe (design capacity of 10,000 m³/h), the outlet pipes to Erbil city are DN 1,200 pipe (to Erbil city along the 60m Ring Road) and DN 1200 pipe (to the south of Erbil city). These distribution mains are gravity pipes which are also pressure reduced in areas of low elevations.

Hawler Reservoir (1,640 m3)

Hawler Reservoir is located in the east of Erbil city with the capacity of 1,640 m3, serving some city quarters. The reservoir is supplied by DN 700 pipe from Dawajin reservoir. The outlet pipe of DN 300 is distributing water by gravity.

Kasnazan Reservoir (5,000 m3)

Kaznazan town is located about 20km east of the city center. The Kaznazan Reservoir is located in the east of Kaznazan town center, supplying water to the town. The inlet pipes of DN 100 are from deep wells around the reservoir, and an outlet pipe of DN 200 pipe is supplying water by gravity.

Qala Tanks (1,200 m3)

There are two ground tanks of 450m3 each and one elevated tank of 300m3 at Qualat Hill constructed in 1924. These tanks are served by Ifraz 1 and Ifraz 2 distribution system and some of deep wells. These tanks are supplying the city center such as Al-Arab quarter and Al-Tajeel quarter by gravity.

Stadium Elevated Tank (1,500 m3)

Located at south of the city center, the elevated tank with the capacity of 1,500m3 were constructed in 1967. The tank was initially connected to the distribution system from Ifraz 1 and Ifraz 2, however due to insufficient pressure, it was disconnected to the distribution system, then connected to the deep well under the tank.

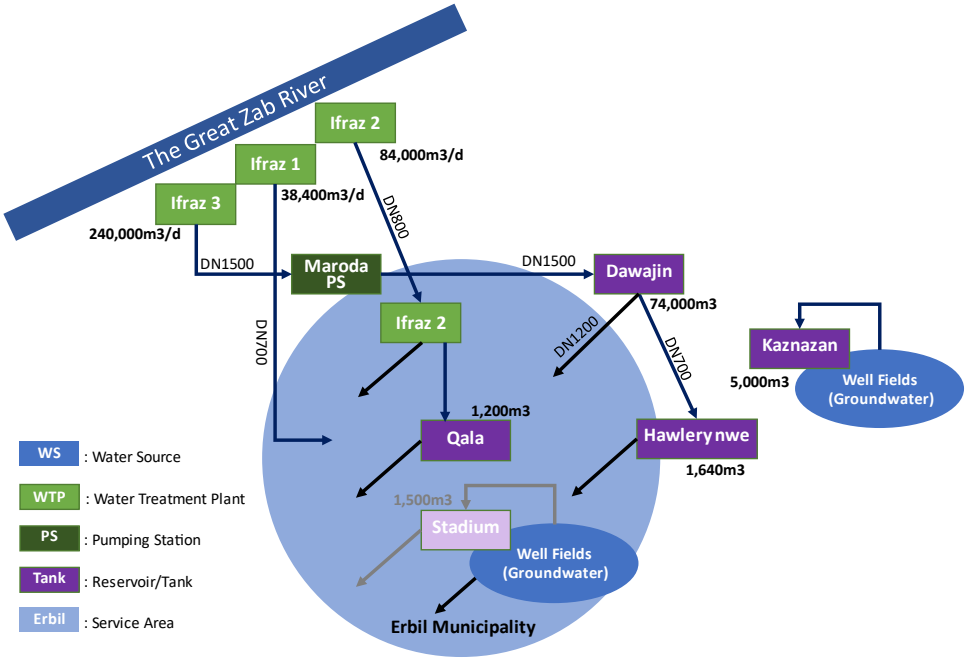


Figure 8.2.2 Concept Diagram of Water Supply System in Erbil

Other Tanks

In Erbil city, there were constructed 7 storage tanks of the capacity of 300 to 4,500 m3. Most of them are made of steel. All elevated tanks were originally connected to the distribution system, serving water to the adjacent city quarters by gravity and balancing the water supply distributions. However, during the deterioration of water supply conditions between 1980 to 2000, the distribution network lacked sufficient pressure resulting the elevated tanks left empty without filling water. AS a consequence, some reservoirs were connected to deep wells and others were disconnected, by-passed or abandoned.

The following table lists the storage tanks with a short description.

Table 8.2.4 List of Storage Tanks in Erbil

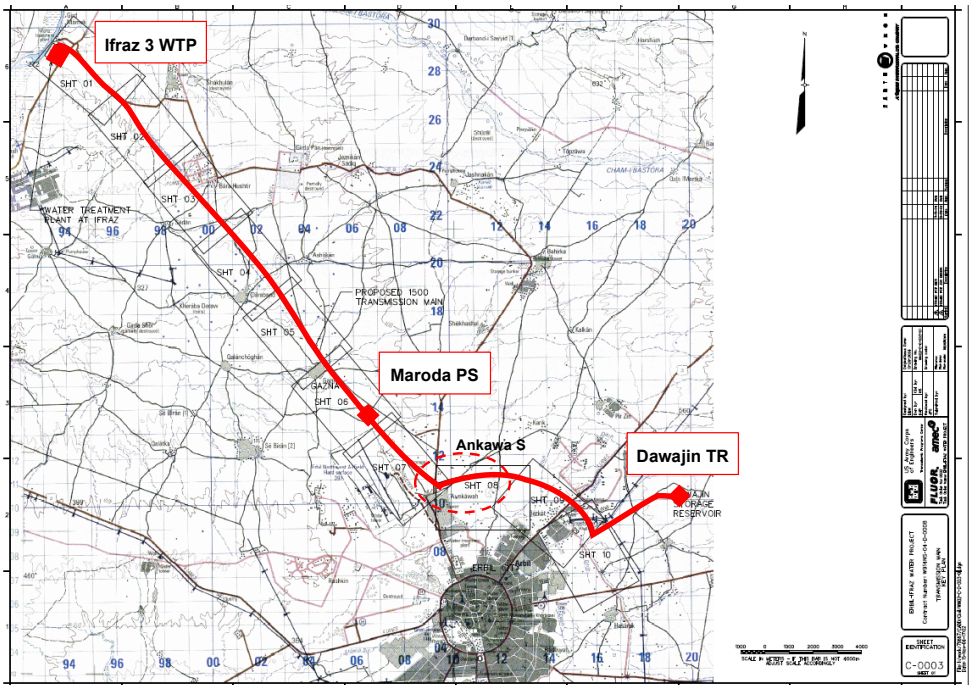
	Name	Location	Capacity (m3)	Supply from	Supply to	Elevation	Remarks
1	Al Qualla	Qualat Hill, city center	2 x 450 GT 1 x 300 ET	Ifraz 1 &2 deep wells	Al-Arab, Al-Tajeel, Al-Qualla quarters	+ 12 m 430m asl	Built in 1924 Operational
2	Stadium	Stadium city center S	1 x 1500 ET	Deep well under tank	Stadium	+ 16 m 410m asl	Built in 1967 Operational
3	Al-Mustafi	Tayrawa quarter	1 x 500 ET	Ifraz 1 &2	Al-mustawi, Tayrawa quarters	+ 15 m 410m asl	Built in 1959 Not Op.
4	Saidawa	Saidawa quarter, SW	1 x 1500 ET	Ifraz 1 &2	Saidawa quarter	+ 16 m 415m asl	Built in 1960 Not Op.
5	Setaqan	Seraqan quarter	1 x 1500 ET	Deep wells	Setaqan quater	+ 16 m 420m asl	Built in 1960 Not Op.
6	Tayrawa	Salahadin quarter	1 x 1500 ET	Ifraz project	Salahaddin quarter	+ 16.9 m 410m asl	Built in 1984 Not Op.
7	Saylo	Saylo quarter	1 x 1500 ET	Ifraz project	Saylo, Kuran quarter	+ 16.9 m 401m asl	Built in 1984 Not Op.
Total Storage Capacity			Appr. 15,000m3				

Source: : Kurdistan Region Infrastructure Water sector Master Plan Hydraulic Calculation Report, 2012

Maroda Pumping Station

Maroda PS located about 20km south of the WTP Ifraz 3 and north northwest (NNW) of the Erbil city center. From the PS, water is transferred to Dawajin TR with the total capacity of 74,000 m3. There are four high lift pumps in Maroda PS:

- Q 426 m3/h x H200 m x 3 pumps, and
- Q 300 m3/h x H 220 m x 1 pump.



Source: Ifraz3 construction drawings

Figure 8.2.3 Location of Ifraz 3 WTP, Maroda PS and Dawajin TR

4) Transmission and distribution pipe

The total length of transmission pipes from the WTPs to the distribution reservoirs or elevated tanks in Erbil city is about 120 km, while the total length of distribution pipes is approximately 3,000 km.

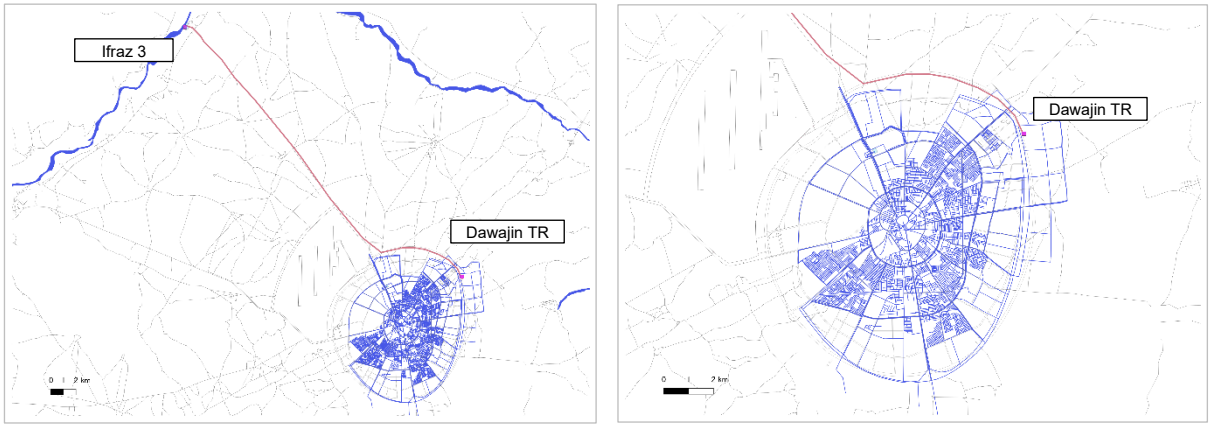
The transmission pipe from Ifraz 1 WTP to the city is 50km long of Ductile Iron Pipe (DIP) with diameter of DN 700, the transmission pipe from Ifraz 2 Intake Facility via the Ainkawa Ifraz 2 WTP to the Al Qualla water distribution tanks in the city is 27km long of Steel Pipe (SP) with diameter of DN 800, and the transmission pipe from Ifraz 3 via Maroda Pumping Station to Dawajin Terminal Reservoir is Grass Reinforced Pipe (GRP) with diameter of DN 1500, 32km long.

For existing distribution pipes, there is information on a total of 1,445 km organized in the Kurdistan Water Sector M/P in 2012 as shown in the table below, but the latest information since then was not available from EWSD. The distribution pipes installed over four to five decades ago are deteriorating and causing leaks. The information below needs to be updated as new distribution pipes were installed through KRG budget, JICA projects (IQ-P11, P28) and others.

Table 8.2.5 List of Existing Distribution Pipes (as of 2011)

Dimension	Material and Length [m]											Total Length	
	DI	n/a	CI	DIK	DN	GRP	PE	PEK	PVC	ST	STg	[m]	[%]
50		1,310										1,310	0.1
65									50			50	0.0
75		2,024					124			93,647	10,917	106,713	7.4
90								981				981	0.1
100	277,875	46,573	3,733	19					4,047	246,088		578,334	40.0
110							65,140	259,540				324,680	22.5
150	35,779								841	74,553		111,173	7.7
160							12,376	46,330				58,706	4.1
200	214			42,166	471		2		5	32,870		75,729	5.2
250	3,773			970						20,719		25,462	1.8
300	176			3,556						5,589		9,320	0.6
400	139			4,393						2,416		6,949	0.5
450										140		140	0.0
500	19,522									20		19,542	1.4
600	1,640			703						270		2,613	0.2
700	49,512			243								49,755	3.4
800	8,053			1,101						26,982		36,136	2.5
900	44											44	0.0
1000				1,193								1,193	0.1
1200	4,374											4,374	0.3
1300										30		30	0.0
1500	50					32,038						32,088	2.2
Total [m]	401,152	49,907	3,733	54,343	471	32,038	77,642	306,851	4,943	503,324	10,917	1,445,322	
Length [%]	27.8	3.5	0.3	3.8	0.0	2.2	5.4	21.2	0.3	34.8	0.8		

Source: Kurdistan Region Infrastructure Water sector Master Plan Hydraulic Calculation Report, 2012



Source: JICA Project Team

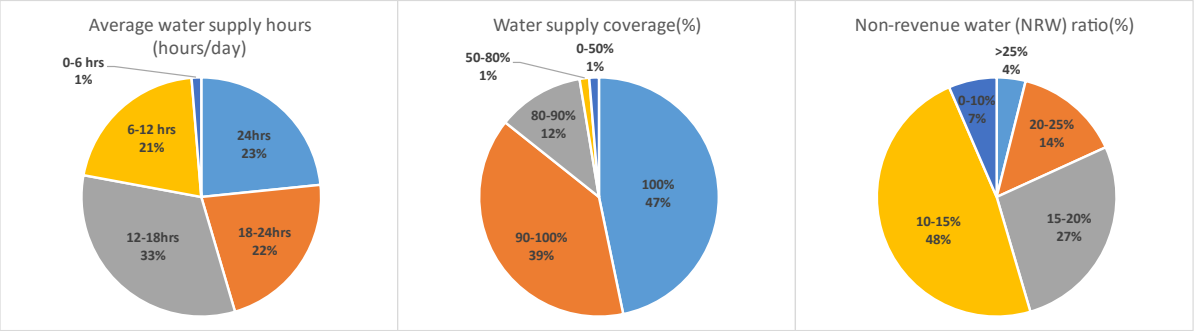
Figure 8.2.4 Existing Water Supply Network

(2) Water supply services

1) Water supply hours

According to the EWSD, water supply coverage in Erbil city exceeds 95% including water supply from groundwater, but only the city center is served by a continuous 24-hour water supply, and only about 25% of the total population in Erbil city is said to be served for more than 10 hours per day. This is due to the absolute lack of production in the WTPs, leakage and theft of water from distribution pipes and excessive consumption of water by the population. The recent break in the distribution pipe from Ifraz 3 to Dawajin terminal reservoir, which resulted in several days of water cut-off, has also contributed to the water shortage.

The JPT obtained data from the EWSD on water supply hours, water supply coverage and Non-Revenue Water (NRW) for each quarter of Erbil Municipality. The graphs are shown in the figure below. The figures are quite optimistic compared to the situation known from interviews with other organizations and existing reports. In addition, the data is area-specific information not corresponding the population.



Source: EWSD 2022

Figure 8.2.5 Water Supply Services in Erbil City

2) Non-revenue water (NRW)

According to General Directorate of Water and Sewerage (GDWS), NRW of Erbil Water Supply System is around 40-45%, while the data obtained from EWSD shows in the figure above is something 15-20%. The discrepancy can be due to the fact that NRW is calculated in different ways by each organization. Note, Kurdistan Water Sector M/P prepared by KRG in 2012 showed that the NRW ratio was 25% of water consumption and the water tariff collection ratio was 55% in Erbil city.

3) High water consumption

Per capita water consumption in Erbil city is reported to be between 375 and 400 lpcd[1], which is significantly higher than the global average of 162 lpcd for middle-income countries[2]. This excessive consumption is caused by the massive use of tap water for washing roads, gardening, car washing and cooking during Islamic festivals.

The values measured by consultants when formulating the Urban Planning Sector's Erbil 2030 MP were in excess of 700 lpcd, and the M/P proposes 400 lpcd as the average daily water consumption per person. On the other hand, the Kurdistan Water Sector M/P in 2012 defined the average water consumption as 270 lpcd and the maximum peak consumption as 375 lpcd. The Sewerage Master Plan for Erbil City in 2007 in the sewage sector also adopted 350 lpcd as the per capita daily sewage consumption. According to the latest EWSD data, water consumption per household in 2022 is 1.53 m3 per day.

(3) Financial conditions

Water tariffs in the KRG are drafted by the GDWS, proposed by the MOMT and approved by the Ministerial Council. The water tariffs are set without a time limit and are revised as necessary. The current water tariff structure was revised in April 2021, as shown in the table below.

Table 8.2.6 Water Tariff Rate of KRG in 2022

	Type of Subscribers		Monthly Usage (m^3)	Unit Cost (IQD/m^3)
1	Residential Areas	A	0 – 5.0	50
		B	5.01 – 15.0	150
		C	15.01 – 30.0	400
		D	30.01 – 60.0	600
		E	60.01 over	2,000

1 KRG Ministry of Planning & UNDP, Building the Kurdistan Region of Iraq: The Socio-Economic Infrastructures, 2012
2 World Bank, The Kurdistan Region of Iraq: Assessing the Economic and Social Impact of the Syrian Conflict and ISIS, 2015

2	Place of Worship	1	400
3	Governmental Institutions	1	400
4	Semi-governmental Sectors	1	400
5	Commercial, Industrial & Tourism	1	600
6	Shop Washing in All Kinds	1	1000

Source: EWSD 2022

Water tariffs are calculated by multiplying the amount used by the unit rate set for each type of contract. There are six categories of contracts: residential, places of worship, governmental institutions, semi-governmental sectors, commercial, industrial and tourism, and "shop washing in all kinds". "Shop washing in all kinds" includes businesses such as hotels, laundries and car washes. The residential tariffs are divided into five levels according to the amount of use, with a metered system whereby the tariff increases as the amount of use increases. However, as actual usage cannot be measured for households without water meter, households that use over 60 m3 per month are charged a fixed amount.

Levels of current water tariffs are set at very low compared to average household incomes in the Kurdish region and do not generate enough revenue to cover the O&M costs of existing facilities. Due to low tariff revenues, the water utility (EWSD) is heavily dependent on government subsidies and MOMT recognizes that its current financial situation, which relies on the budget allocated by the government, is not sustainable. Before, fees collected by MOMT were delivered to the KRG Treasury, but that system was abolished at the end of 2018, allowing the GDWS to use the fee income for maintenance and management costs.

Privatization of water and wastewater services is under consideration, and in March 2019, a financial analysis and management simulation of the case for privatization was carried out. It is expected that the management structure, including representatives, board members and organizational structure, sould then be studied in detail and a clear plan drawn up, after which privatization will be implemented with the approval of the KRG Prime Minister.

As a first step towards privatization, part of the KRG's water services, meter reading and billing, were outsourced to a private company. This has reduced the unpaid water bills (arrears) and the financial performance of the water utility is improving.

(4) Organization

Water supply in the Kurdistan Region is under the jurisdiction of the General Directorate of Water and Sewerage (GDWS) under the MOMT, while water supply services in Erbil city are provided by the Erbil Water and Sewerage Directorate (EWSD).

1) GDWS

General Directorate of Water Supply and Sewerage (GDWS) under MOMT oversees the water supply and sewerage services in the Kurdistan Region. GDWS has a total of 17 departments, including 14 water departments and 2 sewerage departments, divided into regions and facilities. There used to be three sewerage directorates in Erbil, Sulaymaniyah and Dohok governorate however, the Erbil Sewerage Directorate (ESD) was merged with the Erbil Water Directorate (EWD) in April 2021, becoming Erbil Water and Sewerage Directorate (EWSD), and staff were transferred. In 2022, the total number of GDWS staff was approximately 14,000, consisting of around 10,000 permanent staff and 4,500 temporary staff; a breakdown of each directorate was not available.

2) EWSD

Erbil Water and Sewerage Directorate (EWSD) is responsible for the planning, design, construction, operation and maintenance of water utilities in Erbil municipality. EWSD employs approximately 2,000 staff, 100 at the WTP and 700 at the deep well facilities. In 2019, the Erbil Sewerage Directorate (ESD) was integrated and transferred to the same site office.

EWSD is not independent in terms of management and finance due to its organizational structure, where

EWSD is one of directorates under GDWS and GDWS is a directorate of MOMT. In addition, as a water utility, EWSD needs to strengthen its technical and administrative capacity to operate and maintain the Erbil water supply system in an efficient and effective manner.

(5) Water sector policy and master plan

Draft water and sanitation policy (2010)

This policy was developed by GDWS and other water and sewerage sector actors as part of the UNICEF-supported project "Development of Water and Sanitation Policy for the Kurdistan Regional Government". A draft was developed in 2010 but has not been approved by the KRG Parliament.

The principal objective of the water and sanitation policy is to ensure the public health by providing minimum water supply services, preventing waterborne diseases and improving living conditions.

The policy is also intended to provide guidance to all public and private stakeholders on a) increasing access to safe water and adequate sanitation, b) management, finance and regulation of water and sanitation services, c) promoting municipal water conservation and control water pollution, d) promoting the knowledge and behavior changes of population in better use of water and sanitation facilities.

Kurdistan water sector M/P (SETEC, 2012)

"Kurdistan Water Sector M/P" was prepared as a master plan for entire water sector development in Kurdistan Region by GDWS by appointing German SETEC Engineering Co. Ltd. The M/P consists of much volume of overall Kurdistan water sector plan. Among the documents, the master plan for Erbil water supply facility is described in "*Kurdistan Region Infrastructure Water sector Master Plan Hydraulic Calculation Report WD-Erbil Horizon; 2035*" submitted in July 2012.

This master plan is based on a target year of 2035, with a planned water supply of 1.9 million people and an average water consumption of 270 lpcd. The planned water supply capacity (daily water demand) was projected by dividing Erbil city into five service areas. Daily maximum volume was calculated considering the peak factor (daily maximum/daily average) of each service area, Average peak factor is 1.39. Different hourly peak factor was applied for each service area which is shown in the table below.

Table 8.2.7 Projected Water Demand in 2035 in Kurdistan Water Sector M/P

Service Area	Population (2035)	Average Demand			Peak Day Demand			Peak Flow
		Lpcd	m^3/d	$m^3/year$	Factor	Lpcd	m^3/d	m^3/h
Kasnasan Town	32,133	270	8,676	3,166,714	1.75	472.5	15,183	1,093.2
Kasnasan	154,509	270	41,717	15,226,821	1.51	407.7	62,993	3,842.6
Pirzeen+Bahrka	490,429	270	132,416	48,331,787	1.40	378.0	185,382	10,196.0
Dawajin	616,900	270	166,563	60,795,495	1.36	367.2	226,526	11,326.3
Berkot	627,272	270	169,363	61,817,654	1.36	366.9	230,165	11,508.2
Total	**1,921,243**	—	518,735	189,338,471	—	—	**720,249**	37,966.0

Source: Kurdistan Region Infrastructure Water sector Master Plan Hydraulic Calculation Report, 2012

The future population in 2035 was estimated by following way: (a) firstly, population projections were calculated using the Kurdistan Regional Statistics Office (KRSO), using the population as of 2011 and a growth rate of 3.2%. (b) It was then assumed that the existing settlements (Mahallas) is densely populated and that only 50% of the population would be habitable to live in the future. (c) Moreover, it was estimated the population that would be able to live in new residential areas as a result of urban development. In (d), the overspill from present built-up areas (b) to be housed in new residential areas (a-b) was calculated, which is below the population in (c), so it is determined the new residential areas (c) have enough capacity to accommodate the population (d). Also (e) the projected population living in areas outside Erbil City was also taken into account, and the total (b + c + e) was calculated in (f) as has been carried out. As shown in the table below, the estimated population in 2035 is 1,946,740.

Table 8.2.8 Population Projection in 2035 in Kurdistan Water Sector M/P

	Area	Population (2011)	Population (2035)
a.	Overall population and projection with a rate of 3.2%	772,803	1,658,956
b.	Mahallas in presently built-up areas	772,803	931,208
c.	New residential areas to be developed as per M/P	0	913,152
d.	Overspill from presently built-up areas (b) to be housed in new residential areas (a-b) (Since it is smaller than the population of the new residential area (c) to be accommodated, it is OK)	0	727,748
e.	Population within the built-up area outside of Erbil town	65,035	102,380
f.	**Total Population after using combination method （b＋c＋e）**	**837,838**	**1,946,740**

Source: Kurdistan Region Infrastructure Water Sector Master Plan Hydraulic Calculation Report, 2012

Regarding the water supply sources, new WTP, Ifraz 4, with treatment capacity of 480,000m3/d is proposed to be constructed at the location of neighbouring the intake facilities of Ifraz 1,2 and 3 form the Great Zab River. Ifraz 3 was planned to be expanded to the capacity of 240,000m3/d, which was realized after the M/P under the JICA loan project. On the other hand, the old WTPs, Ifraz 1 and 2, were suggested to be closed in the future and that the deep wells will be abandoned due to low groundwater levels and deteriorating water quality or will be reserved for use as emergency water sources.

Table 8.2.9 Water Production and Demand in 2035

WTP	Constructed year	Design Capacity (m^3/d)	Capacity in 2011(m^3/d)	Future Capacity (2035)		Demand 2035 (m^3/d)
				(m^3/d)	(m^3/h)	
Ifraz 1	1968	38,000	38,000	38,000	1,600	― (closed)
Ifraz 2	1983	69,000	48,000	48,000	2,000	― (closed)
Ifraz 3	2006	240,000	144,000	240,000	10,000	240,000
Ifraz 4	Plan			480,000	20,000	480,000
Total			**230,000**	**806,000**		**720,000**

Source: Kurdistan Region Infrastructure Water sector Master Plan Hydraulic Calculation Report, 2012

The M/P proposed several measures to meet water demand in the target year 2035, including WTPs, pumping stations, distribution reservoirs, transmission pipes, distribution blocks, district metered areas (DMAs), supervisory control and data acquisition (SCADA), and upgrading and installation of distribution pipes. The distribution network was hydraulically analyzed for each distribution zone and improvements have been proposed, whereas leakage and NRW have not been considered in detail.

Table 8.2.10 Development Plan in Kurdistan Water Sector M/P

Category	Water Supply Situation in 2012	Development Plan
Intake	230,000 m3/d of water is taken at existing intake facilities Iflaz 1, 2 and 3. In addition, about 800 wells registered in the EWD and an unknown number of unofficial deep wells are also present, resulting in a dramatic decrease in the groundwater level.	Planned water supply rate in 2035 is about 720,000 m3/d Expansion of the No. 3 WTP to 10,000 m3/h Construction of a new No. 4 WTP with a capacity of 20,000 m3/h Theoretically, the above two WTPs can cover the future demand of Erbil. No.1 and No.2 WTPs will be disposed of or continue to operate as backup water sources.
WTP	Existing WTPs No.1 WTP fraz 1: 38,000m^3/d No.2 WTP fraz 2: 48,000m^3/d No.3 WTP fraz 3: 144,000m^3/d	Proposed WTPs Upgrading of the No. 3 WTP: Existing 6,000 m^3/h → 10,000 m^3/h (original design capacity) Construction of new No. 4 WTP of 20,000 m^3/d
Reservoir	Existing Distribution Reservoirs Dawajin Reservoir: 24 000 m^3 Kasnazan Reservoir: 5,000 m^3	Existing Distribution Reaervoirs Berkot Reservoir: 70,000 m^3 Dawajin New Reservoir: 50,000 m^3 (Expansion of existing reservoir) Pirzeen Reservoir: 60.000 m^3 Kasnazan Reservoir: 20.000 m^3
Pipeline	In April 2012, a problem was reported with DN1,500 GRPs bursting more frequently than expected.	Establishing the distribution zones & DMA, Introduction of SCADA, Replacement & installation of distribution networks

Source: JICA Project Team

(6) Laws and regulations

The laws and regulations applicable in the Kurdistan Region are basically the same as those of the Iraqi federal government. Many regulations are derived from the Iraqi ones, however, KRG also established its own regulations based on the Constitution. Although there are provisions in the Iraqi Constitution for the establishment of water sector organizations, the Water Law, which defines the objectives and responsibilities, is yet to be implemented in the Iraqi Federation. On the other hand, the KRG is currently in the process of preparing a water law, which awaits approval by parliament.

The laws and regulations related to water supply include the following:

Iraq constitution

Iraqi Constitution was enacted in 1921 and thereafter has been amended and updated eight times. The current Constitution, as amended on 15 October 2005, sets out a wide range of obligations for individuals or legal entities, ranging from the administrative division between central and local government to civil codes such as land acquisition. It contains many articles on water and sanitation sector.

- Article 30 provides that "the State shall guarantee social and health security".
- Article 33 guarantees the citizens' right of citizens to live in a safe and protected environment.
- Article 110 empowers federal and regional governments to enact laws to protect the environment and to develop strategies and regulations for the equitable distribution of national water resources.

Protection of rivers and public water from pollution No.25/1967

The law regulates the discharge of wastewater into public waters. Article 7 prohibits the discharge of untreated wastewater into public water bodies. Articles 8 and 9 provide for mechanisms to protect public waters from pollution by wastewater. Article 10 prohibits the illegal discharge of wastewater and sewage effluents into public waters. The law also sets out national water quality standards and wastewater quality standards.

Drinking water quality standards law No.417/1974

The law establishes the drinking water quality standards in Iraq. Compared with WHO guidelines and Japanese drinking water standards, TDS value of Iraqi standards is higher than that of WHO and Japan, which is taken into account the distribution of areas with high salinity of raw water.

Table 8.2.11 Drinking Water Standards in Iraq

Parameter	Unit	Iraqi Standard (Law No. 417/1974)	WHO Guidelines	EU Diectives	Japanese water standards
TDS	Mg/l	500-1,500	≤ 1,000		≤ 500
K	Mg/l	250			
Na	Mg/l	200	≤ 200	200	≤ 200
Ca	Mg/l	75-200			
Mg	Mg/l	50-150			
Cl	Mg/l	200-250	≤ 250	250	≤ 200
HCO_3	Mg/l	125-200			
TH	Mg/l	100-500			≤ 300
pH		6.5-8.5	6.5-8.5	6.5-9.5	5.8-8.6

Source: EWSD

Law of water conservation practices No.2/2001

The law regulates the overall use of water, including the conservation and development of the water resource environment. The Federal Government recognizes water as a fundamental resource for social and economic development. The law prohibits the discharge of wastewater into public water bodies and

encourages recycling to re-use wastewater.

KRG water law (Draft)

Whereas the above laws are Iraqi federal laws, the Water Law, drafted by the GDWS and submitted to the KRG Parliament, will be enacted as the KRG's own law. The law provides for rules governing the operation of water supply facilities, penalties and fines for illegal activities, and water tariffs. Water tariffs are based on a metered tariff system, while sewerage tariffs are set at the same rate as water tariffs. While the basic tariff, the unit price per m3 and the diameter of water pipes have already been determined, the price level of sewerage tariffs may change in the course of further discussions.

Laws on water tariff, water and sewerage projects

In addition to the above laws, the following legislations on water tariffs and water and wastewater projects have been enacted.

- Water Tariff System, Instruction No.1 of 2018 (Gazette No.225)
- First Modification for Water Tariff System, Instruction No.2 of 2021 (Gazette No. 264)
- Protection of Water and Sewerage Structures' Projects, Law No.4 of 2021 (Gazette No. 269)

(7) Existing and planned projects

JICA water supply improvement project in Kurdistan (L/A No. IQ-P11, IQ-P28) [*Completed*]

This loan project is part of JICA's post-war reconstruction assistance to Iraq and aims to improve the water supply conditions in KRG, specifically, Halabja, Sulaymaniyah, Erbil and Duhok. Phase-1 (IQ-P11) was signed in March 2009, but since then some project components have not been completed due to the lack of sufficient funding. For Erbil Municipality, the Erbil Water Supply Improvement Project included the expansion of the WTP and construction of the transmission and distribution pipeline facilities. Subsequently, some scopes needed to be changed from the original plan, including the cancellation of a part of the scopes and the addition of the replacement of the existing pipelines. The initial and revised plans for the phase-1 of the Erbil Water supply Improvement Project are summarized in the table below.

Table 8.2.12 Scope of Work of Erbil Water Supply Improvement Project (I) (IQ-P11)

Package	Original Plan	Revised Plan (as of January 2018)
1. Expansion of No.3 WTP	Production Capacity: 96,000m3/d Raw Water Pumps: 3units Mixer in Rapid Mixing Chamber Flocculator-Clarifier Rapid sand Filters Pumps Chemical Injection Facilities Standby Generator	Production Capacity: 96,000m3/d Raw Water Pumps: 3units x 2,000m3/hr Mixer in Rapid Mixing Chamber Flocculator-Clarifier: 4units Rapid sand Filters: 8units High Lift Pump: 3units x 2,000m3/hr Chemical Injection Facilities Standby Generator Intermediate Pump Station
2. Construction of Transmission and Distribution Facility	Transmission: Dia.600mm, DIP, 3.27km (Zone-I) Reservoir: 75,000m3 Pumping Stations Distribution Trunk Main: Dia.600mm, DIP, 2.1km (Zone-I) Dia.200-800mm, DIP, 12.9km (Zone-II) Dia.200-1,000mm, DIP, 10.0km (Zone-III-mid) Distribution Feeder Main: Dia.600mm, DIP, 1.5km (Zone-I) Dia.1,200mm, DIP, 4.1km (Zone-II) Dia.1,400mm, DIP, 3.0km (Zone-III-mid)	i)~iii) No change iv)~v) Distribution Network (New and Replacement) Distribution Network: Total 173.19km
3. Replacement of Distribution pipe	(Zone-II) Dia.50-75mm, HDPE, 159.25km Dia.100-150mm, PVC, 38.86km Dia.200-350mm, DIP, 17.56km	No change

Source: JICA. Assistance for Water Supply Improvement Project in Kurdistan, Final Report, 2018

The second phase of the project (IQ-P28) was signed in September 2018 with a loan agreement (L/A); financing is planned for the scope that was not completed in IQ-P11. The following scopes were planned to be implemented for Erbil.

Table 8.2.13 Scope of Work of Erbil Water Supply Improvement Project (II) (IQ-P28)

Package	Plan	Contents
No.3 WTP	Procurement of spare parts for WTP	For Intake pumps and Transmission pumps
Distribution Network	Rehabilitation of water distribution network in each district in the central area (total length: 45 km)	Mustawfi 4.1 km (Dia.125 mm HDPE) Minara2 4.5 km (Dia.125 mm HDPE) Saidawa 2 4.5 km (Dia.125 mm HDPE) Setqan 1 4.5 km (Dia.125 mm HDPE) 30m ring road 6.4 km (Dia.125 mm HDPE)

Source: JICA. Assistance for Water Supply Improvement Project in Kurdistan, Final Report, 2018

Project progress and future challenges include the following:

[WTP]

Ifraz 3 WTP was expanded under IQ-P11 and is now operating at its maximum design flow of 240,000 m3/d.

[Transmission & Distribution Pipes]

The renewal of the old distribution pipe network in the city center has been completed and will contribute to the reduction of NRW. On the other hand, for the development of the distribution network, in addition to Zone II, where the population has increased rapidly in recent years, Zones I and III (middle area) were newly included as target areas.

However, Zone I (central area), which was not scoped due to budget shortfalls, has quite old pipes (more than 100 years old) and a high leakage rate, making it urgent to install a new water distribution network.

Ifraz 4 Water treatment plant construction project (UK export finance, UKEF) [Ongoing]

The Ifraz 4 WTP and transmission pipe construction project, which is also included in the Kurdistan Water Sector M/P, involved in an MOU between the KRG and the UK Government in 2014 and a loan agreement signed by the KRG and UKEF in December 2016[3]. Subsequently, a British company Biwater was awarded the contract to develop water and wastewater facilities in Erbil and Sulaymaniyah Municipalities, and preliminary studies for the project, including social and environmental impact assessments (SEIA), field surveys and detailed design, have been carried out. However, the implementation of Ifraz 4 water project in Erbil has been suspended for a couple of years due to financial crisis hit after 2014 and disagreements over budget between Baghdad and Erbil.

According to a statement by the Chairman of the Erbil provincial council in 2021[4], the delayed Ifraz 4 water project is moving towards implementation and the water shortage problem in Erbil is expected to be solved before long. After completion of Ifraz 4, all abstraction of groundwater from wells in Erbil is planned to be stopped in order to preserve groundwater.

8.2.2 Key Planning Issues

(1) Mater plan

[Key Issue]

- Erbil 2030 MP and Water Supply M/P2012 are not harmonized.
- Water use efficiency is very low in Erbil, as evidenced by high water consumption and a high NRW.

[3] https://www.gov.uk/government/news/ukef-supports-biwater-contract-with-kurdistan-regional-government
[4] https://nrttv.com/En/detail6/546 (accessed 13/01/2022)

[Possible Solutions]

- In updating the MP, reflect the current issues and develop a realistic plan through full dialogue and consensus-building with the relevant agencies.
- Plan and implement two measures: water demand management and NRW measures.

(2) Legislation, institution and system

[Key Issue]

- The water tariff system has been flat-rate, and currently being shifted to a metered system. Although metered, the water tariffs are set low and do not lead to the prevention of water wastage.
- There is no integrated data on existing water supply facilities. There is GIS section, but both hardware and software are inadequate.

[Possible Solutions]

- Tiered tariffs with higher charges as water consumption increases, limiting water wastage.
- Capacity building of the GIS section through increased PCs and UPSs and human resource training; and development of GIS data.

(3) Infrastructure

[Key Issue]

- Leakage rate of pipeline is very high due to ageing of existing distribution pipes.
- Frequent breakdowns in transmission pipes between Ifraz 3 WTP and Dawajin Reservoir cause 2-3 days water cuts.
- Implementation of Ifraz 4 WTP project seems suspended after the DBO Contract bidding in 2016.

[Possible Solutions]

- Investigate and repair leaks and replace old pipes.
- The GRP pipes currently used is vulnerable to climatic influences and deteriorates significantly in Erbil, so the water pipes will be replaced with different DIP pipes.
- Monitor the progress of the project through the GDWS and facilitate its prompt implementation.

(4) Operation & Services

[Key Issue]

- Due to a shortage of water sources, continuous 24-hour water supply is limited to the centre of Erbil, with intermittent water supply in most areas.
- Very high turbidity of raw water exceeding the treatment capacity of WTPs restrictions on water abstraction.

[Possible Solutions]

- Urgent implementation of Ifraz 4; control of water consumption through water demand management.
- Develop a business continuity plan (BCP) to ensure that services can continue to be provided even in the event of an emergency such as high turbidity in raw water.

8.2.3 Sector Strategies & Policies

(1) Overall Goals of Water Supply Sector

The Overall Goals of the Water Supply Sector development in Erbil 2050 MP, which are outlined in Kurdistan Water Sector Master Plan (MOMT, SETEC, 2012), contained in the latest policies of Draft Water and Sanitation Policy (MOMT, 2010, under finalization) and which will realize the Long-term Development Visions, can be summarized as below.

- WSU-I: Increase the access to clean water
- WSU-II: Develop additional water sources
- WSU-III: Improve efficiency of water distribution
- WSU-IV: Decrease water consumption and water loss

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Water Supply Sector mainly support the realization of the Strategic Orientations #4: Intensify the metropolitan area through a new multi-core and fluid model and #5: Build a strong, efficient and resilient infra-structure network providing sufficient service (See Section 6.3), which implements especially the Long-term Development Visions (See Section 4.2) of Efficient Administrative Capital (EAC) and Available Serviced Land and Buildings (ASL).

(3) Strategies & Policies of Water Supply Sector

Table 8.2.1 below summarizes the Strategies & Policies of Water Supply Sector proposed to tackle existing issues and to achieve Erbil 2050 MP Long-Term Visions and Overall Sector Goals.

Table 8.2.14 Strategies & Policies of Water Supply Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Water Sources and Water Treatment Plant (WTP)	**WSU-S1**: **Construction of new WTPs** Two WTPs, Ifraz 4 (20,000m3/hr) and No.5 WTP/ Mandawa (min. 20,000m3/hr), will be constructed to ensure water production to meet future demand.	- **WSU-S1-1**: Construction of Ifraz 4 WTP - Ⓐ **WSU-S1-2**: Construction of No.5 WTP - Ⓑ **WSU-S1-3**: Construction of Mandawa WTP	- Limited water supply capacity and continuous 24-hour service (WSU-02) - [WSU-II] Develop additional water sources
Strategic Reservoir	**WSU-S2**: **Construction of strategic water reservoirs and storage tanks** Four strategic reservoirs for Ifraz water supply system for Erbil city centre and three strategic reservoirs for Mandawa water supply system for the northern development area.	- **WSU-S2-1:** Construction of four (4) strategic reservoirs for Ifraz water supply system - Ⓑ **WSU-S2-2:** Construction of three (3) strategic reservoirs for Mandawa water supply system	- Limited water supply capacity and continuous 24-hour service (WSU-02) - [WSU-III] Improve efficiency of water distribution
Transmission and distribution pipeline	**WSU-S3**: **Implementation of leakage control and Non-Revenue Water (NRW) reduction** Estimating the amount of water leakage in the existing transmission and distribution pipelines and investing to the activities to reduce the NRW.	- **WSU-S3-1:** Capacity building of water sector staff on leakage control and NRW reduction project	- Low water use efficiency evidences by high water consumption by households and high NRW (WSU-01) - [WSU-IV] Decrease water consumption and water loss

Water Tariff and Financial System	**WSU-S4**: **Reform of water tariff and financial system** Review of water tariff system and introduction of self-supporting accounting system (corporate account) to ensure the cost recovery.	- **WSU-S4-1:** Capacity building of water sector staff on financial system reform	- Low water use efficiency evidences by high water consumption by households and high NRW (WSU-01) - [WSU-III] Improve efficiency of water distribution
Water Consumption	**WSU-P1**: Policy 1 Unit water consumption for domestic use will be 330 lpcd. Water consumption will be gradually reduced to 300 lpcd by 2050. Unit waster consumption for non-domestic shall be determined based on the actual water use for different purposes.	Update the Water Sector Master Plan and conduct the water use survey to determine the actual water use for non-domestic purposes.	- Low water use efficiency evidences by high water consumption by households and high Non-Revenue Water (NRW) (WSU-01) - [WSU-III] Improve efficiency of water distribution
Continuous Water Supply	**WSU-P2**: Policy 2 Continuous supply of water, 24 hours a day, 7 days a week will be achieved.	Implement the projects for: 1) Construction of WTPs, 2) Reduction of NRW	- Limited water supply capacity and continuous 24-hour service (WSU-02) - [WSU-III] Improve efficiency of water distribution
Water Quality	**WSU-P3**: Policy 3 Water supply from WTPs shall comply with WHO drinking water quality guidelines.	Implement the projects for: 1) Construction of WTPs, 2) Upgrading of existing WTP to international standards	- Very high turbidity of raw water (WSU-03) - [WSU-I] Increase the access to clean water

Source: JICA Project Team

8.2.4 Water Supply Sector Development Plan

(1) Water Demand Projection

2) General

Water demand projection is prepared based on the population forecast prepared by JICA Project Team (See Section 4.3). The GDUP and JPT expect the projected population of the Erbil 2050 MP target area to increase up to 3 million by 2050 including IDPs. The respective population projections for the Erbil city centre and the northern development area have been described in Section 4.3.

3) Water Demand Projection

The following conditions were used to project the overall water demand for Erbil 2050MP.

Unit Demand

According to the latest information from the GDWS, which is responsible for the water supply sector in the Kurdistan Region, there is a water consumption of 1.23 m3/day per household connection, and using the JPT household survey results of 3.65 persons per household, the water consumption per person per day is 330 litres. Therefore, **the unit water demand is set at 330 lpcd in this MP**.

For reference, the Kurdistan Water Sector Master Plan (2012) sets the water supply intensity at 375 lpcd, while the Sewerage Master Plan (2007) adopted 350 lpcd.

With regard to per capita water demand, the water sector stakeholders (JCC members) agreed to gradually reduce the current 330 lpcd to 300 lpcd by 2050, in order to reduce the dependency on groundwater, which is threatened by a significant decline in water table, and to enable the development of water treatment plants through the effective use of limited investment funds. Therefore, the policy in this MP is to reduce the future water demand by 10% from the current level to 300 lpcd.

Non-Residential Demand

In Erbil, many industrial and commercial establishments have their own groundwater sources. The current water demand of non-residential use of public water services is estimated around 10% of that of residential use. In the future, the use of groundwater for industrial and commercial use will be reduced in gradual steps, and to encourage connections to the public water supply, future connection rates will be set at progressively higher. Thus, it is assumed that the amount of non-residential water demand for the industrial and commercial areas will increase from the current 10% to 15% to 20% of the total amount of residential water demand for the estimation. he percentage of non-residential wastewater discharge was reviewed by the GDWS and EWSD, and it was agreed to use the assumed percentages.

Non-Revenue Water (NRW)

With regard to the non-revenue water (NRW) ratio, no systematic survey has been carried out in Erbil so far and actual figures are not available; GDWS gives a figure of around 45%, while, based on financial losses compared to water production and income in recent years, it was estimated to be around 57%.

Meanwhile, given the water sector policy of reducing the NRW, it is assumed that this ratio will decrease in stages from 45 to 40 to 30 up to 20%. This ratio is used to calculate the required water production with the addition of estimated physical losses.

Required Water Production

Based on the above conditions, the water production requirements by 2050 are shown in the table below. From the demand projections, the required water production by 2050 is approximately 1,224,000 m3/d.

Table 8.2.15 Water Demand Projection (330 → 300 lpcd)

Item		2025	2030	2040	2050
Population		**1,982,000**	**2,200,000**	**2,620,000**	**3,009,000**
Residential	Unit Demand (lpcd)	**330**	**325**	**315**	**300**
	Daily Demand (m3)	654,100	715,000	825,300	902,700
Non-Residential	Unit Demand (%)	10%	10%	15%	20%
	Daily Demand (m3)	65,400	71,500	123,800	180,500
NRW	Ratio (%)	45%	40%	30%	20%
	Daily Demand (m3)	153,700	163,400	171,300	141,000
Required Water Production		**873,200**	**949,900**	**1,120,400**	**1,224,200**

Source: JICA Project Team

Current Water Production

The current water production is shown in the table below. In 2023, the water production of the three WTPs and 1,400 wells was a total of 649,000 m3/d. (Total of 271,000 m3/d from WTPs, with an average operating capacity of 78%, and an estimated 378,000 m3/d from wells). This is compared to the water production requirement of 873 000 m3/d in 2025 in the table above, which is expected to result in a shortfall of about 200, 000 m3/d of water.

Table 8.2.16 Current Water Production (2023)

Water Source	Design		Current Operation (2023)		
	m3/hr	m3/d	m3/hr	m3/d	%
Ifraz 1	1,600	38,400	1,200	28,800	75%
Ifraz 2	2,880	69,120	2,100	50,400	73%
Ifraz 3	10,000	240,000	7,000	168,000	70%
WTP Total	14,480	347,520	**10,300**	**246,800**	**71%**
Deep Wells	(Estimated: 1,400 x 15-20 m3/hr x 10-15 hours operation)			378,000	
Total (2023)				**624,800**	

Source: JICA Project Team

(2) Water Supply Development Plan

1) Water Service Options

The water service area based on the future land use plan of Erbil 2050 MP is shown in the figure below. Under Erbil 2050 MP, a total of 400 000 people is planned to reside in the northern development area by 2050, which will be newly developed in the area north to Erbil center. Therefore, the water service area will be established by adding this northern development area to the existing water distribution zones in the Erbil center.

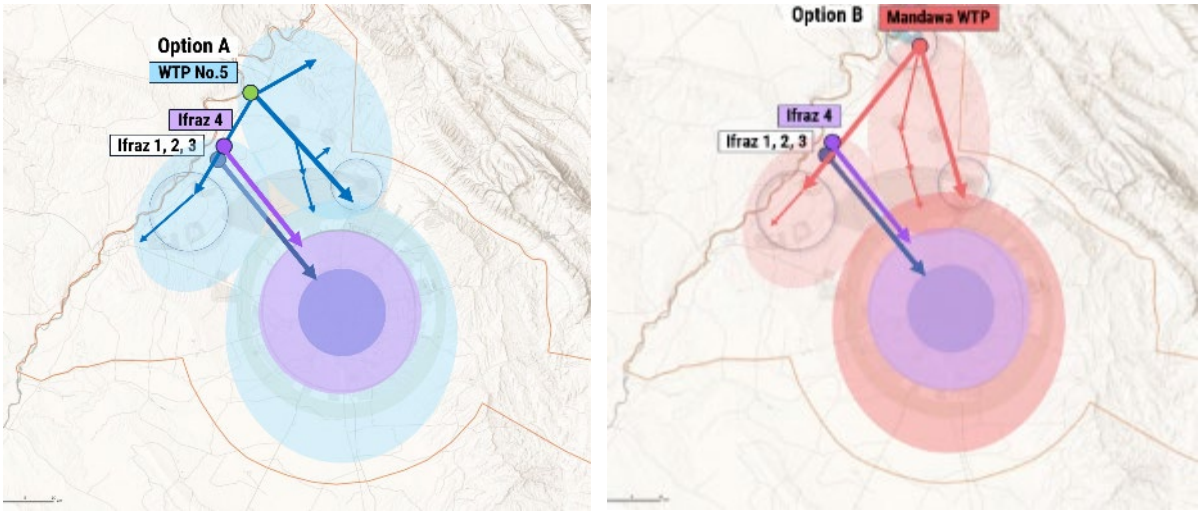
This MP will develop plans according to the case where the Mandawa Dam Project will not be realised (Option Ⓐ) and where the project will be implemented (Option Ⓑ).

Option Ⓐ : Without Mandawa Dam

Under this option, all water produced at the new planned Ifraz4 WTP would be supplied to Erbil center, in order to augment the current system that serves water from the existing WTPs Ifraz 1, 2 and 3 to Erbil centre. Meanwhile, a fifth WTP will be constructed to cover the water demands of northern new development areas and future population growth in suburb of Erbil. As there is no construction of Mandawa Dam, the WTP No.5 will be constructed near or upstream of the Ifraz WTPs to supply water to the northern development areas. As no new development area will be set up near Mandawa, there will be no need to align the transmission pipeline to the north.

Option Ⓑ : With Mandawa Dam

Under this option, a new fifth WTP would be constructed near the Mandawa Dam, assuming that the dam authority allows some of water production from Mandawa Dam to be used for drinking water. Regarding the Ifraz 4 construction and the transmission of water from there, the same as above option, in order to augment the current system of Ifraz 1, 2, and 3, all water produced at the new Ifraz4 WTP will be delivered to Erbil center. Then, in order to cover the water demands of the newly development areas in the north and future population growth, the Mandawa WTP to be constructed at Mandawa to supply water to the newly developed areas in the north and suburb of Erbil. To the northwestern development area will be also covered by the Mandawa WTP, thus the transmission pipeline will be aligned from Mandawa WTP.



Option Ⓐ　　Option Ⓑ

Source: JICA Project Team

Figure 8.2.6　　Water Service Option Ⓐ and Option Ⓑ

2) Water Treatment Plant (WTP)

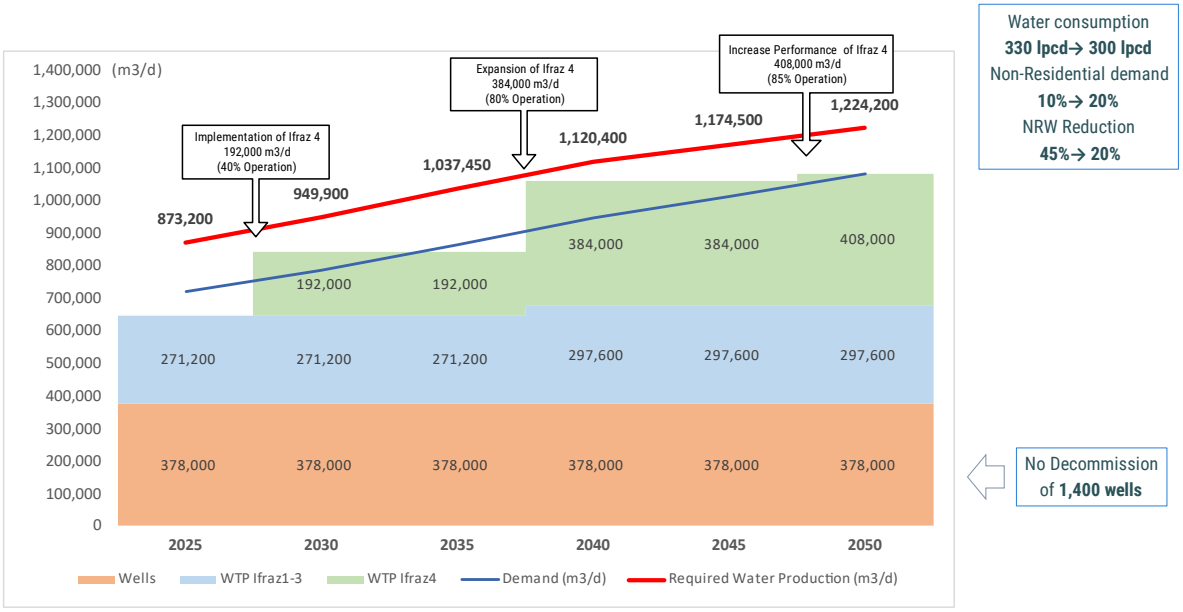
As shown in Table 8.2.2, the residential water demand in 2025 is 654,000 m3/d, and adding the non-residential water demand and NRW to this,873,000 m3/d of water production is required. On the other hand, the total maximum production of the three existing WTPs is 347,000 m3/d, which is significantly short of the water production at the WTPs. This shortfall is met from groundwater, and more than 60% of the water demand is dependent on groundwater.

Thus, there is a large gap between the overall water demand and the required water production in Erbil. In order to cover this water demand and reduce dependence on groundwater, the development of new WTPs is an urgent task. Figure 8.2.2 and Figure 8.2.3 show the WTP development plan based on a comparison of water demand and water production.

Scenario-1

In this scenario, Ifraz 4 WTP will be constructed in addition to the existing wells, Ifraz 1, 2 & 3 WTP.

The plan of Ifraz 4 WTP was carried out up to the design under UK support, which has been suspended. Under Scenario-1, the project will be restarted and the WTP is completed with 50% of the proposed water production capacity by 2030 and operates at 40% of production. Subsequently, by 2040, this WTP is expanded to 100% of the planned capacity and continues to operate at 80% of production, with plans to increase production to 85% by 2050. Meanwhile, groundwater abstraction will continue to meet the water demand, and the existing 1,400 wells will continue to be used without reducing their number.



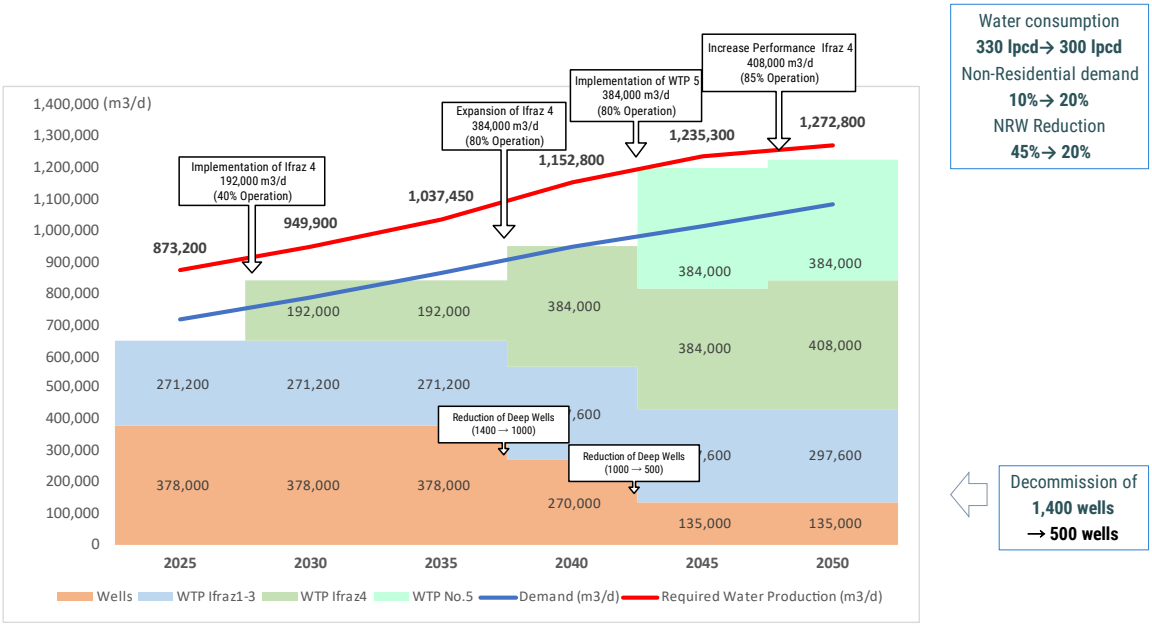
Source: JICA Project Team

Figure 8.2.7 WTP Development Plan Scenario-1

Scenario-2

In this scenario, construction of Ifraz 4 in addition to the existing WTPs Ifraz1, 2 & 3 and an additional new WTP No.5 is constructed, whilst the number of existing wells is gradually reduced as the production of the WTPs increases.

Scenario-2 involves completing 50% of the Ifraz4 WTP by 2030, with 40% production; Ifraz4 will be expanded to 100% by 2045, with 80% of its water production until 2050. In addition, a new fifth WTP with a maximum production capacity of 480,000 m3/d (20,000 m3/hr) will be constructed by 2040. This WTP No.5 shall be planned to operate at 80% of production until 2050. On the other hand, in order to reduce current groundwater dependency, the number of wells is planned to be gradually reduced from 1,400 to 500 after 2045. This scenario is preferred in terms of groundwater reservation.



Source: JICA Project Team

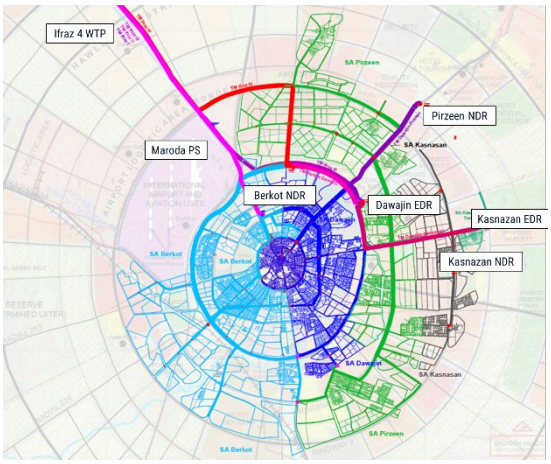
Figure 8.2.8 WTP Development Plan Scenario-2

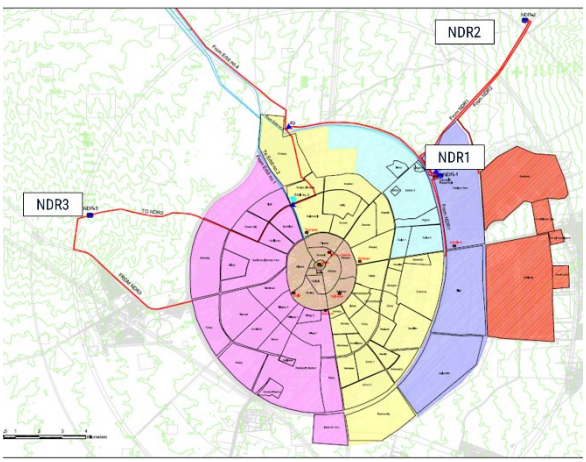
The reason for the large difference in NRW between the two scenarios is that NRW is calculated for the amount of water produced in the WTPs. As the production of the scenario with WTP No.5 is larger than the production of the scenario with 4 WTPs, the NRW is also larger. It is assumed that groundwater sources are on-site or in small systems with little or no losses.

3) Transmission and Strategic Reservoir

Transmission and distribution facilities of water supply system including transmission pipes, reservoirs, distribution pipe networks and pumping stations will be constructed based on the Kurdistan Water Sector MP in 2012 and the land use plan of Erbil 2050 MP.

Four strategic reservoirs for Ifraz water supply system for Erbil city centre and three strategic reservoirs for Mandawa water supply system for the northern development area.





Reservoir	Capacity	Status
Berkot	70,000 m3	New
Dawajin	75,000 m3	Existing
Pirzeen	60,000 m3	New
Kasnazan	20,000 m3	New
Kasnazan Town	5,000 m3	Existing

Reservoir	Capacity	Remarks
NDR 1	180,000 m3	Near Dawajin
NDR 2	100,000 m3	North East
NDR 3	20,000 m3	West

Source: Kurdistan Water Sector M/P and JICA IQ-P23 Consultant Team

Figure 8.2.9 Water Distribution Network Plans

It should be noted that the approximately 32 km of transmission pipe leading from Ifraz 3 to Dawajin reservoir via Maroda pumping station was installed during the construction of Ifraz 3 in 2006. However, it has been ruptured 30 times at different locations between 2007 and 2022, with 21 leaks in the last five years (since 2018) in particular. The majority of leaks were located near the Maroda pumping station. Repairing the leaks take 16-24 hours, and in some cases the water supply was cut off for two to three days in the water service area of Ifraz 3 WTP. Officers of EWSD is busy dealing with complaints.

The transmission pipes are made of φ1500mm Glass-fibre Reinforced Plastic (GRP) pipes with pressure resistance of 16 bar. The GRP pipes are known particularly weak at the joints, and there have been many breakages during road construction excavation.

This transmission pipe is critically important for Erbil's water supply system and is the only transmission pipe that carries water from Ifraz 3 WTP to Erbil city center. Steel pipes or ductile iron pipes should normally have been selected, but due to financial constraints, GRP pipes had to be installed during the construction period.

The GRP pipes in around 2.7 km section were replaced with carbon steel pipes in 2023 under the KRG's budget, especially where frequent leakages were occurring. The remaining sections also require urgent measures and are expected to be replaced sequentially under the KRG budget.

Source: JICA Project Team

Figure 8.2.10 Route Map and longitudinal Section of Water Transmission Pipeline

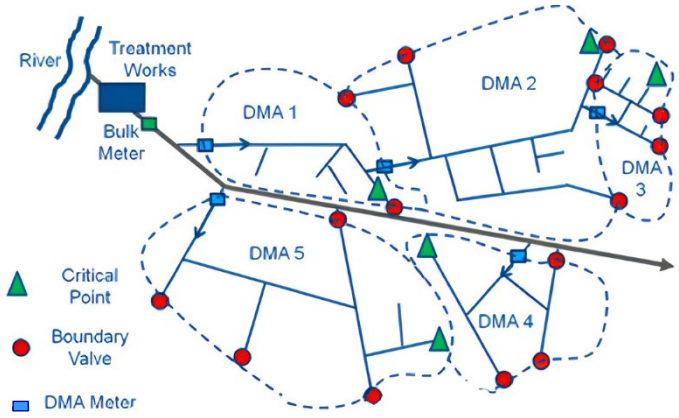
4) Distribution Management and NRW Reduction

Inadequate water supply hours and insufficient water pressure are the chronic problems of water supply in Erbil. To solve these problems, it is urgent to manage water distribution properly and to reduce NRW through leakage control. Information on the water distribution network in Erbil is currently being compiled and centralised by EWSD's GIS Section, and this data will be used to analyse the distribution pipe network and identify leakage points, enabling appropriate water distribution management planning and leakage control. Distribution management and leakage control includes the following activities:

- Centralisation of water distribution network data with topographic information
- Pipe network analysis and distribution management for the entire water supply system

- Identification of problems such as physical leakage, illegal connection, malfunction of water meter
- Formulation of distribution management improvement plan
- Formulation of leakage control (leakage detection and repair) plan
- Setting of District Metered Area (DMA) in pilot area and implementation of NRW reduction

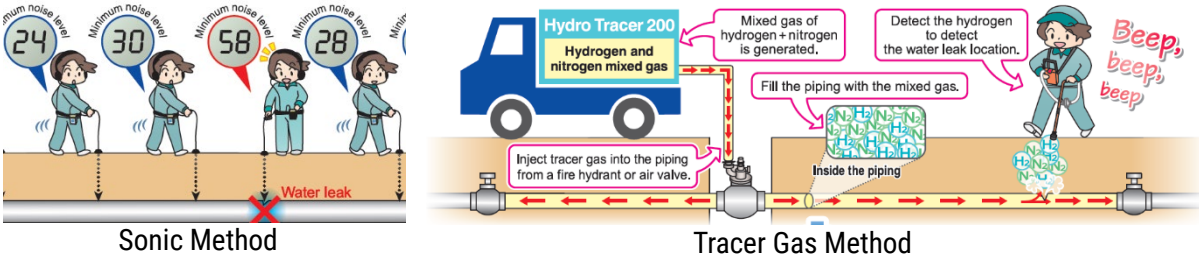
As NRW reduction measures, small pilot areas will be selected as a starting point and DMAs will be constructed in the areas. If necessary, bulk meters and DMA meters, as well as gate valves to make the DMAs fully independent, will be installed to check the water use balance in the fully closed pipeline networks. If there is a discrepancy between the water inflow into the DMA and the sum of water usage at the customer meters, this means that there is a physical loss of water within that DMA, so leaks and illegal connections shall be investigated and repaired. The following figure illustrates the concept of the DMA construction.



Source: UN-IHE, Roadmap to Non-Revenue Water Reduction/Management

Figure 8.2.11 Concept of DMA Construction

Regarding the leakage detection, in intermittent water supply situations, such as in Erbil, the distribution pipes are not always filled with water, so the leakage cannot be detected using the conventional sonic or ultrasonic methods of detection. Therefore, a leakage detection method using tracer gas, which can detect leakage points even when water is cut off, will be considered. As shown in the figure below, this technology involves feeding tracer gas (a mixture of hydrogen and nitrogen gas) into a pipe and using a hydrogen gas detector to detect the hydrogen gas leaking from the leakage point and locate the leakage point.



Source: JICA, Tegucigalpa Water Supply Data Collection Study Final Report

Figure 8.2.12 Leakage Detection Methods

5) Water Tariff and Financial System

Water tariffs need to be reviewed, because suspension of water supply service is not allowed for unpaid customers, and the unit price increases in stages as usage increases with metered charges, but is capped for usage above a certain amount. As a result, the system does not enable the collection of large amounts of water tariffs from customers who use a lot of water correspondingly.

A further improvement to the water bill payment method is to provide for payment outside of the counter. For example, introduce services such as direct debit from banks account or tie-ups with mobile phone

companies to enable payment by mobile phone credit.

Regarding the financial system, Erbil's water utility currently uses general accounting, which is not able to secure sufficient funds for the replacement of facilities through the accumulation of cost depreciation, expenditure from retained funds and borrowing corporate bonds. The accounting system is therefore reviewed and plans are in place to introduce corporate accounting in the future.

6) Water Demand Reduction

In Erbil, per capita water consumption is very high, said to be around 400 lpcd or 700 lpcd maximum, which has significant impact on the scarcity of water sources. This is influenced by lifestyle and religious customs, but the use of water-based air coolers is also a major factor of high rate of water consumption. Thus, awareness-raising activities to promote water conservation among residents shall be continued.

As a policy of the water sector in this MP, the stakeholders agreed to set the per capita water consumption at 330 lpcd in 2023, which will be gradually reduced to 300 lpcd by 2050. The following activities are recommended to reduce water consumption.

Individual Behaviour Solutions
- Turn the tap off during shaving, brushing teethes, washing dishes
- Use bucket for washing car instead of the hose
- Sweep the entrance porch and street instead of washing with the hose
- Use greywater and/or rainwater for watering the garden
- Install water saving devices and fittings to taps, shower, toilet etc.
- Install electric air cooler instead of water-based air cooler

Technical Solutions
- Reduce Non-Revenue Water (consumer water losses)
- Reuse treated wastewater to industrial or agricultural purposes

Financial / Institutional Solutions
- Improve water tariff: a) Progressive b) Differential
- Work collaborately with energy sector for water and energy efficiency

(3) Water Supply Development Action Plan

The table below summarizes the development scenarios towards 2050 describing the short-, mid- and long-term implementation plans for each of the items in the Waste Management System Improvement Plan above.

Table 8.2.17 Action Plan of Respective Terms

Theme	Short-Term (up to 2030)	Mid-Term (2040)	Long-Term (2050)
Water Service Area	- Revision and formulation of water service area and distribution zoning	- Formulation of distribution zones in line with the land use plan	- Expansion of distribution zones in line with the land use plan
WTP	- Construction of Ifraz 4 with production capacity of 240,000m3/d (50% of planned capacity)	- Expansion of Ifraz 4 with production capacity of 480,000m3/d (100% of planned capacity) - Increasing the operation performance of Ifraz 3 up to production capacity of 204,000m3/d (85% of total capacity)	- Construction of WTP no.5 with production capacity (480,000m3/d)
Transmission and Reservoir	- Installation of new transmission pipe from Ifraz 4 to Erbil Center - Construction of strategic reservoirs under Ifraz 4 project	- Construction of storage reservoirs and pumping stations to enhance the sufficient volume and pressure of water to Erbil center	- Installation of new transmission pipe from WTP No.5 to the mew northern development areas - Construction of storage reservoirs for new northern

	- Replacement of all sections of transmission pipe from Ifraz 3 to Dawajin Reservoir		development areas
Distribution Management and NRW Reduction	- Conducting network analysis of all distribution pipe - Formulation of distribution management plan - Construction of DMAs at pilot areas (pilot project) - NRW reduced to 40%	- Implementation of the distribution management plan - NRW reduction activities at pilot areas - NRW reduced to 30%	- Implementation of the distribution management plan - Expansion of NRW reduction activities to other areas - NRW reduced to 20%
Water Tariff and Financial System	- Study and analysis on the appropriate water tariff structure - Introduction of cooperate account	- Revision of water tariff structure - Implementation of corporate account	- Revision of water tariff structure
Water Demand Reduction	- Plan and implementation of awareness raising campaign and environmental education - Reduction of water consumption to 325 lpcd	- Implementation of awareness raising campaign and environmental education - Reduction of water consumption to 315 lpcd	- Implementation of awareness raising campaign and environmental education - Reduction of water consumption to 300 lpcd

Source: JICA Project Team

(4) Priority Projects

Among the above development action plans, particularly the most urgent and important short-term initiatives are proposed as priority projects. For more information, see the profiles summarised in 10.2 Proposed Sector Priority Project.

1) Erbil Water Distribution and NRW Management Capacity Development Project

The project will analyse the pipeline network of the Erbil water system and corrects the imbalance of water pressure and water quantity through the proper water distribution management. Also, the project will introduce NRW reduction measures to supplement scarce water resources by reducing physical and financial losses of supplied water. The project will be implemented in a form of capacity development project including a pilot project, in which fully independent DMAs will be constructed in the targeted plot areas, and the water supply will be monitored by bulk meters and individual house meters, and the leakage will be reduced through the leakage detection and repair of leaks in the pipelines.

2) Erbil Water Treatment Plant (WTP) Construction Project

The project aims to increase the production of drinking water in Erbil by constructing the new Ifraz 4 WTP, to improve water supply services and contribute to the future reduction of the high dependency on groundwater in Erbil. Ifraz 4 was planned and designed by KRG through an international loan, but it has been suspended at pre-construction stage, and there is no prospect of implementation being resumed. There is an urgent need to coordinate with the funding agency of Ifraz 4 and KRG to secure the fund to proceed the construction work as soon as possible, as Erbil is experiencing serious water shortages, especially in the summer months, and residents are increasingly critical of the water supply in Erbil.

3) Replacement of Transmission Pipe from Ifraz 4 to Dawajin Service Reservoir

Frequent breakages of transmission pipe that deliver water from Ifraz 3 WTP to Dawajin Reservoir via Maroda Pumping Station have occurred in recent years, more than 20 times, and the KRG has budgeted for a section (2 km) where breakages are particularly frequent to be replaced from the fragile Grass-fibre Reinforced Pipe (GRP) to the solid GIP. However, the remaining section remains with old pipes of GRP, and thus in order to reduce the risk of breakages, water is only being pumped at 80% of the planned

capacity of the booster pumps, which means that the production capacity of the WTPs is not being used fully. Therefore, the replacement of transmission pipes in all sections is required to improve the production performance of the WTP and to reduce water shortages to some extent.

8.2.5 Recommendations

(1) Revision and Updating of Water Sector Master Plan

In Erbil's water supply sector, the "Kurdistan Water Sector M/P" (SETEC), developed in 2012, sets out the direction of water supply development with 2035 as the horizon, but more than 10 years have passed and the regulations, technologies and socio-economic conditions have changed. Therefore, the existing M/P needs to be reviewed or renewed. The new M/P should include a water supply plan for the northern promotion and development area in addition to the Erbil center.

In addition, for the development of specific water supply facilities, a 10-year water supply development plan (construction plan, financial plan, operation and maintenance plan), including the installation of distribution pipes in the city and the expansion of the water supply area, should be formulated, discussed and priorities for facility development should be set and implemented in accordance with those priorities.

(2) Securing Water Sources

The urban planning sector has drawn up long-term plans for new residential developments and industrial zones, however in order to realise these plans, it is first necessary to secure an adequate water source. For the existing urban area inside the 150 m ring road, the immediate development of Water Treatment Plant 4 (Ifraz 4) should be implemented, and for the northern new development areas, the realization of Mandawa Dam and the commitment to supply water to a new water treatment plant as a source of drinking water is considered to be the most realistic.

(3) Regulation and Monitoring of Groundwater Use

Despite the KRG's commitment to groundwater conservation as a key issue, most water sources for new residential buildings and factories are groundwater, and the actual amount of water used is not yet known. The sectors of water resources, water supply, urban development, industry and environment should work together to implement groundwater conservation initiatives. To this end, it is recommended that an integrated water resources management (IWRM) platform be set up, regulations enacted and enforced, and a monitoring system developed and implemented.

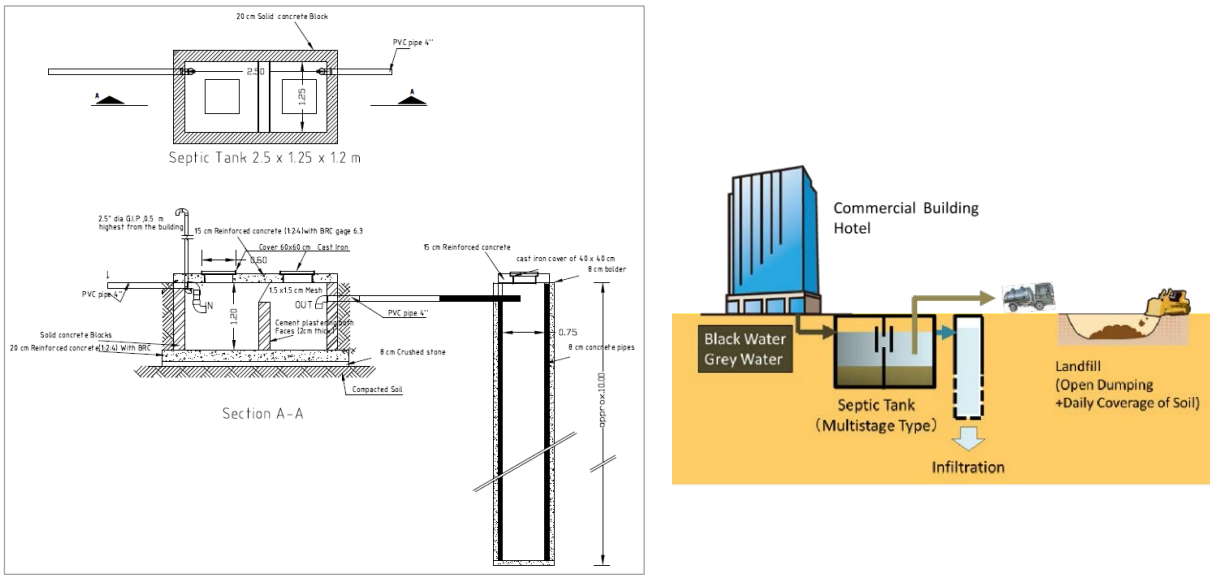
8.3 Sewerage

8.3.1 Existing Conditions

(1) Sewerage/ Sanitation Infrastructure

1) On-site treatment facility

There is no public sewerage system yet in Erbil, where sewage (black and grey water) from hotels and commercial establishments is treated in septic tanks installed on site such as garden or parking area, and the supernatant water from septic tanks is discharged into a cesspool to infiltrate deep into the ground. In households, black water seeps into the ground from the septic tank or cesspool, and grey water is discharged to the stormwater drainage.



Source: (left) EWSD, (right) JICA Preparatory Survey on Sewerage Construction Project in Kurdistan Region, 2014

Figure 8.3.1 Drawings and Illustration of On-site Treatment System

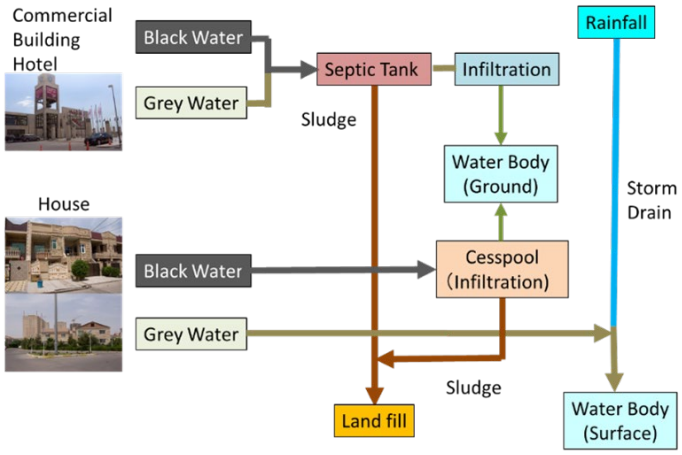
Septic tanks are rectangular structures made of concrete or layered bricks, with different capacities depending on the volume treated. Septic tank is on-site facility that essentially treats black water through an anaerobic treatment process.

Cesspools are tubular facilities with underground depth of 8-10m and 1m diameter. Conventional cesspools have gaps around the periphery, allowing black water to seep underground at the subsurface layer. Current cesspools are constructed by digging a hole 10-12m deep and stacking concrete rings 1m in diameter and 1m long one by one.

Regarding the installation of on-site treatment facilities, Erbil Municipality only grants permission for the construction of new buildings with the installation of sanitation facilities as a condition of the permit. The owner of the building is responsible for maintenance, including sludge removal. Desludging from septic tanks is undertaken by a private contractor.

2) Stormwater drainage

Rainwater is drained through about 247 km of stormwater drainage facilities into public water bodies outside the 100 m ring road. Grey water from households and commercial buildings is also discharged into stormwater drainage. Greywater mixed with stormwater discharged to public water bodies on the outskirts of Erbil is used by farmers for irrigation illegally. The current status of the stormwater and wastewater in Erbil is shown in the figure below.



Source: JICA Preparatory Survey on Sewerage Construction Project in Kurdistan Region, 2014

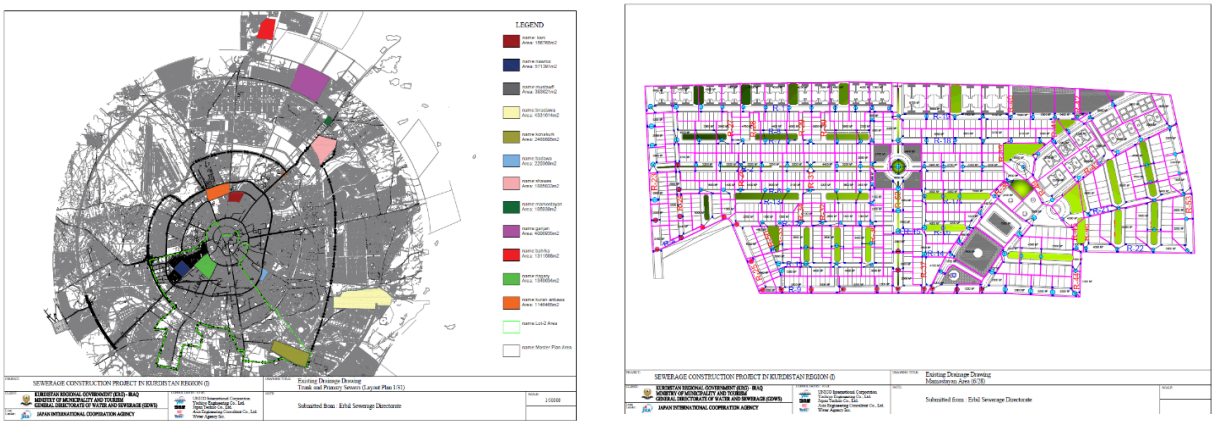
Figure 8.3.2 Basic Flow of Stormwater Drainage and On-Site Wastewater Treatment System

According to Sewerage Division of EWSD, the stormwater drainage network covers 45-50% of total area in Erbil Municipality. Not all roads have drainage system. The existing drainage network is shown below. There is existing stormwater drainage channels totally 247 km in length (about 2000 km if the irrigation channels which drain rainwater are added), 14 underground reservoirs with storage capacity of 10,000 m3 and one drainage pumping station in Erbil.

Figure 8.3.3 Existing Drainage Network

Drainage channel

Piping of drain pump station



Source: JICA Project Team

Figure 8.3.4 Existing Drainage in New Residential Areas

The drawings of the drainage pipe network of the new residential areas are well organized in rather detailed information, as shown in the figures above, since installation of drainage channels are also mandatory in the new residential areas. However, as the drawings are in CAD format, it is necessary to integrate this information with the GIS data organized in the urban development sector.

3) Sludge treatment

Since there is no sludge treatment facilities in Erbil, collected sludge from septic tanks and cesspools is either transported to landfills for disposal or illegally dumped on vacant land.

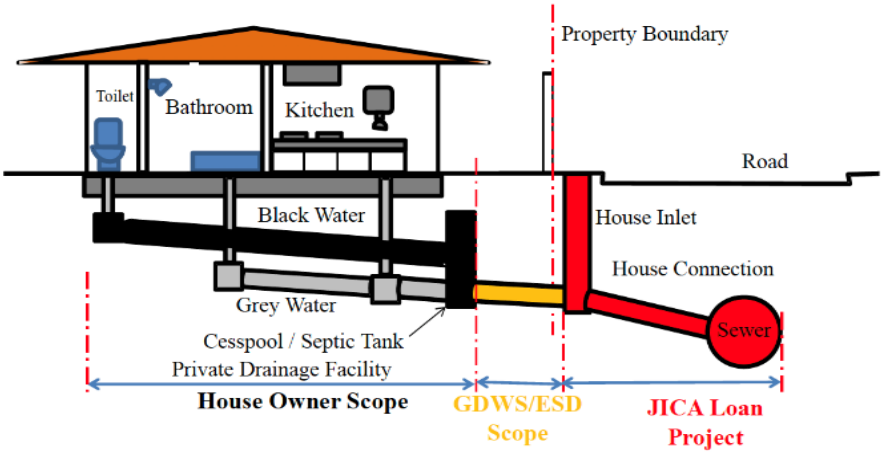
Sludge collection in Erbil Municipality is carried out by private companies on demand call-basis. There are 50-60 sludge collection vehicles in Erbil Municipality. The cost of collection and disposal ranges from IQD 25,000 to IQD 70,000 per collection, depending on the location of the house and the installation of the hose that draws it away.

The frequency of desludging depends on the condition of the soil around the cesspool and the amount of wastewater generated from individual household, and it is estimated to be once every three to six months for households.

Desludging truck and disposal of sludge

Sludge disposal site

4) Off-site facility (sewerage & WWTP)



Source: JICA. The Detailed Design Study for the Sewerage Construction Project in Kurdistan Region (I), 2017

Figure 8.3.5 House Connection of Centralized Sewer System

There are currently no centralised sewerage facilities in Erbil, although a JICA Loan project is currently under implementation, which plans to build a wide area sewerage system and wastewater treatment plant (WWTP) covering the south-western part of Erbil city. In this facility, Black and Grey Water generated by households and commercial buildings will be collected together in sewage pipes and treated in a WWTP.

There are also decentralised sewers and communal-type septic tanks that cover relatively small areas, rather than large, centralized sewerage treatment plants as planned in the JICA project. In decentralized systems the sewers are called "small bore sewers", "effluent drains" or "simplified sewers ", etc., and are often designed with a small pipe bore and shallow burial depth which collect treated water (supernatant) of septic tanks and grey water.

(2) Financial situation

Although sewerage tariffs have not yet been imposed, sludge withdrawal fees are collected directly from residents by private desludging companies. Upon completion of the sewerage infrastructure, sewerage tariffs will be set at 100% of the water tariff, in line with Iraqi federal regulations. EWSD has directly implemented sewerage and drainage works, but at present only discharges grey water into stormwater drainage channels. As EWSD does not levy sewerage/drainage charges at present, the costs of these sewerage and drainage works are covered by government subsidies.

In April 2021, the GDWS was restructured and the ESD was merged with the EWD to form the EWSD. This is expected to facilitate the collection and management of water and wastewater tariffs and improve financial management of water and wastewater services. On the other hand, this organizational reform has resulted in a reduction of staff in the Sewerage sector, leaving the Sewerage Division of the EWSD understaffed.

(3) Organization

Sewerage and drainage in the Kurdistan Region are governed by the General Directorate of Water and Sewerage (GDWS) under the MOMT, while sewerage and drainage in Erbil City is the responsibility of the Erbil Water and Sewerage Directorate (EWSD).

Previously, the sewerage sector in Erbil functioned as the Erbil Sewerage Directorate (ESD) under the GDWS, but in April 2021 there was a restructuring of the GDWS and the ESD merged with the EWD to form the new EWSD. As a result of this, some functions of the ESD were absorbed into the EWD, there was a reduction in staffing and the ESD is suffering from severe staff shortages.

(4) Existing wastewater policy and plan

Sewerage master plan for Erbil City (Vössing, 2007)

The Sewerage Master Plan for Erbil City was prepared by the German consultant Vössing between 2005 and 2007, at about the same time as the Erbil 2030 MP in the urban planning sector. The master plan proposes, based on a separate sewerage system for domestic wastewater and rainwater, one WWTP and a total of 2,190 km of sewers in the city,

This master plan targets year 2035, assuming a population growth rate of 3.5% from the base year (2005) and a sewerage service population of 2.4 million in 2035. The basic design criteria are based on a unit flow rate (water use) of 350 lpcd, a sewerage connection rate of 90% and industrial wastewater as 10% of domestic wastewater. For peak flow rates, the peak hour factor for domestic wastewater is 1.5 and that for industrial wastewater is 1.0. HDPE (high-density polyethylene) is the recommended material for sewer pipes with a diameter of 500 mm or smaller, and GRP (glass fibre reinforced plastic) for pipes with a diameter of 600 mm or larger.

The following basic principles of sewerage development are proposed in the MP.

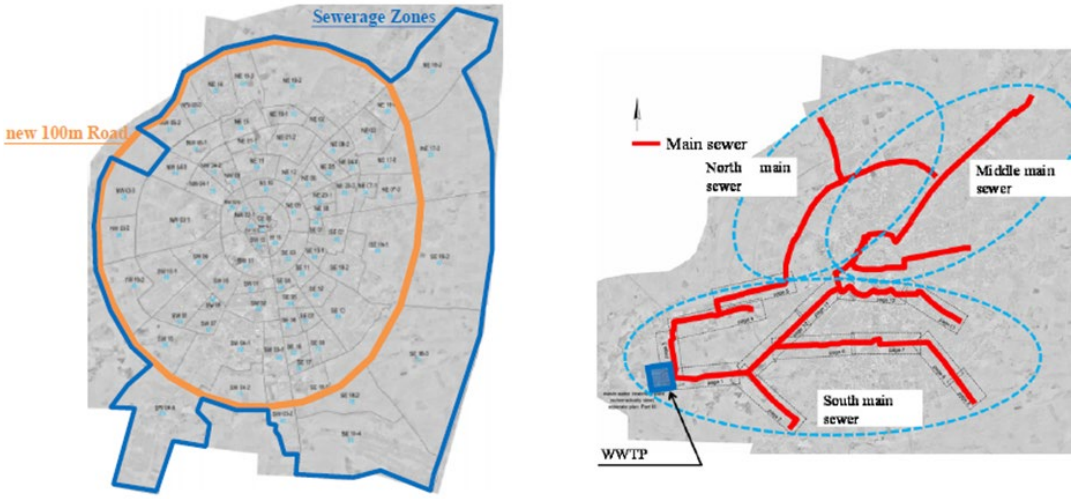
- Sewerage development will be implemented in steps in several phases.
- Phase 1 is to construct a WWTP with a capacity of 210,000 m3/d, equivalent to 25% of the total sewerage system, with a design target population of 600,000.
- Following the completion of Phase 1, the final design WWTP with a capacity of 840,000 m3/d of sewerage system will be constructed in several phases.
- The first priority areas are identified as Nawroz and Nishtiman areas in the south-west of Erbil city, where groundwater pollution is most severe, and will be targeted for sewerage construction in the Phase 1 project.
- The sewerage service areas will be expanded in all areas in counterclockwise order from east to north, starting from the first priority area mentioned above.

Table 8.3.1 shows the basic items of the overall and first phase plans, and Figure *** shows the sewerage zones and trunk sewers in the basic plan.

Table 8.3.1 Summary of Overall Plan and Phase-1 Plan in Erbil Sewerage M/P

Item	Unit	Phase-1 (target year 2007)	Overall Plan (target year 2035)
Project Area		Southwest of Erbil	Whole Erbil
Design Population	Person	600,000	2,400,000
Wastewater Collection Method	—	Separate system	Separate system
Design Daily Msx. Sewage Flow	m^3/d	210,000	840,000
WWTP	place	1	1
Trunk Sewer (1,200-2,400mm)	km	81	81
Primary Sewer (400-1,000mm)	km	78	89
Secondary Sewer (200-350mm)	km	1,020	2,020

Source: : JICA, Preparatory Survey on Sewerage Construction Project in Kurdistan Region, 2014



Source: JICA, Preparatory Survey on Sewerage Construction Project in Kurdistan Region, 2014

Figure 8.3.6 Sewerage Zones in Overall Plan and Layout of Main Sewers

(5) Laws and regulations

There is very limited legislation on wastewater and drainage management in Iraq and the Kurdistan Region. Law No. 25/1967 on Protection of Rivers and Public Water from Pollution and Law No. 2/2001 on the Water Conservation Practices are relevant to sewerage and drainage. In addition, a draft Sewerage Act is being prepared for the operation of the sewerage system to be constructed in Erbil under IQ-P23.

Protection of rivers and public water from pollution No.25/1967

National environmental water quality standards, standards for discharge into public waters and standards for discharge into the sewerage system are stipulated. Particularly, the standards for discharges to sewerage systems are stipulated in accordance with the Japanese standards. On the other hand, the standards for discharge into water bodies for public use, the Iraqi SS and BOD5 values, are more lenient than the Japanese and EU directives.

Law of water conservation practices No.2/2001

The law underlines the importance of preserving water resources in environmentally, economically and socially appropriate manner. It also prohibits the discharge of wastewater into public water bodies and encourages the reuse of wastewater. Article 5 stipulates that the National and Provincial Environmental Councils (NPECs) have the power to regulate the quality of wastewater discharged to public water bodies, sewers and stormwater.

(6) Existing and planned projects

JICA sewerage construction project in Kurdistan region (I) (L/A No. IQ-P23) [*Ongoing*]

The project is a JICA loan project for the construction of sewerage works and WWTP in the south-west of Erbil city in line with the Sewerage Master Plan for Erbil City. The L/A was signed in June 2015 and the detailed design survey was carried out between 2015 and 2017. However, the tender for the contractor selection was unsuccessful, and tender drawings and specifications have been reviewed and the project was re-tendered in 2021.

The project targets the priority areas of the Sewerage Master Plan, particularly the Nauros and Nishtman quarters, where sanitation conditions are very poor. In addition, pilot areas for pipe work (secondary sewerage and connection pipe work) will be set up in these two regions with the aim of transferring technology to local counterparts.

As shown in the Table 8.3.2 below, the design sewage flow rate, which determines the size of the sewerage works, was compared with the planned water supply and sewage flows in previous M/Ps. The design flow rate of 840,000 m3/d as set out in the Erbil Sewerage M/P was adopted as the long-term sewerage development planning for this project.

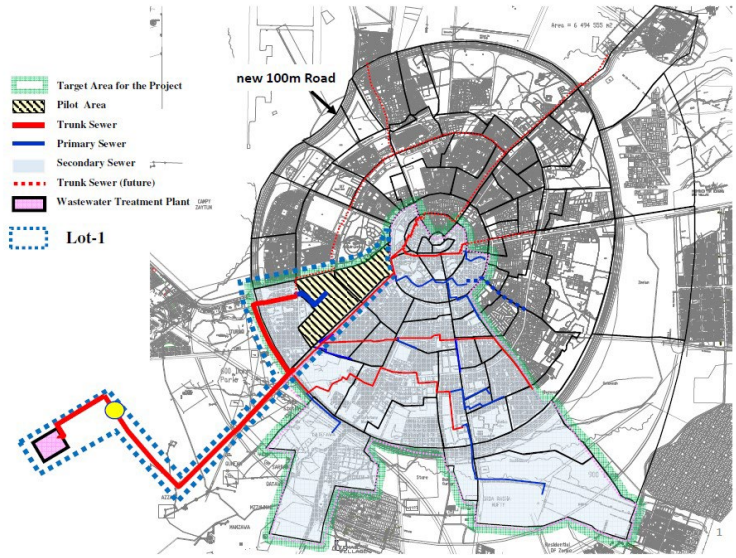
Table 8.3.2 Water Demand and Design Wastewater Flow in Existing M/Ps

Existing M/P	Target Year	Design Flow at Target Year	Remarks
Kurdistan Water Sector M/P	2035	720,000	Water demand
Erbil 2030 MP	2030	823,720	Design wastewater flow
Erbil Sewerage M/P	2035	840,000	Deign wastewater flow

Source: JICA Preparatory Survey on Sewerage Construction Project in Kurdistan Region, 2014

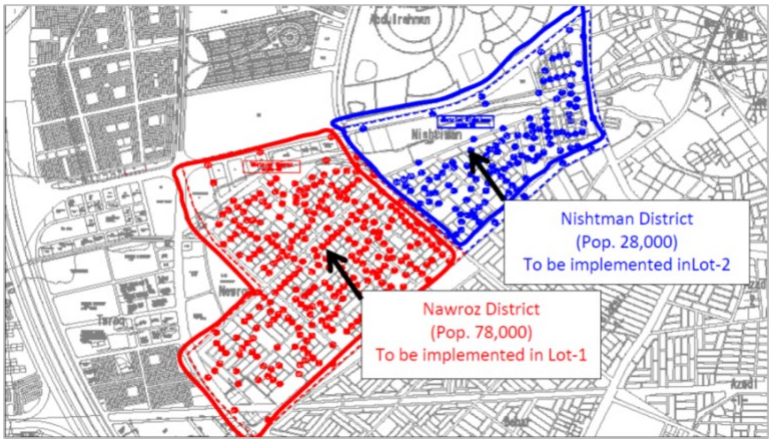
The following maps show the target areas where sewerage system is planned to be constructed in the project and the areas where connection works are planned to be carried out under the pilot project.

The south-west area of the city will be served by sewerage system through the project, but the remaining areas need comprehensive wastewater management to ensure that the existing on-site treatment facilities are operated properly and to improve sanitation in the city.



Source: JICA. The Detailed Design Study for the Sewerage Construction

Figure 8.3.7 Project in Kurdistan Region (I), 2017 Target Area of Sewerage Construction Project in Kurdistan Region (I)



Source: JICA. The Detailed Design Study for the Sewerage Construction Project in Kurdistan Region (I), 2017

Figure 8.3.8 Map of Lot-1 and Lot-2 Sewer Pipe Installation in the Pilot Area

8.3.2 Issues to be tackled

(1) Mater plan

[Key Issue]

- Erbil 2030 MP and Sewerage M/P2012 are not harmonized.
- There are clear plans for sewerage development, but measures for wastewater management in areas with no sewerage system in place are undefined.

[Possible Solutions]

- In updating the MP, develop a realistic plan through full dialogue and consensus-building with the relevant agencies.
- Develop and implement city-wide inclusive sanitation (CWIS) programme.

(2) Legislation, institution and system

[Key Issue]

- The installation of sewage treatment facilities is a condition for construction permits for new buildings, but there is no monitoring system in place to ensure compliance.
- Information on existing drainage facilities is not organized and data is difficult to obtain.

[Possible Solutions]

- Co-ordinate with relevant environmental departments to strengthen monitoring and regulations.
- Organize and list information on existing drainage facilities and centralize it in GIS data.

(3) Infrastructure

[Key Issue]

- Due to inadequate sewage treatment and sanitation facilities, foul odours can be detected in the city.
- Sludge from existing sanitation facilities is dumped on vacant land due to lack of treatment facilities.
- Stormwater drainage facilities only cover 20% of Erbil city.

[Possible Solutions]

- Improve the performance of existing facilities, including cleaning and updating existing sanitation facilities, rehabilitating drainage channels and planning for regular sludge withdrawal.
- Plan sludge treatment facilities.
- Assess the current status of stormwater drainage facilities and develop an improvement plan.

(4) Operation & services

[Key Issue]

- ESD, the directorate responsible for sewerage in Erbil before, merged with EWD in 2021 to be ESWD. This has led to redundancies and the sewerage department is understaffed.
- A sewerage tariff structure needs to be developed as sewerage system and WWTP are constructed.

[Possible Solutions]

- transfer of skills from experienced staff.
- Study on the sewerage tariff structure.

8.3.3 Sector Strategies & Policies

(1) Overall Goals of Sewerage Sector

The Overall Goals of the Sewerage Sector development in Erbil 2050 MP, which are outlined in Sewerage Master Plan for Erbil City (MOMT, Vössing, 2007), contained in the latest policies of Draft Water and Sanitation Policy (MOMT, 2010, under finalization) and which will realize the Long-term Development Visions, can be summarized as below.

- WWT-I: Upgrade living environment with appropriate sewerage system and sanitation
- WWT-II: Decrease the pollution load to improve the urban water environment

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Sewerage Sector mainly support the realization of the Strategic Orientations #4: Intensify the metropolitan area through a new multi-core and fluid model and #5: Build a strong, efficient and resilient infra-structure network providing sufficient service (See Section 5.4), which implements especially the Long-term Development Visions (See Section 4.2) of Efficient Administrative Capital (EAC) and Available Serviced Land and Buildings (ASL).

(3) Strategies & Policies of Sewerage Sector

Table 8.3.3 below summarizes the Strategies & Policies of Sewerage Sector proposed to tackle existing issues and to achieve Erbil 2050 MP Long-Term Visions and Overall Sector Goals.

Table 8.3.3 Strategies & Policies of Sewerage Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
City-Wide Inclusive Sanitation (CWIS)	**WWT-S1: Implementation of CWIS approach** Improvement of sanitation in both areas covered by the sewerage system and other areas will be done in parallel.	- **WWT-S1-1**: Revision and update of Sewerage Master Plan to incorporate the CWIS approach. - **WWT-S1-2**: Improvement of drainage network and sanitation facilities	- Inadequate sewerage system and limited treatment capacity (WWT-01) - [WWT-I] Upgrading of living environment with appropriate sewerage system and sanitation
Wastewater Treatment Plant (WWTP)	**WWT-S2: Construction of new WWTPs** Completion of the WWTP under JICA loan project (IQ-P23) for Erbil city center and construction of decentralised WWTPs at the northern development area.	- **WWT-S2-1**: Implementation of JICA WWTP project (IQ-P23) - **WWT-S2-2**: Construction of Decentralised WWTPs	- Inadequate sewerage system and limited treatment capacity (WWT-01) - [WWT-II] Reduction of the pollution load to improve the urban water environment
Sewerage Network	**WWT-S3: Construction of new Sewerage Networks** Construction of the sewer pipes for collection wastewater to be treated at the JICA WWTP for Erbil city center and construction of sewerage networks for decentralised WWTP systems at the northern development area.	- **WWT-S3-1:** Construction and expansion of sewerage network in Erbil city center - **WWT-S3-2:** Construction of sewerage network for decentralised WWTP systems.	- Inadequate sewerage system and limited treatment capacity (WWT-01) - [WWT-I] Upgrading of living environment with appropriate sewerage system and sanitation
Reuse of Treated Wastewater	**WWT-S4: Promotion of reuse of treated wastewater** Construction of tertiary treatment facilities at WWTPs that will enable the reuse of treated wastewater for irrigation and other purposes. Raising awareness to encourage the people to	- **WWT-S4-1:** Construction of tertially treatment facilities at WWTPs - **WWT-S4-2:** Environmental awareness activity to promote the	- [WWT-II] Reduction of the pollution load to improve the urban water environment

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
	reuse the treated wastewater.	reuse of treated wastewater	
Wastewater Tariff System	**WWT-S5**: **Introduction of Wastewater Tariff** Setting wastewater/sanitation tariff and collection of fee for the services.	- **WWT-S5-1:** Introduction of wastewater tariff and collection of the fee for sanitation services	- [WWT-I] Upgrading of living environment with appropriate sewerage system and sanitation
Wastewater Treatment Systems	**WWT-P1**: Policy 1 Centralised wastewater treatment system in Erbil city center and decentralised wastewater treatment system in the northern development area, to collect and treat all grey and black water discharged from residential and commercial developments.	Update Sewerage Master Plan to incorporate the decentralised wastewater treatment systems at the northern development area.	- Inadequate sewerage system and limited treatment capacity (WWT-01) - [WWT-II] Reduction of the pollution load to improve the urban water environment
Pretreatment of Industrial Effluent	**WWT-P2**: Policy 2 Effluent from the industrial areas shall be collected separately, with pre-treatment facility at each industry	Strengthen monitoring and penalties to ensure compliance with the regulations requiring pre-treatment of industrial effluents.	- [WWT-II] Reduction of the pollution load to improve the urban water environment
Reuse of Treated Wastewater	**WWT-P3**: Policy 3 Re-use of the treated wastewater effluent for irrigation of landscape greens in open areas and roads.	Installation of regulations on the re-use of treated wastewater and awareness-raising through public awareness raising activities.	- [WWT-I] Upgrading of living environment with appropriate sewerage system and sanitation

Source: JICA Project Team

8.3.4 Sewerage Sector Development Plan

(1) Wastewater Discharge Forecast

2) General

Wastewater discharge forecast is prepared based on the population forecast prepared by JICA Project Team (See Section 4.3). The GDUP and JPT expect the projected population of the Erbil 2050 MP target area to increase up to 3 million by 2050 including IDPs. The respective population projections for the Erbil city centre and the northern development area have been described in Section 4.3.

3) Wastewater Discharge Forecast

The following conditions were used to forecast the overall wastewater discharge for Erbil 2050MP.

Unit Wastewater Discharge for Residential Area

According to the latest information from the GDWS, the water consumption per person per day is 330 litres. In the Sewerage Master Plan (2007), unit wastewater discharge was calculated at 80% of the unit water consumption at the time, 270 lpcd and 350 lpcd respectively, and similarly in this MP, 80% of present unit water consumption, 330 lpcd, is set as unit wastewater discharge. Therefore, the unit wastewater discharge is set at 265 lpcd in this MP.

As the policy in this MP is to lower the current water demand of 330 lpcd to 300 lpcd by 2050 gradually from the perspective of water resource conservation, the sewage discharge in 2050 will also decrease in gradual steps from 265 lpcd to 240 lpcd.

Unit Wastewater Discharge for Non-Residential Area

Erbil will be more developed in urban areas in near future and the treatment of wastewater from non-

residential such as commercial and industrial establishments will need to be considered. It is assumed that the amount of non-residential wastewater discharge will increase from the current 10% to 15% to 20% of the total amount of residential wastewater discharge for the estimation. The percentage of non-residential wastewater discharge was reviewed by the GDWS and EWSD, and it was agreed to use the assumed percentages.

Connection Rate to Sewer Pipes

When planning the development of sewerage systems, it is common practice to draw up a scenario for a gradual expansion of facilities until the final goal, where 100% of the discharged wastewater enters the sewer pipes and all of it is treated at the wastewater treatment plant (WWPT). For this reason, the capacity of the WWTPs to be developed is calculated from the percentage of sewer pipe installation (i.e. connection rate).

The accurate connection rate in Erbil has to be surveyed in the future, but the presumption is that by 2027, when Phase-1 Lot-1 of IQ-P23 is completed, the number of households connected to the sewerage system will be 4,000, which is approximately 2% of the total number of households in the centre of Erbil. Using this connection rate as a starting point, development scenarios were outlined to increase the connection rate. Two scenarios were considered, assuming that the sewerage system will be developed and connected to each house in stages by 2050, and that the connection rate to the sewerage system in 2050 will be 70% and 45% respectively. From these rates, the amount of wastewater inflow to the sewerage system can be calculated, and the capacity of the WWTP required can be estimated. Thus, in this MP, the future expansion of the WWTP is planned to proceed in parallel with the extension of the sewerage network and house connection (sewerage coverage).

Wastewater Discharge Forecast

Based on the above conditions, the wastewater discharge forecast and wastewater inflow to the sewerage system by 2050 of Sceneario-1 and Scenario-2 are shown in the table below.

Table 8.3.4 Wastewater Discharge Forecast

Item		2027	2030	2040	2050
Population		**1,982,000**	**2,200,000**	**2,620,000**	**3,009,000**
Residential	Unit Discharge (lpcd)	**265**	**256**	**248**	**240**
	Daily Discharge (m3)	540,400	563,200	649,800	722,200
Non-Residential	Unit Discharge (%)	10%	10%	15%	20%
	Daily Discharge (m3)	54,000	56,300	97,500	144,400
Wastewater Discharge Total (m3/d)		**594,400**	**619,500**	**747,300**	**866,600**
Scenario-1: 70% at 2050					
Connection Rate		2%	11%	40%	70%
Wastewater Inflow to Sewerage System		**11,900**	**67,300**	**445,100**	**606,600**
Scenario-2: 45% at 2050					
Connection Rate		2%	8%	26%	45%
Wastewater Inflow to Sewerage System		**11,900**	**47,100**	**196,600**	**390,000**

Source: JICA Project Team

(2) Sewerage and Wastewater Management Development Plan

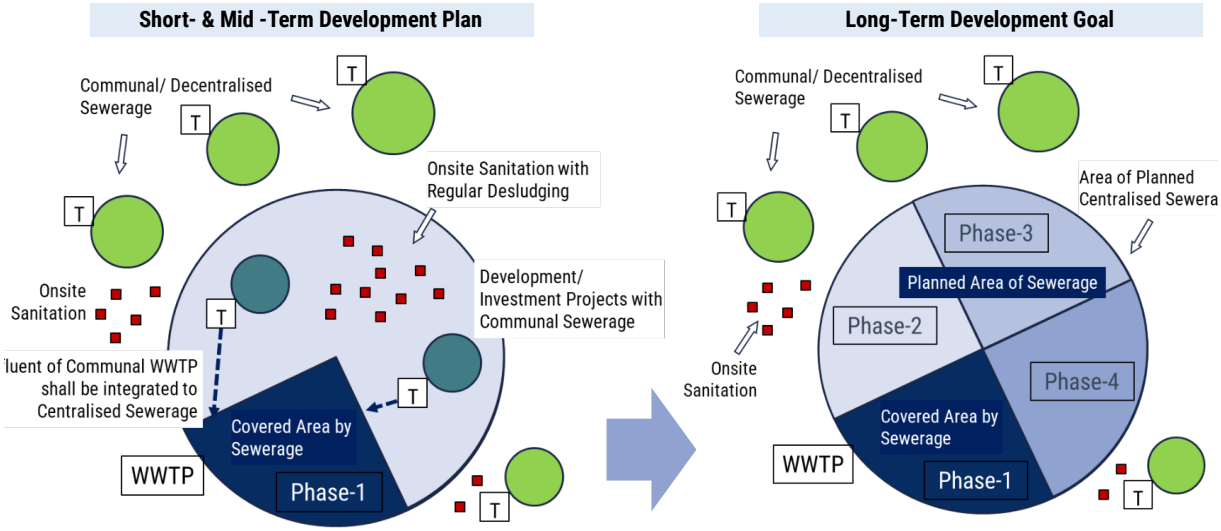
1) Integrated Wastewater Management

Wastewater management in Erbil city center is currently being implemented under the Erbi Sewerage Construction Project IQ-P23, in line with the Erbil Sewerage Master Plan (M/P) 2012. With the implementation of IQ-P23 Phase-1, by 2030, approximately 1/4 of the central area within Erbil 120m Ring Road is expected to become sewerage zones in where discharged wastewater is collected and treated at the WWTP.

Meanwhile, wastewater from the remaining 3/4 of the underserved areas of the sewerage system will continue to be treated by existing onsite sanitation facilities, with sludge being regularly drawn off and greywater discharged into the drainage channels. In addition, the management of wastewater drainage of the 400,000 people expected to reside in the new development area in the north to Erbil center also needs to be considered.

Even if the goal is to achieve a centralised wastewater treatment system with sewer pipe network and WWTP in future, the improvement of the current wastewater/sanitation system is most important and urgent task.

In this context, a holistic wastewater management plan will be developed by Erbil, which will consider the appropriate facility development, operation and maintenance, sludge withdrawal and sludge treatment for centralised and decentralised wastewater treatment systems. These classifications are shown in the figure below.



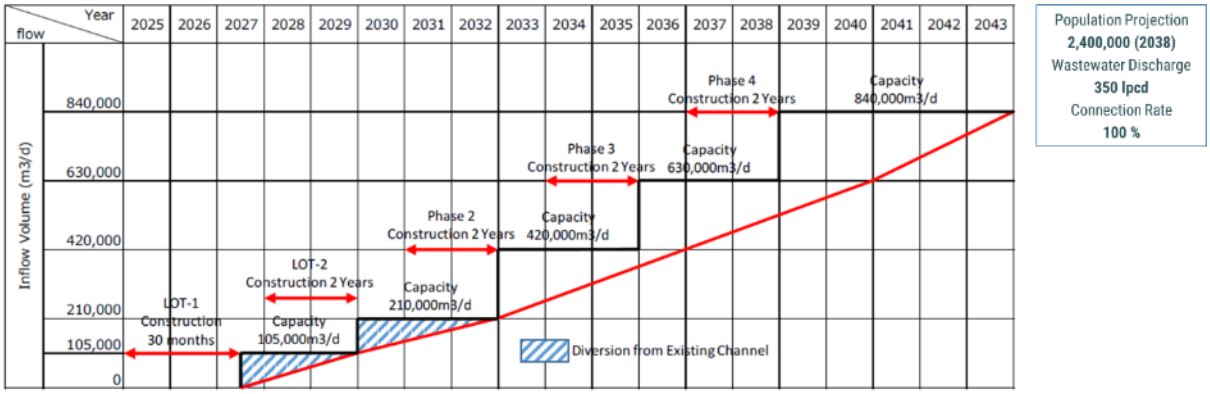
Source: JICA Project Team

Figure 8.3.9 Phased Wastewater Facility Development Plan

2) Centralised WWTP

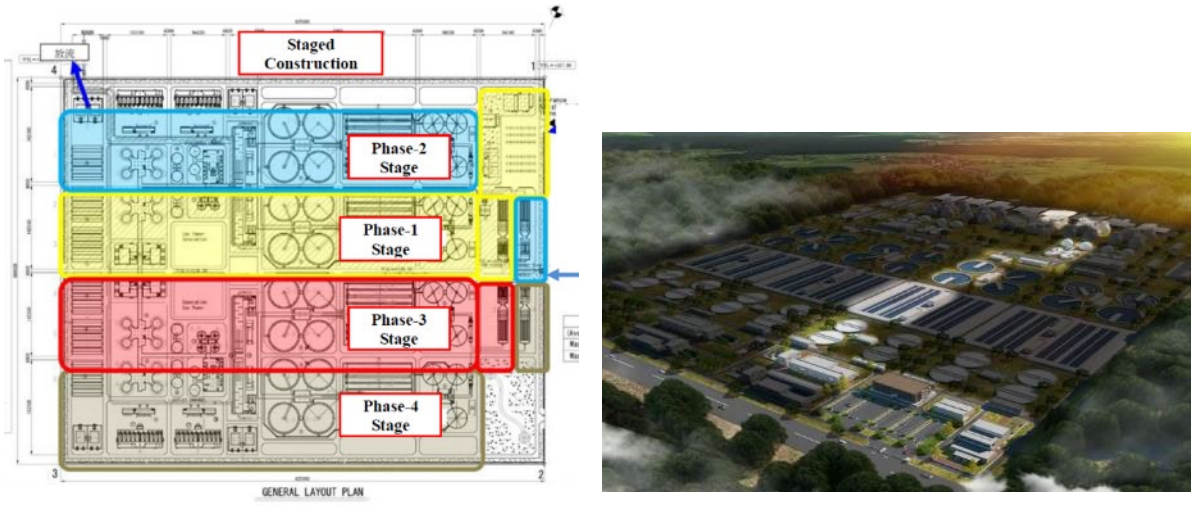
IQ-P23

The current development plan of the JICA loan project IQ-P23 is summarised below. The project is divided into four phases, each phase of which is planned to expand the WWTP with a treatment capacity of 210,000 m3/d, and to develop the sewerage pipe network in a clockwise direction, starting from the south of Erbil city center. Phase 1 Lot 1 currently plans to construct a new WWTP with treatment capacity of 105,000 m3/d by 2027, as well as the construction of sewerage pipe network (trunk sewer, primary sewer, secondary sewer) using the interceptor method and house connections (or lateral connections) to 4,000 households in the pilot area. In Phase 1 Lot 2, the WWTP is planned to be expanded to double the treatment capacity to 210,000 m3/d, while the construction of trunk sewer, primary sewer, secondary sewer, and lateral connections are implemented in sequence. The following figures show the phased implementation plan of IQ-P23 and the expansion plan of the WWTP.



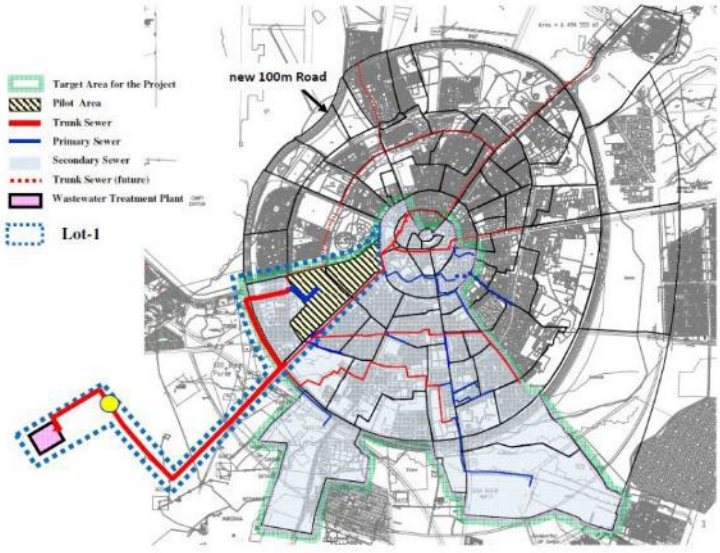
Source: JICA IQ-P23 Consultant Team

Figure 8.3.10 Phased Implementation Plan under IQ-P23



Source: JICA IQ-P23 Consultant Team

Figure 8.3.11 Phased Expansion Plan of WWTP under IQ-P23



Source: JICA IQ-P23 Consultant Team

Figure 8.3.12 Planned Construction Site under IQ-P23

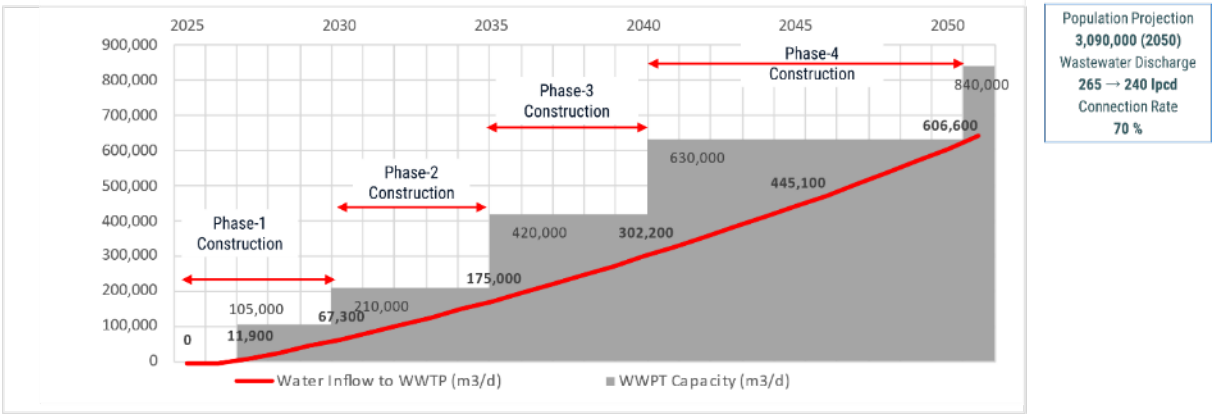
The planned wastewater discharge of 350 lpcd under IQ-P23 is higher flow compared to the projected wastewater discharge of 265 lpcd gradually decreasing to 240 lpcd by 2050, in response to the water demand reviewed in this MP (330 lpcd to 300 lpcd). Therefore, the flows into the WWTP have been reviewed here.

In addition, as mentioned above, the connection rate (or coverage rate) to the sewerage system through sewer pipe installation was reviewed, and Scenario-1, where 70% of the population of Erbil will be connected to the sewerage system by 2050, and Scenario-2, where 45% will be connected to the sewerage system.

Scenario-1

Under this scenario, 70% of Erbil residents will be connected to the centralised sewerage system and their wastewater treated by MP horizon 2050. This scenario is based on extending sewer connections at an increase of approximately 3% per annum from 2% at the completion of Phase-1 Lot 1 of IQ-P23.

Under this scenario, the wastewater inflow to WWTP in 2050 will be 606,600 m3/d. Timeline for the WWTP expansion is Phase-1 (210,000 m3/d) by 2030, Phase-2 (420,000 m3/d) by 2035, Phase-3 (630,000 m3/d) by 2040, and Phase 4 (840,000m3/d) by 2050.



Source: JICA Project Team

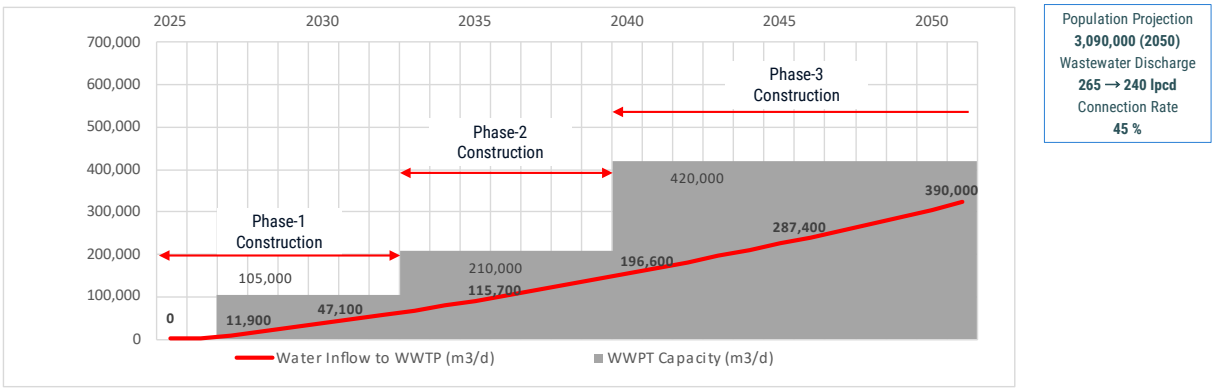
Figure 8.3.13 WWTP Development Plan Scenario-1

Regarding the gap between the WWTP treatment capacity and wastewater inflow, the sewerage system to be constructed under IQ-P23 is a system that collects not only sewage but also greywater discharged from households and stormwater flowing through the drainage channel. The trunk main sewer to be constructed in Phase-1 has points of connection to drainage channels, from which greywater and stormwater will inflow. Extension of sewer pipes and improvement of drain channels are also planned to be implemented in Phase-1 Lot 2 of IQ-P23.

Scenario-2

Under this scenario, 45% of Erbil residents will be connected to the centralised sewerage system and their wastewater treated by MP horizon 2050. This scenario is based on extending sewer connections at an increase of approximately 2% per annum from 2% at the completion of Phase-1 Lot 1 of IQ-P23.

Under this scenario, the wastewater inflow to WWTP in 2050 will be 390,000 m3/d. Timeline for the WWTP expansion is Phase-1 (210,000 m3/d) by 2033, Phase-2 (420,000 m3/d) by 2040, and Phase-3 (630,000 m3/d) by 2050.



Source: JICA Project Team

Figure 8.3.14 WWTP Development Plan Scenario-2

3) Decentralised WWTP and Sludge Treatment

As mentioned in the section on integrated wastewater management above, decentralised wastewater treatment systems are promoted or improved in areas underserved by centralised sewerage system. Decentralised wastewater treatment systems include on-site sanitation facility and communal WWTP with simplified sewer, both collect and treat sewage (black and grey water) but not stormwater.

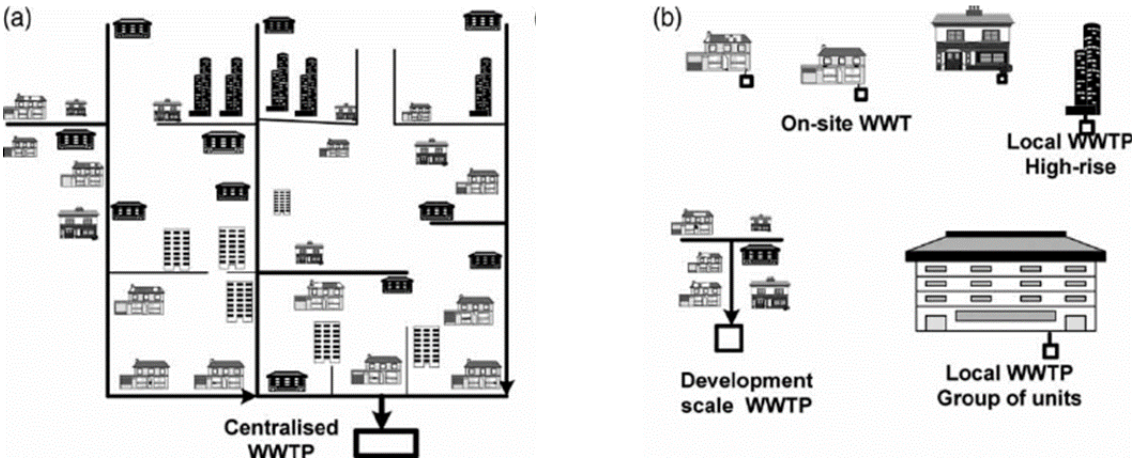
These sanitation facilities and treatment plants require regular sludge withdrawal, and thus the proper desludging practice and sludge treatment must be established in decentralised wastewater treatment systems.

Onsite Sanitation

Wastewater treatment facilities located on the respective building premises. In addition to septic tanks and cesspools, there are also aerobic treatment tanks that use electricity for aerobic treatment process.

Communal WWTP

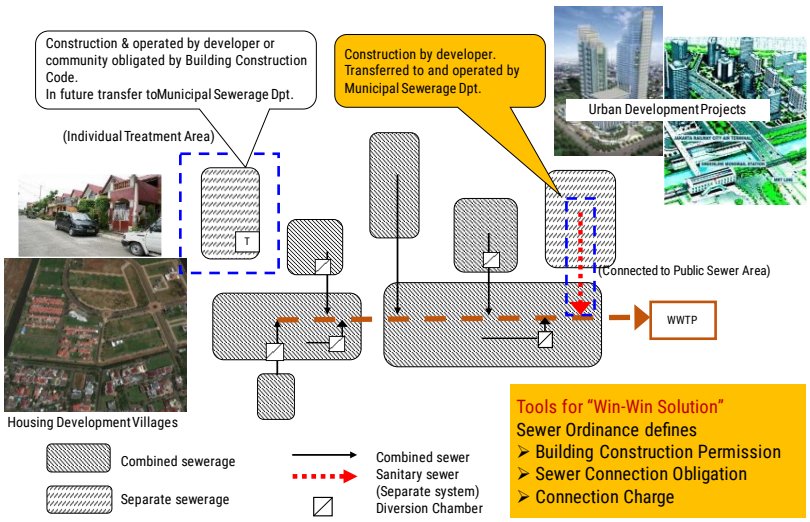
Wastewater treatment facilities with sewerage pipes in new residential development areas, small suburban settlements, high-rise building complexes, shopping complexes etc.. They are relatively large treatment installations.



(a) Centralised Wastewater Treatment System (b) Decentralised Wastewater Treatment System

Source: Ashok K Sharma, 2013, Decentralised systems - Definition and drivers in the current context

Figure 8.3.15 Centralised and Decentralised Wastewater Treatment Systems



Source: JICA Project Team

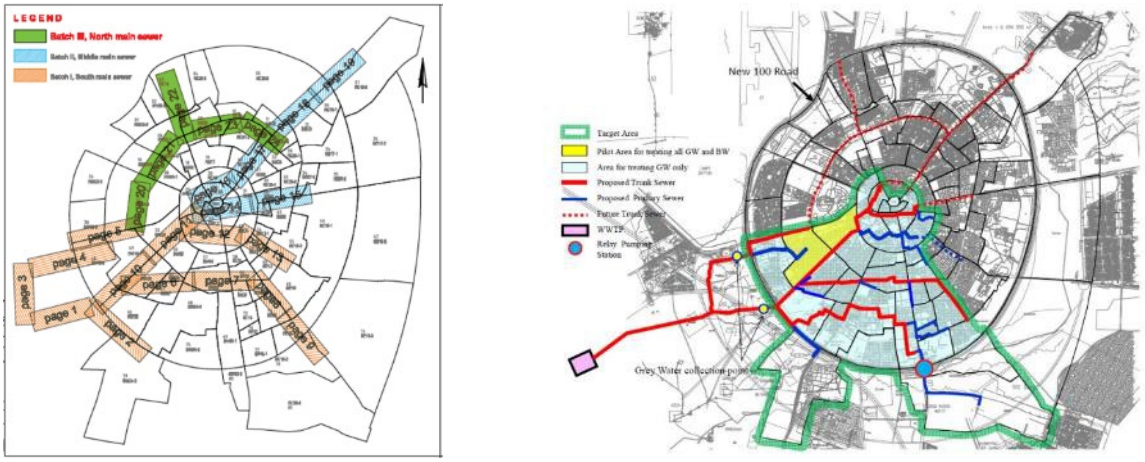
Figure 8.3.16 Applicable Sewerage System for Urban Development

Sewerage System for Urban Development

One of the most effective urban planning measures is to oblige development projects with private investment to install individual wastewater treatment plants respectively. The sewage discharged by residents of new residential villages and urban high-rise compounds will be treated at decentralised WWTP systems. And the individually treated wastewater can be discharged to the municipal sewerage system, thereby reducing the load on the centralised WWTP. A further advantage is that private investment in the development of sewerage facilities reduces the burden on public capital investment.

4) Strategic Expansion of Sewer Network and Improvement of Drainage

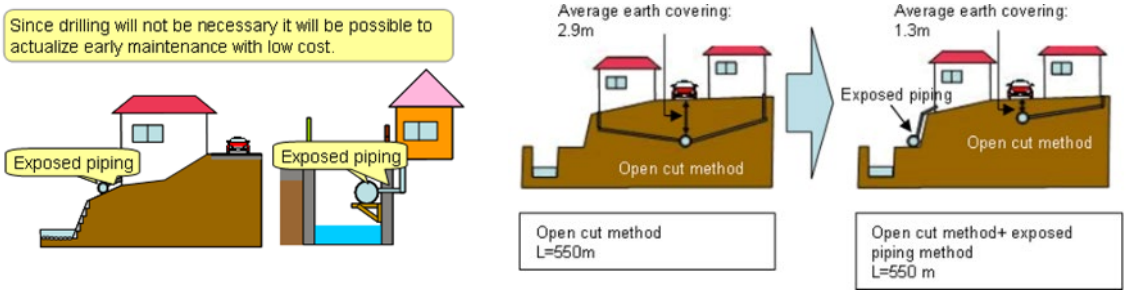
Below shows plans for the sewerage mains in Erbil Sewerage M/P and Phase-1 of IQ-P23. Basically, there are no major changes and it is planned to start the development from the south area inside the Erbil 120m ring road. In the WWTP, the gap between the planned treatment capacity and the incoming sewage flow is planned to collect greywater and stormwater flowing through drainage channels. Thus, in order to ensure constant flow of wastewater in the drainage channels connected to the trunk sewers and to reduce negative environment such as odour and aesthetics, it is planned to improve the existing drainage channels in parallel with the construction of the main sewer pipes.



Source: Erbil Sewerage M/P and JICA Preparatory Survey on Sewerage Construction Project in Kurdistan Region

Figure 8.3.17 Layout Plan of Main Sewer Pipes

For reference, the figure below shows how sewer pipes can be laid by utilizing private land, channel space, riverbanks, ditches, etc. instead of under roads, in order to reduce construction costs, shorten the construction period and avoid coordination with other buried infrastructures. This is useful as an intermediate measure when the laying of sewer pipes is planned for a short period of time, although in the future the pipes will be laid underground to a suitable depth.



Source: Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan

Figure 8.3.18 Quick Installation Methods of Sewer Pipe

5) Reuse of Treated Wastewater and Sludge

Treated Wastewater and Sludge can be utilised as alternative resource through proper treatment. The promotion to reuse the treated wastewater and sludge for such as agricultural or gardening purposes is recommended.

Reuse of Treated Wastewater

The reuse of treated wastewater is expected to be a new water source for agricultural irrigation under constraint of groundwater resources. In addition to this, where the decentralised wastewater treatment is installed in newly development areas, these treated waters can also be utilised for gardening and landscaping. In such cases, it should be ensured that the quality of treated water meets standards and, if necessary, additional tertiary wastewater treatment facilities shall be considered.

Reuse of Sludge

Sludge can be re-used as fertiliser, construction material or energy source, depending on its treatment method. The most common way of reusing sludge generated at the WWTPs or drawn from existing sanitation facilities is using it as fertiliser or soil improvement agent after composting. In addition to this, incinerated ash, obtained after drying and incineration of the sludge, can be re-used as a cement material. As another sludge treatment method, methane gas can be generated by anaerobic digestion and reused as energy, or the dried sludge can be solidified and used as solid fuel, or the heat generated by incineration can be converted into electrical energy and reused as an energy source.

6) Wastewater Tariff System

The implementation of IQ-P23 will lead to the collection of sewerage tariffs, and it is considered to be collected together with water tariffs in Erbil. A similar approach is being considered for Erbil. The tariff structure is planned to start at a low level of below 50% of water tariffs, gradually increasing to 80% of water tariffs in the future. It is also recommended that wastewater charge or environmental tax be levied on all residents.

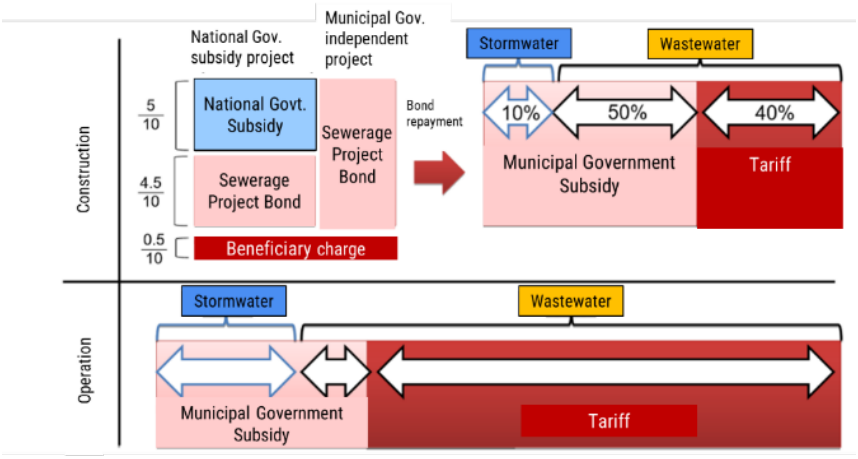
The construction and operation costs of sewerage systems are significant, and it is difficult to recover the costs from user charges alone. Therefore, public subsidies and bonds are often used to cover the costs.

As an example, the financial resources for sewerage projects in Japan are shown in the figure below. In Japan's sewerage projects, the cost of treating sewage discharged from residents and factories is covered by wastewater tariffs, while the cost of managing stormwater to protect the city from flooding is covered by municipal government taxes and other funds. Also, as sewerage systems play a major

public role in conserving the water quality of rivers and lakes, government funds are granted for the construction costs of the facilities.

Sewerage Project Bond

Construction investment in sewerage systems requires a large amount of money at one time, while the facilities will be used for a long period of time, so the financial sources are obtained by borrowing corporate bonds, which are repaid over a long period of time to ensure fairness in the burden between generations.



Source: Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan

Figure 8.3.19 Quick Installation Methods of Sewer Pipe

(3) Sewerage and Wastewater Management Action Plan

The table below summarises the development scenarios towards 2050 describing the short-, mid- and long-term implementation plans for each of the items in the Waste Management System Improvement Plan above.

Table 8.3.5 Action Plan of Respective Terms

Theme	Short-Term (up to 2030)	Mid-Term (2040)	Long-Term (2050)
Integrated Wastewater Management	- Formulation of integrated wastewater management plan for both centralised and decentralised systems	- Implementation of the integrated wastewater management plan	- Implementation and revision of the integrated wastewater management plan
Centralised WWTP	- Construction of WWTP with treatment capacity of 210,000m3/d (Phase-1)	- Expansion of WWTP with treatment capacity of 420,000m3/d (Phase-2)	- Expansion of WWTP with treatment capacity of 630,000m3/d (Phase-3)
Decentralised WWTP and Sludge Treatment	- Revision and formulation of wastewater regulations applicable to investment/ development projects - Construction of communal WWTPs at Erbil suburbs - Conducting the regular desludging of onsite facilities	- Enactment of the wastewater regulations applicable to investment/development projects - Construction of communal WWTPs in northern new development areas - Conducting the regular desludging of onsite facilities	- Revision of the wastewater regulations - Construction of communal WWTPs in northern new development areas - Conducting the regular desludging of onsite facilities
Sewerage Network and Drainage Channel	- Installation of new sewer pipes under IQ-P23 - Promotion of lateral (house) connections to sewerage system - Improvement of drainage	- Expansion of sewerage network to phase-2 zones - Implementation of lateral connections to sewerage system - Improvement of drainage	- Expansion of sewerage network to phase-3 zones - Implementation of lateral connections to sewerage system - Improvement of drainage

	channels in southern area of Erbil center	channels in north-western area of Erbil center	channels in north-eastern area of Erbil center
Wastewater Tariff System	- Study and analysis on the appropriate wastewater tariff structure - Imposition of sewerage tariffs	- Revision of wastewater tariff structure - Consideration of environmental tax	- Revision of wastewater tariff structure - Imposition of environmental tax
Reuse of Treated Wastewater and Sludge	- Plan and implementation of awareness raising campaign and environmental education	- Implementation of awareness raising campaign and environmental education	- Implementation of awareness raising campaign and environmental education

Source: JICA Project Team

(4) Priority Projects

Among the above development action plans, particularly the most urgent and important short-term initiatives are proposed as priority projects. For more information, see the profiles summarised in 10.2 Proposed Sector Priority Project.

1) Capacity Building Project on Wastewater Management in Erbil

The project is a capacity development project to strengthen the capacity of sewerage sector officials in the planning and implementation of integrated wastewater management. The project will assess the status of existing sewerage and drainage system construction, the use of existing sanitation facilities, and formulate plans for future sewerage and drainage system improvement, as well as for improving sanitation facilities and establishing a decentralised wastewater management system including desludging and sludge disposal. The project will also carry out F/S and construction, operation and maintenance of the decentralised small sewerage system under the pilot project in model towns.

2) Erbil Sewerage and Drainage Improvement Project

The project aims to improve the treatment performance of the WWTP to be constructed under IQ-P23, which is planned for implementation, by upgrading the sewer pipes and drainage channels in the target area, and to reduce flood risk by cleaning and rehabilitating drains that are contributing to inundation due to their poor functioning. Another expected effect of the construction of secondary sewage pipes is to facilitate house-to-house connections and reduce the environmental impact caused by the discharge of sewage into the environment.

8.3.5 Recommendations

(1) Development of the Integrated Wastewater Management Master Plan

The existing master plan for the sewerage sector in Erbil is based on the development of centralised sewerage systems. On the other hand, as the construction of centralised sewerage systems involves both time and costs, plans are also needed for the management of wastewater during the period until such facilities are in place. Therefore, a comprehensive master plan for wastewater management, based on the City-Wide Inclusive Sanitation (CWIS) concept, needs to be developed and approved by the sewerage sector.

(2) WWTP and Sewerage and Drainage Plan

The proper operation of the sewerage system in Erbil requires not only ensuring the completion of the WWTP and sewer pipe networks, which are currently implemented under the JICA loan project (IQ-P23), but also the phased expansion of the sewers and the individual connections to ensure that sufficient volumes of wastewater flow into the WWTP for proper treatment.

Therefore, it is necessary to formulate a 10-yearly sewerage development plan, which includes the expansion of sewerage zones in the city and the laying of sewer networks, as well as a construction,

financial and operation and maintenance plan, setting priorities for the development of facilities and implementing them according to these priorities.

(3) Comprehensive Stormwater Management Plan

The sewers currently being developed under the JICA project IQ-P23 are interceptor systems, which capture stormwater drainage in addition to sewage. It is therefore efficient to develop the sewerage system and stormwater drainage channels in parallel. In Erbil, the development of urban areas has led to an increase in the run-off ratio of the rainwater and increased flooding damage in low-lying areas, thus a comprehensive stormwater management plan is urgently needed to prevent serious damage from stormwater run-off in the future and to ensure the smooth discharge of stormwater and its recharge underground.

(4) Industrial Wastewater Management

Although this MP covers municipal wastewater and does not include industrial wastewater, the Erbil Sewage Sector needs to develop a plan for industrial wastewater management as well. Environmental legislation and sewerage regulations for industrial wastewater need to be strengthened, penalties for non-installation of wastewater treatment facilities by individual or grouped industrial units need to be more strictly enforced. The Environment Protection and Improvement Board (EPIB) and EWSD need to be given enforcement powers in industrial wastewater management.

Additionally for the approval and licensing of new industrial zones to be built in the Erbil urban and suburban area, EPIB and EWSD shall ensure the installation of primary wastewater treatment facilities and compliance with wastewater quality standards for industrial wastewater with adequate monitoring and penalties as one of condition of the approval.

8.4 Solid Waste Management

8.4.1 Existing Conditions

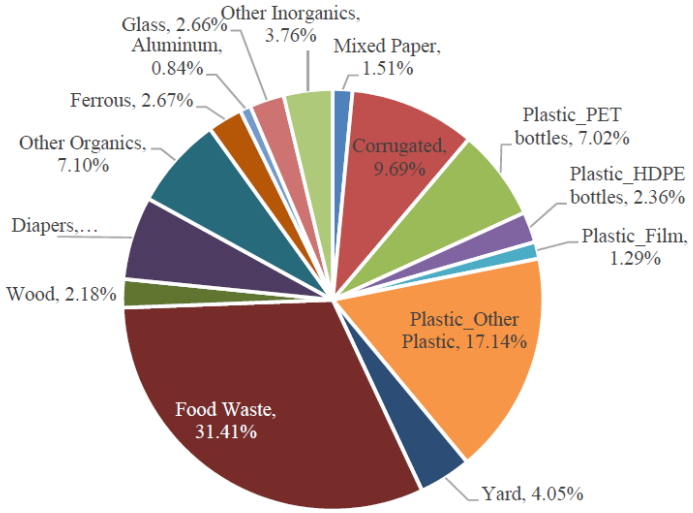
(1) Solid Waste Management Infrastructure & Services

1) Generation of municipal solid waste

According to Directorate of Services and Environmental Protection (DSEP), the Directorate responsible for solid waste collection, transport and landfill in Erbil, the amount of waste generated in 2022 is approximately 1,900 t/d, or 1.33 kg/c/d per person per day.

The results of the waste composition survey conducted in 2020 shows that food waste and other organic waste amounted to 38%, while the four different types of plastic waste totalled 28%. Paper and cardboard accounted for 11%. The proportion of plastic is slightly larger than in other Middle Eastern cities, where the proportion of organics is between 50 and 60% and the proportion of plastic is between 10 and 20%.

The figure below shows the results of the waste composition survey.



Source: DSEPSWT, MOMT

Figure 8.4.1 Municipal Solid Waste Composition in Erbil City in 2020

2) Collection and transportation

Municipal waste is collected twice or three times a week in most part of Erbil City from waste bins placed in front of houses or near buildings. Collection in commercial areas is conducted daily. DSEP is outsourcing the collection and transport service to private companies. Six companies collect waste in Erbil City, and four companies collect waste from towns on the outskirts of Erbil. Waste generation is around 1,900 ton/day with 600 trucks transporting to the disposal site every day. In addition, approx. 3,500 ton/day of construction waste such as bricks and concrete are generated, according to DSEP.

Table 8.4.1 Waste Collection and Transportation in Erbil City

Collection system	Door to door collection
Collection frequency	Commercial area: daily collection (charged) Residential area: 2 or 3 days per week (free of charge)
Collection coverage area	98% of Erbil City
Amount of municipal waste	Approx. 1,900 ton/day in 2022
Amount of construction waste	Approx. 3,500 ton/day in 2022

Garbage bin and waste collection

Garbage collection in allays

Garbage bin in commercial street

Segregation of waste at source is not common in Erbil City and even separated waste are mixed and transported by the collection trucks. The collection of waste from residential areas is free of charge, while the collection from commercial areas is charged a waste collection fee.

3) Intermediate treatment facility (ITF)

Currently there are no specific activities of recycling and intermediate treatment conducted by Erbil city. Some information was given about the Waste-to Energy (WtE) project moving towards implementation and that there are plans to build a recycling plant, but no further details were available.

In addition, there are two waste sorting plants in Duhok Governorate and a Refuse Derived Fuel (DRF) plant in Sulaymaniyah Governorate according to MOMT. The planning of ITF in Erbil will draw on the experience of implementation of these facilities.

Small informal groups are carrying out recycling activities collecting cardboard, metals, plastics and tires but DSEP does not have sufficient information or data on their activities.

4) Final disposal

Kani-Qirzhala landfill site is the only disposal facility in Erbil. It is located within Erbil municipality, about 15 km west from city center. The disposal site is government-owned land and covers an area of 37 ha as shown figure below.

Figure 8.4.2 Location of Kani Qirzhala Disposal Facility

More than 75% of the landfill area is already filled, and there are concerns that it will be full in 2-3 years. Therefore, new disposal site needs to be constructed before the Kani Qirzhala disposal site is closed, but the selection and securing of land for disposal facility has been very difficult.

Two years ago, the village of Rajqadan (west of Kani-QirZhala, near the Greater Zab river) was selected as a potential site, but the plan failed due to strong opposition from the local population.

Figure 8.4.3 Kani Qirhzala Disposal Facility

Disposed municipal waste

Heavy equipment at disposal site

Trucks in queue

The management of the disposal site is also outsourced to private company, whose contract was renewed in June 2022 (IQD 100 million/month). As a result, six new bulldozers, two shovels, one excavator and one wheel loader were deployed. Before that, the equipment in operation was only two bulldozers, which were not able to handle the large amount of waste that was being brought in.

5) Medical waste

Medical waste is the responsibility of the Ministry of Health. Some large hospitals treat medical waste by their own incinerators, while small clinics and laboratories have no treatment facilities and dispose their medical waste mixed with the municipal waste which are collected and landfilled together with general waste.

6) Industrial waste

Industrial waste is the responsibility of the Ministry of Industry. In recent years, increased foreign investment has led to an increase in construction demand in Erbil, which in turn has resulted in a rapid increase in the amount of construction waste generated. Illegal dumping of construction waste into natural waterways has also increased, and the recent flooding damage in Erbil is said to have been caused by blocked waterways due to illegal dumping of construction waste.

There is a plan to implement four recycling plants for industrial waste, but detailed information was not available. Recycling needs to be promoted, as after reclamation the volume will be reduced to 10%.

Illegal dumping of construction waste

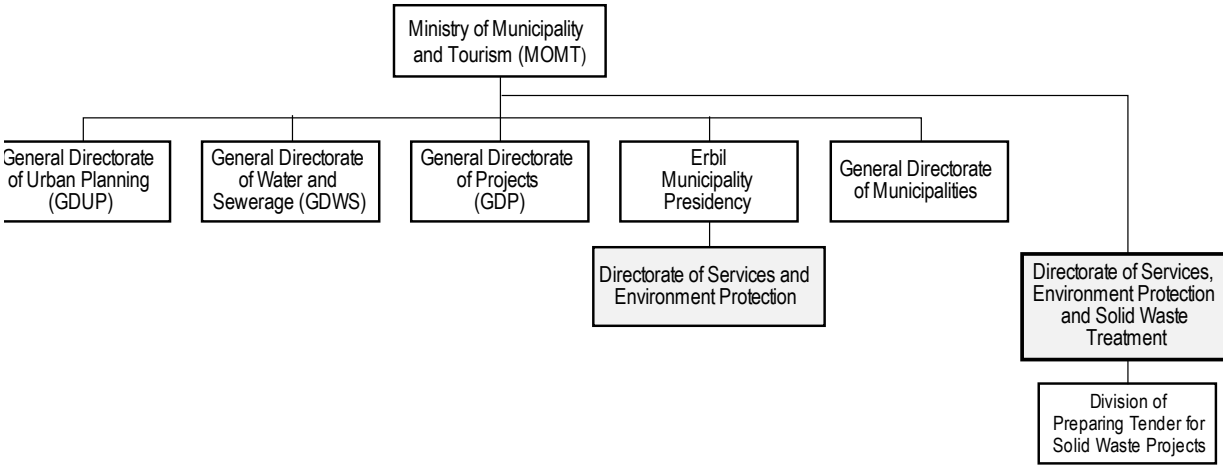
Cleaning of illegal dumping

(2) Organization

Solid waste management in the Kurdistan Region is under the control of the Directorate of Services, Environmental Protection and Solid Waste Treatment under MOMT, while solid waste collection and management of final disposal site in Erbil is under responsibility of the Erbil Directorate of Services and Environmental Protection under the Erbil Municipality Presidency.

Directorate of services, environmental protection and solid waste treatment (DSEPSWT)

DSEPSWT is responsible for allocating budgets for SWM services, tendering for waste collection companies, supervision of city cleaning, solid waste collection, transport and landfilling in Kurdistan Region. The Directorate is under MOMT aligned with DGUP and GDWS, and has eight (8) staff.

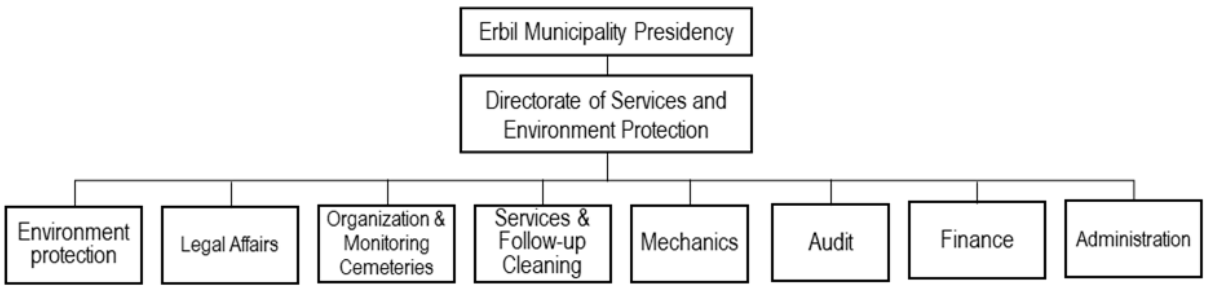


Source：DSEPSWT

Figure 8.4.4 MOMT Organization Structure of MOMT and DSEPSWT

Directorate of services and environmental protection (DSEP)

DSEP is under the Erbil Municipality Presidency within the MOMT and has about 180 employees. It supervises and follows up cleaning operations in the city, manages solid waste collection and transport from streets, neighbourhoods and squares, and educates the population on environmental protection and urban cleaning. They are also responsible for the operation and management of the Erbil disposal site (Kani Qirzhala), monitoring and arranging cemeteries, and maintenance and refuelling of the heavy equipment and vehicles in their possession.



Source：DSEP

Figure 8.4.5 Organization of DSEP

(3) Existing Solid Waste Policy and Plan

Erbil solid waste master plan, 2011 (UNICEF)

The master plan was developed with UNICEF support for solid waste management in the Erbil Governorate, but was not approved and has not been applied to the solid waste management sector.

The MP comprises a needs, vision and action plan for solid waste management in Erbil Governorate, with proposed technologies for solid waste recovery, re-use and disposal specific to Erbil. It also contains an assessment of existing solid waste management systems, population and waste generation projections, guidelines for private sector participation, equipment and human resource proposals, landfill site design, demonstration projects, maintenance guidelines and an assessment of hazardous and medical waste.

Based on the analysis of the current situation, the MP develops short-, medium- and long-term investment plans and proposes the main objectives and action plans for solid waste management in each of the planning periods.

Draft KRG solid waste management policy 2017 (MOMT)

The KRG's draft solid waste management policy was developed in 2017 and provides a roadmap towards improving solid waste management in the Kurdistan Region over the next decade. The policy was developed in response to the increasing number of internally displaced persons, the changing geopolitical scenario and other changes. It aims to improve solid waste management to improve solid waste collection and strengthen solid waste treatment and disposal capacities through comprehensive and effective solid waste management. The policy also proposes a new system that will improve solid waste management by eliminating overlapping areas of responsibility of relevant agencies and clarifying the division of responsibilities between them.

Furthermore, as improving solid waste management requires significant capital investment beyond what the government can currently commit, the policy also proposes to reduce the government's financial burden through the involvement of the private sector. It suggests possibilities for private sector involvement in waste management in general, including design, construction and operation.

The draft policy also includes a draft waste management act as an annex, but neither the policy nor the act have been approved and have not been applied to date.

(4) Laws and regulations

The KRG has inadequate laws, regulations and technical guidelines for solid waste management. Despite a draft solid waste management act was prepared by the MOMT several years ago, it has not been approved and entered to date. The laws currently in force are summarized as follows. There are no specific regulations on solid waste management in KRG, which is in compliance with the Iraqi central government's environmental regulations.

Municipalities directive act in KRG, Iraq with amendments of No.6/1993

The law regulates the establishment and abolition of municipalities in KRG, as well as their authorities. The articles include the obligation of the municipalities to collect solid waste and to keep the cities clean. The law serves as a draft for a solid waste management policy in Kurdistan Region.

Law No. (8) of 2008 on protection and improvement of the environment in Kurdistan region

This Law No. (8) is regarded as the main solid waste management legislation in KRG. The law defines environmental pollutants as solid, liquid or gaseous substances, noise, vibration, radiation, heat, glare, etc., or biological factors that lead directly or indirectly to environmental pollution.

The law defines waste as "solid, liquid or gaseous substances that cannot be used or recycled as a result of various types of activities". Hazardous waste is defined as "waste that, due to its content, causes or is likely to cause serious harm to humans or the environment". This law also specifies the methods of disposal of these wastes.

Law No. 2 (2007) – establishment of KRG ministry of municipality and tourism

The law establishes MOMT and specifies the Ministry's functions and responsibilities. Article 2 of the law provides for the provision of clean water, sewage and stormwater management, construction of roads, bridges and tunnels, plant for the quality and quantity of various municipal services, and ensuring the needs of residents for playgrounds, parks, etc., as part of regional and administrative services.

The law also stipulates that MOMT is responsible for planning and implementing activities that contribute to local economic development through effective land use policies and urban planning. It also stipulates that the Ministry is responsible for maintaining a clean and hygienic environment and for the proper maintenance of green spaces in cities and districts.

Existing and planned projects

Waste to energy (WtE) project (MOMT) [*Ongoing*]

According to DSEPSWT, MOMT has procured a consultant to conduct a feasibility study (F/S) and the F/S is ongoing. It is expected that the construction of the WtE facility should be completed within approximately three years.

The project was initiated after the KRG Prime Minister strongly encouraged the development of a WtE facility in Erbil and MOMT was instructed by the Prime Minister to raise funds to develop a WtE facility.

Since there is no intermediate waste treatment facilities (ITF) in Erbil, studies on a couple of options for installing ITF were discussed with KRG, which included the continuation of landfill disposal with the introduction of recycling plants, composting of organic waste and the WtE facility. It was decided after consultation that the WtE facility should be constructed. KRG recognizes that the construction of the WtE facility would involve high costs, but considers the benefits to outweigh the costs in terms of stabilization of hazardous waste, generation of energy and reduced reliance on the disposal site.

8.4.2 Key Planning Issues

(1) Mater plan

[Key Issue]

- Erbil 2030 MP and Waste M/P2012 are not harmonised. Waste M/P2012 has not been officially approved and applied.
- Lands for new disposal site and intermediate facilities have not been secured.

[Possible Solutions]

- In updating the MP, reflect the current issues and develop a realistic plan through full dialogue and consensus-building with the relevant agencies.
- Coordinate among stakeholders on land expropriation for disposal site and intermediate facilities.

(2) Legislation, institution and system

[Key Issue]

- There is a ministerial ordinance on fee collection, but fee is not collected from residents, fee collection from businesses is inadequate.
- No monitoring and control of illegal dumping of construction waste.
- There are no regulations on waste segregation and there is no recycling philosophy.

[Possible Solutions]

- Carefully explain the fees charged for waste collection to gain the understanding of residents, and consider and introduce efficient methods of fee collection.
- Co-ordinate with relevant environmental departments to strengthen monitoring and regulations.
- Draft legislation on waste segregation and recycling activities and carry out public awareness-raising activities.

(3) Infrastructure

[Key Issue]

- Remaining capacity of Kani-Qirzhala disposal site is estimated at 2-3 years. No alternative sites are available.
- A tender by MOMT for WtE project was unsuccessful and it is pending.

[Possible Solutions]

- Search for potential new disposal sites and coordinate the land expropriation and acquisition.
- Review the plan and facilitate implementation in order to implement the project.
- Introduction of biogas plant for effective use of organic waste and reduced CO_2/CH_4 emissions.

(4) Operation & services

[Key Issue]

- Environmental education and public awareness activities on waste management and recycling are rarely implemented.

[Possible Solutions]

- Plan and implement environmental education and public awareness activities on separate collection of waste.

8.4.3 Sector Strategies & Policies

(1) Overall Goals of Solid Waste Management Sector

The Overall Goals of the Solid Waste Management Sector development in Erbil 2050 MP, which are outlined in Erbil Solid Waste Master Plan (MOMT, UNICEF, 2012, not approved), contained in the latest policies of the Draft KRG Solid Waste Management Policy (MOMT, 2017, under finalization) and which will realize the Long-term Development Visions, can be summarized as below.

- WPR-I: Establishing the sustainable solid waste management (SWM) system
- WPR-II: Improvement of urban environment and public health by waste reduction and stabilization
- WPR-III: Introduction of 3R (reduce, reuse, recycle) to contribute the sustainable SWM

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Solid Waste Management Sector mainly support the realization of the Strategic Orientations #5: Build a strong, efficient and resilient infra-structure network providing sufficient service (See Section 6.3), which implements especially the Long-term Development Visions (See Section 4.2) of Efficient Administrative Capital (EAC).

(3) Strategies & Policies of Solid Waste Management Sector

Table 8.4.2 below summarizes the Strategies & Policies of Solid Waste Management Sector proposed to tackle existing issues and to achieve Erbil 2050 MP Long-Term Visions and Overall Sector Goals.

Table 8.4.2 Strategies & Policies of Solid Waste Management Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Regulation	**WPR-S1**: Strategy 1 **Formulation of regulations on SWM** Formulation of SWM regulations to encourage the source segregation, impose waste fees and facilitate the improvement of SWM facilities	- **WPR-S1-1**: Articulation of the regulations in coordination with environmental authorities	- No legal framework specified to SWM - [WPR-I] Establishing the sustainable SWM system
Waste Generation	**WPR-S2**: Strategy 2 **Promotion of waste minimization and separation at source** Encouraging waste minimization and source separation based on the concept of 3Rs (Reduce, Reuse & Recycle).	- **WPR-S2-1**: Plan of awareness raising and environmental education on waste minimization and source separation based on the concept of 3Rs - **WPR-S2-2:** Conducting the city-wide waste generation study to determine the waste component and design the waste treatment facilities	- Relatively high daily solid waste production rate per capita (WPR-01) - [WPR-I] Establishing the sustainable SWM system - [WPR-III] Introduction of 3Rs to contribute the sustainable SWM
Waste Collection and Transportation	**WPR-S3**: Strategy 3 **Implementation of separate collection and constriction of waste transfer stations** Separate collection of recyclables (cans, bottles, plastic, paper, kitchen waste, etc.), hazardous and construction wastes of transfer stations to reduce the waste volume and transport cost	- **WPR-S3-1**: Implementation of separate collection - **WPR-S3-2:** Constriction of waste transfer stations at Erbil city center and northern development area	- Relatively high daily solid waste production rate per capita (WPR-01) - [WPR-I] Establishing the sustainable SWM system - [WPR-II] Improvement of urban environment by waste reduction and stabilization

Intermediate Treatment Facility (ITF)	**WPR-S4: Strategy 4** **Introduction of Proper waste intermediate treatment systems** Intermediate waste treatment systems (such as incineration, composting, RDF, Mechanical-biological treatment (MBT)) shall be introduced to promote waste reduction and stabilization.	- **WPR-S4-1:** Implementation of intermediate treatment facilities	- Relatively high daily solid waste production rate per capita (WPR-01) - [WPR-II] Improvement of urban environment and public health by waste treatment
Hazardous Waste Treatment	**WPR-S5**: Strategy 5 **Proper collection and treatment of hazardous waste** Treatment facilities of hazardous (medical & industrial) waste shall be constructed and collection system established.	- **WPR-S5-1:** Construction of hazardous waste treatment facility - **WPR-S5-2:** Establishment of system of collection, transportation & storage of hazardous waste	- Mix of hazardous (medical & industrial) waste to municipal waste (WPR-02 - [WPR-II] Improvement of urban environment and public health by waste reduction and stabilization
Final Disposal	**WPR-S6**: Strategy 6 **Development of new sanitary landfill and safe closure of Kani-Qirzhala landfill site.**	- **WPR-S6-1:** Development and construct of new landfill - **WPR-S6-2:** Closure of the existing Kani-Qirzhala landfill site	- Mix of hazardous (medical & industrial) waste to municipal waste (WPR-02) - [WPR-I] Establishing the sustainable SWM system
Solid Waste Management Master Plan	**WPR-P1**: Policy 1 Appropriate SWM Master Plan shall be formulated and approved by the MOMT covering the areas of Erbil city center and the northern development area.	Formulate new Solid Waste Management Master Plan incorporating both the centralised and decentralised SWM system at the northern development area.	- - [WPR-I] Establishing the sustainable SWM system
Waste Generation, Collection and Transportation	**WPR-P2**: Policy 2 Waste minimization and separation at source will be practiced at household level, and separate collection shall be conducted based on a strategic plan incorporating of sorting and recycling activities.	Awareness campaigns and environmental education on waste minimization and source separation based on the concept of 3Rs	- Relatively high daily solid waste production rate per capita (WPR-01) - [WPR-III] Introduction of 3R to contribute the sustainable SWM
Intermediate Treatment	**WPR-P3**: Policy 3 Different type of wastes such as domestic, industrial, medical and agricultural wastes shall be treated separately based on the nature of each type of the waste by incineration, composting, material recovery, and sanitary landfill, etc.	Design and implementation of appropriate intermediate treatment systems for different types of wastes	- Different types of waste nee different types of treatment methods - [WPR-II] Improvement of urban environment by waste reduction and stabilization
Final Disposal	**WPR-P4**: Policy 4 Remaining of treatable waste shall be properly disposed at the sanitary landfill.	Development of new sanitary landfill and establishment of efficient operation and maintenance systems.	- Each type of treatment still has some untreated material which always need final disposal site. - [WPR-I] Establishing the sustainable SWM system

Source: JICA Project Team

8.4.4 Solid Waste Management Sector Development Plan

(1) Solid Waste Generation Forecast

1) General

Water demand projection is prepared based on the population forecast prepared by JICA Project Team (See Section 4.3). The GDUP and JPT expect the projected population of the Erbil 2050 MP target area to increase up to 3 million by 2050 including IDPs. The respective population projections for the Erbil city centre and the northern development area have been described in Section 4.3.

2) Waste Generation Forecast

The following conditions were used to forecast the solid waste generation for Erbil 2050MP.

Unit Waste Generation Rate

According to the latest research1 conducted on the solid waste generation, the unit waste generation rate is 1.1 kg/c/d, while Erbil 2030 MP (MOMT, 2007) determined 1.35kg/c/d. According to the Solid Waste Management sector stakeholders, the waste generation shall be reduced after the environmental awareness will be raised. Therefore, the unit waste generation rate is set as 1.1 kg/c/d. though the further survey on the waste generation is required to confirm this figure.

Waste Generation Forecast

Based on the above conditions, the waste generation forecast by 2050 are shown in the table below.

Table 8.4.3 Waste Generation Forecast

Item	2025	2030	2040	2050
Population	**1,982,000**	**2,200,000**	**2,620,000**	**3,009,000**
Unit Waste Generation Rate (kg/c/d)	1.1	1.1	1.1	1.1
Total Waste Generation (ton/d)	**2,180**	**2,420**	**2,882**	**3,310**

Source: JICA Project Team

Furthermore, based on the waste classification shown in Figure 8.4.1 "Municipal Solid Waste Composition in Erbil City in 2020", the future waste volumes were divided into combustible waste, recyclable inorganic waste and non-recyclable inorganic waste as shown in the table below. Combustible waste account for approximately 80% of the total.

Table 8.4.4 Waste Generation Forecast

Item		2025	2030	2040	2050
(a) Combustible Total (ton/d)		**1,826**	**2,027**	**2,414**	**2,772**
Paper	11.2 %	244.2	271.0	322.8	370.7
Plastic	27.8 %	606.3	673.0	801.5	920.5
Organic	44.7 %	975.4	1,082.7	1,289.4	1,480.8
(b) Recyclable Inorganic Total (ton/d)		**134.5**	**149.3**	**177.8**	**204.2**
Metal	3.5 %	76.5	84.9	101.2	116.2
Glass	2.7 %	58.0	64.4	76.7	88.0
(c) Non-recyclable Inorganic	10.1%	**219.8**	**243.9**	**290.5**	**333.6**

Source: JICA Project Team

(2) Solid Waste Management System Development Plan

1) Formulation of SWM Regulations

An immediate measure that can be initiated to solve Erbil's solid waste problem is the enactment and enforcement of regulations to reduce of waste volumes through segregation at source, separate collection and recycling, in line with the 3Rs concept, as well as to impose waste collection fees. However, it is not easy to introduce waste segregation at source due to existing practices, thus it would be very time-consuming for the behaviour change of the people. Hence, the development and enforcement of SWM regulations, which include the promotion of waste segregation at source, waste fees based on the volume and penalties for illegal waste dumping, is planned as a first step towards proper waste management.

[1] S. A. Othman et al, 2023, Solid Waste Handling Scenario, Management and Economic Study in Erbil City

2) Waste Minimisation and Separation at Source

Waste minimisation and segregation at source is another activity that can be initiated immediately. It is expected to take significant period of time to change the behaviour of Erbil residents due to their traditional habits and so that almost the entire population is able to reduce and properly sort their waste. Therefore, this activity needs to be implemented over the short to long term. It is planned to publicise the importance of waste reduction and segregation at the source and the consequent conversion of waste into resources, the efficiency of waste management costs, as well as the secondary effects such as urban environmental improvement, through public information and internet-based awareness campaigns and environmental education at schools, universities, and other research institutions.

Positive effects of waste minimization and segregation at source are:

- Reduction of waste generation amount
- Improvement of collection efficiency (less cost for collection and transportation)
- Improvement of recyclables quality (cans, bottles, plastic, paper, kitchen waste, etc.)

Considerations on source segregation and separate collection are as follows:

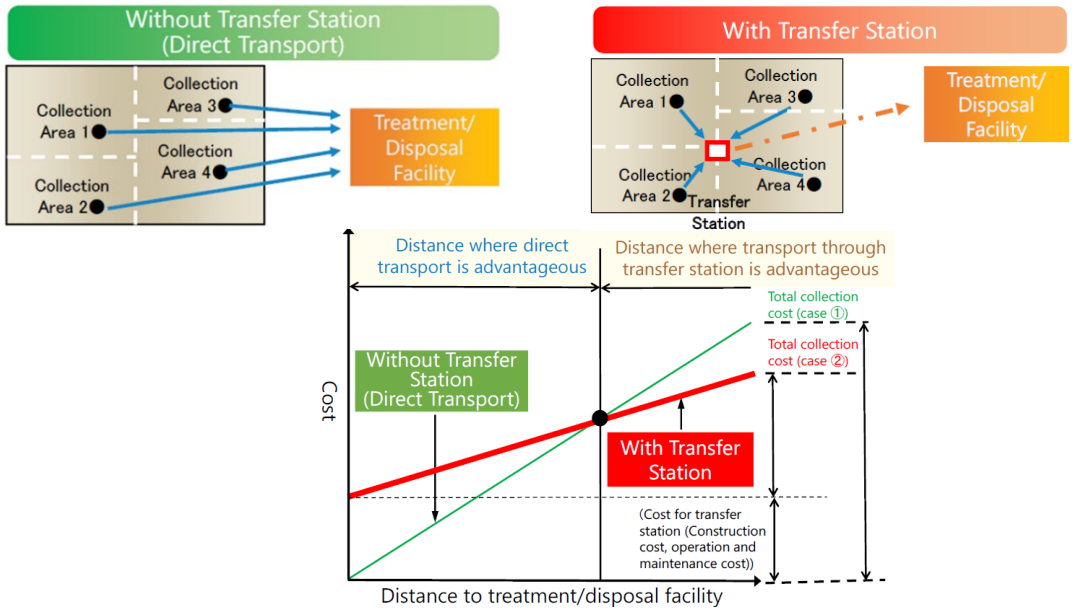
- Municipality to develop collection system with personnel, equipment and funds.
- Set the number of categories and the separation items to gain understanding of the residents.
- Support the growth of recycling industry who receive and handle the separated recyclable items.

3) Waste Collection and Transportation

The collection and transport system will be improved, as at present all waste is collected and transported to the final landfill site without being sorted. Where waste is collected from a wide area and conveyed to a distance landfill site, like Erbil, it is recommended with the installation of transfer stations to improve the efficiency of collection and transport. Transfer stations shall be planned so that, along with the transshipment of waste from small trucks to larger trucks, reduction by compaction, and sorting and shredding may be implemented in the future. The purposes of establishing transfer stations are as follows.

- Transfer of waste from small truck to a larger transport vehicle
- Compaction of waste with compressor to reduce the volume
- Some transfer stations have sorting and shredding equipment for recycling

As shown in the figure below, the installation of Transfer stations is considered to reduce costs if the transport distance is more than 10 km or the transport time is more than 30 minutes.



Source: JICA, 2022, Japan's Experiences on Waste Management

Figure 8.4.6 Comparison between with and without Transfer Station Options

4) Intermediate Treatment Facilities (ITFs)

Intermediate treatment facilities (ITFs), often attached to relay stations, reduce the amount of waste transported to final landfill sites and convert waste into resources using techniques such as incineration (Waste to Energy: WtE), mechanical-biological treatment (MBT) and composting.

Currently there is no formal ITFs in Erbil, while some informal sectors including waste pickers and private entrepreneur collecting recyclables and selling to some dealers of recycling materials.

ITFs that can be constructed and start treatment in a short period under the current situation where waste is not sorted at the source include WtE and MBT which have sorting function. As a short-term measure, it is planned to build these facilities first, followed by composting and recycling facilities once sorting at the source has progressed.

MOMT is considering the development of WtE facility, however, it is still under the feasibility study (F/S) phase, and MOMT is waiting for the Final Report of the study.

5) Selection of Candidate Locations for Transfer Stations and ITFs

On the basis of the final Land Use Plan of Erbil 2050 MP and the selection criteria shared by JPT, the candidate sites suitable for TSs cum ITFs were selected by the JPT. The site selection criteria are as follows.

Table 8.4.5 Selection Criteria of SWM Facilities Sites

1. Exclusionary Siting Criteria

The following areas shall be excluded from site selection of the solid waste management (SWM) facilities:

- Wetlands and floodplains.
- Endangered and protected flora and fauna habitats.
- Parks and preserves.
- Protected sites of historical, archeological, or cultural significance.
- Prime agricultural land.

2. Environmental and Social Criteria

Based on the environmental and social considerations, the following criteria will be applied for any SWM facility:

- Land use compatibility.
- Environmental Justice considerations (e.g., not in minority or low income areas).
- Impact on ground and surface water quality.
- Impact on air quality.
- Noise and aesthetical impact.
- Impact on the local infrastructure.
- Adjacent land uses, including other environmental stressors that might already exist.
- Proximity to schools, churches, recreation sites, and residences.
- Prevailing winds.
- Number of residences impacted (present and future population density).
- Presence of natural buffers.
- Impacts on existing businesses.
- Expansion capability.
- Buffer zones and screening measures.
- Traffic compatibility.
- Impact on historic or cultural features.
- Impact on neighborhood character.
- Transport distance to the facility.

3. Technical Criteria

Technical criteria provide guidance on specific engineering, operational, and transportation conditions that should be considered to ensure that the candidate site is feasible. These criteria address the following issues:

A. Landfill Site

The following criteria are suggested for the selection of landfill sites.

- **River**: Landfill should be constructed at least 100 m away from major river or stream. The distance may be reduced in some instances for non-meandering rivers, but a minimum of 30 m should be maintained in all cases.
- **Lake or Pond**: Landfill should be constructed at least 200 m away from any lake or pond. Because of concerns regarding runoff of waste water contact.
- **Water Supply Wells**: No landfill should be constructed within 500 m of any water supply well. It is strongly suggested that this locational restriction be abided by at least for down gradient wells.
- **Groundwater Table**: A landfill should not be constructed in areas where water table is less than 2m below ground surface. Flow direction of groundwater should be considered.
- **Highway**: Landfill should not be constructed within 200 m of any regional or national highway. This restriction is mainly for aesthetic reasons. A landfill may be built within the restricted distance, but no closer than 50 m, if trees and berms are used to screen the landfill site.
- **Airports**: No landfill should be constructed within the limits prescribed by regulatory agencies (Environment or Aviation Authorities).
- **Habitation**: A landfill site should be at least 500 m from a notified habituated area. A zone of 500 m around a landfill boundary should be declared a No-Development Buffer Zone after the landfill location is finalized.
- **Buffer Zone**: A landfill should have a buffer zone around it, up to a distance prescribed by regulatory agencies.

B. Transfer Stations

In areas that the distance from the end of all collection routes is more than 10 km or 30 minutes, and where the small vehicles are collecting waste, it will be more cost effective to transfer waste to large 15-20 ton vehicles at transfer stations.

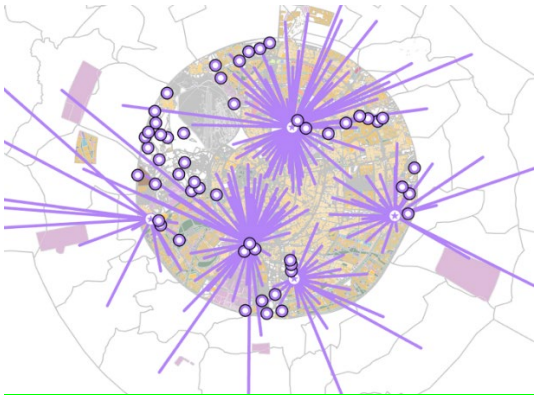
- **Central location to collection routes**: Transfer stations shall be located centrally to waste collection routes to maximize collection efficiency.
- **Access to major transportation routes**: Transfer stations shall have direct and convenient access to major truck routes, arterials and highways.
- **Site size requirements**: Locating a site with sufficient size is critical to operating efficiency and minimizing impacts on the surrounding community. Engineering input can establish preliminary size criteria based on a conceptual design.
- **Sufficient space for onsite truck movement**: Transfer stations need sufficient space for onsite roadways, queuing and parking to allow incoming and outgoing vehicle move around.
- **Truck and traffic compatibility**: The sites shall be located away from areas that have midday traffic peaks and/or school bus and drop-off/pick-up traffic.
- **Space for recycling, composting, and public education**: A transfer station can be sited in areas conductive to recycling or composting activities, also incorporate education center.
- **Buffer space**: Transfer stations shall be located in areas that provide separation from sensitive adjoining land uses such as residences.
- **Access to utilities**: Transfer stations require electricity to operate equipment, water for facility cleaning, and sewerage for wastewater disposal.

C. Intermediate Treatment Facilities (ITF)

Technical criteria for the ITFs are more or less same as the criteria for the transfer station.

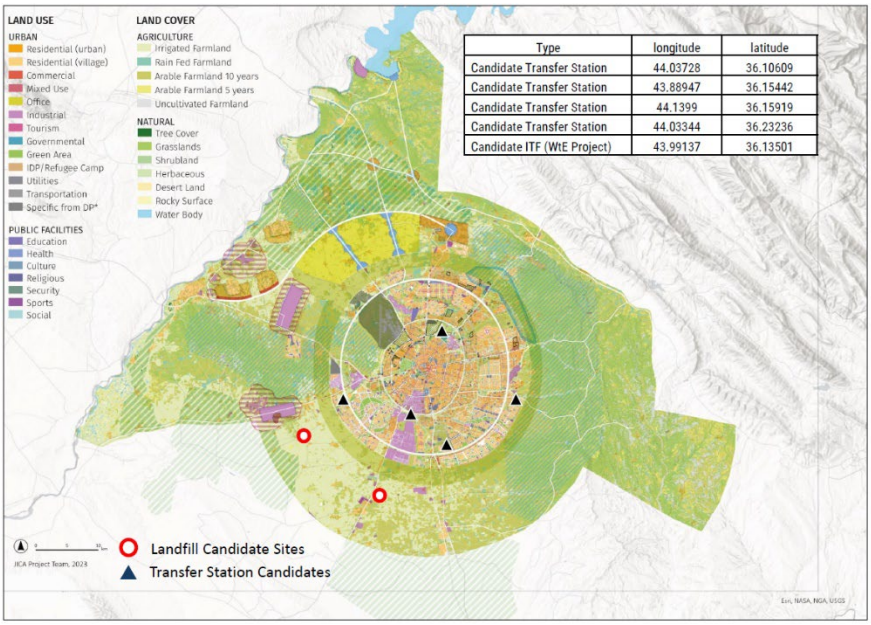
Source: JICA Project Team

Based on these selection criteria, by using the GIS, land with no future use plan and with a minimum area of 20 ha was identified, from which five optimal sites were selected, taking into account the distance from each settlement and the population. These sites will be reserved as land to be used for future waste management after confirmation by waste management stakeholders.



Source: JICA Project Team

Figure 8.4.7 Optimisation of candidate TSs sites using GIS



Source: JICA Project Team

Figure 8.4.8 Candidate SWM locations (5 candidate TSs and 2 final disposal sites)

In addition, the criteria for the technologies in the table below were also presented as a reference for the selection of technologies for the ITFs.

Table 8.4.6 Selection Criteria of ITF Technologies

Criteria	Composting	Anaerobic Digestion	Incineration (WtE)	RDF	Sanitary Landfill
1. Technical status	Widely used	Widely used	Widely used	Widely used	Widely used
2. Type of waste	Sorted organic waste, wood	Sorted organic waste, animal/human excreta, sludge	Unsorted waste	Unsorted waste without hazardous waste	Unsorted waste without hazardous waste
3. Applicable scale	Small to large scale	Small to large scale	Large scale	Large scale	Large scale
4. Operational conditions	Temperature sensitive, long residence time, regular aeration required, odor control, clean input material, contamination measure	Clean, homogeneous and consistent input, good process control	Homogeneous and consistent input, good process control	Clean, homogeneous and consistent input, good process control	Clean, homogeneous and consistent input, good process control
5. Final products	Compost	Methane gas, digestate	Heat	RDF	Methane gas
6. Capital investment	Low for window system, medium for in-vessel system	High	High	Medium	Medium
7. Operational investment	Low for window system, medium for in-vessel system	Medium for manual system, high for automatic system	High	Medium	Medium
8. Land requirements	Medium for window system, low for in-vessel system	Low	Low	Low	High
9. Required skills	Technical skills, training required for in-vessel system	Technical skills, training required	Technical skills, training required	Technical skills, training required	Technical skills, training required
10. Potential	Odor, insect problem	Leakage of	Air pollution	Uncertain heat	Odor, insect, rodent

adverse impacts		methane gas	from syngas and toxic emission	value	methane emission, leachate, limited recovery efficiency
11. Contribution to energy security	None	Power generation from methane gas	Power generation from heat	Energy from RDF	Power generation from methane gas
12. Contribution to food security	Use compost as organic fertilizer	Use digestate as organic fertilizer	None	None, high contamination	None, high contamination

Source: JICA Project Team

6) Final Disposal: Safe Closure of Kani-QirZhala and Opening of Sanitary Landfill

The only landfill site in Erbil, Kani-Qirzhala disposal facility (DF), has regular covering, waste spreading and compaction, adequate heavy machinery and personnel, gas discharge pipes and several environmental protection measures in place, however the absence of a leachate management system means that surface water, groundwater and agricultural activities in the vicinity are at high risk exposed to high risks.

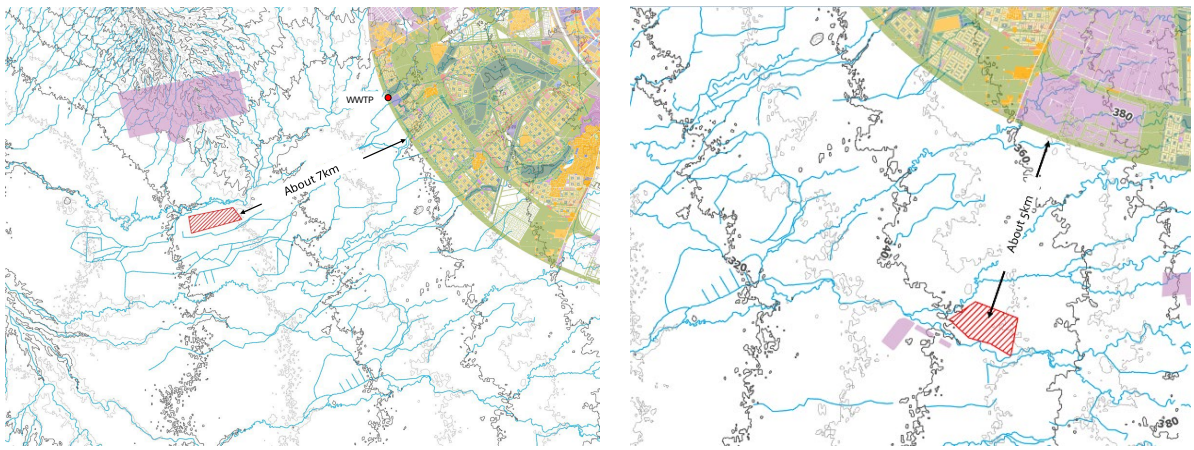
In addition, as the DF will soon be full, the development of new DF sites is an urgent priority.

As it takes 3-5 years to develop a new DF, a life extension plan for the existing DF must first be developed and implemented, while the planning, design and construction of the new DF shall be carried out in parallel. Furthermore, a safety closure plan for the existing DF shall be developed and safety closure must be implemented after the new DF become operational.

Considerations on the new sanitary landfill are as follows:

- Properly designed impermeable liner
- Properly designed leachate drainage layer; Collection pipes and diversion pipe network
- Leachate is diverted to treatment system (biological & chemical)
- Gas emission pipe network connected to centralized collection system
- Machines for compaction and making slopes; applying daily cover soil layer, intermediate and final cover layers
- Visual observations and regular emission tests, groundwater monitoring
- Closure and Post-closure plans are developed

Based on the selection criteria in Table 8.4.6, two locations with no future use plan and with a minimum area of 100 ha were identified by JPT, considering the impact to the water resources and distance from the border of Erbil municipality.



(a) Landfill Candidate Location-1 WSW (b) Landfill Candidate Location-2 SSW

Source: JICA Project Team

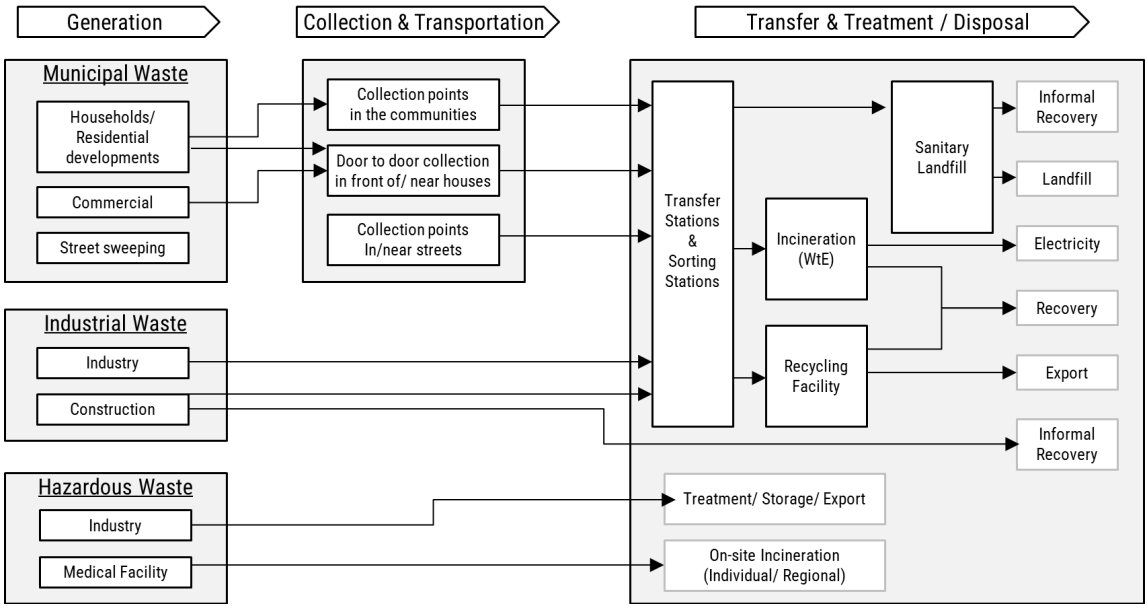
Figure 8.4.9 Candidate Location for New Sanitary Landfill

According to the Guideline No.(1) of 2024 of the Environmental Protection and Improvement Board, Guidelines for classifying projects and determining the location and environmental conditions issued by the Environmental Protection and improvement Board of KRG. The new landfill site must be 5 km away from the municipal boundary. 3 km away from the residential area and 500m away from the public and highway. Modern technology should be used in management, transportation and safe disposal of waste.

As shown in Figure 8.4.9, the proposed new landfill sites are located near the WWTP, which will be constructed under the JICA loan project (IQ-P23), and also not far from the Gwer Industrial Zone. The future development of this area as a recycling zone, where wastewater sludge and combustible waste will be incinerated and recycled, will provide better accessibility (shorter travel distances, proximity to other related facilities), environmental protection (not in the direction of winds and dust storms, nor near water sources or urban areas), and promotion of circular business in Erbil.

7) Hazardous (Medical and Industrial) Waste Treatment

One of the issues in SWM in Erbil is that the municipal waste and hazardous waste are mixed together to be collected and disposed directly in landfill sites. In order to establish an appropriate system of the hazardous waste treatment, a study of the actual situation, data collection and analysis of the hazardous waste generation in Erbil, and formulation and implementation of the plan of collection, storage and treatment of hazardous waste separated from non-hazardous waste are required.



Source: JICA Project Team

Figure 8.4.10 Proposed Solid Waste Flow in Erbil by 2050

(3) SWM Development Action Plan

The table below summarises the development scenarios towards 2050 describing the short-, mid- and long-term implementation plans for each of the items in the Waste Management System Improvement Plan above.

Table 8.4.7 Action Plan of Respective Terms

Theme	Short-Term (up to 2030)	Mid-Term (2040)	Long-Term (2050)
SWM Regulations	- Formulation and enactment of regulations related to SWM	- Enforcement of the regulations - Imposition of waste fees	- Revision of the regulations - Revision of waste fees
Waste Generation	- Study and analysis on the	- Implement the awareness	- Continuation of the

	municipal waste generation - Plan of awareness campaign and environmental education - Public consultation on 3R practices	campaign and environmental education - Source separation based on the concept of 3Rs	awareness campaign and environmental education - Continuation of the waste segregation practices at source
Collection and Transportation	- Plan of separate collection system - Design and construction of the transfer stations (TSs)	- Implementation of the separate collection system - Construction of TSs for the northern development area	- Expansion of the separate collection system covering all areas of Erbil - Monitoring of TSs operations
Intermediate Treatment Facilities (ITFs)	- Design and construction of recovery facility (WtE or waste sorting plant MBT) near final disposal area	- Design and construction of recycling and composting facilities at the TSs.	- Expansion of the recycling and composting facilities covering all areas of Erbil - Monitoring of ITFs operations
Hazardous Waste Treatment	- Study and analysis on the hazardous waste generation - Plan of collection, storage and treatment system of hazardous waste	- Implementation of the collection, storage and treatment system of hazardous waste	- Monitoring of hazardous waste treatment system
Final Disposal	- Plan and design of new sanitary landfill - Plan and implementation of life extension of Kani-Qizhala landfill site	- Construction and opening of the new sanitary landfill site - Implementation of safe closure of Kani-Qirzhala landfill site	- Continuation of use of the new landfill site - Monitoring of landfill operations - Utilisation of closed landfill site as afforestation or green areas for recreation.

Source: JICA Project Team

(4) Priority Projects

Among the above development action plans, particularly the most urgent and important short-term initiatives are proposed as priority projects. For more information, see the profiles summarised in 10.2 Proposed Sector Priority Project.

1) Erbil Solid Waste Management Improvement Project

This project will develop a new waste management M/P as a basis for establishing a sustainable waste management system in Erbil. The aim is thereby to ensure appropriate waste collection, transport and treatment, as well as the establishment of waste sorting and recycling activities at source amongst the residents. The project will include the following activities.

- Development of SWM M/P with financial planning
- Design, construction, O&M plans for intermediate treatment facilities (ITF) and new disposal facility (DF)
- Development of closure plans for existing Disposal site Kani-Qirzhala
- Capacity building of SWM activities, including contract supervision for the implementation of plans
- Capacity building on monitoring and performance evaluation systems for SWM activities
- Develop and implement an environmental education and public awareness plan for waste separation and collection

2) Erbil Disposal Facility (DF) Development and Closure Project

As Erbil's only landfill site, Kani-Qirzhala, will be full in a few years, a new landfill site will be designed and developed to replace this site, while at the same time extending the life of Kani-Qirzhala, while planning for its safe closure. Safe closure of the old landfill site will be carried out after the new landfill site is in service. The following activities are included.

1. Preparation the DF life extension plan for the next five years
2. Development of new DF
3. Prepare the existing DF safe closure plan

3) Erbil Solid Waste Intermediate Treatment Facility (ITF) Construction Project

The project will facilitate the implementation of an intermediate treatment facility (ITF) for incineration and waste generation, which is currently being planned by MOMT, as well as the development of facilities associated with the ITF. This plan is suitable for waste management in Erbil, where a phased recycling behaviour change is planned, as it allows incineration without waste segregation at source. First, the ITF and transfer station will be constructed, and in the future the facilities for segregation and treatment of recyclable waste at the transfer station will be expanded.

8.4.5 Recommendations

(1) Development of the SWM Master Plan, Regulations and Guidelines

As one of the priority projects, the Erbil SWM sector does not have an officially approved M/P, so the development of the M/P is urgent and higher priority. In the development of the M/P, it should be considered that a thorough survey and analysis of the current situation is carried out to ensure the most appropriate approach to sustainable SWM. The development of relevant regulations and guidelines on SWM to operationalise this M/P will also be pursued in conjunction with the development of the SWM master plan.

Furthermore, a 10-year SWM plan should be developed as a viable plan to enable full implementation and operationalisation of the master plan. This 10-year plan should be reviewed and amended every 2-3 years to reflect changing technologies, social and economic conditions associated with the SWM implementation.

(2) Promotion of Collaboration among Stakeholders

To enable effective and sustainable SWM, the SEM sector must collaborate with the Erbil Municipality, industry, agriculture, sewerage and environmental sectors to implement activities to reduce waste at source, handle industrial and agricultural waste, treat sewage sludge and reduce environmental impacts. Close cooperation with the electricity sector is also required to implement the planned waste-to-energy (WtE) as part of the ITF development. In addition, biodegradable/compostable and reusable/recyclable waste is currently collected by the informal sector, and thus close collaboration with these informal sectors is also essential.

(3) Careful Arrangement of Land for ITFs and DF

In selecting candidate sites for SWM-related lands such as ITFs and Disposal Facilities (DFs) to be developed in the future, the above-mentioned criteria were provided by JPT, but no final agreement was reached from the agencies concerned during the project period.

In selecting sites, the urban planning sector shall take the initiative and arrange available lands and carry out land acquisition procedures based on the land use plans, land ownership (public or private) and surrounding land use conditions.

In particular, it is strongly recommended that land be carefully arranged for the development of facilities on final disposal facilities. If it is difficult to acquire land for landfill development, it is suggested that the vicinity of the wastewater treatment plant (WWTP) for which a site has already been secured be reconsidered as a candidate.

8.5 Power & Energy

8.5.1 Existing Conditions

The Ministry of Electricity (MOE) of KRG is responsible for development of the power sector in the Kurdistan Region, including Erbil City. The Iraqi government is not involved in Kurdistan's electricity development plans. In recent years, the Kurdistan Region has not imported electricity from Iraq or neighbouring countries and has been largely unaffected by other countries in terms of electricity supply.

The Kurdistan Region continues to experience power supply shortages. All three provinces, Erbil, Sulaymaniyah and Duhok, have limited electricity supply through issues such as load shedding. In Erbil, the supplied power demand is 1,072 MW in 2022, but potential peak demand is 2,221 MW, meaning that the suppressed demand is 1,149 MW which is more than half of the potential peak demand.

Table 8.5.1 Supplied Demand and Potential Peak Demand in Kurdistan Region in 2022

(Unit: MW)

	Erbil	Sulaymaniyah	Dahuk	Total
Supplied Demand	1,072	888	749	2,709
Potential peak demand	2,221	2,133	1,532	5,886
Suppressed demand	1,149	1,245	783	3,177

Source: MOE

(1) Generation

The power system in the Kurdistan Region will be interconnected with 400kV (under development) and 132kV lines. Therefore, when considering power supply to the Erbil area, it is necessary to take into account the generation capacity and electricity demand not only in Erbil but also in the entire Kurdistan region.

The total generation capacity of the Kurdistan Region is 5,865 MW as of 2023 as shown in the Table 8.5.2. It is almost same as the potential peak demand of the whole region at 5,886 MW. In short, the capacity of the generation facility needs to be increased to meet with the growing power demand. The current bottleneck of power supply is the supply of primary energy. Due to the shortage of the gas and oil caused by financial difficulties, the output of the generation facility has been limited. Therefore, many power users are using private generators, which is leading to high electricity costs and increased CO_2 emissions.

Table 8.5.2 Power Plants in Operation in 2023

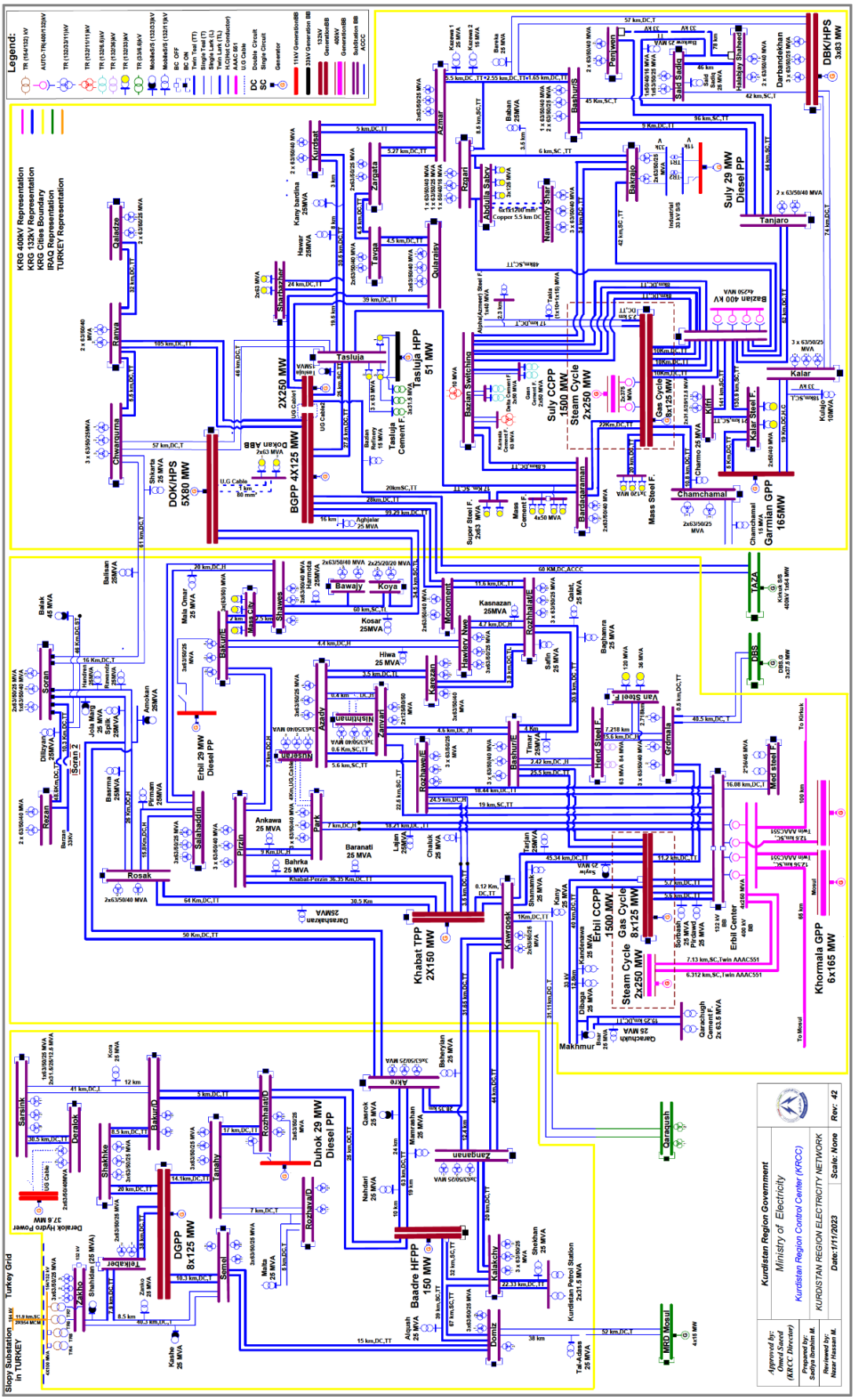
Power Plant	# of units	Designed Capacity (MW)	Generation Capacity (MW)	Type of Project	Owner	Type of Fuel
Erbil Combine Cycle	10	1,500	1,200	IPP	Mass Global	Gas + Diesel
Sulaymania Combine Cycle	10	1,500	1,200	IPP	Mass Global	Gas + Diesel
Duhok Simple Cycle	8	1,000	800	IPP	Mass Global	Gas + Diesel
Baadre Diesel Power Plat	13	150	148	IPP	Poltex	HFO
Tasluja Diesel Power Plant	30	51	40	Governmental	MoE	HFO
Erbil 29 MW	4	29	25	Governmental	MoE	HFO
Sulaymania 29 MW	4	29	25	Governmental	MoE	HFO
Dohok 29 MW	4	29	25	Governmental	MoE	HFO

Power Plant	# of units	Designed Capacity (MW)	Generation Capacity (MW)	Type of Project	Owner	Type of Fuel
Erbil Simple Cycle Khormala / Kar Group	6	960	800	IPP	KAR Group	Gas + Diesel
Bazyan Simple Cycle	4	1,000	900	IPP	Qaiwan	Gas + Diesel
Khabat Thermal Power Plant	2	300	300	Governmental	MoE	HFO
Dokan Hydro PP	5	400	100	Governmental	MoE	Water
Darbandikan Hydro PP	3	249	100	Governmental	MoE	Water
Garmian GG	190	165	165	IPP	Agriko	Flare Gas
Deraluk Hydro PP	2	37	37	Governmental	MoE	Water
Total	283	7,399	5,865	-	-	-

Source: MOE

(2) Transmission

The transmission network as of 2023 is shown in Figure 8.5.1. Until now, the 132 kV transmission line has been the backbone transmission line within the Kurdistan Region, but a 400 kV network is being developed to provide transmission flexibility for the three provinces of the Kurdistan Region.

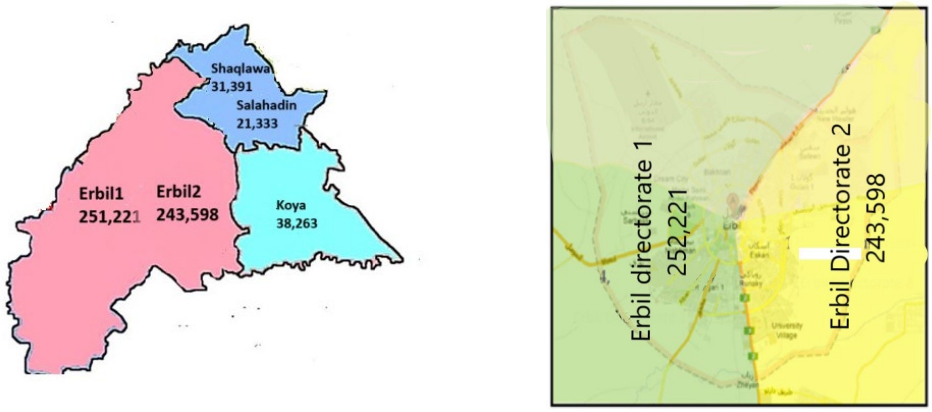

Legend:
KRG 400kV Representation
KRG 132kV Representation
KRG Cities Boundary
IRAQ Representation
TURKEY Representation
DBK/HPS 3x83 MW
Derbandekhan
Halabjay Shaheed
Said Sadiq
Penjwen
Basheriis
Azmar
Kurdsat
Zargata
Rzgari
Abdula Sabr
Nawendy Star
Bakrajo
Suly 29 MW Diesel PP
Tanjaro
Qularaisy
Tasluja
Tasluja HPP 51 MW
Tasluja Cement F.
2X250 MW
BGPP 4X125 MW
DOK/HPS 5X80 MW
Bazian Switching
Suly CCPP 1500 MW Steam Cycle 2x250 MW
Gas Cycle 8x125 MW
Bazian 400 kV
Kalar
Kalar Steel F.
Kifri
Charmo 25 MVA
Chamchamal
Garmian GPP 165MW
Bardarash
Mass Steel F.
Super Steel F.
Mass Cement F.
Ranya
Galadze
Chwarqurna
Shkarta 25 MVA
Shatbazine
Aghjalar 25 MVA
Taza
DBS
Koya
Bawaly
Kosar 25MVA
Shawes
Mela Ebr
Nala Omar 25 MVA
Balisan 25MVA
Balak 45 MVA
Soran
Soran 2
Kozan
Rosak
Bakrajo
Erbil 29 MW Diesel PP
Amokan 25MVA
Jola Mang 25 MVA
Dibrya 25MVA
Basima 25MVA
Pirman 25MVA
Salahaddin
Ankawa 25 MVA
Pirzin
Park
Baranati 25 MVA
Bahrka 25 MVA
Lajan 25MVA
Chaka 25 MVA
Tarjan 25MVA
Shamamk 25 MVA
Kany 25 MVA
Khabat TPP 2X150 MW
Kwarkook
Erbil CCPP 1500 MW Steam Cycle 2x250 MW
Gas Cycle 8x125 MW
Erbil Center
Sorkan 25 MVA
Piramagrun 25 MVA
Kandenawa 25 MVA
Dibaga 25 MVA
Bnar 25 MVA
Qaradagh Cement F. 2x 63.6 MVA
Makhmur
Qaradagh 25 MVA
Khormala GPP 6x165 MW
Grdmala
Hend Steel F.
Van Steel F.
Basarine
Rozhalate
Monomark
Kasnazan 25MVA
Hawlery Nwe
Karezan
Hiwa 25 MVA
Azady
Nishtiman
Zanyary
Bakrajo

There are twenty-four (24) 132 kV substations, including 2 private substations in Erbil. The total capacity is 3,787 MVA as of May 2022. According to the result of the power system analysis of the Transmission and Distribution Master Plan, some 132 kV transformers will be overloaded in 2022-2023. It is therefore planned for the installation of new transformers and construction of new 132 kV substation. Details are shown in Section 8.5.4.

After the formulation of the Erbil 2030 MP, 132 kV network is to be reinforced in Erbil City. Some of the new substations are not included in the Erbil 2030 MP. Capacity however remains insufficient, since the current power demand in Erbil is higher than the power demand forecasted in the Erbil 2030 MP.

(3) Distribution

Distribution voltages in Erbil are 33kV, 11kV and 0.4kV. Distribution facilities are being developed in Erbil according to the *Electricity Distribution Development Plan 2017-2026*. The Erbil Governorate is divided into five Distribution Directorates, operating under the General Directorate of Electricity in Erbil. Electricity distribution functions including operation, maintenance, development of distribution networks and customer service are decentralized and delegated to these Distribution Directorates. The geographic demarcation of the distribution directorates is shown in Figure 8.5.2. The target area of Erbil 2050 MP is Erbil D1 and D2 and a part of Permam.



Source: Electricity Distribution Development Plan 2017-2026

Figure 8.5.2 Demarcation and Consumers in Distribution Directorates of Erbil

1) Distribution network assets

Electricity network assets include all components of electricity networks and consumer installations that are owned by the Ministry of Electricity (MOE), such as substations, power lines, transformers, switches, consumer meters and other equipment. The MOE and Erbil General Directorate of Electricity are responsible for the procurement, installation, operation, maintenance, management, renewal or disposal of the network assets. The following table provides an account of the existing distribution network assets based on the asset records of the General Directorate of Electricity in Erbil as of 2023.

Table 8.5.3 Distribution Network Assets in Erbil as of 2023

Directorate	Substations		Mobiles			11/0.4 kV Trans, Nos	33 /0.4 kV Trans, Nos	11 kV Fdrs, Nos	33 kV Fdrs, Nos	33 kV Dist. Fdrs, Nos	11kV Feeders Length, km		33kV Feeders Length, km	
	132 /33 /11	33 /11	132 /11	132 /33	33 /11						OH	UG	OH	UG
Erbil D1	9	14	12	2	3	13,039	87	364	29	15	4,637	576	256	128

Erbil D2	7	6	7	-	0	6,904	26	253	15	10	1,808	630	5	103
Permam	1	1	2	-	-	834	-	36	2	1	317	38	53	3
Shaqlawa	1	3	2	1	-	1,255	-	41	5	-	245	37	107	7
Koya	2	2	2	-	1	1,189	1	45	4	1	1,092	17	48	2
Total	20	26	25	3	4	23,221	114	739	55	27	8,100	1,300	479	244

Source: MOE

2) 11 kV distribution network

Primary distribution to various localities is carried out through 11 kV overhead lines and underground cable networks. 11 kV feeders originate from 132 kV or 33 kV substations. The 11 kV distribution network is considered the core distribution system.

Table 8.5.4 Results of 11 kV Feeder Analysis

Info	Unit	Erbil D1	Erbil D2	Shaqlawa	Permam	Koya	Erbil Gov.
11 kV Feeders	Nos	364	253	41	36	45	739
Demand on 11 kV Feeders	MW	1171	866	111	115	125	2,388
Overloaded Feeders (>310A)	Nos	73	22	2	5	1	103
Feeders with V/Drop (>10%)	Nos	21	0	13	4	6	44

Source: MOE

Following is the remarks with respect to the peak demand (winter);

- During the winter of 2023, a total of 103 11 kV feeders were loaded beyond 310 A (warning level) and 40 feeders were loaded beyond 350 A (critical level).

In addition, according to the Electricity Distribution Development Plan 2017-2026, the following are indicated with regard to voltage drop and power outages.

- A total of 97 11 kV feeders are affected by more than 10% voltage drops during peak demand hours. This is about 16% of all 11 kV feeders. Most of the existing 11 kV feeders inside main cities are not affected by voltage drops; however, a majority of feeders serving small towns and rural areas are affected by voltage drops.
- System Average Interruption Frequency Index, SAIFI = 65 times /year
- System Average Interruption Duration Index, SAIDI = 54 hrs /year

It should be noted that these values refer only to middle voltage distribution system reliability and they do not account for interruptions due to load shedding, transmission and low voltage feeder interruptions. In any case, these reliability indices of the 11 kV network indicate low levels of supply reliability. These levels compared with international norms indicate serious reliability issues that need to be addressed.

3) 33kV distribution network

Followings are brief situation of 33kV network according to the Electricity Distribution Development Plan 2017-2026.

- Six 33 kV sub-transmission feeders are affected by more than 10% voltage drop at peak demand conditions. Certain percentage of these voltage drops at 33 kV level will be compensated by the on-load tap changers at the 33/11 kV substations to minimize its effect on 11 kV side.
- A total of nineteen 33 kV sub-transmission feeders are overloaded at peak demand conditions.

8.5.2 Key Planning Issues

The followings are the key planning issues for the Erbil 2050 MP.

(1) Power demand forecast

- The demand forecast until 2032 is formulated in the Transmission and Distribution Master Plan. It will be expanded to 2050.
- The demand of each distribution directorate will be studied and accounted for in the distribution network development plan.

(2) Generation

- A generation master plan and an energy mix target for the introduction of renewable energy is not exist in KRG.
- The capacity of generation facility is not enough for future power demand.
- The primary energy supply is not enough and it is leading to the limitation of output of generation facility.
- There is a published regulation for the introduction of renewable energy. However, measures to stabilise the system are not sufficient and investment support measures, including investment guarantees, tax incentives, etc. for the introduction of renewable energy are not well developed in the KRG.

(3) Transmission and distribution

- The development plan for transmission network based on the Transmission and Distribution Master Plan will be reflected in the Erbil 2050 MP. But the Master Plan is not approved by KRG officially.
- The transmission and distribution network development plan will be updated based on the demand forecast in Erbil 2050 MP for each area. At present, overloading of 132kV transformers and overloading and voltage drop of distribution network of 33kV and 11kV are key issues to be resolved.
- The progress of the project to underground the distribution lines are reviewed and reflected in the Erbil 2050 MP. As shown in table 8.5.4, undergrounding of distribution lines appears to have made some progress in Erbil D1, D2 and D3.

In Erbil, the power supply is not enough against the power demand and the reliability is not enough. Some of consumers are using their own generator in this situation. Therefore, the improvement of balance of power supply and demand is top priority such as improvement capacity of generation, improvement of transmission and distribution network, demand side management, etc.

8.5.3 Sector Strategies & Policies

(1) Overall Goals of Power & Energy Sector

The Overall Goals of the Power & Energy Sector development in Erbil 2050 MP, which are outlined in Transmission and Distribution Master Plan (MOE, September 2022, under finalization) and Electricity Distribution Development Plan 2017-2026 (Erbil Governorate, November 2016), and which will realize the Long-term Development Visions, can be summarized as below.

- ELC-I: Improvement of power supply capacity, reliability and efficiency for stable power supply in Erbil
- ELC-II: Extension and modernization of the power grid to meet the future urbanization plan

- ELC-III: Advancement of low carbon power supply and demand side management to support low-carbon city development

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Power & Energy Sector mainly support the realization of the Strategic Orientations #4: Intensify the metropolitan area through a new multi-core and fluid model and #5: Build a strong, efficient and resilient infra-structure network providing sufficient service (See Section 6.3), which implements especially the Long-term Development Visions (See Section 4.2) of Efficient Administrative Capital (EAC) and Available Serviced Land and Buildings (ASL).

(3) Strategies & Policies of Power & Energy Sector

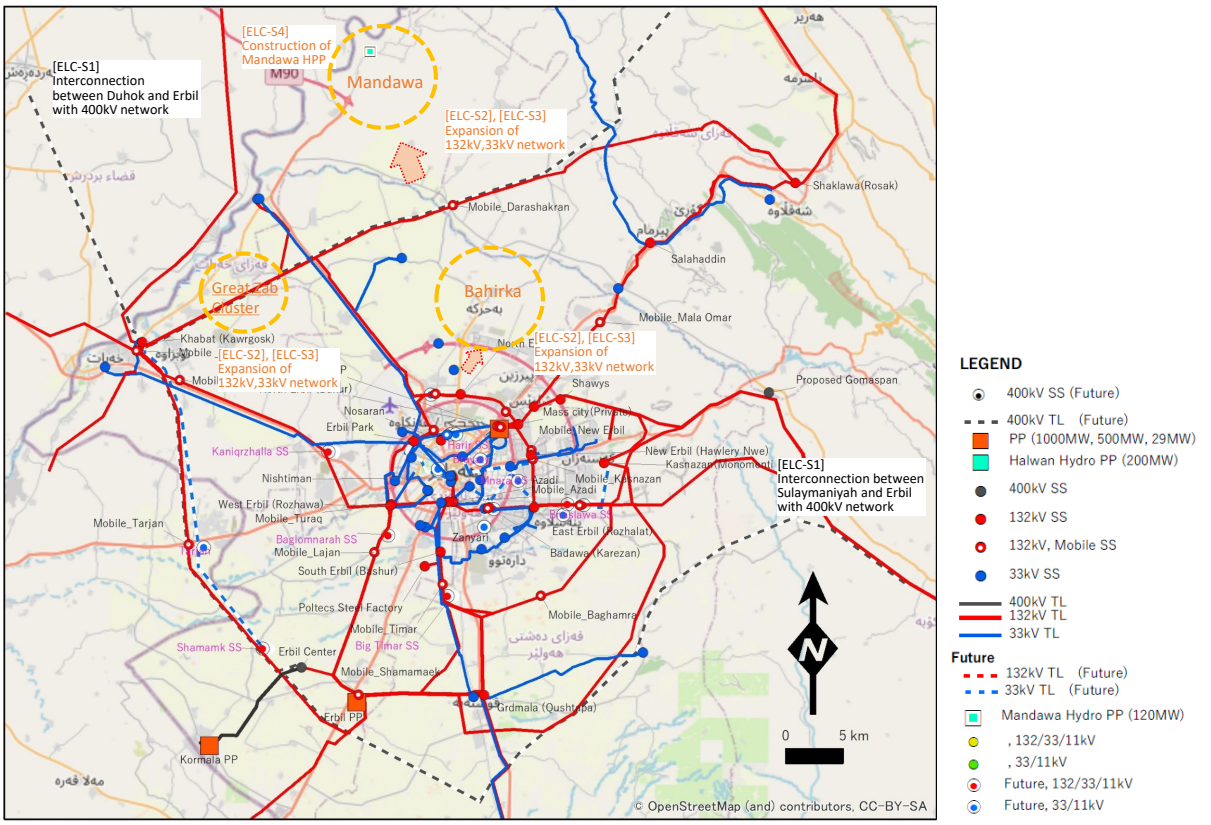
Table 8.5.5 below summarizes the Strategies & Policies of Power & Energy Sector proposed to tackle existing issues and to achieve Erbil 2050 MP Long-Term Visions and Overall Sector Goals.

Table 8.5.5 Strategies & Policies of Power & Energy Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Transmission network	**ELC-S1**: **The expansion of the 400 kV network** *[MoE]* It will not only improve reliability of supply to Erbil, but it will also facilitate transfer of energy from Erbil to other regions when the surplus power generated in Erbil is available.	- **ELC-S1-1**: **Construction of 400kV network** Harir AIS SS 400/132 kV, 4*250MVA Gomaspan AIS SS 400/132kV, 4*250MVA 400kV Transmission line from Erbil Center SS to Duhok SS (193km) 400kV Transmission line from Erbil Center SS to Duhok via Harir SS (105+135km) 400kV Transmission line from Erbil Center SS to Sulaymania SS via Gomaspan SS (75+135km)	- Instability of electricity grid leading to frequent power cuts (ELC-01) - Dependency of a large portion of households on private generators (ELC-02) - [ELC-I] Improvement of power supply capacity and reliability
Transmission network	**ELC-S2**: **The expansion of the 132kV network** *[MoE]* 132kV network supply the power as a backbone of the transmission network to the area of which power demand will be increased.	- **ELC-S2-1: Construction of 132kV S/S and 132kV lines** *[MoE & JPT]* Project list is shown in table 8.5.11. Proposed Project list is shown in Table 8.5.16 to Table 8.5.18.	- Instability of electricity grid leading to frequent power cuts (ELC-01) - Dependency of a large portion of households on private generators (ELC-02) - [ELC-I] Improvement of power supply capacity and reliability - [ELC-II] Extension and modernization of the power grid
Distribution network	**ELC-S3**: **The improvement of the 33, 11kV network** *[MoE]* - Expansion of 33, 11kV network to the new dev. area. - Improvement of voltage drop of 33, 11kV network with the construction of new 33kV lines and substations.	- **ELC-S3-1: Construction of 33kV S/S and 33kV lines** *[MoE & JPT]* Project list is shown in Table 8.5.12 to Table 8.5.14. Proposed Project list is shown in Table 8.5.16. - **ELC-S3-2: Improvement of voltage drop** *[MoE]*	- Instability of electricity grid leading to frequent power cuts (ELC-01) - Dependency of a large portion of households on private generators (ELC-02) - High electricity cost (ELC-03) - [ELC-I]

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
	- Undergrounding existing 33, 11kV overhead lines. Priority should be given to City Centre especially within the 60m road.	Installation of Automatic voltage regulators or Pole mounted line capacitors	- [ELC-II]
Generation (renewable energy)	**ELC-S4**: **Increase the generation capacity of renewable energy** *[MoE]* - Construction of new hydro power plant - Promotion of PV	- **ELC-S4-1: Construction of Hydro power plant (HPP)** *[MoE & JPT]* Mandawa HPP (120MW planned) **ELC-S4-2: Promotion of PV** *[MoE & JPT]* Erbil Solar Power Plant (150MW, max) Installation of PV system to household, gov. facility. Promotion of renewable energy investment such as Feed-in tariff (FIT).	- Dependence on fossil fuels and Low percentage of renewable energy - [ELC-III] Introduction of Renewal Energy
Distribution	**ELC-S5: Promotion of energy efficiency** *[MoE]* - Smart Ready Energy Metering Upgrade - Demand Side Management and Energy Efficiency Improvement	- **ELC-S5-1:** Installation of smart ready electronic type meters - **ELC-S5-1:** Build up the framework of demand side management system	- High non-technical energy losses in the system estimated to be high as 19% - Peak demand is exceeding the power supply capacity - [ELC-I]
Primary energy	**ELC-S6**: Improvement of production of fuel (natural gas, fossil fuel), and improvement of fuel supply network to the power station *[MoE]*	Out of scope of this master plan	- Limitation of generator output due to the lack of fuel. - [ELC-I]
Transmission	**ELC-P1**: Transmission voltage is 400kV, 132kV. 400kV lines provide transmission flexibility for the three provinces of the Kurdistan Region. 132 kV transmission lines are the backbone transmission line within Erbil *[MoE]*	Finalizing the transmission and distribution Master Plan	- Formulation of future power supply network development plan is required.
Distribution	**ELC-P2**: Distribution voltage is 33kV, 11kV and 0.4kV. New distribution lines constructed in the Erbil city centre will be underground cable. Existing 33kV and 11kV overhead lines in the Erbil city centre will be changed to underground cable. Undergrounding of 33kV lines are higher priority.	Update the Electricity Distribution Development Plan in Erbil	- Formulation of detail distribution plan in Erbil need to update.
Generation (renewable energy)	**ELC-P3**: Introduction of renewable energy will be promoted although no specific targets have been set in KRG. A framework will be created to promote investment in renewable energy, equipment for grid stabilization will be installed after the introduction of renewable energy.	Formulate the generation master plan including the development plan of renewable energy	- Formulation of future generation plan is required. There is no target for development of renewable energy now.

Source: JICA Project Team



Source: JICA Project Team based on the data from MOE

Figure 8.5.3 Existing Power Grid and Future Expansion Plan in Erbil

8.5.4 Power & Energy Sector Development Plan

(1) Power demand forecast

For the Erbil 2050 MP, the power demand forecast is updated by using the value of the Transmission and Distribution Master Plan. According to the Transmission and Distribution Master Plan, the potential peak demand (real peak demand) in Erbil in 2022 and 2032 are 2,221 MW and 3,511 MW respectively as shown in Table 8.5.6. For the demand forecast until 2050, the medium case of the power demand until 2032 in the Transmission and Distribution Master Plan is extended.

Table 8.5.6 Power Demand Forecast

(UT: MW)

Scenario-MEDIUM GROWTH	Peak Power Demand											Av. Growth
Year	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	
Erbil	2,221	2,439	2,616	2,757	2,881	3,046	3,174	3,277	3,365	3,427	3,511	4.7%
Dohuk	1,532	1,672	1,784	1,870	1,984	2,068	2,157	2,230	2,282	2,313	2,330	4.3%
Sulaimaniyah	2,133	2,266	2,403	2,511	2,638	2,732	2,846	2,923	3,005	3,077	3,126	3.9%
KRG	5,886	6,378	6,803	7,138	7,504	7,845	8,177	8,430	8,652	8,817	8,967	4.3%

Source: MOE

The peak power demand for this project is calculated using the following steps.

1) The demand forecast for Erbil governorate is extended until 2050 using the forecast of Transmission and Distribution Master Plan.
2) The demand of the project area is 77% of the total Erbil governorate demand based on the actual results in 2022 (Table8.5.7 and Figure8.5.4).

3) The ratios of demand in 2022 in each sector are calculated from the electricity consumption of each sector from 2018 to 2022.
4) The ratios of demand in each sector for each cross-section 2030, 2040 and 2050 are calculated from the population growth rate and the land area of each sector (Figure 8.5.5).
5) The demand of each area (zone I ~ zone XII) is calculated from the population and land area of each sector for each cross-section (2030, 2040 and 2050) (Table 8.5.8).

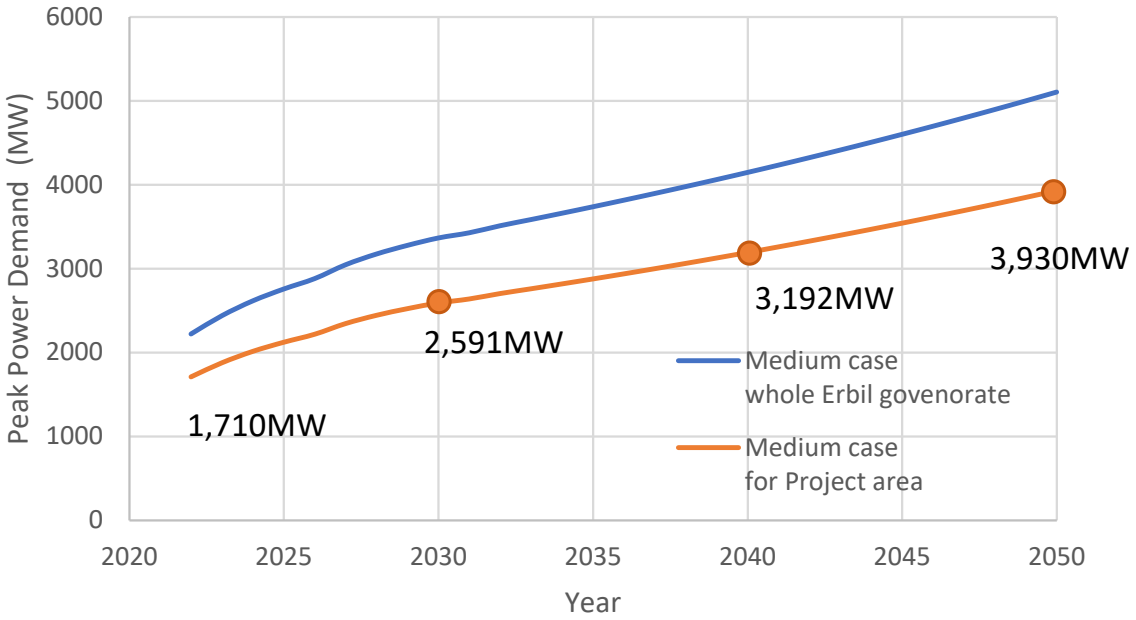
Table 8.5.7 shows the actual peak demand in 2022 in Erbil Governorate. Project area of the Erbil 2050 MP is Electricity Distribution Directorate (1) and (2) which are 77% of peak demand in Erbil Governorate. Figure 8.5.4 shows the peak power demand forecast until 2050 in the project area. Growth rate of power demand from 2030 to 2050 is 2.1%/year which is based on the information from MOE.

Table 8.5.7 Peak Power Demand in 2022 in Erbil Governorate

(Unit: MW)

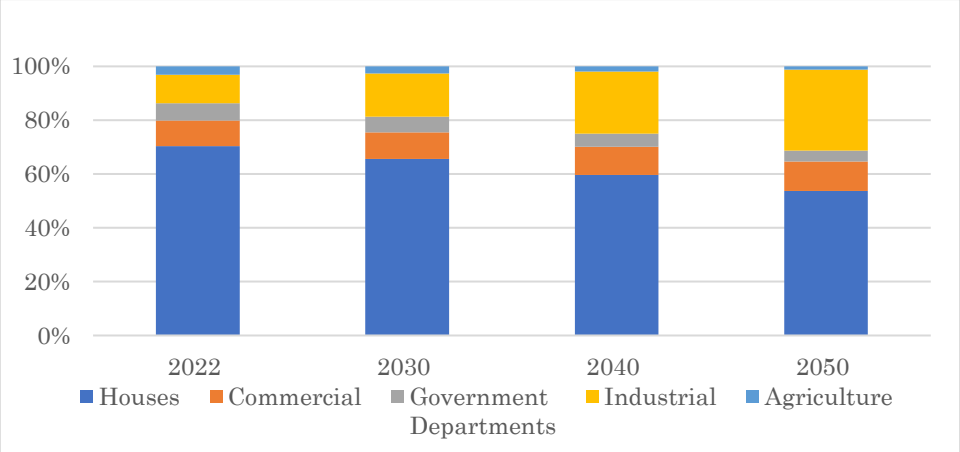
Month	Electricity Distribution Directorate (1)	Electricity Distribution Directorate (2)	Salahaddin	Shaqlawa	Soran	Koya
Jan	1154.0	897.9	114.0	103.6	268.6	130.3
Feb	1070.3	782.9	111.2	94.5	249.9	118.4
Mar	1096.4	765.6	110.2	100.8	246.9	120.5
Apr	880.0	578.0	96.0	75.6	203.0	91.4
May	857.6	556.4	88.7	69.6	169.1	83.0
Jun	952.8	577.4	91.5	70.5	160.5	84.5
Jul	999.2	576.4	95.3	71.7	157.0	87.6
Aug	1034.0	588.3	97.2	71.7	161.9	90.2
Sep	1018.2	553.2	96.7	69.4	154.2	83.7
Oct	901.3	506.0	90.2	63.6	155.9	84.0
Nov	917.4	701.8	95.0	93.7	222.5	104.6
Dec	1047.3	769.6	110.0	100.7	234.0	118.3
Average	994.0	654.5	99.7	82.1	198.6	99.7
Ratio (%)	0.46	0.31	0.05	0.04	0.09	0.05

Source: MOE



Source: JICA Project Team based on the Transmission and Distribution Master Plan

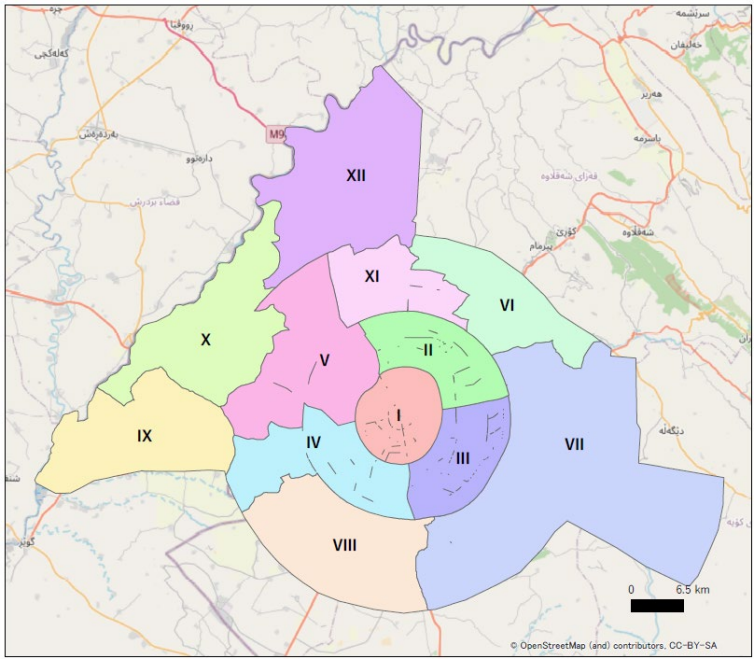
Figure 8.5.4 Peak Power Demand Forecast in the Project Area



Source: JICA Project Team

Figure 8.5.5 Sectoral Share of Electricity Demand

To check the balance between power supply and demand for each area, Erbil City is divided into twelve zones for study as shown in Figure 8.5.6. Table 8.5.8 shows the power demand of each zone. Power demand of zone X, XI, and XII is typically increased. For zone X, new industrial area will be developed after 2030. For zone XI and XII, future primary development cores are expected, Bahirka and Mandawa.



Source: JICA Project Team

Figure 8.5.6 Twelve Zones for Studying the Balance of Power Supply and Demand

Table 8.5.8 Power Demand for Each Zones in 2022, 2030, 2040, and 2050

(Unit: MW)

		Zone												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Demand	2022	587	247	284	151	48	52	38	69	42	127	31	32	1,710
	2030	833	397	433	329	71	66	53	98	55	162	52	41	2,591
	2040	917	598	563	413	85	67	57	105	53	228	66	40	3,192
	2050 Ⓐ*	1,021	652	645	539	166	138	63	119	62	281	182	62	3,930
	2050 Ⓑ*	1,019	651	644	530	163	133	62	117	61	276	179	94	3,930

Note: "2050 A" is Option Ⓐ without Mandawa dam, "2050 Ⓑ" is Option B with Mandawa dam.
Source: JICA Project Team

(2) Primary energy

The current biggest challenge for energy sector in the Kurdistan Region is primary energy supply. While the power generation capacity has met the demand of the entire KRG as of 2022, the insufficient supply of natural gas limits the generation output and causes electricity supply shortages.

Therefore, there is a need to urgently establish a production and supply network for natural gas and other energy sources. Details on primary energy supply are not mentioned in this Erbil 2050 MP because it is beyond the scope. This is an issue for the KRG as a whole.

(3) Generation

The power generation plan needs to be developed not only for Erbil district, but for the entire KRG. Followings show the development plan and challenges but the detailed plans are not included, it is out of scope of Erbil 2050 MP.

1) Generation Master Plan

There is a list of future developed generation plant. But the generation MP included energy mix targets is not formulated. Therefore, it is recommended that the future target and generation master plan will be formulated for the KRG.

2) Development Plan for generation facility

The planned future capacity of generation is 7,365 MW (Existing generation capacity: 5,865MW, Planned and proposed generation capacity: 1,500MW) in KRG, which is short of demand 8,967 by 1,602 MW in 2032 and requires an additional power development plan. The planned and proposed generation facilities are listed in Table 8.5.9.

In order to contribute to the development of low-carbon city, in addition to promoting renewable energy, the switch to low CO_2 emissions generation should be promoted such as thermal power generation using natural gas and combined cycle gas turbines.

Table 8.5.9 Expected Operation Date for New Power Plants

Power Plant	# of units	Designed Capacity (MW)	Generation Capacity (MW)	Type of Project	Owner	Expected Operation Date
Erbil Solar PP 1	-	150	25	IPP	Ster Group	2024
Erbil Solar PP 2	-	150	25	IPP	Ster Group	2024
Duhok Solar PP	-	150	25	IPP	Zagros.co	2024
Soran KPP (Kinetic Power Plant)	200	100	100	IPP	Deco-EG-DWB-MCT-TVCO	2025
Zakho KPP	200	100	100	IPP	Deco-EG-DWB-MCT-TVCO	2025
Raparin KPP	100	50	50	IPP	Deco-EG-DWB-MCT-TVCO	2025
Garmian KPP	100	50	50	IPP	Deco-EG-DWB-MCT-TVCO	2025
Sarsang flare gas PP	-	300	300	IPP	-	Proposed
Khurmala combine cycle	2	500	400	IPP	-	Proposed
Bazyan combine cycle	2	500	400	IPP	-	Proposed
Sulaymania Solar PP	-	150	25	IPP	-	Proposed
Total	602	2,200	1,500	-	-	-

Source: Development/Update of the Transmission and Distribution Master Plan for the KRG MOE

Development plan of renewable energies is following.

i) PV

Erbil solar PP (150MW x 2) is planned to be commissioned in 2024. The maximum output is expected to be 150 MW x 2, with an average output of around 25 MW each. Other projects are under planning include the installation of PV in government facilities.

In Erbil, PV is considered to be a competent power source for the future realization of a low-carbon city, and policy and measures are required to promote the installation of PV in the private sector and households.

As a government-led measure to introduce renewable energy, the installation of PV in public facilities and government buildings is being considered. This is proposed in the SEAP, with a total capacity of 1,290 kW to be installed in 25 places at an estimated cost of 2,580 thousand USD.

Also, MOE is considering to prepare regulations for investment projects (residential, industrial etc.) to provide their own electrical energy using PV in case the demand is less than 1 MW. The draft outline is following:

- The investors should try to find space within their project area to provide solar energy. Otherwise, land should be provided by relevant directorates for them to provide solar energy (equivalent to their need) to feed the national grid.
- In case the project is residential, they should provide solar energy for each unit individually.
- There were also other regulations mentioned to be prepared such as using electrical appliances (like boilers, public lighting, etc.) that depend on solar energy.

ii) Hydro

Discussions on hydropower have not progressed due to complexities such as the lowering of the groundwater table and the relationship with agriculture. Mandawa HPP (120MW planned) is planned to construct to supply the power around the Mandawa core.

iii) Wind

F/S have been carried out at about 32 onshore wind power sites, and it has been confirmed that the feasibility is low. In mountainous areas, there are some potential areas, but there are issues in terms of economics, such as the construction and maintenance of transmission lines, and the prospect of commercialization is not yet clear.

iv) Geothermal

Geothermal energy is also considered to have potential, but studies have not progressed.

v) Biomass

Biomass energy is also considered to have potential such as generation electricity from solid waste, but studies have not progressed.

Based on the above, PV generation is appropriate for Erbil in the current situation. The costs and assessments for each type of power generation are summarized in the table below.

Table 8.5.10 The Costs and Assessments for Each Type of Power Generation

	Construction cost 2022 *2 (USD/kW)	Capacity factor 2022 (%)	Levelised cost of electricity 2022 (USD/kWh)	Remarks	Evaluation *1
Solar PV	876	17	0.049	In terms of economics and potential, PV is considered to be a competent power source in Erbil. But it doesn't generate the power at peak load time during night. It means that other	3

	Construction cost 2022 *2 (USD/kW)	Capacity factor 2022 (%)	Levelised cost of electricity 2022 (USD/kWh)	Remarks	Evaluation *1
				generation facilities or energy storage facilities should be installed for night-time. To promote the installation of PV, policy and measures needs to be formulate by KRG. In addition, in order to make effective use of the electricity generated, the regulatory system will need to be designed for energy resources introduced on the demand side, such as electric vehicles usages.	
Hydropower	2,881	46	0.061	KRG has potential for Hydropower. But discussions on hydropower plant construction have not progressed due to complexities such as the lowering of the groundwater and the relationship with agriculture.	2
Onshore wind	1,274	37	0.033	There is potential around mountain area, but there are issues in terms of economics, such as the construction and maintenance of transmission lines.	2
Geothermal	3,478	85	0.056	KRG has some geothermal potential, further studies are required.	2
Bioenergy	2,162	72	0.061	Although construction cost are higher than for thermal power plant, it is recommended to promote the Bioenergy as a source of power with a low environmental impact.	3
Concentrating solar power	4,274	36	0.118	There is potential for Concentrating solar power in Erbil, but the initial cost is higher than for the other generation facilities.	2

Note: *1 Evaluation: 3 is highest and 1 is lowest.
*2 Combined cycle: 1,252 USD/kW, Simple cycle gas turbine: 512 USD/kW (Source US-EIA 2021 Annual electric generator report)

Source: IRENA Renewable power generation costs in 2022 (Remarks and evaluation is made by JICA Project Team)

In the northern region, the new development areas shown in Table 8.5.11 are planned to be developed, and if policies to encourage the installation of rooftop PV installations in these areas are promoted, it will contribute to the low-carbon development of the city. If solar power generation facilities were installed in 428 ha, which corresponds to 0.05% of the total area of 8,567 ha, it would be possible to install solar power generation facilities with a total capacity of around 300MW (in case 0.07kW/m^2). Furthermore, if PV that can be installed on walls and windows, such as perovskite solar cells, are developed and introduced, it will be possible to increase the total maximum output. The above installation factor of 0.05 is a provisional value for rough estimation and needs to be considered.

Table 8.5.11 New Proposed Urbanization in Northern Development Area

Zone	Area (ha)
1st Ring	1,544
2nd Ring	6,438
3rd Ring	161
4th Ring	424
Total	8,567

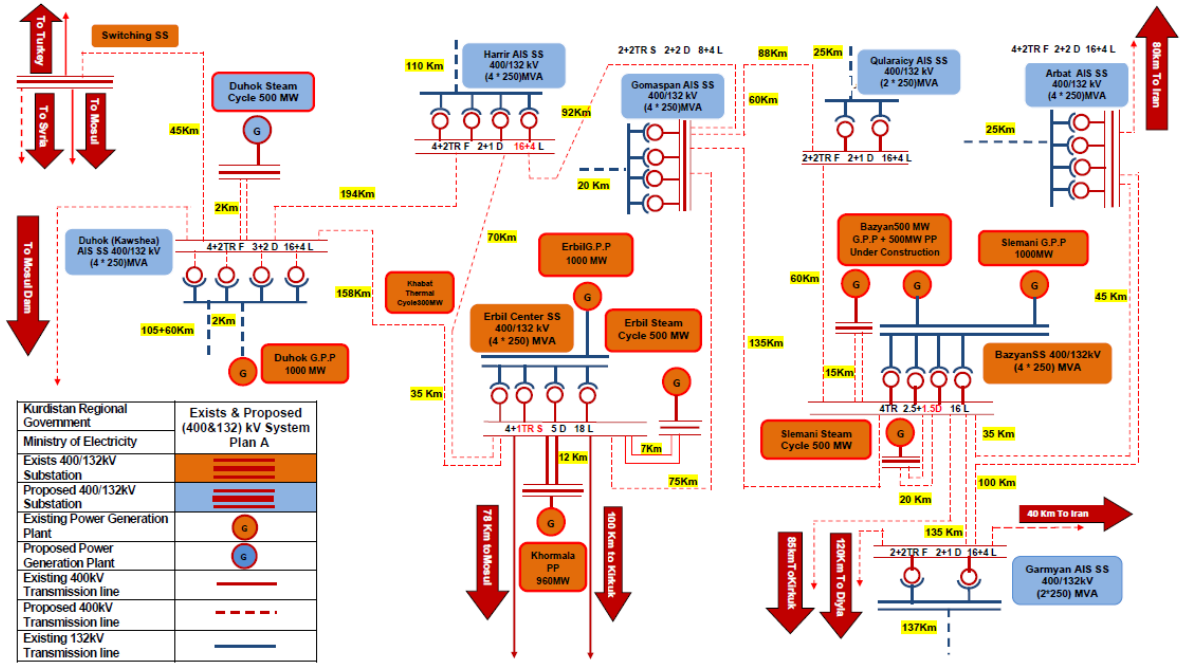
Source: JICA Project Team

(4) Transmission and distribution

To meet the growing power demand, development of transmission and distribution network is required.

1) 400kV network

400kV network need to be developed for interconnection among each governorate. It will not only improve reliability of supply to Erbil, but it will also facilitate transfer of energy from Erbil to other regions when the surplus power generated in Erbil is available. Figure 8.5.7 shows the development plan of 400 kV network.



Source: MOE

Figure 8.5.7 Development Plan of 400 kV Network in KRG

According to the Transmission and Distribution MP, 400kV transmission lines will be connected with Erbil Duhok and Sulaymaniyah by 2032.

Table 8.5.12 Project List of 400 kV Network Related to Erbil City

No.	Project name	Detail	Location	Year
1	Harrir 400kV/132kV substation	AIS substation, 4*250 MVA	Erbil	2028
2	Gomaspan 400kV/132kV substation	AIS substation, 4*250 MVA	Erbil	2032
3	400 kV Transmission line between Erbil and Duhok	Double Circuit, 2*ACSR 490/75, 2 OPGW OHL between Erbil to Duhok 400kV SS (length193 km)	Erbil, Duhok	2028
4	400 kV Transmission line between Erbil and Harrir	Double Circuit, 2*ACSR 490/75, 2 OPGW OHL between Erbil to Duhok 400kV SS (length 105 km)	Erbil	2028
5	400 kV Transmission line between Erbil and Sulaymaniyah	Double Circuit, 2*ACSR 490/75, 2 OPGW OHL between Erbil to Sulaymaniyah 400kV SS (length 75+135 km)	Erbil, Sulaymaniyah	2028
6	400 kV Transmission line between Erbil and Gomaspan	Double Circuit, 2*ACSR 490/75, 2 OPGW OHL between Erbil to Sulaymaniyah 400kV SS (length 75+135 km)	Erbil, Gomaspan	2032

Source: MOE

2) 132kV, 33kV, and 11kV network

To meet the growing power demand in Erbil city, following projects are planned for 132 kV, 33kV, and 11kV network.

Table 8.5.13 Project List of 132 kV Substation and 132 kV Lines in Erbil

No.	Project Name	Detail	Location	Year
1	132kV/33/11kV Frokaxana Substation	2*125 MVA	Frokaxana	2026
2	132kV/33/11kV Bahirka Substation	3*63 MVA	Bahirka	2026
3	132kV/33/11kV Big Timar Substation	3*125 MVA	Erbil center	2028
4	132kV/33/11kV Shamamk Substation	2*125 MVA	South west area	2028
5	132kV/33/11kV 8 Hasarok Substation	3*63 MVA	8 Hasarok Qr.	2028
6	132kV/33/11kV Baghulmnara Substation	3*63 MVA	Baghulmnara	2030
7	132kV/33/11kV Rojhalat/2 Substation	3*63 MVA	Erbil center	2030
8	132kV/33/11kV Malaomer Substation	3*125 MVA	Mala Omer	2032
9	132kV/33/11kV Gomaspan Substation	3*63 MVA	Gomaspan	2032
10	132kV/33/11kV Zanko (Baghamra) Substation	3*125 MVA	Erbil center	2032
11	132kV/33/11kV Kaniqrzhalla Substation	3*125 MVA	Kaniqrzhalla	2032

Source: MOE

Table 8.5.14 Project List of 33 kV Substation in Erbil

No.	Project Name	Detail	Location	Year
1	33kV/11kV Brayaty Substation	2*31. MVA Connected with North Substation and Hawerli Nwe Substaion	Erbil center	2028
2	33kV/11kV Ronshnbiry Substation	31.5 MVA Connected with Karezan Substation and South Substaion	Erbil center	2028
3	33kV/11kV Tarjan Substation	2*31.5 MVA Connected with Shamamk Substation and Kawrgosk Substaion	Tarjan	2028
4	33kV/11kV New Korean Substation	2*31.5 MVA	Erbil center	2028
5	33kV/11kV New Badawa Substation	2*31.5 MVA	Erbil center	2028
6	33kV/11kV Bnaslawa Substation	2*31.5 MVA Connected with 8 Hasarok Substation and Kasnazan Substaion	Erbil center	2028
7	33kV/11kV Mnara Substation	2*31.5 MVA Connected with Karezan Substation and East Erbil Substaion	Erbil center	2028
8	33kV/11kV Sami Abdulrahman Park Substation	2*31.5 MVA Connected with Nishtiman Substation and Park Substation	Erbil center	2028

Source: MOE

Table 8.5.15 Project List of 33 kV and 11kV Distribution Lines in Erbil

No.	Project Name	Detail	Location	Year
1	Extracting 11kV feeders from 132/33/11kV Zanyari substation	9 feeders	Erbil center	2024-2028
2	Extracting 11kV feeders from Grdachal Mobile	2 feeders	Erbil center	2024-2028
3	Extracting 11kV feeders from Iskan 33/11kV substation	7 feeders	Erbil center	2024-2028
4	Extracting 11kV feeders from Monomenti Shahidan 132/33/11 kV substation	2 feeders	Erbil center	2024-2028
5	Extracting 11kV feeders from Bakur (132/33/11)kV substation	2 feeders	Erbil center	Completed as of 2024
6	Extracting 11kV feeders from Nusaran 132/33/11kV substation	7 feeders	Erbil center	2024-2028

No.	Project Name	Detail	Location	Year
7	Extracting 11kV feeders from Nishtiman 132/33/11kV substation	10 feeders	Erbil center	2024-2028
8	Extracting 33kV feeders from Karezan 132/33/11kV substation to (Badawa WarzKari) Substation.	2 feeders	Erbil center	2024-2028
9	Extracting 33kV feeders from Karezan 132/33/11kV substation to Iskan 33/11kV Substation.	1 feeder	Erbil center	2024-2028
10	Extracting 33kV feeders from Karezan 132/33/11kV substation to HanaCity 33/11kV Substation.	2 feeders	Erbil center	2024-2028
11	Extracting 11kV and 33kV feeders from Bahrka 132/33/11 kV substation	-	Erbil center	2024-2028
12	Extracting 11kV and 33kV feeders from Shawes 132/33/11 kV substation	-	Erbil center	2024-2028
13	Extracting 33kV line from Bahrka 132/33/11 kV substation to JazhniKan 33/11kV Substation	13km	Erbil center	2024-2028
14	Extracting 33kV and 11kv feeders from MalaOmer Substation	Underground cable	Erbil center	2027-2031
15	Extracting 11kV and 33kv feeders from Kaniqrzhalla 132/33/11 kV substation	-	Erbil center	2030-2032

Source: MOE

Table 8.5.16 Other Project Lists of 11kV Network

No.	Project Name	Detail	Location	Year
1	Relieve overloads for 11/0.4 kV Transformers	250 transformers	All Districts	2024-2028
2	Expanding and installing new distribution networks for several residential quarters (50 region in different quarters)		All Districts	2024-2028

Source: MOE

Table 8.5.17 shows the comparison between power demand and transformer capacity for each zone. As for the transformer capacity, the capacity which will be installed by above planned projects are included for 2030, 2040 and 2050. There are two options for 2050. Option A is without Mandawa dam and Option B is with Mandawa dam. The red highlighted cells show the insufficient power supply. This is a simplified comparison of the supply and demand situation based on 11kV transformer capacity, and transmission line capacity and the transmission system as a whole need to be taken into account in detail planning.

In 2022, there are shortage of power supply in several zone, but most of them will be resolved after completion of above listed projects in 2030. For zone X, XI and XII, power supply will not enough due to the development of industrial area and future primary cores.

Table 8.5.17 Balance of Power Demand and Supply Considering the Planned Project

(Unit: MW)

		Zone												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2022	Demand	587	247	284	151	48	52	38	69	42	127	31	32	1,710
	Transformer Capacity 11kV	1,503	660	398	416	22	41	57	60	23	185	23	46	3,431
	Difference	916	412	113	264	-27	-12	19	-9	-19	57	-9	14	1,721
2030	Demand	833	397	433	329	71	66	53	98	55	162	52	41	2,591
	Transformer Capacity 11kV	1,843	660	671	596	168	41	57	132	79	221	131	46	4,643
	Difference	1,010	263	237	267	98	-26	4	34	24	58	78	5	2,052
2040	Demand	917	598	563	413	85	67	57	105	53	228	66	40	3,192
	Transformer Capacity 11kV	1,843	660	779	596	276	149	165	132	79	221	131	46	5,075
	Difference	926	62	216	183	191	82	108	27	26	-7	64	5	1,882

2050 A	Demand	1,021	652	645	539	166	138	63	119	62	281	182	62	3,930
	Transformer Capacity 11kV	1,843	660	779	596	276	149	165	132	79	221	131	46	5,075
	Difference	822	8	134	57	110	11	102	13	17	-60	-52	-16	1,145
2050 B	Demand	1,019	651	644	530	163	133	62	117	61	276	179	94	3,930
	Transformer Capacity 11kV	1,843	660	779	596	276	149	165	132	79	221	131	46	5,075
	Difference	825	8	135	66	113	15	102	15	18	-56	-48	-48	1,145

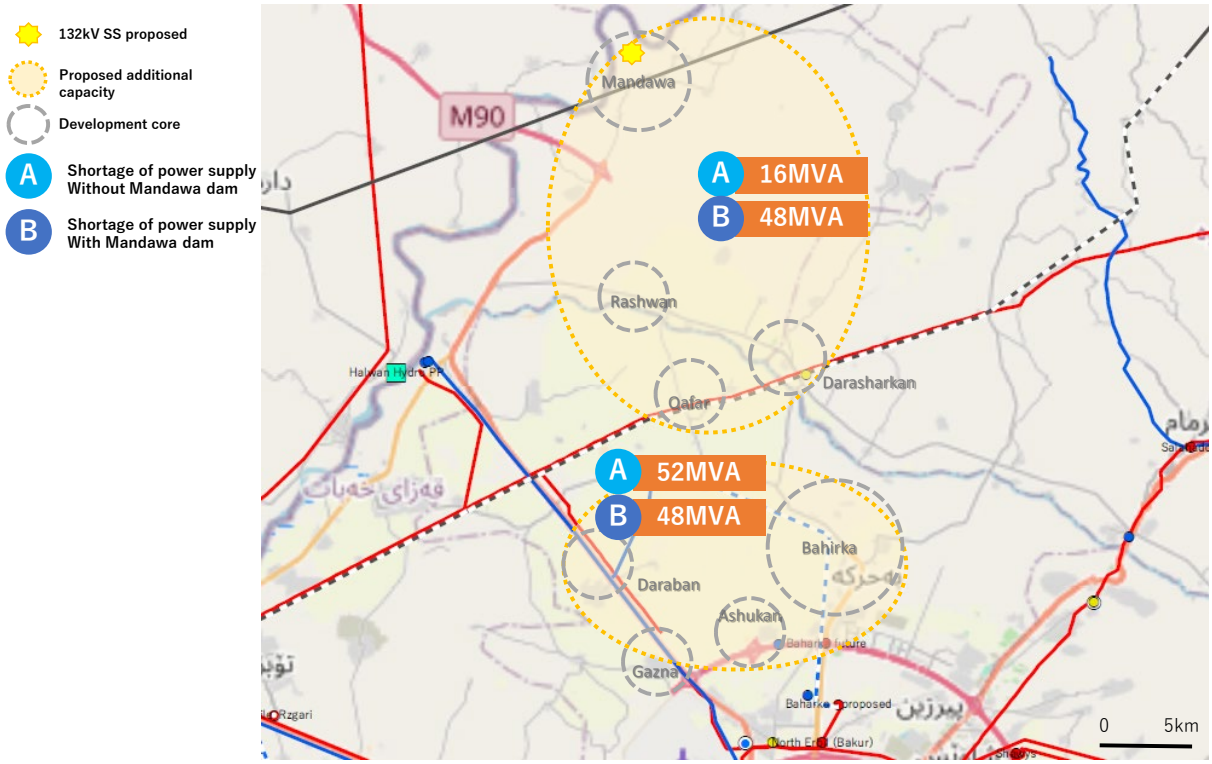
Note: Capacity of transformer is converted from MVA to MW using power factor 0.9
Calculated based on the principle that the peak load factor is allowed to be up to 100 %.
Source: JICA Project Team

To meet the development plan of Erbil 2050 MP, some additional projects are proposed for zone X, XI, and XII as follows.

(a) Bahirka core (zone XI), Mandawa core (zone XII)

Figure 8.5.8 shows the development plan of the north area of Erbil. In the north area of Erbil, several development core is planned. Mandawa core and Bahirka core are the primary development cores and they are expected the huge growth of power demand.

Construction of 120 MW hydro power plant is expected at Mandawa for Option B. To supply the generated power to the future development core, Construction of Mandawa 132kV substation and Darasharkan 132kV substation are proposed and these substations are connected to the 132kV Bahirka substation. Also, 33kV Bahirka substation and Rashwan substation, and 33kV Daraban substation are proposed to supply the power to each core.



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Source: JICA Project Team

Figure 8.5.8 Development Plan of the North Area of Erbil

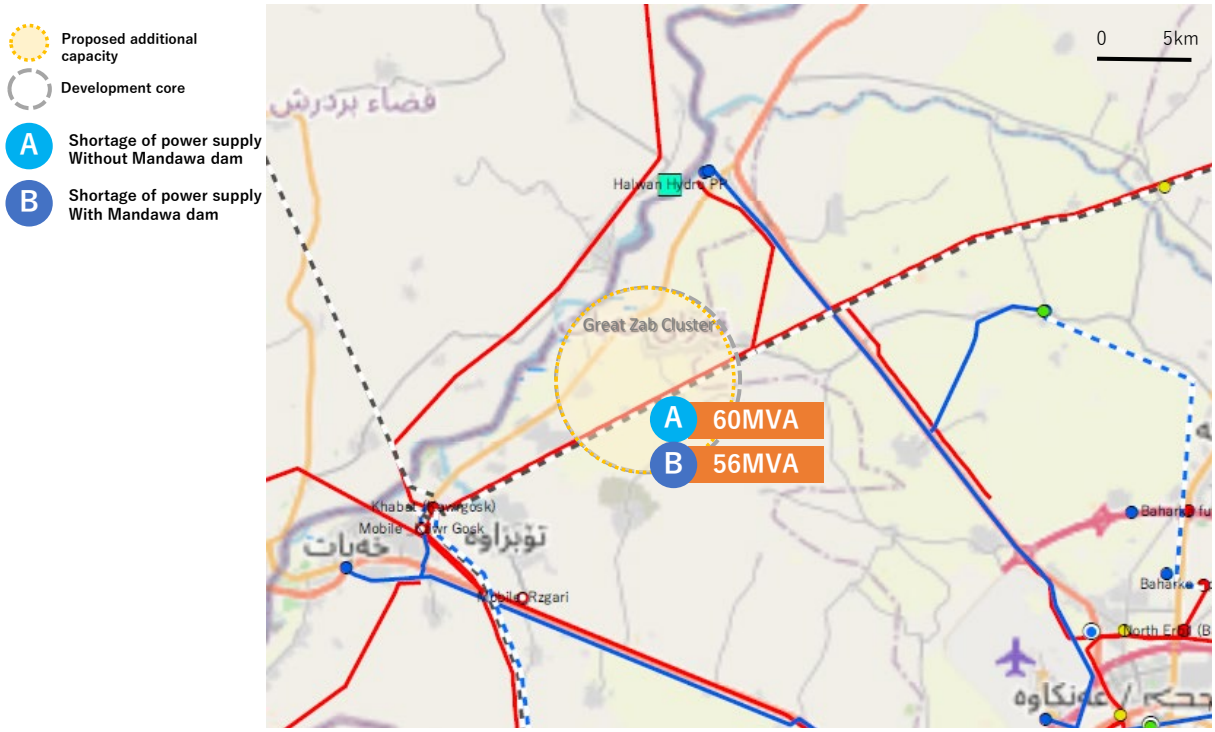
Table 8.5.18 Example of the Proposed Project in the North Area of Erbil

No.	Project Name	Detail	Location	Year	Option A	Option B
1	Bahirka 33/11kV substation	2*31.5 MVA	Bahirka	2022-2030	eligible	eligible
2	Daraban 33/11kV substation	2*31.5 MVA	Daraban	2022-2030	eligible	eligible
3	Mandawa 132/33/11 kV substation	2*63 MVA	Mandawa	2030-2040	not eligible	eligible
4	132 kV Transmission line Mandawa-Bahirka	Overhead	North area	2030-2040	eligible	eligible
5	Rashwan 33/11 kV substation	2*31.5 MVA	Rashwan	2030-2040	eligible	eligible
6	Ashukan 33/11 kV substation	2*31.5 MVA	Ashkan	2030-2040	eligible	eligible
7	33kV distribution lines Bahirka-Grdachal-Rashwan	Overhead	North area	2030-2040	eligible	eligible

Note: Reference to existing standard equipment capacity
Source: JICA Project Team

(b) Great Zab Cluster Core (zone X)

Figure 8.5.9 shows the development plan of the west area of Erbil. Great Zab Cluster development core is planned in the west area and the shortage of power supply will be 60 MVA in 2050 even if the transformer capacity of planned project is taking into the consideration. Therefore, the construction of 132kV Great Zab Cluster substation is proposed in the development core.



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Source: JICA Project Team

Figure 8.5.9 Development Plan for the Great Zab Cluster Core

Table 8.5.19 Example of the Proposed Project for the Great Zab Cluster Core

No.	Project Name	Detail	Location	Year
1	Great Zab Cluster 132 /33/11 kV substation	3*63 MVA	Great Zab Cluster core	2030-2040

Note: Reference to existing standard equipment capacity
Expected to be connected from existing 132kV transmission line
Source: JICA Project Team

Table 8.5.20 shows the balance of power demand and supply considering the planned and proposed projects. For the proposed project a) and b), further study is required to determine the specification, place of the substation and route of the transmission lines.

Table 8.5.20 Balance of Power Demand and Supply Considering the Planned and Proposed Projects

(Unit: MW)

		Zone												Total
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2022	Demand	587	247	284	151	48	52	38	69	42	127	31	32	1,710
	Transformer Capacity 11kV	1,503	660	398	416	22	41	57	60	23	185	23	46	3,431
	Difference	916	412	113	264	-27	-12	19	-9	-19	57	-9	14	1,721
2030	Demand	833	397	433	329	71	66	53	98	55	162	52	41	2,591
	Transformer Capacity 11kV	1,843	660	671	596	168	41	57	132	79	221	244	46	4,756
	Difference	1,010	263	237	267	98	-26	4	34	24	58	192	5	2,165
2040	Demand	917	598	563	413	85	67	57	105	53	228	66	40	3,192
	Transformer Capacity 11kV	1,843	660	779	596	276	149	165	132	79	329	301	175	5,482
	Difference	926	62	216	183	191	82	108	27	26	101	234	135	2,290
2050 Ⓐ	Demand	1,021	652	645	539	166	138	63	119	62	281	182	62	3,930
	Transformer Capacity 11kV	1,843	660	779	596	276	149	165	132	79	329	301	103	5,410
	Difference	822	8	134	57	110	11	102	13	17	48	118	41	1,480
2050 Ⓑ	Demand	1,019	651	644	530	163	133	62	117	61	276	179	94	3,930
	Transformer Capacity 11kV	1,843	660	779	596	276	149	165	132	79	329	301	175	5,482
	Difference	825	8	135	66	113	15	102	15	18	52	122	81	1,552

Note: Capacity of transformer is converted from MVA to MW using power factor 0.9
Calculated based on the principle that the peak load factor is allowed to be up to 100 %.
Source: JICA Project Team

3) Improvement of Distribution Quality and Reliability

Table 8.5.21 shows the major issue and measures for distribution network in Erbil.

Table 8.5.21 Major Issue and Measures for Distribution Network

Item	Major Issue	Measures	Effectiveness and remarks
Reliability	Power outage due to overload	Improvement of capacity of distribution equipment such as transformers	It has planned as shown in Table 8.5.13 and Table 8.5.14.
		Demand side management	Reduce the peak demand.
	Accidental power outage	Two-routing of distribution lines	When an accident happens, power can be supplied continuously by the other distribution line.
		Replacement of ageing equipment	It has planned as shown in Table 8.5.14.
		Installation of Auto-Reclosers	• Immediate clearance of transient faults. In case of permanent faults, only faulty section will be isolated. • Reduced downtime of feeder due to faster location of fault. • Additional protections provided though the AR downstream of the feeder.

Item	Major Issue	Measures	Effectiveness and remarks
			• Stress on substation breaker due to frequent tripping operations is reduced.
		Fault Indicators to Minimize Feeder Tripping Downtime	Minimize the power outage time
Quality	Voltage drop	Installation of New 33/11kV substation and improvement of 33kV and 11 kV network	By installation of new substation near the load, voltage drop and loss are improved.
		Installation of Voltage Regulator	Continuously regulate voltage variations in real-time by increasing or decreasing the output voltage. Voltage regulators are not recommended for power lines that are already overloaded.
		Installation of Capacitor	Voltage Regulators is considered as preferred option for improvement of voltage drop but it is not recommended for power lines that are already overloaded.
	Harmonic	Introduce harmonic measurement equipment	By improving the ability to identify the location where harmonics occur, the problems will solve quickly.
Distribution loss	Commercial loss	Installation of smart ready electronic type meters	• Reduce the commercial loss • Promote the distribution management system such as Transformer load management system • Promote the demand side management
	Technical loss	Load centralization	By installation of transformer at the center of the load, distribution loss is reduced.
		Optimizing the capacity of transformer	• The installation of multiple small-capacity amorphous transformers instead of a single large-capacity transformer. • The voltage drop is reduced as well as the loss due to the shortening of the span of the low-voltage distribution lines.
		Using higher voltage for distribution	By expansion of 33kV network near the load instead of 11kV, distribution loss will be reduced.
		Replace the distribution lines	The selection criteria for the appropriate capacity for the demand are established and replaced. When replacing, covered wires are introduced in place of bare wires to reduce the occurrence of distribution line accidents.

Source: JICA Project Team based on the information from MOE

(a) Improvement of Distribution Reliability

i) Installation of Auto-Reclosers

Majority (over 70%) of the faults in distribution networks are temporary (transient) faults which are normally cleared by one of more auto-reclosing shots. However, this facility is not enabled in the 11 kV breakers at the substations in KRG. Installation of Auto-Reclosers (AR) is recommended for long 11 kV feeders to improve reliability. ARs can be installed at the beginning of long branches and main feeder sections downstream of the feeder. This will provide following benefits.

- Immediate clearance of transient faults.
- In case of permanent faults, only faulty section (and sections downstream of it) will be isolated.
- Reduced downtime of feeder due to faster location of fault.
- Additional protections provided though the AR downstream of the feeder.
- Stress on substation breaker due to frequent tripping operations is reduced.

In general, feeders subject to high failure rates are the feeders with excessive lengths. Accordingly, feeders with excessive feeder lengths (> 40 km) have been selected for installation of Auto-recloser units as indicated in Table 8.5.22.

Table 8.5.22 Recommended 11 kV Feeders for Installation of Auto-Reclosers

Directorate	Substation	Fdr	Load (A)	Length (km)	Coverage (km)	Trans	No of AR Units
Erbil D1	Dashti H	F2	283	142	36	216	3
	Dashti H	F5	242	96	22	140	2
	Dashti H	F7	244	84	21	175	2
	Dashti H	F3	229	47	20	78	1
	Grdmala	F12	317	93	25	159	3
	Qarachough	F5	347	150	40	166	3
	Qarachough	F1	114	77	22	82	2
	Qarachough	F3	218	127	28	126	3
	Lajan	F3	170	96	32	133	3
	Lajan	F4	116	70	22	108	2
	Lajan	F6	342	42	12	79	1
	Qushtapa	F4	160	43	12	63	1
	RozhAwa	F18	256	48	7	102	1
	Sarbasti	F13	358	57	26	80	1
	Shamamek	F2	353	100	27	173	3
	Shamamek	F6	298	99	19	157	3
	Shamamek	F5	221	81	25	146	2
	Shamamek	F1	273	65	19	127	2
	Shamamek	F3	333	49	16	106	1
	Tarjan	F4	359	122	29	157	3
	Tarjan	F6	156	42	11	62	1
Erbil D2	Baghamra	F6	238	44	12	86	1
Erbil D3	Grdachal	F5	325	58	19	120	2
	Malaomar M	F1	164	41	10	100	1
Total							**82**

Source: Electricity Distribution Development Plan 2017-2026

(b) Improvement of Distribution Quality

i) Voltage Drops in 11 kV Feeders

The voltage drop issues in some of these feeders can be corrected using new 11 kV feeders from proposed substations. However, there are some isolated 11 kV feeders for which no new feeders could be connected. Automatic Voltage Regulators were considered to resolve voltage drops in such feeders.

In order to continuously regulate voltage variations in real-time by increasing or decreasing the output voltage, automatic voltage regulators provide the optimum solution. One issue with the application of automatic voltage regulator in distribution lines is that; when voltage is substantially improved the load currents tend to increase. This is as a result of the effect of increased voltage on resistive loads. Therefore, voltage regulators are not recommended for power lines that are already overloaded. Considering this limitation, installation of automatic voltage regulators are recommended for 11 kV feeders Lajan substation feeder No.3 in this project area.

However, voltage regulators are not recommended for overloaded lines. Therefore, in such cases use of pole mounted 11 kV capacitors have been recommended for the following feeders.

Table 8.5.23 Recommended 11 kV Feeders for Installation of Pole Mounted Line Capacitors

Directorate	Substation	Feeder	Load (A)	Length (km)	Coverage (km)	Transformers (unit)	Max Voltage Drop (%)	Capacitance to be installed (KVAR)
Erbil D1	Dashti H	F2	283	141.5	36	216	35	3x200
	Grdmala	F12	317	92.5	25	159	23	3x300
	TuraqMobile	F5	347	39.1	23	47	22	3x300

	Tarjan	F4	359	122.1	29	157	32	3x300
	Shamamek	F2	353	99.8	27	173	31	3x300
	Sarbasti	F13	358	56.8	26	80	28	3x300

Source: Electricity Distribution Development Plan 2017-2026

(c) Improvement of Distribution Loss

i) Installation of smart ready electronic type meters

The non-technical energy losses in the system are estimated to be high as 19%[1]. Majority of non-technical losses are attributed to metering errors and pilferage. If no corrective measures are taken, the loss percentage is likely to increase further in future especially with implementation of revised electricity tariffs.

MOE initiated Smart Metering Project. This project was planned to address above issues and to modernize energy metering system in KRG. Objectives of this project included minimizing non-technical losses, improving energy accountability, establishing Advanced Metering Infrastructure (AMI) and automated billing system, preventing electricity pilferage, providing flexibility to implement multiple tariff structures (such as time of day tariffs), demand management and control, and provision of online access to energy consumption data. However, this project has not been completed mainly due to the funding constraints.

The project is now in the last phase and it will complete by 2024.

Target Outcomes

- Reduction of non-technical losses.
- Sustain reduced losses at minimum level.
- Improved electricity supply services to consumers.
- Energy auditing at distribution transformer level.
- Transformer load management system.
- Advanced Metering Infrastructure (AMI)
- Smart ready energy metering system for future conversion to smart metering.

The implementation of the Smart Meter project in the Iraqi Kurdistan Region is currently underway. This initiative involves the deployment of 1,435,000 smart meters, matching the number of consumers in 2017 when the project was initiated. As of December 2023, a total of 1,353,524 meters have been installed, which accounts for 94% of the planned meters and 75% of the total consumers, estimated to be 1,800,000 by the end of that year.

The project has had a significant positive impact by reducing distribution losses and protecting distribution assets through the application of load limits on consumer meters.

(d) Demand Side Management (DSM) and Energy Efficiency Improvement Program

Electricity utilities plan to meet growing power demand from two fronts; supply side and demand side. Supply side measures include adding generation capacity and increasing the capacity of transmission and distribution systems. The demand side measures include action to control increase of demand by minimizing wastage or non-productive use of energy, loss reduction and improvement of efficiency in energy usage. The demand side management strategies are highly cost effective as they do not require high investments for plant and equipment. The installation of smart meters enable some of following measures.

[1] Erbil Governorate Electricity Distribution Development Plan 2017 – 2026

Proposed DSM Measures (for selection)

- Consumer education to minimize wastage of electricity through media campaigns, programs for school children, awareness programs including messages sent through electricity bills, social media, websites etc.
- Provide incentives (such as electricity bill discounts) to consumers for reducing demand.
- Promotion campaigns such as participation in 'Earth Hour' campaign
- Promoting (or enforcing under current circumstances) bulk electricity consumers to use their backup generation plants to minimize grid supply consumption.
- Implementation of cost recovery electricity tariffs (considered as a key proposal in the proposed electricity reforms roadmap).
- Enforcement of maximum demand charge for bulk consumers. Promoting use of power factor correction equipment for industrial consumers.
- Restricting maximum power consumption by individual consumers using current limiters.
- Promote and provide incentives for use of alternate energy sources such as gas / kerosene for heating. Consider possibility of 'enforcing' use of diesel fired boilers for heating purposes in commercial and apartment buildings. (Ex. System practiced in Amman city).
- Facilitate and promote use of grid connected PV system (solar panels).
- Increased action to minimize illegal connections and theft of electricity.
- Application of demand reduction techniques by lowering supply voltage in the city areas (not affected by excessive voltage drops). Feasible VO (voltage optimization) technologies for KRG include LDC (line drop compensation) and VFR (Voltage Fixed Reduction) that can be applied at the substations.
- Consider possibility of adjusting standard local time during winter season to save electricity (practiced in several countries). This action may also require agreement with central Government.

Proposed Energy Efficiency Improvement Measures

- Educate consumers about energy efficient equipment and its advantages.
- Educate and provide guidelines for construction of houses and buildings with good thermal insulation.
- Promote use of CFL/LED lamps for lighting purposes.
- Promote use of solar / hybrid/ heat pump type water heaters.
- Develop and implement energy labelling scheme (ex. Energy star ratings) for electrical equipment and consumables. This may be carried out in coordination with the universities and other relevant Ministries.

Develop and enforce 'energy efficient' building code, in coordination with the Ministry of Municipalities and other relevant authorities.

4) Method of distribution network (overhead line conductor / underground cable)

Application of overhead line conductors is advantages in respect of initial cost, maintenance. Also, when fault occurs, as the fault detecting on overhead line is less difficult than underground cable, the time required for repair the overhead line conductor is expected to be greatly shorter than that of underground cable. Finally, the installation cost of overhead line is lower than that of underground cable.

For the new construction of distribution network in the 100-meter ring road, underground cable will be applied for the visual and comfort aspect. On the other hand, for the outside area of 100-meter ring road, overhead line will be applied.

For the existing overhead lines inside the 100-meter ring road, those are converted to the underground cables gradually, but the expansion and capacity increase of the distribution network is high priority to meet the growing power demand.

8.5.5 Recommendations

(1) Development of the Master Plans (Generation MP in KRG and Distribution MP in Erbil)

The power generation plan needs to be developed not only for Erbil district, but for the entire KRG. There is a list of future developed generation plant. But the generation MP included energy mix targets is not formulated. Therefore, it is recommended that the future target and generation master plan will be formulated for the KRG.

In addition, the existing distribution MP, *Electricity Distribution Development Plan 2017-2026*, has been already out of date and needs to be updated to reflect the actual situation.

(2) Measures to Promote Renewable Energy

Erbil 2050 MP aims to realize a low-carbon city, and the introduction of renewable energy is one of the key issues. However, at present, the KRG does not have a plan for that provides a roadmap for the introduction of renewable energy. Also, a framework for measures to promote renewable energy investment and measures to stabilize the grid through the introduction of renewable energy has not been developed. Therefore, it is recommended that the following studies be conducted for the future promotion of renewable energy.

Table 8.5.24 Examples of Measures to Promote Investment in Renewable Energy and Status of Introduction in Each Country

Country	FIT/FIP*1	RPS*2	Grants / Subsidies / Rebates	Tax Credit for Investment & Production	Public loans, etc.
UK	●	●	●		●
Italy	●	●	●	●	●
Netherlands	●		●	●	●
Canada	○	○	●	●	●
Sweden		●	●	●	●
Spain	●		●	●	●
Denmark	●		●		●
Germany	●		●	●	●
Japan	●	●	●	●	●
Finland	●		●		
France	●		●	●	●
USA	○	○	●	●	●

Note ● is introduced at the national level and ○ is introduced at the state level.
*1 FIT: feed-in tariffs, FIP: feed-in premium
*2 Renewables Portfolio Standard (RPS) is a regulation that requires the increased production of energy from renewable energy sources
Source: REN21, RenewableEnergyPolicyNetworkforthe21thCentury, *Renewables2013GlobalStatusReport*

Table 8.5.25 Measures to Stabilize the Grid when Introducing Renewable Energy (Reference examples based on Japanese case)

	Short term	Mid term	Long term
Operational improvements (including planning, standardization of specifications, etc.)	**Measures both renewable power supply side and demand side** ➢ Output suppression and disconnection of renewable energy power sources in the event of a lack of regulating power ➢ Examination of specifications for power conditioner (PCS) output adjustment and communication functions for grid interconnection of renewable energy power ➢ Study specifications for home/building/community energy management devices ➢ Development of a system for predicting the output of renewable energy power sources and proper assessment of fluctuations **Measures mainly on the part of the electric utility** ➢ Future Image of the Electric Power System (Smart Grid) ➢ Expanding Regulatory Capability through Revision of Power Supply facility Operations	**Measures mainly on the part of the electric utility** ➢ Revision of feed-in orders (priority operation of renewable electricity under economically rational surplus control) ➢ Grid operation considering generation characteristics of renewable energy based on weather forecasts, etc.	**Measures mainly on the part of the electric utility** ➢ Flexible operation of pumped storage (pumping during the day)
Infrastructure Development	**Measures both renewable power supply side and demand side** ➢ Measuring combined output during large scale deployment of renewable electricity ➢ Study on introduction of storage batteries, etc. for output fluctuation control ➢ Construction of access lines and substations as needed in grid vulnerable areas **Measures mainly on the part of the electric utility** ➢ Study of distribution voltage elevation (which can reduce the range of voltage rise and distribution losses) ➢ Installation of a voltage regulator (SVC) on the high voltage system ➢ Building an inter-regional interconnection line	**Measures both renewable power supply side and demand side** ➢ Development and introduction of improved power conditioners (PCS) with added output adjustment and communication functions ➢ Develop and implement home and building/community energy management systems ➢ Study of centralized battery control and frequency suppression control schemes ➢ Partial installation of storage batteries ➢ Utilization of heat storage heat pumps, plug-in hybrid/EV on-board batteries (charging only) ➢ Consideration of introducing pumped storage power generation for effective use of surplus electricity (pumped during the day) ➢ Utilization of emergency power stock **Measures mainly on the part of the electric utility** ➢ Implementation of distribution	**Measures both renewable power supply side and demand side** ➢ Spread of improved power conditioners (PCS) with added output regulation and communication functions ➢ Spread of home/building/community energy management systems ➢ Installation of storage batteries ➢ Plug-in Hybrid/EV Automotive Battery Utilization (Charging and Discharging) **Measures mainly on the part of the electric utility** ➢ Further expansion of smart grid ➢ Inter-regional interconnection line reinforcement

	Short term	Mid term	Long term
		voltage elevation ➢ Installation of voltage regulators (SVCs) on high voltage systems ➢ Smart Grid (flexible operation of the grid using smart metering, demand response, and coordinated control with distributed power and energy storage systems) ➢ Transmission and substation upgrades as needed in grid vulnerable areas	
Review of the system	➢ Standardization of grid interconnection consultation procedures ➢ Grid Interconnection Guidelines ➢ Deregulation of grid voltage range ➢ Increased efficiency regarding the operational status of inter-regional interconnection lines ➢ Cost sharing and support measures for installation of storage batteries, etc. ➢ Rules for output curtailment and disconnection of natural energy sources ➢ Establishment of regulations related to security management ➢ Cost sharing and support measures for transmission and substation expansion and construction of access lines and substations in grid vulnerable areas	➢ Ensure transparency of imbalance costs, etc., and develop open markets ➢ Study on the possibility of structural reform of the electric utility industry ➢ Introduction of daily hourly and real-time electricity rate system	Transparency of imbalance costs, etc., and open markets are required as prerequisites.

Source: Study Group on Renewable Energy Dissemination Policies for Establishing a Low-Carbon Society in Japan, "Renewable Energy Deployment Policies for Establishing a Low-Carbon Society (Proposal)," 2009,
Advisory Committee for Natural Resources and Energy in Japan, "Interim Report of the Subcommittee for Wind Power Generation System Interconnection Measures," 2005
New Energy Industrial Forum, "Proposal for the Promotion of the Introduction of Wind Power Generation Systems," 2006

8.6 Telecommunications Sector

8.6.1 Existing conditions

This section mentions the existing conditions in the telecommunications sector from the perspectives of "Private companies in the telecommunications sector", "Fiber network infrastructure", "Mobile network and communications", "Frequency allocation", "Cyber security", "Vision2030" and "Contribution to a low-carbon society" as below.

The Ministry of Transport and Communications (MOTAC) is responsible for managing and supervising the telecommunications sector in the Kurdistan Region and also responsible for internet services, tuning frequencies for audio and visual media and postal services.

The JICA Project Team summarized the existing conditions of the telecommunications sector in Erbil based on the results of interviews conducted in Erbil in August 2022 with relevant organizations and information gathered through desk research, which are shown below.

(1) Private companies in the telecommunications sector

As shown in Table 8.6.1, Erbil is served by a variety of Internet service providers, mobile phone companies (described later in the next section), private operators offering telecommunication, etc.

MOTAC owns the fiber optic cable transmission backbone network, microwave network, etc., and its operation and maintenance services are outsourced to some private companies in the table below such as Newroz telecom and Korek Telecom.

Table 8.6.1 Private Companies in the Telecommunications Sector in Erbil

No.	Name	Category
1	Korek Telecom	Mobile service
2	Asiacell	Mobile service
3	Zain Iraq	Mobile service
4	Newroz telecom	Internet and telephone service
5	FTTH (Fiber to The Home)	Internet service
6	NASSTEL	Operation and maintenance service
7	Iraqcell	Internet service
8	Tornet	Korek telecom main aggregator
9	Tishknet	Internet and Telephone Service
10	TarinNet	Communication and internet service
11	DIL Technology	Fiber optic network operator
12	DTS (Darin Telecom Service)	Telecommunication service
13	Fastlink	Internet service
14	Blue Fiber	Internet service
15	Kernel	Information technology
16	Primam	Telecommunication service

Source: JICA Project Team

The following table shows the broadcasting companies associated with Erbil and Kurdistan Region. People mainly use pay-per-view/free Internet TV and satellite TV, and the Team was unable to confirm any operations for analogue/digital terrestrial TV.

Table 8.6.2 Broadcasting Companies in Erbil

No.	Name	Category
1	Rudaw	Internet TV (News, documentary)
2	Net TV	Internet TV (General)
3	Kurdmax	Internet TV (General)
4	Kurdmax Show	Internet TV (General)

No.	Name	Category
5	Kurdmax Pepule	Internet TV (Kids)
6	Kurdistan24	Internet TV (News, documentary)
7	Korek TV	Internet TV (Music)
8	Ava Entertainment	Internet TV (General)
9	Zagros TV	Internet TV (General)
10	Kurdistan TV	Internet TV (General)
11	United Mix Media	Satellite TV
12	Istar HD	Satellite TV
13	HD Box	Satellite TV
14	Family Box	Satellite TV and Internet TV

Source: JICA Project Team

(2) Fiber network infrastructure

As mentioned in the previous section, MOTAC owns the fiber optic cable transmission backbone network and outsourced maintenance and operation for the network to private companies. Figure 8.6.1 shows the facilities that are operated and maintained by Newroz telecom in Erbil city.

Facilities in Ankawa Exchange

Relay station in town

Figure 8.6.1 Fiber Optic Facilities in Erbil

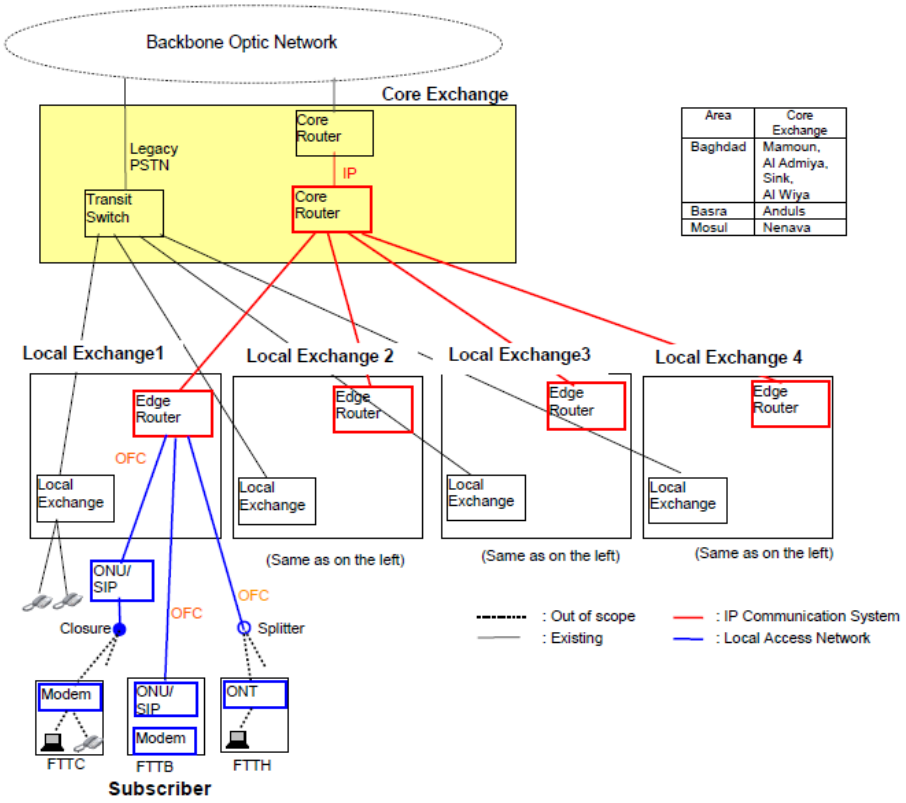
Erbil 2030 MP provides the following assumptions in the Design criteria section.

The data services transport network, based on DSL technology over the copper network, is dimensioned separately from the voice network according to the broadband connectivity forecast taking into account the expected PC (Personal Computer) penetration and demographic information.

However, interviews with MOTAC have revealed that analogue copper lines are already not in use, and projects such as FTTH (Fiber to the home) and FTTG (Fiber to the Government) are being implemented for the installation of optical fiber networks. Based on the above, it can be inferred that the situation has changed from that assumed in Erbil 2030 MP, and the existing copper line network has been replaced by an IP communication network.

Diagram of Figure 8.6.2 explains the outline of the IP communication system and local access network. This figure outlines the network in another part of Iraq[1], showing the plans for updating the IP communication system, indicated by the red line, and the local access network, indicated by the blue line. It is assumed that the network has been updated according to the same policy for Erbil, although details are unknown as the information has not been shared.

[1] Since information on Erbil was not available, the Team have used a network diagram of other areas of Iraq that are considered to be in the same situation to illustrate this point.



Source: Preparatory survey on the construction and development of telecommunications network for major provinces in Iraq. -- Japan International Cooperation Agency: Nippon Koei Co., Ltd., 2011.3.

Figure 8.6.2 Outline of IP Communication System and Local Access Network

(3) Mobile network and communications

In Erbil, Korek Telecom, Asiacell, and Zain Iraq obtained licences and provide mobile phone services, and these operators have achieved 100% population coverage of 3G network services[2]. In addition, as of 2023, in the Kurdistan region, including Erbil, LTE service is available in key areas of the city[3]. The following table shows the number of users of the three main mobile phone companies in Iraq.

Table 8.6.3 Number of Subscribers of Major Mobile Companies in Iraq

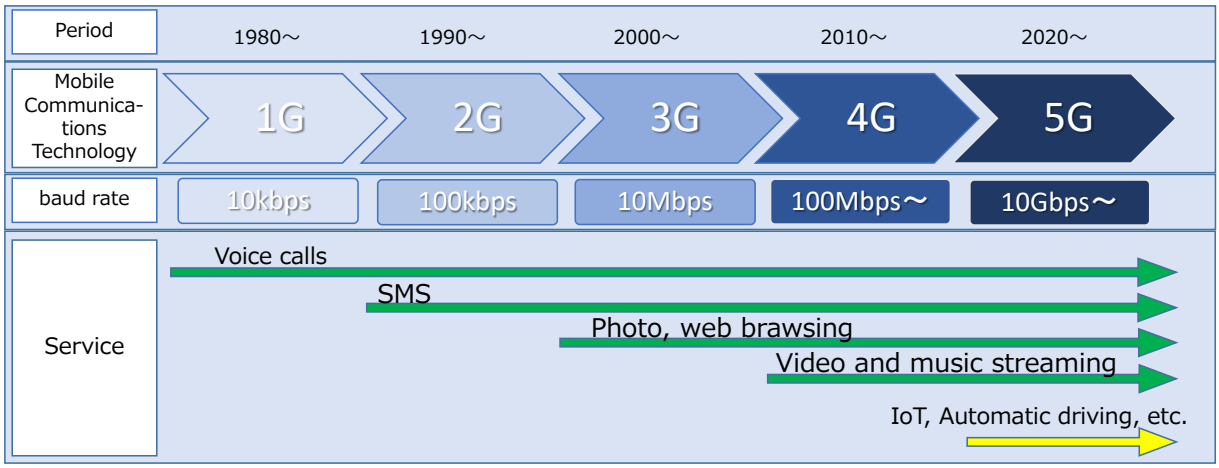
No.	Name	Subscriber
1	Korek Telecom	Over 7.0 million
2	Asiacell	Over 17.0 million
3	Zain Iraq	Over 8.5 million

Source: On the web site of each company

According to MOTAC, several telecommunications carriers have obtained 5G licenses and are expected to begin 5G operations by the end of December 2022. However, as of January 2023, no announcement has been made for the start of 5G operation.

Figure 8.6.3 below shows the global transition of communication technologies for mobile communications. In the future, 5G communications which can be realized “high-speed, large-capacity,” “highly reliable, low-latency” and “multiple simultaneous connections,” and 6G communications are expected to be commercially available around 2030 in the developed countries. However, as of 2023, it is still in the process of developing 5G communication stations in non-urban areas all over the world. One major reason for the slow progress in infrastructure installation for 5G is said to be the lack of killer content that can take advantage of 5G’s characteristics.

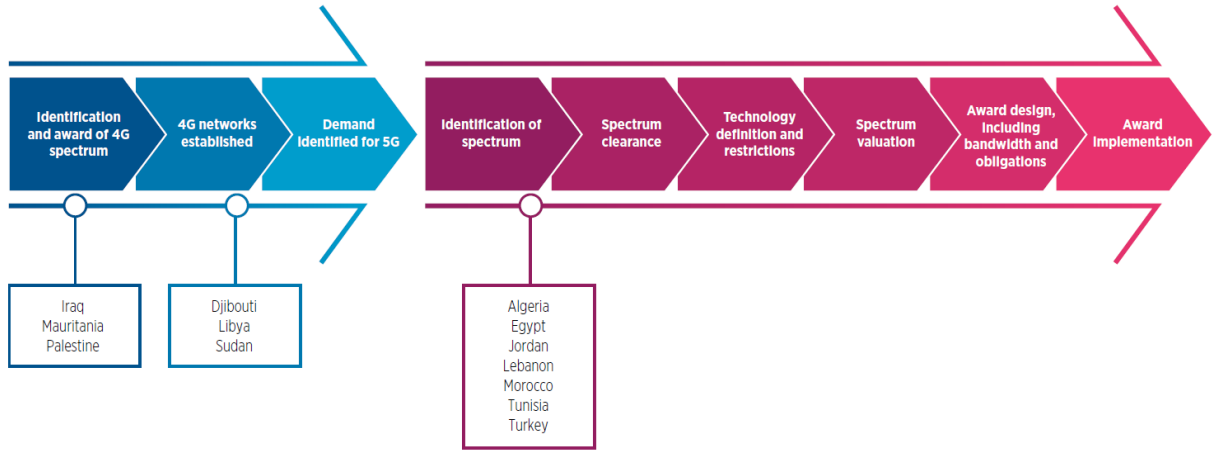
[2] ITU World Telecommunication/ICT Indicators (WTI) Database 2020
[3] https://www.budde.com.au/Research/Iraq-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses



Source: JICA Project Team

Figure 8.6.3 Global Transition of Communication Technologies for Mobile Communications

The figure below shows the current status of roadmaps for 5G implementation in Middle Eastern countries. Erbil launched LTE services in 2013, but since 4G services were not launched in the rest of Iraq until 2020, it is categorized in the same slow progress group as Mauritania and Palestine and is expected to take a little longer to launch 5G services.



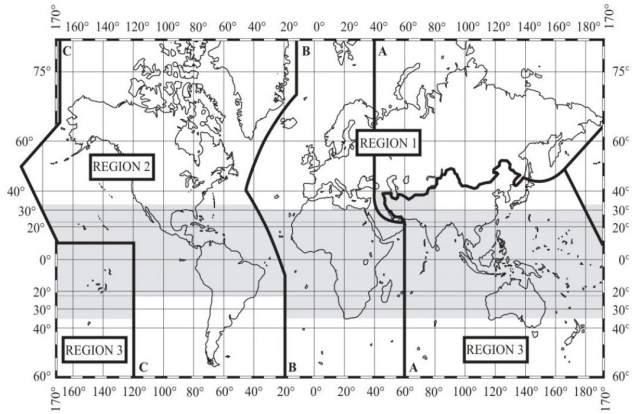
Source: Roadmaps for awarding 5G spectrum in the MENA region by GSMA

Figure 8.6.4 Estimated Current Status on Roadmap for 5G

(4) Frequency allocation

The Republic of Iraq including KRG is a member of the International Telecommunications Union (ITU) and the country's frequency allocation is planned in accordance with ITU-R Region-1. The regulatory body governing communications policy is the Ministry of Communications of the central government, and the Communications and Media Commission (CMC) is charged with regulating the country's radio frequency spectrum activities such as planning, allocations, and licencing[4]. According to MOTAC, the frequency planning is being done in cooperation not only with the central government of Bagdad, but also with the relevant agencies on the KRG side.

[4] https://halberdbastion.com/intelligence/countries-nations/iraq



Source: ITU

Figure 8.6.5 Region Map of Frequency Allocation (ITU)

Source: CMC

Figure 8.6.6 National Frequency Allocation Table, Republic of Iraq

The following table shows the frequency bands currently used as mobile phone frequencies for the Republic of Iraq.

Table 8.6.4 Number of Subscribers of Major Mobile Companies in Iraq

Mobile network	Frequency band[5]	Launched from
2G	GSM 900, GSM 1800	2003[6]
3G	UMTS 2100 (1)	2007[7]
4G (LTE)	LTE 2300 (40), LTE 2500 (41), LTE 2600 (7)	2013[8]
5G	To be assigned by CMC	-

Source: JICA Project Team

It is considered necessary to build 5G networks in the future, but to meet all the performance requirements of 5G networks, low frequency (below 1 GHz), medium frequency (such as 3.5 GHz), and high frequency (such as 26 GHz and 40 GHz) frequency bands are needed. Therefore, it may be necessary to release the following frequency bands in stages in the future.

- All or partial release of 2G and 3G frequency bands
- Release of the analog terrestrial broadcasting band after the analog switch over

Although MOTAC requested the Team to provide support for frequency planning, but the scope of those assistance will be for the entire country of Iraq. Since this MP project covers Erbil city, assistants regarding frequency planning is excluded from the scope of Erbil 2050 MP.

(5) Cyber security

Since strategies such as “cyber security,” “cloud computing,” and “e-government” generally assume a stable telecommunications infrastructure, the Team confirmed the current status of policies related to these topics. Department of Information Technology (DIT) is responsible for government digital services and the Digital Transformation of Kurdistan Regional Government, and “Cyber security”, “Cloud computing”, “e-Government”, etc. are covered by DIT.

Digital Transformation is one of the top priorities of the KRG’s ninth cabinet[9]. Therefore, the KRG

[5] https://www.gsmarena.com/network-bands.php3?sCountry=IRAQ

[6] https://medialandscapes.org/country/iraq/telecommunications/overview#:~:text=The%20first%20permit%20for%20mobile,the%20South%20of%20the%20country.

[7] https://en.wikipedia.org/wiki/Mobitel_(Iraq-Kurdistan)

[8] https://www.commsupdate.com/articles/2013/06/05/regional-telecom-lte-network-goes-live-in-kurdistan/

[9] https://gov.krd/dit-en/activities/news-and-press-releases/2022/october/the-digital-transformation-strategy-of-the-kurdistan-regional-government-was-announced-in-a-ceremony-by-the-prime-minister/

through the DIT was committed to delivering KRG's first Digital Transformation Strategy, which includes the following six (6) Core Strategic Activities: Digital governance, Digital architecture, Human capital, User centered design, Security & Data privacy, and Procurement.

The Team will review the details of the strategy and include in the Erbil 2050MP, as necessary, projects such as the development of telecommunications infrastructure that would support the strategy.

(6) Vision 2030

Vision 2030, developed by the KRG, identifies the region's development priorities for the next 10 years and establishes the strategic directions and goals that the region seeks to achieve. The Vision identifies four (4) pillars and twelve (12) regional priorities. The following are excerpts from the description of these priorities that are considered relevant to telecommunications. The telecommunications sector part of the Erbil 2050 MP will be prepared for content to ensure that the policies and plans contribute to the realization of these demands.

Table 8.6.6 Items regarding Telecommunications Sector in Vison 2030

Regional Priority	Parts related to telecommunications sector
3: Healthcare	We will also modernize the medical equipment and technologies used by our medical professionals, ensure access to affordable medicine and adopt e-health practices to improve performance.
6: Institutional performance	Digitize government services and launch an e-government initiative to improve access, transparency and delivery of services.
8: Economic diversification and fiscal sustainability	We will also introduce modern farming machinery and techniques, support innovation, build the skills of our farmers, market our agricultural products; and focus on value added products.
9: Private sector and business environment	Private banks will be stimulated to increase lending to private sector, and we will implement policies that reduce dependency on cash transactions and introduce digital financial tools to foster financial inclusion, particularly among rural populations.
10: Labor force	Strengthen MoLSA online jobs portal and offer additional active labor market programs, such as employment services, career guidance and job counseling, to help match job seekers with employers and enhance citizens employability.
11: Energy and Infrastructure	We will also improve revenue collection and adopt smart metering; shift to cost reflective tariffs that protect the most vulnerable households; and reduce technical and commercial losses from the network.
Ditto	Improve KRI's connectivity and readiness by enhancing ICT services.

Source: Vision 2030, KRG

(7) Contribution to a low-carbon society

As a result of interviews with MOTAC, no projects related to "contribution to a low-carbon society" are currently being implemented. Referring to the "Low Carbon Society Action Plan for the Telecommunications Industry," a plan used by Japan Business Federation (Keidanren) to guide activities in the sector concerned, the plan indicates the promotion of the following two (2) items.

- Reduce CO2 emissions by promoting energy conservation and efficiency in telecommunication networks, facilities, data centers, equipment, etc.
- Contribute to the realization of a low-carbon society through the use of clean energy for telecommunication facilities and equipment.

Since the above is considered applicable to Erbil city, the Team will consider incorporating "energy conservation and efficiency improvement of telecommunication-related facilities and equipment" and "utilization of clean energy" into Erbil 2050MP.

8.6.2 Key planning issues

The following are the key planning issues for the Erbil 2050 MP.

(1) Confidentiality of information related to the telecommunications sector

The following information required for the schematic and detailed design of the project proposed in the Erbil 2050 MP was not available as of June 2024.

- Number of towers for mobile/backbone networks
- Current situation on 4G and 5G
- Mobile network plan for future
- Plan for cyber security, cloud computing, e-government, etc.

Therefore, it is necessary to obtain the above information from MOTAC, DTI, and other relevant organizations before proceeding with the detailed study and implementation of the proposed project described below.

(2) Lack of shared infrastructure

Through the field survey in August 2022, the Team confirmed following issues with local telecommunication engineer.

- Each project and telecom operator is digging up roads and laying communication lines according to their own plans.
- In the many telecom tower sites, each telecom operator is secure their own power source.

(3) Delays in infrastructure development for 5G

According to Korek Telecom engineers, in order to create a 5G communication environment in Erbil, communication antennas need to be installed every 150 meters, but these measures have not progressed. As of June 2024, 5G communications operations have not yet begun.

(4) Guideline/law for 5G facility installation

According to an engineer of Korek Telecom, there are not enough guidelines/law in place for the construction of 4G/5G telecom towers and facilities. There's only an environmental law for the installation.

8.6.3 Sector Strategies & Policies

(1) Overall Goals of Telecommunication Sector

The Overall Goals of the Telecommunication Sector development in Erbil 2050 MP, which are outlined in KRG Vision 2030 and which will realize the Long-term Development Visions, can be summarized as below.

- [TLC-I] Providing secure, high-quality, and affordable telecommunications services in Erbil
- [TLC-II] Promoting the introduction and use of the latest ICT technologies
- [TLC-III] Introduction of telecommunication technologies/facilities in Erbil that contribute to the creation of a low-carbon city.

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Telecommunication Sector mainly support the realization of the Strategic Orientations #3: Innovative & Diversified Economy and #5: Robust, Efficient & Resilient Infrastructure Networks (See Section 5.4), which implements especially the Long-term Development Visions (See Section 4.2) of Cybercity (CYB).

(3) Strategies & Policies of Telecommunication Sector

Table 8.6.7 below summarizes the Strategies & Policies of Telecommunication proposed to tackle existing issues and to achieve Erbil 2050 MP Long-Term Visions and Overall Sector Goals.

Table 8.6.7 Strategies & Policies of Telecommunication Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Secure Telecommunication Infrastructure	**TLC-S1**: Ensuring Secure Telecommunication Infrastructure	Rehabilitate existing telecommunications infrastructure facilities and conduct periodic maintenance. [Partial change from Erbil 2030 MP Review] Expansion of Fiber Optic Network Service Area [MOTAC] Expansion of cell phone network service area OPGW project [MOTAC] Fiber infrastructure laid on 132KV and 33KV power towers will be utilized for telecommunications. Expansion of postal service and increasing the number of post boxes [MOTAC]	TLC-I: Providing secure, high-quality, and affordable telecommunications services in Erbil
Next Generation Technology	**TLC-S2**: Introduction of Next Generation Technology	To install antennas for 5G/6G cellular communication networks to promote the introduction of 5G/6G mobile networks. (Next Generation Wireless Communication System Development Project) Publicly soliciting local 5G demonstration projects from the private sector and universities	TLC-II: Promoting the introduction and use of the latest ICT technologies
Low-carbon City	**TLC-S3-1**: Contribution to the Low-carbon City by updating the telecommunication facility	By sharing of telecommunication facilities. [MOTAC] - Shared Tower for Telecommunication - Shared power supply for Telecommunication - Shared Culvert for Telecommunication By introducing energy-saving and clean energy in telecommunication facilities and data centers, etc. - Energy saving of routers and LAN switches through optical communication technology, etc. - Improved efficiency of data center air conditioning By using renewable energy as a power source (or as a part of power source) for telecommunication infrastructure.	TLC-III: Introduction of telecommunication technologies/facilities in Erbil that contribute to the creation of a low-carbon city
Low-carbon City	**TLC-S3-2**: Contribution to the Low-carbon City by using ICT technology	Reduce CO2 emissions by promoting the use of ICT technology - Server Virtualization and Cloud Computing Smart Grid - BEM, HEM - Inverterization of motors	Ditto

Source: JICA Project Team

8.6.4 Telecommunication Sector Development Plan

(1) Ensuring Secure Telecommunication Infrastructure

Kurdistan Region of Iraq Vision 2030 states “Improve KRI's connectivity and readiness by enhancing ICT services”. The Cybercity Vision, which is one of the long-term visions, states “Improve KRI's connectivity and readiness by enhancing ICT services”.

Also, The Cybercity Vision, which is one of the long-term visions of Erbil 2050 MP, states that “Full Information and Communications Technology (ICT) coverage throughout the city, with quick, efficient and free Internet access to all government and urban services.”

As these indicate, telecommunications is the infrastructure necessary to connect services, people, and organizations, and a stable supply of this service is a prerequisite for people's lives, public services, education, medical services, and business operations.

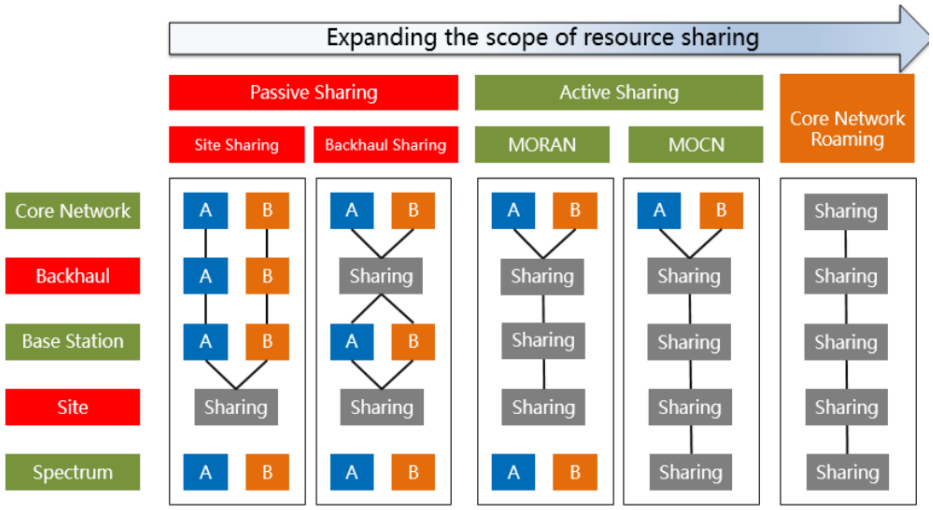
Erbil city has fiber optic communications, cellular network communications, and postal services, and this Erbil 2050 MP develops the projects necessary to ensure the stable operation of these infrastructures. (See Table 8.6.1)

(2) Introduction of Next Generation Technology

As indicated in the Cybercity Vision in the previous section, there is a need to provide free Internet services for accessing public services in the future. Next-generation communications are expected to be used for these services. To prepare the foundation for such an environment, early introduction of 5G is desirable, but as of June 2024, 5G services have not been launched in Erbil.

In order to begin operating 5G communications, the CMC, a central government agency, must allocate frequencies for 5G communications. In addition, the infrastructure for 5G communications needs to be addressed by installing communication antennas approximately every 100 meters. The high cost of implementing 5G infrastructure development with each carrier's own funds is considered to be one of the barriers to 5G implementation.

Therefore, the JICA Project Team proposes the introduction of 5G through "infrastructure sharing," which has been adopted in Europe, the U.S., China, and other countries.



Source: GSMA

Figure 8.6.7 Network Resource Sharing Model

Infrastructure sharing" is classified into two categories according to the extent of sharing: “Passive Sharing,” in which sites and towers are shared, and “Active Sharing,” in which wireless equipment and other items are shared.

Worldwide, passive sharing is the main type of infrastructure sharing, but active sharing is also being

used in Europe, China, and other countries. The details of which combination is optimal will be determined after conducting a feasibility study.

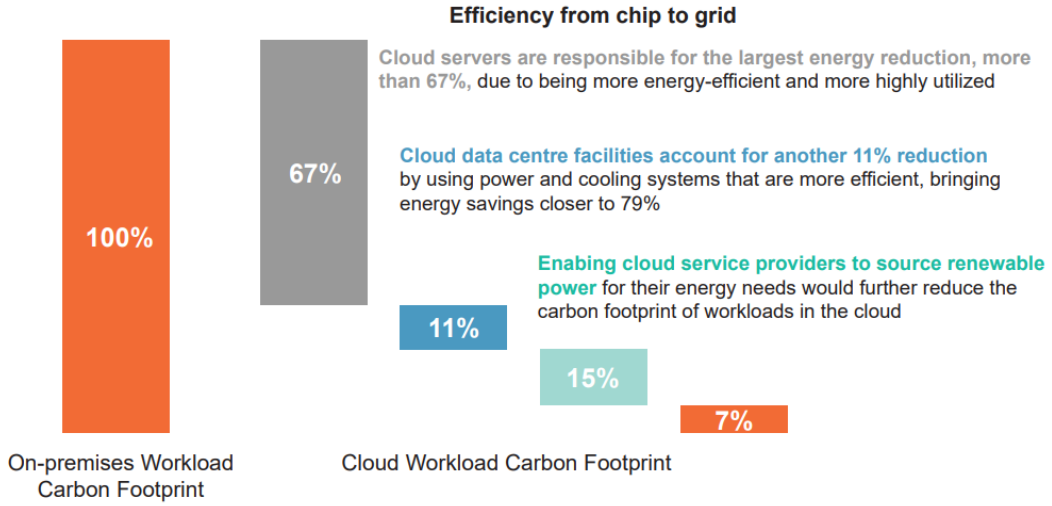
It also plans to publicly solicit applications for pilot projects similar to those conducted in Japan for local 5G, which is expected to be used in the future in areas such as manufacturing, medical care, safety management, surveillance, and research. The project will encourage the participation of private companies, universities, and other organizations in Erbil, and promote the development of 5G technology.

(3) Contribution to the Low-carbon City

The following are examples of ICT technologies that are highly effective in reducing CO2 emissions.

- Server Virtualization and Cloud Computing Smart Grid
- BEM, HEM
- Inverterization of motors

In the case of Server Virtualization and Cloud Computing Smart Grid, which is closely related to the telecommunications field, AWS reports10 that CO2 emissions can be reduced by nearly 80% simply by shifting on-premise servers to the cloud, as shown in the figure.



Source: 451 Research/S&P Global Market Intelligence

Figure 8.6.8 Carbon Reduction Potential of Cloud Infrastructure Compared with Surveyed APAC Enterprises and Public Sector Organizations

8.6.5 Recommendations

(1) Sector Plan Update

Due to its characteristics, the telecommunications sector part of Erbil 2050 MP needs to consider (1) its relationship with the central government, (2) its relationship with the KRG, (3) its relationship with private companies, and so on.

Currently, the telecommunications sector master plan for the KRG has not been formulated. Therefore, the survey team believes that it is necessary to organize the central government's plan and the KRG's telecommunication-related plans and formulate a KRG telecommunication master plan. After the KRG Telecommunications Master Plan is formulated, this telecommunication sector part of MP will be updated accordingly in accordance with the contents of the said plan.

10 https://d1.awsstatic.com/institute/The%20carbon%20opportunity%20of%20moving%20to%20the%20cloud%20for%20APAC.pdf

(2) Necessity for legislation and coordination among relevant agencies

The following table provides information on the necessary legislation and coordination with relevant agencies for the project proposed in the telecommunications sector part of Erbil 2050 MP. It is essential that these actions be taken in order for the project to proceed smoothly.

Table 8.6.8 Necessary Legislation and Coordination for Telecommunication Sector

Proposed telecommunication sector project in Erbil 2050 MP	Necessity of legislation	Necessity of coordination among multiple agencies involved
TL-1 Telecommunication Facilities Sharing Project	Legislation on Joint Use of Telecommunications Infrastructure	Telecommunication carriers and landowners
TL-2 Next Generation Mobile Communication System Development Project	- Legislation on Joint Use of Telecommunications Infrastructure - Regulations related to 5G/6G construction, installation, and safety	Ditto
TL-3 OPGW Project	None	MOTAC and MOE
TL-4 Project to Introduce Clean Energy for Telecommunication Facilities	None	MOTAC and MOE
TL-5 Project to Introduce Cloud Computing System for Ministries in Erbil	None	KRG Ministries in Erbil

Source: JICA Project Team

8.7 Flood Management Sector

8.7.3 Existing Conditions

For the analysis of existing conditions of flooding, refer to Inundation Analysis in Appendix.

8.7.2 Sector Strategies & Policies

(1) Overall Goals of Flood Management Sector

The Overall Goals of the Flood Management Sector development in Erbil 2050 MP, which were suggested during Erbil City Flood Conference (2022) and which will realize the Long-term Development Visions, can be summarized as below.

- FLO-I: Reduce the risk of flooding, by ensuring (1) Zero risk outside of 120m ring road against 50-year ARI (Average Recurrence Interval) flood. In order to implement flood control measures at an early stage, the immediate goal is set as Zero risk outside of 120m ring road against 2021 flood, and (2) Zero risk inside of 120m ring road against 10-year ARI rainfall
- FLO-II: Control stormwater runoff in order to avoid flooding events
- FLO-III: Prevent the risk of flooding in order to ensure human life safety
- FLO-IV: Contribute to tackling water scarcity and promote recreation and amenities

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Flood Management Sector mainly support the realization of the Strategic Orientations #1: Establish the foundations for urban sustainability, resilience and adaptation to climate change (See Section 5.4.1), which implements especially the Long-term Development Vision (See Section 4.2) of Water-Conscious City (WCC).

(3) Strategies & Policies of Flood Management Sector

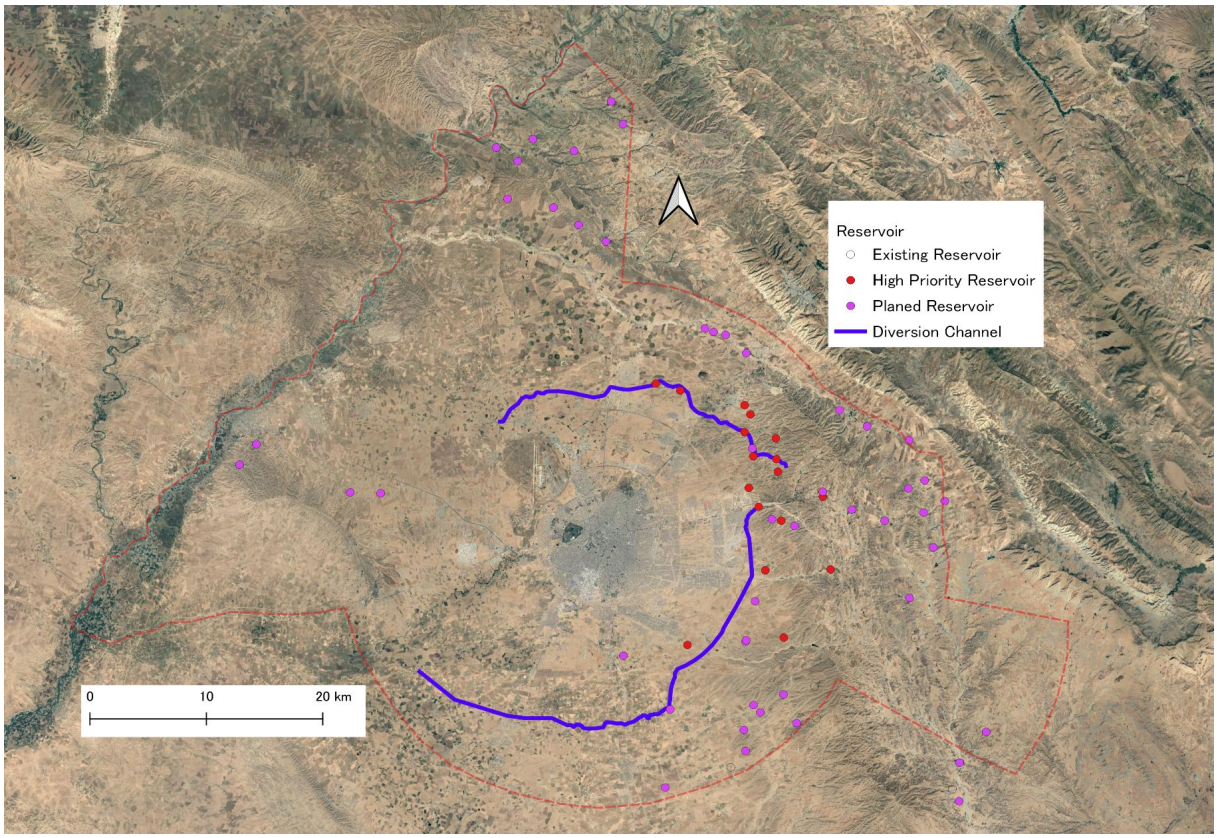
Table 8.7.1 below summarizes the Strategies & Policies of Flood Management Sector proposed to tackle existing issues and to achieve Erbil 2050 MP Long-Term Visions and Overall Sector Goals.

Table 8.7.1 Strategies & Policies of Flood Management Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Planning	**FLO-S1:** Flood Control Plan outside of 120m Ring Road	- **FLO-S1-1**: Formulate flood control plan for 50-year ARI flood, including the following: o Statistical analysis of rainfall o Survey for river network and river profile o Runoff analysis o Discharge capacity analysis of river o Determination of discharge allocation o Design of flood control facilities (e.g. reservoirs culverts, river)	- Lack of rainfall data - Absence of standard, manual and guideline for flood control plan - Cooperation with related organizations (coordination of plans among related organizations)
	FLO-S2: Stormwater Drainage Plan inside of 120m Ring Road	- **FLO-S1-2**: Formulate **s**tormwater drainage plan for 10-year ARI rainfall, including the following: o Statistical analysis of rainfall o Plan of stormwater drainage network and determine sub-catchment areas o Runoff analysis o Design of stormwater drainage facilities	

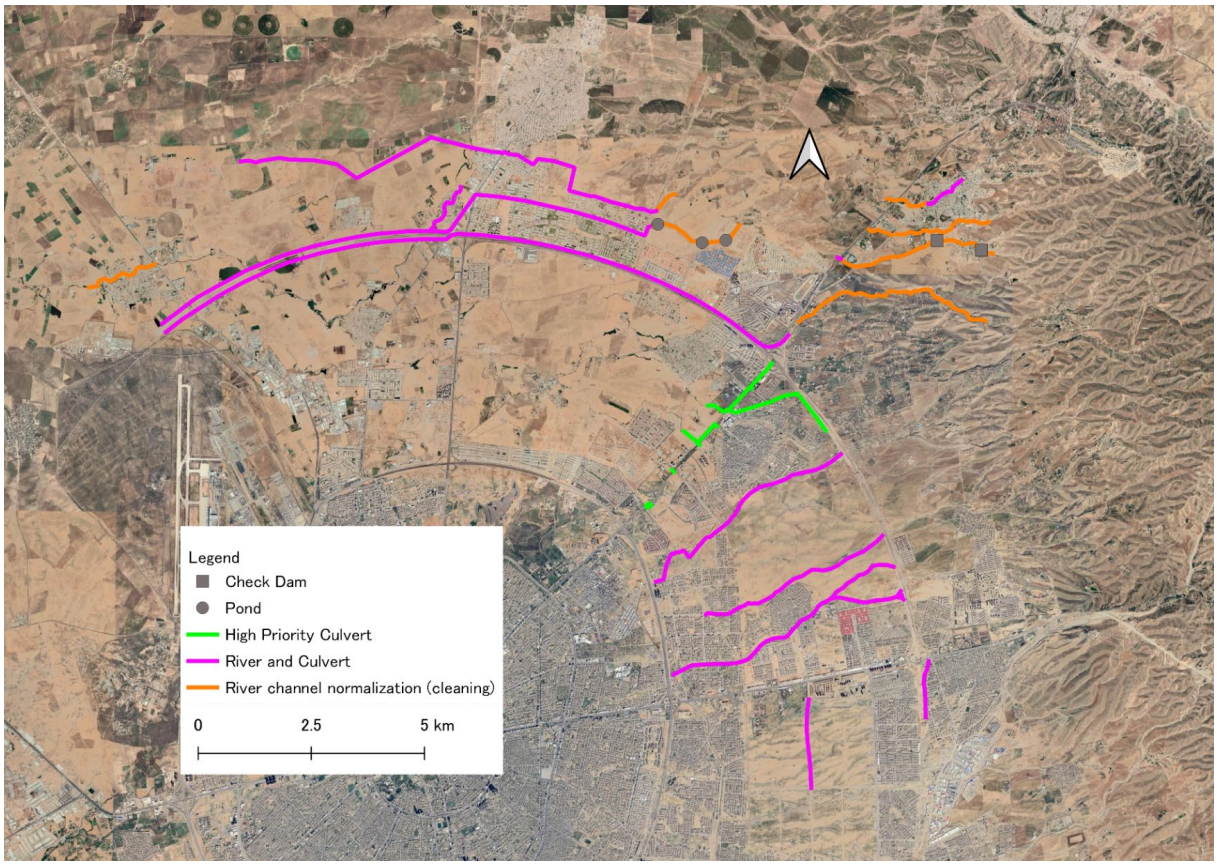
Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Structural measures outside of 120m Ring Road	**FLO-S3**: Control of peak discharge	- **FLO-S3-1**: Construction of high priority reservoirs (17) - **FLO-S3-2**: Construction of planed ponds/reservoirs (48)	- [FLO-I] Reduce the risk of flooding - [FLO-II] Control stormwater runoff in order to avoid flooding events - [FLO-IV] Contribute to tackling water scarcity and promote recreation and amenities - Changes in water use environment - Multiple uses of reserved water - Cooperation with related organizations (coordination of plans among related organizations)
	FLO-S4: Increase of discharge capacity of flood control facilities (e.g. culverts, river)	- **FLO-S4-1**: Construction of high priority culverts - **FLO-S4-2**: Improvement of Kornish stream - **FLO-S4-3**: River channel normalization (cleaning) - **FLO-S4-4**: Construction of ponds and check dams - **FLO-S4-5**: Construction and improvement of rivers and culverts - **FLO-S4-6**: Construction and improvement of flood control facilities (e.g. reservoirs, culverts, river) required as a result of flood control plan	
	FLO-S5: Divert the flow direction of flood	- **FLO-S5-1**: Construction of diversion channels	
Non-structural measures	**FLO-S6:** Develop early warning system	- **FLO-S6-1**: Installation of rain gauges - **FLO-S6-2**: Installation of water level gauges - **FLO-S6-3**: Installation of communication equipment - **FLO-S6-4**: Installation of visualization and forecast system - **FLO-S6-5**: Installation of visualization and forecast system - **FLO-S6-6**: Establishment of communication network	- [FLO-III] Prevent the risk of flooding in order to ensure human life safety - Lack of rainfall data and water level data - Capacity building - Cooperation with related organizations
	FLO-S7: Establish emergency flood protection plan	- **FLO-S7-1**: Strengthening the rescue system	- [FLO-III] - Capacity building - Cooperation with related organizations
Management	**FLO-S8:** Designate river areas and secure the areas	- **FLO-S8-1**: Expropriation of lands required as a result of flood control plan	- [FLO-II] - Illegal activity (Illegal Occupation, Illegal Dumping) - Cooperation with related organizations - Absence of flood control plan and hazard map
	FLO-S9: Urban planning regulations	- **FLO-S9-1**: Designation of High Flooding Risk Zonesss - **FLO-S9-2**: Establishment of zoning regulation for residential and other land uses for rainfall infiltration at the plot	
	FLO-S10: Strengthening maintenance management system	- **FLO-S10-1**: Purchase of heavy equipment	
Structural measures inside of 120m Ring Road	**FLO-S11:** Expansion of stormwater drainage network	- **FLO-S11-1**: Construction and improvement of stormwater drainage facilities required as a result of stormwater drainage plan	

Source: JICA Project Team



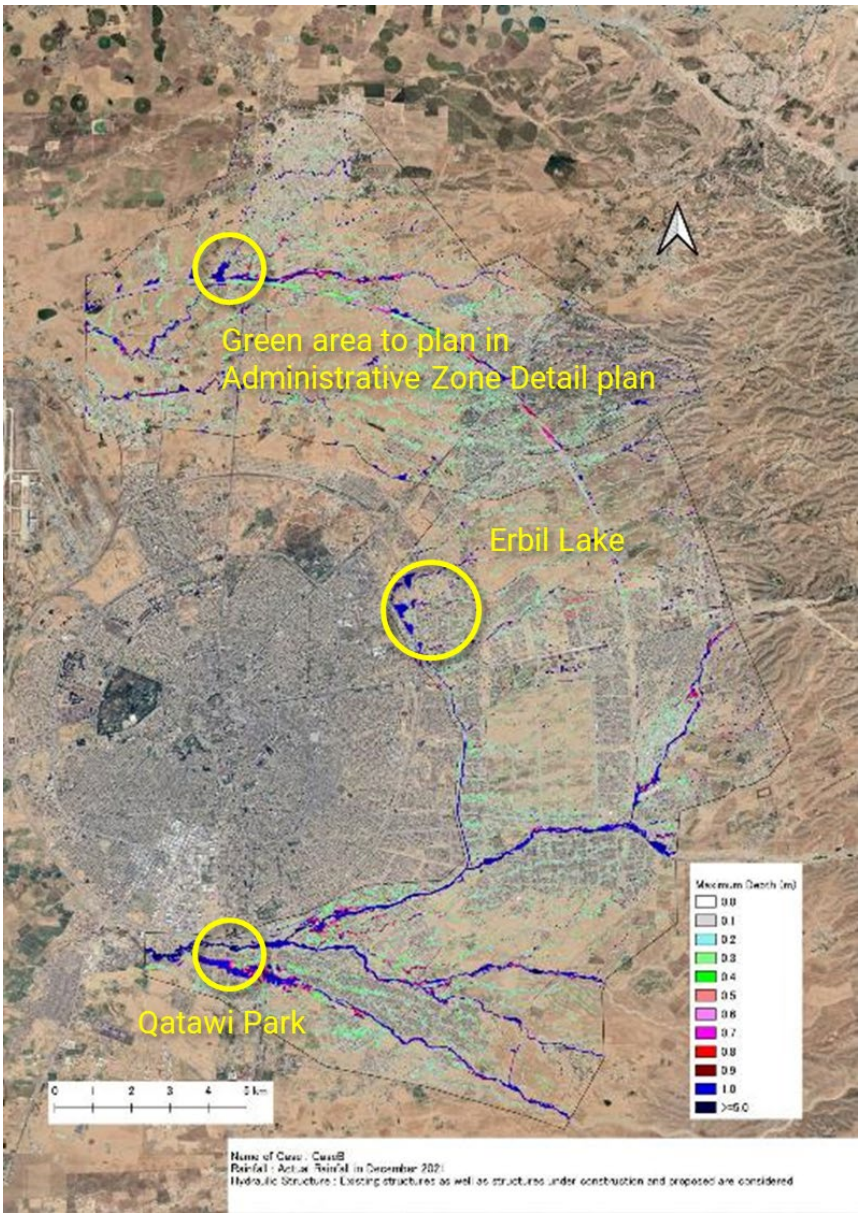
Source: Irrigation Directorate

Figure 8.7.1 Location of Flood Control Facilities (1/2)



Source: GDWS

Figure 8.7.2 Location of Flood Control Facilities (2/2)



Source: JICA Project Team

Figure 8.7.3 Erbil 2050 MP Proposed Green & Blue Area to Tackle Flooding Risk

CHAPTER 9
PUBLIC FACILITIES PLANNING

9.1 Existing Condition of Public Facilities

Public Facilities are a vital component of any urban settlement, they respond to practical and functional needs of the society such as health, education, safety, culture and religious practices.

During the recent years and specifically since its autonomy, the KRI has established major steps towards the implementation of public buildings of various sectors (health facilities, schools, religious buildings, youth centers and others). This development was specially observed in the capital, Erbil, which became the synonym of new opportunities in a stable and open environment.

However, following the invasion of ISIS and the subsequent economic crisis, most of the envisioned public facilities were put on hold. Besides funded projects by countries and NGOS (such as South Korea, the WHO and UNICEF), serving both refugees and the hosting communities, the implementation of major public facilities is barely witnessed. Erbil 2030 MP, approved in 2007 and last updated in 2012 and most recently KRG Vision 2030, look at public facilities as a main constituent. However, obstacles stand in the way of a concrete implementation. Existing institutions and their built structures are facing major threats. While some are overpopulated in the absence of new buildings, the others are decaying due to lack of maintenance and low-budget operation.

Understanding the current condition of the public facilities is challenged by the data availability. Our understanding of the various sectors is based on the obtained data, which is not only limited but is mostly not updated. It also varies between sectors, leaving us with unbalanced level of understanding. We may also add that in some cases documented data do not reflect the existing conditions, thus presenting a certain margin of inaccuracy. According to the 1st SEA Consultation (see Part III, Section 2.2), almost 22% of the citizens identified the main problem in their neighborhood within the category of public facilities; with lack of education facilities being the main concern, followed by health and sport facilities.

The aim of reviewing and understanding the existing condition of public facilities is to pinpoint the gaps and weakness in the planning process of these facilities. By the end of this Survey, we expect to issue an updated Master Plan of Erbil in which public facilities:

- Are equally distributed among sectors and neighborhoods;
- Serve the citizens irrespective of status, background or social class;
- Have the adequate size and infrastructure to properly serve its expected users;
- Have the most advanced legislation, administration and skilled human resources;
- Provide all the needed services to the inhabitants, at a close proximity to their place of residence or work;
- Are a source of pride, reflecting the future identity of Erbil: grounded with history, planning for the future;
- Open to continuous development through research and technology;
- Are visually recognizable and often landmarks in the urban context.

9.1.1 Current Public Facilities Planning Process & Framework

(1) Overview

Although the research is done from within and in collaboration with the Ministry of Municipalities and Tourism (MOMT), specifically its urban planning departments, we were unable to trace a clear process of planning, a comprehensive framework and a clear set of rules and regulations. Most public facilities were implemented in Erbil following the founding of the autonomous KRI. Under the constitution, the KRG has considerable powers to legislate a range of areas including health services, education, policing and security. However, the systems that shaped these relatively new facilities were inherited from the

Iraqi system, which had gone through ups and downs and in a dire need for update.

In parallel, and as part of its autonomous perspective, the KRI disregarded the inherited system in many aspects. However, in the absence of a clear alternative, randomness and lack of coordination became dominant. This was mainly felt in the visits we paid to municipalities and ministries. We noticed a major lack of coordination at all levels, whether in the applied laws and norms or in assigning responsibilities.

(2) Current planning of public facilities

Planning of public facilities for the city of Erbil exists on both the masterplan and the district plans.

In the proposed masterplan of the city in 2007, large zones of public facilities are allocated. These fall under wide categories such as educational, health, institutions and others. A list of "New Projects", including educational and healthcare institutions, among others, proposes specific projects on dedicated plots. The land use plan, part of Erbil MP2030, includes categories of public facility land uses. It also proposes a number of community facilities, based on a projected population of 2.5 million people in 2030.

In the planning departments of the MOMT, the planning of public facilities is, however, not based on Erbil MP2030 or any other masterplan. In fact, the planning happens at the level of the detailed or district plans.

(3) Planning of public facilities in district plans

Prior to 2019, the Presidency of Municipalities took the responsibility of designing local plans, either using its own expertise or by commissioning external consultants. A ministerial order No.8-68/1 issued on 24/12/2020 gives the General Directorate of urban Planning (GDUP) and the Urban Planning Directorate in the different governorates - the entities under the Ministry of Municipality and Tourism- the responsibility of the urban planning. The order states the different responsibilities ranging from policy making to conducting workshops and survey to the design and the design approval of detailed sector plans.

A ministerial letter No.4032 dated 05/05/2021 addressed to the 6 Urban Planning Directorates defines the procedures and guidelines for preparing, approving and handling Sectoral Maps (also referred to as Detailed Plans DP). By observing a number of approved Detailed Plans at the Urban Planning Directorates of Erbil (UPDOE), we were able to read a different range of detailing in relation to the planning of Public Facilities; in relation with the scale of the detailed plan and whether it is prepared by UPDOE or by a private consultant. This may range from a basic allocation of plots as "Services" to a more detailed planning where schools, mosques, green spaces, primary health centers and commercial functions are assigned dedicated plots and areas.

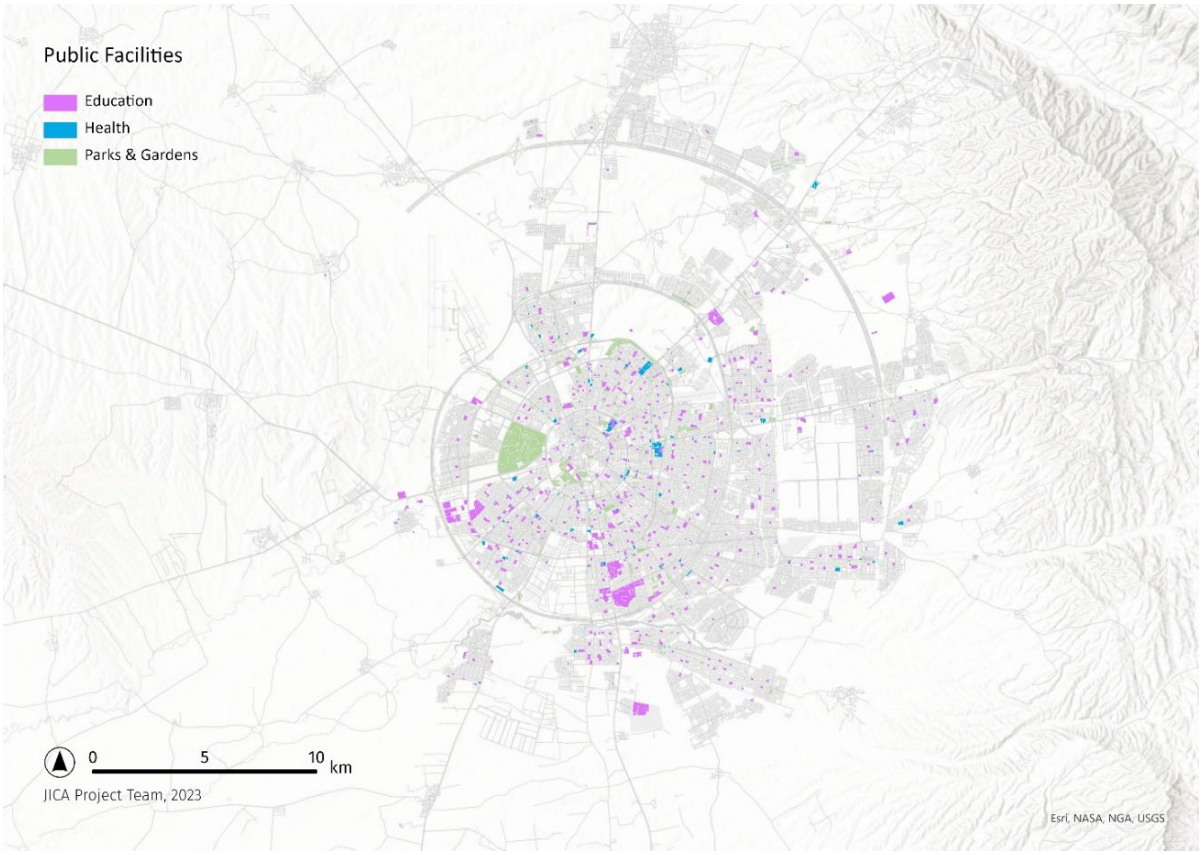
(4) Planning rules and regulations

There is no clear reference for a set of regulations or a handbook that guides the work of the planning department or that can be handed to a consultant. While some planners mentioned the Iraqi Standard, others referred to common practice and knowledge.

In summary, the updated version of the Iraqi standard 2018 covers to a big extent the basic requirements in terms of the provision of public facilities, following planning criteria that correspond to a contemporary city planning. Unlike the previous versions, it acknowledges the high-rise construction, and doesn't encourage it unless necessary. In parallel, the updated rules account more for the role of the private sector in planning, design and construction. It also focuses on the importance of urban design, environmental criteria and the creation of sustainable communities, whether in rural or urban contexts. The Iraqi standards encourage the implementation of small-scale urban facilities within the neighborhoods.

However, the application of the new Iraqi guidelines is not necessarily happening in the KRI urban planning departments. If its applied, it is the result of an individual preference and need for guidance. We did not feel the binding power of these regulations. An official handbook issues by the MOMT, for non-residential buildings permits, only tackles setbacks and building envelope on the urban level.

On the other hand, most of the ministries developed their own set of "recommendations" for the development of their facilities. These recommendations vary, whether addressed to a public or a private facility (hospitals, health center, clinics, schools, mosques). The urban planning dimension varies among these guidelines. They are more tackled in the guidelines of the Ministry of Health (MoH) and the Ministry of Endowment & Religious Affairs (MoERA), less in the Ministry of Education (MoE), which focuses more on the planning of the school in terms of classrooms and other functions.



Source: JICA Project Team

Figure 9.1.1 General Distribution of Public Facilities in the Project Area

(5) Ownership of public facilities

The lands in Erbil are mostly owned by the Ministries of Agriculture and the Ministry of Finance. The Ministry of Endowment and Religious Affairs also have a good amount of land properties.

In Urbanized areas and areas where detailed plans are approved, lands dedicated to services or owned by the MOMT. When a specific program is dedicated to a land, its ownership may be transferred to the related ministry. Built public facilities are owned by the related ministries, who are respectively responsible for management, operation and maintenance based on yearly allocated budget by the Ministry of Finance. Due to the current lack of financing for the public sector and the privatization of services, the ministries feel the threat of losing the lands dedicated to their future projects, to be converted to other uses or to be offered to private investors.

9.1.2 Existing Conditions for Each Type of Public Facilities

(1) Education sector

1) Institutional framework

Three ministries and some private establishments provide education in the KRI. The MoE is responsible for basic and secondary education, including secondary vocational education. The Ministry of Higher

Education and Scientific Research (MoHESR) is responsible for tertiary two-year and four-year technical and academic education as well as for postgraduate education. And the Ministry of Labor and Social Affairs (MoLSA) is responsible for postsecondary nontertiary adult training (www.rand.org).

The basic structure of education is similar to the rest of Iraq, except that compulsory education extends till grade 9, versus grade 6 in the rest of Iraq. School Education is made of two levels, basic (grades 1 to 9) and secondary (grades 10 to 12). At the secondary level, students may choose one of two tracks, vocational or preparatory education.

2) Existing conditions & geographic situations

Received data from the Ministry of Education, in the form of tables includes a good amount of information on each school type: Kindergartens | Primary Schools |Secondary Schools | High Schools | Quick Learning |Vocational Schools | Educational Complexes

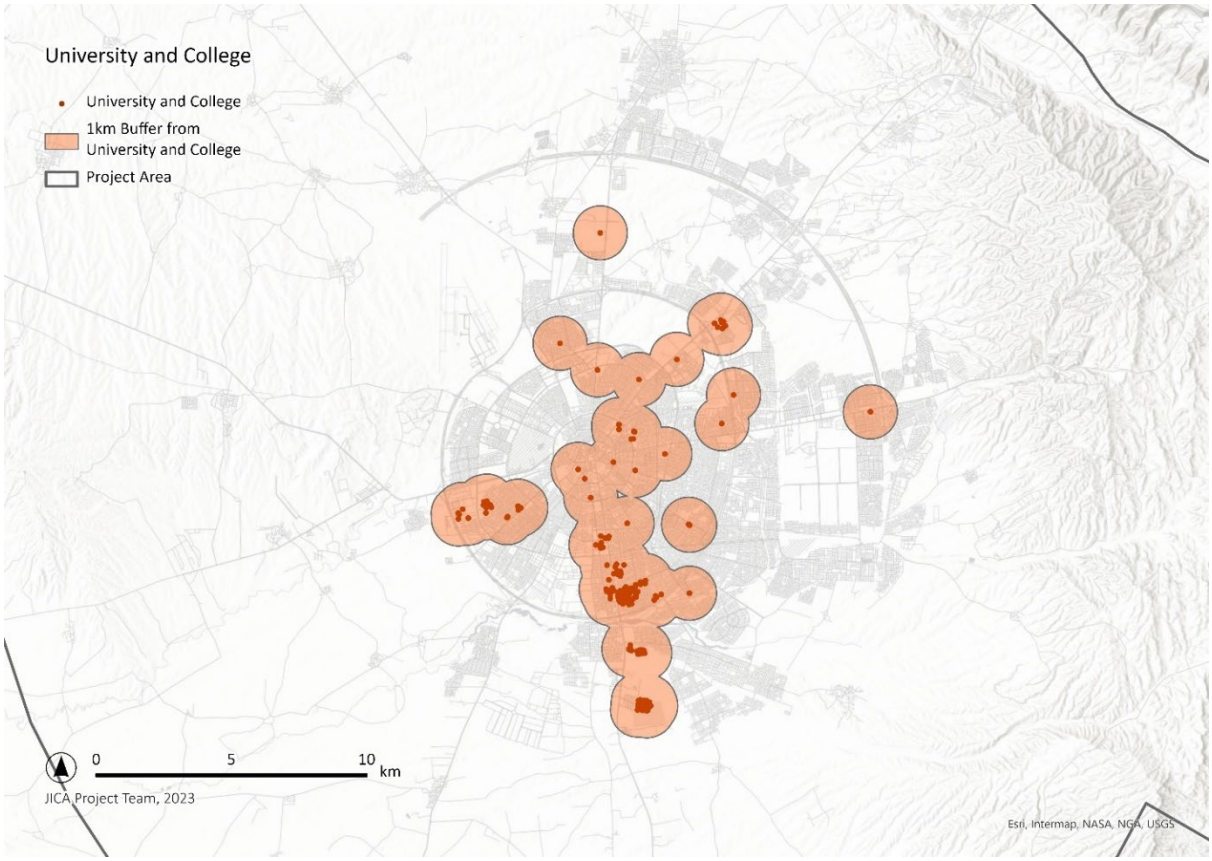
The table includes the following data for each type of Educational Institution:

Name of the school/ year of establishment/ longitude and latitude/ classification/ type of education/ language/ property number / number of students/ source of electricity/ power feeder/ power transformer number/ type of education/ day or evening/ gender/ available amenities/ year of construction.

This information is extracted from the ministry's restricted access website www.e-perwarda.com.

The location of most of the schools on the map is not accurate. The Ministry did not provide any GIS data. In parallel, the ministry shared with us a list of 148 (18-classroom) schools that are needed, in different parts of Erbil. In the table, a dedicated location, numbered plot and land area are defined. All these are requested projects by the MoE, awaiting budget allocation by the Ministry of Finance (MoF).

The availability of electric power is a main concern for most schools, even the newest neighborhoods, where evening shifts are taking place in the dark. Heating is offered though gas heaters.



Source: JICA Project Team

Figure 9.1.2 Distribution of Universities and Colleges in the Project Area

There are a total of 5 public universities and 1 polytechnical school in Erbil. Salaheddin, Erbil Medical and Erbil Polytechnical universities fall within the project area, with colleges in different locations in the city, mostly focused in Municipality 5 along Kirkuk Street, offering high level of academic services. In parallel, the number of private universities outgrew the public ones in the last few years, with more in the pipeline as per the Ministry of Planning (MoP) and Ministry of Higher Education and Scientific Research (MoHESR).

3) Existing and planned policies

The most important policies in the field of education in the KRI were historically related the use of the Kurdish language as the main teaching languages instead of the imposed Arabic language. Minorities right for education was also granted by using their mother tongues languages in schools in their areas. Arabic, Turkmani, Syriac and Armenian are used in schools.

In 2010, the KRG asked RAND to assess the status of K–12 education and its incipient reforms. RAND then made three strategic recommendations to improve access to and quality of K–12 education. The reports with policies were issued in 2016 by the Ministry of Planning and the Ministry of Education.

PPP: Following the success of some private schools in Erbil and with the new adopted policy by the government to create more partnerships with the private sector, PPP schools were implemented. Fakhir Mergasori International School (FMIS) is an example of a SABIS school, established in 2008 with the intention of serving the children of martyrs.

In the presence of a large number of refugees in Erbil, UNHCR with official "Education Partners" developed a number of policies to ensure refugee integration in education.

"The Refugee Education Integration Policy, "REIP", is a policy developed by the Kurdistan Regional Government with support from the UN Agencies and education partners to ensure that refugee and asylum seeker children have access to quality education on an equal basis as host community children."[1]

4) Planning & construction norms

The Ministry of Education is in the process of developing its own sets of rules and regulations to guide the planning and design of public schools, which the planning departments supposed, need further developments. These recommendations are not officially binding yet. They follow the previous categories of schools of 9/12/18 classrooms. As a result, all 18-classroom schools have an equal BUA while the allocated plot in the DP may vary. Lucky schools may have larger plots and more open spaces.

On an urban level, private schools' guidelines define a minimum distance from any polluting function, a minimum area for a green space. It also sets a number of parameters such as number of toilets, class rooms and offices sizes, while taking into account the type of school and number of classrooms.

5) Issues and challenges of the sector

- There is a major lack of educational facilities in terms of number of schools, distribution, poor quality of the facilities and the services;
- The lack of financing is a major obstacle for building new schools, extending existing ones and providing services such as electricity and drinkable water;
- Quality of public schools varies among areas and neighborhoods. In many cases, schools are over-congested. Some lack natural light and access to clean toilets and potable water;
- New development projects (mainly gated cities and towers) responding to a high increase in population are avoiding or delaying the provision for public schools and are congesting exiting ones;

[1] https://help.unhcr.org/iraq/en/rights-and-obligations/education/refugee-education-integration-policy/

- The lack of financing facilities by the public sector is coupled with a privatization of the educational sectors. Private schools and universities (mostly international) are encouraged and their implementation is being facilitated by the government (specifically the Board of Investors). However, most citizens cannot afford private education.

(2) Healthcare sector

1) Institutional framework

The health services in Kurdistan region are delivered to the population at three levels: Ministry of Health, Directorate of Health in each governorate, and the district health offices at the district level. There are 2 types of health services provided by the public sector: Hospitals and Primary Health care Centers (categorized A to E). There are 3 public emergency hospitals as well as emergency wards at other hospitals. Main PHC, categories A&B are staffed by one physician. PHC branches are staffed with paramedical personnel. The MoH in the KRI was established on the 1990s following the same organizational structure and system as the Iraqi health care system, at a moment where the Iraqi system itself was deteriorating as the result of the 2 wars and the sanctions[2] . The health services are provided at a very low cost, giving access to healthcare for all. The PHC centers are located within the neighborhoods, making them accessible within less than 30 minutes.

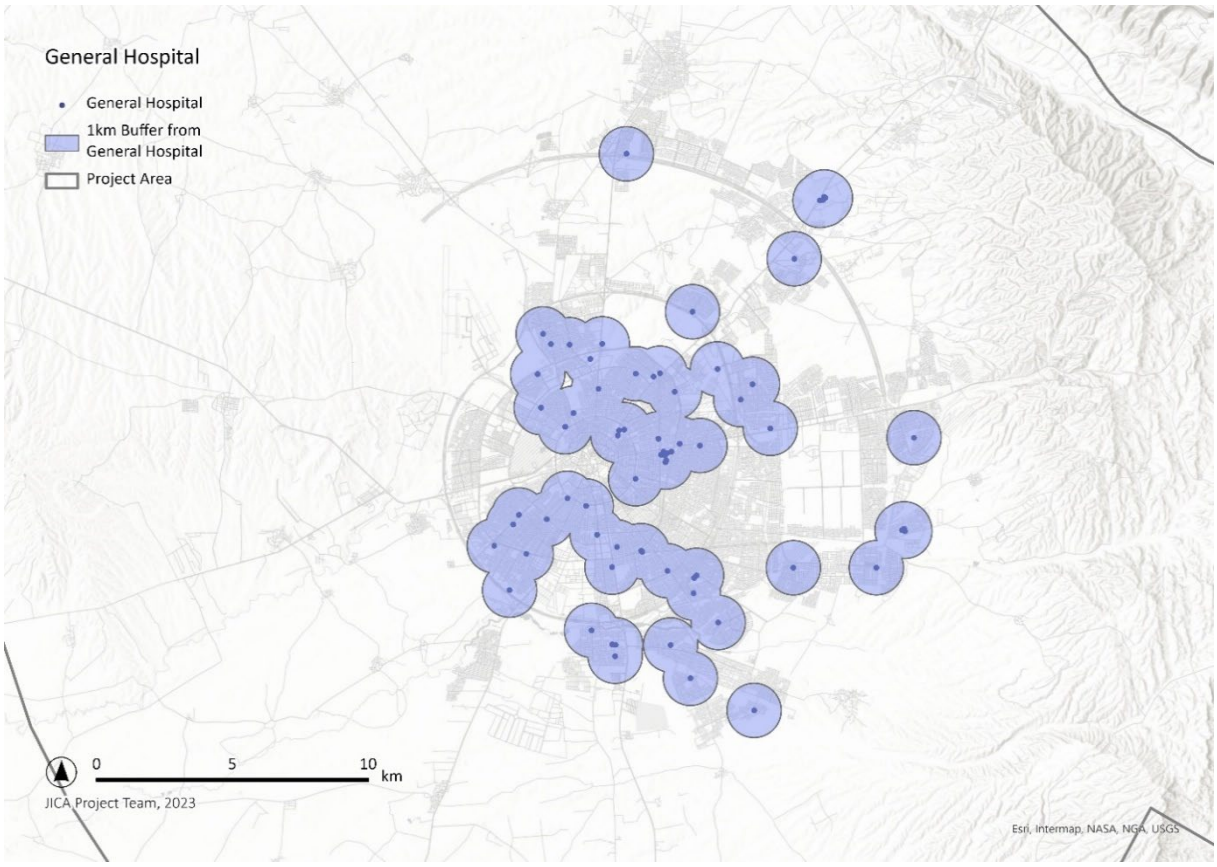
2) Existing conditions & geographic situations

There is a total of 16 public hospitals in Erbil and 54 PHC (Main and branches) as per the MoH. The list of 29 private hospitals and more than 50 registered medical centers are expected to grow with more approved projects by the BOI.

Several lists detail the public health institutions, specialized medical complexes and hospitals across Erbil with code, name, type, latitude and longitude and number of beds where applicable. Private clinics and private hospitals area are also listed without details. An Atlas of Health Ministry of Planning Joint Humanitarian Information Center (JHIC) Erbil 2007 is available online. However, no GIS data was shared by the MoH.

While the PHC are distributed in the neighborhoods based on the DP, many hospitals are concentrated on major roads, mostly north of Erbil, at very close distance from each other. We were unable to find any law that organizes the distance between hospitals in an urban context. A 20 km minimum distance is required between hospitals outside the city. Similarly, gathering pharmacies and clinics close to each other is a common practice. The “Doctors’ Street” is a common destination for anyone looking to see a doctor or purchase medication.

[2] Iraqi health system in Kurdistan region: medical professionals’ perspectives on challenges and priorities for improvement. https://conflictandhealth.biomedcentral.com/articles/10.1186/1752-1505-4-19



Source: JICA Project Team

Figure 9.1.3 Distribution of General Hospitals in the Project Area

3) Existing and planned policies

Erbil's MoH lacks clear strategic policy directions, resulting in uncoordinated planning and fragmented projects. According to a study by Rand, one of the major challenges of the sector is the lack of any policy that organizes what is called a *Dual practice*, in which physicians work part of their time in the public sector and part in the private sector.[3] Another practice happening is the funding of the private practice using the public Funds.

Similar to the Education sector, world organization and foreign countries fund the implementation of new projects, as well as the renovation and rehabilitation within existing hospitals.[4]

4) Planning & construction norms

Hospitals and specialized health districts are defined at the level of the masterplan. Primary Health centers are included in DP without further details. The MoH will then assign the category and services in the PHC. Received Guidelines from the MoH (without dates, legal stamps or issuing entity) set the "Disciplines of building and renovating health institutions" based on categories: Public Hospitals/ PHC run by doctors / run by health workers/ rural health centers / health promotion centers / a dental specialty center/ a dental unit within a health center/ a dental unit within a rural health center. All these guidelines take into account population served, distance from other centers and relate between the requirements of the health centers and the number of schools in the served community.

The MoH presents a handbook to guide the opening of a private hospital. The Language is Arabic, applicable to the whole Iraq. The received scanned document and its soft copy have no date, no official decree or signed entity. The scanned document is stamped by "ErbilMD- Switzerland". Composed of

[3] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6183772/
[4] https://www.undp.org/iraq/press-releases/baharka-hospital-officially-opens-erbil

54 pages, it includes logistics and medical and planning guidelines.

5) Issues and challenges of the sector

In summary, the healthcare system is a major focus in the KRI. There is a commitment to improve it as the level of facilities and healthcare providers and stuff. However, the services are overused, especially due to the rapid increase in population. The events of the past years and the economic crisis degraded the facilities. The lack of funds is reflected in a lowered budget for operation and maintenance, absence of new projects and a degradation of the quality of services and a diminishing number of doctors and medical staff. SEA public consultation results reflect this concern. Many requested focused on improving the PHC services, knowing that only PHC categorized A&B are attended by a physician. However, those are only available for few hours a week, making the service unreliable.

The visits paid to public hospitals (East Erbil Emergency Hospital & Rizgary Hospital) show the physical deterioration of finely built but old facilities. Despite their status, the public hospitals attract a lot of patients, many of them commuting more than 100km.

While public hospitals are struggling, private hospitals are on the rise. More women are deciding to give birth in private hospital instead of public hospital as per Kurdistan Region Statistics Office / Kurdistan Region 2014-2018 indicators. This shows a declining trust in public hospitalization. The MoH expressed worries about the lack of control over the rapidly expanding private healthcare system. The Board of Investors is a main decision maker in the development and space allocation of private Hospitals. Following a request by a private investor, the board on investors offers the land for free. The masterplan is not referred to when allocating hospitals. GDUP 's role is very limited, focused on setting setbacks and minor design parameters. In parallel, the main concern of the citizens is the absence of health insurances, restricting the access of the majority of the population to private healthcare.

(3) Sport, socio-cultural and recreational facilities

1) Institutional framework

The planning department at the Ministry of Culture and Youth is responsible for the planning and implementation of cultural centres, sport centres and courts, youth centres, indoor and outdoor pool clubs. There are 3 categories of Sport Facilities: Public, Private and Institutional. The largest number of which is owned by private clubs yet monitored by the Ministry through the General Directorate of Sports. The playgrounds in the neighbourhoods are mostly owned by political parties. The rest are either owned by the Governorate or the Directorate of Sports.

Libraries fall under the scope of the General Directorate of Public Libraries within the MoCY.

Museums are categorised into 3 types: National, cultural and Archaeological. Different museums are under the Directorates of Archaeology within the MoMT or the Directorate of Municipalities within the MoMT. 2 museums (Ankawa and an unfinished museum) are under the MoCY.

2) Existing conditions & geographic situations

The MoCY shared a list of List of 8 Existing Youth Centers with general location and area and a list of 5 unfinished or uninitiated Youth Centers with general location and area. GIS data is also unavailable.

Table 9.1.1 Public Libraries Data

Number of Public Libraries in KRI	92
Number of Public Libraries in Erbil	30 (8 of which in the project area)
Number of Visits to Libraires in Erbil	32658
Number of Books in Libraries in Erbil	276866

Source: Directorate of Libraires, MoCY

The number of museums is quite limited in a city with a rich cultural heritage. Some museums are on hold or awaiting a budget approval. The Directorate of Archaeology shared the need to build new

museums (National Museum, Anfal Museum, Museum facing the citadel).

3) Existing and planned policies

In 2021, a law was issued allowing individuals and private sector to open cultural museums and galleries, following the directorate's guidelines. However, many of these are being open using the permit of a commercial shop.

4) Planning & construction norms

The MoCY follows typical designs for the facilities, with minor variation based on the size of the land. All sport centers for example follow 2 typical designs. There are no set rules and regulations but a handbook of a typical design prepared by an external consultant. However, the planning department acknowledges the need to update most of these criteria for future projects especially in relation to safety and parking.

In sport facilities, public projects follow international norms, which private projects are nor requested to abide by it.

5) Issues and challenges of the sector

- Lack of financing for a sector that is not considered a priority, putting 37 projects are on hold. With most of the facilities being open to the public and free, the ministry has a very minimal income and thus is unable to finance itself;
- Low maintenance and low operation budget for the existing facilities;
- Lack of owned property, which makes the facilities volatile. The General Directorate of Libraries, itself in a rented property, mentioned a library in the city center which had to be shut down, since the land did not belong the MoCY. The Ankawa Public Library is also on a rented land. A number of other libraries occupy a room within other governmental institutions;
- A proposed project for a 200 m2 numerical library which can be linked to 71 other numerical libraries in different counties awaits a budget allocation. A sport city allocated in the MP2030 is urgently needed;
- Most libraries are small, unpleasant and disconnected from the urban context;
- A limited number of museums and cultural facilities;
- Sport and youth centers are city-scale facilities, fenced and car dependent. Small-scale facilities in the neighborhoods are mostly institutional (schools, collages, political parties), keeping the kids in the neighborhoods with little access to recreational spaces. In parallel, when municipalities are not executing neighborhood gardens, their dedicated plots (as per DP) are privatized by the residents of the houses overlooking them.

(4) Religious sector

1) Institutional framework

The Ministry of Endowment and Religious Affairs is responsible for establishing, managing and supervising mosques and religious sites and meeting their needs. It is also responsible for supervising, monitoring and investing in Waqf (endowment) properties to grow their revenues.

The number of Christian religious buildings is fewer (20 in total), and mainly concentrated in areas populated by different Christian communities specifically Ankawa. The churches, chapels and monasteries are built and managed by the related missionaries, coordinating with the General Director of Christian Affairs.

The cemeteries, however do not belong to the MoERA and are managed by the Presidency of Municipalities.

2) Existing conditions & geographic situations

Unlike all other public facilities that suffer - to various degrees- from the failure to fulfill the needs of the rapidly growing population, the religious buildings, mostly mosques are built at a very high rate.

The reason is mainly cultural and religious, where citizens strive to donate money to build mosques. The request is higher than the available dedicated lands and doners are registered on waiting lists.

Although this is a relief for the state, in the sense that the citizens are funding these public services, it can also be seen as a threat on other needed public facilities within the communities. As mentioned earlier, plots designated for services are delicate. In some local plans, multiple mosques are built while other needed facilities are disregarded.

The Atlas of Mosques in a compilation of all mosques in Kurdistan till 2004, by a private data office JIMC in Erbil. The Atlas maps mosques per sector, with a location map and provides most of the following details:

Type / neighborhood/ year of construction / ownership (public or private) / Founders name / Area of the plot/ Built-up area / number of people served/ location.

The cemeteries are allocated in different parts of the city and at different distances from the city center. With the growth of the city, what was in the outskirts is now in the core of the city.

3) Planning & construction norms

The MoERA sets a list of guidelines for the construction of mosques and ceremonial halls by donors. These guidelines insist on abiding by the detailed plans that allocate plots for neighborhood mosques. It also mentions that a green area may never be used to build a mosque. This request must be the result of the high demand on building mosques, sometimes threatening the most delicate land use: the open space. In addition, it encourages more green spaces within the mosque plot and suggests building 2 floor mosques to minimize footprint.

The guidelines categorize 4 types of mosques and ask the MoMT and the MoERA to follow this categorization.

Table 9.1.2 Urban Guidelines for Planning Mosques

Type	Label	Min. Plot Area (m2)			Min. distance between mosques (m)	Min. % of plot area for greenery	Min. % of plot area for parking
A	Great Mosque	12,000	On roads not less than 20m wide. It should be located near the greenery or the main street or in open spaces or squares.	Domes, minarets, halls for men and women, two houses, jurist Rooms and bathroom or washroom, a center for teaching the Holy Quran and a library.	1,500	25%	35%
B	Central Mosque	8,000-12,000	on roads not less than 20m wide	The dome, minaret, hall for men and women, one house and bathroom (washroom)	1100	25%	35%
C	Medium Mosque	5,000-8,000	on roads not less than 15m wide.	Domes, minarets, one house, hall and bathrooms	900	25%	35%
D	Small mosques	2,500-5,000	(For districts and sub-districts)	Domes, minarets, one house, a banquet hall and bathrooms	600	20%	20%

Source: MoERA

4) Issues and challenges of the sector

There is no current need for additional mosques in Erbil. What is actually needed are urban design measures to integrate the available mosques in the city as an extension of the public space and a meeting point for the residents. Planning for additional cemeteries is included in the 2030 MP and EGB. However, these need to be reviewed as some of them are replaced by residential developments.

(5) Safety sector

This sector includes all institutions and facilities that aim to serve the community by providing justice, safety and protection. The Ministry of Interior is responsible for fire stations, police stations and part of the prisons while some youth and women prisons are managed by the MoL.

The MoI did not share any information on the location, conditions or planning of its facilities.

The household survey showed the satisfaction of the majority with accessibility & quality of policing of crime, in a city that is considered mostly safe. On the other hand, only 52% were satisfied with the accessibility and quality of fire departments.

We relied on the data of the Presidency of Municipalities and an academic article to understand the distribution of the fire stations.

The article[5] published in 2014 reviews Fire Departments services in Erbil from an urban planning perspective and evaluates their current geographical distribution quantitatively and qualitatively. It concluded a weak coverage and unplanned distribution of the fire departments. It Also proposed locations for additional stations based on a combination of criteria.

Table 9.1.3 Available Fire Stations in 2014

Name	Year of establishment	Neighbourhood	Number of Employees	Number of Vehicles	Number of 2009 Incidents
Shorish	1973	Safeen	48	1	180
Khanaqa	1964	Khanaqa	46	2	92
Azadi	1985	S. Industrial	55	2	92
Kurdistan	2008	Nawroz	53	2	64
Shahid Nariman	2006	Eskan	60	2	64
Rezgari	2008	Zahayen	61	5	96
EIA Airport	2011	Airport	82	7	Not available

Source: Article

A fire department in Ankawa was later established.

[5] Wahab, Sarwa. (2014). Modeling the Suitability Analysis to Establish New Fire Stations in Erbil City Using the Analytic Hierarchy Process and Geographic Information Systems.

Source: JICA Project Team

Figure 9.1.4 Distribution of Police Stations and Fire Stations in the Project Area

The Ministry of Labor and Social Affairs shared the list of public orphanages and elderly houses, autism centers and private nurseries.

The judicial council, part of the Ministry of Justice, shared a list of 14 courts that are in need for new buildings. They are currently located within other governmental buildings or are renting a private property.

In addition, the Ministry of Finance and Economy shared a list of all its departments belonging to its 10 directorates. The Ministry of Finance and Economy (MoFE) defined the directorates and departments that do not have an appropriate building and in need for new ones. After categorizing the directorates into high and low number of visitors, it also set its recommendations for allocating land and buildings within the MP.

In conclusion, many of the institutional facilities that aim to serve the residents of Erbil need to be considered in the MP2050.

9.1.3 Key Planning Issues

(1) Planning issues

While UPDOE planners made sure to allocate lands and BUA for public facilities, many challenges constrain their work:

- The lack of a unified base plan, where detailed plans are looked at as a totality. Public facilities are implemented in the different DPs without looking at the surrounding existing or planned facilities. This leads to a redundancy in some cases and to undesired proximity in some other cases.

- Designing DPs as a response to the requirements of the Municipality Council at the Presidency of Municipalities and the Board of Investors. Responding to investments and commercial desires guide these DP while public needs may be disregarded.
- The lack of planning skills and the need for more training and exposure.
- The confusion at the level of the applied planning rules and regulations.
- The lack (or absence) of coordination with the related ministries. For instance, there is a total lack of communication between UPDOE and the MoE in terms of the needed education facilities in detailed plans and a lack of coordination between the MoE and MoH is sharing birth rates and expected school admissions.

(2) Financial issues

The different ministries implement yearly projects based on an allocated budget by the Ministry of Finance.

The economic crisis had its impact on the planning and implementation of all types of public facilities. Almost all ministries and departments visited shared lists of needed projects that require financing.

In the case of schools, this need is the result of an unprecedented population growth, with an influx of new comers from Iraq and other countries. The same impact is observed on hospitals and primary health centers. In such conditions, social, cultural and sport facilities are not seen as a priority.

(3) Ownership issues

The Judicial council and the General directorates of Libraries, among others, shared the need for appropriate facilities. Many of these are currently in rented buildings or within other public institutions.

In parallel, the ownership of the public facilities is not necessarily by the related ministry. For instance, museums are owned by 3 different departments in 2 ministries. A main library is owned by the transportation directorate.

(4) Private developments

Residential Investment projects are of 2 main forms: Fenced Villages and high-rise buildings. These 2 typologies emerged in Erbil in the recent years without responding to a masterplan vision or land use.

Villages are required to include public facilities, based on GDUP requirements. However, the developer of the project, usually a private investor, keeps the planning and the construction of these facilities to the latest stage possible (Example: Dream City). They also aim to reduce their dedicated plot areas to gain more sellable residential BUA. In Some cases, the unbuilt educational facilities are compensated on other lands, acquired from the government, in further locations away from the development. (Example: Lalav development & school)

Usually rising beyond the 150 road, the free-standing high-rise buildings do not connect to the urban tissue. The relation with the street and low-rise construction is not studied. Even the distance between the towers themselves is not calculated to provide the right amount of light, ventilation, view and firefighting access.

While the towers are reflected in a higher number of people per square meter, they do not provide any facilities to serve the increasing population.

The towers are over congesting existing schools, and adding traffic as most of their users target specific schools (mostly private) not necessarily in their proximity. Note that there is no binding law that forces parents to register their students in schools withing their neighborhoods; although it is sometimes used as a reason to accept or refuse students in some schools specially the few ones labelled as “typical” for providing a better educational service.

(5) Regulations issues

Absence of clear laws that regulate the planning and the design of public facilities. While some regulations are inherited from the Iraqi law, these are not applied by all. Add to it the irrelevance of this law, especially with the emerging towers and increased density.

In parallel, there are different attempts to develop laws and regulations specific to Kurdistan regions within the different ministries. However, these are not unified in one handbook and most of them are not official.

Related data and planning indicators are not systematically published and never used in the planning of public facilities.

(6) Urban design issues

The simple observation of the 2 approved detailed plans shows a systematic allocation of plots dedicated to basic public facilities, as well as city scale facilities along the main road. The plan is designed without examining the context. Block size and distance between facilities is the only followed criteria, ending up with spaces of poor spatial identity.

On an urban design level, most public facilities do not feel like a natural extension of the public realm. Youth centers, sport facilities, libraries and the mosques are fenced which minimizes their potential role as a public space. Medium and small-scale public facilities are lacking.

This translates the fact that the operation of the public facilities happens at city scale, by the ministries and not at the level of the neighborhoods by the municipalities.

In the update of the masterplan, streets, open spaces, landscape and public facilities should be envisioned as a connected human-scale network.

9.2 Sector Strategies & Policies

(1) Overall Goals of Public Facilities Sector

The Overall Goals of the Public Facilities Sector development in Erbil 2050 MP, which are outlined in KRG Vision 2030 and contained in the latest policies of the Ministry of Education (MoE), Ministry of Higher Education and Scientific research (MOHESR), Ministry of Health (MoH), Ministry of Culture and Youth (MoCY), Ministry of Endowment and Religious Affairs (MoERA) and Ministry of Interior (MoI), and which will realize the Long-term Development Visions, can be summarized as below.

- [PBF-I] High-quality of Public Services: High-quality education, health and culture for all, focused on research and innovation, to equip Erbil's youth with adequate skills.
- [PBF-II] International Exposure of Monumental Facilities: Provide facilities of high international standards that will benefit from a good reputation beyond the borders of Kurdistan and reinforce the local economy, such as with medical tourism.
- [PBF-III] Proximity, accessibility and Inclusivity: Public facilities should be designed to be accessible, at close distance, to all members of the community, regardless of age, mobility, or disability. They should have the adequate size and infrastructure to properly serve their expected users.
- [PBF-IV] Distribution and strategic allocation: Public facilities should be well distributed in the city. Large scale facilities should not be clustered in one area. An even distribution and a strategic integration of major facilities give a unique character to each part of the city.
- [PBF-V] Hierarchy of Public facilities: The different scales of public facilities should be acknowledged in the planning process, reflecting the incremental scales of the urban life. Planning standards should be applied to provide the appropriate sizes and needs from neighbourhood to city levels.

- [PBF-VI] Visual Identity and Significance: Public facilities should be designed with attention to aesthetics and cultural significance. They may add to the cultural identity of a community and serve as landmarks or symbols.
- [PBF-VII] Sustainability and Environmental Responsibility: Public facilities must respond to climate change by incorporating sustainable and environmentally responsible practices at the level of planning, construction and operation.

Overall, the goals of public facilities planning are to create spaces and infrastructure that reflect the image of the city, meet the needs of the public, contribute to the well-being of communities, and support sustainable, safe, and economically viable environments.

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of Public Facilities Sector mainly support the realization of the Strategic Orientations #6: Create liveable and human-scale neighbourhoods connected through public transportation and #2: Improve international competitiveness through regional connectivity and integration (See Section 5.4), which implements especially the Long-term Development Visions (See Section 4.2) of Accessible & Affordable Services for Good Quality of Life (AAS), International Quality Service Centre (IQS) and Competitive City (CMP).

(3) Strategies & Policies of Public Facilities Sector

Table 9.2.1 below summarizes the Strategies & Policies of Public Facilities Sector proposed to tackle identified existing issues and to achieve Overall Sector Goals and Erbil 2050 MP Strategic Orientations.

Table 9.2.1 Strategies & Policies of Public Facilities Sector

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
International and National Scale Facilities	**PBF-S1**: Develop International and National Scale Public facilities to enhance the positioning of the capital of KRG, at international/ national scale by introducing major projects that transform the image of Erbil and create economic and social impact. Refer to Section 5.3.2 for the map of the location of Internal and National Scale Public Facilities. *[Proposed in response to Vision 2030 – proposed actions are coordinated with GDUP/ MoCY/MoH/ MoSRHE/MoERA]*	- **PBF-S1-1**: **Erbil National Library and Regional Archive**, a cultural complex that celebrates the diverse culture heritage in Erbil, in printed and digital books, manuscripts and archival materials. Proposed location: North of Ankawa (despite that land might not be guaranteed) [2050]	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and strategic allocation
		- **PBF-S1-2**: Proposed **Sport City** in Erbil 2030 MP to be replaced by 2 sport complexes. Both locations are ideal for their easy accessibility and ability to host events: **1. North Sport Complex** with Olympic pools, indoor and outdoor water activities. Proposed Location: Daraban mixed-use core, easy access on 150m road- with the possibility of allocating a biogas production facility from waste treatment, adjacent to the sport complex [2040] **2. South Sport Complex** with international stadium, focusing on football, popular in KRI. Proposed Location: Intersection of 100 m road with Kirkuk Road (Plot Fid 75). Gateway facility, linked to	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and strategic allocation

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
		Baghdad. [2040] + confirm National stadium proposed on detail plans, east of the city.	
		- **PBF-S1-3**: **Erbil International Fair Central** EIFC**. (**PBF-S1-3A) The current fair, located in Sami Abdulrahman park, has an area of 17,000 sqm and is UFI approved. However, a venue less than 20,000 sqm is categorized "small", based on the Global Association of the Exhibition Industry standards. Proposed Location: Same location as proposed in Erbil 2030 MP. Land parcel to be shared with the proposed **Erbil National Museum (**PBF-S1-3B) [2050]. A National Museum is a necessity for the image of the capital, to gather and exhibit the history of Kurdistan.	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and strategic allocation
		- **PBF-S1-4**: **Erbil Medical City:** to serve the need of Kurdish people, with high quality services for the whole Kurdistan and to cover the need for cancer and contagious diseases treatments. Psychological treatments and addiction rehab centers may also be part of the same complex. Proposed Location: Qafar secondary core, a central location between Mandawa, Bahirka and the Great Zab cluster. [2050]	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and strategic allocation
		- **PBF-S1-5**: **Grand Mosque of Erbil**, to allow for large prayers, attract visitors and become part of the cityscape. Proposed Location: The radial interface of Gazna secondary core, at park intersection with the Green Belt. [2040]	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and strategic allocation
		- **PBF-S1-6**: **National performance hall,** for art, **theatre** and music events. A unique architectural gem with outdoor extension. (Inspiration: Oman opera house) Proposed Location: Bahirka development core. Currently a homogeneous residential area, a high value project will change the image of the area and attract visitors and mixed-use activities. [2050]	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and strategic allocation
		- **PBF-S1-7**: **Entertainment Park:** Located between Ararat city and Khabat secondary core, and separated	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
		from the industrial zone by a green buffer, the entertainment park is a family destination for fun and leisure. [2040]	strategic allocation
		- **PBF-S1-8**: Kurdish Cultural Event Holding open-theatre. Located mid-way between the Citadel and Shaqlawa, and sharing location with Bragh Tourism Hub.	- [PBF-II] International Exposure of Monumental Facilities - [PBF-IV] Distribution and strategic allocation
	PBF-S2: Propose significant projects in the southern part of the city. These projects will not only balance the shifting center of Erbil towards the north, but will also connect to the neighboring cities further south.	- **PBF-S2-1**: Salaheddin University Campus and Proposed South Sport Complex are inclusive facilities. Strategically located in the southern part of the city on Kirkuk Road, they serve all the citizens and reinforce the connection with the southern cities.	- PBF-02: Unequal penetration rate of public facilities among sectors and neighborhoods throughout Erbil - PBF-03: Distance of public facilities from residential neighborhoods and inadequate size and infrastructure of public facilities
Metropolitan Scale Facilities	**PBF-S3:** Plan and execute large scale public facilities in parallel with an overall development plan, and use these facilities as catalysts to initiate and direct the development of new cores and new major roads.	- **PBF-S3-1**: Setting the new campus of Salaheddin University, to include all the currently scattered colleges including Erbil Medical University (Kirkuk Road) - Build the Polytechnic University in its allocated land (Kirkuk Road).	- PBF-05: Spreading of private schools & clinics as supplier of education and health services.
		- **PBF-S3-2**: Maintaining the 60% coverage of tertiary education by the national university, by allocating for a future campus in a new location (Mandawa new development core.)	
	PBF-S4: Implement new public projects to regenerate areas in the existing city center through adaptive reuse.	- **PBF-S4-1**: **Art & Culture Hub**: The site of the old silos is an ideal location – at proximity to the citadel- for entertainment facilities focused on youth, music and art. An incomplete open theatre exists on site. An existing plan for a museum is to be confirmed. The warehouse structures to be converted into art and culture (similar to meatpacking Copenhagen/ Alserkal Dubai) [2040]	- [PBF-IV] Distribution and strategic allocation - [PBF-VI] Visual Identity and Significance - [PBF-VII] Sustainability and Environmental Responsibility
		- **PBF-S4-2**: Study the future plan of converting the different colleges of Salaheddin University, while taking into account the traffic impact of these new projects within the city center. [2050]	
Municipality Scale Facilities	**PBF-S5-A:** Create hubs of community-oriented facilities at the centers of the new sub-cores, connected to public transit, to act as magnets of social life in Erbil**.**	- **PBF-S5-1:** By adding community activities such as neighborhood health centers, libraries, multipurpose halls, youth clubs, sport activities and pocket gardens and by prioritizing the pedestrian movement, the community hubs will act as a gate	- [PBF-I] High-quality of Public Services - [PBF-IV] Distribution and strategic allocation - [PBF-V] Hierarchy of Public facilities - PBF-01: Deficit of

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
	PBF-S5-B: Applying similar strategy (PBF-5-A) on the existing urban fabric, where applicable, through an overlay of commercial and social activities at road intersections among residential communities.	to the residential district and a tool to tie the neighborhoods together. These facilities serve a larger number of user and provide more services than the ones within the individual neighborhoods.	educational & healthcare public facilities to match the needs of citizens - PBF-02: Unequal penetration rate of public facilities among sectors and neighborhoods throughout Erbil
	PBF-S6 **Erbil MP Update of Long-Term Vision (2006):** Erbil 2050 MP pursues the Vision of providing affordable and good quality of life to citizens, but prefers to put the emphasis on improving the accessibility of services.	- **PBF-S6-1:** Abiding by the zoning plan which defines uses and regulations and allocate lands for public facilities and community services. - **PBF-S6-2:** Connecting district-scale public facilities to public transport.	
	PBF-S7 Clustering facilities that are complementary, with the aim of creating shared benefits and social interactions	- **PBF-S7-1:** Creating educational campuses where kindergartens, schools and leisure are in one location for optimal use of resources, easier transition between age groups, pedagogical benefits, all day and all year operation	
	PBF-S8 Giving some streets unique identities, such as healthcare and cultural service, a successful typology in Erbil and Iraq. *[GDUP]*	- **PBF-S8-1:** Defining the zoning and providing the needed infrastructure for commercial strips, strategically located and well connected.	
Neighborhood Scale Facilities	**PBF-S9:** Ensure access by all citizens, to public facilities at a proximity to their residences. Basic needs such as primary health care, kindergartens and primary education facilities should be accessible within safe walking distance. *[Proposed in response to Vision 2030]*	- **PBF-S9-1:** Applying urban planning concepts and standards to create well-served neighborhoods, where parcels and location of public facilities are based on population needs. Access to facilities should be studied in relation to streets hierarchy. The size of the lot and the facility should be adequate to the number of served users. - **PBF-S9-2:** Introduce mobile facilities such as mobile libraries and health stations in remote areas.	- [PBF-III] Proximity, accessibility and Inclusivity - PBF-03 Distance of public facilities from residential neighborhoods and inadequate size and infrastructure of public facilities - PBF-04 Encroaching and land use change of public land reserves planned for public facilities
	PBF-S10: Ensure safety and security of all neighbourhoods	- **PBF-S10-1:** Allocating fire stations, police stations and visually identified security posts.	
	PBF-S11: Healthy community that includes walking, biking and outdoor activities in its daily rituals. *[MoH]*	- **PBF-S11-1:** Implement sidewalks, bike lanes, safe crossing to access public facilities by foot or bike. Outdoor gyms and sport activities in neighborhood centers can be located in the open space of the	

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
		public facilities such as PHC and schools- to be used by the whole community.	
	POLICIES		
National Scale Facilities	**PBF-P1**: Abide by the masterplan and long-term planning.	**PBF-P1-1**: Making the Masterplan 2050 official and the allocated zones and strategies for large-scale public facilities legally binding.	- PBF-04 Encroaching and land use change of public land reserves planned for public facilities
	PBF-P2: Provide free public primary education and health care services to all citizens		
Metropolitan Scale Facilities	**PBF-P3**: Enforce zoning and land-use regulations at all the public agencies and private sector.	**PBF-P3-1**: Formulate a permit acquisition system which ties the approval of any development to the provision of necessary public facilities.	**[key Planning Issue/ Planning Issue/ Private Development]** Private projects (in the forms of gated communities and towers) avoiding the construction of Public Facilities within their developments, as replacing them with residential units is more profitable **[key Planning Issue/ Planning Issue/ Ownership issues]** The Judicial council and the General directorates of Libraries, among others, shared the need for appropriate facilities. Many of these are currently in rented buildings or within other public institutions. In parallel, the ownership of the public facilities is not necessarily by the related ministry. For instance, museums are owned by 3 different departments in 2 ministries. A main library is owned by the transportation directorate.
	PBF-P4: Empowering the municipalities and strengthening their financial autonomy to implement and maintain public facilities.	**PBF-P4-1:** Reviewing the work flow to give the planning departments within MoMT, more power to lead the planning process and to abide by the zoning plan.	
Municipality Scale Facilities	**PBF-P5:** Introduce sustainability concepts and application through public facilities. This would create long term environmental benefits and financial savings and set the model for private developments.	**PBF-P5-1**: LEED for cities and communities (American) and BREEAM communities (British), Urban sustainability framework (WB) can be a starting point, to develop a more local framework to integrate and assess sustainable design, to face the threats of climate change, in the master planning of new communities and regenerations projects.	- [PBF-VI] - [PBF-VII] Sustainability and Environmental Responsibility - Key planning issues: The lack of a unified base plan, where detailed plans are looked at as a totality. - Public facilities are implemented in the different DPs without looking at the surrounding existing or planned facilities. This leads to a redundancy in some cases and to undesired

Theme	Sector Strategy / Policy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
			proximity in some other cases. - Designing DPs as a response to the requirements of the Municipality Council at the Presidency of Municipalities and the Board of Investors. Responding to investments and commercial desires guide these DP while public needs may be disregarded. - The lack of planning skills and the need for more training and exposure. - The confusion at the level of the applied planning rules and regulations. - The lack (or absence) of coordination with the related ministries. **Regulations issues:** - Absence of clear laws that regulate the planning and the design of public facilities. - In parallel, there are different attempts to develop laws and regulations specific to Kurdistan regions within the different ministries. However, these are not unified in one handbook and most of them are not official. - Related data and planning indicators are not systematically published and never used in the planning of public facilities.
	PBF-P6: Inter-disciplinary planning, research and design.	**PBF-P6-1 & PBF-P8:** Reinforce the shared committees to coordinate between planning departments in MOMT and planning and engineering department in the ministries (MoH, MoE, etc.). A main duty of these committees is to set up-to-date national standards for public facilities planning.	
	PBF-P7: Creating a unified GIS data base for all public facilities.	**PBF-P7-1**: Data sharing and common servers among directorates.	
	PBF-P8: Revise the applied standards and norms in planning for future need of public facilities	**PBF-P8-1**: Create Urban laboratories within municipalities and directorates, engaging professionals, academics and governmental employees. The Collaboration between experts allows for a holistic problem solving and comprehensive future planning.	
Neighborhood Scale Facilities	**PBF-S9**: Review the list of Public Facilities to include at neighborhood level.	**PBF-P9**: In addition to basic facilities: recreation, culture safety and security should be provided within neighborhood or at intersection of neighborhoods. These should be reflected in detailed plans and private developments plans.	- Safety and security issues were reflected in SEA consultations - The lack of belonging translates into lack of care for the common space, as well as a compromised sense of safety.
	PBF-P10: Participatory approach and community engagement	**PBF-P10**: Empowering the citizens and their local representatives and involving them in decisions related to their neighborhoods. Events, shared activities and public art also create the sense of community.	

Source: JICA Project Team

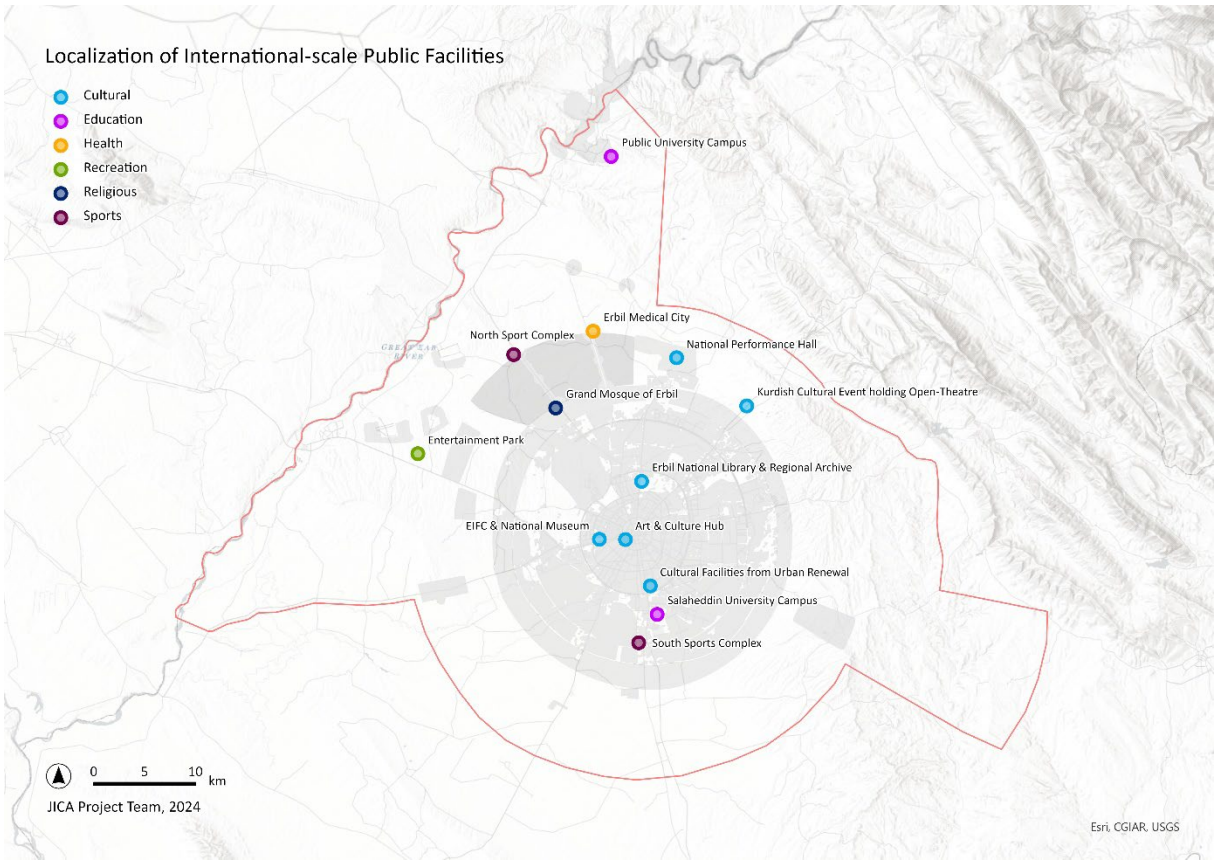


Figure 9.2.1 Proposed Large Scale Public Facilities for MP2050

9.3 Public Facilities Sector Development Plan

9.3.1 Applied Standards

There are more than one set of guidelines to follow when planning for the provision on public facilities. Different countries might follow different standards based on the assessment of the needs of their inhabitants, the specificity of the country in terms of life style, habits, social practices and environmental setting.

In Kurdistan, the Urban and rural housing standards in Iraq, 2018 is mostly followed in the planning departments of the ministry of municipalities and tourism (MOMT). The General Directorate of Urban Planning (GDUP) recommends following these standards as they are the closest to the urban conditions in Kurdistan. The household average of the Iraqi family is 6 persons. As per GDUP, the household average in KRG is slightly lower.

In parallel, different ministries had issues their guidelines for the construction of public facilities. These guidelines are some cases an update of the Iraqi standards, based on the current conditions and challenges.

The Iraqi urban and Rural Housing Standard sets planning criteria based on Residential Precinct, Neighborhood, Community and District which are defined based on household average, dwelling average and number of dwellings.

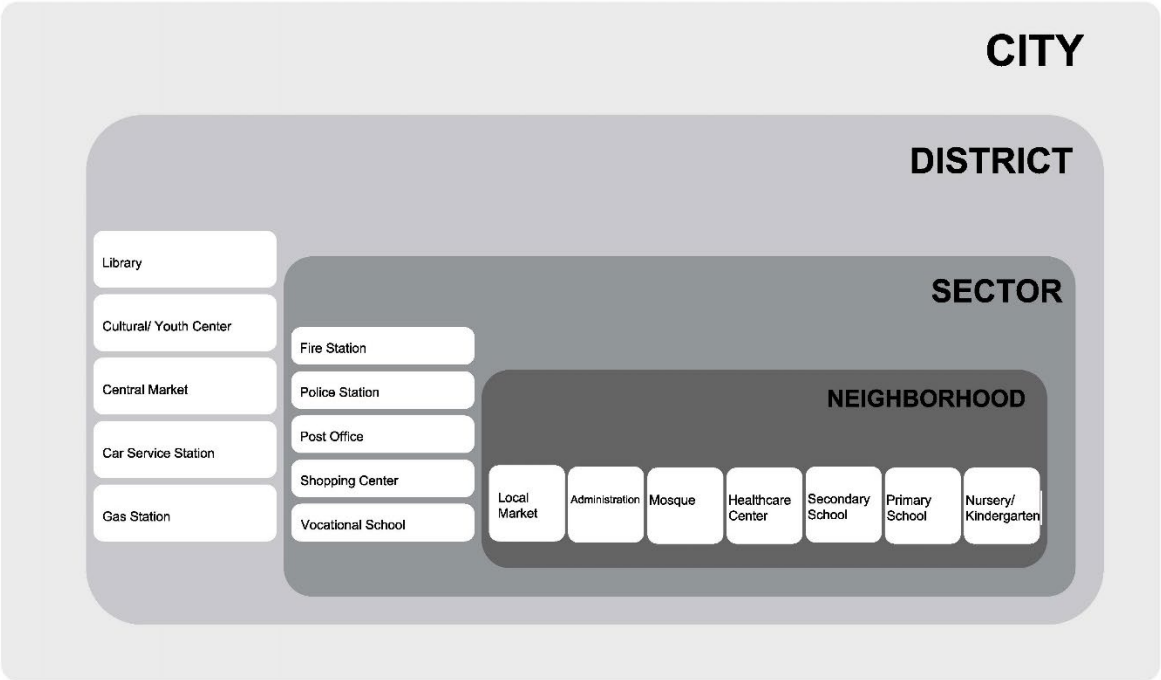
- Residential Precinct is formed of 15 to 75 housing units.
  - Household Average (6 persons).
  - Dwelling Average (100 to 540 inhabitants)
- Neighborhood: is formed by 4 Residential Precincts.
  - Household Average (6 persons).

- Dwelling Average (2400-3600 inhabitants)
- Number of dwellings (400-600 dwellings)
  - Community: is formed of 4 Neighborhoods
- Household Average (6 persons).
- Sector Average (9600-14400 inhabitants)
- Number of dwellings (1600-2400 dwellings)

Table 9.3.1 Community Facilities Required for Different Sizes of Residential Areas

Type of Facility	Location of facility		
	2400-3600 inhabitants (Residential Neighborhood)	**9600—14400 inhabitants (residential Community)**	**37600-56400 inhabitants (Residential District)**
Educational	Nurseries	Secondary schools (boys)	
	Kindergartens	Secondary schools (girls)	
	Primary schools	High school (boys)	
		High School (girls)	
Health	Branch Health Care Center	Primary Health Care Center	Consultation Health Care Center
Religious		Mosques and Churches	
Socio-cultural		Basic Culture Centers*	Main Culture Centers
		Basic Youth Centers*	Main Youth Centers
Commercial and Hospitality	Local stores	Small shopping centers	Main shopping centers
	Local markets	coffeeshops	
		Restaurants	
Administration and Public services		Local administration	
		Primary post offices	Post offices
		Primary police station*	Police station
		Primary fire station*	Fire station
Transportation		Small Gas Stations*	Gas Stations
		Small Car Maintenance Stations	Car Maintenance Stations
Entertainment	Play Areas	Sport Playgrounds	
	Sport Playgrounds	Parks and Piazzas	
*It is recommended to provide these facilities for residential communities smaller than the (district) in the absence of these services in the areas close to these communities.			

Source: JICA Project Team; Iraqi Urban standards



Source: JICA Study Team; Iraqi Urban standards

Figure 9.3.1 Public Facilities per Population in the Iraqi Standards

Defining urban clusters, that adds up to create a higher-level agglomeration and dedicating the needed public facilities accordingly to a clear and structured approach proved to be a successful approach. The most interesting aspect of this methodology is scale. Smaller public facilities are inserted in precincts and neighborhoods making them functional and safe. Larger public facilities are introduced in sectors and districts. In parallel to serving the residents, they link between neighborhoods and create a need to communicate and dialogue.

The drawback of relying on this planning approach in the context of Erbil is that it doesn't take into account the emerging towers in different parts of the city. The standards refer to low-rise and high-rise however the different in density between the 2 typology is just an increase of 50%, which doesn't correspond to the situation in Erbil. The high-rise in the Iraqi standards assumes 9 to 12 floors. The towers in Erbil extend much higher than this assumption.

A tower of 30 floors, 2 apartments per floor is an average of 300 residents, the equivalent of an average size residential precinct.

In an ideal planning, the high-rise building would be allocated dedicated zones and their public facilities would be provided within their ground floor, podium floors and at their proximity.

In Table 9.3.2 planning indicators for each type of facility based on population, served age group, to define needed plot area, net and gross BUA and maximum commuting distance.

Table 9.3.2 Planning Indicators for Urban Community Facilities

	Type of Facility	Users' age percentage of the total population	The percentage of people served	Land area (m2)	The net built-up area (m2)	The total building area(m2)	distance maximum to reach (m)
1	**Nursery School**	12.34%	5-40% of the age group*	15.50 -18.00 per user	7.00 -8.50 per user	9.00-10.5 per user	300
2	**Kindergarten**	5.78%	25-50% of the age group*	15.50 -16.00 per user	5.80 -6.40 per user	7.25-8.00 per user	300
3	**Primary Schools**	15.4%	100% of the age group	6.00 -8.50 per user	3.00 -3.60 per user	3.75 -4.50 per user	500
4	**Secondary schools**	7.00%	85% of the age group	8.37 -9.38 per user	3.72-4.00 per user	4.65-5.15 per user	500
5	**High Schools**	6.28%	72% of the age group	10.90 -11.80 per user	4.30 -5.00 per user	5.30-6.30 per user	800
6	**Healthcare Centers**	100%	100% of the served population	0.16 -0.08 per served person	0.03-0.05 per served person	0.04-0.065 per served person	600-1200
7	**Mosques & Churches**	100%	100% of the served population	0.30 per served person	0.1 per served person	0.125 per served person	800
8	**Cultural Centers**	100%	100% of the served population	0.175 per served person	0.045 per served person	0.055 per served person	800
9	**Youth Centers**	21.14%	100% of the age group	1.70 per served person	0.24 per served person	0.30 per served person	800
10	**Shops**	75%	100% of the population	0.30 per served person	0.12 per served person	0.144 per served person	200
11	**Local Markets**	75%	100% of the population	0.50 -0.55 per served person	0.25-0.30 per served person	0.30- 0.36 per served person	500
12	**Shopping Centers**	75%	100%	0.60 -0.80 per served person	0.24 per served person	0.28- 0.30 per served person	800
13	**Coffeeshops**	20%	100%	0.15 per served person	0.07- 0.9 per served person	0.15 per served person	500
14	**Restaurants**	30%	100%	0.25 per served person	0.12 per served person	0.15 per served person	500
15	**Local Administration**	100%	100%	0.07 per served person	0.035 per served person	0.042 per served person	800
16	**Post Offices**	100%	100%	Min. area 500	Min. area 250	Min. area 300	800
17	**Police Stations**	100%	100%	Min. area 1200	Min. area 480	Min. area 600	1600
18	**Fire Stations**	100%	100%	0.048 per served person	0.01 per served person	0.012 per served person	2000
19	**Gas stations**	100%	100%	0.05 per served person	0.008 per served person	0.01 per served person	1200
20	**Car Service Stations**	10-20%	100% of the served population	0.30 per served person	0.08 per served person	0.1 per served person	1200
21	**Play Areas**	18.13%	100% of the age group	1.40 per served person	-	-	150
22	**Playgrounds**	15.48%	100% of the age group	1.6- 10 per served person	-	-	200-300
23	**Sport Areas**	13.27%	100% of the age group	1.75- 3.0 per served person	-	-	500-800
24	**Parks & Piazzas**	100%	100% of the age group	0.75-2.25 per served person	-	-	800

* The total number of children served may vary depending on the circumstances of each region and on the percentage of women working there.

Source: JICA Project Team; Iraqi Urban standards

The user's age groups followed in the above table corresponds to the whole Iraq population. Refining these percentage based on Erbil yearly condition allows for more accurate projections.

Additional standards:

1) Within KRI

The following categorization, population and catchment area of the health centers are used in the MoH of KRJ and are communicated from the MoH of Baghdad:

- major/main/primary health centers (called Type A)

  served population: not be less than 10,000 people

  The distance to the nearest main health center should not be less than 7-10 km

- doctor-run secondary health centers with dental unit (called Type B)

  served population: 5,000 to 10,000 people

  The distance to the nearest health center (primary or secondary) should not be less than 5-7 km.

- doctor-run secondary health centers (called Type C)

  served population: 3,000 to 5,000 people

  The distance to the nearest health center (primary or secondary) should not be less than 5-7 km.

- Health-workers run health centers (called Type D)

  served population: 1,000 to 3,000 people

  The distance to the nearest health center (primary or secondary) should not be less than 5-7 km

The above standards are to be compared to the Iraqi standards 2018:

- Type A is secondary فرعي and serves 4,800 people

  The distance to the nearest health center should not be less than 1.6 km (coverage radius 800m)

- Type B is primary ويسمى مركز صحي رئيسي and serves 12,000 people

  The distance to the nearest health center should not be less than 1.6 km (coverage radius 800m)

- Type C is Consultation health center صحي استشاري and serves 40,000 to 50,000 people

  The distance to the nearest health center should not be less than 2.4 km (coverage radius 1200m)

While Type A in the Iraqi standards refers to the smallest typology of health centers, serving the smallest number of residents, Type A is the MoH standards refers to the largest, most equipped typology of health centers, serving the largest number of residents.

The same duality in applied standards is found in planning for education facilities. The MoE is following its own standards which are an update on the Iraqi urban standards 2018, with some amendment to accommodate the current situation in Erbil

These regulations are based on the expected population, calculated based on number and size of the apartments. 1BR apt= 1kid, 2BR apt= 2kids, 3BR apt= 3kids.

2) Erbil 2030 MP

The master plan report issues in 2007 follows simplified standards. It defines ratios of facilities per population and needed land area for each.

Table 9.3.3 Planning Indicators in Erbil 2030 MP

Type of facility		Applied standards	
Education	High Schools	1 / 25,000 pop.	1.1 ha for each
	Intermediate Schools	1 / 25,000 pop.	0.9 ha for each
	Primary Schools	1/5,000 pop.	0.55 ha for each
Health	Clinic Centers	1 / 40,000 pop.	0.5 ha for each
	Health Center	1 / 4,500 pop.	0.25 ha for each
Security	Main Police Station	1/100,000 pop.	0.5 ha for each
	District Police Station:	1 / 50,000 pop.	0.3 ha for each
	Fire station	1 / 80,000 pop.	0.5 ha for each
Community Services	Telephone Exchange	1/50,000 pop.	0.5 ha for each
	Youth Center:	1 / 45,000 pop.	0.65 ha for each
	Public Library	1 / 45,000 pop.	0.11 ha for each
	Cultural Center	1 / 45,000 pop.	0.6 ha for each
	Post Office	1 / 50,000 pop.	0.2 ha for each
	Cinema	1 / 45,000 pop.	0.27 ha for each
	Social Center	1 / 20,000 pop.	0.22 ha for each
	Multipurpose Hall	1 / 45,000 pop.	0.45 ha for each
Religious Buildings		1/7,500 pop.	0.4 ha for each
Cemeteries		1 / 50,000 pop.	6 ha for each

Source: JICA Project Team; Erbil 2030 MP report

3) International standards

Table 9.3.4 International Planning Indicators

Type of facility		Applied standards			
		Population served	Beneficiary number/ PF	Facility area and campus area (m2)	Catchment area (m)
Education	Secondary Schools	-	300-3000	8000	1500-3000
	Primary Schools	-	1000	1000-4000	500-1000
	Kindergarten	-	1000	500 - 1000	750
Health	Hospital	150,000	105-130 beds/150,000 (WHO)	15,000 min.	5,000-10,000
	Health Center	5000 (WHO) (2 to 3 PHC per 10,000)	10-20beds	1200	1000

Source: JICA Project Team

The applied standards in Erbil 2030 MP as well as the international standards usually issued by organizations such as WHO, UNESCO and the World Bank, only give a broad estimation of the number of facilities. They do not tackle the particularities of the context such as demographics, social and cultural factors, infrastructure and others.

9.3.2 Existing Public Facilities in 2022

Since the start of the Erbil MP update project in 2022, the project team collected a large amount of data in order to understand the current situation and to set the base for future planning.

Collecting data on existing public facilities required collaboration with a large number of institutions, as public facilities spread over different categories.

Under 5 main categories, we were able to allocate public facilities on the map, within project boundaries and to calculate the available public facilities within traffic zones (TAZ). Please refer to section 5.5 of the report for a map of all traffic zones.

In parallel, and to assess the current condition of public facilities in terms of availability and distribution,

we calculate the real needs on 2022 based on the most convenient standards.

The table below shows per category, the available, needed and missing public facilities.

Please refer to Appendix available in digital format for detailed tables.

Table 9.3.5 Comparison between Available and Needed Public Facilities in 2022

Population in 2022	Education			Health			Cultural			Sports Areas			Religious			Security		
	Needed in 2022	Existing in 2022	Missing facilities	Needed in 2022	Existing in 2022	Missing facilities	Needed in 2022	Existing in 2022	Missing facilities	Needed in 2022	Existing in 2022	Missing facilities	Needed in 2022	Existing in 2022	Missing facilities	Needed in 2022	Existing in 2022	Missing facilities
1,861,870	2,077	883	1,194	172	151	21	150	10	140	4,043	161	3,882	167	397	-230	420	274	146

Source: JICA Project Team

The numbers show the major deficit in educational facilities (57.4%). Health, culture, sport areas and security facilities are all below the needs of the current populations.

Religious facilities on the other hand are above the minimum requirement.

The deficit in sport recreational facilities is obvious in the city of Erbil. However, the large number of "needed sport areas" in 2022 should be read in parallel to the urban planning methodology of the Iraqi standards, where 4 levels of sport and recreational outdoor spaces are categorized.

In our calculations, we followed the middle range in terms of required land areas per user and per facility, ranging from 162 m2 play area to 19,800 m2 sport field.

9.3.3 Existing and Approved Public Facilities till 2040

The following table shows the number and areas allocated for public facilities. This includes existing facilities in 2022, allocated facilities in approved detailed plans and approved unique projects at city scale.

As mentioned in the report, the detailed plans will cover the need of the projected population in terms of residential supply till 2040.

Table 9.3.6 Total Number and Land Area for Planned and Approved Public Facilities Based on Projected Population in 2040

Total population in 2040	Education		Health		Cemeteries		Cultural		Sports		Religious		Security	
	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)
2,620,343	1,670	12,918,705	236	1,587,500	53	3,330,000	65	1,123,432	196	2,385,314	563	2,371,171	299	4,852,344

Source: JICA Project Team

Based on the table of expected total public facilities till 2040, there will be total of 3346 public facilities in Erbil, on a total land area of 26,898,626 m2 divided as follows:

- 1,670 education facilities covering a land area of 12,918,705 m2
- 236 healthcare facilities covering a land area of 1,587,500 m2
- 53 cemeteries, covering a land area of 3,330,000 m2
- 65 cultural facilities, covering a land area of 1,123,432 m2
- 196 sport facilities, covering a land area of 2,385,314 m2
- 563 religious facilities, covering a land area of 2,371,171 m2
- 299 security facilities, covering a land area of 4,852,344 m2

Table 9.3.7 Total Needed Public Facilities in 2040

Total population in 2040	Education		Health		Cemeteries		Cultural		Sports		Religious		Security	
	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)
2,620,343	2,921	7,998,231	242	1,570,982	24	952,311	5,686	5,952,817	235	785,491	591	691,087	2,921	7,998,231

Source: JICA Project Team

A comparison between existing and supplied public facilities till 2040 from one side and the calculated needs based on applied planning standards from another side, helps identify the gaps within some traffic zones and possibly an excess of facilities in other zones.

Table 9.3.8 Comparison between Existing and Planned Versus Needed Public Facilities in 2040

Traffic Zone (TAZ)	Detailed Traffic Zone (DTAZ)	Population	Education			Health			Cultural			Sports Areas			Religious			Security		
			Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities
1		13	0	0	0	0	0	0	1	1	-1	0	-	0	0	0	0	0	-	0
2		3,685	4	5	-1	0	2	-2	0	-	0	8	-	8	0	2	-2	1	-	1
3		7,228	8	3	5	1	0	1	1	-	1	16	2	14	1	1	0	2	2	0
4		8,720	10	9	1	1	0	1	1	-	1	19	-	19	1	4	-3	2	-	2
5		5,452	6	8	-2	1	1	0	0	-	0	12	-	12	0	1	-1	1	1	0
6		17,484	20	17	3	2	7	-5	1	-	1	38	2	36	2	6	-4	4	2	2
7		10,182	11	7	4	1	3	-2	1	-	1	22	2	21	1	3	-2	2	1	1
8		11,214	13	4	9	1	0	1	1	2	-1	24	-	24	1	2	-1	3	-	3
9		3,070	3	4	-1	0	0	0	0	-	0	7	-	7	0	0	0	1	1	0
10		18,715	21	7	14	2	4	-2	2	-	2	41	-	41	2	2	0	4	-	4
11		16,887	19	4	15	2	2	0	1	-	1	37	2	35	2	3	-1	4	-	4
12		3,578	4	5	-1	0	0	0	0	-	0	8	-	8	0	2	-2	1	-	1

Traffic Zone (TAZ)	Detailed Traffic Zone (DTAZ)	Population	Education			Health			Cultural			Sports Areas			Religious			Security		
			Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities
13		1,484	2	1	1	0	1	-1	0	-	0	3	-	3	0	2	-2	0	-	0
14		946	1	1	0	0	0	0	0	-	0	2	-	2	0	8	-8	0	-	0
				0	0		0	0		-	0		-	0		5	-5		-	0
16		1,333	1	0	1	0	0	0	0	1	-1	-	-	3	0	3	-3	0	-	0
17		1,806	2	2	0	0	0	0	0	-	0	4	-	4	0	10	-10	0	-	0
18		5,981	7	9	-2	1	6	-5	0	-	0	13	-	13	1	2	-1	1	1	0
19		6,235	7	2	5	1	1	0	1	-	1	14	1	13	1	1	0	1	-	1
20		6,910	8	7	1	1	1	0	1	-	1	15	2	13	1	4	-3	2	-	2
21		5,822	6	8	-2	1	0	1	0	-	0	13	-	13	1	4	-3	1	1	0
22		6,489	7	5	2	1	0	1	1	-	1	14	1	13	1	2	-1	1	-	1
23		8,497	9	8	1	1	2	-1	1	-	1	18	-	18	1	4	-3	2	3	-1
24		2,399	3	3	0	0	2	-2	0	1	-1	5	1	4	0	2	-2	1	-	1
25		4,021	4	10	-6	0	1	-1	0	-	0	9	1	8	0	0	0	1	-	1
26		5,139	6	7	-1	0	1	-1	0	-	0	11	-	11	0	1	-1	1	-	1
27		11,808	13	7	6	1	13	-12	1	-	1	26	2	24	1	3	-2	3	-	3
28		1,754	2	2	0	0	2	-2	0	-	0	4	-	4	0	0	0	0	-	0
29		3,758	4	4	0	0	0	0	0	-	0	8	-	8	0	3	-3	1	1	0
30		17,647	20	8	12	2	0	2	1	-	1	38	-	38	2	2	0	4	1	3
31		8,923	10	6	4	1	0	1	1	-	1	19	1	18	1	5	-4	2	-	2
32		6,957	8	5	3	1	2	-1	1	-	1	15	-	15	1	1	0	2	1	1
33		2,150	2	5	-3	0	0	0	0	-	0	5	-	5	0	2	-2	0	-	0
34		3,337	4	5	-1	0	2	-2	0	-	0	7	1	6	0	2	-2	1	2	-1
35		3,178	4	4	0	0	0	0	0	-	0	7	-	7	0	1	-1	1	-	1
36		8,394	9	7	2	1	1	0	1	-	1	18	-	18	1	3	-2	2	3	-1
37		20,447	23	19	4	2	5	-3	2	1	1	44	1	43	2	4	-2	5	1	4
38		4,562	5	1	4	0	0	0	0	-	0	10	-	10	0	1	-1	1	-	1
39		17,355	19	11	8	2	2	0	1	-	1	38	2	36	2	8	-6	4	2	2
40		10,849	12	10	2	1	0	1	1	-	1	24	2	22	1	6	-5	2	-	2
41		9,284	10	9	1	1	1	0	1	-	1	20	2	18	1	4	-3	2	1	1
42		17,444	19	8	11	2	0	2	1	-	1	38	-	38	2	6	-4	4	1	3
43		-	0	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	-	0
44		17,742	20	0	20	2	0	2	1	-	1	39	-	39	2	0	2	4	-	4
45		21,554	24	0	24	2	0	2	2	-	2	47	-	47	2	0	2	5	-	5
46		21,794	24	0	24	2	0	2	2	-	2	47	-	47	2	0	2	5	-	5
47		9,262	10	9	1	1	0	1	1	-	1	20	-	20	1	0	1	2	1	1
48		4,610	5	0	5	0	0	0	0	-	0	10	-	10	0	0	0	1	-	1
49		9,778	11	49	-38	1	0	1	1	-	1	21	1	20	1	2	-1	2	-	2
50		8,020	9	13	-4	1	1	0	1	-	1	17	-	17	1	2	-1	2	1	1
51		13,334	15	7	8	1	4	-3	1	-	1	29	2	27	1	2	-1	3	-	3
52		8,639	10	5	5	1	0	1	1	-	1	19	-	19	1	2	-1	2	3	-1
53		33,058	37	12	25	3	2	1	3	-	3	72	5	67	3	10	-7	7	2	5
54		5,083	6	4	2	0	0	0	0	-	0	11	-	11	0	1	-1	1	1	0
55		3,853	4	6	-2	0	0	0	0	-	0	8	-	8	0	1	-1	1	-	1
56		7,104	8	3	5	1	1	0	1	-	1	15	-	15	1	3	-2	2	1	1
57		9,636	11	7	4	1	0	1	1	-	1	21	-	21	1	1	0	2	1	1
58		41,590	46	24	22	4	3	1	3	-	3	90	6	84	4	7	-3	9	1	8
59		6,566	7	3	4	1	1	0	1	-	1	14	2	12	1	3	-2	1	-	1
60		8,312	9	6	3	1	3	-2	1	-	1	18	1	17	1	2	-1	2	2	0
61		12,995	14	9	5	1	1	0	1	-	1	28	2	26	1	2	-1	3	-	3
62	*621*	25,718	29	32	-3	2	2	0	2	-	2	56	8	48	2	12	-10	6	-	6

Traffic Zone (TAZ)	Detailed Traffic Zone (DTAZ)	Population	Education			Health			Cultural			Sports Areas			Religious			Security		
			Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities
	622	24,828	28	18	10	2	1	1	2	-	2	54	6	48	2	18	-16	6	-	6
63	*631*	31,787	35	46	-11	3	5	-2	3	-	3	69	-	69	3	12	-9	7	-	7
	632	5,684	6	12	-6	1	0	1	0	-	0	12	-	12	1	3	-2	1	-	1
64	*641*	38,657	43	16	27	4	8	-4	3	1	2	84	2	82	3	14	-11	9	1	8
	642	23,129	26	17	9	2	6	-4	2	6	-4	50	-	50	2	8	-6	5	2	3
	643	37,262	42	9	33	3	1	2	3	-	3	81	2	79	3	9	-6	8	-	8
	644	6,291	7	0	7	1	1	0	1	-	1	14	1	13	1	6	-5	1	-	1
65		2,660	3	1	2	0	1	-1	0	-	0	6	4	3	0	0	0	1	12	-11
66	*661*	18,757	21	43	-22	2	2	0	2	2	0	41	6	40	2	3	-1	4	-	4
	662	24,112	27	0	27	2	1	1	2	-	2	52	6	46	2	0	2	5	-	5
67	*671*	15,745	18	29	-11	1	4	-3	1	-	1	34	-	34	1	5	-4	4	-	4
	672	15,675	17	30	-13	1	4	-3	1	8	-7	34	-	34	1	8	-7	4	11	3
	673	10,046	11	25	-14	1	2	-1	1	-	1	22	1	21	1	5	-4	2	-	2
	674	34,299	38	10	28	3	0	3	3	-	3	74	-	74	3	3	0	8	-	8
	675	14,540	16	8	8	1	3	-2	1	-	1	32	1	31	1	7	-6	3	1	2
68		65,885	74	11	63	6	6	0	5	2	3	143	5	138	6	11	-5	15	3	12
69		53,941	60	2	58	5	0	5	4	-	4	117	-	117	5	0	5	12	-	12
70		39,784	44	4	40	4	1	3	3	1	2	86	-	86	4	2	2	9	1	8
71		19,036	21	4	17	2	2	0	2	-	2	41	1	40	2	6	-4	4	204	-200
72	*721*	6,190	7	11	-4	1	2	-1	0	1	-1	13	-	13	1	0	1	1	-	1
	722	4,547	5	4	1	0	1	-1	0	-	0	10	-	10	0	2	-2	1	-	1
	723	4,028	4	4	0	0	1	-1	0	2	-2	9	-	9	0	0	0	1	-	1
	724	15,738	18	12	6	1	2	-1	1	-	1	34	1	33	1	4	-3	4	-	4
	725	12,459	14	14	0	1	2	-1	1	-	1	27	-	27	1	3	-2	3	2	1
	726	17,613	20	24	-4	2	0	2	1	-	1	38	6	32	2	5	-3	4	-	4
	727	8,950	10	3	7	1	0	1	1	-	1	19	-	19	1	3	-2	2	-	2
73	*731*	8,212	9	3	6	1	0	1	1	-	1	18	-	18	1	3	-2	2	-	2
	732	6,042	7	2	5	1	0	1	0	-	0	13	3	10	1	2	-1	1	-	1
	733	77	0	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	-	0
	734	26,560	30	7	23	2	0	2	2	-	2	58	-	58	2	0	2	6	-	6
	735	3,629	4	0	4	0	0	0	0	-	0	8	-	8	0	0	0	1	-	1
74	*741*	24,888	28	38	-10	2	3	-1	2	-	2	54	2	52	2	5	-3	6	-	6
	742	23,345	26	14	12	2	2	0	2	1	1	51	8	43	2	11	-9	5	3	2
	743	10,228	11	1	10	1	3	-2	1	3	-2	22	2	20	1	6	-5	2	-	2
75	*751*	10,939	12	2	10	1	4	-3	1	-	1	24	1	23	1	1	0	2	-	2
	752	11,038	12	3	9	1	0	1	1	-	1	24	2	22	1	3	-2	2	-	2
	753	32,955	37	15	22	3	0	3	3	-	3	72	2	70	3	4	-1	7	-	7
	754	13,532	15	1	14	1	1	0	1	-	1	29	-	29	1	3	-2	3	-	3
	755	10,356	12	3	9	1	0	1	1	-	1	22	-	22	1	2	-1	2	-	2
76	*761*	2,890	3	1	2	0	0	0	0	-	0	6	2	4	0	2	-2	1	-	1
	762	8,351	9	2	7	1	0	1	1	-	1	18	-	18	1	2	-1	2	-	2
	763	22,912	26	23	3	2	9	-7	2	-	2	50	8	42	2	8	-6	5	-	5

Traffic Zone (TAZ)	Detailed Traffic Zone (DTAZ)	Population	Education			Health			Cultural			Sports Areas			Religious			Security		
			Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities
77	*771*	17,591	20	25	-5	2	2	0	1	-	1	38	-	38	2	3	-1	4	-	4
	772	5,756	6	22	-16	1	3	-2	0	-	0	12	1	11	1	3	-2	1	-	1
	773	24,921	28	30	-2	2	2	0	2	-	2	54	1	53	2	15	-13	6	-	6
78	*781*	2,704	3	0	3	0	0	0	0	-	0	6	-	6	0	1	-1	1	-	1
	782	4,562	5	0	5	0	0	0	0	-	0	10	-	10	0	2	-2	1	-	1
	783	20,306	23	16	7	2	0	2	2	-	2	44	4	40	2	4	-2	5	-	5
	784	5,603	6	0	6	1	0	1	0	-	0	12	-	12	1	0	1	1	-	1
79		5,592	6	0	6	1	0	1	0	-	0	12	-	12	1	0	1	1	-	1
80		3,429	4	0	4	0	0	0	0	-	0	7	-	7	0	0	0	1	-	1
81	*811*	8,235	9	0	9	1	0	1	1	-	1	18	-	18	1	0	1	2	-	2
	812	10,211	11	39	-28	1	2	-1	1	-	1	22	-	22	1	4	-3	2	-	2
	813	4,692	5	28	-23	0	3	-3	0	1	-1	10	1	9	0	7	-7	1	1	0
82	*821*	2,362	3	10	-7	0	0	0	0	-	0	5	1	4	0	1	-1	1	-	1
	822	12,118	14	41	-27	1	3	-2	1		1	26	-	26	1	3	-2	3	-	3
	823	26,716	30	25	5	2	2	0	2	-	2	58	3	55	2	7	-5	6	-	6
	824	1,716	2	0	2	0	0	0	0	-	0	4	1	3	0	0	0	0	-	0
	825	9,464	11	20	-9	1	5	-4	1	-	1	21	-	21	1	4	-3	2	2	0
	826	8,576	10	15	-5	1	3	-2	1	-	1	19	2	17	1	3	-2	2	1	1
	827	11,993	13	8	5	1	0	1	1	-	1	26	2	24	1	2	-1	3	-	3
	828	181	0	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	-	0
	829	311	0	0	0	0	0	0	0	-	0	1	-	1	0	0	0	0	-	0
83	*831*	1,896	2	0	2	0	0	0	0	-	0	4	-	4	0	0	0	0	-	0
	832	11,223	13	4	9	1	0	1	1	-	1	24	-	24	1	1	0	3	-	3
	833	886	1	0	1	0	0	0	0	-	0	2	1	1	0	0	0	0	-	0
	834	14,186	16	36	-20	1	2	-1	1	-	1	31	-	31	1	2	-1	3	1	2
	835	314	0	0	0	0	0	0	0	-	0	1	-	1	0	0	0	0	-	0
84		4,969	6	0	6	0	0	0	0	-	0	11	-	11	0	0	0	1	-	1
85	*851*	21,370	24	0	24	2	3	-1	2	21	-19	46	-	46	2	7	-5	5	-	5
	852	18,378	21	5	16	2	0	2	1	-	1	40	3	37	2	4	-2	4	-	4
	853	10,668	12	19	-7	1	2	-1	1	-	1	23	-	23	1	4	-3	2	-	2
	854	13,773	15	19	-4	1	3	-2	1	3	-2	30	2	28	1	4	-3	3	2	1
86	*861*	34,959	39	22	17	3	4	-1	3	-	3	76	14	62	3	2	1	8	-	8
	862	16,510	18	16	2	2	3	-1	1	3	-2	36	1	35	1	7	-6	4	-	4
	863	14,744	16	27	-11	1	1	0	1	-	1	32	2	31	1	4	-3	3	3	0
	864	11,335	13	3	10	1	0	1	1	-	1	25	2	23	1	1	0	3	-	3
	865	9,572	11	28	-17	1	0	1	1	-	1	21	5	16	1	16	-15	2	-	2
87		4,484	5	0	5	0	0	0	0	-	0	10	-	10	0	0	0	1	-	1
88	*881*	31,550	35	5	30	3	1	2	3	1	2	69	-	68	3	0	3	7	2	5
	882	28,272	32	14	18	3	4	-1	2	-	2	61	2	59	3	7	-4	6	-	6
	883	2,447	3	0	3	0	0	0	0	-	0	5	2	3	0	0	0	1	-	1
	884	10,518	12	4	8	1	4	-3	1	-	1	23	-	23	1	2	-1	2	-	2
	885	606	1	0	1	0	0	0	0	-	0	1	-	1	0	0	0	0	-	0
	886	5,987	7	0	7	1	0	1	0	-	0	13	-	13	1	0	1	1	-	1
89		1,151	1	0	1	0	0	0	0	-	0	2	-	2	0	0	0	0	-	0
90	*901*	14,477	16	8	8	1	1	0	1	-	1	31	-	31	1	3	-2	3	2	1

Traffic Zone (TAZ)	Detailed Traffic Zone (DTAZ)	Population	Education			Health			Cultural			Sports Areas			Religious			Security		
			Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities
	902	8,095	9	0	9	1	0	1	1	-	1	18	-	18	1	0	1	2	2	0
91		18,035	20	0	20	2	0	2	1	-	1	39	1	38	2	0	2	4	-	4
92	*921*	3,702	4	0	4	0	5	-5	0	-	0	8	4	4	0	0	0	1	-	1
	922	3,765	4	0	4	0	0	0	0	-	0	8	-	8	0	0	0	1	-	1
	923	13,425	15	19	-4	1	2	-1	1	-	1	29	2	27	1	6	-5	3	1	2
93		19,358	22	0	22	2	0	2	2	-	2	42	-	42	2	0	2	4	-	4
94	*941*	16,257	18	1	17	2	0	2	1	-	1	35	2	33	1	2	-1	4	-	4
	942	29,367	33	8	25	3	1	2	2	1	1	64	-	64	3	4	-1	7	1	6
	943	37,290	42	4	38	3	1	2	3	-	3	81	-	80	3	5	-2	8	1	7
	944	8,399	9	0	9	1	0	1	1	-	1	18	-	18	1	0	1	2	-	2
95		9,457	11	0	11	1	0	1	1	-	1	21	-	21	1	0	1	2	-	2
96	*961*	9,464	11	10	1	1	0	1	1	-	1	21	-	21	1	1	0	2	-	2
	962	15,618	17	10	7	1	0	1	1	-	1	34	-	34	1	0	1	4	-	4
	963	44,858	50	13	37	4	0	4	4	-	4	97	-	97	4	0	4	10	-	10
	964	15,878	18	10	8	1	0	1	1	-	1	34	-	34	1	3	-2	4	-	4
	965	28,810	32	16	16	3	1	2	2	-	2	63	2	61	3	6	-3	7	-	7
	966	9,125	10	5	5	1	0	1	1	-	1	20	2	18	1	2	-1	2	-	2
97		8,744	10	0	10	1	0	1	1	-	1	19	-	19	1	0	1	2	-	2
98		17,049	19	0	19	2	0	2	1	-	1	37	-	37	2	0	2	4	-	4
99		36,575	41	0	41	3	0	3	3	-	3	79	-	79	3	0	3	8	-	8
100		12,863	14	0	14	1	0	1	1	-	1	28	-	28	1	0	1	3	-	3
101		11,476	13	0	13	1	0	1	1	-	1	25	-	25	1	0	1	3	-	3
102		2,304	3	0	3	0	0	0	0	-	0	5	-	5	0	0	0	1	-	1
103		5,287	6	0	6	0	0	0	0	-	0	11	-	11	0	0	0	1	-	1
104		34,555	39	0	39	3	0	3	3	-	3	75	-	75	3	0	3	8	-	8
105		51,015	57	0	57	5	0	5	4	-	4	111	-	111	5	0	5	12	-	12
106		7,693	9	0	9	1	0	1	1	-	1	17	-	17	1	0	1	2	-	2
107		7,536	8	0	8	1	0	1	1	-	1	16	-	16	1	0	1	2	-	2
108		16,068	18	0	18	1	0	1	1	-	1	35	-	35	1	0	1	4	-	4
109	*1091*	194	0	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	-	0
	1092	29,534	33	4	29	3	0	3	2	-	2	64	1	63	3	0	3	7	-	7
110		6,312	7	5	2	1	0	1	1	-	1	14	-	14	1	1	0	1	-	1
111	*1111*	6,788	8	18	-10	1	1	0	1	-	1	15	-	15	1	3	-2	2	-	2
	1112	383	0	0	0	0	0	0	0	-	0	1	2	-1	0	0	0	0	-	0
	1113	5,727	6	10	-4	1	0	1	0	2	-2	12	-	12	1	1	0	1	2	-1
	1114	10,677	12	0	12	1	0	1	1	-	1	23	-	23	1	0	1	2	-	2
112		14,267	16	0	16	1	0	1	1	-	1	31	-	31	1	0	1	3	-	3
113		22,699	25	0	25	2	0	2	2	-	2	49	-	49	2	0	2	5	-	5
114		10,850	12	0	12	1	0	1	1	-	1	24	-	24	1	0	1	2	-	2
115		2,707	3	0	3	0	0	0	0	-	0	6	-	6	0	0	0	1	-	1
116		4,532	5	0	5	0	0	0	0	-	0	10	-	10	0	0	0	1	-	1
117		2,920	3	0	3	0	0	0	0	-	0	6	-	6	0	0	0	1	-	1
118	*1181*	8,678	10	20	-10	1	0	1	1	-	1	19	4	15	1	21	-20	2	-	2
	1182	2,910	3	0	3	0	0	0	0	-	0	6	-	6	0	0	0	1	-	1
119		135	0	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	-	0
120		225	0	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	-	0
121		16,909	19	0	19	2	0	2	1	-	1	37	-	37	2	0	2	4	-	4
122		19,885	22	0	22	2	0	2	2	-	2	43	-	43	2	0	2	4	-	4
123	*1231*	19,677	22	0	22	2	0	2	2	-	2	43	-	43	2	0	2	4	-	4

Traffic Zone (TAZ)	Detailed Traffic Zone (DTAZ)	Population	Education			Health			Cultural			Sports Areas			Religious			Security		
			Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities	Needed in 2040	Existing and planned till 2040	Missing facilities
	1232	28,341	32	0	32	3	0	3	2	-	2	62	-	62	3	0	3	6	-	6
	1233	421	0	0	0	0	0	0	0	-	0	1	-	1	0	0	0	0	-	0
				0	0		0	0		-	0		-	0	-	0	0		-	0
125		3,457	4	8	-4	0	1	-1	0	-	0	8	-	8	0	3	-3	1	1	0
126		7,514	20	19	1	2	1	1	1	-	1	38	1	37	2	5	-3	4	2	2
127		10,200	11	19	-8	1	4	-3	1	-	1	22	3	19	1	4	-3	2	2	0
128		357	0	0	0	0	0	0	0	-	0	1	-	1	0	1	-1	0	-	0
129		383	0	1	-1	0	0	0	0	-	0	1	1	1	0	0	0	0	1	-1
130		5,370	6	14	-8	0	0	0	0	-	0	12	-	12	0	1	-1	1	-	1
131		26,303	29	31	-2	2	4	-2	2	-	2	57	2	55	2	5	-3	6	2	4
132	*1321*	3,274	4	5	-1	0	1	-1	0	-	0	7	-	7	0	0	0	1	-	1
	1322	8,611	10	8	2	1	1	0	1	-	1	19	1	18	1	0	1	2	-	2
	1323	6,188	7	15	-8	1	2	-1	0	-	0	13	1	12	1	2	-1	1	2	-1
	1324	1,111	1	0	1	0	0	0	0	-	0	2	-	2	0	0	0	0	-	0
Total		2,620,343	2,921	1,670	1,251	242	236	6	211	65	146	5,686	196	5,490	235	563	-328	591	299	292

Source: JICA Project Team

The third column is each categories helps understand the lack and the need of facilities per traffic zones.

In education for instance, some traffic zones have a major lack of facilities. TAZ 90 has no educational facilities, and needs 41 facilities. TAZ 68, 69, 70, 91, 963, 104 and 105 are some of the poorest in educational facilities.

On the other hands, some traffic zones have an excess of educational facilities. This is the case of TAZ 49, 812, 813 and 772. It is also important to read these numbers in relation to the map. For instance, TAZ 661 has an excess of 27 educational facilities, with proportion to its expected population in 2040. On the other hand, TAZ 662 lacks 22 facilities. However, the proximity of the 2 areas partially resolves the issue. This is not the case of other parts of the city where students need to have long commutes in order to access schools.

9.3.4 Education Sector Development Plan

1) Nurseries, kindergartens, primary and secondary education

Existing propositions by the Ministry of Education:

The MoE has a list of new schools that need to be built in different parts of Erbil. However, due to current restrictions, the main focus is on the rehabilitation of existing schools. A list of 357 schools in Erbil governorate requires renovation. The priority list is of 384 classrooms to be renovated or added to existing 20 schools.

Recommendations:

- Review the distribution of students in the existing schools in parallel with planning new schools
- Add more classrooms in existing schools where needed, while preserving a maximum of 60% building footprint and 40% outdoor areas. Structural studies and traffic impact shall be carried prior to any extension.
- Create educational complexes that join students of different age groups with shared educational and leisure activities.
- Preserve and maintain traditional schools built with stone, as they hold a culture and heritage value.

Targets (KPI):

- One shift per school. The main reason is to preserve the quality of the school, to create a sense of belonging by the students and to open the playground and fields of the schools for the community after school hours.
- An average number of 25 students per classroom

Private sector:

- 25 educational projects by private investors have been allocated lands based on the request of the board of investment. Another 59 projects are in the process of approval and land allocation. The majority of these are schools and educational institutes.

Future needs:

- The education plan will take into account the needs for kindergartens, primary and secondary schools in the different neighborhoods. Based on current and future population in 2040 and 2050, the required number of classrooms and the needed land area is determined.
  Based on GDUP recommendation, the Iraqi standards will be followed.

Observation of the existing and expected education facilities till 2040:

- High concentration of education facilities in TAZ 813, 821, 812, 822, 865
  Very Low concentration of education facilities withing GB in TAZ 11, 29, 38, 643, 65,674,68,69, 70,71, 727, 732,734, 743, 751, 752, 754, 761, 762, 765, 841.

Based on this observation, a redistribution of education facilities is recommended to ensure equal distribution and less commuting.

i) Future needs of nurseries in 2040 and 2050

Based on the projected population in 2040 and 2050, the total needed number of nurseries is estimated. An estimation that 23% of the age group (0-3 years) will attend nurseries might rise in the next years with more women joining the workforce.

Table 9.3.9 Nurseries: Needs in Numbers and Land Area

Year	Expected population	Children ratio at age 0-3 (12.34% of the population)	5-40% of the age group* (23%)	Land area (m2) 15.50 -18.00 per user (16.75)	The net built-up area (m2) 7.00 -8.50 per user (7.75)	The total building area (m2) 9.00-10.5 per user (9.75)	Average number of nurseries, based on average of 23 kids per nursery **	Average number of nurseries, based on average of 60 kids per nursery ***
2022	1,861,870	229,755	52,844	885,130	409,538	515,225	2,298	881
2040	2,618,303	323,099	74,313	1,244,737	575,923	724,548	3,231	1,239
2050	3,008,501	371,249	85,387	1,430,237	661,751	832,526	3,712	1,423

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

* This percentage varies depending on the number of working women. As more women are in the work field, we apply an average of 23%

** The applied average of 23 kids per nursery is based on a received list from the ministry of labor and social affairs (MoLSA) of 2,200 kids in 97 nurseries across Erbil.

*** The average is based on the minimum in the Iraqi standards, which classify 3 types: 60, 120 and 180 kids/ nursery

As mentioned, the estimated number of nurseries needed may vary depending on the number of kids per nursery. Currently, the average is 23 kids/ nursery, more than 50% less than the minimum number as per the Iraqi standards.

The catchment area for a nursery is 300m, based on the Iraqi standards. Accordingly, the nurseries should be located at 600m from each other.

ii) Future needs of kindergartens in 2040 and 2050

Table 9.3.10 Kindergartens: Needs in Numbers and Land Area

Year	Expected population	Children ratio at age 3-5 (5.78% of the population)	25-50% of the age group* (50%)	Land area (m2) 15.50 -16.00 per user (16.00)	The net built-up area (m2) 5.80 -6.40 (6.10)	The total building area (m2) 7.25-8.00 per user (7.625)	Average number of kindergartens, based on average of 216 students / KG: 12 classrooms, 18 kids per classroom **
2022	1,861,870	107,616	53,808	860,92	328,229	6,564,581	249
2040	2,618,303	151,338	75,669	1,210,703	461,581	9,231,613	350
2050	3,008,501	173,891	86,946	1,391,131	530,369	10,607,373	403

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

* As the state is aiming to increase the enrolment in pre-primary education, we will apply the 50%

Note that the baseline 2020 is 28% and the target of vision 2030 is 81%

** The average number of students/ kindergartens is 228 based on the list of 83 public kindergartens received from MoE

The catchment area for a Kindergarten is 300m, based on the Iraqi standards. Accordingly, the kindergartens should be located at 600m from each other.

More planning criteria for nurseries and kindergartens:

- Accessibility: Nurseries and kindergartens should be located within the neighborhoods, on internal roads with low traffic. Access by foot should be prioritized.
- Zoning: Nurseries must be allocated on plots dedicated for education or social services. Kindergartens fall within the zones for educations.
- Context: Nurseries and kindergartens must be located in safe environments, away from noise and polluting buildings or functions.
- Open spaces and play area should constitute a minimum of 40% of the land area.
- Compatible facilities: These kids related facilities may be located at proximity with neighborhoods gardens and play areas. They may also be allocated as part of educational complexes with facilities targeting older age groups.

iii) Future needs of primary schools in 2040 and 2050

Table 9.3.11 Primary Schools: Needs in Numbers and Land Area

Year	Expected population	Children ratio at age 6-11 (15.4% of the population)	100 % of the age group*	Land area (m2) 8.37 -9.38 per user (9.00)	The net built-up area (m2) 3.72-4.00 per user (3.86)	The total building area (m2) 4.65-5.15 per user r (4.90)	Average number of primary schools, based on 18-classroom typology, 25 students per classroom	Total needed number of primary schools, based on an average 4000 m2 land area/ facility
2022	1,861,870	286,728	286,728	2,580,552	1,106,770	1,404,967	637	645
2040	2,618,303	403,219	403,219	3,628,968	1,556,424	1,975,771	896	907
2050	3,008,501	463,309	463,309	4,169,782	1,788,373	2,270,215	1,030	1,042

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

* Unlike the Iraqi education system, the KRJ system is divided into Primary and Secondary only.

The catchment area for a primary school is 500m, based on the Iraqi standards.

iv) Future needs of secondary schools in 2040 and 2050

Table 9.3.12 Secondary Schools: Needs in Numbers and Land Area

Year	Expected population	Children ratio at age 12-18 (7% of the population)	92.2 % of the age group*	Land area (m2) 10.90 -11.80 per user (11.35)	The net built-up area (m2) 4.30-5.00 per user (4.65)	The total building area (m2) 5.30-6.30 per user r (6.00)	Average number of secondary schools, based on 15-classroom typology, 25 students per classroom **	Total needed number of secondary schools, based on an average 4500 m2 land area/ facility
2022	1,861,870	130,331	119,904	1,360,915	557,555	719,426	320	302
2040	2,618,303	183,281	168,619	1,913,822	784,077	1,011,712	450	425
2050	3,008,501	210,595	193,747	2,199,034	900,926	1,162,485	517	489

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

* NER 92.2 % is based on the target of vision 2030

* The Iraqi standards defines 12-classroom school as maximum from secondary schools. The MoE gives the option of 12 classroom but prefers the 18-classroom typology being on 2 floors and more efficient. An average of 15-classroom per school is followed.

The catchment area for a secondary school is 800m, based on the Iraqi standards

Observations:

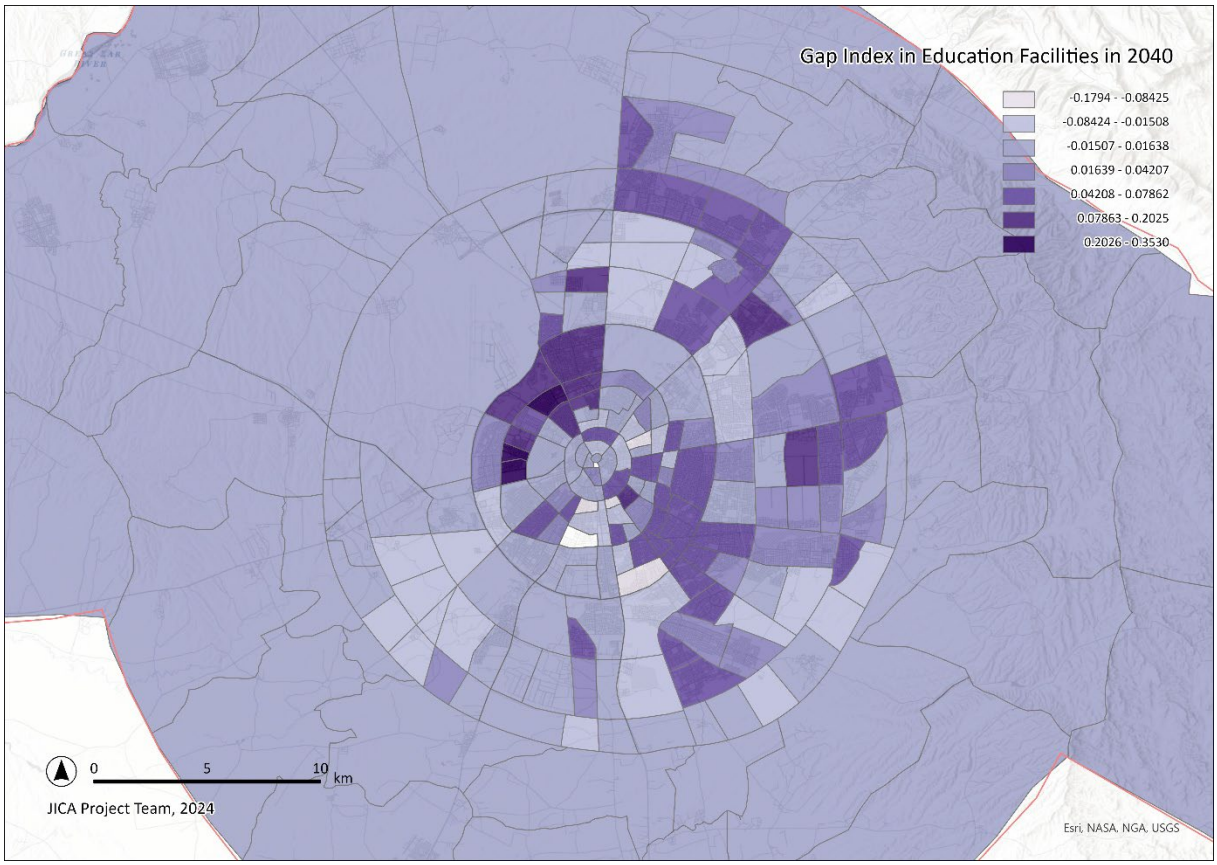
Based on the above estimations, there is a current need in 2022 for an average 2,077 education facilities -excluding tertiary education. Required land area for these facilities is 5,687,526 m2.

These numbers are to be compared to the total number of existing and planned approved education facilities (nursery till secondary/ vocational) till 2040 which are 1,637 facilities on 11,510,084 m2 of land.

Conclusion:

The number of education facilities is 22% less than needed in 2040. The land areas however are more than twice the need and must be reviewed.

The map below shows the different gaps of planned education facilities per traffic zone, till 2040. This includes some TAZ with negative gaps, which translate into an excess of education facilities in relation to the expected population.



Source: JICA Project Team

Figure 9.3.2 Planned Facilities on Needs Gap Index in Education

2) Tertiary education

i) Future needs of universities in 2040 and 2050

Existing plans by the Ministry of higher education and scientific research:

- The plan of the MoHESR is to transfer all the colleges of the public university, including Erbil medical school, into the new campus on Kirkuk Road.
- Erbil Polytechnical school is also expected to move to the new location.
- Kurdistan university (UKH) is expected to be built, occupying a land of approximately 500,000 m2 at the intersection of Baharka road and 120 m road.

Existing plans by the private sector, through BoI:

- University of London is being built on Koya road, occupying a land of 128,562 m2. Its previous location on the Erbil 2030 MP is replaced by Erbil Hills development project and University of Kurdistan future campus.

Recommendation:

- Create a masterplan for private universities in relation with population densities, public transportation and road networks. The aim is to create a good distribution of tertiary education facilities, control the traffic and create economic impact in different parts of the city.
- Encourage economic development around universities through zones of commercial strips and ground floor activities, targeting students, faculty and staff. Furnished apartments and students' residents should also be initiated in zoning.
- Pedestrian priority, public transport nodes and street parking should be accounted to allow smooth access to both standalone university and campuses.

Targets (KPI):

- Preserve the current 60% average of students accessing free higher education in Erbil.

Future needs:

- A new campus for the public university is needed to cover the expected numbers of enrollment until 2050. We propose an additional campus in Mandawa. Locating the new campus in new areas, away from dense urbanization, can be beneficial to students and the new development targets areas. Universities may act as an engine for economic growth in their surroundings. Expected number of students: 20,000

(2) Health Sector Development Plan

i) Future needs of Health centers and health complexes in 2040 and 2050

Recommendation:

- Unified standards are needed for planning future provisions of health centers.
- The allocation of health centers in neighborhoods centers, at proximity with other community-related services creates an identity and a meeting point. Outdoor gym and green spaces can perfectly complement health centers.

Targets (KPI):

- Primary health centers in all the project area (not secondary)
- Health centers accessible by walking distance (8 to 15 minutes) from the residences. To achieve this target, more PHC need to be implemented instead of overloading the existing ones with more target population and more medical teams.

Table 9.3.13 Primary Health Centers (PHC)*: Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (100% of the population)	100 % of the age group	Land area (m2) 0.3 per user	The net built-up area (m2) 0.1 per user	The total building area (m2) 0.125 per user	Average number of PHC based on a population of 12,000 by PHC	Average number of PHC based an average plot area of 1800 m2 per PHC
2022	1,861,87	1,861,870	1,861,870	558,561	186,187	232,734	155	310
2040	2,618,303	2,618,303	2,618,303	785,490	261,830	327,288	218	43
2050	3,008,501	3,008,501	3,008,501	902,550	300,850	376,063	251	501

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones

* Secondary health center will not be adopted in urban areas at per MoH

The catchment area for a PHC is 800m, based on the Iraqi standards

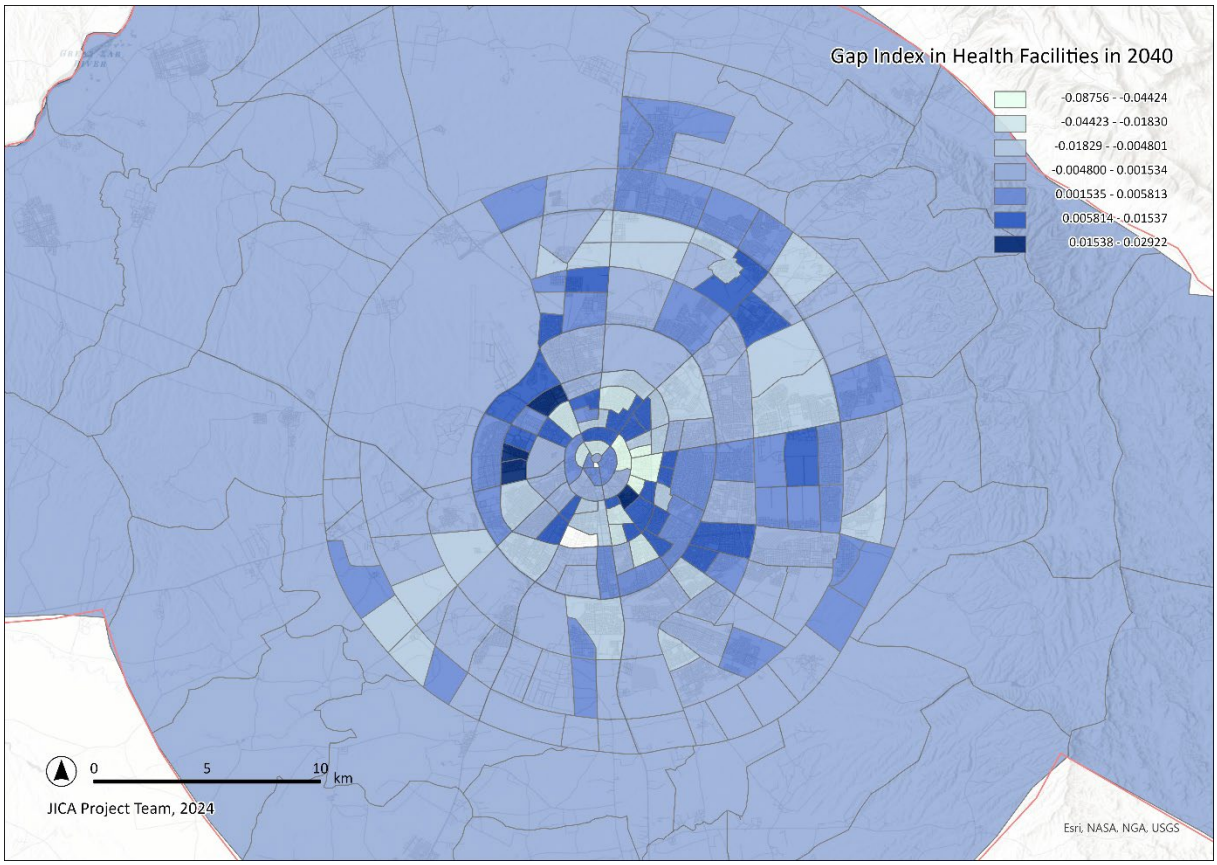
Observations:

- Based on the above estimations, there is a current need in 2022 for a minimum of 155 PHC, assuming that each PHC serves a population of 12,000 residents.
- As per received documents, there are currently 54 PHC (primary and secondary) and 10 public health complexes, as per the MoH data. - which is almost one third of the current need.
- Based on the above estimations, there will be a need in 2040 for a minimum 219 PHC, assuming that each PHC serves a population of 12,000 residents.

Based on calculated current conditions and planned approved detailed plans, there will be 236 healthcare facilities covering a land area of 1,587,500 m2 in 2040.

However, this number includes Hospitals and clinics, in addition to the PHC. After subtraction, the conclusion is the need for additional PHC in 2040.

The map below shows the different gaps in planned health facilities for 2040, per traffic zone.



Source: JICA Project Team

Figure 9.3.3 Planned Facilities on Needs Gap Index in Health

ii) Future needs of Hospitals in 2040 and 2050

Recommendation:

- The future distribution of general and emergency hospitals must follow the shifting center of the city towards the north. There are currently 3 public emergency hospitals in the project area and a number of private hospitals with emergency wards. More emergency hospitals will be needed to cover the needs of the expanding urbanization.
- The catchment area of a hospital is the community of people being served by the hospital or medical center. The determinants of a catchment community are based primarily on the geographic boundaries, distance and travel time to the hospital. The "Immediate catchment community." is 5 to 10 km range.
- Another secondary determinant is the wish to capture the market of potential clients whether far or near the medical center. "Beyond immediate catchment community."
- The number of beds should be calculated based on population densities and the travel time to the closest hospital may not exceed 30 minutes (30 km approximately).
- Another factor that contributes in a more accurate allocation for future hospitals is the rate of activation of nearby hospital which, according to the MoH, should not be less than (60%).

Targets (KPI):

- 20 beds/ 10,000 (currently 12 beds/10,000).
  Note: Based on the planning directorate at the MoH, the current challenge is the public hospitals is the deficit in the number of operation rooms and not in the number of beds. This may be related to the change in the medical practice and types of procedures.

Table 9.3.14 Hospitals: Needs in Numbers and Land Area

Year	Expected population	Needed number of beds, based on a ratio of 27/10,000	Needed number of physicians, based on a ratio of 2/1,000	Number of needed hospitals, based on a recommended average of 300 beds per hospital	Number of needed hospitals, based on an average of 100 beds per hospital*	Needed land for hospital, based on a ratio of 1.5 ha per 100 beds (m2)
2022	1,861,870	5,027	3,723	17	37.	558,561
2040	2,618,303	7,069	5,236	24	52	785,491
2050	3,008,501	8,123	6,017	27	60	902,550

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

* 100 beds per hospital is the minimum, set by the MoH for public hospitals. However, it is recommended to establish hospitals with higher number of beds (200 to 300 beds on average)

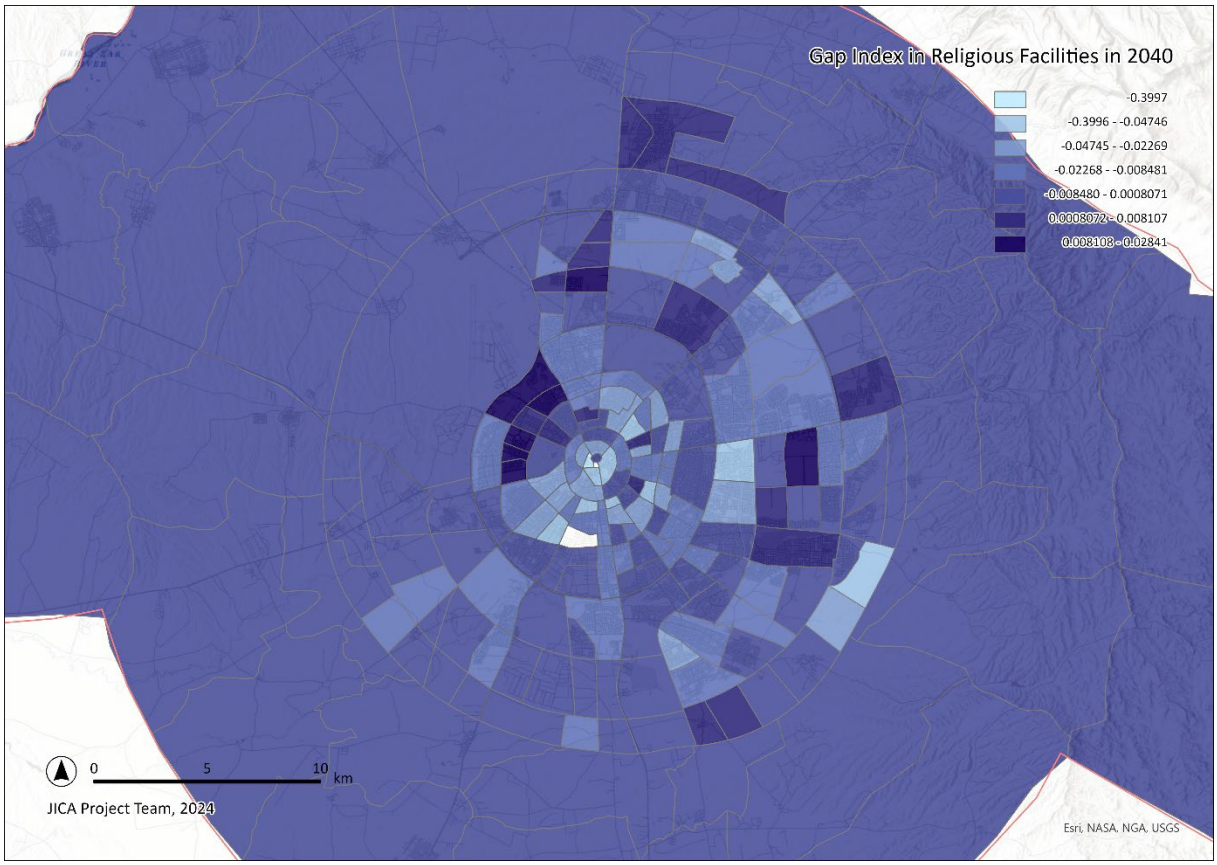
The number of governmental hospital beds in Erbil = 12 per 10,000 based on latest official data in 2023

Number of total hospital beds = 17.8 per 10,000 based on latest official data in 2023

Erbil had 8 health professionals per 10,000 population in 2022 (KRSO source) And 11.6 per 10,000 based on latest official data in 2023.

9.3.5 Religious Sector Development Plan

The map below shows the existing and planned religious building till 2040, per TAZ. The majority of the TAZ has a negative gap, which means more religious building that the indicated in the planning standards.



Source: JICA Project Team

Figure 9.3.4 Planned Facilities on Needs Gap Index in Religious

Future Plans:

- There are no major future plans for religious facilities by the MoERA. Some new design schemes for mosques are presented by students and architecture offices.

Recommendation:

- Controlling the number of small-scale religious building and channelling the funds by donors into building a large-scale mosque that may become a monument in Erbil (as proposed by the JICA study team and detailed in public facilities strategies)
- Review the current fencing around most mosques. Instead, including the mosques and other religious facilities within a hub of facilities targeting the public, reinforce the centrality of these activities and allow them the complement each other.

Table 9.3.15 Religious Buildings: Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (100%)	Served 100 % of the age group	Land area m2) 0.3 per user	The net built-up area (m2) 0.1 per user	The total building area (m2) 0.125 per user	(1) Type A + (4) Type B + (16) Type C + (64) Type D	Needed number of mosques Type A	Needed number of mosques Type B	Needed number of mosques Type C	Needed number of mosques Type D	Total needed number of mosques
2022	1,861,870	1,861,870	1,861,870	558,561	186,187	232,733	1.97	2	8	31	126	167
2040	2,618,303	2,618,303	2,618,303	785,490	261,830	327,287	2.77	2.77	11	44	177	235
2050	3,008,501	3,008,501	3,008,501	902,550	300,850	376,063	3	3	13	51	203	270

Source: JICA Project Team
Note: Refer to the annex tables for detailed calculations per traffic zones.
Based on Iraqi standards, the plot areas for mosques range from 1440 and 4320 m2.
Based on MoERA's mosques categories and Iraqi Standards planning norms, we assume the following mosques ratio: (1) Type A + (4) Type B + (16) Type C +(64) Type D
MoERA plot area: Type A (12,000 m2) Type B (8,000 - 12,000 m2), Type C (5,000 - 8,000 m2), Type D (2,500-5,000 m2).
1(A) of 12,000 m2+ 4(B) of 8,000 m2 + 16 (C) of 5,000 m2 + 64 (D) of 2,500 m2 is a total of 85 mosques of 284,000 m2 land area.
The catchment area for a religious facility is 800m, based on the Iraqi standards

9.3.6 Youth and Culture Development Plan

Recommendations:

- Implement small scale youth and culture projects and not restrict it to district level
- Create unique youth hubs, that respond to their context, instead of following a repetitive typology.
- Clustering youth, culture, libraries, open space at the intersection of the neighborhoods or the center of the districts
- Implement sport fields of all scale.

Proposal:

- Transform the current location of UKH, a historic building (train station) into a cultural facility.

i) Future needs of Youth centers in 2040 and 2050

Table 9.3.16 Youth Facilities: Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (21.14%)	100 % of the age group	Land area (m2) 0.17 per user	The net built-up area (m2) 0.24 per user	The total building area (m2) 0.3 per user	1(A) + 2(B)	Number of Type A	Number of Type B	Total need number of youth facilities *
2022	1,861,870	393,599	393,599	316,518	94,464	118,080	9	9	19	28
2040	2,618,303	553,509	553,509	445,111	132,842	166,052	13	13	26	39
2050	3,008,501	635,997	635,997	511,445	152,639	190,799	15	15	30	44

Source: JICA Project Team

* The Iraqi standards give the choice to pick one type of youth facility (A or B), based on the size of the community. However, as we encourage different scales and a variety of youth facilities, we added up the 2 types.

Note: Refer to the annex tables for detailed calculations per traffic zones.

Based on Iraqi standards, the plot areas for youth center range from 6,900 and 20,740 m.

The Iraqi Standards define 2 categories of youth centers from District level (average 48,000 users) to half district level (average 24,000 users).

The catchment area for a youth center is 800m, based on the Iraqi standards.

ii) Future need of Cultural Facilities in 2040 and 2050

Table 9.3.17 Cultural Facilities: Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (100%)	100 % of the age group	Land area (m2) 0.175 per user	The net built-up area (m2) 0.045 per user	The total building area (m2) 0.055 per user	1(A) + 4(B) + 16(C)	Number of Type A	Number of Type B	Number of Type C	Total need number of cultural facilities
2022	1,861,870	1,861,870	1,861,870	325,827	83,784	102,403	5.85	6	23	94	123
2040	2,618,303	2,618,303	2,618,303	458,203	117,824	144,007	8.23	8	34	131	173
2050	3,008,501	3,008,501	3,008,501	526,488	135,383	165,467	9.46	9	38	151	198

Source: JICA Project Team

* The Iraqi standards give the choice to pick one type of cultural facility (A or B or C), based on the size of the community. However, as we encourage different scales and a variety of cultural facilities, we added up the 3 types.

Note: Refer to the annex tables for detailed calculations per traffic zones.

Based on Iraqi standards, the plot areas for cultural facilities range from 1680 and 8640 m2.

The Iraqi Standards define 3 categories of cultural centers from District level (average 48,000 users) to sector level (average 12,000 users)

1(A) of 7680 m2+ 4(B) of 3,600 m2 + 16(C) of 2,100 m2 is a total of 21 cultural facilities of 55,680 m2 land area

The catchment area for a cultural facility is 800m, based on the Iraqi standards

iii) Future needs of Sport Facilities in 2040 and 2050

Table 9.3.18 Playgrounds and Sport Fields: Needs in Numbers and Land Area

		Kids areas (age 1-5) - precinct level			Play areas (age 6-11) - neighborhood level			Sport field (age 12-18) - community level			Park and open areas (all ages) - district level		
Year	Expected population	users ' age percentage of the total population (18.13%)	Total needed area for users (1.40 m2 per user)	Number of play areas, based on an average area of 162.5 m2 (range 100- 225m2)	Users' age percentage of the total population (15.48%)	Total needed area for users, based on an average of 1.3m2 per user (range 1.0 - 1.6m2	Number of play areas, based on an average area of 750 m2 (range 600-900m2)	Users' age percentage of the total population (13.27%)	Total needed area for users, based on an average of 2.4m2 per user (range 1.75 - 3m2)	Number of play areas, based on an average area of 1200 m2 (range 900-1500m2)	Users age percentage of the total population (100%)	Total needed area for users, based on an average of 1.5m2 per user (range 0.75-2.25m2)	Number of play areas, based on an average area of 19,800 m2 (range 7,200-32,400m2)
2022	1,861,870	337,557	472,580	2,908	288,217	374,683	500	247,070	592,968	494	1,861,870	2,7923	141
2040	2,618,303	474,698	664,578	4,090	405,313	526,907	703	347,449	833,877	695	2,618,303	3,927,454	198
2050	3,008,501	545,441	763,618	4,699	465,716	605,431	807	399,228	958,147	798	3,008,501	4,512,752	228

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

Based on the Iraqi standards, the catchment area for a Kids' area is 150m, for a play area 250m, for a sport field 650m and for a park and open areas 800m.

The regulations do not have 2 different categories for sport areas versus parks and green spaces. Large stadiums or sport cities may be included in the park and open spaces, while preserving the right percentages of trees and landscape.

9.3.7 Safety Development plan

i) Future needs of Police stations in 2040 and 2050

Recommendations:

- Implement small scale police stations and posts within communities and neighborhoods, similar to the Koban. These small box-like buildings are staffed by uniformed officers and located at street intersections and main corners to serve and protect the communities all over the country.
  These community stations should be made visually identifiable to create easy access and a sense of safety.
  In scale, they are smaller than the Type B police stations mentioned in the Iraqi standards, as they serve smaller number of people, ideally an average of 20,000 inhabitants.

Table 9.3.19 Police Stations: Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (100%)	100 % of the age group	1 PS Type A + 5 PS Type B per 60,000 users *	Total number of Police stations Type A	Total number of Police stations Type B	Total needed Land area (1800 m2 for Type A and 1200 m2 for Type B)	Total needed Built area (50% of land area)
2022	1,861,870	1,861,870	1,861,870	31.03	31	155	242,043	121,021
2040	2,618,303	2,618,303	2,618,303	43.64	44	218	340,379	170,190
2050	3,008,501	3,008,501	3,008,501	50	50	251	391,105	195,553

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

ii) Future needs of Fire stations in 2040 and 2050

Fire stations are a crucial service to protect lives, properties as well as national resources. There is a current a lack of fire departments and fire stations, to cover the whole city of Erbil; especially after the economic development and the expansion of the city on 2003.

Based on Iraqi standards and the current population, there is a need for 26 main fire stations (type A) and 52 secondary fire stations (type B). By norm, more than one fire station can be grouped within a fire department.

In parallel to availability, the distribution of the fire departments is a main criterion. The efficiency of the service is directly related to the time the fire departments take to respond to a reported incident. The catchment area for a fire stations types A and B is 2000m. Travel time should also be calculated where factors such as traffic and the nature of the roads play a major role.

Table 9.3.20 Fire Stations: Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (100%)	100 % of the age group	1 PS Type A + 2 FS Type B per 72,000 users *	Total number of Fire stations Type A	Total number of Fire stations Type B	Total needed Land area (2300 m2 /Type A 1152 m2/ Type B)	Total needed Built area (30% of land area)
2022	1,861,870	1,861,870	1,861,870	25.86	26	52	119,056	35,717
2040	2,618,303	2,618,303	2,618,303	36.37	36	73	167,426	50,228
2050	3,008,501	3,008,501	3,008,501	42	42	84	192,377	57,713

Source: JICA Project Team

Note: Refer to the annex tables for detailed calculations per traffic zones.

Based on Iraqi standards, there is a need for 1 fire station type A per district of 48,000 inhabitants and 1 fire station type B per half district of 24,000 inhabitants.

While this basic calculation provides a simplified quantitative estimation, more factors, quantitative, qualitative, social and economic should be taken into account for a careful allocation and planning of the facilities. The number of households, the density, the ease of access, the proximity of populated non-residential are some of the factors.

The quality of the services, the machine and the expertise are equally important is assuring the efficiency of the service. The high-rise buildings, often constructed with insufficient plot setback, offer a different challenge from the usual 2 to 3 -story houses.

Similar to other public facilities, new technologies based mostly on GIS, may be applied, giving different weights to each criterion. By introducing advanced planning method, while feeding it with the most specific data, we expect to reach the most tailored made response to the need of the expanding city.

9.3.8 Other Services

(1) Future needs of Post offices in 2040 and 2050

Table 9.3.21 Post Offices: Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (100%)	100 % of the age group	1 PO Type A + 5 PO Type B per 60,000 users *	Total number of Post offices Type A	Total number of post offices Type B	Total needed Land area (860 m2/ Type A, 500 m2 /Type B)	Total needed Built area (60% of land area)
2022	1,861,870	1,861,870	1,861,870	31.03	31.03	155.16	104,265	62,559
2040	2,618,303	2,618,303	2,618,303	43.64	43.64	218.19	146,625	87,975
2050	3,008,501	3,008,501	3,008,501	50	50	251	168,476	101,086

Source: JICA Project Team

The Iraqi standards propose 2 types of post offices. Type A serves 50,000 inhabitants and is located at district level, type B serves 10,000 inhabitants and is located within the neighborhoods.

Post offices are needed amenities that are ideally located in close proximity to residential areas, public transportation hubs, and major roads. Assessing population densities and demographics help planners weigh the volume and types of postal services demanded in each neighborhood.

Note: Refer to the annex tables for detailed calculations per traffic zones.

Post services can be allocated in the same structure with other governmental institution, and even with other functions such as retail.

(2) Future needs of Cemeteries in 2040 and 2050

The standards used in Erbil 2030 MP are one cemetery for 50,000 people and six hectares per cemetery. Its grave size is 1.2m2 per person, which can be considered too small for burial. Thus, the total area required for future cemeteries is recalculated from the standard of grave size from examples in other cities[6][7] and the mortality estimates from the socio-economic framework.

Table 9.3.22 Cemeteries: Needs in Land Area

Year	Estimated death	Needed size of each grave including space between graves and paths (m^2)	Total needed area of cemeteries (m^2)
2040	142,136	6.7	952,311
2050	259,296	6.7	1,737,283

Source: JICA Project Team

Table 9.3.23 shows the total area required for cemeteries by 2040 and 2050. The total area of new cemeteries required between 2040 and 2050 is 784,972 m2.

The area of the proposed forest cemetery in the east side of Erbil 2030 MP is at least 15 million m2 (see Section 3.3) and can be considered over-scaled compared to the actual demand (more than 15 times the demand). Therefore, this proposition from Erbil 2030 MP has been discontinued to foster a more accurately calculated and realistic alternative.

Based on to the Accessible & Affordable Services for Good Quality of Life (AAS) Long-term Vision (see Section 4.2), in order to ensure the accessibility of citizens from each neighbourhood to a nearby cemetery, the decentralization of cemeteries has been encouraged. Following the original concept of forest cemetery proposed in Erbil 2030 MP, the integrations of new cemeteries within the Agro-nodes inside the Green Belt (see Section 10.3.2) minimize the impact on the surroundings and provides better access to the public.

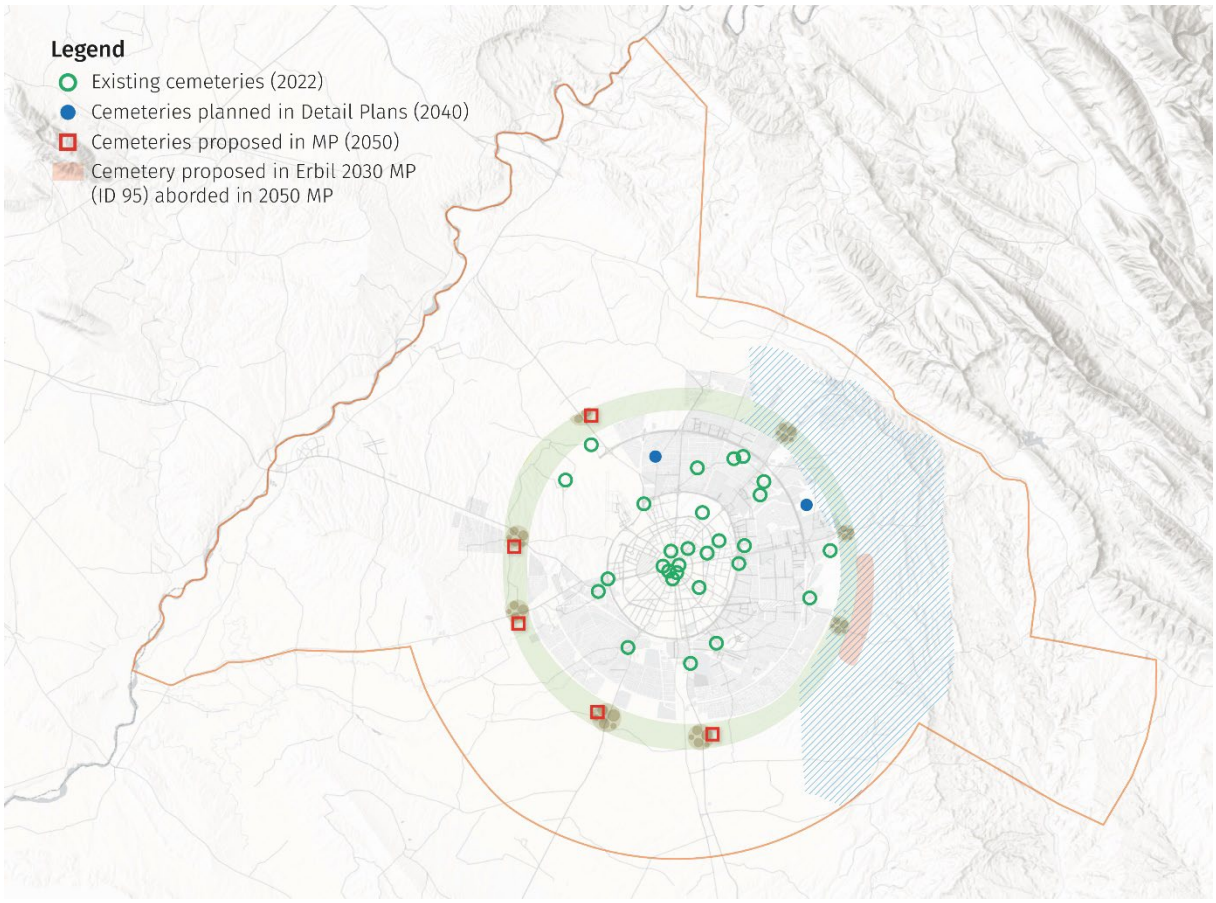
Each one of the 5 proposed cemeteries integrated inside the Agro-nodes has an average area of 150,000 m2 to cover the general demand mentioned above. It shall be noted that, based on the discussions with the Kurdish side, cemeteries have not been proposed within the 3 Agro-nodes which are located inside the Groundwater Recharge Zone.

Recommendations:

- Integrating any new cemetery within the proposed agroforestry and tree planting inside Green Belt.
- The proposed forest cemetery in the Erbil 2030 MP may be duplicated in further parts of the project area, at the outskirt of the Green Belt.
- Norms may be reviewed to take into account the specificities of the religious groups as well as the annual mortality rates.

[6] Information for Muslim Burials of St Albans city & District Council https://www.stalbans.gov.uk/sites/default/files/documents/publications/Cemeteries%20and%20Funerals%20and/GS_C_MuslimBurials_tcm15-16159.pdf

[7] Muslim burials of Bury council, UK https://www.bury.gov.uk/births-deaths-and-ceremonies/deaths/muslim-burials



Source: JICA Project Team

Figure 9.3.5 Cemeteries Development Plan

iii) Future needs of local administration buildings in 2040 and 2050

Local administration buildings are proposed in the urban standards, to be located within the neighbourhoods serving an average of 12,000 inhabitants. The building footprint has an average of 500m2, on a plot of 1,000m2 on average.

These facilities might offer different public services and may minimize the need for commuting into main governmental directorates. They also play a major role in connecting citizens to the state, to enhance sense of safety and belonging.

They may be combined with other services or integrated within larger governmental institutions.

Table 9.3.23 Public Buildings (Local Administration): Needs in Numbers and Land Area

Year	Expected population	Users' age percentage of the total population (100%)	100 % of the age group	Needed land area (0.07 per served person)	Net building area (0.035 per served person)	Gross building area (0.042 per served person)	Number of facilities, based on an average 500m2 gross building area
2022	1,861,870	1,861,870	1,861,870	130,331	65,165	78,198	156.40
2040	2,618,303	2,618,303	2,618,303	183,281	91,641	109,969	219.94
2050	3,008,501	3,008,501	3,008,501	210,595	105,298	126,357	253

Source: JICA Project Team

In the Iraqi standards, markets, shopping centers, coffee shops, restaurants gas stations and car service

centers are also allocated.

(3) Data analysis summary

Table 9.3.24 Public Facilities: Summary of Needs in 2040 and 2050

Year	Population	Education		Health		Cultural		Sports		Religious		Security		Cemeteries	
		Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)
2040	2,618,303	2,921	7,998,231	242	1,570,982	211	903,315	5,686	5,952,817	235	785,491	591	691,087	24	952,311
2050	3,010,551	3,357	9,190,184	311	1,805,101	243	1,037,933	6,533	6,839,947	270	902,550	679	794,077	29	1,737,283
Existing & planned facilities		1,637	11,510,084	236	1,587,500	65	1,133,721	196	2,385,314	563	2,371,171	299	4,852,344	58	3,330,000

Source: JICA Project Team

Education facilities:

By comparing the number of educational facilities, we conclude that more schools will be needed in 2040 and 2050, based in our KPI of 1 shift per school.

If 2-shift system is kept, the number is more than required (not advisable) but their distribution needs to be reviewed.

Health facilities:

The number and allocated areas for health facilities meet the need for 2040. However, the existing facilities include a good percentage of private clinics, which are not part of the future projection. The number of primary health centers still need to be increased to provide accessible free health care.

Cultural facilities:

The existing and planned cultural facilities (total 65) cover only 30% of the need in 2040. As mentioned in the development plan, there is a need for different scales of cultural facilities including neighborhoods and districts. A good distribution of libraries, art, music and youth facilities respond to vision 2030.

Sport facilities:

Similar to culture, sport is not well accounted for in future plans. There is a need to a much larger number of play area, playgrounds, sport courts and stadiums, in addition to national scale sport cities. The neighborhood, community and district scale sport facilities are an essential part of a healthy community.

Religious facilities:

There are much more religious facilities, existing and approved then the need for 2040 and even 2050. In the absence of a monumental grand mosque in Erbil, the donors may be encouraged to find such project. Authorities should also ensure that no plots of lands dedicated for other facilities are lost in order to accommodate donors' requests.

Security facilities:

The low number of security facilities projects the low number of fire stations and police stations and the need for additional ones in the currently urbanized areas and the future cores. The large area of the existing is mostly due to the army base, close to the airport. However, this number does not reflect the police stations and fire stations within the city districts and neighborhoods, and which is lower than then the current and future needs.

Cemeteries:

There is a high number of current and planned cemeteries. However, the area is almost half what is needed in 2040. As mentioned in the development plan, large cemeteries (60,000 sqm) average are encouraged, to be part of the green footprint, at a distance from the urbanized area.

1) Public facilities in the new north cores

As new development cores are planned to the north of Erbil, different types of amenities will be needed to serve the expected future population in the main cores, secondary cores and the residential neighborhoods.

The following tables show the estimated need for public facilities, categorized under the 5 basic types. Option A excludes any development in Mandawa, while option accommodates for it.

Education, health, culture, sport, religion and security are broad categories. Within each and every core or agglomeration, more specific facilities may be planned based, tailored to the specificities of the area and the vision related to its development.

Table 9.3.25 Public Facilities: Needs in the North Cores in 2050 - Option A

North cores	2050 A	Education		Health		Cultural		Sports Areas		Religious		Security	
		Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)
Bahirka	57,600	108	175,953	6	34,560	5	19,872	125	130,956	5	17,280	13	15,203
Bahirka Core	20,100	38	61,400	2	12,060	2	6,935	44	45,698	2	6,030	5	5,305
Gazna core	7,200	14	21,994	1	4,320	1	2,484	16	16,369	1	2,160	2	1,900
Gazna Road Corridor	5,900	11	18,023	1	3,540	0	2,036	13	13,414	1	1,770	1	1,557
Ashukan core	7,125	13	21,765	1	4,275	1	2,458	15	16,199	1	2,138	2	1,881
Ashukan Road corridor	4,050	8	12,372	0	2,430	0	1,397	9	9,208	0	1,215	1	1,069
Daraban core	4,875	9	14,892	1	2,925	0	1,682	11	11,084	0	1,463	1	1,287
Qafar core	7,200	14	21,994	1	4,320	1	2,484	16	16,369	1	2,160	2	1,900
Great Zab Residential	21,950	41	67,052	2	13,170	2	7,573	48	49,904	2	6,585	5	5,794
Intermediate core 1	4,875	9	14,892	1	2,925	0	1,682	11	11,084	0	1,463	1	1,287
Intermediate core 2	4,875	9	14,892	1	2,925	0	1,682	11	11,084	0	1,463	1	1,287
Small core 1	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540
Small core 2	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540
Small core 3	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540
Small core 4	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540

North cores	2050 A	Education		Health		Cultural		Sports Areas		Religious		Security	
		Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)
AgriNeigh A	160,571	301	490,503	17	96,343	13	55,397	349	365,065	14	48,171	36	42,382
AgriNeigh B	N/A	-	-	-	-	-	-	-	-	-	-	-	-
Darashakan Res	5,450	10	16,648	1	3,270	0	1,880	12	12,391	0	1,635	1	1,438
Darashakan MixedUse	7,250	14	22,147	1	4,350	1	2,501	16	16,483	1	2,175	2	1,914
Rashwan Res	7,550	14	23,063	1	4,530	1	2,605	16	17,165	1	2,265	2	1,993
Rashwan Mixed	950	2	2,902	0	570	0	328	2	2,160	0	285	0	251
Mandawa Core	N/A	-	-	-	-	-	-	-	-	-	-	-	-
Mandawa MixedUse	N/A	-	-	-	-	-	-	-	-	-	-	-	-
Mandawa Residential	N/A	-	-	-	-	-	-	-	-	-	-	-	-
	335,697	630	1,025,467	35	201,418	27	115,816	729	763,221	30	100,709	76	88,605

Source: JICA Project Team

Option Ⓑ assumes that the dam of Mandawa and, consequently the surrounding area, will be developed as an attractive destination, close to the city and as a new core.

Table 9.3.26 Public Facilities: Needs in the North Cores in 2050 - Option Ⓑ

North cores	2050 B	Education		Health		Cultural		Sports Areas		Religious		Security	
		Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)
Bahirka	57,600	108	175,953	6	34,560	5	19,872	125	130,956	5	17,280	13	15,203
Bahirka Core	15075	28	46,050	2	9,045	1	5,201	33	34,274	1	4,523	3	3,979
Gazna core	7,200	14	21,994	1	4,320	1	2,484	16	16,369	1	2,160	2	1,900
Gazna Road Corridor	5900	11	18,023	1	3,540	0	2,036	13	13,414	1	1,770	1	1,557
Ashukan core	7,125	13	21,765	1	4,275	1	2,458	15	16,199	1	2,138	2	1,881
Ashukan Road corridor	4,050	8	12,372	0	2,430	0	1,397	9	9,208	0	1,215	1	1,069
Daraban core	4,875	9	14,892	1	2,925	0	1,682	11	11,084	0	1,463	1	1,287
Qafar core	7,200	14	21,994	1	4,320	1	2,484	16	16,369	1	2,160	2	1,900
Great Zab Residential	21,950	41	67,052	2	13,170	2	7,573	48	49,904	2	6,585	5	5,794
Intermediate core 1	4,875	9	14,892	1	2,925	0	1,682	11	11,084	0	1,463	1	1,287

North cores	2050 B	Education		Health		Cultural		Sports Areas		Religious		Security	
		Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)	Count	Area (m2)
Intermediate core 2	4,875	9	14,892	1	2,925	0	1,682	11	11,084	0	1,463	1	1,287
Small core 1	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540
Small core 2	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540
Small core 3	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540
Small core 4	2,044	4	6,244	0	1,226	0	705	4	4,647	0	613	0	540
AgriNeig A	N/A	-	-	-	-	-	-	-	-		-		
AgriNeigh B	153,946	289	470,266	16	92,368	12	53,112	334	350,004	14	46,184	35	40,633
Darashakan Res	5,450	10	16,648	1	3,270	0	1,880	12	12,391	0	1,635	1	1,438
Darashakan MixedUse	7,250	14	22,147	1	4,350	1	2,501	16	16,483	1	2,175	2	1,914
Rashwan Res	7,550	14	23,063	1	4,530	1	2,605	16	17,165	1	2,265	2	1,993
Rashwan Mixed	950	2	2,902	0	570	0	328	2	2,160	0	285	0	251
Mandawa Core	6,375	12	19,474	1	3,825	1	2,199	14	14,494	1	1,913	1	1,683
Mandawa MixedUse	2,850	5	8,706	0	1,710	0	983	6	6,480	0	855	1	752
Mandawa Residential	2,425	5	7,408	0	1,455	0	837	5	5,513	0	728	1	640
	335,697	630	1,025,468	35	201,418	27	115,816	729	763,222	30	100,709	76	88,605

Source: JICA Project Team

2) Public Facilities Planning & Implementation Improvement Measures

Availability, accessibility and affordability remain the 3 basic factors to take into account when planning for public facilities in an urban context.

Availability:

(a) Prioritizing public facility planning: Public facilities are a major constituent of any urban development. Planning for public facilities is fundamental to creating livable, inclusive, and sustainable urban environments that meet the diverse needs of residents, support economic prosperity, and enhance the overall quality of life in cities. Homogeneous developments, mostly residential, had proved to attract less users and to enhance a sense of isolation and unsafety.

(b) Advance planning: Planning for public facilities in advance allows cities to anticipate and accommodate population growth. By projecting future demand for services and infrastructure, planners can avoid shortages, overcrowding, and service disruptions as the population expands. By incorporating long-term considerations into the planning process, cities can save time and money by avoiding the need to retrofit or expand facilities later to meet increased demand.

(c) Up-to-date indicators and tailored standards are essential tools in planning for public facilities in a city as they provide measurable criteria and benchmarks to guide decision-making, assess performance, and ensure quality and efficiency in service delivery.

Universal norms offer a generalized idea. The more accurate the norms, the better they respond to the needs of the inhabitants and their social, economic and geographic specificities.

(d) GIS data base and planning tools: Geographic Information Systems (GIS) play a crucial role in public facilities planning in cities by providing spatial analysis tools and data visualization capabilities. GIS not only maps existing facilities; it may also assess their distribution and services and pinpoint and locate weakness.

By creating a unified digital database of all the public facilities, with all the related data including areas, number of users, services… the planning process would rely on real understanding of what exists and where. The future facilities will be implemented based on geographical needs as well as users' needs and type of facilities. For instance, by creating a mapped data base of primary schools, a new detail plan might not need to add one. Instead, its public facilities will be directed to fill the existing gaps of services within its surrounding.

GIS can also support emergency planning and response efforts by mapping critical infrastructure, evacuation routes, access to needed facilities, vulnerable populations, and resources. It enables authorities to make informed decisions during emergencies and coordinate response efforts effectively.

In parallel, GIS-based maps and interactive tools can facilitate community engagement and participation in public facilities planning by providing residents with visualizations of proposed projects, collecting feedback, and incorporating community preferences into decision-making processes.

Accessibility:

(a) The 15-minue city

The concept of the "15-minute city" is an urban planning idea that aims to create neighborhoods or urban areas where residents can access all of their daily needs within a 15-minute walk or bike ride from their homes. The main objective is to reduce reliance on cars, decrease commute times, promote sustainability, and improve quality of life.

The core of the 15-minute city is mixed-use neighborhood, where people can access live, work, access services such as education, health, recreation and others by walking or biking mostly, without the need for long rides. In practice, some services are ideally reachable within 5 minutes' walk or ride, especially by children and elderly. Other functions can be gradually located within 10, 15 and even 20 minutes radius, based in the frequency of their access and the age bracket of their users.

Harsh weather condition, specifically in summer, makes it harder to reach this goal. To overcome these challenges, it will be necessary to invest in infrastructure to support walking and biking, such as bike lanes, sidewalks, and pedestrian crossings.

This did not stop cities like Riyadh from creating a number of 15-minute neighborhoods. In parallel, the line, the most futuristic project of the Kingdom of Saudi Arabia holds many qualities of the 15-minute city.[8]

Aiming for a 20-minute city as a first step, by a defined percentage of the inhabitants is what Dubai, a city with similar weather conditions is aiming for. In its vision for 2040, the city of Dubai is "aiming to put 55% of the residents within 800 meters of mass transit stations, allowing them to reach 80% of their daily needs and destinations."[9]

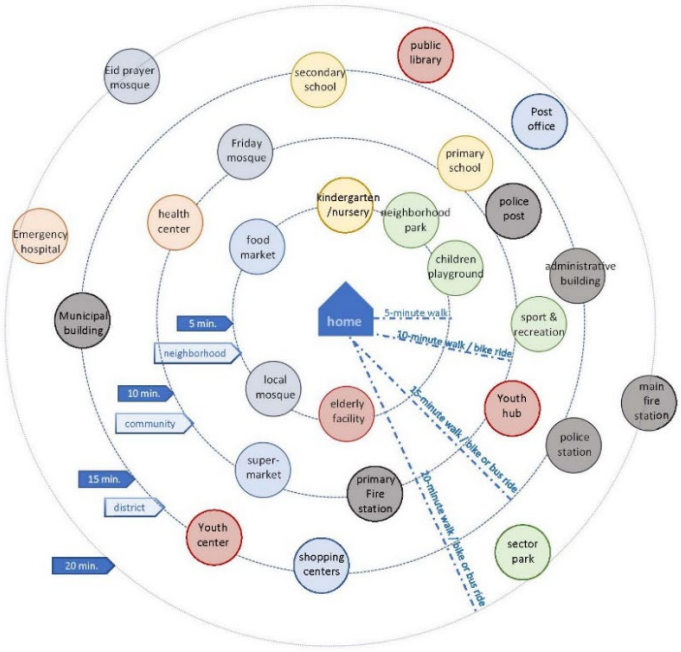
Implementing mixed-use development is the first step towards reaching the 15-minute city.

Moving towards the 15-minute city in Erbil is possible. The concept although newly promoted is the reality of the oldest cities including Erbil. New neighborhoods may be designed with a mixed-use approach, where services are at proximity to the residences. Equally important is connecting the communities to public transportation nodes, to allow ease of movement with minimal reliance on cars.

By also reviewing existing neighborhoods, measures can be applied to create well served communities. Densification, filling the gaps in public facilities and connecting to public transport are some of the steps towards the goal.

The concept of the 15-minutes city doesn't negate the importance of connecting at a broader scale. Infrastructure for regional and international mobility, including highways, railways, and airports, continues to be vital and should be easily reachable from pedestrian-friendly neighborhoods.

[8] https://omrania.com/insights/the-15-minute-city-balancing-ancient-and-modern-mobility/
[9] http://dubai2040.ae/en/projects-and-initiatives/the-20-minutes-city/



Source: JICA Project Team

Figure 9.3.6 Erbil 2050 MP 15-minute City Diagram

(b) Easy access, safe access and impact on traffic flow should be considered when allocating public facilities. Some large facilities such as hospitals, university and secondary schools need to be on main streets for easy access, also locating facilities close to public transport make them easily accessible to a larger portion of the population, including pedestrians, cyclists, and public transit users.

On the other hand, Facilities situated on streets with lower traffic volumes and lower speeds are generally safer for pedestrians, particularly children and elderly.

Public facilities can influence traffic flow and congestion patterns in surrounding areas. Placing facilities near major arterial roads or intersections may increase traffic volumes and congestion, especially during peak hours. On the other hand, locating facilities in areas with good connectivity and access to alternative transportation modes can help distribute traffic more evenly and reduce congestion.

Overall, the location of public facilities in relation to streets, their width, and traffic patterns plays a significant role in determining accessibility, safety, traffic flow, parking, pedestrian connectivity, and transit access. By carefully considering these factors in the planning and design of public facilities, cities can create vibrant, livable, and sustainable urban environments that meet the diverse needs of residents while promoting safety, efficiency, and accessibility for all.

Affordability:

(a) Fund the construction, maintenance and operation of the governmental facilities
(b) Maintain a good ratio of public and free public facilities, especially in the health and educational sectors
(c) Encourage public private partnerships for affordable education and healthcare

Additional urban planning measures and considerations elevates the urban experience and put the public facilities at the service of the citizens:

(a) Order levels and scale:

The notion of high to low order is a major dimension in the planning of public facilities. The concept is detailed in the Iraqi standards but not faithfully applied on ground in Erbil.

- Higher-order public facilities function at the national and international scales They are planned at the level of the city as indicated in MP2050 and in the related strategies.

- Middle and low and intermediate orders are applied on facilities in relation to the number of people they serve and geographic extent they are expected to cover, as seen in the tables of this development plan. This incremental dimension is necessary to serve the citizens within their precincts, their neighborhoods, their district and their city. For instance, implementing sport cities and national stadiums should come in parallel to setting up district scale sport clubs, neighborhood football courts and precincts play areas.

(b) Compatibility matrix: Interrelationship between public facilities

The allocation of public facilities on the detailed plan or larger scale planning, should take into account the level of compatibility between these facilities. Noise, pollution, traffic and safety are among the measures affecting the relation between facilities and the need to join or separate them.

The diagram below 3 levels of compatibility between each 2 types of public facilities: compatible, neutral and incompatible. As an example, a youth center is incompatible with a fire station, has a neutral relation with a post office and can mix nicely with a library or a youth center.

		SECURITY				RELIGIOUS		CULTURE			SPORT					EDUCATION					HEALTH		
	O Compatible Δ Neutral X Incompatible	ADMINISTRATION	POST OFFICE	POLICE STATION	FIRE STATION	CEMETERIES	MOSQUE | CHURCH	LIBRARY	CULTURAL CENTER	YOUTH CENTER	STADIUM	SPORT COURT	SPORT FIELD	PLAY AREA	KIDS AREA	UNIVERSITY	VOCATIONAL SCHOOL	SECONDARY SCHOOL	PRIMARY SCHOOL	NURSERY/ KINDERGARTEN	HOSPITAL	CLINIC	HEALTH CENTER
HEALTH	HEALTH CENTER	O	Δ	Δ	X	X	O	O	O	O	X	Δ	Δ	O	O	Δ	Δ	Δ	Δ	O	O	O	O
	CLINIC	O	Δ	X	X	X	Δ	Δ	Δ	Δ	X	X	X	X	X	Δ	Δ	Δ	Δ	O	O	O	
	HOSPITAL	Δ	X	X	X	Δ	Δ	Δ	Δ	Δ	X	Δ	Δ	Δ	Δ	Δ	Δ	X	X	O	O		
EDUCATION	NURSERY/ KINDERGARTEN	O	X	X	X	X	Δ	O	O	Δ	X	Δ	Δ	O	O	Δ	Δ	O	O	O			
	PRIMARY SCHOOL	O	X	X	X	X	Δ	O	O	Δ	Δ	O	O	O	O	Δ	O	O	O				
	SECONDARY SCHOOL	O	X	X	X	X	Δ	O	O	Δ	Δ	O	O	O	O	Δ	O	O					
	VOCATIONAL SCHOOL	O	X	X	X	X	Δ	O	O	O	O	O	O	Δ	Δ	O	O						
	UNIVERSITY	O	X	X	X	X	Δ	Δ	Δ	O	O	O	O	Δ	Δ	O							
SPORT	KIDS AREA	Δ	X	X	X	X	O	O	Δ	O	Δ	Δ	O	O	O								
	PLAY AREA	Δ	Δ	Δ	X	X	O	O	O	O	Δ	O	O	O									
	SPORT FIELD	Δ	Δ	Δ	Δ	X	Δ	Δ	O	O	Δ	O	O										
	SPORT COURT	X	X	X	X	X	Δ	Δ	O	O	Δ	O											
	STADIUM	X	X	X	X	Δ	X	X	X	Δ	O												
CULTURE	YOUTH CENTER	Δ	Δ	Δ	X	X	O	O	O	O													
	CULTURAL CENTER	Δ	Δ	Δ	X	X	O	O	O														
	LIBRARY	Δ	Δ	Δ	X	X	O	O															
RELIGIOUS	MOSQUE | CHURCH	X	X	X	X	O	O																
	CEMETERIES	X	X	X	X	O																	
SECURITY	FIRE STATION	O	Δ	X	O																		
	POLICE STATION	Δ	O	O																			
	POST OFFICE	O	O																				
	ADMINISTRATION	O																					

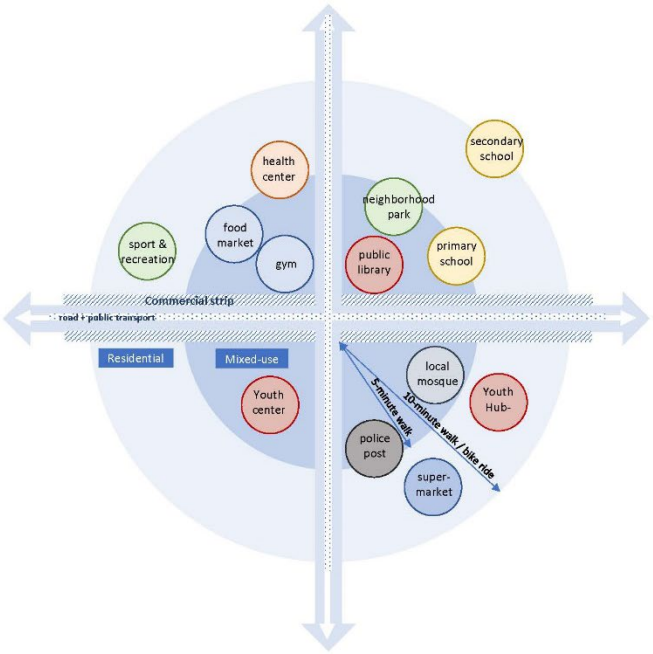
Source: JICA Project Team

Figure 9.3.7 Public Facilities Compatibility Diagram

i) Densification at Central Hubs: create Hubs of activities and social interaction in town centers and new development primary and secondary cores. The new centers act as a connector between the residential districts usually developed as private "villages" or as "detailed plans". High density, overlap to public transport, pedestrian priority, integration of open space and greenery are some of the characteristics of the proposed central hubs.

ii) Overlay zoning at Intersections Hubs: compensate for the lack of public facilities within existing neighborhoods by creating community hubs at the intersections of the neighborhoods. If adding facilities within the neighborhoods is not an option, the focus may be the intersections of neighborhoods (or detailed plans). Transforming the intersection of the different plans into a concentration of facilities would compensate the lack within the neighborhoods but also act as a connector on social and economic levels.

iii) By superimposing overlay zones over the established zoning at intersections, we can impose supplement restrictions, permit or disallow various forms of density as well as provide bonuses and incentives by allowing land-use change and addition on floors to achieve the desired planning intent for that particular area, to initiate these activities hubs. In the case of Erbil, the aim of the overlay zones is to densify the intersections and initiate more facilities targeting the public needs These hubs would be more activated when studied to overlap with public transport.



Source: JICA Project Team

Figure 9.3.8 Facilities Clustering in Cores

iv) Sustainably in Public facilities planning.

By creating well served neighborhood where citizens can walk or bike to work, school, shops, and other services, we can reduce the need for cars. Such measure not only reduce the carbon dioxide emission, but also promote physical activity, which is an important factor in maintaining good health and general wellbeing.

Sustainable cities also have local businesses set up shop in these neighborhoods, creating vibrant and diverse communities.

At the level of design and construction, the buildings of the public facilities can be the first prototype of self- efficient, low emission architecture. Design decisions such as building orientation, size of fenestrations, material selections, constructions approaches, maintenance and operation can all be directed to create sustainable buildings with long-term positive ecological, economic and social impacts.

CHAPTER 10
GREEN AREA PLANNING

10.1 Existing Situation of Green Area Planning

10.1.1 Existing Conditions of Green Areas

Urban green spaces, such as forests, parks, gardens, and public areas, play a vital role in enhancing the livability and sustainability of cities. They offer a lot of advantages, including purifying air, mitigating the urban heat island effect, fostering mental well-being, and preserving biodiversity. Despite their significance, urban green spaces face threats from development and other pressures, underscoring the necessity for prioritizing their preservation and creation through strategies like zoning, community engagement, and public-private partnerships. Recognizing the importance of green spaces and taking proactive steps to plan, protect and promote them can transform cities into more resilient and vibrant environments, benefiting both inhabitants and ecosystems.

Green spaces may be natural environments or man-made and can take different forms and scales. On the planning level, large scale green areas are strategic and are reflected in the masterplan. Smaller scale green spaces are a combination of urban design practices and planning standards. They are reflected in policies and at the level of detailed plans.

Green space planning is particularly crucial for Erbil due to its rapid urban growth, climatic conditions, historical significance, and the need to address risks such as flooding and drought. Preserving and expanding green areas help mitigate urbanization impacts, provide climate regulation, maintain cultural heritage, and enhance residents' well-being. Additionally, green spaces serve as natural buffers against flooding, aid in groundwater recharge during droughts, and mitigate soil erosion and heatwaves, thus promoting urban resilience and sustainable water management.

The government along recent years have tried to implement a number of regulations to mitigate the effect and plan the green aspect at the level of the overall city and at the level of the new developments.

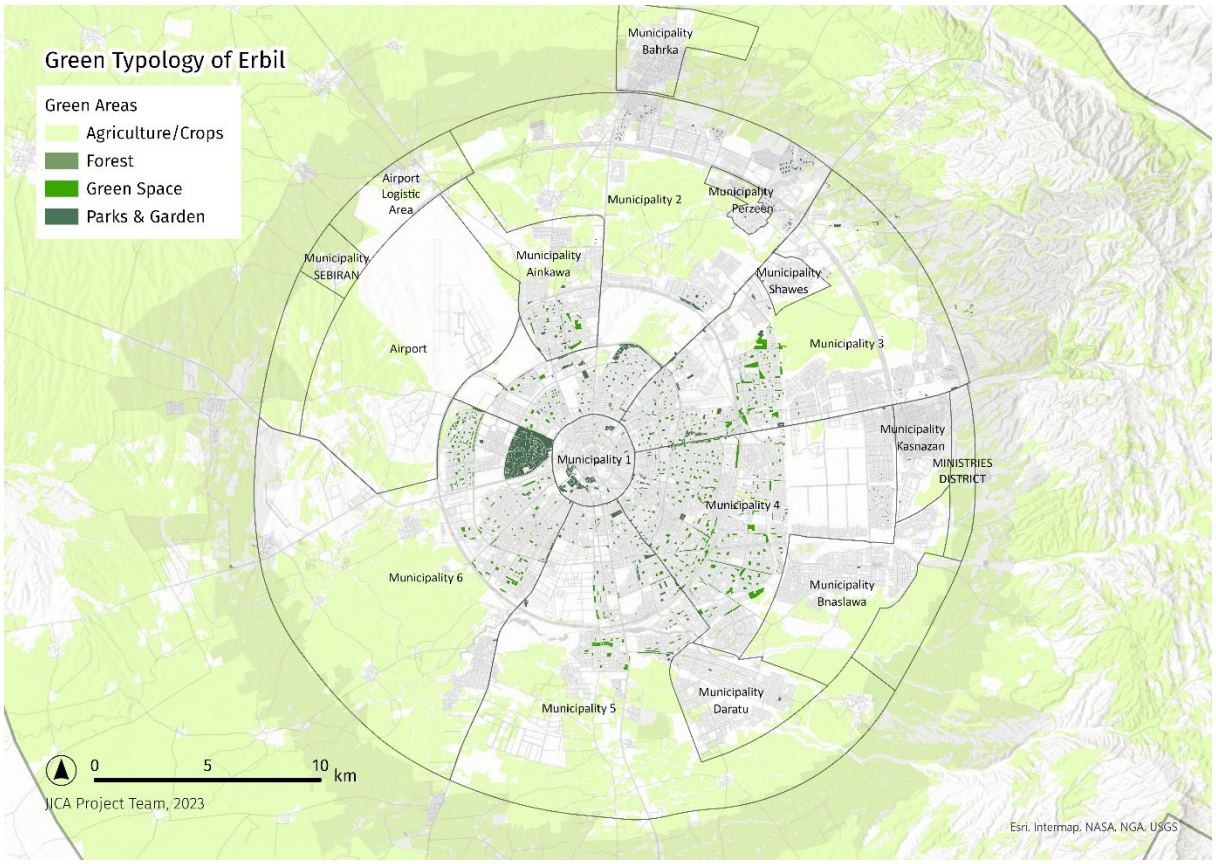
By understanding the current condition of the green areas as well as the provision and planning for future ones, we aim to draw a tangible plan for the implementation of this crucial dimension in the overall planning of Erbil, as a main constituent of Erbil MP 2050.

(1) Distribution of Green Areas in Erbil

According to the data provided by the Directorate of Planning and Management of Green Areas and Parks of Presidency of Erbil Municipality, the total area of urban green areas of Erbil is 8.11 km2. This figure corresponds well to the total area of the two classes of parks & gardens (4.16 km2) and green spaces (4.07 km2) that were extracted in existing Land Use Land Cover data created in the scope of our Project (see Section 2.4.2). Figure 10.1.1 shows the distribution of the different types of green areas of Erbil, within the boundaries of the municipalities.

In a publication by the MOAWR[1], the vegetation ratio in Erbil governorate is equal to 9.05% of the total land area. In the district of Erbil that has an area of 553 km2, 40 km2 is occupied by vegetation, corresponding to a ratio of 7.23%.

[1] Mapping and Estimating Vegetation Coverage in Iraqi Kurdistan Region using Remote Sensing and GIS, in 2015



Source: Existing Land Use Land Cover, JICA Project Team

Figure 10.1.1 Distribution of Green Areas in Erbil

Comparing the area of green spaces to the existing estimated population of the Project Area of 1,861,870 (see Section 4.3), the per capita green area is thus of 4.35 m^2 per capita, which is less than 50% of the minimum of 9 m^2 per capita recommended by World Health Organization (WHO) and far behind major international capitals of London (14 m^2), Paris (15 m^2), Tokyo (33 m^2) or Vienna (45 m^2).

In addition, only a few portion of the lands designated as green area in the Land Use Land Cover data are actually implemented and maintained green areas in reality. This is specifically observed at the level of medium and small-scale parks and gardens (see Section 10.3.1).

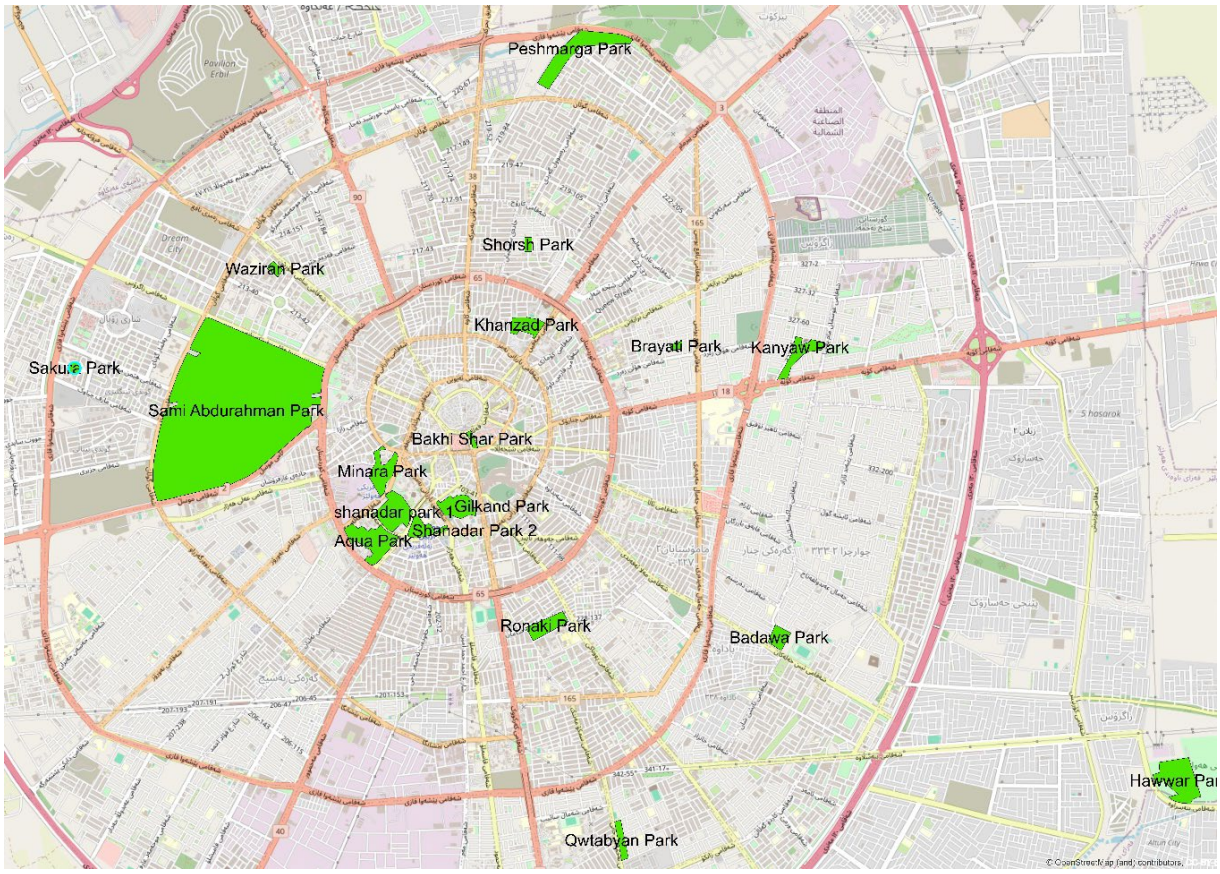
Table 10.1.1 and Figure 10.1.2 detail and illustrate the major public parks in Erbil City.

Table 10.1.1 Major Parks in Erbil

No	Municipality	Park Names	Area (m2)
1	**1**	Shanadar park 1	96,205
2		Shanadar Park 2	43,287
3		Minara Park	69,970
4		Khanzad Park	48,424
5		Gilkand Park	66,354
6		Aqua Park	112,453
7		Bakhi Shar Park	8,362
8	**2**	Shorsh Park	10,660
9		Waziran Park	13,306
10		Peshmarga Park	141,651
11	**3**	Kanyaw Park	60,201

No	Municipality	Park Names	Area (m2)
12		Brayati Park	8,393
13	**4**	Badawa Park	33,417
14		Hawwar Park	136,078
15	**5**	Qwtabyan Park	27,492
16		Ronaki Park	55,100
17	**6**	Sami Abdurahman Park	2,037,583
18		Sakura Park	11,205
Total			2,980,140

Source: Existing Land Use Land Cover, JICA Project Team



Source: Existing Land Use Land Cover, JICA Project Team

Figure 10.1.2 Major Parks in Erbil

Parks and gardens are the dominant typologies of green spaces within the city of Erbil. Other available typologies are street landscapes and private gardens, pertaining to residential, institutional and commercial projects.

Forests also exist in Erbil province. There are 22 other artificial forests in Erbil province, built on 8,346 dunams of land. Kasnazan forest is situated in eastern Erbil and was planted in 1998 on 840 dunams of land. It contains a total of 60,000 trees of various kinds, including pine trees. Further out and on the west side of the city center is located Khabat forest, cut by the Erbil-Mosul Road.

In parallel to its green scape, Erbil, limited to the west by the Zab River, has a number of streams and water canals.

Ponds and dams have been created for water storage and irrigation. In parallel to their utilitarian dimension, they are a destination by visitors for recreation and water sport activities.

Source : https://www.kurdistan24.net/en/story/34646-Felaw-Pond,-a-scenic-haven-for-tourists-in-Kurdistan

Figure 10.1.3 Felaw Pond outside the City of Erbil

(2) Legal & Institutional Framework of Green Area Planning

1) Legal Framework

The planning norms for parks and green areas are stipulated in Iraqi housing standards 2010 -2018 and in Law No 12/ 883 2012 from Kurdistan Regional Government Presidency of the Council of Ministers, Environmental Protection and Rehabilitation Board Office of Artistic Affairs.

Based on the reading of the Iraqi urban and rural standards, there is no much data or guidelines for urban green areas. The law designates 4 scales of urban open spaces without defining green footprint and nature. These open spaces overlap with public facilities sport and recreational areas.

In a letter dated 11/04/2021, the Ministry of Municipalities and Tourism informed the municipalities that 25% of the area in residential plans should be green. It also imposed on investment projects that 25 to 30% of the project area must be dedicated to green areas. GDUP mentioned that in some cases this percentage of green areas is not achieved and investors are requested to compensate by creating gardens in different locations.

In the case of a commercial or industrial project, three rows of evergreen tree lines must be planted around the project area and tree lines of trees must be planted within all the streets inside the project area.

- **Law no. (8) for (2008) Environmental Protection and Improvement in Kurdistan Region – Iraq**, part of the Environmental general legislations issued in Kurdistan Region

  The goal of this law is to achieve the following purposes: First: Maintaining the environment of the region, protecting, improving, developing and preventing it from pollution. Second: Protection of nature and public health from dangerous activities and harmful works to human and environment. Third: Maintaining and developing the natural resources, and rationing their utilization. Fourth: Making the environmental policy a part of general planning of the development in all respects (humanity, industrial, agricultural, urban, tourism fields and others). Fifth: Raising the level of environmental awareness, and establishing individual and community responsibility to environmental protection and improvement and encouraging the voluntary efforts in this field.[2]

- **Act of Forests in Kurdistan Region of Iraq, number 10 of 2012**

  This law aims to: First: maintain stability, natural balance, manage and organize forests and increase the areas. Second: improve the environment; reduce impact of climate changes and

[2] http://www.natureiraq.org/

maintain the environmental diversity. Third: provide of some raw materials required by industry. Fourth: encourage agricultural investment in the field of forests. Fifth: maintain the natural varieties of plants and keep their genetic origin in Kurdistan. Sixth: provide tourism areas. [3]

- **Law (4) of 2021, article 15, section 3** defines a buffer zone of 10 to 20 m for the protection of water stream. The law also sets a minimum distance from water streams to different types of construction as well as a list of fines for any transgressions over the water property.
- **Local Climate Change Adaptation Plan for Kurdistan Region – Iraq**

  November 2023, Environmental Protection and Improvement Board (EPIB) – KRG With UNDP Includes in its Adaptation Action Plan the 2 following sectors, directly related to green areas:

  Biodiversity and Ecosystems:

  1) Establish protected areas and wildlife corridors to conserve biodiversity and support ecosystem services.
  2) Implement reforestation and afforestation programs to restore degraded landscapes and enhance carbon sequestration.
  3) Promote sustainable land and forest management practices, including community-led conservation initiatives.

  Cross Cutting: Ecosystem-Based Adaptation:

  Water Resilience Enhancement through nature-based solutions.

2) Institutional Framework

Different governmental entities play a role in the planning, the implementation and the management of the green areas within the city of Erbil:

General Directorate of Urban Planning (MoMT) is responsible for planning and developing green areas within the city as a holistic strategy. This includes green area planning and design, determining appropriate land use, creating and enforcing zoning regulations, and implementing green space development projects. UPDOE, under MoMT plans green areas within the detailed plans - mostly residential - and ensure the same application by external consultants. UPDOE is aiming to apply a 25 % green footprint on the future detailed plans.

The ultimate goal is to ensure sustainable and equitable provision of green areas for the benefit of the environment and community.

Directorate of Forestry and Horticulture in Erbil city (MoAWR) plays a crucial role in managing and preserving the city's forest resources and horticulture development. Its responsibilities include forest protection and reforestation, horticulture development through the creation of gardens and green spaces, beautifying the city through landscaping, managing urban forests, tree planting, providing environmental education to the public, and monitoring and evaluating its programs. The ultimate goal of the Directorate is to promote the sustainable use of natural resources, protect the environment, and improve the quality of life for residents of the city;

Generate Directorate of Water Resources (MoAWR) is responsible for planning, monitoring, and managing water resources for green areas. This includes providing irrigation water, monitoring surface and groundwater levels, designing and maintaining irrigation systems, managing drainage systems, monitoring water quality, promoting water conservation, and responding to water-related emergencies;

Directorate of Planning and Management of Green Areas and Parks under the **Presidency of Erbil Municipality (MoMT)** is responsible for creating, maintaining, and managing parks and green spaces in the area. It covers various aspects, including identifying suitable locations for parks, developing plans for their creation and management, maintaining parks and facilities, environmental planning, community engagement, event planning, budgeting, resource management, and monitoring and

[3] http://www.natureiraq.org/

evaluation. The aim is to provide safe and accessible green spaces for residents to enjoy while ensuring that the development and control align with environmental protection goals and promote sustainable development. Community engagement is a crucial aspect of the Directorate's work, as it involves the community in identifying their needs and priorities and ensures that they are involved in the planning and managing parks and green spaces;

Board of Environmental Protection and Improvement, regarding green areas, ensures that the board effectively conserves and protects these areas, including developing and implementing policies, monitoring and assessing environmental impacts, controlling invasive species, and monitoring wildlife diversity and protection.

(3) Ongoing Project in Green Area Planning:

1) Million Oak Tree Project by 2025

The Million Oak Tree Project by 2025 project is initiated in 2020 by Hasar Organization in partnership with Rwanga Foundation, and in collaboration with Kurdistan Regional Government, with the support of the city's Ministry of Municipalities and Tourism. The project aims at planting one million trees as a response to the destruction of many forests in KRI and to adapt to climate changes. A part of the project is to plant the median street of the 120-meter road. Also, in terms of connecting the whole green urban network, this 7.5 m green tunnel consists of tree lines, groups, lawns, and vegetation. The first phase of implementation begins from Koya road to Pirmam road. Planting species are divided into three groups of species: oak species (Quercus brantii) as a foundation forest (approx. 80%). Then to enhance biodiversity, there will be trees from native fruit trees and other native trees (approx. 15%). Also, there will be trainer trees from native fast-growing species (approx. 5%).

Source: JICA Project Team based on Hasar Foundation

Figure 10.1.4 Million Oak Tree Project by 2025 Plantation Distribution

According to the Department of Media and Information of the Governorate of Erbil, 300,000 oak trees were already planned by November 2023[4].

[4] https://gov.krd/dmi-en/activities/news-and-press-releases/2023/november/planting-a-million-oak-trees-in-erbil-a-green-initiative-in-progress/

Source : https://www.kurdistan24.net/en/story/29696-Over-100-million-trees-set-to-be-planted-in-Erbil-by-2030

Figure 10.1.5 A Number of Youths are Planting Trees in Masse in Erbil

2) 100 million oak trees in Erbil province:

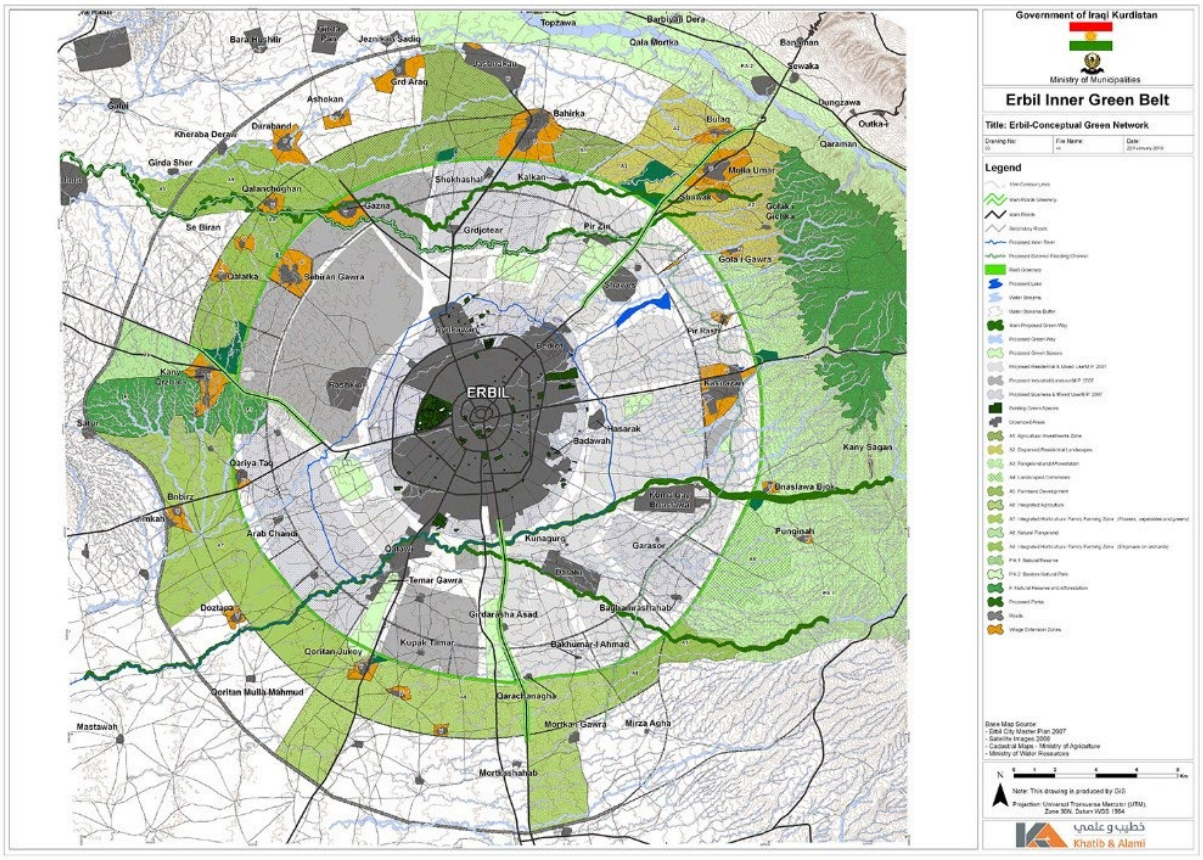
The 100 million oak trees in Erbil province project was announced in 2022 by the MoMT: 100 million trees are set to be planted in Erbil province until 2030. The project described as a "strategic" green scheme will also be implemented in collaboration with Hasar Organization with Rwanga Foundation and the sponsorship of private companies. "With regard to the irrigation of the planted trees, the Organization uses recycled water through a project they had established near a planting site in Erbil."[5]

10.1.2 Review of Inner Green Belt MP (IGBMP)

(1) Context and Outline of Inner Green Belt MP (IGBMP)

Erbil 2030 MP, which was mostly focused on the planning of urban expansion areas, industrial zones, infrastructure and public facilities, did not put much emphasis on planning the development of more green areas, expect for some parks which are mentioned in Section 3.8.3. However, a round-shape Inner Green Belt as well as an Outer Green Belt were designated in the Land Use Layout (see Section 3.3.1) of Erbil 2030 MP, but without much details on the objectives and policies.

[5] https://www.kurdistan24.net/en/story/29696-Over-100-million-trees-set-to-be-planted-in-Erbil-by-2030



Source: MoMT

Figure 10.1.6 Erbil Inner Green Belt Master Plan Land Use Plan

In order to give details and to assess the feasibility of this intention, Inner Green Belt Master Plan was elaborated from 2009 by the Lebanese company Khatib & Alami, with the goals of (1) preservation of the natural and rural environment, (2) avoidance of urban sprawl, (3) providing opportunities for recreational activities to meet current and future needs, (4) preservation of agricultural land and promotion of agriculture and (5) encouraging fruit trees and afforestation. The final report of Inner Green Belt MP was submitted to the MoMT in May 2010, and the plan was approved more than 2 years later, on October 7, 2012, in accordance with the provisions and amendments of Section 25 of Law No. 6 of 1993.

(2) Boundaries of Inner & Outer Green Belts

Inner Green Belt MP has modified and improved the boundaries of the Inner Green Belt that were originally planned in Erbil 2030 MP, but the Outer Green Belt and lungs boundaries have been left unchanged. The major criticism addressed in Inner Green Belt MP regarding the boundaries proposed in Erbil 2030 MP is that (1) it intersects a lot of urban settlements, (2) it does not take into consideration the detailed land morphology and then, as a conclusion, it proposed that boundaries should be defined according to more detailed studies. This comment is not only valid for the Inner Green Belt boundaries, but also for the Outer Green Belt and for lungs boundaries, which are similarly designed without taking into account the reality on the field.

(3) Review of Inner Green Belt MP Implementation

Based on the same methodology that was used for reviewing the contents and implementation status of Erbil 2030 MP (see Chapter 3 Introduction), the following paragraphs and tables shows the results of the review of Inner Green Belt MP.

As a general comment, it must be pointed out that almost no policy or project contained in Inner Green

Belt MP has been properly implemented to date. Regarding policies and legal aspects proposed in terms of zoning and construction regulation, none of them has been integrated in actual binding urban planning documents such as Detailed Plans. Regarding the lack of implementation of proposed projects, this is mainly due to the fact that the implementation of this plan is relying almost totally on new greening and tree planting, which means on novel public or private investments. As mentioned above, the boundaries do not consider existing green areas and basically only designates barren areas to be planted and landscaped. Worldwide green belt planning experiences shows the importance of considering existing farmlands and green areas, and to mobilize local communities for implementation. Creating new green spaces from scratches requires significant investments in land acquisition, soil preparation, and vegetation establishment.

Tables 10.1.2, 10.1.3 and 10.1.4 shows the result of review projects planned in IGBMP.

Table 10.1.2 Review of Landscape & Forestation Projects in IGBMP

Project in Inner Green Belt MP (2012)	Implementation Monitoring Score*		Changes in conditions (2006-2022)	Recommendation for Erbil 2050 MP Integration**	
West hills forestation	**NI**	Not started.	N/A	**Partial**	West Hills forestation overlaps with the west Ground Recharge zone. Forestation area will be partially reduced.
East hills forestation	**NI**	Not started.	N/A	**Partial**	Due to its importance regarding urban green infrastructure as a primary natural green element, Erbil 2050 MP pursues this project. The boundaries of the proposed forestation area will be reduced, with a more condensed canopy.
North Green Way	**AB**	Not started	Many destructions and obstructions have been done on the planned river bed.	**Discontinued**	Unfortunately, many areas have been blocked and destroyed on main natural streams of rainwater. Erbil 2050 MP will not be able to complete this proposal but insists on regaining the 20 meters buffer on both sides on the water body.
South Green Way	**NI**	Not started	Many destructions and obstructions have been done on the planned river bed.	**Partial**	The south greenway is almost passing through urban residential areas that could be developed to integrate activities and preserve natural and semi-natural plantations. 2 large scale detailed plans projects include linear green areas. The planned Qatawi park and the proposed train station are main stops along the greenway. Additional linkages along the water ways and the street scape will be needed to create an uninterrupted linear connection extending to the southern east and west parts of the GB.
Cadastral shelterbelts	**NI**		The villages are expanding and the climatic and environmental conditions are worsened.	**Complete**	The proposed permeable “lattice” of trees (10 -15 m width) provides effective sheltering from cold north west wind and dusty south west wind, while limiting the expansion of the villages.
Agriculture shelterbelts	**NI**			**Complete**	Planting 1 or 2 rows of trees along the boundaries of the farmer parcels, fence and define the property and also serve as wind shelter.
Village peripheral	**NI**			**Complete**	Also known as agroforestry, they

Project in Inner Green Belt MP (2012)	Implementation Monitoring Score*		Changes in conditions (2006-2022)	Recommendation for Erbil 2050 MP Integration**	
shelterbelts					integrate tree growing with crop and livestock production. They serve the villages by improving the environment, limiting expansion and supplementing local livelihoods.
Village heritage trail	**NI**			**Complete**	A network for rural tourism, connected to the proposed agro-nodes.
Landscaped road amenities (1): Main radial roads on RR8	**PI**	Some section of Pirman road have been planted.	N/A	**Complete**	In terms of linkage of the Green Belt to the inner city's amenities and green areas, they are pretty crucial regarding biodiversity and they have a high environmental value. Therefore, Erbil 2050 MP pursues this project.
Landscaped road amenities (2): Secondary Road network	**NI**	Not started.	Villages expanded and some grew to become small towns.	**Complete**	The project should make sure to reduce the existing inner road network to the exact need, in order to connect the villages within GB. In parallel, the proposed low edges along the road verge may be implemented. In parallel to their scenic character, the hedges are a natural fence against trespassing and a valuable wildlife habitat.
Landscaped road amenities (3): Gateways along Salaheddin, Kirkuk and Mosul roads	**PI**	Started on Pirman road.		**Complete**	Acting as virtual portals to the city, the 3 main roads should be highlighted through a distinct landscape of exceptionally ornamental trees, with seasonal colors.

Source: JICA Project Team

Note: (*) **FI**: Fully implemented, **IO**: Implementation ongoing, **NI**: Not implemented, **PI**: Partially implemented not ongoing, **AB**: Abandoned.

(**) **Complete**: Full integration to Erbil 2050 MP is recommended, **Partial**: Partial integration, **Discontinued**: No integration, **TBS**: Integration to be further studied.

Table 10.1.3 Review of Recreational Activities Projects in Inner Green Belt MP

Project in Inner Green Belt MP (2012)	Implementation Monitoring Score		Changes in conditions (2006-2022)	Recommendation for Erbil 2050 MP Integration	
Rest areas (15)	**NI**	Not started.	N/A	**Complete**	The rest areas will be a necessary stop along the bike lane, on the inner side of the inner green belt. They may include shaded resting spots, a water fountain and a public toilet.
Kasnazan Park	**NI**	Not started.	Some parts are overlapping with the existing zoo.	**Partial**	A new boundary is needed for the park to sit between the zoo and the forest.
Bnaslawa Park	**NI**	Not started.	N/A	**Complete**	This park should be implemented in its location. In parallel, the

Project in Inner Green Belt MP (2012)	Implementation Monitoring Score		Changes in conditions (2006-2022)	Recommendation for Erbil 2050 MP Integration	
					existing Bnaslawa park is being expanded.
Qoritan Jukoy Park	NI	Not started.	N/A	**Complete**	Erbil 2050 MP pursues this proposition, in the holistic perspective of enhancing all green areas of Erbil city.
Bahirka Park	**NI**	Not implemented & replaced	Some parts of the park changed and built up for residential purposes.	**Discontinued**	This park cannot be implemented but new green areas are proposed in nearby detailed plans,
Sherwana Park	**NI**		Some parts overlap with an approved Detailed plan. However, the detailed plan might be reviewed due to the allocation of an administrative zone.	**Complete**	This park should be implemented in its location – even if it walls within or adjacent to an administrative zone.
West Gateway Park (Mosul Road)	**NI**	Not implemented.	Designated land is partially occupied by another land use (military compound)	**Partial:** Replaced by a new proposal inside GB	The new proposed location is across the ringway from the old location, inside the GB. Since it overlaps with the ground water recharge zone and the airport property, it will not adopt the land use of the old gateway.
South Gateway Park (Kirkuk Road)	**NI**	Not implemented	Urbanized by industrial warehouses	**Complete** (once illegal industrial warehouses are removed**)**	Planned to become a crucial part of the Green Belt as a recreational activity for sustainable development, the area was designated for sports, exhibitions, and services, and marked the entrance to the city to the South on Kirkuk Road. Erbil 2050 MP pursues this proposition by proposing to develop a park in the surrounding of South Sports Complex (PBF-S1-2-2).
Bastora Gateway Park (Salahedin Road)	**NI**	Not started.	Some part is encroached by developments.	**Partial:** smaller boundary + change in the	Erbil 2050 MP pursues this proposition with

Project in Inner Green Belt MP (2012)	Implementation Monitoring		Changes in conditions (2006-2022)	Recommendation for Erbil 2050 MP	
	Score			Integration	
				program.	changes. The golf course will be replaced by a park. The hippodrome will be moved to replace the open-air theatre.

Source: JICA Project Team

Note: (*) **FI**: Fully implemented, **IO**: Implementation ongoing, **NI**: Not implemented, **PI**: Partially implemented not ongoing, **AB**: Abandoned.

(**) **Complete**: Full integration to Erbil 2050 MP is recommended, **Partial**: Partial integration, **Discontinued**: No integration, **TBS**: Integration to be further studied.

10.1.3 Key Planning Issues

(1) Key Planning Issues to be considered in Erbil 2050 MP formulation

A number of planning issues create a challenge towards the formulation of Erbil 2050 MP in general and specifically in the field of planning and management of the green areas. The key issues can be summarized as follows:

1) Low green footprint, compared to norms and to international cities: The green footprint of the city of Erbil is below the minimum requirement by WHO, for a healthy and clean urban context.
2) Unbalanced coverage of green areas over Erbil's urban extent: The distribution of the existing green area is not spread equally among the different parts of the city.
3) Lack of comprehensive planning of green areas in Erbil;
4) Lack of major forest or green belt at the large metropolitan scale. While forests are very present in the countryside of Kurdistan, Erbil the city has a major lack of dense forestry.
5) Lack of small-scale easily accessible green areas within the urban fabric. These small-scale urban gardens are vital for a healthy community. A good number of them are allocated in plan. However, the majority is lacking in reality.
6) Deficiency of water for irrigation of green areas and parks, a major constraint in Erbil. However, a number of measures may be implemented to face the challenge.
7) Climate: high evaporation rate is a challenge to the greening process.
8) Unsafety of green areas: lack of lighting and neighbouring activities makes green spaces unsafe, especially at night
9) Over-scale of green areas and isolation from residential areas. The most successful and well-maintained parks are the largest in the city. These are prime layers of the urban fabric and a great destination for walking, family gatherings and social events. However, 2 issues may be raised: a) The need to use cars to access these parks, mostly fenced and surrounded by main roads. b) The absence or lack of focus on medium and small-scale parks, which are usually targeted by children and elderly within the urban fabric.
10) Lack of diversity in greening typology. This diversification is necessary for multiple reasons including serving different user groups, serving different users' needs, different ecological and urban settings.
11) Lack of visibility/understanding of legal parks: Due to the absence of neighbourhood gardens implementation, the allocated parcels are privatized.
12) Public vacant lands are not valorised as public spaces. An example is the plot in front of Ramada hotel. Temporary usages of vacant land are not an applied concept in Erbil.

13) Lack of implementation of planned green areas and conversion into land uses with impervious surfaces;
14) Lack of allocated budget for green area services, specifically after 2013;
15) Poor maintenance and management of green areas in Erbil.
17) Cutting and burning trees. According to Erbil forestry police, 8,000 trees in Erbil city's largest artificial forest in Kasnazan were destroyed in a major fire, accidentally started by tourists during a picnic.
18) 40% of the parks area is paved. Most residential outdoor areas are also paved.

Source: JICA Project Team

Figure 10.1.7 Privatization of the Parcels Designated as Public Gardens into Private Gardens

Source: JICA Project Team

Figure 10.1.8 Privatization of the Parcels Designated as Public Gardens into Private Parking

Source: JICA Project Team

Figure 10.1.9 Condition of Some Parcels Planned as Neighborhood Gardens

10.2 Sector Strategies & Policies

(1) Overall Goals of Green Area Management Sector

The Overall Goals of the Green Area Management Sector development aims to fulfill the long-term visions of the masterplan of Erbil 2050, towards a sustainable city. These includes visions such as 1) Carbon-Neutral & Sustainable City (CNS), 2) Water-Conscious City (WCC), 3) Green Fortress & Haven City (GFH), 4) Healthy City (HLC). Planning and managing the green areas also respond to Strategic Orientation 01: Establish the foundations for urban sustainability, resilience, and adaptation to climate change.

In parallel, KRG Commits to the global Agenda 2030 for Sustainable Development and the achievement of (SDGs) under the monitoring of the United Nations.

The overall goals of the green area management plan can be summarized as follows:

- [GAM-I]: Increasing the green footprint of the city, for its benefits on the ecosystem and people.
- [GAM-II]: Increase the quality of the green areas, and raise the level of service.
- [GAM-III]: Diversify economic resources and municipal revenues through urban agriculture and nature-related activities
- [GAM-IV]: Adopt a plan towards Sustainability and Environmental Responsibility to mitigate climate change: The plan should emphasize the importance of environmentally conscious development, adherence to environmental regulations and sustainability principles in identifying and implementing projects
- [GAM-V]: Greenery Protection and Development: The vision includes protecting and developing green areas within urban areas. It seeks to determine the appropriate amount of greenery based on planning standards, protect the allocated green areas, and ensure compliance with environmental regulations and restrictions
- [GAM-VI]: Strengthen the institutional framework and policy landscape for green area standards due to scientific criteria and prosperity planning: Government's sector-specific strategic planning
- [GAM-VII]: Create a network of green and blue spaces (and lines), reintroduce biodiversity, lost due to uncontrolled urbanization, and re-establish the ecosystem for humans as well as animals and natural species.
- [GAM- VIII]: Use greenery as a tool to protect against flooding and control droughts.

(2) Linkage with Strategic Orientations of Erbil 2050 MP

Strategies and Policies of the Green Area Management Sector mainly support the realization of Strategic

Orientation #1: Establish the foundations for urban sustainability, resilience, and adaptation to climate change (See Section 5.4.1), which contributes significantly to the implementation of Long-term Development Vision (See Section 4.2) of Green Fortress & Haven City (GFH).

(3) Strategies & Policies of Green Area Management Sector

Table 10.2.1 below summarizes the Strategies and policies of the Green Area Management Sector proposed to tackle existing issues and to achieve Erbil 2050 MP's Long-Term Visions and Overall Sector Goals.

The Inner Green belt constitute a main element in both the natural and the agricultural layers of the city. MP2050 acknowledges the necessity of implementing the IGBMP and integrates it as part of the land use.

Table 10.2.1 Strategies & Policies of Green Area Management Sector

Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Afforestation ➔ Outside Green Belt ➔ National scale	**GAM-S1-:** Increase Forest canopy through afforestation operations and use belts of forests to build resilience to dust storms in Erbil City.	- **GAM-S1-1:** Complete the implementation of the 4 zones dedicated for forests in the IGBMP, with amendments to fit with the landuse plan: - Expand current Kasnazan forest as a large-**scale** carbon sink for the whole of Erbil city. The boundary of the forest in reduced compared to the IGBMP. - Implement the 2 smaller afforestation areas defined at Z6 extensions - Implement Z6 (West) zone outside GB, adjacent to an existing village. - **GAM-S1-2:** a) Create 2 layers of buffers around the industrial areas in Ararat and Gwer, to separate the residential developments from the industries and to create a visual, sound and air screening. Planting a verdant barrier of trees, known as a Green Wall, as a potent shield against the harmful consequences of dust storms by planting massive areas with bamboos while promoting it industrially. The 500 m buffer has a 100m layer of trees and 400m of agricultural land. b) Implement a 100m deep wall of trees along the southern water channel, to protect against dust storms. - **GAM-S1-3:** Create a linear afforestation of 2 lanes of Platanus (or Albizzia) trees along inner edge of the GB (RW8) to shade the proposed bike lane. Refer to GAM-S4-5. - **GAM-S1-4:** Implement the "lattice of Shelter beds" concept proposed in the IGBMP: 1 or 2 rows of trees that follow the village cadastral boundaries, village peripheries and agriculture land parcels. In parallel to wind breaking and sheltering from cold, they create aesthetically pleasant landscape. - **GAM-S1-5:** Acquire necessary land through purchase, conservation easements, or partnerships with landowners of agricultural lands.	-[GAM-I]: Increase the green footprint of the city -[GAM-II]: Increase the quality of the green areas - [GAM-IV]: Sustainability and Environmental Responsibility - [GAM-V]: Greenery Protection and Development - [GAM-VII]: Recreate biodiversity - [GAM- VIII]: Protect against flooding and control droughts. Lack of major forest or green belt at the sizeable metropolitan scale (GAM-04)

Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
	GAM-S2: Establish long-term afforestation zones at the level of the project area.	- **GAM-S2-1:** Create a map of long-term afforestation zones, to act as a road-map for public entities, private initiatives and organizations. In addition to the main afforestation areas defined in GAM-S1, MoAWR may work on a long-term vision for additional forests. These will play a major role in mitigating climate change, in parallel with future urbanization. - **GAM-S2-2:** Enhance public awareness and education about the importance of significant forests and green belts for environmental sustainability within the educational institutes and community centers.	-[GAM-I]: Increase the green footprint of the city -[GAM-II]: Increase the quality of the green areas - [GAM-IV]: Sustainability and Environmental Responsibility - [GAM-V]: Greenery Protection and Development
Agro-nodes and agroforestry ➔ Green Belt ➔ Metropolitan scale	**GAM-S3:** Intersecting Agriculture and the urban life in the green belt, the proposed agro-nodes and urban agriculture.	- **GAM-S3-1:** Intersect agriculture and the urban life through agro-nodes and set the ground for the agro-nodes pilot projects at strategic locations (intersection of the GB with main roads), accessible by the public. A total of 8 agro-nodes are proposed at the intersections of the arteria roads with the GB, where dense agroforestry will be implemented. The agro-nodes include easy parking spaces, farmers shops, restaurants, plants and flowers nurseries, rest areas, picnic facilities, parks, bike rental and access to the bike lane. - **GAM-S3-2:** Set agroforestry parcels within the agro-nodes. The main characteristic of the agroforestry areas is the dense trees, combining fruit trees and forestry. This clear visual identity is crucial to attract users and to identify the GB as a containing element. - **GAM-S3-3:** Give the 8 agro-nodes unique identities related to the dominant type of fruit trees that they will produce. Complement the trees with the necessary annex artisanal production spaces within the nodes – except for industrial production which may be located outside GB. - **GAM-S3-4:** Include plot 72 (IGB extension) as part of the agro-node on Makhmur Road. With an active frontage, the majority of the plot will be planted with dense trees, as agroforestry. It will also create a buffer between the industrial and the residential zones on both sides of the road. - **GAM-S3-5:** Define zones of forest cemeteries within each agro-node. The aim is to serve the different neighborhoods, in addition to the Landscape Cemeteries (Zone Z4) as in IGBMP.	- [GAM-III]: Diversify economic resources - [GAM-III]: Diversify economic resources and municipal revenues - [GAM-VII]: Recreate biodiversity
	GAM-S4: Promote urban farming/ agriculture as a unique identity of Erbil.	- **GAM-S4-1:** Complement the agriculture lands with other programs that can boost the visibility and the viability such as farmers markets, restaurants, R&D centers, specialized schools, etc. - **GAM-S4-2**: Envision and promote the synergy between agri-food and the urban context as a new way of living in Erbil.	- [GAM-III]: Diversify economic resources and municipal revenues - [GAM-VII]: Recreate biodiversity

Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
		Urban farming is currently promoted by the FAO as an integral part of agricultural production systems[6] and applied in the most developed cities. Paris holds the largest urban rooftop farm in the world extending over 14,000 m2. [7]	
Major Parks ➔ Inside Green Belt ➔ National scale	**GAM-S5**: Create national-scale parks in different locations of the city, including GB and other main locations within the city.	- **GAM-S5-1:** Propose a "Wetland Park" with the proposed ponds, at the intersection of the Ground Recharge Zone with the city, inside the GB. It will act as the open view and calm destination within the city, for the current and future developments in the west of the city. It replaces the proposed West Gateway Park in the Inner GB masterplan. - **GAM-S5-2:** Bastora Park, proposed as the North Gateway Park in the IGBMP. This park will be a main attraction to the city expanding towards the North. (Bahirka core). IGBMP had developed a brief and a preliminary design for Bastora park. However, changes will apply due to changes in vision as well as encroachments by developments. The golf course will be replaced by a park. The hippodrome will be moved to replace the open-air theatre. - **GAM-S5-3:** Kirkuk Park. MP2050 pursues the development of the South Gateway Park as in IGBMP, as it also corresponds to the proposed south sport city. All current constructions on the plot shall be relocated. - **GAM-S5-4:** Qatawi Public Park is a main park, proposed in southern part of the city. A pond will be integrated on the landscape of this park, strategically located next to the proposed train station. This park will showcase a variety of native trees and plants. - **GAM-S5-5**: Kasnazan Public Park as a gate to Kasnazan forest, leading to the valley tourism area. The footprint of the park is updated to sit between the existing zoo and forest. It also includes commercial venues, part of the agro-node on Koya road. - **GAM-S5-6:** Implement Banaslawa Public Park as in IGBMP - **GAM-S5-7:** Implement Koritan Jucoy Park as in IGBMP - **GAM-S5-8:** Implement Sherwana Public Park, within the administrative area. - **GAM-S5-9:** Plan and implement the needed parks and green areas of all scales in the new north cores, to respond to the population needs and to mitigate the urban expansion.	-[GAM-I]: Increase the green footprint of the city -[GAM-II]: Increase the quality of the green areas
Global green network and Urban green infrastructure	**GAM-S6:** Establish a comprehensive Global Green	- **GAM-S6-1:** Strategically plan the green and blue layers of the city with the intension of connecting them, to maximize	-[GAM-I]: Increase the green footprint of the city

[6] https://www.fao.org/urban-peri-urban-agriculture/en
[7] https://www.theguardian.com/cities/2020/jul/08/the-future-of-food-inside-the-worlds-largest-urban-farm-built-on-a-rooftop

Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
(UGI) ➔ Outside and Inside Green Belt ➔ National scale + Metropolitan scale	Network that seamlessly interconnects the diverse green and blue zones.	their benefits. Connecting green spaces and water bodies in a city is essential for promoting biodiversity, providing ecosystem services, improving human health and well-being, enhancing climate resilience, fostering social cohesion, and preserving cultural and aesthetic values. - **GAM-S6-2:** Create a green linkage, connecting south west GB with planned large park to the South, with Qatawi park, a strip of green lines reaching a planned linear park as per detailed plan, reconnecting to GB at its south east side. - **GAM-S6-3:** Create a green buffer of a min of 20 m on both sides of the corniche as per regulations. MP2050 proposes a number of stops in the form of parks and sloped banks for recreational activities along the water. 3 plots and a wide buffer of 100 m are indicated in the GA map. - **GAM-S6-4:** Create Green lines along the streets connecting Sami Abdul Rahman Park to the proposed "Wetland Park" (inner part of the GRZ). Trees with wide canopies and proper spacing create the needed shading along these streets. In parallel to their aesthetic, cultural and environmental values. - **GAM-S6-5**: Complete the proposed Prestige routes on 100, 120 and 150 roads with extensive landscape. - **GAM-S6-6**: Implement a bike lane along the inner edge of the Green Belt, with rest areas and commercial stops, shaded from both sides with rows of trees (GAM-S1-3). Additionally, shortcuts pierce through specific programs or cores within the GB, such as agroforestry and cemetery parks. - **GAM-S6-7:** Green Mosul Road at the level of the median, sidewalks and available buffer, with the intention of creating a green linkage from the GB to the Great Zab River. - **GAM-S6-8:** From ringways to local roads, incorporate landscape treatments to enhance the city's aesthetics and ecological connectivity.	-[GAM-II]: Increase the quality of the green areas - [GAM-IV]: Sustainability and Environmental Responsibility -[GAM-VII]: Create a network of green and blue spaces, reintroduce biodiversity, and re-establish the ecosystem. - [GAM- VIII]: Use greenery as a tool to protect against flooding and control droughts.
Create Blue zones	**GAM-S7:** Ponds and dams to become a destination, benefiting from their cooling effect and creating green areas around them.	- **GAM-S7-1:** Create nature-based activities around Bastora touristic dam. - **GAM-S7-2**: Integrate the proposed high infiltration zone in Kaznazan as part of an overall nature destination, with the forest, the park, the agro-node and the zoo. - **GAM-S7-3:** Create a green buffer or trees around Erbil Lake. - **GAM-S7-4:** Transform the corniche from source of pollution and diseases into a unique destination for cooler temperature and recreational activities (GAM-S6-3) - **GAM-S7-5:** Include water features and water fountains in public spaces.	- [GAM-IV]: Sustainability and Environmental Responsibility -[GAM-VII]: Create a network of green and blue spaces, reintroduce biodiversity, and re-establish the ecosystem - [GAM- VIII]: Use greenery as a tool to protect against flooding and control droughts.

Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
Medium and small-scale Parks and gardens ➔ Inside Green Belt ➔ Metropolitan scale + Municipal scale	**GAM-S8:** Create a range of sizes for green spaces, to serve the population in the sector, district, neighborhood and precinct.	- **GAM-S8-1:** Prioritize the implementation medium scale parks and gardens to be accessed by bike or by foot. Currently, most parks are large scale, accessed by cars. Medium scale parks at the level of the district are a great meeting point for families and school outings. - **GAM-S8-2:** Fill the gap in small-scale parks and neighborhood gardens. Green areas under 1500 m2 constitute 3% of the total GA in 2022 and 2% of the total GA planned till 2024. These are specifically important for healthy neighborhood, targeting the most vulnerable users, kids and elderly. - **GAM-S8-3:** Review the urban block to impose a minimum green footprint (25%) in parallel with related criteria such as accessibility, min area, max building footprints. The existing regulation must be activated in all planning departments. - **GAM-S8-4:** Green the inner streets with the right type of trees for shading and aesthetic value. This measure will invite people to walk more, it will also lower the heat during the day. In addition, it will make the residents proud of their neighborhoods. - **GAM-S8-5:** Conduct a city-wide survey and update the data base at UPDOE. Use GIS and urban planning tools to assess the current distribution of green areas based on size, type, identify underserved neighborhoods and monitor the implementation process. - **GAM-S8-6:** Develop a priority list for green area development and expansion in areas with the greatest need. - **GAM-S8-7:** Retrofit existing neighborhoods to include parks, playgrounds, and green corridors connecting residential areas.	- [GAM-I]: Increase the green footprint of the city. - [GAM-II]: Increase the quality of the green areas - [GAM-V]: Greenery Protection and Development -[GAM-VII]: Create a network of green and blue spaces, reintroduce biodiversity, and re-establish the ecosystem Lack of small scale easily accessible green areas (GAM-05)
	GAM-S9: Enhance the quality of small-scale urban green spaces (Public, Neighbourhood, pocket parks, etc.)	- **GAM-S9-1:** Develop guidelines for creating small-scale green spaces, including design standards, plant selection, proper lighting and maintenance requirements. These guidelines should allow standardization for fast and cost-effective application, while staying contextual by responding to the needs in every location. - **GAM-S9-2:** Design for safe and easy access to green areas. This includes pedestrian infrastructure, shaded paths, wheelchair access and lit sidewalks.	Lack of green areas, mainly small-scale green spaces within the urban fabric (GAM-01) Over-scale of green areas and isolation from residential areas (GAM-03) - [GAM-V]: Greenery Protection and Development
Green elements typologies	**GAM-S10:** Diversifying green element typologies to respond to the various needs and	- **GAM-S10-1:** Develop guidelines for diversifying green area typologies such as street landscapes, roof gardens, tree alleys, urban wetlands, rain gardens, community	Lack of diversity in greening typology (GAM-04)

Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
	challenges	gardens, etc. - **GAM-S10-2:** Promote and provide incentives for developers and property owners to implement green roofs, vertical gardens and green facades. - **GAM-S10-3:** Allow and encourage temporary and pop-up green spaces. These can occupy vacant parcels and pedestrian areas. They may be seasonal or event related and have the power to transform urban spaces.	-[GAM-VII]: Create a network of green and blue spaces, reintroduce biodiversity, and re-establish the ecosystem - [GAM-V]: Greenery Protection and Development Lack of diversity in greening typologies (GAM-10)
Native landscape ➔ Outside Green Belt ➔ National scale	**GAM-S11:** Set a preservation and protection plan for the native fauna and flora	- **GA-S11-1**: Survey endangered natural landscapes and identify the risks: urban development, industrial proximity or other practices by citizens…	- [GAM-IV]: Sustainability and Environmental Responsibility
Green species diversity / Environment Enhancement and Sustainability	**GAM-S12:** Recreate biodiversity and preserve native species.	- **GAM-S12-1:** Conduct a biodiversity assessment to identify native plant species suitable for greening projects; as well as adaptive trees that are suitable with the current weather conditions. - **GAM-S12-2**: Create a mix of deciduous and evergreen trees. - **GA-S12-3:** Encourage the use of indigenous species, particularly important in dry or drought prone areas. - **GA-S12-4:** Create public demonstration gardens, showcasing native plants and their benefits. These can serve as educational tools and inspiration for community members. - **GAM-S12-5:** Establish nurseries for native plant propagation and distribution to reduce costs. - **GAM-S12-6**: Introducing the Miyawaki method of tree planting of creating dense urban forests of native trees on degraded lands or within urban developments, using natural reforestation methods. - **GAM-S12-5**: Introduce Xeriscaping: the practice of landscaping with slow-growing, drought tolerant plants to conserve water and reduce yard trimmings. From the beginning, a landscape can be designed to reduce the number of resources needed to maintain it and the amount of waste it produces. - **GAM-S11-5**: Introduce Silviculture: the practice of controlling the growth, composition/structure, as well as quality of forests to meet values and needs, specifically timber production. With proper monitoring, the buffers of Paulownia around industries may also serve for this purpose.	Unbalanced coverage of green areas over Erbil's urban extent (GAM-05) -[GAM-VII]: Create a network of green and blue spaces, reintroduce biodiversity, and re-establish the ecosystem
Water and Irrigation	**GAM-S13:** Addressing water deficiency for	- **GAM-S13-1:** Optimize the freshwater conduit from the Mandawa dam to Bahirka, facilitated through the Qafar channel, holds	Deficiency of water for irrigation of green areas (GAM-06)

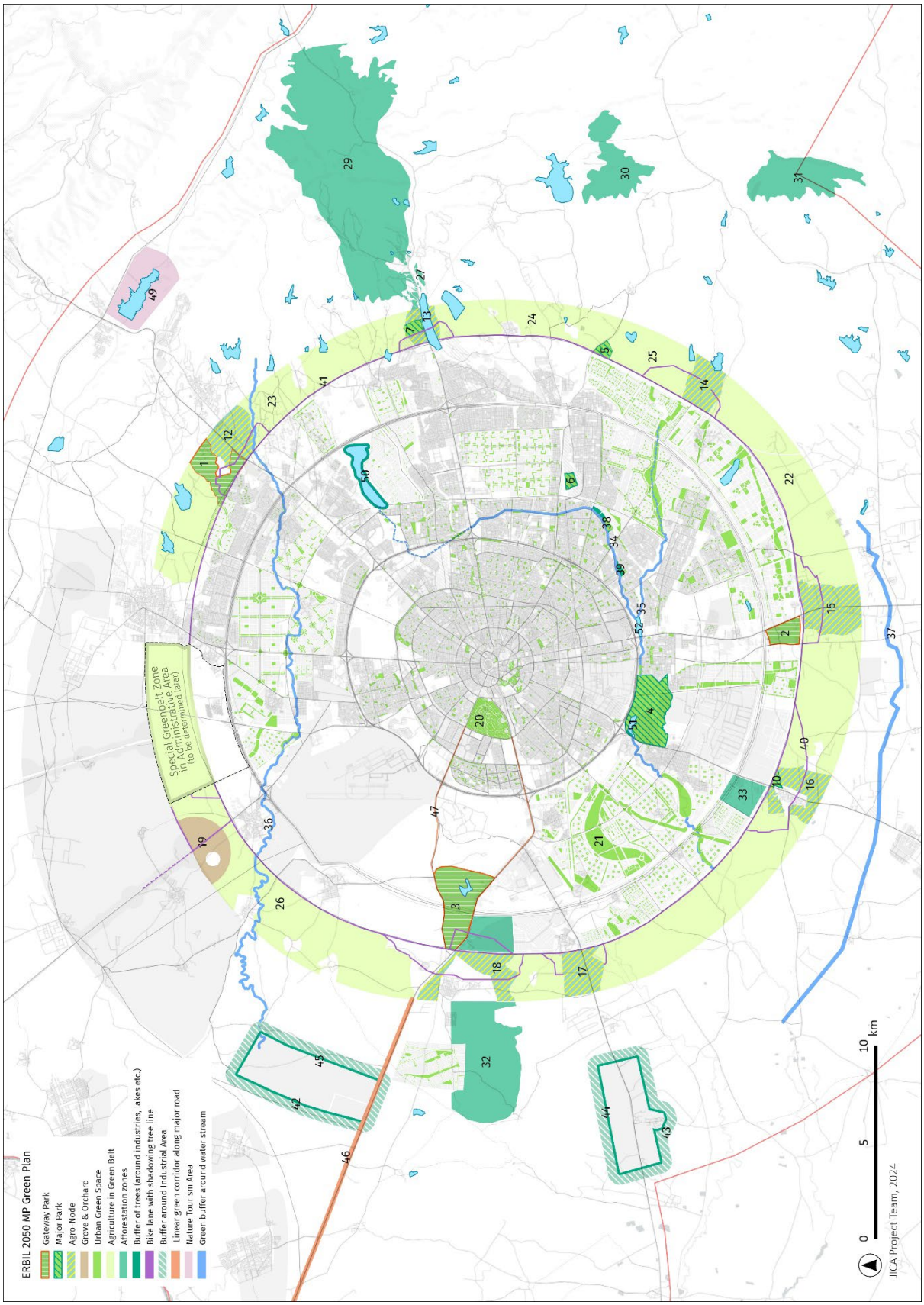
Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
	irrigation of Green Areas	promise for various essential applications. This includes harnessing this freshwater source for afforestation projects and the development of public park areas, thus effectively serving environmental and recreational needs. - **GAM-S13-2:** Implement water-efficient irrigation techniques in green areas, such as drip irrigation and rainwater harvesting systems. - **GAM-S13-3:** Explore using treated wastewater for irrigation to conserve freshwater resources. - **GAM-S13-4:** Develop a water management plan to optimize water use in green areas and minimize waste. - **GAM-S13-5:** Decrease the dependence on wells for irrigation of Green Areas	- [GAM-V]: Greenery Protection and Development
Green spaces ad flood measures	**GAM-S14:** Address flooding through nature-based measures.	- **GAM-S14-1:** Introduce Bioswales and rain gardens as small-scale green infrastructure technologies. - **GAM-S14-2:** Impose Impervious flooring and encourage new material and techniques for outdoor spaces, sidewalks, driveways, and parking lots. - **GAM-S14-3:** Create dense trees overs to intercept rainfall and slow its access to the ground.	- [GAM- VIII]: Use greenery as a tool to protect against flooding and control droughts.
Safety and Security	**GAM-S15:** Create safe green areas all day long.	- **GAM-S15-1:** Improve lighting and security measures in green areas to enhance safety, especially during evenings and nights. - **GAM-S15-2:** Encourage night uses around green areas, such as cafes, restaurants and markets. The cool weather at night is ideal for outdoor activities. Safety may be insured through active street. - **GAM-S15-3:** Increase community policing and neighborhood watch programs to deter criminal activities in green spaces. - **GAM-S15-4:** Conduct regular safety audits and involve residents in identifying and addressing safety concerns.	Unsafety of green areas (GAM-07) - [GAM-V]: Greenery Protection and Development
	POLICIES		
National Scale green area management	**GAM-P01**: Abide by the green area management masterplan and long-term planning.	- **GAM-P1-1:** Make the Masterplan 2050 official and the allocated zones and strategies for green area management legally binding, including the inner green belt in its updated form. - **GAM-P1-2:** Set a vision for green areas, including a GA per capita and a total GA coverage, similar to cities such as London and Riyadh.	Unbalanced coverage of green areas over Erbil's urban extent (GAM 01) Lack of comprehensive planning of green areas (GAM-03)
Metropolitan scale green area management	**GAM-P02**: Draft and/or implement policies to protect green areas from uncontrolled urban expansion	- **GAM-P2-1:** Implement policies to protect and preserve green areas from encroachment and development. - **GAM-P2-2:** Create and promote a policy where local authorities or planning bodies may designate certain areas as local green spaces to safeguard them from	- [GAM-V]: Greenery Protection and Development

Theme	Sector Strategy	Action (incl. Draft Priority Project)	Planning Issue to solve & Sector Goal to achieve
		development and ensure their preservation for the benefit of present and future generations. *In the UK, Local people need to lobby the authority to designate LGS, based on a set of special criteria.* - **GAM-P2-3:** Allocate a portion of the city's budget to establish and maintain small-scale green spaces (to avoid vacant neglected lands and privatized gardens and parking spots).	
Municipality scale green area management	**GAM-P03**: Enforce zoning and land-use regulations at all the public agencies and private sector. **GAM-P04**: Create regulations for all types of land uses, defining the minimum green footprint per plot. **GAM-P05**: Create awareness at all levels on the importance of green areas planning.	- **GAM-P3-1:** Formulate a permit acquisition system which ties the approval of any development to the provision of necessary green areas. - **GAM-P3-2:** Engage local powers such as municipalities and local representatives in the maintenance of parks and gardens. - **GAM-P4-1:** Percentage and nature of green spaces to be decided in correlation with land uses and zoning. i.e: 70% in individual residences within GB, 25% within dense residential areas, 10% in industrial parcels. - **GAM-P5-1:** Introduce the new practices to the public and private sectors through presentations, publications and pilot projects. - **GAM-P5-2:** Create funds and incentives to encourage new practices. - **GAM-P5-3:** Launch Greening the Schools campaign. Not only will it create a natural space for kids to play, it will also raise an eco-conscious generation. School greening is a more holistic approach where schools become more sustainable at all levels. By 2050, all schools should have a green footprint of 25% of its total area. - **GAM-P5-4:** Involve the private sector through the Corporate Social Responsibility (CSR) program in the provision of green open spaces. - **GAM-P5-5:** Fund public art within landscaped areas and impose it on private developments. - **GAM-P5-6:** Establish a green infrastructure fund to finance the creation of new green spaces in underserved communities.	- [GAM-V]: Greenery Protection and Development
Neighborhood scale green area management	**GAM-P06**: Participatory approach and community engagement	- **GAM-P6-1:** Collaborate with local initiatives and organizations to fund and maintain community gardens through public-private partnerships such as Hasar Group. - **GAM-P6-2:** Promote community engagement in designing and maintaining these spaces to ensure they meet local needs and preferences.	- [GAM-V]: Greenery Protection and Development. Cutting and burning trees. (GAM-17)

Source: JICA Project Team

(4) Green Area Plan of Erbil 2050 MP

Table 10.2.2 and Figure 10.2.1 below show the Green Area Plan of Erbil 2050 MP, a spatial materialization of the strategies described above. The Green Area Plan can be considered as an update of the Inner Green Belt Master Plan, integrated into the Erbil 2050 MP.



Source: JICA Project Team

Figure 10.2.1 Erbil 2050 MP Green Area Plan

Table 10.2.2 Proposed Green Areas in Erbil 2050 MP Green Area Plan

ID	Green Area Category	Green Area Name	Planning Initiative	Area (m2)
1	Gateway Park	Bastora Gateway Park	IGBMP	2,508,788
2		Kirkuk Gateway Park	IGBMP	1,209,868
3		Wetland (West Park) Gateway Park	IGBMP	4,866,860
4	Major Park	Qatawi Major Park	KRG	4,194,655
5		Bnaslawa 1 Major Park	IGBMP	530,039
6		Bnaslawa 2 Major Park	UPDOE	167,860
7		Kasnazan Major Park	IGBMP	581,711
9		Sherwana Major Park	IGBMP	382,038
10		Koritan Jucoy Major Park	IGBMP	193,917
11	Agro-Node	Ashukan Agro-Node	JPT	4,631,428
12		Shaqlawa Agro-Node	JPT	3,152,538
13		Koya road Agro-Node	JPT	1,509,901
14		Daratu road Agro-Node	JPT	2,637,728
15		Kirkuk road Agro-Node	JPT	4,973,978
16		Makhmur road Agro-Node	JPT	2,935,759
17		Gwer road Agro-Node	JPT	3,313,201
18		Mosul road Agro-Node	JPT	3,525,640
19	Grove & Orchard	Gazna olive groves	JPT	3,501,857
20	Urban Green Spaces	Urban Green Spaces 2022	*Existing*	7,676,856
21		Urban Green Spaces 2040	UPDOE	26,365,595
22	Agriculture In Green Belt	A1: Agriculture investment zone	IGBMP	8,673,867
23		A2: Dispersed residential orchards	IGBMP	5,228,457
24		A3: Natural Rangeland	IGBMP	19,339,549
25		A4: Landscaped *cemeteries*	IGBMP	6,801,426
26		A5 A6 -A7-A8: Agriculture lands	IGBMP	25,715,115
27	Forest	Existing Kasnazan forest	*Existing*	1,135,701
28		Existing Khabat forest	*Existing*	602,070
29		Extension of Kasnazan forest	IGBMP	37,677,734
30		Z6 extension (1)	IGBMP	5,198,379
31		Z6 extension (2)	IGBMP	6,015,437
32		Z6 extension (west side-GRZ)	IGBMP	12,429,245
33		Proposed forest on plot 72 (GB extension)	JPT	1,934,766
34	Green buffer around water stream	Corniche valley	JPT	526,676
35		South stream	JPT/IGBMP	220,494
36		North stream	JPT/IGBMP	1,564,350
37		Diversion channel close to Shamamk	JPT	2,337,270
38	Proposed Green areas along waterway	Garden 1 Corniche Valley Plot 1	JPT	97,093
39		Garden 2 Corniche Valley Plot 2	JPT	214,954
40	Linear forests with bike lane	Green bike lanes on RW8 in GB (10m)	JPT/IGBMP	0 (82 km long)
41		Green bike lanes within agro-nodes (10m)	JPT/IGBMP	0 (27 km long)
42	Buffer of trees around Industrial Area	Buffer around Ararat industrial zone	JPT	1,495,150
43		Buffer around Gwer industrial zone	JPT	1,734,657
44	Buffer around Industrial Area	Buffer around Ararat industrial zone	JPT	6,357,566
45		Buffer around Gwer industrial zone	JPT	5,720,254
46	Linear green area along major road	100 m buffer of trees on both sides of Mosul Road	JPT	8,534,860
47		Connections Sami Park to proposed central park	JPT	136,750
48	Green footprint in building plots	25% of Green Area footprint in all schools	JPT	2,297,546
49	Nature Tourism	Nature Tourism around Bastora Dam	KRG	5,981,539
50	Lakes with Green buffer	Erbil lake (100 m buffer of green)	JPT	762,457
51		Makhmur lake	*Inside Qatawi Major Park [ID 4]*	
52		Kirkuk lake	*Inside Corniche Buffer [ID 34]*	
53	Green areas in New Northern Development Cores			3,021,277
	TOTAL Area (m2) in Green Belt			**250,614,857**
	Target Area (m2) of Erbil MP 2050			**2,734,545,594**
	% Urban Green Area in Target Area in MP2050			**9.16% ***

Source: JICA Project Team

Note: Based on 3,008,501 population in 2050: 83 m2 per capita (including urban agriculture)
Based on 2,618,303 population in 2040: 95 m2 per capita (including urban agriculture)
(*) 9.16% excludes Agriculture areas outside urban areas

10.3 Green Area Management Plan

10.3.1 Lower-Scale Green Area Planning

(1) Applied standards

Table 10.3.1 Planning Regulations for Public Open Spaces in the Iraqi Standards 2018

Criteria	Kids areas	Play areas	Sport field	Park and open areas
Size	precinct level	neighborhood level	community level	district level
Age group	1 - 5 years	6 - 11 years	12-18 years (boys)	all ages
Users' percentage	18..3 %	15.48%	13.27%	100%
Number of users	20-160	370-550	320-480	9600-14400
Area per user	1.40 m2	1.00-1.60 m2	1.75 - 3.0 m2	0.75 - 2.25 m2
Space area	100 - 225 m2	400 - 600 m2	600 - 1000 m2	7200 - 32400 m2
Full parcel area		600 - 900 m2	900- 1500 m2	
Radius to served area	150 m	200-300 m	500-800 m	800 m
Main function	play area	play and games	sport courts and games	recreation and open spaces

Source: Iraqi Urban Standards 2018

The above regulations from the Iraqi standards define the "public open spaces" under 4 categories: kids play area, playgrounds, sport courts and recreation and open space.

The first 3 categories are not directly associated with green spaces and do not clearly identify green typologies such as gardens, parks or any other type of planted area. They translate into open public spaces, which is why we classified them under sport, youth and culture and calculated the needs for them in public facilities planning chapter.

However, we would recommend a minimum of 50% of these open spaces categories to be green and 75% of it to have impervious surface.

The fourth categories may be translated to "park and open areas", dedicated for "recreation and sports" is, according to this regulation, planned at district level. The expected users per "park and open areas" varies between 9,600 and 14,400 m2. The land area varies between 7,200 and 32,400 m2.

Table 10.3.2 Projected Needs for Public Open Spaces in 2040 & 2050 (Iraqi standards)

		Kids areas (age 1-5) - precinct level			Play areas (age 6-11) - neighborhood level			Sport field (age 12-18) - community level			Park and open areas (all ages) - district level		
Year	Expected population	users ' age percentage of the total population (18.13%)	Total needed area for users (1.40 m2 per user)	Number of play areas, based on an average area of 162.5 m2 (range 100- 225m2)	Users' age percentage of the total population (15.48%)	Total needed area for users, based on an average of 1.3m2 per user (range 1.0 - 1.6m2	Number of play areas, based on an average area of 750 m2 (range 600-900m2)	Users' age percentage of the total population (13.27%)	Total needed area for users, based on an average of 2.4m2 per user (range 1.75 - 3m2)	Number of play areas, based on an average area of 1200 m2 (range 900-1500m2)	Users age percentage of the total population (100%)	Total needed area for users, based on an average of 1.5m2 per user (range 0.75-2.25m2)	Number of play areas, based on an average area of 19,800 m2 (range 7,200-32,400m2)
2022	1,861,870	337,557	472,580	2,908	288,217	374,683	500	247,070	592,968	494	1,861,870	2,7923	141
2040	2,618,303	474,698	664,578	4,090	405,313	526,907	703	347,449	833,877	695	2,618,303	3,927,454	198
2050	3,008,501	545,441	763,618	4,699	465,716	605,431	807	399,228	958,147	798	3,008,501	4,512,752	228

Source: JICA Project Team

Based on this table, 4,512,752 m2 of "parks and open spaces" are needed in 2050, to cater for the 3,008,501 users, in their districts. This is the equivalent of 1.5 m2 of GA per capita.

If we add the 4 categories of open spaces, the total of 6,839,948 m2 is the equal of 2.27 m2 per capita.

Additional standards:

- Erbil MP 2030:
  The master plan report for Erbil MP 2030 also merges "Sport facilities and Parks" under one category of community facilities. In terms of standards, it identifies the need for 1 ha per 22,000 inhabitants. This is the equivalent of 0,45 m2 of sport facilities and parks per capita. In the report, the above formula is applied per sector, where the project area is divided into 12 sectors.
- International standards:
  According to the World Health Organisation (WHO), every city is recommended to provide a minimum of 9 square metres of urban green space for each person, provided that it should be accessible, safe and functional. WHO also suggests that an ideal amount of urban green space can be generously provided as much as 50 square meters per person.

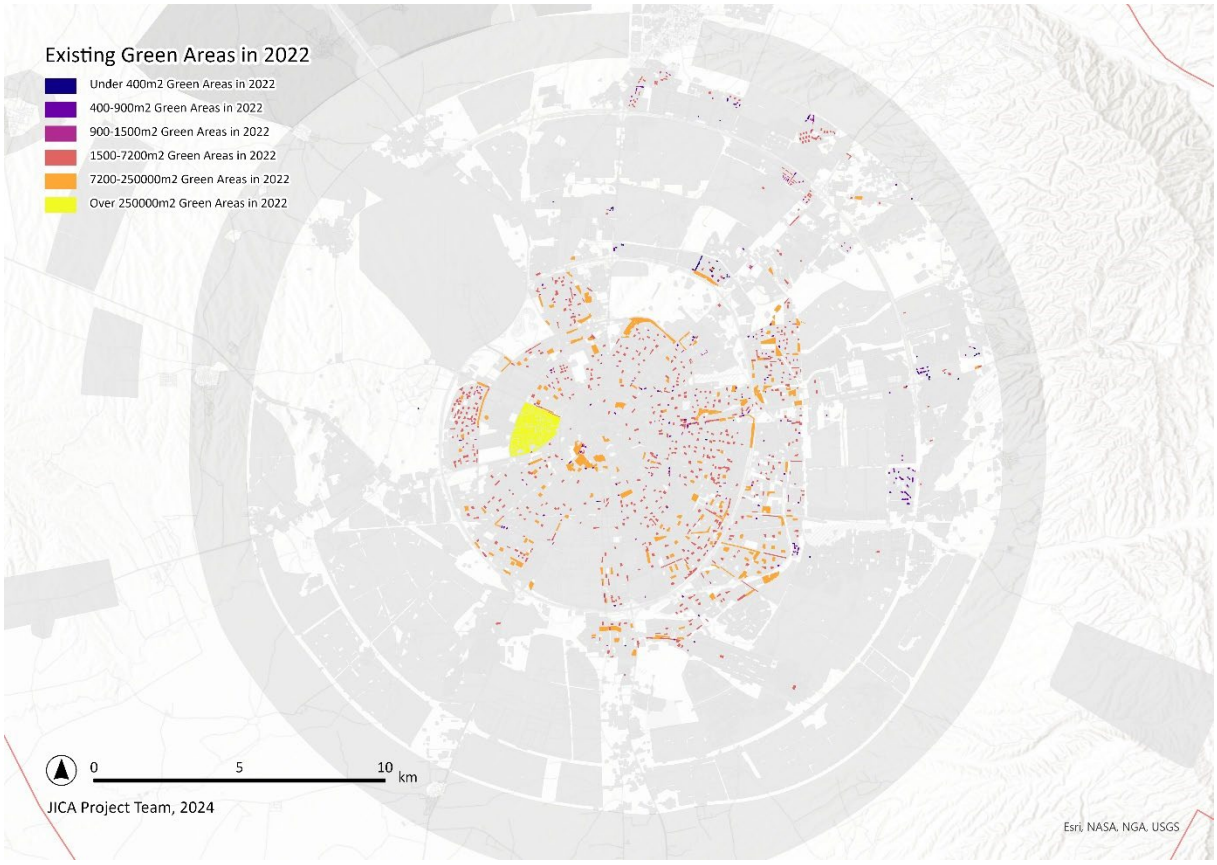
(2) Existing green areas in 2022

Table 10.3.3 Needs for Green Areas in 2022 (WHO requirements)

TAZ	2022	Green Areas		
		Needed in 2022, Minimum WHO requirement (9 m2/ Individual)	Existing in 2022	Missing GA per TAZ
Total	1,861,870	16,756,830	8,364,915	8,391,915

Source: JICA Project Team

Based on the current population of the project area and the minimum requirement by the WHO of 9 m2 of green areas per capita, we notice a current 50% deficiency.

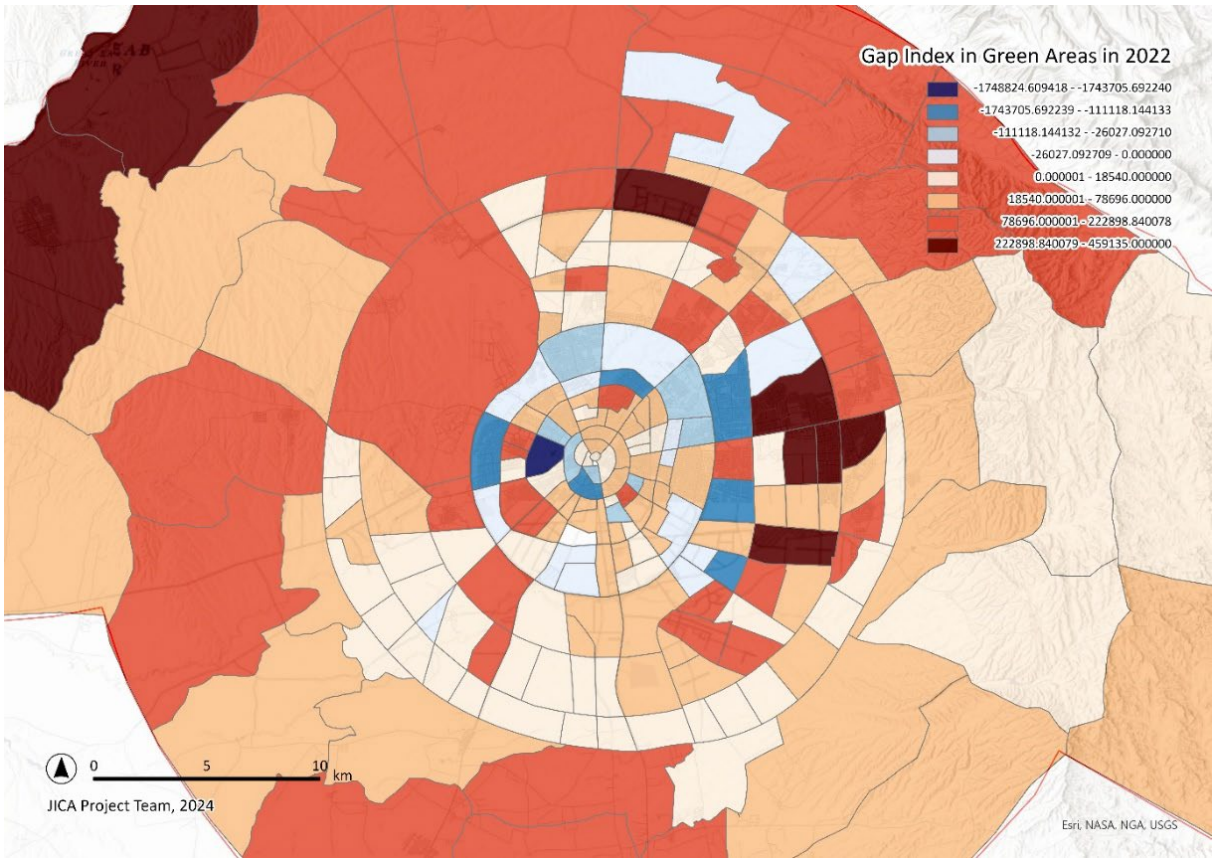


Source: JICA Project Team

Figure 10.3.1 Size Ranges of Green Areas Plots in 2022

Additionally, reviewing green spaces per traffic zone is important because it helps understand the distribution and availability to urban green spaces across the city. Please refer to Table 01 in the Annex for detailed gaps between the minimum requirement and the current situation.

The following map identifies brackets of gaps in Green Areas, in 2022 based on traffic zones:



Source: JICA Project Team

Figure 10.3.2 Gap Index in Green Areas in 2022 per Traffic Zone

The darkest blue traffic zone (TAZ) has a negative gap of green areas which means an excess number of green areas compared to the population it includes. In fact, this specific traffic zone is occupied fully by Sami Abdelrahman park. It must be perceived as a response to the needed green area by the 8 traffic zones that surround it.

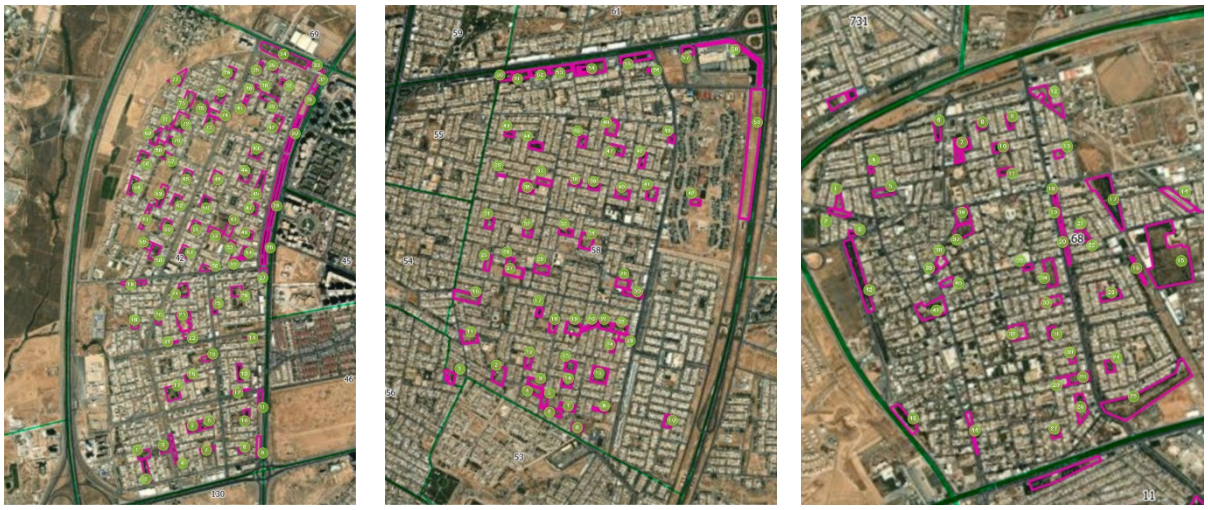
Implementation test and site inspections:

After doing sampling exercise to test the level of implementation of the green areas, we concluded that the above-mentioned GAP index study is only representing the planned GA for 2022 and not the real condition.

By comparing the LULC of 3 samples areas to satellite image, followed with site visits to some of the green areas there. We concluded that only the largest GA (above 250,000 m2) are fully implemented.

Based on the sampling studies and the site visit to a number of land parcels, indicated as neighbourhood gardens, we noticed 4 main conditions:

1) Well maintained gardens, serving residents and other visitors. These constitute around 26% of the total planned green areas
2) Poorly maintained gardens.
3) Vacant lands, sometimes with few trees on the periphery and a concrete construction for the water well. Large vehicles use the land for parking. In addition, private generators and dump sites occupy some of the plots.
4) Privatized gardens, where the parcel is divided into multiple smaller units, fenced and gated for private use by the surrounding residences. Individual parking plots are also occupying the land.



Source: JICA Project Team

Figure 10.3.3 Green Areas Sampling

Based on this more realistic calculation, the deficiency in GA increase to 80%.

Table 10.3.4 Applied Regulations for Public Open Spaces in the Iraqi Standards 2018

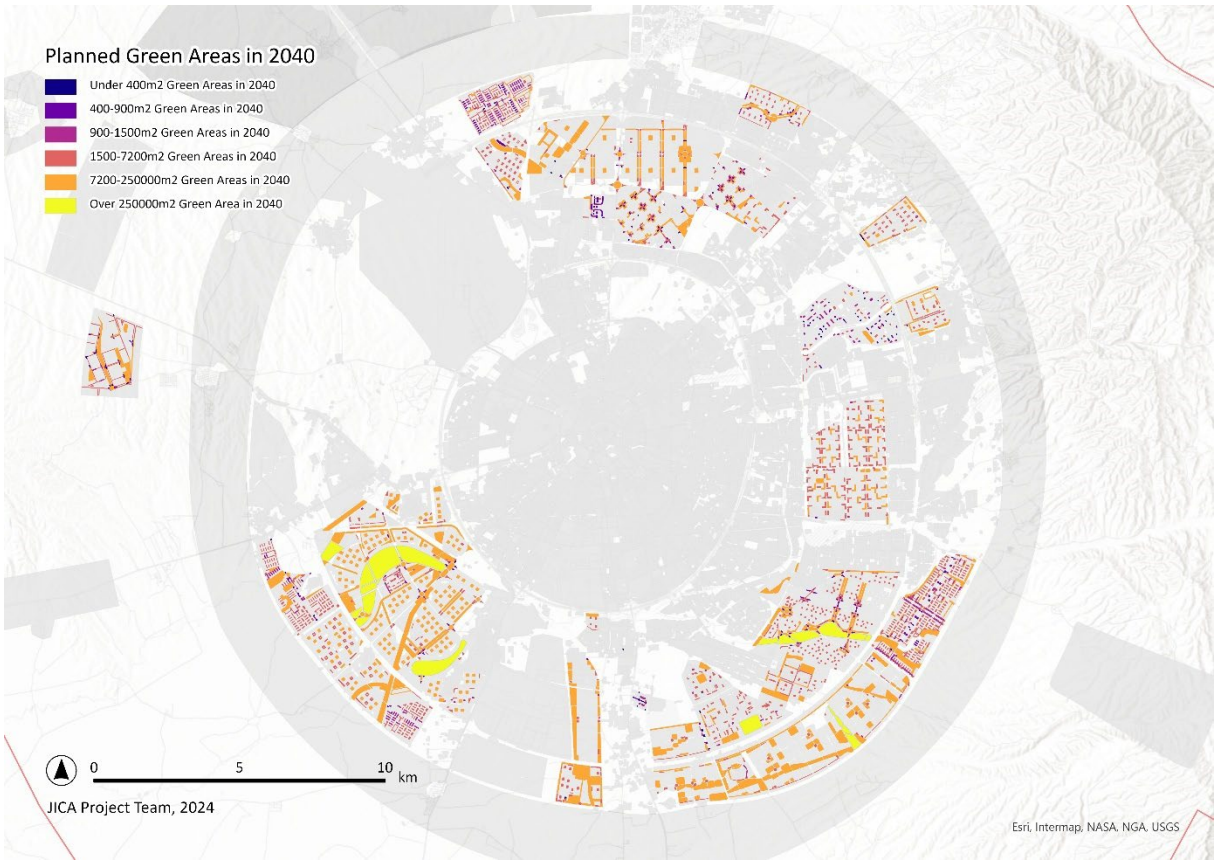
	AREA (m2) OF GREEN AREA IN 2022		
	Planned GA in 2022	Implemented GA in 2022	
Under 400m2	15,410	**26%**	4,007
400-900m2	86,595	**26%**	22,515
900-1500m2	172,787	**26%**	44,925
1500-7200m2	2,817,135	**26%**	732,455
7200-250000m2	3,494,123	**26%**	908,472
Over 250000m2	1,749,410	**100%**	1,749,410
TOTAL	**8,335,461**		**3,461,784**

Source: JICA Project Team

(3) Existing and approved green areas till 2040

Review of the green areas in the approved detailed plans ranging from major parks to small grided gardens:

UPDOE has developed a large number of detailed plans that are expected to respond to the population growth till 2024. These urban neighbourhoods' plans include a rich number of green areas which can be identified visually and in numbers. The percentage of green areas coverage in 3 of the detailed plans varies between 22 and 33.5 %, exceeding in some cases the regulation, not fully applied yet, that defines a minimum of 25% green areas in each development. This regulation targets mostly private developers.



Source: JICA Project Team

Figure 10.3.4 Size Ranges of Planned Green Areas Plots till 2024

Source: JICA Project Team

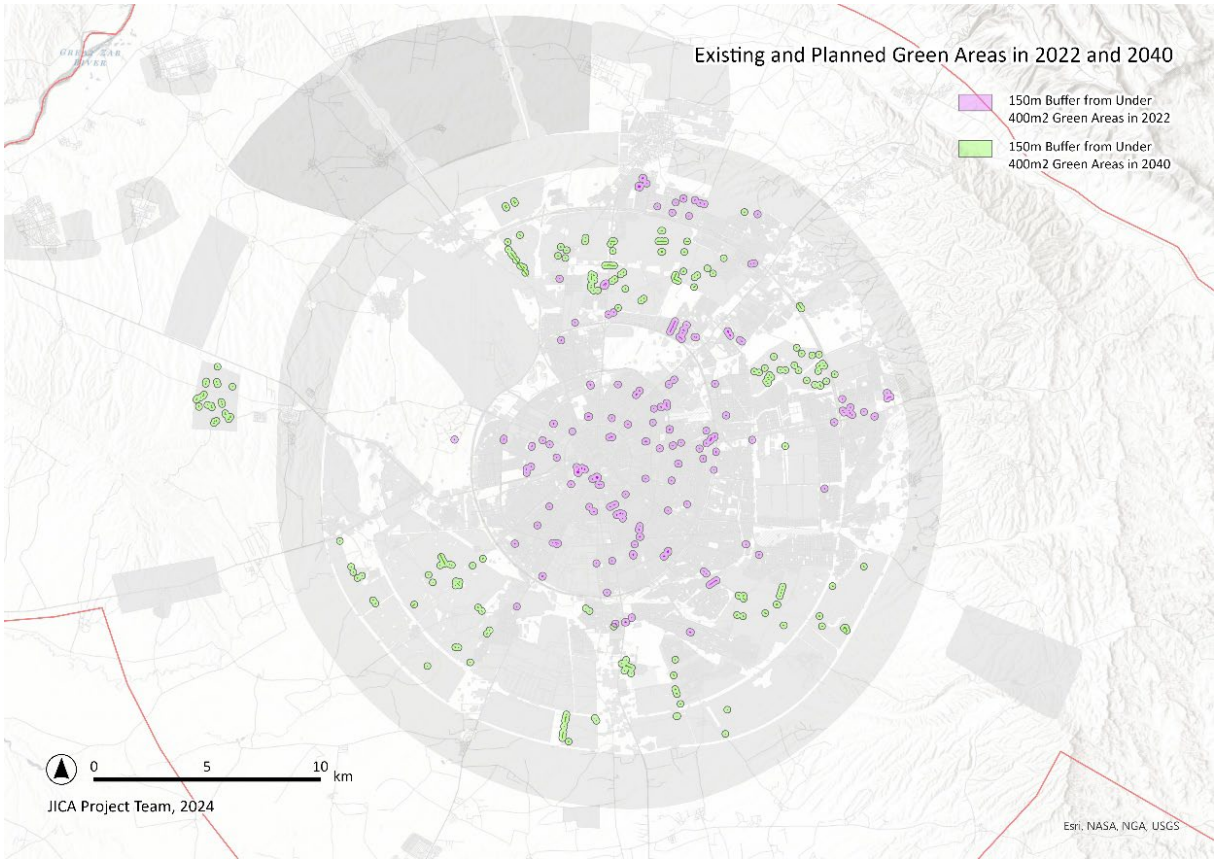
Figure 10.3.5 Approved Detail Plans A, B & C

The largest parks in both developments follow the outline of the existing water way. It is expected that the landscape design includes water bodies and lakes. No additional details about the green areas, their design or the type of greenery was available from UPDOE.

Table 10.3.5 Percentage of Green Areas in Detailed Plans

Zone	Detail plan to implement Area m2	Green Area m2	% Green Area on Detail plan to implement Area m2
Zone A	6,259,190	1,325,992	21.18%
Zone B	27,942,690	8,857,848	31.70%
Zone C	23,507,756	9,132,788	38.85%
Total	57,709,636	19,316,628	33.47%

Source: JICA Project Team



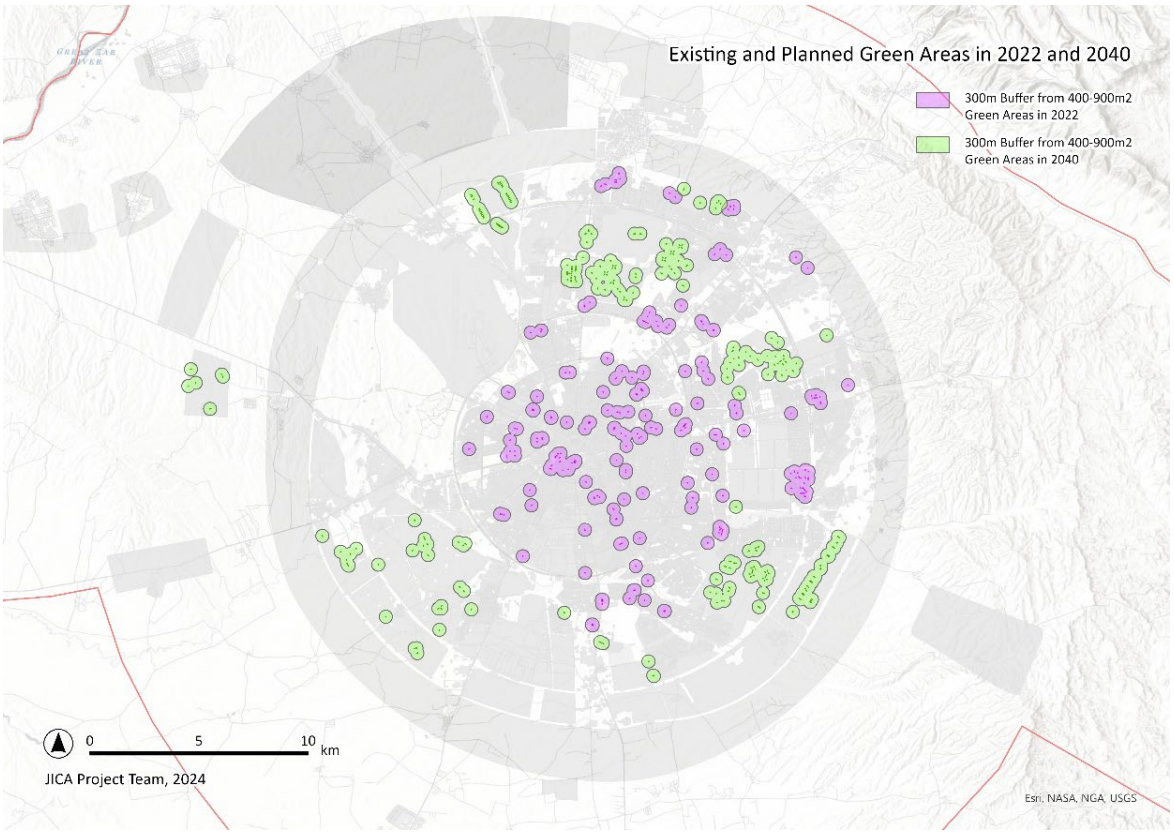
Source: JICA Project Team

Figure 10.3.6 Distribution and coverage radius of GA under 400 m2

Coverage of small-scale gardens and parks:

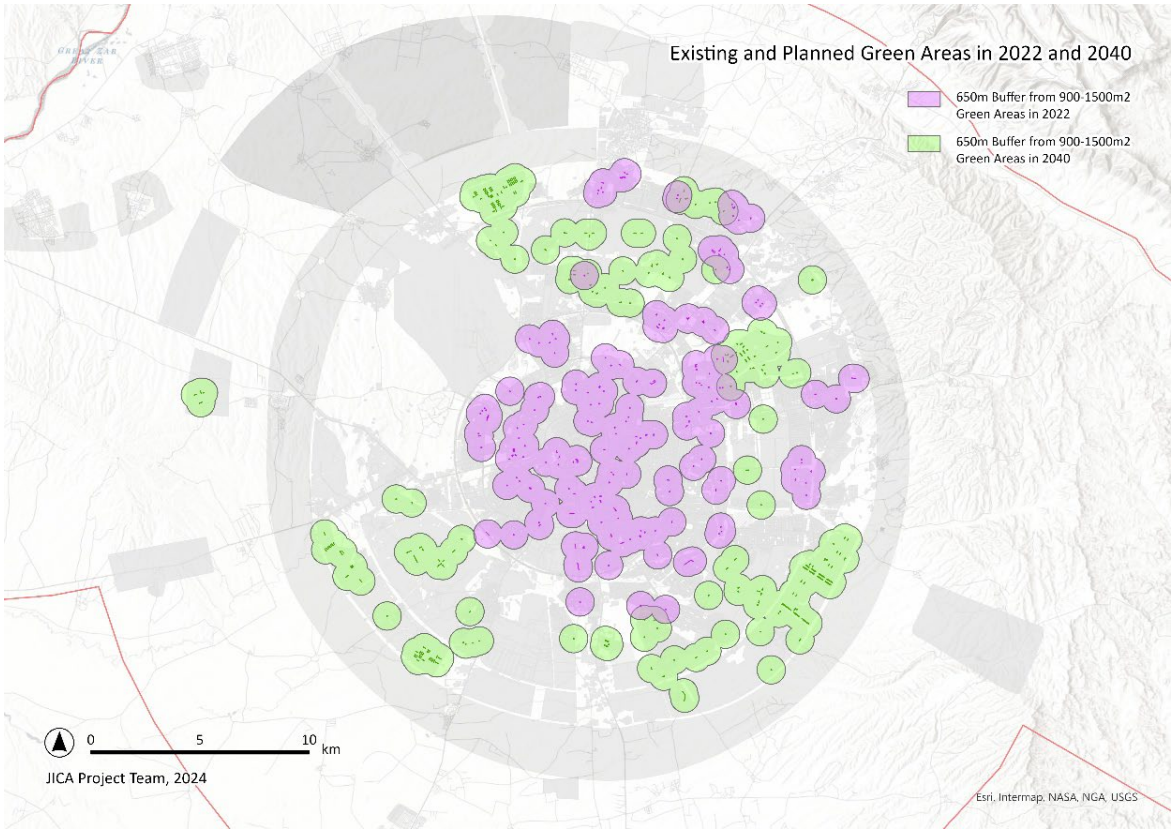
In order to test the distribution and coverage of small gardens, we categorized them into 3 area brackets (below 400 m², 400 - 900 m², 900 - 1500 m²) corresponding to the categories of play areas/ outdoor and sport areas as per the Iraqi standards.

Following the same standards for ideal distance to these spaces, we concluded that the 3 categories are fall short of meeting the citizens' needs, both in terms of area and distribution. The gardens are too small and sparsely located, resulting in long walking distances for most citizens.



Source: JICA Project Team

Figure 10.3.7 Distribution and Coverage Radius of GA between 400 and 900 m2



Source: JICA Project Team

Figure 10.3.8 Distribution and Coverage Radius of GA between 900 and 1500 m2

(4) Green areas Sector Development Plan

a) Implementation improving measures

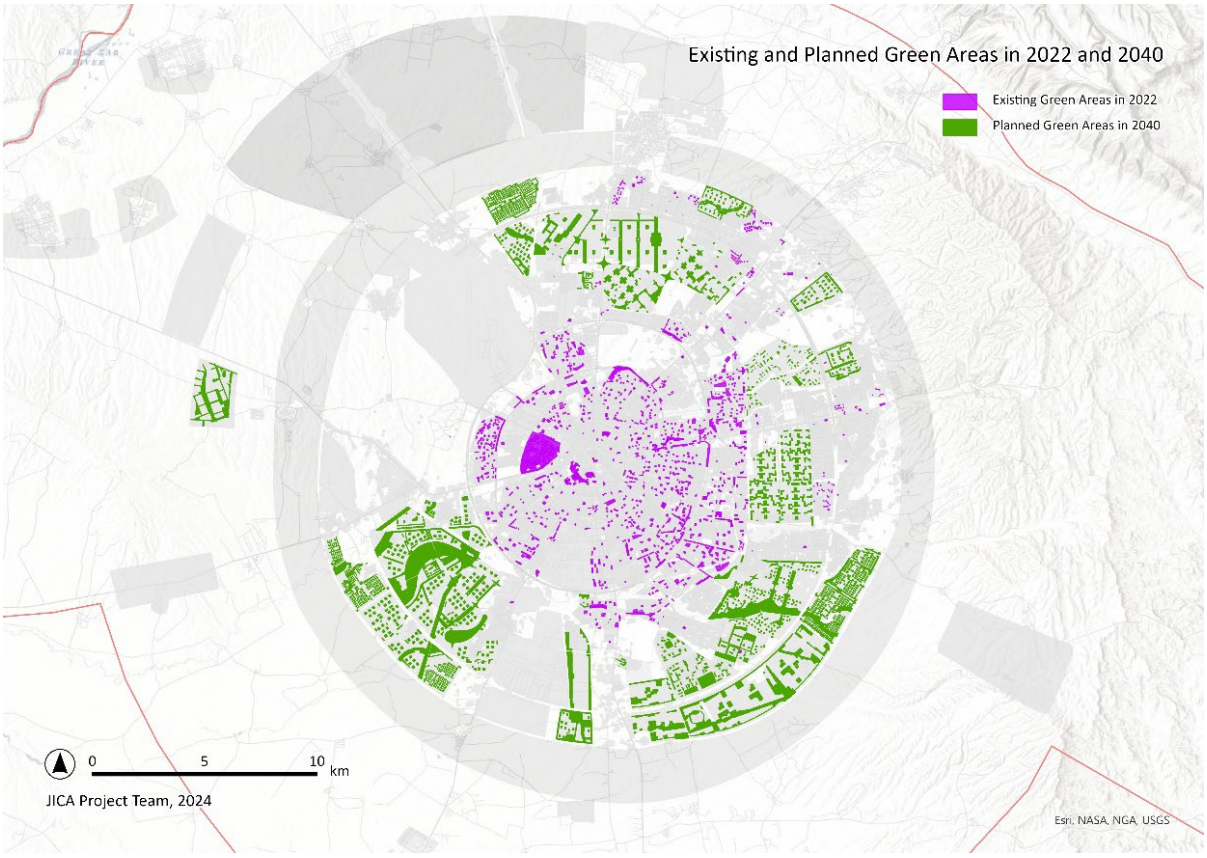
Prior to planning new green areas for the future city, we need to ensure the implementation fo the already planned gardens and parks in 2002. According to UPDOE, the ownership of the parcels dedicated for green areas is high. Although there are a number of encroachments and alternative uses currently o these parcels, the MOMT expressed the ability to implement the green areas, if the budget is allocated.

Accordingly, we assumed 90 % implementation, for Green Areas planned in 2022, by 2040, reflect in policy GAM-P2-3.

Table 10.3.6 Green Areas Implementation Ratios in Detailed Plans

	AREA (m2) OF GREEN AREA IN 2022			EXPECTED AREA (m2) OF GREEN AREA IN 2040			
	Planned GA in 2022	Implemented GA in 2022		Improved Implement. of 2022 GA		Newly Planned GA in 2040	TOTAL GA in 2040
Under 400m2	15,410	**26%**	4,007	**90%**	13,869	**29,123**	42,992
400-900m2	86,595	**26%**	22,515	**90%**	77,936	**146,311**	224,247
900-1500m2	172,787	**26%**	44,925	**90%**	155,508	**339,652**	495,160
1500-7200m2	2,817,135	**26%**	732,455	**90%**	2,535,422	**5,558,838**	8,094,260
7200-250000m2	3,494,123	**26%**	908,472	**90%**	3,144,711	**15,662,557**	18,807,268
Over 250000m2	1,749,410	**100%**	1,749,410	**100%**	1,749,410	**4,858,096**	6,607,506
TOTAL	**8,335,461**		**3,461,784**		**7,676,856**	**26,594,576**	**34,271,432**

Source: JICA Project Team



Source: JICA Project Team

Figure 10.3.9 Existing and Planned Green Areas till 2040

b) Future needs of green areas in 2040

Table 10.3.7 Green Areas Implementation Ratios in Detailed Plans

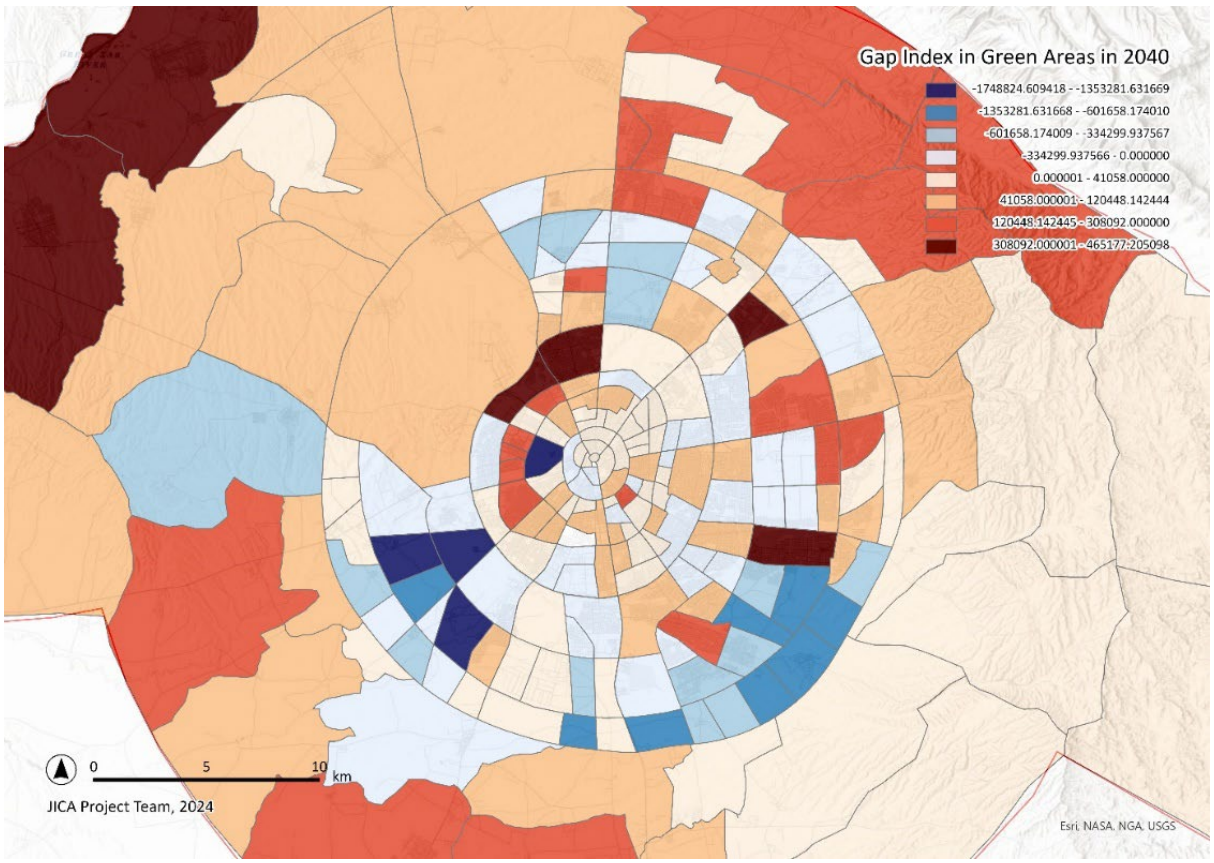
TAZ	2040	Green Areas		
		Needed in 2040 Minimum WHO requirement (9 m2/ Individual)	Existing +Planned till 2040	Missing GA per TAZ
Total	**2,620,343**	**23,564,727**	**35,013,882**	**-11,449,155**

Source: JICA Project Team

Based on the estimated population of the project area in 2040 and the minimum requirement by the WHO of 9 m2 of green areas per capita, a minimum of 23,564,727 m2 of green areas is needed.

The existing green areas in the LULC plan, with the dedicated parcels for green spaces in approved detailed plans exceed the minimum and reach a coverage of 13% approximately.

The gap index map below shows the uneven distribution of green areas among traffic zones.



Source: JICA Project Team

Figure 10.3.10 Gap Index in Green Areas in 2040 per Traffic Zone

c) Future needs of green areas in 2050

Please refer to section 5.5 on the report for the numbered map of all traffic zones.

Table 10.3.8 Green Areas Implementation Ratios in Detailed Plans

TAZ	New_TAZ	2050_A	Minimum WHO requirement (9 m2/ Individual)	2050_B	Minimum WHO requirement (9 m2/ Individual)
1		481	4,329	481	4,329
2		5091	45,819	5091	45,819
3		8634	77,706	8634	77,706
4		8720	78,480	8720	78,480
5		5452	49,068	5452	49,068
6		17484	157,356	17484	157,356
7		10182	91,638	10182	91,638
8		11214	100,926	11214	100,926
9		3070	27,630	3070	27,630
10		18715	168,435	18715	168,435
11		16887	151,983	16887	151,983
12		4046	36,414	4046	36,414
13		1484	13,356	1484	13,356
14		2353	21,177	2353	21,177
15					-
16		2740	24,660	2740	24,660
17		3682	33,138	3682	33,138
18		7388	66,492	7388	66,492
19		7642	68,778	7642	68,778
20		7379	66,411	7379	66,411
21		5822	52,398	5822	52,398
22		6489	58,401	6489	58,401
23		8497	76,473	8497	76,473
24		2399	21,591	2399	21,591
25		4021	36,189	4021	36,189
26		5139	46,251	5139	46,251
27		11808	106,272	11808	106,272
28		1754	15,786	1754	15,786
29		5165	46,485	5165	46,485
30		17647	158,823	17647	158,823
31		8923	80,307	8923	80,307
32		6957	62,613	6957	62,613
33		2150	19,350	2150	19,350
34		3337	30,033	3337	30,033
35		3178	28,602	3178	28,602
36		8394	75,546	8394	75,546
37		20447	184,023	20447	184,023
38		4562	41,058	4562	41,058
39		17355	156,195	17355	156,195
40		10849	97,641	10849	97,641
41		9284	83,556	9284	83,556
42		17444	156,996	17444	156,996
43		0	-	0	-
44		17742	159,678	17742	159,678
45		21554	193,986	21554	193,986
46		21794	196,146	21794	196,146
47		9262	83,358	9262	83,358
48		4610	41,490	4610	41,490
49		9778	88,002	9778	88,002
50		8020	72,180	8020	72,180
51		13334	120,006	13334	120,006
52		8639	77,751	8639	77,751
53		33058	297,522	33058	297,522
54		5083	45,747	5083	45,747
55		3853	34,677	3853	34,677
56		7104	63,936	7104	63,936
57		10574	95,166	10574	95,166
58		41590	374,310	41590	374,310

TAZ	New_TAZ	2050_A	Minimum WHO requirement (9 m2/ Individual)	2050_B	Minimum WHO requirement (9 m2/ Individual)
59		6566	59,094	6566	59,094
60		8312	74,808	8312	74,808
61		12995	116,955	12995	116,955
62	*621*	25718	231,462	25718	231,462
	622	24828	223,452	24828	223,452
63	*631*	31787	286,083	31787	286,083
	632	5684	51,156	5684	51,156
64	*641*	38657	347,913	38657	347,913
	642	23129	208,161	23129	208,161
	643	37262	335,358	37262	335,358
	644	6291	56,619	6291	56,619
65		2660	23,940	2660	23,940
66	*661*	18757	168,813	18757	168,813
	662	24112	217,008	24112	217,008
67	*671*	15745	141,705	15745	141,705
	672	15675	141,075	15675	141,075
	673	10046	90,414	10046	90,414
	674	34299	308,691	34299	308,691
	675	14540	130,860	14540	130,860
68		65885	592,965	65885	592,965
69		53941	485,469	53941	485,469
70		39784	358,056	39784	358,056
71		19036	171,324	19036	171,324
72	*721*	6190	55,710	6190	55,710
	722	4547	40,923	4547	40,923
	723	4028	36,252	4028	36,252
	724	15738	141,642	15738	141,642
	725	12459	112,131	12459	112,131
	726	17613	158,517	17613	158,517
	727	8950	80,550	8950	80,550
73	*731*	8212	73,908	8212	73,908
	732	6042	54,378	6042	54,378
	733	77	693	77	693
	734	26560	239,040	26560	239,040
	735	3629	32,661	3629	32,661
74	*741*	24888	223,992	24888	223,992
	742	23345	210,105	23345	210,105
	743	10228	92,052	10228	92,052
75	*751*	10939	98,451	10939	98,451
	752	11038	99,342	11038	99,342
	753	32955	296,595	32955	296,595
	754	13532	121,788	13532	121,788
	755	10356	93,204	10356	93,204
76	*761*	2890	26,010	2890	26,010
	762	8351	75,159	8351	75,159
	763	22912	206,208	22912	206,208
77	*771*	17591	158,319	17591	158,319
	772	5756	51,804	5756	51,804
	773	24921	224,289	24921	224,289
78	*781*	2704	24,336	2704	24,336
	782	4562	41,058	4562	41,058
	783	20306	182,754	20306	182,754
	784	5603	50,427	5603	50,427
79		5592	50,328	5592	50,328
80		3429	30,861	3429	30,861
81	*811*	8235	74,115	8235	74,115
	812	10211	91,899	10211	91,899
	813	4692	42,228	4692	42,228
82	*821*	2362	21,258	2362	21,258
	822	12118	109,062	12118	109,062

TAZ	New_TAZ	2050_A	Minimum WHO requirement (9 m2/ Individual)	2050_B	Minimum WHO requirement (9 m2/ Individual)
	823	26716	240,444	26,716	240,444
	824	1716	15,444	1,716	15,444
	825	9464	85,176	9464	85,176
	826	8576	77,184	8576	77,184
	827	11993	107,937	11993	107,937
	828	181	1,629	181	1,629
	829	311	2,799	311	2,799
83	*831*	1896	17,064	1896	17,064
	832	11223	101,007	11223	101,007
	833	886	7,974	886	7,974
	834	14186	127,674	14186	127,674
	835	314	2,826	314	2,826
84		4969	44,721	4969	44,721
85	*851*	21370	192,330	21370	192,330
	852	18378	165,402	18378	165,402
	853	10668	96,012	10668	96,012
	854	22912	206,208	22912	206,208
86	*861*	34959	314,631	34959	314,631
	862	16510	148,590	16510	148,590
	863	14744	132,696	14744	132,696
	864	11335	102,015	11335	102,015
	865	15923	143,307	15923	143,307
87		4484	40,356	4484	40,356
88	*881*	31550	283,950	31550	283,950
	882	28272	254,448	28272	254,448
	883	2447	22,023	2447	22,023
	884	10518	94,662	10518	94,662
	885	606	5,454	606	5,454
	886	5987	53,883	5987	53,883
89		1151	10,359	1151	10,359
90	*901*	14477	130,293	14477	130,293
	902	8095	72,855	8095	72,855
91		18035	162,315	18035	162,315
92	*921*	3702	33,318	3702	33,318
	922	3765	33,885	3765	33,885
	923	13425	120,825	13425	120,825
93		96010	864,090	91053	819,477
94	*941*	16257	146,313	16257	146,313
	942	29367	264,303	29367	264,303
	943	37290	335,610	37290	335,610
	944	8399	75,591	8399	75,591
95		137681	1,239,129	133687	1,203,183
96	*961*	9464	85,176	9464	85,176
	962	15618	140,562	15618	140,562
	963	44858	403,722	44858	403,722
	964	15878	142,902	15878	142,902
	965	28810	259,290	28810	259,290
	966	9125	82,125	9125	82,125
97		8744	78,696	20239	182,151
98		37965	341,685	37965	341,685
99		50381	453,429	50381	453,429
100		12863	115,767	12863	115,767
101		95297	857,673	92753	834,777
102		2304	20,736	2304	20,736
103		5287	47,583	5287	47,583
104		34555	310,995	34555	310,995
105		63292	569,628	63292	569,628
106		7693	69,237	7693	69,237
107		7536	67,824	7536	67,824
108		16068	144,612	16068	144,612

TAZ	New_TAZ	2050_A	Minimum WHO requirement (9 m2/ Individual)	2050_B	Minimum WHO requirement (9 m2/ Individual)
109	*1091*	194	1,746	194	1,746
	1092	29534	265,806	29534	265,806
110		6312	56,808	6312	56,808
111	*1111*	6788	61,092	6788	61,092
	1112	383	3,447	383	3,447
	1113	9528	85,752	9528	85,752
	1114	10677	96,093	10677	96,093
112		14267	128,403	14267	128,403
113		22699	204,291	22699	204,291
114		10850	97,650	10850	97,650
115		2707	24,363	2707	24,363
116		4532	40,788	4532	40,788
117		2920	26,280	2920	26,280
118	*1181*	14436	129,924	14436	129,924
	1182	2910	26,190	2910	26,190
119		135	1,215	135	1,215
120		225	2,025	225	2,025
121		16909	152,181	16909	152,181
122		19885	178,965	19885	178,965
123	*1231*	19677	177,093	19677	177,093
	1232	28341	255,069	28341	255,069
	1233	421	3,789	421	3,789
124			-		-
125		3457	31,113	3457	31,113
126		17514	157,626	17514	157,626
127		10200	91,800	10200	91,800
128		357	3,213	357	3,213
129		383	3,447	383	3,447
130		5370	48,330	5370	48,330
131		26303	236,727	26303	236,727
132	*1321*	6578	59,202	6578	59,202
	1322	15456	139,104	15456	139,104
	1323	11426	102,834	11426	102,834
	1324	1111	9,999	1111	9,999
Total		**3,008,501**	**27,076,509**	**3,008,501**	**27,076,509**

Source: JICA Project Team

d) Green Areas in the New North Cores

As new development cores are planned to the north of Erbil, different types of amenities will be needed to serve the expected future population in the main cores, secondary cores and the residential neighborhoods.

The following tables show the estimated need for green areas, based on the minimum requirement, the optimum and the average.

Option Ⓐ excludes any development in Mandawa, while option accommodates for it.

While these calculations set a generic base for the including of green areas in the planning of new developments, site-specific additional input may be dedicated for each and every core. For instance, Bahirka, Gazna, Ashukan, Daraban and Qafar are centered around the concept of agri-neighborhood, which will be reflected in low percentage of BUA and a high green coverage.

Table 10.3.9 Green Areas: Needs in the North Cores in 2050 - Option A

			WHO Standards for Urban Green Spaces		
Nbr.	**North cores**	**2050 A**	**Minimum WHO requirement** (9 m2/ Individual)	**Ideal WHO percentage** (50 m2/ Individual)	**Average percentage** (30 m2/ Individual) *
1	*Bahirka*	57,600	518,400	2,880,000	1,728,000
2	*Bahirka Core*	20,100	180,900	1,005,000	603,000
3	*Gazna core*	7,200	64,800	360,000	216,000
4	*Gazna Road Corridor*	5,900	53,100	295,000	177,000
5	*Ashukan core*	7,125	64,125	356,250	213,750
6	Ashukan Road corridor	4,050	36,450	202,500	121,500
7	Daraban core	4,875	43,875	243,750	146,250
8	Qafar core	7,200	64,800	360,000	216,000
9	Great Zab Residential	21,950	197,550	1,097,500	658,500
10	Intermediate core 1	4,875	43,875	243,750	146,250
11	Intermediate core 2	4,875	43,875	243,750	146,250
12	Small core 1	2,044	18,396	102,200	61,320
13	Small core 2	2,044	18,396	102,200	61,320
14	Small core 3	2,044	18,396	102,200	61,320
15	Small core 4	2,044	18,396	102,200	61,320
16	AgriNeigh A	160,571	1,445,141	8,028,559	4,817,135
17	AgriNeigh B	N/A	-	-	-
18	Darashakan Res	5,450	49,050	272,500	163,500
19	Darashakan MixedUse	7,250	65,250	362,500	217,500
20	Rashwan Res	7,550	67,950	377,500	226,500
21	Rashwan Mixed	950	8,550	47,500	28,500
22	Mandawa Core	N/A	-	-	-
23	Mandawa MixedUse	N/A	-	-	-
24	Mandawa Residential	N/A	-	-	-
Total		**335,697**	**3,021,275**	**16,784,859**	**10,070,915**

Source: JICA Project Team

Option B assumes that the dam of Mandawa and, consequently the surrounding area, will be developed as an attractive destination, close to the city and as a new core.

Table 10.3.10 Green Areas: Needs in the North Cores in 2050 - Option B

			WHO Standards for Urban Green Spaces		
Nbr.	**North cores**	**2050 B**	**Minimum WHO requirement** (9 m2/ Individual)	**Ideal WHO percentage** (50 m2/ Individual)	**Average percentage** (30 m2/ Individual) *
1	Bahirka	57,600	518,400	2,880,000	1,728,000
2	Bahirka Core	15075	135,675	753,750	452,250
3	Gazna core	7,200	64,800	360,000	216,000
4	Gazna Road Corridor	5900	53,100	295,000	177,000
5	Ashukan core	7,125	64,125	356,250	213,750
6	Ashukan Road corridor	4,050	36,450	202,500	121,500
7	Daraban core	4,875	43,875	243,750	146,250
8	Qafar core	7,200	64,800	360,000	216,000

9	Great Zab Residential	21,950	197,550	1,097,500	658,500
10	Intermediate core 1	4,875	43,875	243,750	146,250
11	Intermediate core 2	4,875	43,875	243,750	146,250
12	Small core 1	2,044	18,396	102,200	61,320
13	Small core 2	2,044	18,396	102,200	61,320
14	Small core 3	2,044	18,396	102,200	61,320
15	Small core 4	2,044	18,396	102,200	61,320
16	AgriNeigh A	N/A	-	-	-
17	AgriNeigh B	153,946	1,385,518	7,697,325	4,618,395
18	Darashakan Res	5,450	49,050	272,500	163,500
19	Darashakan MixedUse	7,250	65,250	362,500	217,500
20	Rashwan Res	7,550	67,950	377,500	226,500
21	Rashwan Mixed	950	8,550	47,500	28,500
22	Mandawa Core	6,375	57,375	318,750	191,250
23	Mandawa MixedUse	2,850	25,650	142,500	85,500
24	Mandawa Residential	2,425	21,825	121,250	72,750
Total		**335,697**	**3,021,277**	**16,784,875**	**10,070,925**

Source: JICA Project Team

10.3.2 Upper-level and Strategic Green Areas

1) Afforestation (GAM-S1)

The Afforestation and Reforestation strategies will be implemented in both the eastern and western afforestation areas, as defined in the IGMP, with redefined boundaries by MP2050 to fit with the other land uses. The main aim to increase the green canopy of the city, in parallel with its urban expansion, to enhance local climate and to form a base for biodiversity and sustainability.

This strategy entails introducing various tree species, increasing the number of drought-resistant plants, and conducting programs to raise environmental awareness. Residents can further access walking trails and observation points to enhance their appreciation of these regions' natural beauty. Moreover, we can significantly improve air quality by demonstrating the effectiveness of these measures in mitigating dust and climate challenges. Enhance the well-being of dwellers.

One main afforestation area is just after the existing Kasnazan forest, as well as 2 smaller areas below it. Note that the mountains and foothills that define Erbil's eastern edge from 800 m above sea level were previously forests, destroyed and cut during and after wars. The new boundary of this Eastern Forest is reduced from the IGBMP proposal.

A smaller area to the west of the city has nice scenic hills. The new proposed footprint is reduced, sitting just behind the village overlapping with the IGB

IGBMP explains the rationale behind the choice of these areas for afforestation, mainly the steep topography. Forestation in such conditions prevents soil erosion and slows surface water runoff, allowing water to infiltrate and recharge groundwater reserves.

The forest serves as a wildlife habitat for native and migratory flora and fauna, in proximity of the eastern foothills to the Kurdish Mountain region

Amenity: use of the area for recreation and nature-related tourism. Visually, reforesting the peaks of the Erbil eastern hill range enhances the view within the city eastwards, building on the perception of Erbil as the gateway to the mountains of the Kurdish Region.

Density of trees: The 4 x 4 m grid may be followed, as per MoAWR recommendations, avoiding the current scenario of sparse trees in Kasnazan forest.

Type of trees: Preferably mixing 3 different types of trees such as Oak, eucalyptus and Wild Pistachio.

Soil tests and in-depth studies will be needed for more specific selection.

2) Building Resilience to Dust Storms in Erbil City (GAM-S1)

Dust storms in KRG, particularly Erbil City, are more common during the dry and windy months, typically in the late spring and summer. These dust storms can originate from various directions, but their prevalence may depend on regional weather patterns and seasonal variations. In general, dust storms in Erbil's direction may come from the following sources:

i) Western and southwestern directions: Dust storms can originate from Iraq's western and southwestern regions, particularly during the dry and windy months. These storms can carry dust and sand from desert areas, such as the Syrian Desert and the western parts of Iraq
ii) Southern directions: Dust storms can also come from the south, carrying dust and sand from the desert regions in southern Iraq and neighboring countries.
iii) 3. Local factors: Local wind patterns and terrain can also influence the direction of dust storms in the Erbil area. For example, if there are dry regions to the southeast or east of Erbil, dust storms may come from those directions.

To reduce and protect Erbil City from dust storms, particularly in areas with significant agriculture activities, a comprehensive approach involving green areas and agriculture practices can be implemented:

Afforestation and Inner Green Belt Development:

Increasing trees and implementing Inner green belts in the southern and southwest areas can act as natural barriers against dust storms. Focus on strategic afforestation in the western and southwestern of the city where dust storms typically originate. Creating a robust Inner Green Belt can serve as a protective buffer zone for the city.

Shelter Belts and Windbreaks:

Encourage the practice of **lattice shelter belts within agriculture areas**. These are rows of trees or shrubs strategically planted to reduce wind speed and trap dust. These shelter belts can help mitigate the impact of dust storms while providing shade and improving soil quality for agriculture, particularly in irrigation projects in Shamamk and the others on the Kirkuk Road Qushtapa area. Choosing the right type of trees is necessary. Not all species purify the air equally.

3) Buffers of green and agriculture around industrial areas (GAM-S1)

The first buffer around the industrial areas is a 100 m width of Paulownia, a hardwood native to Asia, is now being adopted in the UK as a “carbon-sucking” tree. In addition to its carbon capturing ability, the fast-growing Paulownia tree is recognised for the quality and strength of its hardwood timber, which has a range of applications. This means the new plantations will have a commercial timber value too.[8]

[8] https://www.fwi.co.uk/business/business-management/agricultural-transition/the-benefits-of-paulownia-trees-for-farm-net-zero-targets

Source: JICA Project Team

Figure 10.3.11 Forest of Paulownia Trees

Another option is the Albizia Lebbeck. A fast-growing tree, available in Kurdistan and that proved to have high carbon sequestration.[9]

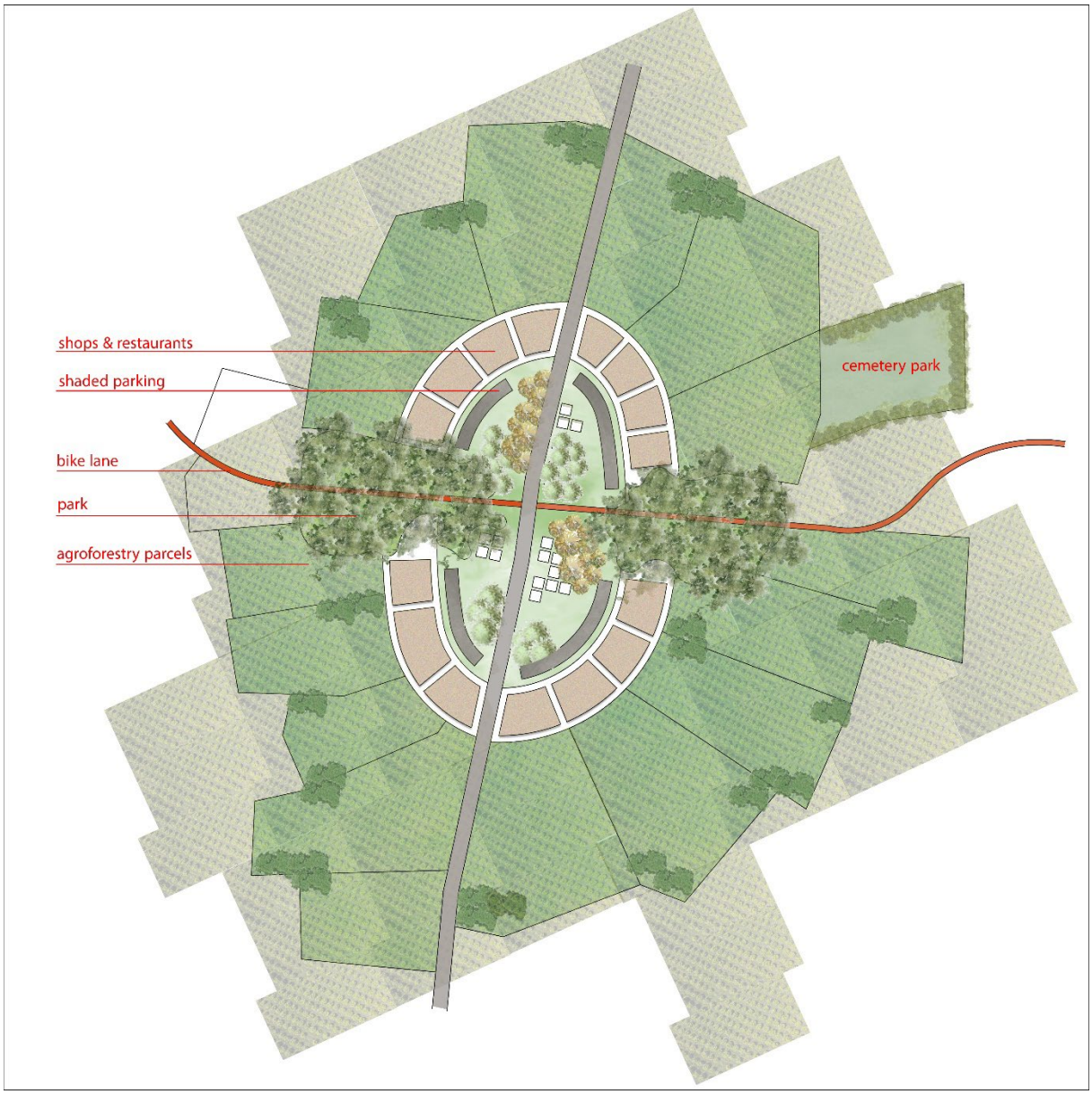
Trees alone will not be able to mitigate the impact of the industries on the air quality. Measures at the level of the operation of the industries are necessary.

4) Urban farming / Agro-nodes (GAM-S3):

FAO (2015) define agroforestry as "a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals". Agroforestry can help support the Sustainable Development Goals such as zero hunger, good health and wellbeing, clean water and sanitation, Decent work and economic growth, Responsible consumption and production…

The figure 10.1.19 illustrates a prototype agroforestry at the intersection of the main road and the green belt. Adjacent to the agroforestry parcels, we propose forest cemetery, a typology that was in included in MP2030. The benefit of forest cemeteries is their participation in the green footprint of the city, in parallel to their aesthetic dimension, their proximity and distribution across the city.

[9] https://www.sciencedirect.com/science/article/pii/S1018364722001598



Source: JICA Study Team

Figure 10.3.12 Prototype of an Agro-Node

The frontage: it will include easy parking + commercial strip including farmers markets, flower shops, artisan and crafts as well as restaurants

The main inspiration for this proposed interface between agriculture and the urban life is the Japanese concept of michi-no-eki.

Michi-no-eki serve as centers for the promotion and sales of locally produced goods to visitors and locals alike. Local products found at michi-no-eki often have a surprising amount of variety, from handmade crafts and specialized products to organically grown crops that change with the seasons.

Source: Google

Figure 10.3.13 Michi-no-eki in Japan

The inner side: The existing agriculture parcels may be merged and re-divided as part of the agro-node masterplan.

Each of the 8 agro-nodes will focus on one type of fruit trees or farming. Proposed agroforests include Olive trees on Makhmur node, Almond trees on Kirkuk node, pistachio trees on Daratu node, berries on Gwer node, Apple trees on Ashukan node, honey production on Kasnazan node, pomegranate trees on Mosul Road and cherries on Shaqlawa road.

Additionally, groves of olive trees are proposed in Gazna secondary node.

Source: Google

Figure 10.3.14 Proposed high density agroforestry

Annex programs:

i) Bike rental and bike lane shortcuts, connected to the main bike lane on RW8. The main purpose is to invite visitors to experience the agriculture lands and to be in direct contact with the farmers.

ii) The cemetery forests. MP2030 introduced the concept of forest cemeteries on a large stretch outside the GB. IGBMP relocated it within GB on Zone Z4.
MP 2050 intends to keep this proposal and to add 8 smaller graveyards, each one adjacent to an agro-node.
International examples have shown that cemeteries may be a main green space in the city: Père Lachaise Cemetery is one of the world's most famous cemeteries and a major tourist attraction in Paris. Opened in 1804, it covers 110 acres and includes numerous trees and wooded areas. The dense tree cover and natural vegetation create a park-like setting that contrasts with the urban environment of Paris.

Zincirlikuyu Cemetery is a notable example of an Islamic cemetery that integrates significant greenery and forested areas within its grounds. Located in Istanbul, Turkey, this cemetery provides an excellent model of how traditional burial practices can coexist with natural landscapes in an urban setting.

Source: https://cityseeker.com/istanbul/892248-zincirlikuyu-cemetery
https://triciaannemitchell.com/2011/09/09/if-headstones-could-talk-pondering-at-paris-pere-lachaise-cemetery/

Figure 10.3.15 Forest Cemeteries in Istanbul and Paris

5) Green network:

The overarching vision of a global green network, or urban green infrastructure, is to connect all existing elements seamlessly. This includes the Inner Green Belt, various green urban typologies within the urban landscape, the primary radial and ringways landscapes, and the southern greenways. It encompasses agriculture activities, including agroforestry, orchard lands, and lattice shelter belts. Furthermore, it incorporates the proposed afforestation areas in the west and east, notably the Kasnazan region. This concerted effort aims to establish a robust global network that offers numerous benefits in terms of sustainability, environmental quality, and biodiversity. It fosters ecological responsiveness, creating a harmonious coexistence of urban and natural elements.

The Southern greenway will connect neighborhoods, parks, and public transportation hubs, encouraging pedestrians and cyclists to utilize them. Additionally, landscaping and beautification initiatives enhance these areas' appeal and ecological significance. To ensure their upkeep, regular clean-up activities and maintenance tasks must be organized with the participation of communities and volunteers.

While the programmatic connection to the Great Zab River is limited, we aim to reinforced it by extensively greening Mosul Road.

In new developments, the green structure plan connects all neighborhoods to the urban forests / parks from the beginning of a project together with infrastructure so everyone has safe access to green.

In existing developments, necessary measures should make neighborhoods safer for bicycles and pedestrians by replacing street crossings with roundabouts or traffic lights along routes to schools, sports and play areas.

International Examples:

The *Promenade Plantée,* also known as the *Coulée verte René-Dumont*, is a pioneering urban park in Paris, France, that exemplifies innovative urban renewal. Established in 1993, this elevated linear park stretches for 4.7 kilometers along a former railway line, the Vincennes railway viaduct, from Bastille to the Bois de Vincennes. The project revitalized a disused industrial space, transforming it into a lush green corridor featuring gardens, pathways, and tree-lined walkways. The Promenade Plantée offers a unique blend of natural beauty and urban scenery, elevated above the bustling streets below. It provides residents and visitors with a serene escape for walking, jogging, and relaxation, while also showcasing diverse plant species and modern landscape architecture. This transformation has enhanced the local

environment, increased property values, and inspired similar projects worldwide, highlighting the potential for creative urban regeneration and the integration of green spaces within city landscapes.[10]

Figure 10.3.16 Paris's Promenade Plantée (Coulée verte René-Dumont)

Wadi Hanifa, a historically significant valley in Riyadh, Saudi Arabia, underwent a remarkable transformation in the early 2000s through a comprehensive rehabilitation project by the Arriyadh Development Authority. This initiative aimed to restore the degraded ecosystem by improving water quality, replanting native vegetation, and implementing flood control measures. The project integrated urban and recreational spaces, creating parks, trails, and picnic areas, while also preserving cultural heritage sites. The restoration significantly improved biodiversity, water quality, and provided a serene environment for residents and tourists. Additionally, it boosted local tourism and increased property values, contributing to Riyadh's economic development. This transformation stands as a model for sustainable urban development, demonstrating the harmonious integration of urban and natural environments.[11]

Figure 10.3.17 Wadi Hanifa: A desert Oasis Running through Riyadh

[10]https://www.researchgate.net/publication/376635200_Micromobility_in_Urban_Trail_Paths_Expanding_and_Strengthening_the_Planning_of_15-Minute_Cities
[11] https://www.arabnews.com/node/1121236/saudi-arabia

6) The corniche rehabilitation

In parallel to the expected project of separating the sewage water from clean water on the corniche canal, it is necessary to give this main asset in the city its full potential as space for recreation. As per regulation, a minimum of 20 m on both sides of the canal shall be protected from any construction. To give it its utmost potential, this area should be landscaped to include green spaces, walkways and gathering areas.

The transformation of the corniche will be reflected positively on all the developments that it crosses through.

Since the canal will be surrounded by walls, we advise creating in specific locations the possibility to get closer to the water. This is a different type of experience that is equally interesting and more contained.

Source: JICA Project Team

Figure 10.3.18 The Corniche – Current Condition

Source: JICA Project Team, Google Maps

Figure 10.3.19 Access to Water in Specific Locations: Example of Shakuji River in Tokyo

Source: JICA Project Team + Google Earth

Figure 10.3.20 Empty Areas along the Corniche with Intervention Potential

7) The Wetland Park

As mentioned above, the Wetland Park or West Park sits on a ground recharge zone. 2 lakes will be implemented as water collectors. Water, meadows and wood decks create the main character of this park, along with clusters of trees and punctual rest areas. It is an ideal place to relax, recharge and reconnect with nature while still being in the city.

The existing wheat agriculture on this land will have to be relocated.

Source : https://www.thewilddeckcompany.co.uk/raised-boardwalk-wetland-boardwalk-design/

Figure 10.3.21 Raised Boardwalk & Wetland Boardwalk Design

Source: Google

Figure 10.3.22 Raised rest areas shaded by trees

8) Diversification of urban green spaces

Public spaces are an integral part of any city. They should offer the possibility of connect with nature and also to connect with others. Urban parks and gardens are one for of public spaces.

Safe accessible green spaces invite people to go out and create an opportunity for them to meet others. Not only does this move affect the physical and mental health, but it also allows people to observe and talk.

Semi-Private and shared green

Community gardens, especially in densely urbanized areas are the lungs of the communities and their meeting point. These spaces are ideal for physical activities, the ideal outing for elderly and possibly a space for shared gardening and farming.

Private green

Private gardens add to the green footprint of the city, participate in the impervious ground, increase biodiversity in the city, helps keep streets and houses cooler, makes neighborhoods attractive.

Residents should be encouraged to plant their outdoor spaces, through campaigns, incentives and shared examples. The citizens of Erbil perceive the city very differently from their countryside where farming and planting is very present. Erbil should learn from developed cities such as Paris and Scandinavian capitals, on the possibility of merging urban lifestyle with greenery.

9) Water efficiency management and irrigation:

In line with the Inner Green Belt Master Plan for Erbil City, a crucial component of the development strategy involves sustainable water management and irrigation methods to ensure the vitality of green areas and the green belt. To address water deficiency issues (GAM-06), the plan emphasizes the development of artificial ponds and dams in the northern and northwestern parts of the city, particularly in the recharge zone. These artificial ponds and dams will serve as crucial water storage and recharge infrastructure, harnessing rainfall and surface water runoff during wet seasons to replenish groundwater and provide a sustainable water source for irrigation purposes in dry periods. Furthermore, the Great Zap Water Extension Branch, Bastora, and Mandawa Dams will be pivotal in augmenting the city's water supply, specifically focusing on supporting green areas and agricultural activities within the green belt. As a part of the overall water management strategy, modern and efficient irrigation methods, such as drip irrigation and rainwater harvesting systems, will be deployed across green

10) Green Rooftops (GAM-S8-2)

The idea of green rooftops, although popular now, may be traced back to as old as ancient Mesopotamia, from the trees and shrubs covering the Ziggurat of Nanna to the hanging gardens of Babylon.

A green roof is the roof of a building that is fully or partially covered with vegetation. Green roofs serve several purposes for a building, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, in parallel to their aesthetic role, the sense of well-being and shared space by the residents.

The city of Chicago in the United States of America sets an example of green rooftops. “Chicago is one of the leading cities for green roofs, with 450 buildings using the technique. In the new, ambitious climate plan from 2008, the city plans to lay 6,000 green roofs by 2020. City authorities hope in this way to combat the urban heat island effect, which Chicago has severe problems with. It is also an adaptation to climate change, which is expected to include more serious heat waves’ [12]

Source: Courtesy of the Chicago Botanic Garden

Figure 10.3.23 The McCormick Place Rooftop Farm

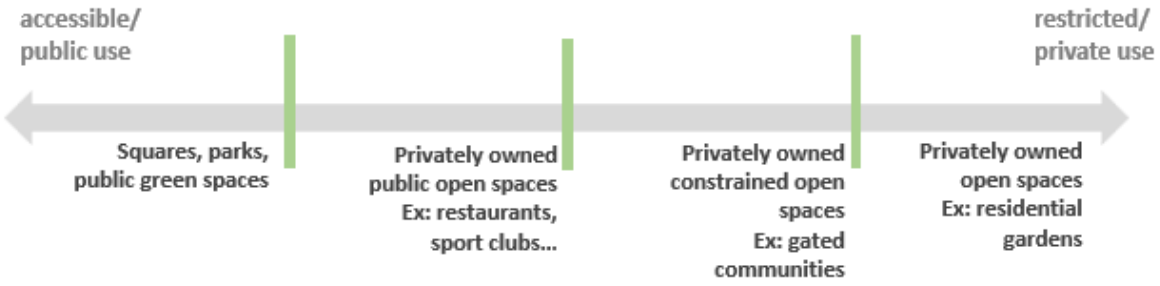
[12] https://wwf.panda.org/wwf_news/?204400/Chicago-green-roofs

(2) Additional Planning & Implementation Improvement Measures

1) Accessibility, Availability and quality of urban green spaces

By observing the map of green spaces in Erbil, we notice a large number of green spaces, of variable sizes. However, the map does not reflect the accessibility to these spaces, which in many cases are private to institutions such as universities, schools or private clubs.

This is why, in planning for green spaces in a city, availability is not enough of criteria. Green spaces need to be accessible by the largest number of people, at a close proximity. In parallel, it has to be well implemented, well maintained and safe.



Source: JICA Project Team

Figure 10.3.24 Understanding Accessibility to Green Spaces

Accessibility is another challenge for 2 main reasons. Private and semi-private green spaces serve a limited number of users. This is why public green should be provided, especially within the most vulnerable communities.

A second challenge to accessibility is physical access. People should be able to access a near-by green space, without the need for a car.

By applying strategies and policies to enhance safe access to green areas (**GAM-S9-2:**), a set of measure would improve access and diversity in urban green typologies. Enhanced accessibility of public parks will be achieved through improved pedestrian and bicycle infrastructure and transportation connectivity. Furthermore, neighborhood parks must be developed in underserved communities based on priority areas, featuring diverse green typologies like playgrounds, picnic areas, fitness zones, and water features. A rigorous maintenance schedule ensures the cleanliness and safety of these areas.

2) Greening the schools: (GAM-S11-4)

Nowadays, children are spending less time in nature – especially in under-privileged neighborhoods_ although more researches are tracing the strong positive associations between urban nature and child well-being, including benefits related to mental and physical health.

Green schools represent a transformative approach to education, emphasizing sustainability, environmental responsibility, and the well-being of students and staff. It goes beyond the physical space, to educate young citizens and create an awareness from young age, on issues related to energy, waste, water and climate and their application within the school space.

Providing a green space within the school should not be limited to the privileged few. This is where initiatives can play a major role in funding green spaces in schools in the city, for kids to meet, play, learn from nature and in nature. School gardens also participate to the total green footprint of the city.

The UNESCO acknowledges “how planting mini forests in urban schools, nurtures biodiversity and inspires environmental stewardship.” It specifically mentions the Miyawaki forest revolution of a concept that traces back to the 1970s, when Japanese Botanist Akira Miyawaki witnessed the decline of forests across Japan. Yet amidst this ecological distress, he noticed resilient pockets of primary forest surrounding temples and shrines. Inspired by these natural wonders, he crafted the Miyawaki method,

planting mini forests across Japan and Southeast Asia.[13]

3) Strengthening Legal and Institutional Framework:

Green spaces are the most vulnerable dimension of the city of Erbil land uses, not in terms of land use change but in terms of implementation, as they are not perceived by the state as an urgency or by the private sector as a source of revenue.

Monitoring is essential in order to endure the implementation of planned green areas, and the preservation of their quality. Responsibility should be given UPDOE or another assigned authority.

The development plan will enhance the Legal and Institutional Framework for Green Area Management. This involves updating and enforcing planning and environmental regulations to incorporate provisions for managing areas.

Additionally, establishing an authority for green area management will be vital at the level of the Green Belt. This authority will oversee planning, implementation, and maintenance activities while providing training programs for city officials and staff involved in green area management.

4) Temporary Urbanism (GAM-S10-3)

Temporary urbanism refers to short-term, mostly low-cost initiatives on underutilised, vacant or public lands. It aims to revitalise local life for economic or social gain, during the period of time that precedes the implementation of the final use or project on this land.

Setting temporary uses on vacant land is equally beneficial to landlords or the public sector, direct users and the community at large. For the land owners, there is certainly an economic benefit. In parallel, the temporary use may help the different stakeholders in identifying the best future uses of the land bases on people practices.

Green is usually a main dimension of temporary projects such as picnic areas, fitness zones, play areas. The size of the parcel may vary from a residual land within a dense urban tissue to a full exposure, prime location land.

Source : https://www.archdaily.com/

Figure 10.3.25 Examples of Temporary Urbanism and Green Acupuncture

5) The importance of design and the aesthetic dimension of green spaces

Integrating nature in the urban connect has a restorative value as it helps balance the stress of the city, the noise, the pollution, the rush and the visual disturbance. This is why the green spaces should have the visual and aesthetic characteristic to uplift the users, to create a positive, joyful, refreshing and

[13] https://www.unesco.org/en/articles/forest-school-unveil-grey-couplands-miyawaki-forest-revolution-unesco-green-citizens-podcast

calming experience.

High quality green space should be easily accessible, by foot or by bike. It should also be designed to be safe and easy to navigate by children, elderly and people with special needs. Additionally, aesthetically pleasing and properly designed green spaces can foster a sense of pride and ownership among residents, encouraging them to maintain and care for these areas.

6) The economic value of parks and green spaces

Increasing high quality green space can generate wide-ranging economic benefits. Worldwide, there a direct link between the value of a property and it's a proximity to a park or green belt or a major green space. This is why private developers invest in shared green paces, water features, walkable pathways and even gold courses.

In parallel to increasing the value of nearby residential assets, green spaces stimulate local economies. They offer recreational opportunities that draw visitors, leading to increased spending in nearby businesses such as restaurants, shops, and hotels.

7) Green as a global approach

Green urban planning represents a holistic approach to city development that prioritizes sustainability, resilience, and the well-being of residents. Increasing the green footprint of the city of Erbil is a major step towards its sustainability. Nevertheless, it won't be enough without a comprehensive methodology.

By integrating green infrastructure, promoting sustainable transportation, enhancing energy efficiency, managing waste effectively, and conserving water, the city of Erbil can create healthier, more livable environments that benefit both people and the planet. Pairing practices with legislations and adopting a collaborative approach, Erbil can make it successfully towards a sustainable city in 2050.

CHAPTER 11
IMPLEMENTATION STRATEGY

11.1 Phased Implementation Schedule

(1) Presentation of the Phased Implementation Schedule

It is expected that the implementation of Erbil 2050 MP starts immediately after the end of the official approval process by KRG (see PART IV), i.e. by the end of 2024, and to be on the safe side, 2025 has been chosen as the first year of the MP implementation period.

The 25-year period of expected MP implementation, from 2025 to the planning horizon 2050, has been divided into the 5 following major phases:

- Phase 1 from 2025 to 2030;
- Phase 2 from 2030 to 2035;
- Phase 3 from 2035 to 2040;
- Phase 4 from 2040 to 2045;
- Phase 5 from 2045 to 2050.

The Phased Implementation Schedule is a crucial tool for the implementing organizations to prioritise development in a particular area of the city, to source adequate funding to finance the different development in a timely manner, and to coordinate harmoniously the development between all different sectors. It provides the government, community, donors and investors with rationale to prioritize infrastructure and associated urban services to incrementally develop in a phased manner. It is therefore crucial that the Phased Implementation Schedule gains ownership and authority throughout KRG public organizations and is acknowledged and followed by all the relevant actors.

(2) Enforcement & Monitoring of the Phased Implementation Schedule

In that sense, it is advised that MoMT/GDUP takes a leading role into enforcing and monitoring the progress of the Phased Implementation Schedule. In terms of enforcement, it is advised that MoMT/GDUP publicize a 5-Year Development Programme with financial plans for each phase. The sequencing of development according to the phasing plan shall require flexibility that is responsive to the market demands. The provision of infrastructure and services planning shall be carried out incrementally and align with 5-year Development Programme. However, each phase shall contain adequate infrastructure and other public facilities to allow the phase to stand on its own without depending on the development of subsequent phases. The prioritization of developmental activities within each phase shall consider, any relocation of people, land management approaches, funding availability, and relevant policies and legislation, that maybe required.

(3) Contents of the Phased Implementation Schedule

The Phased Implementation Schedule, shown in the next pages, contains interlinked phasing calendars for each sector. For each sector, the strategies, policies and Short-term and Priority Projects (see Section 11.2) are given an implementation phasing, the organizations in charge of the implementation, and an estimated cost in millions of USD for implementation. Table 11.1.1 below explains the different phases.

Table 11.1.1 Typology of Implementation Phases

Colour	Phase Name	Description
	Preparation	Conducting initial planning required before the actual development begins: this includes identifying project objectives, stakeholder engagement, securing funding, and setting up project governance structures, etc.
	Implementation of studies	Conducting detailed studies and assessments necessary for the implementation: this may include from technical feasibility studies to detail design for infrastructure, detail plan for urban development, etc.
	Approval/ Legalization	Obtaining the necessary approvals and legal authorizations of the studies implemented earlier from relevant authorities: this includes approval of urban plans, feasibility studies, etc.
	Land Acquisition/ Attribution	Acquiring the land needed for the development: this includes negotiations with landowners, compensation arrangements, resolving any disputes, and official attribution or allocation of land for the project.
	Construction	Physical building of the development. This includes site preparation, construction of buildings, roads, utilities, and other necessary structures.
	Capacity Building of KRG	Enhancing the capabilities of KRG to manage and sustain the development: it involves training, development programs, and institutional strengthening to ensure the KRG has the necessary skills and resources to oversee the project's implementation and operation.
	Operation by KRG solely	In this final phase, the KRG takes over the full operation and maintenance of the project. This includes managing the infrastructure, ensuring its effective use, and conducting regular maintenance and upgrades as necessary to sustain its functionality and benefits.

Source: JICA Project Team

11.1.1 Implementation of Urban Development

Figure 11.1.1 shows the phased implementation schedule of Urban Development sector.

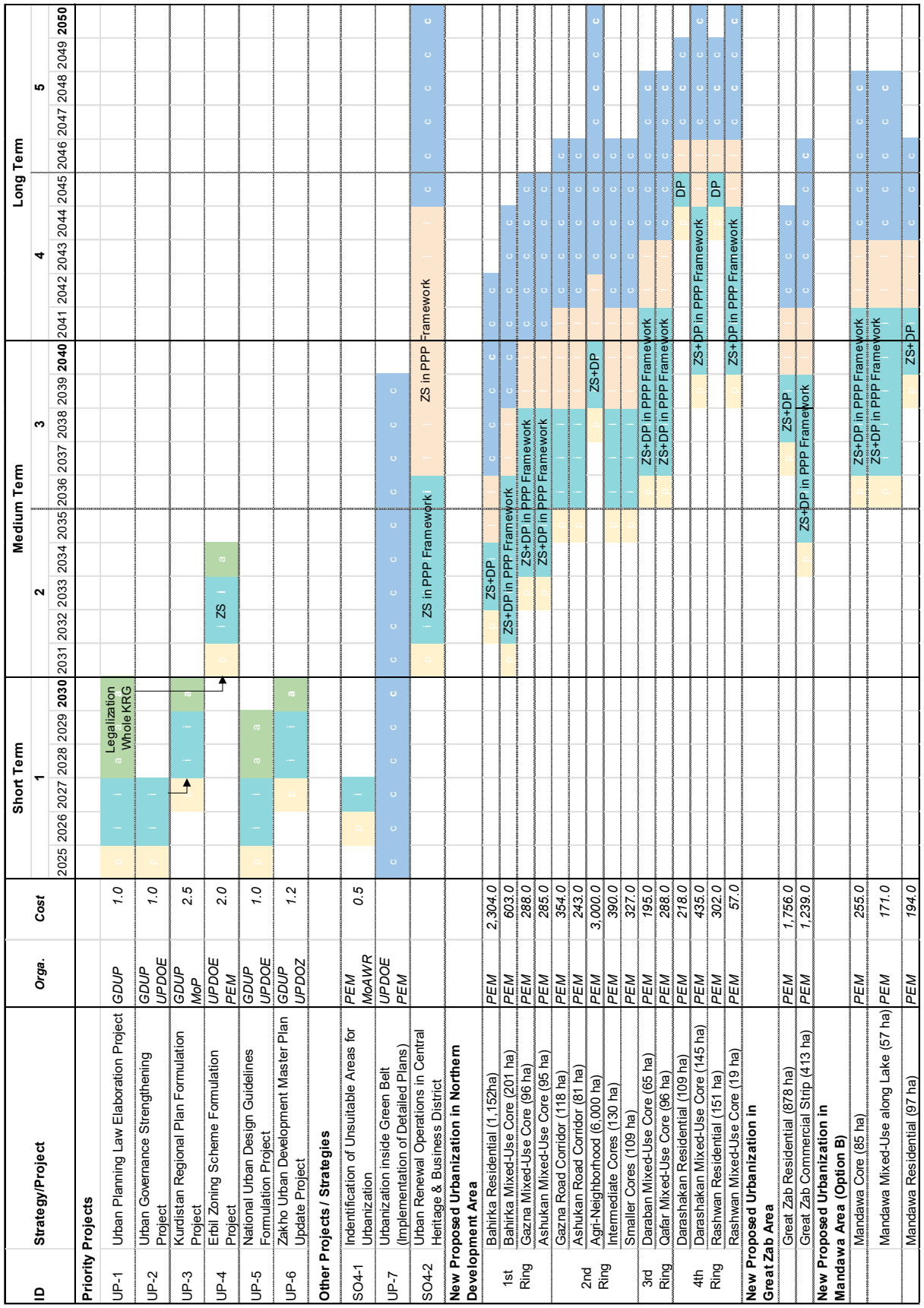


Figure 11.1.1 Phased Implementation Schedule: Urban Development

11.1.2 Implementation of Urban Transportation Development

Figure 11.1.2 shows the phased implementation schedule of Urban Transportation Development sector.

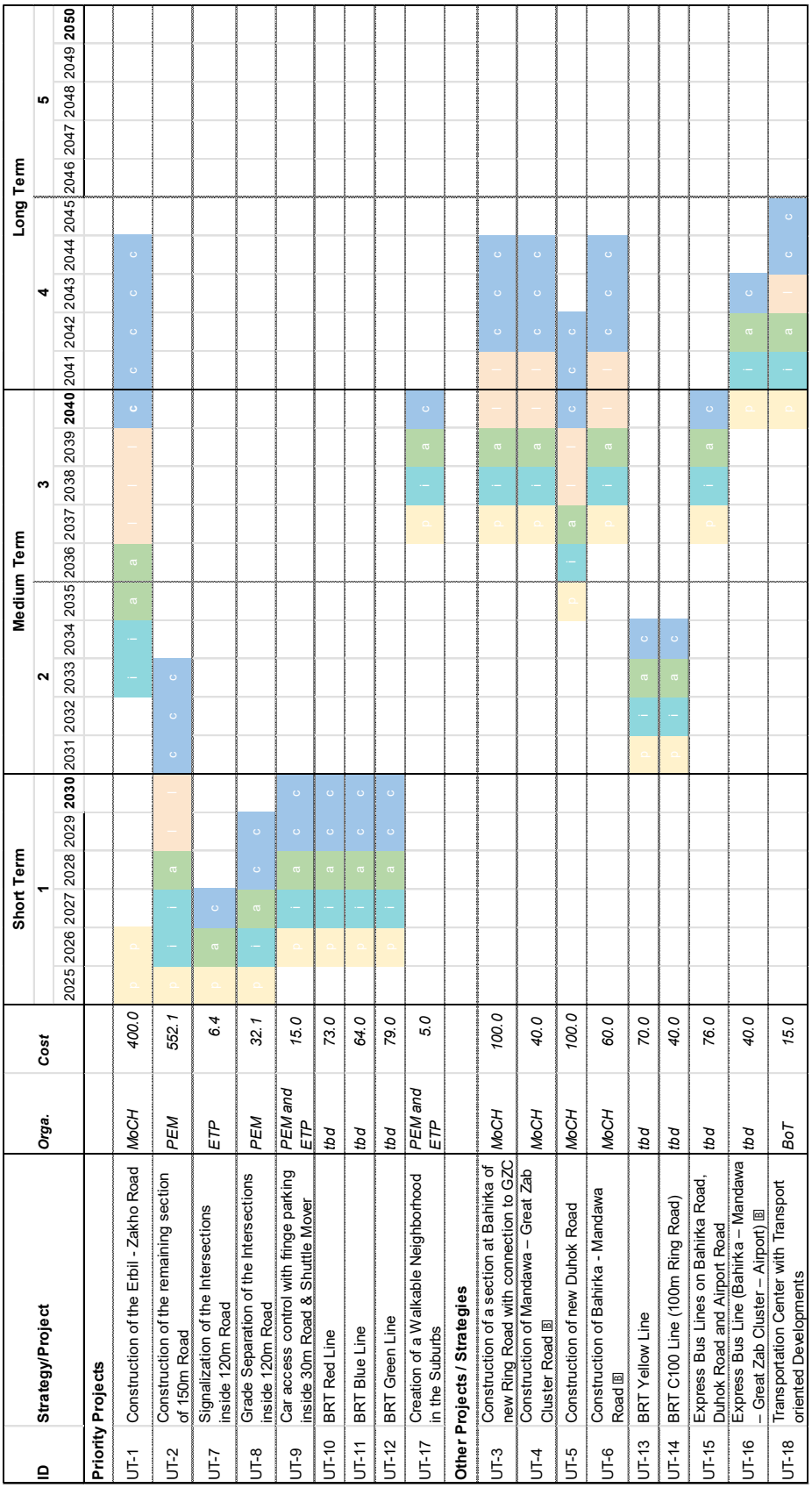


Figure 11.1.2 Phased Implementation Schedule: Urban Transportation

11.1.3 Implementation of Water Resources Development

Figure 11.1.3 shows the phased implementation schedule of Water Resources Development sector.

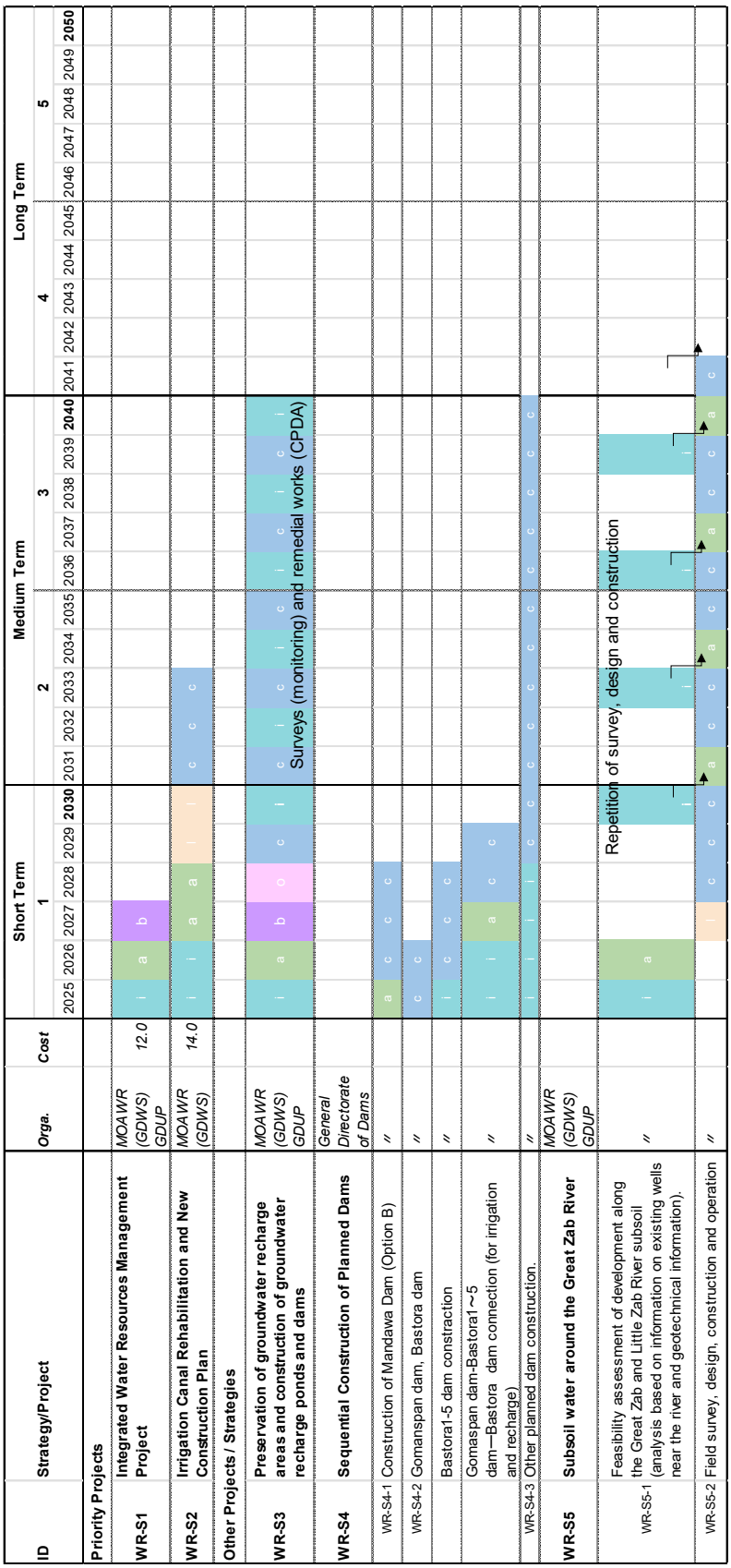


Figure 11.1.3 Phased Implementation Schedule: Water Resources

11.1.4 Implementation of Water Supply Development

Figure 11.1.4 shows the phased implementation schedule of Water Supply Development sector.

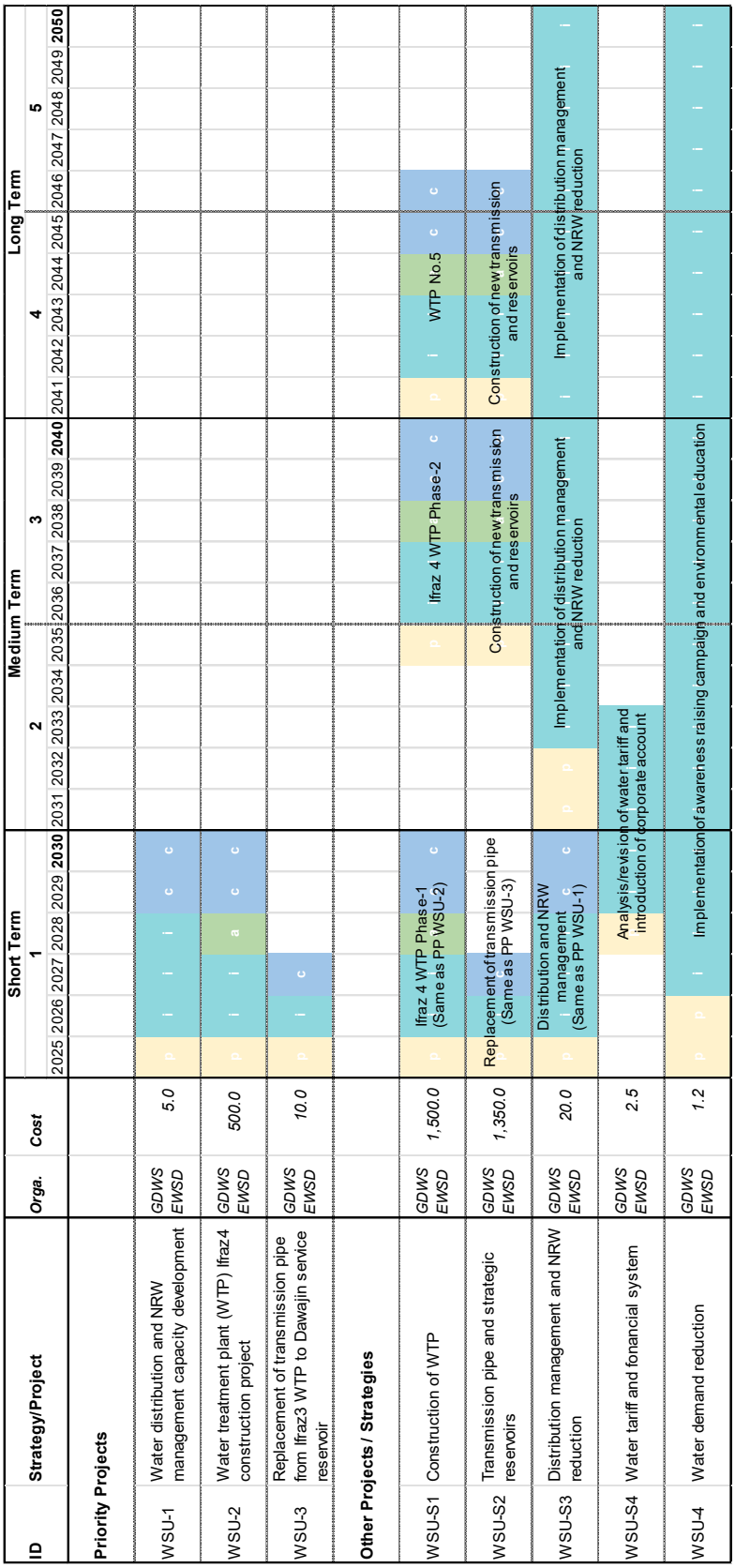


Figure 11.1.4 Phased Implementation Schedule: Water Supply

11.1.5 Implementation of Sewerage Development

Figure 11.1.5 shows the phased implementation schedule of Sewerage Development sector.

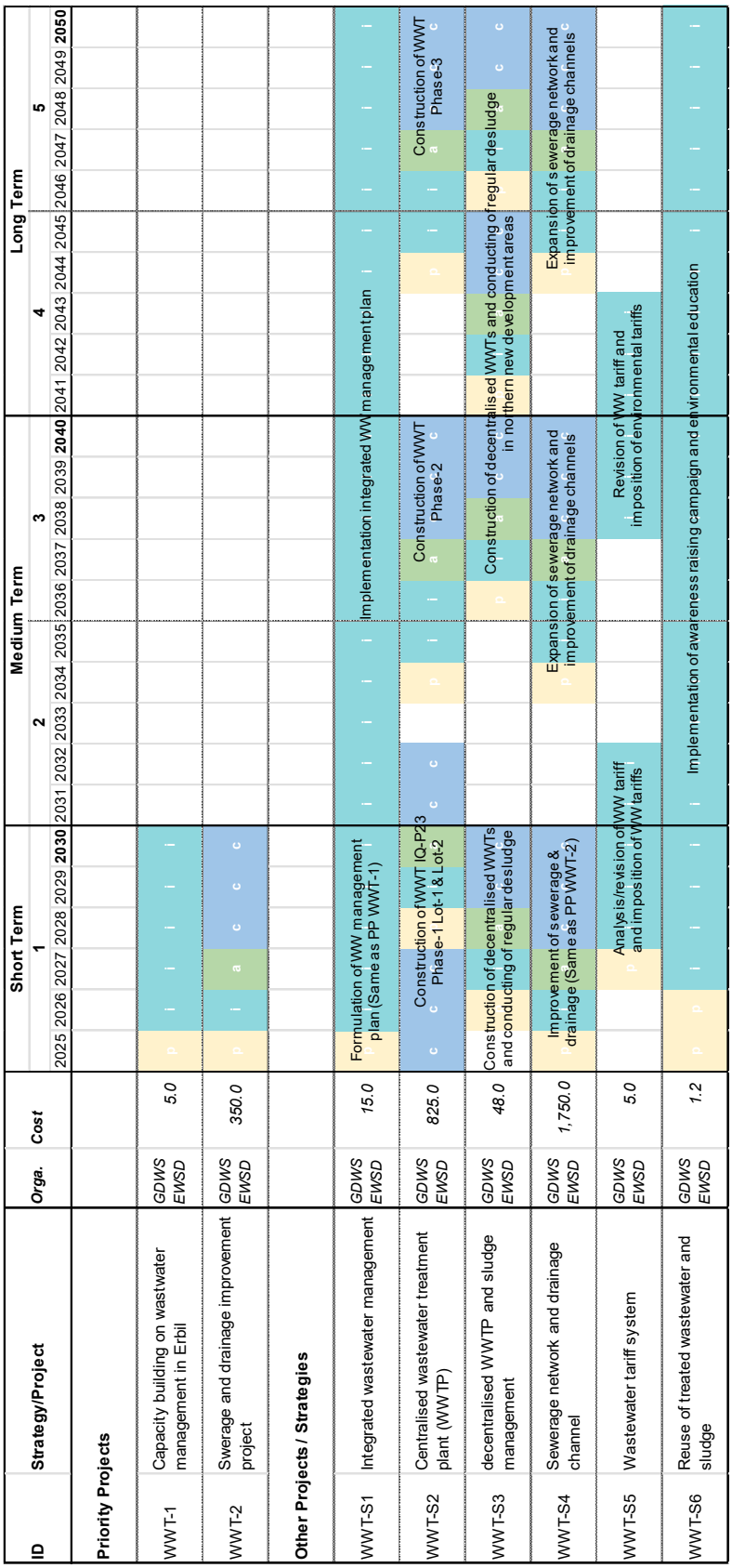


Figure 11.1.5 Phased Implementation Schedule: Sewerage

11.1.6 Implementation of Solid Waste Management

Figure 11.1.6 shows the phased implementation schedule of Solid Waste Management sector.

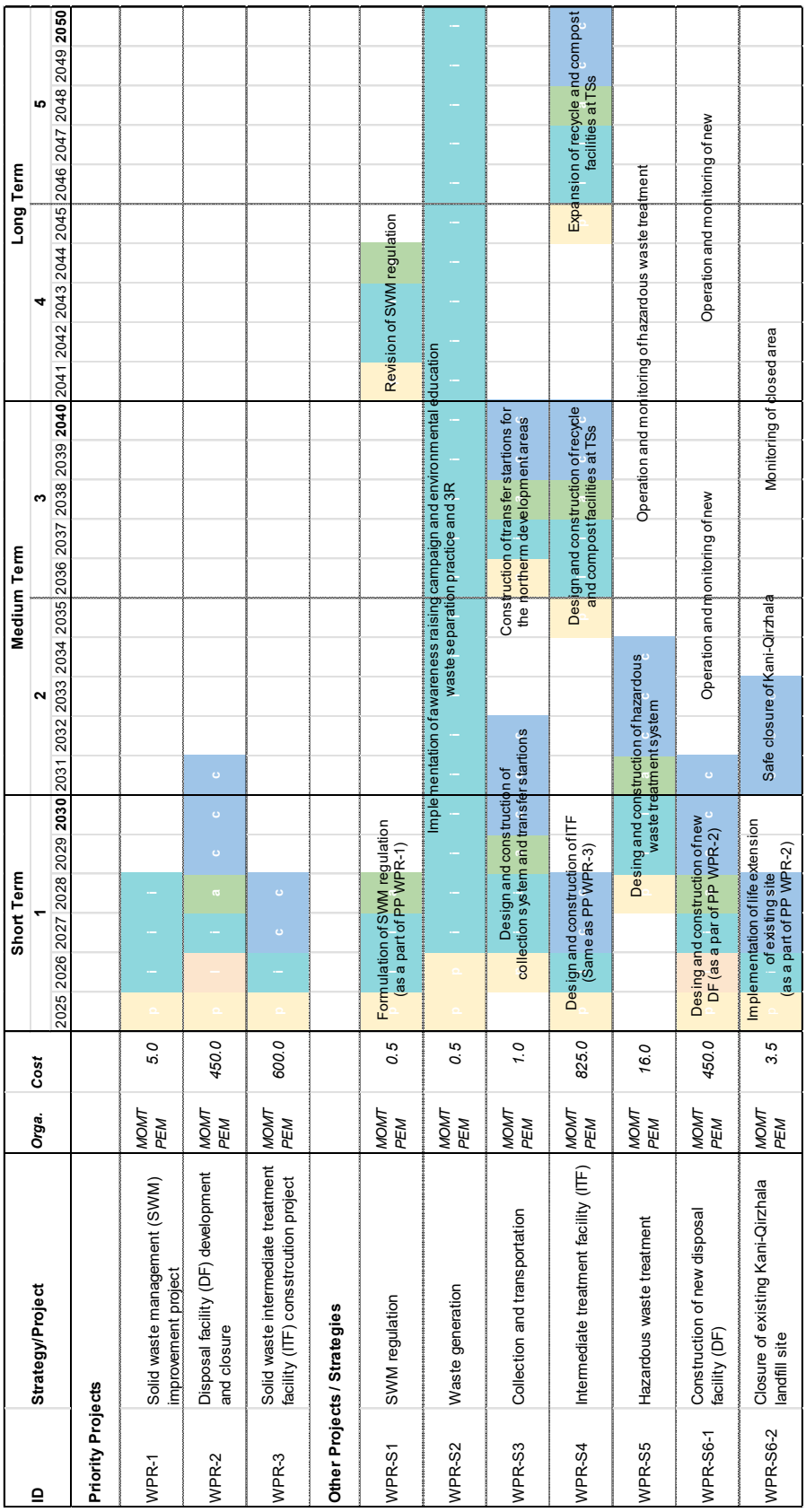


Figure 11.1.6 Phased Implementation Schedule: Solid Waste Management

11.1.7 Implementation of Power & Energy Development

Figure 11.1.7 shows the phased implementation schedule of Power & Energy Development sector.

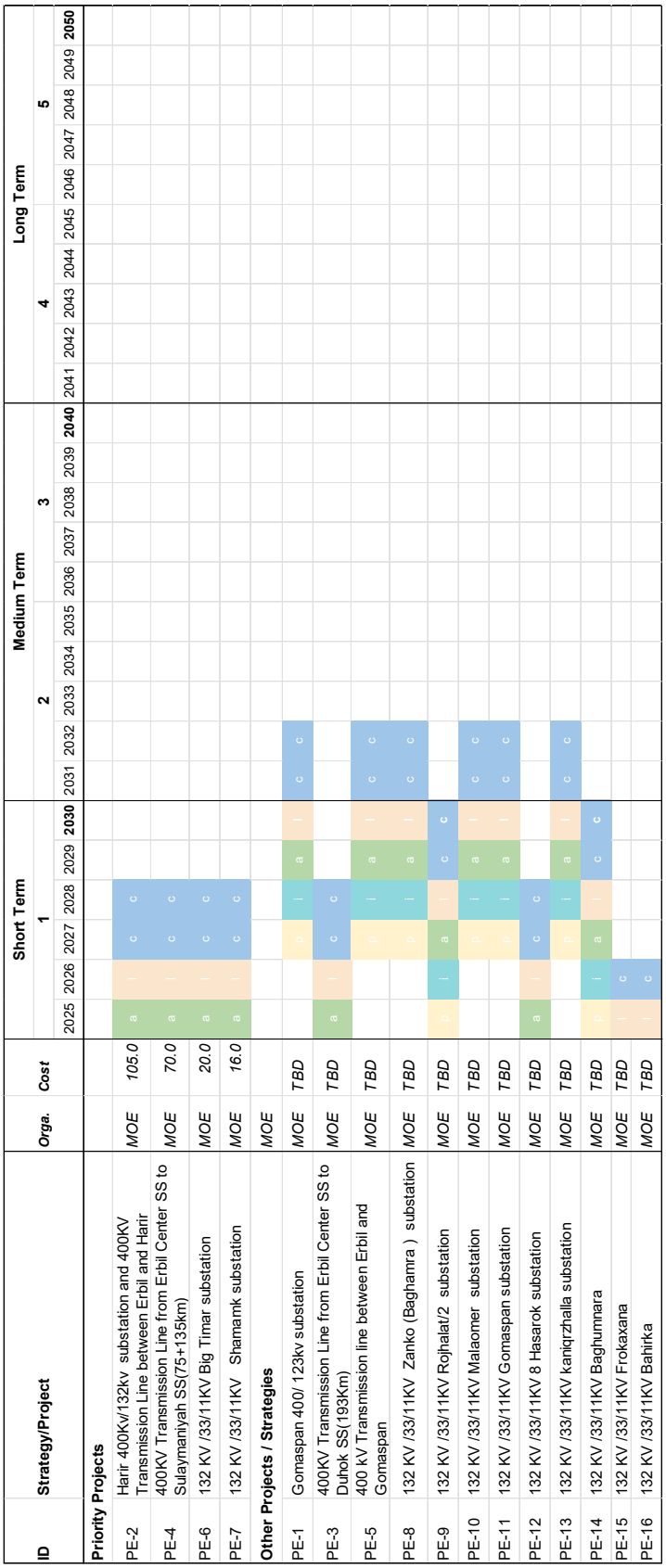


Figure 11.1.7 Phased Implementation Schedule: Power & Energy (1/2)

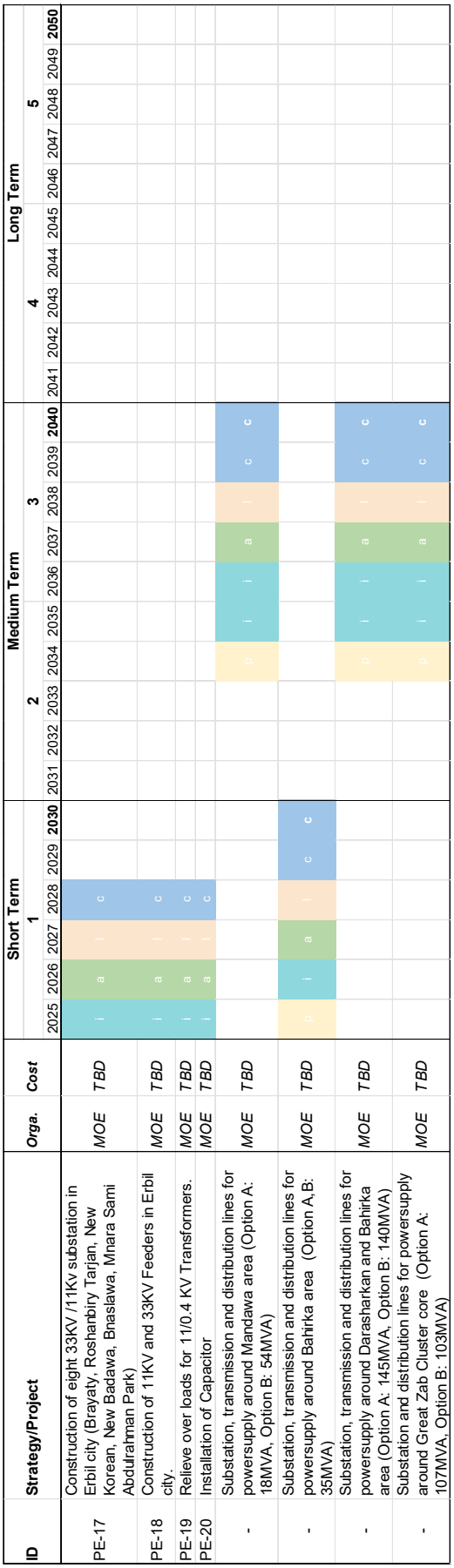


Figure 11.1.7 Phased Implementation Schedule: Power & Energy (2/2)

11.1.8 Implementation of Telecommunications Development

Figure 11.1.8 shows the phased implementation schedule of Telecommunications Development sector.

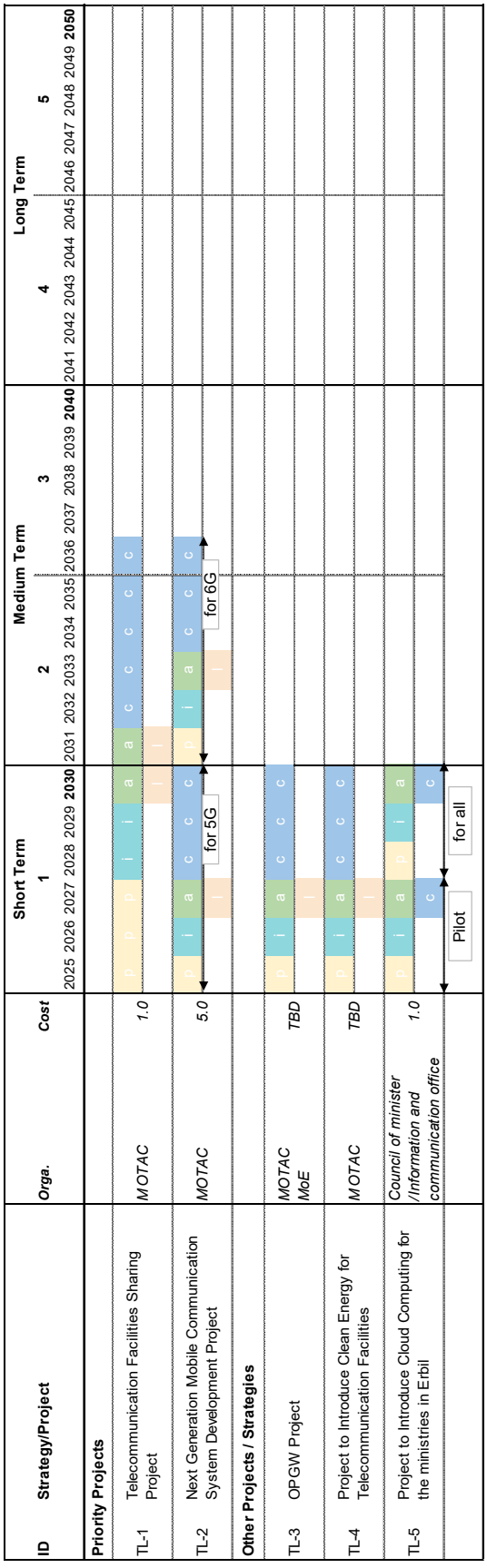


Figure 11.1.8 Phased Implementation Schedule: Telecommunications

11.1.9 Implementation of Public Facilities Development

Figure 11.1.9 shows the phased implementation schedule of Public Facilities sector.

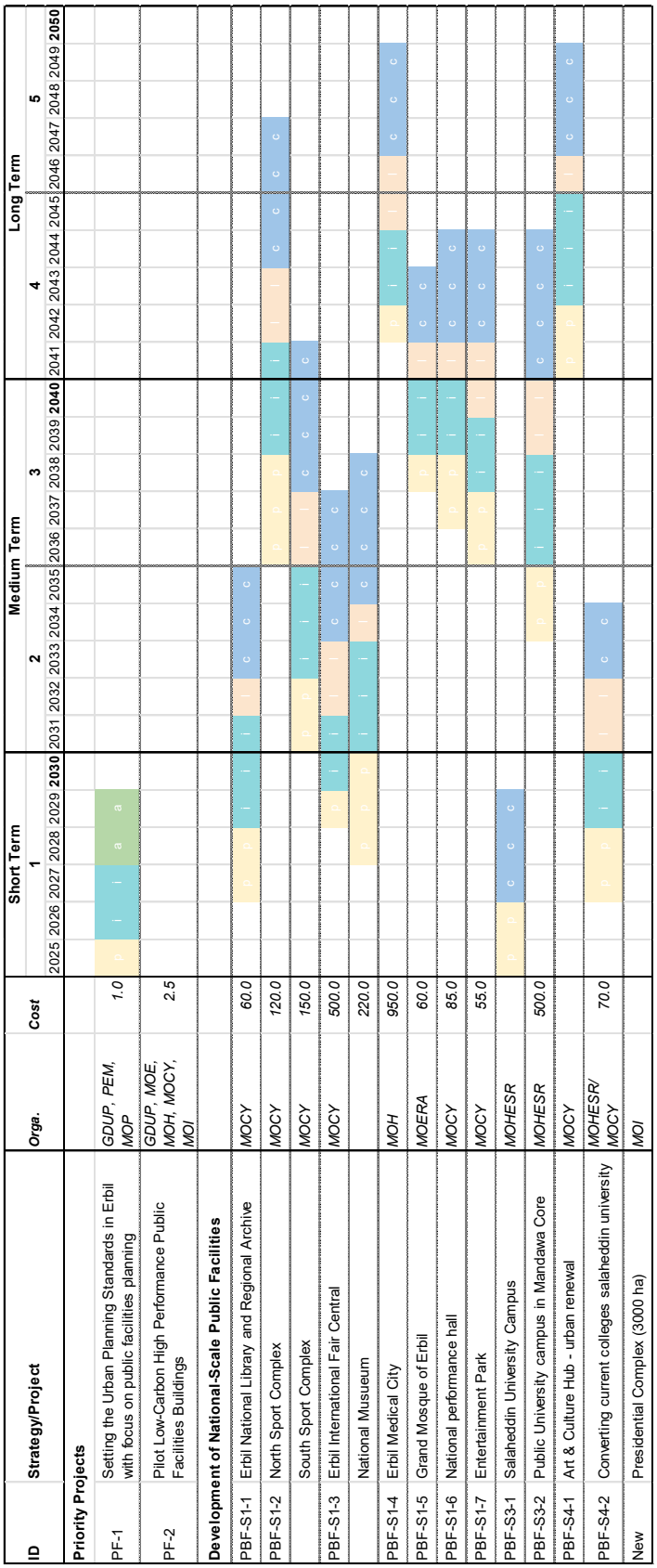


Figure 11.1.9 Phased Implementation Schedule: Public Facilities

11.1.10 Implementation of Green Area Development

Figure 11.1.10 shows the phased implementation schedule of Green Area sector.

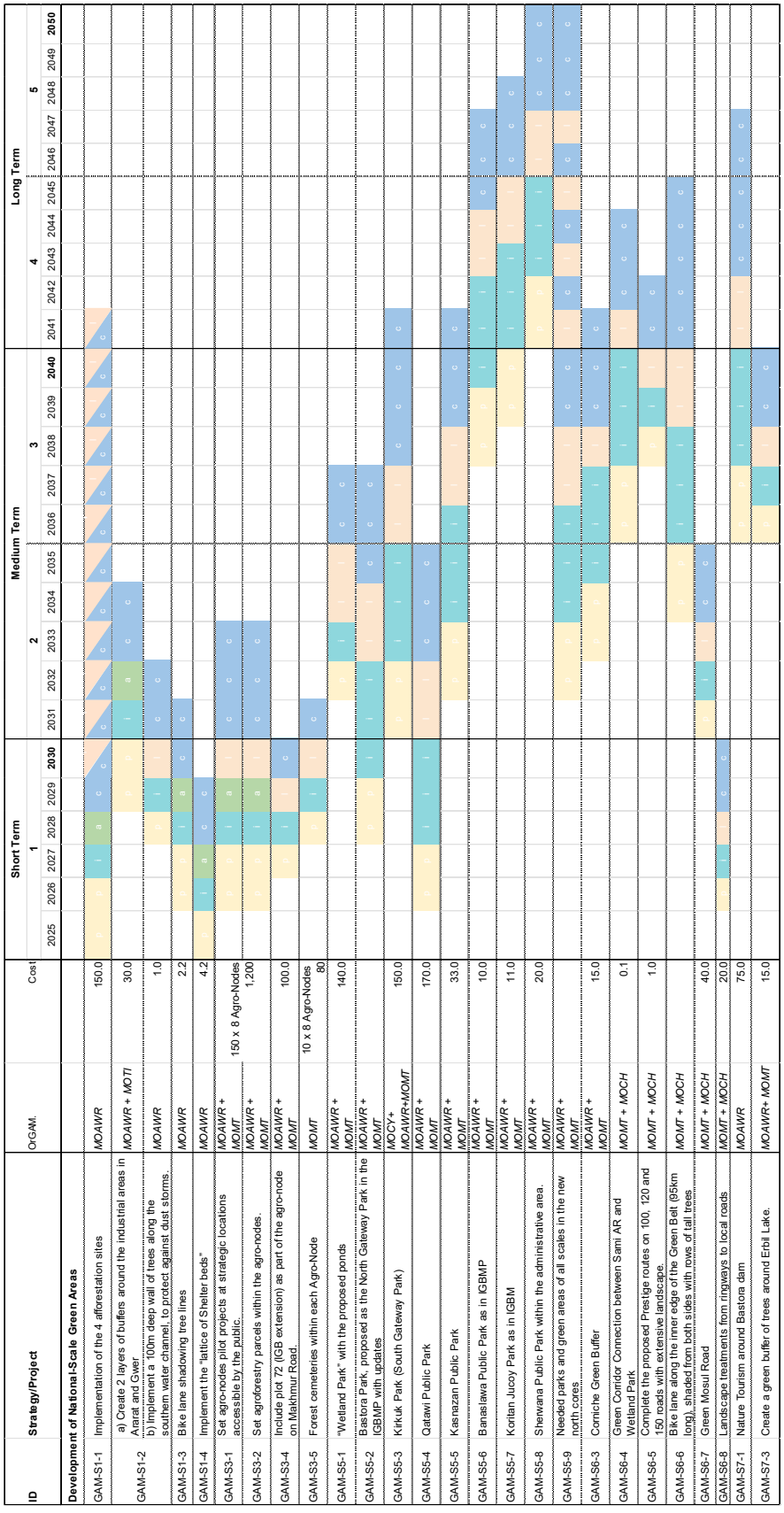


Figure 11.1.10 Phased Implementation Schedule: Green Area

11.2 Short-term & Priority Projects

11.2.1 Establishment of Evaluation Criteria

The projects and programs are proposed in the sector development plan of the Erbil 2050 MP. Among these projects and programs is a set of Priority Projects, which have been selected by scoring the short-term projects in relation to the evaluation criteria. The short-term projects are the projects and programs that should be commenced in the short term until 2030. They will be preferably completed in the short term, but timing of their completion can be expanded to the medium term until 2040 and the long term until 2050.

The evaluation standard is established to reflect the Strategic Orientations (SO) proposed in the Erbil 2050 MP (See Section 5.4). The strategic orientations include the following seven aspects.

- SO1: Establish the foundations for urban sustainability, resilience and adaptation to climate change
- SO2: Improve international competitiveness through regional connectivity and integration
- SO3: Promote innovative & diversified economy and boost employment
- SO4: Intensify the metropolitan area through a new multi-core and fluid model
- SO5: Build a strong, efficient and resilient infrastructure network providing sufficient service
- SO6: Create livable and human-scale neighborhoods connected through public transportation
- SO7: Encourage strong Kurdish identity into the promotion of sustainable tourism

The evaluation standard also includes urgency.

11.2.2 Short-term Projects by Sector

A total number of 71 projects are proposed for the short-term projects from the sector development plan. Those projects are evaluated in respect of the evaluation criteria including urgency. Evaluation point for each evaluation criteria is shown in Table 11.2.1 below.

Table 11.2.1 Evaluation Point by Evaluation Criteria

Evaluation Criteria	Evaluation Point
i) SO1: Establish the foundations for urban sustainability, resilience and adaptation to climate change	3
ii) SO2: Improve international competitiveness through regional connectivity and integration	1
iii) SO3: Promote innovative & diversified economy and boost employment	1
iv) SO4: Intensify the metropolitan area through a new multi-core and fluid model	1
v) SO5: Build a strong, efficient and resilient infrastructure network providing sufficient service	1
vi) SO6: Create livable and human-scale neighborhoods connected through public transportation	1
vii) SO7: Encourage strong Kurdish identity into the promotion of sustainable tourism	1
viii) Urgency	2

Source: JICA Project Team

The short-term projects are classified into 13 sectors, namely, urban planning including GIS data management, economic & industrial development, urban transportation, water resources & irrigation, water supply, sewerage, solid waste management, power & energy, telecommunications, flood management, public facilities, environmental management, and climate change adaptation. The Priority Projects are selected from the short-term projects in each category.

Table 11.2.2 shows the List of Short-term Programs and Projects by Sector as well as their score against Evaluation Criteria.

Table 11.2.2 List of Short-term Programs and Projects by Sector

Project	**SO1**: Establish the foundations for urban sustainability, resilience and adaptation to climate change	**SO2**: Improve international competitiveness through regional connectivity and integration	**SO3**: Promote innovative & diversified economy and boost employment	**SO4**: Intensify the metropolitan area through a new multi-core and fluid model	**SO5**: Build a strong, efficient and resilient infrastructure network providing sufficient service	**SO6**: Create livable and human-scale neighborhoods connected through public transportation	**SO7**: Encourage strong Kurdish identity into the promotion of sustainable tourism	Urgency	**Total Score**	**Priority & High Priority Project**
Urban and Regional Planning										
UP-1 Urban Planning Law Elaboration Project	1	1	1	1		1		2	**7**	◎
UP-2 Urban Governance Strengthening Project	1			1	1	1	1	1	**6**	○
UP-3 Kurdistan Regional Plan Formulation Project		1	1		1		1	1	**5**	○
UP-4 Erbil Zoning Scheme Formulation Project	1		1	1		1		1	**5**	○
UP-5 National Urban Design Guidelines Formulation Project	1	1		1		1	1	1	**6**	○
UP-6 Zakho Urban Development Master Plan Update Project		1							**1**	
Economic & Industrial Development and Investment Promotion										
EI-1: Erbil Rural Area Comprehensive Economic Development Project			1				1	2	**4**	○
EI-2: Erbil Citadel Revitalization & Urban Heritage Enhancement Project			1	1		1	1	1	**5**	◎
Urban Transportation										
UT-1 Construction of the Erbil - Zakho Road					1	1	1	1	**4**	○
UT-2 Construction of the remaining section of 150m Road					1	1	1	1	**4**	○
UT-3 Construction of a section at Bahirka of new Ring Road (probably Ring Way 13 of 2007MP) with connection to Great Zab Cluster				1	1	1			**3**	
UT-4 Construction of Mandawa – Great Zab Cluster Road B				1	1	1			**3**	
UT-5 Widening of Gazna Road				1	1	1			**3**	
UT-6 Construction of Bahirka - Mandawa Road B				1	1	1			**3**	
UT-7 Signalization of the Intersections					1	1	1	2	**5**	◎
UT-8 Grade Separation of the Intersections					1	1	1	1	**4**	○
UT-9 Car access control with fringe parking system inside 30m Road & Shuttle Mover					1	1	1	2	**5**	◎
UT-10 BRT Red Line (Airport – Ainkawa – Qarat – Kirkuk Road/120m Road)					1	1	1	1	**4**	○
UT-11 BRT Blue Line (New Hawler/120m Road – Pirman Street – 30m Road – Makhmur Road/120m Road)					1	1	1	1	**4**	○
UT-12 BRT Green Line (Nawroz/100m Road – 30m Road – Koya Road – Kasnazan/150m Road)					1	1	1	1	**4**	○
UT-13 BRT Yellow Line (Toraq/150m Road – Mosul Road – 60m Road– Runaki Road – Bnasalawa/150m Road)					1	1	1		**3**	
UT-14 BRT C100 Line (100m Ring Road)					1	1	1		**3**	
UT-15 Express Bus Lines on Bahirka Road, Duhok Road and Airport Road				1	1	1			**3**	
UT-16 Express Bus Line (Bahirka – Mandawa – Great Zab Cluster – Airport) B				1	1	1			**3**	
UT-17 Creation of a Walkable Neighborhood in the Suburbs					1	1	1		**3**	
UT-18 Transportation Center with Transport oriented Developments				1	1	1			**1**	
Water Resources & Irrigation										

Project	**SO1**: Establish the foundations for urban sustainability, resilience and adaptation to climate change	**SO2**: Improve international competitiveness through regional connectivity and integration	**SO3**: Promote innovative & diversified economy and boost employment	**SO4**: Intensify the metropolitan area through a new multi-core and fluid model	**SO5**: Build a strong, efficient and resilient infrastructure network providing sufficient service	**SO6**: Create livable and human-scale neighborhoods connected through public transportation	**SO7**: Encourage strong Kurdish identity into the promotion of sustainable tourism	Urgency	**Total Score**	**Priority & High Priority Project**
WR-1 Integrated Water Resource Management Project	3		1					2	**6**	◎
WR-2 Irrigation Canal Rehabilitation and New Construction Plan	3		1					1	**5**	○
Water Supply										
WS-1 Erbil Water Distribution and Management Capacity Development Project	2				1		1	2	**6**	◎
WS-2 Erbil Water Treatment Construction Project	2				1		1	2	**6**	◎
Sewerage										
SW-1 Capacity Building on Wastewater Management in Erbil	1				1		1	1	**4**	○
SW-2 Erbil Sewerage and Drainage Improvement Project	1				1		1	2	**5**	◎
Solid Waste Management										
SM-1 Erbil Solid Waste Management Improvement Project	1				1		1	2	**5**	◎
SM-2 Erbil Disposal Facility Development and Closure Project	1				1		1	1	**4**	○
SM-3 Erbil Solid Waste Intermediate Treatment Facility Construction Project	1				1		1	1	**4**	○
Power & Energy										
PE-1 Gomaspan 400/ 123kv substation		1	1	1	1			1	**5**	
PE-2 Harir 400Kv/132kv Substation and 400KV Transmission Line between Erbil and Harir (105Km)		1	1	1	1			2	**6**	◎
PE-3 400KV Transmission Line from Erbil Center SS to Duhok SS (193Km)		1	1	1	1			1	**5**	
PE-4 400KV Transmission Line from Erbil Center SS to Sulaymaniyah SS via Gomaspan (75+135km)		1	1	1	1			2	**6**	○
PE-5 132 KV /33/11KV Big Timar substation			1	1	1			2	**5**	○
PE-6 132 KV /33/11KV Shamamk substation			1	1	1			2	**5**	○
PE-7 132 KV /33/11KV Harir substation			1	1	1			1	**4**	
PE-8 132 KV /33/11KV Zanko (Baghamra) substation			1	1	1			1	**4**	
PE-9 132 KV /33/11KV Rojhalat/2 substation			1	1	1			1	**4**	
PE-10 132 KV /33/11KV Malaomer substation			1	1	1			1	**4**	
PE-11 132 KV /33/11KV Gomaspan substation			1	1	1			1	**4**	
PE-12 132 KV /33/11KV 8 Hasarok substation			1	1	1			1	**4**	
PE-13 132 KV /33/11KV kaniqrzhalla substation			1	1	1			1	**4**	
PE-14 132 KV /33/11KV Baghumnara			1	1	1			1	**4**	
PE-15 Construction of eight 33KV /11Kv substation in Erbil city (Brayaty ,roshanbiry Tarjan , NewKorean , NewBadawa, Bnaslawa ,Mnara Sami Abdulrahman Park)			1	1	1			1	**4**	
PE-16 Construction of 11KV and 33KV Feeders in Erbil city.			1	1	1			1	**4**	
PE-17 Relieve over loads for 11/0.4 KV Transformers.			1	1	1			1	**4**	
PE-18 Installation of Capacitor			1	1	1			1	**4**	
Telecommunications										

Project	**SO1**: Establish the foundations for urban sustainability, resilience and adaptation to climate change	**SO2**: Improve international competitiveness through regional connectivity and integration	**SO3**: Promote innovative & diversified economy and boost employment	**SO4**: Intensify the metropolitan area through a new multi-core and fluid model	**SO5**: Build a strong, efficient and resilient infrastructure network providing sufficient service	**SO6**: Create livable and human-scale neighborhoods connected through public transportation	**SO7**: Encourage strong Kurdish identity into the promotion of sustainable tourism	Urgency	**Total Score**	**Priority & High Priority Project**
TL-1 Telecommunication Facilities Sharing Project				1					**1**	
TL-2 Next Generation Mobile Communication System Development Project	1	1		1				2	**5**	◎
TL-3 OPGW Project		1			1				**2**	
TL-4 Project to Introduce Clean Energy for Telecommunication Facilities	1				1			1	**3**	
TL-5 Project to Introduce Cloud Computing System for Ministries in Erbil	1				1			1	**3**	
Flood Management										
FM-1 Formulation of flood control plan	3							2	**5**	◎
FM-2 Installation of rain gauges	3							2	**5**	○
FM-3 Formulation of stormwater drainage plan	3							2	**5**	○
FM-4 Construction of reservoirs	3				1				**4**	
FM-5 Construction of culverts	3				1				**4**	
FM-6 Improvement of Kornish stream	3				1				**4**	
FM-7 River channel normalization (cleaning) of rivers	3				1				**4**	
Public Facilities										
PF-1 Setting the Urban Planning Standards in Erbil with focus on public facilities planning	1					1		1	**3**	
PF-2 Pilot Low-carbon High performance public facilities buildings	1					1			**2**	
Environmental Management										
EM-1 Upgrading of Environmental Performance in Erbil	3	1	1					2	**7**	◎
EM-2 Protection of Terrestrial and Aquatic Ecosystem in Kurdistan	1							1	**2**	
Climate Change Adaptation and Green Area Management										
CC-1 Enhancing Urban Resilience through Urban Green Infrastructure Development	1				1	1		2	**5**	◎
CC-2 Enhancing Peri-Urban Resilience through Green Infrastructure Development	1							2	**3**	○
CC-3 Setting up a decentralized climate finance delivery mechanism	1		1					2	**4**	○
GIS Data Management										
GD-1 Development of Erbil Spatial Data Infrastructure		1	1		1				**3**	○

Source: JICA Project Team

11.2.3 Profile of Priority Projects by Sector

A set of project profiles is prepared for Priority Projects, as shown in following pages. Project profiles consist in location, implementation body, objectives, expected effects, investment cost, a description of existing conditions, a project description, issues for implementation, and social and environmental issues.

(1) Urban and Regional Planning (UP)

ID	**UP-1**
Project Title	**Urban Planning Law Elaboration Project**
Location	Kurdistan Region of Iraq
Implementing body	GDUP/MoMT
Objectives	(1) Establish an integrated and comprehensive regulatory framework for urban planning in KRI through the draft Urban Planning Law (2) Ensure the legislation of all necessary and innovative urban planning tools such as Regional Planning and Zoning Scheme, together with basic development and construction procedures (3) Implement Capacity Development of relevant KRG agencies in terms of Urban Planning legislation and regulation in order to empower these agencies to proactively undertake subsequent legal reforms autonomously and in a continuous manner
Expected effects	(1) A binding legislative and regulatory framework will be applied and will make possible to enable sustainable land use planning, promote economic development, guarantee social inclusion and strengthen administrative efficiency; (2) The different KRG agencies relating to urban planning will deal efficiently with legal
Investment cost	1 million USD

Description

(1) Existing conditions

Despite efforts by the General Directorate of Urban Planning at the Ministry of Municipality and Tourism (GDUP/MoMT) to introduce new legislations aimed at improving the regulatory landscape between 2020 and 2022, the existing regulations of urban planning remain piecemeal, resulting in inconsistent implementation and operation. The inadequacy of these regulations is further exacerbated by the outdated nature of some rules and the incongruence of federal (Iraq) regulations with the unique environment of Erbil. The need for a comprehensive and integrated approach is underscored by the fact that even proposed regulations, such as the integrated building regulations for the KRG by UNHABITAT in 2016, have not been officially adopted. As urbanization continues to shape the landscape of the Kurdistan Region, a robust Urban Planning and Land Management Law is essential to address the current challenges arising from fragmented and inconsistent urban regulations and provide a clear and cohesive framework that addresses the specific needs and challenges of the region, fostering sustainable development and efficient urban management.

(2) Project description

- Review of existing laws and regulations related to urban planning, urban development, public domain, construction and land tenure applicable in the KRI;
- Carry out an international benchmarking of best practices in urban planning legislation. By studying successful global practices in different countries such as Japan, UK, France, USA, UAE, etc., the Kurdish model gains insights into effective models and innovative strategies. This comparative analysis helps identify pitfalls and ensures the integration of cutting-edge solutions, aligning the legislation with global standards;
- Establish a draft integrated and comprehensive Urban Planning and Land Management Law, by consolidating existing regulations, addressing inconsistencies, and bridging gaps to create a unified set of rules that cover various aspects of urban planning, including land use, zoning, building codes, and environmental considerations, and covering all levels of planning such as Regional Planning (see UP-3), Urban Development Master Planning, Zoning Scheme Planning and Detail Planning. The aim is to provide clarity and coherence in regulations to guide urban development in a holistic manner;
- Promote the endorsement of the draft Urban Planning and Land Management Law to secure its official approval within the legal framework of the KRG.

(3) Issues for Implementation

- There are no urban planning experts in the Kurdistan Region with knowledge of urban planning legislation and related systems in other countries. For this reason, it is desirable to utilize overseas human resources. It is recommended to utilize overseas human resources through international cooperation.

(4) Social and environmental issues

- None

ID	**UP-2**
Project Title	**Urban Governance Strengthening Project**
Location	Kurdistan Region of Iraq
Implementing body	GDUP, UPDOE
Objectives	(1) Update organizational structure of GDUP, UPD of Governorates and other departments to ensure clear demarcation of roles and responsibilities (2) Strengthen the role of GDUP to be able to formulate visions and strategies that align with KRG policies and tackle climate change challenges (3) Enhance inter-organizational collaboration with GDUP to foster cooperative approaches towards a more resilient, inclusive, and sustainable urban planning (4) Engage GDUP and Urban Planning Directorate of Governorates into Digital Transformation through the introduction of a GIS system and other ICT tools (5) Implement Capacity Development of relevant KRG agencies in terms of Urban Governance, Demography Planning and GIS
Expected effects	(1) Organizational structure and competences of GDUP will be reorganized (2) GDUP's role will be enhanced to achieve comprehensive urban planning that consider various aspects aligned with national goals and visions. (3) Reduce the effects of climate change in the region through good governance (4) Digital Transformation will be achieved
Investment cost	1 million USD

Description

(1) Existing conditions

In the KRG urban planning administration, one of the primary issues lies in the absence of a clear demarcation of roles and responsibilities, resulting in an overlap of competences among various organizations. GDUP, as the central government body, requires enhancement in its role to effectively organize the spatial development and plan population distribution and housing supply across all major cities in Kurdistan. Furthermore, there is a notable lack of cooperation among relevant stakeholders, hindering the collaborative efforts essential for comprehensive urban planning. The demarcation between GDUP and the UPDOE needs clarification to optimize their respective roles. Another critical aspect is the absence of a centralized system, such as a GIS center, for information sharing among stakeholders, resulting in inefficiencies and data silos. Also, the reliance on paper-based documents and procedures contributes to bureaucracy, routine, and inaccuracies in the urban planning process. Moreover, there is the issue of a predominantly engineering and architecture-centric workforce within the sector, emphasizing the need for diverse skills to comprehensively understand and resolve complex urban planning issues. Considering this situation, it is imperative to implement a comprehensive Urban Governance Strengthening Project to foster collaboration, improve efficiency, and introduce modern technologies to overcome the multifaceted challenges faced by Kurdistan's urban planning sector.

(2) Project description

- Review and update the internal organizational structure of GDUP, UPDOE and other relevant departments to ensure clear demarcation of roles and responsibilities;
- Reorganize the main competences of GDUP towards a more central role in KRI in terms of:
  - Organization of Regional Planning (see PP UP-3) of Kurdistan Region;
  - Population forecast, distribution and monitoring in all major cities of KRI in the perspective of better formulation and monitoring of Urban Development Master Plans of each city;
  - Observatory of commercial and offices activities, urban renewal opportunities including industrial brownfields and other urban phenomenon in all major cities of KRI.
- Establish a unique GIS system to carry out urban planning procedures, land titling and cadastral management within KRG administration and to facilitate effective consensus building among stakeholders, while developing the capacity of relevant organizations in mastering ICT and GIS tools;
- Promote Digital Transformation of GDUP and UPDOE by implementing digital platforms and tools to replace paper-based documentation and streamline administrative processes;
- Promote the introduction of software solutions for urban planning tasks, improving efficiency and reducing bureaucratic hurdles.

(3) Issues for Implementation

- There are no urban planning experts in the Kurdistan Region with knowledge of urban governance strengthening. For this reason, it is desirable to utilize overseas human resources. It is recommended to utilize overseas human resources through international cooperation.

(4) Social and environmental issues

- None

ID	**UP-3**
Project Title	**Kurdistan Regional Plan Formulation Project**
Location	Kurdistan Region of Iraq
Implementing body	GDUP (MoMT), Ministry of Planning
Objectives	(1) Formulate the Kurdistan Regional Plan at horizon 2050 (2) Strengthen legal and institutional framework of Regional Planning in KRG (3) Implement Capacity Development of KRG agencies in terms of Regional Planning
Expected effects	(1) Kurdistan Regional Plan at horizon 2050 is formulated, (2) Legal and institutional framework of Regional Planning in KRG is strengthened (3) Capacity of KRG agencies in terms of Regional Planning is developed
Investment cost	2.5 million USD

Description

(1) Existing conditions

In the Kurdistan Region of Iraq (KRI), there is a notable absence of upper-level plans guiding economic and physical development. Although the KRG Vision 2030 has been elaborated by the Ministry of Planning with UNDP support, it remains unapproved as of February 2024 and lacks a spatial dimension. A comprehensive Regional Plan, derived from analyzing each city's urban functions and infrastructure networks, is essential. Such a plan would provide a spatial translation for the broader policies set by the KRG, offering guidance on the roles of all cities like Erbil, Sulaymaniyah or Duhok in achieving development goals. The formulation of the Kurdistan Regional Plan is highly expected as a key missing link between global policies of KRG and urban development Master Plans of each main city, and as a way to reduce the concentration of population in Erbil and therefore increase fair distribution of functions and sustainability.

(2) Project description

- Spatial Organization: defining balanced land use and infrastructure distribution across major urban cores and rural areas of the Kurdistan region;
- Socio-Economic Framework & Economic Development: setting-up realistic GRDP baseline and forecast figures and fostering economic growth through strategic economic activities;
- Transportation Planning: developing efficient regional transportation networks including freight and passenger services through the Kurdistan Inter-City Railway, and considering facilitating exportation to neighboring countries and beyond;
- Environmental Sustainability: promoting sustainable solutions to tackle the effects of climate change and protecting natural resources;
- Housing Supply and Social Equity: elaborating well-balanced housing supply policies based on the careful analysis of housing needs, while addressing social affordability issues;
- Risk Management and Resilience: mitigating risks and enhance regional resilience at the large-scale;
- Inter-Organization Coordination: coordinating planning efforts across ministries and jurisdictions.

(3) Issues for Implementation

- Administrative boundaries of KRI are generally defined, but there have been historical and ongoing discussions and disputes over the exact borders, especially in the Kirkuk area, which might hinder the beginning of the planning process;
- Absence of legal and institutional basis for Regional Planning in KRG would necessitate to propose an original scope and to appoint a responsible implementation agency, in coordination with above-mentioned UP-1 and UP-2 Priority Projects;
- Lack of cooperation between stakeholders might hinder the whole process of Regional Planning;
- Lack of local consultants in the Kurdistan Region with expertise in Regional Planning. For this reason, it is recommended to leverage overseas expertise through international cooperation.

(4) Social and environmental issues

- None

ID	**UP-4**
Project Title	**Erbil Zoning Scheme Formulation Project**
Location	Erbil
Implementing body	UPDOE, Presidency of Erbil Municipality
Objectives	(1) Formulate the Zoning Scheme of Erbil City at horizon 2040 (2) Implement Erbil 2050 Master Plan through the development control and management of land use and urban form
Expected effects	(1) Erbil City (Master Plan Area) will enable to manage and control the land use and urban form based on a Zoning Scheme to be formulated by the Project
Investment cost	2.0 million USD

Description

(1) Existing conditions

Erbil 2030 MP has faced difficulties such as incomplete or inconsistent development against the plan due to lack of management and of integrated control instruments until now. The master plan would be required to secure its implementation by a binding power to manage not only urban activities to be controlled and promoted, including the construction by the private sector but also agricultural land and historical environmental protection by an integrated measure. Within the framework of Erbil 2050 Master Plan Project, a model plan for a zoning system has been experienced as one of the powerful instruments to implement the Master Plan through regulatory or incentive measures. The target area of that Pilot Zoning Scheme was the Municipality 6 of Erbil, with a planning horizon extending to the year 2040.

Based on the lessons learned from the experience of implementing this pilot, it is suggested that KRG related organizations will formulate a Zoning Scheme for the whole city of Erbil, at the horizon 2040, in order to properly implement the development policies and strategies included in updated Erbil 2050 MP.

(2) Project description

- Formulate the contents of the Zoning Scheme in terms of land use control (land and building), form control (urban and building), overlay zoning on the use and form control zoning, and implementation measures through capacity development program enabling UPDOE as key authorities to formulate a zoning scheme and monitor and modify it in association with Presidency of Erbil Municipality (PEM) and General Directorate of Erbil Municipality (GDEM).
- Carry out comparative analyses of best practices in urban form bulk control system (building form regulations) and land use/building control system in conjunction with zoning control system development, taking into account global standards by referrable countries such as Japan, UK, France, USA, UAE, etc., the Kurdish zoning model gains insights into effective models and innovative strategies.
- Formulate a zoning operational guide including management tools of zoning regulations, monitoring and evaluation system for control and management, interpretation of regulation application, variance system, to be applied to Erbil City based on the proposed zoning scheme in Erbil.
- Cooperate and promote a new department in UPDOE to handle with urban control and management in Erbil through the project to formulate a Zoning Scheme Management Unit as initial body toward an official department of UPDOE enabling to coordinate and initiate urban management and control.
- Establish a digital urban management system including an e-development and construction permission system utilizing and enhancing the current function of “e-Regulations Erbil” toward integration of a zoning scheme control system, in which current system plays a very limited role without relevant authorities’ participation (UPDOE, PEM and GDEM).
- Carry out stakeholders’ sensitization program for urban management and control system through the zoning scheme formulation project as one of the inevitable elements to achieve urban management effectively with citizens cooperation including private investors participation.

(3) Issues for Implementation

- There are certain experts in UPDOE in association with PEM and GDEM who shares roles and function among authorities without sufficient capacity handling global strategies and management system and well-organized coordination. As a zoning scheme covers all urban features in the city including other sectors such as road and transportation, civil aviation control, industrial development and management, agriculture land management, therefore external sector coordination would become another key factor for an effective zoning scheme formulation.

(4) Social and environmental issues

- None

ID	**UP-5**
Project Title	**National Urban Design Guidelines Formulation Project**
Location	Gazna Secondary Core Ⓐ or Mandawa Lake City Ⓑ
Implementing body	GDUP, UPDOE
Objectives	(1) Formulate Urban Design Briefs through the formulation of a model urban Zoning Scheme & Detailed Plan in a strategic location of Erbil 2050 MP (2) Formulate the National Urban Design Guidelines of Kurdish Cities
Expected effects	(1) Ensure the realization of a coherent and harmonized urban space and landscape in Kurdish cities through the collaboration between public and private sector (2) Improve the quality of life of citizens living in Kurdish cities
Investment cost	1 million USD

Description

(1) Existing conditions

Presently in Kurdistan Region, there exists a noticeable absence of standardized Urban Design Guidelines to steer harmonious growth of cities, resulting in disjointed urban landscapes that lack coherence and efficiency. The formulation of Erbil 2050 Master Plan represents an essential initiative emphasizing values such as walkability, bicycle usage, Transit-Oriented Development Nodes, and compact densities. Despite these aspirations, the absence of a national framework for Urban Design leaves room for varied interpretations and implementations, leading to inconsistencies in urban development. The impact of private investors on the urban fabrics, particularly with gated communities, has further underscored the need for a unified approach, as divergent development patterns contribute to cities that are not well-linked and fail to achieve the goals of urban sustainability. Recognizing this imperative, the project of formulation National Urban Design Guidelines of Kurdish Cities, under the management of GDUP, aims to draw on the lessons learned from detailed planning in strategic pilot areas integral to the Erbil 2050 MP, namely Gazna Secondary Core Ⓐ or Mandawa Lake City Ⓑ, whose experiences will serve as valuable foundations for creating a comprehensive and cohesive national framework that aligns with the vision of future Kurdish cities.

(2) Project description

- Formulate Briefs in terms of Urban Design through the formulation of a model urban Zoning Scheme & Detailed Plan of Gazna Secondary Core Ⓐ or Mandawa Lake City Ⓑ, relating to the following:
    - Considerations relating to extreme hot weather of Kurdistan in landscape design, including importance of shadow casted by tree alignments, etc.
    - Design of public spaces, parks, and plazas to enhance community engagement, recreation, and social interaction;
    - Design of streetscape, sidewalks, and street furniture to create a pedestrian-friendly environment and encourage alternative modes of transportation;
    - Design standards for public buildings, including guidelines for height, scale, massing, materials, and Kurdish architectural style to ensure visual coherence and compatibility;
    - Principles of sustainability, carbon-neutrality and energy efficiency, as well as environmental conservation into urban design, encouraging green building practices and the use of renewable resources including rainwater infiltration through porous asphalt etc.;
    - Consideration of soft mobility, including pedestrian and bicycle infrastructure, together with vehicular circulation to enhance accessibility, connectivity, and mobility;
    - Integration of public art and creative design elements to enhance the visual appeal and cultural richness of the urban environment.
- Formulate the "National Urban Design Guidelines of Kurdish Cities towards Urban Quality, Sustainability and Adaptation to Climate Change" based on the lessons learned from the pilot experiment of Urban Design Briefs for above-mentioned Zoning Scheme & Detailed Plans.

(3) Issues for Implementation

- None

(4) Social and environmental issues

- None

ID	**UP-6**
Title	**Zakho Urban Development Master Plan Formulation Project**
Location	Zakho City, Zakho Independent Administration
Implementing body	GDUP, Urban Planning Directorate of Zakho, Municipality of Zakho
Objectives	(1) Formulate Zakho Urban Development Master Plan (2) Foster Transboundary Cooperation over several topics between Kurdish and Turkish stakeholders to maximize economic development opportunities (3) Implement Capacity Development of Zakho Urban Planning Directorate and Zakho Municipality
Expected effects	(1) Ensure a sustainable urban development of Zakho city (2) Enhance the role of the newly established Zakho Urban Planning Directorate towards sustainable and effective inter-organizational urban management of Zakho city and surrounding towns (3) Increase commercial exchanges with Türkiye allowing improvement of peace and stability in the whole region and reinforcement of regional integration of Erbil
Investment cost	1.2 million USD

Description

(1) Existing conditions

Zakho, a city in Zakho Independent Administration of Kurdistan Region of Iraq, grapples with pressing urban issues such as unplanned growth, inadequate infrastructure, and environmental concerns. As a city steeped in history and cultural significance, heritage preservation and infrastructure development stand as crucial aspect of any development initiative. The recent establishment of Zakho Independent Administration poses many challenges to the development of Zakho city and the surrounding towns and villages. It is holding a crucial role to boost economic development through sustainable growth and provision of employment opportunities. Moreover, Zakho's proximity to the Turkish border underscores its strategic importance, not only for the Kurdistan region but also for broader regional dynamics, particularly in fostering peace-building efforts with Turkey. The realization of the Zakho Urban Development Master Plan would highly contribute in addressing these multifaceted challenges, promoting sustainable urban growth, tackling infrastructure and environmental challenges, preserving cultural heritage, boosting tourism potential, increasing transboundary freight and contributing to peace and stability in the whole region.

(2) Project description

- Formulate Zakho Urban Development Master Plan based on the model of Erbil 2050 MP, and including the following aspects.
  - Sustainable Land Use & Infrastructure planning: Upgrading and expanding Zakho city's infrastructure to meet the demands of a growing population, including improvements in roads, utilities, public transportation, and other essential urban services to ensure the sustainable development of Zakho;
  - Transboundary Cooperation, Trade, and Stakeholder's Engagement: Recognizing Zakho's strategic proximity to the Turkish border, facilitate cross-border trade, enhance several sectors such as economic cooperation and environmental protection with Türkiye, and promote regional stability.
  - Cultural Heritage Preservation and Tourism Development: Safeguard Zakho's rich history and cultural significance while simultaneously fostering tourism growth. It involves the identification, restoration, and conservation of historical sites, landmarks, and cultural assets to promote the city's unique heritage. Simultaneously, initiatives within this component focus on developing tourism infrastructure, implementing promotional campaigns, and enhancing the overall visitor experience to contribute significantly to Zakho's economic development.

(3) Issues for Implementation

- The political stability of the region and potential security concerns can affect the implementation of the studies.
- The increasing roles of the newly and upgraded stakeholders under Zakho Independent Administration might cause difficulties to implementation due to inadequate coordination and cooperation.
- Lack of urban planning expertise and capacities in the city as a whole and urban planning department and municipality specifically might raise challenges towards implementation

(4) Social and environmental issues

- None

(2) Economic & Industrial Development and Investment Promotion (EI)

ID	**EI-1**
Project Title	**Erbil Rural Area Comprehensive Economic Development Project**
Location	Erbil 2050 MP Project Area
Implementing body	MoMT, Board of Tourism, Presidency of Erbil Municipalities, Dir. of Antiquities
Objectives	(1) Formulate the Erbil Archaeological Tourism Development Plan (2) Elaborate the Participatory Rural Area Development Plan in key villages (3) Implement Capacity Development of KRG agencies in terms of Rural Development and Archeological Tourism Planning
Expected effects	(1) Establishment of Archaeological Tourism in Erbil (2) Preservation of historical artifacts and sites (3) Increase of economic benefits for local villages and communities (4) Enhanced capacity of KRG organizations
Investment cost	1 million USD

Description

(1) Existing conditions

The peri-urban area surrounding Erbil has historically has seen slower economic development and infrastructure growth compared Erbil city. To address this spatial disparity, there is a pressing need for targeted initiatives to stimulate economic growth in the 379 villages surrounding Erbil city. There is no rural development planning process in place to capture the development needs of rural villages around Erbil City.. In addition to the significant potential associated with nature tourism and urban agricultural development in Erbil villages, recent surveys from the Directorate of Antiquities and collaboration with Harvard University have highlighted the historical and archaeological significance of these areas, showcasing untapped potential for cultural and historical tourism. There is a necessity to undertake a comprehensive project that examines various opportunities, embracing both archaeological and ecotourism aspects, to unlock the latent potential of Erbil's rural areas and enable them to thrive through economic development.

(2) Project description

- Formulation of Erbil Archaeological Tourism Development Plan (TOU-S5), including the following:
  - Identification of high-potential archeological sites based on the survey by Directorate of Antiquities and Harvard University;
  - Elaboration of a detailed plan for archaeological excavations, ensuring proper environmental protection of sites as well as documentation and preservation of artifacts;
  - Establishment of touristic facilities such as (1) on-site museums, (2) visitor centers nearby archaeological sites to provide information, (3) gift shops etc.
  - Establishment of a Marketing Strategy that supports the coherent and complimentary network of Erbil Archaeological Sites.
- Formulation of a Participatory Rural Area Development Plan in villages surrounding major archaeological sites such as Sebiran, Gainj, Kawr, Duztapa, to support the smooth implementation of Erbil Archaeological Tourism Development Plan, including infrastructure planning (accessibility roads, parking, public transportation, internet connectivity) accommodation planning (lodging, homestay) and economic development planning (craftmanship promotion, local businesses).
- Implementation of capacity building program towards related organization in order to (1) create training courses for tour guides and educational resources, (2) foster heritage preservation and environmental conservation practices, and (3) boost entrepreneurship and community participation to empower locals.

(3) Issues for Implementation

- Ensuring active participation and support from local communities is crucial, especially in terms of careful preservation of excavated archeological sites and artefacts.
- Promotion of tourism in Kurdish rural areas relies on the prerequisite of a stable level of security in the region and requires strategic marketing to attract visitors.
- Engaging with archaeologists, environmentalists, and tourism experts demands effective collaboration. Ensuring a multidisciplinary approach can be challenging but is essential for project success.

(4) Social and environmental issues

- Implementing ecotourism initiatives and infrastructure development while safeguarding natural resources requires careful planning.

ID	**EI-2**
Project Title	**Erbil Citadel Revitalization & Urban Heritage Enhancement Project**
Location	Erbil
Implementing body	MoMT, Board of Tourism, Erbil Governorate Office, HCECR
Objectives	(1) Formulate the Erbil Citadel Revitalization Plan (2) Elaborate the Erbil City Centre Traditional Urban Heritage Enhancement Plan (3) Carry out Capacity Development of KRG agencies in the field of Urban Heritage Preservation and Revitalization
Expected effects	(1) Erbil Citadel and traditional urban heritage is preserved, modernized and reused (2) Local economy is boosted due to the touristic attractivity of Erbil central area (3) Capacity of KRG organizations in Urban Heritage Revitalization is enhanced
Investment cost	1.5 million USD

Description

(1) Existing conditions

The Erbil Citadel is one of the oldest continuously inhabited settlements in the world, boasting a rich historical and cultural heritage. Recent efforts have focused on the extensive renovation of the Citadel's buildings carried out under the supervision of the High Commission for Erbil Citadel Revitalization (HCECR) under Erbil Governorate Office to preserve its historical significance. The next crucial step is to reintroduce life and vitality into the Citadel, in order to transform it into a thriving hub for tourists and local communities. The primary goal of the Erbil Citadel Revitalization & Urban Heritage Enhancement Project is not merely conservation but leveraging the restored Erbil Citadel for economic growth. By attracting tourists, supporting local artisans and businesses, and showcasing the rich regional culture and history, this project seeks to re-establish the Citadel and surrounding urban heritage area as the restored center of Erbil and Kurdistan, fostering sustainable economic activities and creating a dynamic, culturally immersive experience for all visitors.

(2) Project description

- Formulation of Erbil Citadel Revitalization Plan (TOU-S3), including the following approach:
  - Promotion of Art, Cultural and Educational Facilities with the (1) establishment of traditional dwellings as Heritage Houses to be used as living museums, offering visitors a glimpse into the architecture, furnishings, and daily life of a particular historical period or cultural context or the Citadel, (2) organization of educational programs to enhance visitor knowledge and (3) organization of festivals and cultural events within the Citadel;
  - Supporting the establishment of a variety of accommodation options from high-standard boutique hotels to guesthouse and of authentic Kurdish restaurants and specialty shops;
  - Establishment of spaces for local artisans to produce and sell traditional handicrafts (carpets and kilims, jewelry, textiles, ceramics etc.);
  - Promotion of Kurdistan's Touristic Sites through tourist information centers within the Citadel.
- Formulation of Erbil City Centre Traditional Urban Heritage Enhancement Plan (TOU-S4), including the planning of the restoration of various types of valuable key urban heritage in the oldest part of Erbil City, and their promotion as both cultural touristic attractions and effective places of socialization for local communities, such as (1) Commercial heritage such as Sheikhalla and Qaisary Markets, (2) Traditional houses to be turned into museums or accommodation options close to the Citadel, or (3) Religious heritage such as Choli Minaret, Khanaqa mosque, and numerous other old mosques.
- Implementation of capacity building program towards related organization in terms of Urban Heritage Preservation and Revitalization.

(3) Issues for Implementation

- Gaining support from local communities and stakeholders involves effectively addressing concerns and expectations of nearby residents, businesses, and community groups;
- Adopting a multidisciplinary, technical and institutional approach can be challenging but is essential for project success. International consultants with the experience of heritage revitalization may be necessary.

(4) Social and environmental issues

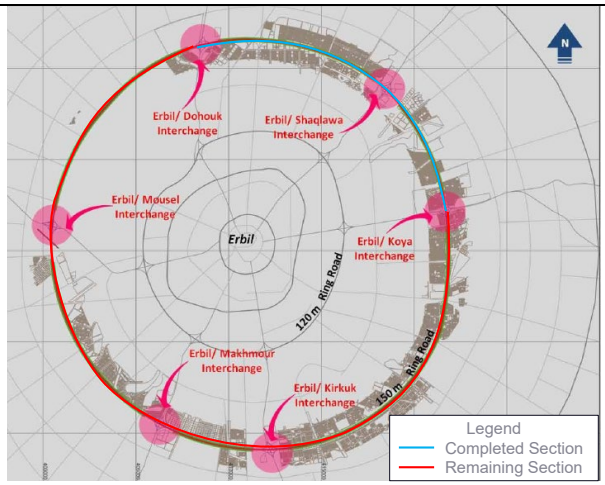
- None

(3) Urban Transportation (UT)

ID	**UT-2**
Project Title	**Construction of the remaining section of 150m Road**
Location	150m Ring Road
Implementing body	Erbil Municipality
Objectives	(1) Reduction of traffic congestion (2) Maintaining the travel speed (3) Completion of main road network
Expected effects	(1) Reduction of through traffic inside Erbil (2) Effective linkage of suburban areas
Investment cost	USD 552.1 million

Description

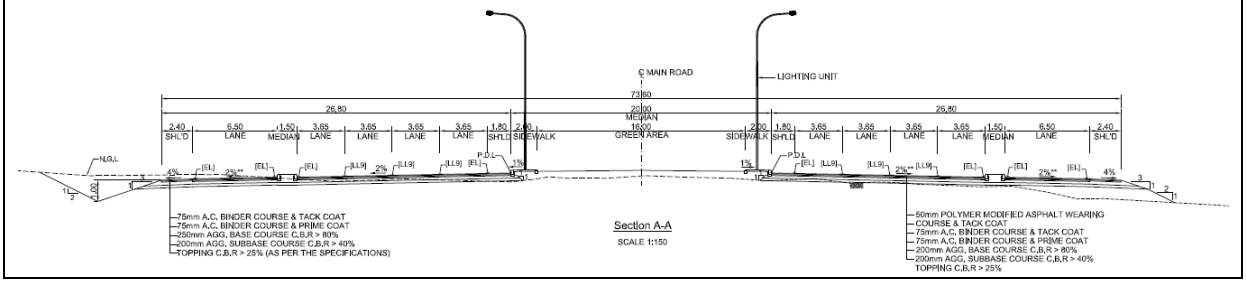
(1) Existing conditions
Based on the Feasibility Study Report done in 2015 the northern section from Koya Road Interchange to Duhok Road Interchange (21km) is open to traffic, but the remaining 59km section needs to be constructed.



(2) Project description
59km section will follow the route proposed by 2007MP and the Feasibility Study. The 150m ring road will provide a fast link to bypass 120m Road and also serve as the important link between the new communities along it. It will function as traffic distributor in the greater Erbil area by linking all arterial roads.

(3) Issues for Implementation
Based on the actual construction cost of the section between Shaqlawa and Baharka of 131 million USD, the estimated total construction cost for 59km would be 552.1 million USD or higher. Local flooding occurs along the completed section between Shaqlawa and Baharka because the road blocks the water flow. Hence appropriate draining across the road needs to be constructed.
(4) Social and environmental issues
Proper mechanism for land acquisition and compensation shall be put on place. Appropriate drainage measures to prevent flooding is also necessary.

Proposed Cross Section



ID	**UT-7**
Project Title	**Signalization of the Intersections**
Location	Major Intersection
Implementing body	Erbil Traffic Police
Objectives	(1) Reduction of traffic congestion (2) Maintaining the travel speed (3) Smoothing traffic flow on main road network
Expected effects	(1) Reduction of travel time (2) Reduction of fuel consumption and emission
Investment cost	USD 6.4 million

Description

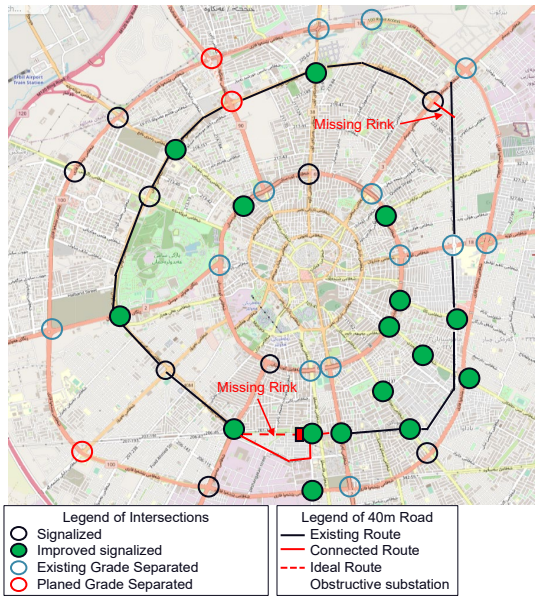
(1) Existing conditions

The traffic congestion in Erbil is observed at many intersections and U-turn points. Traffic congestion is also caused by on-road parked cars. The traffic signal that currently works in for phases creates a long waiting time and reduces the capacity of the intersection. In order to solve congestion at intersections, turning at some intersections are closed by a median. The turning vehicle are therefore using U-turn points nearby and creates a new congestion.

Although the issue about traffic congestion is raised by 9.8% and is much less than the quality of roads (42.2%) according to the Household Interview Survey conducted in 2022 within this Project, high dependency on cars will soon create traffic congestion in the near future.

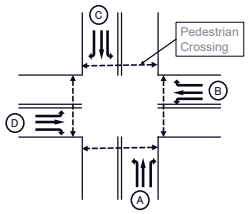
(2) Project description

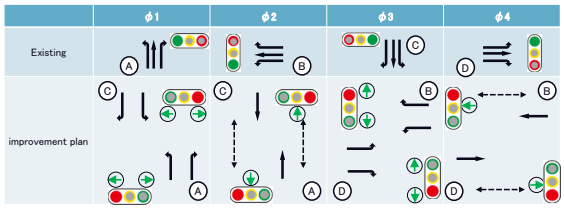
Closed intersections mainly on 40m Road will be changed to signalized intersections, so that 40m Road functions as a ring road. This will distribute the traffic on 60m and 100m Road. Signaling phases will be such that to allow traffic on both directions to pass instead of the existing four phases from each direction in order to increase the capacity of the intersection so that the volume of passing vehicle will increase.



(3) Issues for Implementation

It is very important to avoid head-on collision of vehicle or collision of vehicles with pedestrians. The drivers in Erbil are used to an all-direction signal, but the new signal will allow selected direction only and allows vehicle from the opposite direction to move as well. Awareness campaign to the drivers to strictly observe and follow the signals and enforced traffic control by the traffic police is important until the drivers become familiar with the new signaling system. Since many signals will be installed and in order to prohibit dashing and speeding vehicle speed limit on 60m Road shall be reduced to 60km/h.





(4) Social and environmental issues

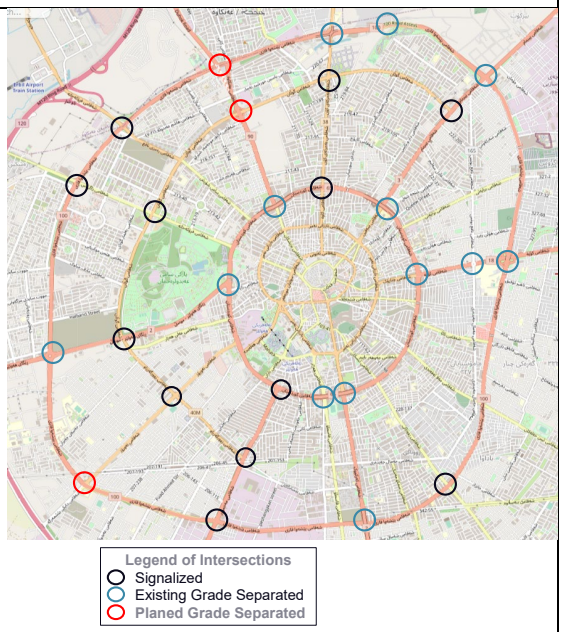
Reduction of congestion in general leads to better environment because the vehicles move smoothly. On the other hand, there shall be effective checks and measures to reduce accidents at intersections.

ID	**UT-8**
Project Title	**Grade Separation of the Intersections**
Location	Intersection of Duhok Road, Nawroz Road with 100m and 40m Ring Roads
Implementing body	Presidency of Erbil Municipality
Objectives	(1) Reduction of traffic congestion (2) Maintaining the travel speed (3) Smoothing traffic flow on main road network
Expected effects	(1) Reduction of travel time (2) Reduction of fuel consumption and emission
Investment cost	USD 32.1 million

Description

(1) Existing conditions

There is currently no serious congestion on Duhok Road although it does not have a grade separated intersection. When the area of the Northern Cores will be developed there will be a big increase of traffic on the Duhok Road. Similarly, the future traffic on the Nawroz Road may rapidly increase when developments and new railway station outside the Municipality 6 is implemented. Erbil Municipality already made a plan for grade separated intersections, so it is desirable to actually implement these plans.



(2) Project description

Depending on the available budget or priority based on traffic volume and congestion the three grade separated intersections will be built. Checks for additional grade separation will be done based on the future traffic volume.

(3) Issues for Implementation

Underpass will be cost effective against flyover, but rain water may flood the underpass. Those negative consequents shall be considered in addition to the construction cost.

(4) Social and environmental issues

Underpass is better for the environment as it does not create traffic noise to the outside area. If it is constructed as a flyover a noise protection wall shall be necessary.

ID	**UT-9**
Project Title	**Car Access Control with Fringe Parking System Inside 30m Road and Shuttle Mover Service**
Location	Erbil City Center
Implementing body	Erbil Municipality and Traffic Police
Objectives	(1) Reduction of car traffic inside 30m Road (2) Creation of walkable city inside 30m Road (3) Raising the heritage value of the historic area.
Expected effects	(1) Creation of the walkable central Erbil (2) Attraction of the visitors and tourists
Investment cost	USD 15 million

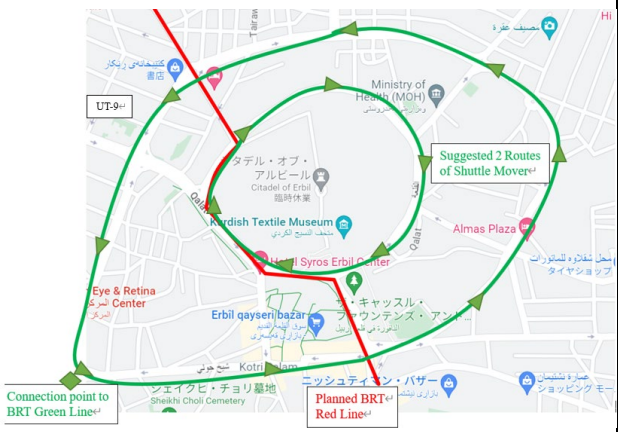
Description

(1) Existing conditions

The streets in the historic area inside 30m Road and around the Citadel is very narrow and maze that is not suitable for the vehicle traffic. The road around the Citadel is mainly one-way, but not in one direction like a roundabout. Therefore, the traffic from the opposite direction convenes in two points creates chronic congestion. Pedestrians and street vendors occupy the narrow streets while cars wondering to find parking place makes the congestion even worse. KRG started the Shekhallah Bazaar Project which aims at conserving the historic area and there is a plan about the traffic regulation measure to close or restrict cars in the Arab Quarter of central Erbil. While the idea to conserve the historic area is in general appropriate, the concept of the traffic regulation lacks alternative mode of mobility. In order to realize the concept of the Shekhallah Bazaar Project, provision of parking facilities on 30m road and alternative means of transportation inside 30m Road will be required.

(2) Project description

The project consists of (1) parking management system and (2) introduction of a slow-moving Shuttle Mover. For (1) parking management, the location of all existing parking spaces and their capacity shall be recorded first. Then, based on the total parking capacity parking permits shall be issued to the residents and shop/business owners. Cars that do not have parking permit are either banned from entering the area inside 30m road or be subject to a high road pricing. A few private parking spaces shall be converted to the taxis pool in order to reduce the wandering and waiting taxis. Fringe parking by private sector shall be promoted along 30m and 60m road. On-street parking may be allowed if the street has enough width, but the parking charge of on-street parking shall be increased every 20 minutes in order to restrict long time parking in addition to the road pricing. Drivers avoiding road pricing and looking for a parking place along or outside 30m shall be guided by a parking app to the nearest available parking facility. Parking charge and road pricing can vary according to the demand and supply which can be controlled by an AI.



To ensure the successful implementation of "on-street paid parking", a phased approach is recommended, consisting of three main stages. The initial phase involves a pilot period of three months, during which the system operates free of charge to gauge community response and fine-tune enforcement mechanisms. Subsequently, the implementation phase extends to six months, introducing nominal charges gradually. Finally, the full-scale rollout encompasses the complete deployment of the paid parking system, marking its establishment as a permanent fixture in the community. This sequential progression aims to minimize negative impacts and enhance project success.

(2) A slow-moving shuttle service around the Citadel for the convenience of the people who park their cars outside of the area moves round the Citadel on two streets in opposite direction and shall also connect to the BRT Red and Green Line so that the visitors of the historic area can move easily and enjoy a car-free environment. The Shuttle Mover may be a kind of 2-3 big carts with seats that are connected together to carry about 30-50 people in one time. E-scooter for hire via app may be introduced at the same time which can run on the same route as the Shuttle Mover.

(3) Issues for Implementation

The success of the "Car Access Control with Fringe Parking System Inside 30m Road and Shuttle Mover Service" project relies heavily on effective management, monitoring, and evaluation, with a well-defined provider structure. Private sector involvement in parking facilities and Shuttle Mover operation is crucial, but collaboration with Erbil Municipality and Traffic Police is necessary for traffic and parking control. To ensure smooth implementation, an official coordinating body is required for overseeing different components. Additionally, establishing proper parking fees, road pricing, and accessibility considerations are essential. A robust technological infrastructure, emphasizing user-friendliness and reliability, is needed for the parking app and related systems. Future scalability considerations to 60m, 40m, and eventually 100m Roads should be part of the planning. Community engagement is a key factor, necessitating effective communication with residents, businesses, and other stakeholders to address concerns and garner support.

Particularly, the following aspects shall be well incorporated:

- ✓ Public Awareness Campaign: Develop a comprehensive public awareness campaign to inform residents, businesses, and other stakeholders about the benefits and details of the proposed changes.
- ✓ Regulatory Framework: Establish a clear regulatory framework that defines the roles and responsibilities of all involved parties, including the private sector, Erbil Municipality, and Traffic Police.
- ✓ Data Privacy and Security: Implement robust measures to ensure data privacy and security for the technological infrastructure, especially considering the use of a parking app that involves user data.
- ✓ Sustainability Considerations: Integrate sustainability considerations in the project, such as the use of eco-friendly technologies for Shuttle Mover services and incorporating green spaces in parking facilities.
- ✓ Emergency Response Plan: Develop an emergency response plan to address potential issues or disruptions in the system and ensure quick resolution.
- ✓ Integration with Existing Systems: Ensure seamless integration of the new system with existing transportation and urban planning systems to avoid conflicts and enhance overall efficiency.

(4) Social and environmental issues

There will be no negative impacts to the communities, because the existing historic area and roads are not modified. The car users may be mostly affected by this project as their free access to the area inside 30m Road will be restricted. Also, business owners and shop keepers in the historic area may object to this project for fear of losing the existing customers coming by car. A well-organized and repeated consultation with the stakeholders needs to be done. Incentives to the local shopper to change the mode from car to bus will reduce the negative impact and promote cooperation, by introducing discount coupons for the shoppers using the public transportation. If the Shuttle Movers are equipped with environmentally friendly engine like hybrid or battery or hydrogen, it will reduce GHG and have positive effect to the environment.

ID	**UT-10**
Project Title	**BRT Red Line**
Location	Airport – Ankawa – Qarat – Kirkuk Road/120m Road
Implementing body	Tbd
Objectives	(1) Provision of a reliable and quality public transport service to access the International Airport, City Center and university area in the South (2) Contribution to reduce car traffic on the main roads (3) Ensure equitable access to public transportation with convenient connections from all residential areas.
Expected effects	(1) Provision of alternate access to the airport. (2) Provision of alternate access to the center of Erbil. (3) Promoting modal shift on Ankawa and Kirkuk Road.
Investment cost	USD 73 million

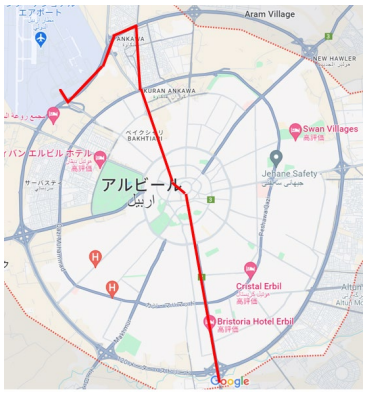
Description

(1) Existing conditions

There is no public transport to the Erbil International Airport. Ankawa is served by a Coaster Bus from the City Center and university area on the Kirkuk Road is served by a big sized bus that terminates in the Center of Erbil. The buses are in general well occupied, but there is no time table and route information at the bus stops. While a regular passenger may be able to use the buses it is not possible to attract new passengers. Traffic volume on the Kirkuk Road is about 50 thousand per day and further increase of car traffic in the future may severe create road congestion that makes commuting during the rush hour time consuming. In addition, when car restriction or congestion charges may be applied for the future, provision of reliable, fast and comfortable alternative means of transportation will be required. According to the Household Interview Survey 75% is currently not considering to use bus. The reasons for dissatisfaction with the bus is no available seats (58.3%), the long waiting time (37.5%), long riding time (29.2%), unreliable or irregular bus route (25%). Therefore, expanding the current bus network would not be an option and a new system of bus service needs to be introduced.

(2) Project description

The route starts at an appropriate location to be determined of the Erbil International Airport and then heads to the neighborhood of Ankawa, using partly 120m road. It accesses the Ankawa Mall where a transportation center with other bus lines (planned as UT-15) will be planned. Then it runs on the Ankawa Boulevard along the eastern edge of Ankawa to 100m Road. Then it follows the 100m Road toward west up to the Ankawa Road. When approaching the city center this line penetrates the area inside 30m Road and Ayubi Street, involving the western section of the Qarat. Southwards it serves, along Kirkuk Road, the already existing settlements, and terminates adjacent to the 120m Road, where an appropriate interchange hub like Park-and Ride is to be constructed. Besides procurement of articulated modern buses operation control center, bus location system and for the convenience of the passengers a mobile application for fare payment and bus location display will be planned. For the fast and reliable bus operation bus priority lane and priority signal will be required on the Ankawa and Kirkuk Road.



Park and Ride system shall be introduced on 120m Road near the airport and at Ainkawa, as well as on the Kirkuk Road.

(3) Issues for Implementation

An effective management structure is a key for the success. While the bus operation can be contracted out to the private sector effective involvement of Erbil Municipality and Traffic Police is necessary because the bus uses the existing roads and intersections.

(4) Social and environmental issues

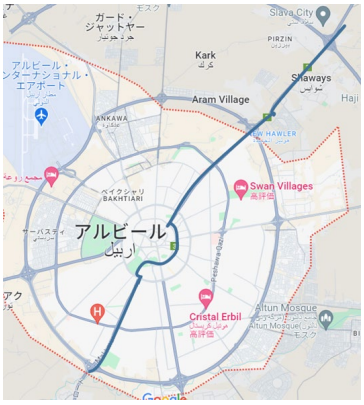
There will be no negative impacts to the communities, because the bus is running on the existing roads. For the car users, lane restriction by the bus priority lane will impact negatively as traffic congestions may occur. Incentives to the commuters to change the mode from car to bus will reduce the negative impact. If the buses are equipped with environmentally friendly engine like hybrid or battery or even hydrogen, it will reduce GHG and have positive effect to the environment.

ID	**UT-11**
Project Title	**BRT Blue Line**
Location	New Hawler/120m Road – Pirman Street – 30m Road – Makhmur Road/120m Road
Implementing body	Tbd
Objectives	(1) Provision of a reliable and quality public transport service along the busy Pirman Road, 30m Road and South Industry Area (2) Contribution to reduce car traffic on the main roads (3) Ensure equitable access to public transportation with convenient connections from all residential areas.
Expected effects	(1) Provision of alternate access to the center of Erbil. (2) Promoting modal shift on Pirman Street and Makhmur Road.
Investment cost	USD 64 million

Description

(1) Existing conditions

The daily traffic volume on the Pirman Street is about 60 thousand and it is one of the most congested arterial roads. Makhmur Road connects the southern industry area with Erbil center. Traffic volume on the Makhmur Road is about 32 thousand per day. Coaster Bus from the City Center runs on both roads. The buses are in general well occupied, but there is no time table and route information at the bus stops. While a regular passenger may be able to use the buses it is not possible to attract new passengers. further increase of car traffic in the future may severe create road congestion that makes commuting during the rush hour time consuming. In addition, when car restriction or congestion charges may be applied for the future, provision of reliable, fast and comfortable alternative means of transportation will be required. According to the Household Interview Survey 75% is currently not considering to use bus. The reasons for dissatisfaction with the bus is no available seats (58.3%), the long waiting time (37.5%), long riding time (29.2%), unreliable or irregular bus route (25%). Therefore, expanding the current bus network would not be an option and a new system of bus service needs to be introduced.



(2) Project description

The Blue Line starting from the north-eastern area of New Hawler adjacent to which a strategic inter-change hub like Park-and Ride is to be constructed outside 120m Road; through the central zone, penetrating inside 60m Road it continues along 30m Road on the east arch. The line then continues along Makhmur Road, serving existing settlements, and reaches 120m Road. Besides procurement of articulated modern buses operation control center, bus location system and for the convenience of the passengers a mobile application for fare payment and bus location display will be planned. For the fast and reliable bus operation bus priority lane and priority signal will be required on the Pirman and Makhmur Road. At the merging point from Makhmur Road and 60m Road a bus priority lane and signal shall be designed for the smooth passage of the bus on two adjacent intersections. Park and Ride system shall be introduced on 120m and 150m Road as well as in Slava City and Shaways for the convenience of the users.

(3) Issues for Implementation

An effective management structure is a key for the success. While the bus operation can be contracted out to the private sector effective involvement of Erbil Municipality and Traffic Police is necessary because the bus uses the existing roads and intersections.

(4) Social and environmental issues

There will be no negative impacts to the communities, because the bus is running on the existing roads. For the car users, lane restriction by the bus priority lane will impact negatively as traffic congestions may occur. Incentives to the commuters to change the mode from car to bus will reduce the negative impact. If the buses are equipped with environmentally friendly engine like hybrid or battery or hydrogen, it will reduce GHG and have positive effect to the environment.

ID	**UT-12**
Project Title	**BRT Green Line**
Location	Nawroz/100m Road – 30m Road – Koya Road – Kasnazan/150m Road
Implementing body	Tbd
Objectives	(1) Provision of a reliable and quality public transport service along the busy Koya and Nawroz Road and 30m Road (2) Contribution to reduce car traffic on the main roads (3) Ensure equitable access to public transportation with convenient connections from all residential areas.
Expected effects	(1) Provision of alternate or new access to the center of Erbil. (2) Promoting modal shift on Koya Road and Nawroz Road.
Investment cost	USD 79 million

Description

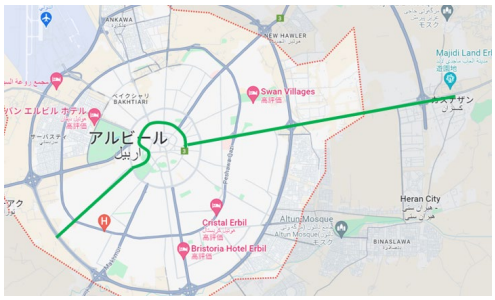
(1) Existing conditions

The daily traffic volume on the Koya Road is about 15 thousand but the area around the intersection with 60m Road is very congested. Nawroz Road connects the Municipality 6 with Erbil center. Coaster Bus from the City Center runs on Koya Road, but not on Nawroz Road. Municipality 6 is expected to be developed with a future railway passenger station so introduction of public transport at the early stage will prevent increase of car traffic that may lead to congestion in Municipality 6 and Erbil center in particular on 60m Road. The Coaster buses are in general well occupied, but there is no time table and route information at the bus stops. While a regular passenger may be able to use the buses it is not possible to attract new passengers. further increase of car traffic in the future may severe create road congestion that makes commuting during the rush hour time consuming. In addition, when car restriction or congestion charges may be applied for the future, provision of reliable, fast and comfortable alternative means of transportation will be required. According to the Household Interview Survey 75% is currently not considering to use bus. The reasons for dissatisfaction with the bus is no available seats (58.3%), the long waiting time (37.5%), long riding time (29.2%), unreliable or irregular bus route (25%). Therefore, expanding the current bus network would not be an option and a new system of bus service needs to be introduced.

(2) Project description

The Green Line serves the already highly urbanized city sectors on the east beyond 120m Road and up to 150m Road. In the central zone it penetrates inside 60m Road, then to follow 30m Road along its western and northern arch. The line then continues along Nawroz Road, serving in the south-west the heavily populated part of the city that is located between 60m Road and 120m Road and reaching the Municipality 6. Besides procurement of articulated modern buses operation control center, bus location system and for the convenience of the passengers a mobile application for fare payment and bus location display will be planned. For the fast and reliable bus operation bus priority lane and priority signal will be required on the Koya and Nawroz Road.

Park and Ride system shall be introduced on 120m Road and at the new railway station as well in Kaznazan where the line terminates.



(3) Issues for Implementation

An effective management structure is a key for the success. While the bus operation can be contracted out to the private sector effective involvement of Erbil Municipality and Traffic Police is necessary because the bus uses the existing roads and intersections.

(4) Social and environmental issues

There will be no negative impacts to the communities, because the bus is running on the existing roads. For the car users, lane restriction by the bus priority lane will impact negatively as traffic congestions may occur. Incentives to the commuters to change the mode from car to bus will reduce the negative impact. If the buses are equipped with environmentally friendly engine like hybrid or battery or hydrogen, it will reduce GHG and have positive effect to the environment.

ID	**UT-17**
Project Title	**Creation of a Walkable Neighborhood in the Suburbs**
Location	Tbd
Implementing body	Tbd
Objectives	(1) Contribution to the healthy city with ample opportunities for physical exercise through everyday walking and cycling. (2) Promote the usage of bicycle as a mean of local transportation to access the center of Mixed-Use Development Cores, by designing dedicated bicycle lanes shaded by trees in all new residential neighborhoods.
Expected effects	(1) Creation of a walkable community and healthy, livable city (2) Reduction of a car dependent life style
Investment cost	USD 2-5 million for each location

Description

(1) Existing conditions

Car dependency in Erbil is very high. According to the Household Interview Survey done by this Project in September 2022 about the preferred mode of travel is that over 70% of the employed people use car, and use of bicycle is 1% and walking 8%. On the other hand, the most preferred mode of the students/pupils is walking (47%). Use of bicycle is 3%. The result shows that the walking is generally within the neighborhood area to go to school.

Although the percentage of the cyclists is very small, the location of the respondents of the Household Interview Survey who are using bicycle is mainly inside the 60m Road and some areas between 100m and 120m Road such as Zanayan-Chwar Chra-Chnar, South Industrial Area, and Ainkawa. There are also a few cyclists in the newly developed area along 150m Road. The destination given by the responses are the same area as the origin, hence the bicycle seems to be used to cover a short distance.

The satisfaction with walkability of the streets is high with 54% completely and 36% partly satisfied according to the Household Interview Survey. Issues cited for walking is uneven payment (58.6%), poor street lighting (50.6%), dirtiness (48.3%), unsafe for walking (48.3%).

(2) Project description

A suitable coordinating body to oversee the various efforts and achievements will be created with possible participation of the GDUP, Erbil Municipality, Traffic Police, and traffic experts or academia. They will be firstly briefed about the outcome of the existing project like Darbandikhan and then create a list of candidate communities to implement the project. Then, the target community shall be selected based on size and population as well as willingness of the community leaders to understand and cooperate. In order to receive a wider participation of the public, involvement of all stakeholders is very important. It will be also important to find out the preferred destination of bicycle user. It may be schools, other public facilities, shopping center, parks, and bus station. Introduction of suitable app to record the distance walked or cycled that gives a discount of the bus fare or shopping may attract the public participation to the project.

The main activities and outputs of the project are: Analyzing the existing situation related to all transport modes, coordinating data collection processes (counting, interviews, surveys), setting mobility visions and goals, organizing workshops and consultation meetings with all concerned stakeholders, drawing up the urban mobility plan with recommendations, and communicating the results. After these steps the bicycle lane and bicycle path will be actually created.

As the main roads in Erbil has sidewalk and side road in general, it will be not difficult to create bicycle path or separate bicycle from pedestrians. The model applied in Darbandikhan aiming at 'Smart Moving City' may be applicable to Erbil.

Road in Darbandikhan before and after the mobility project
Source: MOVE Mobility

(3) Issues for Implementation

Selection of a suitable community with wider public participation is a key for the success. Cooperation of destination facilities to provide convenience to cyclists and pedestrians such as creation of bicycle parking space and offering benefit such as fare discount on BRT or discount coupon to those who reaches a certain level of walked or cycled distance would enhance the public awareness. An app-based mileage recorder will be useful. Role of the Traffic Police will be also important to provide safe walking and cycling. An official coordinating body to oversee and monitor/evaluate the various efforts and achievements will be useful with participation of the selected citizen, facility managers, business group and media in addition to GDUP, Erbil Municipality, Traffic Police, and traffic experts or academia. A regular monitoring and evaluation of the impact to the traffic is necessary to timely adjust the traffic rules to the situation, in particular to avoid traffic congestion and accidents associated with this project. Consideration to the people with mobility challenges needs to be done to ensure the creation of an inclusive community.

The 2050 goal for Erbil will envision a balanced transportation model, with 1/3 private car usage, 1/3 reliance on public transportation, and 1/3 engagement in cycling and walking. Implementing this strategy across many municipalities/communities in Erbil through a competitive and collaborative approach, akin to successful models in EU cities, requires strategic planning and thoughtful project execution. By fostering healthy competition and collaboration among the target municipalities/communities, Erbil can work towards creating a well-rounded, sustainable, and efficient transportation system in line with global best practices.

(4) Social and environmental issues

There will be no negative impacts to the communities and facilities and creation of bicycle parking place will not be a burden. The car users may be hit by this project as they need to pay more attention to the pedestrians and cyclists, therefore, a well-established campaign and enforcement will be necessary.

(4) Water Resources & Irrigation (WR)

ID	**WR-1**
Project Title	**Integrated Water Resources Management Project**
Location	The whole Erbil Governorate
Implementing body	General Directorate of Water Resources Ministry of Agriculture and Water Resources General Directorate of Dams
Objectives	(1) Creation of a consensus-building mechanism of all the water resource-related stakeholders (2) Calculation of sustainable groundwater withdrawal and surface water use (3) Planning of locations and methods for new water resource development (4) Effective groundwater recharge and evaluation of its effectiveness (linkage with irrigation plans, etc.) (5) Study of integrated water resources management details (sustainability, monitoring, education, etc.)
Expected effects	(1) To secure sustainable and safe water for domestic use (2) To secure sustainable and safe water for agriculture
Investment cost	(1) 5M USD, (2) 5M USD, (3) 1M USD, (4) 1M USD

Description

(1) Existing conditions

Currently, groundwater resources are beyond their limits, and if excessive water withdrawal continues at this rate, there is concern that the aquifer will be destroyed. Under these conditions, regarding water withdrawal from the Mandawa Dam has not been finalized, and even if IFRZ IV is constructed, it will not be able to cover the anticipated population growth.

Technical solutions to preserve groundwater resources need to be widely understood by water users so that actions to realize them should be taken by water users at the ground level. At present, however, there exists no mechanism for information-sharing on the risk of groundwater depletion and building consensus toward more rational groundwater utilization.

(2) Project description

Technical Aspect

i. Additional information collection
ii. Field survey (field check of soil and water environment, simple soil test, survey plan)
iii. Measurement of river water volume, groundwater level, and rainfall in the mountain (3 months during the rainy season)
iv. Water balance analysis
v. Calculation of groundwater resources
vi. Calculation of surface water resources in rivers, etc.
vii. Establishment of groundwater development areas and conservation areas.
viii. Setting of appropriate amounts of groundwater use
ix. River water development and its impact on the water environment
x. Cost-effectiveness & feasibility study of new groundwater development
xi. Cost-effectiveness & feasibility study of new rivers and surface water development
xii. Compilation as an integrated water resources management plan (groundwater use, monitoring, water quality conservation, etc.)

Consensus-building Aspect

xiii. Stakeholder analysis to clarify water-related stakeholders (government organizations at central and local levels, water users by type of water use and water source etc.)
xiv. Creation of a mechanism to share information on groundwater and surface water situations and the risk of groundwater depletion among all the stakeholders
xv. Consensus-building on limiting groundwater use to the estimated safe yield level

(3) Issues for Implementation (not including budget issues)

i. In the process of implementing this project, it is necessary to determine feasible water resources development, so discussions (workshops) including GDWR, MoAW, and GDUO are considered necessary.
ii. Field survey procedures and survey costs will be required.

(4) Social and environmental issues

The flow rate of the Great Zab River will decrease due to the withdrawal of subsoil water from the Great Zab and Little Zab Rivers.

ID	**WR-2**
Project Title	**Irrigation Canal Rehabilitation and New Construction Plan**
Location	The whole Erbil Governorate
Implementing body	Ministry of Agriculture and Water Resources General Directorate of Water Resources
Objectives	(1) Survey of the current status of khabat irrigation and design of facility enhancements (2) Planning of sustainable agricultural water supply distribution without relying on groundwater in three agricultural areas (3) Design of irrigation facilities for Shamamuk Irrigation and Baranati Irrigation (4) Maintenance plan for irrigation facilities (including training of maintenance managers)
Expected effects	(1) To secure sustainable and safe water for agriculture
Investment cost	(1) 2M USD, (2) 5M USD, (3) 5M USD, (4) 2M USD

Description

(1) Existing conditions

Currently, the groundwater level in the planned agricultural area is rapidly declining, and the policy is to use surface water in the future.

The existing Khabat Irrigation project has many problems, especially sediment disposal at the intake from the Great Zab River, and facility damage that occurs with each flood makes maintenance difficult. The pumping facilities are also broken and not in operation.

The method of supplying agricultural water for the proposed Baranatiy Irrigation project and Shamamk Irrigation project has not yet been determined. Pumping up is required in these areas due to their higher elevation than the Greater and Lesser Zab rivers. On the other hand, reservoirs and channels for drainage at the relay sites may contribute to the development of water resources such as groundwater recharge.

(2) Project description

i. Information gathering (data collection, field surveys, interviews, etc.)
ii. Repair plans for Khabat irrigation (intakes, pumps, canals)
iii. Irrigation plan for Shamamk irrigation (pumping up 30m from Khabat irrigation is needed. A relay reservoir and drainage canal will be needed)
iv. Irrigation plan for Baranati irrigation (close to the Great Zab River, but needs to raise the elevation up to 100 meters towards the farmland. Relay reservoirs and drainage channels will be needed).
v. Basic irrigation design and costing.

(3) Issues for Implementation (not including budget issues)

i. Local approval is required for irrigation channel route planning
ii. Maintenance and management methods and managers need to be trained

(4) Social and environmental issues

Ideally, it would be necessary to develop farmland where water distribution channels can be easily secured.

(5) Water Supply (WS)

ID	**WS-1**
Title	**Erbil Water Distribution and NRW Management Capacity Development Project**
Location	Erbil 2050 MP Project Area
Implementing body	GDWS, EWSD
Objectives	(1) To improve the water supply service in Erbil with optimum distribution and pressure control (2) To increase the water supply volume by reducing the non-revenue water (NRW) (3) To develop the capacity of financial management and customer management
Expected effects	(1) Stable water supply services achieved by the improving water quantity, water pressure, and water supply hours (2) Sustainable management, operation and maintenance (O&M) of the water supply facilities through stable water supply finances
Investment cost	USD 5 million (Technical Cooperation)

Description

(1) Existing conditions

Water supply services in Erbil are adequate in terms of the O&M of water treatment plants (WTPs), the operation of pumping stations, and the management of spare-parts, pipes, fitting, valves and equipment. On the other hand, there are notable problems such as insufficient water supply amount, water pressure, water and supply hours times due to the absolute shortage of water sources and high water consumption per capita.

Data on the existing distribution pipe network has not been centralised, although drawings have been produced for individual water supply projects in the past, and the GIS Section of EWSD is currently promoting the centralisation process. Therefore, pipe network analysis and water distribution management for the entire water system has not been undertaken.

In addition, the NRW in Erbil is not accurately determined; GDWS gives a figure of around 45%, while the calculated figure from the data on financial records is 57%. As different figures are presented by different officers and different data, improvements in the data collection and handling is required.

With regard to financial aspects, Erbil's water utility is required to consider the fund allocation for the stable repair and renewal of facilities by introducing the concept of depreciation and the accumulation of internal reserves for the renewal of facilities using the corporate accounting system.

Furthermore, the introduction of appropriate leak detection and leak repair skills, and the installation of water meters and meter reading and analysis are also urgent issues, as wastage of water resources due to leakage and overrides is affecting water supply services and tariff revenues.

(2) Project description

This capacity building project aims to improve water supply services and achieve stable water finances through effective water distribution management and NRW measures as well as financial and customer management, and awareness raising activities on water conservation among residents.

・Centralization of water distribution network data and customer data in Erbil and conducting pipe network analysis.

・Developing improvement plans for water distribution management (water quantity, water pressure, water supply hours).

・Capacity building on leakage control (leakage detection and repair) and pipe installation.

・Capacity building on financial management, customer management, tariff setting and payment methods

・Establishment of District Metered Area (DMA) with installing bulk meters and water meters in pilot areas and implementation of NRW reduction measures

・Conduct awareness-raising activities to promote water conservation awareness among residents.

(3) Issues for Implementation

- In the pipe network analysis, several cases should be considered, including the existing distribution network and those planned for future expansion. Attention should also be paid to the transmission and distribution of water to newly development areas to the north of Erbil center.

(4) Social and environmental issues

- In the water conservation awareness campaign for residents, explain that reduced water consumption will contribute to improving the water environment in Erbil as a whole.

ID	**WS-2**
Title	**Erbil Water Treatment Plant (WTP) Construction Project**
Location	Ifraz Intake Area
Implementing body	GDWS, EWSD
Objectives	(1) To increase the water supply amount in Erbil by constructing a new WTP (2) To improve the water supply services by providing the safe drinking water
Expected effects	(1) Contributes to the reduction of groundwater use where significant water table drops are concerned (2) Improved living conditions and quality of life for the residents of Erbil through improved water services
Investment cost	USD 500 million (ODA Loan)

Description

(1) Existing conditions

The population of Erbil in 2025, as projected in the Erbil 2050 MP, is 1.98 million and the required water supply is approximately 654,000 m3/d, whereas the maximum water supply of the three water treatment plants currently supplying water to Erbil is 347,000 m3/d, which is by far the shortest water production. To cover this, there are approximately 1,400 deep wells in the city, which is causing problems of water table decline and deterioration of groundwater quality due to over-pumping of groundwater.

The KRG planned to design and build Ifraz 4, the fourth WTP, through international loan (USD 690 million), but the project was halted at the design stage and there is no prospect of implementation being resumed. There is therefore an urgent need to coordinate with the funding agency of Ifraz 4, the contractor and KRG to continue with this programme, or to construct a new WTP at another source/intake point to meet the shortfall in water supply and reduce dependence on groundwater.

(2) Project description

Conduct outline design study, tender and contract, detailed design study and project implementation to construct a new WTP and water transmission facility in Erbil.

- Understanding and organizing the background, objectives and contents of the project.
- Study on the effectiveness, technical and economic appropriateness of the project.
- Investigation and analysis of water quantity and quality of water sources.
- Development of outline design and estimated project cost for the optimum project content and scale.
- Development of implementation plans and operation and maintenance plans.
- Implementation of tendering and contracting of contractors
- Construction of WTPs and water transmission facilities (water pipes, pumping stations, distribution tanks)
- Conducting the O&M training for WTPs and water pumps.

(3) Issues for Implementation

- If it is difficult to continue the Ifraz 4 project, consider building a WTP elsewhere. In doing so, attention should also be paid to the transmission and distribution of water to newly development areas to the north of Erbil center.

(4) Social and environmental issues

- Confirmation of water rights for WTP water source and EIA need to be carried out.

(6) Sewerage (SW)

ID	**SW-1**
Title	**Erbil City Integrated Wastewater Management Project**
Location	Erbil and Japan
Implementing body	GDWS, EWSD
Objectives	(1) To develop information on existing sewerage and drainage in Erbil (2) To formulate a wastewater management M/P for Erbil (3) To conduct F/S of prioritized project under the M/P
Expected effects	(1) Improved urban environmental sanitation and water pollution (2) Strengthened capacity for city-wide integrated wastewater management
Investment cost	USD 5 million (Technical Cooperation)

Description

(1) Existing conditions

In Erbil, a centralized development wastewater treatment plant (WWTP) and sewerage channels are planned to be implemented under the Erbil Sewerage Construction Project (IQ-P23), an ODA loan. However, in areas outside the sewerage zones, wastewater will continue to be treated in existing septic tanks or cesspits, which are not being properly managed. Thus, problems related to groundwater quality deterioration and urban environmental sanitation are becoming more serious.

In addition, there is a need to address the study of decentralized wastewater treatment facilities in the areas outside the current Sewerage Master Plan (M/P) and newly development areas to the north of Erbil center.

In the sewerage zone of the Sewerage Construction Project (IQ-P23), urban sanitation will be improved by encouraging individual households to connect to the sewerage system, while city-wide integrated wastewater management, including centralized and decentralized wastewater management and sludge management, is important to improve urban sanitation in Erbil as a whole.

Therefore, update of the current Sewerage M/P to include the integrated wastewater management and a feasibility study of Priority Projects will be carried out.

(2) Project description

Develop an M/P for integrated wastewater management, including centralized and decentralized sewage management and sludge management, for the improvement of urban sanitation in the whole of Erbil. The project will include the following elements:

・Compilation of basic information (centralization of data on existing sewerage and drainage, determination of industrial effluent volumes and pollution loads, etc.)

・Formulation of an integrated M/P including centralized and decentralized system and sludge treatment
- Design, construction, O&M plans for centralized WWTP, sewerage channels and pumping stations.
- Design, construction, O&M plans for decentralized WWTPs outside of Sewerage M/P.
- Sludge treatment plans and sludge recycling plans
- Financial planning, organization and institutional framework, including tariff structures and cross-subsidies
- Capacity building of wastewater management activities, including contract supervision for the implementation of the above plans
- Capacity building on monitoring and performance evaluation systems for wastewater management activities
- Develop and implement plans for environmental education and public awareness-raising activities related to wastewater management.

・Propose financing instruments for Priority Projects selected in the integrated M/P

・Implementation of F/S for Priority Projects selected in the integrated M/P

・Strengthening the capacity of officers of Erbil wastewater sector to plan for wastewater management

(3) Issues for Implementation

- Consideration of the use of reclaimed wastewater should be included, but the most appropriate use must be proposed, taking into account wastewater treatment technology, cost and social acceptability.

(4) Social and environmental issues

- SEA is required for the master planning of wastewater management especially for the wastewater treatment facilities.

ID	**SW-2**
Title	**Erbil Sewerage and Drainage Improvement Project**
Location	Sewerage zones of Erbil
Implementing body	GDWS, EWSD
Objectives	(1) To develop sewerage and drainage channels connected to the WWTP to be constructed under IQ-P23 (2) To facilitate individual house connections in sewerage zones
Expected effects	(1) Increased operational capacity of WWTPs to be constructed under IQ-P23 (2) Improved urban environment in Erbil through reduced water pollution and odours due to the construction of sewage drainage channels
Investment cost	USD ** million (ODA Loan)

Description

(1) Existing conditions

In Erbil, the ongoing JICA Erbil Sewerage Construction Project (IQ-P23) will develop a WWTP and main sewage channels, with individual house connections to be made in pilot areas. The connection of sewerage pipes to individual houses outside the pilot area in the sewerage zones is planned to be carried out at the expense of the KRG, and IQ-P23 is also providing technical guidance to GDWS officers on the connection of individual houses.

The interceptor sewerage system to be constructed under IQ-P23 will collect wastewater flowing into the existing drainage system and treat it at the WWTP, however, the existing drainage system is deteriorated with blockage with debris. Therefore, there is an urgent need to secure funding for the phased development of sewerage and drainage channels flowing into the main interceptor pipes.

(2) Project description

Outline design study, tender and contract, detailed design study and project implementation to improve the sewerage and drainage system in Erbil. The project will include the following activities:

- Understanding and organizing the background, objectives and contents of the project
- Examination of the effectiveness, technical and economic adequacy of the project
- Conducting surveys of existing sewerage and drainage channels
- Establishment of an outline design and estimated project cost for the optimum project content and scale
- Establishment of an implementation plan and O&M plan
- Implementing tendering and contracting for contractors
- Improvement works of sewerage and drainage channels
- Implementation of O&M training.

(3) Issues for Implementation

- As of January 2024, IQ-P23 is in the re-tender stage to select a construction contractor, but due to exchange rate fluctuations and rising prices, the first tender was unsuccessful, and there are concerns about whether the second tender will also be successful. Therefore, an external factor is that the construction of the WWTP under IQ-P23 is completed.

(4) Social and environmental issues

- EIA is required for the implementation of drainage and sewerage pipe construction.
- Public awareness and consultation is required for promoting the house connection to the sewerage system,

(7) Solid Waste Management (SM)

ID	**SM-1**
Title	**Erbil Solid Waste Management Project**
Location	Erbil 2050 MP Project Area
Implementing body	MOMT, KRG
Objectives	(1) To develop SWM Master Plan (M/P) in Erbil (2) To establish the sustainable solid waste collection, transfer and treatment system (3) To promote the residents the separation of solid waste and recycling behavior
Expected effects	(1) Capacity development of solid waste management sector in Erbil (2) Improved urban environment through proper solid waste management
Investment cost	USD 5 million (Technical Cooperation)

Description

(1) Existing conditions

In Erbil, solid waste generation has increased significantly in line with population and economic growth. At the same time, municipal waste is collected at source without segregation and waste disposal relies on only one landfill site, Kani-Qirzhala, which poses numerous challenges for proper solid waste management (SWM). More than 75% of the capacity of Kani-Qirzhala disposal is already in use and is expected to be full in the next few years. In addition, none of the planned intermediate treatment facilities (ITFs) have been implemented, as of January 2024, as they were suspended or dropped at the bidding stage.

In addition, a SWM Master Plan for Erbil was developed by UNICEF in 2013, but it was not approved by the KRG as it did not reflect the wishes of local stakeholders, so the SWM M/P is effectively not applied in Erbil. Furthermore, the SWM of the newly development areas to the north of Erbil center is also required to be considered.

Therefore, there is an urgent need to formulate an M/P and strengthen the capacity for proper SWM in Erbil.

(2) Project description

Formulation of a new M/P, taking into account current issues of SWM and applicable technologies.

・Measurement and analysis of data on waste generation, collection, disposal, etc.
・Development of SWM M/P with financial planning
・Supporting the formulation of SWM regulations
・Design, construction, O&M plans for intermediate treatment facilities (ITF)
・Design, construction, O&M plans for new disposal facility (DF)
・Development of closure plans for existing Disposal site Kani-Qirzhala
・Capacity building of SWM activities, including contract supervision for the implementation of the above plans
・Capacity building on monitoring and performance evaluation systems for SWM activities
・Develop and implement an environmental education and public awareness plan for waste separation and collection
・Planning of training schemes for human resource development in the SWM sector

(3) Issues for Implementation

- As SWM involves several relevant agencies, coordination and consensus-building should be carefully considered.

(4) Social and environmental issues

- Public awareness and education activities are involved.

ID	**SM-2**
Title	**Erbil Disposal Facility Development and Closure Project**
Location	Proposed new disposal site and Kani-Qirzhala existing disposal site
Implementing body	MOMT, KRG
Objectives	(1) To design and implement the new disposal facility (2) To establish the sustainable O&M system of disposal facility (3) To conduct proper closure of the existing disposal site
Expected effects	(1) Improved solid waste management with the new disposal facility development (2) Improved urban environment through sustainable disposal facility O&M
Investment cost	USD ** million (ODA Loan)

(1) Existing conditions

The only landfill site in Erbil, Kani-Qirzhala disposal facility (DF), has regular covering, waste spreading and compaction, adequate heavy machinery and personnel, gas discharge pipes and several environmental protection measures in place, however the absence of a leachate management system means that surface water, groundwater and agricultural activities in the vicinity are at high risk exposed to high risks.

In addition, as the DF will soon be full, the development of new DF sites is an urgent priority.

As it takes 3-5 years to develop a new DF, a life extension plan for the existing DF must first be developed and implemented, while the planning, design and construction of the new DF shall be carried out in parallel. Furthermore, a safety closure plan for the existing DF shall be developed and safety closure must be implemented after the new DF become operational.

(2) Project description

1. Preparation the DF life extension plan for the next five years
   a. Topographic survey to determine the waste heights, areas of disposal, etc.
   b. Identification the older disposal areas at the site
   c. Preparation of the operation plan of the DF considering the life extension of the DF for at least 5 years and the requirements for safe closure.
   d. Considering the mining of the old waste and using it as a source of cover materials for the new disposal, as well as using the mined space for disposal of new waste.
2. Development of new DF
   a. Development of selection criteria of the new DF sites
   b. Preparation of the technical standards of the DFs and the operation
   c. Implementation of natural and social surveys for the proposed sites and prioritize the most suitable sites
   d. Formulation of site layout plan, outline design, and environmental management plan (EMP)
   e. Identification of technical specifications of the heavy equipment and other equipment required for landfill operations (generators, aerators, weighbridges, landfill gas and leachate treatment equipment)
   f. Preparation of the cost estimation for construction and procurement of the equipment
   g. Implementation of tendering process after preparing the tender documents and contracting with the qualified contractors
   h. Implementation of construction and equipment procurement tendering
   i. Conducting training of staff and hiring of new staff for the site operation during construction
3. Prepare the existing DF safe closure plan
   a. Preparation of the safe closure plan at the same time as the DF utilization plan after closure
   b. Addressing the slopes inclinations, final cover gradients, thicknesses of the closure layers, storm water drainage and leachate monitoring systems in the closure plan
   c. Implementation of EMP for at least 10 years after DF closure as a part of closure plan.
   d. Formulation of a temporary land use plan for the closed DF for the interim period of 10 years as well as a permanent land use plan after that. During the temporary land use, it should be limited to open space, parking areas, other SWM activities, etc. and no large structures shall be constructed in that time.

(3) Issues for Implementation

- In securing a site for a new landfill site, the agreement of the administration must be obtained, as well as careful explanation and consensus-building with the local residents in the vicinity.

(4) Social and environmental issues

- IEE shall be conducted to prepare the short list of candidate DF sites or the selected site
- EIA and environmental monitoring plan (EMP) of the DF is required based on the national standards as well as any specific additions related to landfills
- Public consultation with stakeholders shall be conducted to explain the project and obtain support and understanding for implementation
- EMP is required for the closure of existing landfill site.

ID	**SM-3**
Title	**Erbil Solid Waste Intermediate Treatment Facility (ITF) Construction Project**
Location	Different Locations in Erbil
Implementing body	MOMT, KRG
Objectives	(1) To study and analyze the most suitable technology option of ITF for Erbil (2) To design and construct the optimum capacity of the ITF (3) To establish the sustainable O&M system of ITF
Expected effects	(1) Improved solid waste management with the new ITF development (2) Improved urban environment through sustainable recycling behaviors
Investment cost	USD ** million (ODA)

Description

(1) Existing conditions

For the proper SWM, segregation at source, treatment including recycling and reduction of waste at ITF are essential, as waste disposal facility (DF) alone is not sufficient. MOMT is considering the development of an incineration (Waste to Energy: WtE) facility as one of ITFs in Erbil, and an F/S is currently conducted. The results of the F/S final report will be used to consider whether MOMT will implement the WtE project.

WtE has the advantages of incinerating all the unsorted waste together and converting the generated thermal energy into electricity generation. On the other hand, its construction and operating costs are very high, requiring advanced technology to operate. Also, it is essential to formulate a sustainable marketing plan for the generated energy to enable recovery of the initial investment and operational costs. In addition, the Government of Iraq and the KRG do not have technical standards for the safe design, construction and operation of these facilities, which needs to be included in the MOMT's planned ITF project to develop the necessary technical standards.

(2) Project description

Outline design study, tender and contract, detailed design study and project implementation to construct the ITF in Erbil. The project will include the following activities:

- Understanding and organizing the background, objectives and contents of the project
- Examination of the effectiveness, technical and economic adequacy of the project
- Conducting surveys of solid waste generation types and volumes
- Establishment of an outline design and estimated project cost for the optimum project content and scale
- Establishment of an implementation plan and O&M plan
- Formulation of technical standards for the safe design, construction and operation of ITF
- Implementing tendering and contracting for contractors
- Construction of ITF
- Implementation of O&M training.

(3) Issues for Implementation

- As there are various technologies available for ITFs, each with different construction and operating costs, income from the sale of generated energy, etc., sufficient consultation with local stakeholders is required prior to selecting the technology to be applied.

(4) Social and environmental issues

- EIA and public consultation are required for the construction of ITF.

(8) Power & Energy (PE)

ID	**PE-2**
Title	**Harir 400Kv/132kv (AIS) substation and 400KV transmission line between Erbil and Harir (105Km)**
Location	Erbil/Shaqlawa /Harir subdistrict
Implementing body	MOE
Objectives	(1) To enhance energy supply to the Soran area, mitigate voltage drop issues, and minimize energy losses. (2) Reduce the load for 132kV network (3) Transferring energy from Erbil to the Soran Region (4) Reducing losses and improving voltage drop
Expected effects	(1) The installation of this substation and transmission line are expected to bring about positive effects, including the reception of high-quality electrical energy and the equitable distribution of electricity among users in Erbil and Soran area.
Investment cost	USD 105 million

Description

(1) Existing conditions

The area experienced a disparity in the amount of electricity received compared to other regions, with fewer hours of electricity supply allotted to them. The project site is a clear space. The line route is not fixed yet.

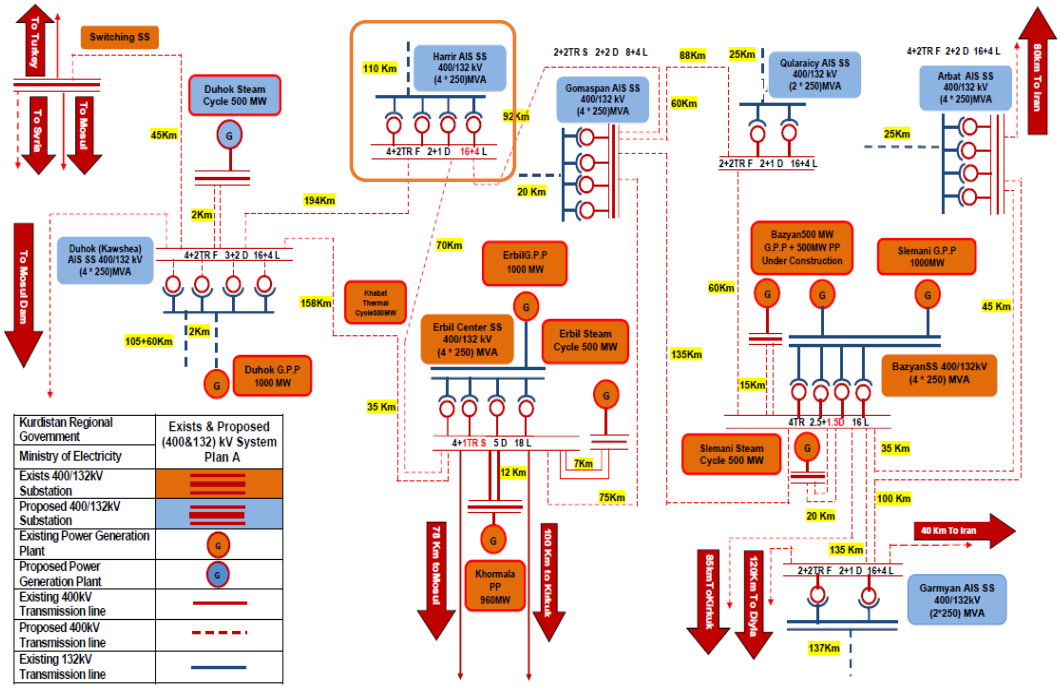
(2) Project description

Installing Harir (AIS) 400/132kV Substation.

- Four 400/132 kV Single-phase Autotransformer (4 x 250 MVA)
- Four Transformer Switchyard 400 kV (4 x 250MVA)
- Three line Switchyard 400 kV
- Four Transformer Switchyard 132kV
- 16 line Switchyard 132 kV

Installing 400KV Transmission Line between Erbil Center and Harir (70+35= 105 Km)

- Single Circuit (2*ACSR 490/75)
- 1 OPGW OHL



(3) Issues for Implementation

This project needs to be implemented in combination with PE-4 (400kV Transmission Line between Erbil and Harir).

(4) Social and environmental issues

No adverse effects on the environment

ID	**PE-4**
Title	**400KV Transmission Line from Erbil Center SS to Sulaymaniyah SS via Gomaspan**
Location	Erbil-Sulaymaniyah
Implementing body	MOE
Objectives	(1) Transferring energy from Erbil to Sulaymaniyah and vice versa.
Expected effects	(1) Receiving dependable and high-grade electrical power, and ensuring secure functioning in Erbil and Sulaymaniyah. (2) Improving the power supply capacity and reliability due to the power interchange between Erbil and Sulaymaniyah.
Investment cost	USD 70 million
Description	

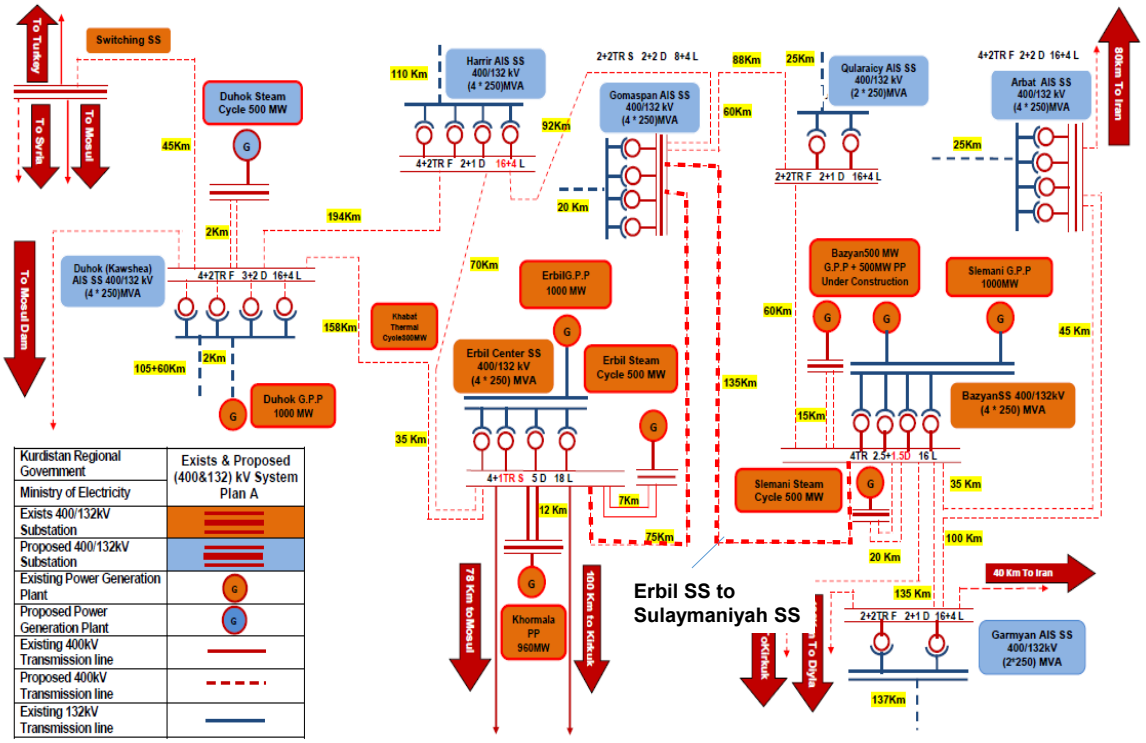
(1) Existing conditions

The area experienced a disparity in the amount of electricity received compared to other regions, with fewer hours of electricity supply allotted to them.

(2) Project description

Installing 400kV Transmission Line from Erbil Center SS to Sulaymaniyah SS via Gomaspan (75+135km)

- Single Circuit (2*ACSR 490/75)
- 1 OPGW OHL



(3) Issues for Implementation

N/A

(4) Social and environmental issues

There is possibility of resettlement along the transmission route. Further study is needed.

ID	**PE-5**
Title	**132/33/11kV Big Timar (AIS) Substation**
Location	Erbil/Center
Implementing body	MOE
Objectives	(1) To alleviate the load on the Bashur Substation (2) To establish electricity connectivity for 600 investment projects (with only one existing Mobile substation of 25MVA) (3) Eliminating the need for a mobile substation.
Expected effects	(1) Improving the power supply capacity and reliability which leads to the improvement of all industrial plants operation in the zone (2) Enhancing voltage stability by reducing voltage drop
Investment cost	USD 20 million

Description

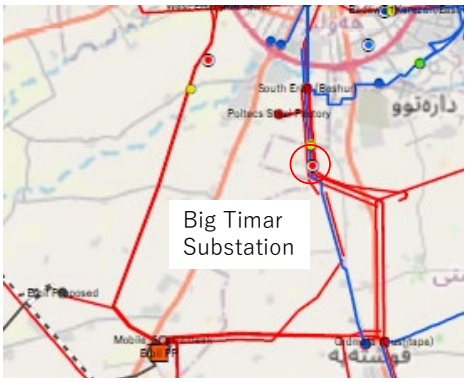
(1) Existing conditions

The area experienced a disparity in the amount of electricity received compared to other regions, with fewer hours of electricity supply allotted to them. The project site is a clear space.

(2) Project description

Installing 132/33/11kV (125*3) MVA (AIS) substation

- Three 132/33/11 kV transformers (125/80/50 MVA)
- Three Transformer Switchyard 132 kV
- Six line Switchyard 132 kV
- 33 kV Swichgears
- 11 kV Swichgears
- 33 kV Distribution lines
- 11 kV Distribution lines



(3) Issues for Implementation

N/A

(4) Social and environmental issues

No adverse effects on the environment

ID	**PE-6**
Title	**132/33/11kV Shamamk (AIS) Substation**
Location	Erbil/Center
Implementing body	MOE
Objectives	(1) To relieve the overloads on feeders for the Maghmur-Shamamk and Guwer area, as well as their respective villages. It aims to improve voltage drop specifically for Maghmur Villages. (2) To alleviate the loads on the Mobil Substation, which currently faces limitations in providing electricity to the area compared to other regions in terms of hours of supply. (3) To reduce the load feeder on the Mobil substation while ensuring electricity provision to factories and agricultural farms that have experienced prolonged periods of electricity unavailability due to feeder overloads.
Expected effects	(1) The installation of the 132/33kV Shamak substation is anticipated to bring about numerous positive impacts to the region, including augmented electricity revenue, enhanced agricultural production, increased job opportunities, and overall prosperity**.**
Investment cost	USD 16 million

Description

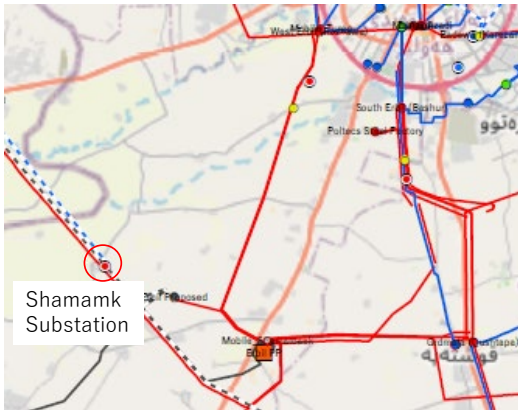
(1) Existing conditions

The area experienced a disparity in the amount of electricity received compared to other regions, with fewer hours of electricity supply allotted to them. The project site is a clear space.

(2) Project description

Installing 132/33/11kv (2*125) MVA (AIS) Substation

- Two 132/33/11 kV transformers (125/80/50 MVA)
- Two Transformer Switchyard 132 kV (4 x 250MVA)
- Two line Switchyard 132 kV
- 33 kV Swichgears
- 11 kV Swichgears
- 33 kV Distribution lines
- 11 kV Distribution lines



(3) Issues for Implementation

N/A

(4) Social and environmental issues

No adverse effects on the environment

(9) Telecommunications (TL)

ID	**TL-1**
Title	**Telecommunication Facilities Sharing Project**
Location	The whole Erbil Governorate
Implementing body	MOTAC
Objectives	(1) Establish rules regarding the sharing of telecommunication facilities (towers, culvert, hut, etc.) that are currently being used in an unregulated manner. (2) Conduct studies on the efficient use of communication facilities (towers, culverts, huts, power source, etc.), coordinate users, and reduce the facilities. (3) Role as a pilot project for telecommunication facilities sharing in the entire KRG
Expected effects	(1) The cost of each telecommunication company is reduced by sharing equipment. (2) The landscape of the City of Erbil will be improved.
Investment cost	USD 1 million (for Feasibility Study)

Description

(1) Existing conditions

Now there are seven thousand (7,000) communication towers in Kurdistan region and nine hundred (900) communication towers in Erbil city. This project causes to reduce Towers number and arranging them, government and people will be benefited and it causes nice view for the cities and to safe environment.

The same situation applies to culverts for communication lines, power supplies for communication equipment, and huts. In many locations, each telecommunication company has developed its own plans, and each company is responsible for securing land, installing equipment, and using the equipment.

(2) Project description

- Project Summary: Conduct a feasibility study of the location, ownership, and usage of existing telecommunication facilities (tower, culvert, power source, hut, etc.) consider efficient use of those. Based on the results of the study, coordinate with users to reduce the facilities.
- Reason and Goal of Project: Reducing facilities number and arranging communication duties
- Beneficiary side: Government and Communication Companies and also people
- Role of this project: After this pilot project will be implemented in Erbil, the infrastructure sharing project will be expanded all over the KRG.

(3) Issues for Implementation

Legislation for shared use of facilities
Coordination with Users
Coordination with landowners

(4) Social and environmental issues

None in particular

ID	**TL-2**
Title	**Next Generation Mobile Communication System Development Project**
Location	The whole Erbil Governorate
Implementing body	MOTAC
Objectives	(1) Support for the development of 5G and next-generation communications (6G) infrastructure in Erbil (2) Promotion of ICT utilization by individuals, companies, and government (3) Role as a pilot project for infrastructure development in the entire KRG
Expected effects	(1) Provision of high-speed, high-capacity, low-latency communications infrastructure for government (e.g., e-government, e-money, smart cities) (2) Promotion of ICT utilization in education, healthcare, private sector, individuals, etc.
Investment cost	USD 5 million

Description

(1) Existing conditions (Cellular Network)
LTE service was launched in Erbil in 2013, and as of 2024, LTE service is available in the main areas of the city in the Kurdistan region, including Erbil.
As for 5G communications, several telecommunications carriers have obtained 5G licenses and were expected to begin 5G operations by the end of December 2022; however, as of February 2024, no announcement has been made regarding the start of 5G operations.
In the future, 6G communications, which can achieve "high speed and high capacity," "high reliability and low latency," and "multiple simultaneous connections," are expected to be commercially available in developed countries around 2030.

(2) Project description
1) Installation of antennas for 5G/6G cellular communication network
Antennas for 5G/6G communication network will be installed in Erbil city in every 150m parcel and connected to the optical fiber backbone network.
2) After implementing a pilot project in Erbil, the antennas for 5G/6G cellular communication network project will be expanded all over the KRG.

(3) Issues for Implementation
To secure antenna locations (e.g., communications towers, telegraph poles, rooftops of facilities)

(4) Social and environmental issues
None in particular

ID	**TL-3**
Title	**OPGW (Optical Ground Wire) Project**
Location	The whole Erbil Governorate
Implementing body	MOTAC, MoE
Objectives	(1) Support for the Effective use of existing public facilities (2) Role as a pilot project for infrastructure development in the entire KRG
Expected effects	(1) Strengthening the telecommunications infrastructure provided by the government and telecommunications companies (2) Creation of job opportunities
Investment cost	To be determined

Description

(1) Existing conditions

The existence 132kV and 33kV electricity poles in KRG have fiber infrastructure, however it has not been benefited yet in communication field.

- Location of power line towers (KRG/Erbil)
- Number of towers (KRG/Erbil)
- Configuration of each tower facility will be confirmed by Ministry of Electricity.
- Status of existing fiber connections will be confirmed by Ministry of Electricity.

(2) Project description

1) Specific details of the construction work

OPGW wire have already been installed on the top of power line towers. However, equipment for connection and establishing SCADA system had not been installed yet. Therefore this project need hardware and software to be considered for service.

2) After implementing a pilot project in Erbil, this communication network project will be expanded all over the KRG.

(3) Issues for Implementation

Coordination between MOTAC and MOE

(4) Social and environmental issues

None in particular

ID	**TL-4**
Title	**Project to Introduce Clean Energy for Telecommunication Facilities**
Location	The whole Erbil Governorate
Implementing body	MOTAC
Objectives	(1) Contribute to the realization of a low-carbon society by introducing clean energy as a power source for telecommunications facilities
Expected effects	(1) Using solar power, wind power, etc. as power sources for telecommunication facilities can reduce carbon dioxide emissions.
Investment cost	To be determined

Description

(1) Existing conditions
- Power sources for telecommunication facilities that can be partially or fully replaced with clean energy (KRG/Erbil)
- Location and number of the above power sources (KRG/Erbil)
- Power supply capacity (kVA), etc. required to operate each telecommunication facility

(2) Project description
1) Specific details of the construction work

2) After implementing a pilot project in Erbil, this communication network project will be expanded all over the KRG.

(3) Issues for Implementation
Maintenance of photovoltaic equipment (power conditioners, batteries, and solar panels) after project implementation and renewal after the useful life of the equipment.

(4) Social and environmental issues
None in particular

ID	**TL-5**
Title	**Project to Introduce Cloud Computing System for Ministries in Erbil**
Location	Erbil city
Implementing body	MOTAC
Objectives	Contribute to the realization of a low-carbon society by introducing cloud server to the ministry's facility in Erbil
Expected effects	Using cloud server instead of on premise server, - it can reduce carbon dioxide emissions. - Server management and operation costs can be reduced. - Data backup and BCP (Business Continuity Plan) measures can be taken.
Investment cost	USD 1 million

Description

(1) Existing conditions
- Operated by Council of minister/Information and communication office.

(2) Project description
1) Select 2 or 3 ministries and agencies that are ahead of others in the shift to cloud computing, such as MOTAC, GDUP, MoHE, MoFA and MoE.
2) Investigate the status of servers in the target ministries.
3) Investigate cloud server service providers and their services in Erbil.
4) The details of the cloud servers to be installed will be reviewed, bidding requirements will be prepared, bids will be submitted, and a supplier will be selected.
5) Evaluate the operational status of the cloud servers after one year of implementation, and improve the operation as necessary.
6) The servers of other ministries and agencies in Erbil will be gradually converted to cloud computing.
7) After implementing a pilot project in Erbil, this communication network project will be expanded all over the KRG.

(3) Issues for Implementation

- Security measures and fault handling will be entrusted to the company that operates the cloud server, so it is necessary to fully consider their business track record, etc.
- Consent of each ministry and agency

(4) Social and environmental issues
None in particular

(10) Flood Management (FM)

ID	**FM-1**
Title	**Formulation of Flood Control Plan**
Location	Kurdistan Region of Iraq
Implementing body	GDWS / EWSD / Irrigation Directorate
Objectives	(1) Flood control (2) Irrigation (3) Groundwater recharge
Expected effects	(1) Flood damage is reduced (2) Water of irrigation and groundwater recharge is secured
Investment cost	USD 2 to 3 million

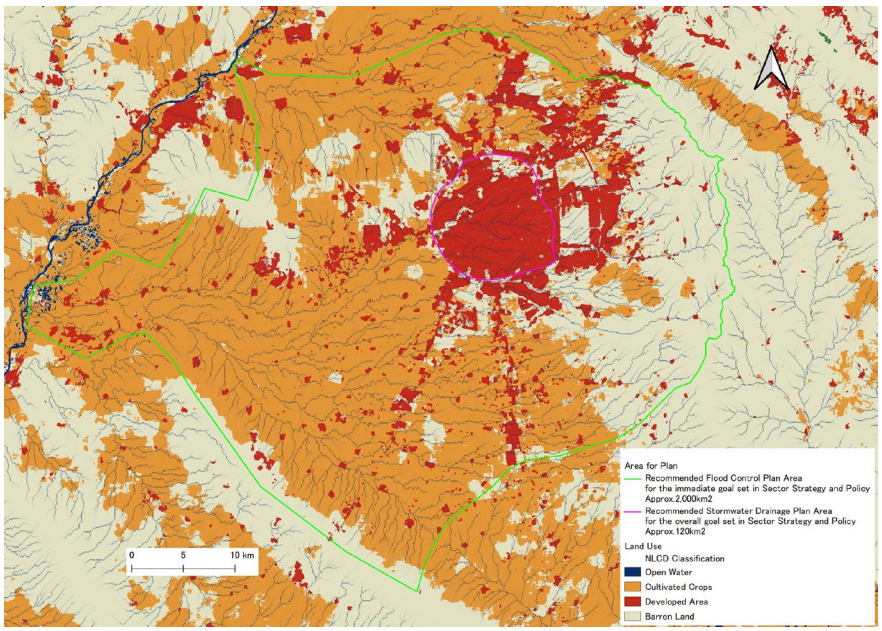
Description

(1) Existing conditions

While assets are increasing due to the progress of urbanization in low land area, the capacity of drainage facilities is decreasing and flood damage is becoming more serious. There were 2 major floods in 2021 and they caused serious damage. Although open channel, culverts, and reservoirs have been planned and constructed, the effects are insufficient and additional measures based on flood control plan covering the entire basin are required.

(2) Project description

Flood control plan for rivers passing through the developed area shall be urgently implemented, covering a basin area of approximately 2,000 km2 as shown in the figure below. (Area inside of 120m ring road is excluded because it is subject to stormwater drainage plan.)



The main project contents are as follows.

-Statistical analysis of rainfall
-Survey for river network and river profile
-Runoff analysis
-Discharge capacity analysis of River
-Determination of discharge allocation
-Design of flood control facilities(e.g. reservoirs culverts, river)

Countermeasures shall be determined based on not only flood control effects, but also irrigation and groundwater recharge.

(3) Issues for Implementation

Lack of rainfall data
Absence of standard, manual and guideline for flood control plan
Cooperation with related organizations (Coordination of plans among related organizations)

(4) Social and environmental issues

None.

ID	**FM-2**
Title	**Installation of Rain Gauge**
Location	Mountainous Region of Kurdistan Region of Iraq
Implementing body	GDWS / EWSD / Irrigation Directorate
Objectives	(1) Understanding rainfall characteristics (2) Estimation of design rainfall
Expected effects	(1) Database of statistical analysis of rainfall is developed (2) Database for early warning system is developed
Investment cost	USD 1 to 2 million

Description

(1) Existing conditions
The amount of rainfall in the Kurdistan Region varies greatly between the mountainous region and developed region (low land). However, the distribution of rainfall in the basins is unclear because there are not enough rainfall gauging stations in the mountainous region. For this reason, it is difficult to predict the amount of runoff and it is not possible to adequately plan flood control facilities. Additionally, there is no information for early evacuation in the event of a flood.

(2) Project description
Rainfall observation stations are installed at one location every 50km2 to 100km2 (approximately 5 locations), targeting mountainous regions. The observation system allows observation data to be received in real time at the related organization's office and can also be used to develop an early warning system.

(3) Issues for Implementation
Lack of human resource for maintenance.

(4) Social and environmental issues
None.

ID	**FM-3**
Title	**Formulation of Stormwater Drainage Plan**
Location	Inside of 120m Ring Road
Implementing body	GDWS / EWSD
Objectives	(1) Flood control
Expected effects	(1) Flood damage is reduced
Investment cost	USD 1 to 2 million

Description

(1) Existing conditions
Due to the lack of stormwater drainage facilities in the developed area, flooding occurs in geographically low areas. The stormwater drainage network covers only 60% of total area in Erbil Municipality.

(2) Project description
Stormwater drainage plan for the area inside of 120m ring road shall be urgently implemented.
The main project contents are as follows.
- Statistical analysis of rainfall
- Plan of stormwater drainage network and determine subcatchment areas
- Runoff analysis
- Design of stormwater drainage facilities

Topographic maps that have already been created by the sewerage project will be used.

(3) Issues for Implementation
Lack of rainfall data.
Absence of standard, manual and guideline for Stormwater drainage plan.

(4) Social and environmental issues
None.

(11) Public Facilities (PF)

ID	**PF-1**
Title	**Setting the Urban Planning Standards in Erbil with Focus on Public Facilities Planning**
Location	The whole Erbil Governorate
Implementing body	MOMT, Presidency of Erbil Municipalities, MOP and related ministries
Objectives	(1) Create a unified set of planning standards for public facilities and amenities that serve the citizens collectively and respond to the unique needs of Erbil
Expected effects	(1) An accurate understanding of the current and future needs of public facilities. (2) The real needs of the current and future population are served in terms of educational, health, culture, social, religious and security facilities, quantitively and qualitatively. (3) Under 15 min walkable access to public facilities creating self-sufficient and vibrant neighborhoods. (4) An unified code for all planners in the public and private sector.
Investment cost	USD 1 million

Description

(1) Existing conditions

Planning for the provision of sustainable and climate proof public facilities is a major step toward creating well-served neighborhoods, where amenities are at proximity to the places of living or work. Currently, there are no unified planning standards. Each planning department of the different municipalities is following a mix of Iraqi, international and locally-made set of standards. There is also a lack of coordination and no sharing of data on demography, land availability, planned projects, building conditions, etc. There is a total absence of norms or regulations on sustainability and adapting public facilities to climate change.

(2) Project description

- An urban laboratory within the MoMT is set up for an estimated period of 12 to 18 months with the aim to create new planning standards for the public facilities in the city of Erbil.
- The lab includes a mix of government planning staff and local and international consultants. The project has an urban as well as an architectural dimension.

The urban lab duties are:

  - Document the current public facilities, the standards applied and their process of establishment from planning till rection, and operation.
  - Carry out a gap analysis and document weaknesses of currently applied standards and procedures.
  - Research, draft, discuss and issue new Erbil standards for planning public facilities.
  - Build the capacity of current planners in applying the new set of standards during workshops.

- Two levels of regulations are produced, urban and architectural:
  - Planning norms, with the aim for availability and accessibility with focus on walkability under the 15-minute city concept.
  - Architectural norms, aiming to set properly sized facilities, with high quality of built space, ensuring the availability of outdoor areas, easy access, relation with the street and other facilities
  - Both level of norms ensure that public facilities are cooling centers for the elderly and children during periods of extreme heat within a 15 minutes walkable reach.

(3) Issues for Implementation

- Buy-in and active participation from the different official entities concerning close coordination and data sharing.

(4) Social and environmental issues

- None, people and the environment will benefit from the new planning standards

ID	**PF-2**
Title	**Pilot Low-carbon High Performance Public Facilities Buildings**
Location	In different locations in Erbil Governorate.
Implementing body	The related ministries (MOE, MOH, MOCY, MOI) with the MOMT
Objectives	(1) Build 5 new public facilities according to the need of the citizens (2) as functioning pilot projects to promote similar future facilities, (3) Spread the awareness on sustainable construction and practices, and (4) a business case for the private sector investment.
Expected effects	(1) Low-cost operation in the public facilities (2) Ideal spatial qualities for the users and visitors on the facilities
Investment cost	USD 2.5 million

Description

(1) Existing conditions:
New public facilities are not in the planning and existing public facilities are outdated, run down, over crowed, not fit for their current demand, unsustainable and overexposed to the impact of climate change.

(2) Project description:
One of the important goals for updating the Erbil MP at horizon 2050 is to adapt to climate change and become a low-carbon city. The public sector needs to lead this ambition and adopt and showcase the best measures and practices on the publicly owned and operated buildings.

- Set up a design committee, responsible for
  - Issuing and guiding the projects, including preparing design briefs.
  - Launching biddings or design competition for the 5 projects:1 school, 1 health center, 1 cultural facility, 1 sport facility, 1 governmental building, individually or in a combined functionality;
  - Awarding a contracting firm and supervising its construction;
  - Organizing workshops with the users of the facilities;
  - Monitoring and evaluating the performance of the facilities after completion.

- A holistic approach to design, construction, operation and maintenance:
  - Design including optimized orientation, building envelope and window location, proper material selection, passive energy, water saving.
  - Construction phase including controlling environmental impact, energy-efficient systems, waste management.
  - Operation and management including energy monitoring, eco-friendly practices, education and engagement and continuous improvement.
  - Incorporate nature-based and passive cooling solutions, e.g., create basements as cooling centers

(3) Issues for Implementation:
- None

(4) Social and environmental issues:
- None, people and the environment will benefit from these demonstration projects

(12) Environmental Management (EM)

ID	**EM-1**
Title	**Upgrading of Environmental Performance in Erbil**
Location	The whole Erbil Governorate
Implementing body	Environmental Protection and Implementation Board (EPIB)
Objectives	(1) To monitor and control the air, water quality and soil quality (2) To collect the data of the air, water quality and soil quality (3) To establish the public announcement system
Expected effects	Improve and prevent environmental pollution through the implementation of environmental monitoring and management
Investment cost	USD 2.5 million

Description

(1) Existing conditions

Numerous industrial zones, encompassing both authorized and unauthorized facilities, are currently in various stages of development or planning. However, there is a deficiency in the quantity of environmental monitoring station, and the implementation of environmental management practices is not functional at all in sectors like industrial, energy, transport, waste management etc. The systematic and continuous monitoring and assessment of air, water, soil quality and noise are crucial for understanding the concentration of various pollutants in the air, water, soil noise, and their potential impact on human health and the environment. JICA has the experience of environmental upgrading of refineries in Iraq, with the Basrah Refinery Upgrading Project started in 2023.

(2) Project description

To achieve the above objectives of the project, the following outputs will be produced

i. Installation the air monitoring stations (stable and mobile) in industrial areas and residential area with heavy duty tracks and private vehicles and establish the financial and technical sustainable mechanism; (the air monitoring stations should measure (CO, CO2, NO2, SO2, O3, PB, PM10, PM2.5))
ii. Installation of meteorological date collecting stations (e.g. precipitation (hourly/ day), wind direction/ speeds/ temperature, humidity, sunshine etc.).
iii. Establishment of the data sharing and analysis system (by Establishment of center of data: unification and centralization of the data among the implementing agencies);
iv. Monitoring and controlling the water waste quality of industries;
v. Developing and strengthening legal regulations in environmental management and pollution control including penalties
vi. Establishment of the public information sharing system (e.g. Air quality Index (AQI), Water quality, meteorological information, noise etc.);
vii. Establishment of the Governmental Investment and Loan Program for the Environmental and Social Consideration Factors: To promote investment in equipment with low environmental impact and eco-friendly;
viii. Public Awareness Activities (Eco-friendly event (e.g. Eco-friendly equipment for industry fair/ Clean energy and technologies that reduce industrial smokestack emissions etc. environment and health awareness event, etc.)

(3) Issues for Implementation

- As EPIB is the consultancy board and initiative organization, demarcation of actual environmental monitoring and survey conducting authorities should be clarified
- For the governmental investment and loan program, it is necessary to coordinate and discuss the public financial allocation and private funds supports.
- Legal and regulation for monitor and control the water waste from industries will be organized, if necessary. Existing legal framework [Guideline for limiting treated swage water and reuse in guideline number (3) of 2023 EPIB published in the Kurdistan Gazette No. (275)]
- The necessary date type (GIS, Satellite etc. will be identified by Feasibly Studies) will be identified.
- AQI and other indicators should be designed with easy understand for the public.

(4) Social and environmental issues

- In order to carry out a proper environmental assessment, appropriate monitoring stations need to be set up, e.g. in industrial estates or in busy traffic areas or in city center. To implement actively, necessary feasibility studies should be conducted.
- In the implementation of government-supported investments and loans, it is necessary to establish mechanisms to prevent corruption.

ID	**EM-2**
Title	**Protection of Terrestrial and Aquatic Ecosystem in Kurdistan**
Title	Protection of terrestrial and aquatic ecosystem in Kurdistan
Location	The whole Kurdistan area
Implementing body	Environmental Protection and Implementation Board (EPIB)
Objectives	(1) To collect the data of biodiverse ecosystem in terrestrial and aquatic area (2) To establish the data base on biodiversity (3) To conserve the natural ecosystems and sustainable land use are promoted (4) To establish of a legal framework for the environment (protection and management of flora and fauna) in the KRG, if necessary
Expected effects	Environmental protection and environmentally friendly development
Investment cost	USD 1 million

Description

(1) Existing conditions

The protection of ecosystems in the Kurdistan Region, including Erbil, is governed by laws/Regulations such as Law No. 8 of 2008 Environmental Protection and Improvement in the Iraqi Kurdistan Region. This law sets out rules for the protection and improvement of the environment. On the other hand, comprehensive information on ecosystems, inhabiting flora and fauna is not publicly available by government; according to the International Union for Conservation of National Resources database, migratory birds and other seasonal migrants have been identified in Erbil, and understanding these flora and fauna is important for environmental protection and nature-friendly development and prior coexistence.

(2) Project description

To achieve the above objective of the project, the following outputs will be produced

i. Carry out surveys to identify flora and fauna habitats of the KRG including resting and nesting areas of migrant birds together with interpretation of satellite images by machine-learning;
ii. Establishment of ecological protection land usage and action plans based on the above studies, and of management mechanisms;
iii. Establishment of an information management mechanism (center of data base/ analysis) with integration of biological and ecological surveys carried out by EIAs and others survey;
iv. Establishment of an ecosystem information disclosure portal;
v. Public Awareness activates (e.g. school activities, Eco-friendly week etc.)

(3) Issues for Implementation

- The implementing agency is listed as "EPIB," but EPIB is listed as the primary initiating (overall coordinating) agency. Therefore, it is necessary to confirm the demarcation of the organizations concerned and to assign roles for actual surveys, etc.
-

(4) Social and environmental issues

There will no significant adverse effects on social and environmental issues. However, there may be some impact on local economic activity and land use.

(13) Climate Change Adaptation and Green Area Management (CC)

ID	**CC-1**
Title	**Enhancing Urban Resilience through Urban Green Infrastructure Development**
Location	Erbil 2050 MP Project Area
Implementing body	MoMT, Board of Tourism, Presidency of Erbil Municipalities, Environmental Protection and Implementation Board (EPIB)
Objectives	(4) Create a green urban infrastructure to reduce the heat island effect. (5) Enhance the quality of life in general by providing public green and wet spaces. (6) Ensure green spaces integrated within the urban fabric by introducing sustainable urban planning and design principles. (7) Promote diverse urban planning by connecting residential, business, and green zones to create lively yet sustainable communities.
Expected effects	(5) Climate Resilience: Improved climate adaptation in urban areas via the development of green infrastructure, mitigating the urban heat island effect, resulting in a more resilient and climate-adaptive city. (6) UGI measures such as rain gardens and bioswales increase water infiltration and and groundwater recharge to ensures a sustainable supply for the city's residents with minimal losses through evaporation or seepage into structures.
Investment cost	million USD

Description

(1) Existing conditions

Erbil City is clearly impacted by climate change. According to the EPIB report, the urban population is exposed to extreme heat, dust storms and water scarcity. If the heat island effect remains unchecked Erbil City will eventually become too hot for comfort during the summer. Currently, green spaces within the Erbil city's urban fabric are not enough to counter the heat island effect. With only 6.3 m2 per capita, Erbil City falls well below the recommended minimum of 9 m2 per capita. This gap is supported by the findings from the SEA Consultation of Erbil Sustainable Capital 2050. The 158 interviewees strongly articulated a vital need for more green spaces. This shared feeling highlights the urgency to bridge this gap in green urban infrastructure, which aligns with the broader objective to create a sustainable and climate-resilient environment as part of Erbil's future expansion.

(2) Project description

Enhance tree cover and green roofs within Erbil City

The aim of this project activity is to increase tree cover by creating green spaces and planting trees along the road infrastructure. Expand tree cover and green roofs within Erbil city, e.g., parks, along ponds, and trees along roads. Promote green roofs to reduce heat transfer from hard roofs contributing to the heat island effect.

Create urban water features within Erbil City

The aim of this project activity is to identify and create water bodies (e.g., neighborhood ponds) and water features (e.g., play fountains) within the urban fabric, to collect and store storm water above or below ground for cooling purposes.

(3) Issues for Implementation

- Establishing and enforcing the new zoning regulations.
- Working closely with local communities to ensure successful execution.
- Adapting infrastructure to incorporate green spaces while maintaining vital urban services.

(4) Social and Environmental issues

- None, to the contrary. There will be improvements in public health and overall well-being.and improved air and water quality and carbon sequestration.

ID	**CC-2**
Title	**Enhancing Peri-Urban Resilience through Green Infrastructure Development**
Location	Erbil 2050 MP Project Area
Implementing body	MoMT, Board of Tourism, Presidency of Erbil Municipalities, Environmental Protection and Implementation Board (EPIB)
Objectives	(1) Mitigate GHG emissions by creating high carbon sinks such as forests and wetlands to counter the impact of global warming. (2) Plant trees to create a Green Wall for Erbil city against dust storms and increase infiltration of storm water to recharge the ground water.
Expected effects	(1) The green infrastructure will sequester CO2, the trees will create a cool environment and reduce heat transfer from exposed surface areas. (2) The Green Wall will break dust storm entering Erbil City and improve air quality. (3) More tree cover will improve water infiltration, increase groundwater recharge minimize runoff and in extension the risk of flooding.
Investment cost	million USD

Description

(1) Existing conditions

The rural surroundings of Erbil City are void of trees and fully exposed to the negative impact of climate change. Land is exposed to drought and flooding, and difficult to cultivate and raise livestock. Peri-urban subsistence and commercial farmers will be unable to continue to supply the markets of Erbil City, increasing food insecurity in general.

(2) Project description

Enhance afforestation to increase tree cover within the peri-urban and urban area of Erbil City

- Expand the existing proposed forest as a large-scale carbon sink for Erbil city.
- Promote agroforestry and tree planting in the Inner Green Belt to improve presence
- Create a Green Wall in the western and southwestern quadrants of Erbil City to ward off dust storms by planting trees as shelter belts as a lattice through farmland.
- Create a forest corridor from the Inner Green Belt to the Great Zab River.

Create protected areas to protect biodiversity and ecosystem services for humans.

- On a grand scale, establish a comprehensive Global Green Network that seamlessly interconnects all green zones spanning from the Inner Green Belt to areas beyond. This ambitious initiative involves strategically installing Green Linkages and deliberately planting trees at key connection points.

(3) Issues for Implementation

- Establishing and enforcing zoning regulations.
- Working closely with local communities to ensure successful execution.

(4) Social and Environmental issues

- None, to the contrary. There will be improvements in public health and overall well-being such as improved air and water quality and carbon sequestration.

ID	**CC-3**
Title	**Setting up a Decentralized Climate Finance Delivery Mechanism**
Location	Erbil 2050 MP Project Area
Implementing body	MoMT, Presidency of Erbil Municipalities, Environmental Protection and Implementation Board (EPIB)
Objectives	(1) Set a delivery mechanism to channel climate finance to stakeholders and beneficiaries (2) Establish a consortium of partners to finance and implement climate adaptation and mitigation projects
Expected effects	Millions of climate finance become available to Erbil City to transition the city and its rural surroundings to become low carbon and climate resilient.
Investment cost	130,000 USD

Description

(1) Existing conditions

Erbil City does not have a clear financial mechanism and partners to receive and channel climate finance to climate proof its rural and urban communities, public and private sector.

(2) Project description

Identify a decentralized climate finance mechanism

This project activity aims to analyze the existing (intergovernmental) fiscal transfer system and identify a budgeting process which allows Erbil City to receive climate finance and channel it to lower government level to finance climate adaptation and mitigation activities in the city and in its peri-urban area.

Set up a consortium of partners

This project activity aims to engage with potential partners such as direct access entities to multi-lateral climate funds (e.g., JICA, UNDP), (regional) development banks (e.g., FMO) and institutional investors, and assess their willingness to partner and leverage climate finance for Erbil.

(3) Issues for Implementation

- None

(4) Social and Environmental issues

- None, potential future funding will create social and environmental benefits.

(14) GIS Data Management (GD)

ID	**GD-1**
Title	**Development of Erbil Spatial Data Infrastructure**
Location	Erbil Governorate
Implementing body	Ministry of Municipalities and Tourism, Erbil Governorate
Objectives	(1) Establish an infrastructure for sharing geospatial information with government organizations and stakeholders. (2) Provide an environment for the distribution and use of various data and information through location information by developing a Geo-portal. (3) Create highly accurate and fresh base maps for improving efficiency in planning and management of infrastructure development, land use planning, urban development, disaster prevention, etc.
Expected effects	(1) Avoid duplication of investment by various organizations in the development and management of geospatial information as a basis for economic development and land development. (2) Common use of the same map (common base map) by many users ensures that specific locations on the map can be identified.
Investment cost	USD 6.8 million (147JPY=1USD)

Description

(1) Existing conditions

Each government organization in Erbil Governorate and Erbil City, under its own authority and according to its own needs, individually creates, collects, and uses geospatial information for infrastructure development, land use planning, urban/rural development and facilities management, using different formats, data models and standards. However, there are no regulations or standard specifications for sharing this data between government organizations. Therefore, a new approach needs to be developed and measures urgently implemented to avoid duplication of investment by each organization in the development/management of geospatial information, which will be the basis for economic development and regional land development in the future.

(2) Project description

1) Preparation of a roadmap for SDI establishment

For the establishment of SDI, the various kinds of condition should be prepared such as legal, institutional, and data managemental aspects in addition to the system development (Geoportal) for spatial data sharing. However, since it is not feasible to meet all the requirements all at once, the road map for SDI establishment should be prepared based on the priority of necessary tasks.

2) Regulation of data publication and sharing within the governmental institutions

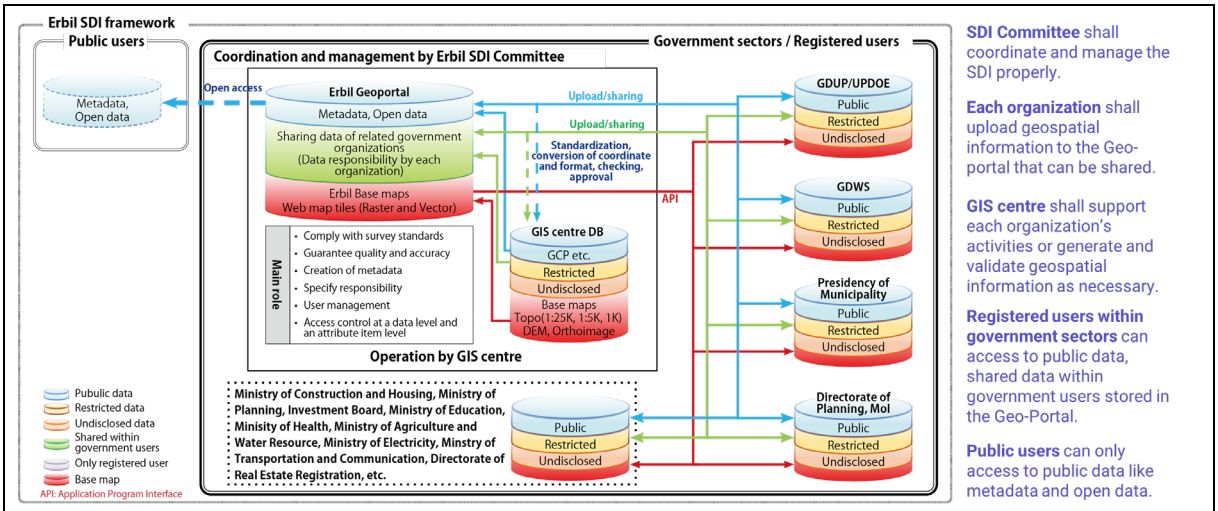
The regulation and standard need to be prepared for the inter-ministerial data sharing. In the developing countries, the regulation and standard are prepared after the NSDI Act is enforced. As of 2023, the regulation related to survey and mapping has not been prepared in the Kurdistan Government. Considering this situation, the regulation for data sharing and standard for data publication are prepared.

3) Creation of the base map

The spatial data sharing requires the common base map. In addition to the base map, the elevation data is essential for regional planning especially for disaster management and infrastructure development. Therefore, the base map which has elevational data is to be prepared at the different level of scale by the area; 1:1,000 scale for city road, 1:2,500 scale for city area except for the road, and 1:10,000 scale for suburban area.

4) Development of Erbil Geoportal

The spatial data sharing system (Geoportal) is developed to share the base map and the other spatial data created by the governmental organizations. The access policy for spatial data is set by the level such as the confidential data within the government and disclosable data to the public. By setting this access policy, public users can access and utilize the spatial data through Geoportal.



(3) Issues for Implementation

- No regulation and standard related to survey and mapping.
- The plan to establish GIS center by Ministry of Municipalities and Tourism is pending. The latest updates on the plan and MoMT's intention need confirmed. The leading organization and implementing body are unclear; may need to be updated.
- Securing the budget for Operation & Management (O&M) after the SDI establishment.
- Establishment of O&M structure including human resources and costs.

(4) Social and environmental issues

Not particular

11.2.4 High Priority Project

High Priority Projects are determined through the scoring system, where the project with the highest score in each sector is selected. Additionally, projects must have a minimum of two Urgency points to qualify. The following is a list of projects that have been selected as High Priority based on these criteria.

- UP-1: Urban Planning Law Elaboration Project
- EI-2: Erbil Citadel Revitalization & Urban Heritage Enhancement Project
- UT-7: Signalization of the Intersections
- UT-9: Car access control with fringe parking system inside 30m Road and Shuttle Mover Service
- WR-1: Integrated Water Resource Management Project
- WS-1: Erbil Water Distribution and Management Capacity Development Project
- WS-2: Erbil Water Treatment Construction Project
- SW-2: Erbil Sewerage and Drainage Improvement Project
- SM-1: Erbil Solid Waste Management Improvement Project
- PE-2 Harir 400Kv/132kv Substation and 400KV Transmission Line between Erbil and Harir
- TL-2: Next Generation Mobile Communication System Development Project
- FM-1: Formulation of flood control plan
- EM-1: Upgrading of Environmental Performance in Erbil
- CC-1: Enhancing Urban Resilience through Urban Green Infrastructure Development

11.3 Financial Analysis

11.3.1 Analysis of Project Costs by Phase

The project cost (land acquisition and construction costs) for each sector by year was totaled to calculate the project cost for each period from short term to long term.

The Priority Project has a total project cost of $2,954 million, with the largest investments in the "Solid Waste" and "Urban Transport" sectors.

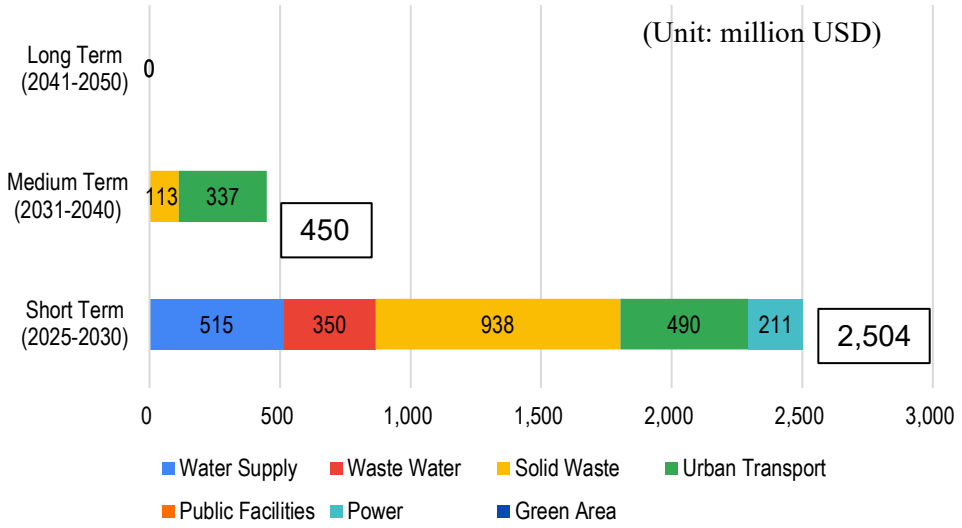


Figure 11.3.1 Investment Cost for the Priority Projects

The total investment amount was $16,579 million, $6,012 million (36.3%) in the short term, $6,714 million (40.5%) in the medium term, and $3,853 million (23.2%) in the long term. The amount of investment in the short term is large considering that the short term investment is for 6 years and the medium and long term investment is for 10 years.

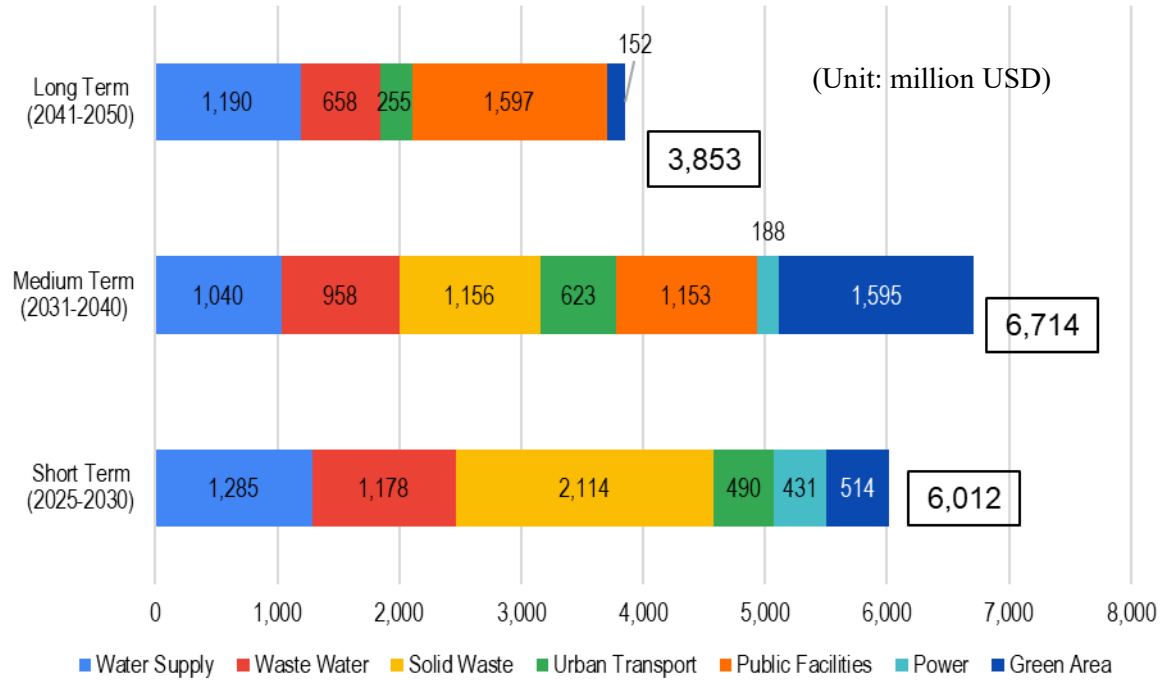


Figure 11.3.2 Investment Cost for the All Projects

Table 11.3.1 Investment Expenses by Sector by Year

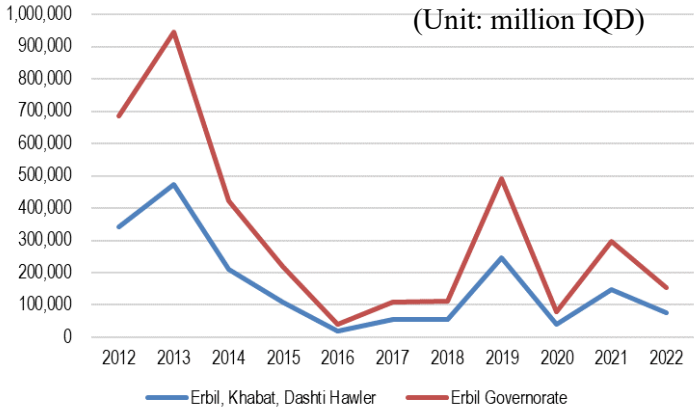
(Unit: million USD)

	Short Term (2025-2030)	Medium Term (2031-2040)	Long Term (2041-2050)	Total
	Priority Projects			
Water Supply	515	0	0	515
Waste Water	350	0	0	350
Solid Waste	938	113	0	1,050
Urban Transport	490	337	0	828
Power	211	0	0	211
Total	**2,504**	**450**	**0**	**2,954**
Average annual investment	**417**	**45**	**0**	**114**
	Other Projects			
Water Supply	770	1,040	1,190	3,000
Waste Water	828	958	658	2,445
Solid Waste	1,177	1,044	0	2,221
Urban Transport	0	286	255	541
Public Facilities	0	1,153	1,597	2,750
Power	220	188	0	408
Green Area	514	1,595	152	2,261
Total	**3,509**	**6,264**	**3,853**	**13,625**
Average annual investment	**585**	**626**	**385**	**524**
	All Projects			
Water Supply	1,285	1,040	1,190	3,515
Waste Water	1,178	958	658	2,795
Solid Waste	2,114	1,156	0	3,271
Urban Transport	490	623	255	1,369
Public Facilities	0	1,153	1,597	2,750
Power	431	188	0	619
Green Area	514	1,595	152	2,261
Total	**6,012**	**6,714**	**3,853**	**16,579**
Average annual investment	**1,002**	**671**	**385**	**638**

Source: JICA Project Team

11.3.2 Validation of Infrastructure Investment Amount

The Figure 11.3.3 shows the trend of government-related expenditures in Erbil Governorate and the area that are related to the study area (Erbil, Khabat, and Dashti Hawler). The amount of expenditures peaked around 2013 and has been declining, indicating that the Governorate is in considerable financial distress. And, in recent years, it has been in the range of 100 to 200 billion IQD ($76 to $153 million).



Source: Erbil Governorate

Figure11.3.3 Governmental Expenditures by fiscal year

In general, infrastructure demand is said to be proportional to the growth rate of GDP, with infrastructure investment as a percentage of GDP at around 9.1% in the Pacific, 8.8% in South Asia, 7.8% in Central Asia, and 5.7% in Southeast Asia. Investment demand in East Asia is 5.2% of GDP (ADB survey).

The GDP of the target regions estimated in this study is as follows (calculated at 1 USD = 1,310 IQD)

- GDP in 2022: 12,215,519 million IQD ⇒ 9,324.8 million USD
- GDP in 2050: 21,758,615 million IQD million IQD ⇒ 16,609.6 million USD

Based on this, the total GDP for each period is calculated as follows

- 2025-2030: 53,778.8 million USD
- 2031-2040: 127,070.5 million USD
- 2041-2050: 153,087.5 million USD

The following is a calculation of the amount of infrastructure investment in each period as a percentage of GDP.

- Short term: 6,012 / 53,778.8 = **11.2%**
- Medium term: 6,714 / 127,070.5 = **5.3%**
- Long term: 3,853 / 153,087.5 = **2.5%**

In other words, the current investment amounts to 11.2% of GDP in the short term, 5.3% in the medium term, and 2.5% in the long term. Compared to the actual figures from the ADB survey mentioned earlier, for the short term, the highest values are beyond the Pacific region, and it is necessary to consider turning some projects to the medium term. However, the amount of investment is sufficient for the medium term and beyond.

11.4 Erbil Master Plan Management

This section outlines the essential actions required for the efficient management of Erbil Master Plan. The primary goal is to establish a comprehensive framework that identifies necessary studies and tools for effective implementation of the MP. To achieve this, the development of a structured set of processes and procedures designed to facilitate a flexible yet rigorous approach to the Master Plan's execution.

11.4.1 Erbil Master Plan Documentation

To ensure the effective management of the Erbil Master Plan, it is crucial to designate a specific organization responsible for the documentation and data management relating to the MP. This entity will play a vital role in managing all relevant contents of the MP, including the comprehensive list of projects included in the phasing tables. This role can be assigned to Presidency of Erbil Municipality.

Also, implementing a versioning ID system for the MP is essential; it will track modifications by noting the last date changes were made, not only to the land use plan but to all aspects of the MP. A strict documentation system must be established to maintain a log of all modifications across the various versions of the MP.

It is imperative that all modifications are uniformly applied to all outputs of the MP, ensuring consistency between the Land Use Plan GIS data and the accompanying technical reports. This approach will help prevent discrepancies, as seen in the 2007, 2010, and 2012 versions of the Erbil 2030 MP (see Section 3.1).

11.4.2 Internal Procedure Manual & Circulars

To facilitate effective management of the Erbil Master Plan, it is recommended to draft an internal procedure manual that outlines standard procedures for reviewing the Master Plan, implementing changes in land use plan, and other related activities. This manual should gain a legal basis by being adopted as formal circulars within the relevant organization responsible for Master Plan management, such as the Presidency of Erbil Municipality.

Additionally, clear procedures for updating the Master Plan among various organizations must be established, ensuring a coherent and collaborative approach to updates. A robust mechanism for technical transfer is also essential; it should ensure that experienced technicians who are well-versed in internal procedures effectively pass their knowledge to new generations of civil servants. This will not

only enhance continuity but also foster a culture of shared expertise, ultimately contributing to the sustainable management of the MP.

11.4.3 Erbil Master Plan Monitoring & Evaluation System

Monitoring and evaluating the progress of the implementation of the Erbil Master Plan is crucial to ensure that it remains aligned with the established goals and objectives. Monitoring and Evaluation (M&E) refers to the systematic process of collecting, analyzing, and using information to track progress and assess the effectiveness of interventions. There are two main options for M&E systems: the traditional approach, which emphasizes stakeholder engagement and participatory methods, and a more innovative approach that leverages digital transformation, featuring cloud-based real-time monitoring. While both systems offer valuable insights, they firstly require meticulous preparation to ensure their effectiveness.

(1) Preparation

1) Establishment of the Implementation Promotion and Monitoring Committee (IPMC)

Establishing an Implementation Promotion and Monitoring Committee (IPMC) is vital for the successful monitoring of the implementation of the Erbil Master Plan. The IPMC will serve as a dedicated body responsible for overseeing the implementation process, ensuring that all stakeholders remain aligned with the MP's objectives. This committee will facilitate effective communication and collaboration among various governmental and non-governmental organizations, promoting a shared understanding of goals and strategies. By proactively monitoring progress, the IPMC can identify challenges and opportunities for improvement, enabling timely interventions to keep the implementation on track. Furthermore, the IPMC will play a crucial role in fostering stakeholder engagement, encouraging active participation from the community, and enhancing transparency in decision-making processes. In summary, the establishment of the IPMC will be instrumental in driving the successful realization of the Master Plan's vision for Erbil.

Table 11.4.1 Proposed Composition of the IPMC

Land use in Erbil MP	Implementation Body	Ministry in Charge
Residential single dwelling	Municipality / Private developers	MoMT / BoI
Residential high-rise buildings	Municipality / Private developers / Investors	MoMT / BoI
Residential affordable housing	Municipality / Ministry of Construction and Housing	MoMT / BoI / MoCH
Commercial	Municipality / Private developers	MoMT / BoI
Roads within municipality boundaries	Municipality	MoMT
Roads outside municipality boundaries	Directorate of Roads and Bridges	MoCH
Water supply network	Directorate of Water and Sewerage	MoMT
Sewerage network	Directorate of Water and Sewerage	MoMT
Solid waste stations/landfill	Municipality / Directorate of Services and Environmental Protection	MoMT
Power supply lines and stations	Directorate of Electricity	MoE
Communications infrastructure	Directorate of Communication	MoTC
Public facilities: Education	Directorate of Buildings	MoEdu
Public facilities: Health	Engineering Department	MoH
Public facilities: Security	Ministry of Peshmerga / Ministry of Interior	MoPesh / MoI
Public facilities: Sport activities	Directorates of Ministry of Culture and Youth	MoCAY
Public facilities: Religious	Ministry of Endowments and Religious Affairs	MoEnd
Public facilities: Entertainment, playgrounds	Municipality	MoMT
Public facilities: Cemetery	Municipality	MoMT
Tourism areas	Directorate of Tourism	MoMT / BoT
Agricultural projects	Directorates of Ministry of Agriculture	MoAWR
Transportation: BRT and LRT	Ministry of Transportation and	MoTC

	Communication	
Transportation: Railway	Ministry of Construction and Housing	MoCH
Water resources: Ponds and Lakes Dams	Directorate of Irrigation & Directorate of Dams	MoAWR
Industrial areas	Municipality	MoMT
Parks	Municipality	MoMT
Forest areas	Directorate of Horticulture	MoAWR
Administrative area	*Sector*	*Sector*
Historic areas preservation	Directorate of Antiquities	MoMT
Greenbelt components	*Sector*	*Sector*

Source: JICA Project Team

2) Setting-up Measurable Monitoring Indicators

Establishing measurable monitoring indicators is essential for effectively tracking the progress and impact of the MP. These indicators can be categorized into two types:

- The first type of indicators measures the degree of implementation of the MP, providing insight into how well the planned actions and projects are being executed.
- The second type of indicators assesses socio-economic changes, reflecting the real-world "effects" of the MP on the community and environment. A set of indicators is proposed to measure the changes accompanying the realization of the Long-term Visions (see Section 4.2). It is important to note that these latter indicators cannot be monitored on a short-term basis or bi-annually due to the challenges associated with obtaining up-to-date data, often derived from comprehensive surveys conducted across the entire area of concern. Additionally, depending on the specific indicators, several years may be required to analyze changes and identify significant trends effectively. Therefore, a thoughtful approach to indicator selection and data collection is crucial for ensuring a robust monitoring framework that truly captures the Master Plan's impact on Erbil's development.

3) Maintaining a Smooth Communication Channel between Decision-Makers: The Decision Hub

It is recommended that the organization in charge of the MP management takes responsibility for the upkeep, updates, and maintenance of the Erbil MP Decision Hub Website, which will serve as the dedicated portal for members of the IPMC until the next MP update in 2030 (see Section 11.4.5 below). The website created within the framework of the Project, utilizing the domain name Erbil2050.com, can remain active until this update, as the planning horizon extends to 2050. Following subsequent updates, the domain name of the website can be transitioned to reflect future planning horizons, such as Erbil2060.com, Erbil2070.com, and so on. To ensure the continuity and availability of these domain names, it is recommended that they be purchased as early as possible.

11.4.4 Erbil Master Plan Database Update & Sharing

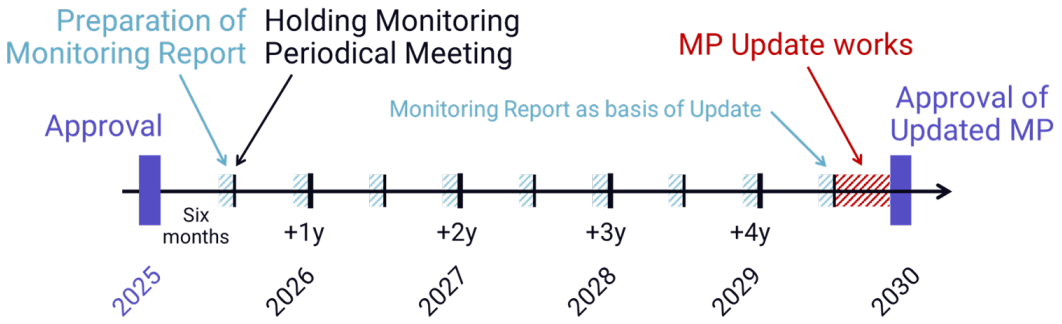
Effective M&E relies heavily on a mechanism for constantly updating information. Therefore, it is recommended that an Erbil Master Plan Database is established and regularly updated to provide stakeholders with the most current data. This Database should serve as a central repository of information related to the Master Plan, encompassing various aspects such as project statuses, implementation metrics, and socio-economic indicators. Importantly, the Database must be made accessible to all relevant stakeholders, including members of the IPMC, rather than being confined to a single organization. By ensuring broad access to the Database, stakeholders can collaboratively engage in informed decision-making, fostering transparency and accountability in the implementation process.

11.4.5 Future Master Plan Reviews & Updates

The Erbil Master Plan must function as a dynamic document that can be reviewed at specified intervals to adapt to the latest natural variations, economic trends, and political changes. As planned by the legal framework of KRG, it is recommended that a comprehensive update of the Master Plan be conducted every five years from the date of its official approval and publication in the Official Gazette. Additionally, if the IPMC identifies during a biannual Monitoring Periodical Meeting that key components such as

the Long-term Vision, Socio-Economic Framework, Strategic Orientations, or Land Use Plan are no longer relevant, updates should be initiated. To streamline the update process and ensure it is completed efficiently within six months, it is essential for the organization responsible for Master Plan management to draft clear Terms of Reference that must be approved by the IPMC. This document should explicitly outline the planning methodology, particularly concerning the review of the Master Plan. Moreover, all necessary data should be prepared in advance to enable consultants to work efficiently. It is also recommended that the Monitoring Periodical Report, presented during the 9th Monitoring Periodical Meeting, include baseline data pertinent to the MP update, thereby providing a solid foundation for analysis and revision.

The Schedule of Future Erbil Master Plan Monitoring & Update is shown below.



Source: JICA Project Team

Figure 11.4.1 Schedule of Future Erbil Master Plan Monitoring & Update