Citrus

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10. Water Resources

10.1 Introduction

The Öksüt Gold Project (the Project) has the potential to impact existing surface water and groundwater due to release of contaminants (e.g. trace metals). Other potential Project impacts include water abstraction for use in ore processing, human consumption and sanitation and changes to the local hydrological and hydrogeological regimes. Impacts may occur during all phases of the Project lifecycle (i.e. construction, operations and closure).

This Chapter provides the baseline hydrological and hydrogeological conditions and presents an assessment of the implications of potential impacts on receptors. The Chapter also presents proposed measures aimed at avoiding or mitigating anticipated impacts to water receptors.

10.1.1 Objectives

The specific objectives of this water resources impact assessment are to:

- identify the main sources of potential impact to water resources arising during the construction, operations and closure phases of the Project;
- determine, quantitatively and qualitatively, whether water discharge and abstraction could potentially impact water receptors in the vicinity of the Project Area;
- assess and define mitigation measures for addressing water resource impacts arising during the various phases of the Project;
- identify long-term management and monitoring measures related to water resources for the closure phase.

10.2 Summary of Policy Content

10.2.1 Turkish Legislation and Standards

The following Turkish legislation is relevant to the Öksüt Project relating to water resources and their management:

- *Regulation on Protection of Wetlands*, Official Gazette No: 28962, Date: 04.04.2014;
- *Regulation on Management of Surface Water Quality* (RMSWQ), Official Gazette No: 28483, Date: 30.11.2012;
- R*egulation on Protection of Groundwater Against Pollution and Deterioration*, Official Gazette No: 28257, Date: 07.04.2012;
- *Groundwater Law*, Law No: 167, Official Gazette No: 10688, Date: 23.12.1960;
- *Regulation on the Water for Human Consumption of the Ministry of Health of Turkey, limit values for drinking and utilization waters* (Ministry of Health, 2005);
- *Regulation on the Protection of Groundwater against Pollution and Degradation* (Ministry of Forestry and Water Affairs, 2012).

10.2.2 EBRD Requirements

The objectives of EBRD PR3 *Resource Efficiency and Pollution Prevention and Control* are to:

- "identify project-related opportunities for energy, water and resource efficiency improvements and waste minimisation;
- adopt the mitigation hierarchy approach to addressing adverse impacts on human health and the environment arising from the resource use and pollution released from the project.

PR3 states the requirement for projects to meet the relevant EU substantive environmental standards, where these can be applied at the project level. Projects must also be designed to comply with applicable national law, and will be maintained and operated in accordance with national laws and regulatory requirements. When host country regulations differ from the levels and measures presented in EU requirements or other identified appropriate environmental standards, projects will be expected to meet whichever is more stringent.

10.2.3 European Union Directives

The following European Directives are relevant to the Project:

- Directive 200/60/EC *Water Framework Directive*;
- Directive 2008/105/EC *on environmental quality standards in the field of water policy*, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council;
- Directive 2006/118/EC *on the protection of groundwater against pollution and deterioration*;
- Decision No 2455/2001/EC *Establishing the List of Priority Substances in the Field of Water Policy*;
- Directive No. 98/83/EC *Criteria for Quality of Water for Human Consumption*;
- Directive 2009/90/EC laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, *technical specifications for chemical analysis and monitoring of water status*.

10.2.4 International Conventions and Treaties to Which Turkey is a Signatory

A number of international treaties and conventions that Turkey is signatory to have relevant to water resource management but do not necessarily directly address water quality. These treaties and conventions are presented in *Chapter 2: Legal Framework*. One convention that is directly relevant to surface water management is:

- *Convention on Wetlands of International Importance* (Ramsar Convention); ratified by Turkey in 1994).

10.2.5 International Guidelines

The World Health Organisation provides a list of limit values of chemicals in drinking water:

- *Guidance values for drinking water quality* established by the World Health Organisation (WHO, 2011).

10.2.6 Project Standards

The Project Standards have been prepared to comply with applicable national laws and regulatory requirements. Where Turkish regulations differ from the levels and measures presented in EU requirements or other identified appropriate environmental standards, the Project Standards meet whichever is more stringent.

The *Regulation on the Management of the Quality of Surface Water* (RMSWQ) Table 5 – *Quality Criteria for the Inland Surface Water Resources* was used to assess the baseline water quality within and in the vicinity of the Project site. The limit values presented in the RMSWQ Table 5

Table 10-1 presents the Project Standards for drinking water. Effluent waste water standards are set out in Table 10-2 below.

Table 10-1: Öksüt Project Drinking Water Standards

Parameter	Units	Turkish Standard	EU Standard	Project Standard
Aluminium (Al)	mg/l	-	0.2	**0.2**
Ammonium ion (NH_4)	mg/l	-	0.5	**0.5**
Antimony (Sb)	mg/l	0.0005	0.005	**0.0005**
Acrylamide	mg/l	0.0001	-	**0.0001**
Arsenic (As)	mg/l	0.01	0.01	**0.01**
Barium (Ba)	mg/l	-	0.7	**0.7**
Beryllium (Be)	mg/l	-	0.0002	**0.0002**
Benzene	mg/l	0.1	-	**0.1**
Benzopyrene	µg/l	0.01	-	**0.01**
Boron (B)	mg/l	1.0	0.5	**0.5**
Bromate	µg/l	10	-	**10**
Cadmium (Cd)	mg/l	0.005	0.003	**0.003**
Calcium ion (Ca^{2+})	mg/l	-	100	**100**
Chloride ion (Cl^-)	mg/l	-	250	**250**
Chlorine (Cl)	mg/l	-	5	**5**
Chromium (Cr)	mg/l	0.05	0.05	**0.05**
Copper (Cu)	mg/l	2	1	**1**
Cyanide (CN)	mg/l	0.05	0.01	**0.01**
1,2-Dichloracethane	µg/l	3	-	**3**
Fluoride ion ($F^=$)	mg/l	1.5	0.7-1.5	**0.7**
Hydrogen Sulphide (H_2S)	mg/l	-	0.1	**0.1**
Iodine (I)	mg/l	-	1.0	**1.0**
Iron (Fe)	mg/l	-	0.2	**0.2**
Lead (Pb)	mg/l	0.01	0.01	**0.01**
Magnesium ion (Mg^{2+})	mg/l	-	30	**30**
Manganese (Mn)	mg/l	-	0.05	**0.05**
Mercury (Hg)	mg/l	0.001	0.0005	**0.0005**
Molybdenum (Mo)	mg/l	-	0.07	**0.07**
Nickel (Ni)	mg/l	0.02	0.02	**0.02**
Nitrate ion (as NO_3^-)	mg/l	50	50	**50**
Nitrite ion (as NO_2^-)	mg/l	0.5	1.0	**0.5**
Phosphate ion (PO_4^{2+})	mg/l	-	3.5	**3.5**
Pesticides	µg/l	0.1	-	**0.1**
Total pesticides	µg/l	0.5	-	**0.5**
Polycyclic aromatic hydrocarbons	µg/l	0.1	-	**0.1**
Selenium (Se)	mg/l	0.1	0.01	**0.01**

Parameter	Units	Turkish Standard	EU Standard	Project Standard
Silver (Ag)	mg/l	-	0.1	**0.1**
Sodium (Na)	mg/l	-	200	**200**
Sulphate ion (SO_4^{2+})	mg/l	-	500	**500**
Strontium (Sr)	mg/l	-	2.0	**2.0**
Tetrachloroethane and Trichloroethane	µg/l	10	-	**10**
Trihalomethanes-total	µg/l	100	-	**100**
Vinyl chloride	µg/l	0.5	-	**0.5**
Uranium (U)	mg/l	-	0.015	**0.015**
Vinyl Chloride (C_2H_3Cl / H_2C)	mg/l	-	0.0003	**0.0003**
Zinc (Zn)	mg/l	-	5	**5**
Radiological Quality				
Total α radioactivity	Bq/l	-	4	**4**
Total β radioactivity	Bq/l	-	1	**1**
Physical Quality				
pH	---		6.5 - 9.5	**6.5 - 9.5**
Taste	Score		As above	
Odour	Score		As above	
Colour	degree		As above	

Notes:
The table shows upper limit values, unless indicated otherwise as a range or lower limit value.
EU Standard is EU Directive 98/83/EC on Drinking Water Quality.
EU Standard for radioactivity expressed as Tritium 100 Bq/l with a total indicative dose of 0.1 mSv/year.

Table 10-2: Effluent Wastewater Standards

Parameters	Unit	Comparative Standards		Project Standard
		Turkish Standard[1]	EU Guidance[2]	Range or Maximum Allowance
Water temperature	°C	<25	-	**25**
Odour	Sense	-	-	**no odour**
pH index	mg0/l	6.5-8.5	-	**6.5-8.5**
Conductivity	(µS/cm)	< 400	-	**<400**
Biochemical Oxygen Demand	mg0/l	<4	25	**<4**
Chemical Oxygen Demand	mg0/l	25-50	125	**25-50**
Cyanide	mg/l	-	-	**0.5[3]**
Copper	(µg Cu/L)	<20	-	**<20**
Cadmium	(µg Cd/L)	<2	-	**<2**
Mercury	(µg Hg/L)	<0.1	-	**<0.1**
Nickel	(µg Ni/L)	<20	-	**<20**

Parameters	Unit	Comparative Standards		Project Standard
		Turkish Standard[1]	EU Guidance[2]	Range or Maximum Allowance
Lead	(µg Pb/L)	<10	-	**<10**
Zinc	(µg Zn/L)	<200	-	**<200**
Ammonium	mg N/l	0.2	-	**0.2**
Total nitrogen	mg/l	0.5	15	**0.5**
Total phosphorus	mg/l	<0.03	2	**<0.03**
Faecal Coliform	(EMS/100 ml)	<10	-	**<10**
Total Coliform	(EMS/100 ml)	<100	-	**<100**

Notes:

[1] Turkish Standards relate to Class I 'High Water Quality' which includes surface waters with a high potential for drinking water, recreational purposes, trout production and livestock raising and farming.
[2] EU standards from Directive 91/271/EEC concerning urban waste water treatment
[3] There are no limit values in Turkish or EU legislation. Limit values have been taken from ICMC Guidance. Discharges to surface waters should not exceed 0.5 mg/l WAD cyanide nor result in a concentration of free cyanide in excess of 0.022 mg/l within the receiving surface water body, and downstream of any mixing zone approved by the applicable jurisdiction. WAD cyanide refers to metal cyanide complexes (Zn, Cd, Cu, Hg, Ni, and Ag) that dissociate under weak acid conditions of pH 4.5 to 6. Free cyanide refers to the sum of hydrogen cyanide (HCN) and cyanide ion (CN-) in a sample. Free cyanide is bioavailable and toxic to organisms in aquatic environments.

10.3 Scope of Assessment Methodology

10.3.1 Spatial Scope

The study area is defined as the Project Area (the EIA Permitted Area plus the access road and powerline corridor) and the hydrological and hydrogeological features that may be impacted by Project activities namely, the sub-basins of the Kızılırmak and Seyhan Basins. The north-south extending Develi Mountains form the divide between the Kizilirmak and Seyhan Basins. The location of the Project Area in relation to these two Basins is illustrated in Figure 10-1. The Sultan Sazlığı wetland is located in the Kızılırmak Basin. The Zamantı River and the Epçe region where the Project's water abstraction wells are located is located within the Seyhan Basin.

10.3.2 Temporal Scope

The temporal scope of this assessment includes the full life-cycle of the Project. Impacts are assessed for the construction, operations and closure phases of the Project.

10.4 Data Collection

Data Sources

For this ESIA, the hydrological and hydrogeological baseline conditions have been assessed based on a range of field studies prepared for the Project, desktop studies and literature and data reviews. The main information and data sources used include:

- Turkish EIA, SRK Danışmanlık Ve Mühendislik A.Ş., Ankara, June 2015 (*Annex B and Annex C*).
- Öksüt Gold Project, Feasibility Study – Preliminary Release, Centerra, May 2015 and 43-101 Report, Centerra, September 2015 (*Annex A*).
- Geological Maps prepared by General Directorate of Mineral Research and Exploration.

- Reports prepared by Golder for the Water Quality Monitoring conducted between August 2008 and May 2013.
- Additional monitoring undertaken in September 2015 as part of this ESIA process are provided in *Annex T*.
- Hydrogeological Impact Assessment and Modelling Study Report for Öksüt Project, SRK Danışmanlık Ve Mühendislik A.Ş., Ankara, October 2015 (*Annex O*).
- Geochemical Impact Assessment and Modelling Study Report for Öksüt Project, SRK Danışmanlık Ve Mühendislik A.Ş., Ankara, October 2015 (*Annex P*).

A Brief summary of baseline data collection studies are presented below.

Golder Associates (Turkey) Ltd. Co. (Golder) was commissioned by Stratex in July 2008 to undertake the initial Environmental Baseline Investigations at the Öksüt Property which included the water quality sampling program within the exploration area. These investigations continued for a year including a total of three water quality sampling sessions. The Environmental Baseline Report was submitted to Stratex in August 2009 recommending a water quality sampling program to be continued as the exploration activities were ongoing (Golder, August 2009). The groundwater was sampled at nine locations; three surface water quality sampling points were identified, however during the sampling program no flow was observed in the creeks.

In January 2011, Stratex commissioned Golder to continue the water quality sampling for 2011. Golder conducted four site visits: January, April, July, and October and submitted its report in December 2011 (Golder, December 2011).

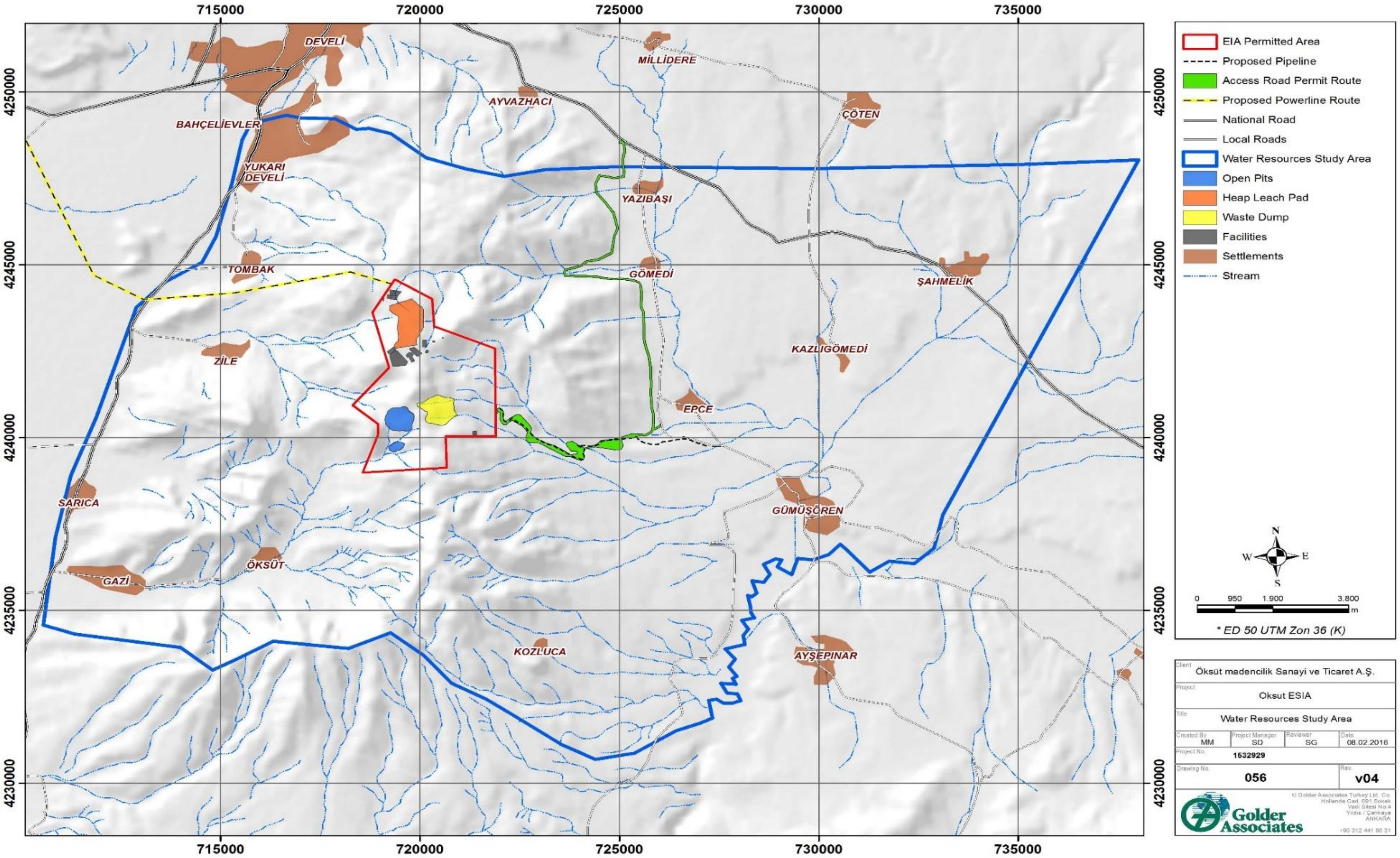
In May 2012, Stratex commissioned Golder to undertake the 2012 water quality sampling program. Two additional sampling points (ZAMANTI-GW and ZAMANTI-SW) were added (Golder, June 2012). Golder conducted three site visits: May, August and November in 2012 and submitted its report after each sampling session.

In January 2013, Golder was commissioned by the Öksüt Project to continue the water quality sampling program for 2013. Three additional sampling points (KSP-9, ZİLE-2, and KSW-4) were added in the first sampling session.

In May 2013, Golder monitored the field parameters and flow rates at 17 monitoring points, including seven springs (KSP-1, KSP-2, KSP-3, KSP-5, KSP-6, KSP-7, KSP-8 and KSP-9), three water sources intended for human consumption (ÖKSÜT-1, ZİLE-1, and ZİLE-2), four surface waters (KSW-1, KSW-2, KSW-3, and KSW-4), one high-discharge spring encountered during the construction of the Zamantı Diversion Tunnel (captured within the 120 m long spring catchment interval and transported via 800 mm diameter pipes for approximately 4 km, 2 m beneath the Zamantı Diversion Tunnel (ZAMANTI-GW) and one surface water sample from the Zamantı River (ZAMANTI-SW). One duplicate sample was taken from KSP-3 and named KSP-4 for QA/QC purposes.

Following the July 2013 expansion of the Project's scope, a hydro-census study was conducted to develop a more detailed database regarding surface hydrology within the Project Area and its surrounds. Between 2013-2015, SRK completed a comprehensive field program to characterize hydrological, hydrogeological and hydrochemical characteristics of the Project Area. SRK constructed two surface flow stations, drilled and installed 30 groundwater monitoring wells and conducted aquifer tests, performed hydrocensus studies. A total of 322 water monitoring locations (hydro-census stations) for both groundwater and surface water were established. The water quality sampling and monitoring performed by SRK started in July 2013 and continued in November 2013, February 2014 and April 2014 and in the summer of 2014, new observation wells were installed. In the subsequent monitoring campaigns, seasonal measurements at 40 locations were undertaken.

Figure 10-1: Water Resources Study Area



The hydro-census stations are illustrated Figure 10-2. *In situ* parameters were measured at all 322 surface and groundwater locations during the first monitoring campaign and included:

- Electrical Conductivity (EC);
- pH;
- Flow Rate;
- Temperature (T);
- Total Dissolved Solids (TDS).

Surface Water Quality Monitoring

The surface water quality monitoring stations were selected on these creeks and their tributaries to represent upstream and downstream of the EIA Permitted Area. A map illustrating the location of the surface water monitoring stations is presented in Figure 10-3. Coordinates and descriptions of the stations are presented in Table 10-3.

Figure 10-2: Hydro-census Sampling Locations

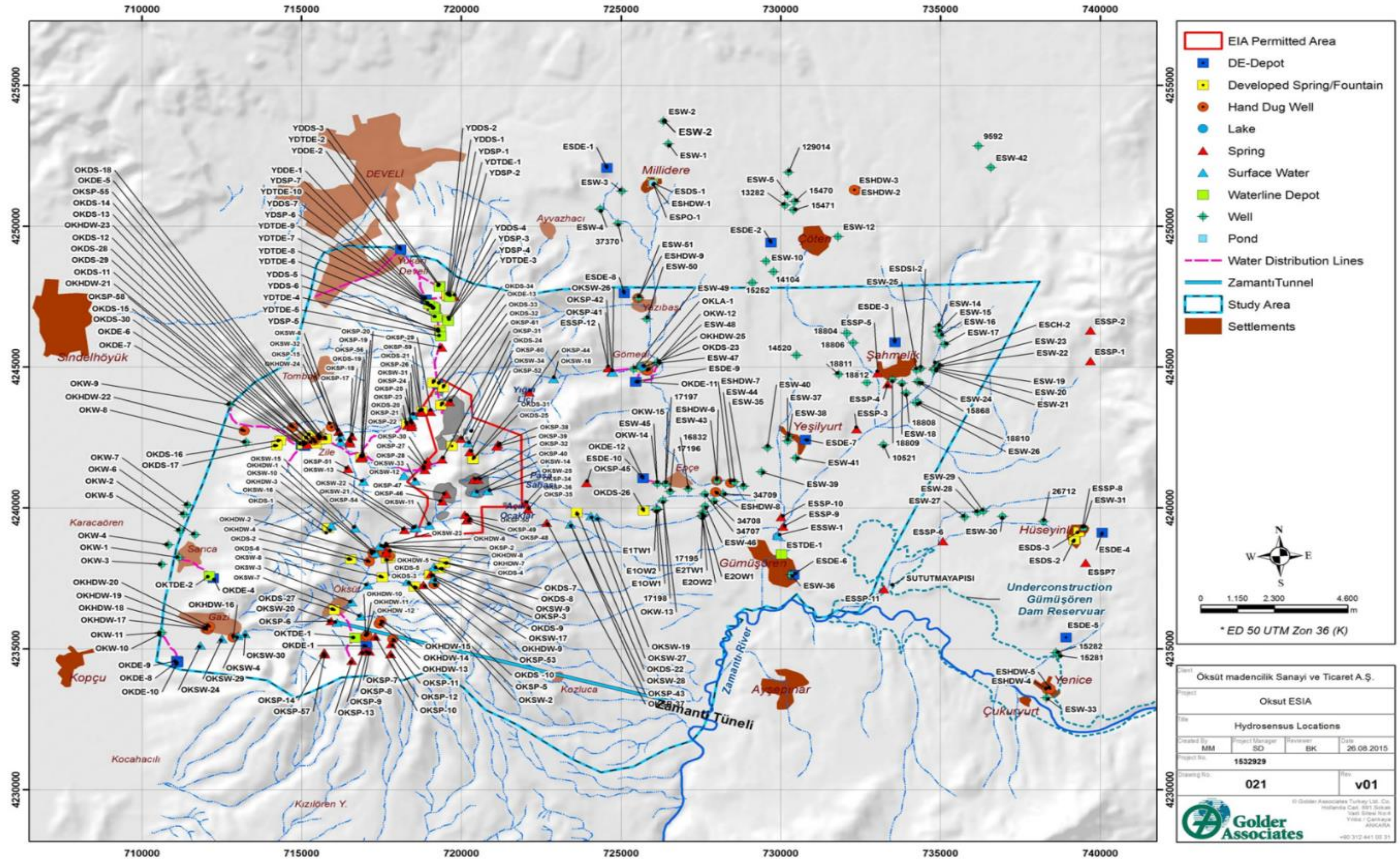


Figure 10-3: Location of Surface Water Sampling and Monitoring Stations

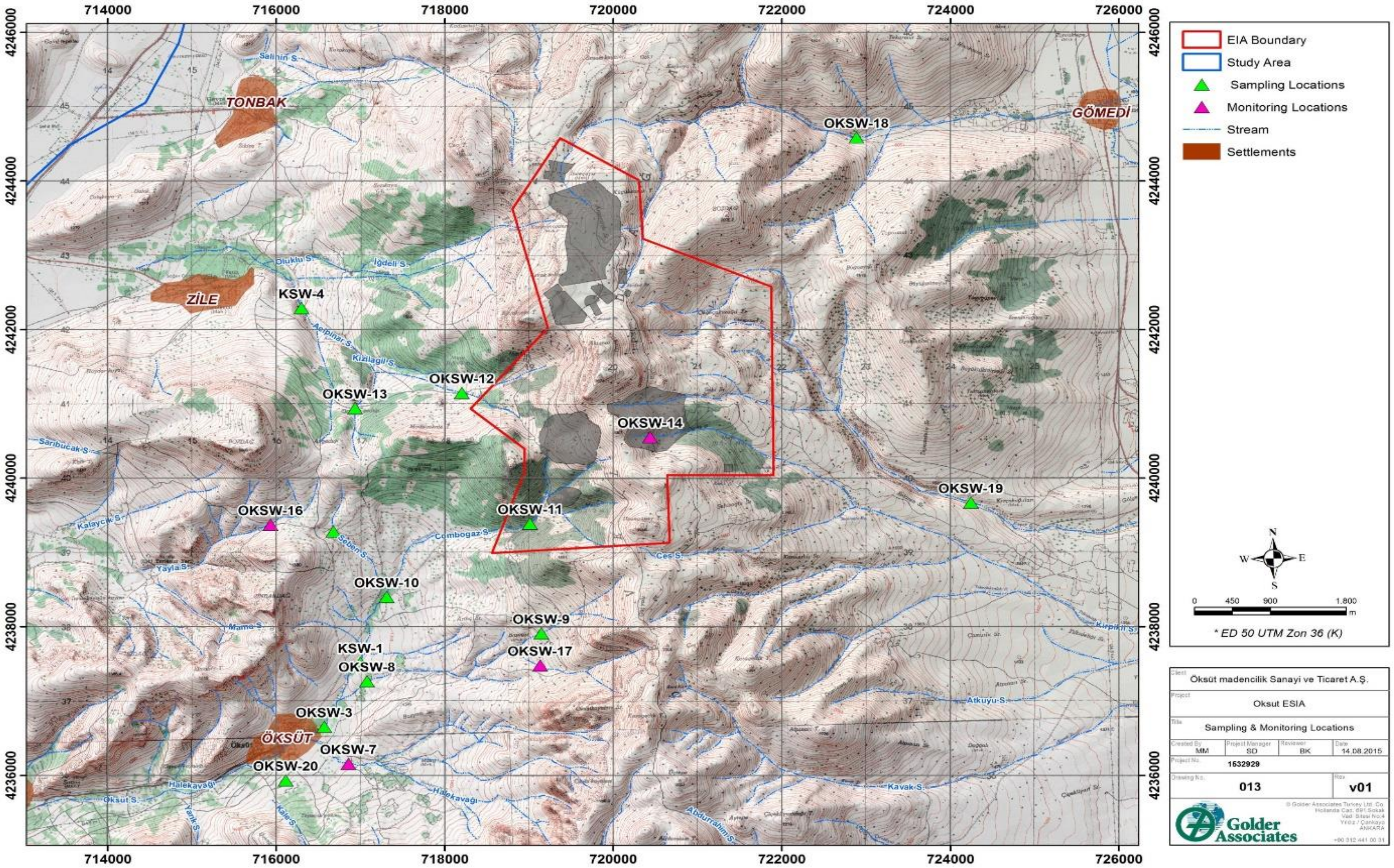


Table 10-3: Coordinates and Description of Surface Water Sampling and Monitoring Locations

Sampling Location/ Monitoring Station	UTM Coordinates UTM Zone 36N, ED50 datum		Description	Measurement Type (S = Sampling, M = Monitoring of In-Situ Parameters)	Monitoring Period
	X	Y			
KSW-1	717001	4237518	Upstream of Pıtıraklı Creek, Village of Öksüt	M, S	Aug 08 - May 13
KSW-4	716301	4242291	Upstream of Acısu Creek, Village of Zile	M, S	Aug 08 - May 13
OKSW3	716572	4236656	Upstream of Pıtıraklı Creek, Village of Öksüt	M, S	Aug 08 - Apr 14
OKSW8	717077	4237267	Upstream of the tributary of Pıtıraklı Creek, Village of Öksüt	M, S	Aug 08 - Apr 14
OKSW9	719147	4237912	Upstream of the tributary of Pıtıraklı Creek, Village of Öksüt	M, S	Jul 13 – Apr 14
OKSW10	717312	4238401	Upstream of Camboğazı Creek, Village of Öksüt	M, S	Jul 13 – Apr 14
OKSW11	719011	4239388	Downstream of Camboğazı Creek, Open Pit (Güneytepe)	M, S	Jul 13 – Apr 14
OKSW12	718203	4241149	Downstream of the tributary of Kızılağıl Creek, Open Pit (Keltepe)	M, S	Jul 13 – Apr 14
OKSW13	716937	4240942	Downstream of Kızılağıl Creek, Open Pit	M, S	Jul 13 – Apr 14
OKSW15	716678	4239282	Upstream of Seben Creek, Village of Öksüt	M, S	Jul 13 – Apr 14
OKSW18	722887	4244585	Downstream of Maraboğazı Creek, Heap leach area	M, S	Jul 13 – Apr 14
OKSW19	724245	4239671	East of Kıvçak Creek, Project site	M, S	Jul 13 – Apr 14
OKSW20	716115	4235934	Surface water from the tunnel directed from the Zamantı River	M, S	Aug 08 - Apr 14
OKSW7	716859	4236156	East of Halekavağı Creek, Village of Öksüt	M	Jul 13 – Apr 14
OKSW14	720410	4240569	Kırpıklı Stream, Waste rock dump area	M	Jul 13 – Apr 14
OKSW16	715936	4239385	North of Yayla Creek, Village of Öksüt	M	Jul 13 – Apr 14
OKSW17	719135	4237461	Upstream of the tributary of Pıtıraklı Creek, Village of Öksüt	M	Jul 13 – Apr 14

The surface water samples analytical results were compared with the *Regulation on the Management of the Quality of Surface Water* (RMSWQ*) Table 5 – Quality Criteria for the Inland Surface Water Resources,* to assess the baseline water quality within and in the vicinity of the Project site and are presented in Table 10-4.

Table 10-4: Turkish Quality Criteria for Inland Surface Water Resources (RMSWQ Table 5)

Parameters	**Water Quality Classes**			
	I	**II**	**III**	**IV**
General Conditions				
Temperature (oC)	≤ 25	≤ 25	≤ 30	> 30
pH	6.5-8.5	6.5-8.5	6.0-9.0	<6.0, >9.0
E.C. (µS/cm)	< 400	400-1000	1001-3000	> 3000
Colour	436 nm: 1.5 525 nm: 1.2 620 nm: 0.8	436 nm: 3 525 nm: 2.4 620 nm: 1.7	436 nm: 4.3 525 nm: 3.7 620 nm: 2.5	436 nm: 5 525 nm: 4.2 620 nm: 2.8
(A) Oxygenation Parameters				
D.O. (mg O_2/L)[a]	> 8	6-8	3-6	< 3
Oxygen Saturation (%)[a]	90	70-90	40-70	< 40
Chemical Oxygen Demand (COD) (mg/L)	< 25	25-50	50-70	> 70
Biological Oxygen Demand (BOD_5) (mg/L)	< 4	4-8	8-20	> 20
(B) Nutrient Parameters				
Ammonium Nitrogen (mg NH_4^+-N/L)	< 0,2[b]	0,2-1[b]	1-2[b]	> 2
Nitrite Nitrogen (mg NO_2^-itrite Nitrog	0.002-0.01	0.01-0.05	> 0.05	
Nitrate Nitrogen (mg NO_3^-itrate Ni	5-10	10-20	> 20	
Total Kjeldahl Nitrogen (mg/L)	0.5	1.5	5	> 5
Total Phosphorus (mg P/L)	< 0.03	0.03-0.16	0.16-0.65	> 0.65
(C)Trace Elements (Metals)				
Mercury (µg Hg/L)	< 0.1	0.1-0.5	0.5-2	> 2
Cadmium (µg Cd/L)	≤ 2	2-5	5-7	> 7
Lead (µg Pb/L)	≤10	10-20	20-50	> 50
Copper (µg Cu/L)	≤20	20-50	50-200	> 200
Nickel (µg Ni/L)	≤20	20-50	50-200	> 200
Zinc (µg Zn/L)	≤200	200-500	500-2000	> 2000
(D) Bacteriological Parameters				
Faecal Coliform (MPN/100 mL)	≤10	10-200	200-2000	> 2000
Total Coliform (MPN/100 mL)	≤100	100-20000	20000-100000	> 100000

Notes:
Compliance with one of the concentration or saturation percentage parameters is sufficient.
Depending on the pH value, the free ammonium nitrogen concentration should not exceed the 0.02 mg NH_3^-N/L.

Intended use based on the quality classification:

Class I – High Quality Water:

- Surface water with high potential for drinking water;
- Water suitable for recreational use, including ones that involve body contact, such as swimming;
- Suitable for trout farming;
- Suitable for animal husbandry and farm water supply.

Class II – Slightly Polluted Water:

- Surface water with potential for drinking water;
- Water suitable for recreational use;
- Suitable for fish farming other than trout;
- Irrigation water if compliant with the standards set by the regulation in force.

Class III – Polluted Water:

- Water suitable for aquatic farming after proper treatment. Industrial water except for industries requiring quality water, such as food and textiles.

Class IV – Highly Polluted Water:

- Surface water with lower quality than Class III quality standards and needs proper treatment to achieve higher quality classification.

Following the data collection programme for the Turkish EIA and as part of the ESIA process, Golder undertook additional surface water monitoring in September 2015, to investigate water quantity and quality at SP-63, SP-73; the Yukarı Develi waterline; SW-6 (Acısu Stream) and SP-56 (Acısu Spring). The water depots along the proposed access road route were also visited and co-ordinates recorded.

Hydrology

A weir was installed on the Acısu Creek (Figure 10-4) to measure the continuous discharge rate from the mine related oxide zone. The second weir was constructed on the ephemeral Öksüt Creek (Çamboğaz s.), (Figure 10-5) to measure the precipitation-related surface runoff and base flow through the catchment.

Weirs monitored the hydrologic characteristics of these surface drainage features and the precipitation-flow relationships. Topographic and creek bed characteristics were taken into account in the design of the weirs. 90˚ V-Notch type weirs were designed and installed. These structures provide the value of the creek flux based on water load.

Schlumberger Divers were installed to measure and record the water level and the open air pressure within the weirs at 20 minute intervals. A barometric pressure sensor was also installed at the Acısu Creek weir.

Figure 10-4: Weir Installed on the Acısu Creek

Figure 10-5: Weir Installed on the Öksüt Creek

Hydrogeology

Primary baseline data to define the hydrogeology of the Project Area and surrounds was collected by SRK for the Turkish EIA:

- water sources and water users within and in the vicinity of the Project Area were identified;
- groundwater monitoring and testing wells were drilled at locations representing the hydrogeological units of the Project Area;
- aquifer tests were conducted and the results were analysed;
- groundwater samples were collected from the wells and were analysed;
- geological data were evaluated;
- results of the groundwater quality monitoring program were evaluated;
- water users were evaluated;
- a conceptual and numerical model of the hydrogeological system of the Project Area was developed.

Groundwater Monitoring

The groundwater monitoring wells drilled within the Project Area were located, as far as possible; to represent the hydro-stratigraphic units with which the Project geological units are in contact. Eleven large diameter (i.e. 175 mm and above) observation and testing wells were drilled within the Project Area. In addition, 15 exploration bores were converted to piezometer wells. The locations of the wells were selected based on the morphology, the location of the ore and the mine facilities in order to examine both chemical and physical characteristics of the system. The geological studies and exploration drilling in the Project Area indicate that the Miocene and Pliocene aged andesite and agglomerate units are the dominant units. The coordinates of the piezometer wells are presented in Table 10-5. Details of the monitoring and testing wells are presented in Table 10-6. The well logs are presented in *Annex Q*. The well locations are illustrated in Figure 10-6.

Table 10-5: Piezometer Wells

Piezometer Wells	Coordinates	
	East	North
CRC-0002	719402	4243988
CRC-0004	719311	4244329
CRC-0006	719580	4243783
CRC-0009	720013	4243392
CRC-0011	719395	4243209
CRC-0012	719635	4242992
CRC-0020	720718	4240599
CRC-0021	721331	4240591
CRC-0023	721728	4240994
CRC-0026	721116	4241403
CRC-0031	720734	4241010
GTP-0001	719186	4239502
GW201301	719257	4240282
GW201302	719222	4239614

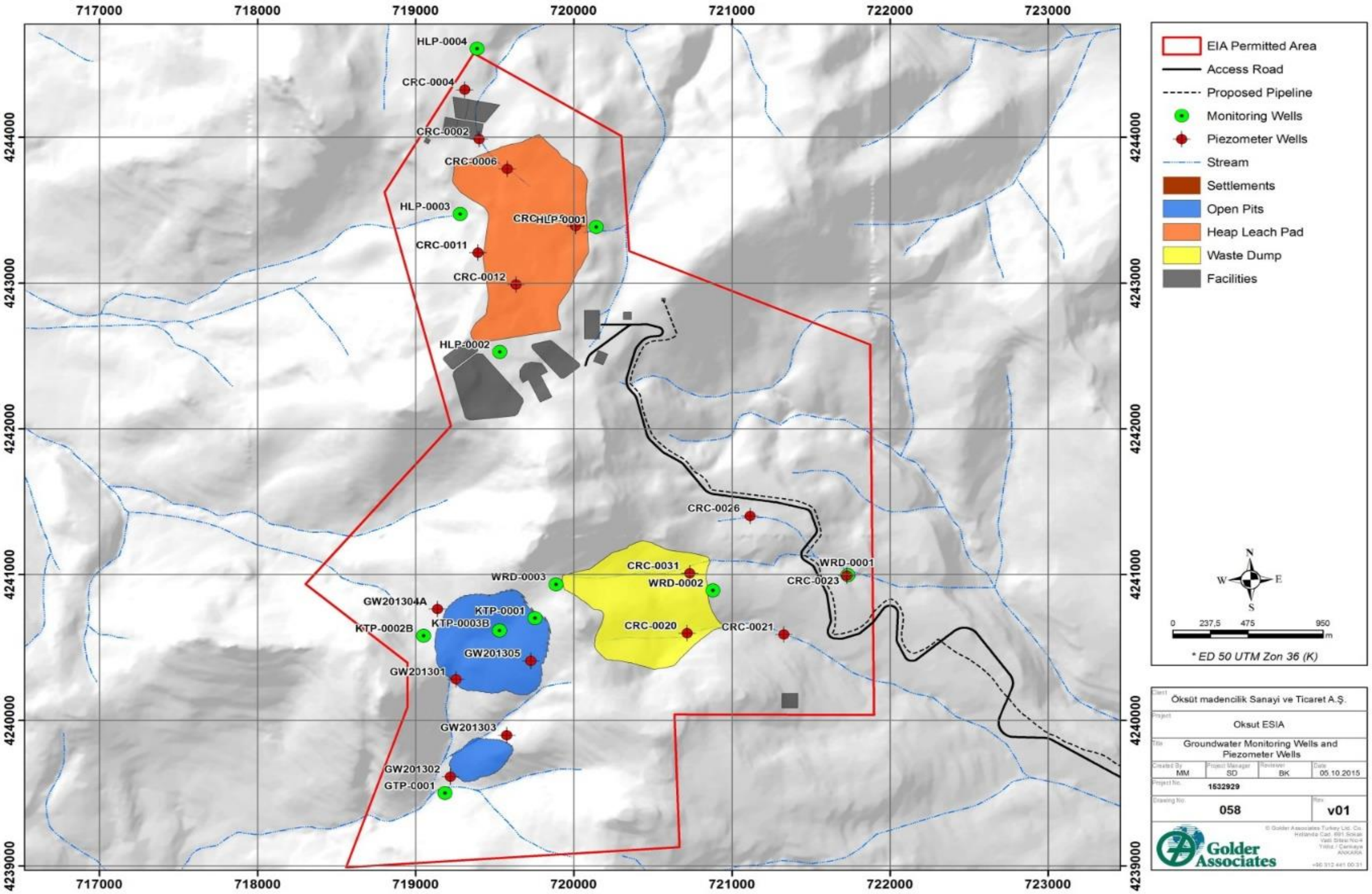
Piezometer Wells	Coordinates	
	East	North
GW201303	719577	4239899
GW201304A	719140	4240765
GW201305	719729	4240408
HLP-0001	720143	4243385
HLP-0002	719533	4242529
HLP-0003	719282	4243475
HLP-0004	719389	4244609
KTP-0001	719755	4240703
KTP-0002B	719050	4240581
KTP-0003B	719531	4240617
WRD-0001	721733	4240998
WRD-0002	720881	4240892
WRD-0003	719888	4240934

Table 10-6: Groundwater Monitoring / Test Wells

Monitoring Wells	Coordinates		Altitude (mASL)	Dates of Drilling		Drilling Method	Drilling Fluid	Hole Diameter (inch)	Well Depth (m)	Filtered Depths (m)
	East	North		Beginning	Completion					
HLP-0001	720143	4243385	1,853	25/06/2014	28/06/2014	AR	DF	10	122	10 - 118
HLP-0002	719533	4242529	1,913	29/06/2014	30/06/2014	AR	DF	10	100	28 - 92
HLP-0003	719282	4243475	1,812	01/07/2014	03/07/2014	AR	DF	10	93	17 - 81
HLP-0004	719389	4244609	1,770	04/07/2014	06/07/2014	AR	DF	10	127	39 - 115
WRD-0001	721733	4240998	1,701	07/07/2014	09/07/2014	AR	DF	10	151	63 - 139
WRD-0002	720881	4240892	1,830	13/08/2014	16/08/2014	AR	DF	12.5	151	51 - 147
WRD-0003	719888	4240934	1,960	18/08/2014	21/08/2014	AR	DF	12.5	174	110 - 170
GTP-0001	719186	4239502	1,619	10/07/2014	12/07/2014	AR	DF	10	124	36 - 116
KTP-0001	719755	4240703	1,906	03/07/2014	09/07/2014	AR	DF	12.5	197	61 - 185
KTP-0002B	719050	4240581	1,748	12/10/2014	02/11/2014	RD	DF+P	12.5	402	298 - 398
KTP-0003B	719513	4240596	1,824	05/09/2014	07/09/2014	AR	DF	12.5	307	159 - 299

Notes:
PVC pipe with a diameter of 175 mm was used in all wells, except for KTP-0002B.
7-15 mm; washed stream gravel.
AR = Air Drill, tri-cone bit.
RD = Rotary Drill.
P = Polymer (Concentrator fluid dissolvable in nature).
DF = Water + Foam.

Figure 10-6: Locations of Groundwater Monitoring and Piezometer Wells



The rationale for selection of the locations of the groundwater monitoring wells is as follows:

- **KTP-0001:** Selected to examine the hydraulic parameters upstream of the Keltepe Open Pit and the hydraulic conductivity of andesite within which the fault zone in the region is located. This groundwater well was also planned as an observation well upstream of the Keltepe Open Pit.
- **KTP-0002B:** Selected to examine the hydraulic parameters of andesite downstream of the Keltepe Open Pit. This groundwater well was also planned as an observation well downstream of the open Pit.
- **KTP-0003B:** Selected to examine the hydraulic parameters of andesite in the region of the Keltepe Open Pit.
- **GTP-0001:** Selected to examine the hydraulic conductivity of andesite in the region of the Güneytepe Open Pit and as an observation well downstream of the Güneytepe Open Pit.
- **WRD-001:** Selected as an observation well downstream of an alternative site for the WRD, which was subsequently dismissed and in order to determine the hydraulic conductivity in the region.
- **WRD-002:** Selected as an observation well downstream of the planned WRD and in order to determine the hydraulic conductivity of the agglomerates and andesite in the region.
- **WRD-003:** Selected as an observation well upstream of the planned WRD and in order to determine the hydraulic conductivity of andesite in the region.
- **HLP-0001, HLP-0002, HLP-0003 and HLP-0004:** Selected in order to determine the hydraulic conductivity of andesite at the HLF site. It was also planned to be used as an observation well.

Additional groundwater wells were drilled near Epçe Village for the Project water supply study. Details are presented in Table 10-7.

Table 10-7: Groundwater Wells Drilled for the Project Water Supply Study

Monitoring Wells	Coordinates (UTM Zone 36N, ED50 datum)		Altitude (mASL)	Drilling Method	Drilling Fluid	Hole Diameter (inch)	Well Depth (m)	Filtered Depths (m)
	East	North						
E1OW1	726145	4239958	1325	AR	SK	6 3/4	108	16-104
E1OW2	726096	4239935	1327	AR	SK	6 3/4	116	24-108
E1TW1	726107	4239943	1326	DD	SK	15,5	152	30-135
E2OW1	727581	4239754	1306	AR	SK	6 3/4	128	16-120
E2OW2	727538	4239696	1307	AR	SK	6 3/4	134	26-130
E2TW1	727547	4239705	1307	DD	SK	15,5	202	38-194

Notes:
PVC pipe with diameter of 175 mm has been used in all wells, except for KTP-0002B.
7-15 mm; washed stream gravel.
AR = Air Drill, tri-cone bit.
DD = Rotary Drill.
P = Polymer (concentrator fluid dissolvable in nature).
SK = Water + Foam.

The following parameters were sampled and measured for water quality:

- pH;
- EC;
- Temperature;
- Oxidation Reduction Potential (ORP).

Samples were taken from the designated surface and groundwater stations and were analysed in the ALS Prague Laboratories. The laboratory results for all sampling campaigns are presented in Annex S.

Water quality data and hydro-geochemical assessments included analysis of:

- Potential spatial and temporal changes in *in situ* parameters;
- Basic anion and basic cation distributions as a reflection of hydro-geochemical characteristics;
- Water quality parameters in comparison with Project Standards.

New observation wells were drilled during the summer of 2014 and nine additional groundwater observation wells were added to the monitoring program. The groundwater monitoring program comprises 12 springs, six fountains, two water depots and nine observation wells. Ten springs, six fountains, two water depots and eight observation wells were sampled to evaluate the quality of groundwater currently existing within the Project Area and its surrounds. Descriptions and coordinates of the groundwater monitoring stations are presented in Table 10-8. Station locations are illustrated in Figure 10-7.

Table 10-8: Coordinates and Descriptions of Groundwater Sampling and Monitoring Stations

Observation Point	UTM Coordinates[1]		Description	Type of Measurement[2]	Monitoring Period
	X	Y			
OKSP6	715921	4235987	Spring, upstream of Neighbourhood of Öksüt	S, M	Aug 08 – Feb 14
OKSP27	718907	4241530	Spring, downstream of open pit (Keltepe)	S, M	Aug 08 – Apr 14
OKSP32	720386	4241006	Spring, downstream of open pit (Keltepe)	S, M	Jul 13 – Apr 14
OKSP46[3]	719409	4240240	Spring, Open pit	S, M	Aug 08 – Apr 14
OKSP47	719524	4240498	Spring, Open pit (Keltepe)	S, M	Jul 13 – Apr 14
OKSP48	720169	4239576	Spring, upstream of open pit (Güneytepe)	S, M	Aug 08 – Apr 14
OKSP51	716461	4241392	Spring, upstream of Neighbourhood of Zile	S, M	Aug 08 – Apr 14
OKDE7	714992	4242246	Water depot in Neighbourhood of Zile	S, M	Jul 13 – Apr 14
OKDS24	719704	4242202	Fountain, upstream of the heap leaching site	S, M	Jul 13 – Apr 14
OKDS27	716019	4236388	Fountain, centre of Neighbourhood of Öksüt	S, M	Aug 08 – Apr 14
OKSP56	716887	4241775	Acısu Spring, upstream of Neighbourhood of Zile	S, M	Aug 08 – Apr 14
OKDS3	717661	4238221	Fountain, upstream of Neighbourhood of Öksüt	S, M	Aug 08 – Apr 14
OKDS28	715269	4242574	Fountain, Neighbourhood of Zile	S, M	Aug 08 – Apr 14
OKDS29	715182	4242465	Fountain, Neighbourhood of Zile	S, M	Aug 08 – Apr 14
OKSP55	715570	4242551	Spring, Neighbourhood of Zile	S, M	Aug 08 – Apr 14
OKSP23	718460	4242959	Spring, upstream of Neighbourhood of Zile	M	Jul 13 – Apr 14

OKSP28	718865	4241355	Spring, downstream of open pit (Keltepe)	M	Jul 13 – Apr 14
OKSP54	718226	4239225	Spring, down spring of open pit (Güneytepe)	S, M	Aug 08 – Apr 14
OKDE15	718102	4249190	Water depot in Upper Develi (the depot where the water line from south of Upper Develi terminates)	S, M	Feb 15
OKDS21	718768	4243443	Spring, downstream of the heap leaching site	S, M	Feb 15
GW201302	719205	4239618	Open pit (Güneytepe) observation well	S, M	Nov 13 – Feb 15
GW201303	719576	4239899	Open pit (Güneytepe) observation well	M	Nov 13 – Feb 15
KTP-0001	719755	4240703	Open pit (Keltepe) observation well	S, M	Aug 14 – Feb 15
HLP-00024	719533	4242529	Heap leaching site observation well	S, M	Aug 14 – Feb 15
HLP-00044	719389	4244609	Heap leaching site observation well	S, M	Aug 14 – Feb 15
GTP-00015	719186	4239502	Open pit (Güneytepe) observation well	S, M	Aug 14 – Feb 15
WRD-0002	720881	4240892	Waste rock dump area observation well	S, M	Nov 14
WRD-0003	719888	4240934	Waste rock dump area observation well	S, M	Aug 14 – Feb 15
KTP-0002B6	719050	4240581	Open pit (Keltepe) observation well	S, M	Aug 14 – Feb 15

Notes:

1 UTMZ on 36N, ED50 datum.

2 S: Sampling work, M: Monitoring work, measurement of field parameter.

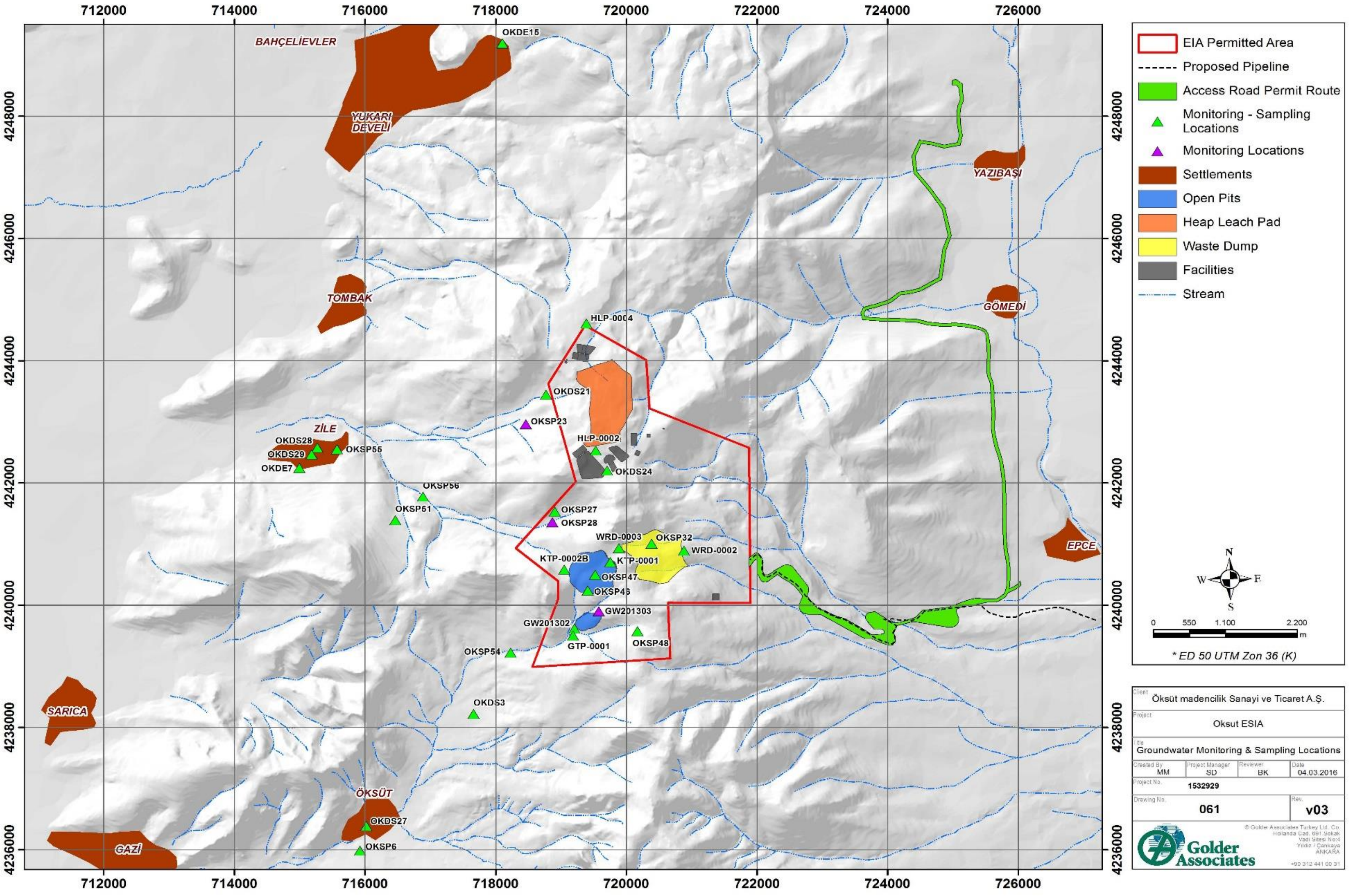
3 November 2008 data were not found suitable for the QA/QC procedures and were removed from the assessment set.

4 Due to accessibility constraints, it was not possible to collect samples from these wells during the period of February 2015.

5 Analyses of the well GTP-0001 in November 2014 showed that that the well development after the construction of the well was not adequate. Therefore, the respective analysis results were not suitable for use in the assessments and hence were removed from the data set. Besides this, the observation point was shifted to GW201302 so that sampling could be made at the same point again. Sampling was done at GW201302 from the period of February 2015 on.

6 Taking into account the potential impact of the material (Bentonite, etc.) used in the construction of the well KTP-0002B on the water chemistry, the analysis result of this well as of November 2014 was not included in the assessments.

Figure 10-7: Location of Groundwater Sampling and Monitoring Stations



10.5 Modelling Methodology

The conceptual hydrogeological model for the Project was developed by SRK (*Annex O*). The model was initially developed for and limited to the Develi Volcanics over which the Project Area lies. The model was extended to include Epçe and the Zamantı River to the east and southeast of the Project Area after the water-supply option for the Project was decided.

10.5.1 Hydro-Stratigraphic Units

Hydro-stratigraphic units in the study area were identified in order to describe the groundwater flow characteristics on a local and regional scale. The classification is based on the hydrogeological and hydro-chemical characteristics of the rocks present in and in the vicinity of the Project Area.

The Project Area straddles the boundary or divide of the Kızılırmak and Seyhan Basins which are separated by the Develi Mountains. Watersheds draining to the west of the Develi Mountains flow into the Kızılırmak Basin and eventually reach the Black Sea while watersheds draining to the east of the Devali Mountains flow into the Seyhan Basin and eventually discharge, on the southern coast of Turkey, to the Mediterranean Sea.

Due to the location of the ore mineralisation, the Open Pits will be located on the western side of the Basins' divide and the WRD and HLF will be located on the eastern side of the divide. From a hydro-stratigraphic perspective, the western portion of the Project Area (Miocene aged andesite) can be divided into two main zones namely, oxidation and sulphidation. The oxidation zone, where the Open Pits will be located, is an extremely fractured and highly permeable zone. No groundwater was encountered within this zone. Where this zone ends, the sulphidation zone begins. With increasing kaolinitation, the sulphidation zone is saturated with water and, in contrast to the oxidation zone, exhibits very low hydraulic conductivity. Water was encountered in this zone and the pH measurements and results of water sample analyses indicated a likeness with the water flowing from the Acısu Spring.

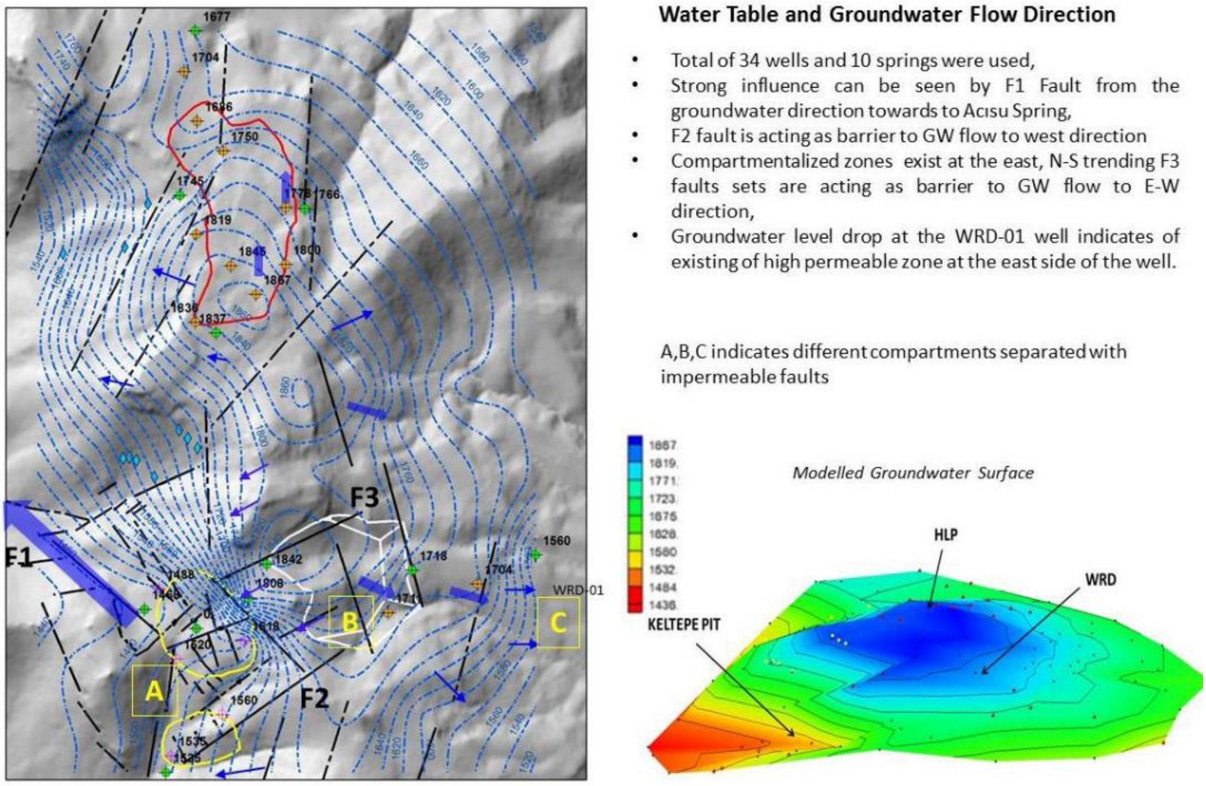
Younger Pliocene volcanics, formed by an alternation of andesite and agglomerate, occur to the east of the Basins' divide. These rocks have a hydraulic conductivity that is less than that of the oxidation zone but more than that of the sulphidation zone. Groundwater levels deepen in an easterly direction. This infers that the hydraulic conductivity increases towards the east as well.

Two elements which are important in terms of hydro-stratigraphy are the existence of the fault zones which function either as a barrier or as a zone of conductivity. These faults have been identified through examining the state of the water table and an analysis of geotechnical and geologic logs and topography. They are included in the conceptual hydrogeological model. There are three main fault types:

- **F1:** This fault zone functions as a permeable zone between the mineralised zone where the Open Pits will be located. It has a thickness of approximately 350 m and allows recharge water to move towards the Acısu Spring. Its depth is the same as the depth of the oxidation zone.
- **F2:** This zone is an impermeable zone. It separates the western and eastern parts of Güneytepe Open Pit. The water levels measured on both sides of this zone (KTP-01: 1,804 masl and GW20135: 1,512 masl) indicate an altitude difference of approximately 300 m.
- **F3:** This zone is an impermeable zone. It runs in a north-south direction and passes approximately through the WRD. The water table exhibits variance on both sides of this zone, although not as pronounced as with the F2 fault zone.

The water table, groundwater flow directions and the fault zones are illustrated in Figure 10-8.

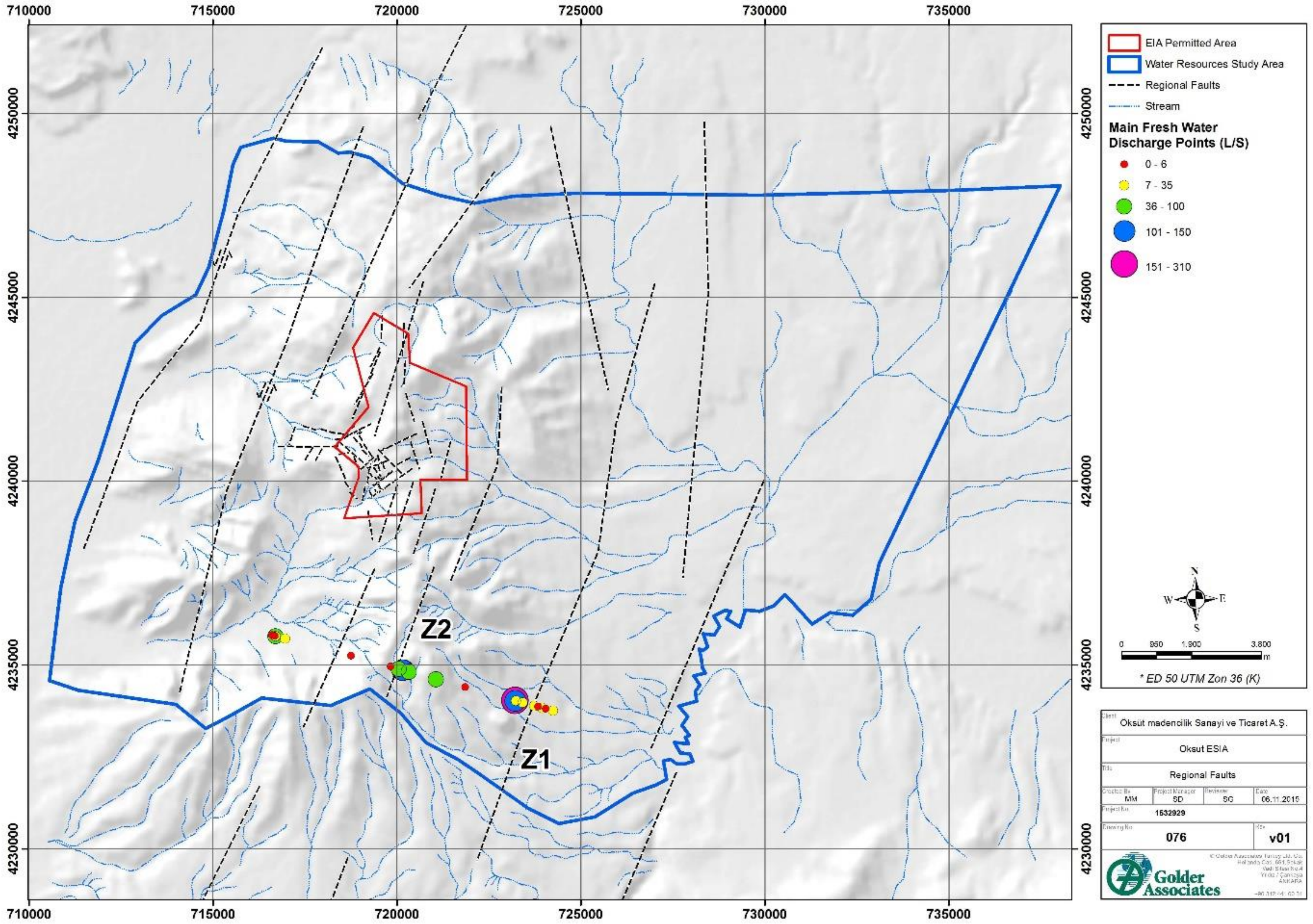
Figure 10-8: Water Table and Groundwater Flow Direction with Influencing Faults



Other important hydro-stratigraphic units within the Project Area are tuffs that emerge on the border of the agglomerate-andesite package. The hydraulic conductivity of these rocks increases towards the east. Groundwater sourced from this strata feeds the irrigation system of Epçe and Şahmelik Villages.

In addition to the three fault zones within the Project Area (i.e. F1, F2, F3), on regional scale and as identified during the geological investigations, two wide fault corridors, referred to as Z1 and Z2, occur. These fault corridors extend from the north of the study area (the exact origin is not known) to the south. When these fault corridors were intersected and crossed during the construction of the Zamantı Tunnel, high water flux was observed. The water discharge has however, decreased over the time. Currently, water discharges from the tunnel at approximately 120 L/s. The originating fault is unknown. The fault corridors Z1 and Z2 are illustrated in Figure 10-9.

Figure 10-9: Z1 and Z2 Fault Corridors



10.5.2 Hydraulic Conductivity and Storage

Based on aquifer test results, the hydraulic conductivity (K) of the formations are as follows:

- Hydraulic conductivity of the sulphidation unit is quite low at 2.0 E^{-9} m/s (geometric mean);
- In the oxidation zone, where mineralisation has developed and where the Open Pits will be located, the hydraulic conductivity value is expected to be quite high at >1.0 E^{-6} m/s;
- In the andesite unit, which is outside the oxidation zone, hydraulic conductivity is between 1.0 E^{-7} m/s and 1.0 E^{-8} m/s;
- In the Miocene aged volcanics, where the WRD will be located, the mean hydraulic conductivity value is 2.74 E^{-6};
- The mean hydraulic conductivity at the HLF site is in the order of 2.47 E^{-7} m/s;
- Fault zone F1 is quite permeable at 1.0 E^{-6} m/s, while Fault zones F2 and F3 are effectively impermeable with a mean hydraulic conductivity of 1.0 E^{-9} m/s;
- In the water supply region, the geometric mean of the wells drilled in the vicinity of Epçe is 6.06 E^{-5} m/s. This rises to the level of 1.15 E^{-4} m/s in the region of Şahmelik. The thickness of the tuff and agglomerate units in this region has been determined to be a minimum 200 m.

Based on literature and test data for storage coefficients, the specific yield for the volcanic units has been calculated to be 0.02. It has been calculated to be 0.07 for the Epçe Aquifer.

10.5.3 Anisotropy and Heterogeneity

Faulting within the Project Area and its surrounds plays a very important role in groundwater transport. Some faults increase the hydraulic conductivity as described above and some faults form impermeable boundaries. Spatial variation of the fractured zones has been determined in regards to the vertical and horizontal extensions of the faults.

The position of the water table in the vicinity of the HLF and WRD sites indicates that the units have slightly more conductivity in the K_Y (vertical) direction than the K_X (horizontal) direction. In view of the fact that the amount of fractures and faulting decreases as the depth increases, it is concluded that there is anisotropy.

10.5.4 Water Table and Flow Routes

In order to simulate the water table within the Project Area and its surrounds, groundwater level measurements were taken from 10 large diameter wells, which were drilled under the supervision of SRK and from 24 wells, drilled as exploration wells, a total of 34 different sampling points. The location and elevation of perennially flowing natural springs and streams were included in the generation of the water table model since these discharges tend to occur where the water table intersects the surface. On the basis that, in general, groundwater is hydraulically linked with surface water, dry stream beds were considered to be features that limit groundwater expression at the surface. An illustration of the simulated groundwater table and details of the analyses made is presented in Figure 10-8.

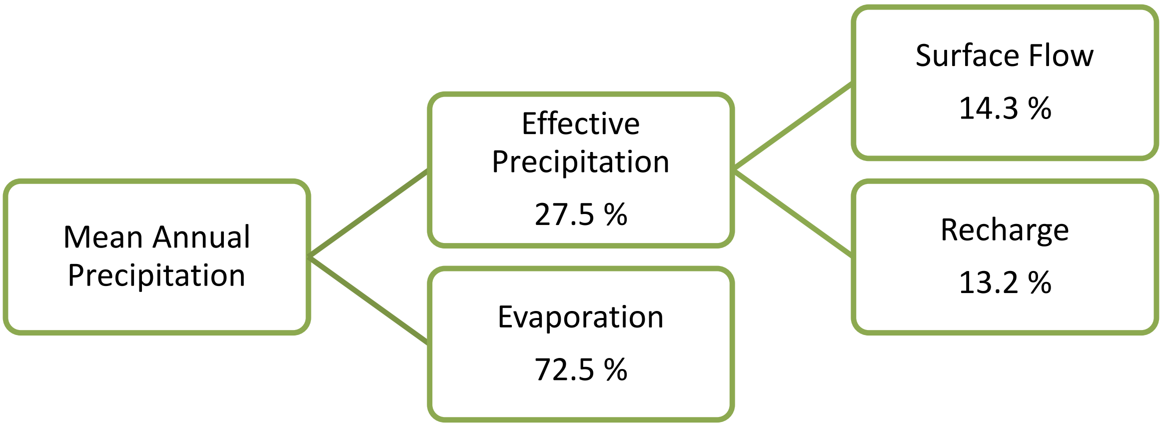
10.5.5 Water Budget

A groundwater recharge calculation was made by establishing a Soil Moisture Deficit Model as described in Section 10.5.1. The recharge models were run by using the data from both the Acısu and Öksüt surface water measurement stations for the Develi Volcanics Complex (DVC) region and the data from the Fraktin flow observation station for the Zamantı region.

Water enters the hydrogeological cycle through precipitation (i.e. rain and snow), the greater part coming from snow melt during spring. According to the result of the hydrologic analyses, 72.5% of the annual mean precipitation in the DVC leaves the system by evaporation. The remaining water (27.5%) is called *effective precipitation*. Of this, about 14.3% joins the system as surface flow and

13.2% as recharge. Using this calculation, it has been determined that the recharge rate in the Project Area is 55.2 mm annually. The flow pathways in the system are illustrated in Figure 10-10.

Figure 10-10: Summary of the Hydraulic Budget (Develi Volcanics)



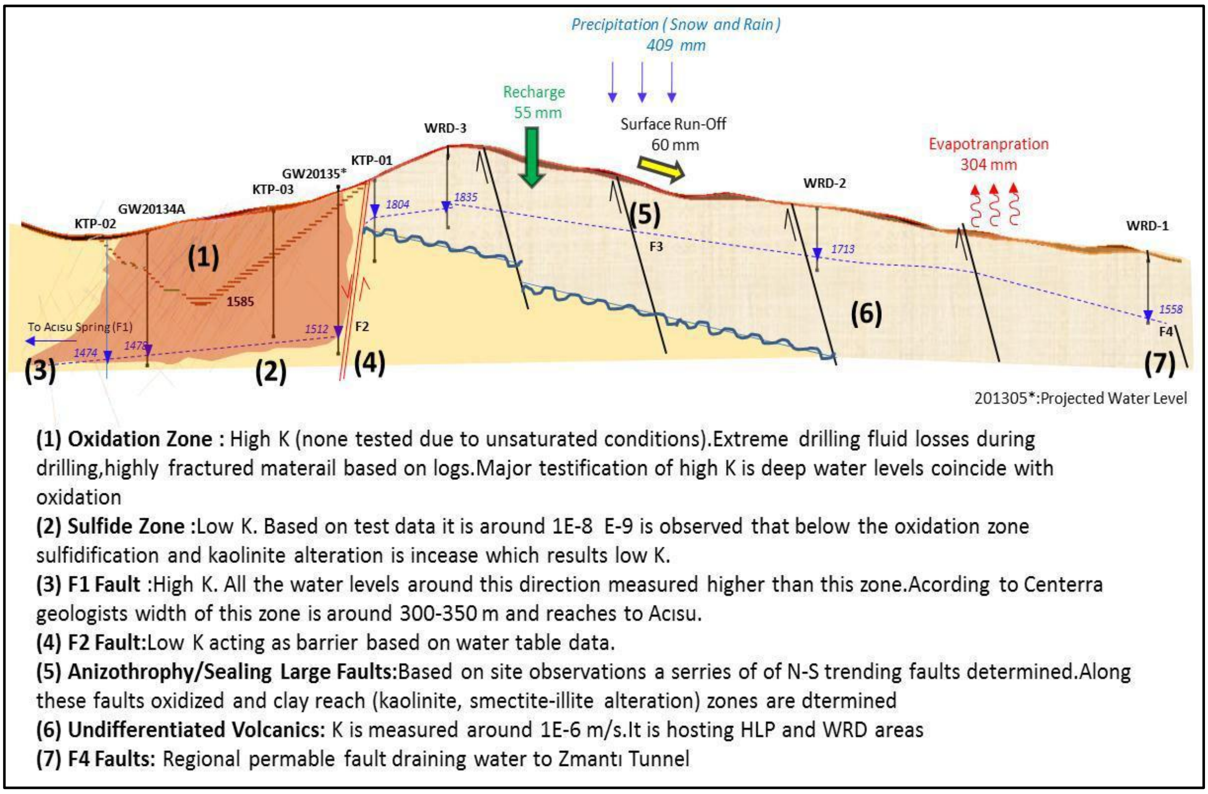
Using the Fraktin flow measurements in the region of Zamantı, it was determined that the recharge rate is approximately 20% of the precipitation and 88 mm annually.

10.5.6 Modelling

Constituents of the Conceptual Model

The conceptual model was developed to determine the groundwater regime in the Project Area, the volume and source of water entering the system, the volume and flow direction of groundwater, the variances in storage capacity of different hydro-stratigraphic units and the volume of water exiting the system. The conceptual hydrogeological model is illustrated in Figure 10-11.

Figure 10-11: Conceptual Hydrogeological Model



Numerical Modelling of Mine Site Hydrology

To understand the groundwater flow regime at the site and the hydraulic interaction of different groundwater systems and conceptual aquifer model, a groundwater numerical model was developed in FEFLOW v6 (WASY, 2010).

The extent of the hydrogeological model was based on the understanding of groundwater flow conditions near the proposed mine facilities with lateral model boundaries set sufficiently far from the mine workings to allow adequate representation of pre-development conditions and potential seepage pathways during operations.

Assessment and Modelling of Water Supply Aquifer

Assessment and modelling of the hydrological system was also undertaken in the Epçe area from where the Project will obtain its water supply.

The maximum water requirement for the plant and other facilities throughout the life of the Project has been determined to be 35 L/s by the Engineering Department of OMAS. In order to source adequate water, a series of studies were conducted in the vicinity of the Project Area and negotiations were held with the 12th Regional Directorate of the State Water Administration (SWA) during these studies.

In a later phase of the water supply studies, Golder drilled two wells (E1 and E2) in the Epçe area. Two 15-day pumping tests were conducted and aquifer parameters were determined. Since these candidate wells are located close to existing Epçe Irrıgation Cooperative wells, SRK used the data to calibrate the groundwater model in preparation for assessing impacts to a nearby well.

10-year transient simulations were conducted for the pre mining scenario (i.e. no mine water supply) and operational phase scenario (35 L/s total abstraction from E1 and E2).

In order to assess the local potential impacts, closest-well hydrographs were generated from the models for both scenarios.

Modelling of Cyanide Concentrations

Due to the use of cyanide in gold extraction, potential environmental contamination by cyanide is an important issue for environmental assessment. Two key points have driven the approach to the modelling and assessment of cyanide in the environment:

- Groundwater and surface water baseline conditions indicate that existing cyanide levels are very low around the EIA Permitted Area and that WAD cyanide concentration is below the detection limits in all of the monitoring locations.
- The Öksüt Heap Leach Facility is designed as a zero discharge facility and cyanide is not planned to be discharged to environment. As a result, any discharge of cyanide to the environment would only occur due to an accidental release or seepage caused by a malfunction of the composite liner system under the Heap Leach Facility. The composite liner system will be composed of 2mm LLDP and 50cm low permeability clay. Best industry practice quality control and quality assurance during the construction of the Heap Leach Facility will prevent any defects or damage to the composite liner system. As a result, seepage of cyanide-containing leachate into the environment is considered to be very unlikely and any seepage that was released would be of negligible significance.

Groundwater modelling studies described in this chapter demonstrate that any leachate arising from the Heap Leach Facility or Waste Rock Dump would take approximately 100 years to migrate a sufficient distance to reach the nearest receptor (the Epçe acquifer). Groundwater quality will be monitored by monitoring wells located around the Heap Leach Facility which would identify any the seepage and movement of any leachate within groundwater. If such contamination were to be detected, OMAS would undertake remedial action to address the source and migration of leachate, preventing it from migrating out of the EIA Permitted Area.

As a result, the following factors suggest that the likelihood of cyanide-containing mine-related leachate from reaching and impacting receptors is extremely low:

- The zero-discharge nature of the of cyanidation circuit used for gold extraction;
- The on-site groundwater quality monitoring system;
- The commitment from OMAS to remediate contamination identified and to prevent impacts to receptors;
- The natural decomposition of cyanide in the environment, particularly over the long timescale that would be required for leachate to migrate sufficiently far to impact the Epçe aquifer[1];
- The attenuation (dilution) of any leachate as it migrates downhill.

Prior to the commencement of gold processing operations, OMAS will undertake specific scenario modelling to understand the potential migration pathways for any cyanide-containing leachate generated from the Heap Leach Facility. The modelling will inform contingency planning for cyanide contamination management within the OMAS Cyanide Management Plan. This scenario modelling will help to develop procedures to monitor for the presence of cyanide in soil and groundwater under and around the HLF and to define the range of management and mitigation options available to OMAS should such an event occur.

General leachate transportation modelling has been undertaken and is reported in the chapter.

OMAS will use the ongoing groundwater monitoring programme to improve understanding of the movement of groundwater and any potential leachate or other contaminants entering the groundwater. This information will be used to support the development of the Detailed Closure Plan for the Project. In addition, this information can be used to support the planning of any remedial actions required in the event that leachate seepage or a spill leads to groundwater contamination.

10.5.7 Impact Assessment Methodology

Impacts to water resources created by Project activities at sensitive receptors are considered when there is an exceedance of any one of the Project Standards for water quality, or when the water quantity is affected.

10.5.8 Assumptions and Limitations

This Chapter and the assessments herein are based upon the Project Description presented in *Chapter 5.*

Analysis of the available geological and hydrogeological data and the results of the completed groundwater modelling indicate that there remain gaps in the overall understanding of the hydrogeological conditions, particularly in the area between Epçe and the WRD. This limitation is evaluated with the uncertainty analyses and conservative case scenarios.

The following additional limitations related to the groundwater model are noted:

- Base flow measurement for the Acısu Spring was conducted over a 16-month period. While this period is considered adequate for a study of this nature, further monitoring will supply more reliable data and can improve model calibration.
- Groundwater level monitoring in the Epçe area was conducted during the wet season. Steady state calibration for this area was calculated assuming that the water levels are in the middle of dynamic and static levels of these wells.
- Zamantı Tunnel fresh water inflow is evaluated with the water strike records conducted during tunnel construction. Although locations of the faults are known, current discharge rates are unknown and hence, are assumed to be proportional to the initial discharge rates.

[1] For example, see *The Management of Cyanide in Gold Extraction,* by Mark J. Logsdon, Karen Hagelstein and Terry I. Mudder. International Council of Metals and the Environment, April 1999.

- Attempts to undertake additional water monitoring in September 2015 was during the dry season and the springs were noted to be dry. It has been recommended to undertake further monitoring during the wet season.
- The detailed Mine Closure Plan has not yet been developed so all impacts and mitigations set out in this ESIA are subject to confirmation in the detailed Mine Closure Plan.

Based on the results of ongoing water resources modelling, OMAS will review and update the conceptual water model, and relevant quantitative modelling, on a two-yearly basis during mine operations in support of mine closure planning.

10.6 Baseline – Surface Water Resources

10.6.1 Objectives

The objective of the surface water baseline is to present data and information for the:

- Characterisation of surface hydrology including water features, drainage and water quality, etc.;
- Identification of current and future surface water uses and users;
- Review of allocation of surface water rights / availability for Project's potable water supply;
- Provision of background conditions to inform the assessment of impacts.

10.6.2 Hydrological Characteristics and Features of the Project Area and Surrounds

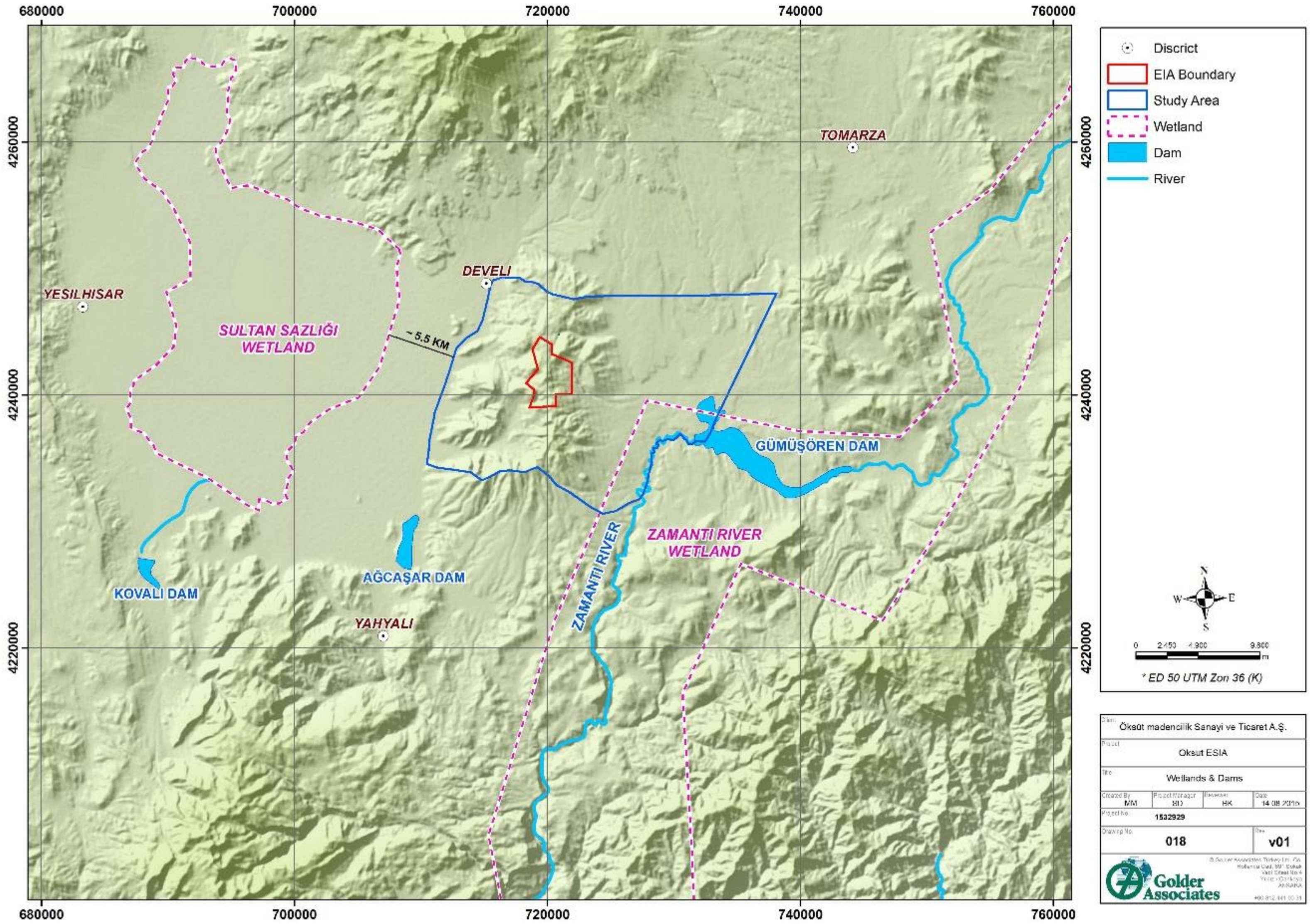
The north-south extending Develi Mountains form the divide between the Kizilirmak and Seyhan Basins. The location of the Project Area in relation to these two Basins is illustrated in Figure 10-12.

Rainfall and snow melt are the contributors to the hydrological regime in the Project Area and its surrounds. There are various ephemeral creeks within the study area and the Acısu Creek, emanating from the Acısu Spring and discharging to east Zile Village, is the only surface water feature that has continuous flow within the study area.

The locations of the dams, ponds and wetlands in relation to the Project Area are illustrated in Figure 10-13 and are described below.

Figure 10-12: Project Site in Relation to the Kizilirmak and Seyhan Basins

Figure 10-13: Project Site Location in Relation to Wetlands, Rivers and Dams



Rivers

The closest river is the Zamantı River which emanates from the Uzunyayla Plateau. The Uzunyayla Plateau is located within the boundaries of the district of Pınarbaşı, Kayseri Province. Over its course, the river passes Pınarbaşı, Tomarza, the Develi Mountains and Yahyalı and joins the River Göksu, forming the River Seyhan. It then discharges into the Mediterranean Sea.

The Zamantı River, is approximately 250 km long, has a basin of 6,335 km^2. The flow monitoring station on this river nearest to the site is the Fraktin Köprüsü Station. Data for the period 1969 to 2014 was acquired from the State Hydraulic Works for use in this assessment. According to the data, the maximum daily mean flow rate is 156 m^3/s and the minimum daily mean flow rate 0.81 m^3/s. The daily mean of the flow data over 45 years is 18.2 m^3/s. In approximately 32% of the period recorded, a flow rate in the range of 10 m^3/s to 15 m^3/s was observed in the river.

The Zamantı River is shown in Figure 10-14 in relation to the Project Area. It is designated as a Naturally and Ecologically Protected Area in the 2015 Environmental Plan[2], and the boundary of this zone is shown in Figure 10-14. Some of the streams that drain the Project Area are tributaries to the Zamantı River.

The relationship between drainage from the Project Area and the Zamanti river basin is discussed in Section 10.8.1, where the ephemeral nature of drainage from the Project Area and the fact that the Zamanti River catchment is two order of magnitude larger than the EIA Permitted Area, are used to justify scoping out impacts to the Zamanti river basin from the impact assessment.

[2] Yozgat-Sivas-Kayseri 1:100000 Scale Environmental Plan (August 2015) http://www.csb.gov.tr/db/mpgm/editordosya/file/CDP_100000/ysk/L35.jpg (from official website of Ministry of Environment and Urbanisation)

Figure 10-14: Zamantı River and its Natural and Ecologically Protected Area Boundary in relation to the Project Area

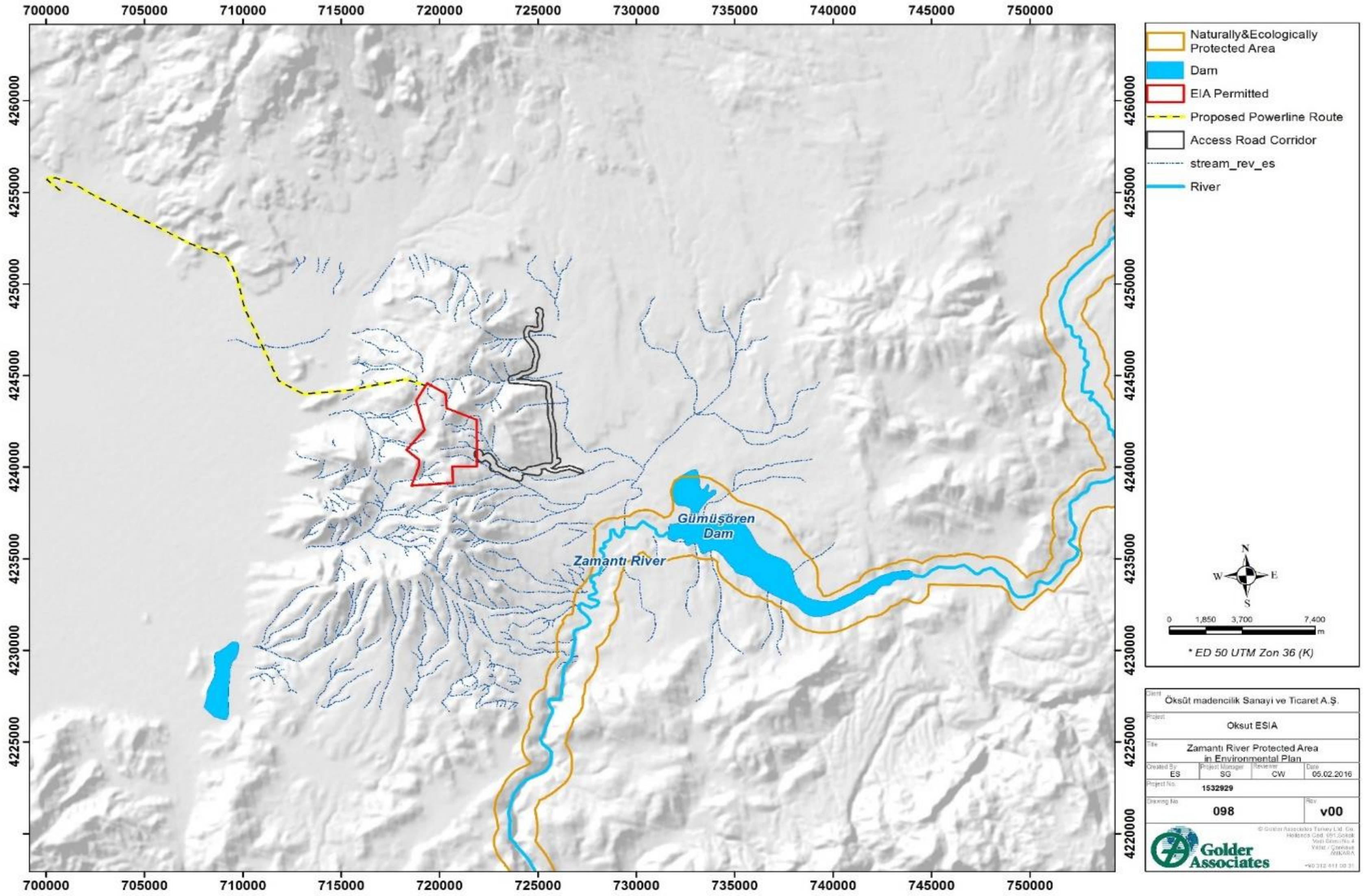
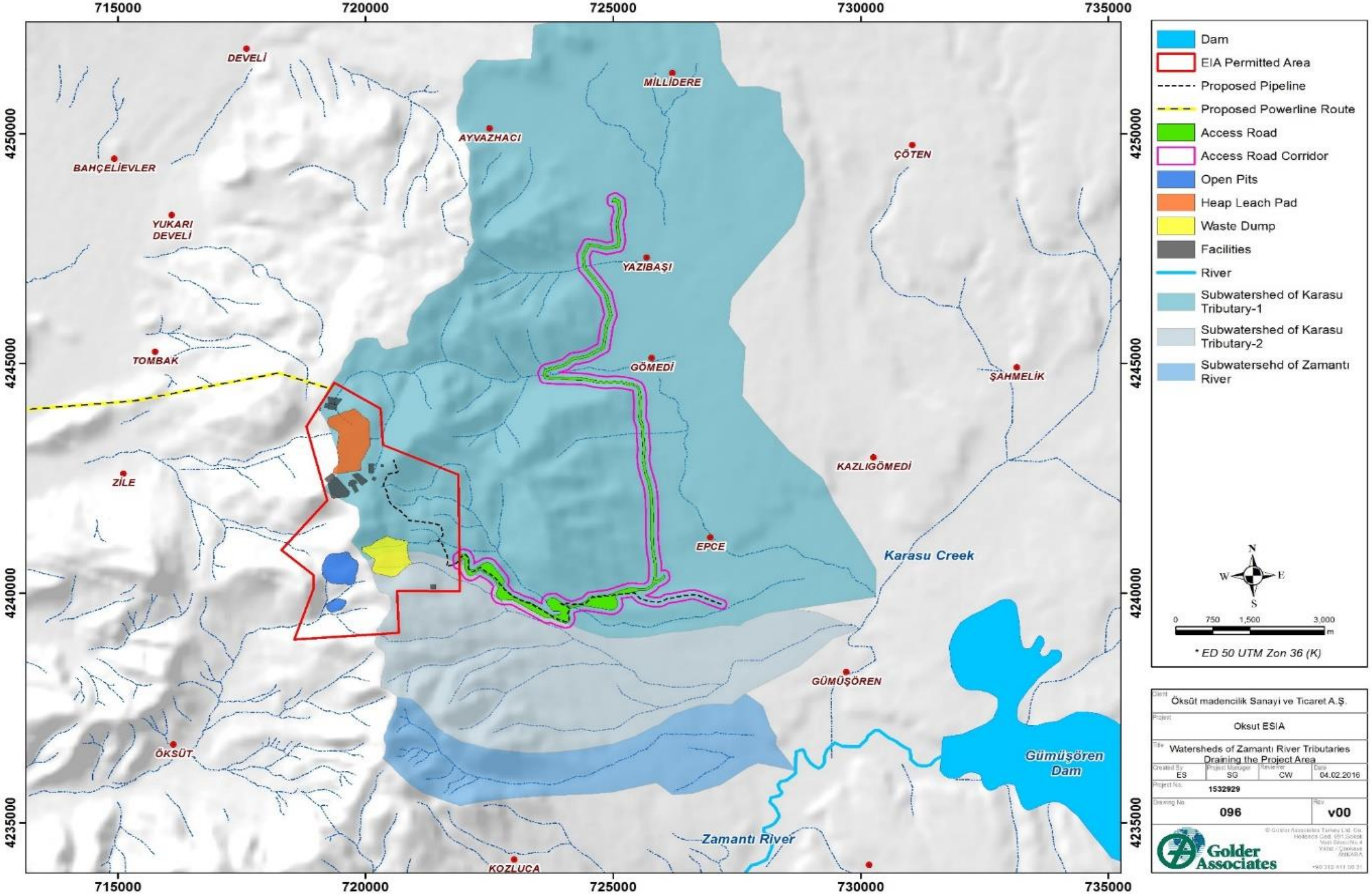


Figure 10-15: Watersheds of Zamantı River Tributaries draining the Project Area



Dams

The Develi Basin Irrigation Project had two development stages, the first stage, which started in 1976 and was completed in 1987, included construction of Ağcaşar and Kovalı Dams, Çalbalma Tunnel, and irrigation and drainage systems. This was in order to irrigate 28,046 ha using surface and groundwater. The Ağcaşar and Kovalı Dams are located 12 km and 32 km, respectively, southeast of the Develi Mountains. Built for irrigation, both dams have been completed and are currently in use.

The Gümüşören Dam on the Zamantı River is the second development stage of the Develi Basin Irrigation Project and is located approximately 13 km east of the Project Area. It is currently under construction with only the body of the dam having been completed.

General information about the Ağcaşar, Kovalı and Gümüşören Dams is given in Figure 10-16 to Figure 10-18Figure 10-18.

Figure 10-16: Ağcaşar Dam[3]

AĞCAŞAR DAM	**Location**	**Kayseri – Yahyalı**
	River	Yahyalı River
	Purpose	Irrigation
	Construction	1979-1987
	Body Fill	Zoned Earth Fill
	Body Volume	1.7 hm^3
	Elevation from the thalweg[4]	24 m
	Lake Volume at Normal Water Level	61.7 hm^3
	Lake Area at Normal Water Level	4.118 km^2
	Irrigation Area	15035 ha

Figure 10-17: Kovalı Dam[5]

KOVALI DAM	**Location**	**Kayseri – Yeşilhisar**
	River	Dündarlı Creek
	Purpose	Irrigation
	Construction	1983-1987
	Body Fill	Zoned Earth Fill
	Body Volume	2.994 hm^3
	Elevation from the thalweg	42 m
	Lake Volume at Normal Water Level	25.1 hm^3
	Lake Area at Normal Water Level	1.67 km^2
	Irrigation Area	3380 ha

[3] http://www2.dsi.gov.tr/bolge/dsi12/kayseri.htm

[4] The *thalweg head of a dam* is the distance from the bottom of the stream bed to the top of the dam. The *thalweg elevation* is the lowest elevation of the bottom of the stream bed.

[5] http://www2.dsi.gov.tr/bolge/dsi12/kayseri.htm

Figure 10-18: Gümüşören Dam[6]

GÜMÜŞÖREN DAM	**Location**	**Kayseri – Develi**
	River	Zamantı River
	Purpose	Irrigation + Power Generation
	Construction	2011 -
	Body Fill	Roller Compacted Hard Fill + Clay seeded sand-Gravel Fill
	Body Volume	1.786 hm^3
	Elevation from the thalweg	30 m
	Lake Volume at Normal Water Level	- hm^3
	Lake Area at Normal Water Level	- km2
	Irrigation Area	20836 ha
	Power	2x2.5 MW
	Annual Production	11.90 GWh

Ponds

The Şehyli Pond is the closest pond to the Project site at 22 km to the southeast. It is built on the Bülbülcük Creek. Information on the pond is provided in Figure 10-19.

Figure 10-19: Şeyhli Pond[7]

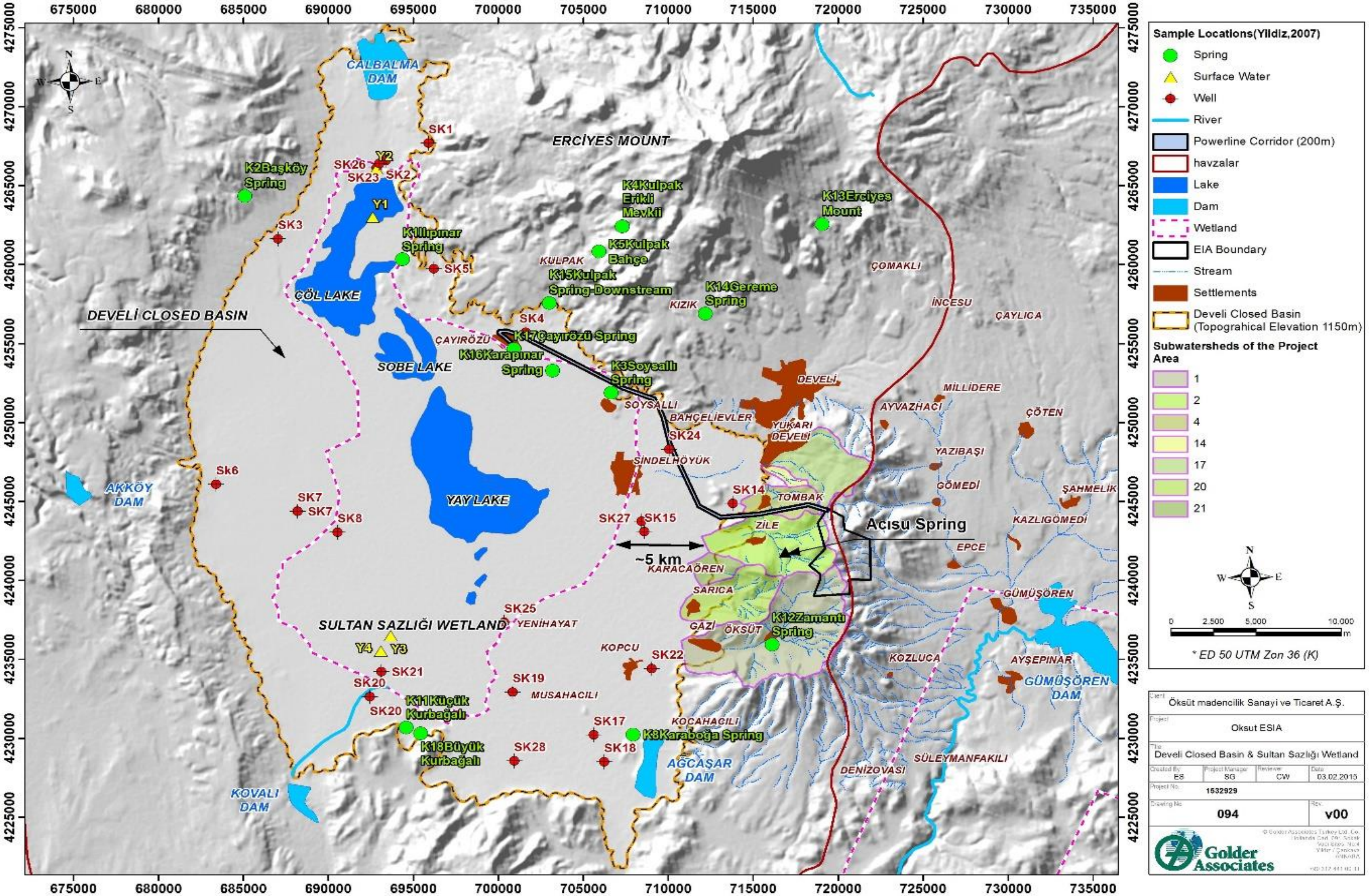
ŞEYHLI POND	**Location**	**Kayseri – Develi**
	River	Bülbülcük Strait Creek
	Purpose	Irrigation
	Construction	1990 - 1992
	Body Fill	Homogenous Soil Fill
	Body Volume	1.467 hm^3
	Elevation from the thalweg	19 m
	Irrigation Area	220 ha

Wetlands

The Sultan Sazlığı wetland is a National Park and Ramsar site, and is located approximately 12 km northwest of the EIA Permitted Area and 5.5 km west of the boundary of the study area, as shown in Figure 10-20 below.

[6] http://www2.dsi.gov.tr/bolge/dsi12/kayseri.htm
[7] http://www2.dsi.gov.tr/bolge/dsi12/kayseri.htm

Figure 10-20: Sultan Sazlığı National Park and surface water features



With a total surface area of 21,000 ha, the land has important flora and fauna species as it hosts fresh and salt water ecosystems together. The wetland contains reeds and meadows.

The fresh water covers an area of approximately 3,650 ha. Water depth is around 2 m. Seasonal fluctuations in water level range from 0.4 m to 0.6 m. Due to the irrigation and climatic change, this wetland faced with water scarcity and water pollution problems, since 1994.

The creeks feeding the Sultan Sazlığı Wetland are primarily the Yahyalı, Yeşilhisar, Dündarlı and Develi Creeks. Within the wetland system there are the Yay Lake, the Çöl Lake, the Eğrigöl Lake, the Sapgöl Lake and reedy isles. In the southern part of the basin, Dundarli Spring feeds Kovali Reservoir and flows out from marble. Gozbasi, Yerkoy, Agcasar and Cinarpinar Springs feed Agcasar Reservoir and these springs flow out from limestone rocks. Kurbaga Springs (Buyuk Kurbaga- Kucuk Kurbaga) and Karaboga Spring drain the water of limestone at karstified Aladaglar Mountain. Soysalli, Ilipinar, Cayirozu, Kurpak and Elbiz Springs are located at the north of the basin, which drain the water of magmatic (basalt) rocks and the snow of Erciyes Mountain feed these springs.

Isotope and water quality analysis from the springs, groundwater wells, streams were carried out in Develi Basin to identify the relation between the surface and groundwater. As a result of the chemical analysis, it was concluded that there was no direct relationship between surface water and groundwater[8].

There is a 5 km distance between the limit of the drainage area within which the Project Area is located and the wetland, as shown in Figure 10-20. In addition, Acısu creek which is the only permanent surface water within the project area which flows towards west (to the Sultan Sazlığı wetland). Acısu water is heavily used for irrigation within the Zile Village and the creek disappear within the irrigation area and cannot be observed at the immediate downstream of the Zile village. Sultan Sazlığı wetland is located 10 km away from the Zile irrigation area. As a result, it can be concluded that the surface waters from the project area do not reach and impact the wetland.

10.6.3 Surface Water Utilisation

The surface water features, water supply lines and depots in the study area are illustrated in Figure 10-21.

Springs

The surface water sources within the EIA Permitted Area are:

- 4 developed springs / fountains
- 17 natural springs
- 4 surface water points
- 1 water depot

The surface water resources in the access road corridor are:

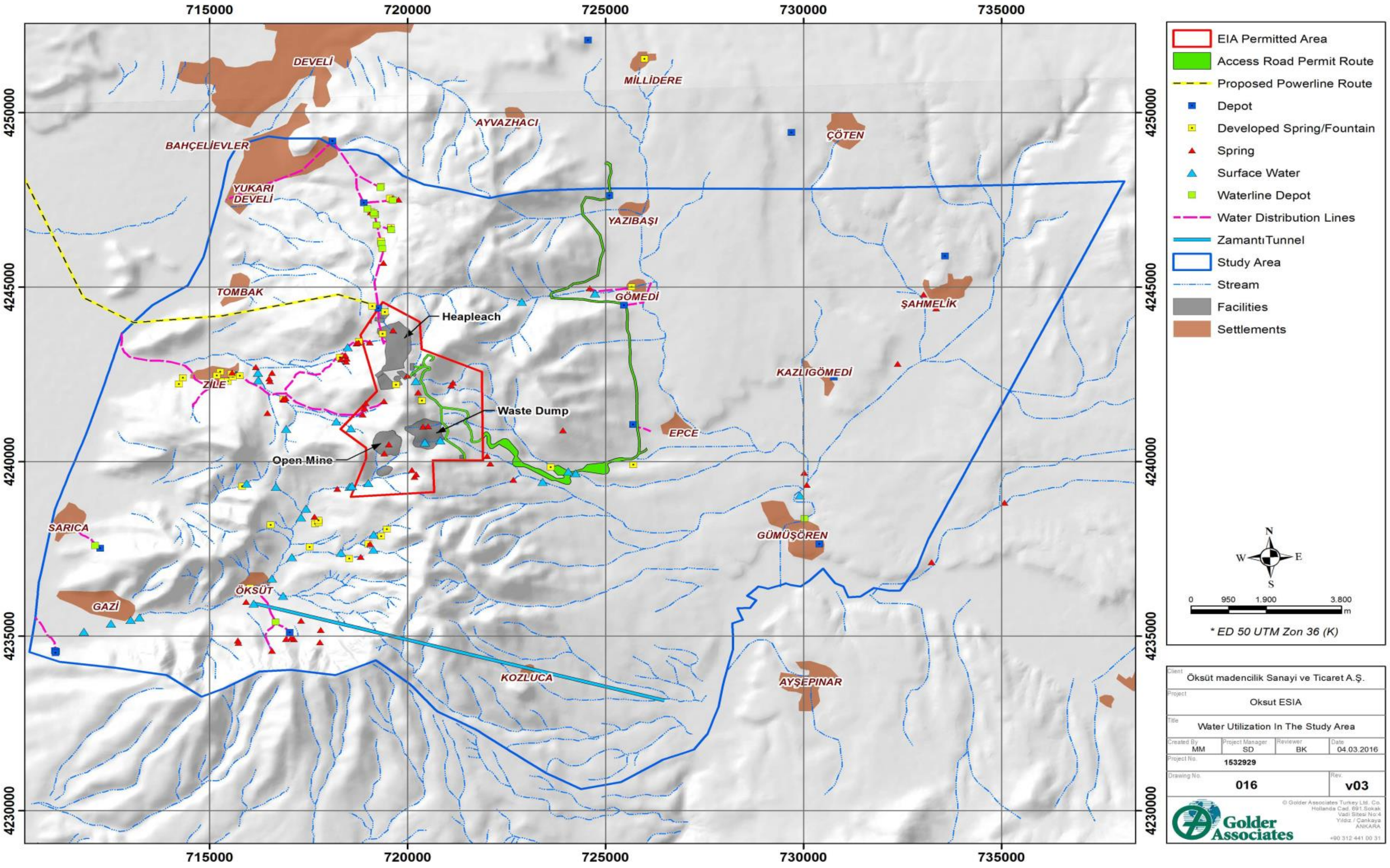
- 3 surface water points
- 2 water depots
- 2 developed springs / fountains
- 1 natural spring
- 1 Epçe water supply well

There are a number of small and large springs in the Acısu Creek area and the mineral water from these springs is used for medicinal purposes. However, the pH of this water is very low and the heavy

[8] Gürer I., Yildiz F.E. (2007). Surface and Groundwater Interaction in Sultan Sazlığı Wetland, Kayseri. Gazi University. Phd Thesis (in Turkish)

metal content of it is very high, and significant and repeated consumption is likely to be harmful for human health.

Figure 10-21: Water Utilisation in the Study Area



Streams

Streams and creeks in the study area include Acısu Creek, Öksüt Creek, Camboğazı Creek, Kızılağıl creek, Kırpıklı Creek, Pıtıraklı Creek and Kıvcak Creek. The majority of these creeks are ephemeral and dry out during the arid season.

Within the EIA Permitted Area, Acısu Creek flows permanently and the seasonal Öksüt Creek begins to flow with surface flows from the south-east of the Güneytepe open-pit area.

Water Distribution Lines

The Municipality of Kayseri and the DSI are responsible for a number of water distribution lines that provide water to nearby villages. Within the EIA Permitted Area, there are two water distribution lines that supply Zile and Yukarı Develi with water. The water distribution line that supplies Yukarı Develi uses a seasonal spring and is used as supplemental water source. Water depots are located along the route of the distribution lines.

Water Depots

One of the methods of water supply to settlements in the study area is by collecting groundwater in storage tanks (cisterns). The water depots supplying Yazıbası and Gömedi are along the access road corridor (a report on the coordinates and a description of the water depots are provided in *Annex T*).

Zamantı Tunnel

The most important use of surface water in the region is for irrigation. The demand for irrigation water in the Develi Basin area is largely met by the Zamantı Regulator and Derivation Tunnel built by the State Hydraulic Works. Annually, 102.83 hm^3 of water is transferred from the Zamantı River to the Develi Basin area and, by using locally sourced groundwater as well, an area of 36,591 ha is irrigated. The tunnel, with a diameter of 3.5 m and a length of 10,700 m, was commissioned on October 31st, 2010. The tunnel is depicted in Figure 10-22.

During construction of the Zamantı tunnel at approximately 4,100-4,200 m, a major fault zone was encountered which led to pressurized groundwater discharge (up to 1000 L/s, now approximately 150 L/s) into the tunnel which caused construction to stop. In order to control the flow and possibly use it for some other purposes (as it was high quality groundwater), the flow was captured in a pipe separated from the tunnel water. The construction of this pipe was completed in 2006 and it is known as the “Gıcık Water” and is also transferred to the Develi Basin area to supplement the water derived from the Zamantı River.

The Öksüt open pits above the groundwater level and therefore dewatering of the open pits will not significantly affect groundwater levels in aquifers below the level of the open pits. As a result, the long term sustainability of the Zamantı tunnel water resource was not assessed as part of the ESIA as there is no linkage between mine operations and the flow of the Zamantı Tunnel. The reduction in flow recorded in the Zamantı Tunnel occurred prior to any activities at the Öksüt mine site when the tunnel transformed the hydrological system from a closed to an open system. The system can be expected to reach steady state in time and even 100-150l/s would be representing the steady state conditions and changes to the hydrological regime are under the control of the State Hydraulic Works (DSI).

Figure 10-22: Zamantı Regulator and Derivation Tunnel

Source: (http://www.dsi.gov.tr/haberler/2013/04/01/develi)

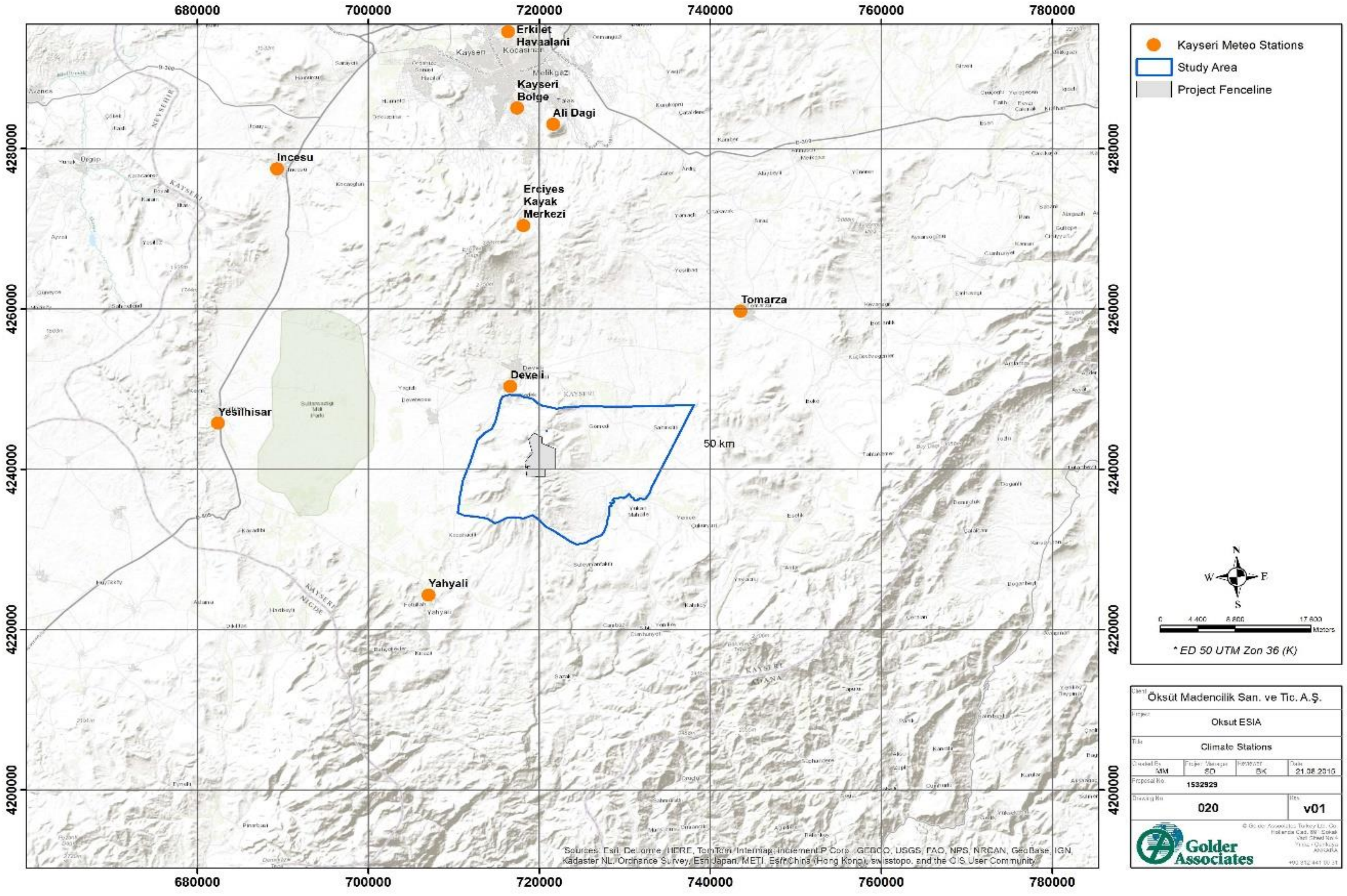
10.6.4 Hydrometeorology

The closest meteorological station to the Project Area is the Develi Meteorological Station (DMS; No. 17836) of the General Directorate of Meteorology. Daily data from the station for the years 1974 to 2014 was obtained from the Directorate for use in this assessment.

Data was also obtained from the Kayseri Meteorological Station (KMS; No. 18149) and used to supplement the Develi data set where certain parameters had not been recorded (i.e. evaporation).

The locations of meteorological stations with respect to the study area are presented in Figure 10-23.

Figure 10-23: Project Site in Relation to Meteorological Stations



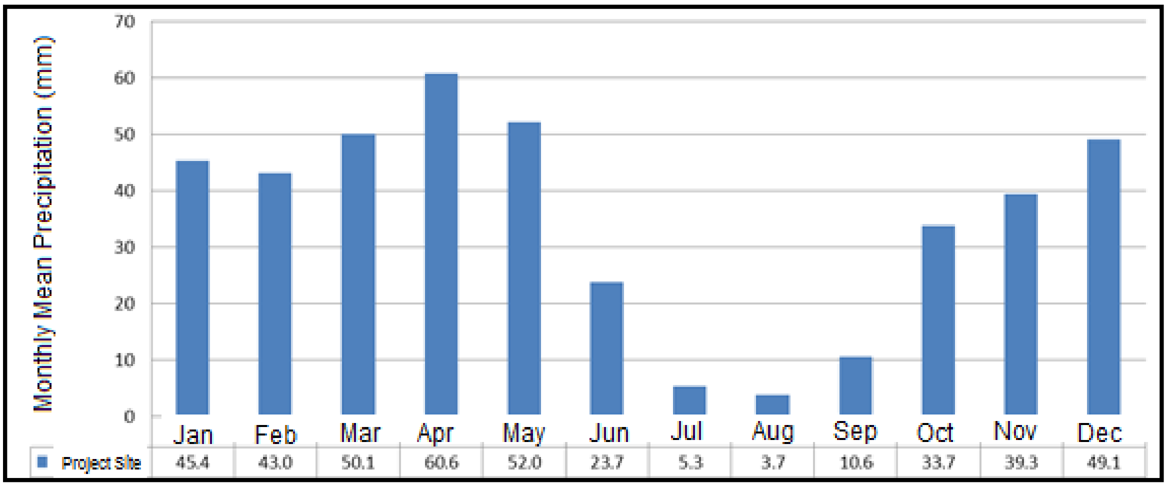
Precipitation

The study area region has a semi-arid, territorial climate characterised by hot and dry summers and cold and rainy winters. The annual mean amount of precipitation is 416.4 mm. The rainiest season is spring during which 39% of overall rainfall occurs. The distribution of rainfall during summer, fall and winter months is 8%, 20% and 33%, respectively. Precipitation during winter mainly occurs as snow.

Develi meteorological station is located at 1,341 m above sea level (asl) and the Project Area's mean altitude is 1,800 m asl. The mean annual precipitation over the last forty years at Develi is 368.5 mm. The groundwater model and EIA assume that the annual amount of precipitation in the Project Area is 416.5 mm which is 1.13 times the annual volume of precipitation at Develi.

Monthly mean precipitation in the Project Area is illustrated in Figure 10-24.

Figure 10-24: Monthly Mean Precipitation in the Project Area

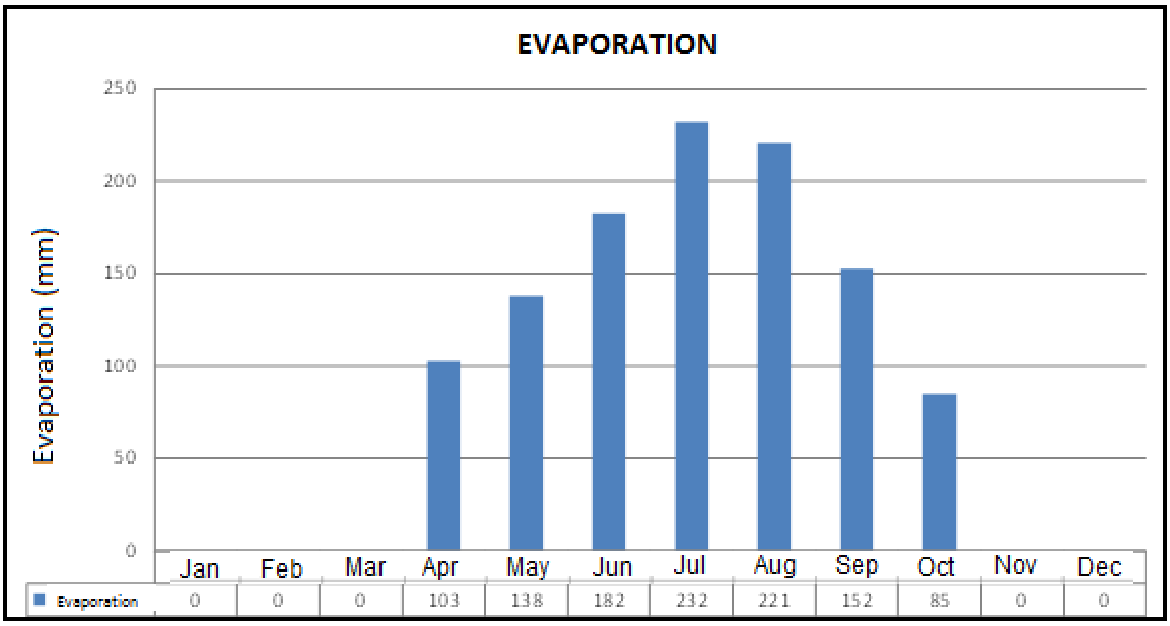


Source: Draft Feasibility Study, June 2015.

Evaporation

Since evaporation data is not recorded at Develi, data from the Kayseri meteorological station was used. Data was acquired for the period 1986 to 2013. Monthly mean evaporation is presented in Figure 10-25. The highest evaporation level recorded is in July at 23.2 mm.

Figure 10-25: Monthly Mean Evaporation at the Kayseri Meteorological Station



10.6.5 Basin Characteristics

Utilising a 1:25,000 scale topographic map, satellite images provided by OMAS and the ArcHydro CBS software program, SRK developed a hydrologic model for the Project Area and its surrounds. The model defines 16 sub-basins (catchments). Of these 16 sub-basins, the Gömedi, Yazıgüney, Kıvçak Dere, Tandirlik Dere, Zile and Öksüt sub-basins will be directly affected by the Project. Kol, Karasu and Zamantı Basins are also included in the study area as these areas will be directly impacted by mining activities and the new access road and water supply pipeline corridors.

Reductions in surface water flow would be observed as a result of surface water within the Project Area being captured and stored for use during construction and contact/non-contact water separation and diversion during operation. Impacts on the mentioned sub-basins and the proposed mitigation measures are provided in the following sections:

- *Section 10.8.2 - Construction Phase Impacts and Mitigation Measures*
- *Section 10.8.3 -Operations Phase Impacts and Mitigation Measures*
- *Section 10.8.4 - Closure Phase Impacts and Mitigation Measures*

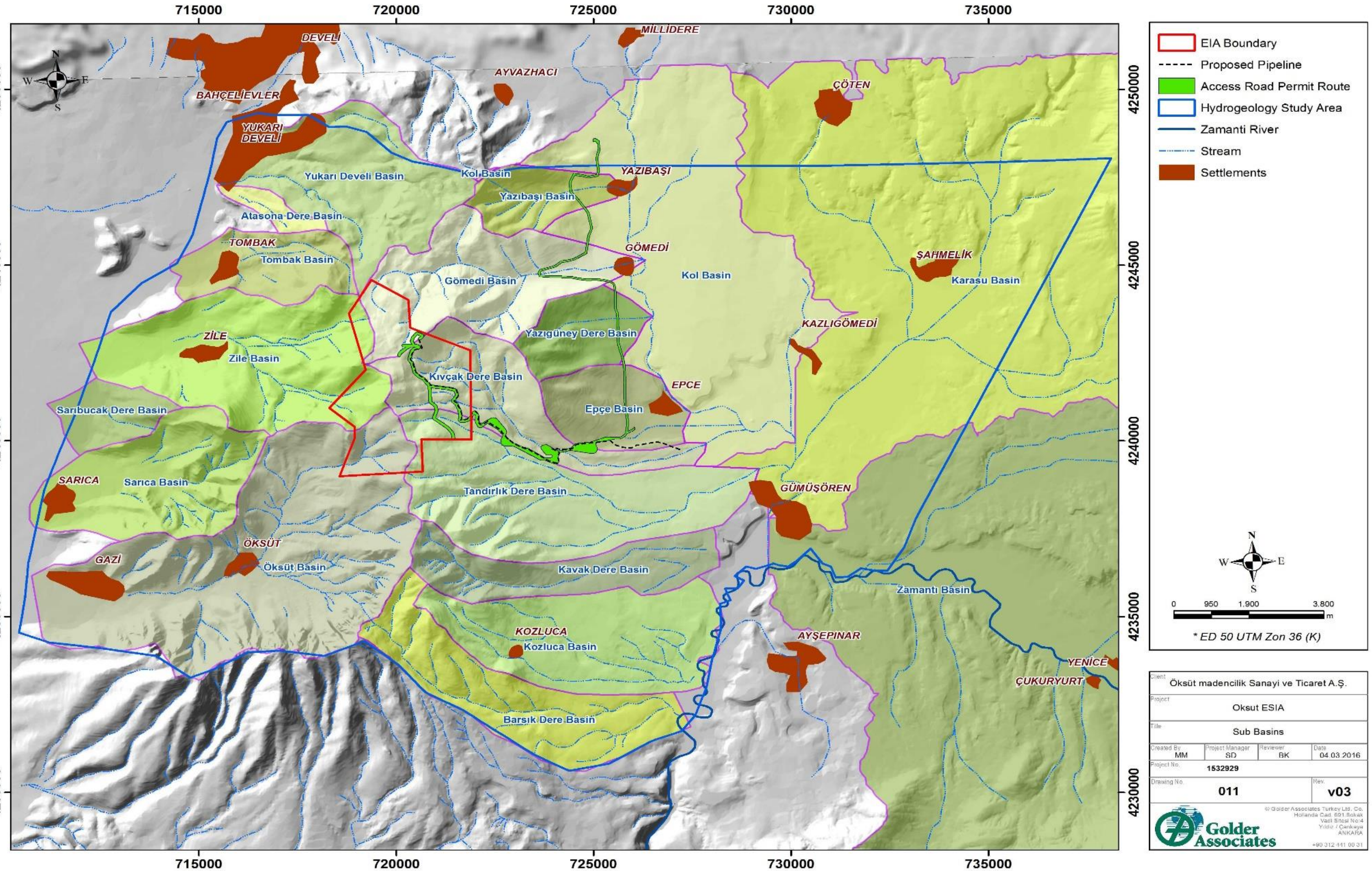
Drainage basin size are also estimated and presented within the sections.

The results of the ArcHydro CBS analysis are presented in Table 10-9. The geographic location and extent of the sub-basins are illustrated in Figure 10-26.

Table 10-9: Sub-Basin Data

Sub-Basin Name	Area (km²)	Mean Basin Gradient (%)	Mean Altitude Above Sea Level (masl)	Longest Drainage (km)	Altitude of Longest Drainage 10% (masl)	Altitude of Longest Drainage 85% (masl)	Main Drainage Gradient (%)
Öksüt Basin	41.7	20.6	1,465.0	12.1	1,110	1,554	4.9
Zile Basin	22.2	15.0	1,435.1	8.1	1,112	1,624	8.4
Tombak Basin	7.5	16.1	1,382.2	5.8	1,117	1,703	13.5
Tandırlık Creek Basin	22.4	11.6	1,574.1	10.6	1,294	1,709	5.2
Gömedi Basin	15.9	15.9	1,684.0	8.7	1,379	1,875	7.6
Barsık Creek Basin	15.0	15.1	1,588.6	10.8	1,299	1,800	6.2
Kozluca Basin	17.8	9.8	1,475.9	8.5	1,273	1,807	8.4
Yazıgüney Creek Basin	5.8	10.9	1,545.8	3.7	1,371	1,666	10.7
Epçe Basin	7.2	8.6	1,425.6	4.8	1,295	1,585	8.1
Atasona Creek Basin	1.6	19.0	1,326.7	3.2	1,144	1,481	14
Yazıbaşı Basin	5.1	14.5	1,564.4	3.9	1,383	1,619	8.1
Yukarı Develi Basin	15.9	18.6	1,525.0	7.2	1,150	1,740	10.9
Kıvçak Creek Basin	12.3	16.8	1,656.6	9.4	1,314	1,667	5
Kavak Creek Basin	98.0	13.7	1,576.4	8.9	1,305	1,780	7.1
Sarıca Basin	15.0	18.6	1,312.9	7.0	1,088	1,451	6.9
Sarıbucak Creek Basin	4.2	10.7	1,205.9	3.4	1,084	1,472	15.4
Kol Basin	44	3.77	1,378.2	-	-	-	-
Karasu Basin	113.5	8.07	1,381.2	-	-	-	-
Zamantı Basin	121.3	10.3	1,385.3	-	-	-	-

Figure 10-26: Location and Extent of Sub-Basins



10.6.6 Baseline Surface Water Monitoring

Within the scope of EIA studies conducted by SRK, a total of 322 water monitoring locations (hydro-census stations) for both groundwater and surface water were established. *In situ* parameters were measured at all 322 locations during the first monitoring campaign and included:

- Electrical Conductivity (EC);
- pH;
- Flow Rate;
- Temperature (T);
- Total Dissolved Solids (TDS).

The coordinates of the 322 hydro-census stations and the *in situ* measurement results of the first field campaign are presented in Annex N[9].

Results

It was observed that the majority of spring discharges in the Project Area and surrounds had a pH of approximately 3.5. The Acısu Creek, located in the Zile Sub-Basin and formed by a spring discharge, is near the Open Pits site and is the closest creek to the Project Area. The pH, EC and TDS measurements of surface water near this area also displayed acidic characteristics. The Öksüt Creek, which gathers surface flows from south-east of the Güneytepe Open Pit area, is also in close proximity of the Project Area.

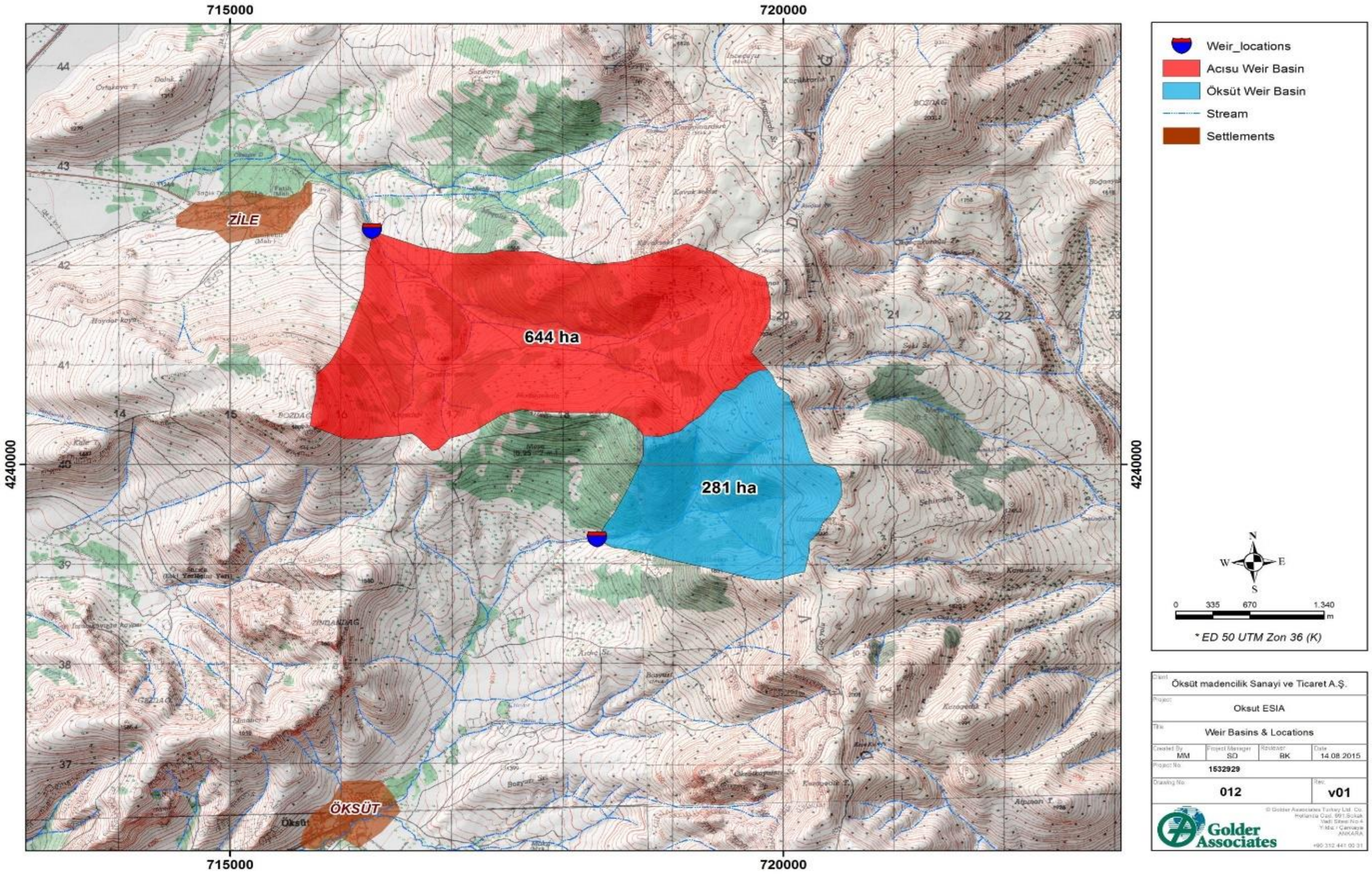
The minimum, maximum and mean flow rates measured at the Acısu and Öksüt weirs are presented in Table 10-10. The weirs locations are illustrated in Figure 10-27.

Table 10-10: Flow Rates Measured at the Weirs

Weir	Minimum Flow Rate (L/s)	Maximum Flow Rate (L/s)	Mean Flow Rate (L/s)
Öksüt (Weir-1)	0	194.2	2.4
Acısu (Weir-2)	3.3	161.4	11.4

[9] Abbreviations used to identify the stations and the number of each station type are as follows:
DE: Water reservoir (23 locations);
DS: Fountain (44 locations);
PO: Pond (1 location);
LA: Lake (1 locations);
W: Well (94 locations);
HDW: Shallow Well (34 locations);
SP: Spring (77 locations);
SW: Stream (33 locations);
TDE: Transmission Line Tank (14 locations); and
CH: Supply Channel (1 location).

Figure 10-27: Location of the Acısu Creek and Öksüt Creek Weirs and the Basins Represented by the Weirs



Hydrographic Analysis

The long term flow rates measured in the Project Area are separated into surface flow and base flow components. The total base flow and total discharge rate give the Base Flow Index (BFI).

The Recursive Filter Method[10] and Single Parameter Digital Filter Method were used in the BFI calculations for the circa 16-months of flow rates measured at the weirs. The Zamantı Monitoring Station data from DSI was also used. The mean BFI values calculated using these methods are presented in Table 10-11.

Table 10-11: Calculated Base Flow Values

Station	Calculated Base Flow Index	Data Capture Period
Acısu Weir	0.67	16 Months (daily)
Öksüt Weir	0.49	16 Months (daily)
Zamantı Monitoring Station (SHW)	0.78	40 Years (daily)

The two different base flow values in the Project Area is explained by the relationship between the zone where the hydraulic conductivity has increased with ore formation and the Acısu Creek. The permanent spring water discharging into the Acısu Creek increases the BFI. The general flow within the Project Area is however; more congruent with data collected from the Öksüt weir (i.e. in general, surface water flow is represented by non-permanent streams). The base flow value from the Öksüt weir has therefore, been used in the calculation of the general recharge to the Develi volcanics.

Data obtained from the Fraklin Bridge / Zamantı River flow meter are congruent with the high hydraulic conductivity which feeds the river (i.e. K: $1x10^{-4}$ m/s to $1x10^{-5}$ m/s in the Epçe and Şahmelik regions). The flow in the river is more a result of groundwater recharge than surface water recharge. In the calculation of recharge in this region, the BFI from the Zamantı River Flow Meter has been used.

Calculation of Recharge and Soil Moisture Model

To determine the recharge in the Project Area, a soil budget model was developed using parameters related to temperature, precipitation, soil and vegetation characteristics. In the model, Potential Evaporation (PE) was calculated using the Blaney-Criddle method. Subsequently, Actual Evaporation (AE) was calculated using the soil moisture budget model of the Food and Agriculture Organisation (FAO) of the United Nations[11]. The Effective Precipitation (EP) and flow were then calculated using flow data recorded at the two weirs. Finally, using the base flow data from the Zamantı River Flow Meter, the recharge was calculated as the difference between the EP and the surface flow.

Considering the base flow index value obtained from the Öksüt weir (0.49) and the precipitation values recorded at the DMS plus a factor to account for the higher altitude of the Project Area (i.e. DMS x 1.13), the EP was calculated to be 27.5% and the recharge to be 13.2% (55.2 mm) of the Mean Annual Precipitation (MAP). By using the base flow index (0.78) obtained from the Fraklin Bridge / Zamantı River flow meter, the recharge was determined to be 89 mm on average. A summary of these findings is presented in Table 10-12. The base flow index calculations are presented in *Annex O*: *Hydrogeological Impact Assessment and Modelling Study Report for Öksüt Project.*

[10] Eckhardt, K., 2004. How to construct recursive digital filters for baseflow separation. Accepted for Hydrological Processes
[11] Allen, R.G.; Pereira, L.S.; Raes, D. & Smith, M. (1998). Crop evapotranspiration – Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper, No. 56, FAO, Rome

Table 10-12: Recharge to Develi Volcanics

Year	Evapotranspiration (actual) (mm)	Effective Precipitation (mm)	Recharge (mm)	Recharge %	Year	Evapotranspiration (actual) (mm)	Effective Precipitation (mm)	Recharge (mm)	Recharge %
1974	308.7	116.89	56	18.2	**1994**	271.6	9.49	5	1.7
1975	426.4	143.59	69	16.2	**1995**	329.7	78.43	38	11.4
1976	349	86.79	42	11.9	**1996**	372.2	96.33	46	12.4
1977	400.3	135.76	65	16.3	**1997**	330.5	21.56	10	3.1
1978	368.7	90.08	43	11.7	**1998**	520.2	241.12	116	22.2
1979	373.9	63.81	31	8.2	**1999**	362.3	156.69	75	20.8
1980	418	204.20	98	23.4	**2000**	414.2	137.54	66	15.9
1981	458.3	92.12	44	9.6	**2001**	328.6	0.00	0	0.0
1982	311.2	74.37	36	11.5	**2002**	389.2	94.40	45	11.6
1983	451.7	131.75	63	14.0	**2003**	391.5	101.96	49	12.5
1984	256.4	83.85	40	15.7	**2004**	375.5	112.03	54	14.3
1985	359.3	13.42	6	1.8	**2005**	375.4	89.90	43	11.5
1986	311.6	43.92	21	6.8	**2006**	331.3	12.24	6	1.8
1987	494.7	147.09	71	14.3	**2007**	419	77.22	37	8.8
1988	409.3	204.20	98	23.9	**2008**	337.3	73.11	35	10.4
1989	210.1	204.20	98	46.7	**2009**	468	189.57	91	19.4
1990	298.5	83.89	40	13.5	**2010**	507.8	143.36	69	13.6
1991	422.9	46.41	22	5.3	**2011**	328.9	126.79	61	18.5
1992	360.7	89.31	43	11.9	**2012**	383.4	24.58	12	3.1
1993	321.8	111.44	53	16.6	**2013**	308	102.37	49	16.0

10.6.7 Surface Water Hydro-Chemical Properties

Monitoring Points

The Project Area is drained through the Camboğazı Creek in a south-westerly direction and through the Kızılağıl and Acısu Creeks in a north-westerly direction. The planned WRD area is drained through the Kırpıklı Creek in an easterly direction.

In Situ Parameters

The surface water parameters measured in situ in the Project Area, are summarised in Table 10-13. The distribution of the average pH and EC is shown in Figure 10-28 and Figure 10-29. Monitoring stations found to be dry during all sampling periods are not presented in the tables or the graphics.

Temperature

The temperature values of the surface waters varied between 4˚C and 21˚C throughout the year.

pH

The measured pH of the surface waters were found to be at neutral and slight basic values, except for station KSW4 on the Acısu Creek. It noted that the point where pH was observed at the lowest level within and in the vicinity of the Project Area is station KSW4. According to the measurements at this station, pH values vary between 4 and 4.5.

The average pH values at stations OKSW11 and OKSW10 which are downstream of the Güneytepe Open Pit sites are 7.6 and 7.4, respectively, which can be classified as neutral to slightly basic.

The pH values at stations OKSW1, OKSW8 and OKSW3 which are upstream of the Öksüt Village on the Pıtıraklı Creek are slightly basic.

Station OKSW19, on the Kıvcak Creek east of the Project Area and that would drain the WRD, was dry during the sampling campaign. The measurements were hence taken in the spring, approximately 100 m above the stream bed. The average pH value was 7.2.

Station OKSW18, located east of the Project Area and that would drain the HLF displayed a slightly basic character with an average pH of 8.1.

Electrical Conductivity (EC) values

The lowest EC value within the Project Area was measured at 60 µS/cm at station OKSW14 during November 2013 and April 2014. The highest EC value was measured at 2,850 µS/cm at station OKSW10 during November 2013. The average EC value measured at station OKSW11 on the creek that would drain the Güneytepe Open Pit was 500 µS/cm. At stations OKSW3, OKSW8, OKSW10 and OKSW16, higher EC values were measured compared with the other stations. The average EC measurements at station KSW4, which is located on the Acısu Creek and through which the planned Keltepe Open Pit would drain, was 492 µS/cm. It was observed that the EC values measured at stations OKSW3 and OKSW8 displayed seasonal variance. The measurements at station OKSW8 were relatively high from November 2013 onwards and during February and April 2014. It was observed that the EC measurements at station OKSW3, which is located in downstream of station OKSW8, increased during February and April 2014.

Table 10-13: Surface Water Seasonal In-Situ Measurements

Station	Location Description	Temperature (°C)			pH			EC (µS/cm)			ORP[12] (mV)		
		Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
KSW1	Upstream of Pıtırıklı Creek, Village of Öksüt	11.8	4.9	18.7	7.94	6.83	8.89	867	597	1611	135	16	195
OKSW3	Upstream of Pıtırıklı Creek, Village of Öksüt	13.7	7.7	18.2	8.10	7.14	8.41	834	570	1370	223	174	286
KSW4	Upstream of Acısu Creek, Village of Zile	13.2	8.2	18.2	4.35	4.17	4.53	492	403	581	346	305	387
OKSW7	East of Halekavağı Creek, Village of Öksüt	7.8	5.3	10.3	7.62	7.25	7.98	540	510	570	223	158	287
OKSW8	Upstream of the tributary of Pıtırıklı Creek, Village of Öksüt	14.5	8.1	19.4	8.00	6.94	8.45	810	482	1310	214	138	289
OKSW10	Upstream of Camboğazı Creek, Village of Öksüt	11.3	8.8	13.3	7.37	7.09	7.58	1953	1470	2850	209	57	305
OKSW11	Downstream of Camboğazı Creek, Open Pit (Güneytepe)	8.4	4.5	12.3	7.58	7.42	7.73	500	310	690	227	203	251
OKSW14	Kırpıklı Stream, Waste rock dump area	10.1	9.5	10.6	6.79	6.52	7.05	60	60	60	180	77	283
OKSW16	North of Yayla Creek, Village of Öksüt	9.2	4	14.4	7.78	7.68	7.88	1400	1350	1450	314	305	322
OKSW17	Upstream of the tributary of Pıtıraklı Creek, Village of Öksüt	16.0	16	16	6.98	6.98	6.98	520	520	520	132	132	132
OKSW18	Downstream of Maraboğazı Creek, Heap leach area	9.5	9.5	9.5	8.10	8.10	8.10	190	190	190	302	302	302
OKSW19	East of Kıvçak Creek, Project site	11.2	10	12	7.20	6.7	7.42	140	120	150	289	206	334
OKSW20	Surface water from the tunnel directed from the Zamantı River	12.9	4.6	20.7	7.98	6.73	8.61	477	360	680	204	80	292

[12] Oxidation Reduction Potential.

Figure 10-28: Average Surface Water pH Values Measured at Monitoring Locations

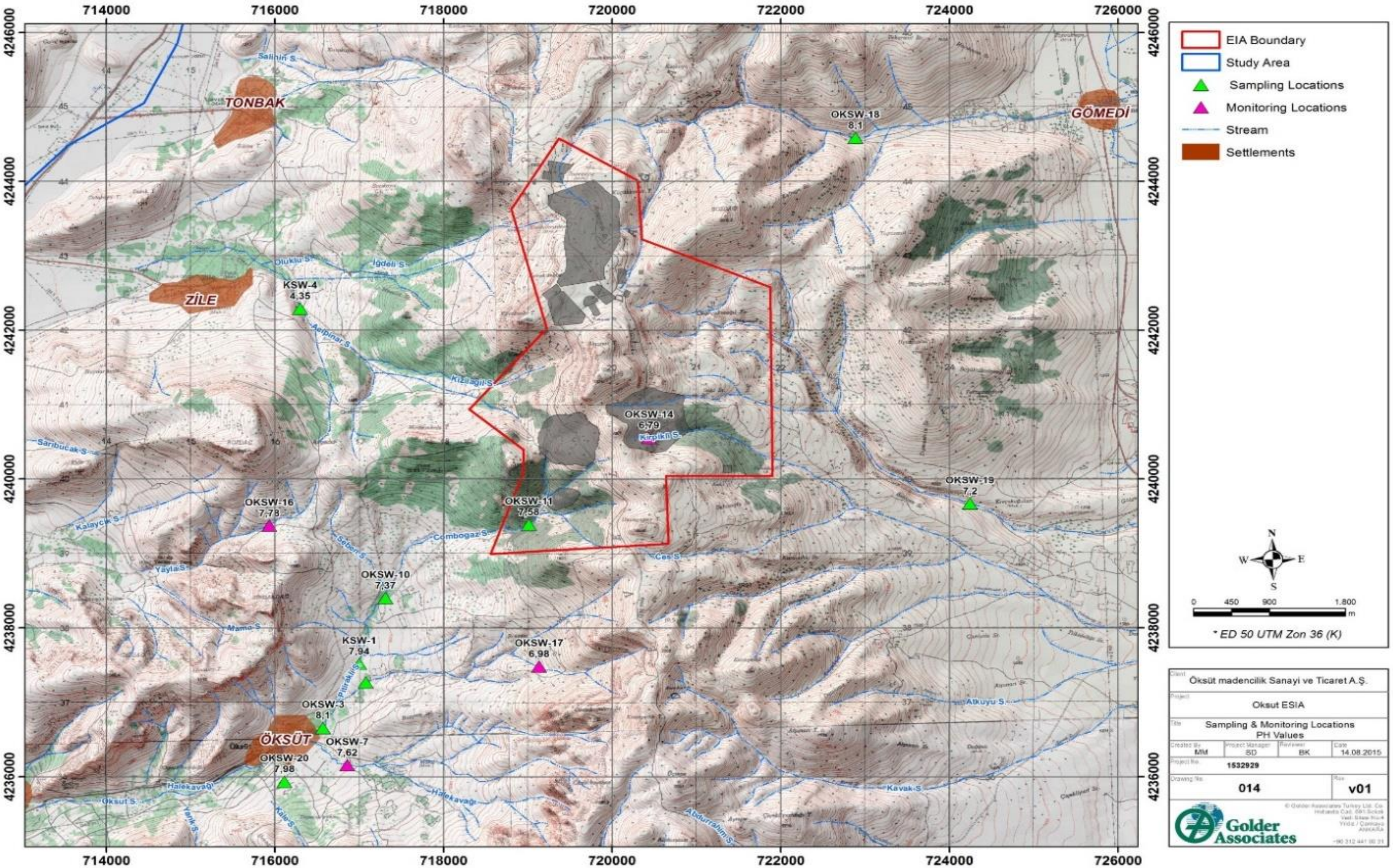
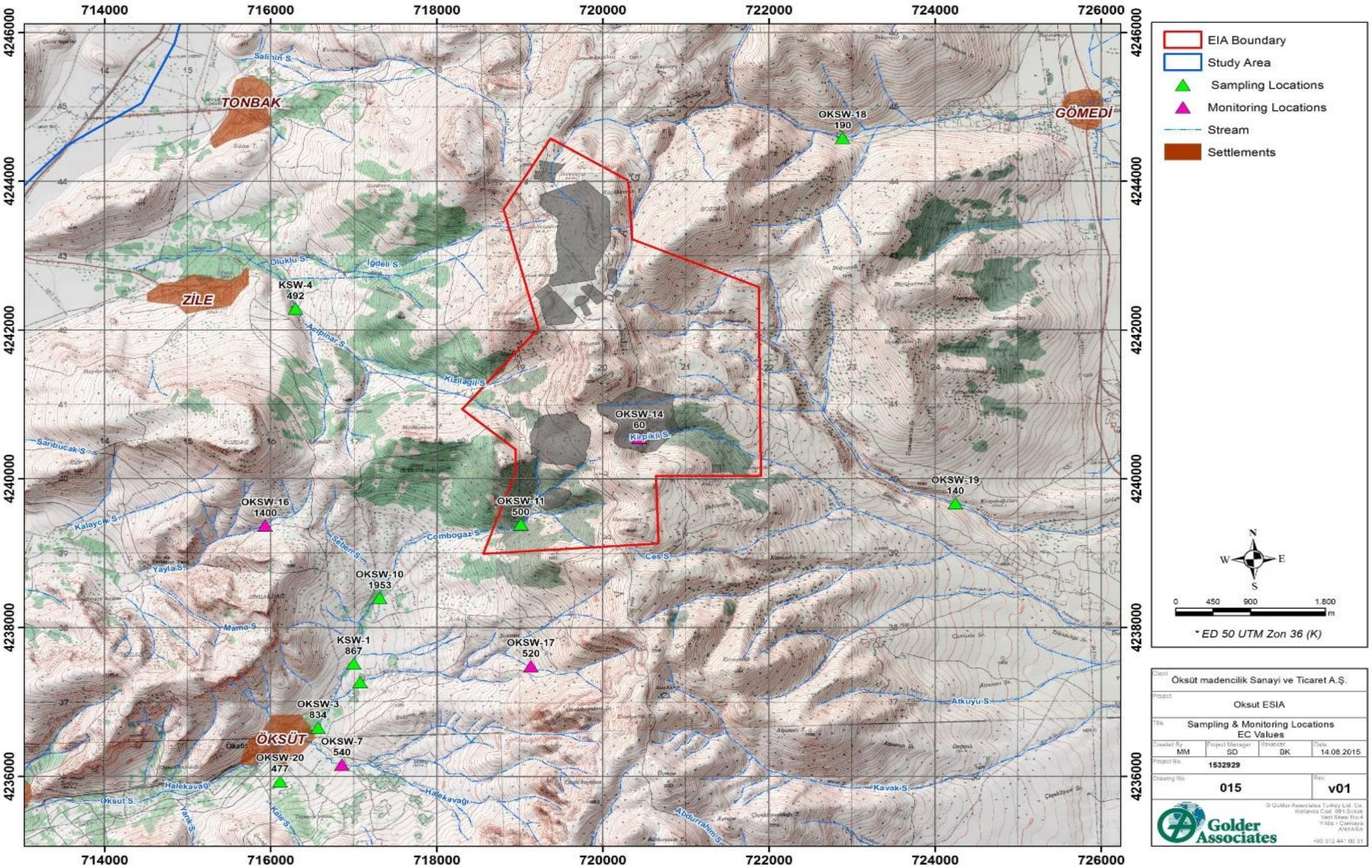


Figure 10-29: Average Surface Water EC Values Measured at Monitoring Locations



The ionic characteristics of surface water samples and hydro-geochemical facies of the waters have been assessed using the Piper diagram (Figure 10-30) and the Schoeller diagram (Figure 10-31 to Figure 10-33).

Figure 10-30: Piper Diagram of Surface Water Samples

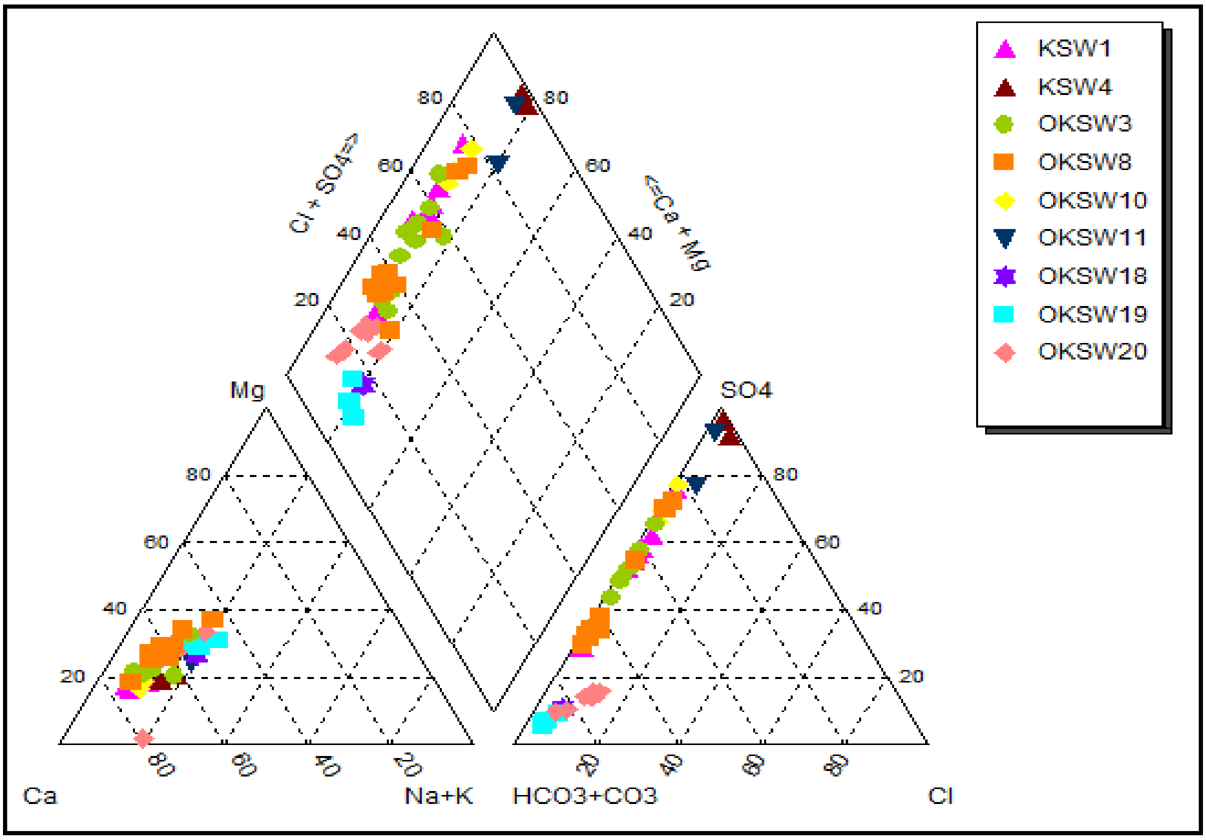


Figure 10-31: Schoeller Diagram Stations KSW1, OKSW3, OKSW8, OKSW10 and OKSW11

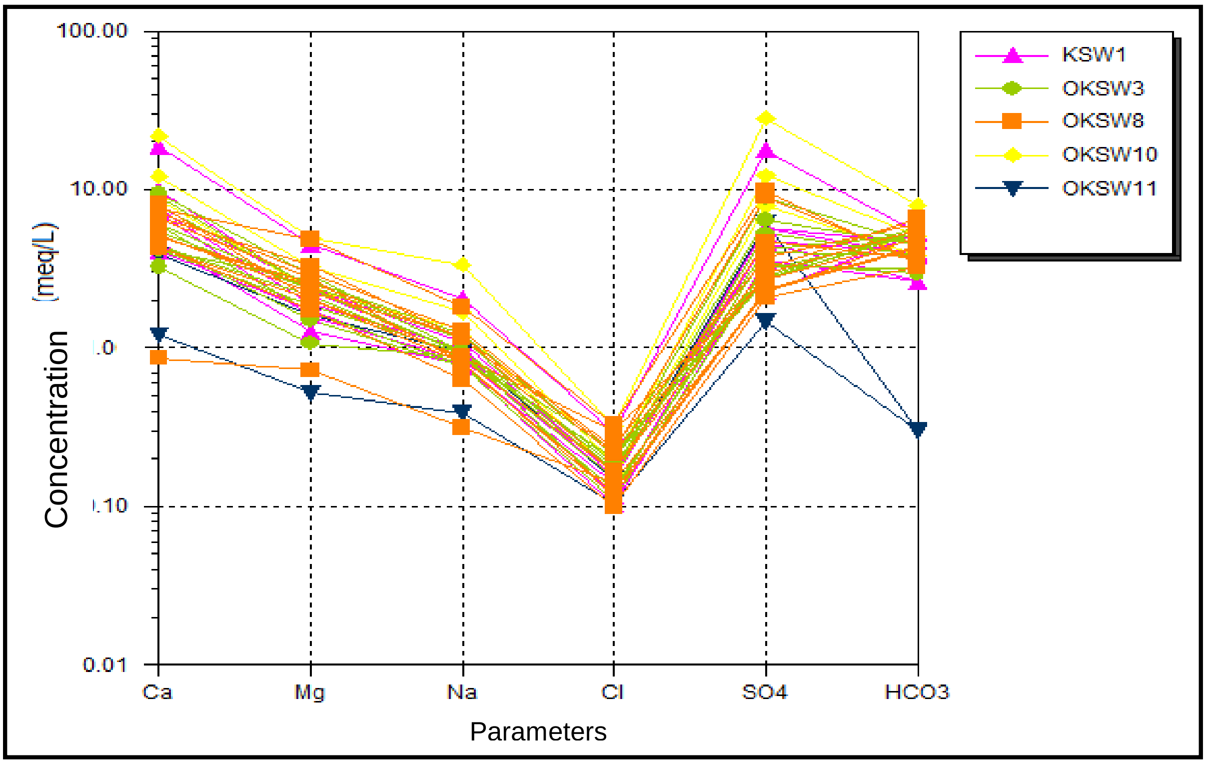


Figure 10-32: Schoeller Diagram Station KSW4

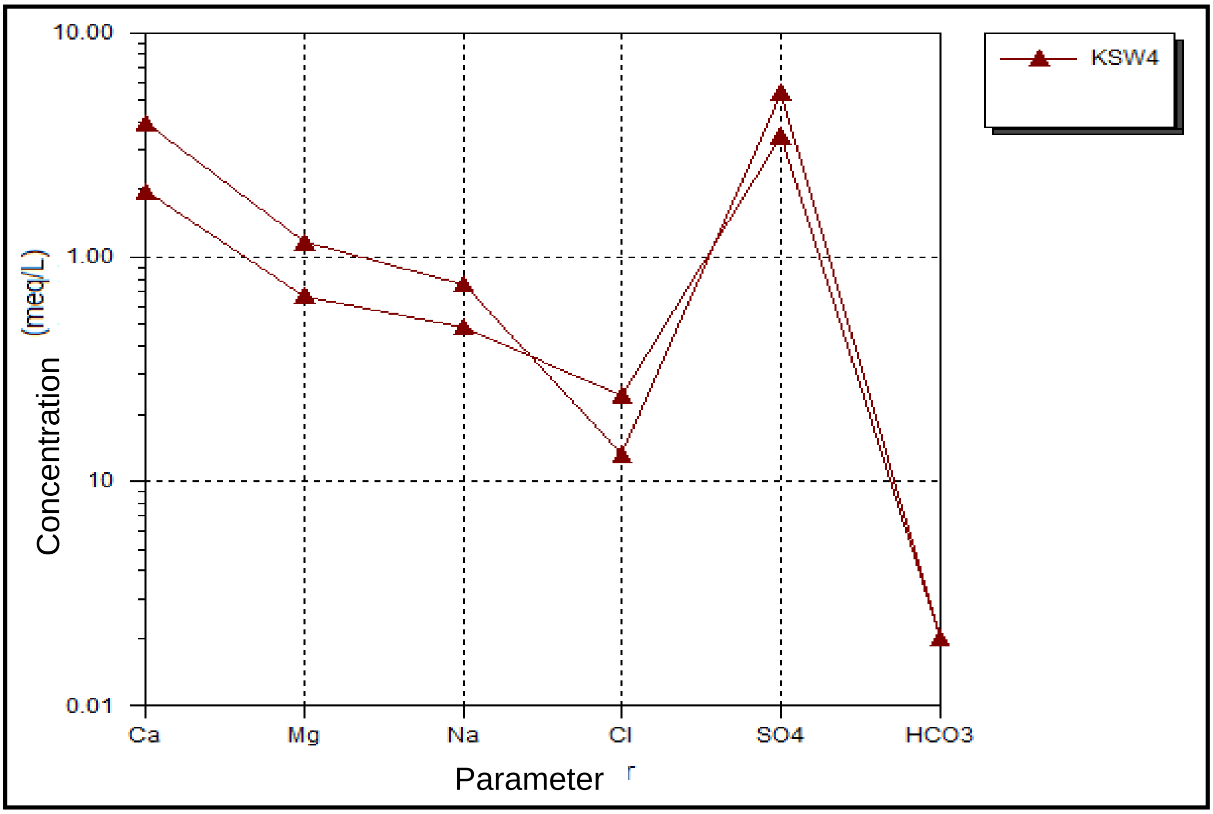
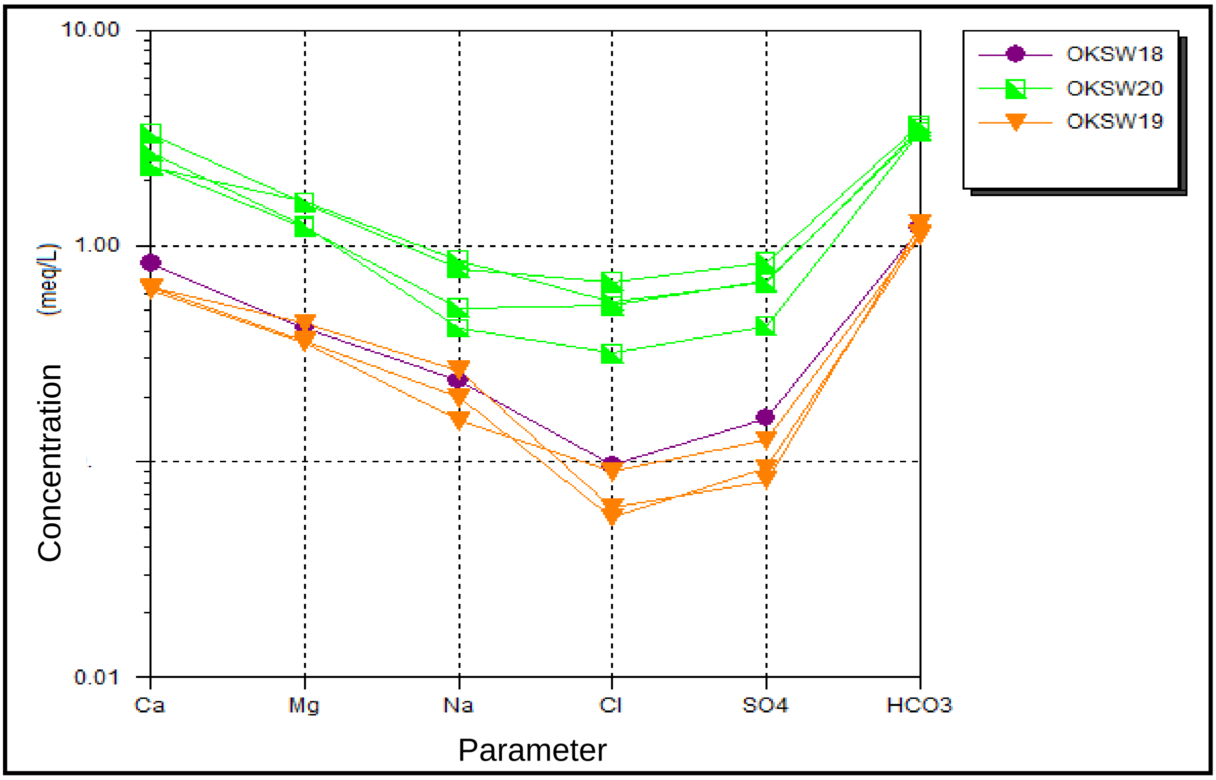


Figure 10-33: Schoeller Diagram Stations OKSW19, OKSW20



According to the Piper and Schoeller diagrams, there are three main types of hydro-chemical facies. The dominant major cation in all surface waters is calcium (indicating fresh water) and suggests some weathering from soils and rocks. Calcium causes water to be hard and contributes to the scale-forming properties of water.

The dominant anion concentrations are diverse depending on their SO_4 and HCO_3 contents. The Sources of sulphate (SO_4^{2-}) can include the dissolution of gypsum and anhydrite and / or the weathering of pyrite and iron sulphides. Sulphate is usually present in mine water. The occurrence of sulphate depends upon the reduction / oxidation potential of the water. In reducing conditions, sulphate reduction produces hydrogen sulphide. In oxidising conditions, sulphides may be oxidised to sulphates. The following summarises the results of water sample testing in terms of their hydro-chemical facies:

- Samples collected at station KSW4 on the Acısu Creek, which flows in a north-easterly direction from the Project site toward Zile Village, were found to be of Ca-SO_4 facies;
- Samples collected at stations KSW1, OKSW11 and OKSW10, located on the Camboğazı Creek which drains the planned Güneytepe Open Pit area, were observed to be of Ca-SO_4 facies;
- Samples collected during different seasons at stations OKSW3 and OKSW8, which are located downstream of the abovementioned stations, were observed to be Ca-SO_4, Ca-Mixed and Ca-HCO_3 facies;
- Samples collected at station OKSW18, which is located east of the Project site, from station OKSW19 located downstream of the WRD area and from station OKSW20, which has been directed from the Zamantı River through an underground duct to the Öksüt Village, were determined to be of Ca-HCO_3 facies.

The Schoeller diagram illustrates that among the surface water features within the study area, which are of Ca-SO_4 facies, station KSW4 differs from the others with relatively lower HCO_3 values.

10.6.8 Surface Water Quality Baseline Assessment

The surface water samples analytical results were compared with the *Regulation on the Management of the Quality of Surface Water* (RMSWQ) Table 5 – *Quality Criteria for the Inland Surface Water Resources* to assess the baseline water quality within and in the vicinity of the Project site. The limit values presented in the RMSWQ Table 5 are presented in Table 10-4.

The comparison of the surface water quality results with the above water quality criteria is presented in Table 10-14.

Table 10-14: Comparison of the Surface Water Quality with the Water Quality Criteria

Monitoring Station	Sampling Period	RMSWQ		
		Class II	Class III	Class IV
KSW1	Jan 11	P	E.C.	-
	Apr 11	EC	-	-
	Jul 11	NO_2	-	-
	Oct 11	EC, NO_2	-	-
	May 12	EC, NO_2	-	-
	Feb 13	EC	-	-
	May 13	EC, NO_2	-	-
KSW4	Feb 13	COD, P	-	pH
	May 13	Ni, EC	-	pH
OKSW10	Nov 13	-	EC	-

Monitoring Station	Sampling Period	RMSWQ		
		Class II	Class III	Class IV
	Feb 14		EC, NO_2	-
	Apr 14		EC	-
OKSW11	Feb 14	EC	NO_2	-
	Apr 14	-	-	-
OKSW18	Apr 14	-	-	-
OKSW19	Jul 13	P	-	-
	Nov 13	-	-	-
	Feb 14	P		NO_2
OKSW20	Aug 12	-	NO_2	-
	May 12	-	-	-
	Nov 12	NO_2	-	-
	Feb 13	NO_2	-	-
	May 13	NO_2	-	-
	Jul 13	EC	NO_2	-
	Nov 13	EC	-	-
	Feb 14	EC	-	NO_2
	Apr 14	-	-	-
OKSW3	Apr 11	EC	-	-
	Jul 11	-	-	-
	Oct 11	EC	-	-
	May 12	EC, NO_2	-	-
	Nov 12	EC	-	-
	Feb 13	EC	-	-
	May 13	EC, NO_2	-	-
	Jul 13	EC	-	-
	Nov 13	EC	-	-
	Feb 14		EC, NO_2	-
	Apr 14	EC	-	-
OKSW8	Apr 11	EC	-	-
	Jul 11	-	-	-
	Oct 11	EC	-	-
	May 12	EC	-	-
	Nov 12	P, EC	-	-
	Feb 13	EC	-	-
	May 13	EC, NO_2	-	-
	Jul 13	EC	-	-

Monitoring Station	Sampling Period	RMSWQ		
		Class II	Class III	Class IV
	Nov 13	-	EC	-
	Feb 14	-	EC	NO_2
	Apr 14	EC	-	-

1 Regulation on Management of Surface Water Quality (RMSWQ), Ministry of Forestry and Water Affairs, 2012

The comparison with the Regulation (RMSWQ) concludes that 13 of the surface water analytical results indicate Class II waters, where the major common parameters causing the exceedance are EC and NO_2.

The EC and TDS values are relatively high in relation to the relatively high SO_4 concentrations observed at the Camboğazı Creek, to which the Güneytepe Open Pit will drain.

Stations KSW1, OKSW10 and OKSW11 are located on the tributaries of the Camboğazı Creek. The samples taken from station OKSW3 and station OKSW8, located on the same creek showed elevated EC and TDS, associated with SO_4, seasonally. The high EC values at the locations near the Camboğazı Creek are considered to be associated with the local geology. The high NO_2 values are likely due to organic pollution (i.e. agricultural, domestic, animal husbandry, wild storage, sewage, etc.) but no specific source was identified during baseline studies.

Stations OKSW18 and OKSW19, represent the different basins east of the Project site. The creek where the Station OKSW20 is located is directed through the underground tunnel from the Zamantı River, which has rather low EC compared to the rest of the results. The NO_2 concentrations at these locations are associated with organic pollution.

The majority of the samples collected at stations OKSW3 and OKSW8 are classified as Class II due to elevated EC.

Station OKSW10 is classified as Class III due to EC and NO_2 concentration and station OKSW11 (February 2014) due to NO_2 concentrations.

It was observed that the water quality classes of some surface water sampling stations varied by season. The EC and NO_2 values which increased seasonally were detected at stations KSW1 (January 2011), OKSW8 (November 2013) and OKSW20 (August 2012 and July 2013). Based on these two parameters, the waters were classified as seasonally Class III.

Station KSW4 on the Acısu Creek is classified as Class IV due to its pH.

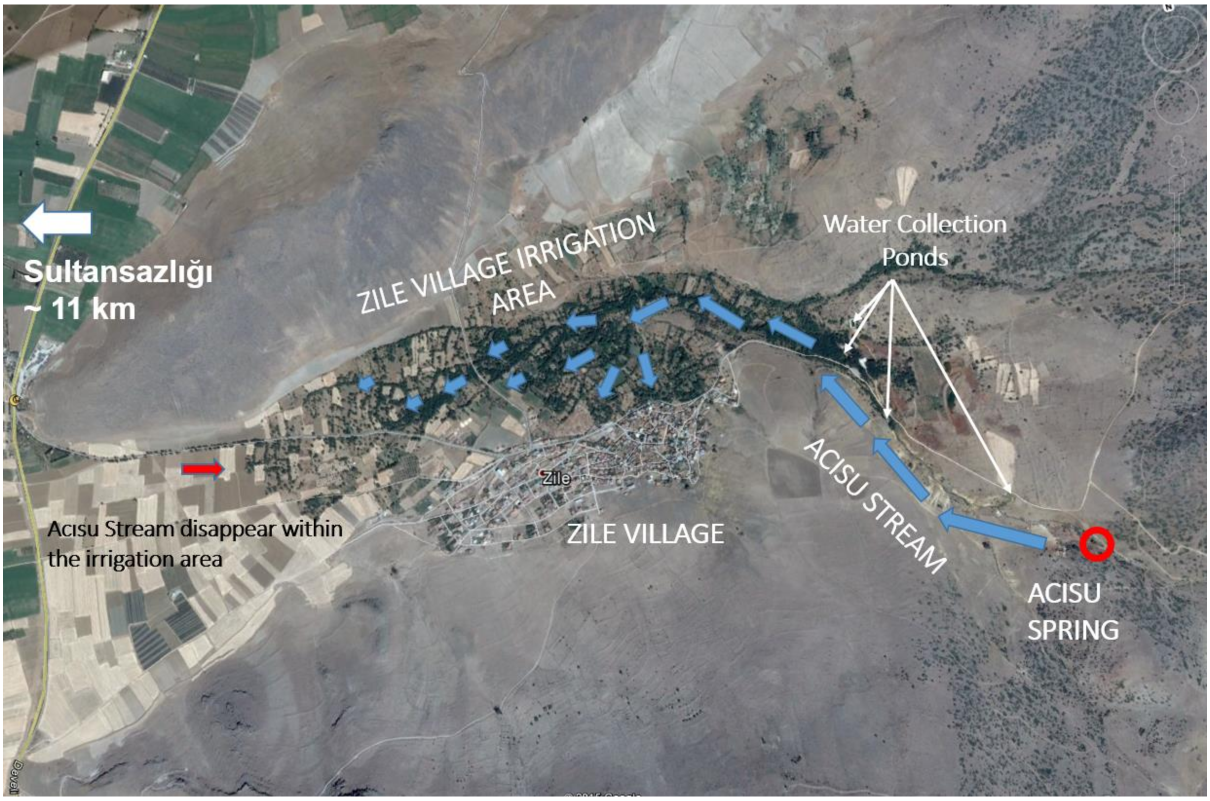
Use of Acisu Spring and Creek

The Acisu Spring is used for traditional medicinal purposes as spa water to be drunk for its alleged health-giving properties, and is also used for crop irrigation. The water is classified as Class IV and the low pH is accompanied by elevated levels of heavy metals and is not therefore suitable for drinking water. Figure 10-34 shows (a) Acısu Spring, (b) Acısu Creek upstream of Zile, (c) ponds collecting Acısu water and (d) irrigation structures in Zile. Field surveys have shown the local residents do divert and use the water in the Acisu Creek for irrigation purposes as illustrated below. Refer to *Annex T* for further information.

Figure 10-34: Photographs of Asicu Spring, stream, ponds and irrigation

Acısu creek which is the only permanent surface water within the project area which flows towards west (to the Sultan Sazlığı Wetland). Acısu water is heavily used for irrigation within the Zile Village and the creek disappear within the irrigation area and cannot be observed at the immediate downstream of the Zile village. Sultan Sazlığı wetland is located 10 km away from the Zile irrigation area in that respect it can be concluded that the surface waters from the project area do not reach and impact the Sultan Sazlığı Wetland.

Figure 10-35: Asicu Creek and Use for Irrigation



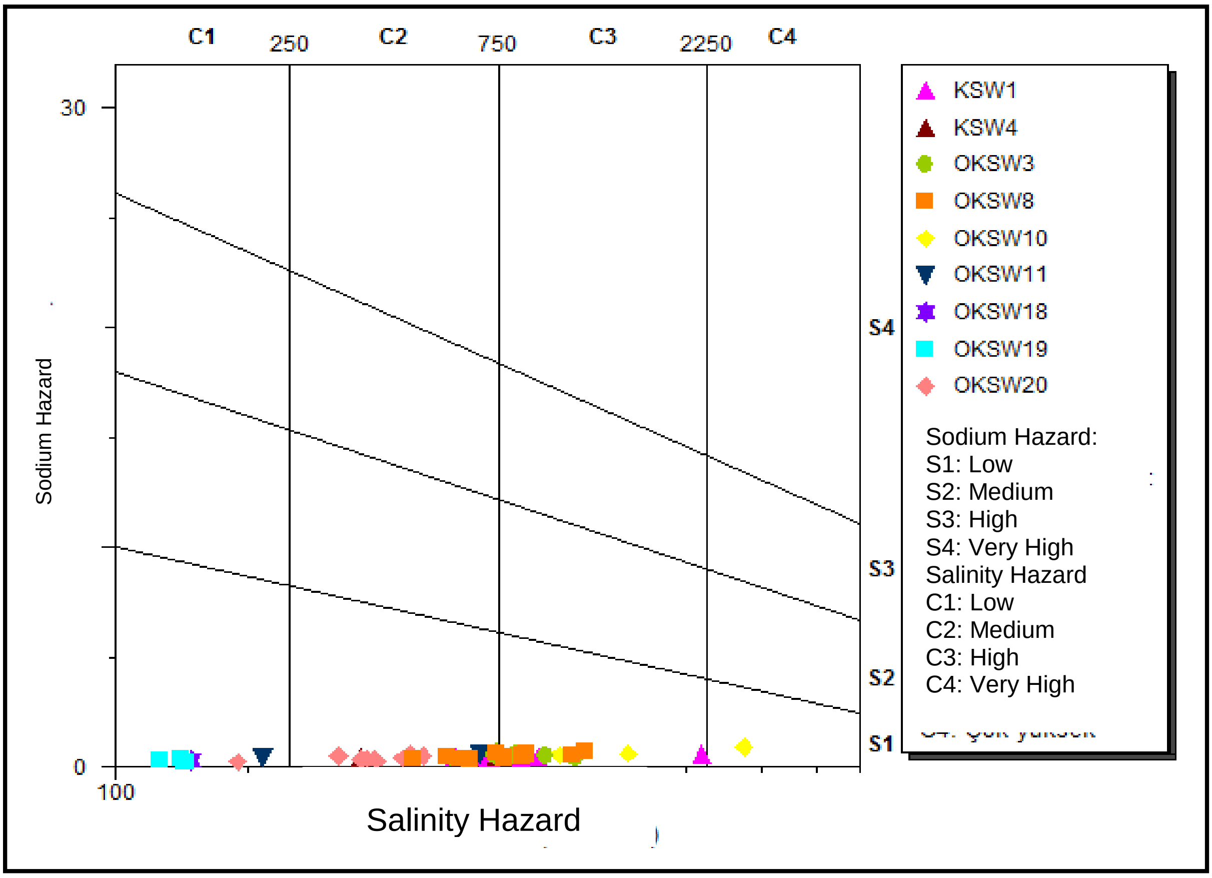
Suitability for Irrigation Water

In order to determine the suitability of existing surface water features for use as source of irrigation water, the Wilcox diagram was used (Figure 10-36). According to the Wilcox diagram, surface water quality is grouped based on potential hazard classes as presented in the legend of Figure 10-36.

All of the surface waters are in the low sodium hazard class (S1) but exhibit different salinity hazard classes as follows:

- Stations OKSW18 and OKSW19 represent low salinity hazard (C1);
- The only surface water representing very high salinity hazard (C4) was the sample taken from station OKSW10 in November 2013 and this would not be suitable for irrigation;
- It was observed that the rest of the samples belonging to this station represented high salinity hazard (C3) and these would not be suitable for irrigation;
- Other surface water samples represented medium (C2) and high (C3) salinity hazards.

Figure 10-36: Wilcox Diagram of Surface Water Samples



Cyanide Baseline Concentrations

Project baseline monitoring results indicate that Weak Acid Dissolvable Cyanide (WADCN)[13] and Total Cyanide (TCN)[14] concentrations are below the detection limit <0.005 mg/L in all of the surface water monitoring points.

10.6.9 Sensitivity of Surface Water Resources

The Öksüt Project is a high-sulphidation epithermal deposits with the potential to develop acidic and highly metalliferous waters through oxidation of the sulphide minerals present in the sulphidic portion of the deposit and the leaching of the minerals with stored acidity (e.g. alunite) in the oxidised portions of the deposit. In the variably wet and dry climate at the mine location, spikes of acidic waters can develop from the dissolution of secondary minerals that formed during the dry period. The current geochemical dataset indicates that nearly all waste rock, spent ore and the pit walls resulting from mining at the Öksüt Project will generate acid either due to leaching of naturally occurring sulphate minerals or oxidation of pyrite. Due to the negligible carbonate content (i.e. low neutralisation potential) of the rock, acidic conditions are expected to develop rapidly for waste rock and first contact waters will be acidic resulting in leaching of trace metals at concentrations which would exceed water quality standards.

Rocks with lower sulphide and sulphate content may be expected to leach rapidly for a shorter period than rock with elevated sulphide content as sulphate minerals are flushed and depleted. Rock with

[13] Cyanide is generally measured as one of three forms: free, weak acid dissociable (WAD), and total. Free cyanide refers to the cyanide that is present in solution as CN or HCN, and includes cyanide-bonded sodium, potassium, calcium or magnesium. Free cyanide is very difficult to measure. WAD cyanide is the fraction of cyanide that will volatilize to HCN in a weak acid solution at a pH of 4.5. WAD cyanide includes free cyanide, simple cyanide, and weak cyanide complexes of zinc, cadmium, silver, copper, and nickel.

[14] Total cyanide measures all of the cyanide present in any form, including iron, cobalt, gold and platinum complexes.

higher sulphide content can be expected to leach acidity over longer periods to due to ongoing acid generation from sulphide oxidation. Spent ore samples can be expected to show a delay in development of acidic conditions due to leaching of residual lime added during heap leach process however, basic pH conditions are favourable for leaching elements such as arsenic and antimony. Spent ore contact waters may initially have elevated arsenic and antimony concentrations transitioning to heavy elements especially in solution as cations as pH decrease.

These findings are consistent with global experience with mining of similar types of high sulphidation epithermal gold deposits.

Even though the project has high ARD and Metal Leaching potential, the sensitivity of the hydrology component is considered as **medium**, considering that the surface water features are scarce around the Project Area. The only stream showing continuous flow is the Acısu Creek which is of low quality and are in high demand with limited potential for substitution on a regional scale. The receiving surface water features have moderate natural resilience to imposed stresses that may potentially be incurred by mining activities.

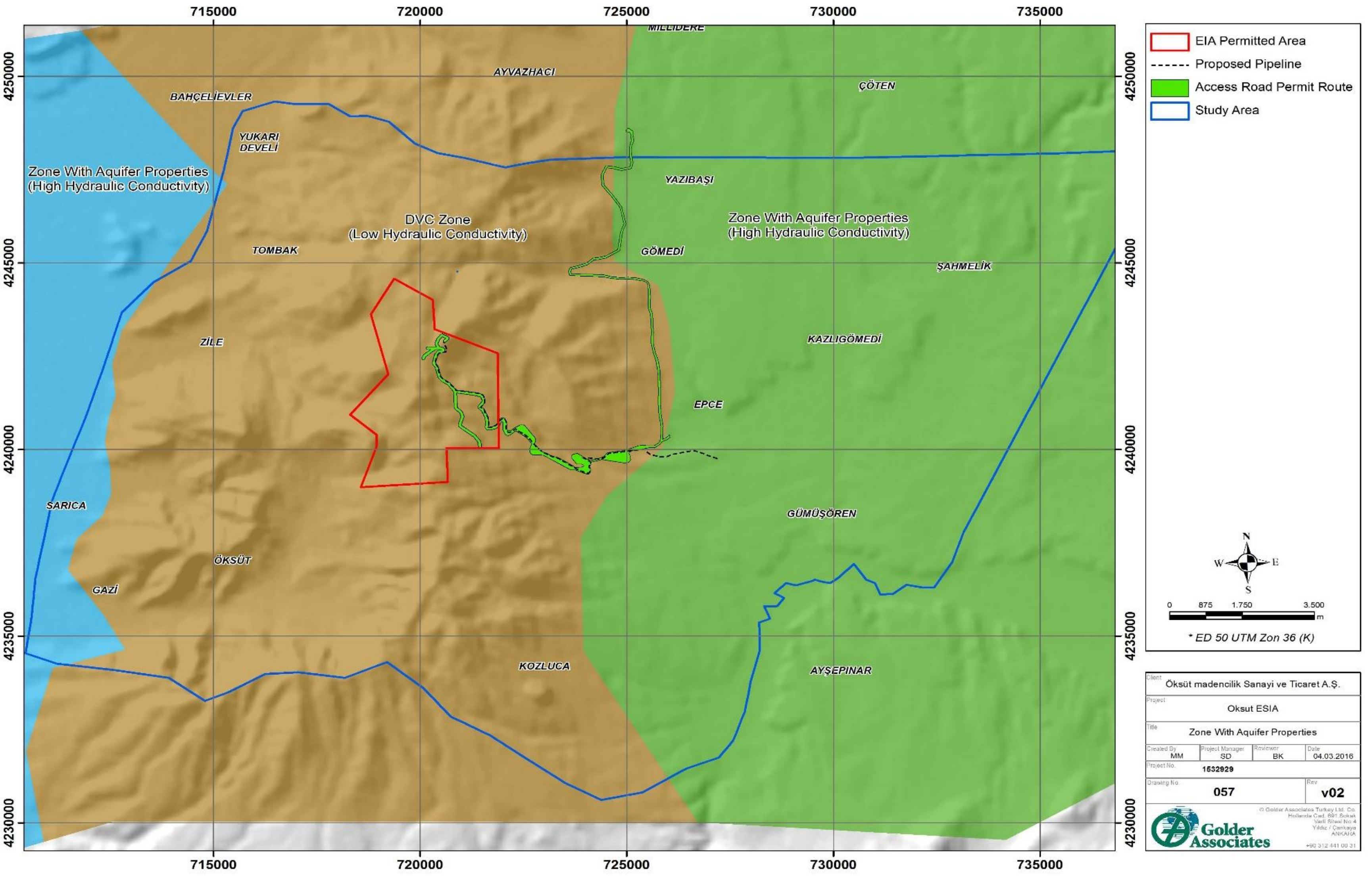
10.7 Baseline - Groundwater Resources

Detailed geochemical characterisation, acid rock drainage and metal leaching potential and water quality prediction studies have been completed for the Project and the studies are presented in *Annex P - Geochemical Impact Assessment and Modelling Study Report for Öksüt Project.*

10.7.1 Hydrogeological Characteristics of the Project Area and Surrounds

The Miocene aged Develidağ Volcanic Complex (DVC), which is related to the formation of a number of volcanoes along the Central Anatolia Fault Zone, forms the general geology of the study area. The DVC is surrounded by pre-Miocene (possibly Paleozoic) aged Central Anatolia crystalline complex and Quaternary-aged volcanics and sediments. The units with aquifer characteristics within the DVC are Quaternary aged alluvia which are generally located on stream / valley bottoms and andesite whose hydraulic conductivity has increased with faulting. The DVC is surrounded by aquifers formed by Quaternary aged alluvium units in the west and by tuff and agglomerate layers in the east. The generalised distribution of hydraulic conductivity in the region is illustrated in Figure 10-37.

Figure 10-37: Generalised Distribution of Regional Hydraulic Conductivity



10.7.2 Groundwater Monitoring / Test and Piezometer Wells

The Open Pits, WRD, HLF and other mine facilities will be located at an elevation of approximately 1,900 m asl, where the Miocene-aged andesite, younger Pliocene-aged tuff and agglomerates come into contact. The Open Pits will be located west of the Kızılırmak and Seyhan Basins' division on the Miocene-aged andesite and the other facilities will be located on the Pliocene-aged volcanics.

The area where water supply wells have been installed in Epçe east of the Project Area, there are three different hydrogeological units. The oldest is mid-Miocene aged andesite, a member of the DVC. The andesite is in contact with a fault system that extends in a north-south direction and with upper Miocene aged agglomerate, a member of the Sarıca volcanics, which has high hydraulic conductivity and is considered to be the main aquifer in the region. The northern part of this contact zone is covered with lower Pliocene aged tuff, which is a member of the Valibaba ignimbrites.

10.7.3 Aquifer Tests (T, K and S)

Aquifer tests were conducted to determine the hydraulic parameters (i.e. transmissivity [T], hydraulic conductivity [K] and storage [S]) of the hydro-stratigraphic units within the Project Area and to determine the boundary conditions of the aquifer. A total of eight pump tests and nine slug tests were performed. Slug tests were performed at the wells with low output and at the piezometer wells.

A summary of the pump tests performed is presented in Table 10-15 and a summary of the slug tests is presented in Table 10-16. Results of the pump tests performed at the Epçe water supply wells are presented in Table 10-17. Detailed analytical results of the tests performed are presented in *Annex R.*

A graphical representation of the distribution of hydraulic conductivity results by locations across the Project Area and the elevations of the wells is presented in Figure 10-38. The hydraulic conductivity at each well location in the Project Area is presented in Figure 10-39.

Table 10-15: Summary of Pumping Tests Conducted within the Project Area

Location	Well No	Test Type	Analysis Method	K (m/g)	K (m/s)
HLF Area	HLP-0001	Constant Flow Pump Test	Cooper-Jacob	7.80E-01	9.03E-06
			Theis Recovery	9.30E-01	1.08E-05
	HLP-0002	Constant Flow Pump Test	Cooper-Jacob	5.18E-02	5.99E-07
	HLP-0003	Constant Flow Pump Test	Theis	2.85E-02	3.30E-07
	HLP-0004	Constant Flow Pump Test	Cooper-Jacob	6.00E-02	6.94E-07
				9.85E-02	1.14E-06
Keltepe Open Pit	KPT-001	Constant Flow Pump Test	Cooper-Jacob	3.94E-01	4.56E-06
				8.90E-01	1.03E-05
Güneytepe Open Pit	GTP-001	Constant Flow Pump Test	Cooper-Jacob	4.00E-03	4.63E-08
WRD Area	WRD-0002	Constant Flow Pump Test	Cooper-Jacob (late)	4.02E-01	4.65E-06
	WRD-0003	Constant Flow Pump Test	Papadopoulos Cooper	1.79E-01	2.07E-06

Table 10-16: Summary of Slug Tests Conducted within the Project Area

Location	Well No	Test Type	Analysis Method	K (m/g)	K (m/s)
HLF Area	CRC-0002	Slug Test	Hvorslev	8,00E-03	8,80E-08
	CRC-0004	Slug Test	Hvorslev	6,00E-03	6,80E-08
	CRC-009	Slug Test	Hvorslev	3,60E-02	4,20E-07
	CRC-0011	Slug Test	Hvorslev Raising Head	3,38E-04	3,91E-09
			Hvorslev Falling Head	1,87E-04	2,17E-09
	GW20134A	Slug Test	Hvorslev	1,66E-04	1,93E-09
Güneytepe Open Pit	GW2013-02	Slug Test	Hvorslev	2,70E-04	3,12E-09
	GW2013-03	Slug Test	Hvorslev	1,32E-05	1,53E-10
WRD Area	CRC-0020	Slug Test	Hvorslev	2,10E-02	2,47E-07
	CRC-0031	Slug Test	Hvorslev	7,50E-01	8,68E-06

Table 10-17: Summary of the Pumping Tests Conducted at the Water Supply Wells

E1TW1		E2TW1	
Observation Well	**K (m/s)**	**Observation Well**	**K (m/s)**
E1OW1	1.61E-04	E2OW1	9.25E-06
E1OW2	8.62E-05	E2OW2	5.62E-06
17198	1.99E-03	34707	2.45E-04
Geometric Mean	3.02E-04	Geometric Mean	2.33E-05
Arithmetic Mean	7.47E-04	Arithmetic Mean	8.66E-05

Note:
Wells 17198 and 34707 are registered wells of the State Hydraulic Works.

Figure 10-38: Distribution of Hydraulic Conductivity versus Well Elevation

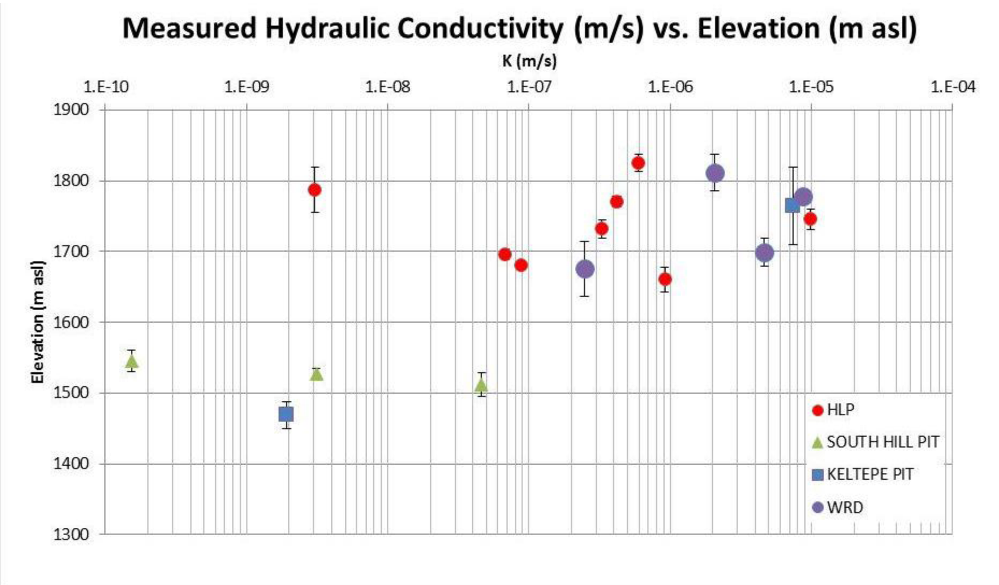
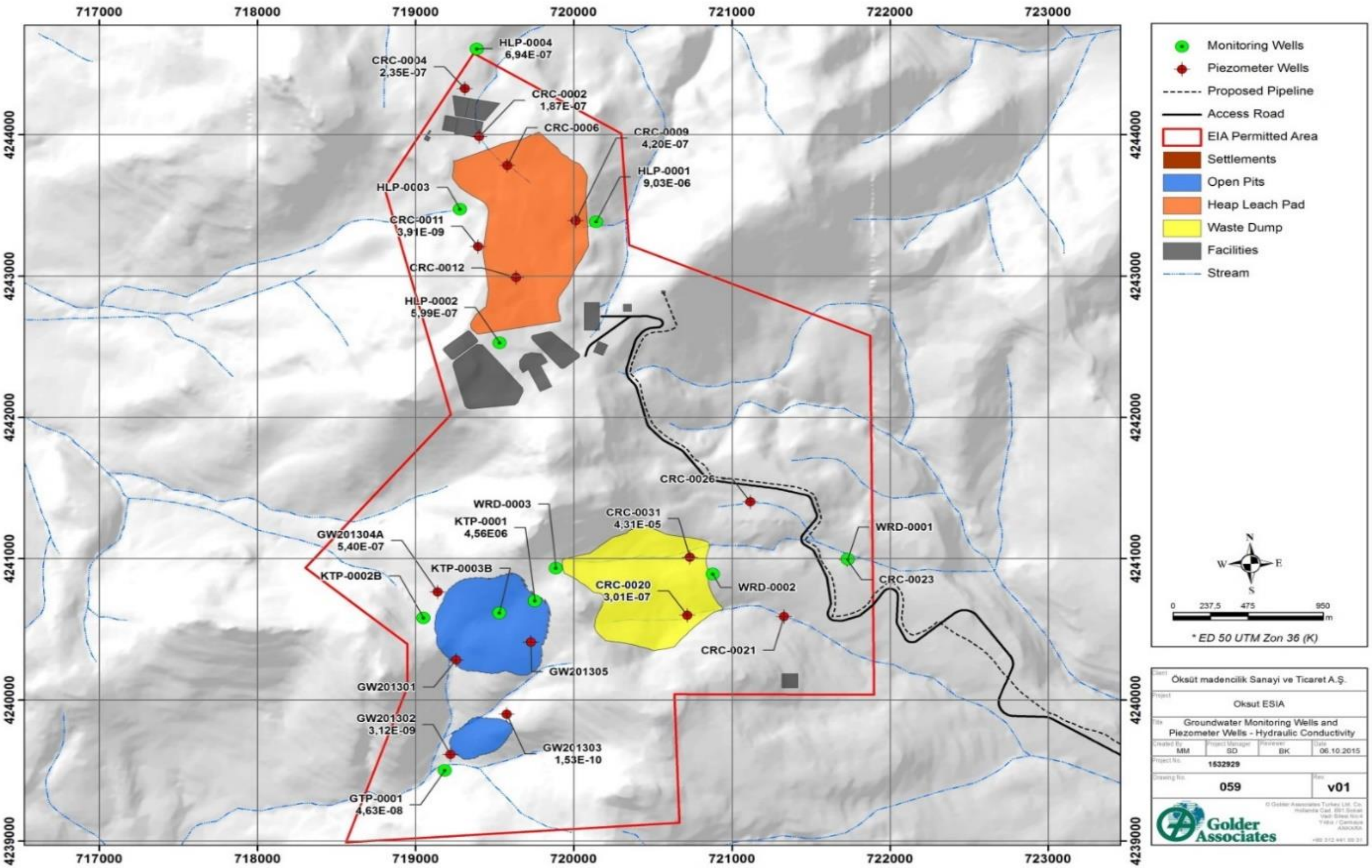


Figure 10-39: Hydraulic Conductivity Distribution across the Project Area



10.7.4 Groundwater Levels

Within the Project Area, groundwater levels were recorded in eight observation wells drilled for the purpose of water quality measurements and aquifer tests and in eleven wells converted from exploration wells to piezometer wells. These wells were monitored to measure the reaction of the aquifer to stresses such as precipitation, evaporation and spring discharge. The measurements were used to determine the hydraulic gradient, flow directions and the depth of groundwater below the ground level. The coordinates of the wells and their topographic elevations are presented in Table 10-18. Their locations are illustrated in Figure 10-40. Changes in groundwater levels over time are presented graphically in Figure 10-41.

At three monitoring locations, pressure probes were used to collect continuous measurement and at other locations, a water level meter was used for recording single measurements during the field programme.

Table 10-18: Groundwater Level Measurements

Location	Well No	X	Y	Z	Well Diameter (inch)	Well Depth (m)	Mean Water Level (Depth from Surface, m)	Mean Water Level (mASL)
Heap Leach	CRC-0001	719077	4244514	1775	5	97	32	1,743
	CRC-0002	719402	4243988	1795	5	120	109	1,686
	CRC-0004	719311	4244329	1790	5	102	86	1,704
	CRC-0006	719581	4243782	1821	5	100	72	1,750
	CRC-0007	719800	4243603	1855	5	100	82	1,773
	CRC-0009	720013	4243392	1862	5	100	84	1,778
	CRC-0010	719805	4243189	1880	5	100	62	1,818
	CRC-0011	719395	4243209	1870	5	115	51	1,819
	CRC-0012	719634	4242991	1890	5	117	45	1,845
	CRC-0013	719808	4242795	1900	5	112	33	1,867
	CRC-0014	720013	4243002	1901	5	112	100	1,800
	CRC-0015	719391	4242603	1920	5	116	84	1,836
	HLP-0001	720143	4243385	1853	10	122	89	1,763
	HLP-0002	719533	4242529	1913	10	100	76	1,836
	HLP-0003	719282	4243475	1812	10	93	69	1,743
	HLP-0004	719389	4244609	1770	10	127	93	1,678
Waste Rock Dump	CRC-0020	720718	4240599	1815	5	104	101	1,714
	CRC-0022	721332	4240799	1771	5	84	68	1,703
	CRC-0031	720734	4241010	1839	5	63	60	1,779
	WRD-0001	721733	4240998	1701	10	151	142	1,559
	WRD-0002	720881	4240892	1830	12.5	151	117	1,714
	WRD-0003	719888	4240934	1960	12.5	174	125	1,835
Güneytepe Open-Pit	GTP-0001	719186	4239502	1619	10	124	84	1,535
	GW201302	719205	4239617	1627	3.7	110	95	1,531
	GW201303	719571	4239880	1765	3.7	220	189	1,576

Location	Well No	X	Y	Z	Well Diameter (inch)	Well Depth (m)	Mean Water Level (Depth from Surface, m)	Mean Water Level (mASL)
Keltepe Open-Pit	KTP-0001	719755	4240703	1906	12.5	197	102	1804
	KTP-0002B	719050	4240581	1748	12.5	402	279	1,469
	GW201304A	719135	4240758	1772	3.7	325	294	1,478
	GW201305	719722	4240406	1872	3.7	407	360	1,512

Figure 10-40: Elevations of Groundwater Monitoring Wells

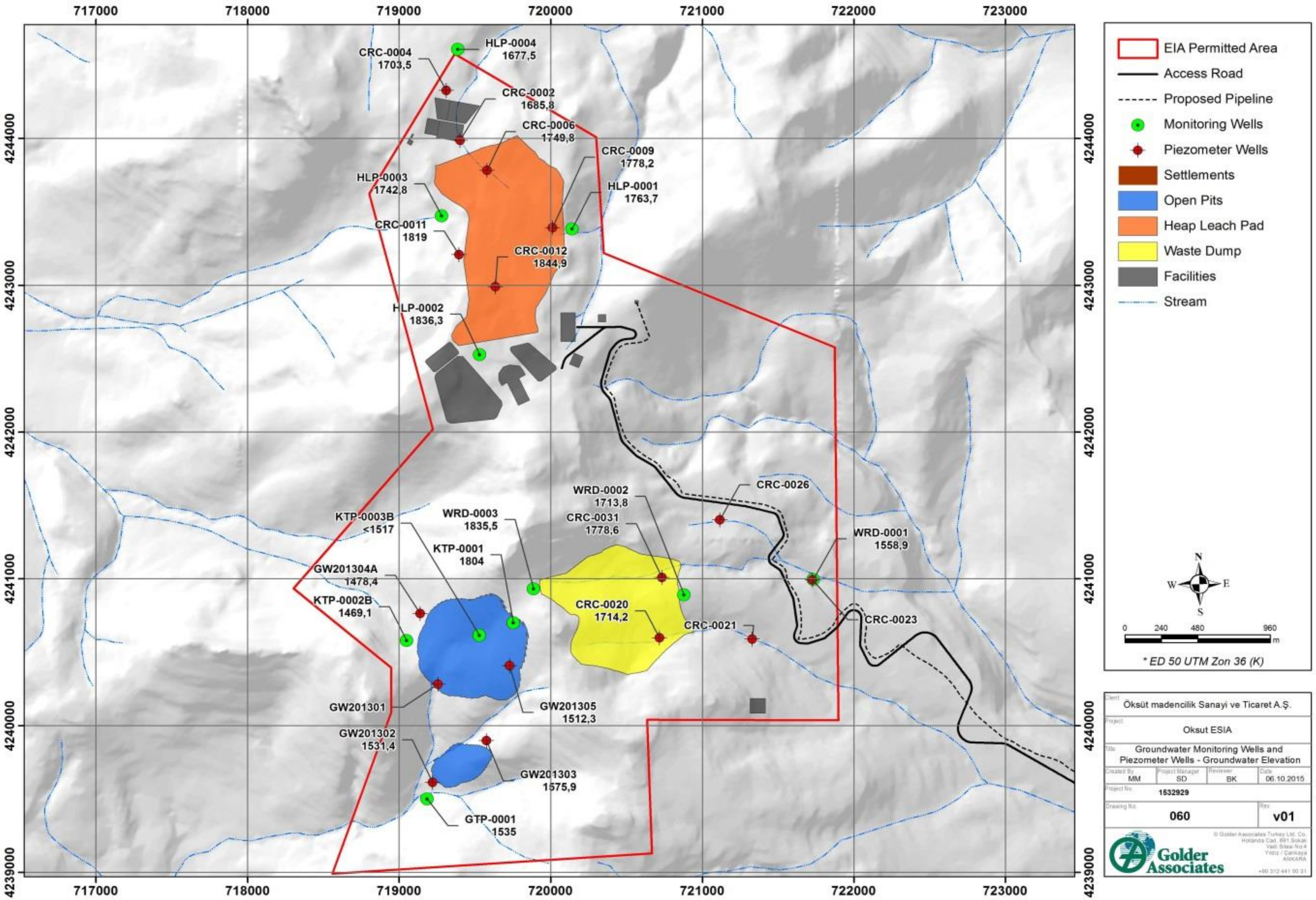
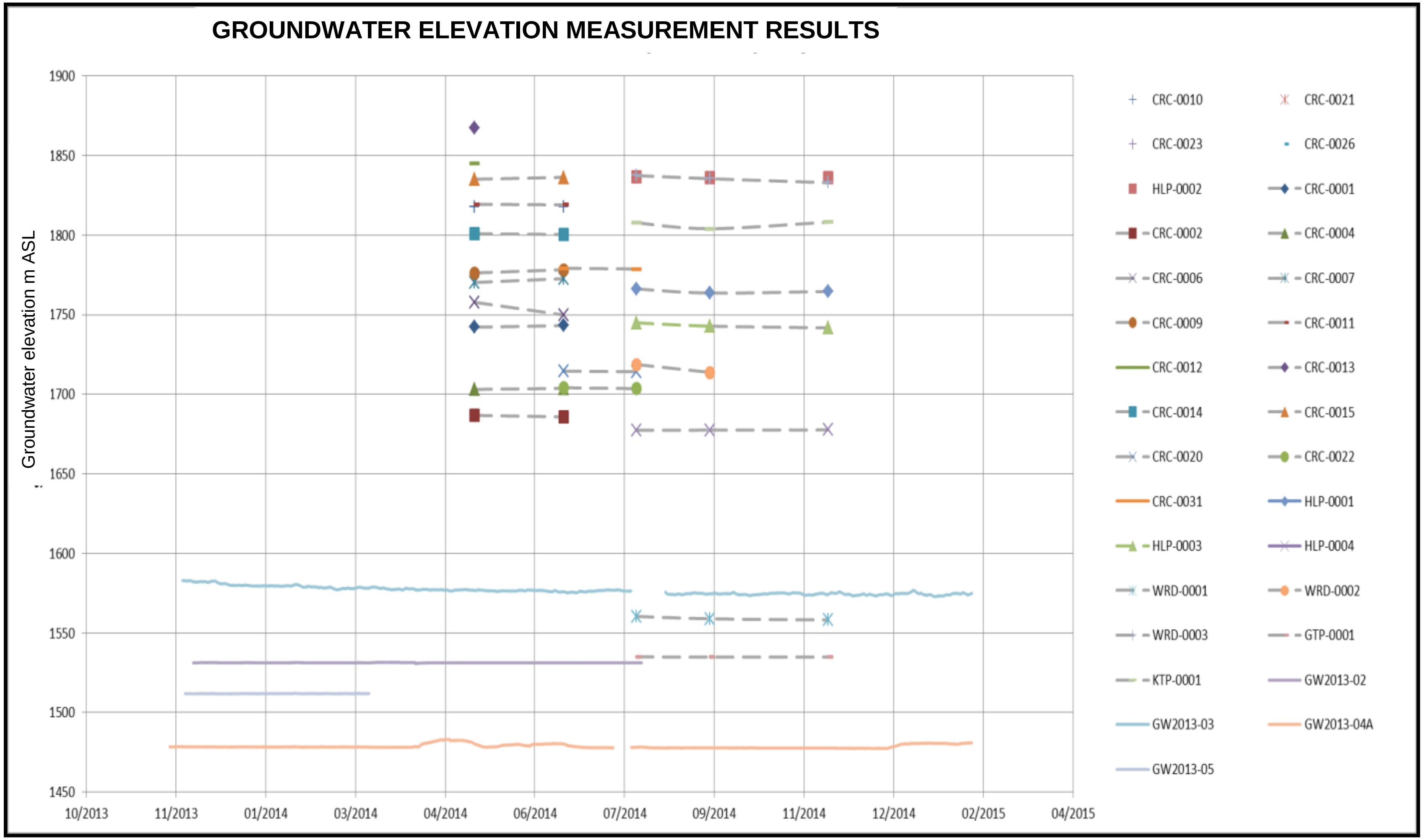


Figure 10-41: Groundwater Level Measurements



10.7.5 Groundwater Quality

In Situ Parameters (T, pH and EC)

Groundwater Wells

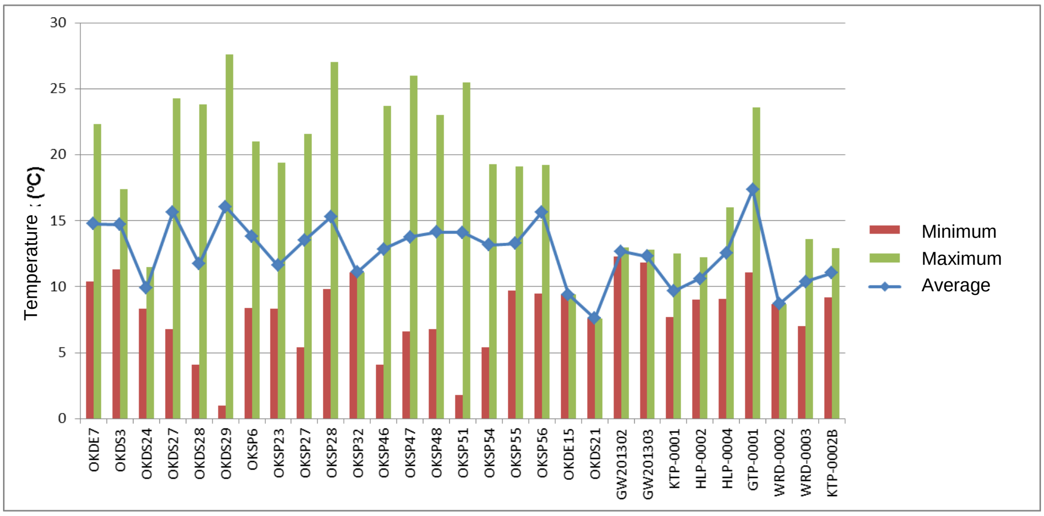
Average, maximum and minimum values of temperature, pH and EC measured at the monitoring stations are presented in Table 10-19 and Figure 10-42. Average values of groundwater pH and EC are illustrated in Figure 10-43 and Figure 10-44 respectively. Full results are presented in *Annex S* separately for each period. The stations found to be dry during all sampling campaigns are not included in the tables or graphs.

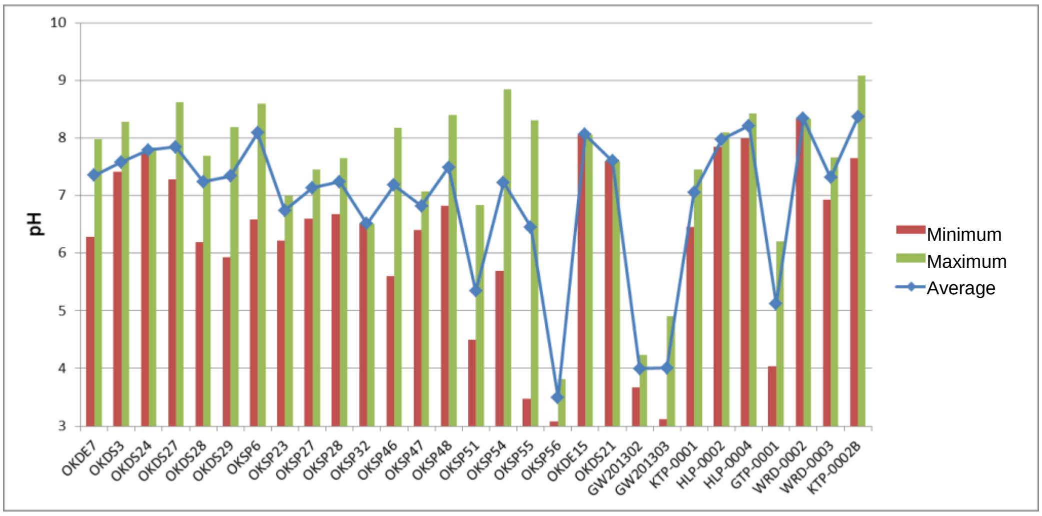
Table 10-19: Average, Minimum and Maximum Values of the Site Parameters

Observation Well	Measurement Period	Temperature (°C)			pH			EC (µS/cm)		
		Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
OKDE7	Jul 13 – Apr 14	14.8	10.4	22.3	7.4	6.3	8.0	304	155	730
OKDS3	Aug 08 – Apr 14	14.7	11.3	17.4	7.6	7.4	8.3	569	273	810
OKDS24	Jul 13 – Apr 14	9.9	8.3	11.5	7.8	7.8	7.8	85	80	90
OKDS27	Aug 08 – Apr 14	15.7	6.8	24.3	7.8	7.3	8.6	129	87	181
OKDS28	Jul 13 – Apr 14	11.7	4.1	23.8	7.2	6.2	7.7	235	126	340
OKDS29	Aug 08 – Apr 14	16.0	1.0	27.6	7.3	5.9	8.2	418	211	1200
OKSP6	Aug 08 – Feb 14	13.8	8.4	21.0	8.1	6.6	8.6	300	161	521
OKSP23	Jul 13 – Apr 14	11.6	8.3	19.4	6.7	6.2	7.0	118	80	170
OKSP27	Aug 08 – Apr 14	13.5	5.4	21.6	7.1	6.6	7.5	223	130	618
OKSP28	Jul 13 – Apr 14	15.3	9.8	27.0	7.2	6.7	7.7	118	80	140
OKSP32	Jul 13 – Apr 14	11.1	11.1	11.1	6.5	6.5	6.5	60	60	60
OKSP46	Aug 08 – Apr 14	12.9	4.1	23.7	7.2	5.6	8.2	222	105	391
OKSP47	Jul 13 – Apr 14	13.8	6.6	26.0	6.8	6.4	7.1	217	120	320
OKSP48	Aug 08 – Apr 14	14.1	6.8	23.0	7.5	6.8	8.4	175	20	924
OKSP51	Aug 08 – Apr 14	14.1	1.8	25.5	5.3	4.5	6.8	523	440	630
OKSP54	Aug 08 – Apr 14	13.2	5.4	19.3	7.2	5.7	8.8	647	268	970
OKSP55	Aug 08 – Apr 14	13.3	9.7	19.1	6.5	3.5	8.3	656	440	880
OKSP56	Aug 08 – Apr 14	15.7	9.5	19.2	3.5	3.1	3.8	635	333	828
OKDE15	Feb.15	9.4	9.4	9.4	8.1	8.1	8.1	200	200	200
OKDS21	Feb 15	7.6	7.6	7.6	7.6	7.6	7.6	160	160	160
GW201302	Nov 13 – Feb 15	12.7	12.3	13.0	4.0	3.7	4.2	1400	1330	1480
OKPZ3	Nov 13 – Feb 15	12.3	11.8	12.8	4.0	3.1	4.9	300	270	330
KTP-0001	Aug 14 – Feb 15	9.7	7.7	12.5	7.1	6.5	7.5	427	270	590
HLP-0002	Aug 14 – Feb 15	10.6	9.0	12.2	8.0	7.9	8.1	395	330	460
HLP-0004	Aug 14 – Feb 15	12.6	9.1	16.0	8.2	8.0	8.4	190	180	200
GTP-0001	Aug 14 – Feb 15	17.4	11.1	23.6	5.1	4.0	6.2	1250	1010	1490
WRD-0002	Aug 14 – Feb 15	8.7	8.7	8.7	8.3	8.3	8.3	190	190	190

Observation Well	Measurement Period	Temperature (°C)			pH			EC (µS/cm)		
		Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
WRD-0003	Aug 14 – Feb 15	10.4	7.0	13.6	7.3	6.9	7.7	213	110	370

Figure 10-42: Average Minimum and Maximum Values of Groundwater Field Parameters (Measured July 2013 to February 2015)





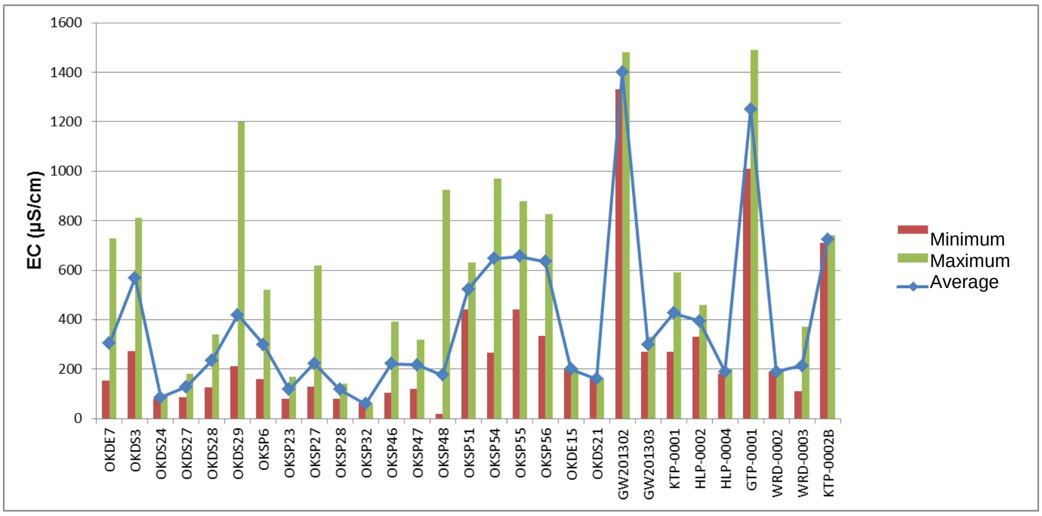

EC (µS/cm)
1600
1400
1200
1000
800
600
400
200
0
OKDE7
OKDS3
OKDS24
OKDS27
OKDS28
OKDS29
OKSP6
OKSP23
OKSP27
OKSP28
OKSP32
OKSP46
OKSP47
OKSP48
OKSP51
OKSP54
OKSP55
OKSP56
OKDE15
OKDS21
GW201302
GW201303
KTP-0001
HLP-0002
HLP-0004
GTP-0001
WRD-0002
WRD-0003
KTP-0002B
Minimum
Maximum
Average

Figure 10-43: Average Groundwater pH Values

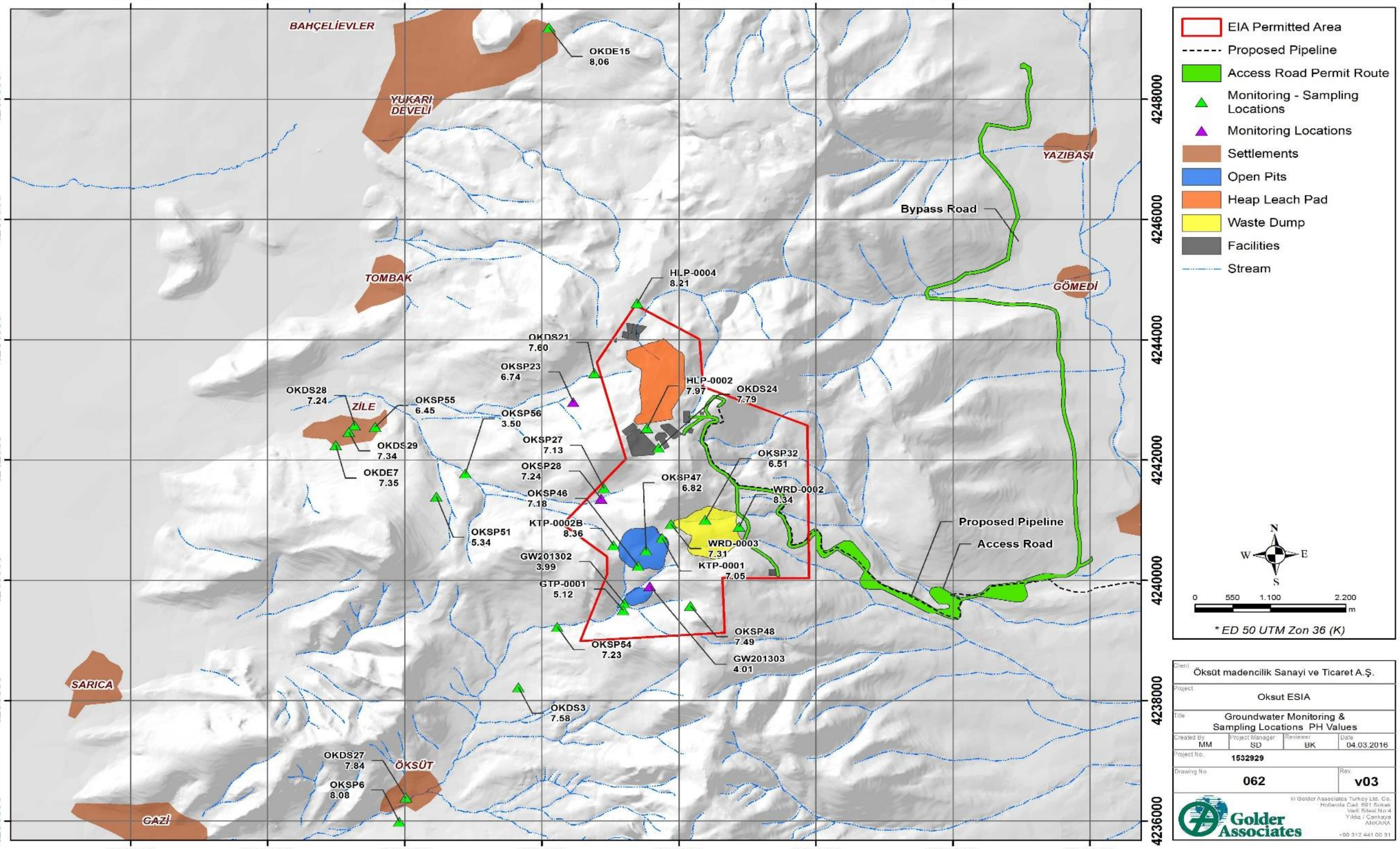
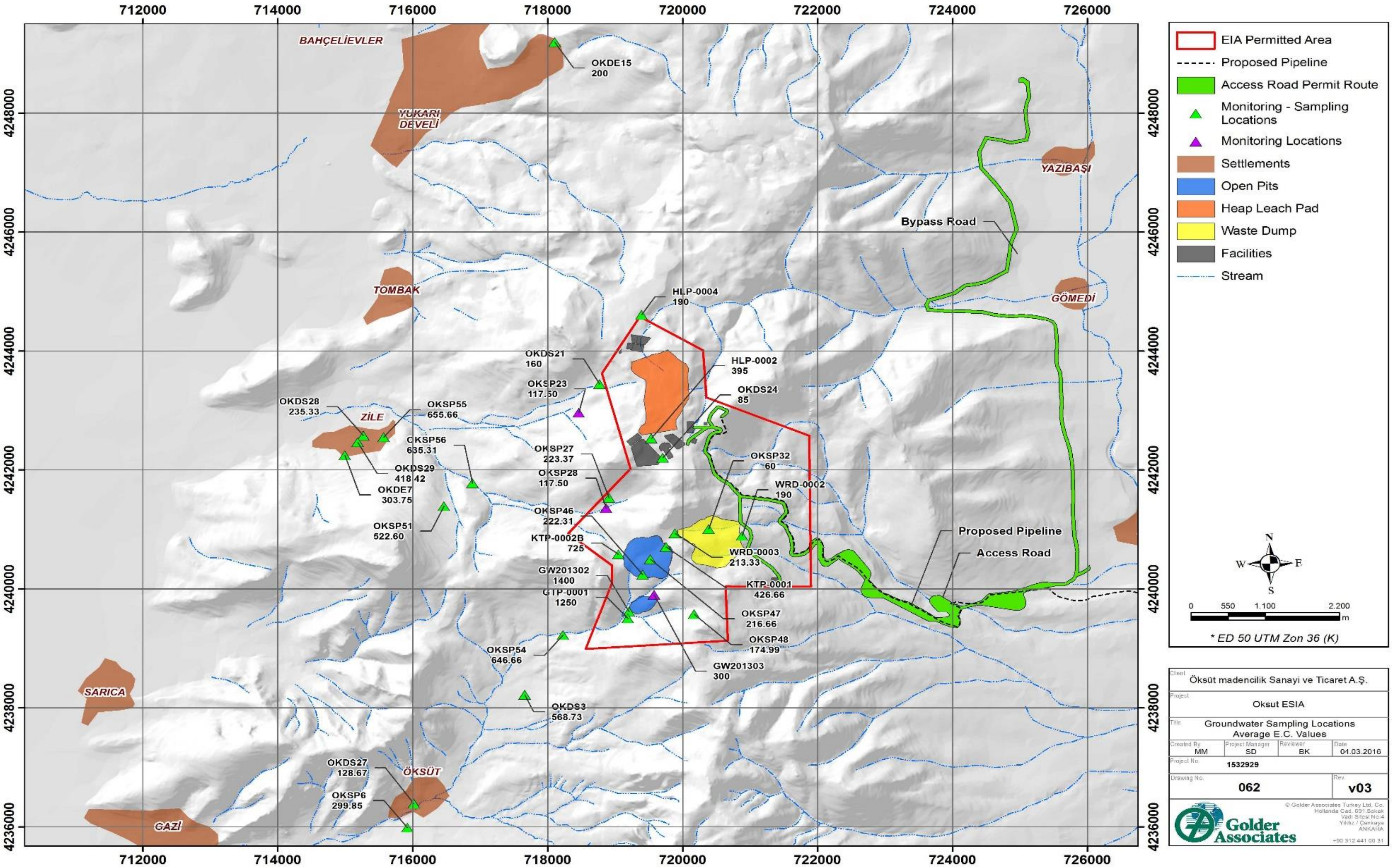


Figure 10-44: Average Groundwater EC Values



Springs and Fountains

Average temperatures measured at the springs, fountains and water storage depots throughout the field studies varied between 7.5˚C and 16˚C. The pH values of the springs, fountains and water depots exhibit a neutral / near neutral to slight basic character in the vicinity of the proposed Open Pit sites and other Project facilities. They indicate acidic conditions at two springs (OKSP51 and OKSP56). The average pH value measured at OKSP51, which is located upstream of Zile to the west of the Project Area was 5.3, while the average pH value measured at OKSP56, which is located downstream of Keltepe Open Pit, which is the Acısu Creek spring, was 3.5.

It was observed that average EC values vary between 60 µS/cm and 650 µS/cm. Conductivity measured at stations OKSP51, OKSP54, OKSP55 and OKSP56 were greater than those measured at the springs and fountains. OKSP54 is located on the Camboğaz Creek that drains the Keltepe Open Pit area. Stations OKSP51 and OKSP56 are located on and in the vicinity of Acısu Creek and they also reflect relatively acidic conditions. Station OKSP55, on the other hand, is located within Zile. Lower conductivity values were measured at the springs and fountains at and in the vicinity of the Open Pits than the values measured at the said points.

The field parameter measurements made at OKSP56, which represents the spring of the Acısu Creek and at the spring OKSP51, which is located nearby by Acısu, indicate that the pH values for these stations are more acidic than the stations across the Project Area and its surrounds and that their EC values are relatively high. The acidic conditions observed at the stations cause increased metal solubility and hence lower water quality. These conditions occur in connection with the natural geological formations.

Observation Wells

It was observed that average temperatures measured at the observation wells were, in general, above 10˚C. pH values measured at the observation wells were lower (3, 9, 4.0 and 5.1, respectively) at stations GW201302, OKPZ3 and GTP-0001, located at the Güneytepe Open Pit site, than the values measured at the other wells and exhibit an acidic character. It was observed that pH measured at station KTP-0001, which is located at the Keltepe Open Pit site, was 7 or above. Lower pH values measured at the observation wells located at the Güneytepe Open Pit are associated with the interaction of the groundwater with the mineralised zone. Higher pH measured at the Keltepe observation well station KTP-0001 are associated with the fact that the observation well is upstream of the fault zone located on the upstream border of the mineralised zone. It was observed that pH values measured at the observation wells located at the WRD site (stations WRD-0002 and WRD-0003) and the HLF site (stations HLP-0002 and HLP-0004), had a slight basic character.

The EC values measured at stations GW201302 and GTP-0001 at the Güneytepe Open Pit site were higher (1,400 µS/cm and 1,250 µS/cm, respectively) compared with all of the groundwater monitoring stations within the Project Area. The average EC value measured at well OKPZ3, which is located upstream of the Güneytepe Open Pit was lower at 300 µS/cm. The average EC values measured at station KTP-0001, which is located in the vicinity of the Keltepe Open Pit, were 427 µS/cm and 725 µS/cm, respectively. The conductivity values measured at the station located at the WRD site and HLF site varied between 200 µS/cm and 400 µS/cm.

Hydro-Geochemistry

Ionic characteristics and hydro-geochemical facies of the groundwater within the Project Area were analysed using the Piper and Schoeller diagrams. The sampling stations were evaluated under two headings as spring / fountain / water depot and observation wells.

Springs, Fountains and Water Depots

According to the major anion distribution of the springs, fountains and water depots, three different groups of groundwater, in terms of hydro-geochemistry, were identified. It was observed that the samples taken from station OKSP56 (Acısu Resource), which is located downstream of the Keltepe Open Pit site, are rich in SO_4 concentrations. SO_4 facies of the Acısu Spring indicates that this station is recharged with the groundwater flow that contacts with the natural geologic formation and the mineralised zone. It was observed that samples taken from the fountain OKSP51 located in the valley on the tributary of the Acısu Creek and from the fountain OKSP55 located in downstream in Zile Village are similarly rich in SO_4 concentrations.

In addition to these stations, it was observed that samples taken from station OKSP54 located downstream of the Güneytepe Open Pit site, were rich in SO_4 ion. Samples taken from station OKSP27, which is located in downstream of the Keltepe Open Pit site and from station OKSP47, which is located at the Keltepe drill site, represent a mixture of SO_4 and HCO_3 in terms of major anions. Other samples taken from the springs and fountains were found to be rich in HCO_3 anion.

Major ion distribution of the springs, fountains and water depots indicates that the samples taken from stations OKSP51, OKSP54, OKSP55 and OKSP56 are of Ca-SO_4 facies, while samples taken from station OKSP27 are of Mixture (Ca-Mg) - Mixture (SO_4-HCO_3) facies. The OKSP46, OKSP6 and OKDS27 are of Mixture (Ca-Mg) - HCO_3 facies. The remaining spring, fountain and water depot stations are Ca-HCO_3 facies.

The results are presented in Figure 10-45 to Figure 10-48.

Figure 10-45: Piper Diagram of Springs, Fountains and Water Depots

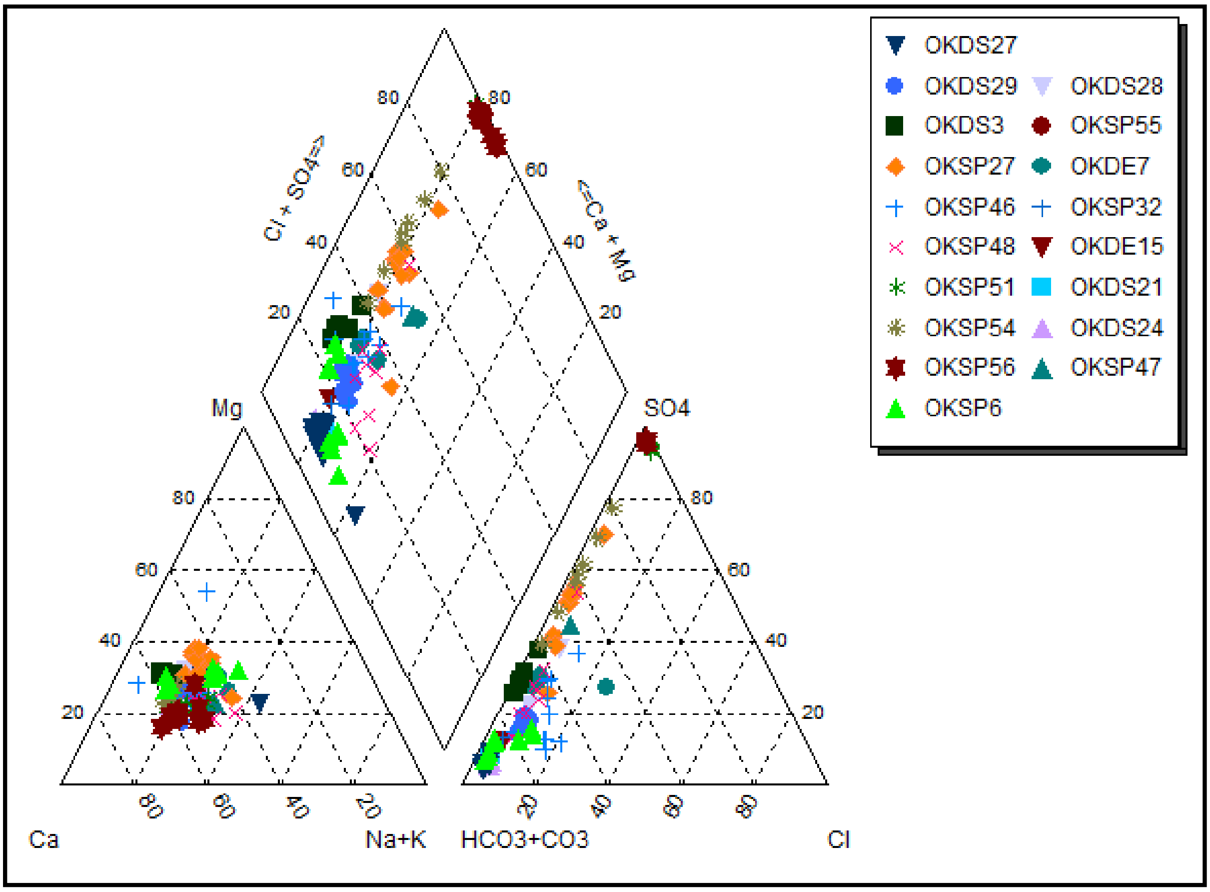


Figure 10-46: Schoeller Diagram of Springs, Fountains and Water Depots of Ca-HCO_3 Facies

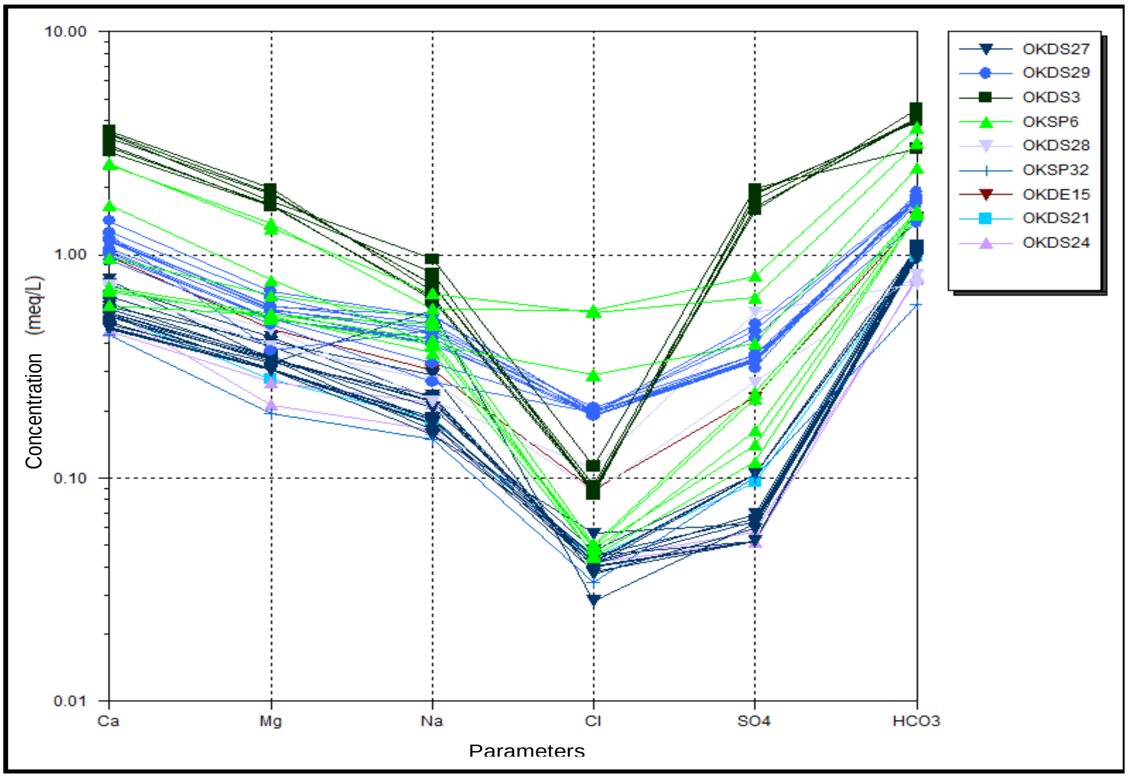


Figure 10-47: Schoeller Diagram of Springs, Fountains and Water Depots of Ca-SO_4 Facies

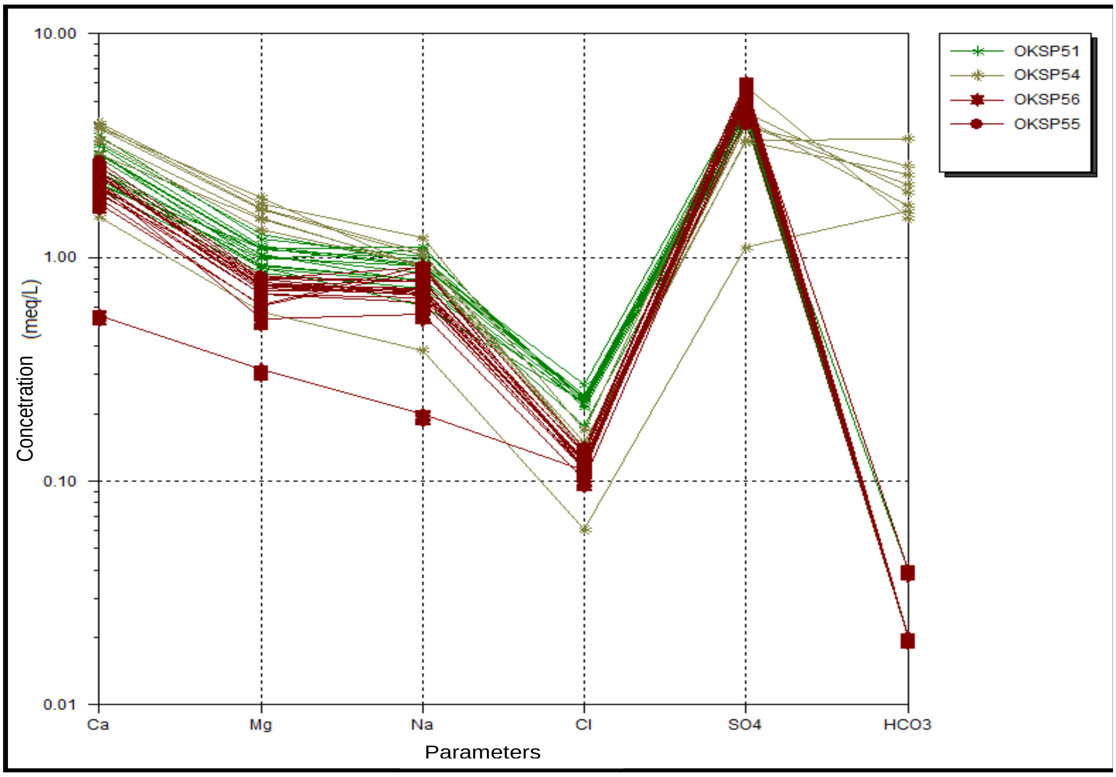
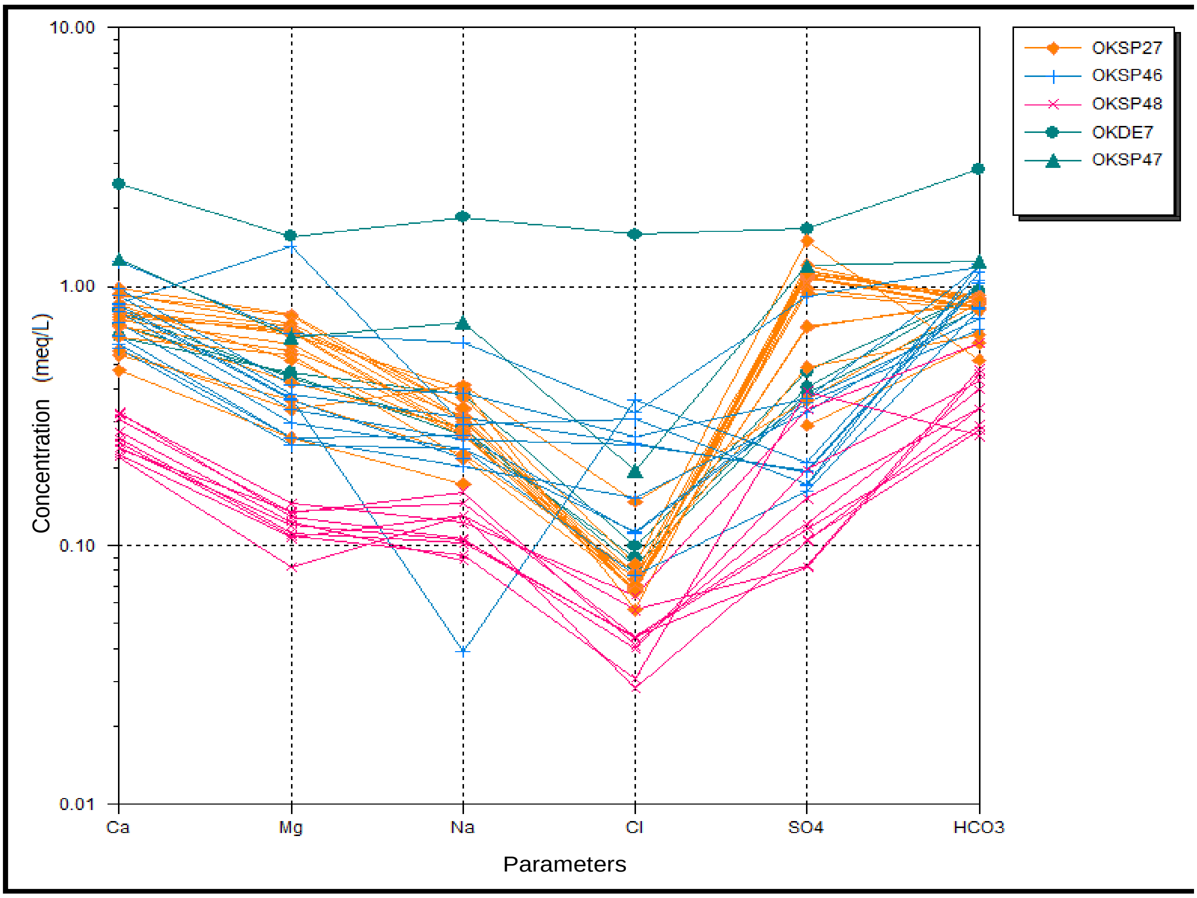


Figure 10-48: Schoeller Diagram of Springs, Fountains and Water Depots of Mixture (Ca-Mg, Ca-Mg-Na) – Mixture (SO_4-HCO_3) Facies



Observation Wells

Samples were taken from observation wells located near the Open Pit sites and other Project facilities to determine the current and pre-construction hydro-geochemical character of the groundwater. Major anion distribution indicates that the wells display diversity in terms of SO_4 and HCO_3 ion concentrations. It was observed that the dominant major anion in the samples taken from stations GW201302 and GTP-0001 downstream of the Güneytepe Open Pit site and from station OKPZ3 wells downstream was SO_4. Samples taken from station KTP-0001 located at the Keltepe Open Pit site also indicated relatively high SO_4 ion concentrations. Samples taken from stations HLP-0002 and HLP-0004 located at the HLF site and from station WRD-0002 located downstream of the WRD site were observed to be rich in HCO_3 ion in terms of major anions. Samples taken from station WRD-0003 upstream of the WRD site display SO_4-HCO_3 Mixture in terms of major anion distribution.

Major cation concentrations indicate that samples taken from stations HLP-0002 and HLP-0004 at the HLF site are characterised by Ca-Mg Mixture. It was observed that the samples taken from stations GW201302, OKPZ3 and GTP-0001 located at the Güneytepe Open Pit site displayed a mixture of Na and Na-Ca. In contrast, the dominant cation in stations WRD-0002 and WRD-0003 located at the WRD site and in the station KTP-0001 located at the Keltepe Open Pit site was found to be Ca.

According to the distribution of major ions, it is was observed that stations GW201302 and OKPZ3 are of Na-SO_4 and Mg-Na-SO_4 facies, while the stations GTP-0001 and KTP-0001 located at the Güneytepe Open Pit site, were found to be of Ca-SO_4 facies. The type of facies of the observation wells WRD-0002 and WRD-0003 at the WRD site was of Ca-HCO_3 and of the wells drilled within the HLF site was Ca-Mg-HCO_3.

The results are presented in Figure 10-49 to Figure 10-51.

Figure 10-49: Piper Diagram of Observation Wells

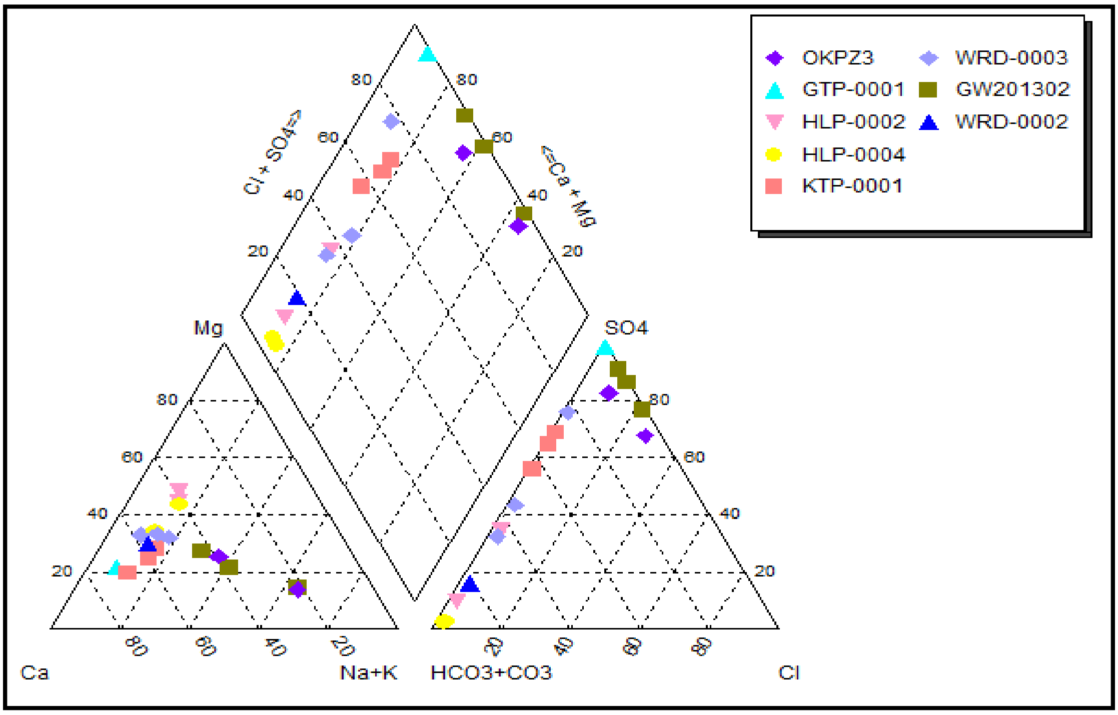


Figure 10-50: Schoeller Diagram of Observation Wells of Ca-SO₄, Na-SO₄ and Na-Mg-SO₄ Facies

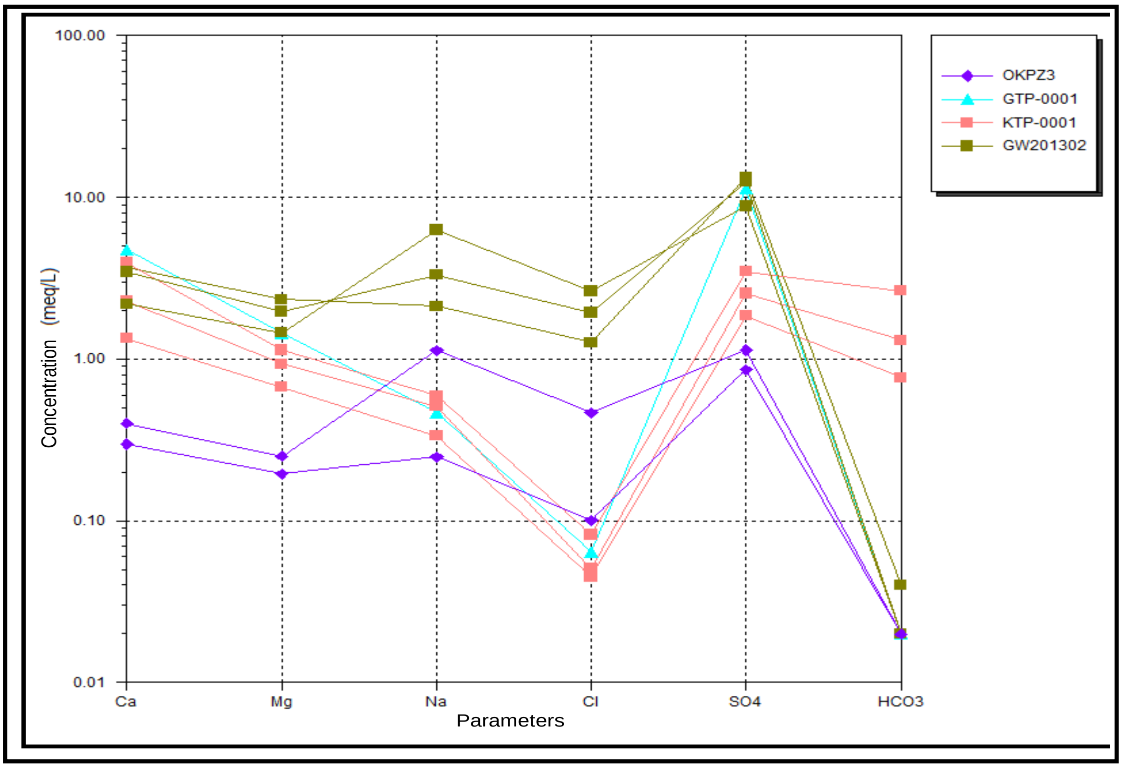
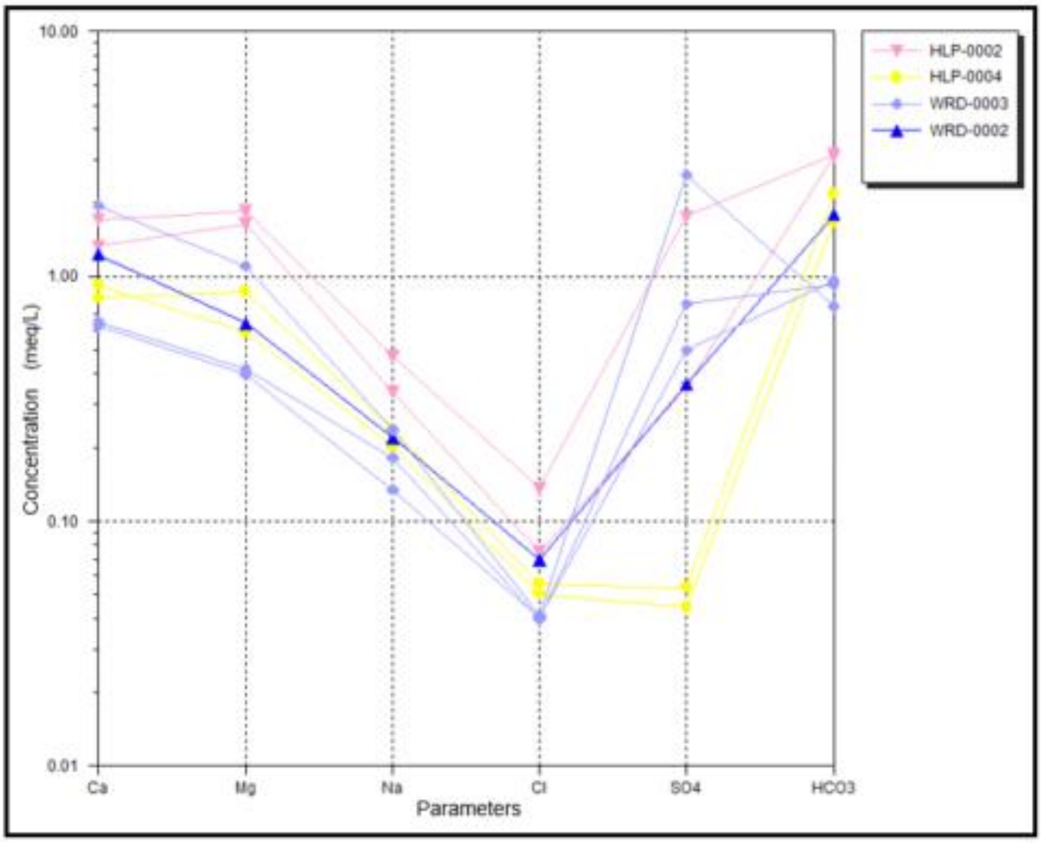


Figure 10-51: Schoeller Diagram of Observation Wells of Ca-HCO₃ and Ca-Mg-HCO₃ Facies



10.7.6 Groundwater Quality (Comparison to Standards)

Comparisons of the groundwater within the Project Area against Turkish and EU drinking water standards are presented in Table 10-20 for the springs, fountains and water depots and in Table 10-21 for the observation wells. In the tables, a list of the parameters that exceed the standards is presented rather than the actual numerical values of measured concentrations. Measured concentrations are presented in Annex S.

Table 10-20: Instances of exceedance of Spring, Fountain and Water Depot Water Quality Against Water Quality Standards

Observation Point	Sampling Period	Drinking Water Standards	
		EU[1], 1998	MoH[2], 2005
OKDE7	Jul 13		
	Nov 13	Fe*	Fe*
	Feb 14	As	As
	Apr 14		Al*, Fe*
OKDS24	Jul 13		
	Nov 13		
OKDS27	Aug 08		
	Nov 08		
	Jan 11		
	Apr 11		

Observation Point	Sampling Period	Drinking Water Standards	
		EU[1], 1998	MoH[2], 2005
	Jul 11		
	Oct 11		
	May 12		Sb
	Aug 12		
	Nov 12		
	Feb 13		
	May 13		
	Jul 13	Fe*	Pb, Fe*
	Nov 13		
	Feb 14		
	Apr 14		
OKDS28	Feb 13		Al*, Fe*
	May 13		
OKDS29	Aug 08	Sb	
	Nov 08		
	Jan 11		
	Apr 11		
	Jul 11		
	May 12		
	Nov 12		
	Feb 13		
	May 13		
OKDS3	Aug 08	Sb	Sb
	Nov 08		
	Jun 09		
	Apr 11		
	Oct 11		
	May 12		
	Aug 12		
OKSP27	Aug 08		Mn*, Fe*
	Nov 08	Mn*	Mn*, Fe*
	Jun 09		Al*, Fe*
	Jan 11	Fe*	Al*, Fe*
	Apr 11		Al*, Fe*
	Oct 11		Fe*
	May 12		Fe*

Observation Point	Sampling Period	Drinking Water Standards	
		EU[1], 1998	MoH[2], 2005
	Aug 12		
	Nov 12	Fe*	Al*, Mn*, Fe*
	Feb 13		Al*, Fe*
	Jul 13		Fe*
	Nov 13		Fe*
	Feb 14		Fe*
	Apr 14		Al*, Fe*
OKSP32	Apr 14	Al*, Fe*	Al*, Fe*
OKSP46	Aug 08		
	Nov 08		Sb
	Jun 09		
	Jan 11	Al*	Al*, Fe*
	Apr 11	Hg	Al*, Fe*
	Jul 11	F	F
	Oct 11		
	Feb 13		Al*
	May 13		
	Jul 13	Fe*	Fe*
	Nov 13		Al*
OKSP47	Nov 13		
OKSP48	Aug 08		
	Nov 08		
	Jun 09		Al*, Fe*
	Apr 11		
	Aug 12		Fe*
	Nov 13	Fe*	Fe*
OKSP51	Aug 08	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Nov 08	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Jun 09	Mn*, Fe*, pH*	Mn*, Fe*, pH*
	Jan 11	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Apr 11	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Jul 11	Al*, Mn*, pH*	Al*, Mn*, Fe*, pH*
	Oct 11	Al*, Mn*, Fe*, pH*	Al*, Mn*, pH*
	May 12	Mn*, pH*	Mn*, pH*
	Aug 12	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Feb 13	Al*, Mn*, SO4*, pH*	Al*, Mn*, Fe*, SO4*, pH*

Observation Point	Sampling Period	Drinking Water Standards	
		EU[1], 1998	MoH[2], 2005
	May 13	Al*, Mn*, pH*	Al*, Mn*, Fe*, pH*
	Jul 13	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, Pb, pH*
	Nov 13	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Feb 14	Al*, Mn*	Al*, Mn*
	Apr 14	Al*, Mn*	Al*, Mn*
OKSP54	Aug 08	MoH	MoH, Al*
	Nov 08	SO_4*	SO_4*
	Jun 09		
	Apr 11		
	May 12		Al*
	Feb 13		Al*, Fe*
	May 13		
OKSP55	Feb 13	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	May 13	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
OKSP56	Aug 08	Al*,Mn*, Fe*, SO_4*, pH*	MoH, Al*, Mn*, pH*, Fe*, SO_4*
	Nov 08	Al*, Mn*, Fe*,SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	Jun 09	Al*, Mn*, Fe*, SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	Jan 11	Al*, Mn*, Fe*, SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	Apr 11	Al*, Mn*, Fe*, SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	Jul 11	Al*, Mn*, Fe*, SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	Oct 11	As, Al*, Mn*, Fe*, SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	May 12	As, Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Aug 12	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	Nov 12	SO_4*, pH*	As, Al*, Mn*, Fe*, SO_4*, pH*
	Feb 13	Al*, Mn*, Fe*, pH*	Al*, Mn*, Fe*, pH*
	May 13	Al*, Mn*, Fe*, SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	Jul 13	As, Al*, Mn*, Fe*, SO_4*, pH*	As, Al*, Mn*, Fe*, SO_4*, pH*
	Nov 13	Al*, Mn*, Fe*, SO_4*, pH*	Al*, Mn*, Fe*, SO_4*, pH*
	Feb 14	Al*, Mn*, Fe*	Al*, Mn*, Fe*
	Apr 14	Al*, Mn*, Fe*, SO_4*	Al*, Mn*, Fe*, SO_4*
OKSP6	May 12		
	Aug 12		
	Nov 12		
	Feb 13		

Observation Point	Sampling Period	Drinking Water Standards	
		EU[1], 1998	MoH[2], 2005
	May 13		
	Jul 13		Pb, Fe*
	Nov 13		
	Feb 14		
OKDE15	Feb 15		Fe*
OKDS21	Feb 15	Al*	Al*, Fe*

Notes:
1 European Union Drinking Water Standards, 98/83/EC, 1998.
Comparisons with the drinking water standards of the WHO and the EU are based on the dissolved metal concentrations found as a result of the analysis and comparisons with the drinking water quality standards of the MoH.
2 Republic of Turkey, Ministry of Health Drinking Water Standards, 2005.
* Indicative Parameters

Table 10-21: Instances of exceedance of Observation Well Water Quality against Water Quality Standards

Observation Point	Sampling Period	Drinking Water Standards	
		EU[1], 1998	MoH[2], 2005
GW201302 (OKPZ1)	Nov 13	Al*, Ni, Mn*, Fe*, SO_4*, pH*	As, Al*, Ni, Mn*, Fe*, SO_4*, pH*
	Apr 14	Ni, Mn*, Fe*, Al*, As, SO_4*, F, pH*	Al*, Ni, Mn*, Fe*, SO_4*, F, pH*
	Feb 15	Ni, Mn*, Fe*, Al*, As, SO_4*, pH*	Al*, As, Ni, Mn*, Fe*, SO_4*, pH*
OKPZ3	Nov 13	Al*, Ni, Mn*, Fe*, pH*	Al*, Ni, Mn*, Fe*, pH*
	Apr 14	Fe*, Al*, pH*	Al*, Fe*, pH*
GTP-0001	Aug 14	Ni, Mn*, Fe*, Al*, As, SO_4*	Al*, As, Ni, Mn*, Fe*, SO_4*, pH*
HLP-0002	Aug 14	As	Al*, As, Pb, Fe*
	Nov 14	Mn*, Pb	Al*, Mn*, Pb, Fe*
HLP-0004	Aug 14		
	Nov 14	As	As, Pb
KTP-0001	Aug 14	Mn*, Fe*	Mn*, Fe*
	Nov 14	Mn*, Fe*	Mn*, Pb, Fe*
	Feb 15	Mn*, Fe*, As	As, Mn*, Pb, Fe*
WRD-0002	Nov 14	Fe*, Pb	Al*, Pb, Fe*
WRD-0003	Aug 14	Mn*, Fe*	Mn*, Fe*
	Nov 14	Mn*, Fe*	Mn*, Fe*
	Feb 15	Mn*, Fe*, Pb	As, Mn*, Pb, Fe*

Notes:
1 European Union Drinking Water Standards, 98/83/EC, 1998.
Comparisons with the drinking water standards of the WHO and the EU are based on the dissolved metal concentrations found as a result of the analysis and comparisons with the drinking water quality standards of the MoH.
2 Republic of Turkey, Ministry of Health, Drinking Water Standards, 2005.

Springs, Fountains and Water Depots

Al, Mn, Fe and pH values were observed to be above the limit values, especially at stations OKSP51, OKSP55 and OKSP56. It was observed that SO_4 concentrations at the Acısu resource station OKSP56 were above the drinking criteria of the EU and the MOH. The spring, fountain and groundwater parameters which exceed the limit values for drinking water are lesser in number and it was observed that the two widely observed parameters were aluminium and iron. It was observed that arsenic concentrations in the water samples taken from OKSP56 during the periods of October 2011, May 2012 and July 2013 were relatively higher than the limit values for drinking water as established by the WHO. It was observed that the sample taken from station OKSP54 during the period of August 2008 contained higher antimony concentration than the limit values for drinking water as established by the WHO.

Observation Wells

Samples taken from the observation wells contain parameters which exceed the drinking water limit values. The parameters that commonly exceed the EU and MOH limit values are manganese and iron. In the samples taken from stations GW201302 (OKPZ1), OKPZ3 and GTP-0001, aluminium, nickel, pH and occasionally arsenic values were above the drinking water limits. In these observation wells, it was observed that nickel concentrations were commonly above the WHO limit values while arsenic and lead concentrations incremented seasonally in the remainder of the wells.

Cyanide Baseline Concentrations

Project baseline results indicate that the concentration of Weak Acid Dissolvable Cyanide (WADCN)[15] is below the detection limit (<0.005 mg/L) in all of the groundwater monitoring points.

Total Cyanide (TCN)[16] concentrations were observed at WRD003, KTP002B, HLP002 and GTP001, which showed TCN concentrations of 0.024 mg/L, 0.016 mg/L, 0.012 mg/L and 0.006 mg/L respectively. The TCN concentrations do not have a regular pattern and elevated cyanide concentrations have not been observed in consecutive baseline data collection sessions. As a result, the results are considered likely to be analytical errors and more samples will be collected, as part of ongoing monitoring, before starting cyanide leaching in order to develop a stronger background cyanide concentration baseline.

WHO sets out a drinking water guideline value of 0.07 mg/L for cyanide, which is considered to be appropriate for both acute and long-term exposure[17]. Similarly, IFC EHS Guidelines set out cyanide guideline values for the mining sector. The cyanide limits, applicable for site runoff and treated effluents to surface waters for general use, are 0.1 mg/L for Free Cyanide, 0.5 mg/L for WAD Cyanide and 1 mg/L for Total Cyanide[18].

Total Cyanide (TCN)[19] concentrations were observed at WRD003, KTP002B, HLP002 and GTP001, which showed TCN concentrations of 0.024 mg/L, 0.016 mg/L, 0.012 mg/L and 0.006 mg/L respectively.

All cyanide baseline measurements are below the WHO drinking water limits and are therefore not considered to pose a risk to human health or the environment.

Due to the future mining activities and the use of the heap leaching method involving cyanide, an ongoing monitoring programme for detection of cyanide in the environment will be conducted.

[15] Cyanide is generally measured as one of three forms: free, weak acid dissociable (WAD), and total. Free cyanide refers to the cyanide that is present in solution as CN or HCN, and includes cyanide-bonded sodium, potassium, calcium or magnesium. Free cyanide is very difficult to measure. WAD cyanide is the fraction of cyanide that will volatilize to HCN in a weak acid solution at a pH of 4.5. WAD cyanide includes free cyanide, simple cyanide, and weak cyanide complexes of zinc, cadmium, silver, copper, and nickel.

[16] Total cyanide measures all of the cyanide present in any form, including iron, cobalt, gold and platinum complexes.

[17] http://www.who.int/water_sanitation_health/dwq/cyanide.pdf

[18] IFC Environmental Health and Safety Guidelines for Mining, December 2007.

[19] Total cyanide measures all of the cyanide present in any form, including iron, cobalt, gold and platinum complexes.

The cyanide monitoring programme will consist of a frequently collection of water samples that will be analysed for total and WAD cyanide. Baseline conditions indicate WAD Cyanide concentration is below the detection limit of 0.005 mg/L in all of the monitoring points including the groundwater wells around the heap leach facility. In that respect WAD cyanide concentrations in the groundwater during operations is expected not to exceed the detection limit of 0.005 mg/L. Further investigations and risk assessments would be initiated if the cyanide concentrations increase and exceeds the pre-operation baseline conditions and if WAD cyanide exceeds 0.005 mg/L limit at the on-site groundwater monitoring wells.

10.7.7 Current and Planned Use of Groundwater Resources

Groundwater in the study area is sourced from deep and shallow wells and is used for agricultural irrigation and water supply to villages via water collection structures built on springs. The locations of the surface water and groundwater monitoring and sampling locations are presented in Figure 10-3 and Figure 10-7.

Identified uses of groundwater include:

- **Acısu Facilities:** There are a number of small and large springs in the region of Acısu and the mineral water from these springs is used for recreational purposes. The water is claimed to have healing properties however its pH is very low and heavy metal content is very high meaning its consumption may actually be harmful to human health.
- **Gıcık Tunnel Water Supply:** Water obtained through the Gıcık Tunnel, which was constructed to drain groundwater encountered during the construction of the Zamantı Regulator and Derivation Tunnel, is transferred to a different pipeline at the outlet of the Zamantı Tunnel and is used to supply water to the district of Develi. As noted in previous sections, with the crossing of the fault zones in the course of opening of the Zamantı Tunnel, approximately 1,000 L/s of water discharged into the tunnel. Flow rates have since decreased to 100 L/s to 150 L/s over a period of approximately 10 years. The Gıcık groundwater is routed by the Municipality of Kayseri and the State Hydraulic Works as drinking water to neighbourhoods and sub-provinces.
- **Wells of Epçe and Şahmelik Irrigation Cooperative:** Approximately 5M m^3/year of water is drawn from the cooperative's production wells to irrigate a total area of 7M m^2 under the responsibility of the cooperative.
- **Village Drinking Water Supply Sources:** All of the settlements in the vicinity of the Project Area are supplied with domestic water from groundwater wells. The abstracted water is stored in tanks (depots). The settlements also use water wells to meet their water demand which increases during summer months.

10.7.8 Irrigation Water Quality

To determine whether the groundwater in the Project Area is suitable for use as irrigation water, a Wilcox diagram was used as illustrated in Figure 10-52 for springs, fountains and water depots and Figure 10-53 for observation wells. According to the Wilcox diagram, all of the water taken from the springs, fountains and water depots were in low sodium hazard (S1) class. It was observed that the waters contained low (C1) and medium (C2) salinity hazard. All of the samples taken from the observation wells were similarly in low sodium hazard (S1), while the water differed in terms of salinity hazard. Wells GW201302 (OKPZ1) and GTP-0001 contained high salinity hazard (C3) and would be unsuitable for irrigation. It was observed that the waters other than these wells contained low (C1) and medium (C2) salinity.

Figure 10-52: Wilcox Diagram for Springs, Fountains and Water Depots

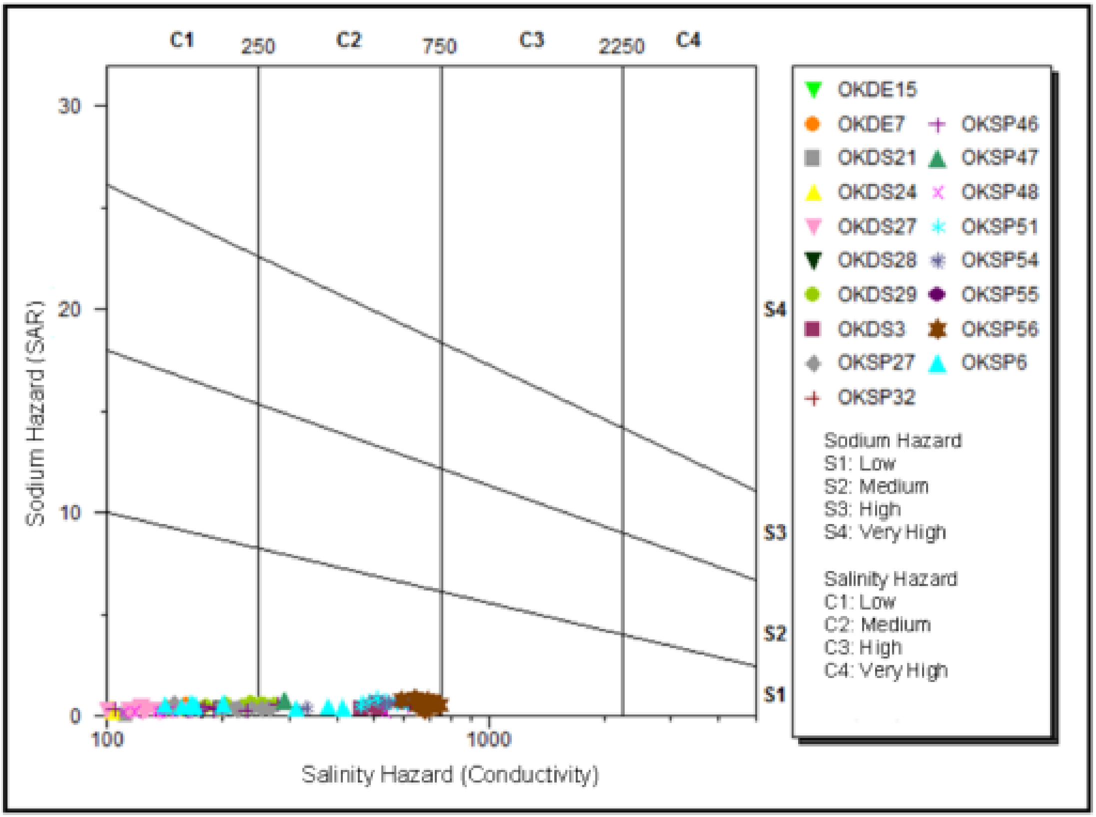
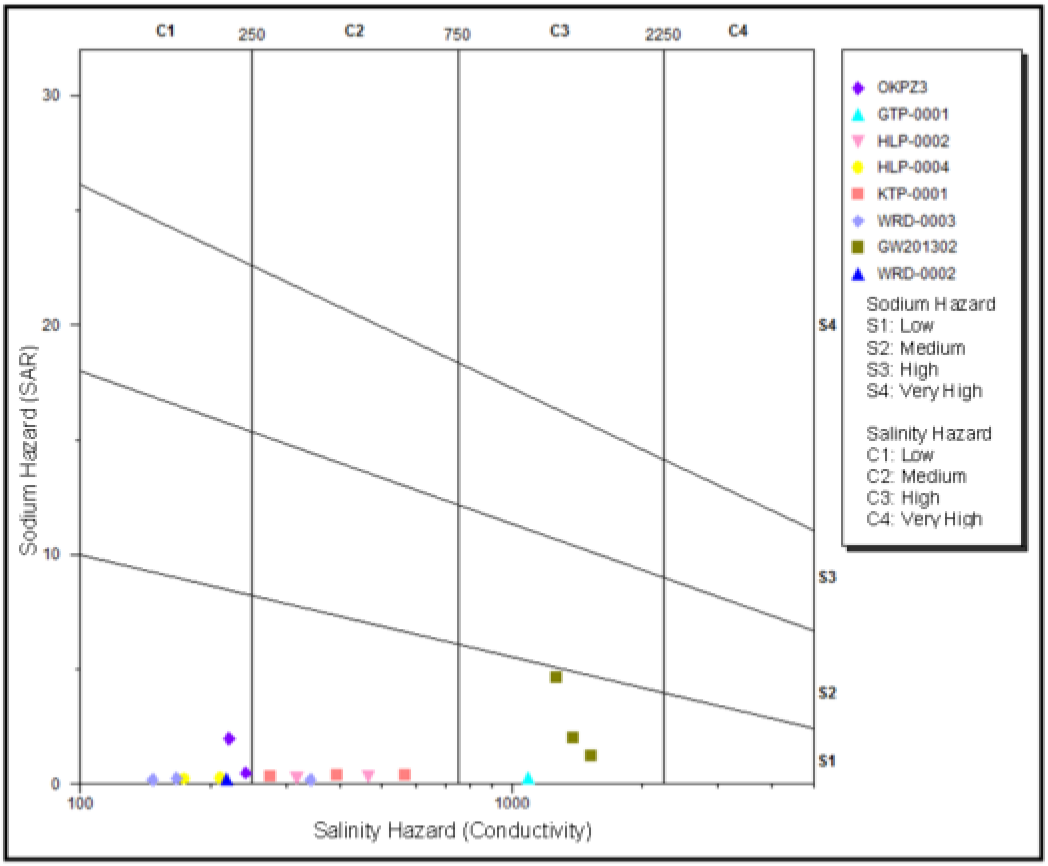


Figure 10-53: Wilcox Diagram for Observation Wells



10.7.9 Sensitivity of the Hydrogeological Receptors

The sensitivity of the hydrogeological component of the environmental baseline is considered **high** based on the fact that groundwater is susceptible to impacts arising from mining activities and is in high demand by other users with limited potential for substitution on a regional scale. Groundwater is considered to have moderate natural resilience to imposed stresses that may occur due to mining activities.

10.7.10 Summary of Water Resources Sensitive Receptors

Ground and surface water resource receptors and their determined sensitivity that have been identified following the baseline characterization are presented in Table 10-22.

Table 10-22: Water Resources Sensitive Receptors

Receptor Sensitivity and Importance	Receptor Name
Very High: Protected area or receptor. An attribute with a high quality and rarity on an international, regional or national scale with little or no potential for substitution.	▪ Sultan Sazlığı Wetland (RAMSAR)
High: Sensitive area or receptor with little resilience to imposed stresses. An attribute with a high quality and rarity on a local scale with little or no potential for local substitution, or with a medium quality or rarity on a regional or national scale with limited potential for substitution.	▪ Epçe area aquifers ▪ Zamantı River Wetland ▪ Acısu Spring and Creek, including users of this Class IV water source ▪ Surface water features within the EIA Permitted Area and access road corridor for drinking water
Medium: Moderately sensitive area or receptor that has some natural resilience to imposed stresses. An attribute with a medium quality and rarity on a local scale with limited potential for substitution, or an attribute of low quality and rarity on a regional or national scale.	▪ Zamantı River ▪ Ağcaşar Dam ▪ Kovalı Dam ▪ Gümüşören Dam ▪ Surface water features within the EIA Permitted Area and access road corridor not used for drinking water ▪ Project area unsaturated zone / groundwater ▪ Project area and local ephemeral creeks / streams
Low: Low sensitivity area or receptor with natural resilience to imposed stresses. An attribute of low quality and rarity on a local scale with potential for substitution locally.	▪ None

Note that the above table identifies sensitive receptors in the vicinity of the EIA Permitted Area. Risks to those receptors are considered in the following sections.

10.8 Impact Assessment

10.8.1 Issues Scoped in and Scoped out of the Assessment

Based on the baseline assessment, a range of issues have been either scoped-in or scoped-out of this impact assessment.

Scoped In

The current geochemical dataset indicates that nearly all waste rock, spent ore and pit walls resulting from mining will generate acid either due to leaching of naturally occurring sulphate minerals or oxidation of pyrite. Due to the negligible carbonate content (i.e. low neutralisation potential) of the rock, acidic conditions are expected to develop rapidly for waste rock and first contact waters will be acidic resulting in leaching of trace metals at concentrations which would be expected to exceed drinking water quality standards.

The key issues, in terms of potential impacts on water resources, include:

- Changes to surface water availability and distribution in the EIA Permitted Area;
- Discharge of run-off from working areas within the Project Area;
- Discharge of run-off and leachate from the Waste Rock Dump (WRD), Heap Leach Facility (HLF) and Open Pit walls;
- Lowering of groundwater levels in community wells in the Epçe area due the additional abstraction of groundwater for Project use;
- Disruption to local surface water and groundwater flows due to the construction of Project facilities and in particular, the WRD, HLF and Open Pits.

Impacts caused by construction of the powerline, including potential impacts on the Sultan Sazlığı wetland. The powerline does not pass through the Sultan Sazlığı national park, but 10 km of the powerline does pass through the buffer zone of Sultan Sazlığı Wetland. The powerline route runs 175 m from the Sultan Sazlığı Controlled Use Area - this will not be affected as all activities during the operation and construction of the power line will be in compliance with the Long Term Development Plan of Sultan Sazlığı Wetland.

Scoped Out

Impacts from discharge of water into the environment

The overall objectives of the design measures and procedures to manage water within the fence line are to:

- Route water that has come into contact with Open Pit walls, Ore Stockpiles, the HLF and WRD to ponds and collection sumps for re-use in ore processing;
- No contact water will be released into the environment;
- Prevent natural ground runoff and non-contact water from entering mine working areas by routing it around mine facilities via diversion channels and ditches;
- Minimise erosion of disturbed areas and when erosion does occur, minimise suspended sediment flow to natural streams via the use of settling ponds.

While these impacts are not scoped out of the assessment, recognition of these potential impacts enables the Project design to avoid and minimize these impacts as far as possible. Those issues that are scoped out are described under "*Impacts to Specific Receptors*" below.

Central to the ground preparation works will be the establishment of mine site drainage infrastructure including under-drains for the WRD, HLF and Ore Stockpile sites, downstream collection ponds and sumps at the same facilities for drained water collection, diversion drains around the Open Pits and Ore Stockpiles and processing facilities, collection drains at the accommodation blocks, offices, workshops and warehouses and piping to route collected water back to storage tanks for re-use in ore processing. With these surface water infrastructure and management provisions in place, the operating mine site will effectively be a "closed system" with no contact water being discharged into the local hydrological system.

All wastewater discharged from the Project's sanitation systems will be re-used in ore processing. There will therefore, be no discharge of wastewater to the environment. On this basis, issues with Project wastewater impacts on water resources is screened out from further assessment.

Impacts on specific receptors

A number of receptors were scoped out from further assessment based on their determined level of exposure to Project activities as follows:

- **Zamantı River**

  The Zamantı River is located 10 km to the east of the EIA Permitted Area. While surface water runoff from the Project Area may eventually drain into the river (as shown in Figure 10-15), it is considered that the volumes from these ephemeral streams will be insignificant in terms of overall river catchment drainage (i.e. the catchment is two orders of magnitude larger than the EIA Permitted Area). The Project will therefore, have no impact on the river's flow volume or water quality.

- **Kovali Dam**

  The surface water drainage lines that feed into the dam are located outside the Project Area and therefore, the Project will not affect the dam.

- **Ağcaşar Dam**

  The surface water drainage lines that feed into the dam are outside the Project Area and therefore, the Project will not affect the dam.

- **Gümüşören Dam**

  The Gümüşören Dam (currently under construction) is 10 km to the east of the EIA Permitted Area. The dam will be fed by the Zamantı River. As with the Zamantı River and Wetland, the volume of water that may feed into the dam from the EIA Permitted Area will be insignificant in terms of the river's drainage catchment (i.e. the catchment is two orders of magnitude larger than the EIA Permitted Area).

The surface water drainage lines within the EIA Permitted Area do not connect with the drainage basins that feed into the Sultan Sazlığı National Park (see Figure 10-20) and therefore, construction and operation of the mine will not to have any impact on the wetland and have been scoped out of the impact assessment.

10.8.2 Construction Phase Impacts and Mitigation Measures

Potential water resource impacts resulting from Project construction activities include:

- Changes to surface water availability and distribution in the Project Area;
- Reductions in surface water flow as a result of surface water within the Project Area being captured and stored for use during construction (e.g. wetting down work areas);
- Reductions in groundwater flow as a result of surface water within the Project Area being captured and stored for use thereby reducing groundwater recharge;
- Reduction in groundwater levels near Epçe as a result of groundwater abstraction for Project use (pre- ore processing);
- Deterioration of surface and groundwater quality as a result of sedimentation and / or release of contaminants to the environment;

- Changes in surface water quality caused by ground disturbance related to construction of the powerline.

Surface Water Availability and Distribution

As noted in Section 10.6.4 , the annual mean precipitation in the Project Area is 416.4 mm. The *effective precipitation* in the Project Area is about 27% of the total annual mean precipitation. This equates to approximately 112 mm per annum. 14.3% of the effective precipitation enters the system as surface flow which equates to approximately 16 mm per annum. The Project's licenced areas cover an approximate 3,995 ha (Chapter 5, Section 5.3) which is circa 39.9M m^2. This means that some 639.2M litres or 639,200 m^3 of water enters the surface water system within the Project's licenced area per annum.[20]

Upstream surface water interception drains, ditches and retention ponds will be installed early in the Project's construction phase. Captured water will be stored for use during construction (e.g. wetting down of work areas, irrigation around the office and accommodation buildings, etc.). Surplus surface water will however, be released to the environment until the ore processing facilities are operational after which it will be diverted for use in ore processing. (Ore processing is expected to commence approximately two years after construction activities commence).

Reductions in surface water flow would be observed as a result of surface water within the Project Area being captured and stored for use during construction and contact-non-contact water separation and diversion in preparation for operations. Impacts on the sub-basins in terms of loss of drainage area are set out below:

Table 10-23: Estimated reductions in drainage basin size due to contact water diversion

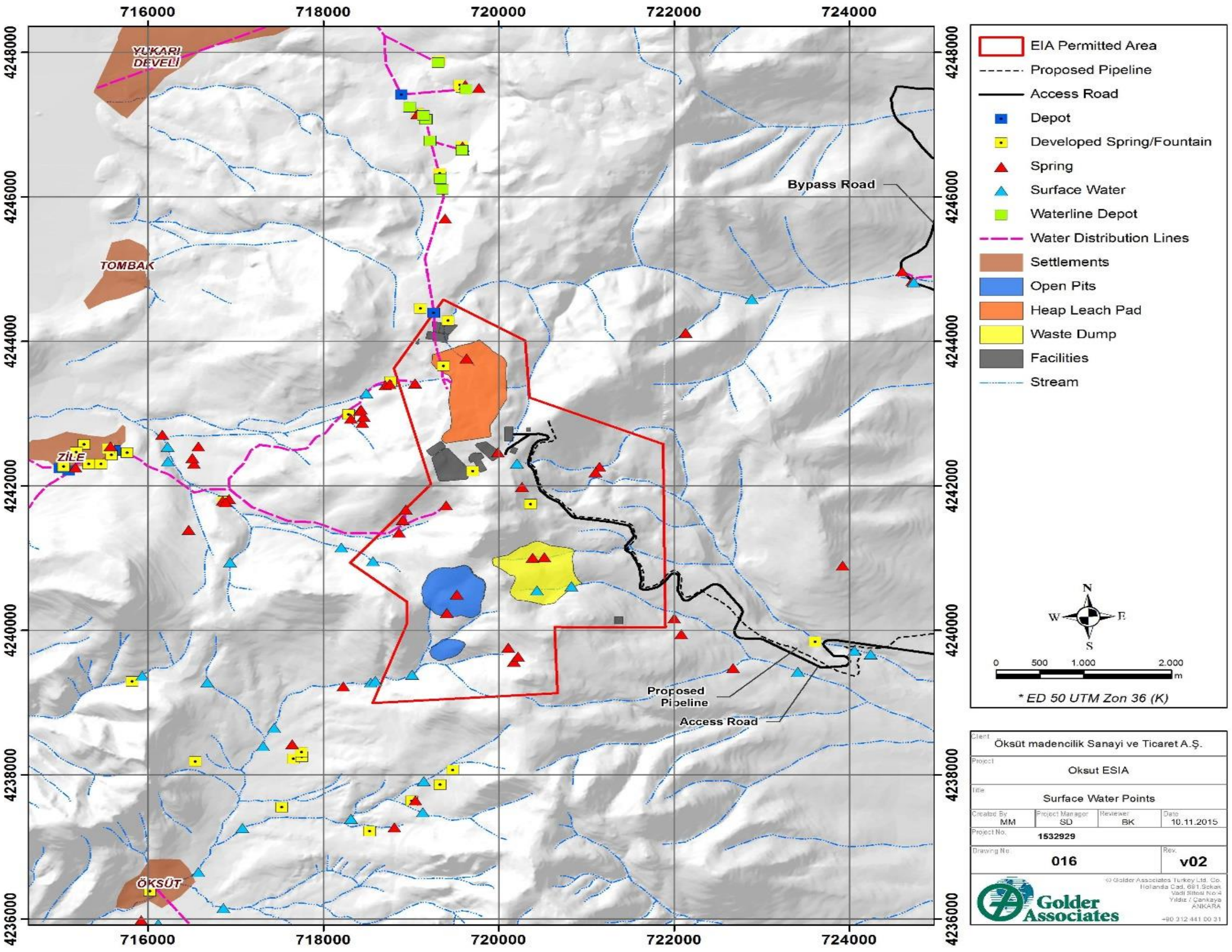
Drainage Basin	Predicted % Size Reduction
Öksüt Basin	1.0
Zile Basin	0.7
Tandırlık Creek Basin	1.8
Gömedi Basin	6.6
Kıvçak Creek Basin	3.2

In addition, a range of surface water resources within the EIA Permitted Area and the access road corridor may either be directly impacted (through removal for mine facilities), or indirectly impacted through changes to flow regimes or loss of access to water users (through fencing). The Yazıbası, Gömedi and Epçe water depots are in the access road corridor and two ephemeral streams cross the access road route. The water sources within the EIA Permitted Area are as follows and set out in Figure 10-54.

- 4 developed springs / fountains (that feed the Zile water distribution line and Yukarı Develi water distribution line);
- 17 natural springs;
- 4 surface water points;
- 1 water depot.

[20] One millimetre of measured precipitation is the equivalent of one litre of rainfall per metre squared.

Figure 10-54: Surface Water Sources within the EIA Permitted Area



Based on the project design as set out in *Chapter 5: Project Description* the following impacts to surface water sources within the EIA Permitted Area are anticipated:

- Heap Leach Facility – 1 spring, 1 developed spring (that feeds the Yukarı Develi water distribution line);
- Open pits – 2 springs;
- Waste Rock Dump – 2 springs, 2 surface water features;
- Other facilities – 1 spring, 2 developed springs.

Springs which may be used by shepherds during the 2-3 month summer grazing season will be permanently lost underneath mine facilities.

A water distribution line to Yukarı Develi will be affected by the Project as the starting section of the water line (and associated springs) will be within the EIA Permitted Area and will be removed. The affected water distribution line is a secondary water source for Yukarı Develi and investigations indicate that the water line does not flow all year round (see *Annex T*). The Turkish EIA identified water sources SP-63, SP-72 and SP-73 as the key water sources identified as replacement mitigation. These water sources were noted to be dry during a field survey in September 2015. The Turkish EIA commits OMAS to undertake additional studies to identify replacement water sources and to construct a replacement water supply pipeline to ensure continuity of supply. OMAS is in the process of further investigations which have been temporarily put on hold due to poor weather conditions over the 2015/16 winter period. OMAS will replace the water supply with the assistance of the Kayseri Municipality Water Affairs Department.

The water distribution line that provides water to Zile will not be affected as it is in a separate water basin to the HLF. Water monitoring will be undertaken downstream as part of the Water Monitoring Plan.

The access road will avoid the water depots in Yazıbası, Gömedi and Epçe.

The volume of surface water run-off that will be captured and used during construction is considered limited in terms of the total annual volume of water that enters the surface water system within the OMAS Licences (which is are significantly larger in area than the EIA Permitted Area).

Impact Assessment

Impact:	Reduction of surface water flow as a result of surface water capture for use and loss of surface water features under permanent mine facilities
Receptors & Sensitivity:	Surface water springs and local streams of medium sensitivity. Developed springs (water sources SP-69 and SP-70) that feed the Yukarı Develi water distribution line of high sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long-term term, ▪ Extent: Local as will only affect water sources within the EIA Permitted Area and the water supply used by Yukari Develi; ▪ Likelihood: Certain to occur as a consequence of Project construction activities. Overall, impact magnitude is determined to be ***high***.
Significance:	Major adverse.

Impact Mitigation

The Project will minimise its use of surface water thereby minimising the amount it abstracts or captures from the local surface water system. Water will be stored during the higher precipitation periods for use in low precipitation periods. Where possible, captured surface water will be re-used. The Conceptual Mine Closure Framework (OMAS-ESMS-CP-PLN-001) sets out the process that OMAS will use to develop detailed closure and rehabilitation plans for the Project with a focus on maximising the amount of land to be returned to its previous use and status.

The impact of the loss of these surface water features on pastureland availability and consequent economic and livelihood impacts on shepherds who currently use the EIA Permitted Area for temporary summer grazing is discussed in *Chapter 16: Infrastructure and Land Use*. OMAS worked with shepherds to identify and implement appropriate and agreed options for replacement water sources for shepherds. Impact mitigation related to loss of access to surface water features in the EIA Permitted Area is a core feature of the Livelihood Restoration Framework (OMAS-ESMS-LR-PLN-001) which sets out a structured process to ensure that local shepherds will not be adversely impacted by loss of access to these water sources for their livestock.

The Turkish EIA investigated alternative water sources to replace the springs used by the secondary Yukarı Develi water distribution line. A water supply of approximately 2.5 L/s (total) was identified using the combined SP-63, SP-72 and SP-73 springs. The Turkish EIA recommended a more detailed study after commencement of the Project. In September 2015, Golder revisited SP-63 and SP-73 and found the springs to be dry, confirming that they are seasonal. It was not possible to reach SP-72. The field visit also confirmed that the developed spring inside the EIA Permitted Area had very low flow (*Annex T*). As mitigation of this impact, OMAS will undertake appropriate investigations and in consultation with stakeholders will identify and commission a suitable replacement water supply.

Residual Effects

Implementation of the proposed mitigation measures will result in a residual effect of **low** significance in terms of reductions in surface water flows and permanent loss of surface water features due to the limited area affected and the implementation of appropriate mitigation measures.

Surface Water Quality

Project construction will commence with ground clearance and levelling in readiness for installation and construction of the mine facilities. This implies that there will be bare areas of ground that will be more susceptible to erosion by surface water run-off. As discussed in Chapter 5, interception ditches and drainage channels will be installed to divert water around Project facilities in order to limit the generation of contact water once the mine facilities are operational. A similar philosophy will apply during the construction phase and active work areas will be equipped with appropriate drainage systems to minimise the amount of surface water that flows over bare ground. Temporary settling ponds will also be installed downstream of work areas in order to capture surface water run-off and allow entrained soil to settle-out prior to being released into the environment.

All fuel and lubricant storage areas will be bunded to 110% of the volume being stored. The bund areas will also be equipped with spill response and clean-up equipment. Relevant construction personnel will be appropriately trained in spill response and clean-up.

The powerline alignment crosses an irrigation project that uses the water from the Gümüşören Dam. Earthworks associated with powerline tower construction may release sediment into any adjacent surface water features. The route crosses three streams (Atdamı Creek at S5-S6, Büyüközü Creek at S11-S12, Kurtdağı Creek at S15-S16) and 10 ephemeral streams.

Impact Assessment

Impact:	Deterioration of surface water quality due to entrainment of soil material or accidental spill of fuels or lubricants.
Receptor & Sensitivity:	Surface water creeks and local streams of medium sensitivity.
Description:	▪ Type: Direct; ▪ Duration: long-term, duration of the construction phase (i.e. circa two years); ▪ Extent: Local as will only affect watercourses within the Project Area; ▪ Likelihood: Soil erosion / sedimentation - likely to occur as a consequence of Project construction activities; accidental spill – unlikely to occur. Overall, impact magnitude is determined to be low.
Significance:	Minor adverse.

Impact Mitigation

Installed construction phase drainage infrastructure is expected to mitigate impacts on surface water quality in terms of increased sediment loads. By allowing entrained soil material to settle out prior to the water entering the downstream creeks and streams, impacts on these surface water features will also be mitigated.

Implementation of pollution prevention and control measures will mitigate impacts on surface water quality in relation to contamination from accidental spills. Immediate remedial action in the event that there is a spill will prevent the contaminants from entering watercourses. Key management plans include:

- Hazardous Materials Management Plan (OMAS-ESMS-HM-PLN-001);
- Emergency Response Plan (OMAS-ESMS-ERP-PLN-001).Monitoring will also be carried out throughout construction as part of the monitoring outlined in the Water Resources Management Plan.

The siting of powerline towers has been undertaken to avoid construction immediately adjacent to watercourses. In addition:

- Construction debris will not be disposed in watercourses;
- There will be no discharges to surface waters;
- No activities will be undertaken within 20 m of watercourses;
- If water course require crossing for construction purposes prior consent will be sought from DSİ;
- Compensation will be provided by TEİAŞ for any damage to wells, springs and irrigation facilities in accordance with the requirements listed in Primary Ministry Decree (2006/27) dated 09.09.2006 and No 26 284.

Construction activities will be executed as per the protocol agreed between the Project and DSI 12th Regional Directorate. Under this protocol, the Project will avoid irrigation pipes, wells, hydrants and towers will not be sited adjacent to such structures. Appropriate management controls have been integrated into the specifications for powerline construction.

Residual Effects

Successful implementation of mitigation measures will result in a residual effect of **negligible** significance on surface water quality.

Groundwater Quantity

The Project plans to install two groundwater abstraction wells in the Epçe area to meet the Project's water demand during operations. The wells will need to be ready to pump water as soon as ore processing commences which is anticipated to be one year after the commencement of Project construction. There is however, a potential for groundwater abstraction to commence within the construction phase. A conservative approach has therefore been adopted for this impact assessment in that it is assumed that the wells will actually pump water shortly after the commencement of construction.

The Project has licences from the DSI at both wells. A monitoring programme was undertaken by OMAS in August 2015 (during the dry period) to confirm water level measurements from the five wells of the Epce wells cooperative.

Impact Assessment

Impact:	Aquifer drawdown as a result of groundwater abstraction for the Project.
Receptor & Sensitivity:	Epçe Area aquifer of high sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long-term, duration of operations; ▪ Extent: Localised as it is expected to only affect the local aquifers; ▪ Likelihood: Certain to occur as a consequence of groundwater abstraction once wells are installed and pumping commences. Overall, impact magnitude is determined to be low.
Significance:	Minor adverse.

Impact mitigation

Groundwater levels in existing wells in the Epçe area will be continuously monitored during the Project's construction and operation phases. Further, an additional monitoring well will be installed between the Project's abstraction wells and the local cooperative abstraction wells. If the expected drawdown is greater than simulated, water supply to the mine will be cut, existing wells will be deepened or new wells will be installed to supplement supply to Epçe so that there is no net deficit. This is set out in more detail in relation to aquifer recharge assessment and impact simulations and the ongoing operations phase monitoring in Section 10.8.3.

Residual Effects

Implementation of the proposed mitigation measures will lead to a residual effect of **negligible** significance. No compensation or offsets are required.

Groundwater Quality

Groundwater is susceptible to contamination from accidental releases of fuels, lubricants or other liquid chemicals. It is also susceptible to contamination if surface water is contaminated and enters the groundwater aquifer via recharge. Project pollution prevention and control measures include bunds, appropriate storage containers and secure storage areas for all hazardous materials. Training of relevant Project personnel hazardous material handling and spill response and clean-up also plays an important role in pollution prevention. Key management plans include:

- Hazardous Materials Management Plan (OMAS-ESMS-HM-PLN-001);
- Emergency Response Plan (OMAS-ESMS-ERP-PLN-001);
- Cyanide Management Plan (to be prepared prior to commencement of operations).

There will be no generation of contact water during the Project's construction phase. Issues associated with potential sedimentation of surface waters are discussed above under surface water quality.

Impact Assessment

Impact:	Reduced unsaturated zone groundwater quality as a result of contamination (e.g. accidental release of fuels, lubricants or other liquid chemicals).
Receptor & Sensitivity:	Project Area unsaturated zone (groundwater receptors) of medium sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Short term as accidental spills will be immediately responded to and promptly cleaned-up; ▪ Extent: Local, as any spill would only affect the unsaturated zone; ▪ Likelihood: Unlikely to occur as a consequence of construction activities. Overall, impact magnitude is determined to be low.
Significance:	Minor adverse.

Impact Mitigation

The adoption of best practice pollution prevention and control measures is expected to mitigate impacts on groundwater quality in relation to accidental spills. In the event that a spill does occur, immediate response will avoid or at least limit its impact on groundwater resources. Accidental spills are unlikely to result in significant changes to baseline conditions. Key management plans include:

- Hazardous Materials Management Plan (OMAS-ESMS-HM-PLN-001);
- Emergency Response Plan (OMAS-ESMS-ERP-PLN-001);
- Cyanide Management Plan (to be prepared prior to commencement of operations).

Residual Effects

Implementation of the proposed mitigation measures will lead to a residual effect of **negligible** significance. No compensation or offsets are required.

10.8.3 Operations Phase Impacts and Mitigation Measures

During operations, the focus will be on the management of surface water drainage and runoff, leachate seepage containment and re-use and sediment control from operational mine areas. Sources of potentially contaminated surface water discharges includes:

- Keltepe and Güneytepe Open Pits;
- WRD;
- HLF;
- Water storage ponds, ore crusher and ore stockpiles;
- Mine site access road and haul roads;
- Administration blocks, offices, workshops and warehouse drainage systems.

Water resource impacts as a result of Project operations phase activities include:

- Reduction in surface flow as a result of surface water within the Project Area being captured and routed for re-used in ore processing;
- Deterioration of surface quality as a result of sedimentation and / or release of contaminated water, including contact water, to the environment;

- Reduction groundwater flow as a result of surface water within the Project Area being captured and re-used in ore processing thereby reducing groundwater recharge potential;
- Deterioration of groundwater quality as a result of the accidental release of contaminated water, including contact water, to the environment.

Surface Water Quantity

During the operations phase, surface water that comes into contact with the WRD, HLF and Open Pits (walls) will be diverted to collection ponds and sumps and will be routed back to the Ore Processing facility for use following treatment as necessary (*Chapter 5: Project Description, Figure 5-9*). Project operations will therefore, impact surface water in terms of the volume of water that enters the natural hydrological system. Estimated reductions in drainage basin size due to HLF, WRD Open Pits and other mine facilities provided in Table 10-24:

Table 10-24: Estimated reductions in drainage basin size due to contact water diversion

Drainage Basin	Predicted % Size Reduction
Öksüt Basin	1.0
Zile Basin	0.7
Tandırlık Creek Basin	1.8
Gömedi Basin	6.6
Kıvçak Creek Basin	3.2

Impact Assessment

Impact:	Reduction of surface water quantity entering the local hydrological system due to off-take for use in ore processing and other mine related activities.
Receptor & Sensitivity:	Local creeks and local streams of medium sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long-term, duration of operations phase (circa eight years); ▪ Extent: Local as impacted surface waters courses drain to larger regional scale rivers; ▪ Likelihood: Certain to occur as a consequence of Project operations phase activities. Overall, impact magnitude is expected to be medium.
Significance:	Minor adverse.

Impact Mitigation

Only surface water that comes into contact with the WRD, HLF and Open Pits will be used in the Ore Processing facility. All other surface water run-off will be allowed to flow into the natural hydrological system. No further mitigations are considered necessary. It is expected there will be a negligible reduction of runoff as diversion channels will return the bulk of surface water run-off to the catchments.

Residual Effects

Implementation of the proposed impact mitigation measures will lead to a residual effect of **negligible** significance.

Groundwater Quantity (Water Supply Impact Simulations)

The maximum water requirement for the plant and other facilities throughout the life of the Project has been determined to be 35 L/s by the Engineering Department of OMAS. In order to source adequate water, a series of studies were conducted in the vicinity of the Project Area and negotiations were held with the 12th Regional Directorate of the State Water Administration (SWA) during these studies.

In a later phase of the water supply studies, Golder drilled two wells (E1 and E2) in the Epçe area. Two 15-day pumping tests were conducted and aquifer parameters were determined. Since these candidate wells are located close to existing Epçe Irrıgation Cooperative wells, SRK used the data to calibrate the groundwater model in preparation for assessing impacts to a nearby well.

The following assumptions were made for the water supply impact simulations:

- recharge to the Epçe plain (89 mm/a) is assumed to occur only in the wet period;
- the Epçe Irrigation Cooperative is currently working actively near the Project Area and pumped a total 2,988,000 m^3 water from five water wells during the five month period, May 2015 to October 2015;
- although the Şahmelik Water Cooperative is not active, in order to model a worst-case scenario, it was assumed that the Cooperative is currently pumping the same amount of water as it drew in the past from the wells (i.e. 429 L/s over the five month period);
- return flow from the irrigation is assumed to be 10% of the abstraction and this amount is entered as a recharge for the irrigation period.

With the above assumptions, 10 years transient simulations were conducted for the pre mining scenario (i.e. no mine water supply) and operational phase scenario (35 L/s total abstraction from E1 and E2).

In order to assess the local potential impacts, closest well hydrographs were generated from the models for both scenarios. The closest well to the E1 well is a cooperative well labelled as 171988 and the closest well to E2 is W-46, a private well belonging to an individual villager.

The water required for the mine (35 L/s) will be 8% of the total irrigation pumping during the dry season. According to the results of the simulations, additional drawdowns at the nearby wells are simulated to be less than 5 m. This impact has been negotiated with the SWA abstraction has been approved with the following commitments:

- An additional monitoring well will be installed between the mine production wells and the cooperative wells;
- A continuous water level monitoring programme will be conducted prior and during the operation, and findings of this monitoring will be reported to SWA;
- If the expected drawdown on the vicinity wells is found to be higher, or in the case of any inadequate yield, pumps of the adjacent wells will be deepened or new wells will be opened by OMAS.

Impact Assessment

Impact:	Reduction of groundwater quantity - model simulations indicate drawdown due to operational water supply requirements will be less than 5 m.
Receptor & Sensitivity:	Epçe area of high sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the operations phase (circa eight years); ▪ Extent: Localised as it is expected to only affect the local aquifers; ▪ Likelihood: Certain to occur as a consequence of water abstraction during the operations phase. Overall, impact magnitude is expected to be medium.
Significance:	Moderate adverse.

Impact Mitigation

Groundwater levels in the Epçe water supply wells will be continuously monitored during the operations phase. An additional monitoring well will be installed between the mine's abstraction wells and the local cooperative abstraction wells. If groundwater drawdown is greater than simulated, the wells will be deepened or new wells installed to supplement supply. Use of groundwater resources is expected to be sustainable based on natural recharge of the local aquifers. Following cessation of mining activities, groundwater levels in the aquifer are expected to return to pre-mining conditions on the assumption that community use of the resource does not substantially increase.

Residual Effects

Implementation of the proposed impact mitigation measures will lead to a residual effect of **negligible** significance.

Groundwater Quality

Calibrated numerical models were employed for the impact assessment evaluations, including both operational and post closure impacts.

During the operational phase, the Open Pits will be excavated, waste rock will be dumped and HLF will be operated. For the operational scenarios, the following assumptions were made:

- The HLF will be completely lined with geomembrane;
- The WRD will be constructed to its ultimate volume;
- Both Open Pits will be excavated to their ultimate dimensions.

Seepage Estimates from WRD and HLF

In order to evaluate the seepage potential of the WRD during the operational phase, a quasi 2D water balance model, HELP (Hydraulic Evaluation of Landfill Performance), was employed to ensure better understanding of hydrological components of the WRD.

In order to run the model, 40 years of daily meteorological data was used from the Develi Meteorological Station. Saturated hydraulic conductivity of the andesite was assigned to bedrock using the pumping test data, whilst literature values were assigned for the hydraulic conductivity of the WRD and lateral drainage layer. Parameters that were used in the seepage calculations are given in Table 10-25.

Table 10-25: HELP Model Parameters for the WRD

	Thickness	Saturated Hydraulic Conductivity
Waste Rock	81.0 m	1 E^{-4} m/s
Lateral Drainage Layer	0.5 m	3 E^{-3} m/s
Compacted Neogene Cover	2.0 m	1 E^{-8} m/s
Andesite	200.0 m	2 E^{-6} m/s

According to the above modelling study, it was determined that:

- Approximately 78% of the mean annual precipitation (MAP) will be lost due to evaporation;
- 9.2% of the infiltrated water will be collected via a drainage layer (gravel and French drains);
- 9.5% of the infiltration will flow through the unsaturated zone of the andesite.

HLF

The planned Composite lining system at the bottom of the HLP is (from bottom to top):

- Prepared foundation;
- Lining made of mineral material with a thickness of 500 mm, with low K (i.e. maximum 1 x 10^{-8} m/s);
- LDPE (Low Density Polyethylene) geo-membrane with a thickness of 2.0 mm and K of 4 x 10^{-15} m/s;
- Drainage layer with a thickness of 600 mm.

The equivalent hydraulic conductivity of the composite lining will be practically impermeable therefore no seepage is expected during normal conditions. In order to simulate engineering defects during the construction of the liner however, a widely-used Analytic Model (Giraud and Bonaparte) was employed to determine the seepage rate. According to this model, seepage from the liner is calculated to be approximately 2.2 E^{-13} $m^3/s/m^2$ (i.e. less than 1% of the MAP).

For the later operational scenarios, seepage from the WRD area is assumed to be 9% of MAP whilst seepage from the HLP is assumed to be 1% of MAP.

Open Pits

According to modelled and measured groundwater levels, both Open Pits will be dry and there will be no dewatering or discharge activities during operations (Table 10-26). Due to the fractured nature of the oxidized zone, no pit lake formation is expected.

Table 10-26: Groundwater Levels and Bottom Elevations of the Deepest Pit Planned

Pit	Elevation of Deepest Pit Planned (masl)	Current Groundwater Level (masl)	Distance to Water Table (m)
Keltepe	1,585	1,507	78
Güneytepe	1,590	1,546	44

Impact Assessment (Acısu Spring)

Impact:	Deterioration of groundwater quality. Particle tracking model simulations indicate particles released from the Open Pits reach the Acısu Spring in approximately 10 years. The existing baseline acidic pH conditions are expected to continue. Solutes, originating from the Pits, are likely to increase relatively with the predicted increase in flow rate in Acısu Spring (see below).
Receptor & Sensitivity:	Acısu Spring: The spring is of high sensitivity. Baseline water quality indicates spring water is not suitable for drinking purposes but the spring feeds a stream that is used for medicinal purposes by local villagers and is also used for crop irrigation.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the operations phase (circa eight years); ▪ Extent: Local to the Acısu Spring; ▪ Likelihood: Likely to occur as a consequence of Open Pit development. Overall, magnitude is expected to be **low** due to dilution and natural attenuation.
Significance:	Minor adverse.

Impact mitigation

A continuous monitoring programme will be implemented at the spring to record flow rates and volumes.

Periodic water quality samples will be taken to identify any changes to the chemical composition of water in the Acisu Spring and Creek.

In the event that deleterious effects (i.e. significant changes to chemical composition) on stream water quality are observed, appropriate remedial measures or other mitigations will be investigated.

Trigger levels have been developed based on IFC and Turkish Water Pollution Control Regulation discharge limits and are provided in Table 10-27. Where there is no defined discharge limit for a specific parameter, or if the baseline concentration is already above the discharge limit, baseline conditions or the modelling results have been used to define the trigger levels. Parameters for which this approach has been adopted include pH, Chlorine, Iron, Fluorine, Aluminium, Cobalt and Manganese.

A conservative approach has been used to define trigger levels as follows:

- Sulphate, Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead and Zinc concentrations reach 50% of the allowed discharge limits.
- The baseline concentrations of pH, Cl, Fe are already above the discharge limits. Trigger levels for these parameters are set as 20% above the Average Baseline Conditions or the Model Results.
- Discharge limits are not set for F, Al, Co, Mn. The trigger levels for those parameters are set as 20% above the Model Results which are higher than the average baseline conditions.
- The trigger level for chromium is set as 0.05 mg/L which is the drinking water limit. The modelling results indicate that the total chromium concentration at Acısu spring will increase however the predicted concentration (0.016 mg/L) will still be significantly lower than the drinking water guideline value.
- Trigger levels are not defined for other metals considering their concentrations are negligible.

Flow and in-situ field parameters will be measured and water samples will be collected based on a defined sampling schedule. The monitoring results will be compared with the existing baseline conditions at each monitoring point. If the parameter concentrations exceed the defined trigger levels, the monitoring and sampling frequency will be increased and a risk assessment study will be conducted to identify the potential environmental and human health risks.

Depending on the outcome of the risk assessment study, further investigations will be initiated to identify the source of the potential contamination and identify appropriate mitigation measures to reduce concentrations to below the relevant trigger level.

Table 10-27: Acısu Spring Trigger Levels

Parameter	Unit	DISCHARGE LIMITS	Trigger Level	Trigger Limit Explanation
pH		**6**	**2.66**	**20% Below the Average Baseline Conditions**
SO_4	mg/L	**2500**	**1250**	**50% Below The Discharge Limit**
Cl	mg/L	**2**	**4.87**	**20% Above the Average Baseline Conditions**
F	mg/L		**0.56**	**20% Above the Model Result**
Al	mg/L		**18.37**	**20% Above the Model Result**
As	mg/L	**0.1**	**0.05**	**50% Below The Discharge Limit**
Ba	mg/L			**Negligible - NO Trigger Limit**
Cd	mg/L	**0.05**	**0.025**	**50% Below The Discharge Limit**
Co	mg/L		**0.09**	**20% Above the Model Result**
Cr	mg/L	**0.1**	**0.05**	**50% Below The Discharge Limit**
Cu	mg/L	**0.3**	**0.15**	**50% Below The Discharge Limit**
Fe	mg/L	**2**	**8.99**	**20% Above the Average Baseline Conditions**
Hg	mg/L	**0.0020**	**0.001**	**50% Below The Discharge Limit**
Mn	mg/L		**0.70**	**20% Above the Model Result**
Ni	mg/L	**0.5**	**0.25**	**50% Below The Discharge Limit**
Pb	mg/L	**0.2**	**0.1**	**50% Below The Discharge Limit**
Sb	mg/L			**Negligible - NO Trigger Limit**
Se	mg/L			**Negligible - NO Trigger Limit**
U	mg/L			**Negligible - NO Trigger Limit**
Zn	mg/L	**0.5**	**0.25**	**50% Below The Discharge Limit**

Residual Effects

Water quality in the spring is expected to remain poor (Class IV) due to natural mobilisation of trace elements from the existing rock strata. Release of solute parameters as a result of mining activities is not expected to exacerbate water quality issues significantly.

The calibrated base case model was used to estimate groundwater flow paths from the planned facilities to their ultimate discharge location. Steady-state particle tracking was conducted with FEFLOW. Effective porosity was set to 2%. The geochemical modelling was undertaken for the water quality prediction for the WRD, open pits and HLF. The modelling methodology started with conceptualisation of the system to be modelled. Following the conceptualisation, elements in the conceptual model were quantified via the use of available baseline and laboratory test data and groundwater and particle tracking modelling results. Geochemical prediction modelling was carried out using the U.S. Geological Survey (USGS) computer code PHREEQCI Version 3.0.6.

Residual impacts are considered to be **minor adverse**.

Impact Assessment (Unsaturated Zone Groundwater)

Impact:	Deterioration to groundwater quality.
Receptor & Sensitivity:	Project Area unsaturated zone (groundwater receptors) of high sensitivity.
Description:	▪ Direct: Seepage of leachate from the WRD and Open Pits; ▪ Duration: Long term, duration of the operations phase (i.e. circa eight years); ▪ Extent: Local; ▪ Likelihood: Likely to occur as a consequence of operations phase activities. Overall, impact magnitude is expected to be medium.
Significance:	Moderate adverse.

Impact Mitigation

Limit the generation of contact water by effectively operating upstream interception trenches around the HLF, WRD, Open Pits and other mine facilities. The HLF will be completely lined with geomembrane. The WRD area will levelled (prior to operation) and under-drains installed to ensure seepage in collected in ponds and returned to the ore processing facilities. Direct precipitation runoff from the Open Pits walls will report to a collection sump and be returned for re-use in ore processing.

Residual Effects

Implementation of the proposed impact mitigation measures will lead to a residual effect of negligible significance.

Groundwater Quantity

Acısu Spring

The link between Acısu Spring and the proposed Open Pits was evaluated during the data collection and conceptualisation study. The distance from the Keltepe Pit to Acısu Spring is approximately 2.5 km and a highly fractured zone exists along this pathway.

Although there will be no dewatering or discharge during the operation of the Open Pits, recharge may be altered in the Pits area. The following scenarios were therefore, simulated to evaluate the potential impacts to Acısu Spring:

- **Scenario 1: Increased Recharge Effects:**

  During Pit excavation, the run-off portion (60 mm/a) of the *effective precipitation* will be trapped in the Pit. There will therefore be potential for increase in the seepage, compared to pre-mine conditions with an undisturbed ground surface. In order to evaluate this impact, the total run-off portion (i.e. 60 mm/a) is assumed to be added to initial recharge rate (55 mm/a). In this scenario, 115 mm/a total recharge rate is therefore applied to the Pits area.

- **Scenario 2: Removal of F2 Fault:**

  In addition to the Scenario 1 changes in recharge, Scenario 2 assumes that the F2 fault hydraulic conductivity will be enhanced due to blasting and hydraulic unloading at the Pit. For this reason, the pre-mining hydraulic conductivity of the F2 fault ($1E^{-9}$ m/s) is assumed to be increased by one order of magnitude (1E-8 m/s).

By conducting these two scenarios, the volume of base flow to Acısu Spring was checked quantitatively. Modelling results indicate that flow to Acısu Spring may increase by 2.5 % (for Scenario 1) and an additional 0.4% increase may occur given the assumptions of Scenario 2. Results of the modelling study are presented in Table 10-28.

Table 10-28: Evaluated Mining Impact to the Acısu Spring

		Base flow	Scenario 1 Increased flow rate due to recharge from pits (115 mm)	Percentage %	Scenario 1 + Scenario 2: The fault at Keltepe open pit is removed due to blasting	Percentage %
Acısu Spring	L/s	7.91	8.11	2.5	8.14	2.9
	m^3/d	683.4	700.7	2.5	703.3	2.9

Impact Assessment (Acısu Spring)

Impact:	Increase in groundwater quantity flowing to Acısu Spring.
Receptor & Sensitivity:	Acısu Spring of high sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the operations phase and into the closure phase;; ▪ Extent: Local to the Acısu Spring; ▪ Likelihood: Likely to occur as a consequence of excavating the Open Pit. Overall, impact magnitude is expected to be low.
Significance:	Positive (increase in spring flow quantity).

Impact Mitigation

An increase in flow within the Acısu Creek is considered a positive impact and therefore, no mitigation measures are proposed.

Residual Effects

The residual effects will be a permanent increase in flow to the spring.

10.8.4 Closure Phase Impacts and Mitigation Measures

A geochemical impact assessment and modelling exercise was undertaken by SRK (2015) to predict the movement of leachate from Project facilities within groundwater. The detailed report is attached as *Annex P*. A summary of key issues and impacts identified is set out below.

Particle Tracking and Geochemical Prediction Modelling

During the post closure period, the Open Pits will remain open and permanent drainage channels will be installed around them. The WRD and HLF will be capped to limit infiltration. For the closure scenarios, the following assumptions were made:

- The HLF will be completely lined with the geomembrane from the top and bottom. Infiltration is therefore assumed to be %1 of MAP (a conservative estimate).
- The WRD will be constructed to its ultimate volume and a closure cap will be installed. This cap is envisaged to be similar to that of the HLF however, during the operation of the WRD, OMAS will conduct trial cover performance tests to finalise this design. For the closure case scenarios, infiltration from the WRD is assumed to be 30% of the uncovered operational seepage rate (3% of the MAP).

- Both Pits are excavated to their ultimate dimensions and will remain as such in perpetuity.
- Mine water supply wells will cease to pump however irrigation wells are assumed to continue pumping at the yearly abstraction rates.
- Gıcık Springs (in Zamantı Tunnel) will continue draining 100 L/s from the fault zones (F4).

The calibrated base case model was used to estimate groundwater flow paths from the planned facilities to their ultimate discharge location. Steady-state particle tracking was conducted with FEFLOW. Effective porosity was set to 2%. The geochemical modelling was undertaken for the water quality prediction for the WRD, open pits and HLF. The modelling methodology started with conceptualisation of the system to be modelled. Following the conceptualisation, elements in the conceptual model were quantified via the use of available baseline and laboratory test data and groundwater and particle tracking modelling results. Geochemical prediction modelling was carried out using the U.S. Geological Survey (USGS) computer code PHREEQCI Version 3.0.6.

The particle tracking simulations are illustrated in Figure 10-55 to Figure 10-57 and the results of the geochemical modelling are summarised as follows:

- **WRD:** Particles were placed on the nodes representing the WRD. According to simulations, the majority of these particles move east. Within 100 years however, they are not simulated as reaching any receptors. Simulations were then extended to 150 years to see further flow paths. After reaching the permeable fault zones (F4), transfer velocity increases but the particles still do not reach the Zamantı Tunnel. A small portion of the particles flow to the west (i.e. on the other side of the groundwater divide) however these are also simulated as not reaching any receptors, including the Zamantı River Protected Area. The tracks taken by the particles do not suggest a particular focus of contamination on the Epçe aquifer as the particles will divide as the move down gradient with particles either moving very slowly or moving southwards when approximately 1km from the boundary of the Epçe aquifer (suggesting that they will not ultimately move into the aquifer) but remain in less sensitive aquifers. A "conservative" case scenario suggests that a very small volume of particles from the WRD may reach the Epçe aquifer after 150 years. Given the uncertainties in such long-term modelling, the most appropriate conclusion to draw is that any contamination of the aquifer is possible but unlikely and that given the volume of the aquifer versus the likely leachate volumes and concentrations that significant impacts to the aquifer are unlikely to occur. The seepage quality from the WRD is predicted to be acidic and have high sulphate and metal concentrations. Parameters that were predicted to be likely to exceed Turkish standards as set out in Table 7.1 of the *Regulation on Water Pollution Control* (SKKY Regulation) (and WHO limits) are pH, arsenic, cadmium, chromium, copper, iron, nickel, and zinc.
- **Open Pits:** Keltepe and Güneytepe pits are expected to remain dry after closure. The inflow into the pits will include runoff from the pit walls and direct precipitation on the open water surface at the bottom of the pits where temporary ponding is likely occur. Evaporation from the open water surface and recharge to groundwater will constitute the water losses from the system. Geochemical modelling was undertaken for the prediction of the quality of contact water potentially discharging to the groundwater. Acidic drainage was predicted for both of the pits. Contact water was predicted to have high sulphate and metals content. The parameters that were predicted likely to exceed Turkish Standards as set out in Table 7.1 of the SKKY Regulation (and WHO limits) are pH, arsenic, copper, iron, nickel and zinc. Groundwater modelling results indicate that the particles seeded to open pit areas quickly flow towards the Acısu Spring. Particles seeded to Keltepe and South Hill reach Acısu in approximately nine and 10 years, respectively. The baseline water quality at Acısu spring and Acısu stream was identified to be poor with acidic properties. High sulphate and metal concentrations were identified for baseline conditions. The baseline water quality for natural Acısu spring and stream is not suitable for potable water supply purposes. Based on the predictive modelling for base case conditions the acidic baseline conditions are expected to continue to prevail at the spring and stream. The solute loads are expected to increase relatively. Accordingly, the downstream solute loads of cobalt, copper, manganese, nickel and zinc in the Acısu spring and Acısu stream were predicted to increase. The remaining parameters were predicted to be in the same inland water quality

class range even for the environmentally conservative mixing conditions. Post-closure water quality prediction results for Acısu stream and springs are presented in Table 10-29 and Table 10-30.

- **HLF:** Flow path distribution from the HLF is radial and within the simulated 100 years, no receptors will be impacted. The numerical geochemical modelling for massive silica and quartz alunite altered ore types indicated near neutral seepage for massive silica and acidic seepage for QzAl ore. For seepage from massive silica ore arsenic, cadmium, copper, mercury, nickel, and zinc were predicted likely to exceed the effluent discharge limits for metallic mines. For seepage from QzAl altered ore, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc were predicted likely to exceed Turkish Standards as set out in Table 7.1 of the SKKY Regulation (and WHO limits).

Figure 10-55: 100 Year Particle Tracking Simulation

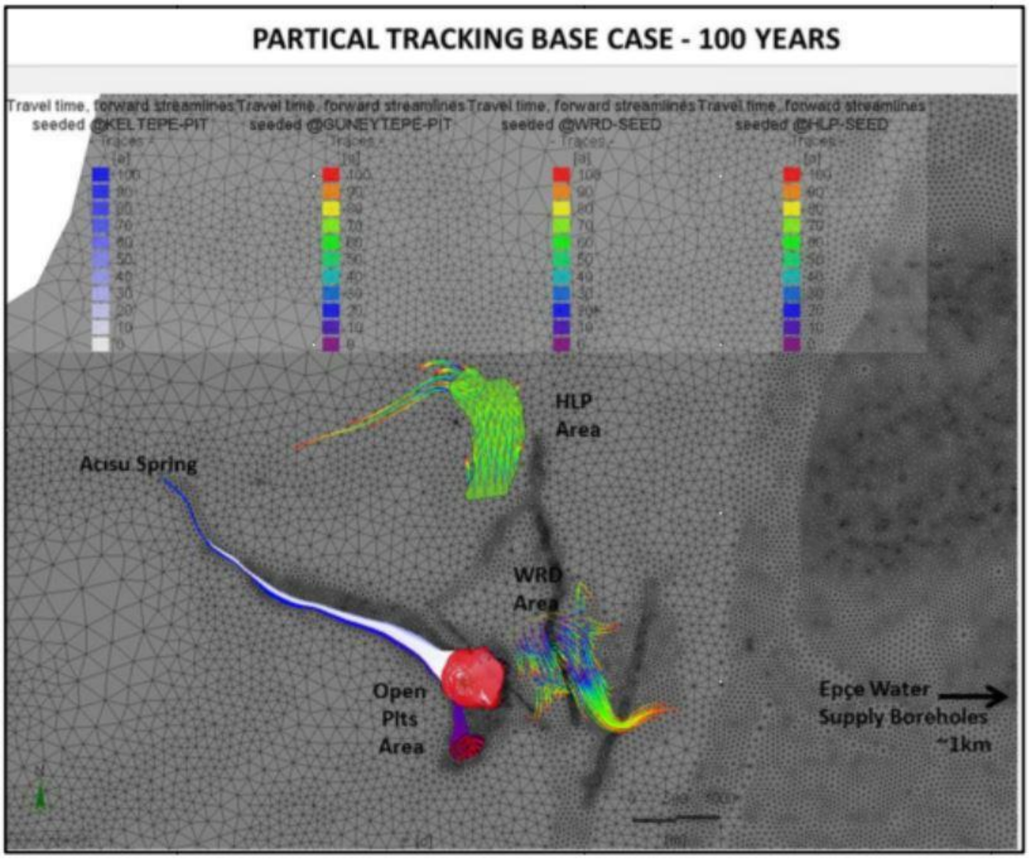


Figure 10-56: 150 Year Particle Tracking Simulation

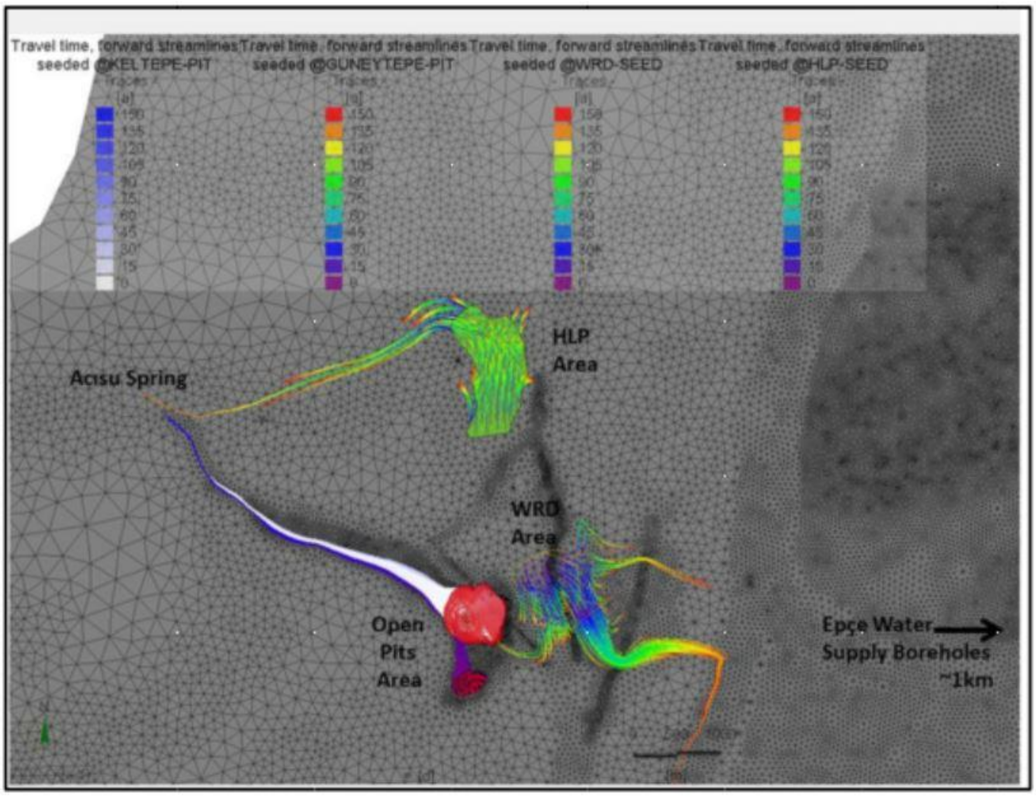


Figure 10-57: 150 Year Particle Tracking Simulation overlaid onto the Project Area map

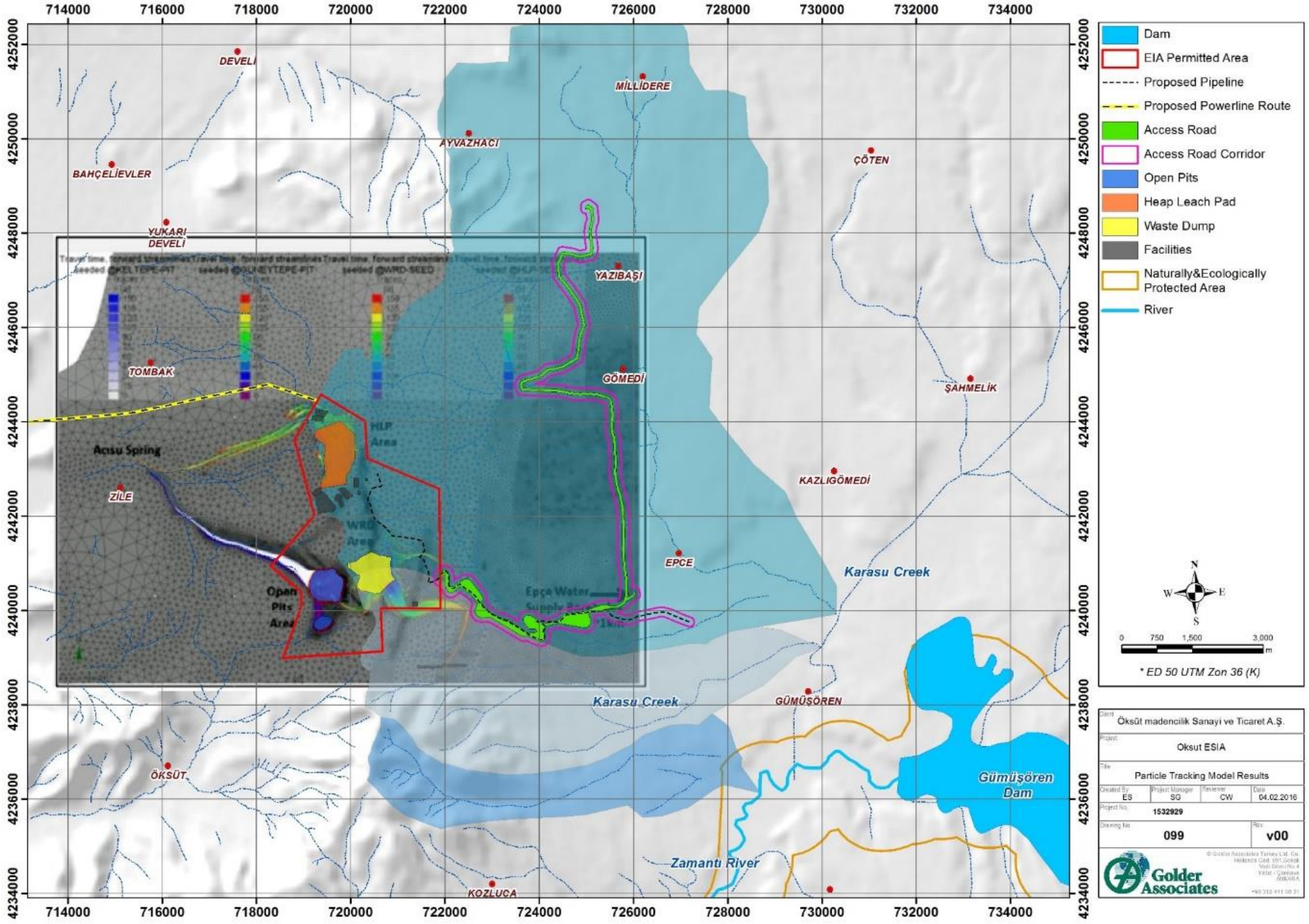


Table 10-29: Comparison of Predicted Water Chemistry against Inland Water Quality Criteria and Baseline Water Quality of Acısu Spring

Parameter	Unit	Ambient and Drinking Water Quality Criteria						Baseline WQ	Prediction for downstream mix (base case conditions - Model 1)	
		Drinking Water Limits		WPCR - Inland Water Quality Criteria						
		WHO	MH/EU	Class I	Class II	Class III	Class IV		Scenario 1	Scenario 2
pH			6.5-9.5	6.5-8.5	6.5-8.5	6-9	1/6-9/14	3.4	3.3	3.3
Alkalinity	mg $CaCO_3$/L		-					0.2000	-35.04	-35.061
SO_4	mg/L		250	200	200	400	> 400	256.6	309.2	317.8
Cl	mg/L		250	25	200	400	>400	4.231	3.231	3.217
F	mg/L	1.5	1.5	1	1.5	2	>2	0.4340	0.4592	0.4625
Ag	mg/L		-					0.0001	0.0001	0.0001
Al	mg/L		0.2	0.3	0.3	1	> 1	11.52	14.89	15.310
As	mg/L	0.01	0.01	0.02	0.05	0.1	> 0.1	0.0076	0.0198	0.0213
Ba	mg/L	0.7	-	1	2	2	> 2	0.0085	0.0083	0.0082
Be	mg/L		-					0.0002	0.0028	0.0031
Ca	mg/L		-					41.16	52.19	53.62
Cd	mg/L	0.003	0.005	0.003	0.005	0.01	> 0.01	0.0002	0.0007	0.0007
Co	mg/L			0.01	0.02	0.2	> 0.2	0.0043	0.0652	0.0730
Cr	mg/L	0.05	0.05	0.02	0.05	0.2	> 0.2	0.0023	0.0145	0.0160
Cu	mg/L	2	2	0.02	0.05	0.2	> 0.2	0.0006	0.1322	0.1492
Fe	mg/L		0.2	0.3	1	5	> 5	4.678	0.0030	0.0030
Hg	mg/L	0.006	0.001	0.0001	0.0005	0.002	>0.002	1.669E-05	2.060E-05	2.108E-05
K	mg/L		-					4.365	4.256	4.242
Li	mg/L		-					0.0027	0.0033	0.0034
Mg	mg/L		-					8.320	13.63	14.31
Mn	mg/L	0.4	0.05	0.1	0.5	3	> 3	0.1942	0.539	0.584
Mo	mg/L	0.07						0.0003	0.0019	0.0021
Na	mg/L		200	125	125	250	> 250	16.18	16.45	16.48
Ni	mg/L	0.07	0.02	0.02	0.05	0.2	> 0.2	0.0058	0.1334	0.1497
P	mg/L		-	0.02	0.16	0.65	>0.65	12.15	12.20	12.20
Pb	mg/L	0.01	0.01	0.01	0.02	0.05	> 0.05	0.0014	0.0016	0.0016
Sb	mg/L	0.02	0.005					0.0008	0.0009	0.0010
Se	mg/L	0.01	0.01	0.01	0.01	0.02	> 0.02	0.0006	0.0024	0.0027
Si	mg/L		-					28.57	5.994	5.994
Sr	mg/L		-					0.1710	0.2086	0.2135
Tl	mg/L		-					0.0007	0.0009	0.0010
U	mg/L	0.015	-					0.0001	0.0006	0.0007
V	mg/L		-					0.0045	0.0181	0.0198
Zn	mg/L		-	0.2	0.5	2	> 2	0.0581	0.2484	0.2728

Notes:

AMBIENT WATER QUALITY CRITERIA

WPCR Inland Water Quality Criteria · Turkish Ministry of Environment and Urbanization (MEU) Water Pollution Control Regulation (WPCR) Inland Water Quality Criteria (MEU, 2008)

Class I: high quality water, Class II: slightly polluted water, Class III : moderately polluted water, Class IV: highly polluted water

DRINKING WATER QUALITY CRITERIA

MH/EU ·Turkish Ministry of Health (MH) Drinking Water Criteria (MH, 2005) and European Union Drinking Water Criteria in accordance with the European Directive 98/83/EC (EU, 1998),

WHO ·World Health Organization (WHO) Drinking Water Criteria (WHO, 2006).

Table 10-30: Comparison of Predicted Water Chemistry against Inland Water Quality Criteria and Baseline Water Quality of Acısu Stream

Parameter	Unit	Ambient and Drinking Water Quality Criteria						Baseline WQ	Prediction for downstream mix (base case conditions - Model 1)	
		Drinking Water Limits		WPCR - Inland Water Quality Criteria						
		WHO	*MH/EU*	Class I	Class II	Class III	Class IV		Scenario 1	Scenario 2
pH			*6.5-9.5*	6.5-8.5	6.5-8.5	6-9	1/6-9/14	*4.2*	*3.5*	*3.5*
Alkalinity	mg $CaCO_3$/L		-					0.2000	-20.17	-20.24
SO_4	mg/L		*250*	200	200	400	> 400	213.0	*270.4*	*277.2*
Cl	mg/L		*250*	25	200	400	>400	6.645	3.622	3.610
F	mg/L	1.5	*1.5*	1	1.5	2	>2	0.2855	0.3235	0.3263
Ag	mg/L		-					0.0001	0.0001	0.0001
Al	mg/L		*0.2*	0.3	0.3	1	> 1	*7.170*	*10.06*	*10.405*
As	mg/L	0.01	*0.01*	0.02	0.05	0.1	> 0.1	0.0005	*0.0133*	*0.0145*
Ba	mg/L	0.7	-	1	2	2	> 2	0.0563	0.0103	0.0101
Be	mg/L		-					0.0002	0.0018	0.0021
Ca	mg/L		-					59.35	51.72	52.82
Cd	mg/L	0.003	*0.005*	0.003	0.005	0.01	> 0.01	4.000E-05	0.0005	0.0005
Co	mg/L			0.01	0.02	0.2	> 0.2	0.0139	0.0444	0.0505
Cr	mg/L	0.05	*0.05*	0.02	0.05	0.2	> 0.2	0.0001	0.0097	0.0109
Cu	mg/L	2	*2*	0.02	0.05	0.2	> 0.2	0.0015	0.0883	0.1014
Fe	mg/L		*0.2*	0.3	1	5	> 5	*1.214*	0.0002	0.0002
Hg	mg/L	0.006	*0.001*	0.0001	0.0005	0.002	>0.002	1.000E-06	1.397E-05	1.435E-05
K	mg/L		-					4.580	3.441	3.432
Li	mg/L		-					0.0001	0.0029	0.0029
Mg	mg/L		-					11.11	13.34	13.87
Mn	mg/L	0.4	*0.05*	0.1	0.5	3	> 3	*0.3500*	*0.3906*	*0.4252*
Mo	mg/L	0.07						0.0002	0.0013	0.0015
Na	mg/L		*200*	125	125	250	> 250	14.30	16.09	16.11
Ni	mg/L	0.07	*0.02*	0.02	0.05	0.2	> 0.2	0.0130	*0.0915*	*0.1043*
P	mg/L			0.02	0.16	0.65	>0.65	0.0040	8.250	8.264
Pb	mg/L	0.01	*0.01*	0.01	0.02	0.05	> 0.05	0.0005	0.0013	0.0013
Sb	mg/L	0.02	*0.005*					0.0010	0.0006	0.0006
Se	mg/L	0.01	*0.01*	0.01	0.01	0.02	> 0.02	0.0010	0.0017	0.0018
Si	mg/L		-						5.995	5.995
Sr	mg/L		-						0.2096	0.2134
Tl	mg/L		-					0.0010	0.0006	0.0007
U	mg/L	0.015	-						0.0004	0.0005
V	mg/L		-					0.0001	0.0121	0.0135
Zn	mg/L		-	0.2	0.5	2	> 2	0.0689	0.1685	0.1875

Notes:

AMBIENT WATER QUALITY CRITERIA

WPCR · Turkish Ministry of Environment and Urbanization (MEU) Water Pollution Control Regulation (WPCR) Inland Water Quality Criteria (MEU, 2008)

Inland Water Quality Criteria

Class I: high quality water, Class II: slightly polluted water, Class III : moderately polluted water, Class IV: highly polluted water

DRINKING WATER QUALITY CRITERIA

MH/EU ·Turkish Ministry of Health (MH) Drinking Water Criteria (MH, 2005) and European Union Drinking Water Criteria in accordance with the European Directive 98/83/EC (EU, 1998).

WHO ·World Health Organization (WHO) Drinking Water Criteria (WHO, 2006).

Conservative Approach

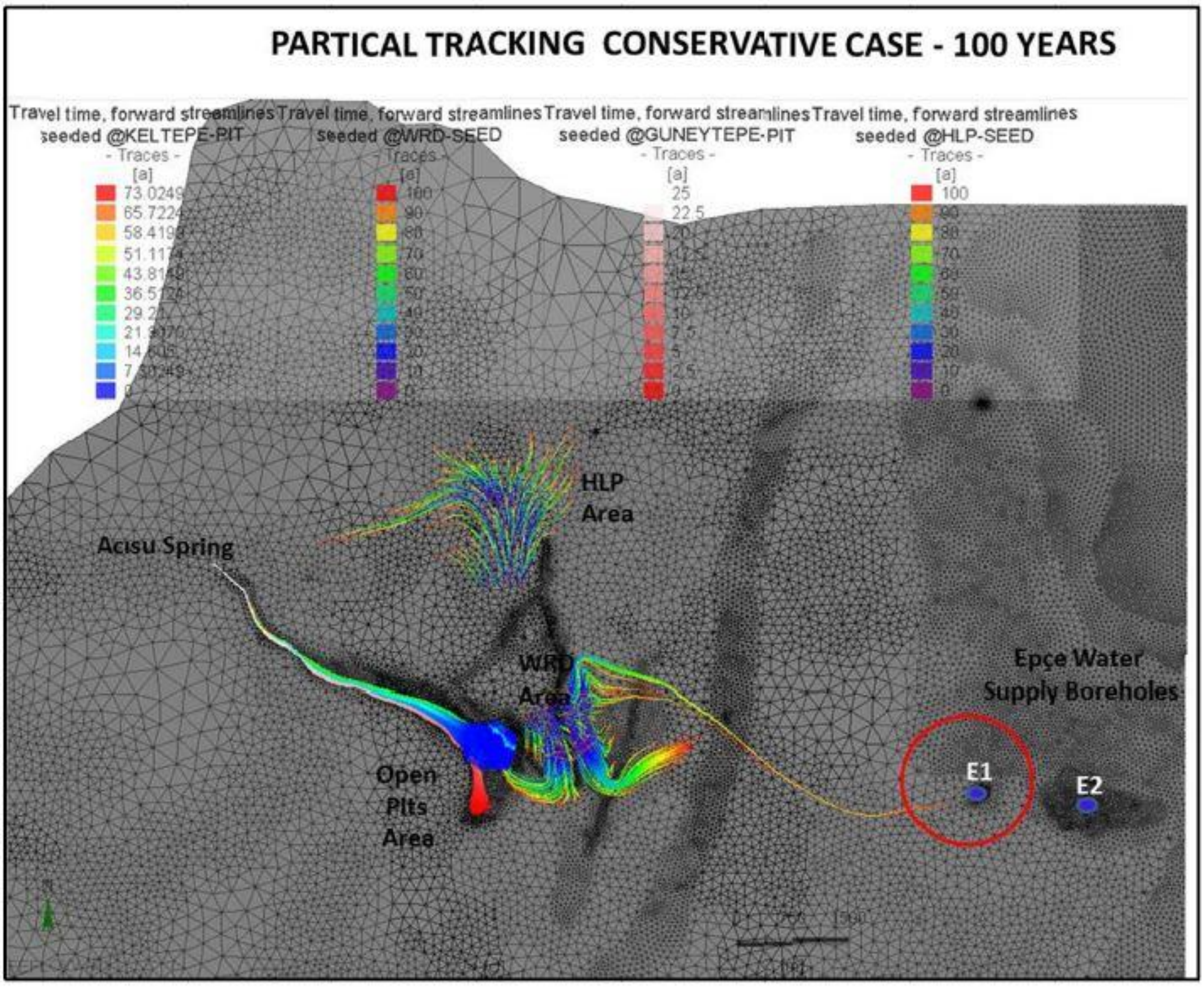
There is an alternative explanation for the deep water level on the eastern side of the WRD. In the base case, this situation is explained with the existence of permeable regional faults draining water to the Zamantı Tunnel. Although the base case is more plausible since it is also explains the mechanism of the Zamantı Tunnel inflow, given the proximity to the Epçe water supply wells, another case is studied as a conservative approach. In this case, instead of having drainage to the Zamantı Tunnel, an enhanced hydraulic conductivity zones at the valley between WRD and the Epçe area is assumed.

To evaluate this conservative scenario, the numerical groundwater model was re-calibrated with the following assumptions:

- Zamantı Tunnel inflow is sourced from deeper faults zones which is not part of this model domain;
- Instead of having drain nodes at the Zamantı Tunnel, this conservative model has high K ($4E^6$ m/s), an order of magnitude higher than other part of the andesite) between Epçe and the WRD downstream;
- Recharge of 89 mm/a into the groundwater system at the Epçe Area;
- Recharge of 55 mm/a to the Develi Volcanics;
- 182 L/s continuous abstraction from the Epçe area via irrigation wells;
- Regional groundwater inflow of 320 L/s from the north eastern boundary.

To evaluate the impacts for the conservative case, particles were placed on the nodes representing the WRD. According to 100 years steady state simulation, a small portion of the released particles (1 in 200) are found to reach the Epçe well area, as shown in Figure 10-58.

Figure 10-58: 100 Year Particle Tracking Conservative Case



In order to evaluate the uncertainty in geology between the WRD and Epçe aquifer, a conservative scenario was generated and the model was calibrated with the assumption of the presence of a high conductive zone between Epçe and WRD. Under this scenario, released particles from the WRD reach the Epçe wells in approximately 90 to 100 years. Further, capture zone analyses has indicated that these wells are primarily recharged by the northern boundary and expected dilution rates for a single particle emanating from the WRD will be in the range of 0.011 (Figure 10-59). This is considered to be a negligible impact on Epçe aquifer water quality. The downstream mixing / dilution affect based on the regional surface and groundwater flow rates were assessed to obtain a general understanding on the potentially problematic parameters. This approach provides an environmentally conservative assessment for the potentially problematic elements because it does not take into account the potential attenuation during the transport process. Accordingly, the contribution of any potential seepage from the Project WRD at Epçe well is significantly low such that impact on the baseline water quality even for environmentally conservative conditions including base case assessment conditions (no effluent treatment or waste rock segregation options applied) is insignificant. WRD downstream water quality assessment results are presented in Table 10-31.

Table 10-31: Comparison of Predicted Water Chemistry against Water Quality Criteria and Baseline Water Quality of Epçe Wells

Parameter	Unit	Ambient and Drinking Water Quality Criteria						Irrigation Water QC	Baseline WQ	Prediction for downstream mix (base case conditions - Model 1)
		Drinking Water Limits		WPCR – Inland Water Quality Criteria						
		WHO	*MH/EU*	Class I	Class II	Class III	Class IV			
pH			***6.5-9.5***	6.5-8.5	**6.5-8.5**	**6-9**	**1/6-9/14**		8.1	7.7
Alkalinity	mg $CaCO_3$/L		_						181.0	169.2
SO_4	mg/L		***250.0***	200.0	200.0	400.0	> 400		6.900	7.224
Cl	mg/L		***250***	25	200	400	>400	**350**	8.040	0.292
F	mg/L	**1.5000**	***1.5000***	1.0000	1.5000	2.0000	>2	**1**	0.0200	0.0211
Ag	mg/L		_						0.0001	0.0001
Al	mg/L		***0.2000***	0.3000	0.3000	1.0000	> 1	**5**	0.0010	0.0024
As	mg/L	**0.0100**	***0.0100***	0.0200	0.0500	0.1000	> 0.1	**0.1**	0.0005	0.0013
Ba	mg/L	**0.7000**	_	1.0000	2.0000	2.0000	> 2		0.0070	0.0070
Be	mg/L		_					**0.1**	2.000E-05	0.0002
Ca	mg/L		_						38.80	34.12
Cd	mg/L	**0.0030**	***0.0050***	0.0030	0.0050	0.0100	> 0.01	**0.01**	4.000E-05	0.0001
Co	mg/L			0.01	0.02	0.2	> 0.2	**0.05**	0.0002	0.0039
Cr	mg/L	**0.0500**	***0.0500***	0.0200	0.0500	0.2000	> 0.2	**0.1**	0.0001	0.0002
Cu	mg/L	**2.0000**	***2.0000***	0.0200	0.0500	0.2000	> 0.2	**0.2**	0.0002	0.0083
Fe	mg/L		***0.2000***	0.3000	1.0000	5.0000	> 5	**5**	0.0051	2.180E-07
Hg	mg/L	**0.0060**	***0.0010***	0.0001	0.0005	0.0020	>0.002			4.261E-08
K	mg/L		_						2.530	2.564
Li	mg/L		_					**2.5**	0.0001	0.0001
Mg	mg/L		_						13.20	13.21
Mn	mg/L	**0.4000**	***0.0500***	0.1000	0.5000	3.0000	> 3	**0.2**	0.0001	0.0001
Mo	mg/L	**0.0700**						**0.01**	0.0002	0.0003
Na	mg/L		***200***	125	125	250	> 250	**9**	**15.70**	**15.74**
Ni	mg/L	**0.07**	***0.02***	0.02	0.05	0.2	> 0.2	**0.2**	0.0002	0.0083
P	mg/L			0.02	0.16	0.65	>0.65		0.0220	0.0318
Pb	mg/L	**0.0100**	***0.0100***	0.0100	0.0200	0.0500	> 0.05	**5**	0.0005	0.0005
Sb	mg/L	**0.0200**	***0.0050***						0.0010	0.0010
Se	mg/L	**0.0100**	***0.0100***	0.0100	0.0100	0.0200	> 0.02	**0.02**	0.0010	0.0011
Si	mg/L		_							0.0001
Sr	mg/L		_							0.0023
Tl	mg/L		_						0.0010	0.0010
U	mg/L	**0.0150**	_							0.0000
V	mg/L		_					**0.1**	0.0139	0.0148
Zn	mg/L		_	0.2	0.5	2	> 2	**2**	0.0120	0.0241

Notes:

AMBIENT WATER QUALITY CRITERIA

WPCR Inland Water Quality Criteria - Turkish Ministry of Environment and Urbanization (MEU) Water Pollution Control Regulation (WPCR) Inland Water Quality Criteria (MEU, 2008)

Class I: high quality water, Class II: slightly polluted water, Class III : moderately polluted water, Class IV: highly polluted water

DRINKING WATER QUALITY CRITERIA

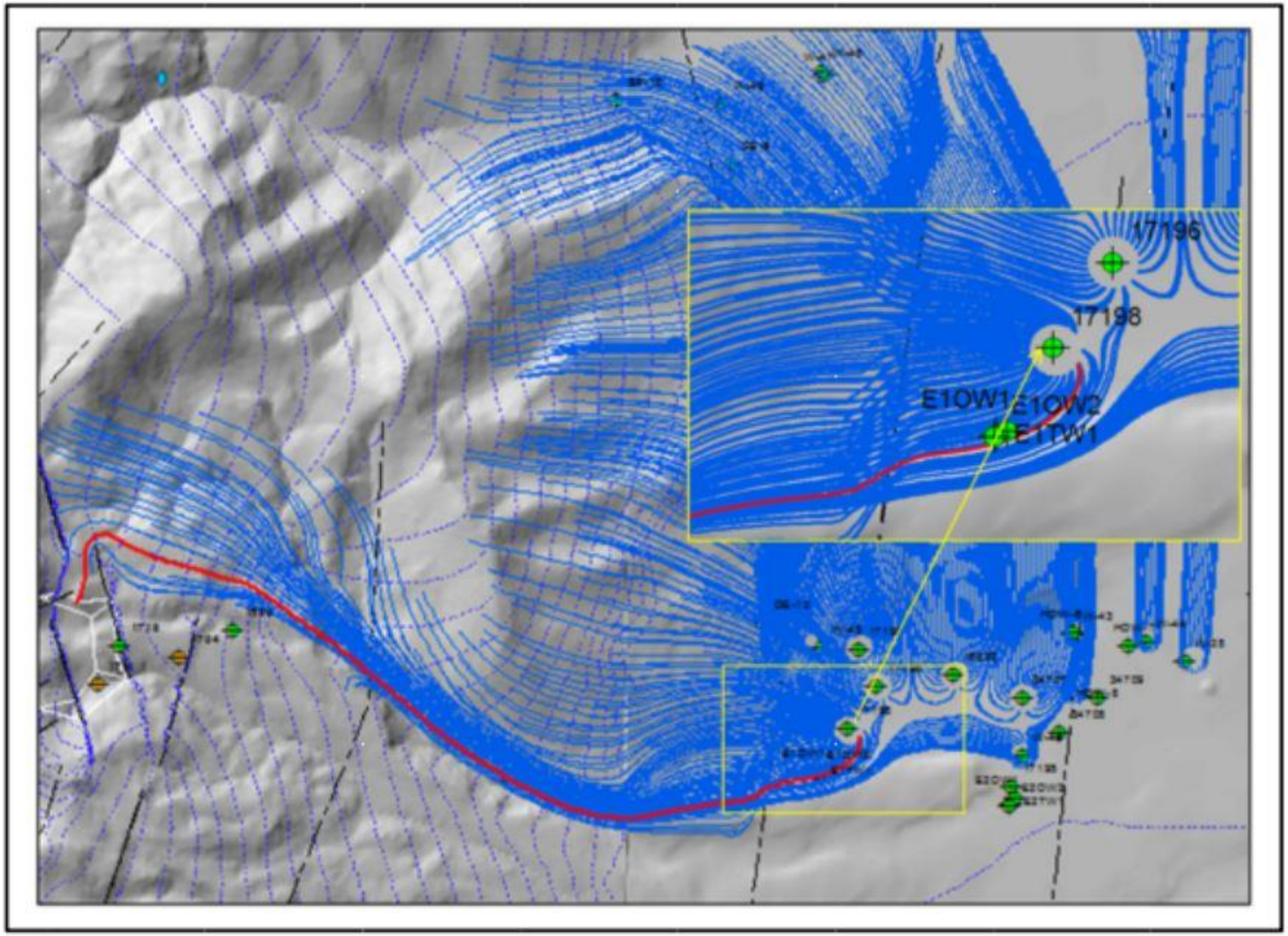
MH/EU -Turkish Ministry of Health (MH) Drinking Water Criteria (MH, 2005) and European Union Drinking Water Criteria in accordance with the European Directive 98/83/EC (EU, 1998).

WHO -World Health Organization (WHO) Drinking Water Criteria (WHO, 2006).

IRRIGATION WATER QUALITY CRITERIA

Irrigation Water QC Maximum acceptable concentrations for heavy metal and toxic elements i irrigational waters and limit values for the classification of chemical quality of irrigational waters given by the Irrigational Water Communiqué on the Technical Guideline for Waste Water Treatment Plants (MEU, 2010)

Figure 10-59: Capture Zone Analysis



The baseline water quality in monitoring wells in the Epçe aquifer indicates a sodium (Na) content of 15.0 mg/L which is in excess of irrigation water standards. The impact on groundwater quality of the Epçe aquifer under the worst case scenario is that sodium concentrations increase to 15.7 mg/l. As a result, while sodium concentrations will be above drinking water standards, the contribution that the Project will make to levels being above the standard are not significant.

During closure, water resource management focuses on limiting the amount of water that passes through the WRD and HLF, the routing of surface water around remnant Project facilities and Project Area rehabilitation (i.e. re-instatement of natural drainage lines). Leachate from the WRD and HLF will abate over time as the facilities will be capped. Water discharge sources during closure include:

- Keltepe and Güneytepe Open Pits (discharge as recharge to groundwater);
- WRD;
- HLF.

The duration of these water resource related discharge sources are constrained to the closure period, typically 100 years.

Water resource impacts as a result of Project related closure activities are:

- Reduction of surface and groundwater quantity;
- Deterioration of surface and groundwater quality.

Surface Water Quality

Impact Assessment

Impact:	Reduction of surface water quality. The Open Pits will remain open following mine closure and runoff from the Pit walls will continue to be generated. The WRD and HLF closure landforms will continue to produce leachate which may enter local watercourses.
Receptor & Sensitivity:	Local creeks and streams of medium sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the closure period (taken as 100 years); ▪ Extent: Local; ▪ Likelihood: Likely to occur as a consequence of mine closure. Overall, impact magnitude is expected to be medium.
Significance:	Minor adverse.

Impact Mitigation

Limit contact water generation by capping the HLF and WRD with low permeable material (e.g. clayey soil). Retain surface water runoff interception channels and ditches to continue to route water round the Open Pits, HLF and WRD.

The Conceptual Mine Closure Framework (OMAS-ESMS-CP-PLN-001) sets out the process that OMAS will use to develop detailed closure and rehabilitation plans for the Project.

Residual Effects

Implementation of the proposed impact mitigation measures will lead to a residual effect of **negligible** significance. No compensation or offsets are required.

Surface Water Quantity

The closure landforms of the HLF and WRD will return areal catchment areas to pre-mining baseline levels. Infrastructure will be removed and roads rehabilitated. The permanent very minor reduction in catchment size due to the Open Pits remaining open (Öksüt and Zile Drainage Basins only) is not considered a material closure impact based on the estimates in Table 10-32.

Table 10-32: Estimated reduction in basin size after closure.

Drainage Basin Name	% Size Reduction (approx.)
Öksüt Basin	1.0
Zile Basin	0.5
Tandırlık Creek Basin	0
Gomedi Basin	0
Kıvçak Creek Basin	0

Impact Assessment

Impact:	Reduction of surface water quantity.
Receptor & Sensitivity:	Local creeks and streams of medium sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of mine closure (taken as 100 years); ▪ Extent: Local; ▪ Likelihood: Likely to occur as a consequence of mine closure. Overall, impact magnitude is expected to be low.
Significance:	Minor adverse.

Impact Mitigation

The volume of water that will be lost from the drainage basins due to water collecting in the Open Pits is considered to be insignificant in terms of the total input to the affected basins. No additional mitigation measures are therefore, proposed. It is anticipated that water will leave the Pits as groundwater recharge thereby adding to flow in the Acısu Spring or it will evaporate.

The Conceptual Mine Closure Framework (OMAS-ESMS-CP-PLN-001) sets out the process that OMAS will use to develop detailed closure and rehabilitation plans for the Project.

Residual Impact

Residual impacts are considered to be negligible and not requiring of further mitigation.

Groundwater Quality

Particle tracking model simulations indicate particles released from the Open Pits reach the Acısu spring in approximately 10 years. A high fracture zone also exists along the pathway from Open Pits to the spring. The existing baseline acidic pH conditions are expected to continue. The solute parameters are likely to increase relatively with the predicted increase in flow rate in the stream.

Impact Assessment (Acısu Spring)

Impact:	Deterioration of groundwater quality
Receptor & Sensitivity:	Acısu Spring: The spring is of high sensitivity. Baseline water quality indicates it's not suitable for drinking purposes. The spring feeds a stream which is however, used for recreational purposes by local villagers.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the closure period (taken as 100 years) or until source rocks oxidise to the point that mobilisation of trace elements effectively ceases; ▪ Extent: Local to the Acısu Spring; ▪ Likelihood: Likely to occur as a consequence of leaving the Open Pits open after mine closure. Overall impact magnitude is expected to be low.
Significance:	Minor adverse.

Impact Mitigation

A closure monitoring programme will be implemented at the Acısu Spring. Should adverse effects on water quality be observed, additional remedial actions will be taken to neutralise water that infiltrates the ground at the mine site post closure.

Residual Effects

The water quality in the Acısu Spring is expected to remain of poor quality permanently. The increased recharge and solute parameters from the Open Pits post-closure are not expected to exacerbate the current baseline conditions to any great extent. The residual impact to groundwater quality is therefore, considered to be **negligible**. No compensation or offsets are proposed.

Impact Assessment (Project Area unsaturated zone)

Impact:	Deterioration to groundwater quality. Open Pits will remain open and the WRD and HLF closure landforms will continue to produce leachate
Receptor & Sensitivity:	Project Area unsaturated zone (groundwater receptors e.g. Epçe) of medium sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the closure period (taken as 100 years); ▪ Extent: Local; ▪ Likelihood: Likely to occur post mine closure. Overall, impact magnitude is expected to be low.
Significance:	The effect significance will be of minor adverse.

Impact Mitigation

Limit generation of contact water by maintaining interception drains and ditches around the Open Pits. The HLF and WRD will be capped to minimise infiltration.

The Conceptual Mine Closure Framework (OMAS-ESMS-CP-PLN-001) sets out the process that OMAS will use to develop detailed closure and rehabilitation plans for the Project.

Residual Effects

Modelling of proposed mitigation measures indicate that particles from the HLF and WRD may reach receptors (principally, the Epçe aquifer) within 100 years. Natural dilution and attenuation together with implementation of the proposed mitigation measures for the closure period may lead to a **minor adverse** residual effect. This is subject to considerable uncertainty and would be the focus of ongoing monitoring to be set out in the detailed Closure Plan.

In order to evaluate the uncertainty in geology between the WRD and Epçe aquifer, a conservative scenario was generated and the model was calibrated with the assumption of the presence of a high conductive zone between Epçe and the WRD. Under this scenario, released particles from the WRD reach the Epçe wells in approximately 90 to 100 years. Further, capture zone analyses has indicated that these wells are primarily recharged by the northern boundary and expected dilution rates for a single particle emanating from the WRD will be in the range of 0.011 (Figure 10-59). This is considered to lead to a negligible impact on Epçe aquifer water quality.

The downstream attenuation/dilution effect based on the regional surface and groundwater flow rates were assessed to obtain a general understanding on the parameters that may cause potential water quality issues. This approach provides an environmentally conservative assessment for the potentially problematic parameters because it does not take into account the potential attenuation during the transport process. As a result, the contribution of any potential seepage from the Project WRD to the water abstraction wells in Epçe is so low that the impact on baseline water quality - even for environmentally conservative conditions including base case assessment conditions (no effluent treatment or waste rock segregation options applied) - is insignificant. WRD downstream water quality assessment results are presented in Table 10-31.

Groundwater Quantity

Acısu Spring

Model simulations indicate increased recharge due to the excavation of the Keltepe Pit. A high fracture zone also exists along the pathway from Pit to the Acısu Spring. Modelling simulations indicate an increase of approximately 2.5% of flows to the spring.

Impact Assessment

Impact:	Increase to groundwater quantity.
Receptor & Sensitivity:	Acısu Spring of high sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the closure period (taken as 100 years); ▪ Extent: Local to the Acısu Spring; ▪ Likelihood: Likely to occur as a consequence of excavating the Open Pit and leaving it open post closure. Overall, impact magnitude is expected to be low.
Significance:	Positive (increase in spring flow quantity).

Impact Mitigation

No mitigation is considered necessary for an increase in flow in the Acısu Spring.

Residual Effects

Residual impacts will be a minor permanent increase in flow in Acısu Spring.

Epçe Wells

Following cessation of mine operations, mine water supply wells will cease to pump. Groundwater levels in the Epçe area are expected to rebound to baseline levels within approximately one wet season thereby re-instating pre-mining conditions.

Impact Assessment

Impact:	Increase to groundwater quantity.
Receptor & Sensitivity:	Epçe wells of high sensitivity.
Description:	▪ Type: Direct; ▪ Duration: Long term, duration of the closure period (taken as 100 years); ▪ Extent: Local to the Epçe area; ▪ Likelihood: Likely to occur as a consequence of cessation of groundwater use by the mining operations. Overall, impact is expected to be medium.
Significance:	Positive (rebound of groundwater levels).

Impact Mitigation

No mitigation is considered necessary for a rebound of groundwater levels.

Residual Effects

Residual impacts will be positive. No compensation or offsets are required.

10.8.5 Summary of Impacts and Mitigation Measures

Summaries of potential impacts and proposed mitigation measures for the construction, operations and closure phases of the Project are presented in Table 10-33, Table 10-34 and Table 10-35, respectively, below.

Table 10-33: Construction Phase Impacts and Mitigation Measures

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans, Policies and Procedures	Residual Effect Significance
Reduction of surface water quantity and loss of surface water features under permanent mine facilities	Surface water receptors (ephemeral creeks/springs) including Yukarı Develi water secondary water supply line water sources	Medium to High	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Certain	**High**	**Major adverse**	Sediment ponds will be constructed at commencement of the construction phase. The ponds will detain and release water to the catchments without resulting in adverse increase in streamflow that would also result in channel scour and erosion. Livelihoods Restoration Framework will address loss of springs and pasture to local shepherds. Replacement water sources will be identified to replace springs lost within the EIA Permitted Area.	**Water Resources Management Plan**	**Low**

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans, Policies and Procedures	Residual Effect Significance
Deterioration of surface water quality - sedimentation	Surface water receptors (ephemeral creeks and local streams)	Medium	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	**Low**	**Minor adverse**	Sediment ponds will be constructed at commencement of the construction phase. Entrained soil material will settle out prior to releasing the water. For powerline construction: ▪ Construction debris will not be disposed in watercourses ▪ There will be no discharges to surface waters ▪ No activities will be undertaken within 20m of watercourses ▪ If water course require crossing for construction purposes prior consent will be sought from DSİ. ▪ There will warning signs at appropriate numbers at the location where the powerline crosses any river bed. ▪ Compensation will be provided by TEİAŞ for any damage to wells, springs and irrigation facilities in accordance with the requirements listed in Primary Ministry Decree (2006/27) dated 09.09.2006 and No 26 284.	**Water Resources Management Plan**	**Negligible**

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans, Policies and Procedures	Residual Effect Significance
Deterioration of surface water quality – contamination from accidental spill	Surface water receptors (ephemeral creeks and local streams)	Medium	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Unlikely	**Low**	**Minor adverse**	Implementation of appropriate pollution prevention and control measures will mitigate impacts on surface water quality in relation to contamination from accidental spills. Immediate remedial action in the event that there is a spill will prevent the contaminants from entering watercourses. This is set out in the Hazardous Materials Management Plan and Emergency Response Plan. Powerline management controls will be as outlined above.	**Water Resources Management Plan** **Hazardous Materials Management Plan** **Emergency Response Plan.**	**Negligible**
Aquifer drawdown due to water abstraction	Epçe Area aquifer	High	**Type** Direct **Duration** Long term **Extent** Localised **Likelihood** Certain	**Low**	Minor adverse	Permitted water abstraction rates have been established to ensure sustainability of the existing aquifer and to ensure significant adverse impacts to other water users are avoided. Continuous water level monitoring programme. An additional monitoring well will be installed between the mine's abstraction wells and local cooperative abstraction wells. If the expected drawdown is higher than predicted, pumps will be deepened or new wells drilled.	**Water Resources Management Plan**	**Negligible**

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans, Policies and Procedures	Residual Effect Significance
Deterioration of groundwater quality due to spillages	Project area unsaturated zone (groundwater receptors)	Medium	**Type** Direct **Duration** Short term **Extent** Localised **Likelihood** Highly Unlikely	**Low**	Minor adverse	Best Management Practises will be implemented that covers the storage and use of oils, lubricants, chemicals and fuel. This is set out in the Hazardous Materials Management Plan and Emergency Response Plan.	**Water Resources Management Plan** **Hazardous Materials Management Plan** **Emergency Response Plan.**	**Negligible**

Table 10-34: Operations Phase Impacts and Mitigation Measures

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans,	Residual Effects
Reduction of surface water quantity.	Surface water receptors (ephemeral creeks and local streams)	Medium	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Certain	Medium	Minor adverse	During the operations phase, surface water that comes into contact with the WRD, HLF and Open Pits (walls) will be diverted to collection ponds and sumps and will be routed back to the Ore Processing facility for re-use. Limit non-impacted water coming into contact with HLF, WRD and Pits by effectively operating upstream interception trenches. The HLP will be completely lined with geo-membrane. The WRD area will levelled (prior to operation) and seepage drainage channels will be operated to ensure seepage in collected and returned to the operation. Direct precipitation runoff from Pit walls will report to a collection sump and returned for re-use in the operation.	**Water Resources Management Plan**	**Negligible**

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans,	Residual Effects
Reduction of groundwater quantity (drawdown)	Epçe Area aquifers	High	**Type** Direct **Duration** Long term **Extent** Localised **Likelihood** Certain	Medium	Moderate adverse	Continuous water level monitoring programme. An additional monitoring well will be installed between the mine's abstraction wells and local cooperative abstraction wells. If the drawdown is higher than simulated, pumps will be deepened or new wells drilled.	**Water Resources Management Plan**	**Negligible**
Deterioration of groundwater quality.	Acısu Spring	High	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Low	Minor adverse	Continuous monitoring programme at the Spring to validate modelling. Periodic water quality monitoring. If significant changes to water chemistry are identified, investigate appropriate mitigations.	**Water Resources Management Plan**	**Minor**

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans,	Residual Effects
Deterioration of groundwater quality.	Project area unsaturated zone (groundwater receptors)	High	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Medium	Moderate adverse	Limit non-impacted water coming into contact with HLF, WRD and Pits by effectively operating upstream interception trenches. The HLP will be completely lined with geo-membrane. The WRD area will levelled (prior to operation) and seepage drainage channels will be operated to ensure seepage in collected and returned to the operation. Direct precipitation runoff from Pit walls will report to a collection sump and returned for re-use in the operation.	**Water Resources Management Plan**	**Negligible**
Increase in groundwater quantity.	Acısu Spring	High	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Low	Positive	Continuous monitoring programme at the Spring No other mitigation proposed for increase in flow.	**Water Resources Management Plan**	**Positive**

Table 10-35: Closure Phase Impacts and Mitigation Measures

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans, Policies and Procedures	Residual Effect Significance
Deterioration of surface water quality	Surface water receptors (ephemeral creeks and local streams)	Medium	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Medium	Minor adverse	Limit contact water generation by capping the HLF and WRD with low permeable material (e.g. clayey soil). Retain surface water runoff interception channels and ditches to continue to route water round the Open Pits, HLF and WRD.	**Closure Plan**	**Negligible**
Reduction of surface water quantity	Surface water receptors (ephemeral creeks and local streams)	Medium	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Low	Minor adverse	The volume of water that will be lost from the drainage basins due to water collecting in the Open Pits is considered to be insignificant in terms of the total input to the affected basins. No additional mitigation measures are therefore, proposed.	**Closure Plan**	**Negligible**
Deterioration of groundwater quality	Acısu Spring	High	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Low	Minor adverse	No mitigation required.	**Closure Plan**	**Negligible**

Impact	Receptor	Receptor Sensitivity	Impact Categorisation	Magnitude of Impact	Potential Effect Significance	Design and Mitigation Measures	Management Plans, Policies and Procedures	Residual Effect Significance
Deterioration of groundwater quality	Project area unsaturated zone (groundwater receptors e.g. Epçe)	Medium	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Low	Minor adverse	Limit non-impacted water coming into contact with the Pits by constructing permanent interception trenches. The HLP will be completely covered to prevent infiltration. The WRD will be completely covered to prevent infiltration.	**Closure Plan**	**Minor adverse**
Increase to groundwater quantity	Acisu Spring	High	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Low	Positive	Closure monitoring programme	**Closure Plan**	**Positive**
Increase to groundwater quantity	Epçe Aquifer	High	**Type** Direct **Duration** Long term **Extent** Local **Likelihood** Likely	Medium	Positive	Closure monitoring programme	**Closure Plan**	**Positive**

10.9 Monitoring Requirements

Water monitoring requirements are outlined in Table 7.2 of the Turkish EIA (included in Table 10-37 below) and are summarised in Table 10-36 which presents the key Project monitoring requirements in respect of water resources.

Where appropriate, participatory monitoring methods will be developed in consultation with local communities. This is outlined in the Water Resources Management Plan (OMAS-ESMS-WR-PLN-001).

Table 10-36: Project Monitoring Requirements

Source	Monitoring Location	Parameters	Frequency
Climate	Weather Station (TBD)	Temperature, wind speed, wind direction, humidity, rainfall, atmospheric pressure	Continuous
Surface water flow	Acısu and Öksüt Weirs	Continuous flow	Continuous recording; quarterly data logger download
Surface water flow	Acısu and Öksüt Weirs	Manual Stage and Photographic Record of Weir.	Quarterly at the data logger download time
Surface water quality	Acısu and Öksüt Weirs	Water Quality: Key parameters only, with full-suite analysis on an annual basis or if required on a risk assessment basis	Quarterly
Surface water quality	Refer to Figure 10-3	Water Quality: Key parameters only, with full-suite analysis on an annual basis or if required on a risk assessment basis	Quarterly & opportunistic
Ground water level	Refer to Table 10-15 and Table 10-17	Continuous	Continuous recording; quarterly data logger download
Ground water quality	Refer to Table 10-17	Water Quality: Key parameters only, with full-suite analysis on an annual basis or if required on a risk assessment basis	Monthly & quarterly for laboratory analysis
Acısu Spring	Acısu Spring	Spot flow	Monthly
Acısu Spring	Acısu Spring	Water quality (changes from the baseline)	Monthly
Surface water quality	SP63, SP72, SP73.	Spot flow	Monthly while replacement water sources for Yukarı Develi are identified
Surface water flow	SP63, SP72, SP73.	Manual Stage and Photographic Record	Monthly while replacement water sources for Yukarı Develi are identified

The Turkish EIA sets out a range of specific water monitoring requirements. These are set out below and are incorporated into the monitoring framework set out in the Water Resources Management Plan (OMAS-ESMS-WR-PLN-001).

Table 10-37: Additional Monitoring Requirements Defined in the Turkish EIA

Component	Monitoring Spot	Monitoring Method	Frequency	Parameter	Purpose
Site parameters of surface waters	At surface water monitoring spots (Mağaraboğazı creek, Kırpıklı creek, Kurtlararkaç creek, and Camboğaz creek)	Site measurements	Quarterly during the construction and operation periods and during the 1st period (rehabilitation) after the closure, once six months during the 2nd period after the closure, and once a year during the 3rd period.	Flow rate, site parameters (T, pH, EC)	Monitor any change in the amount of water, determine appropriate discharge flow rates by taking into account the habitats in the downstream, and identify any material changes in the water quality
Groundwater site parameters - downstream of HLS	At HLS observation wells (HLP001, HLP002, HLP003, HLP004)and at sub-lining drainage system	Site measurements	Monthly during the construction and operation periods and quarterly during the 1st period (rehabilitation) after the closure and once six months during the subsequent period.	Static groundwater levels, site parameters (T, qH, EC)	Monitor the amount of groundwater and the impact of its discharge, compare it with the detailed groundwater discharge plan, and identify any material change in the water quality
Groundwater site parameters-project site	At other observation wells (WRD001, WRD002, WRD003, KTP002B, GTP001)	Site measurements	Monthly during the construction and operation periods, quarterly during the 1st period (rehabilitation), once six months during the 2nd period and yearly during the 3rd period, after the closure.	Static groundwater levels, site parameters (T, pH, EC)	Monitor the amount of the groundwater and the impacts of its discharge, compare it with the detailed groundwater discharge plan, and identify any material change in the water quality
Groundwater quality - surrounds of the project site	Important springs and fountains (OKDS21, OKDS22) in the surrounds of the project site (OKDS21, OKDS22)	Site measurements	Quarterly during the construction and operation periods and during the 1st period (rehabilitation), once six months during the 2nd period and yearly during the 3rd period, after the closure.	Static groundwater levels, site parameters (T, pH, EC)	Monitor any change in the amount of the water, identify any material change in the water quality

10.10 Outline Water Monitoring Program

The water monitoring will include the quantity and quality of both surface and groundwater sources located within the impact area of the project. The monitoring locations will allow monitoring of the potential environmental impacts during the construction, operation and post-operation stages of the project

The monitoring program will include the following:

- Flow and groundwater elevation measurements to monitor the quantity of the water sources;
- Measurement of the field parameters (T, pH, EC) to detect any potential change in the water quality;
- Sediment load measurements;
- Sampling and water analysis works for detailed monitoring of the water quality to identify and prevent potential impacts to the receiving environments.

At a minimum the water quality analysis program will include the following parameters:

- Suspended Solids (SS);
- Chemical Oxygen Demand (COD);
- pH;
- Conductivity;
- S_{-2} ;
- Basic anions, including SO_4, Cl and F (as defined in the Water Pollution Control Regulation);
- Dissolved metals and semi-metals (as minimum, Al, As, B, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Se and Zn parameters);
- Basic cations (as defined in the Water Pollution Control Regulation);
- Total Cyanide (TCN) and Weak Acid Dissolvable Cyanide (WADCN).

10.10.1 Monitoring Frequency

Construction and Operation Period

Flow and groundwater elevation measurements, measurement of field parameters and sampling-lab analyses will be performed on a regular basis during the construction and operation periods of the project. Details of the groundwater and surface water sampling and measurement frequency during the construction and periods is set out in Table 10-38 and Table 10-39.

Closure and Post-Closure

The details of Flow and groundwater elevation measurements, measurement of field parameters and sampling-lab analyses frequency during the closure period is set out in Table 10-38 and Table 10-39. The summary is as follows:

- 1st Period – Closure and Rehabilitation (3 Years): Measurement of site parameters and sampling-lab analyses quarterly throughout the closure and rehabilitation period.
- 2nd Period - Post Closure (7 years): Measurement of site parameters and sampling-lab analyses every six months throughout the following seven years.
- 3rd Period – Post Closure (20 years): Sampling-lab analyses and measurement of site parameters at the groundwater monitoring wells within the heap leaching site, at the sub-lining drainage system and at the surface water monitoring spot in the downstream once six months

during the following period until the quality of the water from the units has become stable and at all other observation points once a year. Closure and post-closure monitoring will be continued for up to 30 years.

Sampling frequency will be evaluated according the results of the measurements obtained at the end of the first year. If any adverse impacts are observed during the monitoring, monitoring frequency should be increased and further investigations should be initiated. The monitoring results will be reported to Ministry of Environment and Urbanization, Directorate of State Water Administration (DSI) and other regulatory offices and institutions upon request. In addition, an evaluation report, on the baseline condition description, the effectiveness of the mitigation measures and pit rehabilitation, the closure of the waste rock area and heap leach area, will be prepared and will be submitted to DSI every five years and before the closure for assessment and information.

10.10.2 Groundwater Monitoring Program

Groundwater will be monitored using several groundwater monitoring wells installed at the upstream and the downstream of the Project Facilities.

Groundwater levels and the field parameters (T, pH, EC) will be measured and groundwater samples will be collected and lab test will be performed on defined regular intervals. Details of the groundwater monitoring program is presented below:

Heap Leach Facility

The HLF is surrounded by four groundwater monitoring wells including HLP001, HLP0003 and HLP004 as downstream and HLP002 as upstream observation wells. The groundwater monitoring program will include monitoring and sampling of all of the four wells. Since the observation well HLP002 is located at the upstream of the Heap Leach Facility, the baseline data of the well will be used as reference measurement and will be compared with the other wells (HLP001, HLP0003 and HLP004) during the construction-operation, closure and post-closure periods. An additional groundwater well (HLP005) will be drilled in between HLP003 and HLP004. The proposed well will be located on the Heap Leach Facility' groundwater flow pathway identified by the numerical groundwater model. Any increase in cyanide concentration over the trigger level will trigger risk assessment studies and further technical investigations.

Waste Rock Dump

Potential impacts to the groundwater will be monitored by using three observation wells located at the upstream and downstream of the waste rock dump. WRD003 is located at the upstream and the WRD002 and WRD001 are located at the downstream of the dump site. WRD001 is located relatively distant from the WRDe which will allow OMAS to monitor the longer term potential impacts and also assess attenuation and dilution affects. Upstream WRD002 will be used as reference and the monitoring results of the wells will be compared with the earlier measurements and with each other. Risk assessment and further technical investigations will be initiated if significant changes are observed in the monitoring results.

Open Pits

Sampling and measurement of field parameters (T, pH, EC) will be carried out at the observation well GTP001 located at the downstream of the Güneytepe open pit and at the observation well KTP002B located at the downstream of the Keltepe open pit.

Springs and Other Groundwater Monitoring Locations

- Monthly field parameters monitoring and quarterly sampling-lab analyses will be conducted at the spring OKDS21 located at the downstream of the heap leach facility and at the fountain OKDS22 located at the downstream of the waste rock dump.

- Acısu spring (OKSP56) will be monitored and sampled on a monthly basis. Monitoring program will include flow and field parameters (T, pH, EC) measurements and sampling for water quality analyses.
- OKSP32 located at the downstream of the waste rock dump will be monitored according to the schedule presented in Table 10-38.
- Monitoring and sampling will be conducted at OKSP55 (spring with similar water quality with Acısu which is located very close to the Zile Village and the abandoned iron mine) and OKDS28 (spring for Zile Village). Monitoring program is presented in Table 10-38.
- Monitoring and sampling will be conducted at OKDS27 (fountain of Öksüt Village located at the downstream of the Güneytepe Pit) and OKSP54 (spring located downstream of Güneytepe Pit) according to the schedule presented in Table 10-38.
- The water transmission line for the Yukarı Develi water sources will remain under the planned HLF area. With the purpose of providing an alternative water source, flow rate and quality measurements were performed at springs SP63, SP72 and SP73. A more detailed investigation will be conducted after the commencement of the Project with the aim of replacing the Yukarı Develi Transmission Line water sources. When appropriate alternative springs are identified, the selected water sources will be added to the monitoring and sampling program presented in Table 10-38.
- Two additional monitoring wells will be installed between the Project's water abstraction wells (E1 and E2) and the local cooperative abstraction wells (17198 and W46). Groundwater levels at the wells in the Epçe area will be continuously monitored during the Project's construction and operation phases. If the expected drawdown is greater than simulated, water abstraction rates will be reduced, existing wells will be deepened or new wells will be installed to supplement supply to Epçe so that there is no net loss in water supply or availability for other water users. Groundwater quality in well 17198 will be monitored during life of the Project as presented in Table 10-38.
- HLF sub-lining drainage system: Monitoring of site parameters, quality and quantitative measurements will be undertaken from the HLF sub-lining draining system.

A map showing the groundwater monitoring locations are presented in Figure 10-60.

Figure 10-60: Groundwater Monitoring Locations

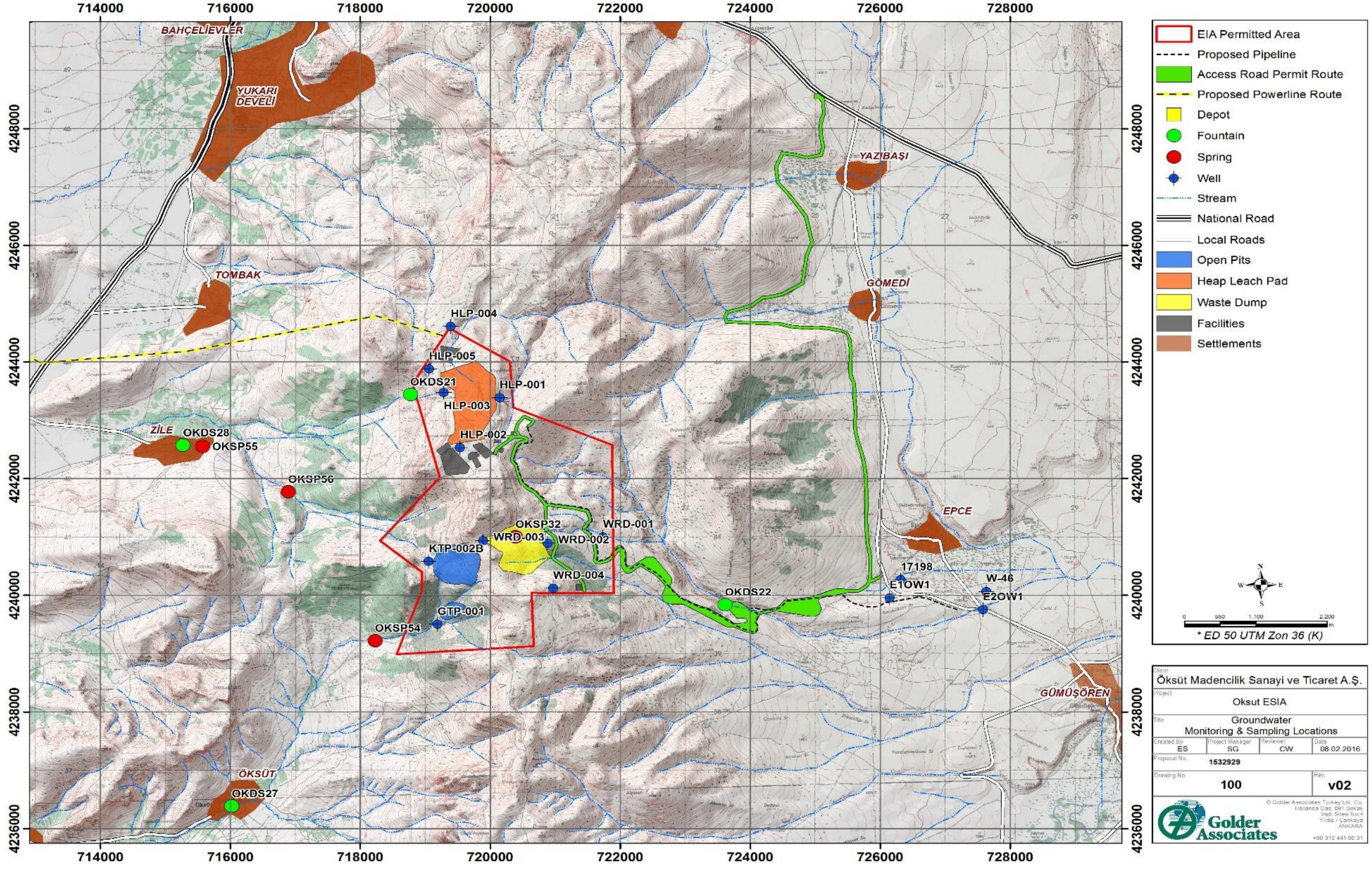


Table 10-38: Groundwater Monitoring & Sampling Program

Type of Spot	Measurement Spots	Parameter	Construction Stage	Operation Stage	Closure Stage		
					1st Period	2nd Period	3rd Period
Wells (Heap Leach Facility)	HLF (HLP-001, HLP-002[1], HLP-003, HLP-004[1], HLP-005-Proposed Well)	Groundwater Level	Monthly	Monthly	Quarterly	6 Months	Once a year
		Field Parameters (T, pH, EC)	Monthly	Monthly	Quarterly	6 Months	Once a year
		Chemical Parameters (Lab Analyses)	Quarterly	Quarterly	Quarterly	6 Months	6 Months
Wells (WRD & Pits)	Keltepe Pit (KTP-002B) Güneytepe Pit (GTP-001[1]) WRD (WRD-001, WRD-002, WRD-003[1])	Groundwater Level	Monthly	Monthly	Quarterly	6 Months	Once a year
		Field Parameters (T, pH, EC)	Monthly	Monthly	Quarterly	6 Months	Once a year
		Chemical Parameters (Lab Analyses)	Quarterly	Quarterly	Quarterly	6 Months	Once a year
Wells (Epçe)	Epçe (17198[2], W-46[2], E1OW1, E2OW1)	Groundwater Level	Monthly	Monthly	Quarterly	6 Months	Once a year
		Field Parameters (T, pH, EC)	Monthly	Monthly	Quarterly	6 Months	Once a year
	Epçe (17198)	Chemical Parameters (Lab Analyses)	Quarterly	Quarterly	Quarterly	6 Months	Once a year
Spring & Fountains	HLF (OKDS21) WRD (OKDS22, OKSP32) Yukarı Develi Spring[3] Öksüt (OKDS27, OKSP54) Zile (OKSP55, OKDS29) Acısu (OKSP56)	Flow Rate	Monthly	Monthly	Quarterly	6 Months	Once a year
		Field Parameters (T, pH, EC)	Monthly	Monthly	Quarterly	6 Months	Once a year
		Chemical Parameters (Lab Analyses)	Quarterly	Quarterly	Quarterly	6 Months	Once a year

[1] continuous measurement will be done by means of pressure probe
[2] One observation well will be drilled between these two wells and one between E1 and E2 mine water supply wells and monitoring will be carried out at these 2 observation wells.
[3] Alternative water source will be identified during construction stage.

10.10.3 Surface Water Monitoring Program

Surface waters located at the downstream of the Project Facilities will be regularly monitored. Monitoring will start during the construction period. The monitoring program will include measurement of site parameters, quantitative measurements (level/flow rate), sediment measurements and sampling for lab analyses. Sediment samples will be taken from the stream bed and analysed as per the parameters specified in the Regulation on the Management of Superficial Water Quality on an annual basis.

Downstream of the Heap Leach Facility

Monitoring of the Mağaraboğazı creek (OKSW18) located at the downstream of the HLF has been undertaken as part of the baseline studies for the Turkish EIA. Monitoring of the quality OKSW18 will continue during the construction, operation and post-operation periods. In addition to quality measurements, suspended solids and sediment monitoring will be conducted.

Downstream of the Waste Rock Dump

Monitoring of the Kırpıklıdere (OKSW14) and Kurtlararkaç creeks located at the downstream of the waste rock dump has been commenced as part of the EIA studies for identification of the current baseline conditions. Monitoring of the quality of the Kırpıklıdere (OKSW14) and Kurtlararkaç creeks will continue during the construction, operation and post-operation periods. In addition to quality measurements, suspended solid and sediment monitoring will be conducted.

Downstream of the Open Pit

Monitoring work will be carried out on the Camboğaz creek (OKSW11) located downstream of the Güneytepe open pit.

Contact Water Collection Ponds and Sumps

Contact water will be collected in contact water ponds located at the downstream of the waste rock dump. Contact water of the ore stockpile and pits will be collected in sumps. Field parameters (T, pH, EC) will be monitored on a monthly basis and the water levels and flows will be measured on a daily basis to prevent any potential overflow. Water quality samples will be collected from the open pit contact water sumps and lab analyses will be conducted on a quarterly basis.

Acısu and Öksüt Creek

Weirs installed on the Acısu Creek and Öksüt Creek will take continuous flow measurements to monitor the hydrologic characteristics of these surface drainage features and the precipitation-flow relationships. Water samples will be collected quarterly to monitor the water quality of Acısu and Öksüt streams

A map showing the approximate location of surface water monitoring locations are presented in Figure 10-61.

Figure 10-61: Surface Water Monitoring Locations

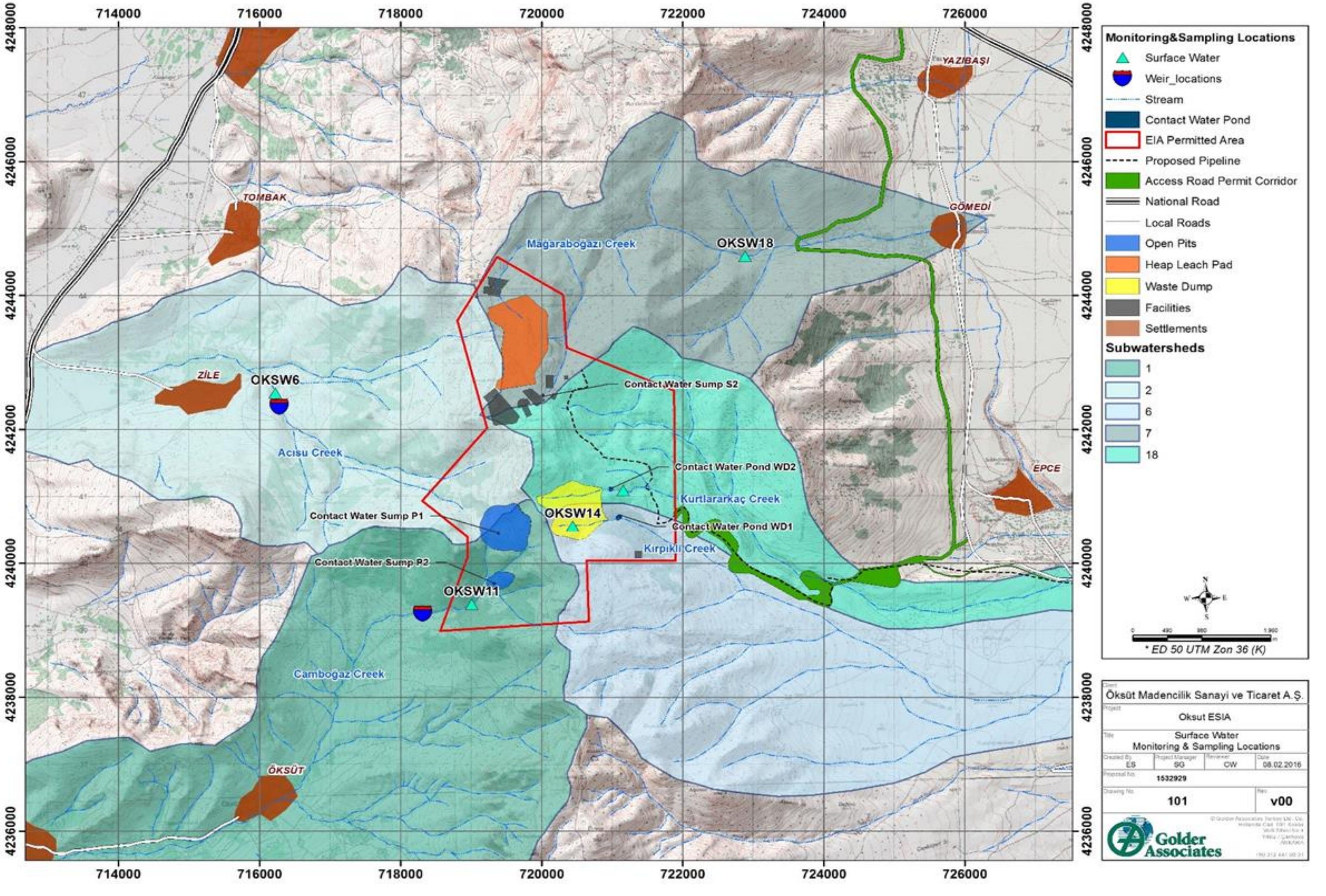


Table 10-39: Surface Water Monitoring & Sampling Program

Type of Spot	Measurement Spots	Parameter	Construction Stage	Operation Stage	Closure Stage		
					1st Period	2nd Period	3rd Period
Weir Locations	Acısu Weir[1] (OKSW-6) Öksüt Weir (Camboğaz Creek (OKSW-11))	Flow Rate	Continuous	Continuous	Continuous	Continuous	Once a year
		Field Parameters (T, pH, EC)	Monthly	Quarterly	Quarterly	6 Months	Once a year
Surface Water	Mağaraboğazı Creek (OKSW-18) Kırpıklı Creek (OKSW-14) Camboğaz Creek (OKSW-11) Kurtlararkaç Creek	Flow Rate	Monthly	Quarterly	Quarterly	6 Months	Once a year
		Field Parameters (T, pH, EC)	Quarterly	Quarterly	Quarterly	6 Months	Once a year
		Chemical Parameters (Lab Analyses)	Quarterly	Quarterly	Quarterly	6 Months	Once a year
		Sediment Amount	Quarterly	Quarterly	Quarterly	-	-
		Sediment Chemical Analyses	-	Once a year	Once a year	-	-
Collection Ponds/Sumps	Waste Rock Contact Water Collection Pond[1] Pit contact water collection sumps Ore stockpile Contact Water Collection Ponds/Sumps Heap Leach Leachate Collection Pond[1]	Flow Rate	Monthly and continuous	Monthly and continuous	6 monthly and continuous	6 monthly and continuous	6 monthly
		Field Parameters (T, pH, EC)	Monthly	Quarterly	Quarterly	6 Months	Once a year
		Chemical Parameters (Lab Analyses)	Quarterly	Quarterly	Quarterly	6 Months	Once a year

[1] where continuous measurement will be done by means of pressure probe

10.10.4 Monitoring of Acid Rock Drainage Potential

Acid Rock Drainage (ARD) occurs when sulphur contained in a rock which is in contact with air gets oxidized and comes into contact with rain, ground or surface water.

The acid generation and metal leaching potentials of the lithological units that will be excavated during the operation will be investigated by further rock and water geochemical analyses. Acid-base accounting and short term static tests on new lithologies encountered during the mining can be performed.

In addition to laboratory analyses, pH, EC and ORP field measurements and chemical analyses of contact waters occurred at the waste rock dump and the open pits will be compared with the results of the geochemical modelling predictions, so that new inputs to the final closure plan and designs can be obtained. The monitoring program is summarized in Table 10-40.

Table 10-40: ARD Monitoring Program

Stage of the Project	Component	Monitoring Spot	Monitoring Method	Parameter	Purpose
Operation period	Open-pit geologic/block model	Waste rock lithology and open-pit surface lithology	Evaluation of updated geologic model	Monitoring of amounts and rates of mine lithology	Operational waste rock management and obtaining of final closure planning
Construction and operation period	Waste rock and open-pit surface lithology	Selected rock samples	Static analyses	Acid generation and neutralization potentials, state of metal leachate generation	Analysis of rocks which have potential to generate ARD or which will be used for neutralization
Construction and operation period	Waste rock and open-pit surface lithology	Selected rock samples and/or existing kinetic analysis samples	Evaluation of updated results of on-going kinetic analyses	Evaluation of the data of acid generation speed, metal leachate generation rate obtained over the longer period	Update open-pit and waste rock dump closure plans and waste rock management plans
Operation period	Quality of contact water obtained at the site	Waste rock dump leachates and open-pit surfaces contract waters	Site measurements and sampling	pH, EC, ORP, measurements and chemical analyses	Comparisons with the results of the water quality estimation models, and operational waste rock management and closure planning