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1. INTRODUCTION OF DRINKING WATER SYSTEMS

1.1 Physical Context and Geography

Turkey extends for almost 1650 km from west to east. It lies between 36^{0}N and 42^{0}N latitudes and between 26^{0}E and 45^{0}E longitudes. A small part of the country is geographically located in Europe, Thrace. The rest of the country, Anatolia or Asia Minor, is in Asia. Asia., with a total area of 780.000 km2 , is surrounded by the Black Sea, Bulgaria in the north, the Aegean Sea and Greece in the west, the Mediterranean Sea, Syria and Iraq in the south, Iran in the east and Armenia and Georgia in the north-east (Figure 1). The total length of border and coastline is 10.765 kilometers, of which 7.816 kilometers are coastlines. (Adem, et al., 2009)

Figure 1. Map of Turkey Turkey
http://www.nationsonline.org/oneworld/map/turkey-map.htm

Turkey has a unique geographical and cultural position at the crossroads between Europe and Asia. Its historical and cultural links with the people of the Balkans, Caucasia, Central Asia, Middle East and North Africa give a special geo-political significance. Hence, it is called as a “cradle of civilizations” and “bridge between the continents”.

The climate of Turkey is semi-arid with some extremities in temperature. Climate and precipitation figures exhibit great variance throughout the country: in the higher interior Anatolian Plateau, winters are cold with late springs, while the surrounding coastal fringes enjoy the very mild-featured Mediterranean Climate. Average annual precipitation is 643 mm, ranging from 250 mm in the Central Anatolia, to over 2500 mm in the coastal area of north-eastern Black Sea. (DSİ, Foreign Relations Office, 2012)

1.2. Drinking Water Resources

There are 25 hydrological basins with a total surface water run-off of 193 billion m3 /year in Turkey as shown in figure 2. (Orman ve Su İşleri Bakanlığı, 2014) 4.9 billion m^3 of water was abstracted from water sources by municipalities to water supply network. Out of this amount, 48.9% was abstracted from dams, 28.3% from wells, 19.2% from springs, 2% from lakes/artificial lakes and sea, and 1.6% from rivers. (TÜİK, Municipal Water Statistics 2012, 2014)

Figure 2. Water Basins

Average amount of water abstracted by municipalities to water supply network was determined as 216 liters per capita per day. In case of three largest cities, amount of abstracted water per capita per day was calculated as 186 liters for İstanbul, 217 liters for Ankara, and 223 liters for İzmir.

Some statistics related with the water resources, transmission, treatment and distribution are given in Table 1.

Table 1. Municipal Water Indicators

Municipal Water Indicators, 2002 - 2012

	2002	2004	2006	2008	2010	2012
Total number of municipalities	3 227	3 225	3 225	3 225	2 950	2 950
Number of municipalities served by water supply network	3 140	3 159	3 167	3 190	2 925	2 928
Rate of population served by water supply network in total municipal population (%)	97	99	98	99	99	98
Total amount of water abstrated to water supply networks by resources (million m^3/year)	4 813	4 954	5 164	4 547	4 785	4 936
Dam	1 796	1 985	1 844	1 810	2 252	2 416
Well	1 455	1 376	1 402	1 276	1 274	1 396
Spring	1 295	1 363	1 380	1 061	1 016	948
River	131	143	305	174	159	78
Lake - Artificial lake/Sea	136	87	233	226	83	98
Amount of water distributed via water supply network (million m^3/year)	...	1 988	2 375	2 401	2 580	2 802
Amount of water treated in water treatment plants (million m^3/year)	1 710	2 079	2 427	2 121	2 520	2 729
Average amount of water abstracted per capita per day (liters/capita-day)	255	255	245	215	216	216

... Data not available.

Above table indicates that, as of 2012 according to the results of Municipal Water Statistics Survey, 2928 municipalities out of 2 950 were served by water supply network. 99% of municipal population is served by a water supply system. In general, 83% of the population (urban 94%, rural 62%) of Turkey has access to improved sanitation, including the households at least having connection to public sewer, septic system or simple pit latrine. (EU Sector Operational Programme, 2014)

Drinking water treatment plants are provided in 346 municipalities, serving 54% of Turkey's total municipal population. TÜİK, Municipal Water Statistics 2012, 2014)

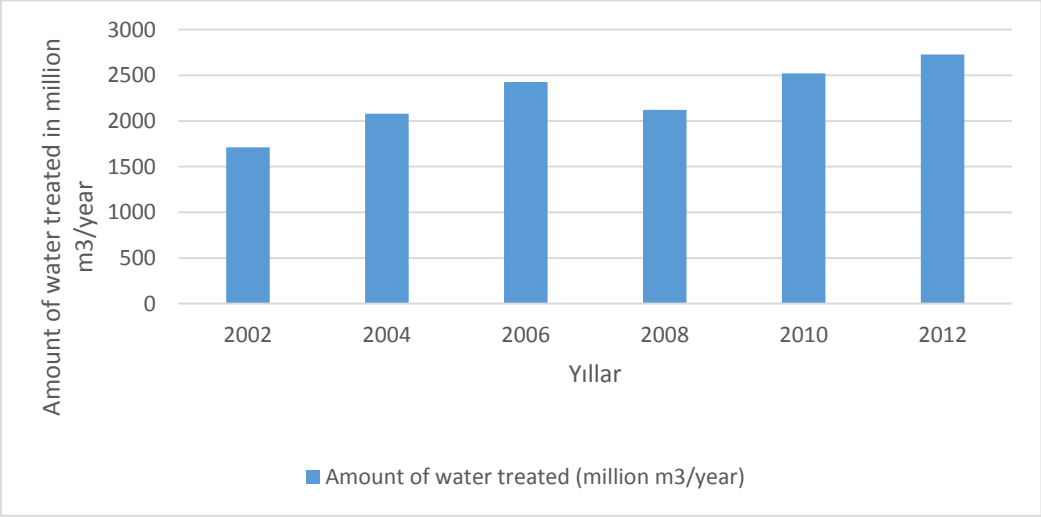

Figure 3. Amount of Drinking Water Treated

As can be seen from Figure 3, **amount of water treated** increased from 1710 million m^3 /year to 2729 million m^3/year for the last 10 years.

Domestic water treatment plants are designed and constructed in accordance with the European standards. The capacities of the treatment facilities constructed vary between 1.600.000 m3/day and 50.000 m3/day depending on the population of the cities. (Adem, et al., 2009)

As of the end of 2011, DSİ has completed 44 water supply projects in operation supplying approximate annual total of 3.31 billion m3 of domestic and industrial water to 34 millions of people. The 32 domestic water treatment plants in 25 cities of above mentioned projects developed by DSİ are being operated by related municipalities. 5,798,788 m 3 /day of water volume is treated in these treatment plants in accordance with European Union standards. 25 cities‟ treatment plants developed by DSİ. After the completion of the construction works, these facilities are transferred to the related municipality.

According to the EU Sector Analysis Report (2014), specific objectives for drinking water quality and treatment are;

- To provide drinking water to the population according to national and EU standards
- To optimize the use of natural resources and to improve the efficiency of the water distribution system
- To reduce the pollution load in receiving water bodies (surface and groundwater) and to protect drinking water systems from contamination;
- To secure efficiency of wastewater treatment plants and to reduce operating costs.

Turkey has been carrying out several water management investment activities during the EU Accession period. Under EOP, out of 32 water management infrastructure projects submitted to the EC, 17 of them are under implementation.

1.3 Management of Water Supply and Water Treatment Plants

The major systematic aspect of water-related activities in Turkey is central planning. At national level five-year development plans are main instrument which aim at ensuring the optimum distribution of all kind of resources among various sectors of the economy.

The Prime-Ministry, related Ministries and the State Planning Organization are the decision makers. Governmental institutions make up the executive level. They have a two-tiered organization. The top management level is the office of the General Directorate of the State Organizations in Ankara, which has a number of different departments. The

second management level consists of their regional directorates or provincial directorates throughout the country. The link between planning in relevant sectors is the main concern. In order to guide planning at the national level and facilitate rational decision making in this respect, a special emphasis is given to develop an overall strategy based on inventory of natural resources including water resources.

1.3.1 Domestic water supply

The authorities responsible for domestic water supply are the DSI, the Bank of Provinces, Municipalities and the SPA. By the end of 2008, 7 billion m^3 of domestic water is supplied to cities and rural areas according to the drinking water standards. Domestic water supply projects are developed by the above mentioned organizations, whereas the operation and maintenance activities are carried out by municipalities and village authorities.

Turkey's 16 largest cities have legally separate and financially autonomous municipal water and sanitation companies called Su ve Kanalizasyon Idaresi (SKIs). The first utility created, formed in 1981, is Istanbul's water authority, ISKI. Throughout the 1980s and 1990s establishment of the other utilities followed.

SKIs exist in the following metropolitan cities: Adana, Ankara, Antalya, Bursa, Istanbul, Diyarbakir, Kayseri, Denizli, Eskişehir, Gaziantep, Izmir, Konya, Malatya, Mersin, Samsun, and Şanlıurfa.

With a population of almost 13.5 million, **Istanbul** is Turkey's largest city. ISKI is the municipality responsible for providing water and wastewater services to Istanbul. The main priorities of ISKI are preserving water resources, providing good-quality water services to the public, and managing and treating wastewater. The total service area of ISKI is 5,342 square km. Within this service area, the municipality manages watermains totaling 15,586 km in length and sewers totaling 12,714 km in length. The transport mains and distribution networks are monitored using the SCADA system.

To manage these networks, ISKI has completed many local and international projects and investments in water/waste management and wastewater treatment. As a result of these projects, **ISKI has 13 water treatment plants, with a combined capability of processing 3,608,000 cubic meters per day.**

Ankara is the capital of Turkey, and the country's second largest city after Istanbul. The Ankara Municipality was created in 1949, but it wasn't until the municipality management model was created in 1980 that the Ankara Water and Sewerage Authority (ASKI) was created.

This change brought in a new era of infrastructure works, including:

- Watershed protection
- Provision of groundwater and surface water drinking water sources
- Distribution of treated drinking water
- Regularly maintenance checks of the city's water quality
- Ongoing maintenance and repairs of networks and plants.

Experiments of water taken from focus points are made Daily. Besides; Experiments for orderly and efficiently working of İvedik, Pursaklar, Çubuk and Kazan Drinking Water Treatment Plants; Experiments for customers complaints, Experiments for ground water quality control, Experiments for dubious water come from related units, experiments for quality of uncultivated water of dams and creeks. Additionally, experiments of quality control of items which are treatment plants needs (lime, aluminium, sulfate e.g) are also made.

Izmir is the third largest city in Turkey, based on population, and is located in the western extremity of Anatolia. The metropolitan area in the Izmir Province has a population of approximately 4 million.
In 1987, the municipality began the Izmir Water Supply and Sewerage Project to promote better environmental conditions in Izmir, reduce health hazards, and to bring about major environmental improvements and economic benefits in the water supply and sewerage sector in Izmir.

1.4 Environmental Investment Expenditures for 2007-2010

Table 2. Environmental Investment Expenditures for 2007-2010, in Euros*

	Water Supply Works (€)	**Waste Water Management (€)**	**Waste Management (€)**	**TOTAL (€)**
2007	2.005.631.408	1.114.155.948	143.463.183	3.263.250.539
2008	1.677.875.653	673.910.379	185.894.705	2.537.680.736
2009	1.125.655.565	741.092.279	146.745.761	2.013.493.605
2010	1.276.421.461	860.448.899	68.110.379	2.204.980.739
TOTAL	6.085.584.087	3.389.607.505	544.214.028	**10.019.405.619**

Source: TurkStat, 2014

The data demonstrates that, with investments of EUR 6.1 billion, water supply works attracted the largest proportion of total investment. Therefore as it will be emphasized in 'Need Analysis' part of this report; supporting the construction, rehabilitation or modernization of the existing drinking water distribution system as well as establishing

adequate water treatment plants is on the agenda of Turkey in line with EU harmonization process.
This amount includes;

- Construction and rehabilitation of drinking water networks;
- Restructuring and modernising of existing mains water and distribution systems (pipes, pumping stations, storage tanks);
- Rehabilitation, upgrading and construction of drinking water treatment facilities;
- Metering, laboratory equipment, leakage detection equipment.

2. IDENTIFICATION OF TARGET GROUPS

Target groups working for water treatment and distribution sectors are responsible for monitoring water quality and play a key role in protecting public health. There is a need for water treatment personnel with the practical, real-world, what-you-need-to-know knowledge and proficiencies concerning water treatment including troubleshooting specific problems, technical assessments, design reviews, bid evaluations, cost reduction audits, market analyses and expert witness services.

Duties vary significantly from job to job and profession to profession but the following list includes typical job duties one might encounter for the people working in water treatment and distribution sector:

- Regulate water quality and production using analytical and flow monitoring equipment in compliance with environmental guidelines.
- Draw samples for laboratory chemical and bacteriological analysis.
- Take and record readings from instruments such as flowmeters and pressure gauges.
- Analyze instrument readings and make necessary adjustments to equipment.
- Troubleshoot and make adjustments to pumping systems to resolve distribution issues.
- Monitor chemical supplies, receive and unload chemicals, and change chemical cylinders when required, following proper safety procedures for handling dangerous chemicals such as chlorine, fluoride, and alum.
- Evaluate, maintain, and repair equipment, tanks, and storage containers.
- Prepare reports and maintain operating logs.
- Monitor Supervisory Control and Data Acquisition (SCADA) equipment.
- Respond to complaints from the public and inquiries from superiors and regulators.

(Eco Canada, Carrier Profiles)

Along the parameters above, target professions' responsibilities and specifications chosen for Pure-H2O Project are given below:

1) Microbiologists: perform microbiological analyses of samples and specimens for detecting the presence of pathogenic micro-organisms. Using aseptic techniques, they prepare samples that include dilutions, filtration, and spread plate analysis. They conduct microbiological analyses of samples and specimens to quality control purposes. They develop techniques in both research and routine monitoring. Microbiologists analyze test results and prepare reports. They may make recommendations for regulations and government policy.

2) Chemists**:** perform chemical analyses of samples and specimens to detect the parameters (pathogen, aesthetic, organic, inorganic, and radiological) of water quality. They use chemical processes and conduct further tests to ensure water is suitable for human use and consumption. They apply specific knowledge in chemical properties and processes to correct any shortfalls in quality. Chemists must also be manually dexterous in order to utilize specialized equipment and conduct experiments. They record detailed notes during testing and purification processes. They liaise with other staff, such as water purification technicians. Chemists contribute to the improvement of water purification processes. They could make recommendations for regulations and government policy.

3) Civil Engineers: deal with the direct construction of the drinking water treatment system; manage the operation and maintenance of civil engineering structures; arrange technological aspects of particular materials ; develope new or improved theories and methods related to civil engineering; determine and specify construction methods, materials and quality standards, and direct the construction work; establish control systems to ensure efficient functioning of structures as well as safety and environmental protection; organise and direct maintenance and repair of existing civil engineering structures; analyze the behaviour of soil and rock when placed under pressure by proposed structures and designing structural foundations; analyze the stability of structures and testing the behaviour and durability of materials used in the construction of the water treatment plant.

4) Environmental Engineers: are the technical professions who provide safe drinking water, treat and adequate water pressure and flow rates for water distribution system. They design, build and operate water treatment plant not only to minimize the risk of infectious disease transmission, the risk of non-infectious illness, and to create a palatable water flavor but also to achieve water quality objectives for the end uses. Environmental Engineers routinely monitor, evaluate and report quality of drinking water. They conduct with related staff including chemists, microbiologist, chemical engineer, electrical

engineer and technician. They also collaborate with government agencies, industry, and academia on the formulation of new or revised regulations for drinking water standards.

5) Electrical Technicians: perform technical tasks connected with electronic and telecommunications engineering, as well as with the design, manufacture, assembly, construction, operation, maintenance and repair of electronic equipment and electronic and electromechanical telecommunications systems of drinking water treatment plants. They design and prepare blueprints of electronic circuitry according to the specifications given; prepare detailed estimates of quantities and costs of materials and labour required for the manufacture and installation of electronic and telecommunications equipment, according to the specifications given for the treatment plant; provide technical supervision of the manufacture, utilisation, maintenance and repair of electronic equipment and telecommunications systems to ensure satisfactory performance and compliance with specifications and regulations; apply technical knowledge of electronic and telecommunications engineering principles and practices in order to identify and solve problems arising in the course of their work.

6) Mechanical Engineers: perform, conduct research and advise on, design, and direct production of machines, machinery and industrial plant, equipment and systems, and advise on and direct their functioning, maintenance and repairs, or study and advise on technological aspects of particular materials, products or processes for the drinking water treatment plants. Design machinery and tools for manufacturing, construction and other industrial purposes for the water plant; advise on designing steam, internal combustion and other non-electric motors and engines used for propulsion of railway locomotives or road vehicles, or for driving industrial or other machinery; advise on and design heating and ventilation systems, steering gear, pumps, and other mechanical equipment; design road vehicle bodies, suspension systems, brakes and other components; design refrigeration systems and equipment; design non-electrical parts of apparatus or products such as word processors, computers, precision instruments, cameras and projectors, etc.; specify and check production or installation methods and work of agricultural and other machines, machinery, tools, motors, engines, industrial plant, equipment or systems, establishing control standards and procedures to ensure efficient functioning and safety of machines.

7) Chemical Engineers: refer to separating dangerous materials from good water as a treatment train. They help design and implement complex chemical systems to purify and disinfect water, overseeing changes in the chemical treatment processes. Chemical Engineers are involved in water quality. They help the agency and a water enterprise and respond to changes in legal requirements.

8) Town planner: Should be responsible for the appropriate site selection for the treatment plants. In the regional planning phase, determination of suitable alternative

sites according to several factors such as; no of settlements, population distribution, current situation of infrastructure and evaluation of other neighboring urban land use decisions. Town planners also inform project designers about population projections of the area to which treatment plant will serve.

9) Research and development department managers: plan, direct and coordinate the research and development activities of the enterprise or organisation, under the broad guidance of the directors and chief executives, and in consultation with managers of other departments or sections.

10) Incinerator, water-treatment and related plant operators: operate and monitor various types of plant, such as incinerators, water treatment plant, air and gas compressors, pumping stations, refrigeration or heating and ventilation systems.

11) Vocational Trainer: Introduce nationally recognised qualifications in relation to vocational areas introduced, set up, plan and co-ordinate vocational learning opportunities. Provide vocational training opportunities in line with industry standard requirements. Ensure the vocational curriculum provision is socially inclusive and provides learning opportunities in line with the National Curriculum, where appropriate. Hold a recognised teaching/vocational qualification commensurate with the post.

3. NEED ANALYSIS FOR VET REQUIREMENTS in WATER TREATMENT SECTOR

The quality of the water environment in Turkey and across Europe is not at the standards required by the Water Framework Directive. Initial work in Turkey, extrapolated to the national level on the basis of 5 river basin districts, has estimated that only some 22-30% of surface waters (rivers, lakes, transitional water, and coastal waters) are reaching the required standards.(Water Framework Directive – Draft National Implementation Plan, 2010)

It is thought that 'the risk for those in developing countries, where there is often poor water treatment and management as well as inadequate medical support, is very much greater' (Gleeson & Gray 1997). Therefore; development of strategies focusing on adaptation and sustainable water management (surface waters as well as ground waters); determination of needs in different sectors (potable water, industry, irrigation) to ensure balanced and realistic supply and demand; ensuring effective use of water resources and to minimize the stress of catchment-based immediate changes (aridity as well as floods) on water quality; improvement of dams (dams for potable water, industrial water, irrigation, hydropower and flood control dams); establishment of irrigation and drainage systems; water supply and improvement of water treatment plants are becoming very important in Turkey. (Ministry of Environment and Urbanisation, 2011)

To this purpose, it is planned to implement a Drinking Water Resources and Treatment Plants Evaluation Project by Ministry of Forestry and Water Affairs: current deficiencies will be determined and mitigated by an integrated approach in relation to drinking water treatment via an overall assessment about the current status of drinking water sector (both legal and institutional structure) and drinking water treatment plants (including issues such as raw and treated water quality, appropriateness of the analysis.

It is because certain services such as source research and development, water supply, distribution and treatment require a complex and detailed process. Both the definition of the problem and the solution require this complex structure to behandled in an integrated manner (Muluk, at al. 2013). Furthermore, recent regulations, laws and directives on this issues are definitely valuable[1]. However, as per the requirements of laws, regulations and EU reports, solely increasing the quality and amount of treatment facilities in Turkey is not enough. The important step to be taken is to operate such facilities in a sustainable and appropriate manner. As already defined in this report, creating healthy potable water

[1] As we emphasized in our project, in the 10th development plan (2014-2018) of Turkey protecting the environment and improving the urban infrastructure is one of the development axes in main objectives. To accomplish this, as stated above in this report regulations relating to the environment and specifically water treatment sector in recent years have made. Some of these regulations within the past five years are listed below:
-Regulation on Principles and Procedures to be followed for Wastewater Treatment Plant Benefitt from Incentive (Officiial Gazette, Dated: 10.01.2010, No:27716)
-Prime Ministry Ordinance on Water Management Coordination Board (Official Gazette, Dated:03.20.2012, No:28239)
-Regulation on Protection of Underground Water Against Pollution and Depredation (Official Gazette, Dated: 04.07.2012, No:28257)
-Regulation on Quality of Surface Water Actually or Potentially Drinking Water (Official Gazette, Dated: 06.29.2012,No:28338)
-Regulation on Protection of Water Basins and Preparations of Management Plans (Official Gazette, Dated: 10.17. 2012, No: 28444)
- Regulation on Management of Surface Water Quality (Official Gazette, Dated: 11.30.2012, No: 28483)
-Prime Ministry Ordinance on Ergene Basin Protection Action Plan (Official Gazette, Dated: 06.13.2013, No:28676)
- Official Statement on Basın Management Board (Official Gazette, Dated: 06.18.2013, No: 28681)
-Prime Ministry Ordinance on Ground Water Management Action Plan (Prime Ministry Ordinance, Dated: 07.11.2013, No: 132059)
-Regulation on Protection and Rehabilitation of Waters Contains Salmonidae and Cyprinidae (Official Gazette, Dated:01.12.2014, No: 28890)
-Regulation on Monitoring Ground and Surface Waters (Official Gazette, Dated: 02.11.2014, No: 28910)
-Official Statement on Protection of Stable Internal Surface Water Against Eutrophication (Official Gazette, Dated: 02.26.2014, No:28925)
- Regulation on Determining Losses of Drinking Water Supply and Distributing Systems (Official Gazette, Dated: 05.08.2014, No: 28994)
- Official Statement on Surface Water. Ground Water, Sediment Samplingand Biological Sampling (Official Gazette, Dated: 02.21.2015, No: 29274)
- -Water Treatment Plants Design and Operation Fundamentals was published in 2013 by Water Management Department of the Ministry of Forestry and Water Affairs.

requires a trained workforce potential in every ring of the chain. In this sense, curriculums of the universities and other higher education institutions are required to be planned accordingly in order to meet the workforce need in water sector. Furthermore, it is required to increase the number of institutions offering vocational teaching opportunities, not the ones that give training completely under academic terms, and it is further essential to develop apprenticeship and vocational training programs to support vocational development. The following sections assess the current situation in Turkey, and analyze the trained workforce need in potable water sector in detail.

3.1 Education System and Vocational Training and in Turkey

Education system in Turkey consists of three main branches: formal, informal and non-formal. Formal education is a kind of regulated training offered to the individuals in the same age group and having the same level of maturity under the roof of a school. It covers 12 years of obligatory education divided into 3 levels: first the primary schools, second the middle schools and third level the secondary schools (high schools). Secondary schools, also known as the high schools, covers vocational and technical high schools.

The non-formal education covers all citizens who have never entered the formal education system, left their studies at any level or who completed any education level. It complete the formal education in terms of training people in general or in vocational and technical fields, and it gives the same qualifications while entitling to use all opportunities of the formal training. In several training institutions, individuals who have left the formal education may receive apprenticeship, assistant master and master trainings, scopes of which were defined by the Vocational Training Law No.3308. All kinds of experience-based learning from voluntary learning without any purpose or intention, which was not acquired through the trainings offered by formal and non-formal training institutions, to conscious and intended learning are defined as informal learning (MoD, 2014).

3.2 The curriculum of Higher Education Institutions to obtaining safe drinking water and its effects

As of 2015, Turkey has 193 universities (https://www.yok.gov.tr/). The number of higher education institutions offering education in the field of water is 141. Furthermore, there are approximately 42 Environment and Water Resources Research Centers and Research Institute Directorates working affiliated to the universities (TUBİTAK, 2010). A more detailed table is given in **Appendix I**. In this context, Turkish education system is not indifferent to the qualified workforce need in the field of water. However, in the short and medium terms, it is required to handle sectoral skill need within the scope of a central planning and coordination in order to harmonize workforce supply and demand.

In the following table **(List 1),** the courses taught in line with the Drinking Water Treatment Plants and Sanitation for Pure Drinkable Water theme and their contents were analyzed. The table includes the courses and courses contents given in the departments

of civil engineering, environmental engineering, chemical engineering, mechanical engineering and microbiology at first cycle program level (Bachelor's Degree) for proffesion groups defined by the project team. However, it should be noted that the Table 3 has been prepared based on an internet research. Deficiencies may appear due to high number of universities in Turkey and as certain universities were renewing their curriculums during the research period. The table may be extended and detailed in time.

- In order to determine the healthy of potable water, chemical characteristics together with the microbiological characteristics are required to be analyzed. It was observed that Chemical Engineering departments have certain water treatment corses covering such issues, while no water-synthesis-related courses were encountered in the other chemistry departments. Chemical analyses for the water quality is required to be included in the curriculum of these departments.

- Civil engineering departments were observed to have several number of classes especially on this subject. On the other hand, even if the mechanical engineering programs do not offer courses specifically on water management or on the relationship between water and environment; mechanical engineers, together with the civil engineers: design and maintain piping and flow routes through water/wastewater treatment plants, water distribution systems and sewers; ensure water treatment plants and water distribution systems operate efficiently and reliably; plan and design tools, engines, and machines to perform specialized functions such as delivering a steady flow of chemicals at a certain rate into the water supply at a treatment plant; and control the installation, operation, and maintenance of equipment upon taking certain courses such as Materials Science and Engineering, Fluid Mechanics, Mechanic Installation Technics, Hydraulics etc. (http://baywork.org/career-path/engineer/mechanical-ngineer/#sthash.TGeiRAm2.dpuf.

- By nature, Environmental Engineering department has several courses covering the process for obtaining safe potable water. In this sense, it is appropriate to argue that these departments do not have any deficiency.

- METU and Hacettepe University offer certain classes on water quality and ecology in their Microbiology and Biology Departments. No other university was observed to analyze water and biological characteristics of water in these departments.

- As far as it was observed, there is no available program to be offered to Research and Development Managers to work in the field of water in Turkey. However, the R&D Managers who follow up innovations in water source research and development and who assist the implementation of the same will have a critical function. In this sense, new programs may be opened under water engineering, environmental engineering or other engineering departments or such training might be included in the curriculums of such currently available programs.

- Even if there is no chemical pollution around the basin and treated waters meet legal conditions when they are taken from treatment facility, most of the water tanks used in Turkey are not disinfected, and microorganisms may develop in old metal pipes. Public institutions undertake the responsibility to supply healthy water to the buildings; however, they do not intervene the subsequent processes. In this sense, the municipalities are required to be authorized to demand water surveys and other certifications demonstrating that the water tanks have been cleaned. At this point, **town planners** may undertake further responsibility besides their main duties, and play an important role in treatment of old and neglected pipes, raising awareness, and taking inventories of old buildings. However, during our research, the curriculums of town planners were determined not to include any classes that informs the students about taking the steps in water treatment facility planning or using the water effectively.

3.3 The curriculum of higher vocational schools to obtaining safe drinking water and its effects

- In Turkey, universities offer 2-year vocational trainings on fresh potable water process. For example, Duzce University has a program called Environmental Protection and Control in which hydrology and hydraulics (compulsory), solid and liquid wastes and control (compulsory), treatment facility operation (optional), and water supply and environmental health (optional) courses. Upon completing the programs, students are hired as a vocational technical personnel working in harmony with the environmental engineers in environmental engineering practices.

- In Selcuk University, Environmental Protection Technology program offers Operation of Treatment Plants (compulsory), Hydrology (compulsory), Water Pollution (compulsory), Water Supply and Sewer (compulsory), Drinking Water Treatment (compulsory), Advanced Treatment Technologies (compulsory) classes. Upon graduating from this program, the students work as Incinerator and Water Treatment Plant Operators.

- Gazi University, Vocational School of Health Services, Environment Department offers Hydrology (compulsory) and Environmental Biology (compulsory) classes. Considering the intermediate staff need in Turkish water sector, it is required to increase the number of departments engaged in the field of potable water in vocational schools of higher education.

- Furthermore, the Chamber of Mechanical Engineers (TMOBB) and affiliated Chamber of Environmental Engineers (CMO) open treatment facility operator courses at certain intervals and gives basic hydraulic training classes.However, as the demand for intermediate technical personnel to work with the engineers is very high, the number of formal and informal trainings are required to be increased as well.

3.4 Competence-Based Assessment in VET in Turkey

Several countries have been designing and implementing national qualification systems in the recent years. In Turkey, the task of developing an NQF (National Qualifications Framework) has been assigned to the Turkish Vocational Qualification Authority (VQA), which came into effect on September 21, 2006. One of the basic duties of VQA is to determine the institutions to prepare the vocational standards, and to establish and operate the National Vocational Qualifications System in line with EU.

Just like the foremost EU countries, Turkey began to determine its own national qualifications framework considering the EQF. Within the scope of lifelong learning, European Qualification Framework helps putting transnational mobility into practice, recognition of qualifications of all individuals in the member countries easily at the Union level, and ensuring relativity of national and sectoral level qualification frameworks. Credit system for Vocational Education and Training (ECVET), which is the complement of EQF, is a means developed to create a common platform for different national and/or sectoral vocational qualification systems to communicate with each other. In this sense, ECVET applies a method that defines qualifications through accumulative and transferable learning outcomes (information, knowledge and qualifications) and credit notes. Turkey aims at using EQF and ECVET to create a modern, flexible and high-toned vocational and technical training system, which is based on lifelong learning, works in harmony with other training systems, and is able to meet the needs of the labor force market[2]. Hence, H20 project serves for this purpose.

3.4.1 Proffesion Definitions in Fresh Potable Water Process in Turkey

2 The adoption of ECVET principles in Turkey is a relatively new area of interest within the Turkish VET reform. Turkey committed to developing an ECVET system under the lifelong learning approach. This commitment was officially declared in an international meeting concerning ECVET on 28th March 2007 in Ankara. Ministry of National Education (MoNE) carried out works for formation of European Credit Transfer System in Vocational Education and Training (ECVET) and also for making it operational. MoNE then organised a series of workshops In the works, representatives of The Turkish Ministry of National Education (MoNE), Council of Higher Education (CoHE) and social partners and, teachers from VET and members from programme developing working groups participated. An ECVET approach specific to Turkey was discussed and based on lessons learnt from the practices of EU Member States. As a result of the workshops supported by national and international experts, a sample work was carried out for preparation of a ECVET Discussion Paper for Turkey and a draft model for crediting supporting this paper and for crediting a formal non-formal training programmes in line with the determined principles.
Next stage at this respect is approval of ECVET draft model and then using it in crediting field-branch curricula
The basic elements of the ECVET approach specific to the Turkish VET context are:

- Learning outcomes are credited based on total learning time.
- Learning outcomes, which lead to qualifications of similar scope, content, complexity and duration, are allocated the same amount of credits.
- Learning outcomes gained through one-to-one learning of up to 20 hours are equivalent to 1 ECVET credit.
- One full educational year of VET education is equivalent to 60 credits. 240 credits can be gained upon completion of 4 years of secondary formal VET education (Altin & Yalçın 2011).

Turkish Vocational Qualification Authority has not completely finalized the vocation definitions to be used in potable water sector. Certain vocational standards defined to be engaged in this field are given below.

Hydrologist (Level 5)

Definition of the Vocation: Qualified persons who, within the scope of the quality systems and upon taking occupational health and safety and environmental measures, organize the work in line with his/her occupation, conduct observation and measurement procedures on surface waters (flow measurement in streams, snow observation, general hydro-meteorology surveys on streams, lakes and dams, sedimentation and water quality observations), build fixed facilities (surveillance facility for gauge, water level and parameters, ropeway facility, snow surveillance facility, precipitation and evaporation facility etc.), apply gauge cross section and stream longitudinal section, and attend vocational development activities.

Occupation's Place in International Classification Systems is ISCO 08: 3111 (Chemical and physical science technicians).

Water Proofer (Level 3)

Definition of the Vocation: Qualified persons who, within the scope of quality systems and upon taking occupational health and safety and environmental measures, organize the work in line with his/her occupation, conduct water-proofing-related procedures in all kinds of structures, and attend vocational development activities.

Occupation's Place in International Classification Systems is ISCO 08: 7124 (Insulation workers).

Hydraulic Pneumatic Technician (Level 4)

Definition of the Vocation: Qualified persons who, upon taking occupational health and safety measures, work in line with environmental protection regulation and quality management system documents, prepare and assemble the circuit elements of automation systems, heavy construction equipment, machine tools, robot systems, and presses in the work places where industrial production is made in line with the requirements of the project, and attend vocational development activities.

Occupation's Place in International Classification Systems is ISCO 08: 7231 (Motor vehicle mechanics and repairers).

Mechanical Installation Proofer (Level 3)

Definition of the Vocation: Qualified persons who, in line with the quality systems and upon taking occupational health and safety and environmental measures, use proofing materials to proof pipes, air ducts, tanks and other equipment against heat, sound and fires, and attend vocational development activities.

Occupation's Place in International Classification Systems is ISCO 08: 7124 (Insulation workers).

Considering Turkey's needs and sector demands, Vocational Qualifications Authority is required to work on different vocational groups such as treatment operators for potable water facilities specialized in troubleshooting specific problems, technical assessments, design reviews, bid evaluations, cost reduction audits, market analyses and expert witness services etc.

LIST 1: Fresh Water Related Courses at Universities in the Turkey (undergraduate)

	University	Course Name	Course Content	Semester	Course Type
Chemical Engineer					
	SELÇUK	DRINKING WATER TREATMENT	Learning basic concepts and information about techniques used in drinking water treatment	6	C*
	GAZİ	WATER POLLUTION and RESOURCES	Water quality and resources of water pollution, preparation of quality models in ground water, Hydrolic cycle, water quality, parameters, water characteristics, water in world and Turkey. Economical and political effect of water Subrobic system: algaes, microorganisms, bacteria, viruses. Water pollution resources	6	C
	GAZİ	ENVIRONMENTAL CEHEMISTRY	Better Understanding of Chemical Methods Used İn Water and	5	E**

			Wastewater Practice.		
	METU	WATER TREATMENT TECHNOLOGY	Nature of water. Impurities in water and their harmful effects. Removal of nonionic suspended and colloidal impurities. Softening by precipitation. Ion exchange. Demineralization process and systems. Demineralizer equipment designs.	4	C
	BOĞAZİÇİ	ENVIRONMENTAL CHEMISTRY	Nature, ecological cycles, classification of toxic substances their distribution and effects on the environment and human health. Methods of qualitative and quantitative analysis, means of detection and protection from toxic substances.	6	C
Civil Engineering					
	ÇUKUROVA	WATER SUPPLY AND SEWERAGE	Determination of all types of water demand. Assessment of available water resources. Conveyance of water. Water tanks. Water	7	C

			distribution network. Sewer systems. Fundamentals of urban hydrology. Design of storm water drainage systems.		
	BOĞAZİÇİ	ENVIRONMENTAL ENGINEERING	Water supply sources, transmission, water distribution reservoirs and networks; wastewater collection and disposal; introduction to water and wastewater treatment methods.	6	C
	PAMUKKALE	HYDROLOGY	Hydrology defination, hydrology basic equations. Rainfall; rainfall measurement and analysis. Evaporation, transpiration, evapotranspiratio n Infiltration, infiltration capacity, infiltration indices Groundwater hydrology, groundwater flows Measuring and analysis of flows Surface runoff (properties of river basin, runoff separate), Analyzing of river basins according to system	5	C

			Hydrograph analysis (component of hydrograps), Unit hydrograph theory, Hydrograph routing (river routing and reservoir routing)		
	SELÇUK	WATER SUPPLY and WASTEWATER DISPOSAL	Teaching basic design and construction knowledge and applications about estimation of population growth and water demands, water sources planning, transportation of water, water storage, water distribution systems and wastewater collection systems. .	7	C
	GAZİ	WATER RESOURCES ENGINEERING 1	Review of fundamental hydraulic principles Hydraulics of hydraulic structures Application of fundamentals of hydraulics to the design of hydraulic structures and stability analysis	7	C
	GAZİ	WATER RESOURCES ENGINEERING 2	Dam reservoirs and design. Types of dams. Control structures of dam. Diversion from	8	C

			dams. Hydropower. Water conveyance and distribution Waste water collection and removal. Stabile channel design.		
	METU	WATER RESOURCES ENGINEERING	Introduction to hydrology and water resources engineering. Basin and hydrologic processes: precipitation, stream flow, infiltration. Hydrograph analysis. Hydrologic flood routing. Groundwater hydrology. Dams and spillways. Municipal water supply systems. Wastewater and stormwater collection and discharge. Irrigation and drainage.	6	C
	METU	HYDROMECHANICS	Teaching the basic concepts of flows in pipes and open channels; to apply continuity, momentum and energy principles for the solution of various pipeline and open channel problems.	6	C
	YEDİTEPE	HYDRAULICS	elements of hydrology; water resources systems,	6	C

			classification of dams; structural design of concrete dams; embankment dams; intake structures; spillways and energy dissipators; weirs and diversion structures; hydropower; irrigation and drainage; coastal enginneering		
	YEDİTEPE	URBAN WATER SYSTEMS	Introduction; elements of the urban water systems; water demand; water supply systems (extraction, treatment and distribution); wastewater systems (collection, treatment and disposal); sludge management; urban stormwater drainage; alternative concepts in water supply and wastewater engineering.	4	C
	HACETTEPE	HYDRAULICS	introduce the students the fundamental principles of fluid mechanics and to form a background for the courses in the	6	C

			field of hydraulics.		
	HACETTEPE	WATER RESOURCES ENGINEERING	Know the development and control methods of water resources; to gain basic knowledge on the planning and management of hydraulic structures; to know the methods regarding the location and effective usage of water resources in energy production.	6	C
	NİĞDE	WATER SUPPLY and SANITATION	Provide the necessary information about water resources and features, gain the basic parameters associated with a resort's drinking water needs according to social and cultural structure. Provide the necessary information for determining the accounting principles of systems and structures associated with the introduction of water. To provide information about the characteristics of the water supply systems	7	C

			channel rainwater and used water.		
	DOKUZ EYLÜL	PRESERVATION of WATER RESOURCES	To emphasize the importance of the protection of surface fresh water resources and their use in terms of sustainability. The national and EU s legislation on the quality and quantity protection of fresh water resources are the main features of the course. The education of the general concepts upon these issues is the main target of the course.	8	E
	DOKUZ EYLÜL	HYDRAULICS	Flow in pipelines (laminar and turbulence flows, flow, energy loss, hydraulic determinations of pipes), uniform flow in open channels (energy loss, uniform flow determination, optimal cross section), nununiform flow in open channels (specific energy, critical regime, flood and stream regimes, channel slope determinations, differential	4	C

			calculations of water surface, non-uniform flow calculations), local variations in water surface(hydraulic jump, cross-sectional variations, local variations), channel controls (lids etc.), flow measurement methods		
Environmental Engineering					
	PAMUKKALE	WATER SUPPLY and WASTEWATER COLLECTION	The course consists of drinking water resources, water supply and transmission, and distribution network system, wastewater sources, wastewater collection systems.	5	C
	19 MAYIS	DRINKING WATER TREATMENT	Drinking water supply, drinking, and objectives of potable water treatment. Drinking water quality criteria and standards. Introduction of relevant regulations, drinking water treatment plants. Flow diagrams, basic operations and processes used in drinking water treatment,	5	C

			collecting pools, ventilation: gas transfer and aerators, the aerators. Used in drinking water treatment plants, drinking water treatment kogülasyo-flocculation mainly in presedimentation basin and design principles, water hardness of the removal methods hardness of water, ion exchange and ion exchanger design principles. Filtration, the design of fast and slow sand filtration, disinfection, control odor and taste in water, pH balancing and the aggressiveness of water, the importance of use of ozone water disinfection, obtaining drinking water from seawater.		
	HACETTEPE	WATER SUPPLY and SEWERAGE	Population projections and determination of water requirement. Water intake from surface waters; Water usage from ground water, its hydraulics, wells, galleries; Water	5	C

			distribution Networks; Piping; Design of water network; Wastewater collection systems-wastewater flow rate determination. Sewage and stormwater system design.		
	SELÇUK	WATER QUALITY MANAGEMENT	The sources of water pollution, Point sources, diffuse sources, Water Quality Parameters, National regulations on water quality management, Water Framework Directive, River Basin Management Plans, Water quality management practices in EU and Turkey	5	C
	METU	UNIT OPERATIONS AND PROCESSES OF WATER TREATMENT	Screening, coagulation and flocculation, sedimentation and flotation, filtration, ion removal by chemical precipitation, disinfection, ion exchange, adsorption, membrane processes and solids handling.	5	C

	METU	WATER SUPPLY AND URBAN DRAINAGE	Water management. Sources of water. Population estimation. Water Demand/Use and Wastewater Generation. Water transmission. Water distribution components. Pumps. Design of water distribution systems. Components and characteristics of sewage. Stormwater management.	6	C
	METU	WATER QUALITY MANAGEMENT	Sources and use of water. Characteristics of water and wastewater. Water quality standards. Management of waste loads and assimilative capacity of receiving waters. Water quality management planning. Fate of pollutants in water environment. Modeling of water quality in natural systems. Computer applications.	6	C
	METU	ENVIRONMENTAL CHEMISTRY	Scope of Environmental Chemistry. Discussion of important relevant concepts	1	C

			of chemistry, and introduction of basic environmental chemical concepts including pH, alkalinity, hardness, dissolved oxygen, Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). Acid-base chemistry and its significance in environmental engineering. Dissolution and precipitation chemistry, and chemical precipitation reactions in water and wastewater treatment.		
	METU	ENVIRONMENTAL MICROBIOLOGY	Introduction to general microbiology. Water and wastewater microbiology. Degradation metabolism of compounds by microorganisms. Enzyme kinetics. Batch growth kinetics. Recycling of minerals and nutrients. Epidemiology and control of diseases. Biological safety.	4	C

	DOKUZ EYLÜL	WATER QUALITY CONTROL	Natural waters, hydrologic cycle and water quality, Saprobic system, suspended and colloidal substances, thermal pollution, inorganic parameters, toxic, radioactive and persistent chemicals, organic parameters, containing substances and water quality, phosphorus and photosynthesis, microbial pollution, modeling of river pollution, hydraulic and hydrological parameters.	6	C
	DOKUZ EYLÜL	WATER TREATMENT	Objectives of water treatment, water resources, drinking water quality criteria and standards, introduction of the related regulations, review of the unit operation and processes for water treatment, mechanical treatment units (screen and microstrainer), aeration methods, cascades (design and structures), sedimentation tanks (design and structures), coagulation and flocculation units (design and structures), filters,	3	C

			rapid sand filters (design and structures), disinfection unit, advanced treatment methods		
	DOKUZ EYLÜL	DESIGN OF WATER TREATMENT PLANTS	Design principles of the mechanical treatment units (screen, microstrainer); using the project data, designing of cascades, design of the sedimentation tank, design of the coagulation and flocculation tanks design of the rapid sand filters, design principals of disinfection units, drawing of the P&I diagram and general layout of the projected system	6	E
	DOKUZ EYLÜL	WATER QUALITY MODELS	The objective of this course is to determine surface and ground water quality using mathematical models.	8	E
	DOKUZ EYLÜL	HYDRAULICS OF TREATMENT PLANTS	Importance of treatment plant hydraulics in general design process. Basic hydraulic formulas and their applications (Continuity, Bernoulli and Momentum equations), measurement of hydraulic parameters (pressure, flow, velocity etc.), head losses in hydraulic	8	E

			design (friction and local), line of energy and pressure, considering a sample data, calculation of the pipe diameters, inlet-outlet structures and similar constructions, drawing of hydraulic profile and vertical application of treatment plant.		
	NİĞDE	WATER POLLUTION CONTROL	Physical and chemical properties of water. Identification of pollution sources and types of pollutants. Drinking water supply and the use of physical, chemical, biological and radiological definition of water, quality parameters. Meaning and importance. Water pollution monitoring studies; Surface and groundwater for water pollution control; Burden on water resources management and waste from the assimilation capacity of the receiving waters; Water quality	5	C

			criteria and standards; Water pollution management planning.		
	NIĞDE	WATER SUPPLY	Characteristics of drinking waters; Population estimation methods; Detection of water supply Spring waters, Wells, Water supply by drain system, Water supply by surface waters; Calculating and designing for pipelines, Water reservoirs, Drinking water network and design principles.	6	C
	NİĞDE	ENVIRONMENTAL CHEMISTRY	Basic chemistry concepts and issues related to environmental chemistry, chemical kinetics and equilibrium, acid base , dissolution and precipitation, oxidation-reduction, the importance of coordination chemistry and environmental engineering , fundamental environmental chemistry concepts such as; pH, acidity, alkalinity, color, turbidity,	2	C

			hardness, dissolved oxygen,biochemical oxygen need for chemical oxygen demand, nitrogen, phosphorus, sulphate, oil and grease and solids in the water and their importance, organic and inorganic pollutants and toxic pollutants in water		
	NİĞDE	TREATMENT OF POTABLE WATER	Basic procedures and practices used in the treatment of potable water	4	E
	ULUDAĞ	WATER QUALITY AND CONTROL	Solving water quality problems of watercourses deteriorating due to human activities. For this purpose, physical, chemical and biological components of the receiving medium and interactions between them are explained in detail.	6	E
	ULUDAĞ	WATER POLLUTION AND ENVIRONMENTAL EFFECTS	Understanding of the causes and environmental effects of key types of water pollution. The goals are to teach the specific water pollutant types and their damage of ecosystem	8	E

	BOĞAZİÇİ	WATER QUALITY MANAGEMENT	Water Quality Sources and uses of water; the hydrological cycle; physical, chemical and biological characteristics and methods of analysis. Water quality standards and global perspectives. Stoichiometry, reaction kinetics and material balances; reactor models in natural systems. Modeling of water quality by the "contaminant movement process" approach. Water quality in rivers, estuaries, lakes and reservoir systems. Introduction to water and wastewater treatment.	6	C
	ÇUKUROVA	TREATMENT OF POTABLE WATER	Drinking water source, physical of drinking water, chemical and biological properties, water analysis, water quality standards, water treatment models, grids, precipitation, filters, water softening, disinfection, improvement of water bodies, water treatment	6	E

			processes, design criteria and applications.		
	ÇUKUROVA	WATER SUPPLY	Water and environmental health, the determination of water demand, population estimation methods, planning of water resources, water resources, the compilation of the waters, groundwater hydraulics, transmission of water, air boilers and sizing, drinking water reservoir, hydraulic analysis of the distribution system.	6	C
Mechanical Engineering					
	MARMARA	MECHANIC INSTALLATION TECHNICS	Wastewater installation design. Automatic control systems design. Calculate the pressure tank installation. Learn the way of clean water systems.	3	C
	GAZİ	HYDRAULIC MACHINERY	Understanding of basic properties of fluids. Learning the methods used for analysis of hydraulic machinery, and force and energy	8	E

			exchange between fluid and the surfaces in content with fluids. To introduce basic properties and importance of pumps and turbines in engineering applications. Related system analysis, design and optimization of the methods used to enforce.		
	ITU	FLUID MECHANICS	A knowledge of fluid concept, and similarities and differences between fluids and gases, solve problems involving viscosity. Surface tension, water vapor calculate hydrostatic forces, moments and point of action on submerged surfaces. Classify flows as uniform/nonuniform, steady/unsteady, compressible/incompressible, laminar/turbulent, 1D/2D/3D, calculate mass flow rate, volumetric. Flow rate and mean velocity in a flow A knowledge about pressure,	8	C

			velocity and mass flow rate measurement techniques. Use control volume concept and Reynolds transport theorem to calculate fluid forces and moments acting on static or moving vanes, nozzles, bends, rotating systems. Apply dimensional analysis, similarity and modeling laws to fluid flow problems		
	METU	THERMODYNAMICS	Basic concepts and definitions. Properties of a pure substance. Equations of state. Work and heat. First law of thermodynamics. Internal energy and enthalpy. Second law of thermodynamics. Carnot cycle. Entropy.	6	C
	AKDENİZ	HYDRAULIC MACHINES	Classification, Euler theory in turbomachines, water turbines; Pelton, Francis propeller and Kaplan turbines, the phenomenon of cavitation., the theory of similarity, pumps; types, working principles and related	6	C

			definitions, centrifugal pumps - their constructions and dimensioning, characteristic curves of pumps and determination of operational points, the selection of pumps.		
Microbiologist (Biology)					
	HACETTETEPE	WATER QUALITY CONTROL	Water quality, parameters of water quality, water pollution, effects of water pollution to living organisms, control of water quality	5	C
	METU	FRESHWATER ECOLOGY	Advanced theoretical aspects of freshwater ecology, impact of land and water use on lakes, interaction between physical, chemical and biological components of freshwater lakes, eutrophication, global changes, and biodiversity of the organisms.	5	C

*C: compulsory
**E: elective

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APPENDİX I

Related Institutions of Higher Education and R & D and application centers with Water Area in Turkey

Higher Education Institutions:

Environmental engineering

1. Abant İzzet Baysal University
2. Akdeniz University
3. Aksaray University
4. Anadolu University
5. Atatürk University
6. Bahçeşehir University
7. Balıkesir University
8. Bartın University
9. Cumhuriyet University (Sivas)
10. 18 Mart University of Çanakkale
11. Cukurova University (Adana)
12. Dokuz Eylul University (Izmir)
13. Erciyes University (Kayseri)
14. Fatih University (Istanbul)
15. Fırat University (Elazig)
16. Harran University (Sanlıurfa)
17. Istanbul Teknik University
18. Istanbul University
19. Kahramanmaraş Sütçü İmam University
20. Kocaeli University
21. Marmara University (Istanbul)
22. Mersin University
23. Namik Kemal University (Tekirdağ)
24. Nigde University
25. 19 Mayıs University (Samsun)
26. Ortadığu Teknik Üniversitesi (Middle East Technical University -METU-Ankara)
27. Pamukkale University (Denizli)
28. Sakarya University
29. Selcuk University (Konya)
30. Süleyman Demirel University (Isparta)
31. Uludağ University (Bursa)
32. Yıldız Technical University (Istanbul)
33. Karaelmas University

Faculty of Agriculture Agricultural Structures and Irrigation

1. Adnan Menderes University Faculty of Agriculture

2. Akdeniz University Faculty of Agriculture
3. Ankara University
4. Ataturk University
5. 18 Mart University of Çanakkale
6. Çukurova University
7. Ege University
8. Kahramanmaraş Sütçü Imam University
9. Namik Kemal University
10. 19 Mayıs University
11 Selçuk University
12. Süleyman Demirel University

Civil Engineering

1. Akdeniz University
2. Aksaray University
3. Anadolu University
4. Ataturk University
5. Atılım University
6. Balikesir University
7. Bartin University
8. Bayburt University
9. Beykent University
10. Bogazici University
11. Bozok University
12. Celal Bayar University
13 University of the Cumhuriyet
14. 18 Mart University of Çanakkale
15. Cukurova University
16. Dicle University
17. Dokuz Eylül University
18. Dumlupınar University
19. Ege University
20. Erciyes University
21. Eskişehir Osmangazi University
22. Fırat University
23. Gazi University
24 Gaziantep University
25. Gazikent University
26. Gümüşhane University
27. Harran University
28. İnonu University
29. Istanbul Kültür University
30. Istanbul Technical University
31. Istanbul University
32. Kahramanmaraş Sütçü İmam University
33. Karadeniz Technical University
34. Kırıkkale University

35. Kocaeli University
36. Maltepe University
37. Mugla University
38. Mustafa Kemal University
39. Namık Kemal University
40. Nigde University
41. Okan University
42. Ondokuz Mayıs University
43. Middle East Technical University (METU)
44. Pamukkale University
45. Sakarya University
46. Selçuk University
47. Süleyman Demirel University
48. Tunceli University
49. Yeditepe University
50. YIldIz Technical University
51. Yüzüncüyıl University
52. Karaelmas University
53. Zirve University

Hydrogeology Engineering

1. Hacettepe University

Department of Fisheries

1. Akdeniz University
2. 18 Mart University of Çanakkale
3. Cukurova University
4. Ege University
5. Fırat University
6. Istanbul University
7. Mersin University
8. Muğla University
9. Mustafa Kemal University
10. Rize University
11. Sinop University
12. Süleyman Demirel University
13. Tunceli University

Geological Engineering

1. Akdeniz University
2. Aksaray University
3. Ankara University
4. Ataturk University
5. Balıkesir University
6. Batman University

7. Bozok University
8. Cumhuriyet University
9. 18 Mart University of Çanakkale
10. Cukurova University
11. Dokuz Eylul University
12. Dumlupinar University
13. Eskişehir Osmangazi University
14. Fırat University
15. Gümüşhane University
16. Hacettepe University
17. Istanbul Technical University
18. Istanbul University
19. Kahramanmaraş Sütçü Imam University
20. Karadeniz Technical University
21. Kocaeli University
22. Mersin University
23. Nigde University
24. Middle East Technical University (METU)
25. Pamukkale University
26. Selcuk University
27. Süleyman Demirel University
28. Tunceli University
29.100. Yüzyıl University

Environment and Water Resources Research Centers

1. Water Resources Development Adnan Menderes University Research and Application Center
2. Akdeniz University Environmental Problems Research and Application Center
3. Anadolu University Environmental Problems Research and Application Center
5. Ankara University Environmental Problems Research and Application Center (CSAM)
6. Ataturk University Environmental Problems Research Center
7. Balikesir University Environmental Problems Research and Application Center
8. Environmental Sciences Research Center of Bilkent
9. University Institute of Environmental Sciences
10. Celal Bayar University Environmental Problems Research and Application Center
11. Cumhuriyet University Environmental Problems Research Center
12. Çanakkale 18 Mart University Environmental Problems Research and Application Center
13. Çukurova University Environmental Problems Research and Application Center
14. Dicle University Environmental Problems Research and Application Center
15. Dokuz Eylul University Environmental Research Center (ÇEVMER)
16. Ege University Environmental Problems Research and Application Center
17. Fırat University Environmental Problems Research and Application Center
18. Gaziantep University Environmental Research Center (GÜÇAM)

19. Hacettepe University Environmental Research Center
20. Hacettepe University International Karst Water Resources Research Center (Ukai I)
21. Istanbul University Environmental Problems Research and Application Center
22. İTU Urban and Environmental Planning Research Center
23. Kırıkkale University Environmental Problems Research and Application Center
24. Marmara University Environmental Problems Research and Application Center
25. Muğla University Environmental Problems Research and Application Center (Mucea)
26 METU Water Resources Engineering Research Center
27. Trakya University Environmental Problems Research and Application Center
28. Uludağ University Environmental Problems Research and Application Center (Uluçam)
29. Yüzüncuyıl University Environmental Problems Research and Application Center

TAGEM Research Institute directorate

1. Southeastern Anatolia Project Ground-Water Resources and Agricultural Research Institute
2. Soil and Water Resources Research Institute / TARSUS
3. Soil and Water Resources Research Institute / MENEMEN
4. Soil and Water Resources Research Institute / ESKİŞEHİR
5. Soil and Water Resources Research Institute / KONYA
6. Soil and Water Resources Research Institute / TOKAT
7. Soil and Water Resources Research Institute / Samsun
8. Soil and Water Resources Research Institute / ERZURUM
9. Ataturk Soil and Water Resources Research Institute / KIRKLARELİ

TUBITAK Marmara Research Centre Environment Institute

1. Water and Wastewater Management
2. Sea, Lake Pollution and Ecotoxicology
3. Air Quality Management
4. Solid-Hazardous Waste and Soil Quality Management

Source: December 2010, Water Area of the National R & D and Innovation Strategy Note for Guidance on the Preparation, TUBİTAK (The Scientific and Technological Research Council of Turkey) Science, Technology and Innovation Policy Department,