FINAL MASTER PLAN

WATER SUPPLY AND SEWERAGE SYSTEM FOR BITOLA AGGLOMERATION

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A Project is implemented by NIRAS and its consortium partners
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LIST OF ABBREVIATIONS

MP	Master Plan
FS	Feasibility Study
EIA	Environmental Impact Assessment
CBA	Cost Benefit Analysis
EU	European Union
EC	European Commission
EEC	European Economic Community
WWTP	Waste Water Treatment Plant
IPA	Instrument for Pre-accession Assistance
RM	Republic of Macedonia
SAA	Stabilization and Association Agreement
MOEPP	Ministry of Environment and Physical Planning
MTC	Ministry of Transport and Communication
IFI's	International Financial Institutions
UNECE	United Nations Economic Commission for Europe
NEAP	National Environmental Action Plan
CFCD	Central Financing and Contracting Department
FYRoM	Former Yugoslav Republic of Macedonia
JKPD	Javno Pretprijatie za Komunalni Dejnosti
NSI	National Statistical Institute
BOD	Biological Oxygen Demand
UWWTD	Urban Waste Water Treatment Directive (91/271/EEC)
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
AEWA	African-Eurasian Waterbird Agreement
CORINE	Coordination of Information on the Environment
EMRALD	Ecological Network made up of Areas of Special Conservation Interest
GDP	Gross Domestic Product
MKD	Macedonian Denars
GVA	Gross Value Added
NTES	Nomenclature of Territorial Units for Statistics
CPI	Consumer Price Index
NBRM	National Bank of the Republic of Macedonia
LEAP	Local Environmental Action Plan

GUP	General Urban Plan
DP	Drushtvo za proizvodstvo (Manufacturing Company)
DT	Drushtvo za Trgovija (Trade Company)
TDPU	Trgovsko Drushtvo za Proizvodstvo i Uslugi (Trade Company for production and services)
DTPTU	Drushtvo za trgovija, proizvodstvo i turisticki uslugi (Company for production, trade and tourist services)
TPGT	Trgovsko drushtvo za gradezhnishtvo i trgovija (Trade company for construction and
DTP	Drushtvo za Trgovija i Proizvodstvo (Trade and Manufacturing Company)
DGT	Dreushtvo za Gradezhnishtvo i Trgovija (Construction and trade company)
ISSN	International Standard Serial Number
HH	House Hold
WS & S	Water Supply and Sewerage
W & WW	Water and Waste Water
SFRY	Socialist Federal Republic of Yugoslavia
Ramsar	Convention on Wetlands of International Importance, especially as Waterfowl Habitat
WFD	Water Framework Directive
PCE	Public Communal Enterprise
TPU	Technical Production Unit
MAFWE	Ministry of Agriculture, Forestry and Water Economy
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
P&L	Profit and Loss
MEAP	Environment Protection Law
COD	Chemical Oxygen Demand
DWTP	Drinking Water Treatment Plant
N	Nitrogen
PR	Pressure Reservoir
AC	Asbestos Cement
PVC	Polyvinyl Chloride
CI	Cast Iron
GI	Galvanized Iron
PE	Polyethylene
PP	Polypropylene

PM	Pumping Station
SCADA	Supervisory Control and Data Acquisition
SS	Suspended Solids
P	Phosphorus
SG	State Gazette
DN	Diamètre Nominal/nominal diameter
l/c/d	Litter per capita per day
SEA	Strategic Environment Assessment
EIA	Environment Impact Assessment
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
IMF	International Monetary Fund
WB	World Bank
SSO	State Statistic Office
HH	House Hold
VAT	Value Added Tax
HDPE	High Density Polyethylene
UV	Ultra Violet
DS	Dry Substance
SBR	Sequencing Batch Reactor
MBBR	Moving Bed Biological Reactor
O&M	Operation and Maintenance
CAPEX	Capital Expenditure
FIDIC	Fédération Internationale Des Ingénieurs-Conseils

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1. INTRODUCTION

1.1. Project framework

The present Master Plan (MP) has been developed within the project EuropeAid/133257/D/SER/MK– „Preparation of studies (FS, EIA, CBA), design documentation and tender dossiers for waste water collection and treatment investment projects in the municipalities of Strumica, Bitola and Tetovo.

The project is a part of the overall national priority for reconstruction and modernization of the infrastructure of Macedonia including the water sector in compliance with the requirements and standards of the European Union (EU).

The measures in the Master Plan are directed towards resolving infrastructure problems of Bitola related to the water supply, sewerage and wastewater treatment.

The objectives of the investment measures in the water supply sector are:

- Provision of drinking water with the necessary quantity and quality to the population;
- Limiting the water losses in the water supply network;
- Increasing the part of the population that is not affected by water supply regime including the elimination of unplanned discontinuations resulting from poor status of the network;
- Improving and expansion of the existing water supply facilities where necessary;
- Designing, construction and/or completion of new water supply facilities, drinking water sources and treatment facilities.

The objectives of the investment measures in the wastewater sector are:

- Optimization of the work of the sewerage network (including reduction of the leakage);
- Increasing the number of population connected to the sewerage network;
- Increasing the number of population, whose wastewater is treated to the necessary degree.

The pointed objectives will be implemented mainly through:

- Definition of the agglomerations in the sense of the Directive 91/271/EEC,
- Review of the existing studies and additional site investigation surveys as necessary,
- Development of sewerage hydraulic model and Master Plan,
- Preparation of Feasibility Study, Environment Impact Assessment and Cost-Benefit Analysis for the investment project for waste water collection and at least secondary treatment, compliant with the requirements of the Directive 91/271/EEC and Directive 85/337 EEC, as amended,
- Preparation of sludge management programme,
- Preparation of outline design for the waste water treatment plant (WWTP),
- Preparation of a procurement strategy and tender dossier for construction of the WWTP, following the FIDIC 1999 contract conditions under the requirements of the 'Practical Guide to Contract Procedures for EU External Actions'.

This project for construction of WWTP in Bitola was financed under provisions of **Council** Regulation (EC) No 1085/2006 of 17.7.2006establishing an Instrument for Pre-Accession Assistance (IPA).

Basic information

The Republic of Macedonia (RM) is a landlocked country situated in the southern part of the Balkan Peninsula, nestled amongst hills and mountains with an area of 25,731 km^2 and some 2,072,000 inhabitants in 2010. It consists of 80 local self-government units - municipalities, divided into 8 planning regions.

In 2000, the Republic of Macedonia began its formal process of rapprochement with the European Union by initiating negotiations about the EU's Stabilization and Association Process, and it became the first non-EU country in the Balkans to sign the Stabilization and Association Agreement (SAA), in April 2001.

In September 2004, the Macedonian government adopted a National Strategy for European integration, supported by the country's parliament through its Commission for European Issues. The European Council officially granted the country candidate status in December 2005.

The EU accession process, among others, requires significant achievement of required environmental performances. Integrated water management based on the principles of sustainable development is one of the important national priorities. Increased investments in environmental infrastructure, with particular emphasis on waste water collection and treatment, drinking water supply, tackling air pollution and waste management, represents country commitments to the principles, priorities and conditions in the accession partnership stipulated in the Council Decision 2008/212/EC of 18 February 2008.

In this regard the Government of RM has committed most public resources to the water and waste sectors through the competent line ministries such as the Ministry for Environment and Physical Planning (MoEPP) and the Ministry of Transport and Communication (MoTC).

The main sources of financing identified in the strategic documents (such as the National Environmental Investment Strategy) are the central budget, local budgets; the Instrument for Pre-accession Assistance (IPA) and funds of other international financial institutions (IFIs).

In accordance with the second review synopsis of the United Nations Economic Commission for Europe (UNECE) on the environmental performance, issued in 2011, it has been recorded that Macedonia has developed an appropriate framework for sustainable water management, through the reorganization of MoEPP and the adoption of the 2008 Law on Water and of the second National Environmental Action Plan (NEAP), accompanied by strategy papers, recommendations and support reports from international institutions. Thus, environmental concerns have been embedded in legislation for the most part. Implementation is the next step that is required to achieve integrated water resources management based on the principles of sustainable development for river basins and trans-boundary international cooperation.

In this context it has been noted that the wastewater treatment from individual sources (municipalities and industry) remains a big challenge as only 10% of existing settlements have access to mechanical and biological treatment of wastewater. Larger cities have no sewage treatment plants. The average rate of wastewater collection in sewerage collection systems is around 60% for households.[1]

Only 12 cities have constructed separate sewage system and there is no monitoring of the wastewater discharge into municipal sewerage systems. The management of the sewerage systems and wastewater facilitates is the responsibility of the public water supply and sewerage enterprises.

Because the Implementation Program for Directive 91/271/EEC is part of the accession negotiations of Macedonia to the EU it is very important for the country politically as well as in terms of financing to fulfil the envisaged measures in this program.

Project stakeholders

Contacts with all project stakeholders are maintained in order to guarantee that the achieved project results reflect the current needs and priorities.

Stakeholder	Role
Central Financing and Contracting Department (CFCD) within the Ministry of Finance	The Contracting Authority for implementation of the Project and for the management of this Contract under the IPA Program.
Ministry of Environment and Physical Planning (MoEPP)	The competent state body with regard to the development and implementation of policies in the area of environmental protection and improvement in the different media and areas

[1] United Nations Economic Commission for Europe, Environmental Performance review for FYR of Macedonia, Second Review Synopsis, New York and Geneva 2011

The Ministry of Transport and Communications (MTC)	Responsible for overseeing development plans for water-supply systems and sewerage network infrastructure, implemented with financial allocations of the state budget.
Bitola Municipality	Formulates and implements the water sector policy at local level; responsible for the investments in the water supply and sewerage sector on the territory of the municipality; Project beneficiary
JKP "Vodovod" Bitola	A public communal enterprise whose core activity is purification and distribution of clean potable water in the city of Bitola and surrounding villages.
JKP "Niskogradba"	Treatment, maintenance and drainage of waste water, and also regulation and maintenance of streets and roads, construction of hydrotechnical facilities and sewerage system.

The project beneficiaries – Bitola Municipality and JKP "Niskogradba" are actively involved in the development of the MP. This fact is very important for achieving the final results on the project „Preparation of studies (FS, EIA, CBA), design documentation and tender dossiers for waste water collection and treatment investment projects in the municipality of Bitola", which contribute to the fulfilment of the Implementation program for Directive 91/271/EC in Macedonia.

1.2. Strategic objective and approach for MP development

The objective of the MP is to determine where and what investments are needed in the water supply and sewerage sectors for achieving compliance with the EU standards within the terms set in the accession treaty.

The MP's objective will be achieved through: capital investments for rehabilitation and modernization of the water supply and waste water infrastructure directed towards improving the quality of services and meanwhile promoting cost recovery.

The MP should show that:

- The proposed investments are part of a long-term and cost-effective development plan;
- The operator is viable and effective;
- The investments are sustainable in time and after their implementation better quality services will be provided to the population as well as the quality of environment will be improved.

The MP has been developed based on an interdisciplinary approach including:

- Collection of primary information from various sources e.g. the NSI, Bitola Municipality and JKP "Niskogradba", JKP "Vodovod" Bitola, MoEPP, etc.
- Secondary analysis of existing strategic documents, materials, project, etc.
- Collection of data on the field e.g. monitoring of the water quantity and water level in the water supply and sewerage network.
- Development of the particular parts of the plan in compliance with the Guide for development of master plans for water supply and sewerage projects.
- Study of the experience from previous project for Feasibility Study for wastewater treatment plant in 1999.

The MP for the water supply and sewerage projects of Bitola is the major instrument for long-term strategic planning to meet the future needs (for a 25-years period) for supply of water and treatment of wastewater on the territory of the city. Therefore this is a very important document for the socio-economic development of Bitola and the environmental protection (surface and ground water) in the region.

Despite the involvement of the stakeholders and their support, the development of the MP encountered some objective difficulties like:

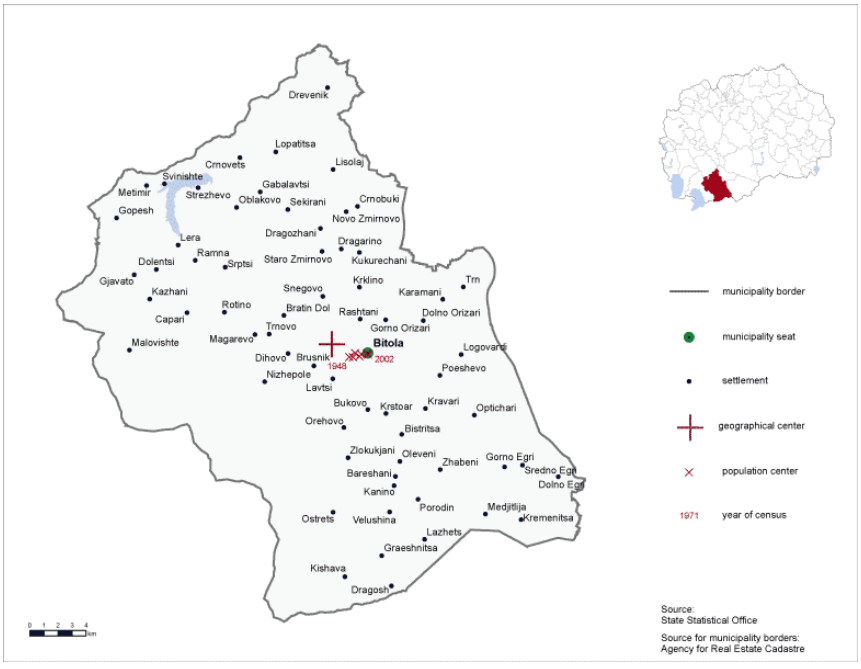
- Partial lack of information or contradictory information related to lack of actual measured water, poor technical archives or old drawings;
- Lack of actual measured water quality and quantity;
- Adoption of general urban plan of Bitola during the project implementation;
- Delays in the confirmation of data from the analyses and the projections.

2. ANALYSIS OF CURRENT SITUATION

2.1. Project Region

The project is implemented in Bitola, which is the second largest city in Macedonia. It is situated on the river Dragor, in the end southwest part of the Republic of Macedonia in the bottom of the Baba Mountain, 13 kilometres away from the Greek border, in the biggest Macedonian valley Pelagonia. The town occupies a surface of 15 square kilometres for the narrower area and over 24 square kilometres for the wider area. The Bitola terrain leans from west to east that is from Pelister and Baba to the Pelagonia Valley or from 710 meters to 590 meters height above the sea level, and the town's average height above the sea level is 650 meters.

The local municipality of Bitola includes 65 settlements and the city of Bitola since the new territorial division in 2004. According to the data from the 2002 census, 95,385 people live in the municipality of which 74,550 are inhabitants in the City of Bitola. Generally speaking, although Bitola is set at the peripheral part of the Republic of Macedonia, it is second largest economic centre after Skopje, as well as an important administrative and commercial centre. Bitola is set in a region of intensively developed agriculture and is important agro-industrial centre, not only for the Pelagonia Valley, but also in the wider south-western region of the Republic of Macedonia.



Map 2-1 Bitola Municipality

Bitola is the economic and industrial centre of south-western Macedonia. Many of the largest companies in the country are based in the city. The Strezhevo water system is the largest in the Republic of Macedonia and has the best technological facilities. The three thermoelectric power stations of REK Bitola produce nearly 80% of electricity in the state. The Frinko refrigerate factory was a leading electrical and metal company. Bitola also has significant capacity in the textile and food industries.

Bitola is also home to twelve consulates, which gives the city the nickname "the city of consuls."

The municipality has two water utility companies **JKP Vodovod** and **JKP Niskogradba**. The two companies are public enterprises originally founded by the Municipality of Bitola. JKP Niskogradba is generally in charge of thesewerage services, the collection of wastewater from domestic and industrial premises; local road building and road maintenance; operation and maintenance of traffic signs and lights within the Municipally.

The activities of JKP Vodovod are limited to the core business of water supply.Charges for water and wastewater are separately invoiced by the companies.

The strategic geographical location of Bitola and its role as the largest settlement in southern Macedonia and large administrative centre are significant factors that should be considered in the development of long-term projections for the water needs.

2.2. Physical Geographical Characteristics

2.2.1. Environment

The environmental state of the municipality of Bitola is generally characterized by good indicators regarding the quality of the different environmental components: atmosphere, water, soil.

The main pollution source of the surface and underground water is the untreated wastewater from urban, domestic and industrial polluters.

A chief source of hazardous emissions in the atmospheric air are the production capacitates which use facilities and technology installations with emission of harmful gasses and substances as well as the domestic sector and the motor vehicles.

The microclimate is influenced by the air pollution caused by the great polluters (REK Bitola, the city boiler rooms, the traffic, the chimneys of the houses and the industrial zone) which release gases that represent one of the components of the thick fogs transiting into industrial smog. Also the new housing blocks of the city, especially the western parts of the city, influence the changing of the microclimate conditions, bringing up some new problems with the airing out, the sunlight supply and the aeration of the whole city.

There is no integrated communal waste management according to the EU Regulations in the Municipality. The basic activities of the municipality in this regard are concentrated on collection and transport of solid waste from the city and 13 villages on the landfill Meglenci situated 17km from the city.

The Pelagonia agricultural combine is the largest producer of food in the country. The agricultural production is mostly oriented on wheat, barley, sunflower, oil seed rape, corn grain, corn silage.

Due to the quality of production in the region and the environmental state in general, the Municipality can use the advantages to create conditions for affirmation of production of ecologically clean agricultural goods.

2.2.2. Climate and relief

Bitola region, as well as the whole Pelagonia Valley is rather southern positioned and due to the latitude should have a modified Mediterranean climate like Tikvesh, Valandovo, Gevgelija and Strumica. But, although Pelagonia Valley is at a distance of 155 kilometres from the Adriatic Sea, and at about 130 kilometres from the Aegean Sea, still the Mediterranean climate influence isn't much felt, because of the high mountainous surrounding of the valley, and its own height above the sea level (it is between 571 and 770 meters) due to which temperate-continental, continental and mountainous climate are predominant.

Generally speaking, according to the characteristics and the appearance of the climate phenomena during a year, Bitola region belongs to a warm continental area. The climate in Bitola has moderate – continental characteristics with an emphasized continental component, because of the closeness of the mountainous relief, the height above the sea level, the near-by valley etc., and these facts make the climate in Bitola and Pelagonia very dynamic and unstable. According to the Kepen's climate classification, the climate in Bitola can be marked with CSW "ax" – a specific variant of the etezic climate with dry and very warm summer, and a rainy winter period, divided into a shorter cold and dry period, with the first maximum rainfall in autumn and the second one in spring. This variant is called Macedonian variant of the etezic climate because it is typical for Macedonia, especially for the regions at 500-600 meters height above sea level. Bitola is a typical representative of this variant with dry and very hot summers, and winters and springs with abundant rainfall.

The average annual temperature is 11.0°C with the highest average monthly temperature of 21.0°C in July and August and lowest of -1.0 °C in January. The temperature amplitude is 21.6 °C while the difference between the maximum absolute of 40.5°C and the absolute minimum temperature of -30.4 °C is 71.6°C.

Table 2-1 Average monthly and annual air temperature in Bitola region

Average monthly and annual air temperature in °C													
Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Temperature	-1.0	2.0	6.0	11.0	15.0	19.0	21.0	21.0	17.0	12.0	5.0	2.1	11.0

In Bitola, July and August are the months with the longest insulation, and December and January – the shortest. The average year sum of insulation for the 1951-1990 period is 2,325.6 hours, which is about 6.3 hours a day. Fog usually appears during autumn, winter and spring, that is from September to May, and most foggy months are December, January, November and February. Thick fogs with only about ten meters of visibility are most common. Such thick fogs are common for the winter period, and sometimes in late autumn (November). The average number of foggy days is 22.77. This number can vary from 9 to 48 days in some years.

The average annual rainfall measured is 535.0 mm withits peaks in spring and autumn. Most drought months are July and August, but sometimes the other extreme can happen - abundant precipitation. The average period of snow lasting is December to March. The average year number of days with a snow covers thicker than 1 cm is 34 days, but often it can vary from 12 to 50 days. The maximal thickness of the snow cover can be from over 60 to over 80 cm.

Table 2-2 Average monthly and annual rainfalls in Bitola region

Average monthly and annual rainfalls in mm													
Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Quantity	41.0	38.0	35.0	53.0	48.0	29.0	31.0	29.0	39.0	53.0	66.0	73.0	535.0

Set on both sides of the river Dragor, Bitola, is enclosed with four hills called "Bair" on the north, that are 640, 770 and 785 meters high, and the fourth, which is called Kale is the highest one (890 meters). They are spurs of the Oblakovo – Snegovo massif. On the south the town is enclosed with the hill Tumbe Kafe, which is a 744 meters high spur of Neolica and Baba Mountain. On the east, Bitola is wide opened to the Pelagonia valley, and on the west Bitola is opened to the fluvial-glacial alluviums of the river Dragor, the wide Gjavat valley, and the high peak Pelister.

The Bitola terrain leans from west to east that is from Pelister and Baba to the Pelagonia Valley or from 710 meters to 590 meters height above the sea level, and the town's average height above the sea level is 650 meters. These parameters make Bitola the highest town among the largest cities in the Republic of Macedonia.

The basic characteristics of the local topographic situation of Bitola result from its location on the boundary of two different physical and geographic entireties. It is in contact with the Pelagonia Valley zone, the hills of the Oblakovo – Snegovo massif, and the mountainous terrain of Baba Mountain and

Pelister. The eastern and the southeaster part of the town are lying on alluvial layers of the Pelagonia Valley, the northern part is lying on hilly terrain of the Bair Hill, and the western and partially southern part of the town are lying in the direction of Baba and Pelister.

These differences greatly influence the look of the town and the structure of its landscape. One side of the town is set on a plain area, and the other side is set on hilly terrain and pluvial material. Two different agricultural branches, gardening and farming in the east, northeast, and southeast, and orchards, gardening and cattle breeding in the west and southwest get in contact in the Bitola area.

The water sources of the Bitola municipality are represented by subsoil, river, reservoir and mineral waters. The river waters are of utmost importance for the water balance. The main raw water resource for Bitola is the catchment area of the Dragor River part of which is owned by the Water Company and part by PE Strezevo. Additional raw water is obtained from the 95 million-m3 storage reservoir of the Strezevo system about 20 km to the west of Bitola.
River Dragor flows through the city of Bitola in length of 4.5 km. It is formed from several smaller rivers: Dihovski Dragor, Bratindolski Dragor and Boroica. Second River is Bukovska reka as well as all springs with regulated riverbed which form the flow of river Kurdeles. Today the riverbed of Kurdeles river has entirely been covered, and an asphalt street constructed above it.
The total length of River Dragor is 25,123 km with the variable water quantity depending from the rainfalls and underground waters of mountain Baba and Pelister. The average flow of river Dragor through the city from November to June is 2-3 m^3/sec. with water level of 10-50 cm.
The largest water reservoir in the region is the artificial lake Strezevo twenty kilometres west from Bitolaon Mountain Ograzden. The lake occupies an area of 7 km^2 and has a capacity of 112 million m^3 of
water. Its maximum depth is 72 meters. This reservoir is used for irrigation, water supply and the production of energy.

Almost the entire area of Pelagonija valley has been pedagogically examined. The core of the valley is consisted of Palaeozoic rocks, especially visible on the hills (Tumbe Kafe, Bair). This rocks are covered up with thick layers of alluvial and diluvial deposits.

2.2.3 Geology and hydrogeology

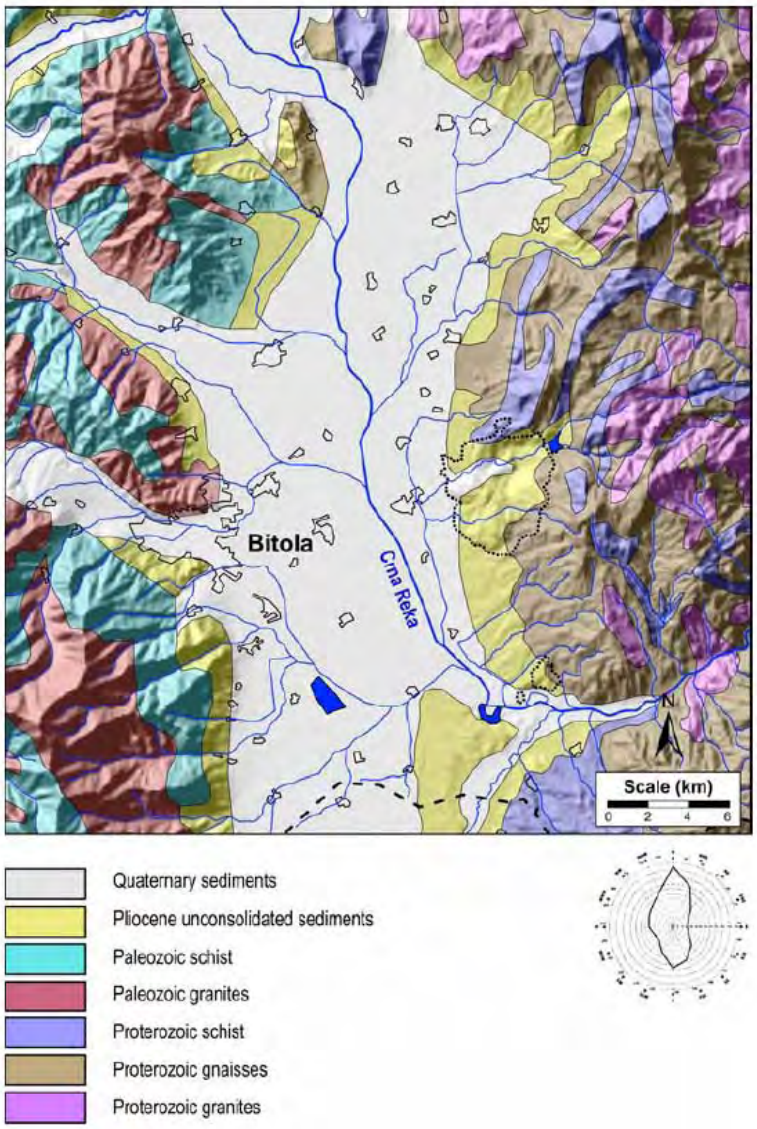
Geological and engineering-geological conditions

The Bitola Basin is located in the southern part of the Country. As a geological structure, it is the northern part of the Pelagonian Basin, which is an elongated intermountain graben system situated in NNW-SSE direction. The total length of the basin is over than 250 km, and it extends from Prilep and Bitola in the north, to Serbia (Greece) in the south. The depression fill comprises a succession of predominantly lacustrine sediments with intercalated lignite seams and fluvial deposits.

The Pelagonian Basin is bordered by two fault systems, which correspond to the two main episodes in its evolution: late Miocene and Pliocene ones. Pleistocene extension of the basin resulted in the development of several sub-basins, one of which is the Bitola Basin. Neogene sediments of the Bitola Basin were divided into four informal lithostratigraphic units corresponding with two sedimentation cycles. On the basis of the mammal fauna found in the upper part of the sediments of the second cycle, these were dated as Pontian/Lower Pliocene. Many authors for the corresponding deposits reported the same age from the Greek part of the basin based on palynological and macropalaeobotanical data.

The Pelagonian graben was initiated first during late Miocene time. The N-S–trending Pelagonian graben is ~100 km long (including a part in the Northern Greece) and up to 25 km wide. It is a complex graben developed on Precambrian gneiss and schist and Paleozoic schist and granite of the Pelegonian tectonic unit. Within the graben there are small horsts and one intragraben horst that divides the main graben into northern and southern parts containing 450–500m and 700–800m, respectively, of sedimentary fill. The graben is bounded on all sides by normal faults. Along the eastern side of the graben the youngest sedimentary layers are displaced up to 70m. The basal units in Pelagonian basin are proluvial-alluvial sediments based on borehole data. Seismic studies indicate that these sediments were deposited in narrow river valleys rather than with a fault controlled graben. Paleontological data from higher stratigraphic levels indicate the graben was initiated in late Miocene time and contained a lacustrine environment from late Miocene to the end of the end of Pliocene and Pleistocene time locally. Considering that there is probably more than 1000m of section in the southern part of the graben, it can be suggested that this part of the graben may has been initiated

during middle Miocene (Badenian-Sarmatian) time. The Miocene-Pliocene section is covered by 5–15m of Pleistocene alluvial-proluvial sediments, except in the southeaster part of the graben, where upper Miocene strata are exposed by uplift and erosion. In this area, the section has been well studied in the Suvodol open pit coalmine and in drill holes in numerous water wells. The sequence is divided into two formations and undifferentiated Quaternary strata.



Map 2-2 Fragment of geological map of Macedonia – Bitola valley and surrounding

The basic facts that can be pointed out for the geo-chronological development of the wider region are:

- The oldest rocks in the Western Macedonian zone have Precambrian age and they are in the frames of the magmatic complex composed from granodiorite, shale granodiorite, syenite rocks and granite;
- For today look of terrain the current geological processes during the Quarter period are important, when the deluvial cover is created over the basic rocks, the glaciofluvial sediment are noted in the foothill of mountain Baba in form of wreath wide several kilometres and alluvial sediments in the foothills of the biggest rivers but mostly they are formed in Pelagonia valley.

All periods of the geological development had big impact over the creation of today condition of the terrain which is manifested with current relief and conditions.

From geo-morphological aspect the wider area characterizes with sharp slopes created from tectonic and erosion processes. On hills it is noted presence of tranches during the contact between different

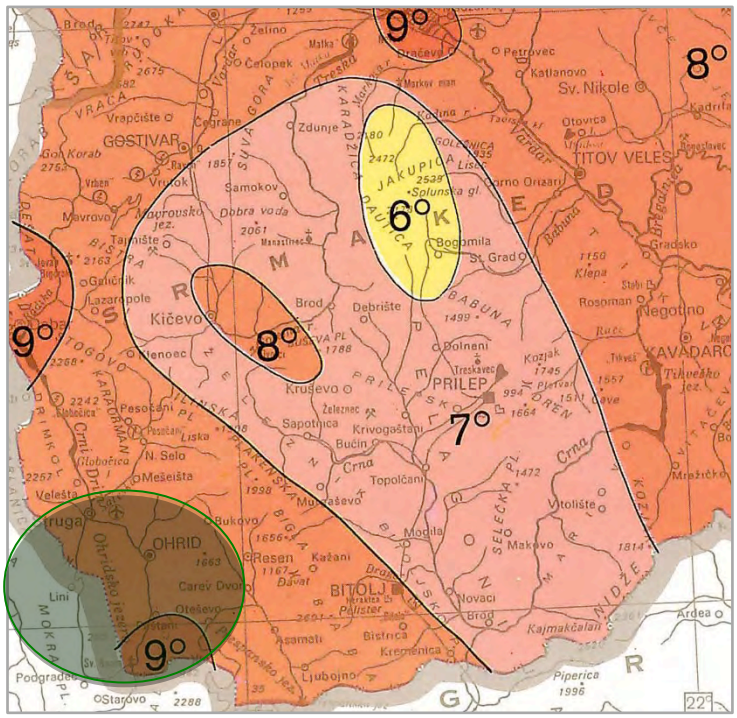
lithological elements i.e. in the contact between the diluvium and glaciofluvial sediments as well viogrus and granites.

The terrain is manly flat with minimal sea level of 585m on km 10 + 426.50 and mountainous area with sea level of 769 m on km 3+034.10. The zone around the transmission line tower AZ3 gently curved ridge with soft. The bias part of terrain of northeast side has relatively sharp slope, which is obvious on the naked basic rocks. The present trenches – valleys in geological sense are in stadium of middle activity. Because of the relatively sharp bow throughout them from time to time they are becoming deeper and because of this, the case of fulfilling of proluvial material in the zone of its connection with the occasional streams is present.

Seismicity of the region

From regional seismological tectonic terms the area belongs to the Western-Macedonian zone, characterized with minor plicate structures and radial tectonics. Extension of the structures in the Western-Macedonian zone is a NW-SE to NNW-SSE. Tectonic development is associated with two major orthogenesis: Hercine and Alpine orogenesis. With Hercine orthogenesis, Paleozoic sediments were regionally metamorphic and corrugated in soft synclinal and anti-synclinal structures. Alpine orthogenesis conditioned strong dynamo-metamorphism, intensive crimping of the terrain and for the most part, processing of the hercine structures. In the later stages of the Alpine orthogenesis (at the end of the Lower or early Middle Pliocene), the terrain was captured with very intensive radial tectonics that formed more tectonic cliffs. Paleozoic metamorphic rocks are intensively corrugated in lenient synclinal and anticline structures. Synclinals are larger, well expressed, while anticlines are less expressed, narrow and open structures. During the Middle Pliocene, certain parts of the terrain were taken by intensive radial tectonics (neotectonics) and as a result, more tectonic ridges were created. As the most remarkable is the Ohrid ridge, oriented in the N-S direction, between the mountain chains Galicica-Karaorman and JablanicaMokra and from N. is limited to the southern slopes of Karaorman. During the formation of the Pliocene ridges, the terrain became very labile with intense manifestation of radial tectonics. It has been active through the whole Middle and Upper Pliocene and acts in the Quarter, with tendency of conciliation.

The area of the city by its seismological characteristics belongs to the zone of high extent seismic activity and expected intensity of 5.7° by Richter. The planned range is between 7 and 8 degrees by Mercali"s scale of expected earthquakes. Earthquakes in the region are mostly shallow (h ≤ 60 km), whereupon most of them have hypocenters to 40 km, and often up to 20 km.



Map 2-3 Seismological map of the wider project location

Hydrogeological conditions

The project area belongs to the basin of river Crna. In this section it covers river Shemnica (in the northern part of the Municipality), river Dragor, river Krstoarska, river Beluska and river Graeshka. Through Bitola runs river Dragor in length of 4.5 km. Dragor arises from many small rivers from Dihovskiot Dragor (in length of 12 km whose spring is formed from waterways that originate from the slopes of Pelister: Sapuncica, Lak Potok, Crvena reka and Klisurica) and Bratindolskiot Dragor or Boroica. The total length of the river Dragor is 25.1 km with extent of the watershed of 67 km, basin of 188 km^2 and average drop of 17.0 ‰. Quantity of water in the river depends solely on rainfall and groundwater from Baba and Pelister. At the peak of the mountain Baba-Pelister there are two glacial lakes, known as "Pelister Eyes"-Big and Small Lake. Mount Baba is rich with springs, streams, and rivers. The most of the springs are situated in the upper parts of the mountain, between the altitudes of 2,000 and 2,200 m. Rivers, in their upper part, have pronounced mountain characteristics, full of plenty clear and cold water. Some streams flow to Lake Prespa, belonging to the Adriatic basin. The ones involved in this Project, run to Pelagonian valley, belonging to the Aegean basin. Some of the streams reach the project area as part of the water channel network of Pelagonia. There are a number of streams, running towards the area worth mentioning: Smilevska reka, with its tributary Kindjirka, Kristoarska reka with its tributaries Stara reka and Zlokucanska reka, Bistricka reka, with its tributary Petkovica, Veluska reka, with its tributary Ostrecka reka, Graeska reka, with its tributaries Kisevska reka and Negocanska reka (formed from Mala reka and Bacilo, and accepting also Dragoska reka), Siva Reka, Ksiropotamos, etc. In accordance with the Decree on categorization of the watercourses, lakes, reservoirs and groundwater ("Official Gazette of RM" no. 18/99) the water quality from Bitola to Crna River belong to the category III. The Veluska reka, Graeska reka, Kristoarska reka belongs to the category II. From the hydrogeological point of view, the present groundwater in the irrigation area can be classified into two groups: groundwater under the free water level at a depth of 1.5-2 m and groundwater under pressure (arterial and sub arterial waters), which are below 50 m and with a flow rate of 0.5 l/s to 9 l/s. Obesity of the hydrogeological collector is different and usually amounts to about 3.0 m. Direction of the movement of groundwater is adequate with the fall on the terrain to Pelagonia basin-Crna River. Water feeding is made by vertical infiltration of rainfall, and partly from surface water streams which occupy the surrounding terrain.

Map 2-4 Hydrography of Bitola valley

2.2.4. Sensitive zones and biodiversity

The natural conditions prevailing in the Republic of Macedonia (relief structure, climate, hydrology, geology, morphology, soils etc.) qualify it to be classified as one of a few countries that despite a relatively modest area still possess a rich variety of habitats, plant and animal species and communities.

Currently in Macedonia there is no categorization of sensitivity of the water bodies. According to the agenda the same should be implemented by year 2016. However, based on the criteria for determination of sensitivity of the water flow, almost all surface water flows in the country can be categorized as sensitive as almost all are recipients of wastewater both communal and industrial. In the same regard it should be taken in consideration that River Dragor and 5th Channel which are recipients of the wastewaters from Bitola are tributaries of River Crna. As such, they bring significant amount of wastewater to the Crna River and contribute to its deteriorating water quality. River Crna is one of the major tributaries to river Vardar which is an international river crossing to Greece. Thus, the larger part of this pollution presents trans-boundary pollution, with all related problems and issues arising from it.

Natural heritage conservation in Macedonia has been regulated by its Constitution and by other related laws and regulations. The Macedonian constitution defines natural heritage as an essential value of the State, enjoying as such priority in the national development plans.

In accordance to the Law on Natural Rarity Conservation, sites of natural heritage have been placed into four conservation groups, each of them having own conservation regime.

These groups are:

- General natural reserves – national parks, strict national reserves, scientific research national reserves, areas with special natural features, characteristic landscape;
- Special nature reserves;
- Specific plant and animal species beyond natural reserves;
- Monuments of nature.

In this regard following are the natural heritage sites registered in the Municipality of Bitola:

National Park Pelister

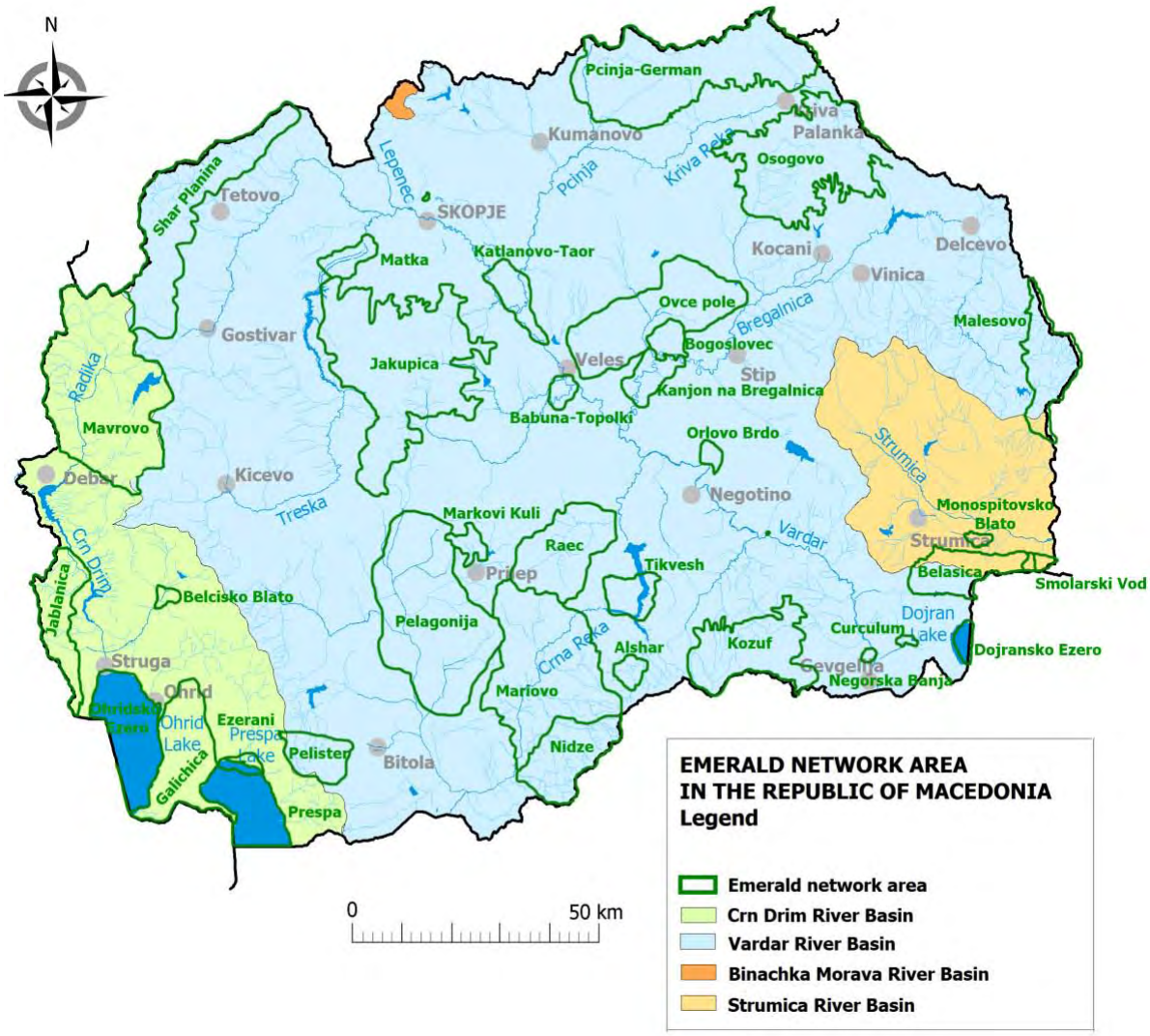
National Park "Pelister" is located in south-western part of Pelagonija, near the town of Bitola. Proclaimed a national park in 1948 for conservation of flora and fauna that grows and lives on its territory. Characteristic flora and fauna representatives in the park are Pelister pine (pinus peuce), and lynx. Tourist-recreational zone of the park offers to the visitors opportunities for rest and recreation in winter and summer.

In accordance to the map of the EMRALD network area in Republic of Macedonia, Pelister and Pelagonija have been mapped within the EMRALD network area.

There is no designated area for conservation of species (e.g. Important Plant Areas, Important Butterfly Areas, etc.) with the exception of the **Important Bird Area Pelgonija (MK0024)**
This site was designated due to the presence of *Falco naumanni, Coracias garrulus, Ciconia ciconia, Aythya nyroca, Burhinus oedicnemus, Lanius minor, Circus pygargus, Falco vespertinus, Pelecanus crispus, Anas strepera, Circaetus gallicus, Buteo rufinus* and *Falco biarmicus.*

The site includes a very small strictly protected area (Lokvi). Most important for Pelagonian birds are programs for preserving and developing different temperate grassland types. Implementation of autochthonous breeds of domestic animals like water buffalo, sheep, short-horned cattle (Busha) and horses in landscape management is essential to preserve the Pelagonian large scale pasture systems (Velevski et al. 2010).

The diversity of animals in the flat part of the area is low as in the case of plants.



Map 2-5 EMERALD network area in Republic of Macedonia

Quality of the cultivated landscape

The flat terrain, the lack of hill dominant, the absence of major complexes of forests (the tree vegetation is grouped in small communities beside the rivers, river beds and torrents), whilst the larger forest communities are located at the surrounding mountains. The quality of one landscape can support the creation of economic activities or to spur their creation, especially in the field of recreation or tourism, or when measures are taken in order to attract activities in certain region.

The relief of the Municipality of Bitola is characterized with mountainous and lowland parts. Baba Mt. extends over its western side, and Municipality occupies the central part of the basin bottom of Pelagonia on east.

The terrain occupied by Bitola is inclined between 715 and 585 meters from west to east, i.e. from Pelister and Baba Mt. to Pelagonia Valley, from 710 to 590 meters, thus positioning the city at the average altitude of 650 meters. These differences in altitudes have significant influence of the appearance of the city and the structure of urban landscape. At one side, the city is settled in a flat landscape, and on the other on hilly land and rinsing material. Bitola is situated in a zone where two distinctive agricultural units come in contact, namely farming and gardening on east, northeast and southeast and fruits and vegetables growing and livestock breeding zone on west and southwest.

Mountain Baba is the third highest mountain in the Republic of Macedonia, after Korab and Shar Mountain. It is located west of Pelagonija valley. Its highest peak is Pelister (2,601 meters) and there are many other peaks higher than 2,000 meters, separated by deep valleys. The Baba massif

stretches in north-south direction and makes the natural border between the Bitola Field on east and the Resen Field and Prespa Lake on west, spreading its southern part into Greece and splitting up the rivers of the region, so that they either flow towards the Adriatic or the Aegean Sea.
For its beauty and variety of nature, 12,500 hectares of the slopes of Mount Baba, at the elevation from 700 to 2,600 meters, are protected within the Pelister National Park.
Mount Baba is characterized by lush, well-watered forests. Flora is rich and diverse with lots of endemic plants. The most important amongst the floral species of Pelister National Park is the *Molika pine*, the autochthonous species from the tertiary age, which can live up to 300 years. The Molika woods are widely spread over the mountain and represent the significant natural wealth of this area.

Pelagonia Valley is very fertile plain and the biggest agricultural, especially grain-growing region in the Republic of Macedonia. The other cultures successfully grown are tobacco, sunflower and sugar beet. Very important is also livestock breeding. Agriculture is encouraged by the significant water resources, managed by dams and canals and the food industry is strongly developed in the region.

The project area is generally characterized with flatland agricultural landscape with intensive agriculture practices. The structure of the landscape is poorly developed. Matrix of the landscape is exclusively agricultural land. There are patches of rural settlements, and urban area of city of Bitola . Small portion of wetland habitats and permanent crops exist at the southern part of area. The area is mainly represented by the irrigation channels and channelized water courses with associated thin belts of wetland habitats along them. The functionality of the landscape in sense of biodiversity and natural ecosystem processes is thus very low.

Landscape visual values. Numerous anthropogenic objects, related to agricultural land use and rural living, are noted. Thus, from nature point of view, the concerned landscape does not have significant visual value.

The typical plant association noted is Scirpeto-Phragmitetum. It develops in a small depression, thus forming occasionally flooded wetland which once was probably with permanent standing water (according to the topographic maps of 1970s). However, due to the system of irrigation channels, the water level of the reed bed is substantially lowered. The community is dominated by the Common red and Common bulrush (*Typha latifolia*). Other typical plant species for this community can be found: *Mentha longifolia*, *Carex* spp., etc. The animal composition of the community is probably typical for this habitat. During the field work few common dragonfly species were recorded: *Sympecma fusca, Sympetrum sanguineum, S. depressiusculum, Aeshna* sp*., Calopteryx virgo* and *C. splendens*. Some common amphibian species also inhabit this habitat (*Rana ridibunda, Hyla arborea,* etc.).

In macro terms of the project area a complex fauna is noted, autochthonous to relict endemic. Mainly in the mountainous parts. The present species are: bear, wolf, fox, doe, deer, chamois, wild boar, marten, wildcat, weasel, etc. From the birds, the representative species are: eagle, falcon, hawk, grouse and many others. Especially significant is the presence of more types of fungi, which are boletus, chanterelle, morel, etc. The grassed ecosystems are occurring in the lowland area, taking larger number of meadow, salt marsh and steppe communities. As such, from fauna aspect, the following are present: steppe lizard, sand boa, horned viper, Balkan whip snake, rabbit, partridge, quail, pheasant, as well as other different types of insects.

The water ecosystems are of key significance for the Bitola region. The existence of artificial lakes, the developed catchment network, especially the catchment of the river Dragor, the smaller surrounding rivers, marshes and swamps –are resulting with several types of ecosystems.

In the lake water ecosystems in the Bitola region, there are more types of fish to be found, mostly represented by the carp, roach, crucian carp. The river ecosystems are rich with barbell, common nase, chub, as well as other type of fish and large number of amphibians.

The river beds, being the main recipients of the waste waters, are significant factor of negative influence on the existing ecosystems which are already under massive anthropogenic pressure, leading to reduction of population of different types of fishes as well as other flora, fungi and fauna (Strategy for protection of the biodiversity in the Republic of Macedonia – 2004).

Cultural heritage

The property cultural monuments in accordance with the Department for protection of the cultural and historical heritage of the Republic of Macedonia are the following:

- Registered monuments of the culture,
- Evidenced monuments of the culture,
- Archaeological localities – all sites or any other marks and traces of the human existence which testify for the eras and civilizations, for which the main source of scientific information are diggings or related discoveries,
- Monumental building units – settlements or architectural complexes, i.e. areas which have special cultural significance as already built complexes, and which are protected and included in the modern development in such extent provided by the type of the protection,
- Individual (architectonic monuments) – architectonic works which have special cultural significance, with their protected immediate surroundings, or location which belongs to them; the works are protected in order to provide protection for their authenticity and enable proper conservation, restoration and revitalization.

In the wider area of Bitola region the following cultural heritage sites have been identified:

- Shirok Sokak (meaning "Wide Alley") is a long pedestrian street that runs from Magnolia Square to the City Park.
- The covered bazaar- built in the 15th century
- The old bazaar in the town centre

o Heraclea Lyncestis

Heraclea Lyncestiswas an ancient Greek city in Macedonia, ruled later by the Romans. Its ruins are situated 2 km south of the present-day town of Bitola. It was founded by Philip II of Macedon in the middle of the 4th century BC, after he had conquered the surrounding region and incorporated it into his kingdom of Macedon. The city was named in honour of the mythological Greek hero Heracles. The name Lynkestis originates from the name of the ancient kingdom, conquered by Philip, where the city was built.

Heraclea was a strategically important town during the Hellenistic period, as it was at the edge of Macedon's border with Epirusto the west and Paeonia to the north, until the middle of the 2nd century BC, when the Romans conquered Macedon and destroyed its political power. The Romans divided Macedonia into 4 regions and Heraclea was in the fourth region. The main Roman road in the area, Via Egnatia went through Heraclea, and Heraclea was an important stop. The prosperity of the city was maintained mainly due to this road. Objects discovered from the time of Roman rule in Heraclea are: Votive monuments, portico, thermae (baths), a theatre and town walls. In the early Christian period, Heraclea was an important Episcopal seat. Some of its bishops are mentioned in synods in Serdica and other nearby towns. From this period are the ensembles of the Small and Great (Large, Big) basilica. The Grave (Funeral) basilica with a necropolis is located east of the theatre.

After a heavy earthquake struck the city in the early 6th. century AD, its inhabitants gradually abandoned it. It is around this time that the region was invaded by the Slavs.

2.3. Socio-economic development

2.3.1. Project area Economy

The Gross Domestic Product (GDP) of Macedonia has reached values of MKD 474 billion (8 billion in €) in current prices in 2013, which is MKD 17 billion higher than the value in 2012. However, in constant 2005 prices, the 2013 GDP amounts to MKD representing a real growth of only 3.1%. These results outline the slow economic recovery of the country following the negative growth of GDP for the last years in 2009 and 2012. Despite some positive signals, Macedonia is still struggling to achieve the average economic growth of over 4.5% from the pre-crisis period, which is unlikely to happen in the near future. Gross external debt as % of GDP grows up to 67.8% in 2013. The total real increase in GVA for 2011 stood at 5.57% and (-1.75%) for 2012.

Table 2-3 GDP in Macedonia

Main indicators	2009	2010	2011	2012	2013	2014*
	Annual percentage change, unless otherwise specified					
Real GDP growth (%)	-0.9	2.9	2.8	-0.4	3.1	3.4
Nominal GDP (billions of denars)	411	434	460	459	474	491
Nominal GDP (billions of euros)	6.7	7.1	7.5	7.5	7.7	8.0

*Source: https://www.imf.org/external/country/index.htm * Forecast of International Monetary Fund*

Exports of goods and services increased by 2.81 % in real terms during 2013, while imports fell by 2.02 %. This negative Trade Balance had a negative contribution to GDP growth.

On a chain basis gross fixed capital formation (investments) increased in real terms by 1.13 %, and the inventories gross capital formation contracted by 0.7 %. Both indicators had a positive contribution to GDP growth.

In 2013[2], almost all sectors in the economy made a positive or neutral contribution to the total economic growth. However, public and private investment in construction contributed to a strong double-digit growth in this sector, with its individual contribution to the overall real GDP growth being the highest (construction contributes to more than the half of total growth). According to the structural analysis, civil engineering (transport infrastructure, in whole) had the largest contribution to the growth of construction activity, and the remaining growth was a result of the positive developments in the housing and non-housing construction, which could be related to government and foreign private investment. The gradual recovery of the economies in the Euro area has led to increased utilization of domestic and foreign export-oriented facilities, and thus to an increase in the value added of industry. The largest contribution to growth was that of the manufacturing industry, where the growth of manufacturing of clothing, machinery and equipment, and textiles contributed greatly to the growth of the industry. The growth of industrial production positively influenced the developments in the transport sector, which is the third component of GDP with the largest positive contribution to the growth of the real economic activity. Other services (except domestic trade which registers stagnation) and the activity in agriculture gave an additional positive stimulus for the growth of the domestic economy.

Regional GDP data is not available for recent years and for municipal or district levels because of the limitations of statistical data, collected for NTES regions only. The agglomeration area of Bitola and serviced territory of water utility companies JKP Vodovod and JKP Niskogradba falls within the boundaries of the Pelagonia Region.

The Pelagonia Region is second largest in Gross Value Added (GVA) after the Skopje Region and produces approximately 10.8 % of the national GVA but has GDP per capita which below the average of the Republic of Macedonia.

Table 2-4 GDP per capita in Macedonia in MKD

Item	2010	2011	2012
Macedonia	211,246	223,357	222,519
Pelagonia Region	225,437	227,732	211,458

Source: Regions of the Republic of Macedonia, 2014

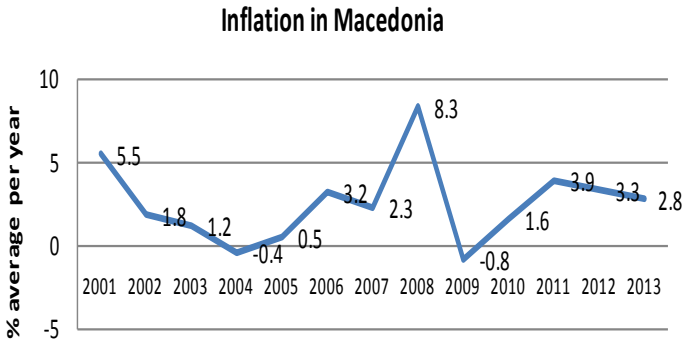
[2]National Macedonian Bank, Annual Report 2013 http://www.nbrm.mk/WBStorage/Files/WebBuilder_Annual_Report_2013.pdf

The Pelagonia Region is fourth largest in GDP per capita after the Skopje, Southeast and Vardar Regions. The index of the average monthly gross wage paid per employee in Macedonia in 2013, compared to 2012, was 101.2. This increase is due primarily to the increase in the average monthly gross wage paid per employee as that for Pelagonia Region is the highest for the country (3.2%). It can be assumed that regional economic growth will follow national trends.

The annual inflation for 2013, measured by means of the consumer price index with respect to the average prices for the previous year, was 2.8% and is the lowest for the last 3 years, but also well over the average inflation in medium term. The increase is largely due to rapid growth of fuel prices because of the unstable international environment. The average inflation for the first half of 2014 is well below 1% and the expected all-year inflation is about 2.5-2%. In the long term for the last 10 years, inflation has not crossed the level of 5%, except for 2008 when it was 8.3%.

This tendency is expected to be stable for the coming years and Macedonia will be among the countries with lowest increase in consumer prices.

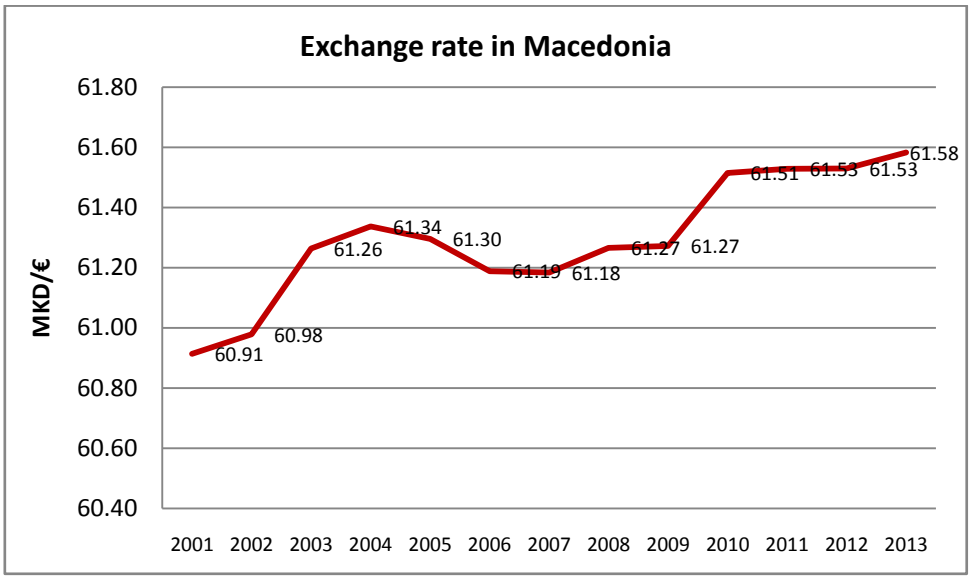
Figure 2-1 Inflation in Macedonia, measured by CPI in % average per year



Source: http://www.nbrm.mk/default-en.asp National Bank of Republic of Macedonia

Since the end of 2001 the exchange rate in Macedonia grows up very slowly and reached level of 61.58 MKD for 1€ in the end of 2013. The overall increase is 1.1% only for the whole period or less 0.1% per year. In January 2002, NBRM started implementing the monetary strategy of targeting the nominal exchange rate of the Denar against the Euro. The objective of the monetary policy is the maintenance of the Macedonian Denar exchange rate stability. Obviously the strategy is successfully implemented and holds the deviation of exchange rate in narrow range.

Figure 2-2 Exchange rate in Macedonia



Source: http://www.nbrm.mk/default-en.asp National Bank of Republic of Macedonia

In medium and long term the exchange rate is expected to continue the course of stable currency in Macedonia.

Population, including spatial distribution, density and types of accommodation

Municipality Bitola covers an area of 794.53 km^2. According to the last official 2002 census 86,408 people live in the Municipality, from which 74,550 people in the city of Bitola which is the centre of the municipality and 11,858 in 18 registered settlements.

Table 2-5 Distribution of Population of Bitola Municipality according 2002 census

	Total population	Households	Dwellings (all types of dwellings)
Municipality of Bitola	**86,408**	**26,387**	**33,232**
City of Bitola	74,550	23,010	28,155
18 settlements	11,858	3,377	5,077

26,387 households units have been registered with the 2002 census, and the average number of household members is 3.27.

Table 2-6 Population of Bitola Municipality

Settlement	Inhabitants
Gorno Orizari	2,454
Poesevo	272
Trn	113
Novo Zmirnevo	41
Karamani	337
Opticari	317
Sredno Egri	299
Dragozani	156
Zabeni	178
Kremenica	134
Medzitlija	155
Dolno Orizari	1,834
Crno Buki	406
Lazec	302
Krklino	611
Logovardi	699
Kravari	880
Kukurecani	966

Source: www.stat.gov.mk

With the new territorial distribution in 2004 the Municipality of Bitola has integrated the city of Bitola and 65 settlements as follows: Bareshani, Bistrica, Bratin Dol, Brusnik, Bukovo, Velushina, Gabalavci, Golesh, Gorno Egri, Gorno Orizari, Greshnica, Dihovo, Dolenci, Dolno Ergi, Dolno Orizari, Dragarino, Dragozhani, Dragosh, Drvenik, Gjavato, Zhabeni, Zlokukjani, Kazhani, Kanino, Karamani, Kishava, Kravari, Krklino, Kremenica, Krstoar, Kukurechani, Lavci, Lazhec, Lera, Lisolaj, Logovardi, Lopatica,

Magarevo, Malovishte, Metimir, Medzitlija, Nizhopole, Novo Zmirnevo, Oblakovo, Oleveni, Optichar, Orehovo, Poeshevo, Porodin, Ramna, Rashtani, Rotino, Svinishte, Sekirani Snegovo, Sredno Ergi, Srpci, Staro Zmirnevo, Strezhevo, Trn, Trnovo, Capari, Crnobuki and Crnovec.

Table 2-7 Distribution of Population of Bitola Municipality according 2004 territorial distribution

	Total population	**Households**	**Dwellings (all types of dwellings)**
Municipality of Bitola	**95,385**	**28,942**	**37,225**
City of Bitola	74,550	23,010	28,155
65 settlements	20,835	5,932	9,070

The territory served by JKP Vodovod and JKP Niskogradba coincides with the territory of Bitola Municipality, which is located in the Pelagonia Statistical Region. The municipality covers a total area of 422.39 km^2 and incorporates 65 residential settlements with a total of 95,385 inhabitants (as of Census 2002), the majority of which live in the city of Bitola.

Table 2-8 Population in the serviced territory

	Population 2002*	Population 2013	Change
City of Bitola	74,550	72,400	-2.88%
Bitola Municipality	95,385	92,647	-2.87%
Pelagonia region[3]	n.a.	232,367	n.a.
Macedonia	2,022,547	2,062,294	+2.2%

** as of Census 2002, Source: http://www.stat.gov.mk/OblastOpsto_en.aspx?id=31*

As of 2013 the population in the serviced territory amounts to 92,647[4] people – approximately 4.5 % of the total national population and 39.9 % of Pelagonia region population. For the 12-year period the population in the serviced territory has decreased by 2,738 people (a reduction by 2.87%), while the average national population has increased by 2.2 %. According to statistical data, the decrease is mainly due to the negative natural growth and ageing of the population, which is not similar to the national tendencies.

The share of urban population in Bitola Municipality is relatively stable during the period 2002-2013, and is 78.15% in 2013. Natural growth has been negative at around -3.3‰ annually. Net migration has been positive during the last years- average 45 persons per year.

Table 2-9 Population dynamics in Bitola Municipality

Items	2002	2009	2010	2011	2012	2013
Population - total	95,385	93,643	93,524	93,236	92,905	92,647
Urban population %	*78.16*	*79.35*	*78.97*	*78.74*	*78.54*	*78,15*
Rural population %	*21.84*	*20.65*	*21.03*	*21.26*	*21.46*	*21.85*
Births	914	989	976	880	881	844

[3] In 2007 Macedonian Government adopted the Nomenclature of Territorial Units for Statistics – NTES ("Official Gazette of the Republic of Macedonia" No. 158/2007). According to the last adoption the Municipality of Bitola is situated in the pelagonia Region.

[4] Last census in Macedonia 2002 and NSI data for 2013

Deaths	1,180	1,134	1,171	1,177	1,262	1,154
Natural growth	-266	-145	-195	-297	-381	- 310
Net Migration	45	39	76	9	50	52

Source: http://www.stat.gov.mk/Publikacii/PDFSG2014/03-Naselenie-Population.pdf and previous

Life expectancy in Macedonia is 74,83 years, according to Statistical Yearbook 2014 and the average age of population is 38 years. For Pelagonia region the average age of population is 40.3 years. Theregion has the most unfavourable age structure -share of the population aged 65+ is 15.3 % whereas share of population aged 0-14 is 15.4 %. Population density of Macedonia is 80.3 and 49.3 for the Pelagonia Region.

Age distribution in the Bitola municipality is similar to the Pelagonia Region average, there is a continuous process of ageing with 15.0% of the population being over 65 years old and only 14.5% of the population being below 15 years of age.

The age dependency ratio (ratio of younger and older dependents - people younger than 15 and people older than 65 - to the working age population – those aged 15 - 64) is 41.9% - lower than the regional average but slightly higher than the national average. The coefficient of demographic replacement (people aged 15-19 years, entering active working age versus the people aged 60-64 years, leaving active working age) is 0.81 i.e. each 100 persons leaving the working age group in 2013 are replaced by 81 persons entering the same group.

Table 2-10 Age distribution of the population

Items	0-14 years	15-64 years	Over 65 years	Age dependency ratio	Coefficient of demographic replacement
Bitola Municipality	14.5%	70.5%	15.0%	41.9%	0.81
Pelagonia region	15.4%	69.3%	15.3%	44.3%	0.9
Macedonia	16.9%	70.9%	12.2%	41.1%	1.19

Source: Regions of the Republic of Macedonia, 2014 and own calculations

The similarity of regional ratios and coefficients also defines the resemblance in the future demographic development – it is very likely that the territory served by JKP Vodovod and JKP Niskogradba and agglomeration area continue to decrease its population in short- and medium term, although the downturn might not be as rapid as current historical trends. The total fertility rate (2009-1.52 and 2013-1.48) will continue to influence negatively birth levels.

The process of population ageing (decreasing relative share of the kids below the age of 15 and increasing share of the population over the age of 65) will keep mortality at a constant degree. Deaths per 1,000 inhabitants in recent years are more than 12 and this is the highest compared to all other regions in Macedonia. The minor positive net migration will be mostly influenced by the likely economic development of the region and will not be a decisive factor of the population forecast.

Major Industrial Companies

In accordance to the data from the Economic Chamber of Macedonia, the Municipality of Bitola is characterized with relatively developed industry. The major economic activity within the municipality is electric power production, but also an important impact has the mining industry sector, agricultural sector, stock-breeding, food industry, construction, trading, transport and textile industry.

Bitola's economy is characterized by the dominant presence of the "processing industry" sector. Having in mind the size of the current processing capacities, this sector plays an important role in the economy of the Republic of Macedonia.

The natural resources have a significant influence on the development of Bitola's economy and Its structure, i.e. the size of certain sectors. Due to the valorisation of the existing possibilities of raw materials and resources, there was a significant growth in the last decades in the following areas: Metal, textile, food-processing, tobacco and graphic industry, production of milk and dairy products,

alcoholic and non-alcoholic drinks, sugar, yeast, denaturised alcohol etc. Bitola and the surrounding area are also well known for their various mineral wealth. This particularly refers to the large quantities of lignite and other non-metals. With respect to the future economic development, it is important to mention the construction of the Industrial zone Zabeni. It covers an area of 244 Hectares and it is located 5 km from the border with the Republic of Greece.

Industries

The industrial structure of the municipality is determined by the commercial enterprises, operating in the spheres of: industry and mining – 195 companies, farming and fishing – 47 companies, forestry – 17 companies, water economy – 7 companies, trade – 857, transport – 180, craftsmanship – 357, construction – 40, catering and tourism – 109, banking and insurance – 46, housing – 10, and others.

The following list gives an overview of the main companies operating on the territory of Municipality of Bitola.

Table 2-11 Industrial Enterprises on the territory of Bitola

Name of legal entity	Economic activity
DOO “Lapor”	Concrete production base
DPT AD ”Pelisterka Skopje”	Production and processing of wine
AD “Pelagonija Gradba”	Concrete production base
DOO “Pivara”	Beer production
AD “Kiro Dandaro”	Printing services
DOO “Mlin Stojchev”	Sunflower oil refinery
DGU “Pelister”	Concrete production base
AD “Fustelarko Borec”	Printing services
DOO “Stenton Gradba”	Concrete production base
IMB “Mlekara”	Dairy
DOOEL “Kompani Z. Radeski”	Dairy with food conservation
AD “4-ti Noemvri”	Sugar factory
DOOEL “Ideal Sipka”	Dairy
AD “F-ka za kvasec i alcohol”	Alcohol and yeast factory
AD “Metalec”	Fireplace and stove factory
AD “Trikotaza Pelister”	Textile company
DOO “Saitis”	Textile company
DOOEL “Cermat”	Ice cream factory
DOOEL “Pecatnica ANS”	Printing services
DG “Granit AD OE Niskogradba region Zapad”	Concrete and asphalt production base

AD "Sokomak – Sokotabs. Dragozani"	Tobacco processing and storage

Source: Municipality of Bitola – data from the Questionnaire

Agricultural sector

The valley and semi-mountainous terrain of the municipality as well as the specific climatic characteristics determine the development of the agricultural sector of Bitola. Pelagonija region is the largest agricultural producer in Republic of Macedonia.

As such the following nature of agricultural production prevails in the region: Cereals (wheat, barley, rye, oats and corn), industrial (sunflower, rape oil, tobacco, sugar beet, etc.), forage crops (corn silage, alfalfa, cattle peas, beans, artificial lawns, etc.), filed cultures (potatoes, watermelons, beans, etc.), vegetables (tomatoes, peppers, onions, cabbage, etc.) fruit (apples, peaches, apricots, plums, cherries, etc.), viticulture (wine and table wine), mushrooms, natural meadows pastures. From this it can be concluded that agriculture in Bitola region offers great opportunities for development and Agricultural farms in Bitola region are with over 35% of combined producers with arable-livestock production. Only few farms (approx. 15%) with specialized commodity production exist. Most farms are mixed where agriculture is not a major activity, but are generating income from other sources. The average size of the farms is about 2 ha and agricultural land use is thus heavily fragmented.

The total area by category of users for agricultural enterprises and individual farms expressed in ha. and % is presented in the table below:

Table 2-12 Agricultural land in Bitola area

	Total surface	**Agricultural surface**	**Utilized agricultural land, ha**					Pastures	Forests	Infertile land
			Total	Arable land Fields and gardens	Orchards	Vineyards	Meadows			
	179,495	**121,660**	**63,776**	**55,766**	**1,222**	**1,313**	**5,475**	**57,884**	**47,516**	**10,319**
Registered enterprises	129,352	78,164	27,941	26,748	326	599	268	50,223	45,193	5,995
Registered Individual farmers	44,378	41,254	34,462	28,608	761	680	4413	6,792	1,436	1,688

The available natural resources are significant preconditions for accelerated prosperity on the territory of the municipality of Bitola in the next period. Thus, potential possibilities for boosting the local development primarily refer to: agriculture and cultivable area, forest potential, mineral wealth etc. For instance, Bitola Field covers the greatest part of the Pelagonia Plain with total cultivable area of approximately 70,000 hectares. This area is mainly ploughed land, and for growing vegetables, orchards, vineyards and meadows.

Stock-breeding

The development of the stock-breeding in the Municipality is conditioned with the adaptation to the European legislation for which the Law on identification and registration of animals was enacted. One of the important conditions to be met in this regard is permanent marking of cattle.

Further development of the agricultural and stock-breeding sectors in the municipality of Bitola is conditioned by the process of harmonization to the European standards and norms for quality, export quotas and production safety norms. The underdeveloped market for land, dispersed land ownership, law capital availability of workers in this sector, disrupted connection between the sectors and the food industry and the insufficient cooperation with the scientific research institutes have been identified as major constrains of development.

The stock-breeding is mainly focused on livestock (cattle, sheep, goat and pigs), poultry (chickens) and beekeeping. The following table summarized the number of livestock by type registered in Bitola region:

Table 2-13 Number of livestock by type of livestock in Bitola region

Livestock	Enterprises	Individuals	TOTAL
Cattle	3,700	15,650	19,350
Cows and stealth calves	1,850	9,250	11,100
Sheep	3,950	51,756	55,706
Sheep breeding	2,520	37,869	40,389
Goats	-	6,000	6,000
Pgis	5,500	4,888	10,388
Sows and gilts	500	687	1,187
horses	-	3,100	3,100
laying hens	200,000	300,000	500,000
Beehive	-	2,500	2,500
Fisheries	270 tones	-	270 tones

Forestry

The forest wealth is also a solid base for more dynamic economic development, since the neighbouring mountains Baba, Pelister, Kajmakcalan and the remaining forest areas have large forest complexes of fire wood and industrial wood.

According to the data from the Statistical office the total forestry fund of Pelagonija region estimates 135,603 m^2 from which 86,362 m^2 are deciduous forests, 12,272 m^2 are conifer forests, 36,232 m^2 mixed forests and 737 m^2 are degraded forests.

The largest and finest forest complexes in Bitola municipality extend to the area of the mountain peak of Kajmakcalan on Nidze Mountain and peak Pelister on Baba Mountain, as well as parts of the Beagle Mountains. The most common types of trees are: white pine, black pine, molika, oak, fir and aspen.

The district of Kajmakcalan covers an area of 14,800 ha reserve of quality forests (pines, pine, fir, beech, etc.).

The district of Baba Mountain with peak Pelister, with the exception of the region of the National Park "Pelister" (the first national park in Macedonia, declared in 1948) covers an area of 10,400 hectares (of which pine - Molika native endemic pettoiglen pine Pinus peuce in the so-called strictly protected zone occupies a complex of 1,600 ha). On the eastern slopes of Baba Mountain low height forests spread from which 8,180 ha of oak, 2,067 ha of beech and 840 hectares other types of forests or 11,087 acres total.

Forest management is the responsibility of the legal entity: Public enterprise Makedonski Shumi, branch Kajmakchalan Bitola.

Thus, logging, wood processing and furniture manufacturing have the opportunity for successful developing within the municipality.

Economic activity and unemployment

The Pelagonia Region is the largest, covering 18.9% of the total land area of the Republic of Macedonia and comprises the Pelagonia basin and the Prespa Lake basin.

The Pelagonia basin, which is the largest plain in the country, the Prespa Lake basin, the specific climate and the extensive hydrographic network are the basic preconditions for the agricultural

development in the region. All of this makes this region the breadbasket of the country and the largest producer of tobacco, apples and milk.

At the same time, the largest coal deposits are located in this region, making it the country's largest producer of electricity.

The Pelagonia region is the second biggest contributor by Gross Added Value (GVA) in Macedonia after Skopje region. Economic development of the Pelagonia region has been stable for the last years with approximately 11.5% share of the national GVA.

Approximately 18.8% of national GVA related to mining and quarrying, manufacturing, electricity, gas, steam and air conditioning supply and 17.9% of national GVA related to agriculture, forestry and fishing comes from the Pelagonia region.

In the recent years, there has been an increasing trend in tourism, shown by the increased number of accommodation facilities, tourists and nights spent in the Pelagonia region. This is mostly due to the revitalization of the Prespa Lake, the Pelister National Park and the winter tourist resort Krusevo and their exploitation for tourism.

The following industrial sectors are relatively developed in Bitola Municipality:

- Construction, construction materials presented by GP,,Pelister" DOO , "Stenton Gradba" DOO, "Granit" AD, "Pelagonija gradba" AD, Lapor" DOO, Monting Inzenering, BV Engineering DOOEL , etc.
- Processing activities presented by "IMB Mlekara" AD, "4-TI NOEMVRI" AD, "ZK Pelagonija AD", "Ideal Sipka" DOOEL, , "Kompani Z Radevski" DOOEL, "Germat" DOOEL, "Mlin Stojcev" DOO, etc.
- Livestock breeding presented by "Bit Konzul Porodin" DOO, "Lisolaj-Beli most ,Lisolaj" DOO, "Varadi, Porodin" DOO
- Mineral water, wine and beer producing presented by "Lozar Pelisterka" AD, "Pivara" DOO, ",,Fabrika za kvasec i alkohol" AD, etc.
- Printing services presented by "Kiro D. Dandaro" AD, "Mikena" AD, "Fustelarko borec" AD, "ANS print" DOOEL, etc.
- Textile industry presented by "Trikotaza Pelister" AD, "Saitis" AD, etc.

In 2010, Socotab DOO Bitola began operations in its new factory on the outskirts of Bitola, Macedonia. This new processing and warehousing facility replaced the two older Macedonian factories which previously had been handling Macedonian tobaccos. This facility handles Prilep, Yaka and Basmak varieties and allows final packing into C48 cartons on site.

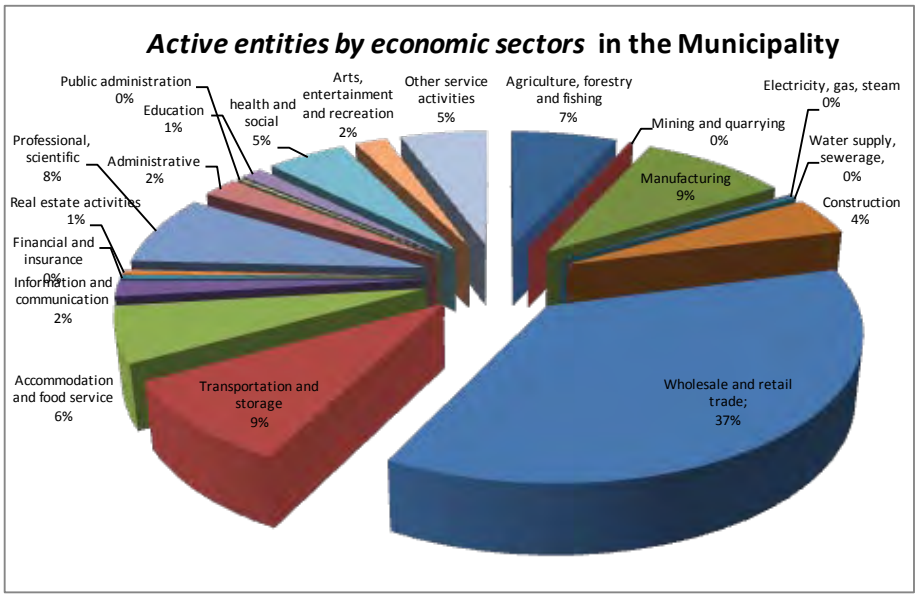
Natural conditions have enabled in the Municipality to develop unique enterprises as **REK Bitola** and **JP Strezevo** . Combine whose basic operation is the production of electrical energy and coal REK Bitola is the largest company in the Macedonian energy supply system and it is composed of two production units: „Suvodol" Mine and Thermal Plant and operational unit. REK Bitola has a share of over 72% in the total energy production of the Macedonian energy system. By opening the new coal mine Brod-Gnietino located in the Pelagonija basin, it is estimated that the operational life of this energy generator will be extended for at least more 15 years.

The irrigation engineering giant JP Strezevo also has wide public importance. The JP Strezevo manages water for irrigation, water supply and protection and flood control. As additional activities JP Strezevo is engaged in the production of electricity from hydropower plants as well as with cultivation of fish and mushrooms.

The **Industrial Zone "Zabeni"** (established by the Council of the Municipality of Bitola in 2008) aims to be a major factor and contributor in local economic development in the entire Pelagonian region. Presently the total number of companies who have purchased plots is 29. The total number of building permits issued is 5 and other 5 await issue of approval. In 2013 the new factory "Kromberg & Schubert" started manufacturing of cable installations for cars. The German owner invested therein around 20 million euro and expects to employ 2,500 people upon reaching full operating capacity. Another factory for the production of PVC and aluminium doors and windows is under construction by a Greek investor.

As of 31 December 2013 the total number of active business entities in Bitola municipality is 3,957. Their structure involves almost all economic sectors.

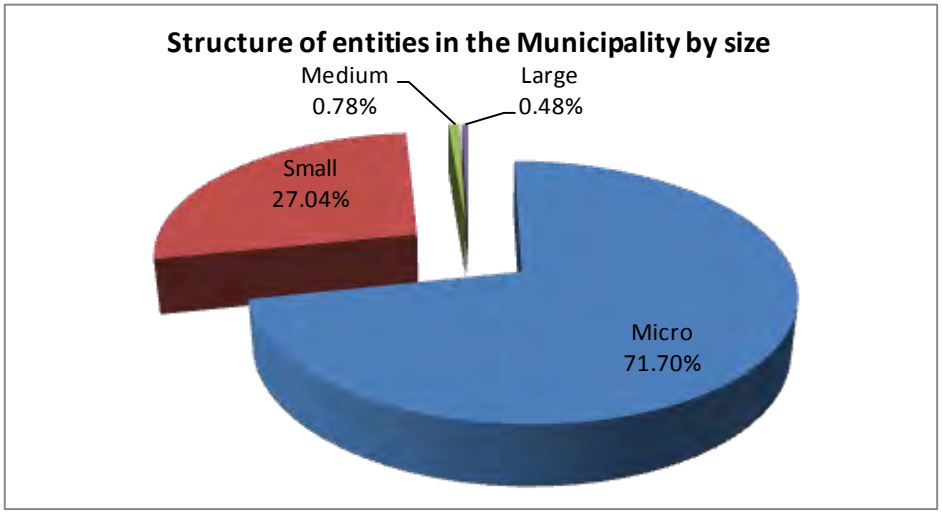
Figure 2-3 Structure of active entities by economic sectors



Source: Statistical Yearbook, 2014

The major part of the active entities is micro enterprises – 71.7%. The groups of large and medium enterprises are represented with less than 1%.

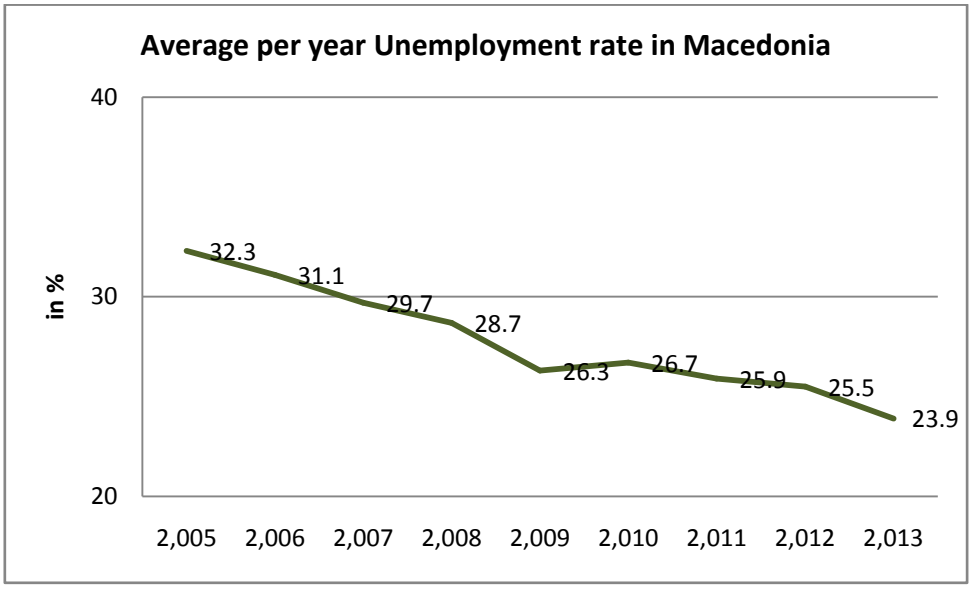
Figure 2-4 Structure of active entities by size



Source: Statistical Yearbook, 2014

National unemployment rate is very high - 30% average for the last 10 years. Figures in the end of the period show a very slight decrease and the level is of 29% (or 23.9% on an average basis) in 2013.

Figure 2-5 Unemployment rate in Macedonia



Source: Statistical Yearbooks, 2010, 2011, 2012, 2013 and 2014

Specific feature of the Bitola municipality - in recent years it had higher activity and employment rates than the total rates at the national level and respectively the lower unemployment rate.

In the next table the employment and unemployment rates of the population at the level of Pelagonia Region are shown in relation to the total rates at the national level.

Table 2-14 Employment and unemployment rates for PelagoniaRegion

	2011		2012		2013	
	Republic of Macedonia	**Pelagonia Region**	Republic of Macedonia	**Pelagonia Region**	Republic of Macedonia	**Pelagonia Region**
Working age population (persons)	1 656 215	**190 697**	1 669 965	**190 155**	1 672 460	**189 136**
Activity rate	56.8	**63.9**	56.5	**62.8**	57.2	**64.4**
Employment rate	38.9	**43.8**	39.0	**46.9**	40.6	**50.1**
Unemployment rate	31.4	**31.4**	31.0	**25.3**	29.0	**22.2**

Source: "Regions of the Republic of Macedonia, 2014", ISSN 1857-6141, STATE STATISTICAL OFFICE

The trends concerning unemployment in the region are also valid for the Bitola municipality - average unemployment rate for the last five years is less than 18% with a trend of continuous decrease.

Household incomes and expenditures – average statistical household and decile groups

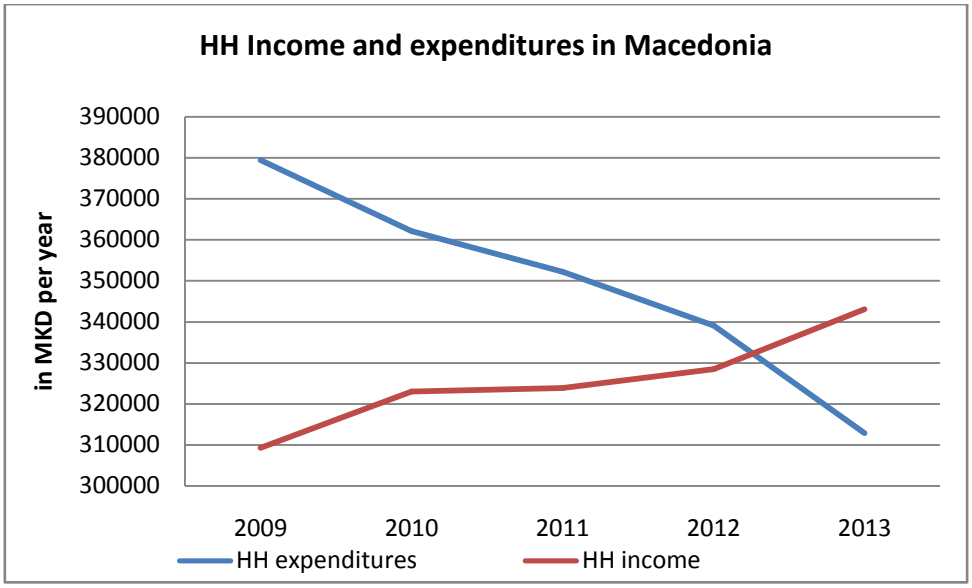
The number of households at national level has decreased despite the growth population development during the last years. The 2002 Census has counted 564.296 households in Macedonia, while the statistical data for 2013 indicates that there are 555.266 separate households in the country. This situation points out that at national level the number of "people per household" was kept. The highest number is in Polog region with 4.4 persons per household. From the census 2002 there is no data for the number of members of household at regional level.

Table 2-15 Number of households and persons per household

	2002		2013	
	Number of households	Average number of persons per household	Number of households	Average number of persons per household
Total for the country	564,296	3.58	555,266	3.57
Pelagoniaregion	72,546	3.28	70,628	3.29
Bitola Municipality	28,942	3.296	28,114	3.295

Source: Statistical Yearbook, 2014 and Regions of the Republic of Macedonia, 2014

Figure 2-6 Household Income and expenditures in Macedonia



Source: Statistical Yearbooks, 2010, 2011, 2012, 2013 and 2014

Until 2012 the household expenditures exceed the income. The gap was compensated by loans. The income has increased by 10.9% for the period, while the expenditure decreased by 17.5% in nominal growth. The real household income for 2013 has increased by 6.8% compared to 2009, taking into account the influence of the inflation.

The wages coming from regular and part-time employment and pensions are the main income sources for Macedonian households. As normally for an agriculturally developed country, the income from farming is on the third place in the sources of household income.

The salaries and the wages represent 62.9% from the total household income in 2013 and they are increased compared to 2009 when they represented 59.7% from the total household income. The pensions are increase by 20.1% in 2013 compared to 21.4% in 2001. The income of the households form agriculture production decreases its share from 9.0% in 2009 to 5.2% in 2013.

The pensions growth exceeds significant the growth of wages over the last 5 years – 6.8% for salaries and 26.3% for pensions, so it is expected that with a pensions reform it will be balanced in the long term perspective.

Table 2-16 National household income by source (MKD)

	2009	2010	2011	2012	2013
Total Income	**309,252**	**322,987**	**323,890**	**321,844**	**343,093**
Monetary Income	294,033	309,618	310,341	317,756	329,708
Revenues on the basis of regular employment	*176,755*	*197,302*	*159,409*	*206,599*	*207,378*
Revenues on the basis of part-time employment	*26,617*	*13,791*	*15,434*	*9,919*	*8,508*
Revenues on the basis of a pension scheme	*54,258*	*56,486*	*58,405*	*63,113*	*68,505*
Other revenues on the basis of social insurance	*4,882*	*5,251*	*5,409*	*6,538*	*5,132*
Revenues from abroad	*8,348*	*9,007*	*10,140*	*6,759*	*9,196*
Net revenues from agriculture	*14,239*	*18,030*	*15,665*	*15,910*	*17,704*
Property leasing and selling	*1,135*	*1,122*	*2,056*	*1,107*	*992*
Prizes, gifts and similar contributions	*1,436*	*1,067*	*2,314*	*825*	*2,418*
Loans (Borrowings)	*101*	*515*	*1, 226*	*1, 149*	*1, 184*
Savings decrease	*5,638*	*7,024*	*3,574*	*5,815*	*8,304*
Other income	*594*	*23*	*707*	*23*	*387*
Value of consumption from own production	14,799	11,804	10,288	9,748	12,143
Income in kind	450	1,566	3,261	941	1,242

Source: Statistical Yearbooks, 2010, 2011, 2012, 2013 and 2014

In Macedonia there is no statistical data for income by decile groups. The poverty threshold is defined as 60% of HH income or income p.c. This threshold is used for determination of affordability level of investments.

The HH income from the wages in Pelagonia region is slightly lower than the national average.

The index of the average monthly net wage paid per employee in 2013, compared to 2012, was 101.2. This increase is due primarily to the increase in the average monthly net wage paid per employee in the: **Pelagonia Region (3.3%),** East Region (2.6%) and Southwest Region (1.9%).

Table 2-17 Comparison of net wages at national and regional level in MKD, annually

Year	Macedonia- average	Pelagonia Region	% of the average for the country
2011	30,602	28,426	92.9%
2012	30,669	28,271	92.2%
2013	31,025	29,173	94.0%

Source: Regions of the Republic of Macedonia, 2014- Average gross wage paid per employee

The household expenditure follows the tendency of conservative changes of the income during the last 5 years, but in the way they are covered by the HH income in 2012. Consumer expenditure within the total household expenditure has not changed considerably within the observed period and is about

18.0% or 3.7% per year. The share of expenditures for housing, water, electricity and fuels has increased from 12.3% in 2009 to 13.45% in 2013. However, the increase of this expenditure is lower than the other cost categories.

Table 2-18 National household expenditures by cost categories (average per household, MKD)

Expenditure groups	2009	2010	2011	2012	2013
Total	**379,433**	**362,125**	**352,240**	**339,077**	**312,901**
Personal consumption	355,752	326,959	321,995	308,939	286,404
Food and non-alcoholic beverages	*154,560*	*141,098*	*138,354*	*134,849*	*135,132*
Alcoholic beverages and tobacco	*15,762*	*13,366*	*11,735*	*11,863*	*9,423*
Clothing and footwear	*25,850*	*21,368*	*20,436*	*17,457*	*15,831*
Housing, water, electricity, gas and other	*46,656*	*41,922*	*40,739*	*48,506*	*42,075*
Furnishing, household equipment and maintenance	*18,133*	*17,719*	*19,251*	*13,013*	*13,873*
Health care	*11,231*	*12,226*	*11,229*	*10,958*	*8,274*
Transport	*20,557*	*21,423*	*27,652*	*22,348*	*19,076*
Communications	*15, 026*	*13 ,273*	*12, 771*	*13, 160*	*10, 253*
Recreation and culture	*11, 176*	*8, 678*	*10, 302*	*7, 491*	*7, 113*
Education	*3,138*	*3,299*	*2,038*	*4,959*	*1,720*
Restaurants and hotels	*17,193*	*16,592*	*14,024*	*11,788*	*10,247*
Miscellaneous goods and services	*16,468*	*15,994*	*13,463*	*12,549*	*13,386*
Membership fees, taxes, customs duties	1,847	1,129	2,074	5,344	1,404
Losses, gifts, contributions and other	4,646	6,505	7,245	4,091	4,178
Repayment of loans and debt servicing	13,612	12,903	14,370	11,883	9,986
Flat, house and property expenditures	2,720	13,396	2,371	3,285	6,089
Savings	856	1,233	4,187	5,534	4,840

Source: Statistical Yearbooks, 2010, 2011, 2012,2013 and 2014

The only groups of expenditure that grow during the examined period are savings (123.9%) and flat, house and property expenditures (465.42%). Keeping in mind the income sources and expenditure structure (large share of expenditures for food and similar products), these values can be explained by the crisis influence and willingness for stable investments.

Health problems

There is no available information about health problems, resulting from a bad quality of the provided water supply and sewerage services.

Existing development plans

The future development of the city of Bitola and the municipality in general is outlined in several development plans and platforms drafted on municipal and regional level:

- Strategic Plan for Local Economic and Social Council (LESC) of the Municipality of Bitola for the period 2013 - 2017
- Strategy for local development of Municipality of Bitola 2014- 2018
- Substrategy for rural development of Municipality of Bitola 2008- 2013
- Programme for development plans of Municipality of Bitola 2015- 2017
- Strategy for cooperation with the Civil Sector 2012 – 2015
- Programme for communal waste management 2014 -2016
- Program for development of the Pelagonija region 2015- 2019
- Strategy plan of the Centre for development of Pelagonija Planning Region 2013- 2017

The Programme for development plans of Municipality of Bitola 2015-2017

The plan for development programs gives overview of all planned capital investments of the municipality, many of which are planned as multi-year investments. These programs give clear picture in which direction the municipality shall develop. The plan gives special attention to the improvement and further development of water supply and sewerage system installations within the Municipality. Two programs have been envisaged which aim at achievement of the aforementioned development plans:

Table 2-19 Extracts from the Plan for development programs of Municipality of Bitola for 2014

Nr.	Name of Budget program	Name of Development program	Goals of the development program	Budget in denars
4	Construction of system for collection and treatment of waste water	JIZ	Construction of sewerage and storm water network in ARM quarter 1 and ARM quarter 2 (sewerage and storm water network on street SRU 1 in ARM quarter 1 and sewerage network in ARM quarter 1 and ARM quarter 2)	60,000,000
5	Construction of water supply system	JGZ	Construction of water supply network in ARM quarter 1 and ARM quarter 2	5,475,216

Except of the aforementioned development plans and strategies, municipality's vision, mission and goals towards the improvement of the ecological environment, social, domestic and communal servicing of the population, increasing the investment opportunities and creating stable employment opportunities have also been processed on the level of development plans and programs. Noteworthy are the following:

- Strategy for development of tourism within Municipality of Bitola
- Local action plan for employment in Municipality of Bitola
- Action plan for social protection

Availability of heating services, of private water supply and sewerage systems and of disposal within the project region.

The town of Bitola does not have an operational thermal supply network. JKP does not have private systems for discharge within the project region.

2.4. Assessment of the legal and institutional framework

2.4.1. Legal framework

The sources of the current national legal framework directly or indirectly dealing with water management or have references that are related to water management are as follows:

- Law on Environment (Official Gazette no. 53/05, 81/05, 7.24, 159/08, 48/10, 124/10, 51/11)
- Water Law (Official Gazette no. 87/08, 6/09, 161/09, 83/10, 51/11)
- Law on Waste Management (Official Gazette no. 85/03, 95/05,103/08)
- Law on Water Communities (Official Gazette no 51/03, 95/05 113/07)
- Rulebook on the form and manner of keeping the register of water communities (Official Gazette no. 4.15)
- Decree on Water Classification (Official Gazette no. 18/99)
- Rulebook on Classification of waterways, lakes, reservoirs and groundwater (Official Gazette no. 18/99, 71/99)
- Rulebook on monitoring of sediment in accumulations (Official Gazette no. 4/99)
- Rulebook on reporting at the state level and on the quantity of water collected in reservoirs, and the amount of water released from them (Gazette. 8/99)
- Rulebook on the content and manner of preparation of plans for river basin management (Official Gazette no. 148/09)
- Decision establishing the National Council on Water (Official Gazette no. 149/09)
- Inland Waterways Act (Official Gazette no. 55/07, Gazette. 9.26, 22/10, 23/11, 53/11)
- Law on Fisheries and Aquaculture (Official Gazette no. 7/08, 67/10, 47/11, 53/11)
- Law on Ratification of the Convention on the Protection of the World Heritage (Official Gazette of SFRY. 56/74)
- Decree on Ratification of the Convention for the Protection of Aquatic habitats of international importance for the protection of water birds (Ramsar) (Official Gazette of SFRY. 9/77)
- Resolution of the impact of climate changes in the Macedonia (Official Gazette no. 10.31)
- Rules Amending the Rulebook for maximum allowable quantities of radionuclides in food, water, air, land, animal raw materials and products of animal and plants, and items for general consumption. (Official Gazette 58/11)

In this regard, the main emphasis is given to the Water Law, Law on Environment and Law on Environmental protection.

The Water Law

In addition to the provisions of the Constitution of the Republic of Macedonia, Macedonian legislation related to water, consists of laws, international treaties and bylaws.

The Water Law provides a legal basis for the protection and management of waters in the country. It regulates the manner of use and exploitation of water resources, protection against harmful actions, protection against comprehensive water extraction and pollution, management of water resources, sources of funding and manner of financing of the activities related to water management, concessions, trans boundary water resources, and other issues of importance in terms of providing unified regime for use of water.

As the Water Law from 1998 did not set up integrated policies and procedures for the protection of water and management of river basins from one side, and on the other side, the need for compliance with EU Directives in the Department of Water Quality (Water Framework Directive 2000/60/EC) as a framework legislation; Directive for the treatment of urban waste water (91/271/EEC), Nitrates Directive (91/676/EEC), Directive on discharge of dangerous substances into water (76/464/EEC); Directive for water quality; Guidelines for prevention and control of pollution and Directives for

monitoring and reporting led to the adoption of new Water Law. This new law was fully operational in 2010 represents one initial effort to address issues related to the quality and pollution of water within an integrated policy and legal framework for future management of water resources. Water Law includes application of the provisions of the Water Framework Directive (2000/60/EC) and the Directive for treatment of urban waste water (91/271/EC).

The waters have been defined as goods of general interest and are the property of the state.

The following EU Directives in the field of water resources management have been transposed into the said Water Law:

- Directive of the European Parliament and of the Council 2000/60/EC on establishing a framework for Community action in the field of water policy;
- Directive of the European Parliament and Council of 98/83/EEC on quality of water intended for human consumption;
- Directive of the European Parliament and Council 76/160/EEC concerning the quality of potable water;
- Directive of the European Parliament and of the Council 1991/271/EEC on treatment of urban waste water;
- Directive of the European Parliament and of the Council 86/278/EEC on protection of the environment, especially the soil, when sewage sludge is used in the agricultural production;
- Directive of the European Parliament and of the Council 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources.

In addition to the above, this law creates a basis for transpose of the requirements of other relevant Directives which will remain in force after the adoption of Water Framework Directive (WFD) 2000/60 within the period specified for each of them.

Water Law further establishes a legal basis for enacting relevant bylaws that will regulate in detail different conditions, procedures, standards and measures, or on the bases of which, the existing will be revised in order to comply with new targets, standards and measures set out in relevant EU Directives.

The following acts of secondary legislation are applicable in the field of water resources management:

- Decree on the categorization of watercourses, lakes, reservoirs and underground water resources ("Official Gazette" No. 18/99);
- Decree on the categorization of water ("Official Gazette" No. 18/99);
- Decree on the basic elements of the plan for protection of flood affected areas ("Official Gazette of SFRY" No. 15/84);
- Rulebook on the contents and manner of keeping the water books ("Official Gazette", No. 2/99);
- Rulebook on contents and manner of keeping records of facilities and equipment for water management ("Official Gazette "No. 17/99);
- Regulations for reporting on the status of the level and quantities in water accumulations and the quantity of water that is discharged into it ("Official Gazette", No. 2/99);
- Rulebook on the form and manner of keeping records of sand, stone and gravel ("Official Gazette" No. 17/99);
- Rulebook on calculating the fee for use of water or use for production of electricity by legal entities ("Official Gazette", No. 1/00);
- Rulebook on the necessary activities and measures for technical monitoring of dams ("Official Gazette" No. 19/02);
- Rulebook on monitoring of sedimentation in reservoirs ("Official Gazette", No. 4/99);
- Rulebook on the manner of determining and maintaining protection zones around potable water sources ("Official Journal of SFRY "No. 17/83, 15/89);

- Methodology for reporting on the status and levels of accumulated water, and the amount of water discharge ("Official Gazette of SRM" No. 16/83);
- Rulebook on the implementation of disinfection, on the scale, type and method for potable water testing, and the conditions which must be met by organizations which preform analyses of potable water ("Official Gazette of the SRM "No. 31/77);
- Rulebook on the quality of natural mineral water ("Official Gazette of SFRY" No. 58/78
- Rulebook on safety of potable water ("Official Gazette RM "No. 57/04);

The Water Law includes some principles determined by the Law on environment (which puts the protection of nature on high level), but is also supplemented by the following principles of sustainable management of water resources:

- Eco-socioeconomic concept which defines water as part of natural processes that require protection, as flora and fauna habitats in the environment. The management of water resources is a public interest.
- Principle of minimizing the use of resources provides prudent and rational use of water during activities that may have an impact on the water.
- Principle of integration: this principle includes integrated water management from several points of view: relation between surface and groundwater resources, their relationship with the ecosystems dependent on water and other environmental media, the consent of directly involved institutions and users and the relationship with other departments, cooperation on issues related to trans boundary water resources, as well as integration of measures and activities for protection of water in all development stages, strategic planning and programing documents issued by public authorities and
- by the local government.
- The principle of the polluter pays which obliges water pollutants to compensate for the cost of treatment of the polluted waters and returning to their original state.
- The principle of compensation costs –water user shall reimburse all costs incurred by the service, including costs related to water resources and use generated in such manner and for costs associated with environment, in accordance with the principle "polluter pays ".
- The principle of pollution prevention at the source of pollution - the pollutant emissions will be prevented at the source of their occurrence.
- The principle of time perspective - according to this principle, the conditions set in water management plans and decisions shall correspond with the time perspective of the expected effects.
- Principle of stakeholder involvement is a principle that obliges the authorities to take into account the interests of all participants in the decision-making process related to the management of water resources and their protection.

In addition to the Water Law some issues related to water are regulated by the following laws:

- Law on Hydro-Meteorological Services ("Official Gazette" No. 19/92, 5/03). The subject of this law are hydrological meteorological issues and refers to the manners of their efficiency;
- Law on Mineral Resources ("Official Gazette" No. 18/99, 29.2). This Law regulates the conditions and manner of geological research and efficiency of exploration of the mineral resources. The law treats the geothermal and groundwater (thermal, thermo-mineral water, mineral and potable water) and mineral resources;
- Fisheries Act ("Official Gazette" No. 62/93). This law regulates the use of water intended for fish farming and fishing in a way that guarantees sustainable reproduction and protection of fish stocks;
- Energy Law ("Official Gazette" No. 47/97, 40/99, 98/00, 94/02, 98/03). This law, among other issues, regulates conditions and measures for the protection of water as part of the living;

- environment and nature in relation to the operation of energy utilities, equipment and facilities;
- Law on safety of food, products and materials in contact with food ("Official Gazette" No. 54/02). The law provides conditions for ensuring the safety of food and products and materials which come in contact with food. The term "food" includes potable water from public water supply systems, bottled water intended for the market, and water for food processing;
- Law on Sanitary and Health Inspectorate ("Official Gazette "No.19 / 95). This law regulates supervision on the safety of public water supply facilities in terms of health and hygiene;
- Law on water communities ("Official Gazette" No. 51/03). This Law regulates the conditions, manner and procedure for establishment of aquatic communities, registration and supervision on their operations and termination of their operations. The term "water community" refers to an association of owners or users of agricultural land for purposes related to the use, management, maintenance, construction, reconstruction and expansion of small irrigation systems and / or drainage;
- Law on water management enterprises ("Official Gazette" No.. 85/03). This Law regulates the establishment, organization, performance, funding, monitoring and termination of operation of enterprises in charge of management water. "Enterprise for Water Management" is a legal entity "sui generis", established with purpose of effective management, use, operation and maintenance of hydro systems, irrigation and drainage systems;
- Law on potable water and drainage of urban communal water ("Official Gazette" No. 68/04). regulates the conditions and the manner of providing services for supply of potable water in the food processing sectors, termination of water supply and drainage, treatment and discharge of urban wastewater in terms of the recipient;
- Criminal Code of Republic of Macedonia ("Official Gazette of RM "No. 37/96, 80/99, 4/02, 43/03, 4.19). With this law, the contamination of drinking water and environmental pollution are treated as criminal acts and are subject of sanctions.

Law on Environment

Law on Environment (Official Gazette 53/05, 81/05, 7.24, 159/08, 48/10, 124/10, 51/11) provides the basic legal framework for environmental protection and introduces basic instruments for environmental protection and improvement of nature previously regulated by separate laws. The law defines rights and obligations of legal and natural persons in the field of environment, and environmental protection and improvement; planning of development documents in the field of environment, such as the National Environmental Action Plan (NEAP) and Local Environmental Action Plans (LEAP), and establishes protective control mechanisms. For the first time the law regulates specific environmental issues such as labelling, environmental monitoring as an integrated system, including environmental information system. The Law on Environment includes basic principles for environmental protection on the basis of which the procedures for environmental management are regulated. The Law regulates issues related to the access to environmental information, public participation in decision-making process for issues related to the environment, procedures on environmental impact assessment, plans for control of industrial accidents, and control mechanisms available to environmental inspectors. The law puts a particular emphasis on integrated environmental permits on the bases of which, a system of gradual adjustment to the required standards for integrated prevention and control of pollution are introduced, through the introduction of integrated permits with which operational plans are reconciled, which is a condition for the existing facilities in the Republic of Macedonia to continue their work.

Environmental Law is the basic law which generally regulates all media and areas in the environmental fields, including the basic global issues. It provides a basis for enacting bylaws for further detailed regulation of particular issues relating to environmental protection. The law provides framework for regulating the media and areas in the environmental fields, through the adoption of special laws including:

- Law on Waste Management ("Official Gazette" No. 68/04, 71/04)
- Law on Nature Protection ("Official Gazette" No. 67/04)
- Law on Ambient Air Quality ("Official Gazette of RM "67/04), and
- Law on Waters ("Official Gazette" No. 4/98, 19/00, 87/08, 6/09, 161/09).The process of

developing new legislation in Republic Macedonia is in accordance with the approximation of the national legislation with the European Union, and in accordance with the Action Plan for European Partnership.

2.4.2. Main institutions

The main responsibilities for water management and water supply and sewerage are shared among the following institutions:

The Ministry of Environment and Physical Planning (MoEPP) is the designated entity for developing national policies and guidelines for the overall water management including river basins management and permitting system. Its mandate is to endorse strategies, practices and measures for water protection against pollution. The MOEPP also supervises the monitoring of water quality and implementation of water related laws.

The Ministry of Transport and Communications (MoTC) is responsible for overseeing development plans for water-supply systems and sewerage network infrastructure, implemented with financial allocations of the state budget.

The localself-governments (Municipalities) are responsible to carry out activities for local water monitoring network such as constructing, operation, maintenance, rehabilitation of water-supply and wastewater collection networks and implementation of wastewater treatment plant (WWTP) projects.

The operation of the water supply and sewerage facilities and systems in the settlements are responsibility of the **municipal-owned enterprises or Public Communal Enterprises (PCEs).**

Ministry of Agriculture, Forestry and Water Economy (MAFWE)is responsible for irrigation, drainage, flood protection and river bed training and erosion control in the boundaries of areas being managed by water economies. In addition, MAFWE is responsible for qualitative and quantitative water monitoring and for the maintenance of dams which are used as sources for irrigation schemes.

As for irrigation and drainage, the present **Water Economies** that are being established under MAFWE auspices are responsible for management of the main facilities and infrastructure on the sub-regional level. They are in charge of management, use, functioning, maintenance and control of the systems with purpose of water supply for irrigation of agricultural land, supply of water the communal enterprises in charge of drinking water distribution, water supply for the industrial and technological purposes including electricity production, drainage and maintenance of the water-economy objects and facilities for flood protection, river regulation and protection from erosion.

On the other hand, the **water users' association** is responsible for managing the irrigation distribution network.

Ministry of Health shares responsibility with MoEPP with regard to the issuing of water quality standards, and is responsible for monitoring of water supply sources along with public users.

2.4.3. Main characteristics of the water supply and sewerage operator in the project area

Institutional capacity of JKP "Vodovod" and JKP "Niskogradba"

The institutional capacity is analyzed from the standpoint of the utilities' capacity to manage their assets (technical and financial) in view of the provision of Water and Waste Water services to the population, and the businesses in the region as well as from the standpoint of the anticipated changes within the asset structure as a result of forthcoming investments.

The analysis is developed in two major directions: (a) analysis of the utilities' staff and their human resource management policies (emphasizing on measures aimed at improving staff qualifications); (b) analysis of the utilities' capacity – their organizational and management structures, existing coordination problems, major internal documents and technical resources (systems) for management and storage of information flows.

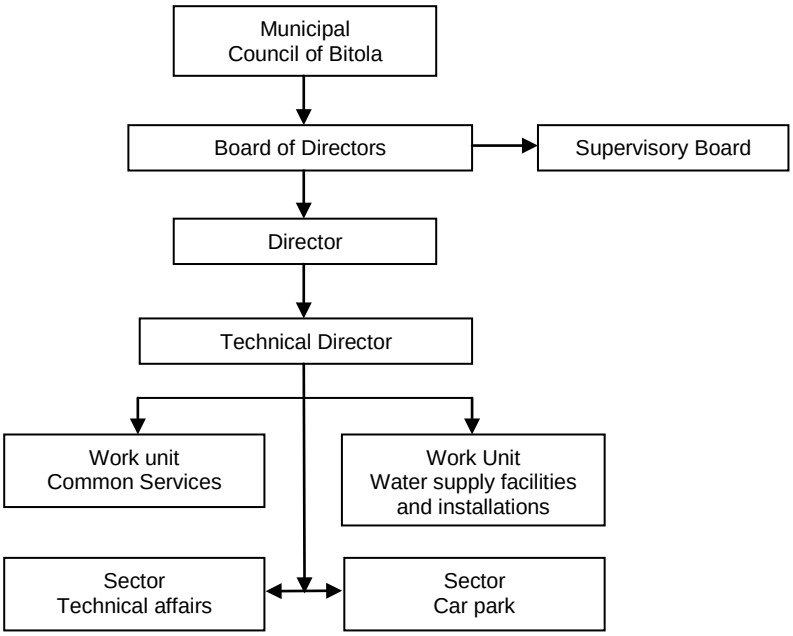
The analysis is based on reported and forecasted data, published in previous studies, internal labour documents as well as information received through the execution of a survey study amongst senior representatives from the entities in subject.

The water supply operator of the serviced area is ***JKP "Vodovod" Bitola***. JKP "Vodovod" Bitola is a public utility company, which is responsible for operating the water supply system, including collection, processing and supply of drinking water in the Bitola, Novaci and Mogila municipalities. Founder of the

Company is the Municipal Council of Bitola. The Municipal council appointed a Board of Directors which is composed of nine members and a Supervisory Board, which is composed of five members. The Company is managed by a Director, which is appointed by the Mayor of the Bitola town. Related to the staff and operations the Director has full autonomy to make decisions within the legislation.

According to the information provided by the Company as of the date of preparation of the present MP in JKP "Vodovod" Bitola there are 217 employees. Since the Company is responsible only for water supply services and there are no services requested beyond that, the administration and technical staff will not be divided in following analysis. The administration staff is at total number of 88 employees and cover positions of Company's Director, Technical Director and Work Unit "Common affairs"- finance, accounting, human resources, legal services, general affairs, etc. The technical staff is at total number of 129 employees and cover Company's Work Unit "Water supply facilities and installations" and sectors "Technical affairs" and "Car park". This amounts to approximately 170 customers per employed worker.

Figure 2-7 Organizational Chart of JKP "Vodovod" Bitola



Source: JKP "Vodovod" Bitola

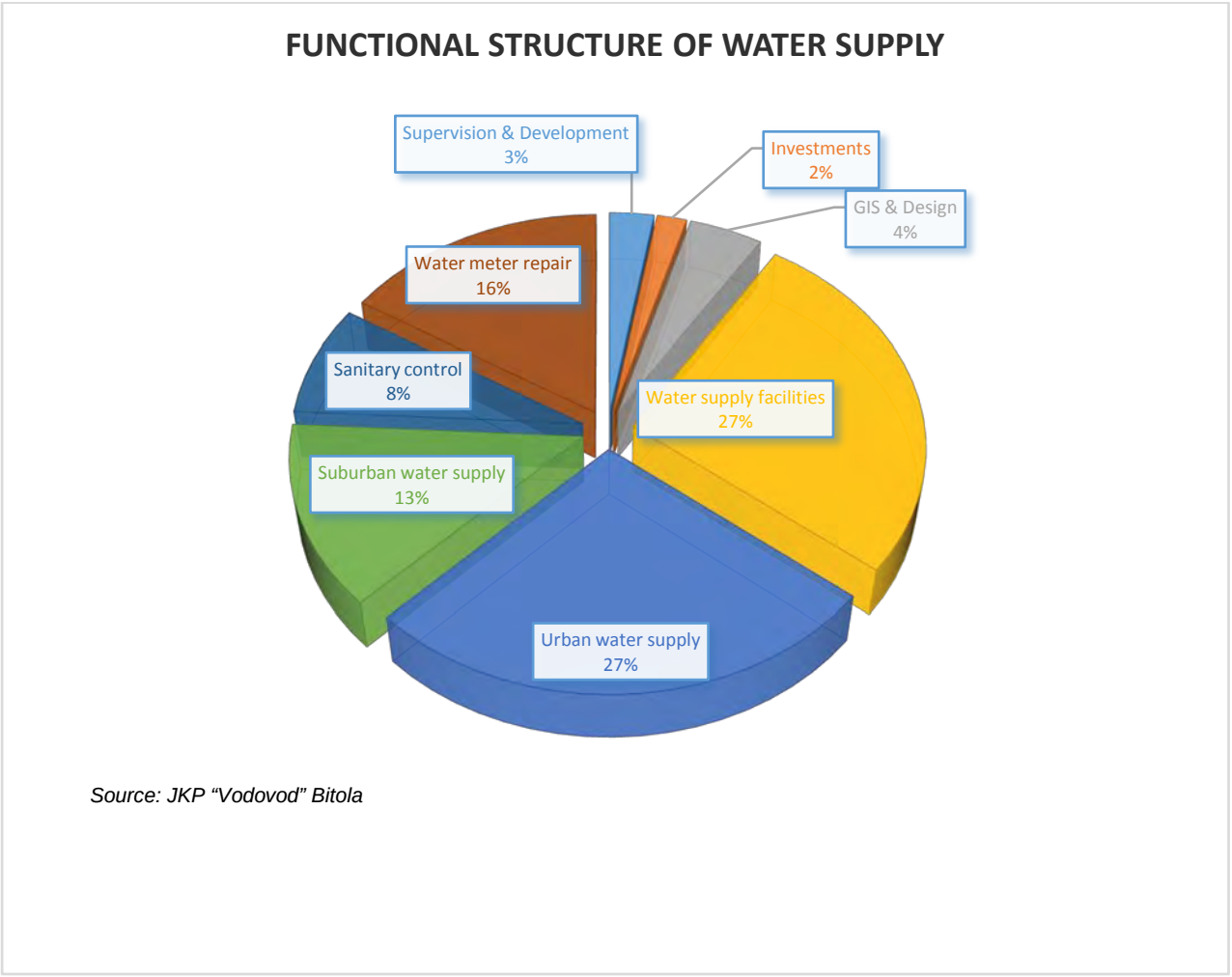
The structure of educational background is comparatively balanced and suitable to the activities related to the provision of services – the share of employees with secondary and specialized secondary education is about ¾ (75%), and the share of employees with university degree is 14%; the remaining 11% have primary or lower education. The share of the latter group can be evaluated as being relatively lower in comparison to other similar companies. Hence, the utility's future policy in the area of human resource management should be aimed at maintain of the share of qualified personnel, which would contribute to the utility's capacity as a whole.

The age structure indicates that around 48% of the employees are 50 years old and above and that only around 22% are below 40 years old. The male/female ratio is about 75%/25% which is normal taking into account the specifics of technical staff activities.

The annual fluctuation of personnel has a coefficient of about 4% on the basis of the number of employees who have left the company and were replaced by new ones. This is almost no fluctuation of personnel, which reflects in comparative stability of the staff.

The following chart shows distribution of the technical staff, working in the Water Supply by functional units.

Figure 2-8 Functional structure of Water Supply in JKP "Vodovod" Bitola



Source: JKP "Vodovod" Bitola

The utility's management has approved Rules for organization of working activities, tasks and functions. In this Rules very precisely are developed the responsibilities, functions, etc. of each of organizational elements within the Work Units and Sectors of the Company. Additionally the staff required per each position is described and strictly followed. Every employee receives a job profile, with which he/she is familiar; it is part of each worker's personal profile. JKP "Vodovod" Bitola has never made an assessment of staff.

The internal evaluation indicates that the JKP "Vodovod" Bitola has experience in the preparation and realization of the projects financed by IFIs. It has a good experience in recent years in implementation of institutional and construction projects, financed by KfW. This constitutes a benefit for the company's capacity, which would positively affect its access to external financial resources, which could be used to foster the utility's development and to the current project. Nevertheless, still the Company was not involved in the EU financed projects and this is a further area for development of its administrative and institutional capacity.

The JKP "Vodovod" Bitola has signed in 2011 a 30-years loan agreement financed by KfW. The loan was used by the Company for some important investments in the period 2012-2013 at total amount of about 1.55 Million EUR. The following investments were made in the Municipality of Bitola:

- Construction of the distribution main for the rezoning of Bair;
- Construction of a 2,000 m³ storage reservoir;
- Supply and installation of control and measuring equipment and associated civil works, upgrading of the existing SCADA system and replacement of electrical installations in the Dovledzik pump station;

- Supply of volumetric water meters and installation of remote reading equipment and supply of leak detection equipment;
- Supply of multi-jet water meters and installation of remote reading equipment.

The following *problematic areas* were determined on the basis of the study:

- The continual improvement of the personnel qualification seems to be undervalued. The utility has not prepared an annual plan for personnel qualification improvement. These are negative prerequisites with regard to the preservation and improvement of employees' qualification level;
- The age structure analyses show that more young and educated staff is required to improve administrative and management capacity of JKP "Vodovod" Bitola.

JKP "Vodovod" Bitola should plan measures to attract young and educated people, who will be trained to enhance their skills.

On the basis of the analysis carried out of the capacity of the utility and on taking into account its functions and resources (human and organizational), it can be concluded that the capacity of JKP "Vodovod" Bitola is sufficiently adequate with regard to the company's current obligations.

Alongside that, the implementation of the following measures is a necessary means for the improvement of the company's capacity:

- From a quantitative standpoint the company's personnel structure seems optimal. From a qualitative standpoint, however, its age structure is in need of improvement; the share of the personnel with above 50 years of age should be decreased, while the share of the personnel with below 40 years of age should be increased.
- The main challenges faced by the utility relate to improvement of the planning and purposefulness of the processes concerning the current professional qualification of the personnel (as part of the "life- time learning" scheme). The preparation of an annual plan to that effect would constitute a suitable organizational measure, which would aid the strengthening of the company's capacity.
- The utility needs to initiate the process of employee training in the field of project management and/or attract experts who are prepared in this field in addition to the currently existing ones. Such measures would constitute a prerequisite for ensuring access to external financial resources, mostly within the frameworks of the operational programs. Should also be considered the fact that these experts might be used in other activities of JKP "Vodovod" Bitola subject to EU funding;
- The establishment of a modern human resource management system within the company is an important institutional necessity, which would greatly contribute to an increase in the utility's capacity, incl. the management of new assets in the future and improvement of the quality of services provided to the consumers.

The waste water systemoperator of the serviced area is ***JKP "Niskogradba" Bitola***.

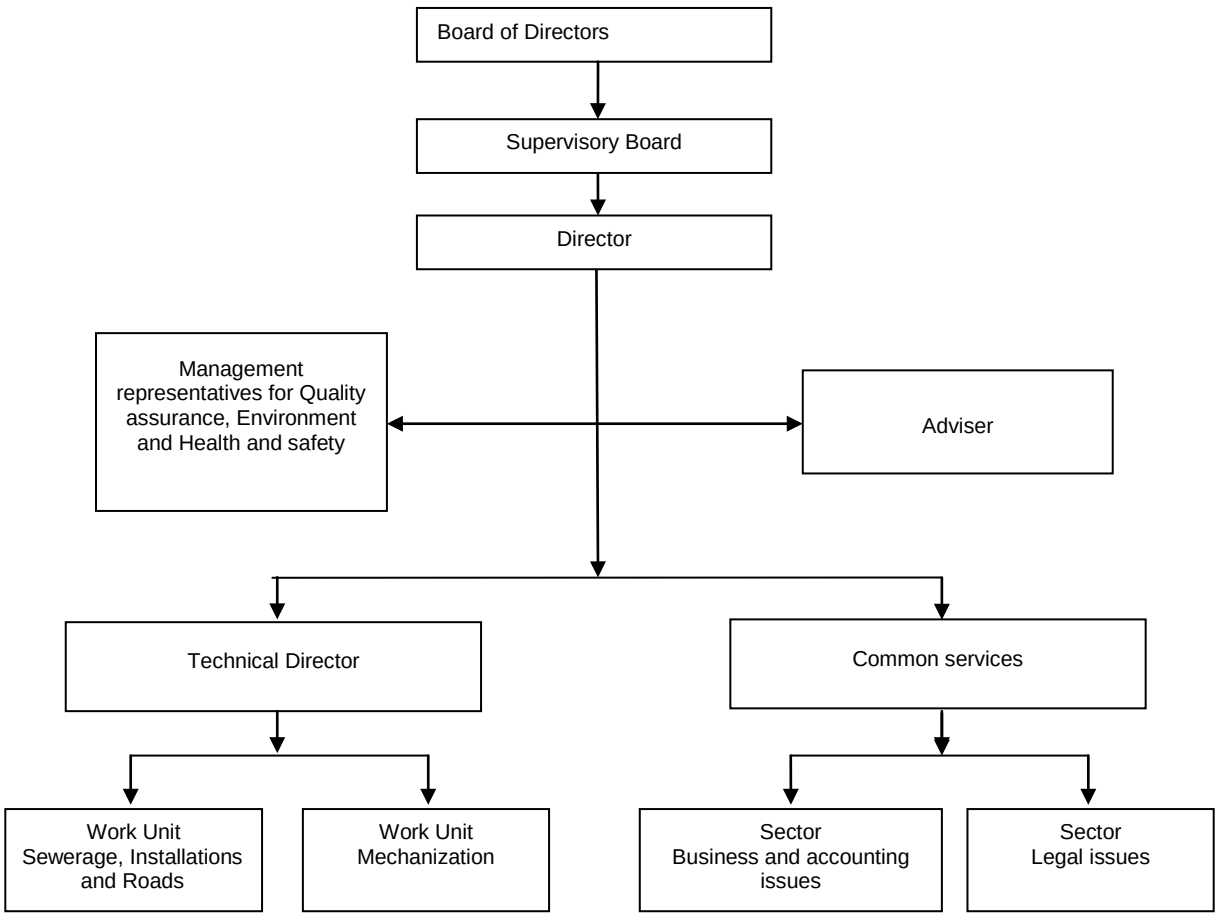
JKP "Niskogradba" Bitola is a public utility company, which is responsible for operation, construction and reconstruction of the waste water system in town of Bitola on one hand and on other hand responsible for some communal services for the town of Bitola – reconstruction and maintenance of streets (including winter period maintenance), supervision and control during the construction works of communal projects, land shafting, other works in the area of infrastructure services. Additionally the Company works on individual contracts (in scope of its capabilities) with private clients not only at the territory of the Municipality but at whole the territory of the Republic of Macedonia. Founder of the Company is the Municipal Council of Bitola. The Municipal council appointed a Board of Directors which is composed of nine members and a Supervisory Board, which is composed of five members. The Company is managed by a Director, which is appointed by the Mayor of the Bitola town. Related to the staff and operations the Director has full autonomy to make decisions within the legislation.

Invoiced potable water quantity by customers is transmitted on CD from Common services Department of JKP Vodovod to sector Business and accounting issue in JKP Niskogradba. They in turn billed to customers consumption of Waste water. Invoiced amount of waste water is based on

figures provided by JKP Vodovod, i.e. ratio is 100% between invoiced water and waste water consumption.

According to the information provided by the Company as of the date of preparation of the present MP in JKP "Niskogradba" Bitola there are 154 employees. Since the Company is responsible not only for waste water services and there are services requested beyond that, the administration and technical staff will be divided in following analysis. The administration staff is at total number of 41 employees and cover Sector "Common affairs"- finance, accounting, human resources, legal services, procurement, general affairs, etc. The technical staff allocated and responsible for the waste water system operation, construction and reconstruction is at total number of 54 employees and is included in the Company's Work Unit "Waste Water Sewerage, Installations and Roads". Since the total number of technical staff allocated for the other communal services of the Company is very similar, compared to those in Work Unit "Waste Water Sewerage, Installations and Roads", just for the purposes of calculation of the ratio "number of customers/employee in this analysis the administration staff will be divided equally between both Work Units of the Company. So for the area of waste water services of this amounts to approximately 330 customers per employee.

Figure 2-9 Organizational Chart of JKP "Niskogradba" Bitola



Source: JKP "Niskogradba" Bitola

The structure of educational background of the technical staff allocated and responsible for the waste water system is comparatively balanced and suitable to the activities related to the provision of services – the share of employees with secondary and specialized secondary education is about 76% and the share of employees with university degree is 11%; the remaining 13% have primary or lower education. The share of the latter group can be evaluated as being relatively lower in comparison to other similar companies. Hence, the utility's future policy in the area of human resource management should be aimed at maintain of the share of qualified personnel, which would contribute to the utility's

capacity as a whole. The age structure indicates that around 50% of the employees are 50 years old and above and that only around 15% are below 40 years old. The annual fluctuation of personnel has a coefficient of about 5% on the basis of the number of employees who have left the company and were replaced by new ones. This is almost no fluctuation of personnel, which reflects in comparative stability of the staff.

The utility's management has approved Rules for organization of working activities, tasks and functions. In this Rules very precisely are developed the responsibilities, functions, etc. of each of organizational elements within the Working Units and Sectors of the Company. Additionally the staff required per each position is described and strictly followed. Every employee receives a job profile, with which he/she is familiar; it is part of each worker's personal profile. JKP "Niskogradba" Bitola has never made an assessment of staff.

The internal evaluation indicates that the JKP "Niskogradba" Bitola has no experience in the preparation and realization of the projects financed by EU and/or IFIs. This constitutes a negative for the company's capacity, which can't positively affect its access to external financial resources, which could be used to foster the utility's development and to the current project. This is a further area for development of its administrative and institutional capacity.

The following *problematic areas* were determined on the basis of the study:

- The continual improvement of the personnel qualification seems to be undervalued. The utility has not prepared an annual plan for personnel qualification improvement. These are negative prerequisites with regard to the preservation and improvement of employees' qualification level;
- Technical staff responsible for waste water services is not allocated in a separate working unit or at least separate sector in the Company's Organizational chart;
- The age structure analyses show that more young and educated staff are required to improve administrative and management capacity of JKP "Niskogradba" Bitola.

JKP "Niskogradba" Bitola should plan measures to attract young and educated people, who will be trained to enhance their skills.

On the basis of the analysis carried out of the capacity of the utility and on taking into account its functions and resources (human and organizational), it can be concluded that the capacity of JKP "Niskogradba" Bitola is sufficiently adequate with regard to the company's current obligations.

Alongside that, the implementation of the following measures is a necessary means for the improvement of the company's capacity:

- From a quantitative standpoint the company's personnel structure seems optimal. From a qualitative standpoint, however, its age structure is in need of improvement; the share of the personnel with above 50 years of age should be decreased, while the share of the personnel with below 40 years of age should be increased.
- The main challenges faced by the utility relate to improvement of the planning and purposefulness of the processes concerning the current professional qualification of the personnel (as part of the "life- time learning" scheme). The preparation of an annual plan to that effect would constitute a suitable organizational measure, which would aid the strengthening of the company's capacity.
- The utility needs to initiate the process of employee training in the field of project management and/or attract experts who are prepared in this field in addition to the currently existing ones. Such measures would constitute a prerequisite for ensuring access to external financial resources, mostly within the frameworks of the operational programs. Should also be considered the fact that these experts might be used in other activities of JKP "Niskogradba" Bitola subject to EU funding.
- Another managerial task, which is of significance to the company's institutional capacity is the on-going monitoring of coordination between the activities of the different Work Units (in cases of such need) undertaking of preventive measures aimed at decreasing the conflict potential of these organizational links. It seems that in current organizational structure there is no body with adequate and enough capacity to do this.

- The establishment of a modern human resource management system within the company is an important institutional necessity, which would greatly contribute to an increase in the utility's capacity, incl. the management of new assets in the future and improvement of the quality of services provided to the consumers.

Financial Capacity of JKP "Vodovod" Bitola

The Company prepares annual and interim reports of the activity as a whole and in accordance with the requirements of the Accounting Law and the Rules for public enterprises. All elements of the operating costs for the water supply activities are according to the Regulations of the Company's accounting policy, which in turn is subject to approval by the Municipality of Bitola Council.

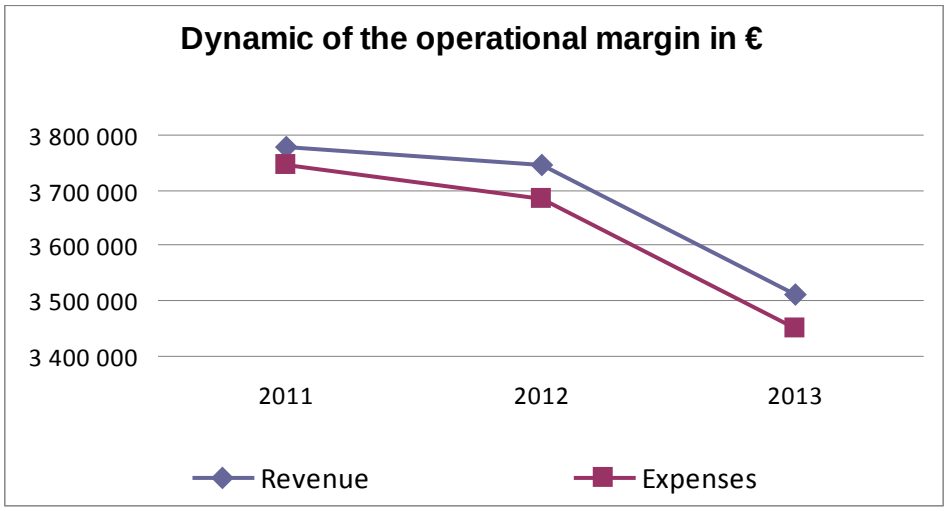
Table 2-20 Main Financial Indicators of JKP "Vodovod" Bitola

Expenses	in €			**Revenue**	in €		
	2011	2012	2013		2011	2012	2013
Materials	1,124,756	1,036,448	844,417	Sales	3,463,282	3,568,515	3,236,524
Deprecations	397,342	419,013	375,394	Other income	313,267	178,270	273,678
Labour	1,648,038	1,655,232	1,668,828			0	0
Other expenses	576,054	573,554	560,086			0	0
Total operating expenses	***3,746,189***	***3,684,247***	***3,448,724***	***Total operating revenue***	***3,776,549***	***3,746,785***	***3,510,202***
Operating profit/loss (EBIT)	30,360	62,538	61,478	Financial income	29,011	26,020	15,654
Financial expenses	26,378	68,925	45,759	Income from financing	0	0	0
Taxes	28,799	17,244	26,663	Total income	3,805,560	3,772,804	3,525,856
Net Income	***4,193***	***2,389***	***4,709***				

Source: JKP "Vodovod" Bitola

As seen from the above table, water supply activities have a profit for the last three years. Moreover the Company's dynamics of income and expenses shows an increase of Operational Margin, due to major decrease of materials expenses.

Figure 2-10 Operational margin of JKP "Vodovod" Bitola



Source: JKP "Vodovod" Bitola

There is a growth in terms of expenses for other expenses – 26.1% and also for wages – 7.5%, while there is a reduction in costs for materials, about 9.6% for the period and very slightly for depreciations, about 0.4%. For the same period Income increases by 13% only.

Depreciation policy of the Company is in accordance with the national legislation for corporate taxation and the regulatory provisions for accounting rules to public enterprises. They are based on the maximum admissible rates for each group of assets. Taking into account strict accounting for depreciation, they are used in determining the tariffs at full amount.

Financial costs of the activities for provision of water and wastewater services now represent about 1.3% of the total operating expenses. They are associated with the loan from KfW. All contributions are paid off on a regular basis and the loan will be repaid in full by the end of 2041.

The investment policy of JKP "Vodovod" Bitola is planned in the framework of an Annual programme of activities and is subject to approval by the Municipal Council of Bitola.

The following conclusions can be summarized on the basis of analyses of the Annual Financial Statement of JKP "Vodovod" Bitola (Income statement, Balance sheet, Net cash Flow Statement etc.) as well as the Annual Programme for 2014 and meetings, interviews and discussions with the Company senior representatives:

- The Company prepares annual and interim reports of the activity as a whole and in accordance with the requirements of the Accounting Law and the Rules for public enterprises.
- The Company has internal Rules for accounting policy in compliance with the national legislation on public enterprises.
- Water supply activities have profits formed on the basis of the revenues from sales.
- The Company pays loan from KfW. All contributions are paid off on a regular basis and the loan will be repaid in full by the end of 2041.

Financial Capacity of JKP "Niskogradba" Bitola

The Company prepares annual and interim reports of the activity as a whole, without separation between the two main sectors – sewerage and mechanization/installations and roads. These are the requirements of the Accounting Law and the Rules for public enterprises. All elements of the operating costs for the activities are according to the Regulations of the Company's accounting policy, which in turn is subject to approval by the City Council.

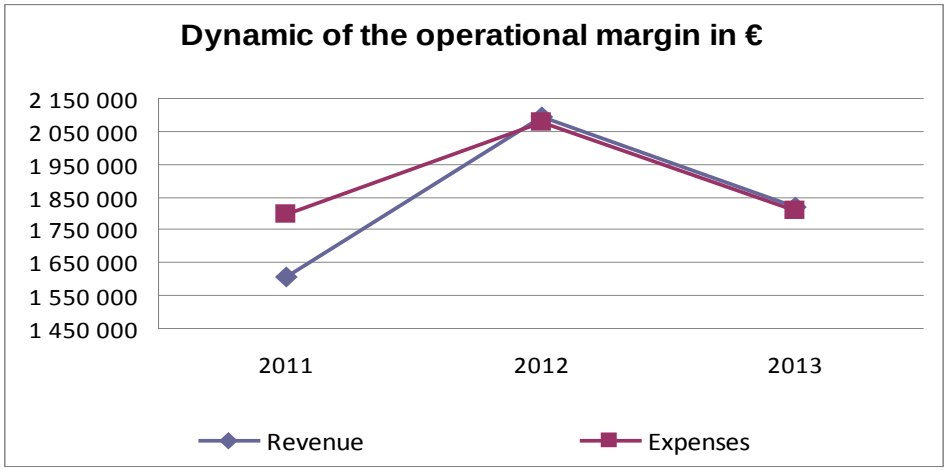
Table 2-21 Main Financial Indicators of JKP "Niskogradba" Bitola

Expenses	in €			Revenue	in €		
	2011	2012	2013		2011	2012	2013
Materials	789,271	1,040,007	713,846	Sales	1,601,182	2,082,436	1,809,401
Deprecations	82,189	82,106	81,824	Other income	3,819	11,523	8,590
Labour	824,718	867,101	886,831			0	0
Other expenses	99,270	89,143	125,164			0	0
Total operating expenses	***1,795,448***	***2,078,357***	***1,807,664***	***Total operating revenue***	***1,605,001***	***2,093,961***	***1,817,991***
Operating profit/loss (EBIT)	-190,447	15,602	10,327	Financial income	3,706	3,510	6,901
Financial expenses	1,463	601	1,299	Income from financing	0	0	0
Taxes	5,818	5,201	7,908	Total income	1,608,707	2,097,471	1,824,892
Net Income	***-194,023***	***13,311***	***8,022***				

Source: JKP "Niskogradba" Bitola

As seen from the above table the Company has a profit for the last two years. Moreover the dynamics of income and expenses shows an increase of Operational Margin, due to some decrease of materials expenses and increase of sales revenues.

Figure 2-11 Operational margin of JKP "Niskogradba" Bitola



Source: JKP "Niskogradba" Bitola

The only growth in terms of expenses is for wages – 1.3%, while there is a reduction in costs for materials, about 25% for the period, depreciations, about 5.5% and also for other expenses – 2.8%. For the same period Income decrease by 6.5% only.

Depreciation policy of the Company is in accordance with the national legislation for corporate taxation and the regulatory provisions for accounting rules to public enterprises. They are based on the maximum admissible rates for each group of assets. Despite strict accounting for depreciation, they are not used in determining the tariffs.

Financial costs of the activities of the Company now represent about 0.1% of the total operating expenses. They are associated with the 6-years loan signed in 2012. The loan is amounted of about 500,000 EUR. Half of this loan was used in 2013 to cover the recent annual financial losses. The other half was used in 2014 to purchase some necessary machinery for the Company's common activities (not especially for sewerage services). All contributions are paid off on a regular basis and the loan will be repaid in full by the end of 2018.

The investment policy of JKP "Niskogradba" Bitola is planned in the framework of an Annual programme of activities and is subject to approval by the Municipal Council of Bitola.

The following conclusions can be summarized on the basis of analyses of the Annual Financial Statement of JKP "Niskogradba" Bitola (Income statement, Balance sheet, Net cash Flow Statement etc.) as well as the Annual Programme for 2014 and meetings, interviews and discussions with the Company senior representatives:

- The Company prepares annual and interim reports of the activity as a whole and in accordance with the requirements of the Accounting Law and the Rules for public enterprises. There is no accounting data for separation of the activities of sewerage and the rest of Company's activities. In this accounting organization it is impossible to carry out reliable estimates of revenue and expenditure separately for sewerage. Given the forthcoming changes and reforms in the water sector in Macedonia, the Consultant will refrain from recommendations for radical changes in the enterprise.
- The Company has internal Rules for accounting policy in compliance with the national legislation on public enterprises.
- Waste Water supply activities have profits formed on the basis of the revenues from sales.
- The Company pays a 6-years loan to cover the recent annual financial losses and to purchase some necessary machinery for the Company's common activities. All contributions are paid off on a regular basis and the loan will be repaid in full by the end of 2018.

2.4.4. Prices (tariffs)

The level of tariffs for Water and Waste Water and Treatment services are determined in accordance with the Law for Water, Public Enterprises Law and Local Government Law. On the government level a Methodology for Approving of Potable Water and Sewerage Prices was established in 2005. The Methodology is an administrative document and does not contain requirements of tariffs calculations as elements of expenditures, losses permitted to cover by tariff, affordable level, rate of deprecations included etc.

The tariffs for water supply are prepared by JKP Vodovod and for waste water by JKP Niskogradba. Council of Municipality approves tariffs setting with decision based on JKPs proposals. Tariffs are defined by the Municipal Council, with social comfort of the population being the leading criterion.

In July 2009, water tariffs were increased by around 125% for households and by around 70% for commercial and industrial customers after 6 years fixed prices. In 2010 JKP Vodovod submitted a proposal for dramatically increase of potable water tariff from 14.00 MKD to 31.25 MKD, but after few months Municipality Council repealed the decision and reduced to the current level of 24.25 MKD.

It is evident from the applied methodology that the price of water supply is determined on the basis of costs at the time divided by the total invoiced amount of sold water. The same approach is applied for waste water tariff.

The waste water tariffs were increased in 2013, after 8 years fixed value. The current waste water tariff system is applicable since 01.11.2013. JKP "Niskogradba" Bitola applies waste water charges for two main customer categories, which are households (Domestic) and legal entities, including Public institutions, Commercial and Industrial customers. The tariff adjustment was based on a Municipal council decision in September 2013. All the calculations for tariff changes are prepared by JKP "Niskogradba" Bitola, based on the detailed analysis of annual revenues, fixed and variable expenses of the Company for the period of 2002-2012. This analyses is made but for the whole Company's activity, not only for waste water services. Moreover whole annual amount for depreciation of Company's assets is included in the calculations. This analyses is the reason the JKP "Niskogradba" Bitola to apply to the Municipal Council to increase the waste water tariffs by 95.44%.

The tariffs by consumers groups are shown in the table below:

Table 2-22 Dynamic of Water and Waste water tariffs in JKP

Services provided	until 2009, MKD/m^3	2009-2013, MKD/m^3	2014, MKD/m^3
Potable Water			
Domestic	14.00	24.25	24.25
Industry	26.70	45.00	45.00
Budgetary and Institutional	26.70	45.00	45.00
Waste Water			
Domestic	5.42	5.42	10.55
Industry	8.10	8.10	15.83
Budgetary and Institutional	8.10	8.10	15.83
Customers for sewerage system only	8.10	8.10	15.83

JKP NIskigradba does not keep separate analytical accounts for the assets of waste water services only, i.e. there is no separate account for other services. These accounts are common for the all activities and are not related to price formation, although depreciation of existing assets is recorded in the Profit and Loss Account. The needs of maintenance costs are covered partly by Bitola Municipality by means of an annual subsidy based on an annual plan for development of waste water services, prepared by JKP Niskogradba. Part of the profits made by JKP of the common activities also remain in the company and are used for maintenance.

Organization of JKP Vodovod existing accounting system is closer to the required for Water Utility, because their main activity is produce and distribute potable water. The needs of maintenance costs are covered partly by Bitola Municipality by means of an annual subsidy based on an annual plan for development of water services, prepared by JKP Niskogradba.

The After examination of water tariffs in JKP “Vodovod” for Water and in JKP “NIskogradba” Waste Water services, it became clear that:

- The Tariffs are not estimated according to “cost coverage approach”;
- Polluter pays principle does not apply completely;
- Affordability level of tariffs is not used in planning process;
- Tariffs are not revised at required frequency to reflect changes in costs; and not reflecting inflation at least:
- Depreciation in some cases is only partly reflected in tariffs because of problems with assets valuation and insufficient inclusion into accounting system.

Meanwhile the Ministry of Environment and Physical Planning is Beneficiary of the completed yet project “Development of National Water Tariff Study”. The purpose of the project is to prepare a National Water Tariff Study for development of an economic instrument for balanced water price system and management of financially sustainable water investment projects. The main results are to develop economic instrument for balanced water price system and management of financially sustainable water investment projects and develop water tariff methodology and structure of the water tariff. Model of Business planning and tariffs calculation are completed and during the implementation period 2015-2017 they have to be applied.

2.5. Water Resources

2.5.1. General characteristics

The water resources of Bitola region are represented by subsoil, river, reservoir and mineral waters. The river waters are of outmost importance for the water balance.

The Dragor River provides most of the water supply for the town and presently all of the urban area of Bitola and to surrounding villages.

Map 2-6 Map of rivers within Crna river basin

The hydrographical network in the Bitola region is quite rich with springs, rivers and their tributaries. Main recipient in Pelagonia valley is Crna River with catchment area of 5,093 km^2. In its course Crna River receives 20 tributaries longer than 10 km, with a total length of 471 km.

On the right side, it receives 14 tributaries with a total length of 325 km and a catchment area of 2,538 km^2, while the left it receives only 6 rivers with total length of 136 km and a catchment area of 1,547 km^2. The rest of the total catchment area of Crna River are tributaries accounted for less than 10 km length.

The City of Bitola lies on both sides of River Dragor, which is a right tributary of the River Crna. Its spring is located near Sapuncica, on the Baba Mountain. Its length is 25 km, with catchment area of 188 km^2 and the relative decline of 50.1 ‰.

Mountain Baba with the Pelister National Park possesses a rich hydrographical network of Mountain Rivers, streams and numerous springs.

The reservoir water is also of significance for the municipal water balance. The largest water reservoir in the region is the artificial lake Strezevo, which is part of the hydro system Strezevo. This hydro system represents a versatile water management system aiming to exploit, manage and protect the water resources and surrounding areas against harmful effects of water such as flooding and erosion.

The collective channel of the hydro system Strezevo enables collection of waters of the watercourses in the Baba Mountain (river Kishavska, Graeshka, Ostrechka, Ziokukanska, Stara river, Kinderka and Dragor). Apart from this basic function, the system actively participates in the replenishment of raw water for the needs of JKP Vodovod Bitola, and the coal sugar factory. The waters are also exploited for hydropower production at the hydro power station Filternica and Dovledjik.

The principal object of the system is 95 m high rock-fill dam with volume of 4,219,000 m^3 built-in material creating a reservoir of 120.00 x 10^6 m^3.

2.5.2. Surface water sources

The main source of water supply of Bitola are:

- **Three water intakes:** Crvena Reka, Lak Potok and Sapuncica, which are part of the Dragor system. The total capacity is estimated to be approximately 480 l/s on average with an estimated maximum capacity of approximately 1,300 l/s. The three water sources are rivers from the Baba Mountain, which are located within the Pelister national park.
- **Artificial lake of the hydro-system Strezevo**, conveyed to a storage reservoir. The intake is operated by JP Strezevo Bitola and is taken into operation during the dry periods of the year when the water capacity of the Dragor system is insufficient to cover the water demands. The reservoir is located on Shimnica River, approximately 22 km from the town, and has a storage volume of 4,219,000 m^3. This lake occupies a volume of 112 million m^3 of water depth at the dam of 72 meters, an area of approximately 7 km^2 and an average width of about 1 km and a length of 7 km.

Main technical details of Strezevo dam and reservoir are given in the following table:

Table 2-23 Main technical details of Strezevo dam

No.	Description	Unit	
1	Dam/Reservoir name		Strezevo
2	River / Catchment		Shimnica River
3	Dam type		Rock-fill dam with clay core
4	Crown level	m	741
5	Height above ground	(m)	76
6	Accumulation volume	(million m^3)	112
7	Water use (purpose)		- irrigation of 20,200 ha - water supply for the Water supply system of Bitola - water supply for Industry - power generation
8	Commissioned by	(year)	1982
9	Main user/ owner		PE Strezevo

Source: JP Strezevo

The existing Macedonian regulations require each user of natural sources to obtain permit for utilization, extraction and/or use of natural resources. Pursuant to this, the water supply company of Bitola, and its legal predecessors have obtained water permit for abstraction of water used for human consumption. Public Enterprise Strezevo poses Permission under 11-UP1 number 119 of 10.09.2014 issued by the Ministry of Environment and Physical Planning for utilization, accumulation and use of water from the river Kishavska, River Graeshka, River Ostrechka, River Zlokukjanska, Stra river, river Kinderka, Dragor River and River Shemnica for the Hydro system "Strezevo" for potable water supply of JKP "Vodovod" Bitola, water supply of REK Bitola and other local industries, irrigation, power production, fisheries, and use of alimentation channel, dam and reservoir "Strezevo" with accompanying facilities, Main supply channel, detailed pipeline network for irrigation, and the use of HPP "Strezevo" HPP "Bioloshki minimum", HPP "Esplatacionen minimum", HPP "Filternica", HPP "Dovledzik" and fishery "Strezevo" with supporting facilities.

Quality of fresh water

The existing Macedonian regulations require each user to ensure that raw water meets the prescribed quality standards for certain water use. In practice, this means that the relevant water supply company is obligated to test the water for its water sources to confirm that it complies with the existing regulation and water quality standards.

Assessment of surface water quality is carried out according to the prescribed criteria defined in the existing legislation, the Water Master Plan of Macedonia, chapter "Protection of Waters" etc. Systematic monitoring of the qualitative properties of the surface water is intended to provide a global picture of the state of water quality and provides data for:

- The level of pollution, pollution trends, which should be used to implement the plan and program for water protection.
- Systematic, complex, continuous and exact information about the environment and pollutants occurrence that adversely affect the water quality.

A network for monitoring the quality of surface water has been established managed by the Republic Hydro-Meteorological Institute. The quality of interstate rivers is monitored at 12 measuring points, where the following parameters are measured: pH value, visible waste substances, significant odour, colour, dissolved oxygen, oxygen saturation, BOD_5, permanganate index, degree of biological productivity, total soluble solids, total suspended solids, ammonium ion, nitrite, nitrate, iron, lead, zinc, cadmium, chromium Cr + 6, specific indicators, indicators of oxygen regime, indicators of mineralization, toxicity of chemical mixtures, probable number of coliform bacteria, radioactivity, quality of water as prescribed by law and assessed summary of the quality provided with the tests. Besides monitoring the quality of interstate waters there is a regional network where quality of running waters is measured. With this monitoring 18 parameters are measured: As, Ag, Al, Ni, Mn, Fe, Cr, Mg, Na, Ca, Zn, Cu, Pb, Cd, Co, K, P, pH. The network of interstate waterways must be included in the monitoring system, which implies procurement of adequate equipment: sensors for continuous monitoring of water quality, alarm system connected to telemetric system for data delivery. Same should be included in the European regional network.

Water quality standards are set in the Regulation on Water Classification (The official gazette of RM No.18/99). This regulation specifies 5 water quality classes and detailed concentrations of over 200 parameters for each class. Water intended for human consumption and food preparation should comply with the standards set for Class I and II.

Class1 This is very clean, oligotrophic water, which in its natural state, with eventual disinfection, can be used for drinking as well as production and processing of food products and is suitable for mating and cultivation of salmonide fish spices. It is constantly saturated with oxygen, with low content of nutrients and bacteria, contains very slight, occasional anthropogenic pollution with organic matters (but not with inorganic matters)

Class 2 This is a less polluted, mesotrophic water, which in its natural state can be used for bathing and recreation, water sports, cultivation of other fish spices (cyprinids), or which after the usual methods of purification / conditioning (coagulation, filtration, disinfection etc.) can be used for drinking and production and processing of food products. The buffering capacity and oxygen saturation throughout the year are good.

Class 3 That is moderately eutrophic water, which in its natural state can be used for irrigation, and after usual purification methods (conditioning) for industries, which do not need drinking water quality. Buffering capacity of the water is low, but it maintains the pH value at a level still suitable for breeding of most fish. Occasionally oxygen insufficiency occurs. The level of primary production is considerable, and some changes in community structure, including fish species can be observed. The load of harmful substances is evident as well as microbiological pollution. The concentration of the harmful substances varies from natural levels to levels of chronic toxicity for the aquatic life;

Class 4 This is strongly eutrophic, polluted water, which in its natural state can be used for other purposes only after certain processing. The buffering capacity is exceeded, which leads to higher levels of acidity, and which affects the development of the offspring. Algae bloom is present. Increased decomposition of organic matter at the same time with the stratification of the water can cause anaerobic conditions and fish death. Microbiologic pollution does

not allow the water to be used for recreation, and harmful substances emitted or released from the sediment (deposits), can affect the quality of the aquatic life. The concentration of harmful substances can vary from level of chronic to acute toxicity to aquatic life;

Class 5 This is much polluted, hypertrophic water, which in its natural state cannot be used for any purpose. The water has no buffer capacity and its acidity (pH value) is harmful for many fish species. Decomposers dominate over producers. Fish and bentozic species are not present constantly. Concentration of harmful substances exceeds acute toxicity levels for aquatic life.

Control of the quality of drinking water is performed daily at the outlets of all intakes, the reservoir systems and control checkpoints around the city.

The control of water quality is performed by sanitary control and protection service, which operates 24 hours a day, in accordance to the defined norms set out in the Rulebook for sanitary safety of drinking water. The Laboratory exist within JKP Vodovod Bitola for chemical-biological testing of water which is equipped with modern equipment for determination of the physical and chemical parameters and microbiological parameters of the water as well as highly specialized staff for this kind of work and prevention.

Regular control is also being performed by the Public Health Institute.

Within the city network of Bitola there are 25 checkpoints to control water quality. Daily samples are taken from 7 checkpoints.

Within the hydro system Strezevo there are two laboratories:

- Chemical - bacteriological laboratory;
- Pedological laboratory.

In the chemical - bacteriological laboratory, organoleptic, physical, chemical and bacteriological parameters are monitored of the water from the collection channel, river basin Shemnica, Strezevo accumulation and water from the reservoir, which is released in the main supply channel.

Pedological laboratory is used to perform tests (pedological determination) of the hygroscopic moisture, retainer - capillary capacity, determination of current soil moisture, and by this the norm of irrigation, prospective determination of total nitrogen, available nitrogen, available phosphorus, available potassium, pH, carbon and humus.

On the bases of the aforementioned control of the potable water, the water from the water supply network of Bitola is reported to be of good quality.

With respect to the sanitary hygienic state of the main recipient River Dragor, it is reported that the river is of class II before entering the city of Bitola, and class IV at the exit of the city due to the high organic pollution from both the households and industry.

According to the Regulation on Water Classification (The official gazette of RM No.18/99 and 71/99) the section of River Dragor from Bitola to its estuary in River Crna, and the section of the 5th Channel from Bitola to the estuary in Crna River, and Crna River from the estuary of river Prilepska to Tikvesh Lake are placed in class III (moderately polluted).

2.5.3. Underground water sources

The most important underground water sources within the Water Management Division of Pelagonija and River Crna to which the wider region of Bitola gravitates are the compact type with free water level at alluvial deposits along the Crna Reka and Shemnica. The sedimentshave good infiltration characteristics and have thickness between 10 and 30 m. Well capacity is between 15 and 40 l/s. Considering hydrogeological characteristics, this aquifer has important potential storage. This source was used for water supply of urban centre Bitola (120 l/s). Now it is used as a reserve source for urban centre Demir Hisar (at alluvium Crna Reka 48 l/s) and Prilep (120 l/s). These sediments originate to Quaternary-Pliocene period.
Prilep area is characterised by compact formation (Neogene sediments) with water level under pressure. Well capacity is up to 10 l/s. At Bitola area also mineral water with CO_2 is important. Well capacity is up to 60 l/s and 3 t/hour CO_2. Karst-fissured (carbonate) formation is present at fringe of Prilepsko pole, eastern part of Crna Reka, Debre and other. The area is drained by a number of

sources – the main ones are Zeleznec (Qcp ≈ 2 m^3/s, Babino ≈ 0.04 m^3/s, Debriste ≈ 0.05 m^3/s, Zrze ≈ 0.03 m^3/s).

Static groundwater level in different areas of the city of Bitola is different and ranges from 0.50 m up to 6.50 m. The numerous wells constructed in the past are almost halved nowadays due to the rapid urban construction and the water is highly contaminated due to the sewerage discharges.

The following table provides the data for the estimated reserves of underground water for the Water Management Division of Pelagonija and Dolna Crna River.

Table 2-24 Estimated reserves of underground water for the Water Management Division of Pelagonija and Dolna Crna River

Water Management division	Type	Groundwater body	Estimated reserves of groundwater	Exploitation (m^3/s)
			Static (h$10^6 m^3$)	
Pelagonija and Dolna Crna River	Compact	Alluvium at Crna Reka		5.0
		Alluvium at river Shemnica		
		Pelagonija (quaternary)	6,105	
		Prilepsko pole (Pliocene)	75	
		Bitolsko Pole (Pliocene)	96	
	Karstfissured			1.0

Source: Water Strategy for Republic of Macedonia (2011 -2041)

2.6. Water pollution

2.6.1. Major sources of pollution

Bitola is well developed regional urban centre with considerable industrial capacities. The water pollutants in this regard are predominantly of domestic and industrial character. Main production activity of the industry is metal, textile, food, tobacco processing, printing industry, production of milk and dairy products, alcoholic and soft drinks, sugar, yeast, spirit. The most important industries and possible point-source polluters are given in table 2.11.

The largest part of the industrial capacities are connected to the existing sewerage system. Those industries which are not connected to the urban sewerage network have their own sewer which is discharged directly into the existing recipients. These industries have the possibility to be connected to the future sewer network and waste water treatment plant.

As shown in the table “Recent wastewater production from industry” (Annex 9-1) the industrial wastewater quantities amount to 3,298 m^3/dayDuring the data collection from the industry it has been noted that some of the industry such is the Tobacco processing factory have their operational local treatment installations for wastewater.

There is no regular measurement of the wastewater flow and quality before discharge into the main recipient. Thus the amount of waste water discharge, by sources of discharge, is estimated according to the common norms for the average water discharged per capita or average water discharges per type of economy which is using water in their technological process.

The only data available in this regard are the measurements preformed in 2014 for the needs of preparation of EIA for the sewerage network of Bitola. There are 10 discharge outlets of the sewerage network of Bitola. A smaller portion of those outlets are for storm water and most are of a mixed system - storm and sewerage.

The data from the aforementioned measurements are presented in the next table:

Table 2-25 Results of Reports for physical – chemical analysis of waste water performed by JZU Center for public health on Bitola on 08.04.2014

Analysis		Outlet 1 K1-1	Outlet 2 Bukovski livadi	Outlet 3 Partizanska	Outlet 4 Stopanski dvor	Outlet 4 Kozhara
pH factor	pH	5.5	5.5	5.5	5.5	5.7
temperature	°C	13.40	12.10	13.00	11.50	10.80
Colour		blured	blured	blured	blured	blured
Smell		noticable	noticable	noticable	noticable	noticable
Suspended solids	mg/l	45.00	42.00	58.00	38.00	40.00
BOD5	mgO_2 /	155.00	110.00	820.00	75.00	79.00
COD	mgO2 /	308.0000	225.0000	1,650.0000	144.0000	163.0000
Total phosphorus (rivers)	mg P/l	2.516	3.33	3.126	1.889	3.518
Total nitrogen	mg N/	15.600	15.900	11.300	14.700	17.000
Ammonium	mg N/	0.300	0.160	0.040	0.600	0.200
Nitrites	mg N/	0.0800	0.0600	0.0400	0.1000	0.1000
Nitrates	mg N/	0.00	0.00	0.00	3.00	0.00
Dissolved oxygen	mg /l	4.90	4.50	4.90	8.90	7.20
Oxygen saturation	%	46	42	46	82	65

Analysis		Outlet 6 Dolno orizari	Outlet 7 Stenton	Outlet 8 Kukurechani	Outlet 9 V. Karangelevski	Outlet 10 Chkrepa
pH factor	pH	5.7	5.5	5.7	5.5	5.7
temperature	°C	11.80	14.60	11.70	11.10	12.30
Colour		blured	blured	blured	blured	blured
Smell		noticable	noticable	noticable	noticable	noticable
Suspended solids	mg/l	42.00	50.00	41.00	37.00	38.00
BOD5	mgO_2 /	90.00	440.00	79.00	27.00	60.00
COD	mgO2 /	182.0000	893.0000	157.0000	50.0000	136.0000
Total phosphorus (rivers)	mg P/l	4.102	5.055	4.31	0.418	2.747
Total nitrogen	mg N/	15.330	21.960	16.000	3.700	16.000
Ammonium	mg N/	0.100	0.060	0.190	0.800	0.040
Nitrites	mg N/	0.0800	0.8000	0.1600	0.1000	0.2000
Nitrates	mg N/	4.00	17.00	0.00	3.00	0.00
Dissolved oxygen	mg /l	3.40	4.20	2.80	7.80	4.85
Oxygen saturation	%	31	41	54	77	45

Due to the absence of WWTP at the moment, the entire wastewaters both from households and industry are discharged without any treatment directly into the recipients. The River Dragor and 5th Channel which are recipients of the storm and wastewaters from Bitola are tributaries of the Crna River. As such, they bring significant amount of wastewater to the Crna River and contribute to its deteriorating water quality. As the main right tributary River Crna further brings the polluted water to River Vardar which is an international river crossing to Greece. Thus, the larger part of this pollution presents trans-boundary pollution, with all related problems and issues arising from it.

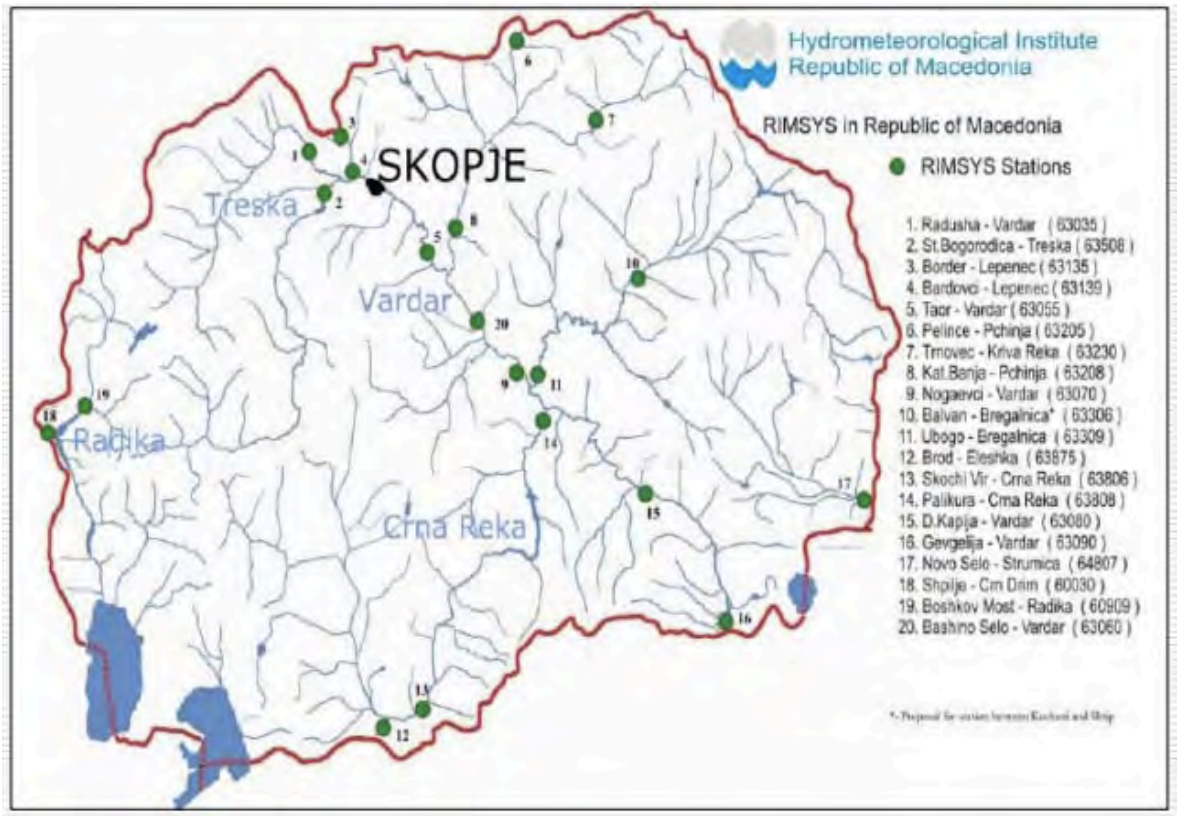
2.6.2. Wastewater Impact

As mentioned in the previous chapter 2.6.1., at the moment of preparation of this study there are no official data on the wastewater quantities discharged into the recipients. During the course of this project and for the project needs the consultant shall organize wastewater flow measurement and wastewater quality tests.

Further, the assessment of the wastewater impact is prepared on the bases of the results from surface water monitoring.

Surface water monitoring of rivers in Macedonia is performed by the Republic Institute for Health Protection (RIHP)/ Chemicals Hazard Information & Packaging (CIHPs) and the Hydro Meteorological Administration (HMA). While the RIHP/CIHPs focus more on parameters of sanitary importance, namely microbiological parameters, the HMA focuses on hydrological as well as water quality parameters.

The objectives of the River Monitoring System Project in Macedonia (RIMSYS) include the long-term assessment of water quality and discharges as well as the establishment of an effective forecasting and alarm system. In accordance to the map provided herewith in Bitola region a station “Skocivir” has been placed, which monitors the water quality of this river.



Map 2-7 RRIMSYS monitoring stations

Source: Hydrometeorological Insitute of Republic of Macedonia

From the data available for the measurements in 2001 to 2004 at this station the following can be concluded:

- high concentration of BOD5 on certain measurement points on Crna Reka, which correspond to a water quality of class IV;
- high concentration of N/I on certain measurement points on Crna Reka, which correspond to a water quality of class II-V;
- The saprobiological analyses show that Crna Reka has a water quality of class IV;
- According to total physical – chemical and saprobiological parameters, we can conclude that the water quality of Crna Reka corresponds to class IV for the measured period.

The data from the above mentioned measurements are given in the next table:

Table 2-26 Basic physical-chemical characteristics of Crna Reka on Skocivir profile

Parameters	IV	V	VI	VII	IX	X	XI	XII	I	II	III
true Colour	5	7.5	7.5	5	2.5	5	/	5	7.5	2.5	5
monthly temperature	11.2	14.6	16.5	19.8	17.4	11.8	8.7	5.4	7.1	8.6	9.1
pH	7.25	7.21	7.27	7.01	/	6.78	7.02	6,64	7.23	7.40	7.02
Alkalinity (mEq / L)	1.6	0	0	0	0	0	0	0	0	0	0
Total value (dH)	4.99	5.49	7.54	9,1	10,67	9,79	7,96	9,98	10,71	9,1	6,9
Carbonate hardness (dH)	0.30	1.51	4.60	5.30	5.46	3.53	3.08	2.27	2.21	1.10	1.50
Carbonate hardness (dH)	4.70	4.00	2.96	3.80	5.20	6.30	4.90	7.71	8.50	8.00	5.40
Rastoren oxygen O_2 (mg / L)	8.26	5.79	4.63	2.73	2.5	1.14	3.25	4.16	2.41	2.08	3.7
BOD5 (mg / L O_2)	7.15	9.20	9.70	10.80	6.60	27.00	14.20	9.98	20.70	11.60	9.54
Ammonium (mg / L)	0.260	0.233	0.663	0.977	3.031	2.403	1.907	1.938	0.406	1.380	1.289
Nitrites (mg / L)	0.023	0.042	0.097	0.094	0.034	0.085	0.072	0.064	0.095	0.067	0.043
Nitrates (mg / L)	1.197	1.275	1.479	1.946	0.915	1.338	2.434	2.414	1.793	1.634	1.121
Bicarbonate (mg / L)	97.6	-363	0	-366	-488	-185	-359	-317	-427	-280	-366
Phosphate (mg / L)	0.212	0.164	0.356	0.598	0.611	0.240	0.397	0.677	0.895	0.567	0.541
Sulphate (mg / L)	16.75	17.33	27.70	52.88	46.84	48.38	35.23	42.92	47.66	65.86	39.76
Carbonates (mg / L)	0	178.8	/	180	240	177	174	156	210	138	180
Chloride (mg / L)	12.70	10.80	14.30	21.70	22.50	23.60	20.80	22	27.54	20,24	16.32
Na Cations (mg / L)	12.06	15.15	20.95	30.20	41.15	26.00	22.58	19.73	29.61	22.93	25.70
K Cations (mg / L)	2.32	5.00	5.24	6.06	7.31	9.15	5.94	5.61	9.216	4.60	5.30
Ca Cations (mg / L)	23.57	30.44	35.65	46.08	49.60	46.70	35.85	39.68	53.05	45.20	41.90
Mg Cations (mg / L)	7.15	5.36	11.11	11.65	16.25	12.99	12.83	19.26	14.31	11.00	11.80
Fe (ηg / L)	95	/	105	25	74	13.5	54	209	114	60	169
Mn (ηg / L)	36	50	86	30	108	43	105	10	121	109	93
Pb (ηg / L)	/	/	/	/	0.62	/	7.57	0.89	0.53	0.96	0.88

Parameters	IV	V	VI	VII	IX	X	XI	XII	I	II	III
Zn (ηg / L)	16.1	25.7	47.5	4.8	2.4	0.7	/	/	0	0	/
Cd (ηg / L)	0.011	0.140	0.017	0.020	/	0.406	0.034	0.158	0	0.088	0.064
Cr (ηg / L)	0.12	0.09	0.62	/	/	0.20	0.65	0.20	0.08	2.51	0.30

2.6.3. Sludge Management and Disposal

2.6.3.1. Sludge from the DWTP

At the moment, the sludge from the clarifiers and backwash water from the DWTP in Bitola is disposed into the recipient river. Consideration should be given in the future to recover the water used for backwashing by thickening the sludge and putting the recovered water back into the clarifier.

Sludge from sedimentation mostly contains 2-5% of suspended solids. Backwash water from rapid gravity filters mostly contains some 0.5 – 1.0% of suspended solids. Sludge treatment will reduce the volume of residual materials disposed of. An effective method of treatment is to reduce the water content from the sludge. A reliable way of achieving this is through the incorporation of an extra sedimentation step. Using a plate separator in combination with the chemical dosing is a proven technique resulting in reduction of the water content of up to 90%. The so called clarified water can then be brought back to the raw water main, at a point just before disinfection. The thickened sludge can be treated in a gravity sludge thickener, up to some 30% of suspended solids. The small amount of water separated from the sludge at this stage can be discharged to the sewer system. Depending on the amount of pollution, the remaining sludge can be dumped on a landfill, used in brick industry or as fertilizer in agriculture.

2.6.3.2. Sewage sludge

Currently, organized sewage sludge management and disposal does not exist on the territory of Bitola. Desludging of septic tanks is usually preformed with pumping in case of defects i.e. hydraulic system failure. As per the information from JKP Niskogradba sludge is than discharged into the existing sewerage network.

Article 2(b) of EU Directive 86/278/EEC concerning sewage sludge suggests that disposal to agricultural land is the recommended option. It requires that sludge must be further treated prior to re-use in agriculture. A number of pathogen destruction technologies are possible including pasteurization or long term storage. Long-term storage on this plant may be the optimum solution.

The early organization of the sludge disposal policy is vital for the operation of the WWTP and the minimization of odour impact. The Operator should:

- Start negotiations with potential end-users of the sludge, such as farmers and forest activities and inform the potential users about the benefits of the bio solids product.
- Define requirements for the sludge treatment (such as pasteurization, addition of lime or others).
- Ensure sufficient storage capacity and transport possibilities.
- Establish an efficient management system for sludge disposal including the regular control of the disposal sites.

2.7. Water Cycle - Existing Situation

2.7.1. Water Supply Infrastructure

The water for the Municipality of Bitola and the other settlements in the water supply service area is provided by:

- **River dragor water system** consisting of three water intakes, Crvena Reka, Lak Potok and Sapuncica with estimated capacity of approximately 480 l/s on average and estimated maximum capacity of approximately 1,300 l/s. The three water sources are rivers from the Baba Mountain, which is located within the Pelister national park.

- **The water intake at the hydro-system Strezevo** located on approximately 22 km from Bitola with a capacity of more than 680 l/s. This water intake is taken into operation during the dry periods of the year when the water capacity of the Dragor system is insufficient to cover the water demands. The intake is operated by JP Strezevo Bitola.

The water supply system is given in Annex 9-2. The water from the Strevezo artificial lake is conveyed to a storage reservoir by gravity and is then pumped via the Dovledik pumping station through a raw water main of length 2,500 m and diameter 700 mm to the Dihovo water treatment plant.

Picture 2-1 Strezevo dam

In accordance to the data provided from JKP "Vodovod", the following chart gives an overview of monthly quantities of supplied raw water to the WTP for year 2014 (5,127,000 m^3).

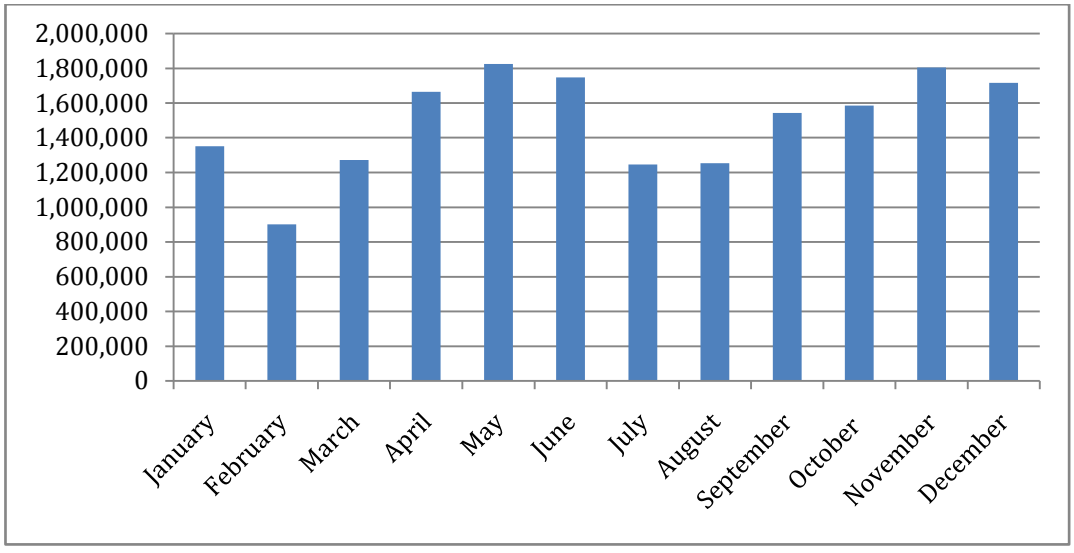


Figure 2-12Quantity of supplied Raw water in m^3 to WTP for year 2014 by month

The raw water is treated in the existing WTP (Water factory) located at the village of Dihovo, at an elevation of 765 masl and with a capacity of 1,080 l/s.

The treatment process comprises the following:

- Pre-chlorination;
- Flocculation and coagulation;
- Rapid gravity filtration through sand beds;
- Disinfection with chlorine gas.

Before entering the filter lines, elements are added in the water, which speed up the process of separation of undesirable ingredients and concentrations, with simultaneous performance of the process of pre-chloriantion.

The department for flocculation consists of 4 pools equipped with vertical mixers to improve the filtration of water.

The filter units are with a total area of 720 m^2, and are used for physical treatment of water.

Picture 2-2 Filter units with sand filters at WTP Dihovo

The mechanical hall consists of air compressors, pumps for backwashing of filtering units and several pump units to provide sanitary water for local needs and process water for the opening and closing of hydraulic valves, as well as the main distribution panel.

In the reinforced corridors are located raw water feeder, outlet for unclear water, and outlet for treated water which goes to the consumers.

The treated water is further transported into clear water tanks with a total capacity of 7,000m^3which serve to offset imbalances in daily consumption. From these tanks the processed water goes into the distribution network by gravity.

The water transmission mains from the Dihovo water treatment plant to the storage reservoirs comprise 14.2 km of cast iron and steel pipes with diameters of 400 mm to 800 mm. There are four transmission mains which distribute the water by gravity:

- From Dihovo WTP to Old Filter Station (reservoir 2)
- From Old Filter Station (reservoir 2) to Epinal (Reservoir 5)
- From Old Filter Station (reservoir 2) to Ovci Bari (reservoir 3)
- From Ovci Bari (reservoir 3)to Novo Zmirnevo

In addition, there are transmission mains that supply the villages around Bitola. These comprise 123.7 km of PE, PVC, AC and steel pipes with diameters of 63 mm to 450 mm.

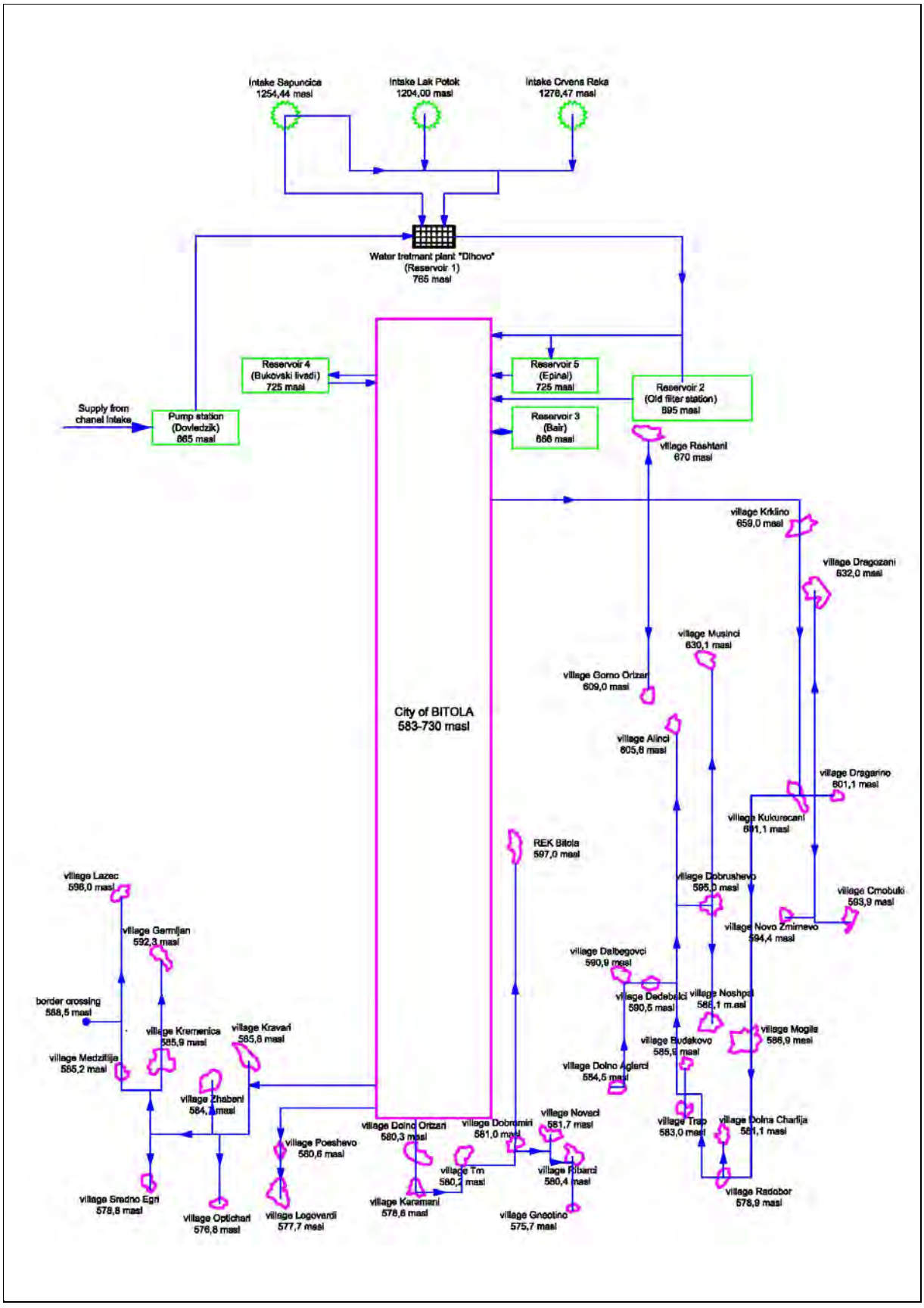


Figure 2-13 Bitola water distribution system – schematic

There are **five water storage reservoirs** in the water supply system with a total volume of 11,110 m³ which are further described:

- **Dihovo WTP** (Reservoir 1) with volume of 3,500 m^3 and top water level of 765 masl. This reservoir was constructed in 1983 in concrete and is reported to be in a good condition.
- **Old Filter station** (Reservoir 2) with volume of 600 m^3 and top water level of 695 masl. This reservoir was constructed in 1966 in concrete and is reported to be in a bad condition.
- **Ovci Bair** (Reservoir 3) with volume of 5,000 m^3 and top water level of 666 masl. This reservoir was constructed in 1975 in concrete and is reported to be in a good condition.
- **Bukovski Livadi** (Reservoir 4) with volume of 100 m^3 and top water level of 725 masl. This reservoir was constructed in 2005 in concrete and is reported to be in good condition.
- **Epinal** (Reservoir 5) with volume of 2,000 m^3 and top water level of 725 masl. This reservoir was constructed in 2013 in concrete and is reported to be in a very good condition.

The water distribution system of Bitola is given in Annex 9-3.

The configuration of the terrain in the city of Bitola requires separation of the water supply system in three different pressure zones in order to align the pressures to each consumer.

Low Zone is the largest by volume. This zone encompasses the highest buildings in the city, most of the industrial facilities and about 25 villages that are part of the regional water supply network.

Middle Zone is supplied with water through standstill chamber in the Brusnichko-lavchanski area with volume V = 100 m^3, and the water level at 725 masl. Part of the settlement Bair, settlement Bukovski Livadi as well as the city hospital are supplied through this zone.

High Zone is supplied with water directly from the filter station at elevation 765 masl. The highest point in this zone is at 730 masl and the lowest is at 695 masl. This is the smallest of the three zones, where relatively newer residential areas are located, a significant portion of which are individual houses.

The arrangement of the water supply system to the three zones is shown in figure 2.3 and is described below.

- Reservoir 1 at the Dihovo water treatment plant supplies Reservoir 2 at the Old Filter Station, Reservoir 5 at Epinal and the High Zone in the town.
- The High Zone supplies Reservoir 4 at Bukovski Livadi which supplies the settlement of Bukovski Livadi.
- The Middle Zone is supplied from Reservoir 5 at Epinal.
- Reservoir 2 at the Old Filter Station also receives water from the Middle Zone.
- The Low Zone is supplied from Reservoir 2 at the Old Filter Station.
- Reservoir 3 at Bair floats on the Low Zone and supplies some of the villages.
- The other villages are supplied from the Low Zone.

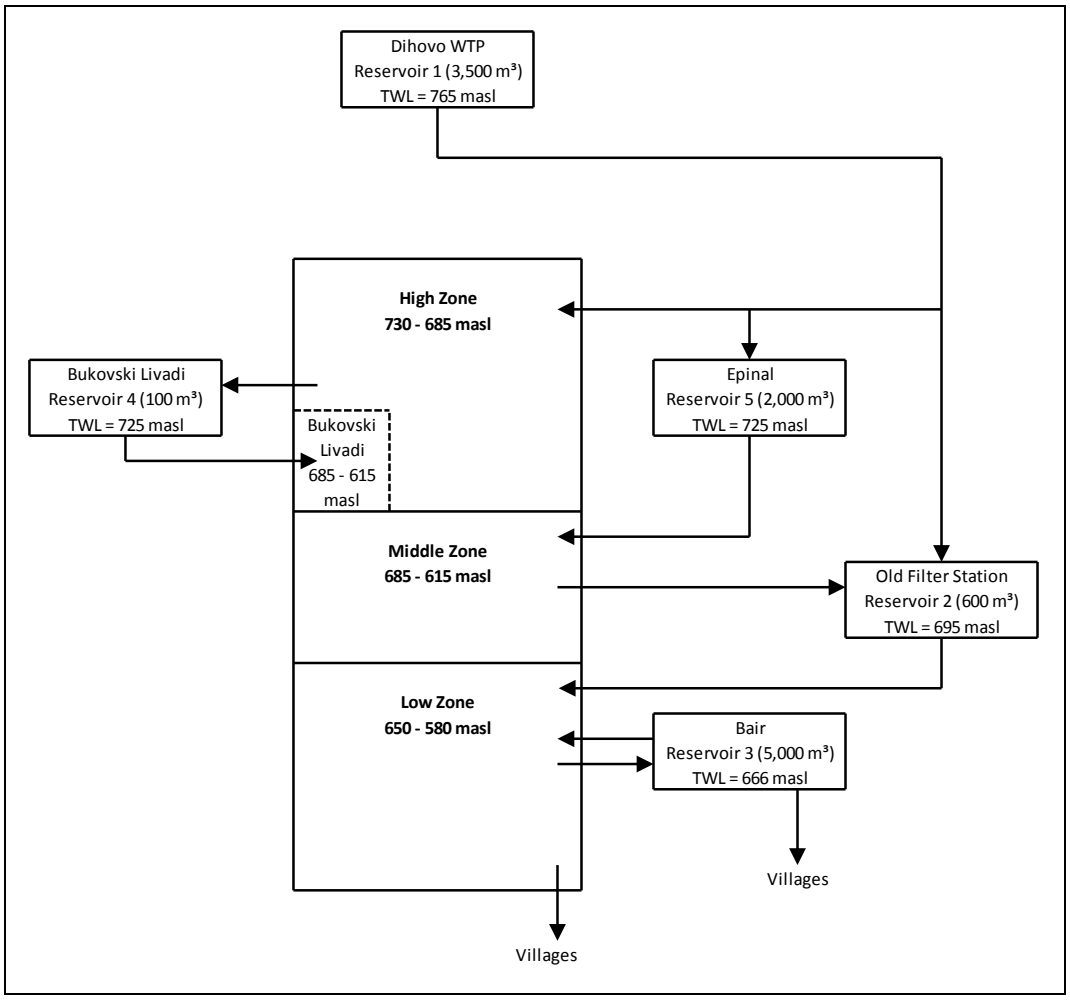


Figure2-14 Water supply to zones

Source: JKP Vodovod

JKP Vodovod Bitola currently supplies water to the city of Bitola and 19 surrounding villages located in Bitola Municipality, 6 settlements in Novaci Municipality and 9 settlements in Mogila Municipality. Details for these villages and their population is presented in the next table:

Table 2-27 Villages in the water distribution network of JKP Vodovod Bitola

SETTLEMENT	POPULATION (2002 CENSUS)
Bitola Municipality	
Bitola	74,550
Crnobuki	406
Dolno Orizari	1,834
Dragozani	156
Gorno Orizari	2,454
Karamani	337
Kravari	880
Kremenica	134

Krklino	611
Kukurechani	966
Lazec	302
Logovardi	699
Medgitlija	155
Novo Zmirnovo	41
Optichari	317
Poeshevo	272
Sredno Eri	299
Trn	113
Zabeni	178
Novaci Municipality	
Dalbegovci	178
Dobromiro	345
Germijan	257
Gneotino	32
Novaci	1,283
Ribarci	130
Mogila Municipality	
Alinci	57
Budakovo	248
Dedebalci	288
Dobrushevo	624
Dolno Charlija	198
Gorna Charlija	3
Mogila	1,526
Radobor	145
Trap	175
TOTAL	**90,193**

An overview scheme of Bitola water supply system to villages is given as Annex 9-4.

Existing pipelines

The water distribution network is made up of a variety of materials including:

- Cast iron
- Steel
- Polyethylene (PE)
- Asbestos cement (AC)
- Polyvinyl (PVC)

The primary network in Bitola has a total length of 17.1 km from which 15.6 km are steel pipes and 1.5 km are cast iron pipes as given in Table 2-28 bellow:

Table 2-28 Existing primary network

Pipe diameter (mm)	Total length (km)	Pipe material	Length, km per age group / Age			
			0-20	21-40	41-70	> 70
800	2.0	Steel		2.0		
600	1.5	Cast iron		1.5		
700	2.6	Steel		2.6		
600	6.0	Steel		6.0		
400	5.0	Steel		5.0		

Source: JKP Vodovod Bitola, year 2013

Distribution pipes are those that are in public streets and other areas up to the customers' property boundaries. Customer service connection pipes are owned by the customers but maintained by JKP Vodovod Bitola and are located between the distribution network and the water meter of the customer.

A breakdown of the distribution network by pipe material, diameter and length is given in the following table:

Table 2-29 Breakdown of water distribution network of JKP Bitola

Diameter of pipe	Pipe Material and length in m				
	Cast iron	Asbestos cement	Steel	PE	PVC
50			349	1,752	2,426
65	2,884	1,552		240	8,406
80	8,453	7,997	796	5,777	36,995
100	1,414	13,261	197	4,561	35,089
125	1,208	852			
150	1,754	14,482	660	2,222	30,193
200	2,468	5,219		5,074	7,967
250		4,660			7,669
300	3,006	6,102	23		8,045
350	775	934	380		

400	1,913		11,214		
500	2,616		3,356		
600	8,550		7,040		
800	1,748		2,222		
Totals	36,789	55,059	26,237	19,626	136,790
Total all	**274,501**				

Source: JKP Vodovod Bitola, year 2013

The distribution network is made up of some 274.5 km of pipeline, ranging in diameter from 50 mm to 800 mm.

Availability of pipes in Macedonia

Most of the pipes used on the existing system originate from factories within the old Federation of Yugoslavia.

Galvanised pipes are manufactured locally to international standards in the pipe factory at Kumanovo. Pipes up to 80 mm in diameter are manufactured.

Steel pipes (200 mm to 1,600 mm) are manufactured in Kumanovo to API, DIN and ISO standards. Various corrosion protections systems such as protective coating and cathode protection are also available.

Asbestos cement pipes used to come from a factory in Slovenia, which does not manufacture asbestos cement pipe any more.

Cast iron pipes used to be imported from Sarajevo in Bosnia, but the factory was destroyed during the war.

Limited quantities of PVC, PE and PP pipes are manufactured locally in Prilep and Gevgelia, Size manufactured up to 200 mm are available.

Valves and fittings are again mostly from Croatia and Serbia, and increasingly from Germany and Austria.

Metering

It has been reported that all customers connected to the water supply network of JKP Bitola are metered.

The water utility owns the service connections in the system up to the meter installation point and the water meter as well. The owner pays for the water meter at the first installation and now the utility changes the meters every 5 years in accordance with Macedonian law.

Combined water meters are installed at high consumer's premises to avoid high inaccuracies at low flows.

Meters are read at least 3 times a year and bills are issued on a monthly basis. Meter reading takes place mainly manually, but in 2013 hand held computers were introduced. There are a considerable number of unread meters, which is due to defects and installation in inaccessible places.

Consumer connections

Introduction

There are about 37,700 service connections in Bitola, of which about 3,000 are for commercial, industrial and institutional customers. The data received from JKP “Vodovod Bitola” regarding the number of consumers per category for the period 2011 – 2013 is presented in the following table:

Table 2-30 Reference for number of consumers on the served area by JKP Vodovod Bitola

Type of services	Number of consumers		
	2011	2012	2013
Water			
Domestic	33,843	34,154	34,577
Industry	2,580	2,650	2,710
Budget organization	298	326	369
Other			
Total:	36,721	37,130	37,656

Source: data from Questionnaire from JKP

A potential customer requires permission from the Municipality for any residential, commercial or industrial development and as part of the process access to utility services such as electricity, solid waste collection and water supply have to be approved. The utilities are consulted as required on the feasibility of the supply.

Once this development application has been approved and the customer has paid the required utility tax he can request a service connection from the water enterprise. The customer has to arrange and pay for the construction of the pipe including the water meter from his building to the edge of his property. The water enterprise will supervise the construction of the service pipe within the property of the customer and carry out the installation of the water meter either inside the building or in a meter pit close to the building.

The pipe becomes the property of the water enterprise and the company is responsible for maintenance of the whole service connection up to and including the watermeter. For apartments there is usually an additional meter for the apartment block, which is used as a control meter to check the measurements of the individual apartment meters.

Service connection pipes

It is becoming common practise in Europe to replace consumer connection pipes with polyethylene pipe although in other parts of the world stainless steel pipe has also been used because of possible damage to plastic pipes. It is therefore proposed that polyethylene pipe is used for service connections on this project. These pipes are fairly flexible and can therefore be easily threaded between other services. The material is resistant to corrosion and many harmful chemicals but presence of hydrocarbons and some organic products can damage the pipe. Fittings for connection to household plumbing are easily available and are not complicated to install.

Consumer water meters

All customers are legally obliged to have a water meter in order to have a house connection. Individual houses usually have a single water meter installed on the property. Apartments on the other hand may have up to 3 domestic meters, installed depending on the internal arrangement. The water enterprise is in charge of meter maintenance and is required to remove, test and recalibrate the meter every five years. Should any repair be necessary the water enterprise will repair the meter and charge the customer for the repairs. Water meters used are mostly imported from countries of the former Yugoslav republic such as Serbia, Slovenia and Croatia. Other domestic water meters from Western Europe are gradually being accepted by the water companies as the availability of spare parts for such meters is becoming better.

The actual number of water meters in Bitola as per the data provided by JKP “Vodovod” for year 2013 is 37,656 from which 34,577 are household connections 2,701 industry and 369 budget organizations.

Meters are optimally read at monthly intervals, or several times per year (at least three times) and estimates are made when access to the meter is not possible or there is a blockage.

Internal domestic plumbing

To provide a complete picture of the water supply situation a short description of the internal plumbing within customer's premises is provided below.

Pipes

Water supply pipes tend to be of galvanised steel, which is also used for the heating pipe system. For drainage, cast iron pipes have been used in the past, but for new constructions PVC pipes are used.

Taps and fittings

Taps and fittings are also imported from Serbia, Slovenia and Croatia but imports from Germany, Italy and Spain are also available on the local market. The quality of fittings from countries of the former Yugoslavia is reported to be good.

Other water users

There also exist other uses of water for which flows are either not measured or measured but not billed and which include the following:

- cleaning water mains;
- public fountains;
- street washing;
- market washing;
- watering green areas;
- Fire fighting.

As mentioned above meters have also been installed on all public utilities and places, like fountains, irrigation of parks etc to meter the consumption of these installations although they are not billed, but the amount of water is reflected in the water balance.

Fire fighting regulations

Water distribution systems must be equipped with fire hydrants in accordance with the Fire Regulations as published in the Official Gazette of RM no. 31/2006.

Fire hydrants need to be provided at a maximum spacing of 150 m and each must have a maximum capacity of 5 l/s. The minimum diameter of pipe to be provided is 80 m for a single hydrant and 100 mm generally. The requirements pressure at each hydrant is 2.5 bar.

The water distribution system of Bitola is equipped with fire hydrants however not all of the above requirements are met.

Operation and maintenance

Level of service

Customer satisfaction is an important factor for the successful management of the water enterprise. It is nowadays usual to measure the level of service provided to customers through indicators for water quality, availability of supply, and pressure. In Western Europe and America It is also usual to measure the degree of response by the company to customers' requests for services, whether request for service connection or for enquiries on water bills.

JKP Vodovod and JP Strzevo as well as the Public Heath Institutes regularly carry out full tests on the raw water and potable water after treatment. The treated water test results are all within the standards required in Macedonia for drinking water.

Non-Revenue Water (NRW)

Definition

Non-Revenue Water (NRW) is defined as the difference between the volume of water entering the system ('production') and the volume of water sold ('consumption'). NRW thus comprises the following:

- errors in measurement;
- estimates of unmetered use of water;
- Leakage in the water distribution system.

The first two components are essential to determine as accurately as possible the amount of leakage in the system. Once the amount of leakage is known, the level of leakage needs to be controlled.

Errors in measurement include the following:

- inaccurate measurement of the amount of water entering the distribution system;
- faulty or incorrectly celebrated (e.g. over-registering) production meters;
- faulty customer meters;
- under-registration by customers meters;
- Inaccurate estimate of water sales in cases where the water meters are not operational.

Estimates are necessary for all unmetered consumption, which includes the following:

- operational use, e.g. flushing of mains, cleaning of service reservoirs;
- losses from known bursts;
- legal unmetered use of water e.g. public fountains, fire and park hydrants;
- illegal consumption;
- unavailable or blocked production meters;
- blocked consumers meters;
- unmetered consumers.

The volume of leakage from a system can only be assessed after the estimates are made of the unmetered water and the measurement errors. These estimates are very difficult to make and can be very inaccurate. However, if the amount estimated is large for a particular item it is usual to install a meter – if only on a temporary basis – to find out the real amount used, or in case of domestic consumption estimates replace the meter.

However, in practice NRW – the majority of which in other countries is usually leakage (real losses), but may include a substantial volume of 'illegal' consumption (apparent losses) – should be between 15% and 20% for a water supply distribution system that is well designed, maintained and operated.

The analysis need to be looked at with care because of the problems of measurement already outlined in the previous sections.

Bitola is a fairly compact town with a high housing density. This should allow losses caused by bursts and leaks to be repaired relatively quickly.

Intervention of the water distribution system

Analysis of the number of repairs carried out on the distribution system is a good indication of the quality of the system and with appropriate system can provide pointers towards the problems noted on the system. With respect to the water supply network of JKP Bitola, the age and condition of some of the pipes are the main cause of frequent defects and water losses in the water distribution network. Replacement of these pipes will assist in reducing real water losses. Replacement of defective galvanised iron and steel service connections will also contribute substantially in reducing real water losses.

The numbers of reported **defects on the transmission mains** in the years 2010 to 2013:

- 2010 - 600 defects
- 2011 - 725 defects
- 2012 - 1,034 defects
- 2013 - 837 defects

Table 2-31 Number of defects in distribution network for year 2013

Pipe diameter (mm)	Pipe material				Total
	CI	PE	PVC	AC	
65				106	106
75		1	31		32
80		19	86	24	129
90		13			13
100		9	23	6	38
150		9	34	9	52
200		31	37	7	75
300	17				17
400	11				11
500	4				4
Total	**32**	**82**	**211**	**152**	**477**

Source: JKP Vodovod Bitola

Table 2-32 Number of defects in service connection pipes by material and size for year 2013

Diameter	Galvanized iron pipes
1/2”	35
3/4”	81
1”	42
1 1/4”	21
1 1/2”	22
2”	34
Total	**235**

Source: JKP Vodovod Bitola

Table 2-33 Number of breaks/leaks in service connection pipes by material and year

Year	Steel	Cast iron	Galvanized iron	PE	PVC	Other	Total defects / leaks
2009							527
2010							559
2011	1	19	210	11	124	91	456
2012	1	21	319	17	133	52	542
2013	2	16	235	23	154	55	585

Source: JKP Vodovod Bitola

Table 2-34 Streets with the largest numbers of defects for year 2013

Street	Total number of defects
Kiril Pejcinovik	12
Stipska	7
Kosta Abrasevik	4
Straso Pindzur	10
Total	**33**

Source: JKP Vodovod Bitola

Flow monitoring

The most important factor in achieving any progress towards water efficiency is better measuring and estimating tools to calculate total water input and sales.

Measurements of flow at the following levels in the water supply system are deemed essential to completely monitoring the system:

- raw water pipes
- production pipes
- services reservoir entry
- service reservoir exit
- pressure zone entry
- district level

The first two measurements are important for monitoring the operating performance of the water treatment plant to ensure that wastage during the purification process is not excessive.

Measurements at the inlets to reservoirs help to identify losses on the bulk transmission mains especially if the mains are particularly long.

Measurements at service reservoir exit and pressure zone entries are necessary to understand the behaviour of each pressure zone. Such zones can be large, depending on the overall size of the distribution system and the geography of the supply zone.

At a more detailed level small districts can be created whereby flows in and out of the district can be measured. In past years such districts have been relatively large, with about 5,000-10,000 customers per district. However, with the better availability of electronic measuring devices, district sizes have been reduced. It is now common to have districts with about 1,000 customers and sometimes with only 500 customers. This type of monitoring is often called ‘district metering’.

As discussed above there are various levels of measurement of zone flows and in general more accurate measurements can be achieved with more flow measurement zones and districts. On the other hand more flow measurement zones means a more complex distribution system, more equipment to maintain and more data to analyse.

The boundaries between the zones being monitored should be made watertight for the measurements to be meaningful.

Leakage control

As soon as the level of leakage in the distribution system is determined the water enterprise can start preparing a programme for leakage control, which can be divided into three areas:

- pressure control
- leakage analysis
- leakage detection

The main perception of leakage control is to control the pressure, measure leaks and then find and repair them. Measuring leakage as accurately as possible will happen with proper implementation of a flow monitoring strategy. As more experience is gained on flow monitoring and the interpretation of the collected data the measurement of leakage will become more and more accurate.

Pressure control

Reduction of leakage by controlling pressure in the distribution system is the first step in any leakage control strategy. As stated previously flows leaks are directly related to the pressure in the system and since leaks cannot be completely eliminated lower pressure will bring the benefit of lower leakage flows.

Pressure is either permanently reduced in the pressure zone or pressure in the system is adjusted on an hourly basis of the required level of service.

Permanent pressure reduction can be achieved by rearrangement of the distribution system, introducing new service reservoirs of pressure reducing valves. The new rearrangement will have to be compatible with the level of service for pressure dictated in the statutes of the water enterprise. A full study of the distribution system will be required to carry out such a rearrangement.

Small areas within the main pressure zone can have high static pressure. It would be beneficial for such areas to be served via a pressure-reducing valve. However, the pressure reduction may be too severe for peak periods when flow and head losses in the pipe are high. The developed modulating pressure reducing valve serves such a situation. This device modulates its own immediate downstream pressure to maintain a fixed pressure at a point further in the distribution system. This is particularly useful for areas with high demand that are at the end of a long pipe and have a high static head.

Another method often adopted is to install a pressure-reducing valve that is only operational after the peak periods of the day. This valve is often installed on a bypass with electrically operated valve activated either on a timer or from a centralised control room.

Leakage analyses

The measurement of leakage depends on the measurement of the inflows into a zone and the consumption of the zone. By the installation of bulk meters and electronic loggers on a zone it is possible to measure the flows into the zone for every hour of the day.

Consumption is usually calculated from the meter readings and estimates carried out at monthly intervals. The volumes thus measured monthly may therefore have to be adjusted to take the different meter reading intervals into account.

Other unmeasured consumption also needs to be estimated. After allowing for these adjustments monthly losses of water can be calculated and monitored monthly.

A more useful measurement of leakage is measurement of night flows especially into small districts. This is more easily carried out when the distribution system has been rearranged for district metering and the night activates of the district can be closely observed.

With district metering night flows are continuously recorded for each district and compared against previously measured minima to produce the absolute minimum ‘’night line’’ flow, which should be mostly leakage and some legitimate night use. The legitimate night use can be determined by appropriate surveys of the customers to determine legitimate night usages of water.

In a relatively large pressure zone, the measurement of night flows is also important, especially in periods when industries are not working and night flow consists mainly of leakage.

Leakage measurement requires the collection and analysis of a large amount of data, which increases with the number of zones of districts to be monitored. However, there are benefits to be gained from increasing the number of districts.

As the number of leakage control districts increase, the districts with higher than average levels of leakage can be identified districts and maximum efforts can be directly into those districts to obtain the best results.

Most of the calculation required for the analyses of leakage can be carried out using a commercial spread sheet. This is sufficient for a relatively small system such as Bitola but on large system

software dedicated to carrying out such calculations has been developed by some water enterprises for their own use.

Leakage detection

Leakage detection is the "art" of finding leaks on the basis of the noise that is emitted by all leaks. It needs a trained operator to find the leaks and once trained the operator needs to use his own initiative to gain more experience on the equipment available to use it to the most advantage.

These are four types of equipment for leakage detection:

- listening sticks
- electronic acoustic amplifiers
- correlators
- leak noise loggers

Listening sticks are metal or timber rods terminating in a device which can be placed directly against the ear to allow the operator to listen the noise transmitted from the pipe.

An electronic acoustic amplifier increases the intensity of the noise picked up from the pipe via a rod in direct contact with the pipe or other equipment connected to the pipe. A ground microphone can also be used to pick up the leak noise transmitted along the pipe. The device also includes electronic filters that remove noise of certain frequencies that are not normally associated with leaks from pipes. The frequency of the noise produced by the leak depends on the pipe material and the ground in which the pipe is buried. The amplified sound is directed to earphones that will permit the operator to identify any potential leaks.

A correlate is similar to the electronic acoustic amplifier except that the device is used to compare the noise picked up at two points of up to 200 m apart. Filters are also provided in the device to screen out unwanted noise. The computer integrated in the equipment analyses the noise from the two sources and through a process of correlation calculates noise intensity at points along the length of the pipe and displays the graph on a screen viewing. This allows the operator to survey very rapidly a length of pipe for a potential without having to walk up and down the length of the pipe with a listening device. Once a potential leak has been located the electronic acoustic device can be used to confirm the location of the leak, which can be on a branch off the main pipe.

Leak noise loggers are noise recorders, usually installed in groups in an area where leaks are suspected, and which record the noise level over the area. Examination of the recorded noise will indicate the likelihood of a leak in the area under investigation. Further investigation using one of the above mentioned equipment will be required to identify the location of the leak more precisely.

An experienced operator sometimes uses all four devices to confirm the presence of a leak because he will have gained experience of all four in the course of his duties. A natural sound without amplification can sometimes be picked up by a trained ear but can be distorted by amplification or filtered out by the equipment.

Existing leakage control

The existing leakage control is established through a monitoring system (SCADA) and installed monitoring points for water flow and pressure in the water supply system. The main control station is located at the Dihovo water treatment plant. The established system enables monitoring of the water flow at and pressure nearly throughout the system. There are three pressure zones in Bitola. All zones are monitored by the SCADA system.

Besides the monitoring of the water flows with the SCADA system, JKP Vodovod owns some leak detection equipment but this is not used.

JKP Vodovod Bitola does not have leakage detection and repair strategy although it owns leak detection and pipe tracing equipment and relies on customers' reports on visible leakages and insufficient water quantities and water pressure.

The SCADA system has partially been upgraded under the Water and Sewerage Programme financed by KfW with the implementation period 2012 – 2014. During Phase I of the project, the SCADA system was upgraded and an additional four pressure regulators (needle valves) and five flow meters were

installed and connected to the SCADA system. 91 customers were equipped with combined mechanical water meters.

Proactive leak detection is required to detect the underground leakages in the transmission and distribution systems, including the service connections. The overall performance of the water network will improve considerable through a planned proactive leak detection programme, investments in pipe renewal or rehabilitation and further pressure reduction. This activity will also assure and define the baseline for the amount of leakage in the three pressure zones and will be used for monitoring purposes.

Due to this, under Phase II of the aforementioned "Water and Sewerage Programme" financed by KfW further investments needs in the SCADA system have been identified:

- Automatization of the filter backwashing currently controlled manually and its connection to the existing SCADA system or to be visualised by new software;
- Pressure and flow measurement installations - Chamber, pipework, fittings and equipment;
- Supply and installation of 6 SCADA substations.

The water losses in the water supply system are shown through the correlation of the procured purified water from the DWTP and the invoiced water towards end users (Shown in details in Chapter 3.3).

Main issues and conclusions

Resource and Water Treatment

It is reported that the resources of raw water are sufficient for the served area of JKP "Vodovod". However reconstruction of the two intakes is required.

The water treatment facilities have sufficient capacity for the demand required during the horizon year of this project. However, some rehabilitation is required to improve the present condition of the plant. This envisages construction and equipping of settling tanks and automation of filter washing and general refurbishment. Construction of disinfection stations for 6 villages is also needed.

Water distribution system

- The transmission main from Dovledzik pump station to Dihovo water treatment plant is reported to be in poor condition and needs to be replaced
- The age and diameter of the pipes in the distribution system are the main constraint on the effective distribution of water and are the main cause for loss of supply for long periods of the daylight hours. These pipes need to be replaced.
- Asbestos cement pipes need to be replaced.
- There is very little monitoring of flows in the distribution system to effectively identify leakage. There is no active leakage detection carried out at the moment.

Service connection

The service connections were mostly made of galvanized pipes, which created problems with corrosion on these pipes. These pipes need to be replaced.

2.7.2. Sewerage Network

About 30% of the City of Bitola has a separate storm water and wastewater collection system whilst the rest has a combined system and the waters of the system are gravitationally discharged in the recipient River Dragor and 5th Cannel. The discharge of untreated wastewater into the Dragor River and 5h Cannel is having serious detrimental environmental effects for about 100 km of the Crna River downstream of Bitola.
Since most of the city's sewer system is a combined system the peak flows during rainy weather are much higher (10 times and more) than the maximum flows during dry weather.

Picture 2-3 River Dragor (city of Bitola)

The sewage network of Bitola city consists of 13 main collectors with a length of approximately 21 km in which the proper secondary channels are connected. The collectors are mainly constructed from concrete, reinforced concrete or Asbestos Cement with diameter ranging from 500 -1,500 mm. These collectors are mainly discharged in River Dragor and 5th Channel from one of the 10 existing outlets.

An overview of the main collectors, their location, length, diameter, material and discharging point are shown in the table below.

Table 2-35 Main Collectors in Bitola

No.	Description of collectors	Location	Discharge point	Type of Sewerage			Length (m)	Pipe diameter (mm)					
			Outlet No.	Waste water	Storm water	Combined		Reinforced concrete	Concrete pipe	AC	Egg-shaped reinforced concrete	PE pipes	Concrete channels
1	Collector K0	"Bukovski Livadi" residential area	**1**			✓	1,900			500 - 800			
2	Collector K1	Industrial zone	**2**			✓	2,900	700 – 1,200					
3	Collector K2	Partizanska street to Borimecka residential area	**3**			✓	3,000	800 – 1,000		500 - 800			
4	Collector K3	Zheleznichka street, along Partizanska street to Sever i Jug str.	**4**			✓	2,000	800 – 1,500					
5	Collector K4	Kaftandzica	**5**			✓	1,500	1,200					2,000x1 500
6	Collector K5	Gorno Orizari	**7**			✓	1,00			600			
7	Storm water collector	Vasko Karangelevski street	**9**		✓		950	500 – 1,000					
8	Collector Jenimaale 2del	.Jenimaale 2 part residential area	**10**			✓	220	1,000					
9	Collector Ivan Milutinovic street	Ivan Milutinovik street, along Boulevard 1vi Maj to Crn most	**5**			✓	2,00		500 - 800		1,200/800		
10	Collector Prilepska street	Prilepska street to Zhikica Jovanovic-Shpanac street	**5**			✓	750		500		800/600		
11	Collector Zheleznichka street	Zheeleznicka street to Dame Gruev street	**5**			✓	800	800 – 1,000					
12	Collector Boris Kidrich street	residential area Karposh, along Boris Kidric street, .Stolarskastreet and Boulevard 1vi Maj	**4**			✓	2,400	600 – 1,000					
13	Collector for M5 regional road	Road to new Graveyard	new outlet		✓		1,300					500 - 630	

As aforementioned there are ten main discharge points. The wastewater from City of Bitola is discharged in eight of them, while two are used for the sewerage network discharge of two neighbouring villages (dolno Orizari and Kukurechani).

Detailed overview of the outlets, their location, pipe diameter, recipient and similar are shown in the tables and figures provided bellow:

Table 2-36 Main Outlets in Bitola

Outlet No.	Collector	diameter (mm)	recipient	remark
1	Collector K0	800	5th Channel, river Crna	
2	Collector K1	1,200	5th Channel, river Crna	
3	Collector K2	1,000	River Dragor, River Crna	
4	Collector K3	1,000	River Dragor, River Crna	
5	Collector K4	2F1,200	River Dragor, River Crna	
6	Collector v. Dolno Orizari	400	River Dragor, River Crna	combined sewerage network from v. Dolno Orizari
7	Collector K5	600	River Dragor, River Crna	
8	Collector v. Kukurechani	300	River Dragor, River Crna	
9	Collector for storm water at V. Karangelevski street	1,000	River Dragor, River Crna	faecal sewerage network of Village Kukurechani
10	Collector Jenimaale 2del	1,000	River Dragor, River Crna	

Picture 2-4 – ***Outlet No.1*** – *Recipient 5th* Channel

Picture 2-5 - Outlet No.2 - – *Recipient 5th* Channel

Picture 2-6 – Outlet No.3 – *Covered part of the river bad of River Kurderes*

Picture 2-7 – Outlet No.4 *– Recipient River Dragor (near Stopanski Dvor – JKP Niskogradba)*

Picture 2-8 – Outlet No.5 – *Recipient River Dragor near bridge on the Regional Road Bitola - Novaci*

Picture 2-9 – Outlet No.6 – *Recipient River Dragor near bridge on the Local Road Dolno Orizari - Karamani*

Picture 2-10 – Outlet No.7 – *Recipient Channel going to River Dragor near Concrete Base Stenton*

Picture 2-11 – Outlet No.8 – *from WWTP in v. Kukurechani in channel going to River Dragor*

Picture 2.12 – Outlet No.9 – *of storm water sewer in River Dragor near HQ of JKP Niskogradba*

Picture 2.13 – Outlet No.7 – *Flow of River Kurderes in River Dragor near Bridge on road Industriski pat*

Map 2-8 Overview map of location of Outlets in Bitola Municipality

It is reported that approx.. 99% of the City of Bitola is covered with sewerage network. The length of pipes for sewage is approximately **180 km.**

Most common used materials:

- Asbestos cement: 120 km
- Concrete and Reinforced concrete: 25 km
- PVC: 20 km
- Polyethylene: 15 km

Table 2-37 Existing Sewerage Network in Bitola

Material of pipe	Length (km)	Diameter (mm)	Year of construction
Asbestos Cement	120	200 250 300 350 400 450 500 600 800 1,000	1975-1997
Concrete and Reinforced concrete	25	250 300 400 500 600 700 800 1,000 1,200 1,500 egg-shaped 800/600 egg-shaped 1,200/800	1955- to today (constructed in different periods as per the needs)
PVC	20	200 250 300 350 400 500	1995-2010
Polyethylene	15	200 250	2008-to today

		300	
		400	
		500	
		600	
		800	

Bitola wastewater collection system is presented as Annex 9-5.

Concerning the villages included in the defined agglomeration the situation is as follows:

Gorno Orizari:
- 90% constructed sewerage network served by JKP Niskogradba

Kravari:
- 95% of constructed sewerage network

Dolno Orizari:
- 90% constructed sewerage network served by JKP Niskogradba. A project design has been preformed for construction of the remaining 10%.

Bukovo:
- No sewerage network. Existing project design.

Karamani:
- No sewerage network. No project documentation has been prepared.

Lavci:
- No sewerage network. No project documentation has been prepared.

Brustnik:
- No sewerage network. No project documentation has been prepared.

An assessment of the wastewater system for Bitola has been done and the following aspects have been covered as part of Master planning:

- The wastewater collection and treatment system:
  - Current wastewater production from both domestic and non-domestic sources, with special attention for industrial wastewater characteristics;
  - Set-up of the existing sewer system;
  - Options for wastewater treatment
- Expected flows and pollution loads
- The proposed wastewater treatment plant
- O&M costs, for sewerage as well as wastewater treatment
- Main issues and conclusions, as well as risks pertaining to the current situation

System operation

The main structural problems reported with the sewer system in Bitola refer to the combined sewer and storm water network, which creates problems with overflowing during heavy rainfalls especially in the winter period. Problems were reported at some of the sewer outlets discharging in river Dragor. Due to the fact that these outlets were constructed at lower level, during heavy rains, the level of the river rises above the level of the outlet, which prevents the discharge of the wastewater into the river and it returns it back into the system thus surcharging the sewerage system and also depositing a large amount of debris. As a result there are frequent blockages and overflows registered at few points. Another problem is the age of the pipes constructed in different period, some of which are more than 50 years old.

Due to this investment in replacement of the old pipes (asbestos cement, concrete and reinforced concrete pipes) are suggests (refer to chapter 4.3.2.1 and 4.3.3.1.) as well as investments in separate

storm water system for parts of the city, which would eventually reduce the load of the existing sewer system.

It has been reported that JKP Niskogradba does not maintain regular and systematic evidence of the defects of the sewerage system and does not possess accurate data on the number and type of defects occurring in the sewerage system.

Flow measurement

There is no flow measurement on the wastewater system. Flow measurements are required to ensure that excessive storm water is not reaching the sewerage system. This monitoring will provide the opportunity to resolve the problem before allowing it to become worse.

Asbestos cement

Asbestos cement pipes make up most of the sewerage system in Bitola. These pipes suffer from corrosion as a result of the production of hydrogen sulphide gas in the sewers should sewage be allowed to become septic in the system through stagnation. The high summer temperature that can be reached in Bitola can cause this condition to be reached within a few hours. The hydrogen sulphide will dissolve in condensation on the walls and roof of the pipe to produce sulphuric acid, which will corrode the cement in the pipe.

Because of the known carcinogens potential of asbestos fibres asbestos cement pipes are not the favoured material used for any pipes. Manufacturers and installers are finding that the precautions required to protect workers from the fibres together with the potential litigations are very expensive and therefore this material is now hardly used.

Proposed sewer material

For the reasons given above, it is not recommended to use asbestos cement pipes for the future sewer network. For the smaller diameters PVC is proposed, and concrete can be used for the larger diameters. PE pipes are also in use in Macedonia but the Consultant does recomed their use due to experience that those get oval during the explotation period. An important factor to consider during construction is the importance of ensuring that the quality of the pipe and of the type of joint used are of the highest quality, to prevent leakage or infiltration.

2.7.3. Wastewater treatment

Currently there is no wastewater treatment plant operational in Municipality of Bitola. The domestic and industrial wastewater is discharging directly into 5th Channel and River Dragor, tributaries of the Crna River. Crna River is a tributary of the Vardar River, which as Transboundary River flows out of Macedonian territory and enters Greece and flows through Greece until it reaches the Aegean Sea.

During the course of preparation of this document the location of the future WWTP has been discussed with the Municipal representatives and several alternatives were reviewed in terms of space and functionality. Finally it has been confirmed that the future WWTP will be located north of Bitola at the distance of approx. 2 km from City of Bitola. The location is situated near the new graveyards, between villages Dolno and Gorno Orizari on cadastre parcel No. 25, KO Bitola 5. The site is in the property of Republic of Macedonia (Property list No.17) and the surface is 51 ha.

The distance to the closest populated places of approximately 0.6 km prevents from odour nuisance even under unfavourable meteorological conditions (refer to Maps 2.9 and 2.10).

The space intended for construction of the wastewater treatment plant covers surface of approx. 10 ha.

In the nearest vicinity of the location runs river Dragor.

Map 2-9 Location of proposed WWTP Bitola

Map 2-10 Location of proposed WWTP Bitola – satellite image

For the proposed location access to the following communal infrastructure will be provided:

- Access road
- Water supplying installation
- Supplying channel
- Electrical power
- Gas pipeline

It is proposed that the access to the future WWTP will be provided by a new asphalt road with a length of approx. 770 m, connecting the site of the WWTP with the existing road str. ”Prilepska” (leads to the cemetery).

The overall territory of the Bitola region is covered with an electricity network and connection to the WWTP will not pose any problem.

Wastewater treatment facilities for the industry

The available information reveals[5] that there are no existing wastewater treatment facilities for industrial companies. It is noteworthy that the amount of recycling process water within the industries is small because of the old type of technologies in use. The water used for washing and transport of sugar beet in the sugar factory is recycled, but the system is old and rather inefficient. When water is too polluted for usage it is discharged, via sedimentation tank to the Channel V. The sediment is used for fertilizing the public green areas of Bitola.

The wastewater from industry is discharged without pre-treatment either to the Channel V or into the Dragor River.

2.8. Present Water Consumption

The major potable water consumers in the service area of JKP "Vodovod" are the households or domestic users, industrial consumers, budget organisations and others such as schools, hospitals, hotels, etc. Data for the invoiced potable water to different consumers during a period of 5 years between 2009 – 2013 was submitted by the JKP "Vodovod".

2.8.1. Potable Water Consumption

Domestic Water Consumption

As per the data provided the current connection rate in the service area of JKP "Vodovod" is 99%. According to data from JKP "Vodovod", the average present net domestic water consumption is about 147 litres per capita per day (l/c/d) for the year 2013. This figure excludes small enterprises (shops and other minor commercial enterprises), and apparent losses due to metering inaccuracies in apartments.

There are around 369 "institutional" consumers supplied by JKP Vodovod. In recent years institutional water demand met by JKP Vodovod is almost the same.

Industrial and Commercial Water Consumption

Bitola Municipality has a relatively developed industry - there are a lot of factories around Bitola. Most of the factories use water in production processes. The majority of the industrial enterprises are connected to the existing water supply system. Only few have their own water resources which are used mainly for process water. Some factories use water from Lake Strezavo.

There are around 2,710 "industrial" consumers supplied by JKP Vodovod. Industrial water demand (including commercial) met by JKP Vodovod decreased from around 1.56 million m^3 in 2009 to 1.24 million m^3 in 2013. The majority of this quantity is consumed by large industries.

Table 2-38 Data about the invoiced potable water for domestic consumption

Items	HISTORICAL DATA				
	2009	2010	2011	2012	2013
Population in the service area, number	91,912	91,576	91,196	90,802	87,275
Domestic Water consumption, m^3/year	4,945,543	4,454,689	4,412,540	4,740,261	4,530,071
Per capita consumption for domestic customers, l/c/day	150.37	135.94	135.21	145.89	145.05

Source: Questionnaire to JKP "Vodovod", data for invoiced water and own calculations

Data about supplied and invoiced water

[5] as well as discussions with Municipal representatives

In the course of the project JKP "Vodovod" provided data for the water supplied for the years 2009, 2010, 2011, 2012, 2013 and 2014, which are further analysed against the invoiced water and water losses in the chapter 2.10. Available information.

2.9. Current Wastewater Volumes

The wastewater volumes discharging to the future wastewater treatment plant depend on the following factors:

- Water consumption from JKP Vodovod;
- Water consumption from Lake Strezavo;
- Infiltration from groundwater.

Since there is no wastewater treatment plant, no data are available for measuring actual volumes of wastewater production.

Water consumption from JKP Vodovod

Water consumption data have been provided by the water supply company JKP Vodovod. The water supply company operates in the town of Bitola and several villages nearby.

The basic potable water consumers in Bitola agglomeration are:

- Domestic consumers
- Institutional consumers (schools, hospitals, public administration etc.),
- Commercial consumers (points of sale, trade, hotel etc.)
- Industrial consumers (enterprises using potable water in their production process and for daily needs).

Water consumption from Lake Strezavo

Lake Strezevo is the main source of technical water supply for Bitola's industry. The great consumers are milk factories, sugar factory, yeast and alcohol factory, etc.

Water consumption from JKP Vodovod, Lake Strezevo and own sources are shown in Annex 9-6.

Infiltration

There are no data available for infiltration into sewers. For preparation of the Feasibility study wastewater measurements will be carried out and a report will be drafted to estimate the quantity of infiltration water. For the purpose of this master plan study, the methodology defined in the German technical guidance – Document ATV/DWA – A128e has been applied. The infiltration discharge in dry weather conditions is determined as follows using a location - specific infiltration discharge rate, which should be between 0.05 and 0.15 l/s/ha, depending on the state of the sewerage network and the level of leakages in the water supply system. Due to the large amount of water losses (48%) which partly will discharge to the sewer network, we apply a rate of 0.12 l/s/ha for the current infiltration rate. The area, covered by sewerage network is 893 ha. Total amount of infiltration is thus 9,259 m^3/day.

2.9.1. Domestic and institutional wastewater volumes

The production of wastewater by the population and related service sector, trade, tourism, education and health facilities is calculated on the basis of water consumption and wastewater generation factor.

The main sources of domestic wastewater are the residential areas and commercial districts. Other important sources include institutions and institutional services -schools, hospitals, local administration, kindergartens etc.

The average domestic wastewater (Qav,d) discharge is based on water consumption, wastewater generation factor and number of population, connected to the sewerage system on the same date. Non-domestic wastewater discharge, comprising discharges from institutional-servicing buildings depends on average time of activity of the considered customer (240 working days). There are around 369 institutional consumers.

No treatment is available for the wastewater of water agglomeration - Bitola town, Gorno Orizari, Dolno Orizari, Kravari, Karamani, Brustnik, Bukovo and Lavci.

There are existing sewers only in Bitola, Gorno Orizari, Dolno Orizari and Kravari. Bukovo and Karamani have projects for construction of sewerage system. Lavci is close to Bitola and half of the main collector to Bitola's sewerage is constructed. Brustnik is as well situated close to Bitola and will be connected to the sewerage system of the town in the future. The sanitation systems used in unconnected villages are cesspits, septic tanks, or direct discharge into the nearest water source.

The domestic and institutional wastewater from Bitola town discharge untreated into Dragor River through main collectors K2, K3, K4 and K5. The domestic wastewater from Gorno Orizari and Dolno Orizari runs to the Dragor through collectors K6 and K7. The domestic wastewater from Kravari runs to the Channel V. The urban sewerage system covers 99% of Bitola town, 90% of Gorno Orizari,95% of Kravari, 90% of Dolno Orizari. Total connection to sewer system in agglomeration area is 96.15%.

Table 2-39Population of the settlements from the agglomeration of Bitola in year 2013

Settlement	Total Population	Connection rate	Population with urban sewer	Population without sewer
Bitola	72,400	99%	71,676	724
Gorno Orizari	4,193	90%	3,774	419
Dolno Orizari	2,684	90%	2,416	268
Kravari	1,492	95%	1,417	75
Bukovo	776	0%	0	776
Karamani	337	0%	0	337
Lavci	338	0%	0	338
Brustnik	241	0%	0	241
Total	**82,461**	**96.15%**	**79,283**	**3,178**

Source: Forecast calculations bases on Census from year 200 and information from Municipality of Bitola

The settlements, served by JKP Vodovod are Bitola town, Gorno Orizari, Dolno Orizari, Kravari, Brustnik and Karamani with total population 81,347.

Wastewater effluent from households and institutional area are based on data for the billed water volume for JKP "Vodovod". The invoiced water quality for household in agglomeration is 4,222,417 m^3/2013 year and for institutional area is 440,005 m^3/2013 year.

In the table below the wastewater effluent from domestic and institutional consumers are shown:

Table 2-40Wastewater effluent flows from domestic and institutional consumers

Item	Unit	Value
Domestic water and wastewater consumption		
Population in agglomeration area, served by JKP "Vodovod"		81,347
Domestic water consumption invoiced by JKP "Vodovod"	m^3/year	4,222,417
Population in agglomeration area (total)		82,461
Population in agglomeration area with sewerage system	96.15%	79,283
Population in agglomeration area without sewerage system	3.85%	3,178
Water consumption p. c.	l/c.day	145.05
Wastewater generation p. c.	l/c.day	130.55

Domestic wastewater to sewer	m³/day	10,350
Institutional water and wastewater consumption		
Institutional water consumption	m³/year	440,005
Institutional water consumption - 240 working days	m³/day	1,833
Institutional wastewater generation – 100%	m³/day	1,833
Total wastewater from domestic and institutional consumers, connected	m³/day	12,183
Infiltration – 0.12l/ha	m³/day	9,259

2.9.2. Industrial and commercial wastewater volumes

General information

There are about 2,710 "industrial" consumers supplied by JKP Vodovod. Over 50% of the industrial wastewater flows emanate from three industries in the Main Industrial Area. Since 1990 industrial activities have declined. Industrial and commercial water demand met by JKP Vodovod for the service area has decreased from about 1.65 million m^3 by 2009 to 1.41 million m^3 by 2013. Most of the major industries are operating on a reduced level. The future of these industries is uncertain and depends largely on the development of new markets and the investment in more modern capital equipment.

In the existing system industrial wastewater is discharged to the Dragor River or either directly or indirectly to Channel V. Industries in the south west area (the Main Industrial Area) discharge their effluent to Channel V by collectors K0 and K1. Industries in other areas discharge their effluents to sewerage systems and ultimately to the Dragor River. Ratio between produsedand invoiced industrial wastewater is 56.23%.

The main industrial polluters are located in the “Main Industrial Zone”. There are two more industrial zones designed and in process of implementation - “Multipurpose industrial zone, KO Bukovo” and “South industrial zone Jabeni” which has own wastewater treatment plant and is not included in the agglomeration. The small industry and commercial enterprises are located in these zones and in the urban part of Bitola.

- **“Main Industrial zone”**

Bigger industrial enterprises are concentrated in “Main Industrial Zone” (sugar factory, yeast and alcohol factory, brewery, dairy factory, etc.).
Sugar factory (4th Novenber)

This is the largest water consuming industry in Bitola.The sugar factory has the capacity to handle about 150,000 tones/year. At present the production is 20,000 tones/year. There has been little increase in agricultural production of sugar beet, and future increases would require investment in new technologies to increase yield levels or expansion of agricultural land. It is therefore considered unlikely to have a significant increase in consumption of raw water in the near future.

The factory processes sugar beet during the 'campaign' which presently lasts for approximately two months in the period September to December and refines raw sugar during the periods January to March and May to July. There are three waste streams from the factory, all of which are discharged to Channel V via lagoons or overland flow:

- Cooling water;
- Settled solids from the wash water used for sugar beet preparation;
- Spent lime and process wastes (mixed with water for pumping).

Cooling water is used during all production periods. The main source of cooling water is Strezevo lake. It is assumed that cooling water will be excluded from future effluent flows to receive treatment.

The wasting of the settled solids from sugar beet wash water only occurs during the autumn campaign and is reported to be at a rate of approximately 55 m^3/h (15 l/s). Thus, in a 60 day sugar beet 'campaign', some 26,400 m^3 of waste water is discharged.

The discharge of spent lime and process waste occurs throughout the refining operations, assumed to be 240 working days per year. The discharge rate is estimated to be 35 m^3/h (10 l/s) giving a total volume of 67,200 m^3 per year.

There is also a 'domestic' wastewater however, that is very small compared to the other waste flows.

Yeast and Alcohol Factory

The Yeast and Alcohol Factory obtains water supplies from JKP Vodovod, Strezevo and their own wells and Channel. The metered consumption from JKP Vodovod and Strezevo in 2013 was 541,886 m^3 but the total water usage was more than twice this amount from own sources for 2013 is 480,000 m^3. Nearly two thirds of water supplied is used as cooling water with the remainder being used in the process for fermentation, dilution of alcohol and washing of yeast. Cooling water is not recycled at present.

In recent years the level of production has increased. It is expected to continue to increase at a moderate rate in the future. All wastewater is discharged to Collector K1, which in turn discharges to Channel V.

Pivara (Brewery)

The factory, which produces both beer and soft drinks, is in receivership and operating at much reduced capacity at present. The production capacity of beer and soft drinks is 75,000 m^3 per year. Water consumption at full capacity could reach 600,000 m^3 per year. Allowing evaporation and other losses, make the potential volume of wastewater to reach 470,000 m^3 per year. Present production is 20,000m^3 beer and 3,000 m^3 soft drinks. The water consumption in 2013 was 19,000 m^3. Wastewater is discharged to Channel V via Collector K1.

IMB Mlekara (dairy products)

At the end of 2007 IMB Mlekara became part of the Dairy Industry Danube Foods Group, or rather part of the Salford investment fund. Mlekara produces a range of dairy products including milk and cheese and also produces some fruit juices. The company's water needs are for production requirements (50% of consumption), cleaning (30%) and employee needs (20%). Production is expected to increase and therefore future expansion is planned. Given the recent operating performance of the company it would be reasonable to assume that consumption levels will continue to increase in future years.

- **“Multipurpose industrial zone, KO Bukovo”**

The industrial zone in Bukovo is designed for light industry, services and storages with area 28.9ha. The working area is 22.3ha from which 40% are built. The complete building of the industrial zone is planned for 2021. Water consumption for this zone is assumed 0.4 l/s.ha for working time 8 hours per day. Total water consumption for 2021 will be 257 m^3/day.

- **Small industries and commercial enterprises**

The rest small industry and commercial enterprises are located in the urban part of Bitola and industrial zones.

These parts comprise mainly small industrial, service and commercial enterprises. In recent years there has been considerable growth in the number of the small commercial, retail and services enterprises. Their main activities are small cafes and restaurants, retail outlets and other service industries such as car repair shops and photocopying offices. In general, these enterprises provide employment for up to ten people.

The most are viable and have a relatively small consumption of water.

Industrial wastewater flows and loads

In order to obtain information on the industrial pollution a questionnaire was prepared which addressed the following main items:

- Type of production
- Annual production volume
- Expected production growth
- Number of workers
- Working days a week
- Shifts per day
- Consumed water quantity
  - From the water supply network
  - From own water sources
- Receiver (sewer, river, local WWTP)
- Type of sewer
  - institutional
  - industrial
  - mixed
  - storm water
- Sewer failures and maintenance problems if any
- Availability of local WWTP
  - Flow Diagram of local WWTP
  - Effect of water treatment
  - State of water treatment
  - Discharge
- Reports from measurements of contamination load in wastewater from the different industries (BOD, SS, N, P, oil, etc.).

In addition, information on the existing industries was asked from the water supply company and the municipality.

During the course of preparation of this document available information from industry has been received. There was no information from measurements of pollution load in wastewater from the different industries.

The quality and quantity of wastewater flows from industries depend on the following factors:

- Water consumption from JKP Vodovod;
- Water consumption from Lake Strezevo;
- Water consumption from own sources;
- Wastewater generation factor;
- Industrial pollution loads.

Water consumption from JKP Vodovod

The water used in industry comes mainly from the water distribution system by JKP 'Vodovod'. The total number of invoices for the “industrial” category is around 2,710 with water consumption 1,346,969 m^3/2013 year of which only 20 is from large industrial enterprises, discharging wastewater with industrial pollution.

Water consumption from Lake Strezevo

In addition to above water consumption several industries in Bitola take their raw water supplies directly from Strezevo. A proportion of this water enters the sewerage system and therefore in sizing the treatment plants consideration must also be given to these industries. The main users of water supplied by Strezevo are sugar factory, milk production, yeast and alcohol factory, tobacco etc. Total industrial water consumption of "raw" water from Strezevo is 922,132 m^3/2013 year.

Water consumption from own sources

Some factories have developed their own resources - yeast and alcohol factory, concrete production and metal factory. Average annual production from the wells is estimated to be around 495,000 m^3/2013 year.

Wastewater generation factor

The wastewater generation factor is depending on the type of industry. For most of industry the wastewater generation factor is accepted 80% and 90%, for cooling water - 0%, for concrete production - 50%.

Industrial pollution loads

Contrary to domestic wastewater, the composition of which, in terms of Biochemical Oxygen Demand (BOD), Nitrogen (N) and Phosphorous (P) is generally known, this is not the case with industrial sewage, which very much depends on the particular type of industry. The pollution of current industry is calculated based on the data from the literature.

The average daily industrial wastewater and BOD_5 loads for 2013 are given in Table 2-41. These projections are based on the data included in Annex 9-7.

Table 2-41Wastewater effluent flow from industry in Bitola in year 2013

Item	Unit	Value
Industrial wastewater flow	m^3/year	737,822
Small industry and commercial wastewater flow	m^3/year	862,338
Industrial and commercial wastewater flow	m^3/year	1,600,159
Industrial and commercial wastewater flow	m^3/d	5,770
BOD load	kg/d	2,333
PE from industry	PE	3,889
Connection rate to sewage	**%**	**56.23%**
Industrial and commercial waste water flow to sewage	m^3/d	3,245
BOD load to sewage	kg/d	1,312
PE from industry to sewage	PE	21,872

Management of industrial water pollution

The critical pollution problems generated by the industries require a specific management to abate the problems.

The combined treatment of industrial wastewater along with the domestic wastewater tends to be advantageous, provided that the former does not contain toxic or persistent substances.

Separate treatment or pre-treatment for industrial wastewater is normally required in cases where it contains toxic substances. The removal of such substances is more efficiently and more economically achieved before the toxic wastes get diluted through their discharge into the sewerage system.

The presence of toxic substances in the sewerage system can be prevented by not allowing new sources to discharge into the system, but the sources already connected to the sewer may remain a problem.

Selective controls should be executed on the discharged industrial wastewater.

The objective of the measures to be taken is first of all, to safeguard the normal functioning of the sewer system and the normal operation of the biological treatment plant, to enable the safe disposal of the produced sludge. The portion of heavy metals and other toxic substances removed by the treatment plant are accumulated in the sludge, often creating serious sludge disposal problems.

Furthermore to protect the receiving water from the portion of toxic substances that is not removed by the treatment plant.

Controls at the source, whenever applicable, tend to have high priority because of their high effectiveness, low cost and ease of implementation.

2.10. Available Information

2.10.1. Input data about the agglomeration

The following input data was submitted by the Municipality of Bitola and JKP "Vodovod" and JKP "Niskogradba" in the process of the Project development:

- Electronic copy for the General Urban Plan for Bitola
- Electronic and hard copy from the Detailed Urban Plan for Industrial Zone KO Bukovo
- Local Development Strategy of Municipality of Bitola for the period 2009- 2014
- Programme for communal waste management 2014- 2016
- LEAP for Bitola 2009-2014
- Electronic copy (DWG file) from the Existing sewerage network of Bitola
- Electronic copy (DWG file) from the main sewer collectors scheme
- Electronic copy (DWG file) from the sewerage outlets in Bitola
- Electronic copy (DWG file) from the Existing Water supply network for Municipality of Bitola
- Electronic copy of EIA for sewerage network of city of Bitola
- Hard copy from the project design for storm and sewerage network for residential area BLR 3
- Hard copy from the project design for storm and sewerage network for residential area BLR 4
- Hard copy from the project design for storm and sewerage network for residential area Strchin
- Hard copy from the project design for sewerage network for village Bukovo
- Hard copy from the project design for sewerage network for village Dolno Orizari
- Electronic copy of the Feasibility Study for Phase II of the Water and Sewerage Programme financed by KfW with the implementation period 2012 – 2014
- Data for the water balance for years 2009 -2014

In addition the consultant has organized surveys as follows which are in progress:

- Topographic survey of the cadastre parcels where the location of the future WWTP is planned
- Geodetic survey and measurement of selected number of manholes within the sewerage network of City of Bitola
- Measurement of waste water flow and quality

2.10.2. Input data about the water supply infrastructure

The following data were submitted by JKP "Vodovod" with respect to the production and supply of potable water

Table 2-42 Supplied Raw water to the Water Treatment Plan

Year	2009	2010	2011	2012	2013	2014
Quantity (m^3)	18,097,300	18,553,400	18,748,936	20,268,704	18,093,500	17,910,298

Table 2-43 Purified water from the Water Treatment Plan

2009

Month	Quantity	
	m3	l/sec
January	1,411,800	527
February	1,276,800	528
March	1,413,600	528
April	1,326,600	512
May	1,430,400	534
June	1,426,300	550
July	1,596,600	596
August	1,548,700	578
September	1,485,700	573
October	1,465,400	547
November	1,376,300	531
December	1,414,600	528
TOTAL	**17,172,800**	**545**

2010

Month	Quantity	
	m3	l/sec
January	1,441,800	538
February	1,285,700	531
March	1,418,600	530
April	1,370,300	529
May	1,416,900	529
June	1,415,200	546
July	1,501,100	560
August	1,603,300	599
September	1,483,300	572
October	1,554,800	580
November	1,533,600	592
December	1,565,300	584
TOTAL	**17,589,900**	**558**

2011

Month	Purified		Overflow*	Distributed	
	m3	l/sec	m3	m3	l/sec
January	1,662,400	621	570,000	1,092,400	408
February	1,399,800	579	420,000	979,800	405
March	1,459,500	545	360,000	1,099,500	411
April	1,587,900	613	520,000	1,067,900	412
May	1,697,600	634	520,000	1,177,600	440
June	1,615,800	623	450,000	1,165,800	450
July	1,362,240	509		1,362,240	509
August	1,378,600	515		1,378,600	515
September	1,256,500	485		1,256,500	485
October	1,219,979	455		1,219,979	455
November	1,127,200	435		1,127,200	435
December	1,118,100	417		1,118,100	417
TOTAL	**16,885,619**	**535**	**2,840,000**	**14,045,619**	**445**

* Overflow: when the water for the distribution is covered it is possible to use the remaining purified water to produce electricity through a diversion from the WTP

2012

Month	Purified		Overflow	Distributed	
	m3	l/sec	m3	m3	l/sec
January	1,391,500	520		1,391,500	520

February	1,292,700	534		1,292,700	534
March	1,482,000	553	267,840	1,214,160	453
April	1,877,200	724	726,000	1,151,200	444
May	2,157,900	806	937,440	1,220,460	456
June	1,712,000	660	520,000	1,192,000	460
July	1,377,440	514		1,377,440	514
August	1,326,900	495		1,326,900	495
September	1,197,100	462		1,197,100	462
October	1,251,680	467	80,000	1,171,680	437
November	1,563,680	603	414,720	1,148,960	443
December	1,926,580	719	776,000	1,150,580	430
TOTAL	**18,556,680**	**588**	**3,722,000**	**14,834,680**	**470**

2013

	Purified		Overflow	Distributed	
Month	**m3**	**l/sec**	**m3**	**m3**	**l/sec**
January	1,262,626	471	178,074	1,084,552	405
February	1,122,142	464	221,994	900,148	372
March	1,764,734	659	751,692	1,013,042	378
April	1,834,921	708	914,062	920,859	355
May	1,915,642	715	964,648	950,994	355
June	1,797,919	694	763,714	1,034,205	399
July	1,158,850	433	14,353	1,144,497	427
August	1,201,152	448	0	1,201,152	448
September	1,046,757	404	0	1,046,757	404
October	1,042,857	389	0	1,042,857	389
November	1,208,006	466	205,314	1,002,692	387
December	1,205,632	450	154,704	1,050,928	392
TOTAL	**16,561,238**	**525**	**4,168,555**	**12,392,683**	**393**

2014

	Purified		Overflow	Distributed	
Month	**m3**	**l/sec**	**m3**	**m3**	**l/sec**
January	1,279,737	478	286,565	993,172	371
February	826,985	342	0	826,985	342
March	1,188,706	444	184,195	1,004,511	375
April	1,550,735	598	594,124	956,611	369
May	1,740,766	650	693,053	1,047,713	391
June	1,661,799	641	526,083	1,135,716	438
July	1,178,679	440	0	1,178,679	440
August	1,184,125	442	0	1,184,125	442
September	1,457,237	562	423,694	1,033,543	399
October	1,507,803	563	464,429	1,043,374	390
November	1,734,971	669	731,420	1,003,551	387
December	1,660,409	620	655,778	1,004,631	375

TOTAL	**16,971,952**	**538**	**4,559,341**	**12,412,611**	**394**

Table 2-44 Invoiced water for legal and private entities

2009

Month	Quantity m3	Quantity l/sec
January	540,476	202
February	570,496	236
March	550,845	206
April	564,070	218
May	549,718	205
June	551,444	213
July	559,213	209
August	710,877	265
September	650,239	251
October	584,714	218
November	578,289	223
December	685,431	256
TOTAL	**7,095,812**	**225**

2010

Month	Quantity m3	Quantity l/sec
January	512,041	191
February	515,009	213
March	511,892	191
April	511,175	197
May	486,775	182
June	496,585	192
July	514,538	192
August	632,359	236
September	574,417	222
October	537,162	201
November	509,682	197
December	515,338	192
TOTAL	**6,316,973**	**200**

2011

Month	Quantity m3	Quantity l/sec
January	485,545	181
February	493,686	204
March	486,209	182
April	471,202	182
May	481,630	180
June	513,565	198
July	516,523	193
August	618,085	231
September	568,157	219
October	550,673	206
November	504,150	195
December	501,626	187
TOTAL	**6,191,051**	**196**

2012

Month	Quantity m3	Quantity l/sec
January	526,275	196
February	533,644	221
March	563,811	211
April	588,171	227
May	531,760	199
June	541,365	209
July	543,346	203
August	650,475	243
September	613,251	237
October	573,144	214
November	524,745	202
December	514,997	192
TOTAL	**6,704,984**	**213**

2013

Month	Quantity m3	Quantity l/sec
January	510,729	191
February	508,318	210
March	491,905	184
April	535,222	206
May	526,225	196
June	522,509	202
July	526,306	197
August	652,163	243
September	604,584	233
October	552,315	206
November	497,387	192
December	480,017	179
TOTAL	**6,407,680**	**203**

2014

Month	Quantity m3	Quantity l/sec
January	496,167	185
February	492,833	204
March	510,682	191
April	530,733	205
May	495,998	185
June	509,420	197
July	496,980	186
August	589,416	220
September	601,124	232
October	527,899	197
November	543,937	210
December	486,719	182
TOTAL	**6,281,908**	**199**

Table 2-45 Paid purified water (distribution losses technical + administrative)

2009

Month	Quantity m3	Quantity l/sec	Quantity %
January	871,324	325	62
February	706,304	292	55
March	862,755	322	61
April	762,530	294	57
May	880,682	329	62
June	874,856	338	61
July	1,037,387	387	65
August	837,823	313	54
September	835,461	322	56
October	880,686	329	60
November	798,011	308	58
December	729,169	272	52

2010

Month	Quantity m3	Quantity l/sec	Quantity %
January	929,759	347	64
February	770,691	319	60
March	906,708	339	64
April	859,125	331	63
May	930,125	347	66
June	918,615	354	65
July	986,562	368	66
August	970,941	363	61
September	908,883	351	61
October	1,017,638	380	65
November	1,023,918	395	67
December	1,049,962	392	67

TOTAL	**10,076,988**	**320**	**59**

TOTAL	**11,272,927**	**357**	**64**

2011

Month	Quantity		
	m3	l/sec	%
January	606,855	227	56
February	486,114	201	50
March	613,291	229	56
April	596,698	230	56
May	695,970	260	59
June	652,235	252	56
July	845,717	316	62
August	760,515	284	55
September	688,343	266	55
October	669,306	250	55
November	623,050	240	55
December	616,474	230	55
TOTAL	**7,854,568**	**249**	**56**

2012

Month	Quantity		
	m3	l/sec	%
January	865,225	323	62
February	759,056	314	59
March	650,349	243	54
April	563,029	217	49
May	688,700	257	56
June	650,635	251	55
July	834,094	311	61
August	676,425	253	51
September	583,849	225	49
October	598,536	223	51
November	624,215	241	54
December	635,583	237	55
TOTAL	**8,129,696**	**258**	**55**

2013

Month	Quantity		
	m3	l/sec	%
January	573,823	214	53
February	391,830	162	44
March	521,137	195	51
April	385,637	149	42
May	424,769	159	45
June	511,696	197	49
July	618,191	231	54
August	548,989	205	46
September	442,173	171	42
October	490,542	183	47
November	505,305	195	50
December	570,911	213	54
TOTAL	**5,985,003**	**190**	**48**

2014

Month	Quantity		
	m3	l/sec	%
January	497,005	186	50
February	334,152	138	40
March	493,829	184	49
April	425,878	164	45
May	551,715	206	53
June	626,296	242	55
July	681,699	255	58
August	594,709	222	50
September	432,419	167	42
October	515,475	192	49
November	459,614	177	46
December	517,912	193	52
TOTAL	**6,130,703**	**194**	**49**

Table 2-46 Potable water input data

Input Data	Year					
Parameters	**Unit**	**2009**	**2010**	**2011**	**20132**	**2013**	**2014**
Total quantity of raw water to the DWTP	m^3/ year	18,097,300	18,553,400	18,748,936	20,268,704	18,093,500	17,910,298
Total produced potable water from the DWTP (to distribution system)	m^3/ year	17,172,800	17,589,900	14,045,619	14,834,680	12,392,683	12,412,611
Transmission and production	m^3/	924,500	963,500	4,703,317	5,434,024	5,700,817	5,497,687

losses							
Total quantity supplied to consumers (invoiced)	m^3/ year	7,095,812	6,316,973	6,191,051	6,704,984	6,407,680	6,281,908
Total quantity of metered and sold water	m^3/ year	10,076,988	11,272,927	7,854,568	8,129,696	5,985,003	6,130,703

On the bases of the aforementioned data, the following chart summarizes the input data about the water supply infrastructure:

Table 2-47 Potable water output data

Output data	Unit	Year				
INDICATORS		**2009**	**2010**	**2011**	**2012**	**2013**
Water supply percentage	%	100	100	100	100	100
Household consumption (% of the total consumption)	%	70.5	70.7	72.1	71.8	72.6
Legal entities' consumption (% of the total consumption)	%	29.5	29.3	27.9	28.2	27.4
Water losses Technical and administrative losses (on the water supply network)	%	59	64	56	55	48

Table 2-48 Output data for water consumption for the base year

Item	Year 2013
Population in served area of JKP	87,275
Population in agglomeration area (served by JKP)	81,374
Water consumption p.c. in l/day	145.05
Water consumption p.c. in m^3/year	52.94
Domestic Water consumption m^3/year -JKP served area	4,530,107

Domestic Water consumption m³/year -agglomeration area	4,222,417
Industry Water consumption m³/year - JKP served area	1,405,540
Industry Water consumption m³/year - agglomeration area	1,346,969
Budgetary and Institutional Water consumption m³/year - JKP served area	472,069
Budgetary and Institutional Water consumption m³/year - agglomeration area	440,005
Total Water consumption in JKP served aream³/year	***6,407,716***
Total Water consumption in agglomeration aream³/year	***6,009,391***

Except for the above data the consultant has discussed the planned investment programme with the representatives of the JKP "Vodovod" and has referred to the following projects too:

Table 2-49 Planned investment programme in the water supply system

No.	Description	Planned period of implementation	Existing analyses and designs
1.	Replacement of DN800 steel transmission main from Dovledzik pump station to Dihovo water treatment plant (D8700 DI pipe) with L = 2,500 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
2.	Reconstruction of the existing water supply network - Replacement of CI pipes with L = 10,400 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
3.	Reconstruction of the existing water supply network - Replacement of CI pipes with L = 10,400 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
4.	Reconstruction of the existing water supply network - Replacement of steel pipes with L = 19,000 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
5.	Reconstruction of the existing water supply network - Replacement of PVC pipes with L = 14,000 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
6.	Reconstruction of the existing water supply network - Replacement of AC pipes with L = 800 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
7.	Reconstruction of the existing water supply network - Replacement of GI pipes with L = 1,000 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
8.	Replacement of existing pipelines with L = 22,800 m approx.	2014 – 2020 year	KfW funded Water and Sewerage Programme
9.	Construction of new administration building	2020 – 2026 year	KfW funded Water and Sewerage Programme
10.	Reconstruction of water intakes (nr. 2)	2020 – 2026 year	KfW funded Water and Sewerage Programme
11.	Replacement of existing pipelines with L = 45,600 m approx.	2020 – 2026 year	KfW funded Water and Sewerage

			Programme
12.	Disinfection station for 6 villages	2020 – 2026 year	KfW funded Water and Sewerage Programme
13.	Pressure and flow measurement installations - Chamber, pipework, fittings and equipment	2020 – 2026 year	KfW funded Water and Sewerage Programme
14.	Supply and installation of SCADA substations complete (nr.6)	2020 – 2026 year	KfW funded Water and Sewerage Programme
15.	Improvements to water treatment plant - Construction and equipping of settling tanks (450,000 euro) - Automation of filter washing and general refurbishment (100,000 euro)	2020 – 2026 year	KfW funded Water and Sewerage Programme
16.	Replacement of existing pipelines with L = 22,900 m approx.	2026 – 2039 year	KfW funded Water and Sewerage Programme
17.	Supply and installation of GIS system as inventory and planning tool	2026 – 2039 year	KfW funded Water and Sewerage Programme

2.10.3. Input data about the sewerage infrastructure

The Consultant has had discussions with the representatives of the Municipality and JKP "Niskogradba" about the existing sewerage system. During the site visits to Bitola, the Consultant has reviewed the available project designs for the sewerage network extension in new residential areas within city of Bitola for which financing has been ensured through Municipal budget. The Consultant has discussed and has taken into consideration the information provided from JKP representatives on all available project designs for the settlements within defined agglomeration as well as for those for which project designs have not yet been prepared. On the bases of the aforementioned documents, information and discussions a layout plan of the sewerage system network for the agglomeration has been prepared (Annex 9-8). The stated layout gives an overview of the existing situation as well as the planned priorities defined with this document.

2.11. Identified future water supply and sewerage projects with ensured financing in the agglomeration

From the discussions with the Municipality and JKP "Niskogradba" during the course of data collection it has been concluded that projects with ensuring financing are twoprojects anticipated to be financed under the Municipal investment programme for development plans for 2015-2017. These two projects are elaborated further bellow:

- Construction of Sewerage and storm water network for new residential area ARM quarter 1 and ARM quarter 2

Within the boundaries of former military complex in the city of Bitola, a new residential area is now being constructed. This residential area is called ARM and for the investment planning development has been divided in blocks (quarters). For this purpose detailed technical documentation for infrastructure investments is being prepared and financed by the Municipality. The referred detailed design anticipates construction of sewerage and storm water network in ARM quarter 1 on street SRU 1 and sewerage and storm water network in ARM quarter 2.The allocated funds are from the Municipal annual budget programme and are estimated at MKD 60 million (€ 980,000). The envisaged timeframe for implementation of this project is the year 2015 – 2016.

- Construction of Water Supply system in the new residential area ARM quarter 1 and ARM quarter 2

In line with the aforementioned municipal programme for construction of new residential area ARM, the Municipality has envisaged financing of the water supply system in the new residential area ARM quarter 1 and quarter 2. For this purpose detailed technical documentation for infrastructure investments is being prepared and financed by the Municipality. The envisaged timeframe for

implementation of this project is the year 2015 and the estimated value of the investment to be allocated from the municipal budget is MKD 5.5 million (€ 90,000).

The Consultant was informed that it is the Municipality's intention to apply for financing from KfW development bank of part of the identified project investments for the water supply network aforementioned in this document.

3. PROJECTIONS

3.1. Methodology and assumptions

3.1.1. Reference periods for investment programmes

Investment program periods are set as follows[6]:

- Short-term: 2015 – 2020;
- Medium term: 2021 – 2027;
- Long term: 2028 – 2039.

In addition to the above mentioned key dates for the investment programming periods, the Consultant defined the following dates and terms:

- **Base year:** 2013;
- The infrastructure which has been put into operation until the end of 2014 has been taken into account;
- **Situation after implementation of on-going projects:** All on-going projects approved before 2013 will not be included in the Master Plans' investment programme. The impact of these investment projects with completion dates between 2014 and 2015 will be taken into consideration in the year 2015 (first year of projection);
- **2021:** First year of operation of infrastructure proposed in the Short-term investment programme, excluding the WWTP for which first operational year is 2020.

3.1.2. Population forecast criteria

Population forecast takes into account:

- Starting level corresponding to 2002 census data and developed to 2013;
- Population is forecasted based on population dynamics: birth rate, death rate and net migration (mechanical growth);
- Birth rate and death rate are forecasted with conventional methods. A trend is established and a constant coefficient or a steady increase/decrease over the years is applied. This approach takes into account the population specifics for urban and rural area.

The forecast for each subsequent year is obtained from the population of the previous year, by adding births, net migration and subtracting deaths. In practical terms:

Population for the forecasted year	**=**	**Population for the year before**	**+**	**Births**	**-**	**Deaths**	**+**	**Net migration**

The population forecast and more detailed methodology are presented in Chapter 3.2 related to socio-economic projections.

3.2. Socio-economic projections

3.2.1. Macroeconomic trends – economic development projections

Macro-economic forecasts include relevant projections for gross-domestic product, inflation and unemployment rates at national and regional levels to be used in the financial analysis of selected investment measures. These forecasts are important as they exert significant influence over future operation and maintenance costs of water and wastewater systems, household incomes and affordability constraints. Relevant details for the specific impact and application of each indicator within the framework of water and sewerage investments are provided in its respective section.

Macro-economic projections are based on existing statistical data from official sources (State Statistical Office, Eurostat, International Monetary Fund, World Bank, National Bank of the Republic of Macedonia etc.) and documents at local level (Strategic Plan for local development of Bitola

[6] In agreement with MEH of Macedonia program periods defined in order to ensure consistency with the operational programming periods.

Municipality, Urban Development Plan for Industrial Zone Bukovo, Urban Development Plan for Industrial Zone Jabeni, FS Water and Sewerage Program, Phase 2, November 2014, Local Employment Action Plan –Bitola, etc.) These documents are quoted accordingly throughout the report.

Gross Domestic Product

Gross domestic product (GDP) forecasts are indicative of the level of economic development at a certain territorial level (national and regional). In addition, real growth of GDP is the main indicator used for income projections[1] and expenditures for salaries and wages within the financial analysis of investment measures. Consequently, as a major driver for household income, GDP growth projections are crucial for determining macro affordability thresholds and therefore for establishing the maximum value of proposed investments in water and wastewater systems and networks.

As indicated in Section 2.3, GDP growth in the country has slowed down considerably since 2009, which was the first time after 2001 with a negative economic growth, caused by the consequences of the global financial and economic crisis. Stability of growth slowly recovers and reaches 2.9% in 2013 which is much lower than pre-crisis levels reaching 6%.

Several prominent financial institutions produce short- and medium-term economic forecasts. The International Monetary Fund (IMF) predicts Macedonian real GDP growth of 3.16% for 2014, 3.44% for 2015 and 3.6% for 2016 (Source: http://www.imf.org/external/pubs/ft/weo/2014/01/pdf/text.pdf, World Economic Outlook 2014). An average growth of 3.3% for the period 2014-2020 is expected by the Economist Intelligence Unit (EIU) with 0.2% increase for 2012 (Source: Country Report – Macedonia, http://country.eiu.com). The World Bank foresees a modest growth of 3.0% for 2014 and 3.3% for 2015 and 2016 respectively (Source:http://www.worldbank.org/en/country/macedonia).

Based on projections of these international financial organisations, the following GDP growth pattern has been established.

Table 3-1 GDP growth assumptions (% per year)

2014	2015	2016	2017	2018	2019	2020	2021 and beyond
3.00	3.50	3.60	3.7	3.77	3.60	3.45	3.3

In medium-term (6 years), growth will follow the predictions of the IMF, reaching 3.45% in 2020, except 2014 for which the Consultant assumed that the WB forecast is more realistic. Valid long-term GDP forecasts are very difficult to provide, given the uncertainty in the European economic development. For these reasons, the recommendations of WB[7] for annual increase of 3.3% have been used for years 2021 and beyond. They are considered to be realistic and in line with expected EU economic growth.

As indicated in section 2.3, Pelagonia Region per capita GDP is higher than the national averages for 2010-2011, but falls down from 2012. The difference in 2013 is 93% from National level of GDP p.c.

Since the increase rates are similar both at national and regional level, the growth assumptions, depicted in the above table can also be applied for GDP projections in the service area without significant loss of forecast reliability.

Inflation

Inflation level forecasts are important for water and wastewater investments for two major reasons: 1) Inflation is used to determine constant and nominal costs and tariffs (e.g. conversion of data from operators' business plans); 2) some relevant components of cost formation (e.g. fuels, electricity, labour etc.) might increase or decrease at a lower or higher rate than the average inflation rate, which would influence cost projections when constant values are used.

[1] "It is recommended considering household's disposable income growth as equal to GDP growth. As a result, current data collected, split by income decile, will be projected using a growth rate equal to the GDP growth" – "*Guidelines for cost benefit analysis of water and wastewater projects supported by the Cohesion fund in 2007-2013".*

[7] Given by PISA notes for Bulgarian Mater Plans preparation

These considerations require that inflation forecasts be provided on 2 separate levels – total inflation, represented by the consumer price index and inflation for major cost components, used in water and wastewater investment projects. The differences between these two levels can be used when projecting the various costs for the proposed investment measures.

The average national inflation rate for the last 10 years is 2.4%, ranging closely from 1.2% (2003) to 2.8% (2013). The last three years of this period (2011-2013) are most relevant, as inflation has stabilised within narrower limits to an average value of 3.3%.

Overview of the IFIs short and middle term prognosis for Macedonian inflation rate shows that IMF figures (http://www.imf.org/external/pubs/ft/weo/2014/01/weodata) are more realistic than those of other institutions (insignificant deviation for 2012 and 2013). For this reason we have adopted their forecast as the most reliable one for the project.

Table 3-2 Average annual Inflation rate assumptions (% per year)

2014	2015	2016	2017	2018	2019	2020	2021 and beyond
1.84	2.30	2.30	2.30	2.30	2.30	2.30	2.30

Projection of operation and maintenance costs of water and wastewater systems requires prediction of individual inflation rates for the major cost categories – materials, fuels and electricity, and external services. These categories are not identically represented in the consumer price index and the following categories have been used as closest substitutions: non-food products, electricity, liquid fuels and services. The dynamics of these categories over the last 3-year period is presented in the following table.

Table 3-3 Inflation dynamics of major cost categories (growth rate per year in %)

	2011	2012	2013	Average	Ratio to total inflation
Total inflation	2.80	-0.40	3.10	1.83	
Non-foods (materials)	4.90	5.50	0.70	3.70	2.02
Services (incl. external)	2.30	1.50	0.40	1.40	0.76
Electricity	5.8	13.3	3.7	7.58	2.05
Liquid fuels	8.90	6.60	-3.40	4.03	2.20

Source: Statistical Yearbook, 2014

Materials and fuel prices grow at a faster rate compared to average inflation, while services tend to rise slower than the average inflation. Electricity and fuel prices in Macedonia are dependent on global commodity prices, thus making projections somewhat unreliable, but the existing stable trends provide some assurance to calculations. This logic applied when determining growth assumptions for these major cost categories over the years.

Table 3-4 Inflation dynamics assumptions - cost categories (growth rate per year in %)

	2014	2015 and beyond
Non-foods (materials)	2.10	1.80
Services (incl. external)	3.70	3.30
Electricity	4.50	4.00
Liquid fuels	2.20	2.10

Exchange rate

Exchange rate is kept at a conservative level of MKD 61.21 for EUR 1 average for the last 20 years. Deviation in the last 3 years is only 0.03% per year. No changes are expected in this aspect in the near future. Even if Macedonia joins the EU, the low inflation rate, stable growth of GDP and other economic factors are reason to justify retention insignificant growth of exchange rate with 0.02% per year.

Taxation

All direct and indirect taxes (pls. see table below) are assumed to remain constant throughout the reference period of the master plan. Every change of these taxes (especially indirect taxes) will have immediate and potentially undesirable effect on inflation. If any long-term changes take place, inflation forecasts will need to be revised at least for the year of the change.

Table 3-5 Taxes by categories, 2011

Taxes	Value
Corporate tax	10%
Income tax	10%
Value Added Tax (VAT)	18%
Social security[8]	22.6%
Health insurance[9]	7.3%

Social security tax has different values depending on the length of services for the insured persons. Health insurance rate depends of the legal status of the person- employees in the country, abroad, pensioner, unemployed etc. An average rate is adopted for the employees in Macedonia. Other rates are higher, but rare cases of employment.

Unemployment

Unemployment levels have a noteworthy influence on water and wastewater investment projects and particularly on income projections and macro-affordability thresholds. Areas with higher unemployment have lower income and different income structure, relying more on pensions, social benefits and subsistence farming. These characteristics lead to lower affordability thresholds, thus hindering large-scale investments.

As indicated in Section 2.3, unemployment in the designated territory has equal to average for Macedonia in 2011 and faster decrease in 2012 and 2013. In 2011 it was 31.4% at national level, but was decreasing to 22.2% in 2013 against 29.0% at national level. This trend and lower wages in the region, give us the reason to assume that poverty line in the Bitola Municipality is very similar to that at national level:

- Rate of 60% of the average household income
- 27.1% of people at risk of poverty rate

These figures are used for affordability threshold determination as a level of household income in the Bitola Municipality and agglomeration area.

PPP[10] for Macedonia, measured by Price level index for Household final consumption expenditure is only 47 (EU28 is 100) and just confirms the risk of affordability of investments.

[8]Social Insurance Act, last amended in July , 2014 (17.5% for mandatory pensions insurance, 4% for disability and occupational diseases and 1.1% for unemployment)

[9]Basis rate for employee, according to Law

[10]Purchasing Power Parities ('PPPs') shall mean spatial deflators and currency converters that eliminate the effects of the differences in price levels between Member States, thus allowing volume comparisons of GDP components and comparisons of price levels

3.2.2. Demographic Projections

The population in the project area, in connection with water services consumption, is characterized by a lower decrease (-0.029%) than the average increase in the country (0.19%) during the period 2002-2013. For the last 5 years natural increase is highly negative (-0.47%), which give us a reason for more conservative forecast of Bitola Municipality in comparison of the forecast of whole country.

There is no strongly expressed seasonality, therefore the average annual amounts, which are necessary for the financial calculations, can be used directly, without adjustment for seasonality.

Three scenarios have been developed for the future population of the region – optimistic, realistic and pessimistic. All scenarios use strictly official Census 2002 data and State Statistic Office publications. No adjustments have been made for possible undercounts as the reports of SSO indicate low levels of unaccounted people.

The optimistic scenario (moderate positive growth) assumes that population development will follow recent historical trends for the last years with respect both to natural increase and net migration. The scenario assumes that the death rate will remain the same as during the last 5 years and net migration - equal of the realistic scenario. The methodology describes links between Region, Municipality and urban and rural settlement level forecast.

The realistic scenario(low positive growth) assumes that population development will follow recent historical trends for the last 5 years, with respect both to natural increase and mechanical movement of the population.. However, the scenario assumes that the loss of population will follow the tendency of the last 5 years, because of the currently stable age structure, which is already identical to the national averages. Net migration is also stabilising to the level of average for the last 5 years. Nevertheless, internal migration is a phenomenon that is volatile and at regional level may change dramatically in a very short time. The scenario assumes slow but constant regional economic growth, generating opportunities for new jobs, attracting skilled and well-educated young people, gaining support from favourable regional policies as key conditions for the successful development of regional economy.

The pessimistic scenario (lowest positive growth) assumes that population development will follow the same historical trends as in the previous scenario, but the loss of population will be according to all previous years, not for the last 5 years only. Unlike the birth rate, which is lower for the last 5 years, the death rate is higher in comparison with the period 2002-2013.

Methodology

Ideally, population projections at regional level need to be prepared by using a cohort-component procedure. Unlike simple extrapolation techniques, such as discounting methods and regression, which project future population without disaggregating it, or identifying the causes for past trends, cohort-component procedures deal separately with the three major components of population change – fertility, mortality and migration. The method is based on the traditional demographic accounting principle:

Population (at the end of the period)	=	Population (at the beginning of the period)	+	Births	-	Deaths	+ / -	Migration

Unfortunately, there is no possibility to establish age-gender cohorts at individual settlement level, because such information is not reported by the national statistics. However, SSO and Eurostat use the cohort-component procedure in the preparation of aggregated forecasts at regional level.

The projection model used by these institutions is characterised by the following features:

- Fertility: age-specific fertility rates applied to the female population; breakdown of births into boys and girls in fixed proportions (51.5% boys, 48.5% girls);
- Mortality: age- and sex-specific death rates applied to population;
- Migration: net migration by age and sex (international and internal migration).

For each of the regional population projections scenarios, assumptions have been formulated in terms of key summary measures for each component of population change. The key summary measures are as follows:

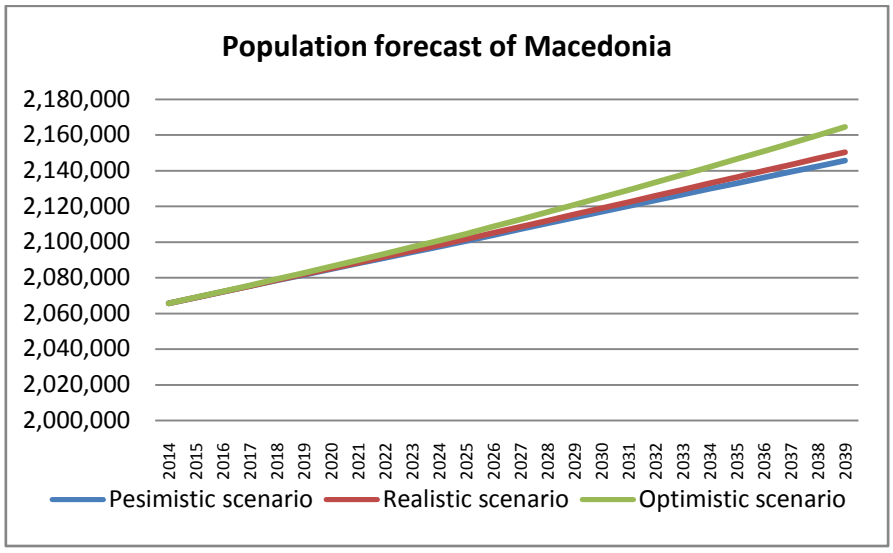
- Fertility: cohort total fertility rate, total fertility rate, mean age at childbearing;
- Mortality: life expectancy at birth, for men and women separately;
- Migration: measuring the intensity of moving to another region.

These key summary measures are subsequently translated into numerical values for each year of the projection period. The regional population projections are conceptually a straightforward generalisation of the national population projections: the only difference is that, while in the national projections the population is just classified by age and sex, in the regional projections there is an additional dimension of population breakdown, namely region of residence.

To ensure full consistency between the national and regional scenario, the regional projection model checks, for each type of event, whether the regional numbers add up to the national number from the national scenario. If not, the regional numbers of events are proportionally adjusted to the national levels.

The results of this procedure are summarised in regional projection tables for each level in three scenarios (pessimistic, realistic and optimistic). The following figure indicates the relevant values for the national level.

Figure 3-1 National demographic projections 2014 – 2039, number of people



Source: Own calculations

In order to account for local level differences, sensitivity coefficients have been obtained at settlement level by deriving a ratio between the 2002-2013 change in population at settlement and Municipality level. These coefficients indicate how individual settlements change demographically with respect to the region and are later used to adjust the above regional projections for each settlement.

$$\text{Sensitivity coefficient at settlement level} = \frac{\text{Yearly change in population (settlement) 2002-2013}}{\text{Yearly change in population (municipality) 2002-2013}}$$

If any obvious inconsistencies (e.g. growth rate much higher or lower than expected) exist between SSO and 2002 Census data, these are adjusted to reflect the most recent data. All adjustments are clearly indicated in the report.

Summary results

On the basis of the proposed methodology, the following results have been obtained for population changes in the designated territory in the available scenarios. The realistic scenario envisages a decrease of 14,388 people for the Municipality and 8,732 people for the agglomeration area. In optimistic scenario their number is respectively 6,932 and 2,433 for agglomeration area. The decrease in the pessimistic scenario is by 15,024 people on municipality level and 9,497 for the agglomeration area.

Table 3-6 Population projections for designated territory

Scenario	2014	2015	2021	2028	2039
Realistic scenario					
Population of Bitola Municipality	92,359	92,048	89,718	85,971	92,359
Population of Bitola town	72,175	71,932	70,111	67,183	72,175
Population of rural area	20,184	20,116	19,607	18,788	20,184
Population of agglomeration	80,821	80,529	79,854	76,519	80,821
Optimistic scenario					
Population of Bitola Municipality	92,635	92,618	92,426	91,925	92,635
Population of Bitola town	72,594	72,581	72,430	72,038	72,594
Population of rural area	20,041	20,037	19,995	19,887	20,041
Population of agglomeration	81,106	81,211	82,128	81,684	81,106
Pessimistic scenario					
Population of Bitola Municipality	92,336	92,001	89,484	85,526	92,336
Population of Bitola town	73,381	73,114	71,114	67,969	73,381
Population of rural area	18,956	18,887	18,370	17,558	18,956
Population of agglomeration	78,389	78,104	79,346	75,837	78,389

The realistic scenario should be used as a basis for all further calculations about future investments in the water and wastewater networks as it is based on assumptions, which are most likely to happen in the agglomeration area during the reference period of the master plan. The pessimistic scenario is necessary only for potential risk assessment of proposed investments in order to prove their viability in unfavourable conditions.

Detailed results

The detailed results at settlement level are presented in the following table in descending population order. These are provided for the realistic scenario only, as the numbers are used for determination of future water demand and affordability calculations. At the end of the reference period, only the town of Bitola and Bukovo will have a population above 2,000 people in the serviced area.

Table 3-7 Population projections for the agglomeration area at settlement level

Settlement name	2014	2015	2021	2028	2039
Town of Bitola	72,175	71,932	70,111	67,183	60,931
Villages:					
Bukovo*	774	771	751	720	653
Dolno Orizari	2,676	2,667	2,599	2,491	2,259
Gorno Orizari	4,180	4,166	4,060	3,891	3,529
Karamani	336	335	326	313	284
Kravari	1,487	1,482	1,445	1,384	1,256
Lavci*	337	336	327	314	284

Brusnik	240	239	233	224	203
Total agglomeration area	82,205	81,928	79,854	76,519	69,399

An assumption is made that Bukovo and Lavci will join to the serviced area of JKP Vodovod till 2021.

The proposed population projections should not be considered as strict forecasts. They demonstrate the probable demographic development on the basis of scientific and realistic assumptions about fertility, mortality, migration, economic development and a unified methodology for regional predictions, applicable across the EU.

3.2.3. Projections of Household Income

Introduction

Income projections have a central role in the planning of future water and wastewater systems as they are the basis for macro-affordability assessments and are determinative of the maximum value of investments. In addition, incomes are important for the overall attractiveness of the region and influence directly internal in-migration.

Household income projections are dependent on the current household income levels and the predicted economic growth of the region. The approach considering households disposable income growth as equal to GDP growth is adopted in the master plan and included as part of the applicable methodology.

Methodology

The average household income in the designated territory is determined at regional level. The following approximation procedure has been applied to derive a common income value:

- Determination of the average household income level in 2013 for the Pelagonia Region
- Establishment of income projections for the region using real GDP growth.
- Averaging projections for household income on the basis of the respective population shares:

$$\text{Average household income} = \sum \frac{\text{Population of district}}{\text{Total service area population}} \times \text{Average income of district}$$

- Projected income is distributed in average for urban and rural area and below poverty line groups on the basis of statistical data for % of the people below poverty line and projection for people leaving in urban and rural area;
- Income per capita is calculated on the basis of 3.3 people per household throughout the reference period, despite the observed historical tendency for members in households for the Pelagonia Region. This indicator is relatively stable and changes are slow and insignificant.
- Income per capita is calculated in Euro using motivated forecast of exchange rate

Summary results

Forecasts for household income within the designated territory are presented in the following table. Real income is projected to increase up to € 4,048 by 2039, but will remain below the national average of € 4,181.

Table 3-8 Household income per capita projections, €/year

Average household income	2014	2015	2020	2028	2039
Macedonia	1,849	1,915	2 ,256	2,925	4,181
Pelagonia Region	1,790	1,854	2,184	2,832	4,048

Projected income is additionally split into urban and rural area groups on the basis of lower income in the rural area in comparison with the income in towns. Coefficient used for rural areas is 0.8 of the income of the urban population, recommended by the World Bank. Although income of the poorest people is defined as 60% of the average income for the region, the share of poor people used in the prognosis is adopted as that at the national level -27.1%. Real GDP growth is used for the projections across all income groups.

Table 3-9 Income distribution in groups for the project area

HH Income by groups	2014	2015	2020	2028	2039
Annual income p.c. urban area in Bitola Municipality in €	1,790	1,854	2,184	2,832	4,048
Annual income p.c. rural area in Bitola Municipality in €	1,432	1,484	1,748	2,266	3,238
Average annual income p.c. agglomeration area in €	1,712	1,773	2,089	2,709	3,871
Average annual HH income in agglomeration area in €	5,888	6,100	7,186	9,317	13,317
Average annual HH income in agglomeration area below the poverty line in €	3,533	3,660	4,312	5,590	7,990
Average annual income p.c. agglomeration area below the poverty line in €	1,027	1,064	1,253	1,625	2,323

The data for household income by poverty line and the average income for the agglomeration area is used in determining the social affordability of investments.

3.3. Water Demand Projections

This section presents the foretasted water consumption trend as well as the expected water demand for the agglomeration of Bitola. The obtained values will be taken as basis for water supply facilities designing, planned to be installed till year 2039 to satisfy the water demand of the agglomeration.

Considering the municipal strategy, rehabilitation of the water supply network should be taken as a preferred option.

The socio-economic survey registered a gradual increase tendency in the city population growth and vice versa for the rural areas. Potable water consumption will follow this trend.

On the basis of the information provided by the Water Company (JKP “Vodovod”), the level of water losses in the water supply network is assessed to follow a decreasing tendency from 56% in the year 2011, 55% in 2012 and 48% in year 2013.

The implementation of the activities described in the Master Plan will contribute to reducing the level of water losses in the water supply network. We consider that fulfilling the projects set up in the Master Plan, the level of water losses will be decreased down to 25%.

The potable water consumers considered in the water demand estimation for the agglomeration of Bitola are as follows:

- Population;
- Industrial enterprises (inclusive service and public sector).

The specific water demand for each type of user is represented by the respective water consumption rate. Along with the improvement of the living standard and technical conditions, water supply rate also changes in order to provide the citizens with a satisfactory level of living comfort.

On the other hand the causes for any irrational potable water usage as well as those for the major water losses in the water supply systems should be eliminated in order to keep water losses down to the minimal levels.
The water demand estimation for populated areas is a complicated process requiring the consideration of a great number of various factors.

Provided there is sufficiently reliable statistical data on the influencing factors, water volumes could be determined more precisely.
The basic potable water consumers in the agglomeration of Bitola are its ***population, public sector*** (schools, hospitals, public administration etc.), ***commercial sector*** (points of sale, trade, hotel etc.) and ***industry*** (enterprises using potable water in their production process and for daily needs). In Bitola agglomeration which is under the responsibility of JKP "Vodovod" only two groups of invoices are prepared: One for the **Domestic** population and one for the rest which is called **Industrial.** The latter include Industrial, Commercial and Public consumption.

The information used for the purposes of the water demand estimation is[11]:

- Supplied water volume and invoiced water volume for year 2013 (number of households and industry) – data provided by JKP "Vodovod", Bitola;
- The amount of water losses in the agglomeration Bitola water supply network -data provided by JKP "Vodovod", Bitola;
- Number of population by year 2039 – projected by the Consultant.

The given annual water volumes representing the billed volumes of the water produced, can be considered as approximate top and bottom limits of the estimated water demand interval variation. As such water consumption rate for the different types of water consumers has been calculated.

The available data on the supplied and billed water volumes to the distribution system after the DWTP shows that a great deal of the system input water volume is lost along the water supply network. Water loss estimation is of a significant importance for the water demand projections and determination.

[11](the water consumption data for each type of consumer allocated by years has been provided by JKP "Vodovod". In this Report the figures from year 2013 will be used)

***Table 3-10 Treated and distributed water from the DWTP to the distribution system* for year 2011-2013**

	2011					2012					2013				
	Purified		Overflow	Distributed		Purified		Overflow	Distributed		Purified		Overflow	Distributed	
Month	m^3	l/sec	m^3	m^3	l/sec	m^3	l/sec	m^3	m^3	l/sec	m^3	l/sec	m^3	m^3	l/sec
January	1,662,400	621	570,000	1,092,400	408	1,391,500	520		1,391,500	520	1,262,626	471	178,074	1,084,552	405
February	1,399,800	579	420,000	979,800	405	1,292,700	534		1,292.700	534	1,122,142	464	221,994	900,148	372
March	1,459,500	545	360,000	1,099,500	411	1,482,000	553	267,840	1,214,160	453	1,764,734	659	751,692	1,013,042	378
April	1,587,900	613	520,000	1,067,900	412	1,877,200	724	726,000	1,151,200	444	1,834,921	708	914,062	920,859	355
May	1,697,600	634	520,000	1,177,600	440	2,157,900	806	937,440	1,220,460	456	1,915,642	715	964,648	950,994	355
June	1,615,800	623	450,000	1,165,800	450	1,712,000	660	520,000	1,192,000	460	1,797,919	694	763.714	1,034,205	399
July	1,362,240	509		1,362,240	509	1,377,440	514		1,377,440	514	1,158,850	433	14,353	1,144,497	427
August	1,378,600	515		1,378,600	515	1,326,900	495		1,326,900	495	1,201,152	448	0	1,201,152	448
September	1,256,500	485		1,256,500	485	1,197,100	462		1,197,100	462	1,046,757	404	0	1,046,757	404
October	1,219,979	455		1,219,979	455	1,251,680	467	80,000	1,171,680	437	1,042,857	389	0	1,042,857	389
November	1,127,200	435		1,127,200	435	1,563,680	603	414,720	1,148,960	443	1,208,006	466	205,314	1,002,692	387
December	1,118,100	417		1,118,100	417	1,926,580	719	776,000	1,150,580	430	1,205,632	450	154,704	1,050,928	392
TOTAL	**16,885,619**	**535**	**2.840.000**	**14,045,619**	**445**	**18,556,680**	**588**	**3,722,000**	**14,834,680**	**470**	**16,561,238**	**525**	**4,168,555**	**12,392,683**	**393**

Overflow: When the water for the distribution is covered it is possible to use the remaining purified water to produce electricity through a diversion from the DWTP to a water power plants.

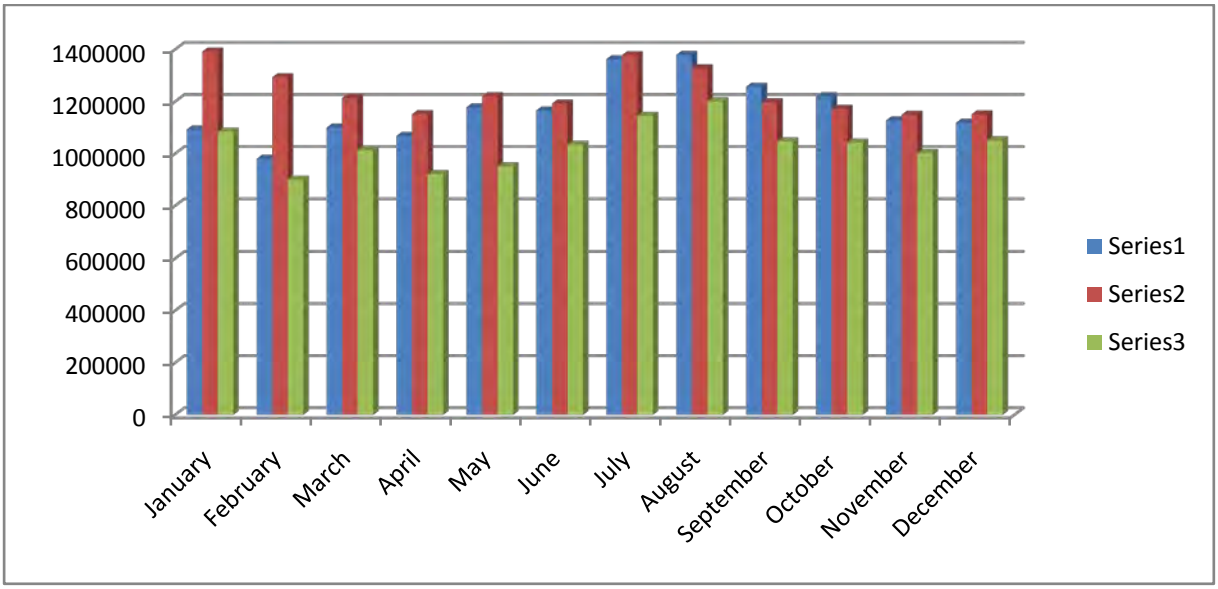


Figure 3-2 Distributed water from the DWTP to the distribution system for 2011-2013

Table 3-11 Water Sold to legal and private entities for year 2011-2013

	2011		2012		2013	
	Quantity		Quantity		Quantity	
Month	**m^3**	**l/sec**	**m^3**	**l/sec**	**m^3**	**l/sec**
January	485,545	181	526,275	196	510,729	191
February	493,686	204	533,644	221	508.318	210
March	486,209	182	563,811	211	491,905	184
April	471,202	182	588,171	227	535,222	206
May	481,630	180	531,760	199	526,225	196
June	513,565	198	541,365	209	522,509	202
July	516,523	193	543,346	203	526,306	197
August	618,085	231	650,475	243	652,163	243
September	568,157	219	613,251	237	604,584	233
October	550,673	206	573,144	214	552,315	206
November	504,150	195	524,745	202	497,387	192
December	501,626	187	514,997	192	480,017	179
TOTAL	**6,191,051**	**196**	**6,704,984**	**213**	**6,407,680**	**203**

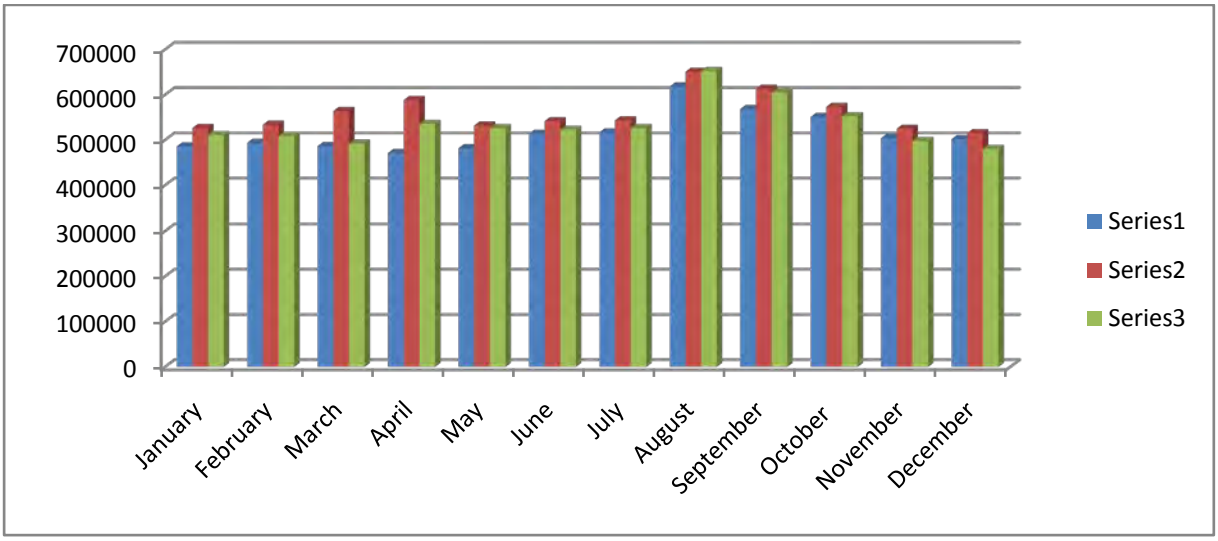


Figure 3-3 Water Sold to legal and private entities for year 2011-2013

Non-Revenue Water

Table 3-12 Monthly data for Non-Revenue water (technical and administrative) from 2011 to 2013

	2011			2012			2013		
Month	**m^3**	**l/sec**	**%**	**m^3**	**l/sec**	**%**	**m^3**	**l/sec**	**%**
January	606,855	227	56	865,225	323	62	573,823	214	53
February	486,114	201	50	759,056	314	59	391,830	162	44
March	613,291	229	56	650,349	243	54	521,137	195	51
April	596,698	230	56	563,029	217	49	385,637	149	42
May	695,970	260	59	688,700	257	56	424,769	159	45
June	652,235	252	56	650,635	251	55	511,696	197	49
July	845,717	316	62	834,094	311	61	618,191	231	54
August	760,515	284	55	676,425	253	51	548,989	205	46
September	688,343	266	55	583,849	225	49	442,173	171	42
October	669,306	250	55	598,536	223	51	490,542	183	47
November	623,050	240	55	624,215	241	54	505,305	195	50
December	616,474	230	55	635,583	237	55	570,911	213	54
TOTAL	**7,854,568**	**249**	**56**	**8,129,696**	**258**	**55**	**5,985,003**	**190**	**48**

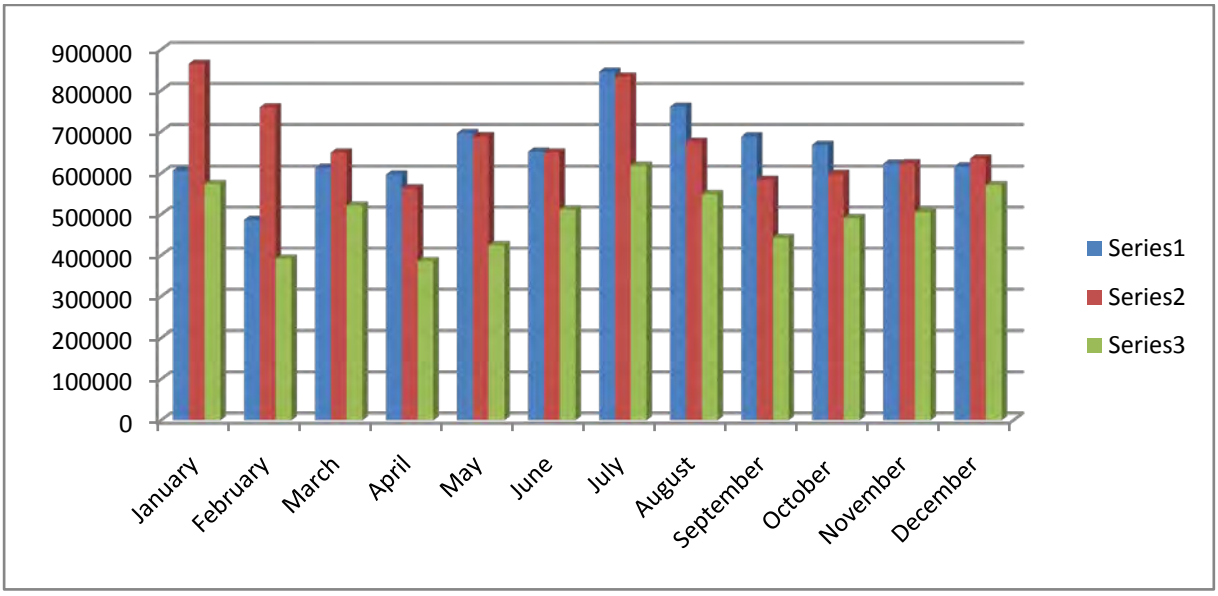


Figure 3-4 Monthly data for Non-Revenue Water for the years 2011 - 2013

Looking at the above figure it can be seen that the treated water to the distribution system has its peeks during the coldest and hottest months, January and July and August. The water losses are topping in the same month indicating that there might be (administrative) losses for securing water pipes against frost during the coldest month (running taps) and a certain use of water for "summer purposes" such as irrigation of gardens etc. In July 2013 the water losses are 24% higher than the 2013 monthly average. When the above is said it as well should be mentioned that the highest amount of invoiced water is during the months August and September which as well could lead to an increase in the technical losses.

Table 3-13 Water losses in Bitola water supply network connected to the DWTP

Year	Total system input volume (m^3/y)	Total consumpti-on = paid for water (m^3/y)	Domestic water consumption (m^3/y)	Industrial sector water consump-tion (m^3/y)	Unaccounted water volume (m^3/y	Water losses %
2011	14,045,619	6,191,051	4,412,540	1,778,511	7,854,568	55.9
2012	14,834,680	6,704,984	4,740,261	1,964,723	8,129,696	54.8
2013	12,392,683	6,407,680	4,530,071	1,877,609	5,985,003	48.3

Non-Revenue Water (Total water losses) comprises of two types of losses: (i) Real Losses (physical losses) and apparent losses (non-physical/administrative).

Water losses The data provided in the above table shows that the level of Non-Revenue Water (NRW) in the water supply system for the year 2013 amounts to 48% after a considerable reduction obtained from 2012 where the NRW was registered to be 55%. Such percentage of water losses could be considered admissible compared to level of water losses registered in other towns of similar sizes in for example Romania and Bulgaria. According to the information provided by the regional Water Company, the 48 % NRW/total water losses for 2013 are split between 36 % real/physical losses (4,489,000 m^3/day) and 12% are apparent losses due to incorrect billing (fail and missing water meters), illegal water consumption (ethnic minority groups that cannot pay) and public use of water for maintenance of parks, road cleaning etc.) equal to 1,496,000 m³/day for year 2013.

NRW/Total water losses for the year 2013 consisting of administrative and technical losses are presented in the table below.

Table 3-14 NRW/Total water losses, year 2013

Water balance	m^3/y	%
Water production in DWTP Bitola, distributed	12,392,683	100%
Sold water (connected to the DWTP)	6,407,680	52%
Unaccounted for water	5,985,003	48%
Technical losses	4,489,000	36%
Administrative losses	1,496,000	12%

Technical losses are for year 2013 assessed by the JKP Vodovod to 36% of the distributed water in the area covered by network supplied from the DWTP. Based on that information the administrative losses are calculated. For the years 2011 and 2012 the JKP Vodovod assess that 44% of the distributed water was lost as technical losses and that 11% as administrative losses.

Even if the water losses are significant, nearly 6 million m³ in year 2013, it is worth mentioning that even if the distributed water decreased from year 2012 to 2013 by 16% the invoiced water volume only decreased by 4.4%. At the same time the losses were reduced by 26.5%!

We envisage water loss reduction down to 25% in the final stage, as a result of a complete reconstruction of the network and depending on the efforts and political will to reduce the administrative losses. In order to make it clear, it is necessary to point out that total losses include:

- Technical water losses, 36% of the purified potable water - (assessed to nearly 4,5 million m^3/y) – potable water losses, due to water supply network depreciation, high water pressure and other technical faults;
- Administrative water losses, 12% of the purified potable water - (assessed to nearly 1,5 million m^3/y) -water losses due to customer metering inaccuracy and illegal water consumption i.e. consumed but unbilled water volumes and the use of portable water for park watering, road cleaning etc.

The Total water losses per kilometre of water supply network amount to 21,819 m³/km/y (technical water losses per kilometre network – 16,365 m³/km/y).

The present report provides the actual water losses from 2013 in details and from 2011 and 2012 in overview. The forecast water loss estimates for all stages till year 2039 have been made based on the assumption that all required measures for their reduction will be implemented. Thus, it is envisaged that water losses will be reduced down to 25% till the final planning stage i.e. year 2039.

The forecast water loss estimates are not to be taken as desirable but all known measures for their elimination and reduction to the minimal level should be undertaken. Some of those activities are not so resource-consuming, such as replacement/instalment of water meters, annual preventive maintenance, due failure repairs, high water pressure reduction in the differentiated zones and local replacement of the water supply network sections experiencing a great number of leaks and failures. Finally the use of purified drinking water for electricity production purposes should be eliminated and the problem with vulnerable ethnic groups not paying for water and not taking care of water wastage should be solved.

3.3.1. Domestic Potable Water Demand

The following parameters are taken into account when preparing the domestic water demand projections:

- Demographic projections for Bitola Municipality and the agglomeration area, shown in chapter 3.2.2. of this report
- Development of serviced area of JKPs and increasing of connection rate for water and waste

water, based on ongoing projects and involved in this MP investments programs. It corresponds to the largest extent to the parameters of initiated water supply infrastructure projects and to the expectations of the municipal leadership and the management of the JKP "Vodovod".

- Domestic water consumption, based on data provided by JKP "Vodovod" for invoiced quantities.
- The price of water supply and wastewater collection services. Tariffs have not changed for a long time with correspondence with low inflation rate and local Water tariff policy. Planned increase for new tariffs of water and waste water services due to the new investments, which expected to leads to a reduction of consumption.

According to data from JKP "Vodovod", the average present net domestic water consumption is about 150 litres per capita per day (l/c/d) average for the last 5 years.

The method used for projection is "elasticity of demand". This method shows responsiveness or elasticity of the water quantity demanded to tariffs for water services. In the implementation of this method balance between level of tariffs and "willingness to pay" should be maintained, measured by Income per capita.

The expression of these two factors is the respective value of HH Income elasticity ratio and Tariffs elasticity ratio. The figures estimated for the factors are shown in the table below, based on historical data.

Table 3-15 Determination of elasticity ratio for water demand

Items	HISTORICAL DATA				
	2009	2010	2011	2012	2013
Population in the served area	87,007	86,719	85,637	82,122	74,626
HH Income in € per month	374.19	389.27	390.27	395.75	413.04
Income per capita per month	108.78	113.16	113.45	115.04	120.07
Water Tariff in €/m³	0.254	0.434	0.434	0.434	0.434
Waste Water Tariff in €/m³	0.088	0.088	0.088	0.088	0.171
Waste Water Treatment Tariff					0,000
Total tariffs without VAT in €/m³	0.343	0.523	0.523	0.523	0.606
Total tariffs with VAT in €/m³	0.360	0.549	0.549	0.549	0.636
Consumption per capita per day in l	159.46	143.90	142.94	154.02	150.59
Increase of consumption per c.p.d.		-9.8%	-0.7%	7.8%	-2.2%
HH Income Elasticity Ratio					23.4%
Tariffs elasticity ratio					-33.0%

Source: JKPD data for water consumption and own calculations

Due to the lack of regular tariffs growth during the period, for tariffs elasticity ratio a real growth of inflation is used. Usually the tariffs level is updated with the annual inflation rate, because it compensates partly the annual growth of HH Income.

Applying the method of elasticity for water demand, the following summary results were obtained:

Table 3-16 Potable water consumption for domestic

Item	2014	2015	2021	2028	2039
Population in serviced area of JKPD	87,007	86,719	85,637	82,122	74,626
Population in agglomeration area of project	81,094	80,821	79,854	76,519	69,399
Water consumption p.c. in l/day	145,49	145,94	135,42	134,17	130,11
Water consumption p.c. in m³/year	53.10	53.27	49.43	48.97	47.49

Domestic Water consumption -JKPD served area	4,529,934	4,528,816	4,232,930	4,021,755	3,544,092
Domestic Water consumption - agglomeration area	4,222,072	4,220,824	3,947,091	3,747,347	3,295,851

3.3.2. Non-domestic demand

The non-domestic customers could be any of the following groups:

- Budgetary and Institutional – schools, hospitals, local administration, kindergartens etc. Usually the tariff set up is similar to the domestic customer group, but in Bitola their tariffs are equal to Commercial and Industry group.
- A number of Water Operators include in this group for free customers as firefighter brigades, churches etc. Such customers do not pay, but the billing system reports their consumption for accounting the losses. JKP Vodovod does not report for such a group in their billing and collection system.
- Commercial and Industry – small and medium business, industry, shops, restaurants etc. All invoices are issued to the customer company's name. Usually the tariff set up is higher than that for domestic customer groups, especially for waste water and treatment process, considering the higher level of pollution from industry in comparison with households. In JKP Vodovod all customers which are not domestic are in the group of commercial/industry.

Forecasts for commercial water consumption are based on the following assumptions:

- The demographic development of the Municipality of Bitola and forecasts up to 2039, taking into account the direct link between population growth and business development, incl. schools, kindergartens, hospitals, administration, etc.
- The historical data provided by JKPD "Vodovod" for water consumption by industry during the period 2009-2013.
- Plans for business development in the Municipality and in separate areas in urban planning - development taken from the Development Urban Plans of Industrial zones in Bitola Municipality.

Analysis of the links between domestic and commercial water consumption, which use water supply services of JKPD "Vodovod" shows that 72.36 % of invoiced water is for domestic and 20.39% for Commercial and Industry. The remaining of 7.24% are for Budgetary and Institutional customers. These amounts do not include entities that use water from own sources. They will be considered separately in forecasts for consumption of wastewater services.

When preparing the forecast for Budgetary and Institutional water consumption in the area of Bitola Municipality, this ratio of 7.24% is being maintained over the whole projection period. The results are presented in the following table:

Table 3-17 Potable water consumption for non-domestic

Item	2014	2015	2020	2028	2039
Industrial Water consumption - JKPD serviced area	1,414,944	1,415,637	1,419,846	1,424,786	1,432,552
Budgetary and Institutional In serviced area	*462,141*	*455,477*	*438,989*	*432,017*	*402,432*
Industrial Water consumption - agglomeration area	1,345,884	1,344,832	1,345,375	1,318,706	1,279,922
Budgetary and Institutional In agglomeration area	*430,733*	*424,501*	*409,345*	*402,541*	*374,244*
Total for agglomeration area	1,776,617	1,769,334	1,754,720	1,721,247	1,654,166

3.4. Wastewater Volumes and Pollution Load Projection

The wastewater flows include the following components:

The wastewater flows include the following components:

- Wastewater flows, generated by domestic, institutional, industrial and commercial;
- Flows, generated by Industry
- The network characteristics - combined and partially separate sewerage system
- Ground water Infiltration (GWI) flows, generated by the drainage of groundwater through the sewerage network.
- Flows due to Rainwater.

3.4.1. Domestic and institutional wastewater flows and loads

The domestic wastewater flow and pollution for the target year are based on the population data and per capita water consumption given in Chapter 3.3.1.

The average domestic wastewater (Qav,d) discharge is based on the considered reference date by the total population, connected to the sewerage network on the same date. The connection rate (proportion of water users connected to the sewerage network) is projected to increase from currently 96.15 % to:

- 97.09% for the year 2021 after implementation of the Priority I Investment measures
- 97.98% for the year 2028 after implementation of the Priority II Investment measures
- 99.91% for the target year 2039 after implementation of the Priority III Investment measures.

The wastewater flows are determined by the factor, which is the proportion wastewater discharged by households to the sewer system out of domestic water consumed. For projecting the future hydraulic and pollution loads it has been assumed that this wastewater generation factor is 90% for domestic and 100% of institutional water customers.

The wastewater flow for institutional customers is assumed to apply for 240 working days per year.

The domestic wastewater load is calculated based on the specific load of pollution per capita, according to the European standard as follows:

- BOD_5 = 60 g/c/d
- COD = 120 g/c/d
- SS = 70 g/c/d
- N = 11 g/c/d
- P = 1.8 g/c/d

The load from institutional customers is included in domestic wastewater load.

In the table below is given the wastewater flows and loads of the estimated future population and institutional consumers:

Table 3-18 Projected domestic and institutional wastewater flows and loads

Item	Unit	2014	2021	2028	2039
Population in agglomeration area	n	82,205	79,854	76,519	69,399
Population in agglomeration area served by sewer system	%	96.15	97.09	97.98	99.91
Population in agglomeration area served by sewer system	n	79,040	77,530	74,973	69,337

Per capita water consumption	l/c.d	145.49	135.42	134.17	130.11
Per capita wastewater generation	l/c.d	**130.94**	**121.88**	**120.75**	**117.10**
Domestic wastewater flow	m³/d	10,350	9,449	9,053	8,119
Institutional wastewater flow	m³/d	1,795	1,706	1,677	1,559
Total wastewater generations from domestic and institutional consumers	m³/d	12,144	11,155	10,731	9,679
Domestic and institutional pollution loads*	kgBOD	3,953	4,412	4,228	3,868

**The load from institutional customers is included in domestic wastewater load.*

3.4.2. Non-domestic wastewater

The projected Industrial and commercial wastewater volumes are based on:

- Industrial and commercial water consumption from JKP "Vodovod", Lake Strezevo and own sources – calculated in chapter 3.3.2;
- Water consumption from Lake Strezevo and own sources
- Connection rate to the sewerage system – 56.23% is the current connection rate. After activities of Priority I (construction of app. 2.93 km pressure main collector from the Industrial Zone in Bitola to collector K1 Ø700 and pumping station) for the reference year 2021 and following years, the rate is set to 90%;
- Wastewater generation factor – depend on type of industry.For most of industry the wastewater generation factor is accepted to be 80% and 90%, for cooling water - 0%, for concrete production - 50% (reference is made to Annex 9-6);
- The average time of activity of the considered customer - in most cases 240 working days, except sugar factory (60 days for washing), Yeast and alcohol factory with 365 working days and commercial enterprises – 312 working days.

The projected water consumption for industries are assessed on an individual basis based on past consumption records and typical values used internationally for future industries. The percentage of water supply discharged as wastewater and the peak rate of discharge vary depending on the type of industry. Special consideration has been given to these factors in deriving the wastewater flows (reference is made to Annex 9-6).

The forecast for wastewater volume and pollution from industry is based on analysis and evaluation of existing information on: Main priorities and specific targets for the development of Bitola Municipality and the creation of economic growth and maximum use of local resources.

Future increase of the investments in the economy and development of the medium and large business companies is expected:

Mlekara (dairy products)

Production levels have been increasing and plans exist for further expansion. The investments of 38 million Euros came as a result of the high production potential of Mlekara as well as the projected image and consumer credibility. Since 2007 till today IMB Mlekara has invested more than 3 million Euros in updating the primary production, providing know-how experience from European markets and has invested more than 4 million Euros in new sophisticated technology to improve the quality of products. The company expects water consumption to grow to meet increases in milk production. Given the recent operating performance of the company it would be reasonable to assume that consumption levels will continue to increase in future years.

4-th of November (sugar factory)

The last seven years factory "4-th of November" operated with highly reduced capacity at about 15% of the full capacity. As a raw material mainly imported sugar-cane is used. From 2015 the company has come to an agreement to use sugar beet for the production of sugar. It is expected that the production of sugar will increase from 20t to 40t in the next years.

Pivara (brewery)

These factories are operating on a quite reduced level, with production mainly taking place following an order for their product. Recovery will largely depend on general economic recovery in the country, but for the factories to effectively compete some investment in modernization of production equipment would be required. There is some discussion of a foreign investor taking over operations of the brewery and should this happen water consumption would be expected to dramatically increase. However, this is at an early stage and hence there is considerable doubt whether this investment will take place.

"Multipurpose industrial zone, KO Bukovo"

The industrial zone in Bukovo is designed for light industry, services and storages with an area of 28.9 ha. The working area is 22.3 ha from which 40% are built. The completion of the industrial zone is planned for 2021. Water consumption for this zone is assumed to be 257 m^3/day for year 2021.

No increase of water and wastewater consumption from Lake Strezevo and own sourses to the main industry is accepted until the end of the target year 2039.

Foreseeing the possibility of investments and growth of the three basic productions of Main Industrial Zone we assume an increase of water and wastewater consumption by 0.5% p.a. until the end of the target year 2039.

At the same time small industries and commercial enterprises will be forced to close down their production because of the import corruption. For these small industries we assume a decrease of water and wastewater consumption by 0.5% p.a. until the end of the target year 2039.

Pollution loads from the industries have been based on their activities. Analysis of existing discharges has not been carried out. Therefore this evaluation has been based on very limited measurements in the past and values obtained for similar industries elsewhere. Moreover, due to the economic situation in Macedonia many of the industries are only operating at a reduced level and some have ceased operating on a temporary basis. This situation makes it very difficult to predict the future pollution loads.

There is a high concentration of food industries in Bitola from which pollution loads are also mostly of biological origin. The main treatment to be selected at the proposed wastewater treatment plant is biological treatment. Although in the process of biological treatment a limited amount of metals will be removed in the sludge, it is not normal to provide metal removal at the wastewater treatment plant as it is easier and less costly to provide chemical pre-treatment at the factory to reduce the high metal loads before discharging into the wastewater system.

For the future industrial pollution it is taken into account that there will likely be an increase in industrial activity, but due to internal measurements and pre-treatment of the industrial wastewater, in fact a limited increase of the industrial pollution may be expected as the result of stringent discharge limits for industrial wastewater, as well as the realization of pre-treatment for industrial wastewater. Thus no increase of pollution load from main industry is accepted until the end of the target year 2039.

A prognosis for future industrial wastewater flows are based on current wastewater volumes and planned expansion of Industry in Bitola. Details for projected flows and pollution are presented in Annex 9-7.

Table 3-19 Industrial wastewater flows and loads

Item		2014	2021	2028	2039
Industrial wastewater from "Main Industrial Zone"	m³/d	2,924	2,983	3,089	3,263
Industrial wastewater from "Multipurpose industrial zone, KO Bukovo"	m³/d	92	185	185	185
Small industry and commercial wastewater flow	m³/d	2,750	2,655	2,564	2,426
Total Industrial (incl. commercial) wastewater flows	m³/d	5,766	5,823	5,837	5,874
connection rate to sewage	%	56.23	90.00	90.00	90.00
Total industry flow to sewage		**3,243**	**5,241**	**5,254**	**5,287**
Industrial pollution loads from "Main Industrial Zone"	kgBOD/d	2,054.7	2,054.7	2,054.7	2,054.7
Industrial pollution loads from "Multipurpose industrial zone, KO Bukovo"	kgBOD/d	11.1	22.2	22.2	22.2
Small industry and commercial wastewater flow	kgBOD/d	267.8	258.6	249.7	236.3
Total Industrial wastewater pollution loads	kgBOD/d	2,333.6	2,335.5	2,326.6	2,313.2
Population equivalent (PE)	PE_{60}	38,893	38,925	38,776	38,553
connection rate to sewage	%	56.23	90.00	90.00	90.00
Population equivalent (PE) to sewage	PE	**21,871**	**35,033**	**34,899**	**34,698**

3.4.3. Sewerage Network Infiltration

Due to the inadequate monitoring and measuring system, the wastewater volume of inflow/infiltration cannot be estimated accurately. In accordance to the local engineering practice for design and dimensioning of the sewerage system, waste water quantities are calculated as percentage (90%) of the water used, increased by 0.12 l/s.ha for infiltration of underground water.

Due to the high level of underground waters in Bitola region from one side and the age and materials of the constructed sewer system high percentage of infiltration should be expected.

It should be noted however that the volume of wastewater discharged varies in a wide range at different periods, since additional water volumes come from the sewerage inflows and infiltration of water coming from the water losses in the water supply network (unaccounted for water, leaks, spills, etc.),

The estimated projections envisage reconstruction and extension of many sections along the sewer thus it is expected that the infiltration will be reduced significantly.

It is necessary to determine more precisely those water volumes by creating sewerage network hydraulic model in the next designing stages, along with entering all changes made in the particular sewerage sections.

3.4.4. Sewerage System

The exiting sewerage system in Bitola as described in details in previous chapter 2.7.2 is predominantly a combined one.

For the purposes of the present study, construction of a separate sewerage system for all the

adjoining villages is assumed, which has the following advantages:

- Storm water flow enters directly the watercourses without mixing with and being polluted by the wastewater flow.
- The proper construction and implementation of wastewater and storm-water systems reduce the level of infiltration and increase the operating efficiency of the WWTP.
- The construction of a storm-water system can be carried out selectively by considering the urban development of the populated area and by making the most of the surface permeability and terrain relief.

3.4.5. Storm Water Volumes

The municipality of Bitola has a combined sewer system in the largest part of the city. Only small parts of the City where new residential areas are being developed are covered with separate sewer system where the storm water is at a higher level, and wastewater at the lower. Due to the above, during heavy rains especially in the winter period, sewage overloads occur and formation of deposits is registered which causes clogs.

For calculation of the quantity of storm water as input for dimensioning of the storm sewer network the so-called rational formula is being used:

Q= F *J* C* ψ l/s)

Where:

F - Catchment area (ha)

J - Intensity of the rainfall [mm/h]

C - Coefficient of leakage and is dependable of the characteristics of the area, which is being drained

ψ - Coefficient of later drainage

In absence of adequate monitoring and measurements, the current storm water loads cannot be precisely determined.

3.4.6. Wastewater Flow and Pollution load Summary

Design parameters for wastewater flow and pollution load are summarized below:

Domestic and institutional wastewater

The domestic wastewater flow (Qav.d) is based on the forecasted number of inhabitants and their specific discharge ratio (wastewater generation ratio).

The amount of institutional wastewater flow (Qav.p) is based on the information from JKP “Vodovod” and and it is assumed that the development of institutional wastewater flow is linked to population development.

The maximum domestic wastewater flow is Qmax.d = Qav.d X Ko. Common peak coefficient for sewerage systems is $Ko = 1 + 2.5/Qav^{0.22}$

The maximum institutional wastewater flow is Qmax.p = Qav.p x Kp. Peak coefficient for wastewater from institution is Kp=2,2.

Industrial and commercial wastewater

The amount of Industrial wastewater flow (Qav.i) is based on the information from JKP “Vodovod”, Strezevo and General Urban Plan for industry development of Bitola Municipality. Foreseeing the possibility of investments and growth of the three main productions of the “Main Industrial Zone” we assume an increase of water and wastewater consumption by 0.5% p.a. until the end of the target year 2039.

The amount of commercial wastewater flow (Qav.c) is based on the information from JKP “Vodovod” and an annual decrease of 0.5 % is assumed.

The maximum industrial Qmax.i and commercial Qmax.c wastewater flow depends on time of activity and type of production. It is assumed that the average day activity is 11 hours – Ki=Kc=2.2. Qmaxi=Qav.ixKi; Qmax.c = Qav.c X Kc.

Pollution loads from the industries is based on existing industries and their activities. Analysis of existing discharges has not been carried out. Therefore this evaluation has been based on very limited past measurements and values obtained for similar industries elsewhere.

Groundwater Infiltration

Concerning the permanent groundwater and leakage infiltration into the sewerage networks, in dry weather conditions, we propose to apply the following methodology:

- In case of available measurements and detailed study regarding the studied sewerage system, it is proposed to take into account the results of the study regarding the infiltration discharges to take into account for present situation and to project it for reference dates based on the evolution of the area of the catchment area;
- In case no such study is available, the methodology defined in the German technical guidance – Document ATV/DWA – A128e is applied, e.g.:
  - Infiltration water is related to the total sewerage catchment area F,ha.
  - The infiltration discharge in dry weather conditions is determined as follows, using a location-specific infiltration discharge rate qiw, which should be between 0.05 and 0.15 l/s/ha - depending on the state of the sewerage network and the level of leakages in the water supply system.

Surface covered with sewerage system for each settlement within the defined agglomeration.

Table 3-20 Surface covered with sewerage system in Bitola agglomeration

Settlement	surface covered with sewerage system
Bitola city	893 ha
Gorno Orizari	69 ha
Dolno Orizari	45 ha
Kravari	35 ha
Bukovo	22 ha
Lavci	6 ha
Brustnik	10 ha
TOTAL	**1,080 ha**

For the purposes of Master Planning, based on big amount of water losses (48%- 5,985,003 m^3/y) we assume an infiltration rate of 0,12 l/s/ha for the current situation. We assume that water losses will decrease to 25% in the final planning stage, as a result of a complete reconstruction of the network and minimise the administrative losses. Therefore the infiltration rate is assumed to decrease to 0.09 l/s.ha after activities of Priority I (replacement of existing water supply pipes), to 0.065 l/s.ha after activities of Priority II (replacement of existing asbestos cement sewerage pipes) and to 0.06 l/s.ha for the target year 2039 after activities of Priority III (replacement of existing concrete sewerage pipes).

Table 3-21 Estimated current and future infiltration in Bitola agglomeration

Item	Unit	2014	2021	2028	2039
Surface, covered with sewerage system- F	ha	893	1,080	1,080	1,080
Infiltration rate - qiw	l/s.ha	0.12	0.09	0.065	0.06
Infiltration - Qgwi=F*qiw*3.6*24	m^3/d	**9,259**	**8,398**	**6,065**	**5,599**

Rainfall flows

About 30% of the town has a separate storm water and wastewater collection system andthe remainder has a combined system.

A combined sewerage system transports both sewage flows and surface water flows to the treatment plant in the same system. Thus the variation in flows received can be very large. High flow discharge is normally very diluted apart from the initial flush and contains a low concentration of pollutant due to the dilution effects of the large volume of 'clean' surface water.

It is assumed that acceptable coefficient of inequality for wet maximum flow to be received by treatment works is kr = 2 or Qrf = Qav X Kr

Design wastewater flow

Based on the previous methodology, the following formula should be used in order to determine the design flow for the elements of the **combined sewer systems**:

- Maximum wastewater flow - Qmax = Qmax.d + Qmax.p + Qmax.c + Qmax.i
- Design maximum wastewater flow for dry weather - Qmdf = Qmax + Qgwi
- Design maximum wastewater flow for wet weather - Qmwf = Qmax*Kr + Qgwi

Design pollution

The load is calculated based on the specific load of pollution per capita, according to the European standard as follows:

- BOD_5 = 60 g/c/d
- COD = 120 g/c/d
- SS = 70 g/c/d
- N = 11 g/c/d
- P = 1.8 g/c/d

The pollution of wastewater from the agglomeration was developed based on the following prerequisite:

- The number of population equivalent is calculated as the sum of the population and the population equivalent from industry;
- Infiltration does not cause pollution load.

Design wastewater flow and pollution load summary

The wastewater flow and the related pollution load of the water agglomeration is shown in the table below:

Table 3-22 Wastewater flow and the related pollution load in Bitola agglomeration

Item	Unit	2014	2021	2028	2039
Population in agglomeration area	n	82,205	79,854	76,519	69,399
Population in agglomeration area served by sewer system	%	96.15	97.09	97.98	99.91
Population in agglomeration area served by sewer system	n	79,040	77,530	74,973	69,337
Water consumption p. c. in l/c.day	l/c.d	145.94	135.42	134.17	130.11
Wastewater generation p. c. in l/c.day	l/c.d	**131.35**	**121.88**	**120.75**	**117.10**
Average wastewater flow					
Domestic wastewater	m^3/d	10,382	9,449	9,053	8,119
Institutional wastewater	m^3/d	1,795	1,706	1,677	1,559

Industrial wastewater - current industry and commercial	m³/d	3,243	5,241	5,254	5,287
Share of industrial wastewater of total wastewater flow	%	13.1	21.1	23.8	25.7
Infiltration - Qdwi	m³/d	9,259	8,398	6,065	5,599
Share of infiltration (Qgwi) of total wastewater flow	%	37.5	33.9	27.5	27.2
Total average wastewater to WWTP	m³/d	**24,678**	**24,794**	**22,049**	**20,564**
Maximum wastewater flow					
Domestic wastewater - Ko=1+2.5/Qav^0.22	m³/h	899	810	772	684
Institutional wastewater - Kc=2.2	m³/h	165	156	154	143
Industrial and commercial wastewater - Ki=2.2	m³/h	297	480	482	485
Maximum wastewater flow - Qmax	m³/h	1,361	1,447	1,408	1,312
Infiltration - Kdwi=1	m³/h	386	350	253	233
Total maximum wastewater flow in dry weather – Qmdf= Qmax + Qdwi	m³/h	**1,747**	**1,797**	**1,660**	**1,545**
Total maximum wastewater flow in wet weather - Qmwf=2*Qmax+Qgwi	m³/h	**3,108**	**3,243**	**3,068**	**2,857**
Population equivalent PE, connected to sewer	n	**100,911**	**112,563**	**109,872**	**104,034**
Population in agglomeration area served by sewer system (incl. institutional consumers)	n	79,040	77,530	74,973	69,337
PE from industry	n	21,871	35,033	34,899	34,698
Pollution load					
BOD_5 load of population	kg/d	4,742	4,652	4,498	4,160
BOD_5 load of industry	kg/d	1,312	2,102	2,094	2,082
Total BOD_5 load	kg/d	6,055	6,754	6,592	6,242
BOD_5 concentration	mg/dm^3	245	272	299	304
COD load	kg/d	,09	13,508	13,185	12,484
COD concentration	mg/dm^3	491	545	598	607
SS load	kg/d	,64	7,879	7,691	7,282
SS concentration	mg/dm^3	286	318	349	354
Nt load	kg/d	1,110	1,238	1,209	1,144
Nt concentration	mg/dm^3	45	50	54	55
Pt load	kg/d	182	203	198	187
Pt concentration	mg/dm^3	7	8	9	9

Discharge parameters

The receiving waters of the Dragor and Crna River according to the Categorisation of Water Courses and Lakes reservoirs and ground waters is determined by the Government of Republic of Macedonia are in Class III and they are not regarded as waters either for bathing use or water contact / recreational use. The Dragor River is classified as water which, in its natural state, can be used for irrigation, and after conventional purification methods can be used by Industries not requiring drinking water quality.

The principles of the European Union Urban Wastewater Treatment Directive (UWWTD, 91/271/EEC) and the Water Frame work Directive (WFD, 60/2000) have been implemented into the Macedonian National Water Act in July 2008. The management and treatment of wastewater have to confirm to the UWWTD standards.

Requirements for discharges from Urban Wastewater Treatment Plants are as per UWWTD 81/271/EEC. The values for concentration or for the percentage of reduction shall apply.

Table 3-23 Requirements for discharges from Urban Wastewater Treatment Plants as per UWWTD 91/271

Parameters	Concentration	Minimum percentage of reduction	Reference method of measurement
Biochemical oxygen demand (BOD_5 at 20C) without nitrification	25mg/l	70-90%	Homogenized, unfiltered, undecanted sample, Determination of dissolved oxygen before and after five-day incubation at 20 ^{0}C +/- 1 ^{0}C, in complete darkness. Addition of a nitrification inhibitor
Chemical oxygen demand (COD)	125 mg/l O_2	75%	Homogenized, unfiltered undecanted sample Potassium dichromate
Total suspended solids	35mg/l (more than 10 000 p.e.) 60 mg/l (2 000 – 10 000 p.e.)	90 % (more than 10 000 p.e.) 70 % (2 000-10 000 p.e.)	Filtering of a representative sample through a 0.45 um filter membrane. Drying at 105 ^{0}C and weighing – Centrifuging of a representative sample (for at least five mins with mean acceleration of 2,800 to 3,200 g), drying at 105 ^{0}C and weighing

Requirements for discharges from Urban Wastewater Treatment Plants to sensitive areas as per UWWD 81/271. One or both parameters may be applied depending on the local situation. The values for concentration or for the percentage of reduction shall apply.

Table 3-24 Requirements for discharges from Urban Wastewater Treatment Plants to sensitive areas as per UWWD 81/271

Parameter	**Concentration**	**Min.%ofreduction**
Total phosphorous	2mgP/l (for10.000–100.000 P.E.) 1mgP/l (formorethan100,000P.E.)	80%
Total nitrogen	15mgN/l (for10.000–100.000P.E.) 10mgN/l (formorethan100.000P.E.)	70–80%

The design requirements and indicators shall be in accordance with the approved IPA application for the Major Project „Preparation of studies (FS, EIA, CBA), design documentation and tender dossiers for waste water collection and treatment investment projects in the municipalities of Strumica, Bitola and Tetovo". The design requirements include construction of a new Wastewater Treatment Plant for Bitola agglomeration, with primary and secondary treatment and sludge treatment facilities designed to achieve the required BOD, COD and TSS standards as stipulated in the Urban Waste Water Directive (25 mg/l, 125 mg/l and 35 mg/l respectively). The possibility for future extension of the plant in order to include tertiary treatment will be ensured due to the probability of future designation of Dragor or Crna River as sensitive in the meaning in the Urban Waste Water Directive.

The proposed effluent concentrations for Bitola WWTP is presented in the table below:

Table 3-25 Proposed effluent concentrations for Bitola WWTP

Parameter	Concentration	Min. % of reduction
Biochemical Oxygen Demand BOD_5	25mgBOD/l	70-90%
Chemical Oxygen Demand (COD)	125mgCOD/l	75%
Total suspended solids	35mgSS/l	90%

4. WATER SUPPLY, SEWERAGE AND WASTEWATER TREATMENT DEVELOPMENT OBJECTIVES

4.1. General Objectives

The main purpose of the master plan is to provide grounds for elaboration of investment measures for Improving the water supply and sewerage system in Bitola Agglomeration.

The implementation of the investment measures will also aim at meeting the requirements related to the country's accession to the EU and commitments, particularly regarding compliance with Directive 98/83/EC on the quality of water intended for human consumption and Directive 91/271/EC concerning urban wastewater treatment.

4.2. Development of the Water System - Objectives

The objectives of the investment measures in the water supply sector as defined by JKP Vodovod and further elaborated with the KfW investment programme are:

- To provide sufficient quantity of high quality drinking water to the population;
- To reduce water losses in the water supply network;
- To increase the share of the households connected to the water supply network through rehabilitation of existing and construction of new water supply systems.

4.2.1. Priorities in reconstructing and upgrade of the water supply network of Bitola agglomeration in the period 2014-2039

Prioritization of the investment measures for reconstructing and upgrade of the water supply network of Bitola has been made on the bases of the consultations with JKP Vodovod and the information from II phase Water and Sewerage Programme financed by KfW

Priority I

- Replacement of DN800 steel transmission main from Dovledzik pump station to Dihovo water treatment plant (D8700 DI pipe) with L = 2,500 m approx.

Due to the condition and age of the current transmission main replacement has been envisaged with DI pipe with length of approx.. 2,500 m. The investment will provide for reduction of the head loss in the transmission main and shall improve the reliability of the system. It has been envisaged that the replacement will reduce the physical losses by approximately 60,000 m^3/year and will save energy consumption.

- Reconstruction of the existing water supply network by replacement of:
  - CI pipes with L=10,400 m. approx. with HDPE pipes
  - Steel pipes with L= 19,000 m approx. with HDPE or DI pipes
  - PVC pipes with L= 14,000 m approx. with HDPE pipes
  - AC pipes with L= 800 m approx. with HDPE pipes
  - GI pipes with L= 1,000 m approx. with HDPE pipes

The assessed current condition of the water supply network reveals deficiencies and causes low level of services (e.g. pressure). Priority replacement of pipe sections where these problems have been

reported has therefore been envisaged in length of approx. 44 km as per the specification of pipe type and length stated above.

- Replacement of existing gate valves

In order to improve the operational efficacy, replacement of about 600 gate valves in the distribution network which are in poor condition has been envisaged according to the following specification:

- DN50 gate valve nr. 10
- DN65 gate valve nr. 30
- DN80 gate valve nr.100
- DN100 gate valve nr.50
- DN125 gate valve nr. 10
- DN150 gate valve nr.100
- DN200 gate valve nr.50
- DN250 gate valve nr.30
- DN300 gate valve nr.40
- Valve box for DN50 to DN150 valves nr.150
- Valve box for DN200 to DN300 valves nr.40

- Replacement of existing pipelines in Bitola

In order to improve operation and to reduce water losses, leaks and repairs in the water distribution system, continuous process of replacement of older pipes in the distribution network will be necessary. Following the priority investment for replacement of 44 km approx. of pipes sections reported above, further reconstructions have been envisaged divided into sections and prioritized as per the investment needs. Thus, under this investment measure replacement of approx. 22,800 m of the existing pipes has been envisaged.

- Construction of new administrative building

As reported the existing rented accommodation used by JKP Vodovod is unsuitable and has high running costs. Due to this and in order to improve the working conditions of JKP Vodovod personnel and operational efficiency, construction of a new administrative building is envisaged.

Priority II

- Reconstruction of two water intakes

The water for the Municipality of Bitola and the other settlements in the water supply service area is provided by river Dragor water system and Strezevo intake. The River Dragor system consists of three water intakes: Crvena Reka, Lak Potok and Sapuncica. It has been assessed that in order to improve the efficacy, reconstruction of the intakes Crvena Reka and Laki Potok is required.

- Replacement of existing pipelines with L = 45,600 m approx.

As aforementioned, continuous process of replacement of older pipes in the water distribution network is necessary in order to improve the operation and to reduce water losses, leaks and repairs in the water distribution system. Thus, under this investment activity further replacement of approx. 45.600 m of the existing pipes has been envisaged.

- Disinfection station for 6 villages

As reported, at present, the residual chlorine concentration of water being supplied to some remote villages is too low. In order to boost the residual chlorine concentration of water being supplied, supply and installation of disinfection stations for six villages has been envisaged.

- Pressure and flow measurement installation including SCADA substations

Investment in flow and pressure measurement installation is required in order to improve the operation and maintenance of the system. The investment envisages procurement of chamber, pipework, fittings and equipment. Additionally, SCADA substations are proposed to acquire the measured data.

- Improvement of existing water treatment plant

At present, there are no settling tanks at the water treatment plant. The coagulated raw water is fed directly onto the filters which results in the need for frequent backwashing. Coagulated matter also passes through the filters into the clear water system. The improvements include the provision of settling tanks, the automation of the filter washing process and general repairs and rehabilitation.

Priority III

- Replacement of existing pipelines with L = 22,900 m approx

The continuous process of replacement of older pipes in the water distribution network as mentioned above, envisaged further replacement of approx. 22,900 m of the existing pipes.

- Supply and installation of GIS system as inventory and planning tool

GIS system should be implemented in order to enable JKP Vodovod to have accurate information on the inventory of the supply system. All network data shall be recorded and verified and the system shall be used as inventory and planning tool.

4.2.2. Priority Investment Programme 2014-2039 for the extension and reconstruction of the water supply network of Bitola Agglomeration

On the bases of the identified project priorities described in previous chapter 4.2.1., the necessary financial resources for their realization have been determined as follows:

Table 4-1 Investment needs in the water supply system in Bitola agglomeration

No.	Description	Value (EURO)
I. Investment measures for achieving the targets of Priority I		
1.1.	Replacement of DN800 steel transmission main from Dovledzik pump station to Dihovo water treatment plant (D8700 DI pipe) with L = 2,500 m approx.	1,230,000
1.2.	Reconstruction of the existing water supply network in Bitola Ø90 – Ø450 - Replacement of CI pipes with L = 10,400 m approx.	1,356,087
1.3.	Reconstruction of the existing water supply network Bitola Ø450 – Ø800 - Replacement of steel pipes with L = 19,000 m approx.	6.047.108
1.4.	Reconstruction of the existing water supply network Bitola Ø160 – Ø315 - Replacement of PVC pipes with L = 14,000 m approx.	2,030,330
1.5.	Reconstruction of the existing water supply network Bitola Ø160 - Replacement of AC pipes with L = 800 m approx.	82,214
1.6.	Reconstruction of the existing water supply network Bitola Ø90 – Ø110 - Replacement of GI pipes with L = 1,000 m approx.	85,742
1.7.	Replacement of existing gate valves in the distribution network which are in poor condition - approx. 600 valves (DN 50 – DN 300)	176,830
1.8.	Replacement of existing pipelines in Bitola with L = 22,800 m approx.	2,052,000
1.9.	Construction of new administration building	300,000
	Total Priority I	***13,360,311***
II. Investment measures for achieving the targets of Priority II		
2.1.	Reconstruction of water intakes (nr. 2)	200,000
2.2.	Replacement of existing pipelines with L = 45,600 m approx.	4,104,000
2.3.	Disinfection station for 6 villages	120,000
2.4.	Pressure and flow measurement installations - Chamber, pipework, fittings and equipment	45,000
2.5.	Supply and installation of SCADA substations complete (nr.6)	28,800
2.6.	Improvements to water treatment plant - Construction and equipping of settling tanks (450,000 euro) - Automation of filter washing and general refurbishment (100,000 euro)	550,000
	Total Priority II	***5,047,800***

III. Investment measures for achieving the targets of Priority III		
3.1.	Replacement of existing pipelines with L = 22,900 m approx.	2,061,000
3.2.	Supply and installation of GIS system as inventory and planning tool	50,000
	Total Priority III	***2,111,000***
	TotalPriority I, II and III	**20,519,111**
Contingencies (10 %)		2,051,911
Costs for design works (5 % from the investment cost)		1,025,956
Cost for supervision (7 % from the investment cost)		1,436,338
	Total Investment Cost	**25,033,315**

4.3. Development of the Waste Water System - Objectives

On the grounds of the data collected for the existing situation and in consultation with the Municipality of Bitola and JKP Niskogradba representatives, the consultant has defined the objectives of the investment measures in the wastewater sector as follows:

- To increase the number of households connected to the sewerage network;
- To reduce the number of leakages and infiltration of the sewerage network and facilities;
- To rehabilitate sections of existing sewerage network;
- To prevent exceeding the thresholds pollution of wastewater discharged in urban sewers through:
  - Implement measures to reduce pollution in the technological units to a rational minimum;
  - Implement measures to re-use water;
  - Introduce waste-free technologies;
  - Introduce best available practices.
- To treat wastewater in wastewater treatment plants.

On the grounds of the description and analysis of the sewerage network condition, presented in the previous sections and in relation to the objectives of this document, the investment projects in the sewerage network of Bitola agglomeration can be prioritized as follows:

Priority I

As discussed in the previous chapters of this document, some of the settlements within the defined agglomeration do not have existing sewerage network and/or are not connected to the sewer system of Bitola Municipality. In absence of a Waste Water Treatment Plant wastewaters from the sewerage systems are discharged into the existing river recipients or torrents. In addition, JKP Niskogradba doesn't have sufficient equipment for operation and maintenance of the sewerage system. Thus the first priority targets for the sewerage network improvement and development within Bitola agglomeration are:

- Remaining sewerage network for village Dolno Orizari Ø300, L= approx.2.0 km.
- Pressure main collector from village Dolno Orizari Ø250 to the WWTP L= approx. 2.3 km and a pumping station
- Pressure main collector from village Kravari to collector K0 Ø160 L = approx. 3,3 km and pumping station
- Pressure main collector from the Industrial Zone in Bitola to collector K1 Ø700 L = approx. 2.93 km and pumping station
- Main collector from Bitola to the WWTP Ø700- Ø1200 L= approx. 4.1 km and river crossing
- Reconstruction of the existing sewerage network – replacement of asbestos cement pipes in Bitola Ø200 – Ø800 – Phase I

- Reconstruction and construction of 3.5 km sewerage network in village Gorno Orizari
- Measuring equipment for waste water flow monitoring
- Specialized vehicle for sewerage network maintenance
  (combined vehicle for sewer water cleaning with high pressure pump and vacuum pump mud collecting)
- High pressure vehicle
- Vacuum vehicle for narrow streets
- CCTV sewerage inspection vehicle

Priority II

Within this priority the projects for reconstruction and rehabilitation works of the existing sewerage network have been anticipated, as well as construction / reconstruction works of storm water channels around the city and further development of the separate storm water network for the new settlements within city of Bitola:

- Reconstruction of the existing sewerage network – Replacement of asbestos cement pipes in Bitola Ø200 – Ø800 – Phase II
- Reconstruction of storm water channel Kurderes with total length L=approx. 2.4 km
- Construction of west storm water channel above settlements Bair with total with length L= approd.0.76 km
- Construction of east storm water channel above settlements Bair and G.Orizari with length L=approx. 3.1 km
- Construction of storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 1 with length L= approx. 1.1 km
- Construction of the storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 2 with length L= approx. 0.8 km
- Construction of storm water perimeter channel for settlement Bukovski Livadi L = approx.. 0.75 km
- Sewerage network for village Bukovo L= approx. 6.45 km;
- Construction of storm water network for main collector at street Partizanska - Bitola Ø600 – Ø1000, L= approx. 4.1 km
- Construction of storm water network for Solunska street L = approx. 1.1 km, Ø1,000
- Construction of storm water network for main collector
  for the boulevard 1st May - Bitola Ø600 – Ø1000, L = approx. 2.9 km

Priority III

In the third phase of the investment activities the reconstruction and rehabilitation works of the existing sewerage network have been anticipated as well as further connection to the sewerage system and future WWTP of remaining villages from the defined agglomeration:

- Replacement of concrete and concrete reinforced pipes in BitolaØ250 – Ø800;
- Construction of sewerage system in village Karamani Ø300, L= approx. 5.6 km, pumping station and approx. 0.58 km pressure main collector to the PC Dolno Orizari;
- Construction of sewerage network L = approx. 3.0 km and main collector to Bitola for village Lavci Ø300 and pumping station;
- Construction of sewerage network L = approx. 4.7 km and main collector to Bitola for village Brustnik Ø300 and pumping station.
- New Sewerage network Ø300 for settlement Strcin L= approx. 1.4 km;
- New Sewerage network Ø300 for settlement BLR (Brusnichko Lavcanski Reon) 3 L= approx. 2.3 km;

- New Sewerage network Ø300 for settlement BLR (Brusnichko Lavcanski Reon) 4 L= approx. 1.8 km;
- New storm water network Ø250 – Ø400 for settlement Strcin L= approx. 2.75 km;
- New storm water network Ø250 – Ø300 for settlement BLR (Brusnichko Lavcanski Reon) 3 L= approx. 1.5 km;
- New storm water network Ø250 – Ø400 for settlement BLR (Brusnichko Lavcanski Reon) 4 L= approx. 3.5 km;

4.3.1. Investment measures for achieving the targets of Priority I

The layout presented as Annex 9-8 in this report outlines the current state within the defined agglomeration with respect to the existing sewerage system network and the proposed future constructions and connections to the main network and later to the future Waste Water Treatment Plant. The identified priority I projects and the defined measures for achieving the projects' targets are mainly focusing on settlements and villages which currently do not have a sewer network but are endowed with a water supply system and which are shall be connected to the future WWTP according to the defined agglomeration. Construction of pump stations and main collectors to connect the settlements and villages from the agglomeration to the future WWTP are also foreseen within the priority I investment.

4.3.1.1. Sewerage system for village Dolno Orizari

Sewerage network

Dolno Orizari is located northwest of Bitola town at a distance of approx. 4 km. The village is connected to the existing water supply system of Bitola.

There is an existing detailed project design for construction of the sewerage network of the village on the bases of which 90% of the network has already been constructed. Therefore, the construction of the remaining part of the sewerage network as well as connection of the existing system to the future WWTP is planned.

The Detailed Design for sewerage network of v. Dolno Orizari has foreseen a network with length L=12,000m with concrete pipes. The network already constructed has a length of app. 10,000 m and consists mainly of concrete pipes. The remaining network to be constructed has a length of app. 2,000 m, for which the consultant suggested PE pipes Ø300.

Due to the configuration of terrain and constructed area the sewerage network is planned with two main collectors to which the secondary network is connected.

The current outlet of the sewer collector is located near the bridge of the river Dragor where the village D. Orizari is connected with the village Karamani.

The designed manholes are made of reinforced concrete with Ø1,000 mm with inside steps and cast iron covers. Due the high level of underground water, minimum depth and slopes of the collectors are adopted.

Main collector

As mentioned above, Dolno Orizari currently discharges into river Dragor. It has been planned for this village to be connected to the future WWTP. In order to achieve this, the consultant has envisaged construction of a pressure main collector Ø250 with a length of approximately 2.3 km.

Pumping Stations
Due to the configuration of the terrain one pump station has been envisaged.

4.3.1.2. Sewerage collector from Kravari to the collector K0

There is no design documentation for this investment activity. The main purpose of this collector is to connect the existing sewerage system in Kravari to the Main Collector K0 of city of Bitola and further to the future WWTP. The envisaged length of the collector is about 3.3 km with diameter Ø160. In absence of design documentation, the Consultant has made an estimate of the required scope of works in terms of quantity and investment value.

Table 4-2 Estimate for construction of sewerage collector from Kravari

Collector - Kravari Ø 160	Unit measure	Quantity
Laying pressure pipe (160) in terrestrial soils	m	3,300.00
WWPSt Kravari - Machinery and equipment	Number	1
WWPSt Kravari - Construction works	Number	1

The Consultant proposes Polyethylene pipes Ø160 to be used and the calculations of the investment costs are done on this base.

4.3.1.3. Sewerage collector from the Industrial Zone in Bitola to the collector K1

There is no design documentation for this investment activity. The main purpose of this collector is to connect the sewerage system in Industrial Zone in the city of Bitola to the Collector K1 and further to the future WWTP. The envisaged length of the collector is about 2.93 km with diameter Ø700 mm. In absence of design documentation, the Consultant has made an estimate of the required scope of works in terms of quantity and investment value.

Table 4-3 Estimate for construction of sewerage collector from the Industrial Zone in Bitola

Collector – Industrial Zone Ø700	Unit measure	Quantity
Laying pressure pipe (700) in ground soil, CC GRP	m	2,930.00
WWPSt Industrial - Machinery and equipment	Number	1
WWPSt Industrial - Construction works	Number	1

The Consultant proposes Polyethylene pipes to be used and the calculations of the investment costs are done on this base.

4.3.1.4. Main collector from Bitola to the WWTP

There is no design documentation for this investment activity. The main purpose of this collector is to connect the sewerage system in city of Bitola to the future WWTP. The envisaged length of the collector is about 4.1 km with diameter range from Ø700 - Ø1,200 mm. In absence of design documentation, the Consultant has made an estimate of the required scope of works in terms of quantity and investment value.

Table 4-4 Estimate for construction of main sewerage collector from Bitola to WWTP

Collector – Bitola Ø700	Unit measure	Quantity
Laying of channel pipes in ground soil cover 2.5 m with asphalt pavement K-1.1		
Ø 700	m'	830
Ø1000	m'	920
Ø1200	m'	1,860
Discharge of overflow channels Ø1,000	m'	490
Water extraction	work shift	1,650
Overflow	Number	6
Passing under the River	Number	1
Discharge of overflow channels	Number	2

The Consultant proposes Polyethylene pipes to be used and the calculations of the investment costs are done on this base.

4.3.1.5. Replacement of Asbestos Cement pipes in the sewerage network in Bitola – I phase

As elaborated in the previous sections the total length of pipes composing the sewerage network of Bitola is 180 km, from which 120 km or nearly 67% are asbestos cement pipes. Staged replacement of these pipes is envisaged whereas in the first phase approximately 4% of the pipes.

For this purpose estimate has been made for the required scope of works in terms of quantity and investment value:

Table 4-5 Estimate for replacement of asbestos cement pipes in the sewerage network in Bitola

	pipe diameter in mm	length in km
Replacement ofasbestos cement pipes	Ø 200	2.8
	Ø 450	1.2
	Ø 800	1.2

The approx. length of asbestos cement pipes to be replaced in the first phase is estimated to 5.2 km.

4.3.1.6. Reconstruction and construction of Sewerage network for village Gorno Orizari

Gorno Orizari is located north of Bitola town. The village is covered approx. 90% with sewerage network. Due to the reported structural problems reconstruction of the existing sewerage network has been envisaged in length of approx.. 3.5 km. The reconstruction mainly envisages replacement of the existing concrete pipes. There is no design documentation for this investment activity, thus an estimate of the required scope of works in terms of quantity and investment value was made on the bases of the obtained layout of the existing sewerage network.

4.3.1.7. Operation and maintenance equipment

During the data collection the operation and maintenance performances and needs of JKP Niskogradba were also discussed. The entity has no or limited equipment and tools to provide for efficient operation and maintenance of the sewerage network. Thus the equipment and machinery listed below were identified as priority investments in order to improve the performance of the utility and network in general terms:

- Measuring equipment for waste water flow monitoring
- Specialized vehicle for sewerage network maintenance (combined vehicle for sewer water cleaning with high pressure pump and vacuum pump mud collecting)
- High pressure vehicle
- Vacuum vehicle for narrow streets
- CCTV sewerage inspection vehicle

4.3.2. Investment measures for achieving Priority II targets

In the group of Priority II investment measures, project investments for reconstruction of the existing sewerage network were envisaged mainly aimed at replacement of existing asbestos cement pipes as well as further development of the sewerage and storm water network. The following investment measures have been identified for achieving the Priority II targets with respect to the reconstruction and extension of the sewerage network:

4.3.2.1. Replacement of Asbestos Cement pipes in the sewerage network in Bitola – Phase II

As elaborated in point 4.3.1.5 replacement of asbestos cement pipes in the sewerage network of Bitola has been envisaged in two stages, whereas under the I priority investment measures, replacement of approximate5,2 km of the AC pipes has been envisaged. Thus with this investmentmeasure replacement of the remaining AC pipes is envisaged in length of approx.115 km.

	pipe diameter in mm	length in km
Replacement ofasbestos cement pipes – II phase	Ø200	2.00
	Ø250	43.20
	Ø300	45.60
	Ø350	6.00
	Ø400	8.40
	Ø500	4.80
	Ø600	4.80

4.3.2.2. Construction and Reconstruction of Storm water perimeter channels

Within the investment programmes of Bitola construction of new or reconstruction of the existing storm water channels around the city have been foreseen and detailed designs were performed for part of it. The consultant has reviewed the available designs and has collected further information from the Municipal representatives for those investment activities for which designs have not yet been performed. On the bases of the collected information the following subprojects have been defined as required investment activities under Priority II:

- Reconstruction of the storm water channel Kurderes; approx. L= 2,400m.
- Construction of the west storm water channel above settlements Bair; approx. L=760m app.
- Construction of the storm water perimeter channel above settlements Bair and G.Orizari; approx. L=3,100 m.
- Construction of the storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 1; approx. L=1,100m.
- Construction of the storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 2; approx. L=800m.
- Construction of storm water perimeter channel for settlement Bukovski Livadi L = approx.. 0.75 km

4.3.2.3. Sewerage system for village Bukovo

Sewerage Network

There is an existing detailed project design for construction of the sewerage network for the village of Bukovo. The summary of the scope of works envisaged with the detailed design is elaborated further bellow:

Bukovo is located in the southern part of city of Bitola at a distance of approx. 5 km and has a water supply network constructed but not a sewerage system. With the detailed design the new sewerage system has been envisaged from PVC pipes, Ø200mm. After the discussions with JKP Niskogradba's representatives, the consultant has suggested modification of the envisaged pipes with PVC or PE Ø 300.

Main collector

A main collector Ø300 connecting the village Bukovo with main collector K0 of the city of Bitola has also been envisaged.

The length of the sewerage network and main collector will be approximately 6.45 km.

Pump Stations

Due to the configuration of the terrain two pump stations will be necessary

4.3.2.4. Storm water network for City of Bitola

Most of the sewer network of City of Bitola is a combined system. As such and with the urban development of the city the load on the existing combined network is constantly increasing which causes frequent problems in the network especially during the heavy rainfall periods.

It has been therefore proposed to construct separate storm water network in parts of the city along the main streets which would contribute to the relief of the sewer load as follows:

- Construction of storm water network for main collector for street Partizanska, Bitola
- Construction of storm water network for Solunska street, Bitola
- Construction of storm water network for main collector for the boulevard 1st May, Bitola

In absence of design documentation, the Consultant has made the following estimate of the required scope of works in terms of quantity and investment value:

Table 4-6 Estimate for construction of storm water collector for Partizanska street , Bitola

New storm water network for main collector network for the street Partizanska - Bitola	**Unit measure**	**Quantity**
Length	m	4,100.00
Excavation	m3	8,200.00
Filling	m3	7,380.00
Sand	m3	820.00
Transport	m3	0.00
Pipe	m	4,100.00
PE ID 600	m	1,000.00
PE ID 800	m	1,000.00
PE ID 1000	m	2,100.00
Manholes	piece	90.00
Gutters	piece	140

Table 4-7 Estimate for construction of storm water network for Solunska street , Bitola

New storm water network for Solunska street, Bitola	Unit measure	Quantity
Length	m	1100.00
Excavation	m3	3740.00
Filling	m3	2700
Sand	m3	190.00
Transport	m3	1050.00
Pipe		
PE ID 1000	m	1,100.00
Manholes	piece	25
Gutters	piece	40

Table 4-8 Estimate for construction of storm water collector for 1st May street , Bitola

New storm water network for main collector network for boulevard 1st May, Bitola	**Unit measure**	**Quantity**
Length	m	2,900.00
Excavation	m3	5,800.00
Filling	m3	5,220.00
Sand	m3	580.00
Transport	m3	0.00
Pipe	m	2,900.00
PE ID 600	m	800.00

PE ID 800	m	700.00
PE ID 1000	m	1,400.00
Manholes	piece	65.00
Gutters	piece	97

4.3.3. Investment measures for achieving the targets of Priority III

In the group of Priority III investment measures for reconstruction of the existing sewerage network were further envisaged mainly aimed at replacement of existing concrete and concrete reinforced pipes as well as construction of the sewerage system and connection to the future WWTP of the remaining villages from the defined agglomeration.

4.3.3.1. Replacement of concrete and reinforced concrete pipes in the sewerage network in Bitola

The existing concrete and reinforced concrete pipes in the sewerage network of Bitola are also envisaged to be replaced under the priority III investment measures. As elaborated in the previous sections the total length of pipes composing the sewerage network of Bitola is 180 km, from which 25 km or nearly 14% are concrete and reinforced concrete pipes. For this purpose estimate has been made for the required scope of works in terms of quantity and investment value:

	pipe diameter in mm	length in km
Replacement of concrete and reinforced concrete pipes	250	1.25
	300	3.5
	400	2.5
	500	2.5
	600	1.5
	700	1.25
	800	1

4.3.3.2. Sewerage network for village Karamani, pumping stations and pressure main collector

Currently there is no sewerage network in the village of Karamani. Design documentation for construction of the required sewerage network has not yet been performed. Thus, in absence of design documentation, the Consultant has made an estimate of the required scope of works in terms of quantity and investment value.
It is proposed that the sewerage network of Karamani will be connected with one main pressure collector to the pressure collector of Dolno Orizari. A pumping station has also been foreseen. The sewerage network shall be constructed from pipes with diameter Ø300 and a length of approximately 5.6 km. In absence of technical documentation for the proposed investments the following estimate has been made by the Consultant:

Sewerage network and PC for village of Karamani	**Unit measure**	**Quantity**
Laying of channel pipes in ground soil cover 3.0 m with asphalt pavement K-1.1 Ø300	m	5,590.00
Water extraction	work shift	480
Sewerage connections for houses	Number	560
Laying of pressure pipeline in ground soil		
WWPSt Karamani 1 Ø75	m'	360
WWPSt Karamani 2 Ø110	m'	220
Machinery and equipment		
WWPSt Karamani 1	number	1
WWPSt Karamani 2	number	1

Construction works WWPSt Karamani 1	number	1
Construction works WWPSt Karamani 2	number	1

4.3.3.3. Sewerage network for village Lavci, pumping station and main collector

Currently there is no sewerage network at the village of Lavci. Design documentation for construction of the required sewerage network has not yet been performed. Thus, in absence of design documentation, the Consultant has made an estimate of the required scope of works in terms of quantity and investment value.

It is foreseen that the sewerage network of Lavci will be connected with one main collector to the main collector to Bitola. Pumping station has also been anticipated. The sewerage network shall be constructed from pipes with diameter Ø300 and a length of approximately 3.0 km. In absence of investment technical documentation the following estimate has been made by the Consultant:

Sewerage network and PC for village of Lavci	Unit measure	Quantity
Laying of channel pipes in ground soil cover 2.5 m with asphalt pavement K-1.1 Ø300	m	1,250
Laying of channel pipes in a rock soil cover 2.5 m with asphalt pavement K-1.1 Ø300	m	1,750
Water extraction	work shift	320
sewerage connections for houses	Number	616
Passing under the road-jacking	m	20
Passing under the River - 2 nr.	m	45
Laying of pressure pipeline in ground soil	m'	45
Laying of pressure pipeline in a rock soil	m'	105
Machinery and equipment WWPSt Lavci	number	1
Construction works WWPSt Lavci	number	1

4.3.3.4. Sewerage network for village Brustnik, pumping station and main collector

Currently there is no sewerage network at village of Brustnik. Design documentation for construction of the required sewerage network has not yet been performed. Thus, in absence of design documentation, the consultant has made an estimate of the required scope of works in terms of quantity and investment value.

It is foreseen that the sewerage network of Brustnik will be connected with one main collector to the main collector to Bitola. A pumping station has also been foreseen. The sewerage network shall be constructed from pipes with diameter Ø300 with a length of approximately 4.7 km. In absence of technical documentation for the investment the following estimate has been made by the Consultant:

Sewerage network and PC for village of Brustnik	Unit measure	Quantity
Laying of channel pipes in ground soil cover 2.5 m with asphalt pavement K-1.1 Ø300	m	4,700
Water extraction	work shift	320
sewerage connections for houses	Number	440
Passing under the road-jacking	m	20
Laying of pressure pipeline in ground soil	m'	145
Machinery and equipment WWPSt Brustnik	number	1
Construction works WWPSt Brustnik	number	1

4.3.3.5. Extension of sewerage network in the city of Bitola – Construction of sewerage network for district Strcin, BLR (Brusnichko Lavcanski Reon) 3, BLR (Brusnichko Lavcanski Reon) 4

Urban development plans of the City of Bitola have foreseen further development of the city through construction of new residential areas and extension of the existing ones. This also requires development of the existing city sewerage network and further connection of the new settlements. With the annual development programme of the Municipality construction of the sewerage network in city district Strcin, BLR (Brusnichko Lavcanski Reon) 3, BLR (Brusnichko Lavcanski Reon) 4 has been envisaged and detailed designs prepared, which the consultant has reviewed during the course of preparation of this document.

With the said detailed designs the following investment activities have been foreseen and were elaborated:

- Construction of approx. 1.4 km sewerage network for district Strcin Ø300
- Construction of approx. 2.3 km sewerage network for district BLR (Brusnichko Lavcanski Reon) 3 Ø300
- Construction of approx. 1.8 km sewerage network for district BLR (Brusnichko Lavcanski Reon) 4 Ø300

4.3.3.6 Construction of storm water network in the city of Bitola – storm water system for district Strcin, BLR (Brusnichko Lavcanski Reon) 3, BLR (Brusnichko Lavcanski Reon)4

Urban development plans of City of Bitola foresee further development of the city through construction of new residential area and extension of the existing ones. This also requires development of the city's storm water network which currently only partially exists. With the annual development programme of the Municipality construction of the storm water network in city district Strcin, BLR (Brusnichko Lavcanski Reon) 3, BLR (Brusnichko Lavcanski Reon) 4, has been envisaged and detailed designs prepared, which the consultant has reviewed during the course of preparation of this document.

With the said detailed designs the following investment activities have been anticipated and elaborated:

- Construction of approx. 2.75 km storm water network for district Strcin Ø250 – Ø400
- Construction of approx. 1.5 km storm water network for district BLR (Brusnichko Lavcanski Reon) 3 Ø250 – Ø300
- Construction of approx. 3.5 km storm water network for district BLR (Brusnichko Lavcanski Reon) 4 Ø300 – Ø400

4.3.4. Summary of the investment measures

A summary of the investment measures by priority envisaged to be implemented on the sewerage system is presented in the following table:

Table 4-9 Summary of the investment measures in the sewerage system in Bitola agglomeration

No.	Description	Diameter	Length
I	**Investment measures for achieving the targets of Priority I**		
1.1.	▪ Sewerage network for village Dolno Orizari – remaining part ▪ Pressure main collector to WWTP	▪ Ø300 ▪ Ø250	2.0 km 2.3 km
1.2.	Pressure main collector from Kravari to collector K0 and Pumping Station	▪ Ø160	3.3 km
1.3.	Pressure main collector from the Industrial Zone in Bitola to collector K1 and pumping station	▪ Ø700	2.93 km
1.4.	Construction of main collector from Bitola to the WWTP Ø700- Ø1,200 and river crossing	▪ Ø700 ▪ Ø1,000 ▪ Ø1,200	0.83 km 1.41 km 1.86 km

1.5.	Reconstruction of the exiting sewerage network - Replacement of asbestos cement pipes in Bitola – Phase I	▪ Ø200 ▪ Ø450 ▪ Ø800	2.80 km 1.20 km 1.20 km
1.6.	Reconstruction and construction of Sewerage network for village Gorno Orizari	▪ Ø200 ▪ Ø250 ▪ Ø300	3.5 km
1.7.	Measuring equipment for waste water flow monitoring	Pcs.	1
1.8.	Specialized vehicle for sewerage network maintenance (combined vehicle for jetting and suction of sewerage)	Pcs.	1
1.9.	High pressure vehicle	Pcs.	1
1.10.	Vacuum vehicle for narrow streets	Pcs.	1
1.11.	CCTV sewerage inspection vehicle	Pcs.	1
II	**Investment measures for achieving the targets of Priority II**		
2.1.	Reconstruction of the exiting sewerage network - Replacement of asbestos cement pipes in Bitola – Phase II	▪ Ø200 ▪ Ø250 ▪ Ø300 ▪ Ø350 ▪ Ø400 ▪ Ø500 ▪ Ø600	2.00 km 43.20 km 45.6 km 6.00 km 8.40 km 4.80 km 4.80 km
2.2.	Reconstruction of the storm water channel Kurderes		2.4 km
2.3.	Construction of west storm water channel above settlements Bair		0.76 km
2.4.	Construction of the east storm waterr channel above settlements Bair and G.Orizari		3.1 km
2.5.	Construction of the storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 1		1.1 km
2.6.	Construction of the storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 2		0.8 km
2.7.	Construction of the storm water perimeter channel for settlement Bukovski Livadi		0.75 km
2.8.	Sewerage network for village Bukovo Main collector to Bitola	▪ Ø300 ▪ Ø300	6.45 km
2.9.	Construction storm water network for main collector for the street Partizanska - Bitola	▪ Ø600 ▪ Ø800 ▪ Ø1000	1.0 km 1.0 km 2.1 km
2.10.	Construction storm water network for main collector for the street Solunska - Bitola	▪ Ø1000	1.1 km
2.11.	Construction storm water network for main collector for the Blvd. 1st May - Bitola	▪ Ø600 ▪ Ø800 ▪ Ø1000	0.8 km 0.7 km 1.4 km
III	**Investment measures for achieving the targets of Priority III**		
3.1.	Replacement of concrete and concrete reinforced pipes in Bitola	▪ Ø250 ▪ Ø300 ▪ Ø400 ▪ Ø500 ▪ Ø600 ▪ Ø700 ▪ Ø800	1.25 km 3.5 km 2.5km 2.5 km 1.5 km 1.25 km 1.0 km

3.2.	▪ Sewerage network for village of Karamani ▪ Pressure main collector to the PC Dolno Orizari	▪ Ø300 ▪ Ø75 - Ø 110	5.6 km 0.58 km
3.3.	▪ Sewerage network for village Lavci ▪ Main collector to Bitola	▪ Ø300 ▪ Ø300	3.0 km
3.4.	▪ Sewerage network for village Brustnik ▪ Main collector to Bitola	▪ Ø300 ▪ Ø300	3.4 km 1.3 km
3.5.	▪ Sewerage network for district Strcin	▪ Ø300	1.4 km
3.6.	▪ Sewerage network for district BLR (Brusnichko Lavcanski Reon) 3	▪ Ø300	2.3 km
3.7.	▪ Sewerage network for district BLR (Brusnichko Lavcanski Reon) 4	▪ Ø300	1.8 km
3.8.	▪ Construction of storm water network for district Strcin	▪ Ø400 ▪ Ø300 ▪ Ø250	0.13 km 0.32 km 2.30 km
3.9.	▪ Construction of storm water network for district BLR (Brusnichko Lavcanski Reon) 3	▪ Ø300 ▪ Ø250	0.20 km 1.30 km
3.10.	▪ Construction of storm water network for district BLR (Brusnichko Lavcanski Reon) 4	▪ Ø400 ▪ Ø300	0.7 km 2.8 km

4.3.5. Priority Investment Programme for the extension and reconstruction of the sewer network of the agglomeration for the period 2014-2039

Table 4-10 Investment needs in the sewerage system in Bitola agglomeration

No.	Description	Value (EURO)
I. Investment measures for achieving the targets of Priority I		
1.1.	Construction of 2.0 km secondary sewerage network Ø300 and app. 2.3 km pressure main collector from village Dolno Orizari	772,400
1.2.	Construction of app. 3.3 km main collector from Kravari to collector K0 Ø160 and Pumping Station	413,500
1.3.	Construction of app. 2.93 km pressure main collector from the Industrial Zone in Bitola to collector K1 Ø700 and pumping station	3,030,100
1.4.	Construction of app. 4.1 km main collector from Bitola to the WWTP Ø700- Ø1200 and river crossing	3,042,380
1.5.	Reconstruction of the exiting sewerage network - Replacement of asbestos cement pipes in Bitola – Phase I	1.000,000
1.6.	Reconstruction and construction of Sewerage network for village Gorno Orizari	616,500
1.7.	Measuring equipment for waste water flow monitoring	25,000
1.8.	Specialized vehicle for sewerage network maintenance (combined vehicle for jetting and suction of sewerage)	400,000
1.9.	High pressure vehicle	150,000
1.10.	Vacuum vehicle for narrow streets	150,000
1.11.	CCTV sewerage inspection vehicle	75,000
	Total Priority I	***9,674,880***

II. Investment measures for achieving the targets of Priority II		
2.1.	Reconstruction of the exiting sewerage network - Replacement of asbestos cement pipes in Bitola – Phase II	22,622,000
2.2.	Reconstruction of the storm water channel Kurderes with total length L=2,400m	1,557,380
2.3.	Construction of the west storm water channel above settlements Bair with total with length L=760m	98,360
2.4.	Construction of the east storm water channel above settlements Bair and G.Orizari with total length L=3,1 m	590,165
2.5.	Construction of the storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 1 with total length L=1,1 m	442,620
2.6.	Construction of the storm water channel above settlements BLR (Brusnichko Lavcanski Reon) part 2 with total length L=800m	340,000
2.7.	Construction of the storm water perimeter channel for settlement Bukovski Livadi	122,000
2.8.	Construction of app. 6.45 km sewerage network for village Bukovo Ø300, main collector Ø300 to Bitola and two pumping stations	1,237,450
2.9.	Construction of app. 4.1 km storm water network for main collector for the street Partizanska - Bitola Ø600 – Ø1,000	573,120
2.10.	Construction storm water network for main collector for the street Solunska - Bitola	176,000
2.11.	Construction of app. 2.9 km storm water network for main collector for the boulevard 1st May - Bitola Ø600 – Ø1,000	403,520
	Total Priority II	***28,162,615***
III. Investment measures for achieving the targets of Priority III		
3.1.	Replacement of concrete and concrete reinforced pipes in BitolaØ250 – Ø800	3,795,000
3.2.	Construction of sewerage system of app. 5.6 km in Karamani Ø300, pumping station and app. 0.58 km pressure main collector to the PC Dolno Orizari Ø75-110	1,146,185
3.3.	Construction of app. 3.0 km sewerage network and main collector to Bitola for village Lavci Ø300 and pumping station	749,185
3.4.	Construction of app. 4.7 km sewerage network and main collector to Bitola for village Brustnik Ø300 and pumping station	1,311,900
3.5.	Construction of app. 1.4 km sewerage network for district Strcin Ø300	122,000
3.6.	Construction of app. 2.3 km sewerage network for district BLR (Brusnichko Lavcanski Reon) 3 Ø300	212,500
3.7.	Construction of app. 1.8 km sewerage network for district BLR (Brusnichko Lavcanski Reon) 4 Ø300	157,000
3.8.	Construction of app. 2.75 km storm water network for district Strcin Ø250 – Ø400	236,885
3.9.	Construction of app. 1.5 km storm water network for district BLR (Brusnichko Lavcanski Reon) 3 Ø250 – Ø300	142,900
3.10.	Construction of app. 3.5 km storm water network for district BLR (Brusnichko Lavcanski Reon) 4 Ø300 – Ø400	318,650
	Total Priority III	***8,192,470***
	TotalPriority I, II and III	**46,029,965**

Contingencies (5 %)	2,301,498
Costs for design works (5 % from the investment cost)	2,301,498
Cost for supervision (7 % from the investment cost)	3,222,098
Total Investment Cost	**53,855,059**

4.4. Targets for Improving and Developing the Wastewater Treatment

The main goal in the development of the water sector in the Municipality of Bitola is the treatment of wastewater from the town of Bitola and the surrounding villages, included in the agglomeration: Gorno Orizari, Dolno Orizari, Kravari, Karamani, Brustnik, Bukovo and Lavci. The constructing of a wastewater treatment plant in compliance with the local and European legislation is a priority, which will improve the environmental parameters.

Treatment of the urban wastewater aims to achieve the requirements related to the country's accession to the European Union and the undertakings made in this respect for the commitments to comply with the EU directives:

- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (in the short "Water Framework Directive)
- Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment

A construction of modern facilities for wastewater treatment in the region, in line with European quality standards for discharged water, will eliminated the adverse impacts on the environment.

Implementation of the project for construction of WWTP for the town Bitola has the following specific objectives:

- Treatment of all wastewater in suitable facilities in compliance with the requirements and time limits, provided in Macedonian and European normative acts
- Improving the quality of surface water and eliminating the adverse environmental impact;
- Achieve a lasting positive effect on preventing health risks to residents and visitors in the area;
- Improving the quality of life of the inhabitants of the settlements included in the project scope;
- Providing better services to the population and business of social affordable prices;
- Eliminating illegal discharges of untreated sewage into the river;
- Achieving a quality of the treated water, meeting the requirements of Directive 91/271/EC and thus to improve the ecological status of the receiving waters - River Dragor and Crna River.

The investment measures proposed for this measure are presented in the table below. A description of options for the proposed treatment plan is presented in Chapter 5 below.

Table4-11Investmentneedsforwastewatertreatmentin Bitolaagglomeration

No.	Description	Value (EURO)
I. Investment measures for achieving the targets of Priority I		
1.1.	WWTP for the agglomeration of Bitola	12,000,000
II. Investment measures for achieving the targets of Priority II		
2.1.	Extension of the WWTP Bitola for nitrogen and phosphorus removal	1,250,000
	TotalPriority I and II	**13,250,000**
Contingencies (5 %)		662,500
Costs for design works (1.5% from the investment cost)		198,750
Cost for supervision (7 % from the investment cost)		927,500
	Total Investment Cost	**15,038,750**

5. ANALYSIS OF ALTERNATIVES

5.1. Definition of basic options

5.1.1. Location of the future WWTP

During the course of data collection and preparation of this document several options were reviewed and discussed with the Municipal representatives in order to select the most suitable location for the future WWTP. The alternatives reviewed and their advantages and disadvantages are presented in the table below:

Option	Advantages	Disadvantages
Option 1: East of Bitola, on the road to v. Logovardi, close to the city	- Larger part state owned land - good infrastructure connection - close to the recipient river	- Insufficient space for construction (6 ha approx...) - partially owned by private owners
Option 2: North of Bitola near the new graveyards, between villages Dolno and Gorno Orizari on cadastre parcel No. 25, KO Bitola 5	- state owned land - sufficient construction surface (55 ha) - good infrastructure connection - close to the recipient river - sufficient distance to residential areas - lower costs for construction of collectors	
Option 3: East of Bitola near the road to v. Logovardi on cadastre parcel No, 855/1 and 193	- state owned land - sufficient construction space (25,8 ha) - good infrastructure connection - sufficient distance to residential areas	- distance to the discharge point - larger financial costs for construction of collectors

On the bases of the above, **option 2** has been selected as most adequate location of the future WWTP.

5.1.2. Water supply and sewerage

For the purpose of solving the problems in the water sector in Bitola agglomeration, the key problems whose solution will result in the improved quality of water supply and sewerage services to the population in the defined agglomeration were evaluated. The requirements resulting from the national legislation as well as the EC legislation were considered and in this respect a number of alternatives for investments have been evaluated. The different technical approaches, related to the above described measures, and the financialparameters for their implementation were reviewed and evaluated. Special mentioning shouldbe made to the circumstance that in the preparation of the current Master Plan the municipalityof Bitola was in an advanced stage of preparation of some of the water supply investment analysis under the KfW funded Water and Sewerage Network programme.

The following methods were used for evaluation of the alternatives:

- Different alternatives for the development of the water supply and sewerage network in the agglomeration, depending on the development of the settlements
- Evaluation of different options for replacement of out-dated water and sewerage networks – based on existing information for their condition, leakages, failures, etc.;
- The capacity of municipality Bitola, JKP “Vodovod” and JKP “Niskogradba” to finance the on-going large scale investments in the water supply and sewerage sector in Bitola. For this

purpose, an analysis of the capacity of the JKP "Vodovod" and JKP "Niskogradba" to generate revenues was performed for the overall 25 year period.

5.1.3. Waste Water Treatment

In order to achieve the best alternative for the design of the Bitola WWTP, it is necessary to evaluate the treatment process technologies available in terms of various monetary as well as non-monetary parameters. These options comprise:

- Primary sedimentation, which is the most efficient mechanism for the removal of floating and suspended solids, both fine and coarse, from raw sewage. Thus, the foul wastewater is treated by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD_5 of the incoming wastewater is reduced by at least 20% before discharge and the total suspended solids of the incoming wastewater are reduced by at least 50%;
- Secondary biological processes, which are efficient in the removal of organic substances that are either in the colloidal size range or soluble. Secondary biological processes essentially provide for the removal of 85% of the conventional pollutants (materials which deplete oxygen from the water: biochemical oxygen demand and suspended solids), and provide acidity control (pH);
- Sludge treatment and disposal - a product of the wastewater treatment process is waste sludge, which can be utilized in different forms depending on the unit treatment process. In considering sludge characteristics required it is then necessary to examine the treatment technologies which are available with the respect to their performance, reliability, standard of maintenance, capital costs and operating costs.

Some processes, however, such as aerated lagoons, stabilization ponds, and extended aeration systems, are designed to operate without primary sedimentation.

PreliminaryTreatment

Municipal wastewater contains pieces of wood, plastic, rags and other large objects which if not removed can clog intake pipes, flow measurement devices or pumps and can cause many operational problems.The objective of preliminary treatment is to remove coarse impurities, sand and grease from wastewater. In general preliminary treatment involves treatment units including:

- Screening and screening's washing/compaction
- Grit removal
- Grease and oil separation.

Primary Treatment

Primary clarifiers are generally used to reduce the solids and organic loading on subsequent treatment units. The main objective of primary treatment is the removal of organic or inorganic settleable solids by settlement for a specific period of time in sedimentation tanks after preliminary treatment.

Primary clarifiers reduces load to subsequent units, but increase load for sludge treatment (require sludge digestion).

Secondary Treatment

Biological treatment comprises the removal of the soluble and colloidal organic matter. The removal can be accomplished by chemical or biological means. In case of mainly domestic sewages, biological treatment is the preferred process.

Removal of carbonaceous compounds is accomplished by biological processes, which are used to convert the finely divided and dissolved organic matter in sewage into settleable biological solids that can be removed in settling tanks (or other alternatives like membranes).

The common biological processes that can be used for medium size WWTPs are:

Conventional Activated sludge

This treatment process involves the aeration of settled sewage mixed with return activated sludge in an aeration tank. Aeration is normally via Fine Bubble diffused aeration with diffusers fixed in a grid array on the tank floor or alternatively via surface aerators.

Activated sludge process is a unit process comprising a biological reactor (activated sludge tank) with associated aeration equipment and a secondary settling tank, both connected by a return sludge recirculation pipeline. The biomass generated in the aeration process is removed via settling in the secondary settlement tank, with a percentage of the settled sludge being re-circulated to the inlet of the aeration tank as return activated sludge to maintain the biomass concentration in the aeration tank.

Depending on treatment targets different zones with different conditions are established inside AT. These zones are mainly categorized according to their oxygen and nitrate content. Anoxic and anaerobic zones are usually equipped with mixers to keep the MLSS in suspension.

What all conventional AS processes have in common, is a need for separate sludge stabilization. This is sometimes done aerobically, which is costly but relatively simple. Hence, the typical solution for sludge stabilization is mesophilic anaerobic digestion. This process is more risky due to the handling of explosive biogas. But the biogas can be used for heating of the digester and operation buildings, in parallel to the production of electric energy.

Extended aeration

The extended aeration is a special type of the activated sludge process. In this process the volume of aeration tank is increased such that the sludge is already stabilized inside the tanks. There is no need for further stabilization. The essential difference between an extended aeration plant and a conventional activated sludge plant is the retention time and the profile and variety of the micro-organisms which inhabit the aeration stages of each process.

The extended aeration process produces a relatively small amount of sludge which is stable and relatively easy to dewater.

The advantages of this process are lower overall investment cost, lesser requirements to number and skills of operators, very robust process in case of strong influent and small toxic shocks, due to large volume. The disadvantages are somewhat higher O&M cost.

Activated sludge withalternating denitrification

This method is a special type of the activated sludge process. The period of aeration is equivalent to the aeration phase, while the period of aeration stoppage is the equivalent of the anaerobic phase. Thus, nitrification and denitrification stages are maintained at different times in the aeration tank and are repeated in a continuous loop. Unless there are extreme fluctuations in influent sewage quality, the system can provide a very stable good quality effluent which has a very high efficiency in ammonia reduction.

Aerated lagoons

Aerated Lagoons come in many variations. In general, they can be grouped into:

- Aerated Lagoons with sludge recycle.
- Aerated Lagoons without sludge recycle.

The first group is basically the same as the AS process, just with the Aeration Tank (AT) being implemented as lagoon instead of a concrete tank. Such an approach makes particular sense for large WWTPs, where it sometimes turns out to be more cost effective constructing dams instead of concrete walls. - Regarding the process elements, please take reference to the flow-sheet of the 1-stage AS process.

The second group does away with Final Sedimentation Tanks. Depending on project specifics, sometimes the final zone of such lagoons is not aerated any more, to reduce solids being flushed out into the effluent. What all such units have in common though, is very low MLSS concentrations. This makes these systems very large, yet still implicating relatively inferior effluent quality to other systems.

Consequently, such systems are not being newly constructed nowadays any more, apart from the odd exception somewhere.

Trickling Filter (TF)

Trickling Filters (TFs) consist of a media bed over which pre-settled wastewater is continuously distributed. It trickles through the filter and is then collected in an underdrain system. As the wastewater is flowing over the filter media (sometimes also called "packing") a microbial slime layer develops on this media. The organics of the wastewater are adsorbed and absorbed to be degraded by the micro-organisms present in this slime layer. With growing thickness of the slime layer the micro-organisms nearest to the filter media receive less and less oxygen, and eventually die off. Thus they lose their ability to cling to the media, and are subsequently washed out. This phenomenon of losing the biological slime is called "sloughing". The higher the organic loading on a filter, the higher the growth rate of the micro- organisms, and the higher is the hydraulic load to provide a sufficient sloughing effect and to avoid clogging. Too much slime within the voids of the filter media would hamper wastewater flow and air circulation.

Since influent hydraulic load can be insufficient, it is common practice to introduce a recirculation of treated effluent to have an operating means to increase the hydraulic load on the TF. This recirculation is mostly only operated during periods when the influent flow rate falls below a defined minimum value.

TFs do not need artificial aeration, which is why they feature low energy/operation cost. They used for carbon remove only.

The effluent of TFs contains the sloughed slimy sludge particles. These are diverted into a sedimentation tank, wherein the biological sludge is separated from the clear effluent. Generally this sludge has better settling properties as activated sludge.

The sludge has to be stabilized separately as explained in the chapter on Activated Sludge.

Rotating Biological Contactor (RBC)

RBCs - just like Trickling Filters - are also based on the principle of attached growth of micro-organisms. The only difference being the technical implementation.

RBCs consist of a large horizontal shaft with mounted plastic media that are partially (mostly about 40%) submerged, and the rest being above water level. The shaft is rotated slowly (1-2 rpm) by means of an electric motor. The plastic media typically features circular plastic disks with very small open spacing between the individual disks, which are mounted perpendicular to the shaft. A standard RBC unit may have a surface area of several thousand m^2. Submerged RBCs with about 70-90 % submergence have not proven successful, particularly due to insufficient oxygen supply.

Aeration is accomplished by the exposure of the biofilm to the atmosphere. Biofilm sloughing is achieved by the wastewater flowing along the disk surfaces back into the holding tank.

A sedimentation unit after the RBC is required to separate the sloughed sludge from the clear effluent.

RBCs suffer particularly from problems with bearings and shaft failure. Generally, their application is mostly limited to small units.

Tertiary Treatment

Tertiary treatment is the advanced treatment process, following secondary treatment of waste water, that produces high-quality water. Tertiary treatment includes removal of nutrients such as phosphorus and nitrogen and practically all suspended and organic matter from waste water.

Removal of nitrogen compounds may be accomplished by physical, chemical or biological methods.

Physical methods include air stripping of ammonia or ion exchange and are generally applied in freshwater (groundwater) treatment. Physical methods are not considered for wastewater treatment.

Chemical methods include breakpoint chlorination, where chlorine is added to sewage to oxidize the ammonia in solution to nitrogen gas and other compounds. This process has a lot of disadvantages such as requiring high chlorine dosages, high operating cost due to chemical requirement and requires high skilled operators. Generally the efficiency of these methods will not yield an effluent that meets the effluent quality criteria and consequently will not be considered.

Biological methods for the removal of nitrogen are involves two step process Nitrification/Denitrification. Two configurations can be applied, separate nitrification/denitrification and combined nitrification/denitrification systems.

Phosphorous may be present in wastewater as organic or inorganic, In general it is present as orthophosphate, polyphosphate, pyrophosphate or organic phosphate. Orthophosphate is the dominating compound.

Phosphorus compounds may be removed by means of chemical or biological processes.

Sludge Treatment

All sewage treatment plants produce sludge as a by-product. The quantity and quality of this sludge is dependent upon the method of sewage treatment and therefore sludge treatment and disposal must be considered as an important part of the sewage treatment process.

Raw sewage sludge can rarely be disposed of without additional treatment, enabling environmentally acceptable disposal. Sludge has high water content and contains harmful bacteria, consequently sludge has to undergo a series of processes prior to final disposal or re-use. The most common processes of sludge treatment comprise thickening, digestion and dewatering.

The first step on sludge handling is the thickening process which aims at increasing the solid fraction in the sludge by removing a significant portion of the liquid mass. Thickening can be accomplished by gravity or mechanical means. Gravity thickening is similar to settling tanks. Mechanical thickening systems include Gravity Belt Thickeners, Rotary Drums, Dissolved Air Flotation and centrifuges.

The second step in sludge handling is the stabilization of sludge. The most common system used for medium size to large municipal wastewater treatment facilities is sludge digestion which converts the organic solids to a stabilized material that can be easily handled and processed for further treatment. Digestion is the process whereby complex organic matter in the sewage sludge is broken down, by the action of bacteria and microorganisms, either aerobically or anaerobically, into simpler and more stable compounds. Anaerobic digestion takes place without the addition of oxygen, and produces methane gas, carbon dioxide and water as by-products.

The last step in sludge handling is sludge dewatering that reduces the water content of the sludge increasing the dried solids content of approximately 4% DS from the conditioning system to approximately 25% DS after pressing. Polymers have to be added that condition the sludge and drastically improve the dewater ability characteristics. Sludge dewatering may be accomplished by three means of equipment: centrifuges, belt filter presses and chamber filter presses.

5.2. Evaluation of alternatives

5.2.1. Water supply and sewerage

Considering that the Municipality has already prepared investment documentation for part of some of the envisaged investment measures, the design documents were reviewed and elaborated towards defining the best feasible design solution in terms of works and value.

More specifically the Consultant has reviewed the following designs and has proposed alternatives to the designs:

Sewerage network for village Dolno Orizari - remaining part

The existing detailed design envisages the wastewater from the sewer system to be discharged at outlet point in River Dragor.

An alternative solution is recommended for the sewerage system to be connected to the future WWTP, through pressure main collector and pump station (Annex 9-8)

In addition and in order to ensure efficient operation and maintenance of the designed network the Consultant recommended replacement of the designed Ø250 PVC pipes with PVC or PE Ø 300.

Sewerage network for village of Bukovo

With the existing detailed design the sewerage network of village Bukovo has been designed with PVC pipes, Ø200mm. In the discussions with JKP Niskogradba's representatives, the option for modification of the envisaged pipes with PVC or PE Ø 300 has been proposed. This alternative has been evaluated and is recommended in order to achieve optimal operation and maintenance of the sewerage network.

5.2.2. Waste Water Treatment

InthisMasterPlanproposed optionsareassessed intermsoftechnicalandwherepossible environmentalbenefits. A detailed option analysis including cost efficiency and present cost is foreseenduringthefeasibilitystudyphase.

The selection of the most appropriate treatment process is generally based on the following general requirements:

- Process reliability: Processes with high reliability and least sensitive to shock loading, operator errors, power failure and inadequate maintenance are to be preferred.
- Requirements for discharges: as per UWWTD 91/271/EEC.
- Energy requirements: The process option with lower energy consumption is preferred, not only due to lower operational costs but also in terms of lower environmental impact on air pollution (CO_2, NOx emissions etc.).
- Sludge handling: While sludge may sometimes be a useful by-product in the form of fertilizer or soil conditioner, there is no doubt that treatment and disposal of sludge are often the most difficult and costly aspects of treatment plants. Therefore, processes that produce predictable, stable sludge and have a low production rate are to be preferred.
- The Plant shall be designed in modules for flexibility of construction in phases as needed and to facilitate maintenance and repair works.
- Layout of treatment facilities to achieve economy, efficiency and effectiveness in operation and performance.
- To have easily accessible equipment and facilities to facilitate maintenance and replacement.

The following table summarizes the technical arguments for the different treatment processes and gives an evaluation of the operation under general conditions.

Alternative	**Advantages and disadventages**
Conventional Activated sludge	Advantages: Flexible operation. Relatively small footprint (0.4 m^2/PE_{60}). Subsequently: less heavy metal introduction into sludge through precipitant, less overall sludge production than with option, no increase of salinity of recipient water, higher pH in effluent and thus more stable nitrification. Disadvantages: Requires separate sludge stabilization. Requires skilled operators. Relatively high cost for Electro Mechanical (EM) equipment. Not economic below a certain threshold size (= 20,000 - 30,000 PE_{60}). Justification for selection: Well-known and well-proven technology. Capable to meet discharge standards. Most widely used wastewater treatment for domestic purposes, process well documented.
Extended aeration	Advantages: Flexible and simple operation. Does not require separate sludge stabilization. Relatively low requirements as to operator's skills. Relatively small

	footprint (= 0.4 m^2/PE_{60}). Disadvantages:Requires large tank volumes. Relatively high O&M cost. Justification for selection: Flexible and simple operation, little requirements to operator's skills.
Activated sludge withalternating denitrification	Advantages: Flexible operation. Capable to meet discharge standards. Disadvantages: .Requires separate sludge stabilization. Justification for non-selection: Flexible operation. Most widely used wastewater treatment for domestic purposes, process well documented.
Aerated lagoons	Advantages: Basically the same concept as conventional activated sludge, but implemented in lagoons instead of concrete tanks. Disadvantages: Requires large lagoon volumes and much land due to low MLSS concentrations. Economically not attractive. Justification for non-selection: Inefficient and expensive
Trickling Filter (TF)	Advantages: Well-suited process for carbon removal only. Reduced energy needs. Relatively small footprint (0.4 m^2/PE_{60}). Disadvantages: Requires separate sludge stabilization. Generally not well suited neither for enhanced nitrogen nor phosphorus removal. Complicated process, if later upgrading to N and P removal may be required. Not very flexible operation mode. Justification for non-selection: Not well suited for VVWTPs that require enhanced nutrient removal. This also matters for those WWTPs below 10,000 PE_{60}, which do not require such treatment level yet, but might require upgrading in future.
Rotating Biological Contactor (RBC)	Advantages: Simple. Well-suited process for carbon removal only. Reduced energy needs. Similarly small footprint (0.4 m^2/PE_{60}). Disadvantages: Requires separate sludge stabilization. Generally not well suited neither for enhanced nitrogen nor phosphorus removal. Complicated process, if later upgrading to N and P removal may be required. Problems with bearings and shafts cannot be safely excluded. Usually not applied to VVWTPs of the size in discussion. Justification for non-selection: Not well suited for VVWTPs that require enhanced nutrient removal. This also matters for those VVWTPs below 10,000 PE_{60}, which do not require such treatment level yet, but might require upgrading in future.
Aerobic sludge stabilization	Advantages: Stable process. Odour generation. Reduces total sludge amount by approx. 25 %. Disadvantages: Relatively high sludge production. High energy consumption. limited treatability in dewatering units
Anaerobic sludge stabilization	Advantages: Stable process. Low energy consumption for mixing and heating Reduces total sludge amount by approx. 35 %. Disadvantages:High investment cost requires specific training of the operator. Safety measures for biogas handling required Potential occupational hazards in relation to biogas handling

As a result of the screening, the following wastewater and sludge treatment options have been selected for further evaluation in the Feasibility Study depending of the status of the receiving waters and hence the effluent standards to be fulfilled:

- **Option 1** - Activated sludge plant with primary clarifiers with anaerobic sludge stabilization in sludge digesters.
- **Option 2** - Activated sludge plant with aerobic sludge stabilization in separate tank.
- **Option 3** - Extended activated sludge plant (aerobic stabilization of sludge in the activated sludge tank).

The three options are based on well-known and well-proven technologies and implemented at other wastewater treatment plants in Europe.

5.3. Conclusions

5.3.1. Water supply and sewerage

As mentioned in chapter 5.1. of this Master Plan, a range of factors limit the opportunities for alternative technical solutions. The most important factor is the already defined location of the future WWTP, and already defined investment projects by the Municipality of Bitola in process of preparation.

The choice of alternatives is based on the identified main goal and four objectives and aims at:

- Full satisfaction of high quality water demand, conservation of existing water resources through overall coverage of the water supply network with projects for reconstruction /replacement /construction, which will result in improved quality of supplied potable water, reduction of water losses, improvement of water pressure in water supply pipes.
- Connection of the total population and businesses from the agglomeration to the sewerage network through implementation of projects for reconstruction/ replacement/ construction of the sewerage network and connections to future WWTP that should result in a highest degree of protection of soils and ground waters.
- Treatment of total wastewater quantity in WWTP, which will result in compliance with the requirements and the terms, laid down in the Macedonian and EC legislation.
- Provision of better services to users at a socially affordable price, through measures undertaken by the JKP “Vodovod” and JKP “Niskogradba” in both infrastructure investments and improvement of the effectiveness and the efficiency of the services.

5.3.2. Waste Water Treatment

The option recommended for Bitola agglomeration Wastewater treatment plant is the “Activated sludge process” with removal of carbon, as defined by the Urban Wastewater Directive.

It is proposed to provide all necessary options for nitrogen and phosphorous removal in the future. The options should include:

- Space and hydraulic head for the future tertiary treatment
- Design of sludge treatment (thickeners, storage tanks, piping, etc.) providing adequate capacity of phosphorous removal in the future.

Summarizing, the proposed process includes the following process units:

- Pumping
- Preliminary treatment using screening, grit removal as well as Fat, Oil and Grease removal. Auxiliaries such as screening compactor, screenings washing, grit classifier, girt washing and waste air treatment to be specified in the Environmental Assessment Study
- Primary sedimentation
- Biological treatment with the provision for future extension for biological nitrogen and phosphorous removal in anaerobic zones
- Secondary clarifiers and Activated sludge recirculation
- Activated sludge mechanical thickening

- Primary sludge gravity thickening
- Anaerobic sludge stabilization
- Post-thickeners/sludge storage
- Sludge dewatering
- Sludge storage area

In addition to the treatment units the following service buildings are required:

- Pump station
- Screening building
- Blower building
- Sub-station building (existing building)
- Guard house
- Administration building including offices, laboratory, control room
- Workshop and storehouse

A product of the wastewater treatment process is waste sludge, which can be utilized in different forms depending on the treatment process. Sewerage sludge has potentially beneficial properties, particularly with regard to nutrient content. In the long-term it is expected that sludge can be reused for agricultural purposes or for land reclamation. According to the MoEPP, all legislation related to the reuse of sludge for agricultural purpose is in place in Macedonia and is in accordance to the EC Sludge Directive.

6. MACRO AFFORDABILITY

Macro-affordability assessment is required in order to determine the viability of proposed investments in water and wastewater systems and to establish realistic limits on the maximum investment values. Macro-affordability is dependent on multiple variables:

- type and timing of investments,
- projected operation and maintenance costs,
- established and expected depreciation policies, sources of financing for the investment (loans, grants, etc.).

All these components are integral part of tariff formation and thus influence affordability. Affordability calculations are only applied to domestic consumption as industrial consumers are able to calculate any water tariffs in their products or services cost formation.

The calculation of maximum tariffs uses the following major assumptions:

- Actual projected domestic water consumption is used throughout the period instead of legislative requirements for projected consumption per member of households. In most of the cases, actual water demand is higher than the artificial threshold and thus the approach does not contradict with legislative requirements;
- Affordability constraint is established on the basis of expected income growth throughout the reference period and the real increase in GDP is used to determine income levels;
- As indicated by statistical data, household size is relatively stable for the last decade and is kept at a constant level of 3.30 people per household;
- Affordable tariffs are calculated in two scenarios (at 4% of the average income and 6 % of the people below the poverty line[12]).

[12]People with income lower than 60% of average income, according to State statistical office definition

Table 6-1 Affordability thresholds and prices

Item	2014	2015	2021	2028	2039
GDP growth, %	3.0	3.5	3.5	3.3	3.3
Household size	3.30	3.30	3.30	3.30	3.30
Projected water consumption, m^3/capita/month	4.61	4.63	4.08	4.04	3.87
Average household income, (constant 2013 values)	5,105	5,284	6,519	8,183	11,695
Average annual HH income in agglomeration area below the poverty line in €	3,063	3,170	3,911	4,910	7,017
Maximum affordable price per m^3 (4% of average income) in €	1.17	1.20	1.60	2.03	2.98
Maximum affordable price per m^3 (6% of income for the people below poverty line) in €	1.05	1.08	1.44	1.82	2.69

Based on the data, concerning the level of affordability for the population in the served area and the relations found between all consumers groups, an assessment of the investments was prepared.

JKP "Vodovod" uses a different tariff for the industry and budgetary groups and the population. It is the same approach applied in JKP Niskogradba for sewerage.

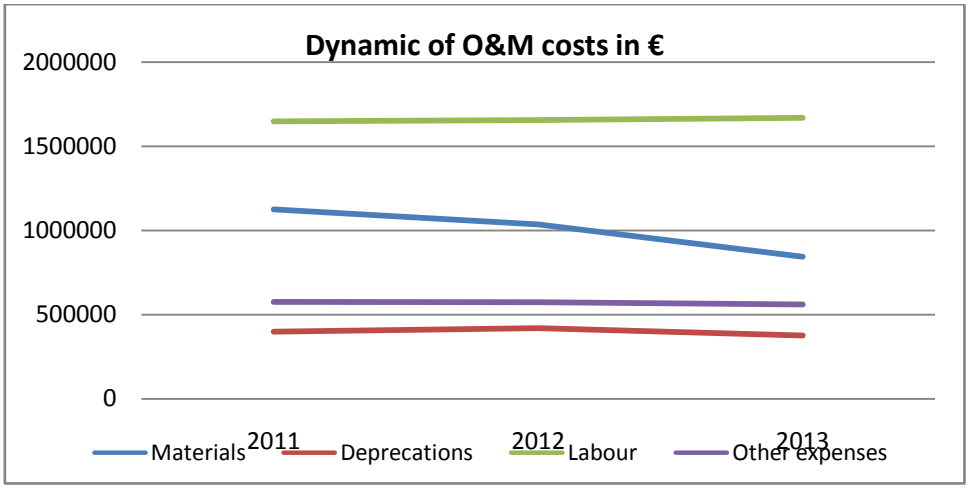
For the whole forecast period it is assumed that the tariffs will cover all operating and maintenance costs. The differences in covering new investments are associated with the different percentage of depreciation included in the operating costs.

The consumption of water services by the industry is 27.64% of total consumption of water services and 21.97% for wastewater. These figures show that the biggest consumer group is the population and its development will have the most significant influence on the forecasted level of investment affordability.

In the text below, the necessary investments will be compared with the financial opportunities for payment and, based on this analysis, the sources of financing will be proposed.

The short analyses made in chapter 2.4.3. shows that revenue and expenditures decrease parallel and only labour costs are rising during the analysed period for JKP Vodovod.

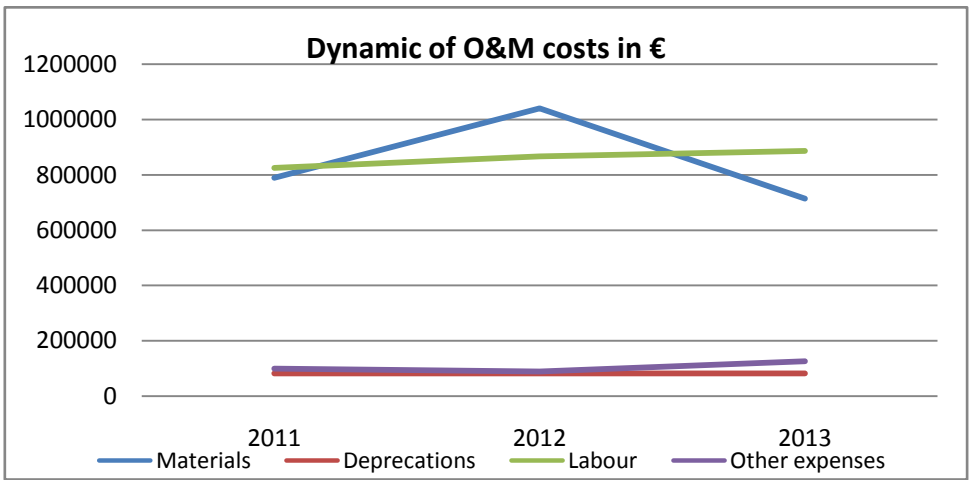
Figure 6-1 Dynamic of Operational and Maintenance costs for JKP Vodovod



The deprecation retained its level for the last years, materials and other expenditures decreased in parallel to revenue. Operational margin is positive for all analysed years and profit invested mainly for water services improvement. For existing assets 100% of deprecation is covered by revenue.

The same short analyses for JKP Niskogradba shows that the dynamic of waste water services is not following the development of water services. In 2012 an increase of 30% in comparison with 2011 is registered and then decline with 13% for 2013. Costs for materials have been increasing in parallel with the revenue trend. The figures for O&M costs are shown in sub-chapter 2.4.3.

Figure 6-2 Dynamic of Operational and Maintenance costs for JKP Niskogradba



Affordability assessment requires the establishment of incremental operation and maintenance costs that will influence tariff formation and the ability-to-pay for water and wastewater services. Incremental operating and maintenance costs are calculated on the basis of the assumptions, listed in detail in Chapter 3.1, while a summary is provided below:

- Water supply – annual operating and maintenance costs are as follows: equipment and machinery (3% of construction costs), water mains (0.15%), distribution networks (0.5%), civil works (0.5%), electricity (0.08 €/kWh);
- Wastewater discharge – annual operating and maintenance costs are as follows: equipment and machinery (3% of construction costs), main collectors (0.20%), secondary sewerage network (0.6%), civil works (0.6%), electricity (0.08 €/kWh);
- Wastewater treatment plants – annual operating and maintenance costs in the amount of 4.5% (all inclusive).

In addition, the following distribution of construction investment costs has been assumed in order to derive a realistic estimate of incremental operating and maintenance costs.

Table 6-2 Distribution of construction investment costs

Name of assets	Pipes	Civil works	Mechanical and electrical
Wells	-	70%	30%
DWTP	-	55%	45%
Water mains	100%	-	-
Distribution networks	100%	-	-
Reservoirs and tanks	-	85%	15%
Pumping stations	-	60%	40%
WWTP	-	55%	45%

Name of assets	Pipes	Civil works	Mechanical and electrical
Main collectors	100%	-	-
Sewerage network	100%	-	-
WW Pumping stations	-	60%	40%

The methodology of affordability calculations involves several subsequent steps as follows:

- Determination of the maximum possible revenues given the projected water consumption and the upper limit of tariffs in the different scenarios. This calculation does not include the level of revenue collection as water operators are not allowed to account for this category when proposing tariffs in front of the Council of Municipality. Revenues from industrial clients are also included in order to fully simulate the income cash flow within the operator despite the fact that they are not affected by affordability calculations;
- Projections for the existing operation and maintenance costs and depreciations ("without the project" scenario). After a statistical analysis for price changes against the average inflation, all operation and maintenance costs are held at their current level in constant 2013 prices except for personnel costs which increase in line with the real inflation growth;
- Projections for the incremental costs of new investments ("with the project" scenario) for each of the investment periods. The above assumptions have been used to calculate operation and maintenance costs for new investments. Due to the satisfactory level of investments in water supply systems in the medium- and long-term, existing costs have been reduced because of efficiency improvements and reduction of losses;
- Projections for the incremental depreciations as a result of the new investments ("with the project" scenario) for each of the investment periods. The following assumptions have been used: 50 years useful life for pipes; 45 years useful life for civil works; 10 years useful life for mechanical and electrical equipment. 30 years useful life for all other infrastructure elements. All assets which reach the end of their useful life are replaced and depreciations are calculated on the replacement value;
- Accounting for the sources of financing – EU and national grant funding have been calculated with 100% grant financing rate. The affordability analysis assumes that loan payments are included as tariff formation element (e.g. loan paid back by the water company) More detail schemes for financing possibility will be developed in FS stage of the project;
- Determining the difference between overall revenues and overall operation and maintenance costs in all possible scenarios. In case the difference is a positive number, investments are considered affordable as the operator will generate enough revenues from affordable tariffs to cover all operation and maintenance costs (including replacement of assets with shorter life span). If the established difference is negative, then investments are not affordable and an investment limit is provided for each of the periods.
- The extent of possible coverage of depreciation is the final step in determining the affordability, if there is any such opportunity, i.e. if investments have proven to be affordable without including the depreciation for the new assets. The total amount of all necessary expenses for depreciation is compared with the difference between total revenue and total expenses. This ratio indicates the degree of inclusion of depreciation that can be covered by the affordable level of income set at 4% of the average income of the average HH Income and 6% for the group of people below poverty line.

Maximum possible revenues at each of the 2 separate affordability thresholds are indicated below.

Table 6-3 Maximum level of revenues at the affordability thresholds

Affordability threshold	2014	2015	2021	2028	2039
Domestic revenues at 4% of average income	3,362,273	3,401,898	4,567,718	5,973,071	8,727,365
Domestic revenues at 6% of group below the poverty line	3,077,335	3,113,602	4,180,624	5,466,879	7,987,758
Institutional and industrial revenue at max prices set to 4% of average income	1,552,687	1,595,529	2,272,204	3,067,655	4,888,081
Institutional and industrial revenue at max prices set to 6% of group below the poverty line	1,397,418	1,435,976	2,044,983	2,760,889	4,399,273
Total revenues at 4% of average income	4,914,960	4,997,428	6,839,922	9,040,726	13,615,446
Total revenues at 6% of group below the poverty line	4,474,753	4,549,578	6,225,607	8,227,768	12,387 ,30

Existing operation and maintenance costs are calculated on the basis of the historical figures for 2011-2013 (as average for the last 3 year in constant prices). They are used in the model for affordability assessment for calculation of “without the project” scenario for the reference period. These O&M costs are added with incremental costs of scenario “with projects”.

Based on the data for the costs necessary for new investments, incremental costs for operation and maintenance of the networks are determined. In practice, these are newly arising costs that are added to the current expenses and that should be together covered by the new tariffs for the services. It is the ability to cover a certain degree of the total costs that is the subject of this study of the affordability of investment. CAPEX depreciation costs include incremental depreciations resulting only from new investments and existing depreciations. Existing depreciations, including on-going investments, are equal and included in both “without the project” and “with the project” scenarios. Periodic maintenance costs are calculated in the operating costs on the basis of the assumptions listed in Chapter 3.1. of the Master Plan.

Table 6-4 Incremental O&M costs (“with the project” scenario), EUR

Type of cost	2014	2020	2021	2028	2039
Incremental O&M costs		520,820	1,220,348	1,951,671	2,226,398
Incremental CAPEX - depreciation (100%)		601,550	1,524,016	2,481,963	2,724,756

Partial loan financing can be considered as an addition to different depreciation scenarios. Currently, only one scenario is considered – full grant financing for Municipality. Such decision has been taken as a result of the Contracting Authority instructions for a financial scheme of this project in the Short term program for WWTP construction.

The situation could be different for the medium and long term programs, however an up-to-date analysis should be prepared and the decisions on potential loans should be made on a project by project basis.

The results for affordability of investments are presented in the following table.

Table 6-5 Affordability of selected alternative -EUR/year

Indicators	2020	2021	2028	2039
Total revenue* – Total costs (excluding depreciation for the new assets)	431,440	664,369	1,607,284	4,890,324
Ability to cover incremental depreciation, %	15%	35%	60%	100%

*Total revenue in this calculation is on the basis of maximum tariffs for average income and threshold of 4%.

We can conclude from these results that all planned investments in the short, medium and long term investment programs are affordable at 83%[13] inclusion of depreciation for the new assets in the tariff for water and sewerage services for all consumer groups. For the poorest households in the project region coverage level of depreciations is 60% average for the prognosis period. For the first 3 years , after the investment of WWTP and full short term investment program the maximum affordable tariffs of lowest quintile may not cover even O&M costs. In these conditions the Financial stability of the water operators is guaranteed. Based on the macro affordability analysis developed, it may be concluded that for short term program:

- The investment components proposed within the framework of the short-term investment programme are affordable at tariffs, corresponding to approximately 4% of the income of the household with average income. Until end of the short term program 19% of the deprecation for new investments is possible to include in the tariffs and to preserve them on affordable level..
- To cover operation, maintenance expenditures and depreciation charges resulting from investments made, tariffs will reach levels within the range of EUR/m³ 1.60(with VAT) in the year 2021, with present value of EUR/m³ 0.79.
- Such a tariff can make it difficult for lower income households to sustainably pay their bills for W and WW services – those who are not able to allocate 6% of their income for WSS services. For that reason, it is necessary to consider options for differentiated block tariffs depending on the consumption rate and/or targeted financial support for low-income population.

In order to improve the revenue of the water operator, the Consultant recommends introducing differentiated tariffs for sewage and treatment for the industry, taking into account the higher degree of pollution of this group of consumers.

- The medium-term investment programme can be fully implemented given the projected household income levels and the applied affordability threshold of 4% of the average HH income.
- With this investment program, the tariffs may include also 78% of the depreciation of newly acquired assets, while maintaining the affordability of the prices for water services. At the end of the forecast period for the medium-term program, tariffs may reach a maximum levels of 2.05 € / m ³ for HH with average income
- The HH with income below poverty line maximum affordable tariff is 1.82 €/m³ at the end of the planning horizon at a threshold of 6% of their income and coverage ratio of depreciations for a new assets is 34%.

The implementation of the long-term investment programme depends entirely on the degree of implementation of investments within the two previous periods, especially the short-term program, where the largest amount of investments is concentrated. In this period, however, we have a faster growth of population income compared to the growth of the necessary tariffs and that is why we can make following conclusions:

- The long-term program may include 100% of depreciation of newly acquired assets, using a threshold of 4% of the average income.

[13] For the whole prognosis period

- It is expected that, with such implementation of investments, the tariffs would reach 2.98 €/m³ at the end of the period, using a threshold of 4% of average income.
- For the poorest households in tariff 2.69 €/m³ may include 85% of depreciation at threshold of 6%.

Regarding the macro-affordability conclusions for all scenarios, it should be noted that a number of assumptions have been made for the parameters used. Any change in these assumptions could lead to new results and new conclusions accordingly. Such parameters could be: faster than expected decline or growth of population, change in the age structure of population, slower than expected economic growth in the designated territory, legislative changes in the sector related to the method of pricing, etc. In view of these risks, investment decisions should be refined on a project by project basis and the respective information relevant for each of them. The Consultant will follow exactly this approach in the FS stage.

7. ACTION PLAN FOR THE IMPLEMENTATION OF PROJECTS

The Action Plan described in this section, covers the measures to be implemented by the local authorities (municipality, two JKP, MoEPP and other local institutions) and the consultants at the different stages of the preparation and the implementation of the projects.

The Action Plan is divided to the following general sections:

- Assistance for the Preparation of Strategic Environment Assessment (SEA)
- Feasibility study;
- Environmental impact assessments;
- Cost benefit analysis;
- Development of Procurement Strategy
- Assistance in completing IPA Application
- Preparation of Draft outline design for treatment facilities
- Preparation of Draft Tender Dossiers for works

The activities are presented in the table below:

Strategic Environment Assessment (SEA)		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Review and comments of prior reports - Procedure for approval of the SEA	- Review and comments to the draft SEA and prior reports - Stakeholders' involvement and organization of public consultation process - Submittal of final version of Master plan and SEA to MoEPP - Involvement in prioritisation of measures included in the Water master plan and in selection of highest priority measures as basis for an investment project for IPA financing for scoping of investment project	- draft SEA report for the prepared Water Master Plan for the water agglomeration - incorporate relevant comments made by the Municipality and prior reports to the MoEPP - support the Municipality in stakeholders' involvement and organization of the public consultation process - support the Municipality during the public consultation process on the Water Master Plan and SEA - assist the Municipality for final version of the Water Master Plan and SEA to be submitted to the MoEPP

		- Scoping of investment project based on the most priority measures as identified in the Water master plan
Feasibility Study		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Provision of monitoring of the process of elaboration of the feasibility study - Organisation of steering committee for approval of deliverables	- Provision of financial and operational data, requested by the consultant for the purpose of the feasibility study; - Support to the consultant to perform visits in local enterprises, checks of the wastewater quality and - the status of the environmental registers; - Support to the consultant to carry out necessary field investigations and surveys - Provision of funding for the research, which is outside the scope of work of the consultant, but are included in the priority investments program. - Review of the completeness of feasibility study performed by the consultant. - Participation in organization of workshop / public consultation for all relevant beneficiaries in terms of presentation of outputs	- Elaboration of a feasibility study in accordance with the scope of work for the sewerage network and WWTP - Carry out the necessary measurement campaigns; - Prepare documents in cooperation with the Municipality and Water company; - Prepare a report for industrial wastewaters in accordance with the scope of work. - Assistance in organization of workshop / public consultation for all relevant beneficiaries in terms of presentation of outputs
Environmental impact assessments		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Provision of monitoring of the process of elaboration and approval of EIA	- Support during the public consultations process; - Provide staff support to the consultant in the elaboration of the documentation; - Coordination with the consultant of the EIA requirements for the overall projects, that should be included in the application; - Support for the application of the polluter pays principle as part of the tariffs strategy; - Mobilization of media and political - support for the public consultations process; - Responsible for ensuring suitable - meeting halls for the public - consultations; - Checks whether the required annexes to the application are duly signed and approved by the respective bodies	- Discussion of EIA requirements with the relevant authorities at state and local level; - Preparation of a review report of the projects in the investment program for the first time period'; - Preparation of alternative solutions for the realization of the project (including zero alternative) - Preparation of documentation in accordance to the Macedonian legislation; - Elaboration of the public consultation measures; - Support local administration in development of Public Consultation Plan and public hearings - Preparation of a short version of the EIA for inclusion in the application.

Cost benefit analysis		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Provision of monitoring of the process of elaboration of the CBA - Support and discussion of the proposed tariffs and financial conurbation of the local and central authorities - Organisation of steering committee for approval of deliverables	- Provision of accounting and other relevant data and information about operational costs related to the existing infrastructure; - Provision of information about real and forecast invoiced quantities of supplied water and collected wastewater; - Discussion of the proposed tariffs with local and central authorities. - Provision of accounting data and forecasts to the consultant for the purposes of the cost-benefit analysis; - Provision of data regarding existing and proposed loans; - Discussions with the consultant of the financial contribution of the local and the central authorities.	- Presentation and discussion of the socio-economic context and the objectives of the project - Clear identification of the investment project and elaboration of financial models - Economic analysis and risk assessment - Elaboration of necessary reports for the application; - Review of the forecast for financial suitability
Development of Procurement Strategy		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Provision of monitoring of the process of development of the procurement strategy - Approval of deliverables	- Discussions with the consultant of the procurement strategy and provision of data for development of the strategy	- Development of procurement strategy for service contracts and for works construction contracts
Assistance in completing IPA Application		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Provision of monitoring and consultancy in the preparation of the application - Approval of deliverables	- Consultations with the local and central governments officials in the submission of the application; - Review of the application and verification	- Preparation of information for the application with respect to: o Information on the body responsible for implementation o Information on the nature of investment and a description of its financial volume and location o Results of Feasibility Studies o Implementation timetable of the project o Assessment of the overall socio-economic impact of the project based on the prepared CBA o Environmental Impact Assessment o Financing Plan - Checks whether the supporting documentation is approved and signed

Preparation of Draft outline design for treatment facilities		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Provision of monitoring and consultancy in the preparation of the designs - Approval of deliverables	- Discussions with the consultant of the proposed technical solution and employer's requirements and schedule - Provision of input information and data for service connections	- Preparation of outline designs for the waste water treatment plant (FIDIC Yellow Book 1999) - Collecting information on the location of services (such as water supply, electricity, telecommunications, etc.) - Preparation of designs in accordance with the requirements of the EU UWWTD and relevant national legislation
Preparation of Draft Tender Dossiers for works		
MoEPP **Contracting authority**	**Municipality & Water company**	**Consultant**
- Provision of monitoring and consultations in the preparation of the tender dossiers - Approval of deliverables	- Consultations with local and central governments regarding the technical specifications of the tender dossiers - Review of tender dossiers and scopes of work for technical assistance	- Preparation of draft tender dossier for the waste water treatment plant (FIDIC Yellow Book 1999) - Preparation of draft tender dossier for the sewerage system (FIDIC Red Book 1999) - Detail relevant requirements for environmental monitoring plan based on the final approved EIA - Detail requirements for the Contractor to prepare training materials and manuals for WWTP staff - Prepare documents to obtain construction permits

8. INVESTMENT STRATEGY

Based on the assessment of the different technical alternatives and the cost evaluation of the necessary measures for achieving the objectives set in the Master Plan, an investment program was prepared for the development of the water supply, sewerage and wastewater treatment sector in Bitola. The following factors have been taken into account in the elaboration of the investment program:

- The overall investment needs in the water supply and sewerage sector amount to EURO 93.93 million.
- The allocation of needed investments for the period 2015-2039 is as follows: for construction, rehabilitation and modernization of the facilities for the supply of drinking water – EURO 25.0 million; for construction, rehabilitation and modernization of the sewerage facilities – EURO 53.8 million; for treatment of wastewater – EURO 15.0 million.
- The calculations for all investments are based on the evaluation of the construction activities as presented in this Master Plan.
- The assessment of the financial capacity of Bitola municipality to finance costs for investment projects in the water sector reveals that the municipality is highly restricted with this regard. Thus an assumption has been made that in the short run the municipality will be supported through various mechanisms to cover its portion of the financing of the investment projects as well as for bridge financing on behalf of the state through various mechanisms.
- The distribution of the investment burden between Bitola municipality and the JKP "Vodovod"

and JKP "Niskogradba" has been provisionally made by assuming that the municipality will participate in the co-financing of sewerage projects.

- The developed investment program determines the general financial frameworks of the projects. Thus, the precise parameters of the future projects will be determined based on detailed technical and financial calculations. If the circumstances change, the entire Master Plan including the Investment Program should be reviewed. Under all circumstances a revision/update should be done at least every 5 years.
- In the course of preparation of the investment program, the 25-year period has been divided into three periods: short-term – for the 6-year period 2015-2020, medium-term – for the 7-year period 2021-2027 and long-term for the 12-year period 2028-2039. The allocation of the investments in the said periods is performed on the base of the prioritization of the investment measures as elaborated in chapter 4.2, 4.3 and 4.4.of this document.

Table 8-1 Long, mid and short term investment programme for Bitola agglomeration

Component	Investments, euro			
	2015-2020	**2021-2027**	**2028-2039**	**Total**
Water Supply	16,299,579	6,158,316	2,575,420	25,033,315
Sewerage	11,319,610	32,950,260	9,585,190	53,855,060
WWTP	13,620,000	1,418,750		15,038,750
Total	**41,239,189**	**40,527,326**	**12,160,610**	**93,927,125**

9. ANNEXES

Annex 9-1 Recent wastewater production from industry consumers

Annex 9-2 Water supply system

Annex 9-3 Water distribution System

Annex 9-4 Water supply for villages

Annex 9-5 Wastewater collection system

Annex 9-6Recent water consumption levels of industrial

Annex 9-7 Prognoses for industrial flows and loads

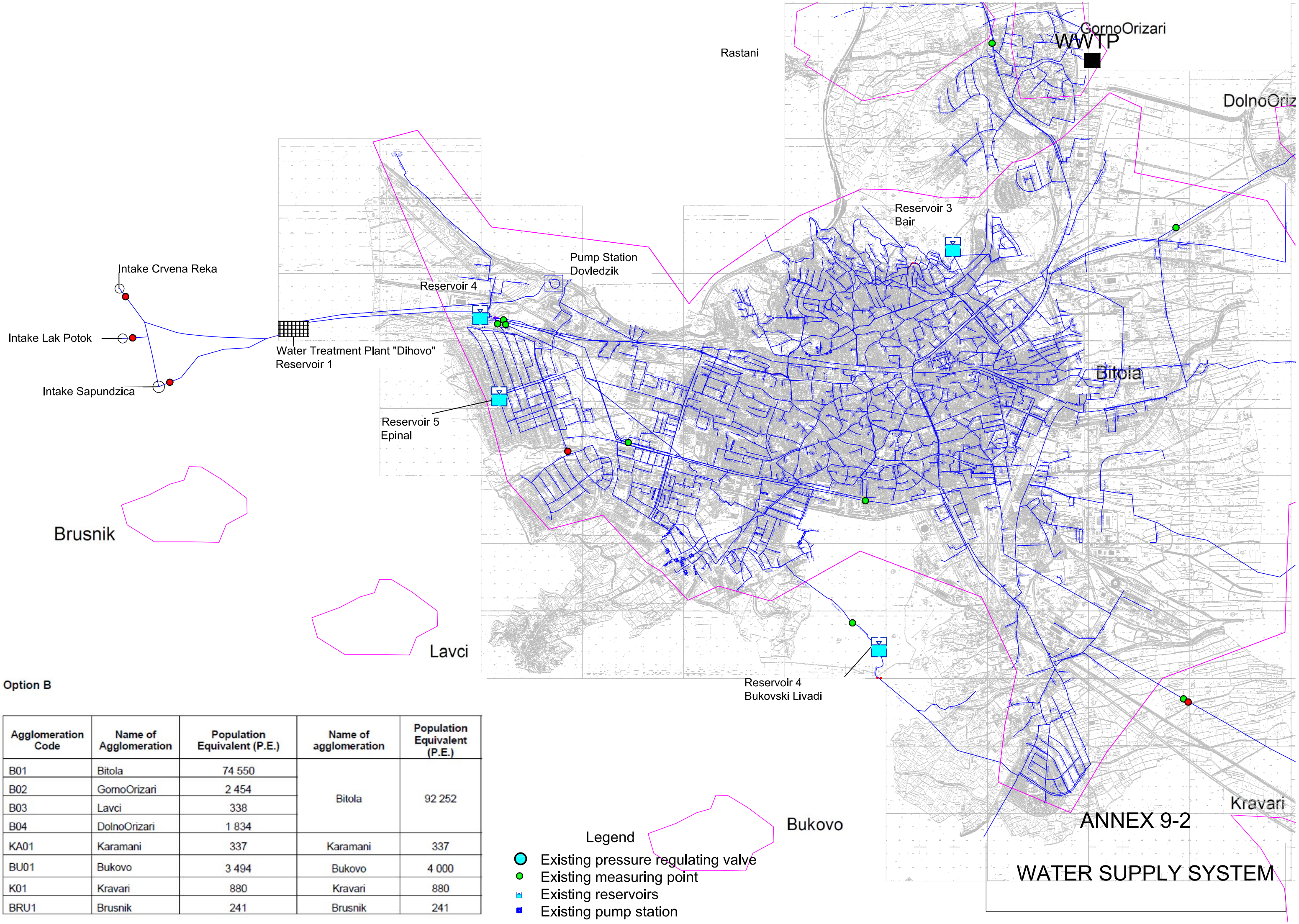
Annex 9-8 Sewerage Network Improvement Development

Annex 9-9Macro affordability (excel file)

Annex 9-1 Recent wastewater production from industry

Industry in Bitola			Employees	Quantity of production		Water consumption			Wastewater quantity					BOD_5		PE
No.	Name	Type of production	no.	ton	m³	Q m³/year	Working days	Q m^3/day	% of water wasted to sewers	Qav m³/year	Qav m^3/day	Coefficient of inequality	Qmax m^3/hour	mg/dm³	kg/day	number
Main Industrial Zone																
1	Doo Lapor	concrete base				471	240	1.96	50	236	0.98	2.50	0.10	0	0.00	0
2	DPT AD Pelisterka Skopije	wine cellars	10		1,000	37,756	240	157.32	80	30,205	125.85	3.20	16.78	550	69.22	1154
3	AD pelagonija gradba	concrete base				1,666	240	6.94	50	833	3.47	2.50	0.36	0	0.00	0
4	Doo Pivara	beer factory	19			19,906	240	82.94	80	15,925	66.35	3.20	8.85	950	63.04	1051
5	AD Kiro Dandaro	printing office	177			8,348	312	26.76	90	7,513	24.08	2.30	2.31	0	0.00	0
6	DGU Pelister	concrete base	5		2,500	2,730	240	11.38	50	1,365	5.69	3.20	0.76	0	0.00	0
7	AD Fustelarko borec	cartons	155	1,800		2,001	240	8.34	80	1,601	6.67	2.30	0.64	0	0.00	0
8	Doo Stenton gradba	concrete base	95		6,500	24,405	240	101.69	50	12,203	50.84	3.20	6.78	0	0.00	0
9	IMB Mlekara	dairy production				177,407	240	739.20	80	141,926	591.36	2.50	61.60	1250	739.20	12320
10	Dooel Kompani @ Radevski	dairy with cannery				32,380	240	134.92	80	25,904	107.93	2.50	11.24	1250	134.92	2249
11	AD 4ti Noemvri	sugar factory	150	20,000									0.00	0	0.00	0
	washing					29,330	60	488.83	90	26,397	439.95	1.50	27.50	370	162.78	2713
	process water					84,000	240	350.00	80	67,200	280.00	1.50	17.50	900	252.00	4200
	cooling water					78,986	240	329.11	0	0	0.00	1.50	0.00	0	0.00	0
12	Dooel Ideal shipka	dairy	53	4,550	12,000	65,407	240	272.53	80	52,326	218.02	2.30	20.89	1250	272.53	4542
13	AD fabrika za kvasec I alkohol	yeast and alcohol factory	136	12,000									0.00	0	0.00	0
	process water					341,886	365	936.67	80	273,509	749.34	1.50	46.83	450	337.20	5620
	cooling water					680,000	365	1,863.01	0	0	0.00	1.50	0.00	0	0.00	0
14	AD Metalec	factory for production of fireplaces				2,544	240	10.60	90	2,290	9.54	2.50	0.99	0	0.00	0
15	AD Trikotaja Pelister	textile industry	218	100		14,792	240	61.63	90	13,313	55.47	3.20	7.40	0	0.00	0
16	Doo Saitis	textile industry	512			10,157	240	42.32	90	9,141	38.09	3.20	5.08	0	0.00	0
17	Dooel Cermat	ice cream	84	1,300		23,787	240	99.11	80	19,030	79.29	2.30	7.60	300	23.79	396
18	Dooel Monting inginering	installation of steel structures	59	2,000		5,000	240	20.83	80	4,000	16.67	2.30	1.60	0	0.00	0
19	Dooel Pechatnica ANS	printing office	18			935	312	3.00	90	842	2.70	3.20	0.36	0	0.00	0
20	GD Granit AD OE Niskogradba region zapad	concrete and asphalt base				17,623	240	73.43	70	12,336	51.40	2.50	5.35	0	0.00	0
	Total main industrial zone:					**1,661,517**		**5,823**		**718,092**	**2,924**		**250.52**		**2054.67**	**34244**
Multipurpose Industrial Zone, KO Bukovo																
1	Light industry					24,662	240	103	80	19,730	82	2.5	8.56	120	9.86	164
	Total industrial zone Bukovo:					**24,662**		**103**		**19,730**	**82**		**8.56**	**120**	**9.86**	**164**
	Total industrial wastewater flow and load:					**1,686,179**		**5,925**		**737,821**	**3,006**		**259**		**2065**	**34409**
Small industry and commercial enterprises:						**1,077,922**	**312**	**3,455**	**80**	**862,338**	**2,764**	**2.5**	**288**	**110**	**304.03**	**5067**
	Total wastewater flow and load:					**2,764,101**		**9,380**		**1,600,159**	**5,770**		**547**		**2369**	**39476**
Connection rate to sewerage system:										**56.23**	**56.23**				**56.23**	**56.23**
TOTAL wastewater to sewerage system										**899,804**	**3,244**				**1,332**	**22,198**

* Source of information: Questionnaires, JPK "Vodovod", Bitola Municipality



Option B

Agglomeration Code	Name of Agglomeration	Population Equivalent (P.E.)	Name of agglomeration	Population Equivalent (P.E.)
B01	Bitola	74 550	Bitola	92 252
B02	GornoOrizari	2 454		
B03	Lavci	338		
B04	DolnoOrizari	1 834		
KA01	Karamani	337	Karamani	337
BU01	Bukovo	3 494	Bukovo	4 000
K01	Kravari	880	Kravari	880
BRU1	Brusnik	241	Brusnik	241

Rastani

GornoOrizari

WWTP

DolnoOrizari

Reservoir 3
Bair

Pump Station
Dovledzik

Reservoir 4

Water Treatment Plant "Dihovo"
Reservoir 1

Reservoir 5
Epinal

Bitola

Lavci

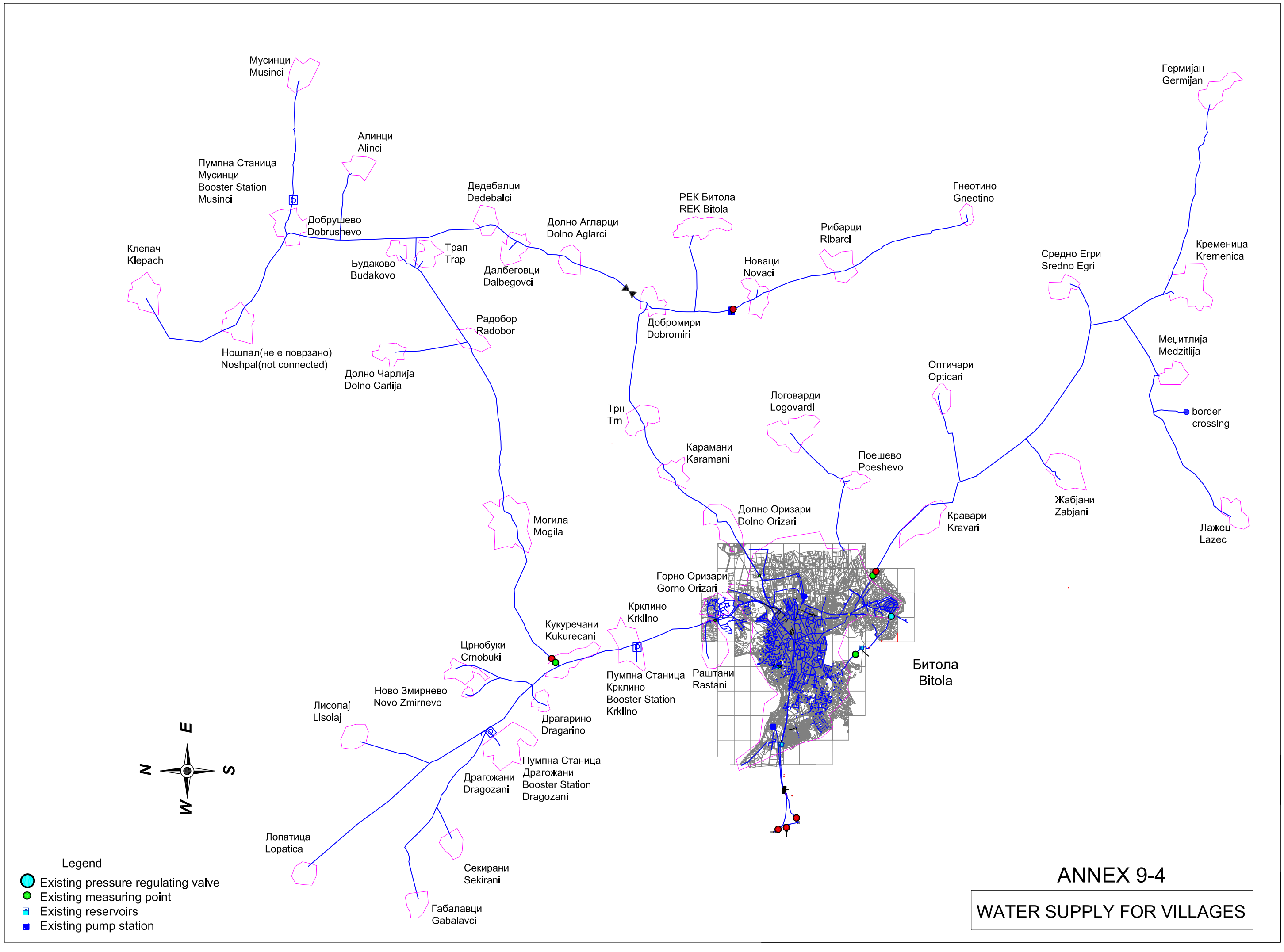
Reservoir 4
Bukovski Livadi

Legend

- Existing pressure regulating valve
- Existing measuring point
- Existing reservoirs
- Existing pump station

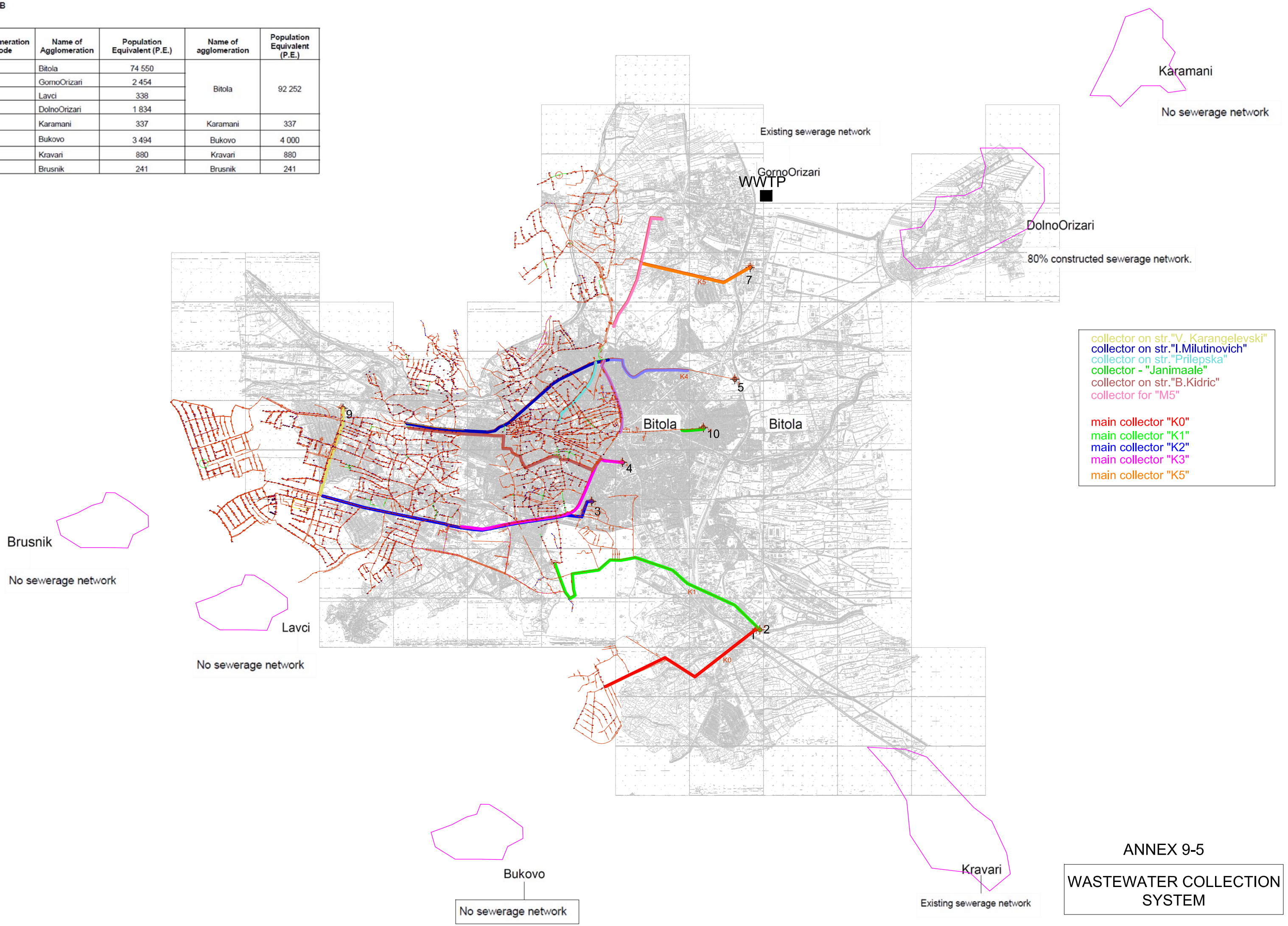
ANNEX 9-3

WATER DISTRIBUTION SYSTEM


Мусинци
Musinci
Алинци
Alinci
Пумпна Станица
Мусинци
Booster Station
Musinci
Добрушево
Dobrushevo
Клепач
Klepach
Дедебалци
Dedebalci
Трап
Trap
Будаково
Budakovo
Долно Агларци
Dolno Aglarci
Далбеговци
Dalbegovci
РЕК Битола
REK Bitola
Гнеотино
Gneotino
Рибарци
Ribarci
Новаци
Novaci
Добромири
Dobromiri
Германијан
Germijan
Средно Егри
Sredno Egri
Кременица
Kremenica
Меџитлија
Medzitlija
Оптичари
Opticari
border
crossing
Ношпал(не е поврзано)
Noshpal(not connected)
Радобор
Radobor
Долно Чарлија
Dolno Carlija
Трн
Trn
Логоварди
Logovardi
Карамани
Karamani
Поешево
Poeshevo
Могила
Mogila
Долно Оризари
Dolno Orizari
Кравари
Kravari
Жабјани
Zabjani
Лажец
Lazec
Горно Оризари
Gorno Orizari
Крклино
Krklino
Кукуречани
Kukurecani
Црнобуки
Crnobuki
Пумпна Станица
Крклино
Booster Station
Krklino
Раштани
Rastani
Битола
Bitola
Ново Змирнево
Novo Zmirnevo
Лисолај
Lisolaj
Драгарино
Dragarino
Пумпна Станица
Драгожани
Booster Station
Dragozani
Драгожани
Dragozani
Лопатица
Lopatica
Секирани
Sekirani
Габалавци
Gabalavci
N
E
S
W
Legend
Existing pressure regulating valve
Existing measuring point
Existing reservoirs
Existing pump station
ANNEX 9-4
WATER SUPPLY FOR VILLAGES

Option B

Agglomeration Code	Name of Agglomeration	Population Equivalent (P.E.)	Name of agglomeration	Population Equivalent (P.E.)
B01	Bitola	74 550	Bitola	92 252
B02	GornoOrizari	2 454		
B03	Lavci	338		
B04	DolnoOrizari	1 834		
KA01	Karamani	337	Karamani	337
BU01	Bukovo	3 494	Bukovo	4 000
K01	Kravari	880	Kravari	880
BRU1	Brusnik	241	Brusnik	241



ANNEX 9-5

WASTEWATER COLLECTION SYSTEM

Annex 9-6 Recent concumption levels of industrial consumers

Industry in Bitola			Employees	Water consumption					
No.	Name	Type of production	no.	From the Water Company "Vodovod" m³/year	From own sources m³/year	From Strajevo *** m³/year	Total m³/year	Working days	m^3/day
Main Industrial Zone									
1	Doo Lapor	concrete base		471			471	240	1.96
2	DPT AD Pelisterka Skopije	wine cellars	10	37,756			37,756	240	157.32
3	AD pelagonija gradba	concrete base		1,666			1,666	240	6.94
4	Doo Pivara	beer factory	19	18,906	1,000		19,906	240	82.94
5	AD Kiro Dandaro	printing office	177	8,348			8,348	312	26.76
6	DGU Pelister	concrete base	5	2,730			2,730	240	11.38
7	AD Fustelarko borec	cartons	155	2,001			2,001	240	8.34
8	Doo Stenton gradba	concrete base	95	3,340	9,000	12,065	24,405	240	101.69
9	IMB Mlekara	dairy production		15,972		161,435	177,407	240	739.20
10	Dooel Kompani @ Radevski	dairy with cannery		3,550		28,830	32,380	240	134.92
11	AD F-ka 4ti Noemvri	sugar factory	150	5,128		187,188			
	washing						29,330	60	488.83
	process water						84,000	240	350.00
	cooling water						78,986	240	329.11
12	Dooel Ideal shipka	dairy	53	65,407			65,407	240	272.53
13	AD fabrika za kvasec I alkohol	yeast and alcohol factory	136	32,012	480,000	509,874			
	process water						341,886	365	936.67
	cooling water						680,000	365	1,863.01
14	AD Metalec	factory for production of fireplaces		2,544			2,544	240	10.60
15	AD Trikotaja Pelister	textile industry	218	1,480		13,312	14,792	240	61.63
16	Doo Saitis	textile industry	512	10,157			10,157	240	42.32
17	Dooel Cermat	ice cream	84	15,195		8,592	23,787	240	99.11
18	Dooel Monting inginering	installation of steel structures	59		5,000		5,000	240	20.83
19	Dooel Pechatnica ANS	printing office	18	99		836	935	312	3.00
20	GD Granit AD OE Niskogradba region zapad	concrete and asphalt base		17,623			17,623	240	73.43
	Total $_{\text{main industrial zone}}$:			**244,385**	**495,000**	**922,132**	**1,661,517**		**5,823**
Multipurpose Industrial Zone, KO Bukovo									
1	Light industry			24,662			24,662	240	102.76
	Total $_{\text{industrial zone Bukovo}}$:			**24,662**			**24,662**		**102.76**
Total industrial water consumption:				**269,047**	**495,000**	**922,132**	**1,686,179**		**5,925**
Other industry and commercial enterprises:				1,077,922			1,077,922	312	3,455
Total water consumption from industrial and commercial enterprises:				**1,346,969**			**2,764,101**		**9,380**

* Source of information: Questionnaires, JPK "Vodovod", Bitola Municipality

Annex 9-7 Prognoses for industrial and commercial flows and loads

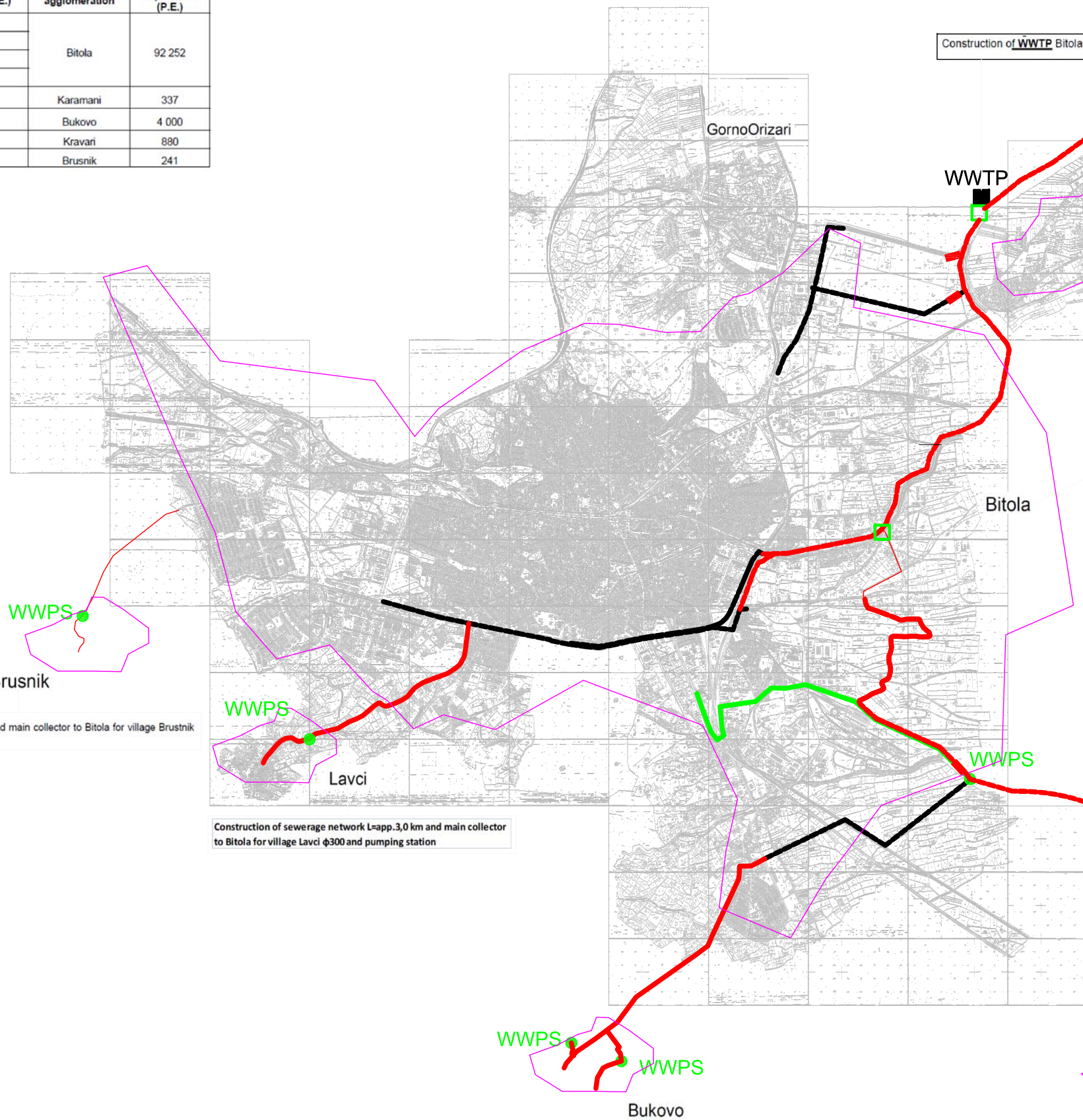
№	PARAMETER			CURRENT	FORECAST			
				2013	2014	2021	2028	2039
I.	**Water Consumption in agglomeration**							
1	***From JKP "Vodovod"***							
1.1	Main Industrial Zone	m3/year		244,385	245,607	254,333	263,369	278,222
1.2	Multipurpose Industrial Zone, KO Bukovo	m3/year		24,662	27,745	55,490	55,490	55,490
	Total Industrial Water consumption from JKP "Vodovod"	m3/year		**269,047**	**273,352**	**309,823**	**318,859**	**333,712**
1.3	Small industry and Commercial Enterprises	m3/year		1,077,922	1,072,532	1,035,552	999,847	946,210
T	**Total Industrial (incl. commercial) Water consumption from JKP "Vodovod"**	m3/year		**1,346,969**	**1,345,884**	**1,345,375**	**1,318,706**	**1,279,922**
2	***From own water sources***							
2.1	Main Industrial Zone	m3/year		495,000	495,000	495,000	495,000	495,000
3	***From Strajevo***							
3.1	Main Industrial Zone	m3/year		922,132	922,132	922,132	922,132	922,132
T	**Total Industrial Water Consumption**	m3/year		**2,764,101**	**2,763,016**	**2,762,507**	**2,735,838**	**2,697,054**
II.	**Industrial Wastewater production in agglomeration**							
1	Main Industrial Zone	m3/year		718,092	718,092	732,562	758,589	801,371
		m3/d		2,924	2,924	2,983	3,089	3,263
2	Multipurpose Industrial Zone, KO Bukovo	m3/year		19,730	22,196	44,392	44,392	44,392
		m3/d		82	92	185	185	185
3	Commercial Enterprises	m3/year		862,338	858,026	828,442	799,878	756,968
		m3/d		2,764	2,750	2,655	2,564	2,426
T	**Total Industrial Wastewater Production**	m3/year		**1,600,159**	**1,598,314**	**1,605,395**	**1,602,859**	**1,602,730**
		m3/d		**5,770**	**5,766**	**5,823**	**5,837**	**5,874**
	Connection rate	%		56.23	56.23	90	90	90
	Total Industrial Wastewater to sewage	m3/year		**899,804**	**898732**	**1444856**	**1442573**	**1442457**
		m3/d		**3,245**	**3,242**	**5,241**	**5,254**	**5,287**
III.	**Industrtial Wastewater Pollution**							
1	Main Industrial Zone - BOD5	kg/d		2054.67	2054.67	2054.67	2054.67	2054.67
2	Main Industrial Zone	PE		34244	34245	34245	34245	34245
3	Multipurpose Industrial Zone, K0 Bukovo - BOD5	kg/d		9.86	11.10	22.20	22.20	22.20
4	Multipurpose Industrial Zone, K0 Bukovo	PE		164	185	370	370	370
5	Small industry and Commercial Enterprises - BOD5	kg/d		269.18	267.83	258.60	249.68	236.29
6	Small industry and Commercial Enterprises	PE		4345	4464	4310	4161	3938
T	**Total BOD5 from Industrial and commercial enterprises**	kg/d		**2333.71**	**2333.60**	2335	2327	2313
	Connection rate	%		56.23	56.23	90	90	90
	Total BOD5 to sewage	kg/d		**1312.30**	**1312.18**	2102	2094	2082
T	**Total P.E. to sewage**	PE		**21872**	**21870**	**35032**	**34898**	**34697**

Prognoses for Multipurpose Industrial Zone, KO Bukovo

	Multipurpose Industrial Zone, KO Bukovo	unit	quantity (total at 100 % completion)					
	Development of Industrial Zone	% of total	100	40	45	90	90	90
	Light Industry	ha	22.3					
	specific consumption	[lit/sec/ha]	0.4	0.4	0.4	0.4	0.4	0.4
	Total surface	ha	22.3	8.92	10.035	20.07	20.07	20.07
	Water demand	m3/day	257	102.76	115.60	231.21	231.21	231.21
	Wastewater generation (factor 0.8 of water demand)	m3/day	206	82.21	92.48	184.97	184.97	184.97
	Wastewater generation per year	m3/year	49,324	19730	22,196	44,392	44,392	44,392

Option B

Agglomeration Code	Name of Agglomeration	Population Equivalent (P.E.)	Name of agglomeration	Population Equivalent (P.E.)
B01	Bitola	74 550	Bitola	92 252
B02	GornoOrizari	2 454		
B03	Lavci	338		
B04	DolnoOrizari	1 834		
KA01	Karamani	337	Karamani	337
BU01	Bukovo	3 494	Bukovo	4 000
K01	Kravari	880	Kravari	880
BRU1	Brusnik	241	Brusnik	241



Construction of WWTP Bitola

Construction of sewerage system in village Karamani Ø300, L= app. 5.6 km, pumping station and app. 0.58 km pressure main collector to the PC Dolno Orizari;

Construction of 3.5 km secondary **sewerage network** Ø250 and app. 2.3 km **pressure main collector** from **village Dolno Orizari** Ø250 to the WWTP and a pumping station

Pressure main collector from the Industrial Zone in Bitola to collector K1 Ø700 L = app. 2.93 km and pumping station

Main collector from Bitola to the WWTP Ø700- Ø1200 L= app. 4.1 km and river crossing

New Sewerage network Ø250 for settlement Strcin L= app. 1.4 km;

New Sewerage network Ø250 for settlement BRL 3 L= app. 2.3 km;

New Sewerage network Ø250 for settlement BRL 4 L= app. 1.8 km;

New Sewerage network Ø250 for settlement ARM 1 L= app. 6.3 km;

New Sewerage network Ø250 for settlement ARM 2 L= app. 2.4 km;

New storm water network Ø250 – Ø400 for settlement Strcin L= app. 2.75

New storm water network Ø250 – Ø300 for settlement BRL3 L= app. 1.5 k

New storm water network Ø250 – Ø400 for settlement BRL4 L= app. 3.5 k

New storm water network for settlements ARM 1

New storm water for settlements ARM 2;

New storm water network for district ARM 1 Ø300 – Ø800, L= app. 6.3 km

New storm water network for district ARM 2 Ø300 – Ø600, L= app. 2.4 km

Construction of sewerage network L = app. 4.7 km and main collector to Bitola for village Brustnik Ø300 and pumping station.

Construction of sewerage network L=app.3,0 km and main collector to Bitola for village Lavci ϕ300 and pumping station

Sewerage network for village Bukovo L= app. 6.45 km;
Main collector Ø300 for Bukovo to Bitola and two pump stations

Pressure main collector from village Kravari to collector K0 ϕ160 L=app.3,3km and pumping station

LEGEND

- New collector
- Existing collector
- Pressured pipeline
- WWPS Waste Water Pump Station
- MM Mitigation Manhole
- Overflow

ANNEX 9-8

SEWAGE NETWORK
IMPROVEMENT & DEVELOPMENT