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The Environmental Impact Assessment of the Bethlehem Multidisciplinary Industrial Park

By

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Dedication

To my beloved family; husband Salameh and children Suleiman, Ruslan, Firas and Sabrina who supported me all through my study years.

I will not forget my parents, father Judeh who taught me patience, perseverance and perfection and mother Su'ad who with her love helped me all the way. To my brothers Walid and Zuheir and my sister Maysoon.

A special dedication to the angel who brought new sunshine to our family, my beloved granddaughter Yeleina.

Declaration

I will certify that this thesis is submitted for the Masters degree as a result of my own research except where otherwise acknowledged. This thesis has not been submitted for a higher degree to any other university or institution.

Signature

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Abstract

A Bethlehem Multidisciplinary Industrial Park (BMIP) came as a result of an agreement between the Palestinian Authority and the Republic of France to establish an industrial park covering an area of 530 dunums in the South Eastern part of Bethlehem near the village of Hindazeh, where small and moderate sized industrial enterprises will be moved. The aim of this industrial park is to attract investors, both local and international ones, to participate in developing the economy of the area and its surroundings. The project comprises storm water drainage, water, energy and telecommunication network and supply, roads, wastewater collection and treatment, solid waste collection system and disposal.

Environmental impact assessment (EIA) aimed to identify and predict the impact of the project on the bio-geophysical environment and on human health and well-being, to analyze the site and to process alternatives and provide solutions to mitigate the negative consequences in the future. Potential disturbances may be more costly to correct after their occurrence than before.

The study was based on thorough investigation of the site and its baseline conditions. Ground water of the main well fed by the watershed of the project site was analyzed for anions, cations, pH, electrical conductivity (EC), and total dissolved solids (TDS). Soil of the project site was analyzed for cations, moisture, pH, EC, TDS, organic matter and composition. Flora and fauna were studied in addition to the study of topography, geology, hydrogeology, water resources, climate, air quality, noise, public uses, socio-economic environment, agriculture, historical and sacred places, water supply, wastewater and solid wastes. Interviews

and meetings were held for the public consultation. Palestinian and international laws and regulations concerning pollution control were also revised and evaluated.

The potential environmental impact of industrial activities was found to be significant on air, water and ground quality. It was found also that the project site lies in an inhabited rural area, very sensitive to pollution. Analyses showed that the site is free of any pollution in soil and water, in addition to the presence of threatened fauna and flora. Hence, strict measurements have to be taken in monitoring the project during the construction and the operation phases to protect the environment, health and welfare of residents and workers in the BMIP.

ملخص البحث

تحقق إنشاء المنطقة الصناعية متعددة الأغراض في منطقة بيت لحم نتيجة لتفاهم مشترك بين الحكومة الفرنسية و السلطة الفلسطينية ، حيث اتفق على تسخير ما مساحته 530 دونما في المنطقة الواقعة جنوب شرقي مدينة بيت لحم و بالتحديد بالقرب من قرية هندازة حيث ستقام أو تنقل بعض الصناعات الخفيفة و المتوسطة. إن الهدف من إنشاء المنطقة الصناعية هو جذب المستثمرين المحليين و الأجانب للمساهمة في تطوير المنطقة و ما حولها. يحتوي المشروع المقترح على وسائل للتخلص من مياه الأمطار و الصرف الصحي و النفايات الصلبة و معالجة المياه العادمة، بالإضافة إلى شبكات المواصلات و المياه و الاتصالات و الطاقة.

يهدف تقييم الأثر البيئي لتحديد و التنبؤ بأثر المشروع على البيئة البيولوجية الفيزيائية و الجيولوجية و على صحة و رفاهية الإنسان. يعنى التقييم بتحليل الموقع و دراسة البدائل و الحلول للتخفيف من الآثار السلبية في المستقبل، حيث أن إصلاح الضرر بعد حدوثه يكون مكلفا.

استند البحث إلى دراسة معمقة للموقع و الوضع الحالي . تم تحليل المياه الجوفية للبئر الرئيسي التي تتم تغذيته من منطقة المشروع، حيث درست الأيونات الموجبة و السالبة و درجة الحموضة و الإيصالية الكهربائية و المواد الصلبة الذائبة. حللت التربة لدراسة الأيونات الموجبة و الرطوبة و درجة الحموضة و الإيصالية الكهربائية و المواد الصلبة الذائبة و المواد العضوية . درست الثروة النباتية و الحيوانية بالإضافة لدراسة طبوغرافية و جيولوجية الموقع و مصادر المياه و التربة و المناخ و جودة الهواء و الضجيج و الاستخدامات العامة للأراضي و البيئة الاقتصادية و الاجتماعية و الزراعة و المواقع التاريخية و الدينية و شبكة المياه و المجاري و النفايات الصلبة. أجريت لقاءات و اجتماعات تحت عنوان استشارة الجمهور كما و تمت مراجعة و تقييم القوانين و التشريعات الفلسطينية و الدولية المتعلقة بالتلوث البيئي.

وجد أن الأثر البيئي للنشاطات الصناعية قد يكون وخيما على جودة الهواء و المياه و الأرض و أن المشروع يقع في منطقة سكنية ريفية حساسة جدا للتلوث البيئي. أثبتت التحاليل خلو الموقع من تلوث المياه و التربة بالإضافة إلى وجود نباتات و حيوانات مهددة بالانقراض. لذلك يجب اتخاذ الإجراءات المشددة لمراقبة و ضبط المشروع خلال مرحلتي الإنشاء و التنفيذ لحماية البيئة و صحة السكان و العاملين و رفاهيتهم.

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List of Abbreviations

Symbol	description
°C	Degrees Celsius
AFD	French Agency of Development
Area A	Area under PNA Authority
ARIJ	Applied Research Institute-Jerusalem
BMIP	Bethlehem Multidisciplinary Industrial Park
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation and Liability
CFR	Code of Federal Regulations
CFU	Colony Forming Unit
COD	Chemical Oxygen Demand
dB	Deci Bell
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EIP	Eco Industrial Park
EQA	Environmental Quality Authority
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
GIS	Geographic Information System
IDARA	Integrated Development of Agricultural and Rural Areas
Km	Kilometer
m	Meter
m^2	Squared meters
m^3	Cubic meters
masl	Meters above sea level
µS/cm	Micro Siemens/centimeter
MBAS	Methylene Blue Active Substances
MCM	Million Cubic Meters
MEKOROT	The Israeli Water Company
MEnA	Ministry of Environmental Affairs
mg/l	Milligram per liter
mm	Millimeters
MOPIC	Ministry of Planning and International Cooperation

NEPA	National Environment Policy Act
OMW	Olive Mills Wastewater
PCB	Polychlorinated Biphenyls
PCBS	Palestinian Central Bureau of Statistics
PCU	Platinum Cobalt Units (True color units)
pH	Potential of Hydrogen (Acidity Scale)
PIEFZA	Palestinian Industrial Estate and Industrial Free Zone Authority
PNA	Palestinian National Authority
POP	Persistent Organic Pollutants
ppm	Parts per million
PSI	Palestinian Standardization Institution
PVC	Polyvinyl Chloride
PWA	Palestinian Water Authority
RCRA	Resource Conservation and Recovery Act
S/cm	Siemens per centimeter
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TDS	Total Dissolved Solids
TKN	Total Kheldal Nitrogen
TN	Total Nitrogen
TOC	Total Organic Carbon
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
Type A Industries	Hazardous waste industries
Type B Industries	Environmental friendly industries
UNEP	United Nations Environment Program
VOC	Volatile Organic Compounds
WHO	World Health Organization
WSSA	Water Supply and Sewerage Authority

Chapter One

1.1 Introduction

A Bethlehem Multi Industrial Park (BMIP) came into reality as a result of the common agreement between the Palestinian National Authority and the Republic of France signed on the 24th of June 2008 which stated to put under use of the project an area of around 500 dunums in the South Eastern part of Bethlehem city near the village of Hindazeh, where small and moderate sized industrial enterprises of different types will be moved. France invested 13 million dollars in the project. The total investment in the project is expected to be around 35 million dollars (Feasibility Study, 2009). The main investors in the project are Deska Company from Evens Group and the French agency of Development (AFD). Peugeot, Nestlé, France Telecom and other French companies have plans to build facilities in the park. It is expected to open in 2011 (Feasibility Study, 2009).

The main aim of this industrial park is to attract investors, both local and international ones, to participate in developing the economy of the area and its surroundings. This project will promote Bethlehem's industrial sector, where 7000 jobs are expected to be created (Feasibility Study, 2009). Three potential groups of investors might be interested in the BMIP; current Palestinian industries, new enterprises and foreign investors.

The majority of industries in the southern districts of the West Bank are not located in industrial zones. They are located in commercial and residential regions, or in random industrial areas. In Bethlehem district, the only industrial zone exists in Beit-Jala for garage and other light industries. Other industries are located in Deheisha and Al-Khader or scattered throughout the towns for food production, mechanical works, and handcrafts.

The planned project for the BMIP is a pioneer project that comprises storm water drainage, water, energy and telecommunication network and supply, roads, wastewater collection and treatment, solid waste collection system and disposal. It will also introduce training services, to provide the Palestinian industry with high quality and diversified technical and vocational skills (Feasibility study, 2009).

Industrial pollution is considered one of the major issues in environmental protection. Industries contribute to the pollution of the environment, especially in the absence of regulations that force manufacturers to reduce their hazardous impacts.

Industrial Facilities are divided into two types based on their waste water production. The first type produces toxic, hazardous waste water with high content of chemicals and needs pretreatment before it could be released into the public sewerage system. These industries are classified as type (A) or "heavy industries". The other type which is “environmental friendly” produces wastes that can be released directly to the public sewage system without pre-treatment. These industries are classified as type (B) or "light industries".

Industrial activities are important to the economy as they add to the financial well-being, they support rural activities and they employ people (IDARA, 2001).

“Sustainable rural development must be put at the top of the agenda of the European Union, and become the fundamental principle which underpins all rural policy in the immediate future and after enlargement” (European Conference on Rural Development, 1996).

“Rural development policy must be multi-disciplinary in concept, and multi-sectoral in application, with a clear territorial dimension.” (European Conference on Rural Development, 1996).

According to the Palestinian Environmental Assessment Policy, industrial estates are amongst the proposed projects for which an environmental impact assessment is mandatory.

Environmental impact assessment (EIA) means a detailed assessment of the environmental impacts of a proposed project according to approved terms of reference.

The identification of such impacts along with the associated mitigation measures can be used to prevent any future costly environmental problems. EIA is to provide solutions for the environmental damages caused by the project during both the construction as well as the operation phases. (Palestinian Environmental Assessment Policy, 2000).

EIA is a tool designed to identify and predict impacts of the project on the bio-geophysical environment and on man's health and well-being, to analyze the site and process alternatives and provide solutions to mitigate the negative consequences on man and the environment. Disturbances are always much more expensive to correct after their occurrence than before (FAO corporate document).

EIA should consider the EIA Policy assigned by the Palestinian Environmental Quality Authority (EQA), the standards, regulations and requirements of the Palestinian Standardization Institution (PSI), the Palestinian Environmental National Strategy and also according to the international regulations such as the World Bank Group.

1.2 Problem Statement

Industrial parks enhance the economical prosperity and well-being of nations, as they increase employment and progress, especially to developing countries like Palestine. It is preferable to achieve sustainable development while conserving and enhancing environmental quality. Ensuring an adequate standard of life must not negatively affect the basic needs, social, cultural and historical values as a result of development activities. This should conserve biodiversity, landscapes and the sustainable use of natural resources.

The BMIP project comprises around 500 dunums (in two stages) at the south-eastern periphery of Bethlehem in region “A” (under Palestinian National Authority “PNA”). This is a vast rural area which is adjacent to few villages (Hindazeh, Jinnatah, Harmaleh, Khalayel-el-Loz, Breid’a, Khallet-el-Jame’and Dahret-el-Nada), and consequently might have impacts on the following main fields:

1- Water resources pollution; including ground water and surface water resources.
2- Soil pollution.
3- Air pollution.
4- Fauna and flora.
5- Noise and vibration pollution.
6- Socio-economic effects on the local community (land use change and land degradation and agriculture).
7- Historical, archaeological and sacred sites.
8- Occupational and public health.
9- Solid waste and industrial waste water management.
10- Aesthetics and landscape quality.

1.3 Hypothesis

Industrial activities generated as a result of the construction and operation phases of the Bethlehem Multidisciplinary Industrial Park (BMIP) will lead to significant disturbances to the environment and the health and well being of workers and residents of the region around it.

1.4 Objectives

This EIA study is to provide an environmentally and socio-economic sound and acceptable industrial park throughout the implementation and operation of the project. This can be achieved by having a set of activities and objectives amongst are:

1- To study the baseline environmental data for future comparison of the environmental condition since the operation of the project onward.

2- To identify the possible impacts of the industrial park on the physical, biological, social and the economical environment of the targeted area and its close surroundings.

3- To suggest proper mitigation measures to either eliminate or minimize possible environmental impacts on the mentioned elements.

The EIA is to identify possible on-site and off-site negative impacts that might arise from different project activities.

Chapter Two

Regulations and Laws Governing EIA and Environmental Pollution Control.

Industrial activities should be controlled and monitored by regulations and laws both local and international so as to minimize their possible negative environmental impacts.

2.1 Palestinian Regulations

During the past ten years, the PNA has set laws and regulations to govern pollution control, such as the Palestinian Environmental Assessment Policy, Law No. 7 for the year 1999 and the Palestinian Environmental National Strategy.

2.1.1 The Palestinian Environmental Assessment Policy:

PNA seeks to achieve sustainable economic and social development through conserving and enhancing environmental quality and by encouraging and promoting economic and social development. Environmental assessment provides an effective way of integrating environmental factors into planning and decision-making processes. Therefore, the Ministerial Council approved the Palestinian Environmental Assessment Policy, through resolution No: 27- 23/4/2000 (The Palestinian Environmental Assessment Policy, 2000).

The goals of the policy are to ensure an adequate standard of life without negatively affecting the basic needs and the social, cultural and historical values of people as a result of development activities, to preserve the capacity of nature to clean itself, to conserve biodiversity and to avoid irreversible damage and to minimize reversible damage from these activities (The Palestinian Environmental Assessment Policy, 2000 article 2).

2.1.2 Law No. 7 for the Year 1999, by the Environment Quality Authority (EQA)

Some of the articles of this law set for industrial pollution and damage control are the following:

Article5: This law guaranties the right of every human being to live in a sound and clean environment, to protect the country's natural wealth and economic resources and maintain the historical heritage without damage or side effects as a result of industrial or agricultural or constructional activities.

Article 12: No one may process, store, distribute, use, treat or dispose of any solid, liquid or gaseous hazardous materials or wastes except according to regulations by the Ministry of Environmental Affairs (MEnA).

Article 18: It is prohibited to bulldoze the agricultural land or transport its soil for the purposes other than agricultural purposes.

Article 19: The MEnA determines the standards pertaining to control air pollutants rates which may cause harm or damage to the public health, social welfare or environment.

Article 20: The owner of the installation is responsible for the protection of the workers and the neighbors against any leakage or emission of any pollutants inside or outside the place of work.

Article 25: The MEnA formulates the standards for limiting the environmental disturbance originating from the different activities.

Article 26: All parties undertake upon the operation of machines or other activities not to exceed the permitted limit for the intensity of noise and vibration.

Article 42: The MEnA determines the necessary conditions for conserving the biological diversity in Palestine.

Article 43: The MEnA formulates the criteria which determine the forest plants and trees whose picking, cultivation, destruction or cutting is temporarily or permanently prohibited in a manner that ensures the existence or continuity.

Article 44: It is prohibited to carry out any works or activities damaging natural reserves, forest areas, public parks, archaeological and historical sites or touch the aesthetical level (Law No. 7, 1999, Environment Quality Authority).

2.1.3 Palestinian Environmental National Strategy

The Palestinian environmental strategy contains a separate strategy element for industrial pollution control, containing the following components:

- Setting industrial air emission and waste water standards.
- Regulations regarding the use of burning fuels, including prohibition or limitation of used oil or other ‘dirty’ sources of energy.
- Setting regulations for environmental protection of exploitation of stone quarries.
- Setting regulations for industrial solid and hazardous waste management.
- Setting regulations for industrial zones, including establishment of common environmental protection measures and facilities and regulations for traffic and noise emissions.
- Setting up a monitoring and enforcement system that supports the previous measures (MEnA, 2000).

2.1.4 Regulations Governing Industrial Sewage Disposal in Bethlehem Municipality.

These regulations are part of PWA Regulations Governing Sewage Disposal prepared for Bethlehem Municipality in November 2002. They include the Palestinian Water Law of 2002, national standards published by the Palestinian Standards Institute, Palestinian Environmental Quality Authority Laws, and relevant local government laws.

The objectives of these regulations are:

a. To prevent the introduction of pollutants into the public/regional wastewater systems that will interfere with the operation of the system or contaminate the resulting sludge.

b. To prevent the introduction of pollutants into Bethlehem Municipality and/or regional wastewater systems that will pass through the system, inadequately treated, into the environment.

c. To improve the opportunity to recycle and reclaim municipal and industrial wastewater and sludge.

d. To protect both the general public and the personnel operating in Bethlehem Municipality and/or regional wastewater systems who may be affected by wastewater and sludge from the wastewater system.

e. To provide for the equitable distribution of the cost of operations, maintenance, and improvement of the wastewater system; and to cover the cost of administering these regulations.

f. To preserve the hydraulic and solids handling capacities of the Bethlehem Municipality and/or central wastewater systems.

Prohibited discharges in Bethlehem Sewerage according to PNA regulations are shown in **Appendix 2.1.** Discharge limitations in wastewater according to the Palestinian Standardization Institute (PSI) are shown in **Appendix 2.2.**

2. 2 International Regulations.

Some of the most prominent international regulations concerning the environmental impact assessment and environmental protection and pollution control are summarized in **Table 2.1.**

Table 2.1: The most prominent international regulations concerning EIA and environmental protection and pollution control (Pepper et al., 1996, p367).

Regulation	Purpose/Scope
Policy	
National Environment Policy Act (NEPA) (Enacted 1970)	Promotes efforts to prevent or eliminate damage to the environment by assessing environmental impacts of implementing major programs early in the planning stage.
Pollution Prevention Act (1990)	To prevent or reduce pollution at the source.
Integrated Development of Agricultural and Rural Areas (IDARA)	Instituting water demand management.
Principle 17 of the Rio Declaration on Environment and Development.(Enacted 1992)	
Article 5 of the Legal Principle for Environmental Protection and Sustainable Development, adopted by the Environmental Law of the World Commission on Environment and Development.	
Goals and principles of EIA, UNEP, 1987.	
Water	
Clean Water Act (Enacted 1948)	Eliminates discharge of pollutants into navigable waters.
1977 Amendments.	Covers regulation of sludge application.
Safe Drinking Water Act (SDWA) (Enacted 1974)	Protects sources of drinking water and regulates proper water treatment techniques.
Clean Air	
Clean Air Act (Enacted 1970)	Intended to protect and enhance the quality of air resources in compliance with ambient air quality standards.
1977 Amendments	Defines issues to prevent industries from benefiting economically from non-compliance.
1990 Amendments	Address acid precipitation and power plant emissions.
Hazardous Waste	
Comprehensive Environmental Response,	Provides an enforcement agency, the authority to

Compensation and Liability (CERCLA). (Enacted 1980). Amended in 1986.	respond to releases of hazardous wastes especially solid waste.
Superfund Amendments and Reauthorization Act (SARA). (Enacted in 1986).	Adds new authorities to CERCLA. Involves toxic chemical recall reporting.
Toxic Substances Control Act (TSCA) (Enacted 1976)	Sets up the toxic substances program administered by EPA .It also regulates labeling and disposal of PCB's.
Amendment of 1986	Addresses issues of inspection and removal of asbestos.
Resource Conservation and Recovery Act (RCRA). (Enacted 1976). Amended in 1984.	Defines hazardous wastes. Requires tracking of hazardous waste. Regulates facilities which burn wastes and oils in boilers and industrial furnaces.
Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). (Enacted 1947).	Regulates the use and safety of pesticide products.
Amendments of 1972	Ensures that environmental harm does not outweigh the benefits.

2.3 The Rio Conference and Agenda 21 Concerning Solid Waste and Wastewater.

The Rio Conference (Earth Summit of 1992) resulted in the adoption of Agenda 21, which focused in one of its chapters on the environmentally sound management of solid wastes and wastewater. The incorporation of this chapter came as a response to the United Nations General Assembly resolution No 44/228.

> "The Conference should elaborate strategies and measures to halt and reverse the effects of environmental degradation in the context of increased national and international efforts to promote sustainable and environmentally sound development in all countries(section 1, paragraph 3) and environmentally sound management of wastes as among the environmental issues of major concern in maintaining the quality of the Earth's environment and especially in achieving environmentally sound and sustainable development in all countries"(section 1, paragraph 12 g).

2.4 National Interim Primary Drinking Water Regulations.

There are 16 substances listed in the National Interim Primary Drinking Water Regulations with a concentration value which is the basis for rejecting the supply. These maximum contaminant levels are set under the authority of Public Law 93-523, December 1974, in the Safe Drinking Water Act. **Table 2.2** shows the maximum contaminant levels for the inorganic chemicals in drinking water (SDWA, 1974).

Table 2.2: Maximum contaminant levels for inorganic chemicals in drinking water (SDWA, 1974).

Element	Maximum Contaminant Level (mg/l)	Comments
Arsenic	0.05	Recognized poison, chronic effects, carcinogenic, skin cancer.
Barium	1.0	Recognized toxic effects on heart, blood vessels, and nerves. Muscle stimulant.
Cadmium	0.01	Acute poisoning in humans via foods. Concentrated in kidney and liver.
Chromium	0.05	Carcinogenic on inhalation
Lead	0.05	Recognized poison with daily intakes with food, water, air and inhaled smoke.
Mercury	0.002	Recognized poison at work. Fatal dose from 20 mg to 3 gm of salts.
Nitrates as N	10	Methemoglobinemia in infants on milk formulated from contaminated waters.
Selenium	0.01	Recognized occupational poison and causes livestock poisoning.
Silver	0.05	Silver retention causes argyria, the blue-gray discoloration of the skin, eyes and mucosal membranes.

2.5 Protection of the Environment Operations Act, 1997.

This act came into force to control the activities of certain uses to ensure that likely environmental impacts are monitored. It contains a list of activities that require the occupier of the premises of certain activities to have a license authorizing these activities and not to exceed prescribed levels set in relation to the emission of noise or air impurities (Wagga Wagga, 2005).

2.6 Guidelines for Drinking Water Quality.

Countries set guidelines for drinking water standards. Palestinian guidelines are somewhat consistent with the World Health Organization (WHO) standards. **Table 2.3** illustrates some of international and Palestinian standards.

Table 2.3: Some international and Palestinian guidelines for drinking water standards, according to WHO regulations, 2004, and PSI regulations, 2010.

Property	PSI Standard	WHO Standard
F. Coliform (CFU/100 ml)	0	0
pH	6.5-8.5	6.5-8.5
Turbidity (TU)	5	5
TDS (mg/l)	1000	< 1000
Na+ (mg/l)	200	< 200
Cl- (mg/l)	250	< 250
NO_3^- (mg/l)	50	<50
SO_4^{--} (mg/l)	200	< 200
$HCO3^-$ (mg/l)	500	< 500
EC (μS/cm)	500	< 500

Chapter Three

Literature Review

3.1 Status of Air Pollution in Palestine.

Air quality is subject to continuous deterioration in Palestine. Palestine lacks measurements and monitoring stations for air pollution. Industrial activities, transportation, energy consumption and open burning of solid waste are the main factors contributing to this problem. In almost all Palestinian districts, urban air pollution is worsening. Rapidly growing cities, more traffic, use of dirty fuel, growing energy consumption, increasing number of quarries and stone cutting facilities and lack of industrial zoning reduce air quality.

Because of the technology in some industries in the West Bank such as using dirty fuel and reliance on outdated industrial processes in addition to the absence of monitoring and the location of industrial facilities in the proximity of densely populated areas, this problem is worsening. Quarries and stone cutting facilities emit huge amounts of dust in the air. Charcoal processing releases particulates, CO, CO_2, nitrogen oxides and volatile organic compounds (VOC's) into the atmosphere. Smoke and hazardous gases are emitted from workshops and bakeries as they reuse used motor oil and old tires as fuel (ARIJ, Localizing agenda 21 in Palestine, 2001). This implies that localizing industries in industrial zones with continuous monitoring plays a role in decreasing the deterioration in air quality in Palestine. But in the same time, these industrial zones should be away from the built-up and inhabited areas and subject to very strict precautions and continuous monitoring.

3.2 Biodiversity Status in Palestine and Bethlehem Governorate.

Bethlehem region lies mainly in the south-eastern mountains of Palestine. Mountainous ecosystems in Palestine are fragile and important ecosystems. They are a storehouse of medicinal plants, biological diversity and endangered species. They are susceptible to accelerated soil erosion and rapid loss of habitat and genetic diversity. In many areas, this is accompanied by excessive livestock grazing, deforestation and loss of biomass.

Large scale unplanned human activities have a severe impact on Palestinian biodiversity. Many species are disappearing before they can be documented (ARIJ, Localizing agenda 21 in Palestine, 2001). Many of the species appearing in the historical record are now extinct. Human actions have increased the rate of extinction to levels that the nature cannot compensate. Seventy three species of mammals and 120 species of birds became extinct between the years 1801 and 1950 in Palestine. Some of the extinct mammals are the cheetah *Acynonyx Jupatus*, Syrian brown bear *Ursus arctus syriacus*, Mesopotamian Fallow Deer *Dama mesapatomica*, and Roe deer *Capreleus capreleus*, in addition to different species of wolves and hyenas. Many reptilian species are threatened due to intensive agricultural practices, overgrazing, vegetation cover loss or unplanned human activities. Birds and their habitats suffer from many threats such as urban expansion, lack of land use policies, illegal hunting, degradation of vegetation cover and unsustainable agricultural practices (ARIJ, Localizing Agenda 21 in Palestine, 2001).

3.3 Special Problems Associated With Pesticide Manufacturing and Use.

There are special problems related to the manufacturing, misuse or overuse of pesticides, which made some of them internationally banned, as they are considered carcinogenic or mutagenic. Persistent Organic Pollutants (POP's) harm the environment and endanger human health. They are toxic, long lasting and travel in multiple cycles during evaporation, air transportation and condensation. 122 countries have banned the use of 12 of the POP's. They are the pesticides; Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Mirex, Toxaphene, the industrial chemicals PCB's (polychlorinated biphenyls) and hexachlorobenzene as well as dioxins and Furans, which are the byproduct of combustion of industrial processes.

These chemicals are responsible for many cancer types, such as lymphomas, leukemia, hematological malignancy, reproductive system and urinary system tumors, soft tissue tumors, brain tumors and others. The people are at risk under both occupational and environmental conditions. Air, water, soil and human adipose tissues can be loaded with residues of pesticides and other toxic metabolites. These residues can bioaccumulate and bioconcentrate across the food chain, such as organic halides, organmetallics, and nitrosoamines.Organic solvents and aerosol propellants (Fluorochlorocarbons) diffuse in the environment (ARIJ, Localizing Agenda 21 in Palestine, 2001).

3.4 Industrial Wastes

The industrial revolution is a period of unparalleled productivity, but it is also a period of unrestrained "by-productivity", during which unprecedented quantities of raw industrial wastes are discharged into the environment. Industrial wastes are classified as "hazardous" or "non-hazardous" by the American "Code of Federal Regulations" (CFR 40, Part 261). Industrial wastes classified as hazardous have obvious potential for producing deterious impacts on human health and the environment. The non-hazardous wastes constitute the bulk of the waste generated by industry (Pepper et al, 1996).

The Resource Conservation and Recovery Act (RCRA) defined the solid waste and the hazardous waste as a by-product or discarded material if it is ignitable (burns readily), corrosive, or reactive (explosive), or if it contains certain amounts of toxic chemicals (Gertler, 1995).

Regardless of their classification as hazardous or non-hazardous, industrial wastes are of four major types based on their physical characteristics.

a) Combustible Wastes: yield byproducts that can be released into the atmosphere as gases or particulate pollutants when they are not properly filtered.
b) Solid Wastes: release pollutants into the atmosphere via dust or particulate transport. When these wastes come into contact with water, the soluble constituents can be leached out into the soil surface or below.
c) Sludge and Slurry Wastes: release pollutants into the soil and groundwater from both their solid and liquid phases.
d) Wastewaters: Due to their liquid state, they are a potential source of pollution if discharged into the aquatic or terrestrial environments without pretreatment.

Pollutants whose impact on the environment is most severe are those usually found in liquid or gas phases, because they can be transported into large distances and thus affect large segments of the environment (Pepper et al, 1996).

Harmful components of certain elements such as nitrogen, sulfur, chlorine, fluorine, etc…, may be widely mobilized, that is transported through the soil by the action of subterranean groundwater. Other elements may be converted from innocuous forms, like mercuric sulfide, to highly toxic forms like methyl mercury. Some elements such as heavy metals like Selenium and Chromium are highly toxic in their elemental form. So, industrial chemical wastes have to be safely managed in the environment. A risk assessment of potential health and welfare effects should be made with taking appropriate mitigation measures (McLaughlin, 1982).

Hazardous wastes are wastes that pose a potential hazard to humans, plants or animals. These wastes can be in the form of sludge, liquid, gas or solid. The impact of industrial discharge depends not only on its collective characteristics such as biological oxygen demand (BOD) and suspended solids, but also on its content of specific inorganic substances. The generated industrial wastes contain toxic elements such as aluminum, chromium, lead, zinc and nickel. For example aluminum industry produces aluminum and acidic wastes. Electroplating produces nickel, chrome and acidic wastes. All of these inorganic substances are considered hazardous and negatively affect the health if accumulated in the body (ARIJ, 1998).

3.4.1 Wastewaters

Many industries such as paper industries and food processing plants use large volumes of water. Metal-finishing plants and many chemical industries that manufacture plastics, pharmaceuticals, fibers, detergents, and paints also use huge volumes of water. Therefore, these industrial processes generate large volumes of polluted wastewater that either must be treated or discharged directly into the environment. Developer of industrial effluents into the sewerage system should pay additional charges to compensate for the pollution they are producing (Wagga Wagga, 2005).

Metal finishing plants as an example can generate wastewaters that contain significant amounts of metals with concentrations up to 1000 mg/l of Cr, Ni, Cu, Zn, Fe, and Cd. Food processing plants and paper industries usually generate wastewaters that are low in metals but high in organic constituents and salts containing Na^{+}, Cl^{-}, SO_4^{-2}, and CO_3^{-2} (Pepper et al, 1996).

3.4.2 Solid Wastes and Sludges

In industrial processes that produce solid wastes, the waste products are either present in water as colloidal suspension or mixed with water as slurries or sludges.Many industrial sludges may contain metals, metalloids and other elements in a suspended or mixed liquid /solid phase that makes the disposal complicated. Metal plating and metal finishing industries produce acidic sludges(pH < 2) and contain more than 1% (10,000 mg/kg) of one or more of the following metals (Cr, Ni, Cu, Zn, Fe, and Cd).Because these wastes have both acute and chronic toxic effects, they must be neutralized or oxidized and physically stabilized before disposal (Pepper et al, 1996).

3.5 Eco-Industrial Parks (EIP)

An EIP is a community of companies located in a single region that exchange and make use of each other’s by-products or energy. While some people consider all waste as a hazard to health and the environment that must be destroyed or prevented, many others consider it as an economic resource. Industrial parks can be a network of companies that exchange and make use of by-products, by integrating principles of industrial ecology, pollution prevention and sustainable design (Desrochers, 2000).

EIP’s provide one or more of the following benefits over traditional operations:

- Reduction in the use of virgin materials.
- Reduction in pollution.
- Increased energy efficiency.
- Reduction in the volume of waste products requiring disposal (Gertler, 1995).

An eco-industrial zone is a combination of environmental thinking and industrial strength. It includes the standard elements of the triple-bottom line of sustainable development: social, environmental and economic success. It reduces business environmental impact, creates friendlier infrastructure and enhances businesses' environmental performance by coordinating business-to-business networking to add value to wastes (Mitham, 2009).

An eco-industrial park involves a network of firms and organizations working together to improve the environmental and economic performance. It is a type of symbiotic relationship between participating firms seeking enhanced environmental and economic performance through collaboration in managing environmental and resources issues, including energy, water, and materials. The goal of an EIP is to improve the economic performance of the participating companies while minimizing their environmental impact (Lowe, 1997). Components of this approach include green design of park infrastructure, cleaner production, pollution prevention, energy efficiency and inter-company partnership.

Several basic strategies are fundamental to develop an EIP, which are:

- Integration into natural systems.
- Energy systems; to maximize energy efficiency through co-generation of energy and to use renewable sources.
- Materials flow and waste management for the whole site. This emphasizes pollution prevention especially with toxics, maximum re-use and recycling of materials among EIP businesses and reducing toxic materials risks through integrated site-level waste treatment.
- Designing water flows to conserve resources and reduce pollution (Indigo, 2006).

3.6 EIA of Industrial Zones in Palestine

There are six main Palestinian industrial zones in the West Bank and six industrial zones in Gaza strip, in addition to some industrial compounds in Ramallah, Beit-Jala, ‘Anabta, Hebron and Gaza city. **Table 3.1** shows the main industrial zones in the West Bank and some of the main industries held according to previous research.

Table 3.1: Industrial zones in the West Bank and Gaza (2006،أبو كرش).

Industrial zones in the West Bank			Industrial zones in Gaza Strip	
Location	Industries		Location	Industries
Nablus	Food industries, textiles, shoes, leather.		Gaza	Gas, textiles, electricity
Jenin			Der El Balah	
Tulkarm			Rafah	Technology
Jericho	Exploiting Dead Sea resources		Municipal industrial societies	Small domestic industries
Qualquilyia			Border zones	
Tarquoomia			Israeli-Palestinian-Jordanian-Egyptian cooperation	

Israeli colonies in the West Bank host several polluting industries which produce hazardous waste. These industries include aluminum, batteries, leather tanning, textile dyeing, fiberglass and other chemical industries. Waste generated from these industries affects various areas in the West Bank (ARIJ, 1998). These industrial zones occupy an area of approximately 302 hectares. Israel has given permits to four new Jewish industrial zones to be established in the West Bank in Area "C" near Ramallah, Nablus, Hebron and the Jordan Valley (ARIJ, 1998). **Table 3.2** shows industrial zones in colonies in the West Bank.

Table 3.2: Industrial zones in colonies in the West Bank (ARIJ, 1998).

Industrial Zone	District	Area(Hectare)
Hinnanit	Jenin	10.99
Barqan	Nablus	14.87
Ariel	Nablus	14.84
Ma'ale Efrayim	Nablus	2.58
'Atarot	Jerusalem	145.78
Mishor Adumim	Jerusalem	109.92
Quiryat Arba'	Hebron	3.35
Total Area		302

The major industries within these industrial zones include: Aluminum, leather tanning, textile dyeing, batteries, fiberglass, plastics, and other chemical industries. Many Israeli industries are being moved to the west bank, most of which produce hazardous waste materials. These industries are shown in **Table 3.3.**

Table 3.3: Israeli industries in the West Bank (ARIJ, 1998)

District	Industrial Location	Industry
Nablus	Barquan	Aluminum, fiberglass, plastic, electroplating
	Allon Morieh	Aluminum, food canning, textile dyeing
	Shilo	Aluminum, leather tanning
Ramallah	Halamish	Fiberglass, leather tanning
	Givout Hadassah	Rubber
	Nili	Aluminum
	Shelta	Fiberglass, plastic
	Atarot	Aluminum, cement, plastic, food canning and others
Hebron	Quiryat Arba'	Winery, building Blocks, tiles, plastic
Jerusalem	Mishor Adumim	Plastic, cement, leather tanning, detergents, textile dyeing, aluminum, electroplating
Jenin	Homesh	Batteries, aluminum, detergents
Tulkarm	Near 1967 border	Pesticide, Dixon gas, fiberglass

Israel has moved many of its polluting industries from places inside Israel to areas near the 1967 border or inside colonies. A pesticide factory in Kfar Saba has been moved to an area near Tulkarm. The wastewater has damaged the citrus trees and polluted the soil and groundwater in the area (ARIJ, 1998).

Dixon gas industrial factory which was located in Netanya has been moved near Tulkarm. Solid waste is burned in free air. Solid waste located in western Tulkarm has fiberglass and polyesters. Burning this waste results in the emission of dangerous black smoke and toxic gases. The Israeli government has moved a military camp from this area because Jewish soldiers have been affected by the fumes of these industries. Palestinian lands located at the foothills of industrial zones are highly vulnerable to the flow of industrial waste (ARIJ, 1998).

Industrial wastewater generated from Barquan industrial zone flows into the nearby Wadi and pollutes the agricultural lands of the Palestinian villages Sarta, Kafr ed Deik and Bruqin, in Nablus district. The generated wastewater from most of the industries is not treated and heavy metals often flow into Palestinian fields. Moreover, the generated solid waste is generally dumped without treatment into Palestinian land (ARIJ, 1998).

Chapter Four

Project Phasing and Types of Industries Expected to Move to the BMIP.

4.1 Project Phasing.

The project land is divided into two parts; Part 1 is the Waqf land which is already rented and controlled by PIEFZA. This part is about 220 Donums in area including a 24 donums cemetery, and will be phase 1 of the project. It is expected to accommodate the industrial needs for the southern West Bank area for the next 10 years. The rest of the land which is about 300 Donums is a privately owned land and the landlords are refusing presently to rent it to the PIEFZA. It is supposed to be considered as phase 2 of the project for the following 10 years after the first stage (Feasibility Study, 2009).

Public uses that are proposed to be included in the BMIP will be located in an intermediate location within the BMIP to be as close as possible to all industries and are estimated to occupy 4 donums of phase 1 area. These public uses are:

- Administration and recreational building.
- Civil defense center with a small medical center, a fire and a police station.
- Training center.
- Bank branch (Feasibility study of BMIP, 2009).

4.2 Industries Expected to Move to the BMIP

Industries are classified into 2 types according to their waste production. The first type produces hazardous waste products which need pretreatment before it is safe to be dumped within the public sewerage system. These industries are classified as type “A” and are under the following industrial categories:

- Manufacture of clothes and textiles.
- Tanning of leather; manufacture of bags and shoes.
- Manufacture of chemicals & its products.
- Manufacture of metal products.

- Car painting and grange mechanics.
- Brick factory.

The other type which is environmental friendly produces wastes that can be dumped directly within the public sewage system where no pre-treatment is needed. These industries are classified as type “B” and are under the following categories:

- Manufacture of food and beverages.
- Manufacture of wood and its products.
- Manufacture of paper and its products.
- Manufacture of rubber and plastic.
- Manufacture of non-metallic products.
- Manufacture of machinery and equipment.
- Manufacture of furniture.
- Handcrafts.

Type “B” industries are estimated to be about 60% of the total number of industries moving in the BMIP. It is assumed that 70% of the total area needed for industrial facilities is for type “B and 30% of the area is for type “A” industries (Feasibility study, 2009). **Table 4.1** shows the percentage of industries willing to move to the BMIP according to the Bethlehem Chamber of Commerce and Industry and the estimated weighed average area needed for every industry.

Table 4.1: Percentage of types "A" and "B" industries and weighed average areas (Feasibility study, 2009).

Type A industries			
Industry	Expected % of total industries	Average area/facility (m^2)	Weighed average area (m^2)
Manufacture of clothes and textiles	6.9%	765	52
Tanning of leather, manufacture of bags and shoes	5.7%	2407	137
Manufacture of chemicals, cosmetics and their products	6.0%	1535	93
Manufacture of metal products (Aluminum and stainless steel)	21.4%	1312	281
Total	40.0%		563
Type B industries			
Manufacture of food and beverages	8.4%	1341	113
Manufacture of wood and its products	20.4%	918	187
Manufacture of paper and its products	0.1%	1750	1
Manufacture of rubber and plastic *	20.6%	2615	538
Manufacture of non-metallic products	4.7%	8214	390
Manufacture of machinery and equipment	0.2%	703	1
Manufacture of furniture	5.6%	656	37
Total	60.0%		1267

From the above table it is noticed that the weighed average area for the type “A” industries is 563 m^2 and for type “B” industries is 1267 m^2, that is 30/70 ratio from the total area of the project.

4.3 Allocation of Industry Types and Layout Scenarios.

To avoid polluting the Wadi, and the agricultural soil, type A industries will be gathered in one location uphill in the North, with an area of 30% of the total industrial park (Feasibility Study, 2009). This allows similar industries to share pre-treatment industrial plants. Industrial unbuildable areas have to be left as green areas or as public buildings to insulate the facilities from the existing public buildings such as the residential areas and the schools. **Appendix 4.1** shows the location of types A and B industries in the project site (Feasibility study, 2009).

Generally, it is agreed upon that no stone cutting facilities would be in the park. But four scenarios were planned for the project. The owner has to choose one of them.

4.3.1 Planning Scenario 1: Ring Road Planning Scenario

In this scenario, roads follow the contour lines, which make it easier for the drainage network. Circulation is free with no definite entry and exit points. Advantages of this scenario are easier sewage networks and shorter roads. The disadvantage is the need for wider roads for exit and entrance.

4.3.2 Planning Scenario 2: Loop Roads Planning Scenario

This scenario is based on loop roads with exact entry and exit points to the park. Advantages of this scenario are the ability to have one way, and accordingly narrower roads with less cost, the ease of defining entrance - exit points and the ability to group related industries in shared entrance roads.

4.3.3 Planning Scenario 3: Combined Scenario

This scenario is a combination of the previous ones in order to include the advantages and to exclude the disadvantages of both. In this scenario a surface water drainage system runs along the whole project in the Wadi area, a road combination between the two previous scenarios as well as two entrances for the project: one for trucks and industrial circulation, the other for workers and employees.

4.3.4 Planning Scenario 4: Including Stone-Cutting Industry

The planning layout here is similar to scenario 3 except that a special zone is designated for the heavy stone cutting industry. The land will be divided into three parts; Part 1: for environmental friendly industries, Part 2, for stone cutting factories, and part 3 for the toxic waste producing industries (Feasibility study, 2009). The four planned scenarios are summarized in **Table 4.2**.

Table 4.2: Layout scenarios for land use areas (Feasibility study, 2009).

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Areas in m²			
Type A industries	36,553	32,159	37,000	45,670
Type B industries	70,816	88,647	75,000	45,670
Stone cutting industry	0	0	0	45,670
Empty land			25,000	
Roads	54,896	50,582	26,600	26,600
Ground water reservoir (2000m2)	500	500	500	500
Waste water treatment plant	3,000	3,000	3,000	3,000
Public buildings	4,000	4,000	4,000	4,000
Green areas	26,515	17,824	25,500	25,500
Total	196,280	196,712	196,600	196,600

Chapter Five

Baseline Data of the Study Area

5.1 Location

The BMIP project site is under the Palestinian authority control in region "A", located at 5 kilometers South East of Bethlehem city, at 8 kilometers from Jerusalem, at 70 kilometers from the Jordanian borders and at 40 kilometers from Ashdod port. It lies between Hindazeh village and Jinnatah village at 15 Km North of Hebron as shown in **Figure 5.1**. The neighborhood is partially urbanized with few houses to the North West as well as another neighborhood to the South East, a cemetery and two schools West and North West of the project site. The geographic coordinates of the project site are 31° 40̀ North and 35° 13̀ East (Feasibility Study, 2009).

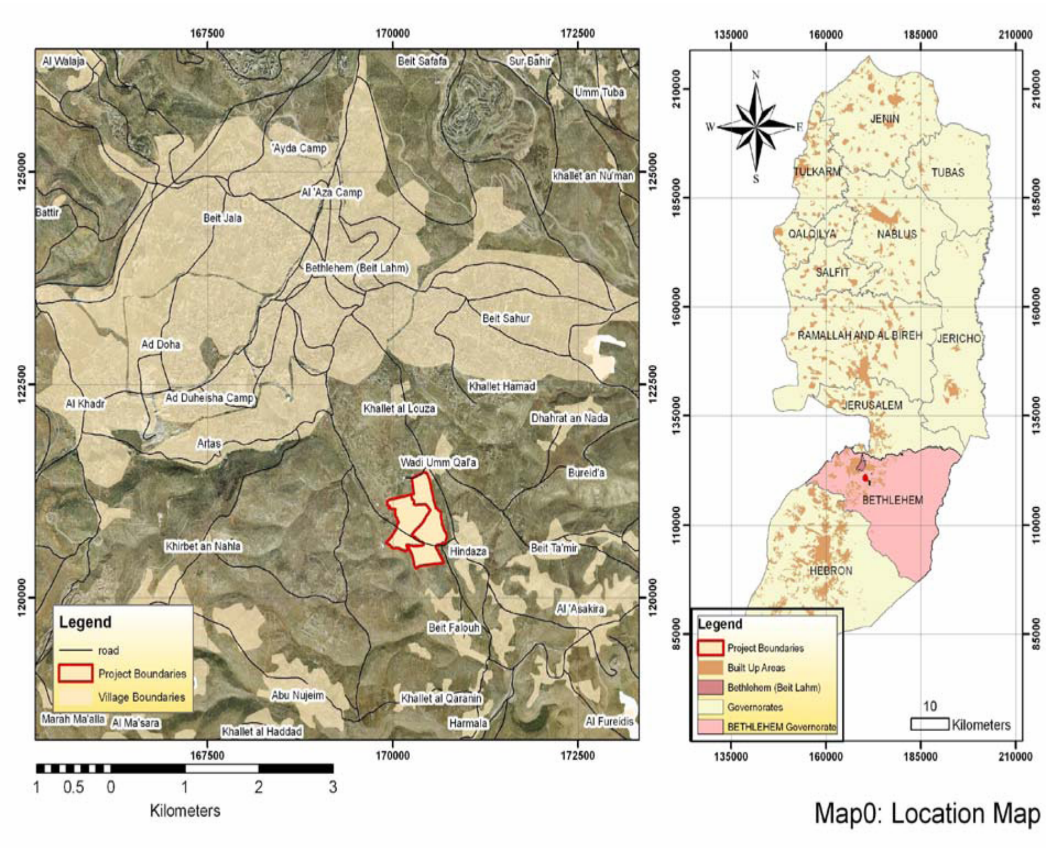

Figure 5.1: Location of the BMIP (Feasibility study, 2009)

It is proposed to be constructed on 500 dunums out of which 220 dunums are Wakf land and the rest is privately-owned land. The project is to be constructed within two stages; stage one on the Wakf land to be completed within 10 year time frame and the second stage on the privately owned land to be completed in additional 10 years frame. The Wakf land contains a cemetery of about 24 Dunums, which leaves about 196 Dunums available for stage 1 (Feasibility Study, 2009). **Appendix 5.1** shows the two stages of the project.

Access to the project passes through built-up areas or narrow roads, so there is a need to widen and rehabilitate the existing roads or to open new roads in order to avoid passing through built-up areas.

Industries in Bethlehem Governorate are not confined in specific areas, especially for those that intend to be transferred to the BMIP, (small and medium enterprises). Industrial waste that is generated by such industries is neither treated nor disposed of in proper and environmentally friendly methods. As a result of their spreading out inside residential and agricultural areas, such factories are producing negative impacts on their surroundings, especially the inhabited areas.

The current activities in the project site before the construction of the BMIP have low impacts on the environment, and hence, water, soil, air and noise pollution level in the area is at its minimum. It is important that monitoring and control methods should be set up and adopted during the different stages of the project.

5.2 Topography

The project site is located within the central section of Jerusalem hills. It is about 670 masl in the North West descending to 635 masl in the South East within 500 meters distance, thus having low gradient of about 7%. The site is a low sloped area; most of the site area is less than 20% slope, a considerable portion of the site is less than 10% slope. The site of the project comprises an elongated shape that is in the mid way between the village of Jinnatah to the South Eastern part and Bethlehem city to the North Western part (Feasibility Study, 2009).

The Southern part of the area is almost flat; the central Eastern part is hilly and has a rough rocky topography. There is a central strip North South that forms a small flood plain with terraced fields, associated with a fertile and a moderately deep soil (depth ranges from 1-2 meters). The nearest real deep valley lies to the South of the borders of the project site. The Eastern and Western parts of the project area have a concave shape surface directing the main gradient to the central flat flood plain of the project site, thus constituting a small watershed of the surface runoff water for the surrounding concave hills **(**Feasibility study, 2009). **Appendix 5.2** shows a general topographic view of the BMIP.

5.3 Geology, Hydrogeology and Water resources

5.3.1 Geology and Hydrogeology

The Bethlehem formation corresponds to the upper Cenomanian age. The North-Eastern part of the formation is dominated by dolomite and dolomitic limestone, while the southern part is chalky. It acts as a confining aquiclude for the Hebron formation which is beneath. Dolomitic formations of the Jerusalem district are affected by faults and joints.

Groundwater wells in Jerusalem district are considered phreatic and are of depth between 150-420 m. Joints are often up to one meter wide, mostly filled with dirt and allow high infiltration to the lower formations. (ARIJ, Environmental Profile, volume 6, Jerusalem District, 1996)

The Bethlehem formation outcrops on both flanks of Judean anticline, marked by limestone, dolomite and chalky marl. Its total thickness varies from 30 m in the West to 150 m in other parts (ARIJ, The Status of the Environment in the West Bank, 1997).

The existence of fissures, fractures, joints and karstification, in addition to the rock permeability and porosity, makes the area vulnerable to potential hydrogeologic pollution (ARIJ, Palestinian Localized Agenda, 2006).

The site lies above Jerusalem hydrological basin to the East of the main underground watershed, and drains eastwards.

The Jerusalem Desert Basin is a part of the Eastern mountain aquifer which consists of two different levels, these are the lower and middle Cenomanian aquifers which vary in thickness between 385-630 meters , composed mainly of limestone, dolomite, chalky limestone, marl and dolomite. The other level is the upper Cenomanian Turonian aquifer, located at a depth ranging from 300-500 meters, and some of its water emerges from springs close to the fault line west of the Dead Sea ('Ein Gidi). The lithology of the first part of this system is mainly dolomite that permits only slow rate of flow. The main surface drainage system of the area to the South of Bethlehem is Wadi al Ta'amira that drains in the Dead Sea to the South East. **Appendix 5.3** shows the geological map of Jerusalem area. (Frimerman D., Geology of Israel in pictures). **Appendix 5.4** shows the stratigraphy of Jerusalem area. (Arkin Y. et al., 1997). **Table 5.1** illustrates the hydrostratigraphic column beneath Bethlehem District.

Table 5.1: Hydrostratigraphic column beneath Bethlehem District (Rofe and Raffety, 1969).

Geological formation	Geological stage	Thickness (meters)	Aquitype
Alluvial gravel	Holocene (Recent)	0-20	-
Lissan formation	Pleistocene	10-30	-
Beida formation	Miocene Pliocene	60-100	Aquiclude
Jenin formation	Eocene	100-120	Aquiclude
Abu dies formation	Senonian	40-150	Aquiclude
Jerusalem formation	Upper Cenomanian-Turonian	50-130	Aquifer
Bethlehem formation	Upper Cenomanian	30-150	Aquitard

Hebron formation	Middle Cenomanian	130-260	Aquifer
Yatta formation	Lower Cenomanian	60-100	Aquitard
Upper Beit Kahil formation	Upper Albian	325-530	Aquifer

A syncline dips to the East which results in an Eastern flow of ground water making the local ground water aquifer sensitive to pollution. The local ground water aquifer adjacent to the project site to the South and Eastern south is classified as highly sensitive water resource area (MOPIC, 1996).

This sensitivity is due to:

1. The presence of many deep fractures extending to the local aquifer.
2. The presence of major surface watershed areas that recharge the local aquifer with flowing water from the surrounding areas.
3. The high annual rainfall with an average of more than 500 mm.
4. The relatively moderate to deep ground water level, phreatic aquifers where depth ranges from 160 to more than 350 meters in some places, necessitating strict precautions in areas where the depth of ground water is not deep, especially where fractures exist (MOPIC, 1996).

There are some springs to North of the site near Beit Sahour and in Wadi Artas. In addition to these springs, deep pored ground water wells are abundant in Bethlehem district. One of these wells is directed to the north of the site (Beer Hindazeh). The total annual abstraction of these wells is estimated at 11.5 million m^3. There are a total of 15 springs in Bethlehem district that have a combined annual discharge rate of about 550,000 m^3 (PCBS, 2007).

5.3.2 Water Resources in the project site

Palestine is among the countries with the scarcest renewable water resources, amounting to only 100 m^3 per capita per year. Water demand exceeds the available water supply. The gap between water demand and water supply is growing due to population growth, higher standard of living, the need to expand irrigated agriculture and industrialization

(Localizing Agenda 21 in Palestine, 2001). There are two possible sources of water supply to BMIP; PWA well fields and Israel Mekorot Wells.

PWA Water Supply System

There are 8 wells constructed by PWA in Bethlehem area, but the constraint is the frequent failure of well pumps for 5 out of the 8 wells. Currently, only 3 out of 8 wells are under operation, PWA1, PWA2, and Hindazeh. Other Wells are not operated in full capacity due to continuous failures in operation. If all wells are supposed to be operating in full capacity then BMIP can be provided with a maximum of 50 m^3/hr from Palestinian Water Authority (PWA) Water Supply System. At that time, the water supply will reach 28,000-30,000 m^3/day for the Bethlehem area (Feasibility Study, 2009).

Israeli – Mekorot Wells

Securing a reliable supply from Israel is an option which is possibly politically difficult. The Israelis control much greater water resources in the area. Israeli wells operated by Mekorot, the Israeli Water Company, include Herodion 1, 2, 3, and 4. It can be assumed that water supplies will be limited. This factor influences the type of industries allowed to take place in the project (Feasibility Study, 2009)

The expected total water consumption has been estimated at approximately 620 m3/day after full operation of the BMIP, but we should take into consideration the assumption of 1% annual increase in water demand. It is estimated that the park would require a range of 100,000 to 150,000 m^3 of water annually (Feasibility Study, 2009).

Water consumption required for the BMIP will be provided by the existing Mekorot water system in the project area. This means that the water coming to Bethlehem will be decreased by this amount, but Bethlehem area already suffers from problems in receiving water. The main feeder which will feed the Industrial Park, feeds large areas in Beit Jala and Bethlehem. These areas will suffer from the increased load in addition to the suffering from the insufficient water pressure.

There were two suggestions to overcome the problem of water shortage in Bethlehem and Beit-Jala by WSSA so as to provide the BMIP project with enough water, proposing to increase the amount of MEKOROT water to the elevated western part of Beit-Jala by additional 1000 m^3 daily, or by increasing MEKOROT water supply to the area around Caritas Hospital by additional 1000 m^3 daily (Feasibility study, 2009).

Tables 5.2 and 5.3 show some characteristics of wells in Bethlehem governorate surrounding the project site. Data were taken from a previous research done by the Environmental Studies Department in Al-Quds University for a Master thesis. The study covered seven of the total of eight wells in the interval between November 2007 and August 2008.

Table 5.2: Characteristics of Bethlehem Governorate wells around the project site (Elias, 2010).

No	Well	Aquifer	Well Depth (meters)	EC (μS/cm)	T (°C)	pH
1	**Herodion (1)/ H1**	Upper	350	506	20.2	7.48
2	**Herodion (2)/ H2**	Lower	770	545	21.8	7.35
3	**Herodion (3)/ H3**	Lower	800	566	22.8	7.39
4	**Herodion (4)/ H4**	Lower	691	598	24.5	7.28
5	**Hindazeh/ Hn**	Upper	330	546	21.9	7.31
6	**PWA 1**	Lower	600	588	20.2	7.33
7	**PWA 2**	Lower	851	596	21.7	7.28

Table 5.3: Chemical characteristics of Bethlehem Governorate wells around the project site in mg/l (Elias, 2010).

Well	Na+	K+	Mg+2	Ca+2	NH4	Cl-	HCO3-	SO_4-2	NO3-	PO4-	TDS
H1	44.80	1.27	35.40	88.50	0.01	35.45	489.73	12.00	23.20	0.32	453.0
H2	9.80	4.61	71.40	62.50	0	30.50	505.65	13.00	6.00	0.06	703.4
H3	67.60	5.12	10.90	46.70	0.01	30.50	304.70	15.00	5.00	0.08	268.3
H4	15.25	1.83	11.70	15.60	0.01	30.49	76.44	14.00	13.90	0.36	179.2
Hn	13.18	0.67	34.84	65.92	0.01	34.24	336.36	12.00	12.80	0.13	510.0
PWA1	5.70	0.15	31.50	87.20	0.15	33.32	368.65	10.00	16.30	0.11	552.9
PWA2	16.80	2.20	39.00	120.40	0.05	35.45	529.34	13.00	9.00	0.16	765.2

In this research, Hindazeh Well was studied and compared to previous studies.

5.4 Soil

The soil of the project is of two main types: brown and pale rendzina located mainly in flat areas, whereas the second major type uphill is the bare rocks and shallow brown lithosols. Due to its location in the valley plain and the accumulation of moisture and eroded organic matter from uphill, such soil is very fertile and is being used for cultivation with olive groves. Local residents cultivate their land with wheat, barley, lentils and vegetables. The bare rocks and shallow brown lithosols are characterized by high percentage of rock outcrops with a high stoniness. This soil is also subject to overgrazing, intensive flooding and erosion that make it shallow. **Appendix 5.5** illustrates the brown lithosol and the bare rocks. **Appendix 5.6** illustrates the excavation in the project site showing soil strata.

The soil in the site has a depth of about 1.5-2 meters in the valley (Wadi); it has also a low percentage of stoniness with an organic matter content of about 9% (Feasibility Study, 2009). It is used for field crops cultivation in addition to olive groves.

Rendzina soil is rich in organic content; with relatively high content of clay (30% - 80%).The pale rendzina has a considerable content of sand (عابد و وشاحي، 1999).

5.5 Climate (Temperature, Precipitation and Relative Humidity)

The climate in the project site is typical East Mediterranean climate with rainy warm winters and dry hot summers. The average annual temperature in the area ranges from 18°C to 20°C. The coldest months are January and February with an average temperature of 10°C, and a minimum of 7°C that can drop to zero°C in January. The maximum temperature occurs during July and August with a monthly average of about 26°C and a maximum of 31°C during August and September (ARIJ, Environmental Profile, Vol. 6, 1996).

The annual precipitation ranges between 420 to 450 mm/ year. The rain falls normally between November through early days of May with a maximum rain occurring during the months of December, January, February and March. The rains in the area are of cyclonic nature, so they fall mainly in intense and intermittent heavy showers. The rainy days in the area are between 40 to 50 days/ year (ARIJ Environmental Profile, Vol. 6, 1996). **Appendix 5.7** shows average rainfall in Bethlehem area.

Relative humidity ranges between 50% and 90% with an annual average of 70%, being highest during winter with an average of 66% and lowest during summer with an average of 29%. (ARIJ, Environmental profile, Vol.6, 1996).

Figure 5.2 illustrates the average monthly rainfall and the mean annual rainfall in Bethlehem District. **Table 5.4** summarizes the climatic parameters in Bethlehem Area. **Table 5.5** summarizes the average annual rainfall in the main Bethlehem District cities around the project site.

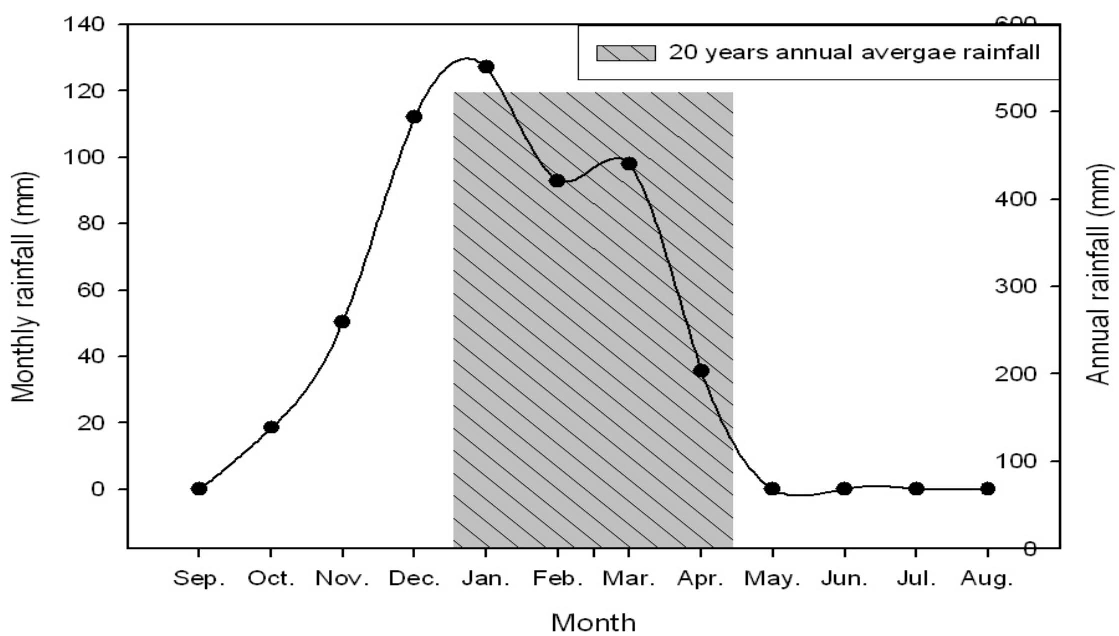

Figure 5.2: Average monthly rainfall and mean annual rainfall in Bethlehem. (ARIJ database).

Table 5.4: Climatic parameters in Bethlehem area. (Orani and Efrat, 1980).

Mean annual rainfall	100-700 mm
Mean annual evaporation	1400-2600 mm
Mean annual temperature	17°-23° C
Mean annual relative humidity	60%
Mean relative cloudiness	20-35%
Sunshine on average	7-13 hours

Table 5.5: Average rainfall in Bethlehem area (ARIJ database)

Bethlehem	495 mm
Beit-Jala	555 mm
Beit Sahour	455 mm
Za'atara	275 mm

5.6 Wind Direction

The prevailing winds in the site are mainly westerly and south westerly winds with a speed of more than 30 km an hour during winter, whereas the wind speed becomes slower during summer time of about 10 to 12 km per hour. Central Palestine experiences a cyclonic wind of speeds between 50 to 60 km per hour in winter. These cyclonic winds bring rain with them. Meanwhile, the country experiences waves of hot, dry, sandy and dusty southerly winds which originate from the Arabian Desert during the months of April, May and mid June that are known locally by the name Khamaseen (ARIJ Environmental Profile, Vol.6, 1996).

This means that the Eastern neighbors of the site are air pollution threatened **Appendix 5.8** shows the prevalent wind direction in the site. A possible solution could be to create a green buffer green area to the eastern side of the project land.

Industrial parks usually contain factories that can produce gas pollutants. These pollutants are carried by means of wind to the surrounding environment. It is important to study the prevalent wind direction in order to locate the air pollution threatened surroundings.

Metal industries generate wastes that may contain hazardous metals. At very high temperatures, metal compounds volatilize, significant amounts of relatively volatile toxic materials can be released into the atmosphere. Also incineration of toxic organic wastes high in volatile metals (Hg, Cd, Zn, As) can discharge significant amounts of metals in the atmosphere. Low-temperature gaseous emissions and particulates such as aerosols and dust can be airborne and disperse over great distances (Pepper et al., 1996).

Many other pollutants are unburned hydrocarbons, CO, CO_2, NO_x, SO_2, smoke, particulate matter and many others. Many of them are carcinogenic substances or they might affect the health of nearby populations (Holdgate, 1979).

5.7 Flora and Fauna

Flora and fauna are considered the most important resources in an ecosystem. Much of Palestinian life depends on the essential goods and services provided by variety of genes, species, populations and ecosystems.

Palestine has a very rich biotic diversity, with high density of biotic species (flora and fauna) due to the following:

1- The land is located at the cross roads of the two largest continents (Asia and Africa), creating the only land bridge between these two gigantic biotic zones.

2- It is located between two water bodies; each is connected to a major and different marine biotic system: the Red Sea and the Mediterranean Sea.

3-Palestine has varied and diversified topography, diversified rock formations and soil types, different climates and climatic zones with numerous micro climates.

4- Palestine is a part of one of the most important global geological and biotic phenomenon, the Afro-Asian Rift Valley; with all its biotic richness.

5- It is one of the oldest cultural landscapes on earth, rich with cultural exchange that has enriched the biodiversity of domesticated and natural plant and animal life (ARIJ, The status of the environment in the West Bank, 1997). Although Palestine has a small land area, it is characterized by a rich variety of flora. It is estimated that it has 2483 species of higher plants belonging to 700 genera and 114 families. (ARIJ, Localizing Agenda 21 in Palestine, 2001)

Bethlehem area is dominated by the Mediterranean zone which is covered with evergreen forests in which *Quercus calliprinos, Ceratonia siliqua, Pistachia lentiscus, Pistachia palaestina, Sarcopterium spinosum* are dominant. Local forests are characterized as common oak forests, stone oaks, pistachio and carob formations. The Eastern slopes region is also dominated by *Marjorana syriaca, Artemisia herbalba, Eryngium glomoratur, Asphidullus microcarpy, Ononis natrix* and many other plants (Breighieth, 1998).

According to the literature review and two field visits held to the project site in March and April 2010, the flora found in the site was documented by a Canon EOS 500 D camera. Documented flora is shown in **Table 5.6** Most of the flora was medicinal, cultural and economic plants.

Table 5.6: Flora documented in the project site.

Scientific name	Common name	Arabic name
Acanthus syriacus	Bear's Breech	اف الدب/أقنثا سورية
Adonis aestivalis	Pheasant's eye	حنون البس
Adonis palaestina	Palestine Pheasant's Eye	عين القط (أدونيس فلسطين) حنون
Allium orientale	Wild Garlik	ثوم بري
Anagallis arvensis	Pimpernel	عين القط
Anchusa strigosa	Bugloss	الحمحم المهاب

Anemone coronaria	Common Anemone	شقائق النعمان
Anthemis bornmulleri	Chamomile	بابونج
Anthemis palaestina	Palestinian chamomile	أقحوان فلسطيني
Artedia squamata	Crown Flower	دريمة
Arum palaestinum	Arum	لوف
Avena sterilis	Wild Oat	شوفان بري
Bromus tectorum	Downy brome grass	الشويعره
Capsella bursa-pastoris	Shepherd's purse	قلب الراعي
Carthamus tenius	Slender Safflower	قوس
Conium maculatum	Poison Hemlock	الشوكران السام
Cynodon dactylon	Bermuda grass	انجيل
Ecaballium elaterium	Squirting cucumber	فقوس الحمار/الجنج
Eragrostis cilianensis	Spreading love-Grass	الحلفا الحولية
Gundelia tournefortii	Gundelia	كعوب/عكوب
Hedypnois cretica	Crete weed	رويسة الجبل
Hordeum bulbosum	Bulbous Wild barley	شعير بري
Malva sylvestris	Common Mallow	خبيزة
Notobasis syriaca	Syrian Thistle	خرفيش الحمير
Ononis natrix	Sticky Restharrow	شبرق أو شبرج
Orchis anatolica	Anatolian orchid	السحلب الأناضولي
Papaver umbonatum	Corn Poppy	دحنون
Polypogon monspeliensis	Annual Beard grass	ذيل الفار
Ridolfia segetum	False Fennel	ينسون بري
Sinapis arvensis	Charlock	خردل (لفيتة صفراء)
Vicia ervilia	Bitter Vetch	كرسنة/ارسنة

Documentation and classification of flora were according to some references such as: (www.flowersinisrael.com), (معهد الأبحاث التطبيقية، التاريخ الزراعي النباتي في فلسطين،2002), (جاد اسحق، أزهار برية من فلسطين، 1993). Many plants among the documented plants are supposed to be endangered and protected species. They were found in sparse and small aggregations.

In addition to the documented plants, literature revealed that the following wild plants are supposed to be found in the project site, some of which are endangered species like thyme (الزعتر) and sage (المريمية) (**Appendices 5.9/a, b, c, d** show some documented wild plants). According to literature, many wild plants are supposed to be found in the project site in addition to the previously documented plants. These are summarized in **Table 5.7**.

Table 5.7: Flora supposed to be found in the project site. (ARIJ, flora and fauna database, 1995) (أزهار برية من فلسطين،1993) (التراث البيئي النباتي في فلسطين،1992)

Scientific name	Common name	Arabic name
Anchusa aegyptiaca	Prickly Alkanet	مصيص
Ballota undulata	Common Black Horehound	رسان، أسفان
Bellevalia flexvosa	Common Roman-squill	عنصول
Biscutella didyma		صحون الراعي
Calicotome villosa	Spiny Broom	قندول أصفر
Carlina hispanica	Corymbed Thistle	زند العروس
Centaurea Iberica	Iberian Centaury	مرار
Chiliadenus iphionoides	Common Varthemia	شتيلة
Crepis sancta	Holy hawk's-beard	صفيره
Diplotaxi erucoides	White Rocket	شلوة بيضاء (حويرة)
Echium angustifolium	Viper's bugloss	حمحم
Erodium gruinum	Crane Storks bill	إبرة العجوز
Erodium malacoides	Crone Storks bill	ابرة العجوز

Eryngium creticum	Syrian Eryngo	قرصفة زرقاء
Euphorbia hierosolymitana	Spurge	لبين، حلبوب
Filago desertorum		قطينة
Fumaria densiflora	Dense-Flowered Fumitory	رز الدجاج
Lamium amplexicuale	Great Henbit	قريص الجاجة
Linum pubescens	Pink flax	اتان زهري
Majorana syriaca	Marjoram/Thyme	زعتر
Onobrychis squarrosa	Cock's – comb	ضرس العجوز
Paronychia argentea	Silvery Whitlow – wort	رجل الحمامة
Pisum sativum	Dwarf pea	بازلاء برية
Plantago Lanceolata	Buckhorn plantain	اذان الكبش
Ranunculus asiaticus	Asian Butter Cup	نموار
Reseda alba	White mignonette	ريسدا أبيض
Salvia fruticosa	Common sage	مريمية
Sarcopoterium spinosum	Spiny burnet	بلان، نتش
Scandix pecten-veneris	Shepherd's Needle	مشط الراعي
Scolymus hispanicus	Spanish Oyster Plant	قوص
Sedum rubens	Red Stonecrop	عرف الديك
Sedum rubens	Red Stonecrop	حميض
Silene aegyptica,	Egyptian Catchfly	حلوان
Silene conoidea	Conoid Catchfly	الشب العايق
Tordylium aegyptiacum	Egyptian Hartwort	دريهمة
Valerianella vesicaria	Bladder Corn Salad	حشيشة القط
Vicia narbonensis	Broad-leaved Vetch	فول إبليس

The animal wildlife in Palestine consists of a wide variety of invertebrates, amphibians, reptiles, birds and mammals. Eight amphibian species are recorded in Palestine, such as *Salamanders maculosa* (endangered) and *Triton vittatus* (rare). Three species of frogs exist.

There is a high diversity of reptiles in Palestine, 93 species and subspecies, which have an important role in the ecological balance as they form an important food source for predators. According to literature and testimonies of residents of the project area, reptiles which are supposed to be in the project site are: Greek Tortoise (السلحفاة البرية), Zeric Lizard(السحلية الناعمة) , Rock Agama (الجردون العادي), Arabian Gecko(أبو بريص) ,Lined lizard(السحلية المخططة) , common chameleon (الحرباء) , Sheltopusik (حنحوف) , in addition to many species of snakes (ARIJ fauna and flora database,1995) .

Birds in Palestine are very diverse, with 511 species recorded, between migratory and domestic birds. Palestine is an important migratory route for North Palearctic birds. In the project area, these species are supposed to exist: Wheat Eater (الأبريق), Sparrows (الدويري), White Wagtail (الذعرة البيضاء), Crested Lank,(القبرة المتوجة) Rock Dove (الحمام الأزرق), Yellow Vented Bulbul (البلبل), Great Tit (الصفجع),Quail (السمان),Hoopoe (الهدهد)and many others .(1992 معهد الأبحاث التطبيقية، طيور فلسطين الشائعة،)

As for the mammals in Palestine, there exist 33 families with 113 species. The number of mammals decreased and many species are endangered. According to witnesses in the project site, there are species of Gazelles (غزال الجبل الفلسطيني) / endangered, fox (الثعلب) / endangered and moles .(الخلند الفلسطيني) Many mole boreholes were documented in the project site shown in **Appendix 5.10.** (1993 ، معهد الأبحاث التطبيقية، الثدييات في فلسطين).

Invertebrates that are supposed to be found in the project area are the Black spider (العنكبوت الأسود), Syrian spider (العنكبوت السوري) , Darkling beetle (الخنفساء السوداء), Lady beetle (الخنفساء المزركشة), Blue- winged grasshopper (الجندب ذو الأجنحة الزرقاء), Indian house cricket (الجندب الهندي), Oriental Hornet (دبور البحر المتوسط), Wood Ant (نمل الخشب), Swallow tail butterfly (الفراشة فاقدة الذنب), Mediterranean banded scolopendra ام أربعة و)

(أربعين المخططة, House centipede (عصا موسى المنزلية), and many others (ARIJ fauna and flora database,1995).

In Bethlehem area, there had been many dangers threatening natural resources. The main dangers in the area are:

1. Long history of natural resources exploitation and the lack of proper management during its history.
2. The high population density in the area, and the increasing population growth.
3. Pollution by sewage waters and Wadi (valley) systems, and sanitation problems in particular.
4. Habitat destruction by construction of settlements, military camps, deforestation, unplanned urban development, mining and quarrying.
5. Overgrazing which led to the reduction and almost extinction of the natural vegetation cover, and increasing soil erosion.
6. Extensive use of agro-chemicals, poisoning insectivore birds and other predators of insects.
7. Uncontrolled hunting and bird catching (ARIJ, Localizing Agenda21 in Palestine, 2001).

5.8 Ambient Air Quality

The project site lies in the rural region of Bethlehem. It has a good air quality throughout the year and there are no urban or industrial air pollutants in the area and its vicinity. The most serious issue here is the presence of a boys' school adjacent to the project site and a girls' school nearby, in addition to built-up area in the vicinity of the project site, which might harm both residents and students directly.

Metal industries generate wastes that may contain many hazardous metals and metalloids, such as Pb, Zn, Ni, Cu, Cd, Cr, Hg, Se, As, and Co. These industries might require very high temperatures. At high temperatures, many other metals volatilize, such as mercury, cadmium, zinc and arsenic and they can release significant amounts of relatively volatile toxic metals into the atmosphere (Pepper et al., 1996).

In addition, incineration oxidizes most carbon–based wastes into carbon dioxide and water vapor. Also, other metals may be released into the air as particulate matter during the incineration if the incinerator gas is not filtered. Atmospheric contaminants may include low-temperature gaseous emissions and particulates such as aerosols and dusts originating from industrial processes and on-site activities. Airborne contaminants move and are deposited over great distances and large areas of land. These airborne materials can consist of relatively benign chemicals such as phosphorus and sulfur, or toxic materials such as heavy metals or complex organic compounds (Pepper et al., 1996).

Most of the vehicles in the West Bank use leaded gasoline except for new vehicles. Therefore it is expected that the level of lead will increase in the air by heavy traffic expected after the operation of the project. Inhaled or digested lead may cause poisoning and disturbance in the gastrointestinal system, accompanied by pain excessive tiredness, continued headaches, loss of appetite, nausea and muscular pain. In children, inhaled lead may cause brain damage (Watkins, 1991). Trucks and heavy machinery use diesel as fuel. Their emission of sulfur oxide (SO_2) is extensive. Unmaintained diesel engines with incomplete combustion produce large amounts of pollutants (Watkins, 1991).

5.9 Noise Pollution

Noise health effects can be immense and come from elevated noises which might affect people on the long-run and also might interfere in the work environment, normal speech communication and nearby residents' biological need for sleep. It might cause hearing impairment, hypertension, vasoconstriction, ischemic heart disease, annoyance, stress, sleep disturbance and decreased school performance (Wikipedia, Health Effects from Noise).

Environmental noise regulations specify a maximum outdoor noise level of 60 to 65 dB, while occupational safety organizations recommend that the maximum exposure to noise is 40 hours /week at 85 to 90 dB. The recommended noise level for indoor residences is less than or equal to 45 dB. (Wikipedia, Health Effects from noise).

There are no noise pollution traces in the project area as it is a rural region, which makes a real obligation to keep the noise pollution as low as possible during execution and activation of the project. Moreover, there is a school in the vicinity, where noise might have negative impacts on the students and workers. The site lies in a very calm region, thus loud noises might interfere with the presence of wild fauna which are already suffering from many threats noted in section 5.7 of this chapter.

5.10 Public Uses and Green Areas

The BMIP site is surrounded by several public uses that include two schools, a mosque and a cemetery, in addition to many residential buildings in the North and the East. The village of Harmaleh is so near and may easily be air polluted. The boys' school is adjacent to the project site that might be susceptible to air and noise pollution in addition to annoyance from increased traffic to and from the project site operation. **Appendix 5.11** shows land and public uses in the project area.

The site of the project is a green area. During spring, it is noticed that the Waqf land is planted with wheat, barley and lentils. The area is rich with wild vegetation that is essential for the well-being and the heritage of the villagers. Most important green areas are olive trees areas plantations which can be found especially in the Wadi which lies in the south-eastern side of the project site, where the soil is fertile and the surface water is expected to run through.

The project site was screened for unbuildable areas shown in **Appendix 5.1**, where the sieved areas are:

1- Steep sloped areas with slopes more than 25%.

2- Existing olive trees areas.

3- Cemetery.

4- The Wadi bed.

5- A buffer of 25 meters from existing buildings surrounding the site (Feasibility study, 2009).

Water cycle is highly affected by the surfaces on which rain falls. Rocky and smooth surfaces drive surface flow to the valleys, while soil helps rain water to infiltrate to the groundwater. Moreover, Water quality could be affected when rain falls over roads and built-up areas and could be contaminated with asphalt and cement especially if it falls over a watershed or sensitive areas. 21% of Palestinian built-up areas and 29% of Israeli colonies lie over water sensitive areas in Bethlehem area.(أريج ، 2002، أثر النشاطات العمرانية)

5.11 Socio-Economic Environment

The occupied Palestinian territories over the past 8 years, have been suffering from drastic economic setback due to the prolonged closure and isolation measures. Future projections of the economic condition in the occupied Palestinian territories are strongly influenced by the continued setbacks in the political situations.

The BMIP gives new possibilities for employment; specifically for Bethlehem, Beit Sahour and Beit Jala as well as Hindazeh , Jinnatah, Harmaleh, Breid'a, Khalayel-el-Loz, Khallet-el-Jame', Dahret-el-Nada and Irtas villages adjacent to the project. It can also attract workers from Hebron district, which is so near to the project site.

The total population of Bethlehem Governorate is about 176235 divided into 89743 males and the 86492 females. The total number of population above 10 years old is estimated at 120845 divided into 61542 males and 59303 females. The economically active persons are about 41169 divided into 34548 males and 6621 females, which means that the majority of the labor force is male. (PCBS, 2007 census). **Appendices 5.12(a, b)** show the population groups in the West Bank by governorate, sex and age group.

According to PCBS census of 2007, the highest unemployment rate in the West Bank was found in Bethlehem governorate, with approximation of 17% among those older than 10 years old (PCBS,2007 census) as shown in **Figure 5.3**.

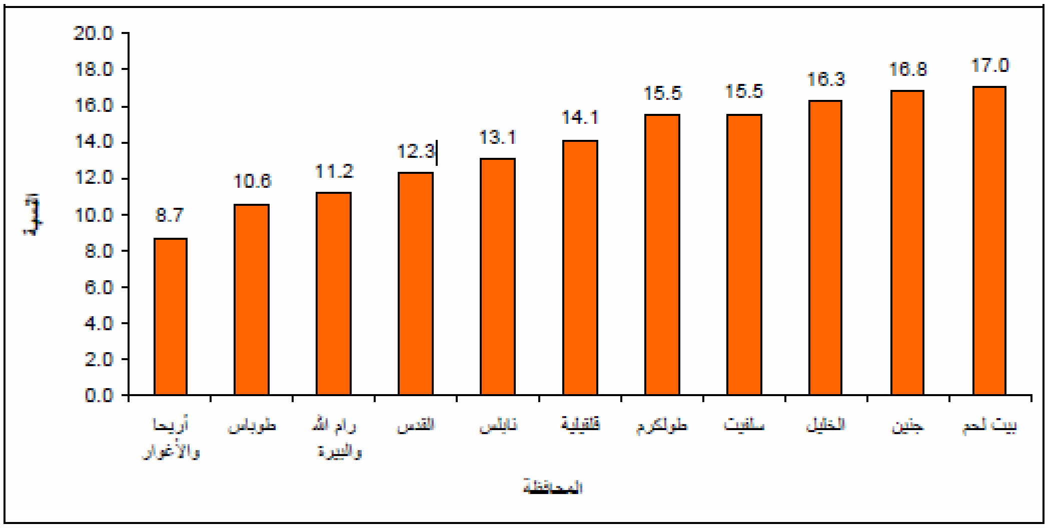

Figure 5.3: Unemployment in the West Bank (PCBS, 2007 census).

There are 26 types of manufactures at Bethlehem area, many of which are considering moving to the BMIP, which could be a good labor pool from which the different factories of the new industrial park can draw needed experienced employees with new job opportunities. The industrial park will also offer a training center which will add to the qualifications of workers and enhance their expertise (Feasibility study, 2009)

The site nearby Hindazeh village has a total population of 4799 divided into 2416 males and 2383 females, among them hundreds of males and females who would be potential workers in the proposed new industrial park (PBCS census, 2007).

A major demand for the industrial park is to promote local industries for the foreign market, activate FDI (Foreign Direct Investment) and open new markets by facilitating the export. Consequently, encouraging the investors to consider major steps toward expanding their enterprises and move to BMIP.

5.12 Agriculture

Agricultural activities, in the site of the industrial park and its surrounding, are characterized by few types of cultivation and fluctuation of production according to the amount of rainfall as well as the economic condition of the market. With regard to the major existing land use in the site, it is mainly rain fed agriculture; rain fed fruit trees, olive trees and grapes. Olive plantations in the surrounding of the project site occupy about 30 dunums (Feasibility Study, 2009). **Appendix 5.13** shows olive plantations in the project site.

About 50 dunums of the surrounding area are devoted to cultivation of rain fed field crops and summer vegetables; wheat, barley, lentils, chickpeas and other leguminous crops. Rain fed summer vegetables are snake cucumber, squash, tomatoes, onions and okra (Feasibility study, 2009). **Appendices 5.14** and **5.15** show olive trees areas and summer crops areas.

Irrigation is not common in the project site and its surroundings due to the lack of enough water and the improper climatic conditions prevailing. When water is so scarce for agriculture, it cannot be provided sufficiently for industry.

In addition to the agricultural activities in the site, the inhabitants of the area are practicing in-house livestock raising especially sheep and goats, but there are no systematic and well managed animal farms for livestock raising. Due to the low economic standards of the inhabitants, people are forced to get their livestock outside in the open fields for grazing; resulting in a severe destruction of the plant cover and a consequent soil erosion problem**.** Sheep grazing in spring are shown in **Appendix 5.16.** In spite of that, the shepherds who were interviewed expressed the feelings of annoyment from the possibility to lose their sole source of income if the project takes away 500 dunums of their land where they raise their animals.

Recently, the economy of the study area is changing toward employment, industry and services, hence practicing agricultural activities became a partial time job for most of the peasants of the study area. Such changes can be considered an enhancing factor that would contribute to the success of the project.

5.13 Historical, Sacred and Archeological sites

Palestine is characterized by its wealth in sacred, archaeological locations and scenic landscapes due to its rich nature and history. Bethlehem area in particular is considered one of the richest touristic sites in the West Bank, due to its archaeological hierarchy and it constitutes a large potential for investment in tourism.

There is an archeological site at the North Eastern upper part of the project with some archeological remains that have not been dated or documented by any of the literatures. This site is called by the nearby communities as Al Khirba. Except for this site, there are no any other historical or cultural heritage sites inside the site of the project or in its surroundings. **Appendix 5.17** shows Al-Khirba historical site.

There is a new Muslim cemetery at the Western edge of the site constructed on the Awqaf land shown in **Appendix 5.18.**

5.14 Water Supply and Wastewater

Water supply system and sewerage system are amongst the main basic services required for the success of any industrial project.

The industrial park is located in an area served by internal water network where the water is provided from the West Bank Water Department, in addition to private-owned house wells.

The expected daily water consumption after operation of the BMIP was estimated at approximately 615 m^3. It was recommended that the project water supply would be secured from both PWA and MEKOROT resources with the need of construction of a 2000 m^3 local reservoir (Feasibility Study, 2009). Estimated water need during the operation of the BMIP is summarized in **Table 5.8**.

Table 5.8: Estimated water need for the project activities after operation according to the feasibility study of the project.

Year	Number of industries	Daily water consumption/industry (m^3)	Daily overall water consumption (m^3)	Annual water consumption (m^3.)
2010	50	3.8	190	57000
2015	100	3.9	390	117000
2020	150	4.1	615	164500

The area is not served with a sewerage network. All the houses in the area are using cesspits for sewage water disposal. These cesspits are not lined by internal impervious layer so as to prevent deep percolation of sewage water to the groundwater, hence, causing sometimes pollution of the adjacent ground water wells. Pollution comprises high concentration of nitrate and fecal coliforms. Some of the houses in the area are emptying their cesspits with tankers and get rid of the waste water in the nearby valley. This method of waste water disposal is causing pollution to land, agriculture and water resources as well as risk to the human health in the area (Feasibility study, 2009). The BMIP project can be considered a pioneer and an environment friendly project in the way that it comprises sanitation and sewerage collecting, disposal and treatment plant, which can be used in the whole region surrounding the project.

Due to the sloping topography of the site, a gravity-piped sewage collecting system will be designed to collect the sewage in the treatment plant. It is estimated that daily wastewater quantity will be around 560 m^3 after operation of the BMIP (Feasibility study, 2009).

Wastewater quality varies according to water use in each factory and facility. Each factory and facility must release its wastewater for sewerage system considering an allowable effluent quality where special pretreatment has to be conducted.

The manufacture of clothes and textiles, tanning of leather; manufacture of chemicals and metal products are the main industries which may invest in the BMIP and may greatly contribute to the amount of pollutants in their waste water. Special pretreatment is needed in these facilities before dumping their waste products in the sewerage system. Effluents with high organic load or having toxic or corrosive properties require pretreatment before being discharged to sewers.

Secondary wastewater treatment produces treated effluent and does not remove total dissolved solids during the treatment processes causing the recycled wastewater to contain high concentrations of salts. When used for irrigation, its quality threatens the environment, human health and sustainability of crop production. This effluent contains some pathogens and its chlorination or bromination may generate harmful compounds. Prolonged use of secondary effluent in irrigation induces soil salinity and alkalinity, which are harmful to soil and to plant growth (Tamimi, 2003). Tertiary treatment eliminates more salts and contaminants and therefore it can be used for industrial water treatment to be fit for agricultural use.

To achieve environmentally sound waste management, four issues should be applied in waste management:

1- Minimizing waste.
2- Maximizing environmentally sound waste reuse and recycling.
3- Promoting environmentally sound waste disposal and treatment.
4- Extending waste service coverage (ARIJ, Localizing agenda 21, 2001).

The treated effluent can be reused for restricted irrigation of landscaped areas on site. Thus, it is necessary to produce a reasonable quality effluent; therefore it is proposed to treat the sewage to acceptable and reasonable standards.

According to the World Health Organization (WHO), the standard amounts of certain parameters of the treated effluents suitable for irrigation are shown in **Table 5.9** (Masjedi et al., 2010).

Table 5.9 : Standard of effluent parameters appropriate for irrigation (WHO,1989)

Parameter	Amount suitable for agriculture
BOD (mg/l)	100
COD (mg/l)	200
TSS (mg/l)	100
Total Coliform (no/100 ml)	1000

Trace (heavy) metals are constituents of most industrial waters. Many of these metals are pollutants that are can cause cancers. But some of these metals are necessary for the growth of biological life. The presence of any of theses metals in excessive quantities will interfere with many beneficial uses of the water because of their toxicity. Therefore, it is desirable to control the concentration of heavy metals when considering reuse options such as the case of controlling Boron concentration when the treated effluent is planned to be used for irrigating agricultural corps.

5.1.5 Solid Waste Disposal

The localities nearby the site are served with solid waste collection and disposal by Bethlehem municipality, although some parts are not frequently served due to its far-reaching by vehicles. These parts collect and dump their solid waste in the nearby areas; in backyards, on vacant lands or at the entrance of the village, and sometimes burn the accumulated solid waste, causing pollution to their surroundings. The BMIP has no dumping site, though the surrounding area is served by the dumping site in Wadi-al-Nar. There is a future plan to construct a sanitary landfill nearby al Minya village at 15 kilometers from the BMIP (Feasibility Study,2009).

The BMIP could produce large quantities of variable solid waste materials that fall in two categories; industrial waste and domestic waste. Domestic solid waste can be vegetables and kitchen wastes, paper and paper products and recyclable materials (glass, metals, and plastics).

The project includes the construction of a regional landfill site at Al-Menya (15 km to the south of BMIP). Bethlehem Municipality expects that the site will be under operation after 1.5 year from now. This site will comprise solid waste recycling facility especially for glass, metals, plastics, and cardboard (Feasibility study of BMIP, 2009).

Chapter six

Possible Impacts of the BMIP on the Environment.

6.1 Environmental Impacts During the Construction Phase.

Construction activities can be very serious if not properly managed and monitored.

This phase might create negative impacts on the following:

1. Noise and vibration due to heavy vehicles and machinery excavating and digging especially to the inhabited area and the school nearby.
2. Dust from earth works.
3. Runoff erosion from cut and fill areas: due to the changes that will occur in the geomorphology of the area, a possible change in the surface hydrology that might lead to acceleration of water runoff and consequent flooding.
4. Dust, odors and fumes from the excavation, traffic and other related activities.
5. Farmers and shepherds displacement from the project area.
6. Displacement of the residents in the periphery of industrial park.
7. Displacement of large quantities of fertile soil.
8. Destruction of agricultural and grazing land (i.e. olives and field crops plantation).
9. Loss of fauna and flora, especially threatened species.
10. Aesthetic disturbance (landscape and sceneries).
11. Possible impact on al Khirba archeological site at the north western part of the industrial park.
12. Sealing up the ground surface by cement and asphalt, thus reducing the soil infiltration capacity and consequent decrease in ground water recharge.

6.2 Environmental Impacts During the Operation Phase.

The potential impacts of the project are mainly associated with the operation phase. The possible negative impacts result from the industries that are expected to move to the industrial park. Some of these industries would have environmental impacts once operation begins. According to Agenda 21, the following manufactures might have the following possible impacts:

a) *Textile manufactures*: Manufactured products include printed and dyed fabrics. Effluents from these industries contain high concentrations of ionic substances, organic colors and reactive dyestuffs, in addition to heavy metals used for fixing colors.

b) *Tanning hides and skins*: They use potentially damaging chemicals to human health and the environment such as chromate salts, ammonium, sulfate, sulfuric acid, and arsenic salts.

c) *Shoe industry*: It is a chemical industry which uses around 25 chemicals used as organic solvents. For example benzene, hexane, cyclohexane, chlorinated hydrocarbons such as 1, 1,1-trichloroethane dichloromethane. Cleaning chemicals, gluing and varnish and some hazardous chemicals like PVC, isocyanate and polyurethane. These chemicals have negative impacts on the atmosphere. Toxic fumes vented in the shoes industry cause harm to both workers and the environment.

d) *Olive mills*: 0.3 MCM's of OMW (Olive Mills Wastewater) are dumped yearly in the West Bank. Phenols, Tannins, leganin and other non-degradable components can pollute the surface and ground water. They are a health hazard and a source of ground water pollution.

e) *Chemical Industries*: They are the major source of hazardous pollutants. These industries produce pesticides, fertilizers, batteries, paints, plastics, pharmaceuticals and medical industries. Wastes produced in producing or using these chemicals cause harm to the environment and are hazardous to human health as well (ARIJ, Localizing agenda 21 in Palestine, 2001).

This implies that strict measures should be held to minimize the negative impacts of the industrial activities either by minimizing waste generation or by waste recycling instead of using new raw materials in the industry.

6.2.1 Impacts on Water Resources.

With limited water resources, water is the most important issue in the environmental assessment. Water quantity as well as water quality are important. Once the water resources become polluted, it becomes difficult or impossible in some cases, to rehabilitate and reuse this polluted water. The ground water of the area is characterized by slow flow rate with low microbiological activity level, resulting in a low potential of ground water self purification. It is then demanded to prevent or reduce the risk of ground water pollution to minimum level, which can be done by preventive measures.

The expected total water consumption during the operation phase of the project and according to the feasibility study of the BMIP has been estimated approximately at 620 m^3/day. It is estimated that the park would require a range of 100,000 to 150,000 $m^3$of water annually. Considering 1% annual increase in water demand, this quantity will increase every year.

This means that the water coming to Bethlehem area will be decreased by this amount, but Bethlehem area already suffers from problems in receiving water. The main feeder which will feed the Industrial Park, feeds large areas in Beit Jala and Bethlehem. These areas will suffer from the increased load in addition to the suffering from the insufficient water pressure (Feasibility study, 2009). Potential impacts on ground water and the possible contaminants are shown in **Table 6.1.**

Table 6.1: Possible contaminants of groundwater caused by industrial activities.

Contaminant source	Possible contaminant
Metal products	Low pH, high content of toxic metals, chlorinated hydrocarbons from solvents, anti-grease and spray painting.
Chemicals and cosmetics. Detergents, pesticides, synthetic fibers and resins	High BOD, high TOC, toxic benzene derivatives, low pH.
Leather products	Heavy metals, low pH and salt solutions.
Textiles	High pH, high BOD, high COD, high TDS, high water demand
Plastic and rubber products	Thermal pollution due to heating and cooling water, high BOD, high COD, high TSS, high TOC, oil and grease, total phenols , zinc.
Car painting and grange mechanics	Grease, used oil, heavy metals.
Lathe	Grease, oil, soap, soda water.
Brick factory	High TDS, high turbidity.
Food and beverage manufactures	High BOD, high COD, high TSS, colloidal and dissolved organic substances, bacteria, odors.
Stone cutting	High carbonate content, sealing up the ground surface by stone cutting slurry, reduction of soil infiltration capacity and consequent decreased water recharge, high pH, pollution with magnesium, aluminum, and other trace elements, high water demand.

The site of the project is vulnerable to hydrogeologic pollution because the aquifers are mostly phreatic. The project area is characterized by relatively moderate to deep ground water level where depth ranges from 160 up to 350 meters in some places. Studies show the existence of fissures, deep fractures extending to the local aquifer, joints and karstification.This issue implies that handling, monitoring and disposal of hazardous and dangerous solvents should be handled carefully.

The site lies above Jerusalem hydrological basin to the East of the main underground watershed, and drains eastwards. A major surface watershed area recharges the local aquifer with flowing water from the surrounding areas. The project site has a concave shape surface directing the main gradient to the central flat flood plain of the project site, thus constituting a small watershed of the surface runoff water for the surrounding concave hills (Feasibility study, 2009).

Surface water flows in the Wadi in the project site and feeds the local aquifers. Any industrial pollution can be drastic concerning the local groundwater wells in the area and especially Hindazeh ground water well. It is recommended to separate the flood water from the industrial water by constructing a separate drainage system for every purpose. It is also recommended to pretreat industrial water from certain industries, such as textiles' dying, metal galvanization, chemical industries before they are discarded in the main treatment plant. Treated industrial water can then be used for irrigation of olive trees or landscaping plants. It is also recommended that no stone cutting facilities would be introduced to the project as they constitute the most harmful sources of pollution.

A syncline dips to the East which results in an Eastern flow of ground water making the local ground water aquifer sensitive to pollution. The local ground water aquifer adjacent to the project site to the South and Eastern south is classified as highly sensitive water resource area (MOPIC, Volume 2, 1996).

Leather tanning, metal finishing, including electroplating, chemical factories and olive oil pressing are major sources in producing industrial waste in the West Bank. Wastewater from tanneries includes heavy metals such as Chromium, Arsenic and sulfide. Wastewater generated from the olive oil mills contains high BOD and TSS values (BOD: 42,000 mg/l and TSS: 65,000 mg/l) (ARIJ, Localizing Agenda 21 in Palestine, 2001).

A very important issue should be taken into consideration, that is the construction of the BMIP, which will eventually cover approximately 500 dunums, will inhibit rainwater, as surface runoff from infiltrating in the Wadi, as construction materials, buildings, cement and asphalt will seal the watershed, thus huge amounts of water will be lost and would not feed the groundwater in this delicate area known for its water shortage.

6.2.2 Impacts on Soil.

Soil of the project site is shallow and fragile with relative low fertility, therefore it is important to protect any fertile soil that would be disturbed or has a potential disturbance due to the operation of the industrial park. The potential impacts on the soil are almost similar to that of the water resources. During the operation phase large areas of soil would be either pulverized or contaminated. Potential impacts on soil are shown in **Table 6.2.**

Table 6.2: Potential impacts on soil caused by industrial activities.

Contaminant source	Possible contaminant
Metal products	Low pH, High content of toxic metals, chlorinated hydrocarbons from solvents, anti-grease and spray painting.
Chemicals and cosmetics. Detergents, pesticides, synthetic fibers and resins	High BOD, high TOC, toxic benzene derivatives, low pH.
Leather products	Heavy metals, low pH and salt solutions.
Textiles	High pH, high BOD, high COD, high TDS.
Plastic and rubber products	High BOD, high COD, high TSS, high TOC, oil and grease, total phenols, zinc.
Car painting and grange mechanics	Grease, used oil, heavy metals.
Lathe	Grease, oil, soap, soda water.
Brick factory	High TDS.
Food and beverage manufactures	High BOD, high COD, high TSS, colloidal and dissolved organic substances, bacteria, odors.
Stone cutting	Soil surface sealing, soil pollution by high carbonates and other associated metals of the slurry, loss of vegetative cover, decrease of infiltration rate and a consequent decrease in the soil water content. Major effects on the surrounding landscape with disintegration of fauna and flora. High Area demanding.

Systematic soil analyses for heavy metals and hazardous chemicals should be held. Complete separation should be done between industrial oil or water and the harvested water. Stone cutting facilities should be prohibited in the project site due to their detrimental effects on soil. Soil erosion can be stopped by constructing retaining walls.

6.2.3 Impacts on Air Quality.

Expansion of industrial activities is one of the key factors responsible for the deterioration of air quality. Vehicle emissions using unleaded gasoline that might increase in the project area will pollute the air. Stone cutting premises facilities lying near the residential areas emit particulate matter harmful to the respiratory system. Metal factories and bakeries that use motor oil as fuel emit large amounts of toxic gases such as CO and CO_2 (ARIJ, Localizing agenda 21 in Palestine,2001).

After the operation of the BMIP, the traffic will be extensive to and from the project site. Most of the vehicles use leaded gasoline. Therefore it is expected that the level of lead will increase in the air. Inhaled or digested lead may cause poisoning and disturbance in the gastrointestinal system, accompanied by pain and excessive tiredness, continued headaches, loss of appetite, nausea and muscular pain. In children, inhaled lead may cause brain damage (Watkins, 1991). Trucks and heavy machinery use diesel as fuel. Although diesel produces only traces of CO, its emission of sulfur oxide (SO_2) is around ten times higher than gasoline. Unmaintained diesel engines with incomplete combustion produce large amounts of pollutants when compared to gasoline (Watkins, 1991).

The project site lies in a rural area, supposed to be free of air pollutants. No industrial activities or gas emissions are found there that might pollute the atmosphere. Moreover, there are many small villages around the project site. Wind direction is generally western to south-western in the project site, thus the villages to the east and south-east are susceptible to air pollution after operation of the project. Air pollution will be caused by traffic fumes, routine industrial discharge and industrial catastrophes. Such pollution will primarily affect the human health as well as the environmental aesthetic state. Air pollution might affect Hindazeh, Jinnatah and Beit Ta'mir. Strict precautions have to be taken in addition to continuous monitoring to eliminate the danger of gas pollution in the future, such as the use of adequate filters in chimneys and the use of new technologies to avoid the emission of hazardous gases. Possible air pollutants from industrial activities are depicted in **Table 6.3**.

Table 6.3: Potential air pollution after operation of the industrial park.

Contaminant source	Possible contaminant
Metal products	Halogenated hydrocarbons, heavy metals (Lead, Chromium,...),Toxic chemicals(Chlorine, Ammonia ,Fluoride)
Chemicals, cosmetics, detergents, pesticides, synthetic fiber and resins.	Sulfur oxides, Nitrogen oxides, hydrocarbons, photochemical oxidants, odors, toxic chemicals(Chlorine, ammonia, Fluoride)
Leather products	Odor, fumes, smell, rotten and decayed particles.
Textiles	Odor from hydrocarbons, smoke, VOC's.
Plastic and rubber products	Particulate matter, VOC's, particulate matter from dry additives and granulation of polymers, fine aerosols from heating of thermoplastics.
Car painting and grange mechanics	VOC's
Lathe	Dust, metal and organic particles.
Brick factory and construction materials	Toxic heavy metals (Lead).
Food and beverages manufacturing	Smell, odor, ammonia, organic volatile gases.
Traffic	Diesel fuel combustion from locomotives emits heavy metals (Cadmium, Chromium, Lead, and Nickel).Sulphates, nitrates and particulate matter.
Stone cutting	Dust formation moving for long distances, inflammables, decreasing visibility, deterioration of buildings and plant cover from dust.

Special measures should be taken to minimize the negative impacts of the operation of the BMIP on air. Installation of effective filters in every facility to trap harmful or hazardous emissions is recommended. Transportation must be well organized to a minimum to decrease the impact of pollution. This might be done by construction of special roads or by organizing public transportation to and from the site.

6.2.4 Impacts on Public and Occupational Health.

Any industrial activity might impose its negative impacts on health, either occupational or public health.

1. Heavy machinery and heavy vehicles coming to and leaving the industrial park might cause high vibrations and loud noises that might cause disturbance and probable health effects on both workers in the industrial park as well as the surrounding inhabitants of the neighboring built up areas.
2. Acid rain containing high levels of sulfuric or nitric acids can contaminate ground water.
3. Air pollution may cause respiratory diseases by photochemical pollutants, sulfur oxides and other air pollutants.
4. Chronic health effects may result from routine occupational exposure to dust, particulates (especially from stone cutting), chemicals, and permanent high temperature and humidity.
5. Polluted air with sulfur dioxides, nitrogen dioxides, and particulate matter can cause and aggravate respiratory disease.
6. Introduction of pesticides or similar chemicals raises the possibility of carcinogenic and mutagenic and adverse reproductive effects.
7. Risk of occupational accidents, explosions, fire and other working hazards.

Measures of safety should be taken to decrease the potential of exposure to toxic and hazardous materials both to the public and to occupational health. Strict precautions should be met in the working sites to lessen the probability of work accidents. Pollution should be kept at minimum, as the project area is inhabited from residents as well as the presence of the schools in the vicinity.

Table 6.4 summarizes some of the negative transient and chronic occupational and public health effects, either induced by the exposure to excessive concentrations in short periods or the exposure to cumulative effects over long periods.

Table 6.4: Selected substances producing transient or chronic occupational and public health effects (Chanlett, 1979, pp. 214,215).

Substances producing transient effects from excessive concentrations in periods of less than 1 day.			
Substance	Source of exposure	Substance	Source of exposure
Ammonia	Chemical manufacturing	Hydrogen cyanide	Chemical manufacturing
Carbon monoxide	Combustion processes	Chlorine	Chemical manufacturing
Hydrocarbon mixtures	Solvents and thinners	Petroleum ether	Grease extraction
Sulfur dioxide	Acid manufacturing, ore smelting	Perchloroethylene	Degreasing, dry cleaning
Trichloroethylene	Degreasing	Zinc oxide	Brass and bronze founding, welding, burning of galvanized metal
Substances producing chronic effects from cumulative exposures in periods ranging from months to years.			
Benzene	Solvent and chemical use	Carbon tetrachloride	Solvent and chemical use
Carbon disulfide	Rayon manufacture	Asbestos	Asbestos cloth manufacture
Arsenic	Insecticide manufacture	Beryllium	Metallurgy
Lead	All lead use	Mercury and its salts	Electric apparatus, agricultural chemicals
Nitro benzene	Chemical manufacture	Silica	Drilling, grinding, cutting on materials containing crystalline silica

Occupational as well as public exposure to certain organic and inorganic substances might induce cancer as shown in **Table 6.5**.

Table 6.5: Cancer-inducing occupational exposure to some industrial organic and inorganic substances (Chanlett, 1979, pp38, 39)

Compound	Site affected	Comment
Organic substances.		
Benzidine	Bladder	Aniline dyes, plastics and rubber.
Beta-naphtylamine	Bladder	Dye and pesticides
Chloromethyl ether	Lung	In making exchange resins
Vinyl chloride	Liver	Angio-sarcoma among PVC workers.
Alpha naphtylamine	Bladder	Making dyes, herbicides, food colors, color film.
Ethyleneimine	Unknown	Carcinogenic in animals. Paper and textile processing, herbicides, resins.
Inorganic substances		
Arsenic	Skin, lung.	Ore refineries
Asbestos	Lung and intestinal tract	Asbestos weaving and insulation use
Chromates	Lung	Ore refining
Nickel	Nasal cavity, lung	Nickel refineries

6.2.5 Noise and Vibration.

Industrial parks in general have negative noise and vibrations impacts initiated by heavy traffic and heavy vehicles movement. This impact is also initiated by the operation of some machinery in the project site. These impacts affect the inhabitants of the surrounding buildings as well as the workers and employees of the premises. Precautionary measures should be taken to minimize these negative impacts.

The noise and vibration standards allowed according to the Palestinian Standardization Institute (PSI) are shown in **Table 6.6.**

Table 6.6: Noise and vibration standards (PSI, Planning Policy Guidance, Note 24)

Noise source	Time	Area A	Area B	Area C	Area D
Road Traffic	07:00- 23:00 23:00- 07:00	< 55 dB < 45 dB	55-63 45-57	63-72 57-66	> 72 > 66
Rail Traffic	07:00- 23:00 23:00- 07:00	< 55 dB < 45 dB	55-66 45-59	66-74 59-66	> 74 > 66
Air Traffic	07:00- 23:00 23:00- 07:00	< 57 dB < 48 dB	57-66 48-57	66-72 57-66	> 72 > 66
Mixed Sources	07:00- 23:00 23:00- 07:00	< 55 dB < 45 dB	55-63 45-57	63-72 57-66	> 72 > 66

It has to be taken in consideration that the BMIP project lies in area A, so the maximum allowed noise and vibration pollution should be at very low levels. The equipment should be low noise equipment with built-in noise reduction devices and working hours should be limited to certain hours and certain days. Sensitive noise receptors are the built-up areas around the project site and the two schools.

High levels of vibrations and noise are detrimental to the hearing capacity of workers and inhabitants of adjacent buildings, and it can cause hypertension, vasoconstriction, ischemic heart disease, annoyance, stress, psychological disturbance and decreased school performance, especially because there are two schools in the vicinity of the project site.

6.2.6 Impacts on Flora and Fauna.

Bethlehem area is characterized by the Mediterranean zone which is very rich in its biodiversity and constitutes one of the richest ecosystems in the world. Urbanization, deforestation, industrialization and overgrazing as well as the loss of land due to the Israeli occupation hurt the unique and fragile plant and animal populations. Of the estimated 2,483 plant species in the West Bank, 149 are unique for the region. About 43% of them are common, 27.5% are rare and 25.6% are very rare (Shmida, 1995).

There are sparse water resources to hold up these plants in the eastern slopes of Bethlehem area, which are threatened by pollution and destruction or fragmentation of natural habitat and degradation of vegetative biomass by urban expansion and infrastructure, overgrazing, industry or construction of roads.

From 1971 to 1999, it is estimated that 23% of the West Bank forests has been destroyed. Rangelands and natural pastures were affected by the Israeli occupation settlement-building policy, Designating areas as military closed areas resulted in intensive grazing especially in areas as the eastern Bethlehem slopes where rainfall is limited (ARIJ, Localizing agenda 21 in Palestine, 2001).

Bio-climatologically classification of the West Bank is shown in **Table 6.7**.

Table 6.7: Bio climatologically classification of the West Bank in km², showing rainfall in mm (ARIJ, GIS Unit, 2000).

Area	Extreme arid (50-100mm) km²	Arid (100-200 mm) km²	Hot steppes (200-300 mm) km²	Semi arid (300-500 mm) km²	Sub humid (400 mm) km²
Semi coastal (Tulkarm Qualkilia) (West)				53	421.1
Hilly area (Middle)			650	60	2500
Eastern slope (North/ South)	168.9	338	788	225	56
Dead sea + Jordan valley (East)	54.1	270.8	270.8		
Total	223	608.8	1708.8	338	2977.1

Bethlehem hills lie in the middle hilly area and the eastern slopes which are characterized by moderate to low rainfall. This zone is dominated by chalk, shale and dolomite rocks subject to severe weathering and receiving annual rainfall between 200-600 mm. This zone is exposed to degradation because of the following factors:

- Faulty slope cultivation, leading to soil erosion.
- Overgrazing causing vegetation cover depletion.
- The cultivation of marginal land.
- Urbanization and population expansion.
- Soil contamination by liquid and solid wastes.
- The Israeli strategy deliberately encourages the elimination of trees and vegetal cover leading to reduction of infiltration rates. Corresponding increase in surface flow enhances the rate of land erosion.
- Severe water exploitation (ARIJ, Localizing agenda 21 in Palestine, 2001).

This implies that the construction of an industrial park in such a fragile area, might subject the land and vegetation to additional degradation and loss of fauna and flora. From the field study done in this area, many plants were documented, but many others and according to the testimonies of inhabitants are already extinct due to the previously mentioned reasons.

6.2.7 Aesthetic Disturbance.

The project area is a natural scenic area with different landscapes, from rocky landscapes to wild plants area to olive trees plantations. The establishment of the project might disturb the natural beauty of the site. It is foreseen, from the design of the project that it is proposed to add a buffer zone of trees so as to isolate the BMIP from the surrounding area. It is best to plant trees and vegetation related to the nature of the region. Olive trees might make a very natural buffer zone, which must be planted the sooner the better, because these trees need a long time to be large enough to be considered a buffer zone. Excluding the Wadi area from construction activities is recommended so as to have minimum aesthetic disturbance. The loss of vegetation in the project site will eventually disturb the natural view.

6.2.8 Impacts on Agriculture

Bethlehem area is classified as an arid to semi arid region with a Mediterranean climatic type. The diversity of cultivation and biomass of different species of indigenous wild plants is controlled by variations of climatic conditions. Eastern slopes have the largest area of natural pastures in the West Bank and contain most of the livestock in Bethlehem area, owned mainly by Bedouins. Due to limitations of rainfall, barley is the main crop cultivated in the eastern slopes.

Rainfed agriculture is dominant in Bethlehem district comprising around 98.7% of total cultivated area. Olive trees and grape vines are the most prominent fruits comprising around 93% of fruit production. Some of the other fruit trees are almonds, apricots, apples and plums. Fruit production comprises around 62.2% of the total rainfed crops while field crops range around 32.2% of the total rainfed area, such as wheat, barley, bitter vetch, lentils, chickpeas, snake cucumber, squash, tomatoes, onions, garlic and okra (Environmental Profile, Bethlehem District, 1995)

Irrigated agriculture occupies a small area due to limitations of water availability. Water for irrigation is totally dependant on springs in valleys of some villages surrounding the area, such as Artas, Husan, Nahhalin, Battir and Wadi Fukin. Irrigated agriculture is dominated by cabbage and egg plants, cauliflower and pumpkin (Environmental profile, Bethlehem district, ARIJ, 1995)

Lithosols dominant in the project site are:

a) Bare rocks and desert lithosols. They are characterized by slight soil depths especially in moderately sloping areas and plateaux.They are generally formed from hard limestone, dolomite and chalk. Major vegetation are shrubs, such as *Retama roetam*, *Anabis articulata*,and *Zygophyllum demosum.* This type of lithosols is limited for grazing.

b) Brown and pale rendzina. They are mainly used for the cultivation of annual field crops such as wheat and barley. Around 30-50% of these lithosols are outcropped with rocks. The dominant land uses of these soils are mainly wheat, barley, lentils, vineyards, olives and fruit trees (ARIJ, Environmental profile, Bethlehem district, 1995).

The construction as well as the operation phases of the BMIP might have detrimental effects on the agriculture in the site as well as threatening a large area of grazing land for livestock. Barley, wheat and lentils are cultivated in wide areas as well as the presence of olive trees plantations. This type of agriculture and livestock herding are considered essential to the inhabitants of the project area and might deprive them from the major source of income as well as destroying agriculture.

6.2.9 Impacts on Land Use.

The project area lies in region "A" that is under the PNA authority. This implies that it is amongst the scarce areas where the Palestinian citizens are allowed to construct houses or any other buildings. The population of the project area is increasing quickly. The surrounding villages are expanding drastically. Taking out nearly 500 dunums of their land to establish an industrial park will inhibit and disrupt any opportunity to the villages' expansion.

The most important negative impact on the land uses is the loss of hundreds of dunums of land used for grazing and agriculture. This was obviously noticed during the interviews with the inhabitants of the village of Hindazeh as well as the shepherds. Shepherds are living mainly by raising their livestock on this land, and it means that they will lose their essential source of income to the project.

Moreover, and from the public consultation with either the citizens or the village councils of Jinnatah and Hindazeh, it was obvious that there are fears that the waste water treatment plant which, according to the project master plan, will occupy around 3 dunums, would devour their lands with the possibility of disturbance from odors and air pollution from either the operation of the project or the treatment plant.

The presence of two schools in the vicinity, one of which is very adjacent to the project, will cause inconveniences to the students. The built up area is also very near to the project land, which might create disturbance either from the condensed traffic to and from the project site or from the industrial activities in the park.

6.2.10 Wastewater and Sewage Treatment.

Due to the sloping topography of the BMIP site, a gravity piped sewage collection system will be constructed to carry sewage flows to the sewage treatment plant. Industrial wastewater will be discharged into the sewerage system depending upon its characteristics and quantity. Effluents with high organic load or having toxic or corrosive properties require pretreatment before discharge to sewers.

The types of industrial effluents that can cause problems in sewage treatment systems are:

1. Effluents with a high organic biodegradable content from slaughter-houses, dairies and other food processing plants. Such effluents require treatment to reduce the content of biodegradable organisms.
2. Effluents containing non biodegradable organic matter, e.g. textile industry wastes, require pre-treatment by physical methods before discharging into the sewerage system.
3. Effluents with high inorganic contents from building, steel, chemicals, fertilizers, gas etc. industries which may contribute to extreme values of pH, chlorides, alkalinity, nitrogen, phosphorus, copper, zinc, chrome, cyanide, heavy metals, grit and toxic materials. Such effluents may require pH correction and removal of toxic materials.
4. Effluents from the petro-chemical industries, having a high proportion of phenols, hydrocarbons, grease, oil etc. should not be allowed to discharge into the sewerage system.

In order to protect the central sewage collection system of the BMIP and the public sewer system, industries with harmful effluents shall have their own pre-treatment facilities (Feasibility Study, 2009).

Typical ranges of concentration values for industrial wastewater are shown in **Table 6.8.**

Table 6.8: Range of concentration values for industrial wastewater (Industrial wastewater Treatment Plants Self-monitoring Manual)

Origin of waste	pH	TSS mg/l	BOD mg/l	COD mg/l	TDS mg/l
Dairy industry	4	12150	14000	21100	19000
Yeast industry	5.3	540	2100	3400	3500
Fruits and vegetables canning	5.5	2200	800	1400	1270
Textile industry	6.5	1800	840	1500	17000
Pulp and paper industry	8	1640	360	2300	1980
Beverage industry	9	760	620	1150	1290
Tanneries	10	2600	2370	4950	8500
Fish canning	11	565	890	2350	8218

The table shows that the effluents of certain industries should be pretreated before they are dumped into the main sewerage. A wastewater treatment plant is to be constructed in the project site. This plant is estimated to occupy around 3 dunums of the project land. The inhabitants of the surrounding area and the village council of Jinnatah have fears that this plant might cause the spread of bad odors and air pollution to the surrounding areas. Moreover, the large area that this plant will occupy is huge relative to the whole project area, thus devouring big areas of the land.

There are objectionable components of contaminants and pollutants all of which industrial wastewater may carry. **Table 6.9** illustrates the major eight contaminants, their effects and typical sources.

Table 6.9: Objectionable components of industrial wastewaters, their effects and typical sources (Chanlett, 1979, p 181).

Component Group	Effects	Sources
1. Bio-oxidizables, expressed as BOD's	Deoxygenation, anaerobic conditions	Canning, distilleries, breweries, milk processing, pulping and paper making.
2. Primary toxicants: As, CN, Cr, Cd, Cu, F, Hg, Pb, Zn.	Fish kills, cattle poisoning, and accumulation in flesh of cattle.	Metal cleaning, plating, pickling, chlorine generation, battery making, tanning.
3. Acids and alkalines	Disruption of pH buffer systems.	Pickling, textiles, chemical manufacture, wool scouring, laundries.
4. Disinfectants: Cl_2, H_2O_2, formalin, phenol	Selective kills of microorganisms, taste and odor	Bleaching of paper and textiles, resin synthesis, penicillin preparation, gas and coke manufacture, dye and chemical manufacture.
5. Ionic forms : Fe, Ca, Mg, Mn, Cl, SO_4	Change water characteristics; staining, hardness, salinity, encrustations.	Metallurgy, cement making, ceramics.
6. Oxidizing and reducing agents NH_3, NO_2^-, $NO3^-$, S^{--},SO_3^{--}	Altered chemical balances ranging from rapid oxygen depletion to over nutrition, odors, selective microbial growths.	Gas and coke making, fertilizers, dyeing and synthetic fiber making, wood pulping, bleaching.
7. evident to sight and smell	Foaming, floating, and settleable solids; stinks, anaerobic bottom deposits; oil , fats, grease.	Detergent wastes, tanning, food and meat processing, beer sugar mills, woolen mills, poultry dressing,.
8. Pathogenic organisms: bacteria, toxic fungi and viruses	Infections in man, reinfection of livestock, plant diseases from fungi-contaminated irrigation water.	Abattoir wastes, wool processing, fungi growths in waste treatment works, poultry-processing wastewater.

6.2.11 Impacts from Solid Waste

The BMIP comprises many industries, many of which might produce waste materials or hazardous wastes. During the construction phase, building materials have to be disposed of in an environmentally friendly way. These wastes include building materials such as wood, cement, tiles, metals, cardboard, etc…

During the operation phase, the BMIP should have a landfill to dispose of wastes. The hazardous materials should be kept at a minimum or recycled, according to Agenda 21 in Palestine. The surrounding remote inhabited area is not well serviced with proper solid waste collection system. Large quantities of solid waste from the BMIP will be produced in a higher amount than the capacity of the current collection system. **Table 6.10** summarizes the possible solid wastes that might be produced during the operation phase of the project.

Table 6.10: Possible solid wastes to be produced by the BMIP.

Type of industry	Solid waste produced
Manufacture of food and beverages	Plastic, cartons, empty packages of food waste and expired products.
Manufacture of textiles	Garment pieces, cartons and empty packages.
Tanning of leather; manufacture of bags and shoes	Plastic material, leather, cartons and empty packages.
Manufacture of wood and its products	Wood, cartons and empty packages.
Manufacture of paper and its products Cartons and Empty packages	Cartons and empty packages.
Manufacture of chemicals & its products	Chemicals, cartons and empty packages.
Manufacture of rubber and plastic	Plastic, cartons, empty packages, and other solid waste.
Manufacture of non-metallic products.	Stones, soil, dust and other solid waste.
Manufacture of metal products	Chemicals, metal pieces.
Manufacture of furniture	Wood.

Solid waste management has to be adopted through different stages of collection, transport, disposal and recycling of the waste to prevent pollution of soil and groundwater and to protect health.

Most of the industries have a potential for recycling their solid waste products (Metal products, textiles, plastic products, leather products, food and beverages, carpentry). This implies that it is essential to collect the solid waste in a recyclable way, after classification of these wastes with the least environmental consequences.

Precautionary steps should be taken in handling and disposing of toxic and hazardous waste products and ensuring that the hazardous waste is not mixed with the conventional waste. At the dump site the responsible municipality should provide special confined and impermeable areas or compartments that are assigned for hazardous solid waste so that the conventional waste will not be mixed with it.

6.2.12 Impacts of Stone Cutting Industry in the BMIP.

Stone cutting industry has many implications and negative impacts on natural resources as well as on the environment. It is estimated from previous studies that the required area per stone cutting firm is around 4 dunums, with an annual average of water consumption of 11093 m^3. This means that the average daily demand on water in the BMIP will increase from 622 m^3/day to 720 m^3/day if 8 stone cutting firms will be added to the project site. This also implies that the average wastewater flow will increase from 560 m^3/day to 648 m^3/day (Feasibility study, 2009).

The slurry to be accumulated in the sedimentation tanks needs to be disposed of outside the BMIP. This waste product has solid concentration around 100.000 mg/l which damages the sewerage system if disposed of directly into them (Feasibility study, 2009). This slurry has many impacts on the soil it causes soil surface sealing, soil pollution by high carbonates and other associated metals, loss of vegetative cover, decrease of infiltration rate and a consequent decrease in the soil water content. It might cause major effects on the surrounding landscape with disintegration of fauna and flora.

The slurry might also have its negative impacts on ground water quality shown as high carbonate content, sealing up the ground surface thus reducing soil infiltration capacity and consequent decreased water recharge, high pH, pollution with magnesium, aluminum, and other trace elements.

Possible impacts on air quality are dust formation moving for long distances, inflammables, decreasing visibility, deterioration of buildings and plant cover from dust.

6.2.13 Public Consultation and acceptability.

To ensure success for any project, public consultation and acceptability as well as stakeholders' acceptability is a must. A successful project must take into consideration their ideas and their suggestions; it must ensure local communities' socio-economic benefits, answer to their fears and provide them with ultimate satisfaction from the project. A successful project has to provide the community with infrastructure and services, such as health centers, roads, water, sewerage and telephone networks, job opportunities and other facilities.

The project area depends mainly on livestock raising and agriculture. If the BMIP is to succeed, it should provide the inhabitants with reasons to accept the project. This can be done by providing them with water available for their households, agriculture and livestock. The wastewater treatment plant can provide water appropriate for these activities. It must assure them that they are not losing their agricultural land and the land for grazing.

Chapter Seven
Methodology

The study was based on field visits, laboratory analyses, interviews, meetings, and other available auxiliary data from the concerned parties and a study of related literature concerning the project site.

Soil and water samples were analyzed at the Center for Chemical and Biological Analyses Laboratory at Al-Quds University. A study of flora and fauna was also made in the project site.

Three soil samples were taken from three different sites of the project; from the rocky slope area, from the olive trees plantation and from the valley (Wadi), on April 11/2010. They were analyzed for moisture, organic composition, cations (K^+, Mg^{+2}, Na^+, Ca^{+2}), pH, EC and TDS in addition to percentages of clay, sand and silt. Project site coordinates read by GPS NOKIA N 95 from the specimen points were; Latitude= N 31.6791, Longitude= E 35.2125, Altitude= 637 masl.

Water samples were taken from Hindazeh groundwater well in one liter polyethylene bottles already rinsed with well water for 10 minutes to avoid contamination, sealed with parafilm, put in heat-proof container and sent in the same day to Al-Quds University lab for analyses. Water samples were analyzed for the major cations and anions (Na^+, K^+, Mg^{+2}, Ca^{+2}, Cl^-, SO_4^{-2}, NO_3^-, HCO_3^-) by ion chromatography. EC and pH were measured by EC and pH meters and TDS were calculated. Hindazeh well coordinates read by GPS NOKIA N 95 were; Latitude = N 31.6853, Longitude= E 35.2036, Altitude= 646 masl.

A study of flora and fauna was held in the project site. Some plants were documented by a Canon EOS 500 D camera during three site visits in March and April 2010, and then compared to literature about Palestinian flora in some references as well as internet sites concerning flowers in Israel. Animals supposed to be there were studied according to testimonies of villagers as well as a study of literature from ARIJ about Palestinian fauna in the project area. Mole holes were photographed during visits to the site.

Data about the groundwater and soil of the site were also taken from the Palestinian Water Authority, ARIJ database as well as data from previous research done by Master students in Al-Quds University.

Data and information were collected from the Ministry of Planning and International Cooperation, Ministry of Environmental Affairs, Palestinian Water Authority, Palestinian Central Bureau of Statistics, Bethlehem Chamber of Commerce as well as information from ARIJ (Applied Research Institute in Jerusalem).

For the public consultation, meetings and interviews were held, targeting the Village councils of Hindazeh and Jinnatah, and their inhabitants for their socio-economic and environmental acceptability of the project. According to the Palestinian Environmental Assessment policy, it is required to consult the stakeholders. Accordingly, meetings were held with the stakeholders who are:

1. PIEFZA (Palestinian Industrial Estate and Industrial Free Zone Authority), whose main responsibility is to monitor and help in the future monitoring and management of different activities within the BMIP.
2. Bethlehem Chamber of Commerce and Industry, which is responsible for the facilitation and enhancement of the local investors / manufacturer participation in the BMIP.
3. Bethlehem Municipality, whose major responsibility is to secure the basic infrastructure and services to the BMIP, as well as to ensure that such services will not affect the nearby residential areas by the operation of the BMIP (Feasibility Study, 2009).
4. The French Agency of Development (AFD) responsible for financial support.
5. The Water Supply and Wastewater Authority in Bethlehem (WSSA), responsible for managing the water supply and sewerage network services.

Chapter Eight
Results and Discussion

From the research that was held concerning industrial zones, certain crucial points were concluded:

- Neither the Palestinian Environmental Law No.7 of 1999, nor the Palestinian Environmental Strategy has addressed hazardous waste generation, treatment or management, nor did they address any matter related to a future direction towards waste minimization or waste recycling. The regulations and amendments should focus on waste minimization and waste recycling as a strategy to prevent the generation of such wastes.
- Palestinian environment is deteriorating due to the lack of monitoring. Industrial activities, transportation, energy consumption, stone cutting facilities and quarries, lack of industrial zoning and methods of waste disposal are the main factors contributing to this dilemma.
- Palestinian ecosystems are fragile. They host medicinal plants, biological diversity and endangered species.
- Eco-industrial parks reduce environmental impacts, create friendlier infrastructure, save water resources and enhance economic success.
- Israeli industrial activities adjacent to the Palestinian borders as well as random Palestinian industrial activities contribute greatly to the deterioration of the Palestinian environment.

Regarding the BMIP, certain issues have to be taken into consideration:

Project Site choice

- The project site lies in an inhabited area in region “A”. It is adjacent to residential houses, two schools, a cemetery and a historical site.
- The land reserved for phase two of the project is privately-owned land that the owners refuse to give it presently to the BMIP.

- The project lies in an agricultural area planted with summer crops and olive trees. Many residents depend on the open land for their livestock to graze. Taking away around 500 dunums of the agricultural and grazing land might create insecurity among the residents of the region.
- The establishment of the BMIP in region "A" will stop further expansion of the villages of Hindazeh and Jinnatah. It should have been planned to be established in area "C" where the environmental impacts would be less where there are no residential areas around. There was a suggestion to establish it near the village of Artas, in area "C", but the Israelis opposed the idea. There was another suggestion to establish it near Beit-Fajjar, where there is a concentration of quarries and stone-cutting industries, so the environmental impact would be less, as this region is already an industrial polluted area.

Groundwater Resources Quality and Quantity

- The site lies partly on a slope. This might cause runoff contamination with industrial wastes. The eastern and western parts of the project site direct the main gradient to the central flood plain, considered a watershed of the surface runoff water towards the valley (Wadi).
- Bethlehem geologic formations are governed by faults, joints, karstification and fractures. They allow high infiltration to the lower formations.
- According to the water analysis of Bethlehem groundwater wells held by previous studies, as well as the present analysis held for Hindazeh well in particular, which is fed by the watershed of the project site, the groundwater is appropriate presently for domestic and agricultural use. This issue has to be considered during the operation of the project, because these wells feed the whole region of Bethlehem. Any future contamination or pollution might affect the welfare and health of the whole governorate. Results of Hindazeh groundwater well analysis are illustrated in the **Table 8.1.**

Table 8.1: Water analysis of Hindazeh groundwater well for the sample of 11/4/2010.

Na ppm	K ppm	Mg ppm	Ca ppm	Cl ppm	SO_4 ppm	NO_3 ppm	HCO_3 ppm	pH	EC µs/cm	TDS ppm	F ppm
24.4	1.5	14.65	48	17.88	8.24	12.5	47	6.6	570	280	2.86

It is noticed that the results are nearly consistent with the data collected in the previous studies with small deviations which are considered normal according to seasonal differences.

According to Wilcox Scale, 1955, TDS value of 280 implies that the groundwater is of medium salinity, which can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most instances without special practices for salinity control. According to Wilcox Scale, 1955, the Sodium content and the EC of 570µs/cm, imply that the water is good for irrigation (ARIJ, Water Resources, 1998).

From the data above, it is noticed that Hindazeh well has physical and chemical properties consistent with the Palestinian and international standards set for the ideal drinking water. Any industrial activity should take into consideration the present status of the groundwater, with utmost care not to pollute it by industrial wastes.

- Scarce water resources in Bethlehem area might be a constraint to the operation of the project. To provide the BMIP with adequate volumes of water, it has to be purchased from MEKOROT, which makes the whole project under the mercy of Israeli political decisions and pressure.
- Providing the BMIP with sufficient quantities of water during its operation phase might deprive Beit-Jala and some elevated parts of Bethlehem from appropriate quantities of water taking into consideration the population growth and the BMIP development in the years to come.

Soil Quality

- The soil of the project area is brown and pale Rendzina which is fertile and contains high organic content. Pollution control must be considered in performing any industrial activity.

Soil analysis was held at the Center for Chemical and Biological Analyses laboratory at Al-Quds University. Three samples of soil were collected. **Table 8.2** shows the main physical and chemical characteristics of these samples.

Soil Sample 1 was taken from the Wadi (Valley) planted with olive trees.
Soil Sample 2 was taken from the meadow planted with barley.
Soil Sample 3 was taken from the slope rocky area.

Table 8.2: Soil analysis of project site samples. (11/4/2010).

Sample	Soil moisture	pH	EC µs/cm	TDS ppm	K^+ ppm	Mg^{++} ppm	Na^+ ppm	Ca^{++} ppm	Organic matter	Clay %	Sand %	Silt %
Soil 1	4.91%	6.6	510	250	3.05	2.92	33.15	53.2	8.9 %	41.9	14.7	43.4
Soil 2	4.61%	6.4	560	270	4.25	2.20	20.25	45.4	9.6 %*	41.7	29.4	28.9
Soil 3	4.83%	6.7	540	260	4.81	2.00	20.80	46.2	8.8 %	51.0*	14.1	34.9

The soil sample 2 is characterized by higher organic matter due to the agricultural activities in the site. Soil sample 3 is characterized by higher clay content. It is taken from the rocky site, subject to erosion due to its slope. As a result, these are healthy types of soil with relatively high organic content that should be taken into consideration in the operation phase of the project. Care should be taken to conserve the rich cultivable soil.

Ambient Air Quality

- The prevalent wind direction is western to South-western, making the eastern neighbors of the project air-pollution threatened.
- The project site lies in a rural area with good air quality. It is recommended that no stone cutting activities or quarrying facilities to be in the project, with strict regulations and monitoring to prevent any future pollution.

Flora and Fauna

- Many plants were documented in the project site. Some plants are scarce, protected and extinction-threatened. They were found in sparse and small aggregations.
- According to two field visits held to the project site in March and April 2010, the flora found in the site was documented by a Canon EOS 500 D camera. Documented flora is shown in **Table 5.6.** Most of the flora was found to be medicinal, cultural and economic plants. Documented flora of the site is illustrated in **Appendices 5.9 a, b, c.**
- Wildlife of some rare animals in the region might be harassed by the operation of the project. The possible significant environmental impact of the project on fauna and flora might be habitat and vegetation loss and hence the probable loss of some endangered species of fauna and flora.

Noise Pollution

- The BMIP lies in an inhabited area, in addition to the presence of two schools. Loud noises might interfere with the presence of wild fauna which is already threatened. The sources of noise might be from the machinery in the project site during the construction and operation phases, as well as the noise from the heavy traffic to and from the BMIP.

Land Use

- Activities of the park might destroy the Khirba historical site. It should respect the feelings of Muslims burying their beloved ones in the cemetery nearby, avoiding any disturbance to the sacred place.

Waste Production and Treatment

- Hazardous waste producing industries should pre-treat their effluents, each one according to the pollutants it produces, before pouring them into the public sewerage.
- Treated water from the wastewater treatment plant can be reused (with restrictions) to irrigate the landscaped areas in or around the project site.
- If properly treated as tertiary treatment, water can be used as artificial groundwater recharge.

- Solid wastes should be disposed off in an environmental friendly method in special landfills, avoiding any infiltration of dissolved hazardous materials to the groundwater.
- According to the feasibility study of the project, the manufacture of rubber and plastic were classified as type "B" industries, but they should be classified as type "A" industries due to the negative environmental impacts they produce either during the manufacture or from the wastes they produce.

Public Consultation

- From the meetings with the inhabitants of the project area and the village councils of Hindazeh and Jinnatah, fears from the negative environmental effects on air quality, on soil, on groundwater, on noise and vibration effects on the built-up areas and the schools nearby were noticed. There were also fears from the choice of the project site, for it will limit the villages' expansion as the project lies in area “A”. There is no opportunity to build outside this area which is governed by PNA authority.
- Another constraint was from the construction of the wastewater treatment plant which will occupy nearly three dunums out of their agricultural land. If the treatment plant is to follow the ground gradient, it should be in the valley (the Wadi), that is in the best agricultural land.
- The residents also expressed their fears about the presence of solid waste dump in the area near the residential area.
- Nearly everyone interviewed had fears about the possibility of cancer-inducing industries, especially on the residents and school children near the project site.
- Shepherds had fears about the deprivation of the land appropriate for grazing. They depend on this land to raise their livestock. They expressed their fears also about the loss of medicinal plants and traditional cultivated flora like thyme, sage, malva, and many other plants.
- On the other side, and upon interviewing young people, there was a feeling of satisfaction from the idea of the creation of new job opportunities, of the possibility to revive their villages with new roads, infrastructure, wastewater treatment plant,

telecommunications, health centers, training center, nurseries, a bank and many other facilities.

- The village councils of Jinnatah and Hindazeh were grateful to the reviving of their villages, with fears of pollution if the activities of the BMIP would not be monitored.

In spite of the above-mentioned points, this project is considered a huge and pioneer project, due to the following:

- The West Bank in general and Bethlehem area in particular suffer from unemployment. This project will guarantee thousands of jobs to men and women, thus enhancing the economical situation of the residents in particular and the Palestinian economy in general.
- This project will establish infrastructure for the area; electricity, telecommunications, wastewater treatment plant, solid waste management, new roads, piped water in addition to other facilities such as a health center, a fire brigade, a bank and most important of all, a training center to provide the market with good expertise.
- The zoning of industrial facilities concentrates the similar industries together. They can share the same wastewater pre-treatment technology, thus minimizing the environmental impact.

Chapter Nine
Recommendations

Water Resources

- Separation of the rain flood water from the industrial water by constructing separate drainage systems.
- Continuous testing and monitoring of the surrounding groundwater wells.
- Wastewater treatment of the Type "A" industries before dumping the wastewater in the public sewerage.
- Treated wastewater might be reused in some industries, such as the textile industry as an example.
- Treated wastewater can be used, with some restrictions to irrigate the landscape in the BMIP.
- Treated wastewater (tertiary treatment) can be used, with special precautions as groundwater artificial recharge.
- Due to the minimized infiltration capacity of rain water after the construction and sealing of soil, rain harvesting might be used to compensate the aquifers with water.
- Stone-cutting industry needs big quantities of water, so it is unfavorable.

Soil

- Special precautions should be held not to mix any liquid pollutants from the harvested water.
- Continuous soil analysis for pollution and especially with heavy metals.
- Construction of retaining walls to minimize soil erosion and runoff with appropriate drainage system.
- Stone-cutting industry produces slurry which can clog the soil, in addition to the need of large areas of land for each facility, so it is undesirable.

Air Quality

- Gas filters should be installed according to the type of gas pollutants each facility produces. Gases and dust particles can be prevented from escaping into the air by one or more of the following processes; electrostatic precipitators to collect particulates, carbon monoxide recovery, sprinkling and stabilization sprayers for dust control, installation of bag filters to capture particulates.
- Organizing increased traffic and public transportation to and from the BMIP.
- Air analysis systematically to study temporal and spatial changes on air quality.
- Establishing plant buffer zones around the BMIP to absorb air pollutants.

Noise Control

- Using proper equipment with built-in noise reduction devices.
- Using acoustic barriers to noise sources.
- Restriction of traffic movement, avoiding built-up areas and the vicinity of the schools.

Wastewater Treatment

- Monitoring the composition of effluents for each facility systematically.
- Continuous maintenance of the wastewater treatment plant, to ensure its adequate functioning.
- Tertiary treatment is recommended for hazardous wastewater.
- If used in irrigation, treated wastewater it should irrigate foliage plants for landscaping or trees not vegetables.
- Most of the interviewed residents refused the idea of establishing a wastewater treatment plant nearby their residential area. There might be a problem of odors and hazards to health from its location. It might be moved to a location far away from built-in areas.

Solid Waste

- Care should be taken in handling solid waste for the possibility of the presence of hazardous waste products.
- Most of the solid waste in the BMIP can be recycled (Metal products, textiles, plastic products, food, carpentry).
- Recycable waste should not be mixed with non-recycable waste or with hazardous waste products which have to be transported in special containers.
- Prohibition of burning solid waste in the BMIP or close to it.
- Providing a financial incentive to the industries producing recycable waste by buying their waste products , or imposing taxes on non-recycable waste products to minimize the quantity of non- recycable waste.
- Providing special confined and impermeable dumping sites to minimize the dissolution and infiltration of hazardous soluble waste to the aquifers.

Aesthetic issue

- Planting a plant buffer zone around the BMIP to insulate it from the surrounding areas, to keep an agreeable view in this rural area and to avoid disturbance to the scenery. Different facilities can also be separated by green areas.
- Planted vegetation should be of plants similar to the local plants so as not to disturb the nature of the site.

Occupational Safety

- Strict occupational safety measures have to be held in the BMIP facilities to protect the employees and workers from occupational hazards.
- Upon construction and operation of the project, strict and clear monitoring regulations, standards and management processes must be held to inhibit any environmentally harmful activities in the BMIP.
- Application of proper safety measures to the surrounding communities as well as the inside of the BMIP as well as ensuring the least possible contact between the inhabitants and school children with the BMIP will provide the highest levels of safety.

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Appendices

Appendix 2.1

Prohibited discharges in sewerage according to the regulations set by Bethlehem Municipality according to PWA in 2002**.**

a) Any liquids or vapors having temperature greater than 45º C.

b) Any liquids, solids or gases that are, either alone or by interaction with other substances, sufficient to cause a fire or explosion hazard in Bethlehem municipal and/or regional sewer system.

c) Any malodorous or toxic gases, vapors, fumes, or other substances that either singly or by interaction with other wastes, are capable of creating a public nuisance, a hazard to human health or the environment, or the prevention of entry by Bethlehem Municipality and/or regional sewer system personnel into sewers for maintenance.

d) Any liquids, solids or gases that are not feasible to be treated or reduced by the sewage treatment process employed, or causes the wastewater treatment plant to violate its discharge permit.

e) Any liquids, solids or gases that, singly or by interaction with other material, cause excessive coloration which may pass-through the treatment plant to the environment.

f) Any garbage.

g) Any ashes, cinders, sand, mud, straw, shavings, metals, glass, bones, wood, plastics, stone dust, rags, manure, butcher's waste, or any solids, liquids or other substances capable of causing obstruction to the flow in sewers or other interference with proper operation of the wastewater system.

h) Any water or wastewater containing substances in excess of the limitations contained in **Appendix 2.2**. These limits shall be subject to revision and may be modified to represent concentration or mass based standards.

i) Any radioactive wastes or isotopes of such concentration as to exceed limits established by applicable local or national regulations.

j) Any liquids, solids or gases containing viable pathogenic or parasitic organisms including but not limited to viruses, bacteria, algae, protozoa and amoebas that may pose a health hazard or interfere with the proper operation of the wastewater collection or treatment systems.

k) Any storm water, surface water, groundwater, roof runoff, subsurface drainage, or other non-metered waters.

l) Any substances that may solidify or become viscous at temperatures between 10º C and 45ºC or that may cause obstruction and/or interference with the conveyance system or the treatment plant.

m) Any vegetable or animal oils, fats and greasy material with concentrations greater than 100 mg oil/l (hexane extraction, and milk).

n) Any water added for the purpose of diluting wastes that would otherwise exceed applicable concentration limitations for any wastewater constituent.

o) Any trucked or hauled pollutants, except at discharge points designated by Bethlehem Municipality.

p) Any wastes containing petroleum oil, non- biodegradable oils, or products of mineral oil in amounts that will cause interference or pass-through.

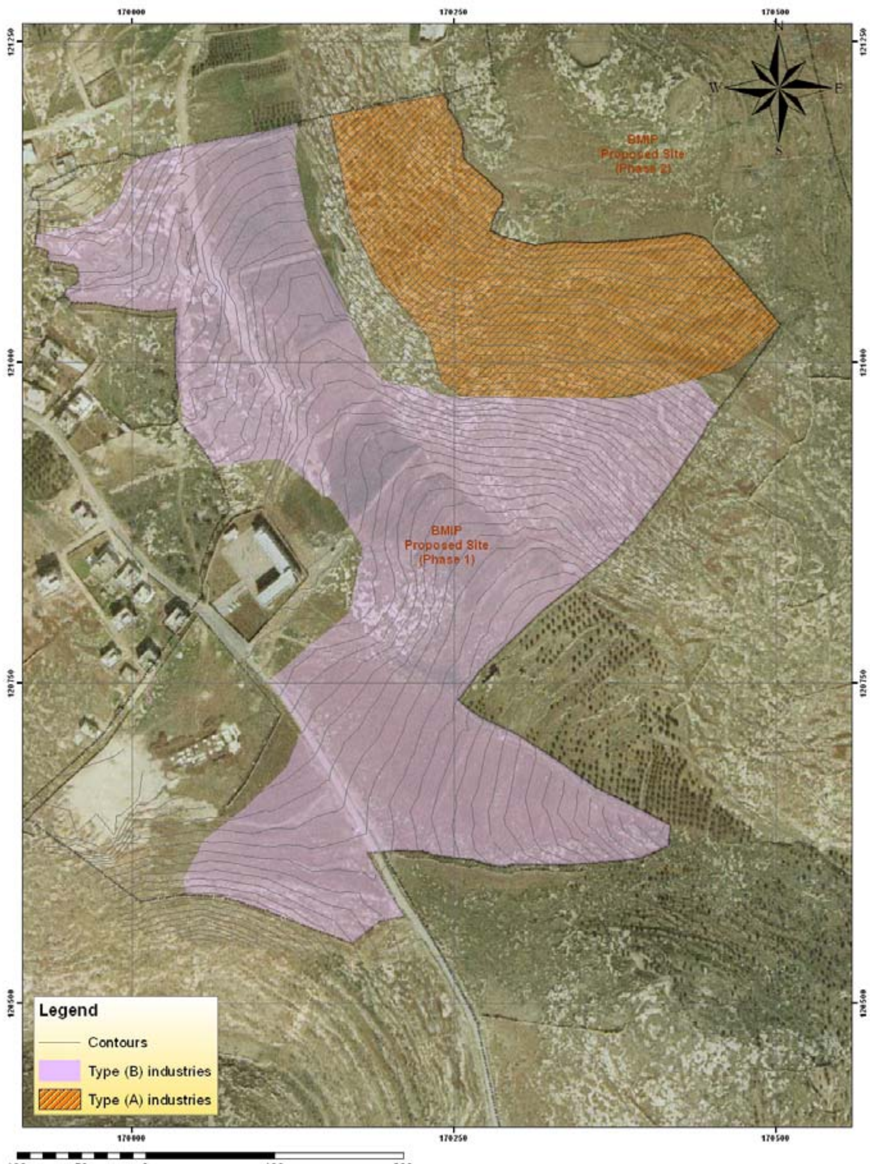
q) Any substance which may interfere with or pass-through the treatment plant untreated or without adequate treatment to the environment.

r) Any glycol compound or derivative used in cooling systems or used in systems for the purpose of altering liquid freezing and/or boiling points.

Appendix 2.2: Discharge limitations in wastewater (Palestinian Standardization Institute (PSI) - standard number 742-2003.

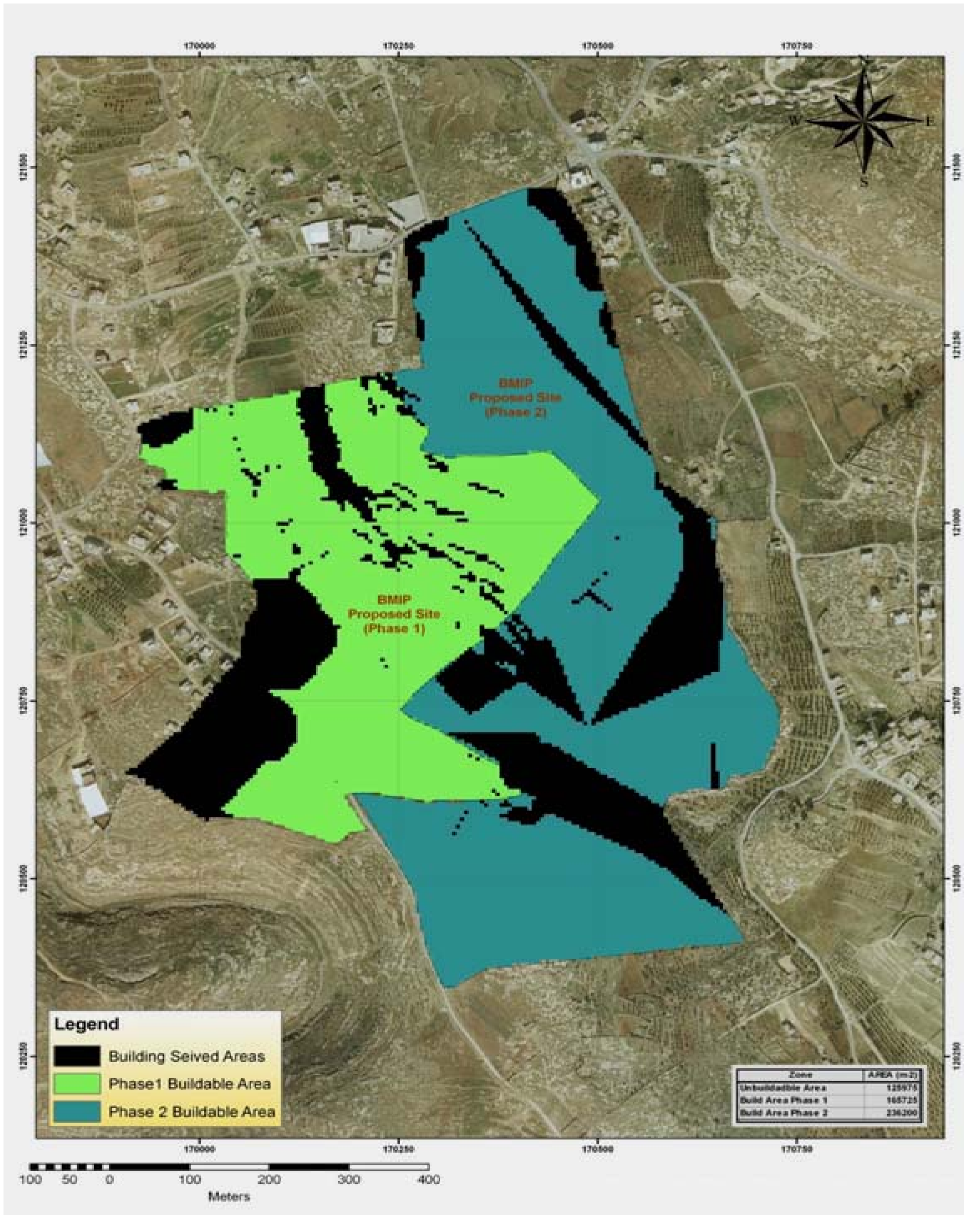
Physical Properties	Maximum Limit (mg/l)
Temperature	45° C
Color (PCU)	150
Total Suspended Solids (TSS)	500
Total Dissolved Solids (TDS)	2500
Chemical Characteristics	
pH range	6.0-9.0
Biological Oxygen Demand (BOD)	500
Chemical Oxygen demand (COD)	2000
Total Kheldal Nitrogen (TKN)	60
Ammonia NH3	45
Nitrate NO3-	30
Fluorides	2
Total Phosphate	15
Sulfides	1
Phenols	3
Fats, oil and grease	100
Mineral Oils	20
Detergent (MBAS)	25
Residual Chlorine	3
Cyanide	1
Beryllium	0.5
Boron	3
Lithium	0.3
Aluminum	10
Heavy Metals	
Total Chromium	1
Tin	1
Nickel	1
Cadmium	0.5
Arsenic	0.25
Lead	1

Manganese	1
Silver	0.5
Mercury	0.05
Iron	50
Zinc	5
Cobalt	1
Selenium	0.05
Vanadium	0.5
Molybdenum	0.15
Copper	2

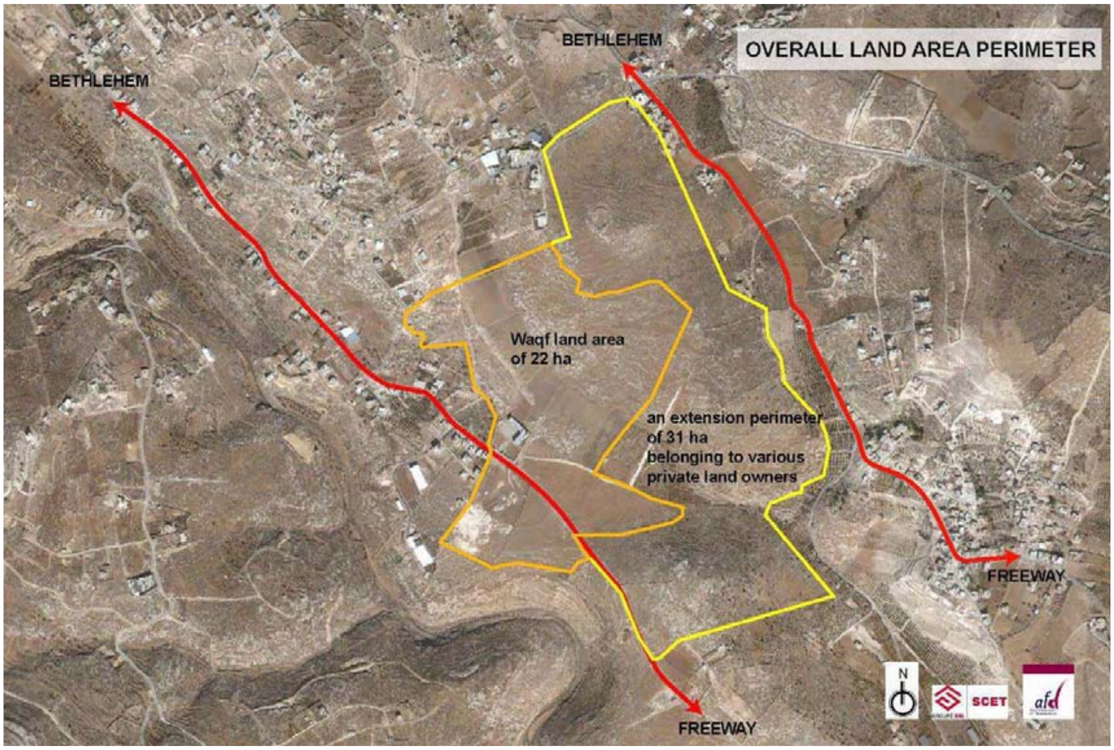


Map2.2: Industrial types allocation

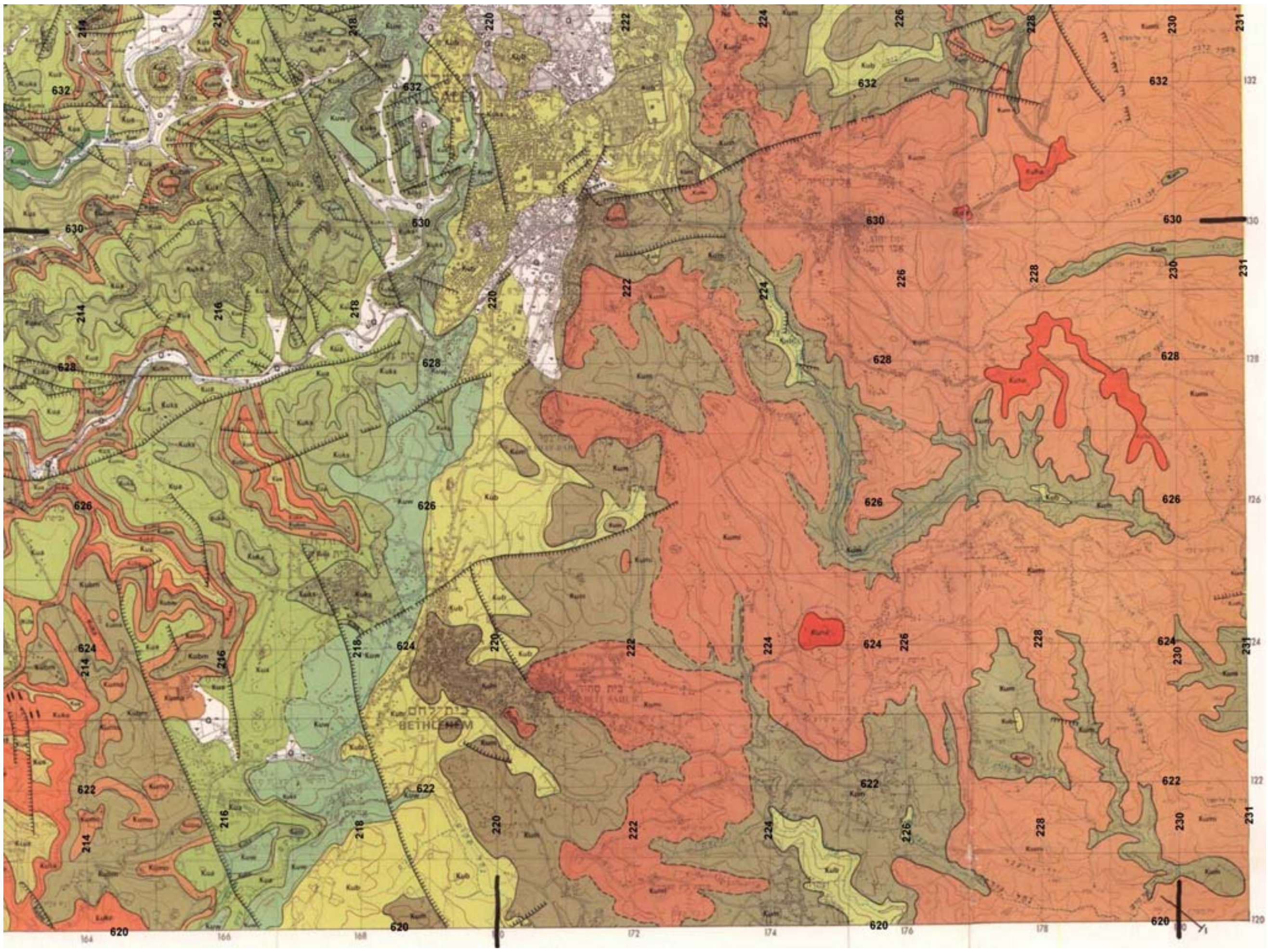
Appendix 4.1: Allocation of different types of industries (Feasibility study of BMIP, 2009).



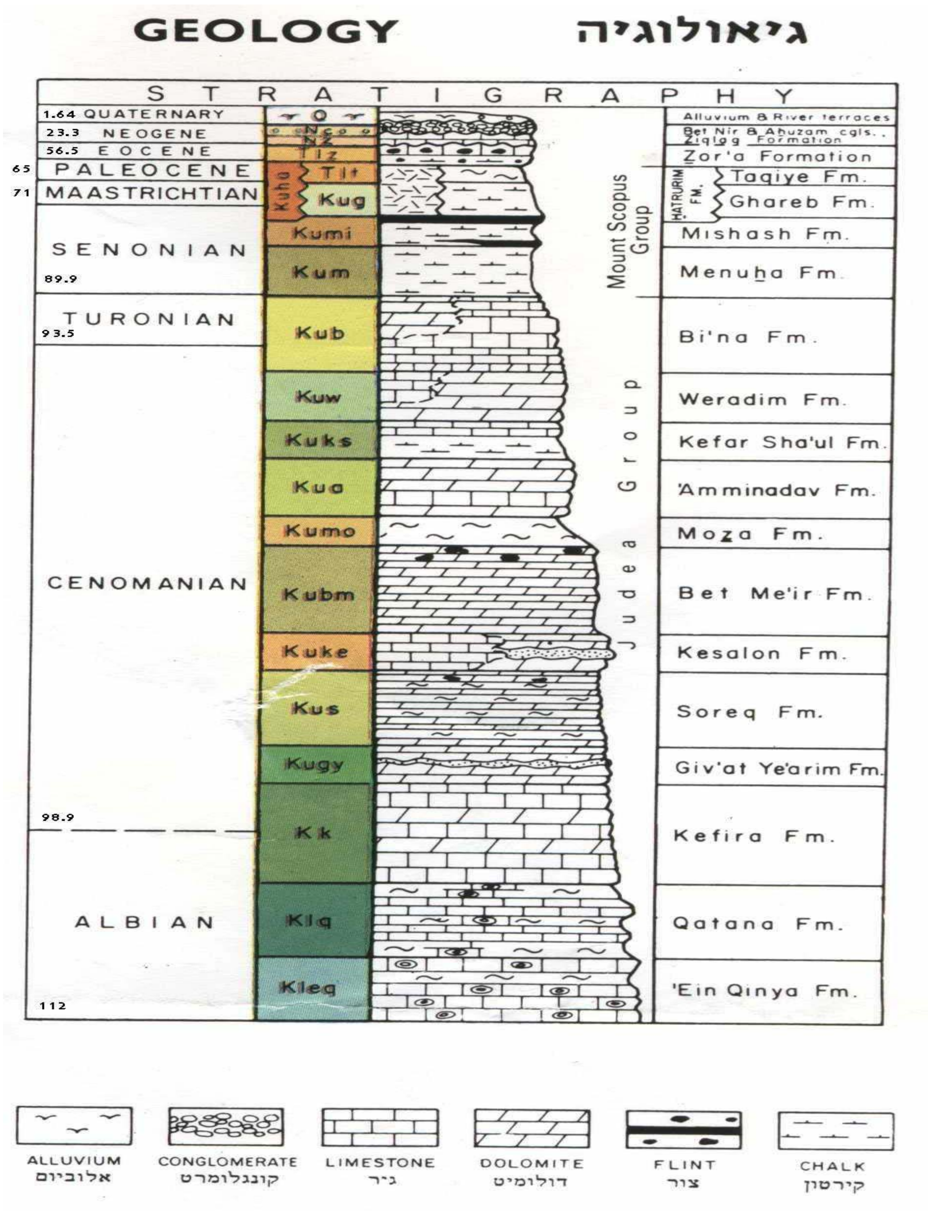
Appendix 5.1: Phases of the project and sieved areas (Feasibility study of BMIP, 2009)



Appendix 5.2: General topographic view of the BMIP (Feasibility study,2009)



Appendix 5.3: Geological map of Jerusalem area (Frimerman,1997)



Appendix 5.4: Geological stratigraphy of Jerusalem area (Arkin et al, 1997)

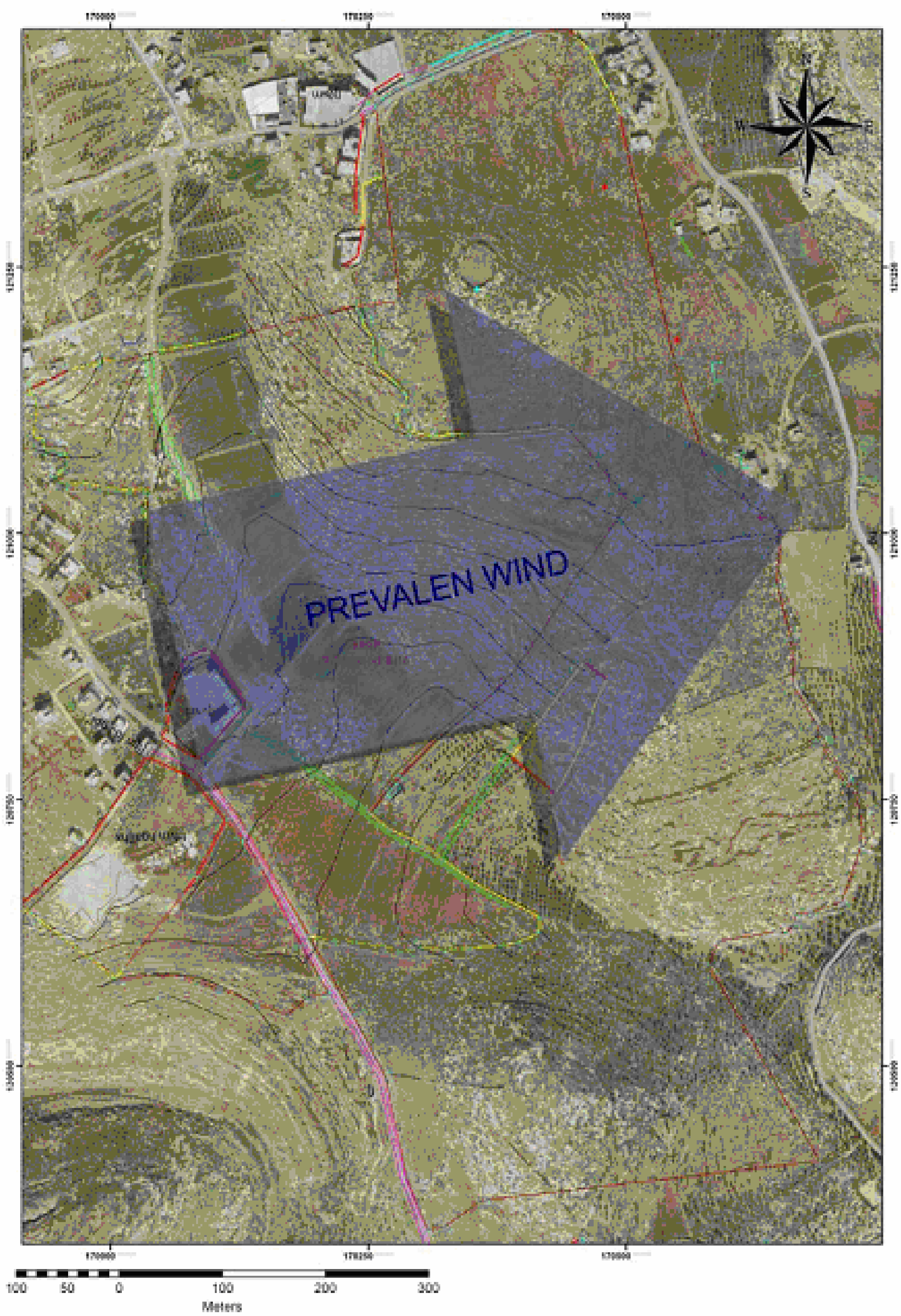
Appendix 5.5: Soil types in the project area (Feasibility study,2009)

Appendix 5.6: Excavation in site showing soil strata.(25/3/2010)

Appendix 5.7: Rainfall in Bethlehem area between 1981- 2007 (ARIJ, 2007)

Season	Month												Total
	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	
1981/1980	0.0	0.0	5.0	357.4	122.6	88.2	74.6	10.0	0.0	0.0	0.0	0.0	657.8
1982/1981	0.0	0.0	59.4	13.2	81.8	194.5	109.8	0.0	0.0	0.0	0.0	0.0	458.7
1983/1982	0.0	17.5	86.8	68.6	268.0	264.5	119.9	12.5	0.0	0.0	0.0	0.0	837.8
1984/1983	0.0	1.2	37.0	11.4	172.1	47.7	127.6	12.0	0.0	0.0	0.0	0.0	409.0
1985/1984	0.0	28.5	22.0	47.0	32.0	223.7	40.0	46.0	0.0	0.0	0.0	0.0	439.2
1986/1985	0.0	8.2	8.5	47.5	66.5	124.7	8.5	28.5	0.0	0.0	0.0	0.0	292.4
1987/1986	0.0	31.0	215.8	124.7	110.9	43.4	93.7	0.0	0.0	0.0	0.0	0.0	619.5
1988/1987	0.0	37.2	13.5	167.2	129.0	164.5	86.8	0.0	0.0	0.0	0.0	0.0	598.2
1989/1988	0.0	7.0	43.8	164.5	93.0	47.0	111.0	0.0	0.0	0.0	0.0	0.0	466.3
1990/1989	0.0	0.0	18.1	4.5	98.5	93.0	102.5	0.0	0.0	0.0	0.0	0.0	/
1991/1990	/	/	/	/	/	/	/	/	/	/	/	/	/
1992/1991	/	/	/	/	/	/	/	/	/	/	/	/	/
1993/1992	/	/	/	/	/	/	/	/	/	/	/	/	/
1994/1993	0.0	134.4	545.7			43.0					0.0	0.0	723.1
1995/1994	0.0	6.0	79.4	27.0	88.0	196.0	169.0	35.0	0.0	0.0	0.0	0.0	600.4
1996/1995	/	/	/	/	/	/	/	/	/	/	/	/	/
-1996 1997	/	/	/	/	/	/	/	/	/	/	/	/	/
-1997 1998	/	/	/	/	/	/	/	/	/	/	/	/	/
-1998 1999	/	/	/	/	/	/	/	/	/	/	/	/	/
-1999 2000	/	/	/	/	/	/	/	/	/	/	/	/	/
-2000 2001	0.0	14.6	6.5	166.5	120.1	131.1	6.0	4.5	75.0	\	/	/	524.3
-2001	0.0	4.0	67.0	123.0	259.5	52.0	*	*	*	/	/	/	505.5
2002													
-2002 2003	0.0	10.2	24.4	202.6	64.7	237.4	130.3	26.0	0.0	/	/	/	695.6
-2003 2004	0.0	4.0	14.0	144.3	127.6	96.0	10.1	0.0	0.0	/	/	/	396
-2004 2005	/	/	/	/	/	/	/	/	/	/	/	/	/
-2005 2006	0.0	11.8	36.7	113.8	82.7	71.8	12.0	107.2	0.0	/	/	/	436
-2006 2007	0.0	19.0	10.0	112.2	107.3	93.3	86.5	*	0.0.	/	/	/	430.1
Grand average													534.7

*/ Missing Data



Appendix 5.8: Prevailing wind direction (Feasibility study of BMIP, 2009)

Acanthus syriacus

Adonis aestivalis + Vicia hervilia

Anagallis arvensis

Anthemis palaestina + Polypogon monspeliensis

Artedia squamata

Arum palaestinum

Appendix 5.9 (a): Flora of the project site.(25/3/2010)

Ononis natrix *Papaver umbonatum*

Sinapis alba *Ridolfia segetum*

Conium maculatum

Appendix 5.9 (b): Flora of the project site. (25/3/2010)

Bromus tectorum

Capsella bursa-pastoris

Carthiamus tenius

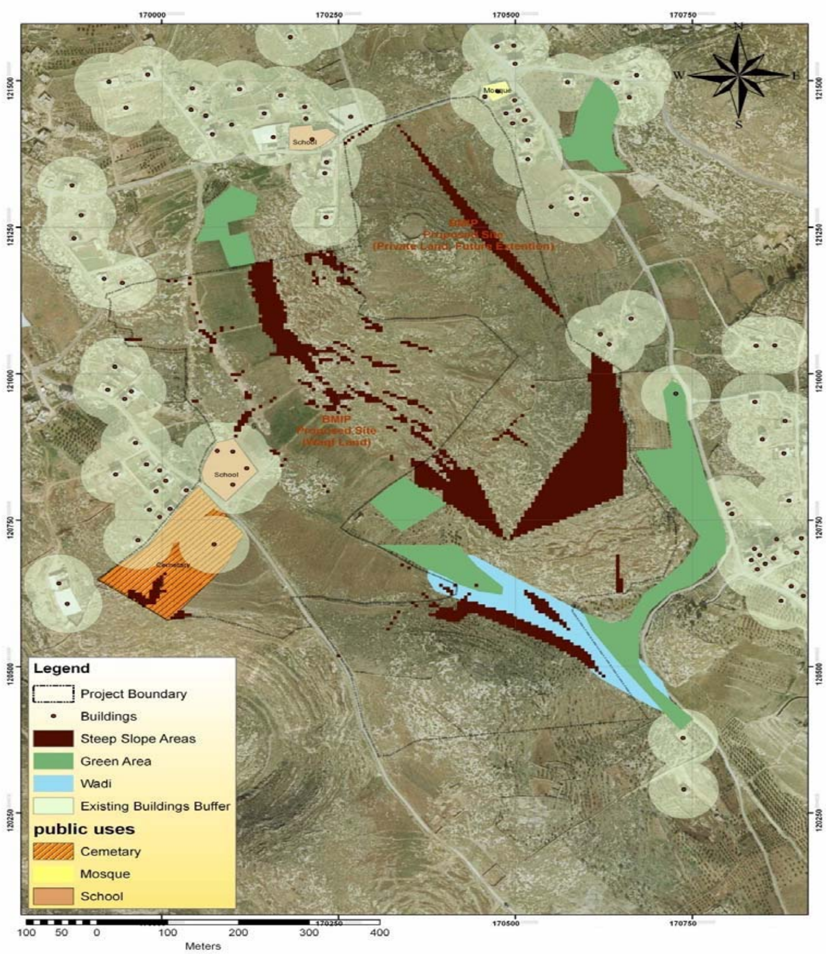
Gundelia tournefortii

Hedypnois cretica

Malva silvestris

Appendix 5.9 (c): Flora of the project site. (25/3/2010)

Appendix 5.10: Mole holes in the project site. (25/3/2010)



Appendix 5.11: Land uses and public uses and green areas of the project area (Feasibility study of BMIP, 2009

جدول 1: السكان في الضفة الغربية حسب المحافظة والجنس، 2007

Table 1: Population in the West Bank by Governorate and Sex, 2007

Governorate	نسبة الجنس Sex Ratio	متوسط حجم الأسرة Mean Household Size	الأسر Households		Population السكان						المحافظة
					Females إناث		Males ذكور		Both Sexes كلا الجنسين		
			النسبة Percentage	العدد Number	النسبة Percentage	العدد Number	النسبة Percentage	العدد Number	النسبة Percentage	العدد Number	
West Bank	**103.1**	**5.5**	**100.0**	**427,097**	**100**	**1,157,339**	**100**	**1,193,244**	**100**	**2,350,583**	الضفة الغربية
Jenin	**103.2**	**5.4**	**11.1**	47,437	**10.9**	126,291	**10.9**	130,328	**10.9**	256,619	جنين
Tubas	**103.3**	**5.6**	**2.1**	9,004	**2.1**	24,728	**2.1**	25,533	**2.1**	50,261	طوباس
Tulkarm	**102.1**	**5.3**	**7.0**	29,938	**6.8**	78,182	**6.7**	79,806	**6.7**	157,988	طولكرم
Nablus	**102.3**	**5.4**	**14.0**	59,663	**13.7**	158,589	**13.6**	162,241	**13.6**	320,830	نابلس
Qalqiliya	**105.2**	**5.5**	**3.9**	16,483	**3.8**	44,453	**3.9**	46,764	**3.9**	91,217	قلقيلية
Salfit	**103.3**	**5.4**	**2.6**	11,103	**2.5**	29,295	**2.5**	30,275	**2.5**	59,570	سلفيت
Ramallah & Al-Bireh	**101.4**	**5.3**	**12.4**	52,834	**12.0**	138,903	**11.8**	140,827	**11.9**	279,730	رام الله والبيرة
Jericho & Al Aghwar	**100.3**	**5.6**	**1.8**	7,615	**1.8**	21,133	**1.8**	21,187	**1.8**	42,320	أريحا والأغوار
Jerusalem	**103.5**	**5.2**	**16.5**	70,434	**15.4**	178,679	**15.5**	184,970	**15.5**	363,649	القدس
Bethlehem	**103.8**	**5.4**	**7.6**	32,667	**7.5**	86,492	**7.5**	89,743	**7.5**	176,235	بيت لحم
Hebron	**104.1**	**6.1**	**21.0**	89,919	**23.5**	270,594	**23.7**	281,570	**23.6**	552,164	الخليل

يشمل السكان الذين تم عدهم فعلاً خلال الفترة من 1-2007/12/16 وتقديرات عدد السكان الذين لم يتم عدهم على ضوء نتائج الدراسة البعدية.

Includes population counted during the period 1-16/12/2007 and uncounted population estimates according to post enumeration survey.

جدول 2 : السكان في الضفة الغربية حسب فئة العمر والجنس والمحافظة، 2007

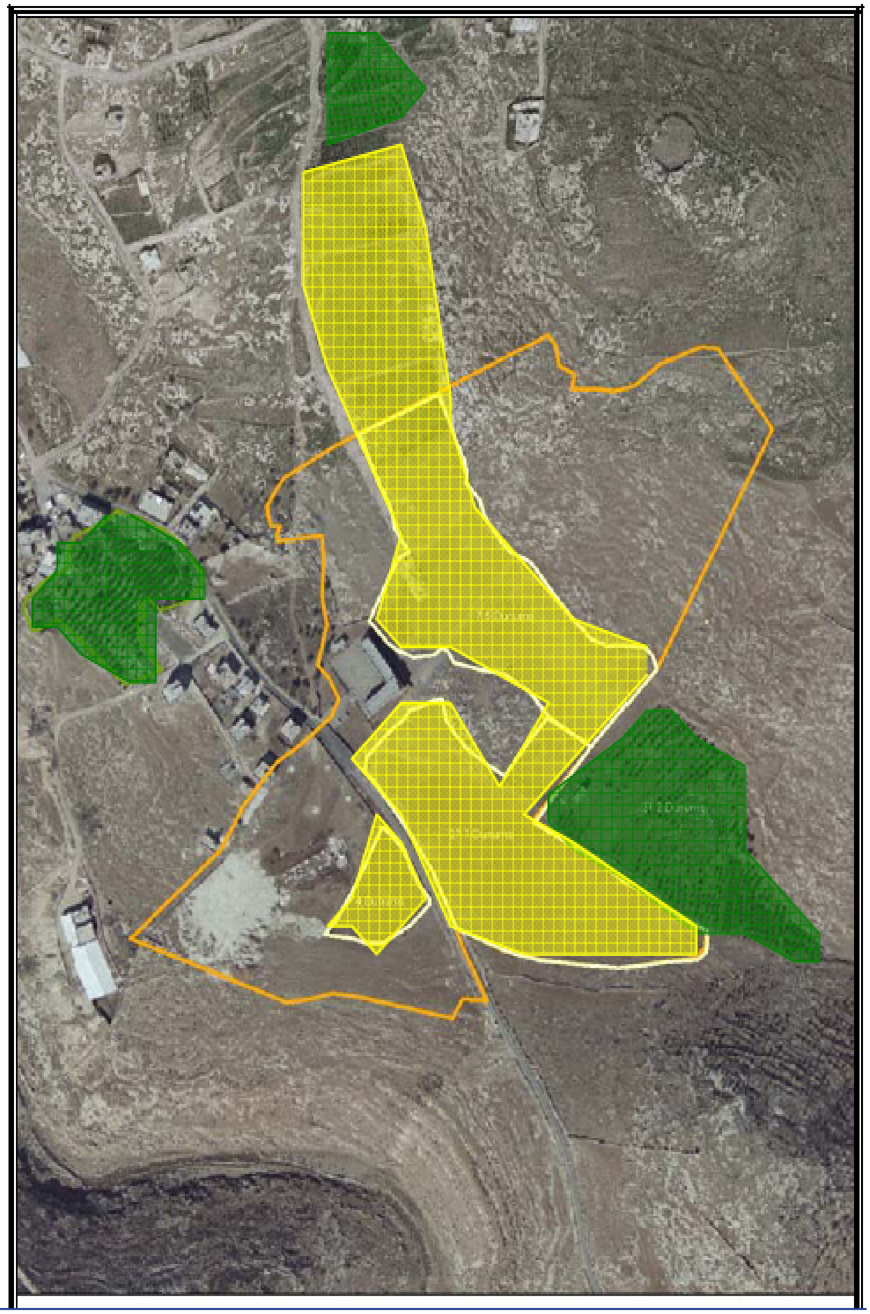
Table 2: Population in the West Bank by Age Group, Sex and Governorate, 2007

Age Group and Sex	Governorate الخليل Hebron	بيت لحم Bethlehem	القدس Jerusalem	أريحا والأغوار Jericho & Al Aghwar	رام الله والبيرة Ramallah & Al-Bireh	سلفيت Salfit	قلقيلية Qalqiliya	نابلس Nablus	طولكرم Tulkarm	طوباس Tubas	جنين Jenin المحافظة	الضفة الغربية West Bank	فئة العمر والجنس
Both Sexes													كلا الجنسين
0 - 4	87,272	22,772	42,466	5,914	34,301	8,635	12,723	42,932	19,802	6,876	33,954	**317,647**	4 - 0
5 - 9	78,024	22,355	44,806	5,553	32,793	7,864	12,136	41,941	19,981	6,360	33,601	**305,414**	9 - 5
10 - 14	75,436	21,601	41,646	5,191	32,998	7,829	11,972	40,699	20,801	6,269	33,146	**297,588**	14 - 10
0 - 14	**240,732**	**66,728**	**128,918**	**16,658**	**100,092**	**24,328**	**36,831**	**125,572**	**60,584**	**19,505**	**100,701**	**920,649**	14 - 0
15 - 19	65,244	19,102	34,789	4,239	30,363	7,036	10,511	36,460	18,907	5,462	29,026	**261,139**	19 - 15
20 - 24	49,042	14,957	28,297	3,311	23,719	5,221	7,830	27,140	13,361	4,262	22,360	**199,500**	24 - 20
25 - 29	39,702	12,773	26,506	2,983	19,644	4,221	6,676	23,128	11,343	3,639	18,629	**169,244**	29 - 25
30 - 34	32,741	11,176	23,114	2,722	17,208	3,800	5,681	21,340	10,130	3,287	17,128	**148,327**	34 - 30
35 - 39	27,854	10,070	19,365	2,352	14,618	3,263	4,716	18,940	8,921	2,788	14,300	**127,187**	39 - 35
40 - 44	22,071	8,340	16,005	2,003	12,877	2,907	4,230	16,895	8,409	2,255	12,369	**108,361**	44 - 40
45 - 49	16,561	6,278	12,163	1,534	10,334	2,187	3,250	12,730	6,870	1,679	9,564	**83,150**	49 - 45
50 - 54	11,312	4,568	9,298	955	7,414	1,601	2,339	8,459	4,335	1,246	6,334	**57,861**	54 - 50
55 - 59	7,745	3,234	6,575	735	5,378	1,043	1,658	6,553	3,343	844	4,886	**41,994**	59 - 55
60 - 64	6,040	2,761	5,554	583	4,315	800	1,283	5,722	2,786	674	4,009	**34,527**	64 - 60
15 - 64	**278,312**	**93,259**	**181,666**	**21,417**	**145,870**	**32,079**	**48,174**	**177,367**	**88,405**	**26,136**	**138,605**	**1,231,290**	64 - 15
65 - 69	4,600	1,967	3,800	407	3,103	658	858	3,932	1,952	571	2,923	**24,771**	69 - 65
70 - 74	3,899	1,630	2,693	310	2,762	631	761	3,363	1,777	454	2,629	**20,909**	74 - 70
75 - 79	2,849	1,309	1,725	199	2,149	521	585	2,295	1,263	385	1,803	**15,083**	79 - 75
80 - 84	1,460	751	1,026	101	1,365	304	321	1,369	763	203	1,045	**8,708**	84 - 80
85 - 89	722	387	510	52	607	117	136	603	317	119	529	**4,099**	89 - 85
90 - 94	308	167	214	16	164	39	45	216	134	31	178	**1,512**	94 - 90
95 +	180	88	105	15	90	21	32	107	84	22	107	**851**	+ 95
65 +	**14,018**	**6,299**	**10,073**	**1,100**	**10,240**	**2,291**	**2,738**	**11,885**	**6,290**	**1,785**	**9,214**	**75,933**	+ 65
Not Stated	5,198	3,680	29,394	1,228	6,739	102	831	1,132	1,513	738	3,287	**53,842**	غير مبين
Total	**538,260**	**169,966**	**350,051**	**40,403**	**262,941**	**58,800**	**88,574**	**315,956**	**156,792**	**48,164**	**251,807**	**2,281,714**	المجموع

Appendix 5.12 a: Population in West Bank by governorate and sex.
b: Population in West Bank by age group, sex and governorate (PBCS census 2007)

Appendix 5.13 : Olive plantations in the project site.(25/3/2010)

Appendix 5.14: Barley and Malva meadows in the project site. (25/3/2010)



Appendix 5.15: Planted area (Summer crops /yellow) and (Olive trees fields /green) (Feasibility study of BMIP).

Appendix 5.16: sheep grazing, school and project excavation in background.(25/3/2010)

Appendix 5.17 : Al-Khirba (Feasibility study of BMIP 2009)

Appendix 5.18: Cemetery in the project site.(25/3/2010)