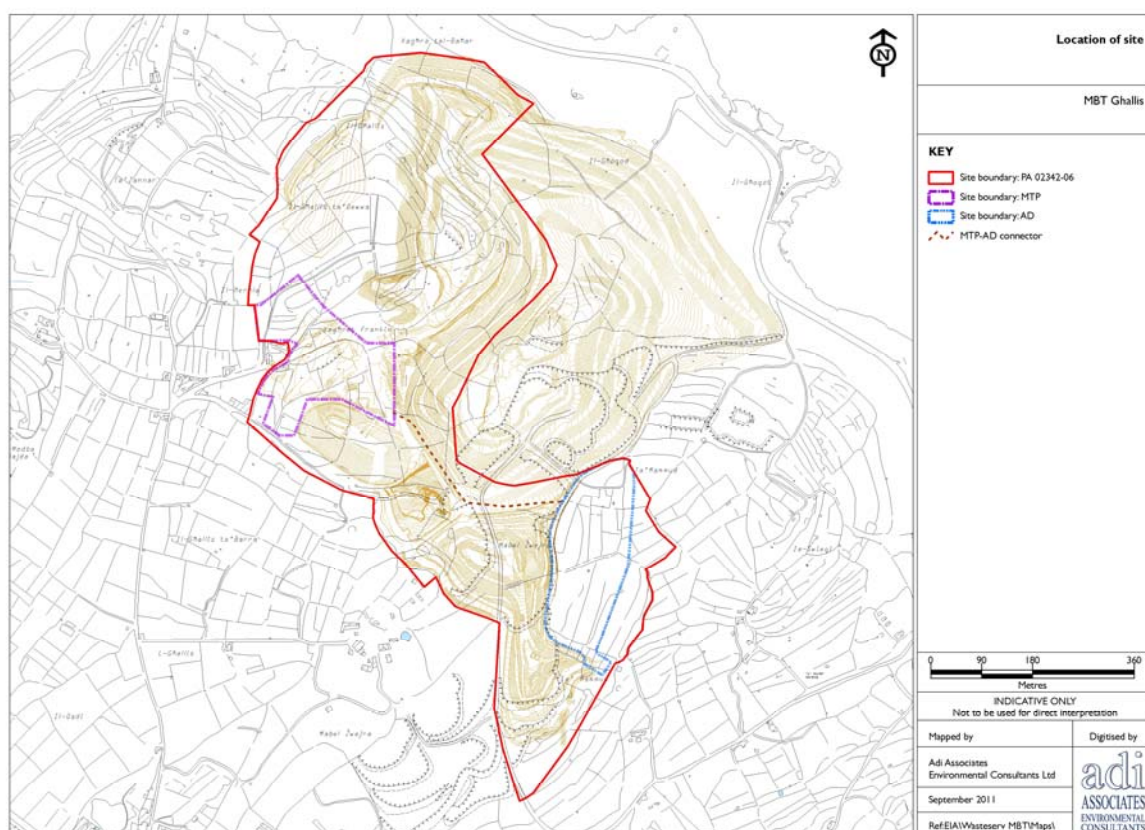


Master Plan for the Maghtab Environmental Complex Naxxar (GF 00121/06)

Environmental Impact Statement Update



Version 1: September 2011

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Master Plan for the Magtab Environmental Complex
Environmental Impact Statement Update

Report for: WasteServ Malta Ltd

Revision Schedule

| Rev | Date | Details | Report Authored by: | Checked by: | Approved by: |
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Adi Associates Environmental Consultants Ltd, Malta, prepared this Environmental Impact Statement Update.

The Environmental Impact Assessment Regulations, 2007 Sections 28(3) and 29(1) require each of the Consultants to declare that they carried out the study or part thereof, that they take responsibility for statements and conclusions contained in their reports or part thereof, and that they have no personal or financial interest in the proposed development.

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Adi Associates has coordinated this EIS Update and has provided technical input to specific parts of the Statement as identified in the previous page.



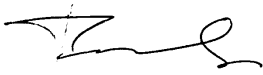

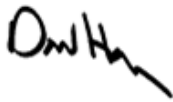
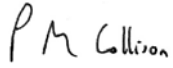



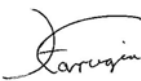

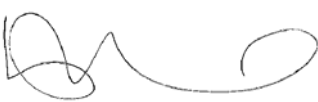

Adi Associates Environmental Consultants Ltd takes responsibility for statements and conclusions contained in the parts of the report prepared directly by its staff. However, statements made and conclusions drawn by the independent sub-consultants who prepared the Technical Appendices and informed the Environmental Statement remain the responsibility of the individual sub-consultants.

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APPENDICES

Appendix 1: Geo-Technical Investigation Report

Appendix 2: Laboratory Analysis Results

Appendix 3: A3 photos

I. INTRODUCTION

- I.1. This Environmental Impact Statement Update (EIS) was commissioned by WasteServ Malta Ltd (WSM), to support its Masterplan for the development of the Maghtab Environmental Complex at Naxxar.
- I.2. A full development application (PA 2342/06) was submitted to MEPA in April 2006. This application covers the entire Waste Management Complex at Ghallis as described below.
- I.3. MEPA determined that the Application required an update to the EIS that was prepared in respect of PA 4834/04 on the basis of Schedule 1B of the Environmental Impact Assessment Regulations, 2007 (Legal Notice 114 of 2007), which deals with screening¹.
- I.4. Hereafter, in this EIS Update, the proposed development is referred to as ‘the Scheme’. A full description of the Scheme is provided in Chapter 4.

PURPOSE OF THE EIS UPDATE

- I.5. The purpose of this EIS Update is to present the findings of the Environmental Impact Assessment (EIA). EIA is the process of systematically assessing the likely significant environmental impacts of the proposals. EIA also ensures that the significance of these impacts, and the scope for reducing them, is clearly understood by both the public and MEPA before a decision is made on whether or not the Scheme should be approved.

BACKGROUND TO THE SCHEME

- I.6. In 2004, WSM applied for the development of a controlled landfill and ancillary facilities (PA 4384/04) at Ghallis. This development permit required the formulation of an Environmental Impact Statement that was prepared by AIS Environmental Ltd and SLR. Full development permission was granted in 2006. According to the EIS, PA 4834/04 comprised the following elements:
 - A controlled landfill for non hazardous, non inert waste of 1.7Mm³ capacity;
 - A controlled landfill for certain hazardous wastes of 100,000m³ capacity;
 - A facility for the interim storage, pre-treatment, and transfer/export of hazardous wastes; and
 - An area for the potential future expansion of the non hazardous landfill.

¹ E-mail communication dated 3rd May 2010 from Ms Charlene Smith (MEPA) to Mr Vincent Magri (WasteServ)

- I.7. The whole of the development is located immediately to the west of the existing Maghtab landfill: the area is known as Ghallis ta'Gewwa. It is located on the northern coast of the island of Malta approximately 2km to the east of Qawra and 7km to the west of Valletta.
- I.8. In March 2010 WSM submitted a Project Description Statement (PDS)² that included a number of changes to the original master plan as approved in PA 4834/04 and included the installation of a Mechanical Biological Treatment Plant. The proposed development comprises the following elements as described in the PDS:
- Extension of Zwejra cell 1;
 - Extension of Zwejra Cell 3;
 - Closure plan for Ta' Zwejra;
 - Construction of a service road along western perimeter;
 - Sanctioning of the extension of the temporary Ghallis Site office;
 - Extension of the northern bund and the Ghallis engineered landfill;
 - Setting up of a fence;
 - Re-orientation of hazardous cell;
 - Introduction of photo voltaics and micro wind turbines;
 - Introduction of a bulky storage refuse area (non-hazardous waste storage);
 - Introduction of an engineered separator between Maghtab and Ghallis;
 - Re-location of wheel wash;
 - Embellishment scheme;
 - Introduction of a bridle path for equestrian activities;
 - The establishment of a pre-landfilling Mechanical Treatment Plant (MTP); and
 - The establishment of a Biological Treatment Plant (AD).
- I.9. The proposed works will be undertaken within the site boundary as shown in **Figure I** below.
- I.7. A full description of the Masterplan is provided in Chapter 4.

² WasteServ Malta Ltd, 2010, Project Description Statement PA02342/06 May 2009 (Revised March 2010)

STRUCTURE OF THE EIS UPDATE

20. Following this introduction, the EIS Update is structured as follows:

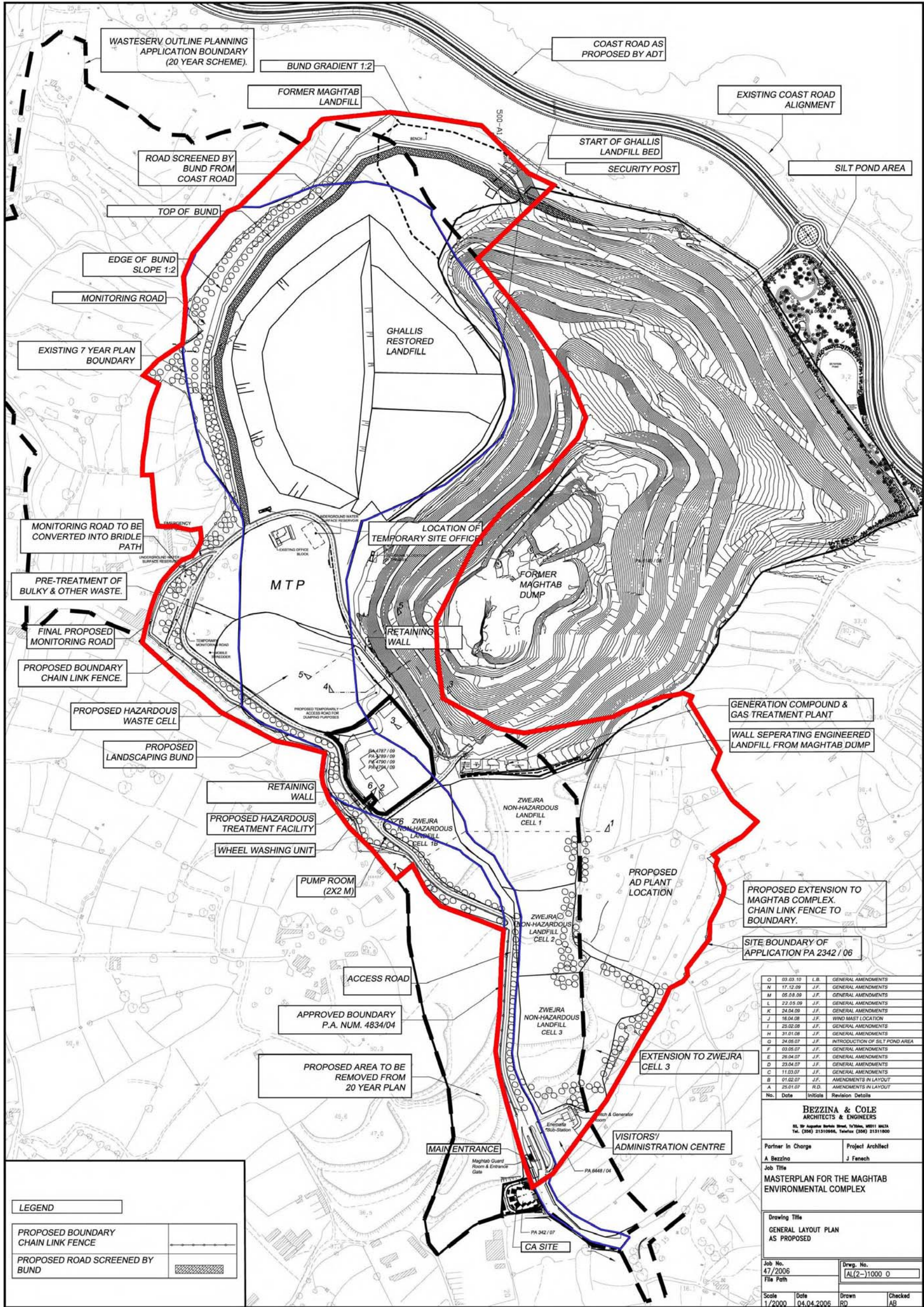
- Chapter 2: EIA Methodology
- Chapter 3: Justification for the Scheme
- Chapter 4: Description of Site and Scheme
- Chapter 5: Legislation and Policy Context
- Chapter 6: Geo-Environment
- Chapter 7: Landscape and Visual Amenity
- Chapter 8: Agriculture
- Chapter 9: Cultural Heritage
- Chapter 10: Noise and Vibration
- Chapter 11: Emissions to Air
- Chapter 12: Social Study
- Chapter 13: Risk Assessment
- Chapter 14: Key Impacts, Cumulative Effects and Summary of Mitigation
- Appendix 1: Geo-Technical Investigation Report
- Appendix 2: Laboratory Analysis Results
- Appendix 3: A3 photos

21. The EIS Update contains the following Technical Appendices (compiled separately as Volume 2 of the EIS):

- Technical Appendix 1: Terms of Reference and Method Statements
- Technical Appendix 2: Geo-environmental Baseline Report
- Technical Appendix 3: Agriculture Baseline Report
- Technical Appendix 4: Cultural Heritage Baseline Report
- Technical Appendix 5: Noise Survey
- Technical Appendix 6: Emissions Study
- Technical Appendix 7: Social study

-
22. The EIS Update includes a Non-Technical Summary in Maltese and English.

Figure I: Master Plan for the Area (as described in the PDS)



2. EIA METHODOLOGY

INTRODUCTION

- 2.1. This chapter sets out the broad method that is used in the EIA for the proposed Scheme. It sets out the key stages that were followed in line with EIA best practice. This chapter also provides a section on how the significance of impacts was assessed, and describes how this was a consistent process throughout the EIA.

THE EIA PROCESS

- 2.2. The current guidance on the EIA process is contained in the Environmental Impact Assessment (EIA) Regulations, 2007. MEPA have indicated that an EIS Update to the EIS submitted for PA 4384/04 is required.

Terms of Reference

- 2.3. As this is an update to an existing EIA (PA 4834/04), MEPA has not issued formal Terms of Reference. The following guidelines have been issued by MEPA:

The EIS Update shall focus on the following:

1. Project description i.e. the EIS update shall include a description of the additional proposed facilities that will be included within the development site including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;

2. Alternatives (sites, layouts and technologies) as relevant;

3. Landscape and visual amenity assessment;

4. Transport;

5. Noise and vibration;

6. Air quality;

7. Waste management issues; and

8. Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.

In addition to the above, the consultant/s is to verify whether as a result of the proposal, the impact significance for the following environmental characteristics outlined below (as presented in the EIS Sections for PA 04834/04), would require an update:

1. Geology, hydrology and palaeontology;

2. Agriculture;

3. *Archaeology and cultural heritage;*
4. *Social impact;*
5. *Land contamination;*
6. *Risk assessment; and,*
7. *Cumulative impacts.*

- 2.4. The EIA Consultants discussed the guidelines with MEPA to clarify certain issues. It was agreed that the EIA Consultants would submit method statements for the studies to be carried out to ensure that the guidelines will be met in accordance with MEPA's requirements.

Method Statements

- 2.5. As required by the EIA Regulations, the Consultants who prepared this EIS Update were approved by MEPA.
- 2.6. Method Statements for agriculture, geo-environment, cultural heritage, landscape and visual amenity, air quality, odour and noise were prepared. The Method Statements outline the baseline survey work to be carried out, the methods used to assess the predicted impacts of the Scheme, and the means by which their significance would be determined. The Method Statements include the following information:
- Introduction listing the objectives of the survey and reference to the ToR;
 - Details of baseline survey methodology;
 - Area of Influence;
 - Competence of surveyors;
 - Field survey methodology;
 - Analytical methodology;
 - Evaluation of data;
 - Identification of potential impacts;
 - Prediction of impacts;
 - Impact significance; and
 - Mitigation.
- 2.7. All Method Statements were accepted by the MEPA. The accepted Method Statements are included in **Technical Appendix I: Terms of Reference and**

Method Statements. The Method Statements were then used as the basis for carrying out the EIA.

EIA APPROACH

- 2.8. Good practice advises that EIA should be treated as an iterative process, rather than a one-off, post-design environmental appraisal. In this way, the findings from the EIA can be fed into the design process, leading to the production of a more environmentally sensitive project. This approach was adopted for this EIA.
- 2.9. Baseline surveys for the specialist EIA topics were undertaken by the Consultants, based on the Area of Influence agreed with MEPA for each topic area.
- 2.10. A detailed assessment of the Scheme's impact on the features present on site and in its environs was undertaken and any potential environmental benefits of the Scheme identified.

Consultation with Key Stakeholders

- 2.11. Early consultation on this Scheme was undertaken where key stakeholders were invited to meet with the EIA Consultants and the Applicant to discuss the Scheme and stakeholder concerns.
- 2.12. The following key stakeholders attended the consultation meetings: Local Councils of Naxxar, St Paul's Bay, and Gharghur. Several other meetings were undertaken by Mr Steven Vella, the social anthropologist, where various stakeholders were interviewed. The findings of the interviews are reported in **Technical Appendix 7: Social Study** and in **Chapter 12** of the EIS Update.

SIGNIFICANCE OF IMPACTS

- 2.1. Assessment of the significance of impacts arising from the Scheme is a key stage in the EIA process. It is this judgement that is key in informing the decision-making process. However, defining what is significant is not a simple task. In general terms, environmental significance involves assessing the amount of change to the environment perceived to be acceptable to the community (Sippe, 1999).
- 2.13. The following criteria have been used to assess the significance of an impact:
 - Type of impact (adverse/beneficial);
 - Extent and magnitude of impact;
 - Direct or indirect impact;
 - Duration of impact (short term/long term; permanent/temporary);
 - Comparison with legal requirements, policies and standards;
 - Sensitivity of receptor (residential dwellings, hotel, craft units, etc.);

- Probability of impact occurring (certain, likely, uncertain, unlikely, remote);
 - Reversibility of impact;
 - Scope for mitigation/enhancement (very good, good, none); and
 - Residual impacts.
- 2.14. Using these criteria, the significance of the impacts arising from the Scheme has been categorised throughout the EIS Update, as follows:
- Not significant;
 - Minor significance; and
 - Major significance.
- 2.15. Definitions of the meaning of the “significance categories” above in relation to each topic area are included in the topic chapters. However, in general terms, if an impact is “not significant”, it is environmentally acceptable; “minor significance” reflects the fact that the impact is manageable; and “major significance” relates to the fact that the impact is environmentally damaging and requires redesign or mitigation measures to minimise it.
- 2.16. The EIS Update contains an assessment of the significance of predicted impacts and, following the proposed mitigation measures, the significance of any residual impacts. A residual impact is any remaining impact that would exist following the implementation of proposed mitigation measures. Mitigation measures and residual impacts are addressed in the chapter of the EIS that deals specifically with the source of the significant effect. A summary of mitigation measures are tabulated at the end of each chapter and a summary of significant impacts is included in Chapter 14.

UNCERTAINTY

- 2.17. The EIA process is designed to enable good decision-making based on the best possible information about the environmental implications of a proposed development. However, there will always be some uncertainty as to the exact scale and nature of the environmental impacts. This arises through shortcomings in information, doubts, or lack of certainty on the likelihood that an incidence would occur, or due to the limitations of the prediction process itself. It is stated in the EIS Update where uncertainties have arisen and where they remain.

PRESENTATION OF THE ENVIRONMENTAL PLANNING STATEMENT

- 2.18. The EIS Update is divided into three main sections after the Introduction and this chapter providing the EIA Methodology. Part I comprises **Chapters 3 to 5**:
- **Chapter 3** provides a justification for the Scheme;

- **Chapter 4** provides a detailed description of the Scheme and its surroundings; and
 - **Chapter 5** summarises the relevant legislation and policy context, including planning policies.
- 2.19. Part 2 of the EIS Update (**Chapters 6 to 12**) describes the potential environmental impacts of the Scheme in relation to a number of different topic areas. These topic areas were identified in the ToR. The information in each of these chapters is structured in a consistent way, as follows:
- Introduction: identifying key issues and how the chapter relates to the requirements of the ToR;
 - Assessment Methodology: a summary of the methods used (desk study, surveys, consultations, etc.) in undertaking the EIS topic chapter;
 - Existing Conditions: a summary of the baseline situation and trends irrespective of the development proposals; and
- 2.20. An assessment of impacts associated with the operation of the Scheme, following the headings below:
- Potential impacts: a summary of the potential impacts of the Scheme;
 - Prediction and significance of impacts: a prediction of the likely impacts of the Scheme against the baseline situation and an assessment of the significance of the impacts;
 - Mitigation measures: a summary of potential mitigation / enhancement measures to offset any identified adverse impacts of the Scheme;
 - Residual impacts: a clear statement of those impacts that still have an impact following mitigation, indicating the significance of the residual impact; and
 - Summary: a summary table of the impacts.
- 2.21. Part 3 of the EIS Update comprises the risk assessment (**Chapter 13**) and addresses the cumulative effects of the Scheme, and summarises the impacts and proposed mitigation measures (**Chapter 14**).

3. JUSTIFICATION

INTRODUCTION

- 3.1. This chapter assesses the Scheme in terms of the objectives it seeks to address and the perceived demand for it.

OBJECTIVES OF DEVELOPMENT

- 3.2. The main objective of the Scheme is to provide a waste management facility for the receiving, sorting and processing of municipal solid and animal manure wastes designed to a high specification in accordance with national and international policies on waste management and good practice.

BENEFITS OF THE SCHEME

- 3.3. Scheme implementation will contribute to fulfilling a number of the objectives and measures put forward in the national Solid Waste Management Strategy 2009, thereby directly addressing current problems related to solid waste management handling and disposal. Scheme implementation will also contribute to ensuring compliance with international and national standards and legislation in the waste management sector.

POLICY & LEGISLATIVE JUSTIFICATION FOR THE SCHEME

- 3.4. The Solid Waste Management Plan for the Maltese Islands, the Waste Management Subject Plan, the Agricultural Waste Management Plan, Solid Waste Management Strategy for the Maltese Islands, the Structure Plan for the Maltese Islands, and the Central Malta Local Plan discuss the management of solid waste in Malta. These are discussed below.

Space for Waste: The Waste Management Subject Plan, 2001

- 3.5. The Subject emphasises the principles of the waste hierarchy and use of the proximity principle including best available technology as a means to manage waste. This built upon the Waste Management Policy (1998) and recognised that significant changes in approach were needed in order for Malta to successfully prepare for EU accession and compliance with the Waste and Landfill Directives.
- 3.6. The Waste Subject Plan provided a snap shot assessment of waste management practices in Malta in 2000. Despite difficulties in securing accurate information about waste arisings and the remaining lifespan/capacities of existing facilities, it provided a comprehensive picture of existing shortfalls in the management of waste. It highlighted a waste management system that was not sufficient to cope with projected waste arisings. In particular it highlighted a waste management regime that was over-reliant on the landfilling of mixed municipal solid waste.

Solid Waste Management Strategy for the Maltese Islands, 2001

- 3.7. The Solid Waste Management Strategy was first prepared in 2001. At the time of preparation, waste streams in Malta were not separated, leading to a mixture of organic and construction and demolition waste being deposited at the main landfill at Magtab. The Strategy was formulated in the context of Malta's accession negotiations with the EU and an increasing realisation that a more integrated approach to waste management was required. The 2001 Waste Management Strategy outlines the following concepts and vision:
- An integrated approach to waste management;
 - A reduction in the quantity and hazard of waste arisings;
 - Higher levels of re-use;
 - Increased recycling and composting;
 - The possible further development of energy recovery technologies (e.g. anaerobic digestion);
 - Safe disposal of residues which cannot be otherwise managed; and
 - Greater public participation in the decision making process.
- 3.8. The original strategy recognised that in the late 1990s the annual tonnage of Municipal Solid Waste and Construction and Demolition Waste disposed to landfill was growing significantly, at an unsustainable rate. The Magtab landfill was not meeting appropriate environmental standards and the quantum of available landfill space was fast diminishing. The Strategy therefore placed significant emphasis on the need to begin separating waste streams and reducing consumption.
- 3.9. The 2001 Strategy introduces targets to reduce the amount of biodegradable waste that goes to landfill, mindful that Malta was likely to require compliance with the EU Landfill Directive (99/31/EC). The Strategy also established a number of targets focused on waste minimisation and better management of waste streams.

Agricultural Waste Management Plan for the Maltese Islands, 2008

- 3.10. The Agricultural Waste Management Plan provides a recommended way forward for the treatment of cattle, poultry and rabbit manure. The Plan takes stock of the livestock sector in the Maltese animal husbandry industry, generates manure estimates, provides treatment options and finally provides a recommended option. The recommended option includes:
- A centralised manure treatment plant in Gozo to be combined with a Mechanical Biological Treatment (MBT) plant for municipal solid waste (MSW) in Gozo;

- A regional manure treatment plant in the North of Malta to treat manure generated in this catchment area. This would be combined with a MBT plant for MSW; and
- A regional manure treatment plant located closest to the remaining farms to treat manures and slurries generated in the north-west, central and south of Malta.

Waste Management Plan for the Maltese Islands, 2008 - 2012

- 3.11. The Waste Management Plan discusses legislation relevant to waste management in the Maltese Islands and presents a detailed picture of the waste arisings. Section 3 on Planning Procedure identifies Government's intention to:

..locate a Mechanical Treatment Plant, including a bio-digester to recover biogas, complete with all ancillary facilities, to reduce the amount of landfilling required. This ideally will be located in the North of Malta in an already committed site and will combined with the treatment of agricultural waste.

Solid Waste Management Strategy for the Maltese Islands, 2009

- 3.12. The 2009 Solid Waste Management Strategy was intended to provide an update to the 2001 Strategy. The 2009 strategy identifies preferred options in terms of proposed solid waste management facilities. The preferred technology mix includes the construction of a mechanical biological treatment (MBT) plant (as one component of a wider waste management strategy that includes other waste management facilities) towards the North of Malta. This plant would treat organic waste that will not be treated at Sant' Antnin and animal husbandry waste transported from within the catchment area of this MBT plant. The Strategy identifies the Ghallis waste management complex as a preferred site for this facility in light of its committed use for waste management operations.

Central Malta Local Plan, 2006

- 3.13. The Central Malta Local Plan identifies an area for the rehabilitation of the Maghtab landfill. The Mechanical Treatment plant is located within the area earmarked for rehabilitation, whereas the biological treatment component is located adjacent to this area.

Summary of Policy Context

- 3.14. It is clear that Government policy is to reduce the amount of waste going to landfill. This is to be achieved by increasing recycling rates and converting organic waste into compost. It is evident that the preferred site for such a facility is at Ghallis, given that the area is already committed to waste management.

LEGISLATIVE CONTEXT

Landfill Directive

- 3.15. As a member of the European Union, Malta is obliged to gradually reduce the amount of biodegradable municipal waste (BMW) that goes to landfill as stipulated in the EU Landfill Directive. Biodegradable waste refers to any waste that is capable of undergoing anaerobic and aerobic decomposition such as food and garden residues, paper and paperboard, or woody materials. Biodegradable municipal waste includes “organics” (food and vegetation residues) plus other waste materials that can decompose (e.g. paper and paperboard, wood).
- 3.16. The quantity and composition of MSW in 2002 (see **Table 3.1**) is taken to be the baseline for calculating Malta’s landfill diversion targets for biodegradable waste under the EU Landfill Directive.

Table 3.1: Quantity and proportion of biodegradable components in MSW in 2002

| 2002 MSW data | Municipal Solid Waste (t/a) |
|----------------------|-----------------------------|
| TOTAL | 214,180 |
| % biodegradable | 66 |
| BMW produced in 2002 | 141,359 |

- 3.17. The EU Landfill Directive requires Member States to gradually decrease the amount of biodegradable waste that is landfilled to levels that represent 75%, 50% and 35% of BMW that was landfilled in the reference year, which is 2002 for Malta. This enables calculating BMW quantities that the EU Landfill Directive will allow Malta to landfill without risking penalty payments. As shown in **Table 3.2**, the amount of BMW that can be landfilled, will decline from 106,000 tonnes today, to around 50,000 in 2020.

Table 3.2: Permissible quantities of BMW to go to landfill in 2010, 2013 and 2020

| Target years | Article 5 (2) Landfill directive | BMW allowed to landfill (t/a) |
|--------------|--|----------------------------------|
| 2010 | 75% | 106,019 |
| 2013 | 50% | 70,679 |
| 2020 | 35% | 49,476 |

- 3.18. Knowledge about the content of organic matter in waste materials is critically important (i) for designing the anaerobic digestion plant (volume of the digester, rate of biogas generation, revenue from energy sales, etc.) and (ii) for calculating the amount of BMW allowed into landfill into the future, without risking penalty

payments. Estimated future arisings of a range of different types of waste are given below and are important for designing processing facilities.

4. DESCRIPTION OF SITE AND SCHEME

INTRODUCTION

- 4.1. This chapter describes the Scheme that is assessed in the EIA. It sets out the purpose of the Scheme and includes a description of the Application Site and its surroundings.

PURPOSE OF THE SCHEME

- 4.2. The main objective of the Scheme is to provide a waste management facility for the receiving, sorting and processing of municipal solid and animal manure wastes designed to a high specification in accordance with national and international policies on waste management and good practice.

SITE DESCRIPTION AND LOCATION

- 4.3. The site is located within an existing waste management site that includes the former landfill, Maghtab, as well as new and proposed waste management facilities in various stages of development including the Ghallis controlled landfill, the Ta'Zwejra temporary storage facility, a hazardous waste storage facility and a civic amenity site. The site boundary is shown in **Figure 4.1**.

Land use

- 4.4. The predominant land uses in the area are related to waste management, agriculture and residences. A map indicating the survey area and the observed land uses is shown in **Figure 4.2**.

Figure 4.1: Site location

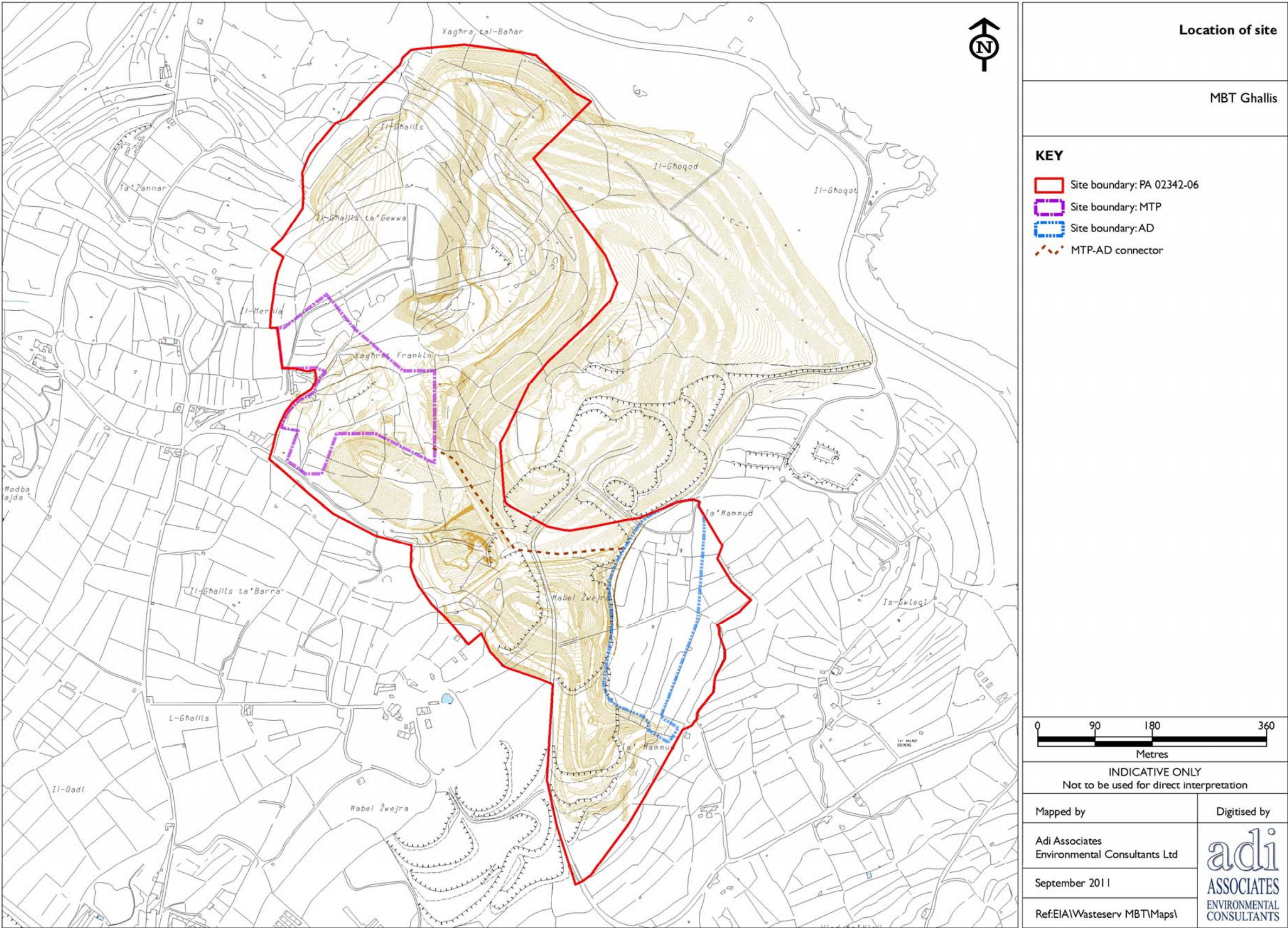
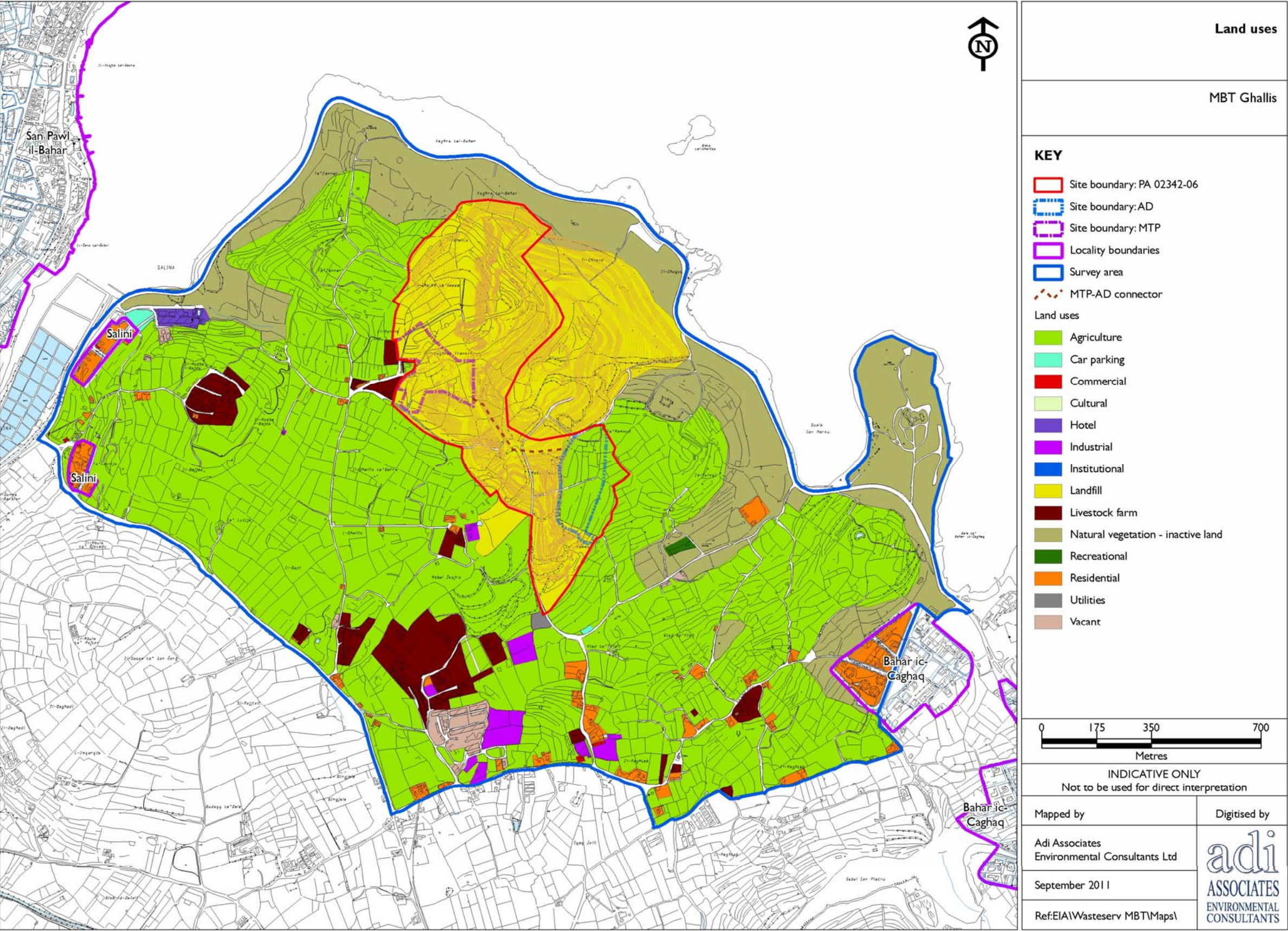


Figure 4.2: Land use



Utilities

Waste

- 4.5. The survey area is overshadowed by past and present landfill operations in the area. The former Maghtab landfill occupies a significant extent of land, forming a man-made hill that is visible from several parts of the Maltese Islands. The landfill was closed in 2004, following which a system of gas wells, pipe works and gas treatment plants were installed to extract, treat and burn landfill gases, see **Figure 4.3**.
- 4.6. After the closure of the Maghtab landfill, two new engineered landfills were formed. The Ta' Zwejra landfill, to the south of the Maghtab site, was a temporary landfill that was operational between April 2004 and December 2006. Unlike its predecessor, the landfill was engineered so as to prevent the spread of toxins from municipal solid waste into the bedrock.
- 4.7. A second engineered landfill was opened in 2006 at Ghallis, to the west of the Maghtab site. It comprises two controlled landfills: one for non-hazardous, non-inert waste with a capacity of 1.7 million cubic metres; and another for certain types of hazardous waste with a capacity of 100,000 cubic metres. Parts of the Ghallis landfill are still being excavated, see **Figure 4.3**.

Figure 4.3: Waste infrastructure within the surveyed area



- 4.8. A Civic Amenity Site is located at the present main entrance to the landfills. This forms part of a network of five sites located across Malta and Gozo. The site is used for collection of domestic bulky waste such as electronic products, furniture, tyres, garden waste, and white goods and hazardous domestic waste.
- 4.9. A privately-owned waste management facility, incorporating an administration building, workshop, stores, and garages is located close to the Civic Amenity Site.
- 4.10. A total of three bring-in sites are located within the survey area, two within Bahar ic-Caghaq and one at Salini.

Water

- 4.11. A sewage pumping station is located close to Bahar ic-Caghaq, in a stretch of degraded land between Bahar ic-Caghaq and the coast road (see **Figure 4.6**).

Agriculture

- 4.12. Apart from waste facilities in the area, the other most significant land use in the area is agriculture.
- 4.13. The span of agricultural land to the left of the landfill is more continuous compared to other parts of the survey area. Fields located in the southern parts of the survey area are interrupted by pockets of rural dwellings and animal husbandry units.

Arable farming

- 4.14. The majority of fields in the area are dry farmed (*raba baghli*) with only a few reserved for irrigated farming (*raba saqwi*). Most of the fields were fallow during the survey. The remaining crops on irrigated fields included marrows, aubergines, honey melons, cabbages and sunflower, see **Figure 4.4**.
- 4.15. Small pockets of vines and olive trees were also noted. A number of carob trees are also present in the area. Very few greenhouses were observed in the area.
- 4.16. There are a number of field rooms in the area, some of which appear disused, see **Figure 4.4**. These are generally used to store agriculture-related implements. Some of these rooms are also used for recreational purposes as evidenced by television antennae and barbeques. Hunting hides were also noted. A detailed description of the agriculture in the area is found in **Chapter 8**.

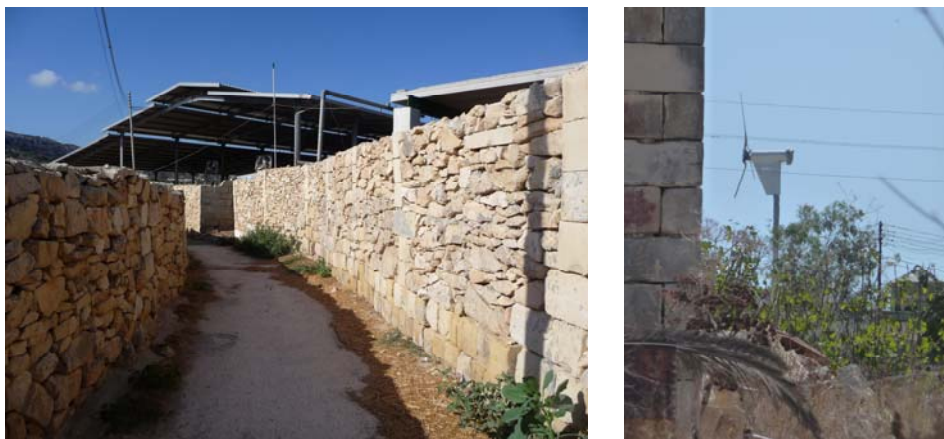
Figure 4.4: Arable farming



Livestock

- 4.17. The Maghtab area is particularly known for the large concentration of animal breeding farms located in close proximity to each other. These include farms that breed rabbits, cows, poultry and pigs, see **Figure 4.5**. The majority of these farms can be considered as *factory farms* where a high density of livestock is bred in a confined area. It is not excluded that small quantities of livestock are also grown on small farms.
- 4.18. Farmer residences are present on a small number of farms.
- 4.19. One of the highest aggregations of livestock farms is found along Sqaq Habel Zwejra. Some farms concentrate on one type of livestock such as poultry, rabbit and cows. Others breed more than one kind, such as pigs and poultry, on the same farm. It is also common that on some of these farms there are stables. An equestrian centre is found along Sqaq Habel Zwejra; another is located within the survey area. The area is also home to a large former poultry farm that lies abandoned.
- 4.20. A cluster of cow farms is found at Il-Hodba l-Bajda at the end of Triq il-Katakombi. This farm complex also includes a farmer's residence and uses a micro wind turbine to generate part of its energy requirements, see **Figure 4.5**. Another cluster of livestock farms is located along Triq ta' Saverja, on the western boundary of the landfill.
- 4.21. Other livestock farms are found dispersed in the survey area. These include two pig farms along the southern part of Triq it-Torri ta' l-Ghallis, a small cluster of farms at the end of Triq l-Irziezet, rabbit farms and mixed livestock farms along Triq il-Kappella ta' Santa Marija, and a rabbit farm along Trejjet il-Kampanjol.

Figure 4.5: Livestock farms



Residential

- 4.22. The largest settlements within the survey area are Bahar ic-Caghaq and Salini. Bahar ic-Caghaq is located to the southeast of the Scheme site, and crosses the boundary of the survey area. The strictly residential zone comprises a mix of detached dwellings and apartments, see **Figure 4.6**.

Figure 4.6: Bahar ic-Caghaq



- 4.23. Salini is located on the opposite side of Bahar ic-Caghaq, to the west of the Scheme site, see **Figure 4.7**. The settlement is split in two, divided by a stretch of degraded land. The southern part of Salini consists of a mix of apartments, terraced houses and a small number of detached dwellings. There are three restaurants in this area namely Trattoria Fiorino d'Oro, Charlie's Inn and Ta' Cassia Salina Restaurant. A chapel dedicated to Annunciation of the Virgin is located here. Across the road to the east of the chapel lie a series of catacombs, see **Figure 4.7**. A small concentration of dwellings lies along Triq il-Katakombi on the way to the farm complex at Il-Hodba il-Bajda.

Figure 4.7: Salini



- 4.24. The northern part of Salini mainly comprises apartments. A military redoubt and two fougasses are found in the vicinity. The Coastline Hotel abuts the northern boundary of Salini. To the south of the hotel are a small number of abandoned dwellings.
- 4.25. The Maghtab rural settlement area is a dispersed linear settlement focused mainly along Triq il-Kappella ta' Santa Marija and Triq ir-Ramla. Dwelling types include terraced houses, villas and restored farmhouses. Some of the residences are large enough to include stables or swimming pools. Other residences (mainly converted farmhouses) are located on rural roads (such as Sqaq il-Qbiela, Sqaq Brimbu and Triq il-Maghtab) off the main roads just mentioned, see **Figure 4.8**. A chapel dedicated to the Assumption of the Virgin is found on Triq il-Kappella ta' Santa Marija.

Figure 4.8: Rural settlements



Industrial

- 4.26. A small number of industrial activities occur within the survey area. These mainly relate to the parking of heavy vehicles and machinery in fields, truck repair at Sqaq Habel Zwejra, a food production factory at Triq il-Kappella ta' Santa Marija and facilities for a construction contractor, see **Figure 4.9**. The latter facilities are split on two sites. The first site located at Triq ir-Ramla has a batching plant and is also

used to store heavy plant. The second site (accessible through a track off Sqaq Habel Zwejra) is a storage site for construction materials.

Figure 4.9: Industrial land uses



Other

- 4.27. The Magtab Shooting Club is found north of Triq ir-Ramla, around 200m to the southeast of the Scheme site. The Ta' Hammut Dolmens are also located in this area.

SCHEME DESCRIPTION

- 4.28. In March 2010 WSM submitted a Project Description Statement (PDS)³ that included a number of changes to the original master plan as approved in PA 4834/04 and included the installation of a Mechanical Biological Treatment Plant. The proposed development comprises the following elements as described in the PDS:

- Extension of Zwejra cell 1;
- Extension of Zwejra Cell 3;
- Closure plan for Ta' Zwejra;
- Construction of a service road along western perimeter;
- Sanctioning of the extension of the temporary Ghallis Site office;
- Extension of the northern bund and the Ghallis engineered landfill;
- Setting up of a fence;
- Re-orientation of hazardous cell;
- Introduction of photo voltaics and micro wind turbines;

³ WasteServ Malta Ltd, 2010, Project Description Statement PA02342/06 May 2009 (Revised March 2010)

- Introduction of a bulky storage refuse area (non-hazardous waste storage);
 - Introduction of an engineered separator between Maghtab and Ghallis;
 - Re-location of wheel wash;
 - Embellishment scheme;
 - Introduction of a bridle path for equestrian activities;
 - The establishment of a pre-landfilling Mechanical Treatment Plant (MTP); and
 - The establishment of a Biological Treatment Plant.
- 4.29. Most of the individual elements listed above do not warrant the update of the EIS, however the construction of the Mechanical Treatment Plant and the Biological Treatment Plant do. For this reason, this EIS Update focuses on these two facilities.
- 4.30. It is noted that the following works have already been carried out by WasteServ:
- Extension of Zwejra Cell 1;
 - Extension of Zwejra Cell 3;
 - Construction of a service road along western perimeter;
 - Sanctioning of the extension of the temporary Ghallis Site office;
 - Extension of the northern bund and the Ghallis engineered landfill;
 - Setting up of a fence;
 - Re-orientation of hazardous cell;
 - Introduction of an engineered separator between Maghtab and Ghallis;
 - Re-location of wheel wash; and
 - Embellishment scheme.
- 4.31. In addition, WasteServ are also constructing a store for low level radioactive waste. This store is being included in the EIS Update, in particular in the risk assessment described in **Chapter 13**.

Extension of Zwejra Cells 1 & 3

Background

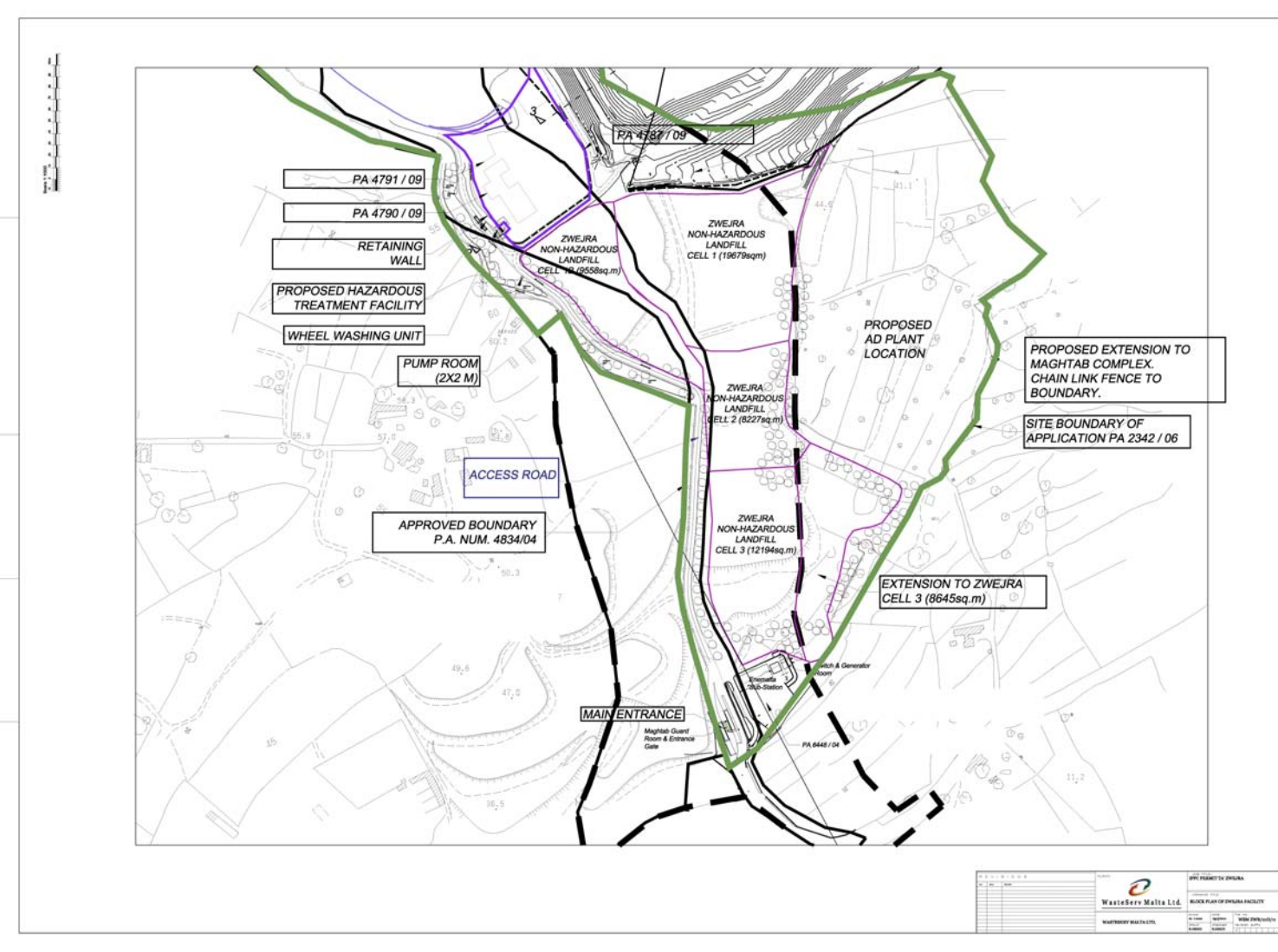
- 4.32. The Zwejra facility was developed in phases consisting of four hydraulically independent cells. All the cells were built as typical, standard design fully contained engineered landfill on the basis of international standards and the requirements of Directive 1999/31/EC on the landfill of waste as transposed by Legal Notice 168 of 2002 Waste Management (Landfill) Regulations.

- 4.33. The engineering specifications for this facility have been derived from the results of hydrogeological, landfill gas and stability risk assessments ensure compliance with the requirements of the Waste Management (Landfill) Regulations, 2002. Construction Quality Assurance reports were prepared during the construction of each phase. These reports are available as part of the IPPC Application.
- 4.34. The facility commenced operations in May 2004 and received non-hazardous wastes over a period of some 34 months in an area measuring approximately 58,300 m². The facility still has a void of approximately 28,688 m³. This will be utilised for the deposit of municipal solid waste (EWC 20 03 01) by October 2012.

Extensions

- 4.35. The extension of the Ta' Zwejra facility includes the creation of a new cell in an area along Ta' Zwejra Cell 1 to attain stabilisation of this first cell. At the same time this extension provided space for the deposit of non-hazardous waste until the first phase of the Ghallis landfill was completed and ready for use. A similar extension was created alongside Ta' Zwejra Cell 3 for the same reasons.
- 4.36. The main aim behind the extension was to achieve the required slope angles to ensure stability of Cells 1 and 3 of the Ta' Zwejra landfill. This was achieved by a reduction in the slope gradients of Ta' Zwejra. This development was carried out on already disturbed land adjacent to the existing Ta' Zwejra engineered cells. The extensions provided additional capacity for waste disposal, which was required in the interim period during which construction works on the first phase of the Ghallis engineered landfill were completed.
- 4.37. The extension to Cell 1 has an area of approximately 9,558 m² whilst the extension to Cell 3 covers an additional area of 8,645 m² (see **Figure 4.10**).
- 4.38. Both extensions were built as typical, standard design fully contained engineered landfill on the basis of international standards and the requirements of Directive 1999/31/EC on the landfill of waste as transposed by Legal Notice 168 of 2002 Waste Management (Landfill) Regulations. Construction Quality Assurance reports were prepared during the construction of each phase.

Figure 4.10: Block plan indicating areas of Ta' Zwejra cells



Closure of Ta' Zwejra landfill

4.39. The closure of the Ta'Zwejra waste management facility will take place gradually in phases for each of the three cells. The main phases in closure and installation of the gas recovery system will include:

- Re-contouring / terracing;
- Capping;
- Installation of gas recovery system;
- Restoration; and
- After care/maintenance.

Capping

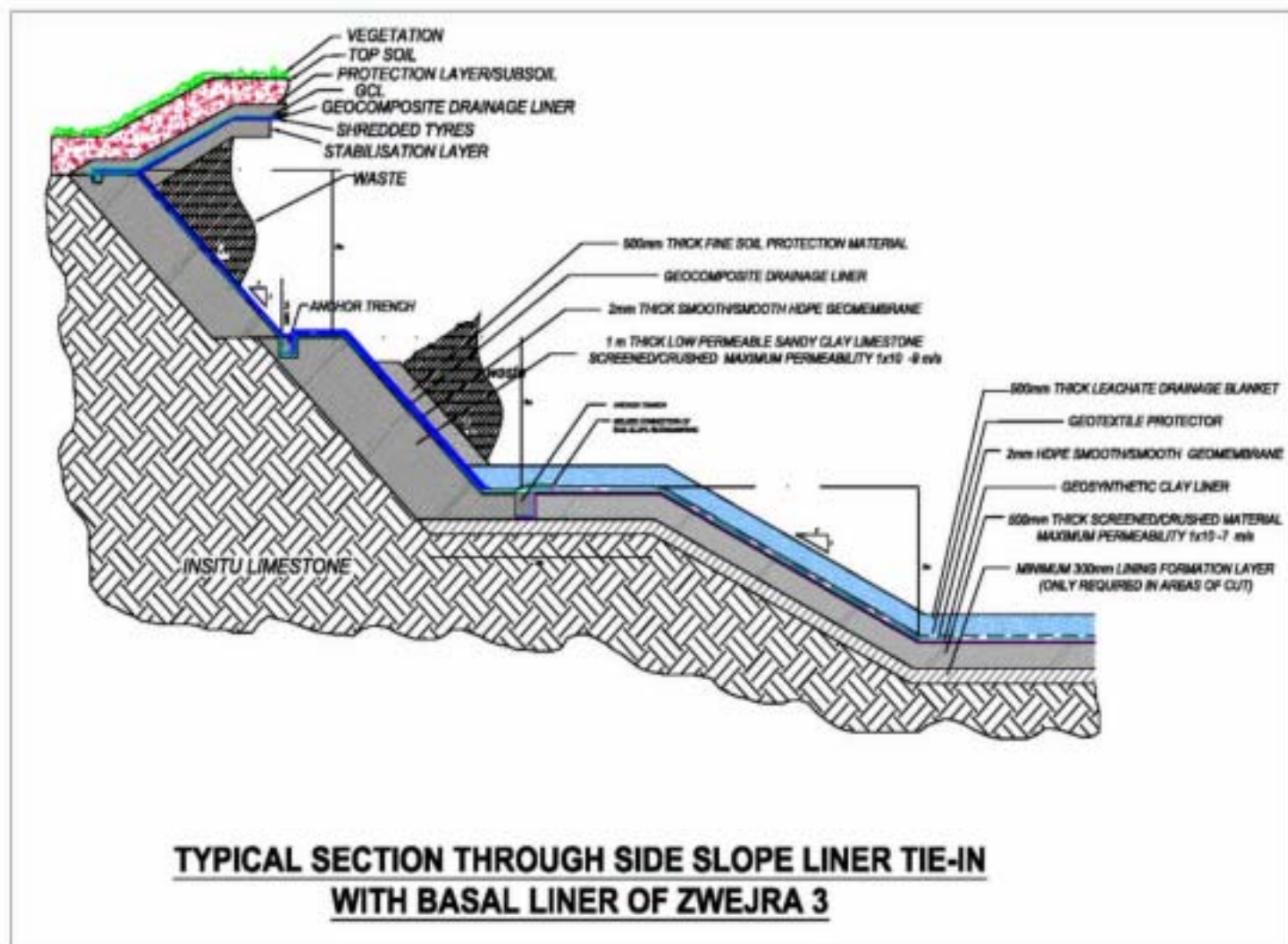
4.40. A number of alternatives were considered prior to selection of the option presented here that includes the use of geosynthetics. The selected option was chosen on the basis that it is considered the most suitable to the local climate, which, on account of its aridity does not promote the formation of leachate. Another consideration is that there are few areas on site with steep slopes. The use of geosynthetics offers a relatively economical and practical solution for landfill capping. The chosen option consists of a composite, versatile lining system, which will include other functions as to provide a low permeability barrier and physical isolation of waste from the environment.

4.41. The system will comprise (from bottom to top):

- 300mm stabilisation layer locally sourced inert material;
- 250nm complementary gas drainage layer (shredded tyres);
- Drainage geocomposite (connected to gas collection pipes);
- Geosynthetic clay liner (GCL);
- 300mm protection later coarse soil/limestone fines;
- 1000mm of final layer of top soil; and
- Vegetation supported by irrigation system.

4.42. The lining system technical design is illustrated in **Figure 4.11**.

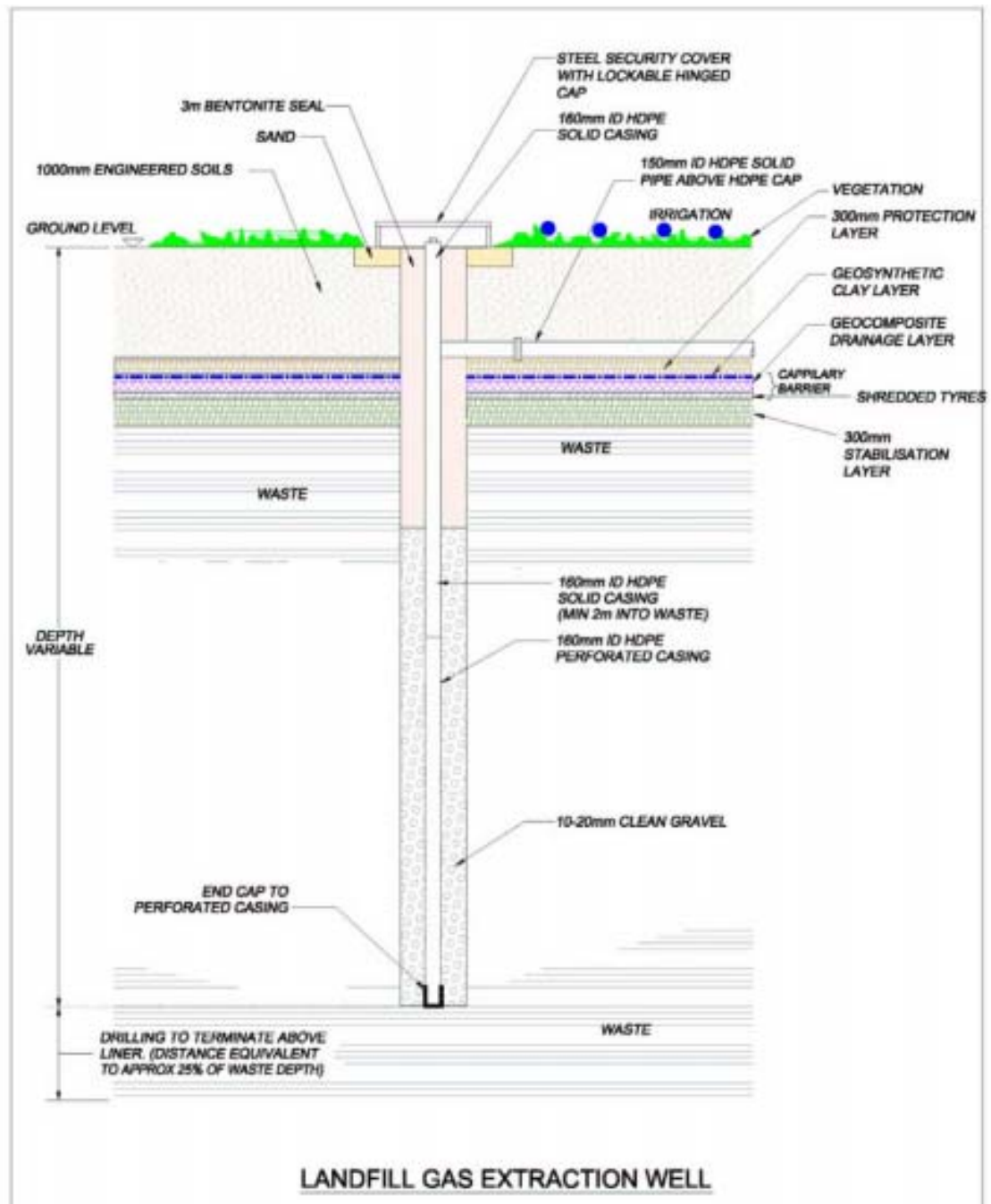
Figure 4.11: Section through side slope liner



Gas extraction system

- 4.43. The gas extraction system will consist of the following activities:
- The installation of approximately 13 drilled gas wells;
 - The installation of wellheads onto the gas wells;
 - The installation of manifolds to connect the gas wells to the gas mains;
 - The installation of condensate drain legs in the gas mains; and
 - The installation of the first part of the gas ring mains in MDPE connecting the manifolds to the gas plant.
- 4.44. The chosen system follows the design principles of the aerial emissions control project installed at Maghtab whereby a landfill gas capture system will be installed including sealed landfill gas wells and chambers connected to headers and pipework. Landfill gas will be combusted. The gas capture system will be connected to the gas treatment system on completion of infilling of each area.
- 4.45. The advantages of installing a gas recovery system include:
- Reduction of greenhouse gas emissions by transforming methane into CO₂ (and potentially using the gas to generate electricity);
 - Reduced risk of explosions and fires;
 - Reduction in odour; and
 - Faster waste stabilisation and provision of after use alternatives for the reclaimed land.
- 4.46. **Figure 4.12** illustrates a typical landfill gas extraction well.

Figure 4.12: Landfill gas extraction well



After use

- 4.47. The site will eventually be fully rehabilitated and will involve re-contouring, placement of soil and landscape planting.

Extension of the Northern Bund to the Ghallis Engineered Landfill

- 4.48. An extension to the Northern Bund of the Ghallis Engineered Landfill involved rock excavation and stockpiling of the excavated material intended for reuse (either through sale of material or reuse on site). The extension area is illustrated in **Figure 4.13** with sections presented in **Figure 4.14**.

Figure 4.13: Block plan illustrating extension area and area for planting

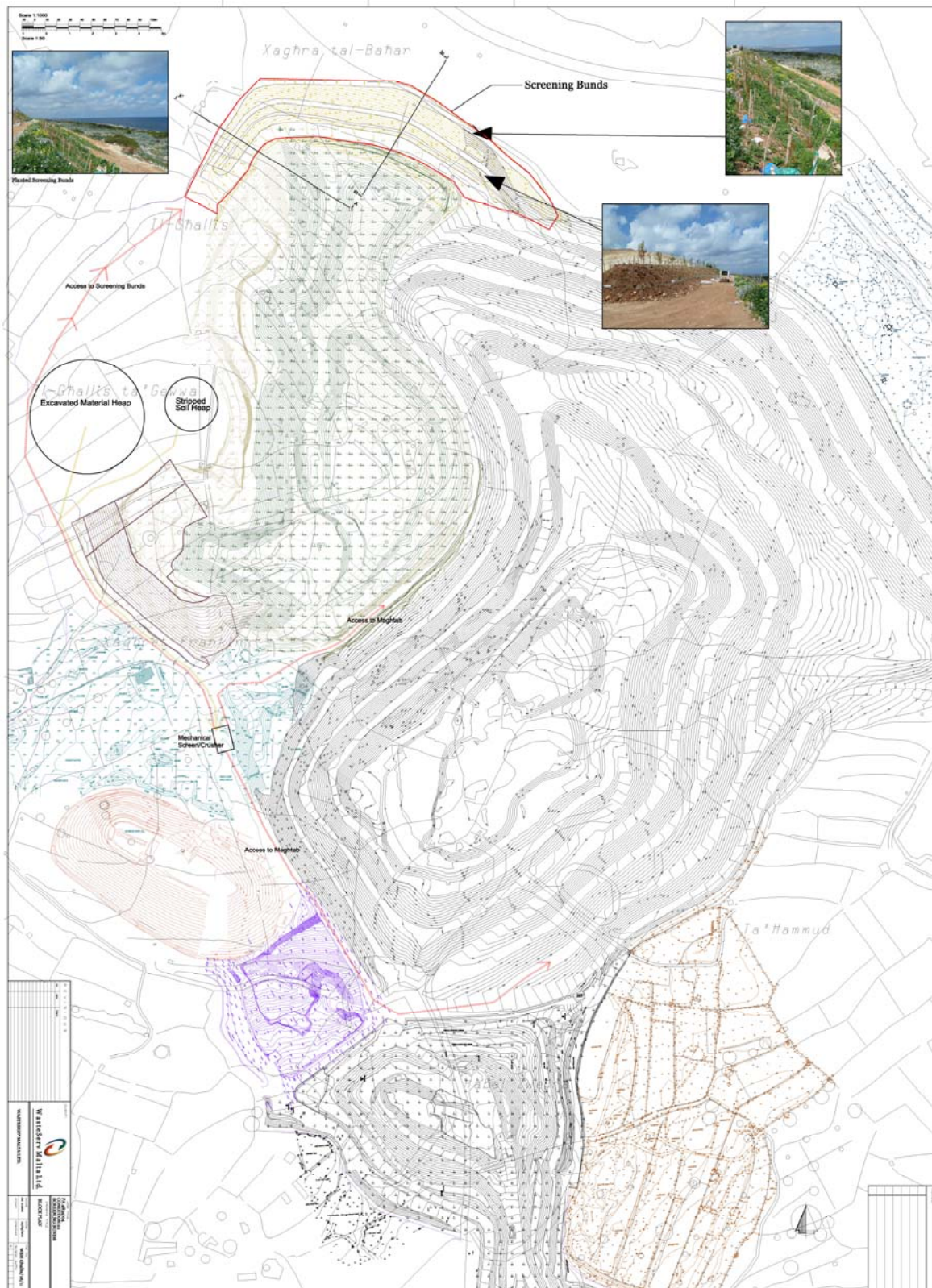
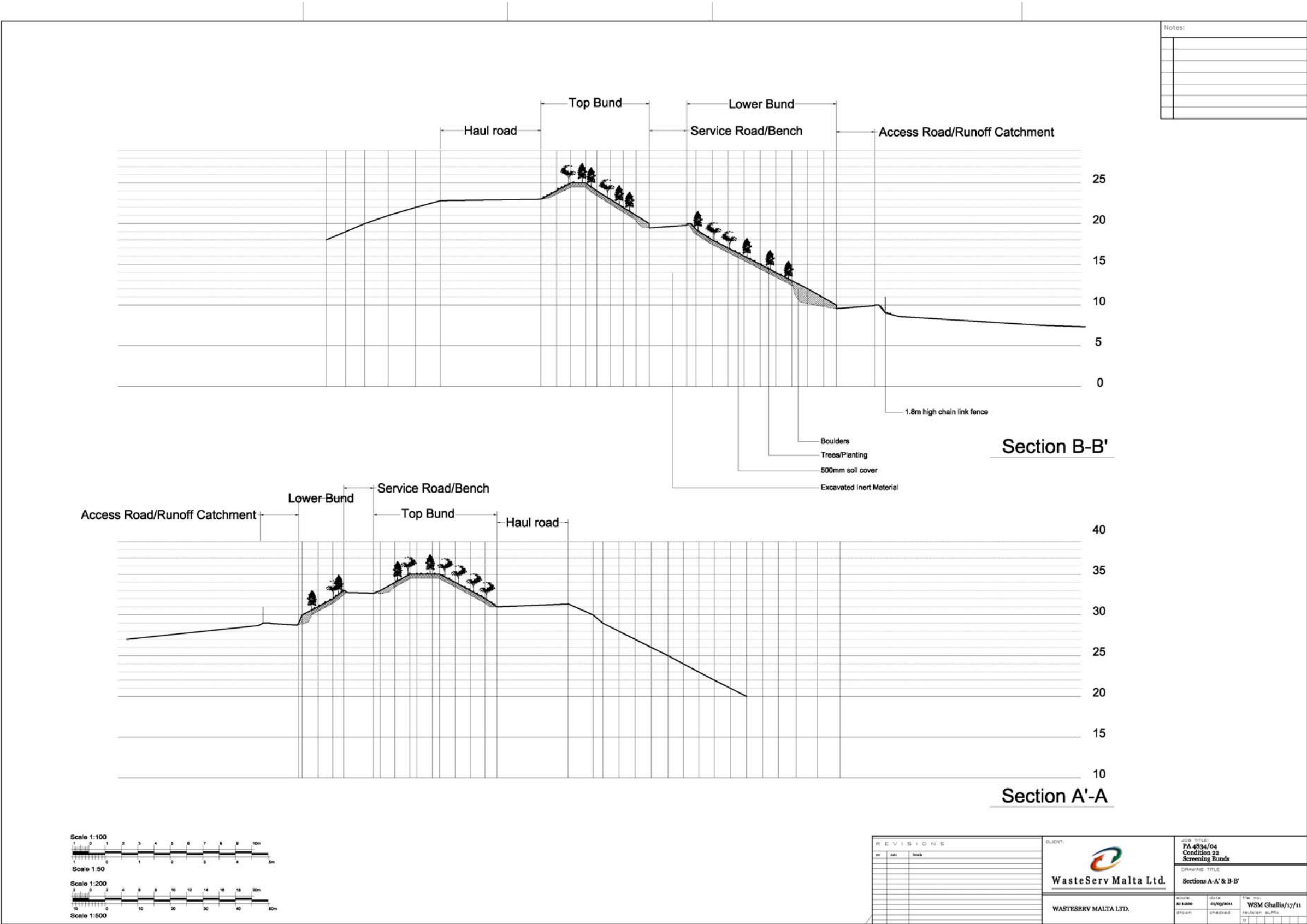


Figure 4.14: Sections through Ghallis mound



Radioactive store

- 4.49. The hazardous landfill operation is described in the 2005 EIS⁴. In addition to the components described, a radioactive store is to be added to the hazardous landfill facility. This store will accept low level radioactive waste. **Figure 4.15 to Figure 4.18** provide plans of the proposed store.

⁴ SLR, AIS Environmental, 2005 Environmental Impact Statement for a Waste Management Facility at Ghallis Ta' Gewwa, Naxxar

SECTION B-B
SCALE 1/10

SECTION A-A
SCALE 1/10

Wasteber Maltis Ltd.
Wasteber Maltis Ltd.
Wasteber Maltis Ltd.

The architectural drawings include:

- BASEMENT PLAN** (SCALE 1:50): Shows the layout of the basement level, including a Lift Room and Utility Rm. Red arrows indicate airflow paths.
- GROUND FLOOR PLAN** (SCALE 1:50): Shows the layout of the ground floor, including a Store, Prep. Area, and Lift Room. Red arrows indicate airflow paths.
- SECTION - Passive Ventilation System** (SCALE 1:50): A cross-section drawing showing the passive ventilation system, including the roof and walls.
- ROOF PLAN** (SCALE 1:50): Shows the layout of the roof, including the ventilation system components.

The drawings are part of a project for the construction of a low-level radioactive storage facility, as indicated by the title block.

Figure 4.17: Elevations of radioactive storage facility

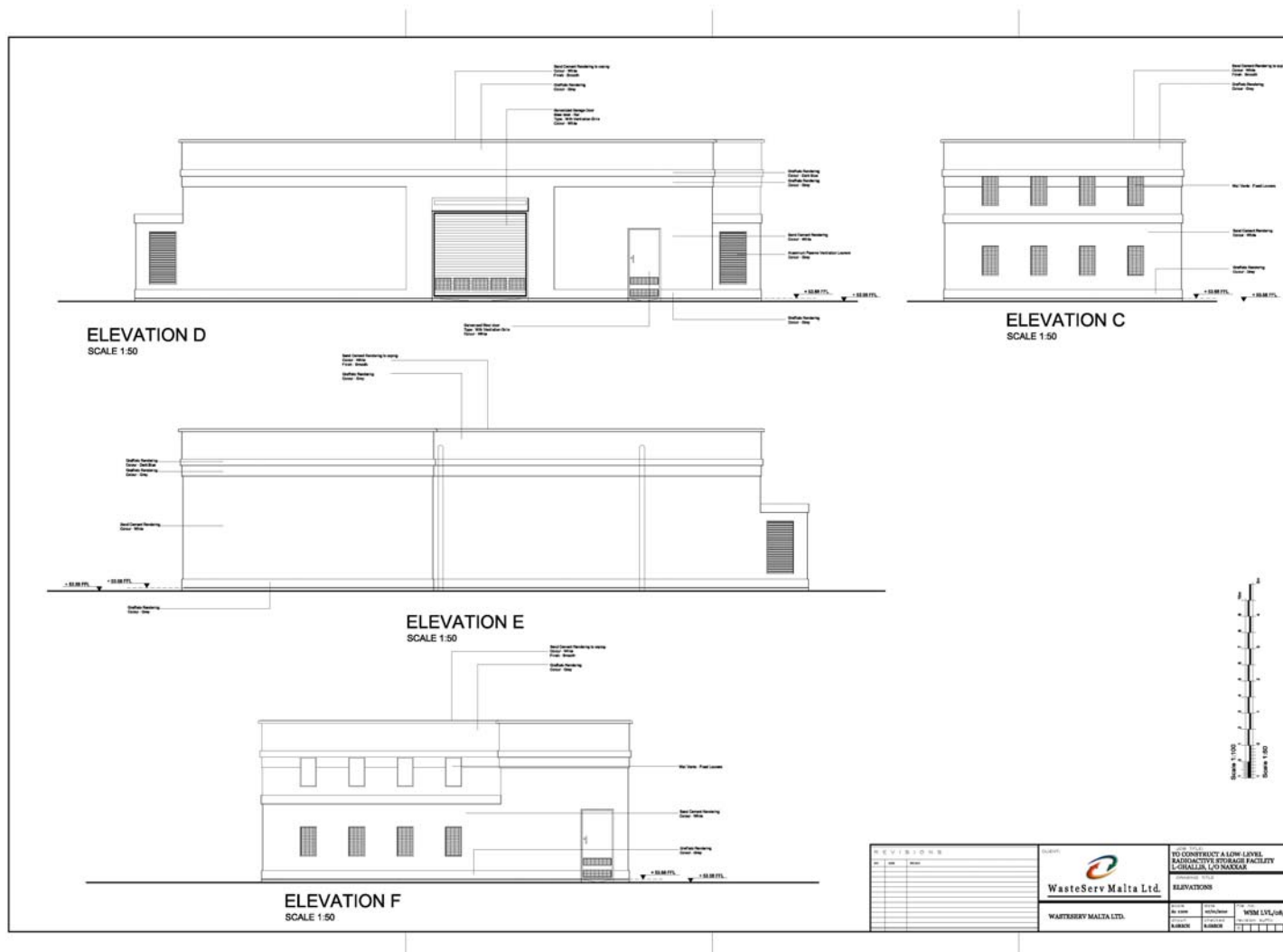
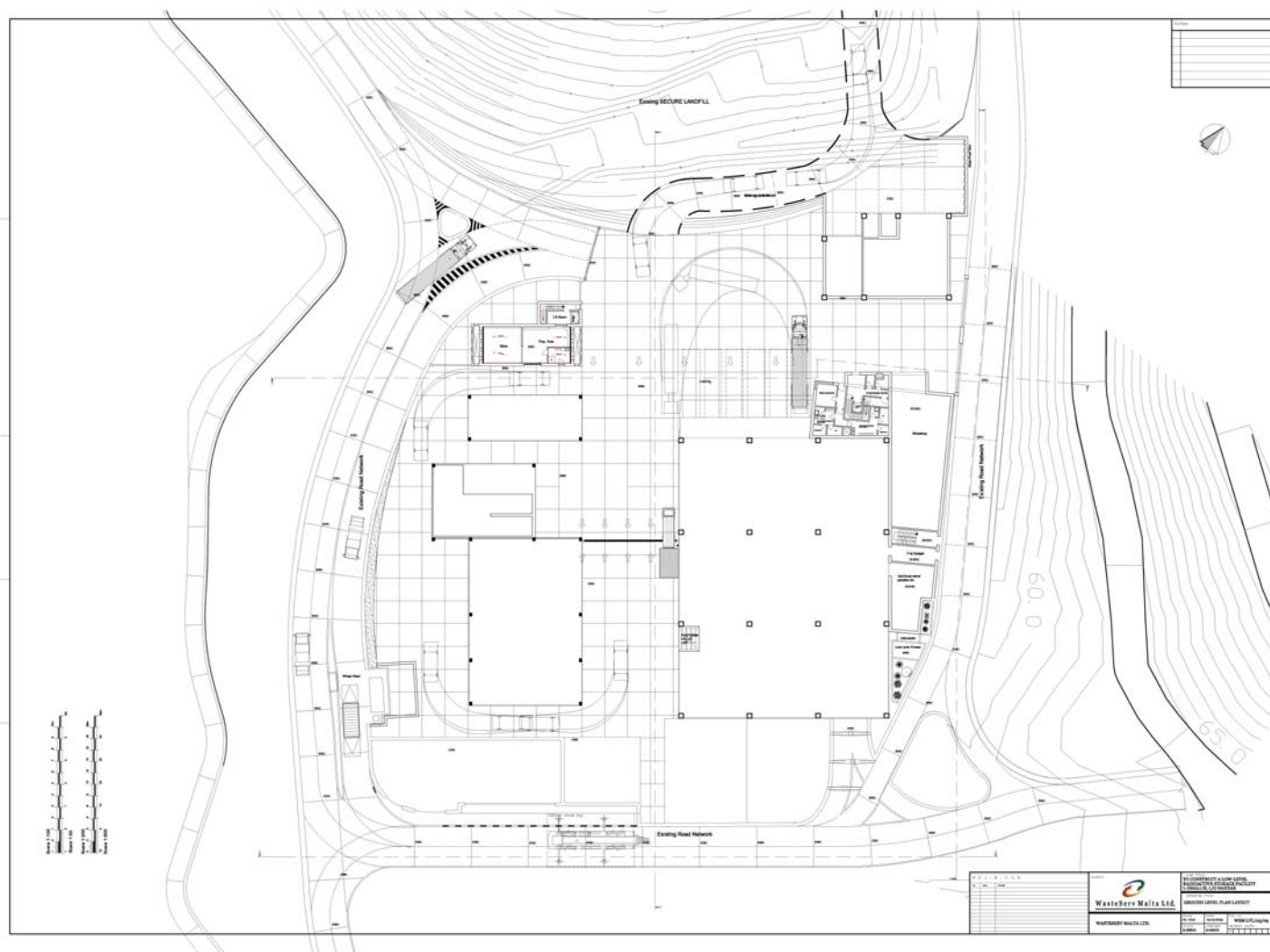


Figure 4.18: Ground floor layout of radioactive storage facility



Mechanical and Biological Treatment Plant

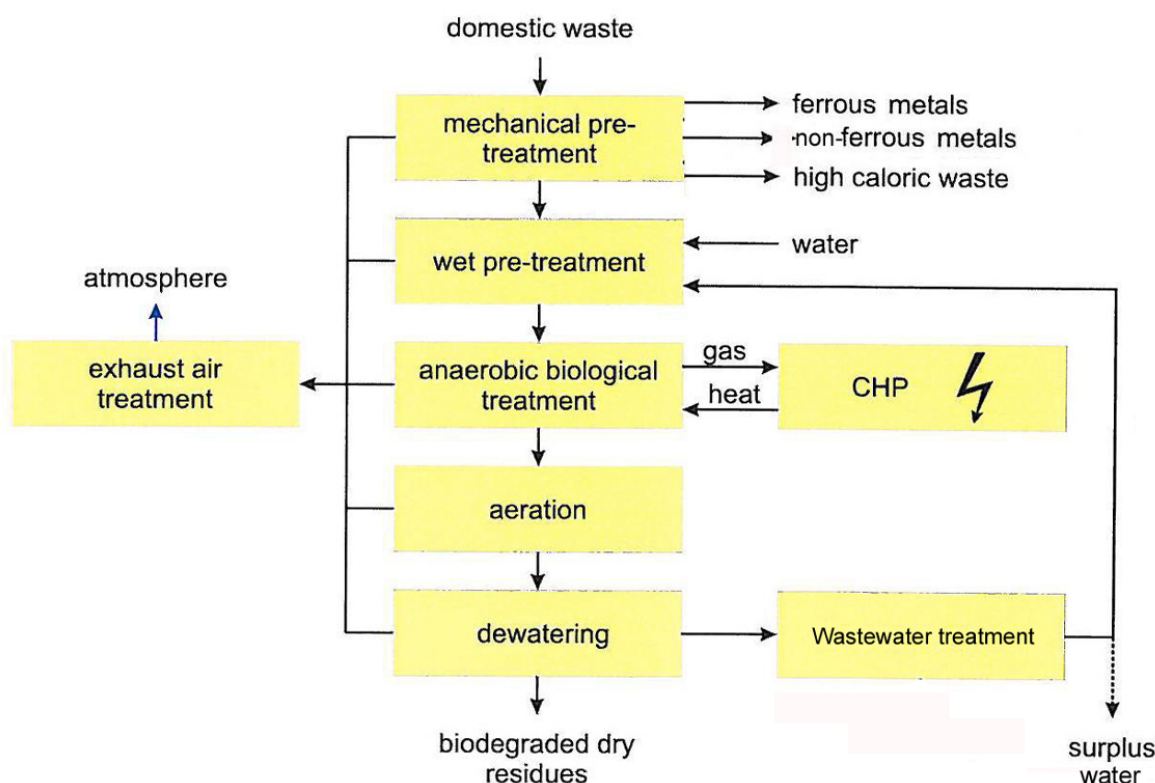
- 4.50. The project comprises mechanical and biological processes (MBT), including anaerobic digestion (AD). The plant has been designed to recover recyclables (i. e. metals), produce RDF (Refuse Derived Fuel) materials, recover energy from the Combined Heat and Power (CHP) plant fuelled by the biogas and produce a refined digestate for end use. A biogas CHP plant is included to maximise energy recovery. Electricity is exported to the grid whilst waste heat from the exhaust systems is used within the process.
- 4.51. The MBT plant will be built at two different locations. The dry and wet pre-treatment facility will be installed on the west of the site while the facility for the biological treatment will be built on east as shown in **Figure 4.19**.
- 4.52. In summary, it is proposed that the MBT and AD facilities will include:
- Access road and paved area on the site for heavy trucks and for storage of containers etc;
 - Reception including weighbridge and electronic registration system of in and out going loads;
 - Mechanical sorting plant for mixed waste including vibrating screen, ballistic separation, near infrared separator and magnetic separator techniques sorting the waste in three fractions, a biowaste, a RDF (refuse derived fuel) and a remaining fraction, which will go to landfill;
 - Wet mechanical treatment of biowaste the fine organic fraction from the household waste line for anaerobic processing;
 - Reception facility for liquid and solid manure from livestock farmers;
 - Pre-storage and pre-treatment of manure for anaerobic processing;
 - Digestion facility for biowaste including heating, pumping and mixing of the feed material for the digestion;
 - Digestion facility for manure including heating, pumping and mixing of the feed material for the digestion;
 - Storage of digestate for solid/liquid separation and after treatment;
 - Solid/liquid separation of the digestate from the two digestion lines;
 - After-treatment of the solid part from the solid/liquid separation in a closed composting system with full control of the airflows;
 - Storage of end products;
 - Water treatment comprising sequential batch reactor (SBR), water storage tank; second stage water treatment by reverse osmosis plant (RO) and vacuum evaporation unit;

- Cooling and dehumidification for the biogas;
- Gas booster station;
- Biogas balancing to allow production of electricity;
- Motor-generator unit for production of electricity from biogas;
- Gas flare and quality management system including gas flare;
- Recovery system for surplus heat and storage for heat to be used in processing plant;
- Transformer with a capacity to supply the treatment facility with the necessary power for operation and allowing sale of the power produced to the grid;
- Treatment for odour of ventilation air, surplus air from composting and from treatment of liquid end products;
- A chimney for discharge of the treated air;
- Compaction/baling of RDF fraction of waste and loading into containers for transport for incineration or disposal to landfill;
- Control room;
- Laboratory;
- Staff facilities including washrooms and bathrooms, canteen, etc;
- Two reservoirs for storage of run-off for the purpose of dust control, irrigation and for fire fighting purposes will be constructed at the MTP facility. An underground rainwater reservoir will also be constructed at the AD plant; and
- Vehicle washing facilities. It is anticipated that they will comprise a separate external wash down area, an automatic drive through wash and a wheel wash.

General plant concept

- 4.53. The Mechanical and Biological Treatment (MBT) facility is designed to accept and process 147,000 tonnes of Municipal Solid Waste (household and bulky waste) per annum. The split of incoming feedstock will be as follows:
- 100,000 tpa of household residue waste; and
 - 47,000 tpa of bulky waste.
- 4.54. The mechanical biological waste treatment plant described is a combination of mechanical sorting and a wet anaerobic digestion as shown in **Figure 4.20**.

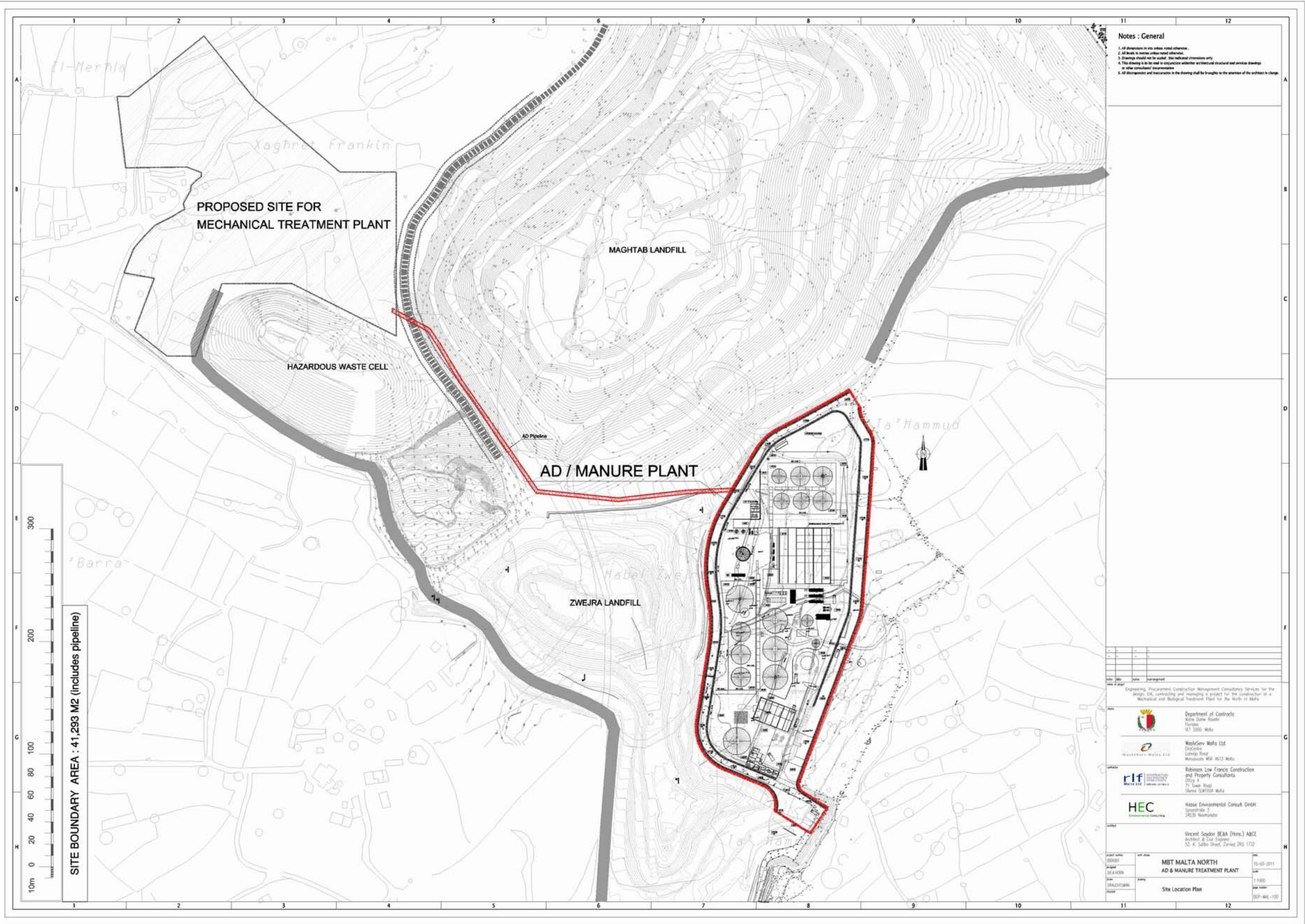
Figure 4.19: Block diagram of the MBT plant for domestic waste



- 4.55. In the mechanical pre-treatment plant the waste will be separated in several waste streams to enable specific recycling or disposal. By separating metals and high caloric waste, a substantial amount of residual waste will be used for material recovery and energy production.
- 4.56. In this stage, the organic fine fraction for the anaerobic digestion stage will also be separated from the incoming household waste stream.
- 4.57. By the integration of a digestion stage, emissions will be minimised and in addition biogas will be produced. This biogas will be transformed into electrical energy and heat with a combined heat and power plant (CHP).
- 4.58. Process water resulting from the dewatering process of the digestion product, will be used for slurring the organic waste fraction before digestion takes place. Surplus water will be treated together with the liquor from digested manure to meet the discharge limits.
- 4.59. The exhaust air is cleaned by means of acid scrubbing and biofilter systems which provide odour control.
- 4.60. The MBT plant will be erected over two separate sites. Waste reception as well as mechanical and wet pre-treatment will be located at the mechanical separation site. The biological treatment process will be located at the planned site for the Biogas Plant to optimise the use of biogas and the digestate handling as well as the waste

water treatment. **Figure 4.20** shows the location of the mechanical treatment and biological treatment facilities.

Figure 4.20: Location of mechanical and biological treatment facilities within the site



Process description

- 4.61. The following sections describe in detail the process for the treatment of household and bulky waste.

Waste reception

- 4.62. Municipal waste and bulky waste will be delivered by lorries into the waste reception hall and stored on the slab.
- 4.63. The hall will provide storage capacity for approximately 1.5 days. The storage of waste should be restricted to a minimum time frame to prevent odour problems caused by decomposition.
- 4.64. A visual control of waste quality will take place before loading the waste into the bag opener or bulky shredder.
- 4.65. Examples of unsuitable materials that may be rejected to prevent damage or performance degradation of the Process Plant are:
- Concrete blocks, bricks, etc;
 - Engine blocks, gear boxes;
 - Large metal units, steel plates, steel girders, metal blocks, etc;
 - Chemicals, paint and varnish;
 - Explosive or dangerous material;
 - Vehicle tyres;
 - Automotive batteries;
 - Electric cables;
 - Hoses;
 - Mattresses, springs etc; and
 - Carpets.
- 4.66. Materials that could wrap upon the axles of the shredder's cutting table should not be fed into the pre-shredder, any such materials entering the shredder must be removed at regular intervals.
- 4.67. Oversize and other reject materials are removed by means of a grab crane or wheel loader. It is assumed that such materials will make up approximately 3 - 5% of the total input waste. Rejected materials will be loaded in separate containers and disposed of.
- 4.68. The pre-sorted bulky waste will also be fed by a mobile tulip grab or wheel loader into the shredder.

- 4.69. Unsuitable material or waste mostly including construction material will be taken off before the shredder. These materials will be loaded in separate containers and disposed of at landfill.

Air curtains

- 4.70. Each of the 5m wide x 8m high doors to the reception hall has an air curtain mounted either side of the opening.
- 4.71. Each air curtain has 4 sections and each section has 3 fans, therefore, for each door there are 12 fans each side of the door. As a result, individual motor failures will not significantly impact the curtain performance.

Dry mechanical pre-treatment

- 4.72. The mechanical pre-treatment of waste is the first step of the process plant. This treatment step will separate the main fractions of the household waste into recyclable, usable or non-recyclable waste streams. The recyclable waste streams are composed of the RDF fraction and both ferrous and non-ferrous metals. The usable waste stream is the biological or fine fraction which is optimised for use in the AD process.
- 4.73. The following objectives are achieved using mechanical treatment:
- Production of a mainly fine fraction optimised for the following digestion process; and
 - The separation of different waste fractions for recycling (e.g. metals, RDF).

Material input

- 4.74. Two waste charging lines will be installed, one line for household waste and a separate line for bulky waste.
- 4.75. The pre-sorted household waste will be fed by mobile tulip grab crane or wheel loader into the bag opener.
- 4.76. A mobile tulip grab and a wheel loader feeds the pre-sorted bulky waste to the pre-shredder of the bulky line.

Mechanical treatment of household waste

- 4.77. The mechanical treatment line for household waste includes the following components:
- Bag opener;
 - Magnetic separator;
 - Drum screen;
 - Star screen;

- Ballistic separation;
- Near infrared separation (NIR);
- Magnetic separators;
- Separator for non-ferrous metal; and
- Second near infrared separator.

Bag opener

- 4.78. At this stage, bags are opened, reject material can be detected and removed, and the flow of material will be batched.
- 4.79. The total amount of the material will be processed within a two-stage screening.

Magnetic separator

- 4.80. The waste fraction will be processed by a magnetic separator before entering the drum screen.
- 4.81. The over-belt magnetic separator will be installed in transport direction.
- 4.82. The recovered iron-containing material will be conveyed to a storage container.

Drum screen

- 4.83. The drum screen allows the production of two fractions, which are the separation of input material with a size of <150mm and >150 mm. The screen overflow will contain mainly material of high calorific value and will be baled.

Star screen

- 4.84. Fractions with a size of <150mm will be separated by a second screen. This star screen enables the separation into two fractions providing sizes of <40mm and 40 - 150mm. One advantage of star screens compared to drum screens is the effective separation of long parts which could cause disturbance in the down-stream process (e.g. twigs or similar).
- 4.85. The fines will be separated from ferrous and non-ferrous material, e.g. aluminium. The remaining flow of material <40mm will be processed within the biological treatment (AD). The flow of material may also be delivered to containers (when the wet pre-treatment should be out of operation).
- 4.86. The star screen overflow (40/150mm) will be delivered to heavy / light separation.

Ballistic separation

- 4.87. The ballistic separation of fractions with size of 40/150mm will be done by a belt air classifier.

- 4.88. The air separation results in the production of two materials streams. At this stage, the material will be divided into light fraction material and into a solid material fraction.
- 4.89. The light fraction includes tenacious and flexible materials, e.g. textiles, foils and paper. The solid fraction includes solid and dense parts, such as stones, cans, bottles, timber, metals and solid plastics.

Near infrared separation

- 4.90. The solid fraction resulting will be delivered to a separator that provides near infrared technology. During this separation process, most of the plastic material, paper, cardboard, wood and textiles will be detected by optical sorting and will then be removed by means of compressed air.
- 4.91. A bale press will be provided to reduce the RDF volume which has to be stored.

Magnetic separators

- 4.92. The fine fraction < 40mm and the residues resulting from NIR separation will be processed by magnetic separators.
- 4.93. Over-belt magnetic separators are installed in transport direction and above the driving pulleys of the conveying belts.
- 4.94. The recovered iron-containing material will be conveyed to a storage container. Inside the container, the material is distributed by means of a shuttle conveyor (moveable conveyor).

Separator for non-ferrous material

- 4.95. Non-ferrous materials e.g. aluminium will be separated from the materials stream and will then be discharged into a container.

Second near infrared separation

- 4.96. An additional optical sorter is placed on the heavy path to landfill. This diverts approximately 50% of the organic material still included in this line to the AD process.
- 4.97. A shredder is installed to reduce the size to <40 mm before the material is brought to the conveyor in front of the mixers.

Mechanical treatment of bulky waste

- 4.98. The mechanical treatment of bulky waste is only targeted on coarse size reduction and separation of ferrous metals. The mechanical treatment line for bulky waste includes the following components:
- Pre-shredder;
 - Vibrating screen;

- Ballistic separation;
- Near infrared separation; and
- Magnetic separator.

Pre-shredder

- 4.99. The first step of bulky waste treatment is the coarse size reduction by means of a pre-shredder.

Vibrating screen

- 4.100. Because the throughput of the bulky waste line is less than the one of the household treatment line the screening will be done by a vibrating screen. This allows also the production of three fractions: the separation of input material with a size of <30mm, 30 – 150mm and the screen overflow >150mm. The overflow will be discharged to a ballistic separator.
- 4.101. The vibrating screen separates effectively the fine material <30 mm of the input, mainly containing inert material. The separation of fines will improve the RDF quality.

Ballistic separation

- 4.102. The ballistic separation of fractions with size of >150mm will be done by a belt air classifier.
- 4.103. The air separation results in the production of two materials streams. At this stage, the material will be divided into light fraction material and into a solid material fraction.
- 4.104. The light fraction is conveyed to a press container station for RDF material.

Near infrared separation

- 4.105. The solid fraction resulting from the ballistic separation and the fraction 30 – 150mm will be delivered to a separator that provides near infrared technology. During this separation process, most of the plastic material, paper, cardboard, wood and textiles will be detected by optical sorting and will then be removed by means of compressed air.
- 4.106. The separated RDF material will also be pressed in containers.

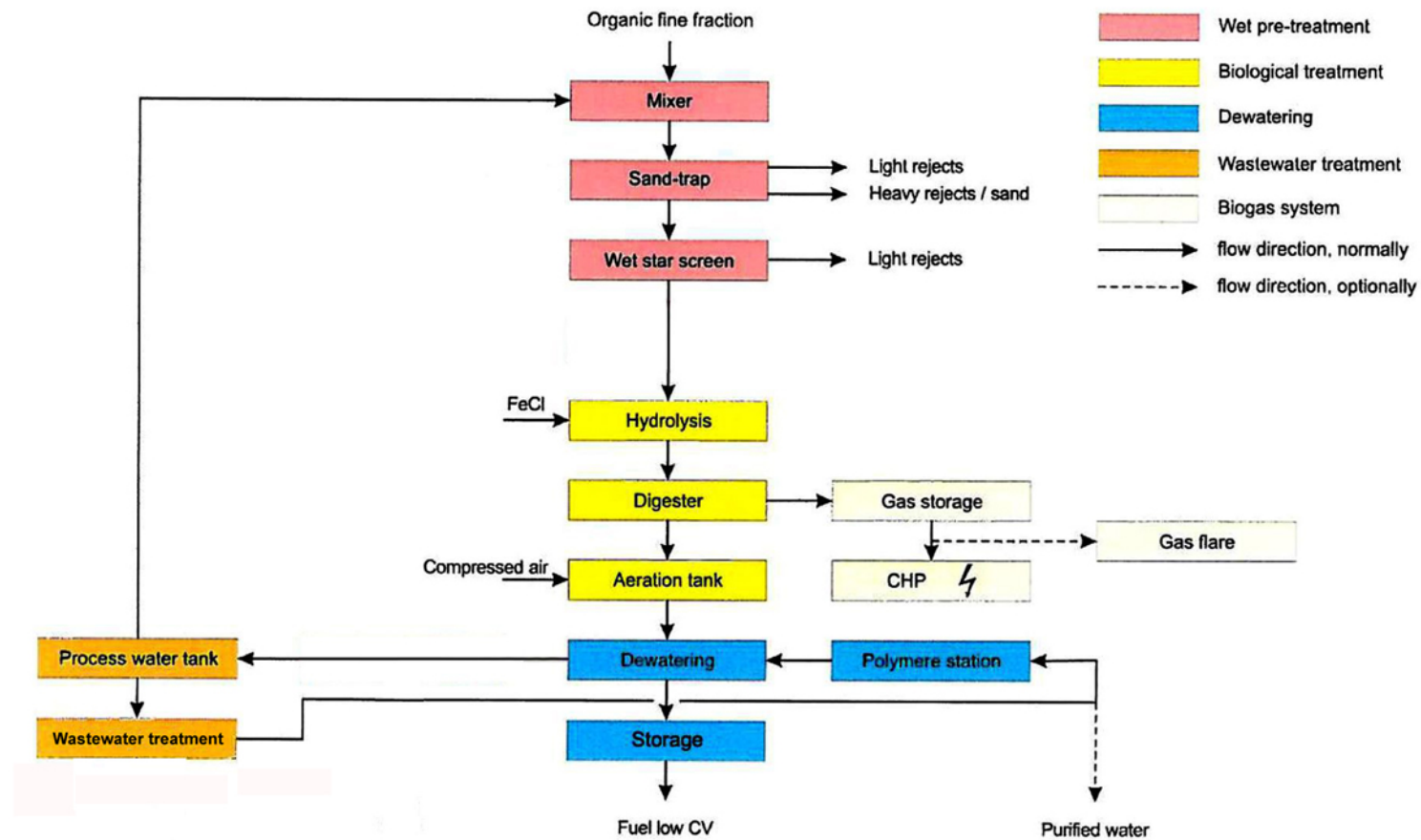
Magnetic separator

- 4.107. The remaining fraction will pass a magnetic separator. Iron-containing material will be removed by an over-belt magnetic separator.
- 4.108. The residues will be loaded / pressed into containers and will be landfilled.

Wet mechanical treatment

- 4.109. The fine grain fraction from the household waste line, with a grain size that is less than 40mm is transported out of the mechanical pre-treatment area to the wet mechanical treatment area.
- 4.110. Here the waste fraction is mixed to a pumpable suspension with process water. Reject heavy and light-density materials are removed.
- 4.111. All treatment steps referring to the fine organic fraction (<40mm), including wet pre-treatment, anaerobic digestion, dewatering, wastewater treatment and the biogas system, are illustrated in **Figure 4.21**

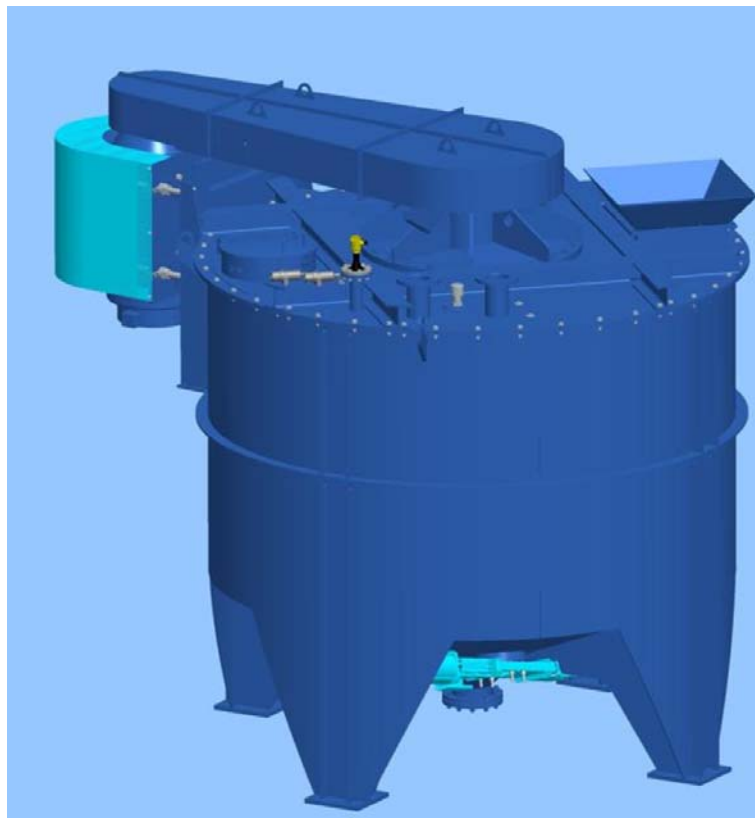
Figure 4.21:Block diagram of organic fine fraction treatment



Mixers

- 4.112. The organic fine fraction with a grain size of <40mm, produced from input waste in the mechanical pre-treatment stage, is largely free from interfering materials and is transported to the mixers via a series of conveyors/screws.
- 4.113. Each mixer operates on a batch process. The material that arrives continuously from the mechanical pre-treatment is distributed alternately to the different mixers.
- 4.114. The organic fine fraction becomes a biological waste suspension with solid matter content (SM) of approximately 10 - 14% SM by adding internal process water. In the mixers the proportion of the biological waste that can be digested is crushed, suspended and partially made into a solution, whilst the components that are not biologically degradable (plastics, textiles, metals, glass, etc) will in the main remain undamaged. **Figure 4.22** depicts a typical waste mixer.
- 4.115. When the mixing process is completed the slurry flows into the sand trap.

Figure 4.22: Waste mixer

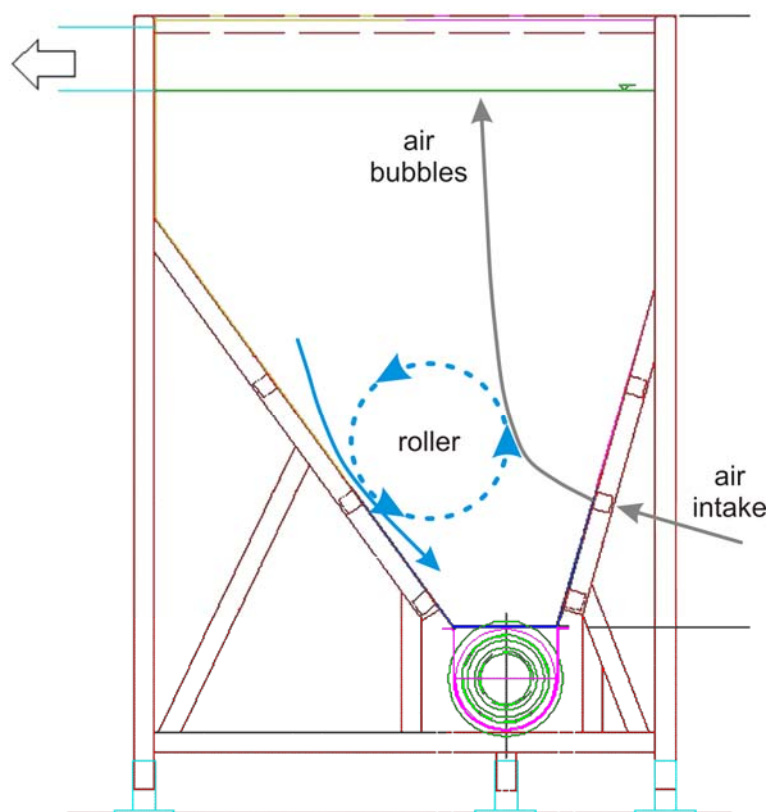


Sand trap

- 4.116. After the mixing process the slurry passes the star screen and then flows through the sand trap (see **Figure 4.23**). Here the heavy fraction e.g. sand, glass and small metal parts is removed from the liquid by means of sedimentation. Separating these inert components particularly protects downstream containers, pumps, the drainage system and other components from abrasion. This also minimises the settling of medium solids in the contents in the downstream tanks due to sedimentation.

- 4.117. Screws convey these inert components into a container. The sand is washed with process water within the rising screw to remove organic contaminations to prevent malodour resulting from the sand container.
- 4.118. A degree of turbulence is still necessary in order to avoid sedimentation of organic compounds. This is achieved by blowing in air from one side of the sand trap in order to generate a water barrel. The air stream can be adjusted manually by means of valves provided at the sand trap. The water barrel must be below the water surface. The air stream adjustment is a compromise between sedimentation of the heavy material, flotation of the light fraction and suspension of the organic compounds.
- 4.119. Floating materials are removed from the surface. They are also transported into a container.
- 4.120. The suspension is pumped out of the sand trap's buffer tank into the mixing tank, which is part of the anaerobic digestion process located at the Biogas Plant site.

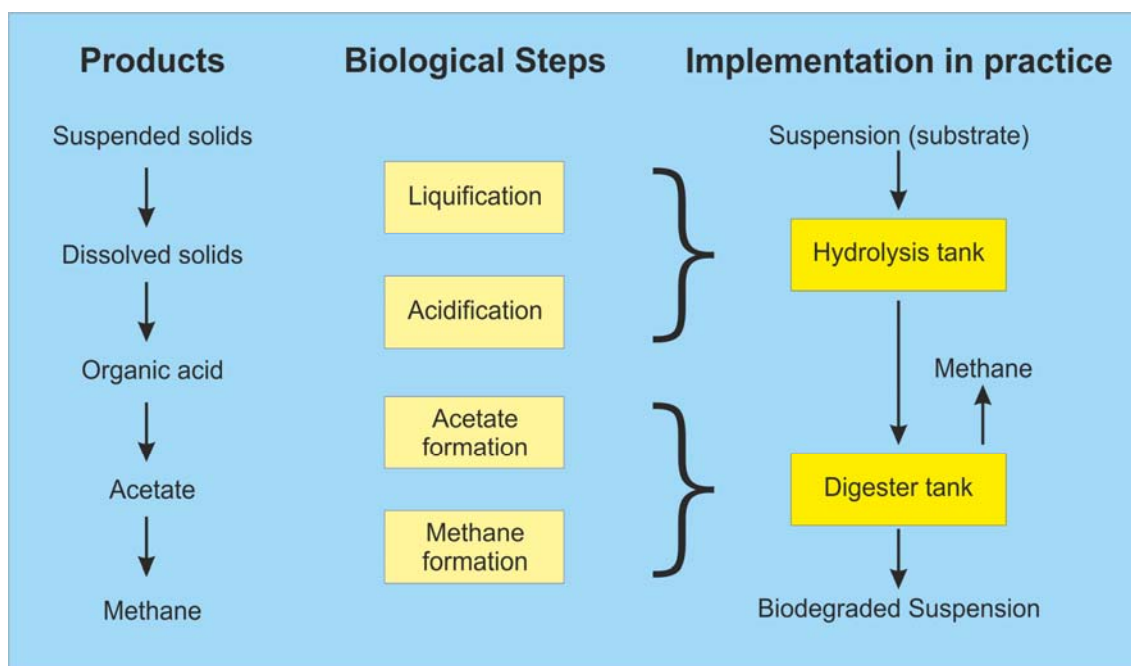
Figure 4.23: Cross section of a sand trap



Anaerobic digestion

- 4.121. The advantages of anaerobic treatment can best be indicated by comparing this process with aerobic treatment. During aerobic treatment, the waste is mixed with large quantities of microorganisms and air. Microorganisms use the organic waste for food, and use the oxygen in the air to burn a portion of this food to carbon dioxide and water for energy. Since these organisms obtain a good deal of energy from this oxidation, their growth is rapid and a large portion of the organic waste is converted into new cells.
- 4.122. In anaerobic treatment, the waste is also mixed with large quantities of microorganisms, however, in this case air is excluded. Under these conditions bacteria grow which are capable of converting the organic waste to carbon dioxide and methane gas. Unlike aerobic oxidation, the anaerobic conversion to methane gas yields relatively little energy to the microorganisms. Thus, their rate of growth is slow and only a small portion of the waste is converted to new cells, the major portion of the degradable waste being converted to methane gas.
- 4.123. The anaerobic digestion process is illustrated in **Figure 4.24**.

Figure 4.24: Anaerobic digestion



- 4.124. In addition to the described formation of methane, two further important biological processes take place during the fermentation. These are sulphate reduction and ammonium/ammonia generation.

Sulphate reduction

- 4.125. Sulphate reducing bacteria convert sulphate (SO_4^{2-}) to sulphide (S^{2-}) under anaerobic conditions as shown by the following equation.



- 4.126. S^{2-} is soluble but depending on the pH value it is in an equilibrium with HS^- and H_2S (Hydrogen sulphide). H_2S is an acidic gas with toxic properties. H_2S gas can condense into the liquid phase and penetrate the biogas system, where in high concentration it can result in corrosion in the CHP. To reduce the potential of corrosion, a biological desulphurisation process will be installed in the biogas system and also iron chloride can be added to the mixing tank to precipitate S^{2-} as FeS (iron sulphide), which is insoluble.

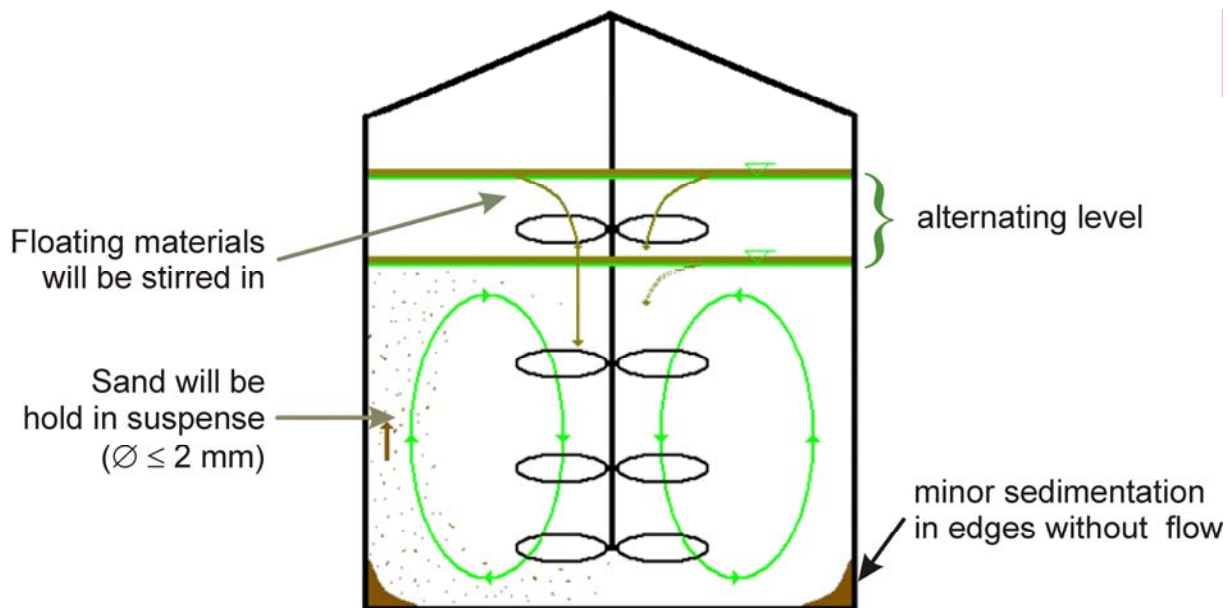
NH_4^+ / NH_3 formation

- 4.127. Waste includes many substances containing nitrogen groups. During the fermentation process these groups are reduced to ammonium (NH_4^+), which is soluble in water. With increasing pH value it converts to ammonia (NH_3), which is also a toxic gas with an acid odour. Quantities of ammonia are released in the aeration tank and in the dewatering area, so that an exhaust air treatment will be necessary.

Mixing tank

- 4.128. The mixing tank is used as a storage and homogenising tank. It compensates the time when no waste is fed into the AD process (e.g. nights, weekend). Peak feed times as well as reduced feed times and variations in the concentration are balanced out here. This leads to the tank being operated with a variable level. The tank is designed for a retention time of up to 3 – 4 days, so that there is also sufficient storage capacity at weekends or over public holidays.
- 4.129. In addition, pre-acidification takes place in the mixing tank.
- 4.130. In the hydrolysis phase the high molecular weight, undissolved materials (polymers) must be transferred by means of enzymes in dissolved fragments. Short warp organic acids, alcohol, hydrogen and carbon dioxide are formed in the acidification phase by the action of different facultative and anaerobic types of bacteria. The anaerobic decomposition process begins in this first reactor.
- 4.131. The tank is fitted with a top-entry agitator to homogenise the content. **Figure 4.25** shows a section of a how a typical mixing tank works.
- 4.132. The tank will be connected to the biogas system.

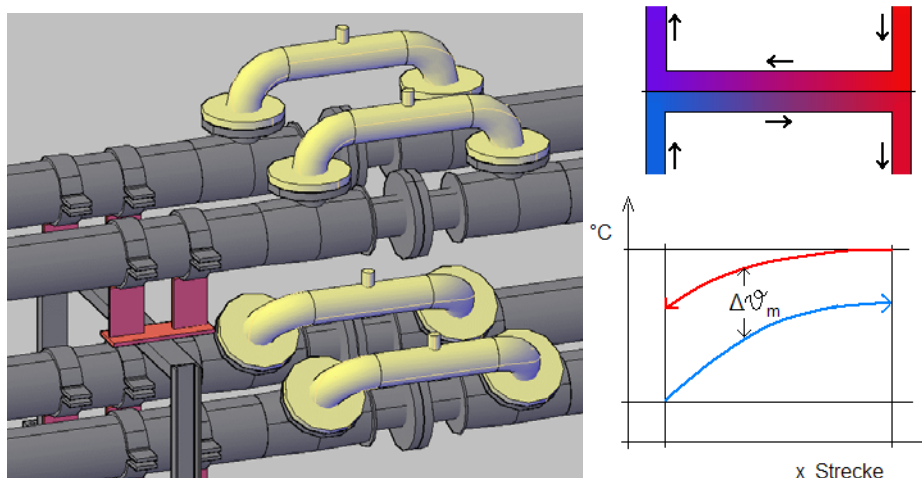
Figure 4.25: Section of mixing tank



Digester

- 4.133. The suspension is then conveyed to the digester tanks. The plant is designed to have one mixing tank and three digester tanks. The digesting reactors are operated with a temperature of approximately 55°C . This temperature is suited to pasteurise the substrate. The feed to the digesters is recorded using a flow meter. In order to achieve a feed that is as steady as possible, each reactor is to be fed several times a day.
- 4.134. Each digester has a separate heating cycle for adjustment of temperature.
- 4.135. The motor cooling water from the CHP units is used as a heating medium in the heat exchangers.
- 4.136. In the double pipe heat exchangers for heating the substrate flows through the inner pipe, whilst the water is pumped through the outer pipe (see **Figure 4.26**). This helps to minimise the potential risk of a blockage within the substrate pipe.

Figure 4.26: Double pipe heat exchanger



4.137. The anaerobic biochemical process takes place in several stages. The methane forming bacteria that are strictly anaerobic react sensitively to changes in pH-value.

4.138. In the step model for methane formation, hydrolysis, acid formation and methane formation take place one after the other:

Decomposition of butyric acid: $\text{C}_3\text{H}_7\text{COOH} + 2\text{H}_2\text{O} \rightarrow 2\text{CH}_3\text{COOH} + 2\text{H}_2$

Decomposition of propionic acid: $\text{C}_2\text{H}_5\text{COOH} + 3\text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + 3\text{H}_2 + \text{H}_2\text{CO}_3$

Methane formation: $\text{CH}_3\text{COOH} \rightarrow \text{CH}_4 + \text{CO}_2$

$\text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$

4.139. The digesters will be fully mixed.

4.140. The hydraulic retention time for the suspension in the reactors is approximately 15 – 18 days. During this time 50% - 60% of the organic dry mass added can be decomposed.

4.141. The biogas produced is fed into the dry gas accumulator. The digestion residue passes to the storage tank.

4.142. Each digester will have the following measuring sensors:

- Temperature measurement for controlling the reactor temperature;
- A measuring system for monitoring the level. The specified and limit values are sent to the electric control and will be used for alarms, safety cut offs and locking;
- The mechanical, gas side external protection consists of an over and under pressure safety valve (see **Figure 4.27**); and
- Pressure measurement.

Figure 4.27: Safety valve



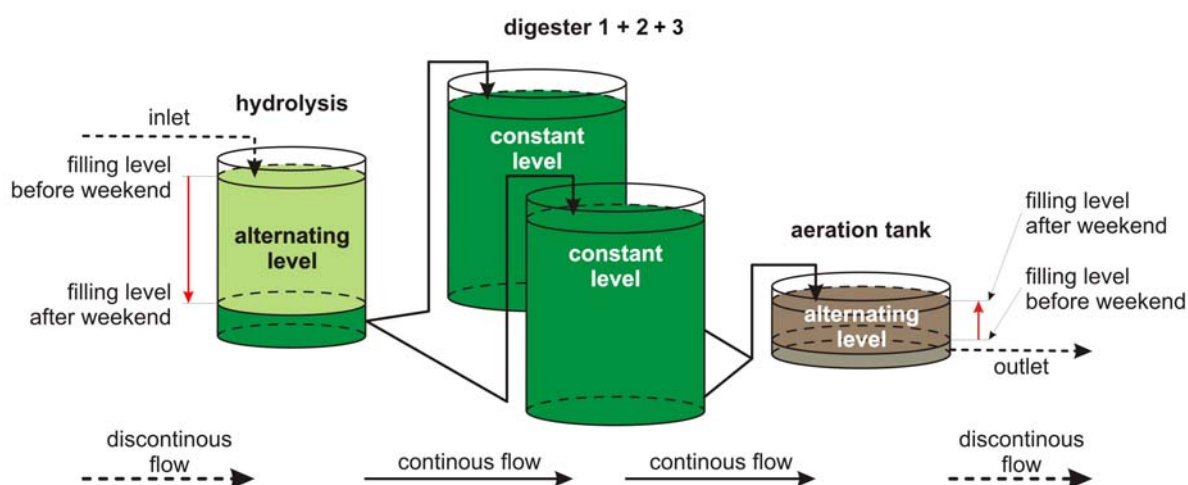
- 4.143. Gas quality measurement will be installed to control the gas composition. The following parameters will be measured: CH₄, CO₂, O₂, H₂S.
- 4.144. The tanks will be mounted up on a concrete foundation within a bund wall. The tanks will be coated with a suited lining to prevent corrosion.
- 4.145. Walls will be insulated and clad using trapezoidal wall profiles.
- 4.146. The digesters have a footbridge for inspection and maintenance work. The footbridge can be reached via a staircase.
- 4.147. The tanks are to be positioned inside a bundwall which can hold at least 110% the content of the largest tank.

Aeration Tank

- 4.148. The dewatering of digestate will be operated on 6 days per week. The aeration tank has to provide sufficient storage volume for the operation cycle of the dewatering process.
- 4.149. The digestate is pumped directly to this tank. The tank will be equipped with an aeration and mixing system. The aeration kills any remaining anaerobic bacteria and removes a certain percentage of ammonia.
- 4.150. A system for dosing an anti-foaming agent will be installed to reduce the formation of foam.
- 4.151. The tank will be connected to the exhaust air treatment system.

- 4.152. Although the mechanical treatment and the dewatering process are in discontinuous operation during the week, microorganisms in the digesters must be continuously provided with substrate. Besides their biological functions, the hydrolysis and the aeration tank therefore operate as buffer tanks in order to assure a continuous AD process.
- 4.153. The flow between the biological treatment steps is shown in **Figure 4.28**.

Figure 4.28: Flow between the biological treatment steps



Dewatering the digested residues

- 4.154. The anaerobic and aerobic treated substrate is fed via pumps from the aeration tank to the dewatering system. Separation of the substrate into a liquid and solid material flow takes place at this stage.

Decanter

- 4.155. Decanters will be provided for dewatering of the substrate. The dewatered residue will reach a dry solids content of approximately 30%.
- 4.156. The substrate is fed via a central feed pipe into the centrifuge drum, which rotates at high speed. Due to the centrifugal force the solids concentrate on the drum wall. With the help of a screw, which rotates with low speed gradient, the solids are continuously transported outside. In the direction of the solid outflow the centrifuge drum has a conical shape, which brings about the phase of the solids being lifted out of the water and flowing back to the water outflow. **Figure 4.29** illustrates how a decanter operates and **Figure 4.30** shows an industrial decanter.

Figure 4.29: Principle of a decanter

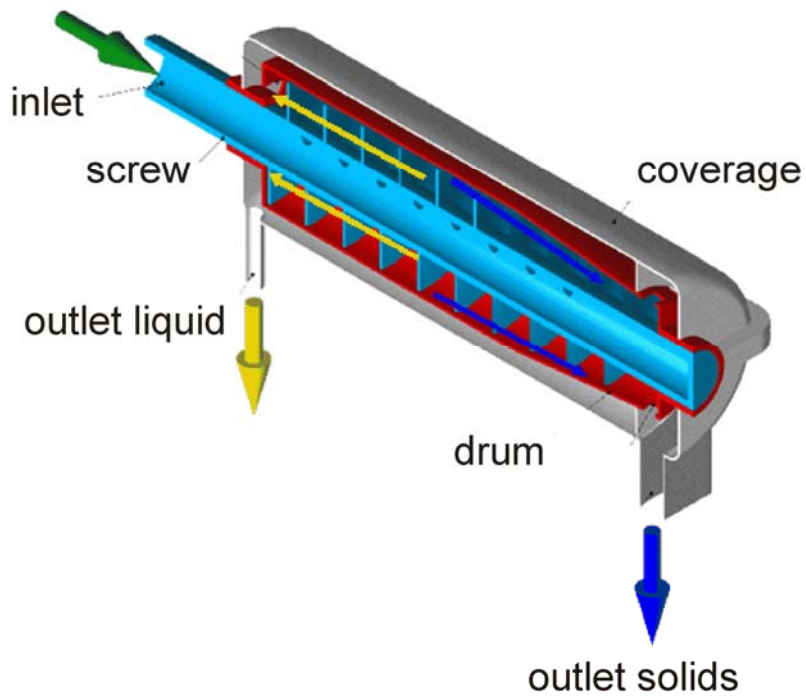
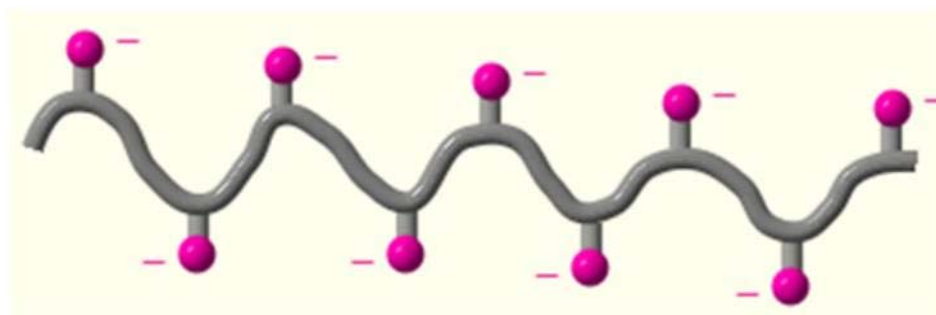


Figure 4.30: Decanter



- 4.157. The speed of the solid outflow will be set with the help of the rotation speed gradient. Increasing rotation speed brings about an increasing solid outflow. A lower outflow provides better dewatering. If outflow is too low, the solids will accumulate in the drum and the decanter will be switched off.
- 4.158. A flocculating agent (polymer) is added to the substrate at the point of entry to the decanters and the dewatered residue can reach a content of approximately 30 - 35% of dry substances.
- 4.159. The solid materials are positively charged on the surface. Polyelectrolytes use this property in order to build up the positively charged solids at the numerous negatively charged groups of the polymer to form larger flakes. **Figure 4.31** illustrates the structure of a polyelectrolyte.

Figure 4.31: Structure of a polyelectrolyte



- 4.160. The decanters will be installed on the first floor of the maturation hall. The solid material falls down to the ground floor. It will be stored in piles by means of a wheel loader for maturation and further loss of water.
- 4.161. The centrate water will be pumped to the process water tank, which has to provide the necessary storage volume for compensation of differences in operation time between dewatering process and mechanical pre-treatment.
- 4.162. Most of the process water is to be used for the slurring process of waste in the mixers. Furthermore process water will be used for washing of sediments (glass, sand, etc) removed from sand trap and for the supply of several flushing devices. However, some excess water will be generated that will need to be treated.

Waste water treatment

- 4.163. A process water tank is provided, to be used as a storage and feeding tank. The process water is mainly taken from the decanter centrate, which is removed during the dewatering process but can also be diluted with service water if required.
- 4.164. Process water is used to supply a number of areas around the site. Two pumps distribute to a number of process areas including the pre-treatment mixers, sand trap discharge conveyors, hydrolysis and digester tank areas and the dewatering plant.
- 4.165. During normal operation, the process water tank is operated with fluctuating levels in order to achieve a buffer capacity. The process water tank is fitted with a

submersible mixer to prevent sedimentation of small solids. Excess process water is fed to the waste water treatment plant.

- 4.166. During the MBT process, different water qualities are required. Process water can be used directly for the mixing process and sand washing whilst water of higher quality is required for flocculation, as a sub-process of the dewatering step. In order to achieve this improved water quality, a waste water treatment plant designed as a membrane plant (e. g. reverse osmosis) can be used.
- 4.167. Some surplus water will be produced depending on the moisture content of waste and its salinity. The MBT surplus water will be treated together with the pre-treated manure in the waste water treatment plant of the manure plant. Here a biological system will be used, mainly designed for nitrogen removal followed by a reverse osmosis plant (RO). An evaporation plant will reduce the quantity of RO concentrate.
- 4.168. The MBT surplus water will be pumped from the process water tank to the centrate storage tank of the manure plant for mutual treatment.

Gas engineering

- 4.169. The gas engineering system consists of gas pipe work and safety analysis, biological desulphurisation, gas drying and gas storage in a double membrane low pressure tank, and finally utilisation with a CHP or burning in a gas flare.
- 4.170. The whole of the gas route is fitted with the necessary safety fittings and deflagration devices for safety reasons.
- 4.171. The biogas flare is used to burn biogas with too low methane content or in the case of a fault in the CHP in a manner that is free from harmful substances.
- 4.172. The biogas has a methane proportion of 50 – 65 vol % resulting in a calorific value of 5.0 – 6.5kWh/Nm³. The hydrogen sulphide content is largely dependent on the input material. Experience with waste from domestic households and organic commercial waste shows that hydrogen sulphide concentrations of 1,000 to 4,000ppm are to be expected in the biogas.

Desulphurisation

- 4.173. In the bio-chemical reaction in the anaerobic digestion reactors sulphate reduction forms hydrogen sulphide (H₂S).



- 4.174. S²⁻ is soluble but depending on the pH value it is in equilibrium with HS⁻ and H₂S. H₂S is an acid gas with toxic properties. H₂S can release the liquid phase and penetrate the biogas system, where in high concentration it can result in corrosion in the CHP.
- 4.175. There are chemical and biological options to reduce the H₂S content in the biogas.

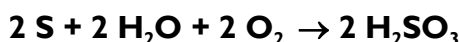
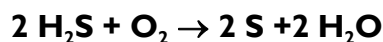
Chemical desulphurisation

- 4.176. One option to reduce the H_2S content in the biogas is to add iron chloride to the hydrolysis tank to precipitate S^{2-} as FeS (iron sulphide), which is insoluble. The sulphide leaves with the digestion residue in a stable phase.



Biological desulphurisation

- 4.177. A biological desulphurisation process for the biogas will be included to reduce the consumption of iron chloride and to prevent an unnecessary increase of salinity in the waste suspension.
- 4.178. The biological oxidation process occurs in a reactor filled with material which is settled with specialised bacteria. These bacteria transform H_2S to sulphur and sulphite using atmospheric oxygen.



- 4.179. A nutrient solution is sprayed continuously over the filling material, whereas the biogas coming from the digesters will be mixed with a certain amount of air and flows upstream through the reactor. The air dosing will be controlled. The oxidation products sulphur and sulphite will be discharged with the nutrient solution. Therefore, the solution, which is recycled over the reactor has to be partly displaced. The quantity of waste solution depends on the H_2S concentration in the biogas and on several reaction conditions like pH.

Gas storage

- 4.180. The gas produced in the digester arrives in a gas store that is designed as a separate double membrane accumulator (see **Figure 4.32**). The gas quantity to be stored varies depending on the gas quantity removed or added. A membrane in the inside of the gas accumulator adjusts itself to these volume variations; depending on filling quantity it either rises or drops. The gas storage is made up of two membranes. The inner membrane that takes up the biogas is surrounded by a protective external membrane. An explosion proof support fan continuously blows air into the space between the inner and outer membrane. The external membrane thus remains blown up tightly, stabilises and protects the construction against wind, rain and snow. The membranes are made of high-strength, polyester cloth coated on both sides with plastic. The membranes have minimal gas permeability. They are also resistant to atmospheric exposure, UV radiation, and fungus and microbe attack, they are flexible, and at the same time extremely robust. The gas is drawn off continuously via the gas compressor station and fed to the CHP or the gas flare. Consequently, there is no storage requirement for the biogas, but rather merely an equalising buffer for variations in the gas production as a pressure balance and control volume for operating the CHP.

Figure 4.32: Gas storage with safety device



Gas booster station

- 4.181. The biogas is retained at the gas outlet nozzles of the reactors with a flow pressure of approximately 10 - 15mbar. The biogas is extracted from the reactors via a gas pipe system and fed to certain consumers by means of suitable gas blowers. The biogas consists mainly of methane and carbon dioxide as well as small quantities of nitrogen, oxygen, hydrogen and other trace gases. The gas is fed with a relative humidity of approximately 100% and a temperature of approximately 50°C. The condensate that arises due to the gas cooling down during transport and separate gas cooling process before the blowers is precipitated via a condensate trap and led to a condensate drain or tank. All units required for the transport of the gas are found in the gas booster stations (GBS).
- 4.182. The GBS is fitted in a pre-assembled container that is sub-divided into two gas tight units, separated by a door from one another, and each separately accessible.
- 4.183. The GBS contains all plant parts required for the transport, measurement, regulation and monitoring of the biogas.
- 4.184. The GBS plant parameters are registered by various measuring devices in the machine room and automatically converted in the electrical switch room via control devices.
- 4.185. The flare control is also located in this switch room. Control of the plant takes place with the aid of conventional relay and control technology.
- 4.186. The GBS is fitted with the necessary measuring instruments for registration, control, regulation and monitoring.

Gas flare

- 4.187. When the gas motors are not working and the level of the biogas storage has reached the relevant limit value, the biogas flare (shown in **Figure 4.33**) is switched on via a pressure switch and the flare is lit via self-ignition.
- 4.188. In order to destroy the organic harmful substances in the biogas, the flare is supplied as a non-insulated combustion chamber with injector burners. It is designed so that over the whole of the dwell time within the (combustion chamber) there is an almost even temperature distribution ($> 800^{\circ}\text{C}$). This ensures complete oxidation of methane and thus a complete burn up rate. Combustion takes place with a sufficient excess of air.

Figure 4.33: Gas flare



Condensate drains

- 4.189. Condensate shafts are connected to low points of the gas lines to drain off the condensate that arises in a controlled manner. The condensate collected in this way is pumped into the mixing and hydrolysis unit via an explosion proof pump. The pump is controlled via a level measuring device.

Gas utilisation

Combined Heat and Power Plant (CHP)

- 4.190. The CHP (see **Figure 4.34**) is used for the production of power and heat. Two packaged engines will be installed. The motor produces electrical power along with thermal energy. The thermal energy is taken from the motor cooling water for heating purposes. The thermal energy can be used for a number of applications including heating the waste suspension up to process temperature. Should the heat consumers not be using heat some of the time, then the heat will be led away via an emergency cooler. The electrical energy produced by the generator will be network synchronised to be fed into the public network. The appropriate transformer and control equipment required to feed the CHP electricity output into the grid will be provided.
- 4.191. The CHP is made up in the main of the following plant components:
- The gas pipe work system;
 - Gas regulating line: the gas regulating line is a component part of the gas engine and is used to regulate the required pressure or quantity of biogas to gas engines. The radial fan can pressurise the gas system to 80mbar, this allows the regulating line to fulfill its function;
 - Fittings;
 - Emergency cooler as a table cooling system for carrying away the cooling water heat into the ambient air when the heat is not used;
 - Supply of lubricating oil. The fresh or used oil will be stored in two double walled tanks. The gas engine's regular oil consumption is equalised via a day tank. After the oil lifetime has passed it can be fed back into the used oil tank via a second pipe system;
 - Exhaust system: tThe exhaust gas is fed into the open air via a sound absorber and chimney. The exhaust gas outlet is 10m above the foundation as a standard. However, following the odour assessment (see **Chapter 11**) the stack height was increased to 20m to ensure best dispersion; and
 - Container: the gas engine and switchboard plant are accommodated in a separate 40 foot container with the relevant sound and heat insulation.

Figure 4.34: CHP plant



Process Air Treatment

Process Air Coverage

Mechanical Pre-Treatment (MPT) site

- 4.192. All areas of the MBT plant, in which there is a malodorous process air, are designed to have an air collection system to remove that air by means of suction. Together with the normal hall ventilation some plant parts are to be provided with source segregation of air, in order to reduce the process air flow.
- 4.193. The following areas of the MPT plant are vented in a targeted manner:
- Waste reception hall;
 - Mechanical pre-treatment hall;
 - Source collected air from defined equipment of mechanical pre-treatment; and
 - Wet pre-treatment area with sand trap, mixers.
- 4.194. The several process air streams are transported by fans. The process air coming from the mechanical and wet pre-treatment hall is used for ventilation of the reception area. The process air volume flow of the whole plant can be clearly reduced with these measures.
- 4.195. The air from the waste reception hall and the source segregated air pass a dust filter before being fed into the exhaust air treatment system consisting of an acid scrubber and a biological waste air treatment system (biofilter).

4.196. The exhaust air from the mixer / sand trap passes an acid scrubber and will be treated afterwards in the biofilter.

4.197. The largest volume of exhaust air results from the waste reception area.

AD site

4.198. The following areas of the AD plant are vented in a targeted manner:

- Aeration tank; and
- Dewatering area.

4.199. Ammonia is the main reason for odour in these areas thereby requiring an exhaust air treatment system. The ammonia can be washed out effectively in an acid scrubber.

Fittings

4.200. Manual isolator valves will be fitted in front of and behind the units for easy maintenance and assembly of the built-in pumps, blowers and other equipment.

4.201. All safety relevant substrate carrying fittings are equipped with end of travel limit switches. These enable exact checking of the current opening or closing state of the shut-off devices. The actuators are controlled via the Programmable Logic Controller (PLC). The actuators are operated pneumatically. The compressed air required for this is produced via a piston compressor with a compressed-air storage vessel. Before the compressed air is distributed to the actuators, the condensate is separated and prepared via a refrigeration dryer.

Measuring technology

4.202. The process control and checking of the whole of the plant technology takes place via an extensive measuring system that is connected to the PLC.

4.203. The measuring system is made up in the main of the following measuring equipment:

- Level measuring of tanks;
- Limit level measuring of tanks;
- Pressure measurements for gas and substrate media;
- Temperature measurements for gas and substrate media;
- Flow measurement for gas and substrate media;
- Oxygen measurement; and
- Measurement of gas quality (H_2S , CH_4 , CO_2 , O_2).

4.204. The required measurements are registered in the PLC and summarised in trends and histories.

- 4.205. **Figure 4.39 to Figure 4.44** illustrate plant layout and design. **Figure 4.54 to Figure 4.58** present mass balances for bulky, municipal, organic fraction and animal waste, respectively.

Anaerobic digestion of animal husbandry waste in the biogas plant

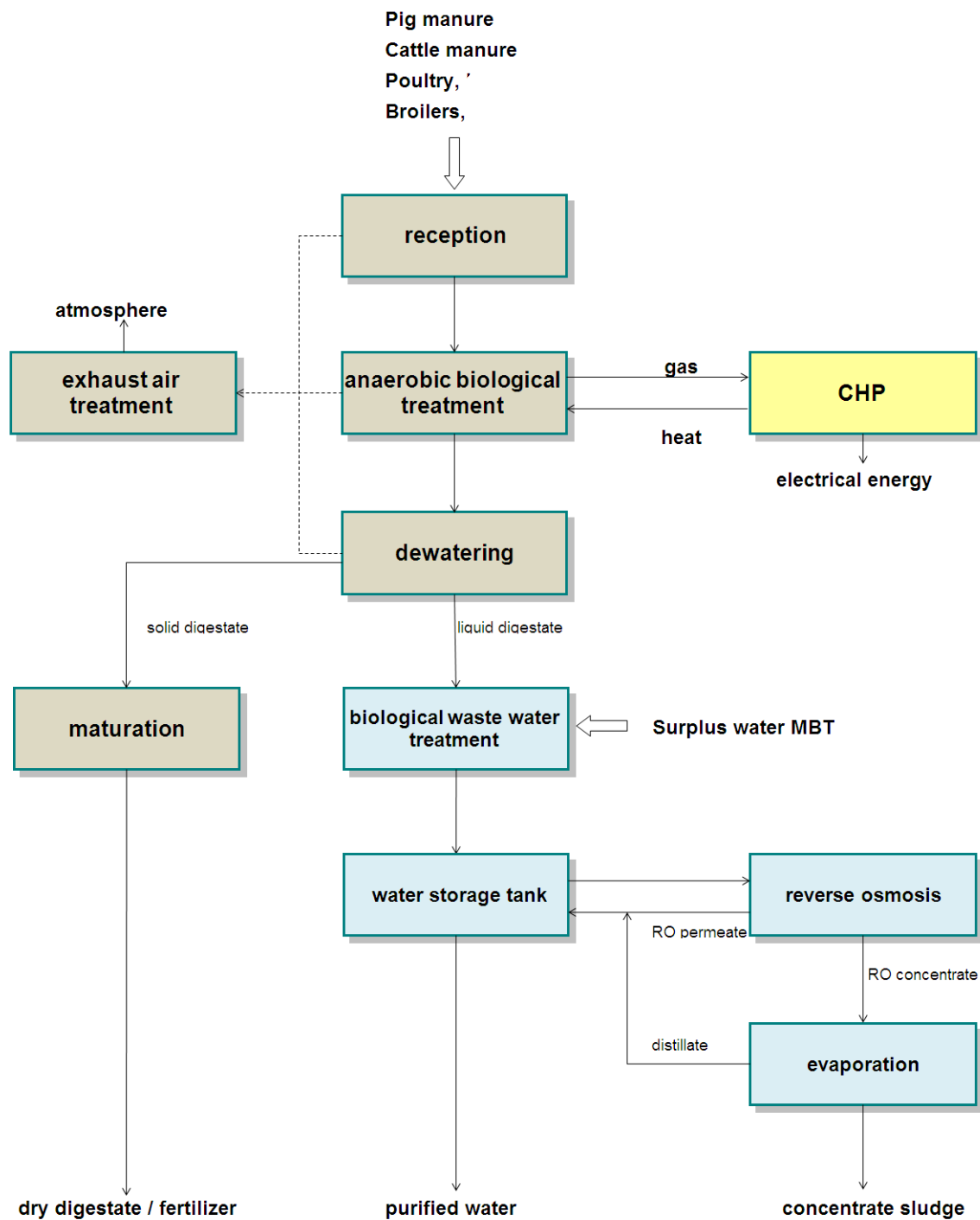
- 4.206. The Biogas Plant (BP) will process 150,000 tonnes per annum of feed stock derived from solid and liquid manure, based on the following:
- 111,000 tonnes per annum of pig manure;
 - 35,000 tonnes per annum of cattle manure; and
 - 4,000 tonnes per annum of solid poultry manure.
- 4.207. These materials will be processed in an anaerobic digestion system followed by a biological treatment of the liquid digestate. Integration of the closed anaerobic system ensures that emissions will be minimised and biogas will be produced. This biogas will be transformed into electrical energy and heat with a CHP.
- 4.208. The digestate will be dewatered to separate the solid fraction from the liquid. The solid digestate will be stored in heaps within a roofed area for maturation and further loss of water. The area is designed to provide approximately 2 weeks storage capacity. The matured digestate can be characterized as a compost and can be used as an agricultural fertiliser.
- 4.209. The liquid digestate or centrate will represent 85 – 90% of the total digestate quantity and will contain approximately 65% of the nitrogen load.
- 4.210. In 2006 the Water Services Corporation announced that it will stop accepting piggery effluent and wastewater from farms once the new wastewater treatment plants become operational. Given that most agricultural land in Malta is already over-fertilised, piggery effluent is quite odorous, and the 2010 Nitrates Action Programme prohibits land application of slurry, the use of liquid digestate as a fertiliser will not be a long term option.
- 4.211. Therefore, the nitrogen load of the centrate has to be reduced as far as possible before discharge to land or sewer or elsewhere. It is intended to use a combination of aerobic and anaerobic biological treatment and an additional physical treatment, a reverse osmosis plant (RO). An evaporation plant will reduce the quantity of RO concentrate before disposal to landfill.
- 4.212. The biological waste water treatment plant is designed as a Sequencing Batch Reactor (SBR). Here the deammonification process will be used, which is a combination of aerobic and anaerobic autotrophic processes. The deammonification process saves approximately 60% of aeration energy compared to the conventional nitrification / denitrification process. In addition, a dosing of a carbon source is not necessary.
- 4.213. However, the deammonification process will reduce ammonium and nitrates only with an efficiency of 85 – 90%. Further treatment will be necessary to meet higher discharge limits.

- 4.214. The elimination of ammonium in a biological treatment plant will proceed with high efficiency. However, the degradation of organic nitrogen compounds takes place only within the anaerobic digestion stage. An efficiency of degradation to ammonium between 30 to 60% can be expected. Thus, the effluent will contain a certain concentration of organic nitrogen which is not degradable within the biological treatment process.
- 4.215. The discharge limits to sewer regarding Total Kjeldahl Nitrogen (TKN) cannot be met with a biological treatment only. For this reason a reverse osmosis plant will be used as second stage. This technique is based on a physical separation process and is able to produce a high quality permeate, in addition to a high concentrated stream.

General plant concept

- 4.216. **Figure 4.35** illustrates the general plant concept.

Figure 4.35: Block diagram of the BP



Process description

- 4.217. The following sections describe in detail the process for the treatment of animal waste. **Figure 4.45** to **Figure 4.52** illustrate the AD plant design.

Manure reception

- 4.218. Both solid and liquid manure will be received at the biogas plant. Solid manure will be delivered to the Reception hall, whereas the liquid manure will be directly pumped into the manure storage tank. Most of the delivered manure will be liquid.

Solid manure input

- 4.219. The Reception Hall has been designed to house approximately 5 days input quantity of solid manure. The transport vehicles will unload the manure on the floor. The solids will be fed into a dosing unit by means of a wheel loader. The dosing unit will need to be filled once a day. Screws will be used to transport the manure into the mixing tank. Here the solid manure will be mixed with the liquid stream to enable transportation into the pasteurisation tanks by pumps.
- 4.220. Handling and feeding of solid manure will be done when doors are closed to prevent any odour emissions. Automatic doors will allow entrance to the reception hall.

Liquid manure input

- 4.221. The liquid manure will be pumped directly into the manure storage tank. The tank provides approximately 6 days storage time. Transport to the plant must be managed in order to guarantee a constant feed of manure into the biogas plant.
- 4.222. The storage tank will be covered to prevent odour emissions.
- 4.223. The liquid manure will be pumped via the mixing tank, which is located within the reception hall, into the pasteurisation tanks.

Pasteurisation

- 4.224. During the pasteurisation stage the manure will be heated for one hour to 70°C. By using heat exchangers the cold incoming substrate can be pre-heated by the hot outgoing substrate. The motor cooling water from the combined heat and power unit will be used for the second heating stage to increase the temperature to the required level. The substrate which is pasteurised will be cooled down to the reaction temperature in the digesters (for the mesophilic digestion approximately 37°C).
- 4.225. The pasteurisation cycle is a 3 hour cycle for each tank. The incoming substrate in Tank 1 will be heated by means of heat exchangers, using the output of Tank 2 for pre-heating and the motor cooling water for reaching the required pasteurisation temperature. The heating process will take one hour. Following this the substrate will be maintained at a temperature of 70°C for another hour. While Tank 1 will be discharged, Tank 3 will be filled and the input heated in counter current. Thus, three tanks are required for a continuous process.

4.226. The pasteurisation tanks will be installed outside, near the gas engines, which provide the necessary thermal energy. The feed to the pasteurisation is recorded using a flow meter.

4.227. The pasteurised substrate will be pumped into the digesters.

Anaerobic digestion

4.228. The anaerobic treatment is the same process as chosen for the treatment of the organic domestic waste fraction, described above.

4.229. The pasteurised manure will be pumped to the digester tanks. The plant is designed to have two digester tanks. The digesting reactors are operated with a temperature of approximately 37°C. In order to achieve a feed that is as steady as possible, each reactor is to be fed several times a day. The feeding sequences result from the pasteurization cycles. The anaerobic biochemical process takes place in several stages, as described above.

Storage tank before dewatering / secondary digester

4.230. The storage tank is used as a storage and homogenising tank prior to the dewatering process as well as a secondary digester. This provides additional time for biogas production. Its storage function leads to the tank being operated with a varying level.

4.231. The tank is fitted with a top-entry agitator to homogenise the content.

4.232. The tank will be connected to the biogas system.

Dewatering the digested residues

4.233. The anaerobic treated manure is fed via pumps from the storage tank to the dewatering system where the separation of the substrate into a liquid and solid material flow takes place via a 2-stage system, described below.

Screw press and centrifuge classifier

4.234. Screw presses will be used in the first stage of the two stage system to produce a solid fraction with a high dry matter content as well as a liquid fraction. The liquid, i.e. the press water, still contains a certain amount of solids, which will be removed in a second treatment step.

4.235. In the second step a centrifuge classifier separator will be used for further treatment of the press water. More solids will be separated here to produce a centrate with less suspended solids.

4.236. The dewatering equipment will be installed on the first floor of the maturation hall. The solid material falls down to the ground floor. It will be stored in mounds by means of a wheel loader for maturation and further loss of water.

Waste water treatment

4.237. A centrate storage tank is provided, to be used as a storage and feeding tank for the centrate water before treatment. The centrate will be pumped into the 1st step, the

biological waste water treatment plant, designed as a Sequencing Batch Reactor system (SBR).

- 4.238. In contrast to the MBT plant the complete liquid fraction quantity resulting from the dewatering of the digested slurry must be treated. The centrate water from the biogas plant contains a high quantity of nitrogen.
- 4.239. The main target of the waste water treatment is to reduce the nitrogen concentration to enable a disposal of the liquid residues from slurry digestion. As most agricultural land in Malta is already over-fertilised, agricultural use of the untreated effluent is not possible.
- 4.240. The surplus water from the MBT plant will be treated together with the liquid slurry in the biological waste water treatment system.
- 4.241. The MBT surplus water will represent a proportion of approximately 20% of the total quantity, but the nitrogen load will be only 5% of the total load. WasteServ are proposing to reuse any surplus water within the Maghtab Environmental Complex.

Characteristics of liquid digestion residues

- 4.242. **Table 4.1** shows the estimated concentrations of significant parameters of both liquid streams (i.e. from the BP and the MBT - AD plant).

Table 4.1: Characteristics (estimated) of liquid digestion residues

| Parameter | Liquid Digestate BP Centrate after dewatering | Surplus water MBT-AD plant Centrate after dewatering |
|--------------|--|---|
| Quantity | 361 m ³ /d | 70 m ³ /d |
| COD | <10,000 mg/l | <4,000 mg/l |
| BOD5 | <2,000 mg/l | <500 mg/l |
| TKN | <5,100 mg/l | <1,200 mg/l |
| NH4-N | <3,300 mg/l | < 1,000 mg/l |
| NO3-N | 0 mg/l | 0 mg/l |
| SS | <500 mg/l | <500 mg/l |
| Temperature | > 30°C | > 25°C |
| Conductivity | 15-20 mS/cm | 15-20 mS/cm |

Centrate storage tank

- 4.243. The centrate storage tank is used as a storage and feeding tank for the biological waste water treatment, which is designed as a sequencing batch system.
- 4.244. The tank is operated with fluctuating levels in order to achieve the required buffer capacity for the batch feed and is fitted with a submersible mixer to prevent sedimentation of small solids.

First Stage of Waste Water Treatment (SBR)

- 4.245. Sequencing batch reactors (SBR) are industrial processing tanks for the treatment of wastewater. A batch system differs from a continuously operated activated sludge system in that the biological degradation process and the settlement of activated

sludge occur in the same tank. The different phases of treatment will not happen in separate tanks but at different time intervals.

- 4.246. The first treatment stage is de-ammonification. De-ammonification is the metabolic short-cut of N conversion and is catalysed by the very slow-growing Anammox (anaerobic ammonium oxidation) bacteria (see **Figure 4.36**). This process is an attractive option for the treatment of ammonium rich streams. It provides a high resource of saving potential compared to the common nitrification / de-nitrification process.
- 4.247. The de-ammonification process is preferred for waste water with high ammonium concentrations > 200 mg/l and low content of biodegradable organic matter. Examples for such streams include leachate from solid waste landfills, supernatants from dewatering of digested sludge, etc. The process has also been applied to the treatment of liquid residues of digested manure.
- 4.248. The most important advantage of the de-ammonification process compared to the conventional nitrification / de-nitrification process is that it needs 60% less aeration energy. Just over half of the ammonium is oxidised to nitrite. The remaining ammonium will be oxidised to nitrogen using the oxygen fixed in the nitrite.
- 4.249. The de-ammonification process comprises both autotroph processes:
- Partial nitrification (aerobic); and
 - Ammonium oxidation (anoxic).
- 4.250. Since no heterotrophic organisms participate in the de-ammonification process, no organic carbon source is needed unlike in the de-nitrification process. Furthermore, the surplus sludge production is very low.
- 4.251. The de-ammonification process will achieve an efficiency in ammonium nitrogen degradation of 85 to 90%.

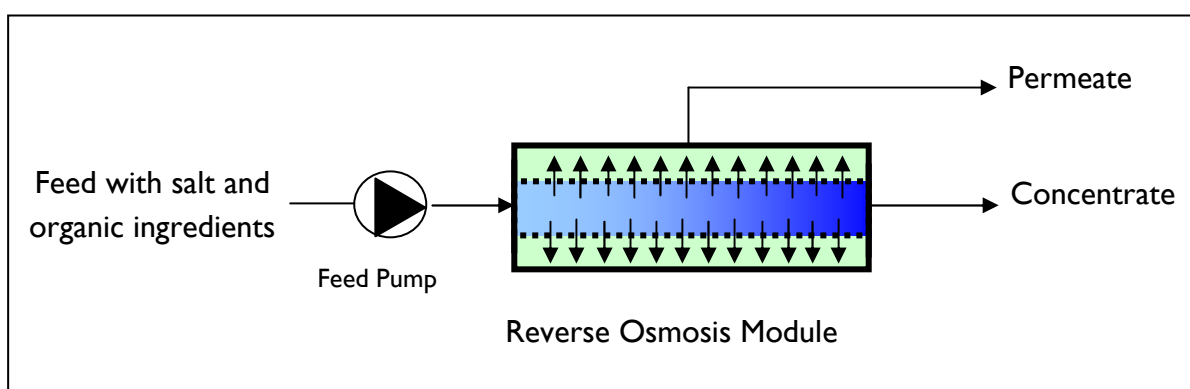
Water storage tank

- 4.252. The pre-treated centrate is pumped from the SBR tanks to the water storage tank. This tank is used as a storage and feeding tank for the reverse osmosis system (RO).
- 4.253. The RO will be fed continuously. The centrate quantity, which has to be treated in the RO stage, depends on the quality of the biological pre-treated centrate.
- 4.254. The feed to RO will be taken from the water storage tank and the produced permeate will be pumped back to this tank. The result is a discharge with lower salt concentration.
- 4.255. The water storage tank offers approximately 6 – 7 days storage capacity for the effluent from the waste water treatment plant before use or discharge.

Second stage of waste water treatment (RO)

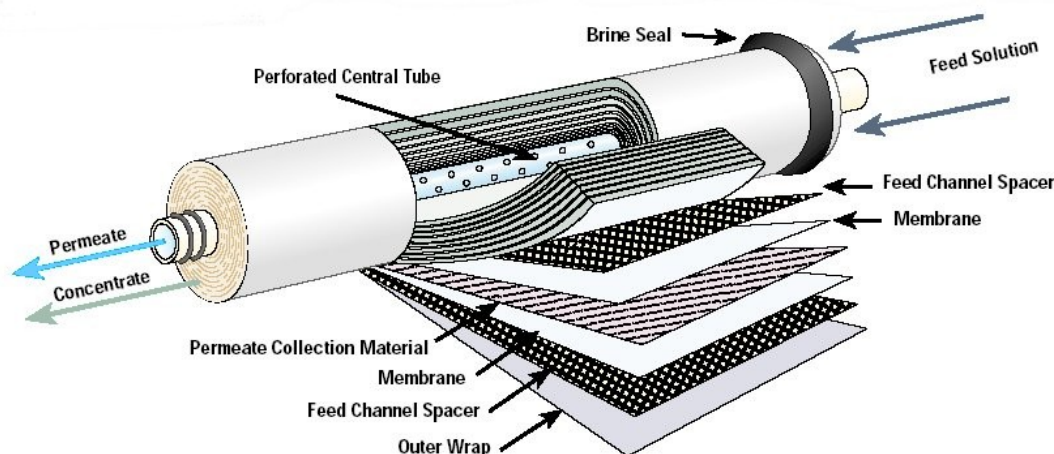
- 4.256. During the MBT-AD process, different water qualities are required. The MBT process water can be used directly for the mixing process and sand washing whilst water of higher quality is required for flocculation, as a sub-process of the dewatering step. Purified water from the water storage tank can be used for this process.
- 4.257. The feed from the water storage tank is pumped under high pressure in the reverse osmosis module. While water molecules can pass the membrane, salt and organic compounds are held back. The permeate is almost clean water, the concentrate is highly contaminated. **Figure 4.36** illustrates a RO module.

Figure 4.36: Reverse Osmosis module



- 4.258. A 2-stage reverse osmosis in combination with two-stage gravel filtration upstream will be installed as second stage of waste water treatment, as illustrated in **Figure 4.36**.
- 4.259. The gravel filtration unit enables further separation of solids from the biological pre-treated water in order to prevent RO-stage blockages. The filtrate contains only dissolved substances. The backflushing water from the filter stage returns to the process water tank.
- 4.260. Gravel filtration is followed by 2-stage reverse osmosis for further cleaning of filtrate to the quality recommended for discharge to sewer.
- 4.261. In order to enlarge the membrane surface the reverse osmosis is equipped with spiral modules, as shown in **Figure 4.37**.

Figure 4.37: Spiral module



- 4.262. The RO produces a water (permeate) which is almost free from salts and other dissolved substances, as well as a waste water (concentrate) stream, which contains all dissolved compounds. The cleaned permeate is controlled online with conductivity measurements and a permeate yield of approximately 75 - 80% is expected, depending on the conductivity level or the salt content of the feed water.
- 4.263. The highly concentrated waste water is discharged into the RO concentrate tank. It will then be treated in an evaporation plant to reduce the quantity, which must be disposed of.
- 4.264. The assumed discharge concentrations of several parameters after different steps of treatment can be found in **Table 4.2**.

Table 4.2: Estimated effluent qualities after different waste water treatment steps

| Parameter | Centrate following dewatering | Centrate following biological treatment 1 st stage | Centrate after biological treatment and RO | Sewer Discharge Control Regulations |
|--------------------|-------------------------------|---|--|-------------------------------------|
| Quantity | 43 l m ³ /d | 43 l m ³ /d | 43 l m ³ /d | |
| COD | < 10,000 mg/l | < 6,000 mg/l | < 800 mg/l | < 82 l mg/l |
| BOD5 | < 1,800 mg/l | < 200 mg/l | < 100 mg/l | < 388 mg/l |
| TKN | < 4,500 mg/l | < 1,600 mg/l | < 100 mg/l | < 100 mg/l |
| NH ₄ -N | < 3,000 mg/l | < 300 mg/l | < 50 mg/l | |
| NO ₃ -N | 0 mg/l | < 500 mg/l | < 60 mg/l | |
| SS | < 600 mg/l | < 500 mg/l | < 50 mg/l | < 500 mg/l |
| Temperature | > 25°C | | | < 40°C |
| Conductivity | 15-20 mS/cm | < 10 mS/cm | 2 mS/cm | |

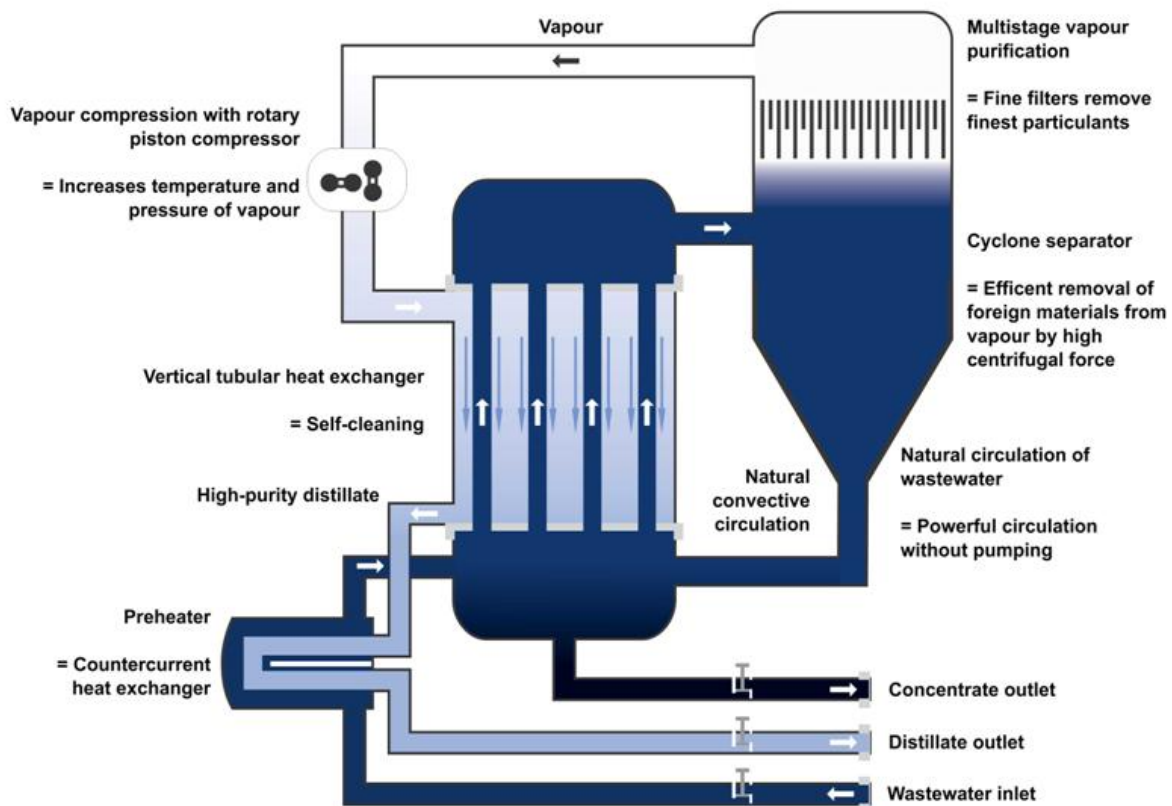
- 4.265. The treated effluent may either be used for internal flocculation process, for agricultural or irrigation purposes, or may be discharged to sewer. WasteServ

consider that if water can be reused it will be reused in the Maghtab rehabilitation project.

Evaporation of RO Concentrate

- 4.266. An energy optimised vacuum evaporation unit will be applied.
- 4.267. The evaporation unit operates solely with thermal (evaporative) separation. The evaporator will be operated fully automatically in three-shift continuous operation.
- 4.268. The designed evaporator excels with its simple and rugged design. It will not incorporate pumps or heating modules (heat input is via compressor). As a result it provides highest operational reliability.
- 4.269. Filling of the unit will be driven by the vacuum created by the compressor. The heat energy is transferred to the waste water (RO concentrate) via compression of inflowing ambient air.
- 4.270. Once the process temperature is attained, a programmable logic controller (PLC) process valve will gradually close and the evaporation process will begin. The process automatically draws in as much wastewater as distillate is let out.
- 4.271. The vapour flows convectively downwards in the heat exchanger shell. The fast-flowing vapour cleans the tubes continuously, providing excellent cleaning even when problem wastewaters will be processed.
- 4.272. The core component of the multistage vapour cleaning is the centrifugal cyclone separator, which removes entrained wastewater and foam so thoroughly that a demister fines filter can be used to filter out microparticles. This configuration ensures a high distillate quality.
- 4.273. The vapour compressor recompresses the cleaned vapour to ambient pressure, at the same time increasing its temperature to approximately 120°C. The vapour then flows into the shell side of the tube-in-shell heat exchanger where it provides its heat of condensation to the evaporating wastewater within the tubes. The distillate generated is cooled in a countercurrent heat exchanger against inlet wastewater and flows from there to the distillate receiving tank. The entire concentration process is controlled by a PLC control system, which adjusts the final concentration by various parameters such as time, throughput, pressure and temperature.
- 4.274. The exact control of process parameters permits attainment of extremely high concentrations in the outlet concentrate.
- 4.275. The concentrate is ejected via the compressed air into the sludge storage tank and the evaporator begins a new cycle.
- 4.276. A schematic of the evaporation process is shown in **Figure 4.38**.

Figure 4.38: Vacuum evaporation process



Sludge Storage Tank

4.277. The sludge storage tank offers approximately 20 days storage capacity for the residue from the evaporator before disposal.

Gas engineering

4.278. The gas engineering equipment will be shared with the MBT - AD plant described above.

Process air treatment

Process air coverage

4.279. The following areas of the biogas plant are vented in a targeted manner:

- Manure reception hall / mixing tank;
- Manure reception tank; and
- Dewatering Area.

- 4.280. In these areas mainly ammonia is the reason for odour, so that an exhaust air treatment is necessary. The ammonia can be washed out effectively in an acid scrubber.
- 4.281. A biofilter will be located near the reception hall to treat the exhaust air from this area to prevent odour emissions from the storage of solid manure.

Figure 4.39: General layout plan of MTP

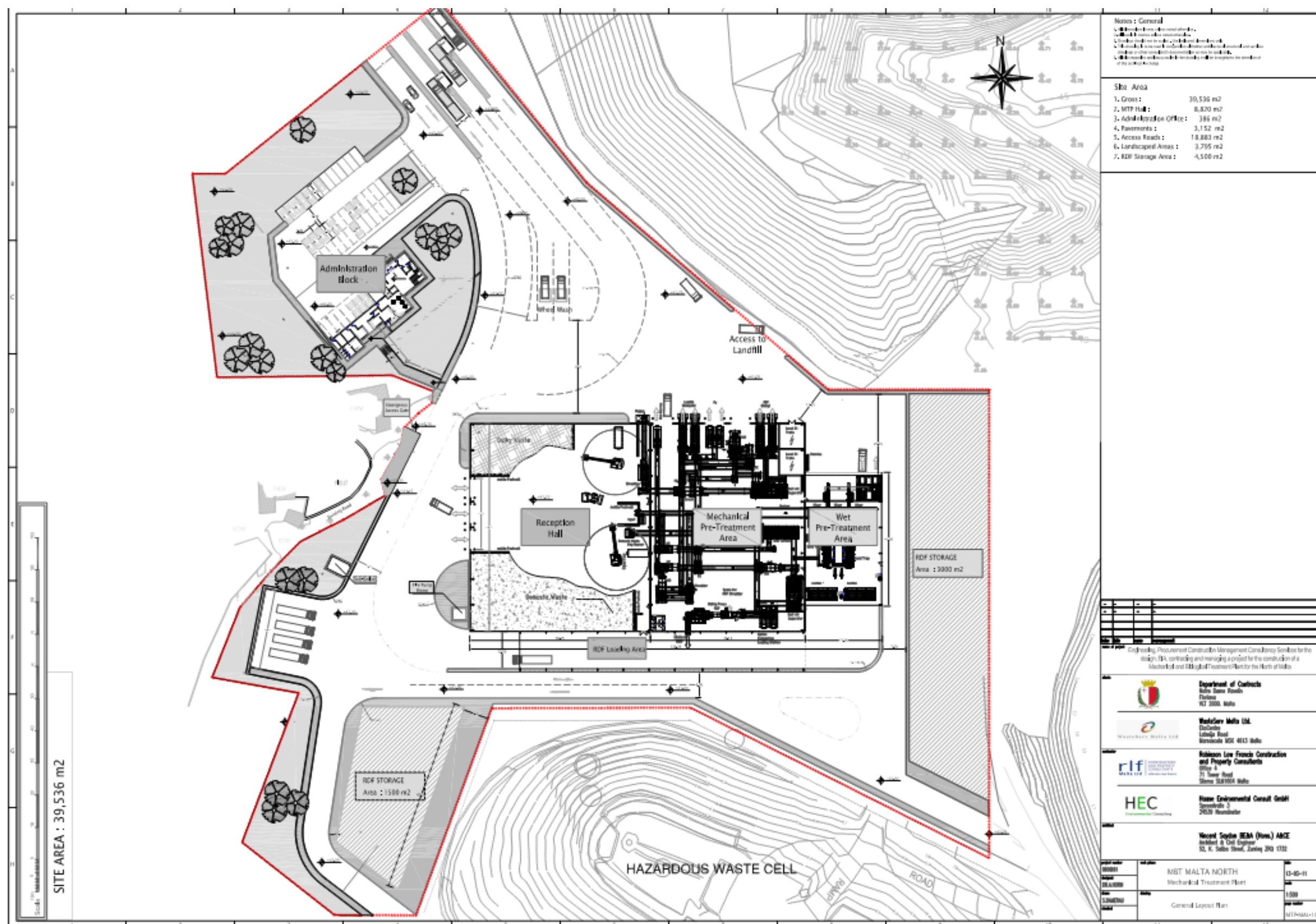


Figure 4.40: Excavation and backfill for MPT

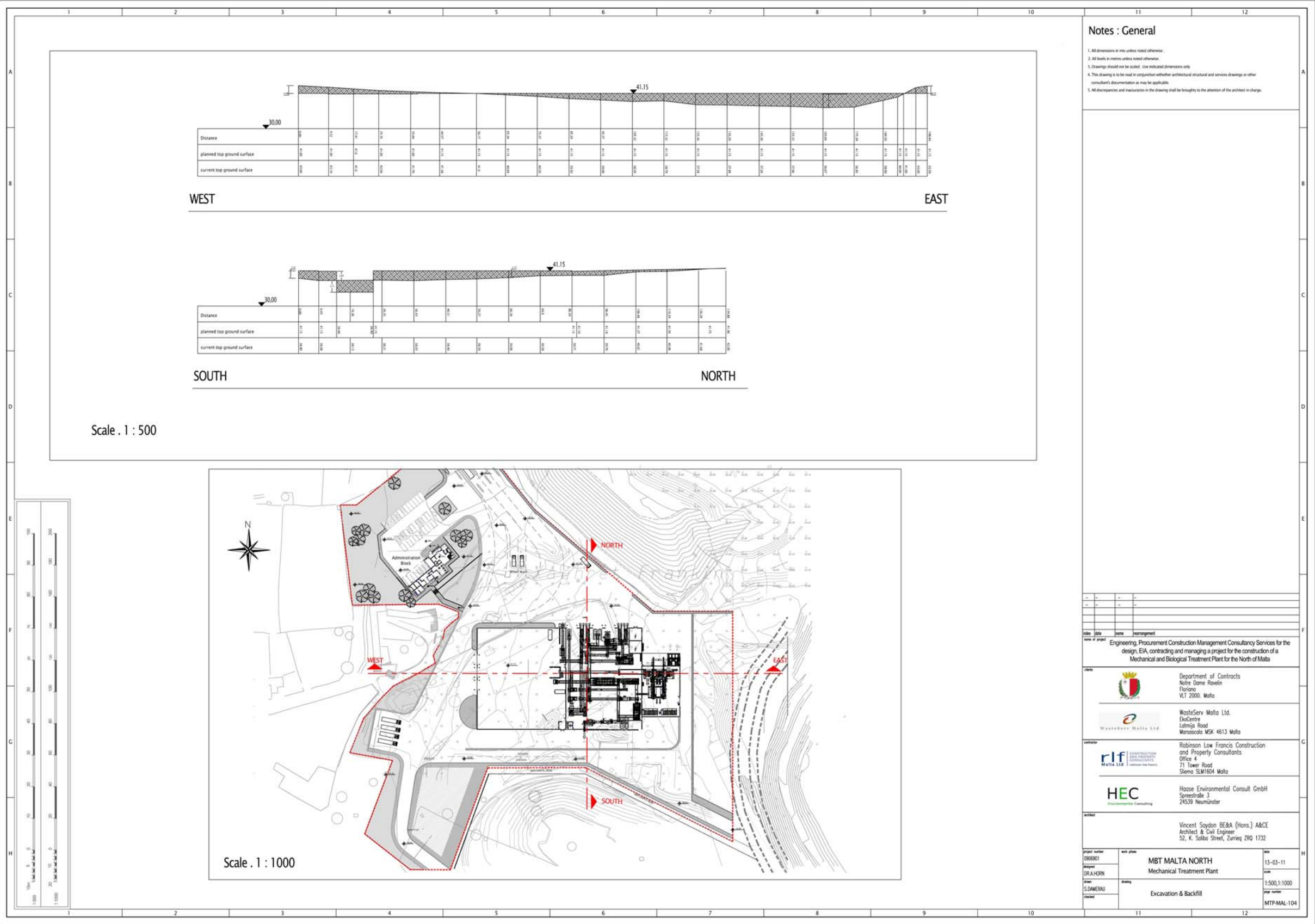


Figure 4.4I: MTP building sections

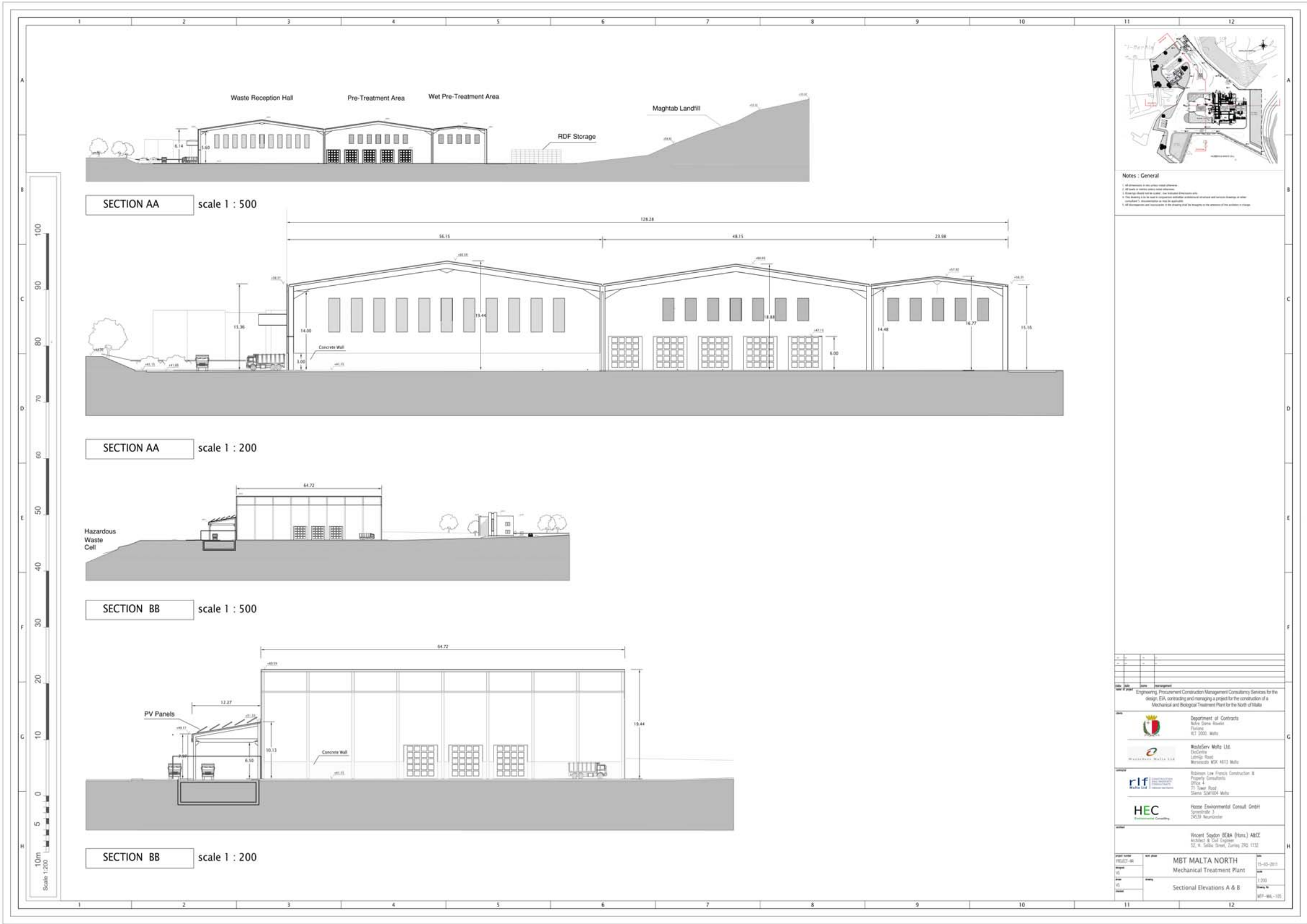


Figure 4.42: MTP pretreatment hall elevations

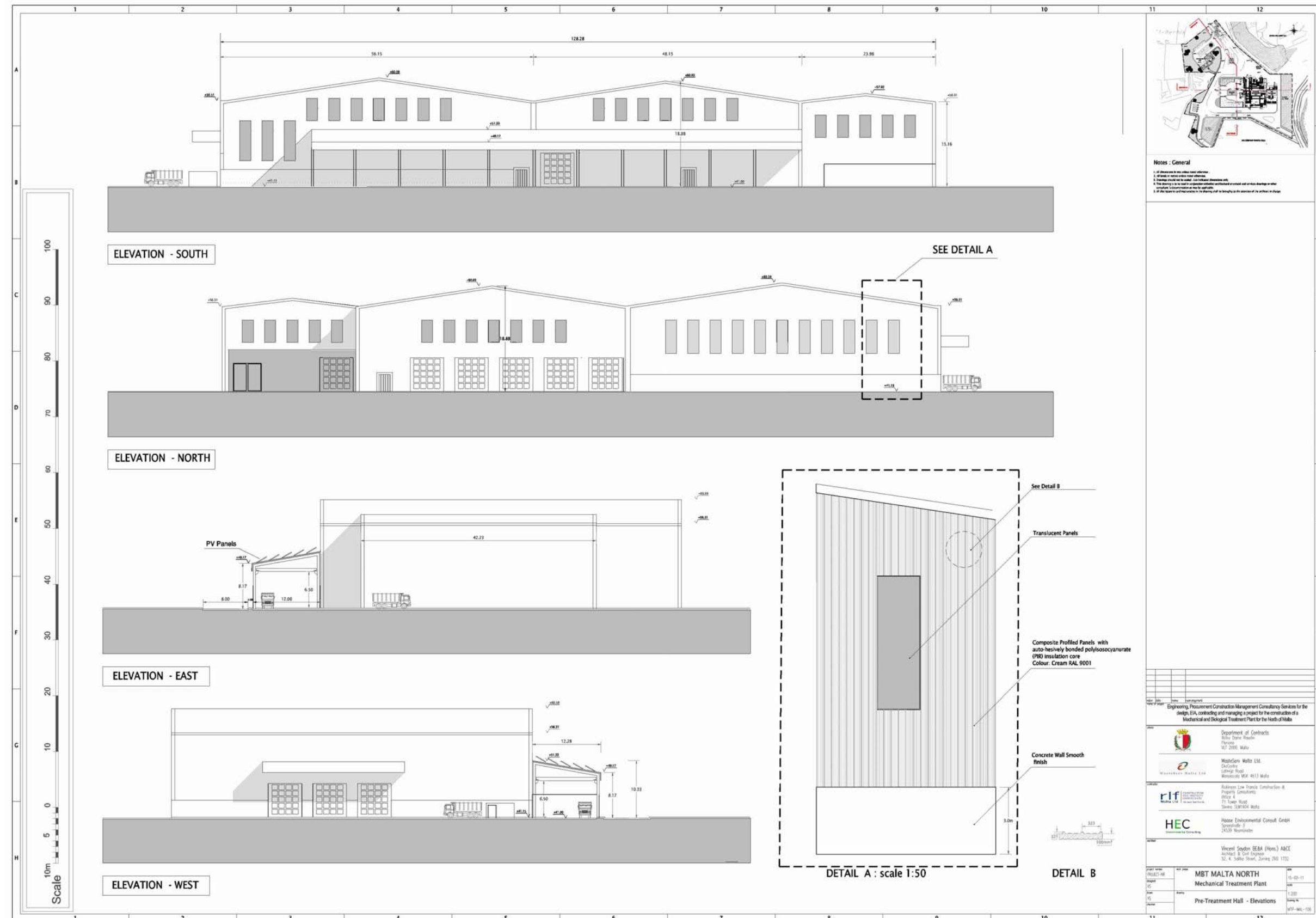
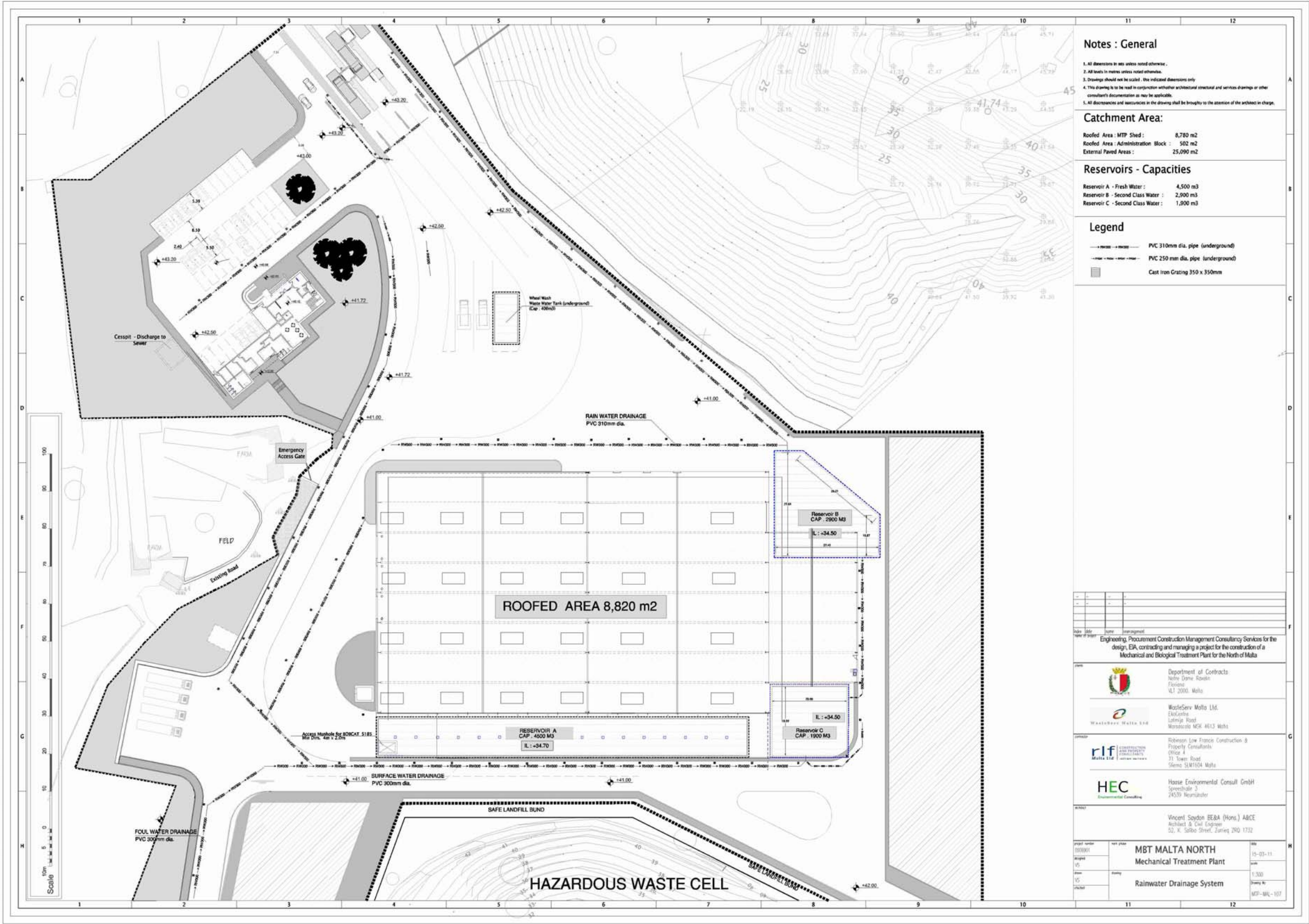


Figure 4.43: MTP rainwater drainage system



KEY PLAN

Notes : General

1. All dimensions in m, unless stated otherwise.
2. All levels in metres unless stated otherwise.
3. Drawings should not be scaled. Use indicated dimensions only.
4. This drawing is to be read in conjunction with other architectural structural and services drawings or other consultant's drawings as may be applicable.
5. All discrepancies and inaccuracies in this drawing shall be brought to the attention of the architect in charge.

| no. | date | name | description |
|-----|------------|----------------|--|
| 1 | 15-03-2011 | DR. A. GABRIEL | Engineering, Procurement Construction Management Consultancy Services for the design, EIA, contracting and managing a project for the construction of a Mechanical and Biological Treatment Plant for the North of Malta |
| 2 | 15-03-2011 | DR. A. GABRIEL | Department of Contracts Notre Dame Rowlin Floriana VLT 2000, Malta |
| 3 | 15-03-2011 | DR. A. GABRIEL | WasteServ Malta Ltd. EcoCentre Lismija Road Marsaxlokk MSX4613, Malta |
| 4 | 15-03-2011 | DR. A. GABRIEL | Robinson Low Francis Construction and Property Consultants Office 4 71 Tower Road Sliema SL11604 Malta |
| 5 | 15-03-2011 | DR. A. GABRIEL | HEC Environmental Consult GmbH Spreestraße 3 24539 Neumünster |
| 6 | 15-03-2011 | DR. A. GABRIEL | Vincent Saydon BEBA (Hons.) AMCE Architect & Civil Engineer 52, K. Saliba Street, Zurrieq ZRQ 1732 |

| Project Number | Work Phase | Date |
|----------------|---|-------------------|
| 0008901 | MBT MALTA NORTH Mechanical Treatment Plant | 15-03-2011 |
| Design | DR. A. GABRIEL | 1:250 |
| Drawn | A. GABRIEL | Plant Layout Plan |
| Checked | | MTP-MAL-200 |

GENERAL ARRANGEMENT PLAN

Notes - General

- All dimensions are in meters unless otherwise stated.
- All levels are in meters unless otherwise stated.
- Proposed dimensions are in meters. No structural dimensions are shown.
- This drawing is to be used in conjunction with other architectural drawings and various drawings at other levels.
- All dimensions and locations in the drawing shall be in accordance with the site plan.

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| 100 | Site Boundary |

Client: MET Wajja North AD & Manure Plant

Project: AD & Manure Plant

Scale: 1:500

Date: 2023-01-10

Author: [Name]

Checker: [Name]

Approver: [Name]

Version: 1.0

Notes:

- 1. All dimensions are in meters unless otherwise stated.
- 2. All levels are in meters unless otherwise stated.
- 3. Proposed dimensions are in meters. No structural dimensions are shown.
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Figure 4.46: AD detail plant layout part I

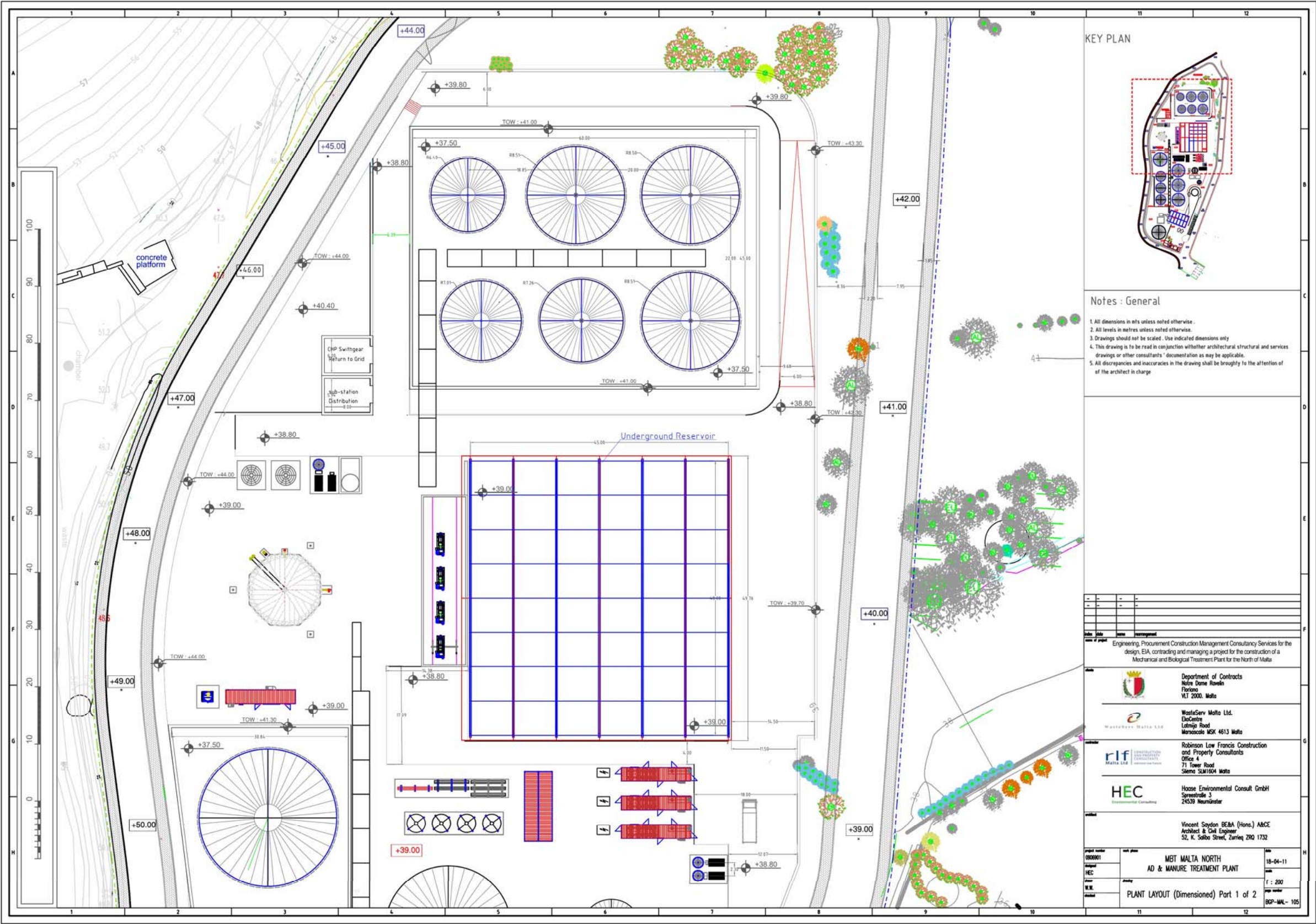
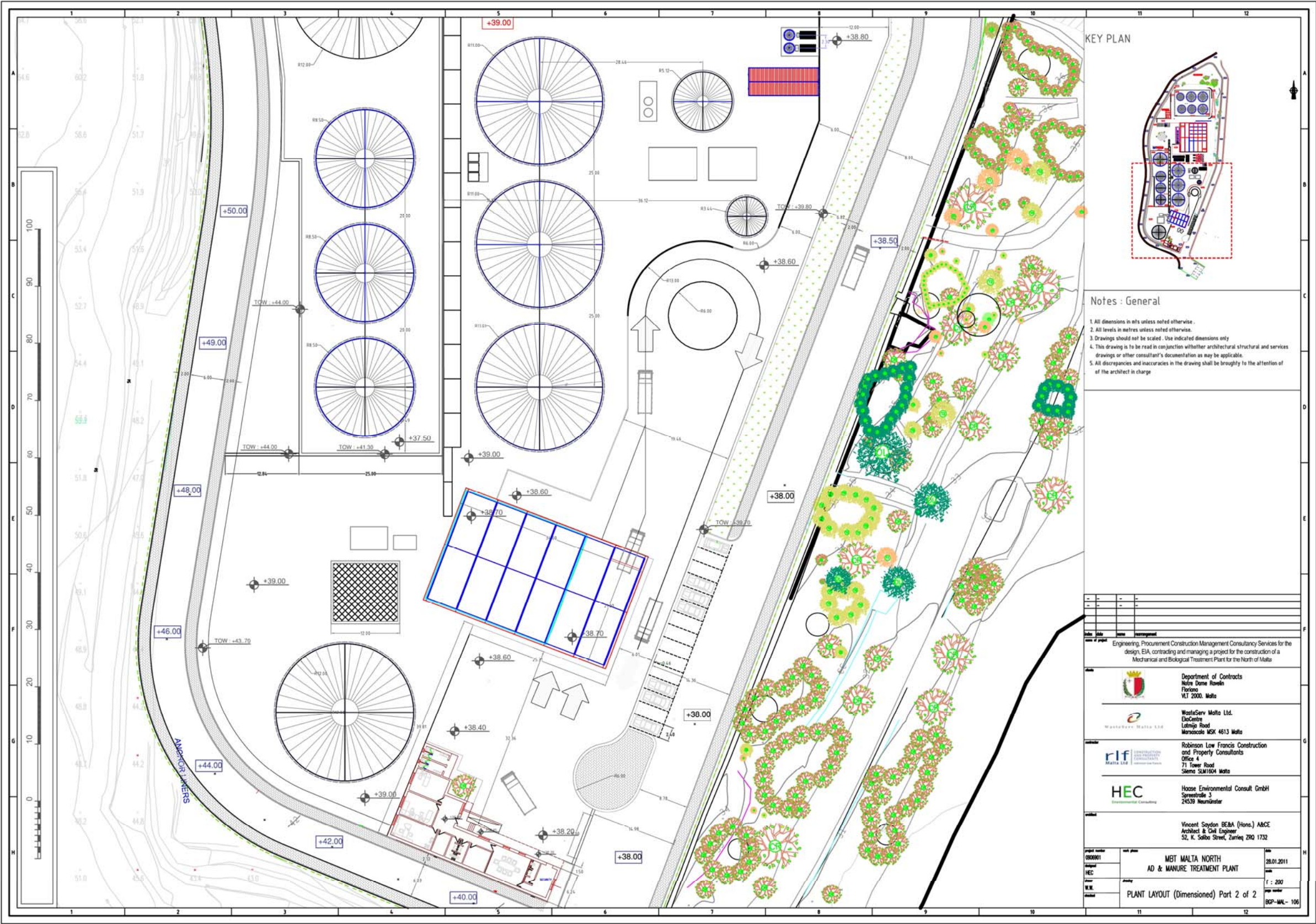


Figure 4.47: AD plant layout detail part 2



SECTION AA

SECTION BB

SECTION CC

KEY PLAN

Notes : General

- All dimensions in mtrs unless noted otherwise.
- All levels in metres unless noted otherwise.
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- This drawing is to be read in conjunction with other architectural structural and services drawings or other consultant's documentation as may be applicable.
- All discrepancies and inaccuracies in the drawing shall be brought to the attention of the architect in charge.

Finishes

- Tanks 7, 8, 21, 22, 23 : Digester Tanks in welded Steel, Insulated Walls in Welded steel, insulated and clad (Fire Class B1) in Colour finish - Grey RAL 7004 Structural Roof in Stainless Steel
- Tank No 25 - Process Water Tank : Structural Steel Walls finished in grey colour - RAL7004 Fabric roof in White Colour
- Tank No 17 : Gas Storage : Fabric Spheroid - colour White - RAL 9003 Fabric Spheroid - in White Colour
- All other Tanks : fabricated in steel and finished in Colour Grey - RAL 7004
- Maturation Hall (ref No 10) : soffit in Insulated Cladding Colour Cream - RAL 9001

| Rev | Date | Description |
|-----|------------|------------------|
| 1 | 15-03-2011 | Issue for tender |

Engineering, Procurement Construction Management Consultancy Services for the design, EIA contracting and managing a project for the construction of a Mechanical and Biological Treatment Plant for the North of Malta

Client

Department of Contracts
Noble Donna Rowella
Floriana
VLT 2000, Malta

Consultant

WasteServ Malta Ltd.
EcoCentre
Lafayette Road
Marsaxlokk MSK 4613 Malta

Architect

Robinson Low Francis Construction and Property Consultants
Office 4
71 Tower Road
Sliema SLM1604 Malta

Engineer

Hoste Environmental Consult GmbH
Spreestraße 3
24639 Neumünster

Architect

Vincent Saydon BEAA (Hons.) ARCE
Architect & Civil Engineer
52, K. Saliba Street, Zurriq ZRQ 1732

| Project number | Client | Date |
|----------------|----------------------|--------------|
| 000001 | MBT MALTA NORTH | 15-03-2011 |
| Design | AD / BGP Plant | Scale |
| Drawn | 1:200 | Sheet number |
| Sheet | Sectional Elevations | BGP-MAL-107 |

Figure 4.49: AD elevations

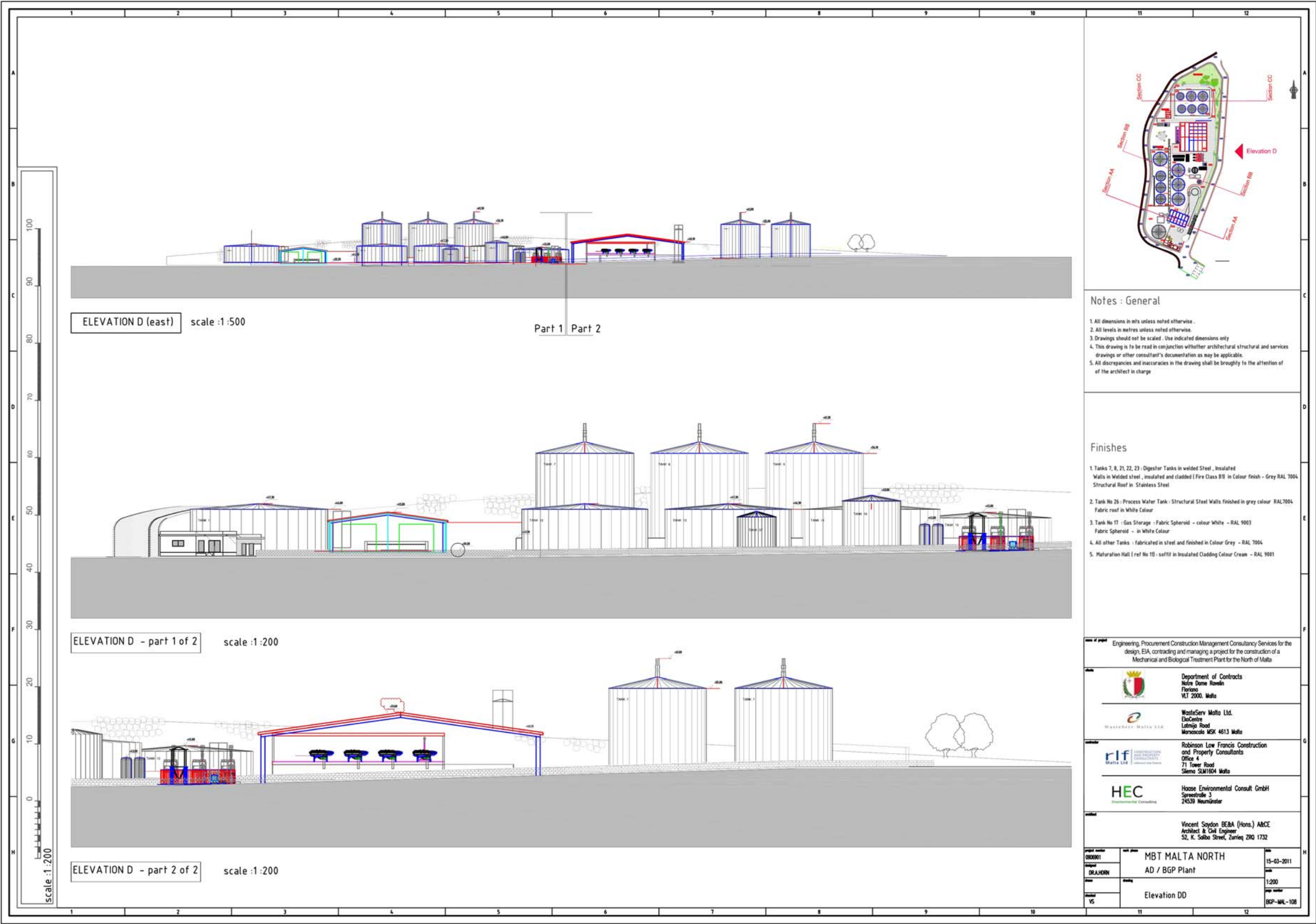


Figure 4.50: AD external and axonometric views

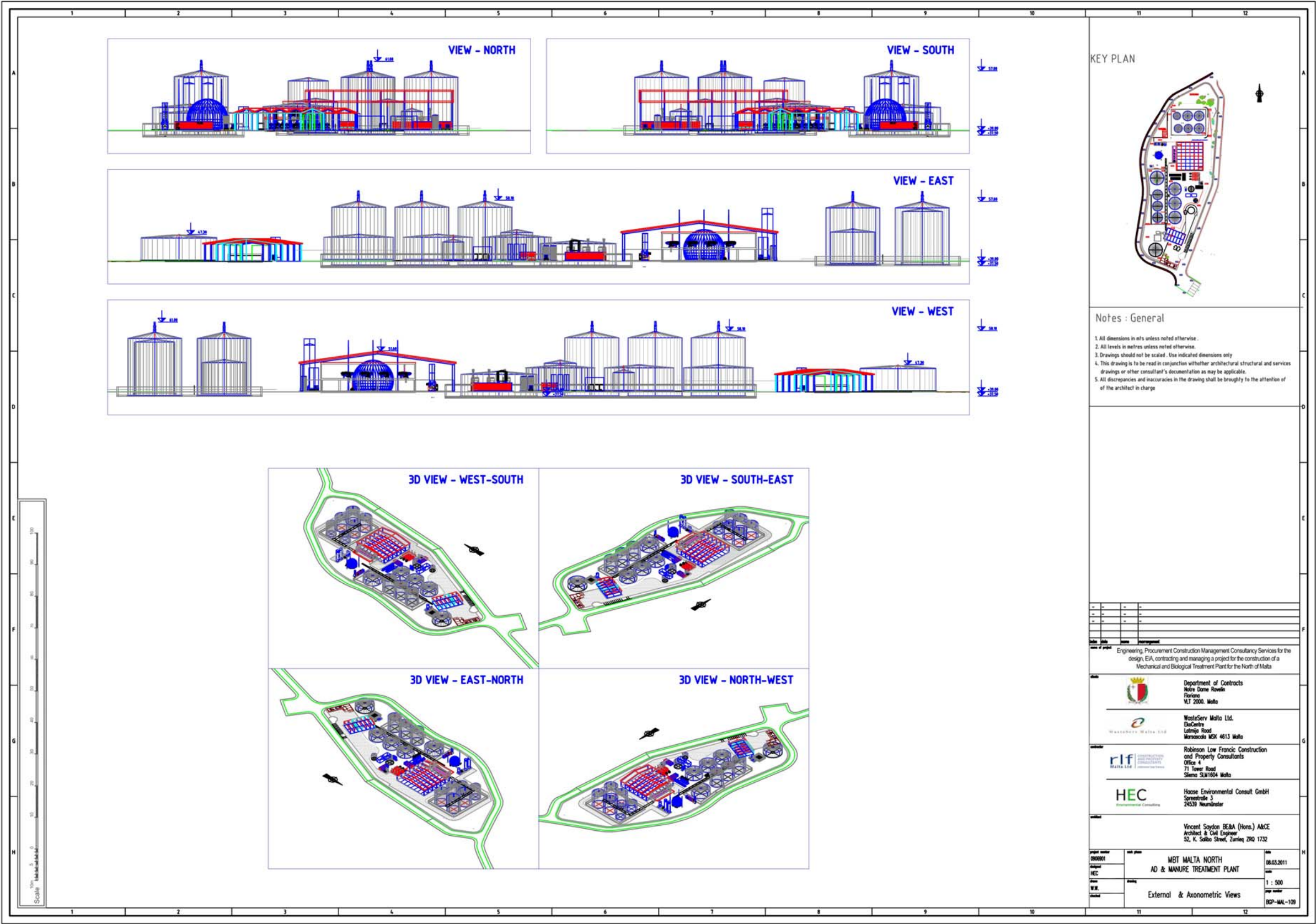


Figure 4.5I: AD elevations and backfill

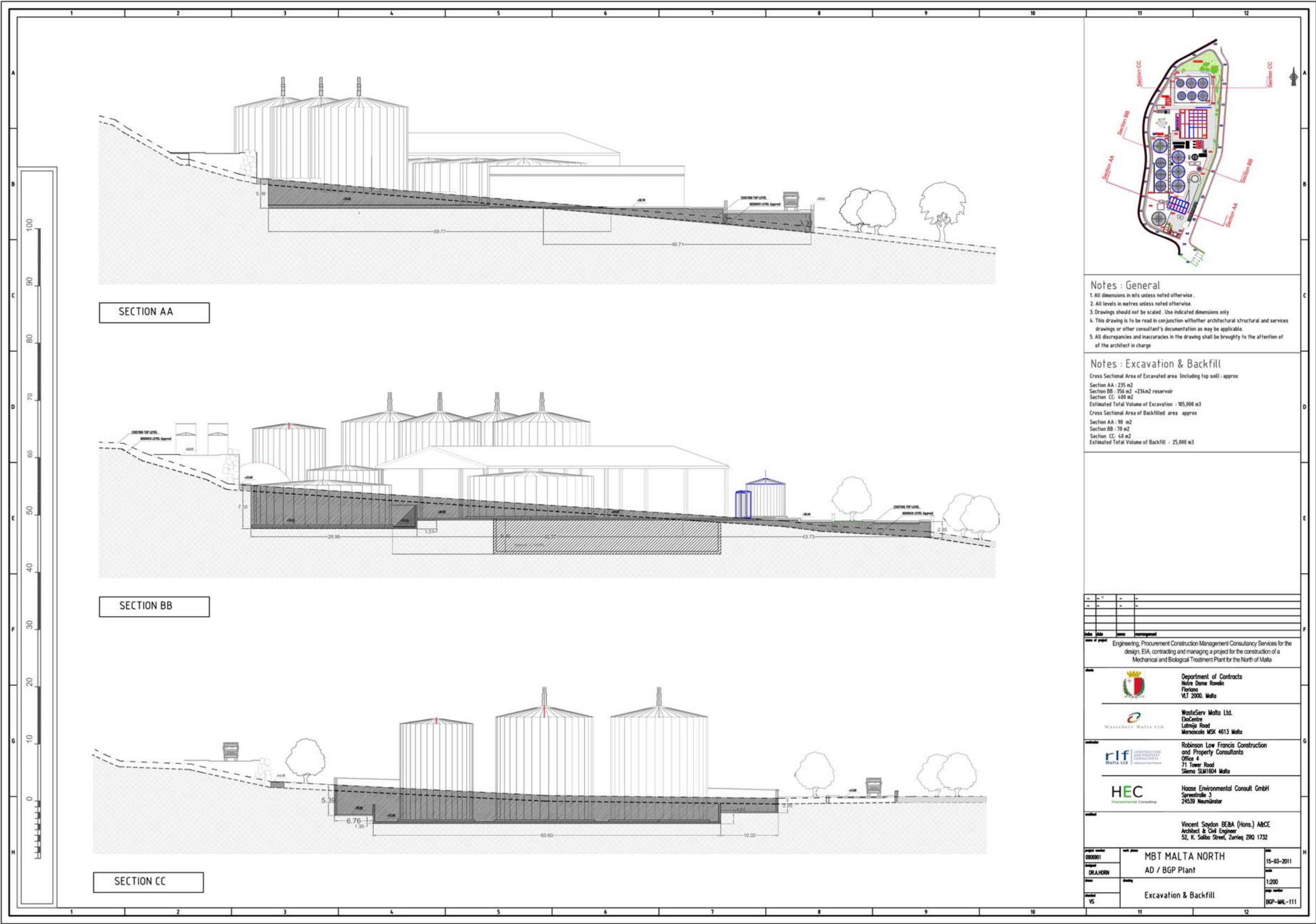
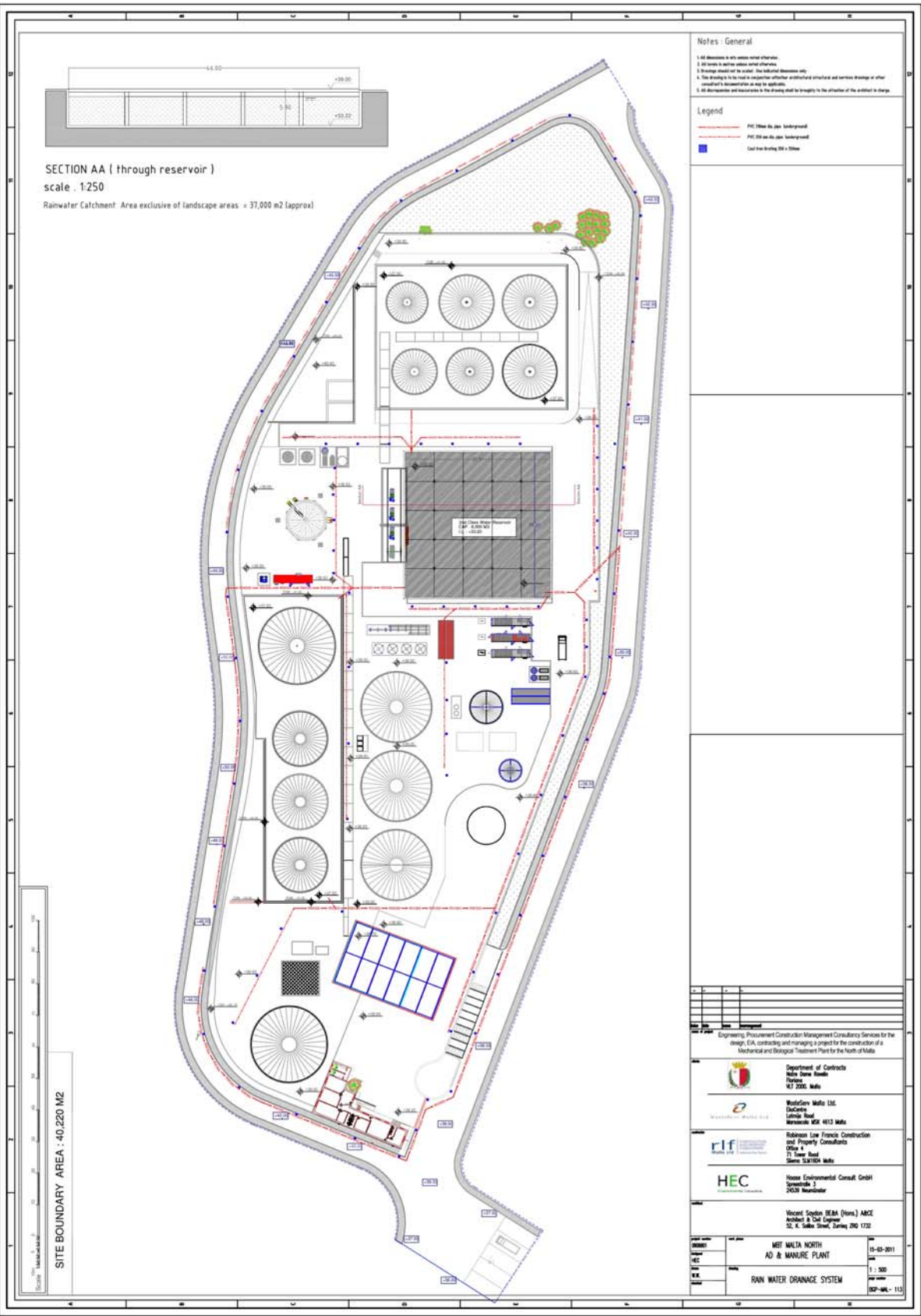


Figure 4.52: AD rainwater drainage system



Notes : General

1. All dimensions in millimeters unless stated otherwise.
2. All levels in meters unless stated otherwise.
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4. The drawing is to be read in conjunction with the architectural structural and services drawings or other relevant documentation.
5. All discrepancies and instructions in the drawing shall be brought to the attention of the architect in charge.

Typical Cross Section Detail of Pipeline -NTS

Pressure Pipe : PE 100, 150 x 11,4, SDR 11
Concrete Sleeper

Section Pipeline

MBT-Area

BCP-Area

MBT MALTA NORTH
AD & Manure Treatment Plant

Pipeline Connection from MTP site BCP site

15-03-2011

1:1000

007-004-118

Figure 4.54: MPT mass balance diagram for bulky waste

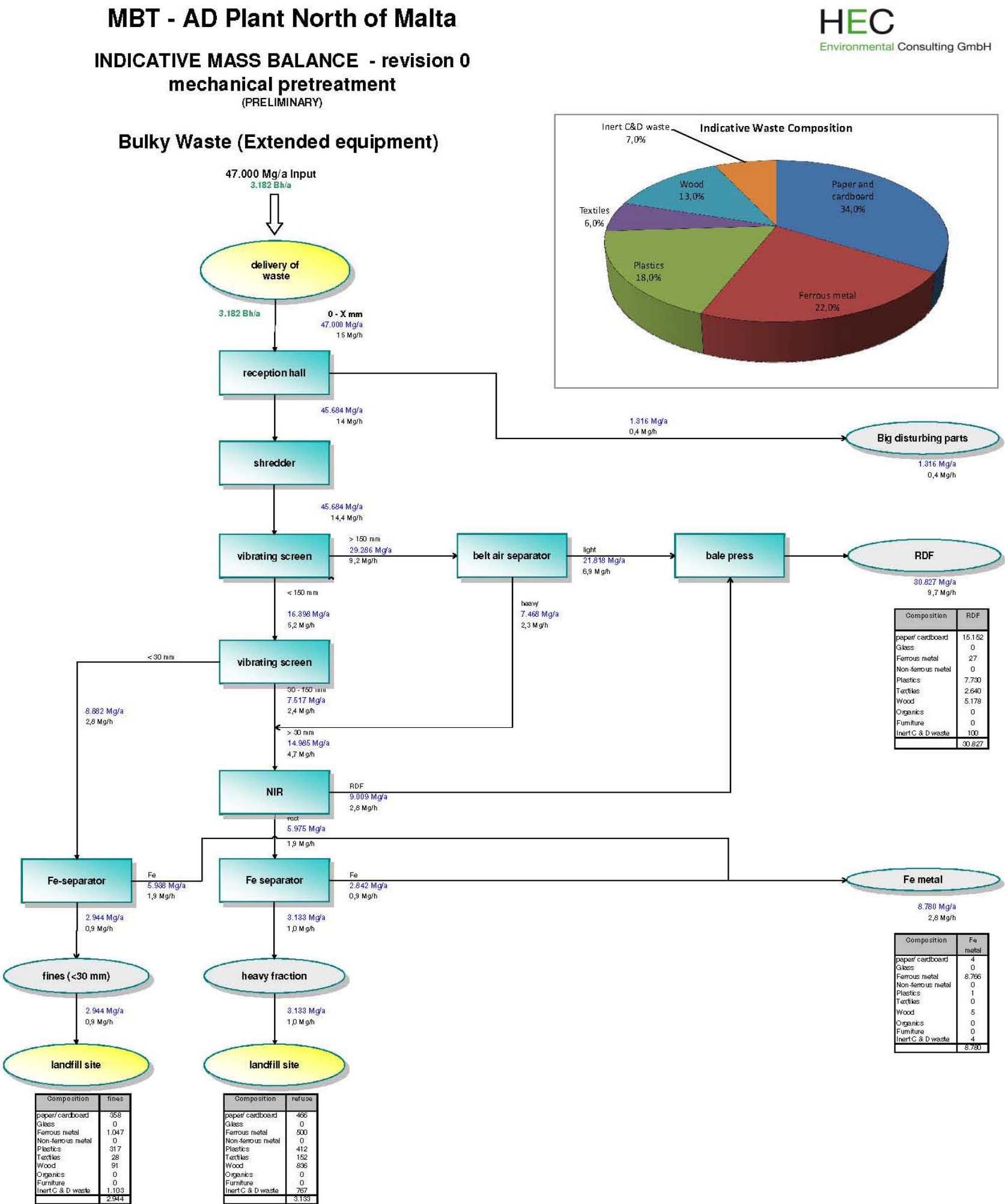


Figure 4.55: MPT mass balance diagram for domestic waste

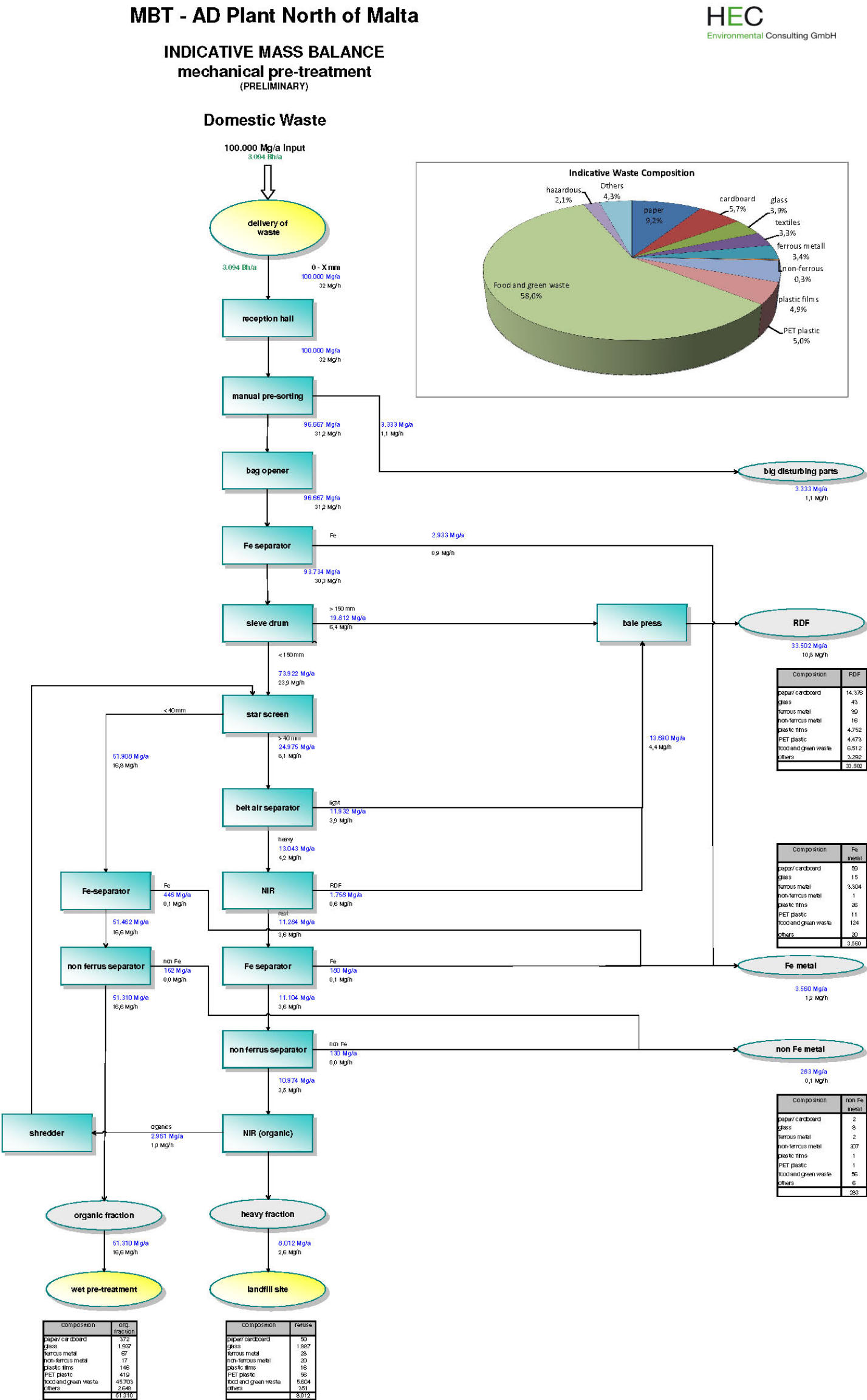


Figure 4.56: Wet pre-treatment of organic fraction

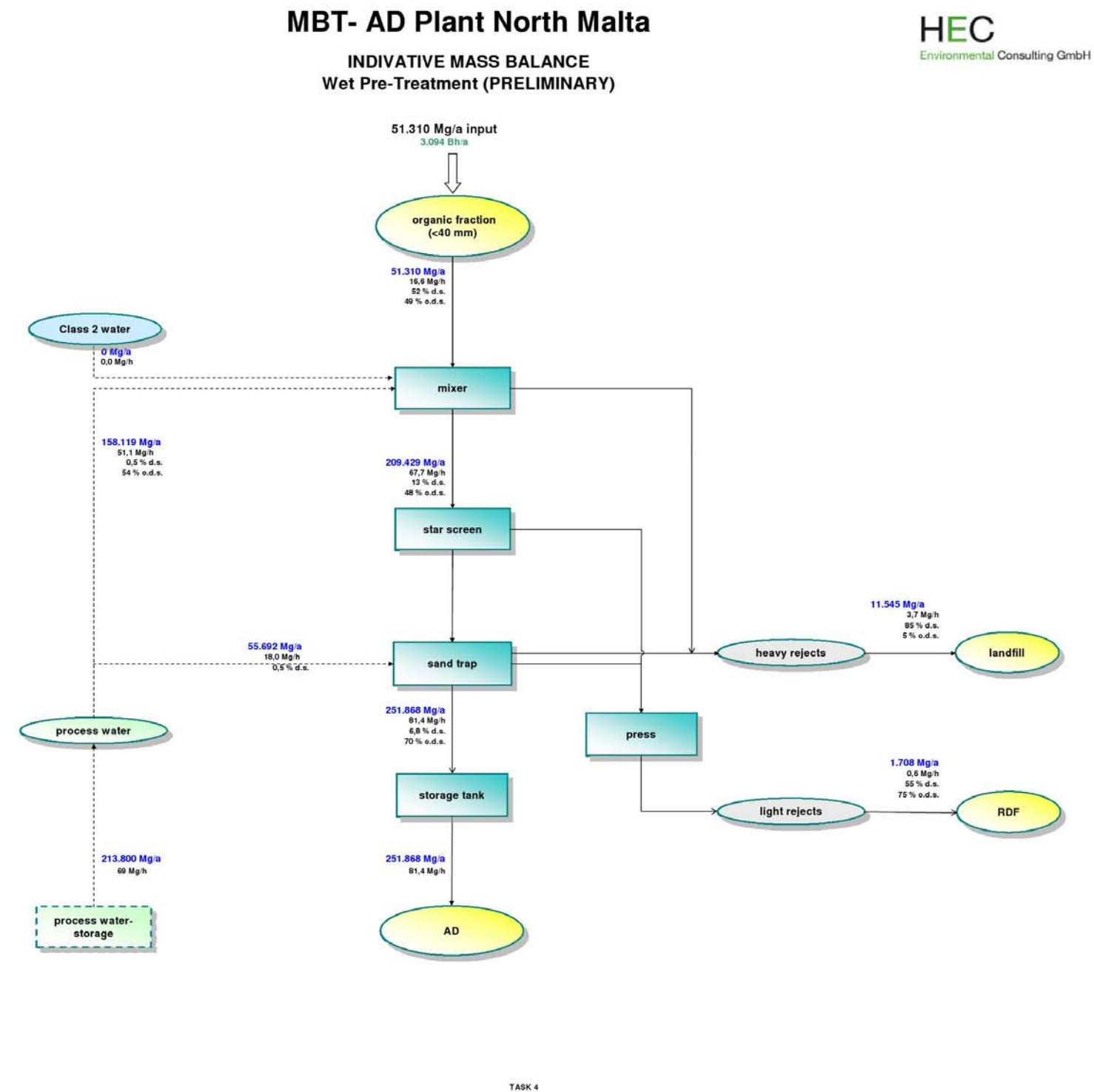
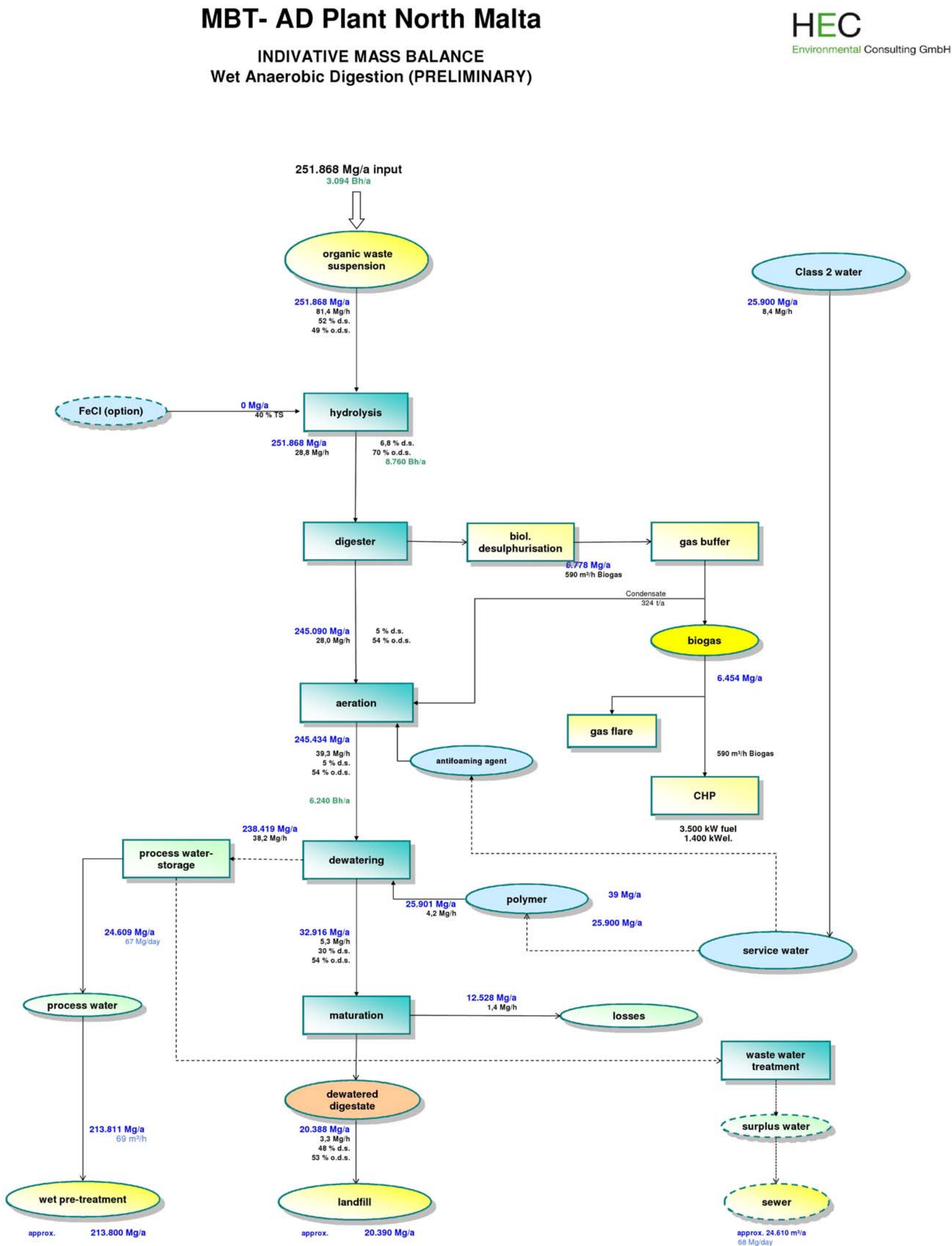
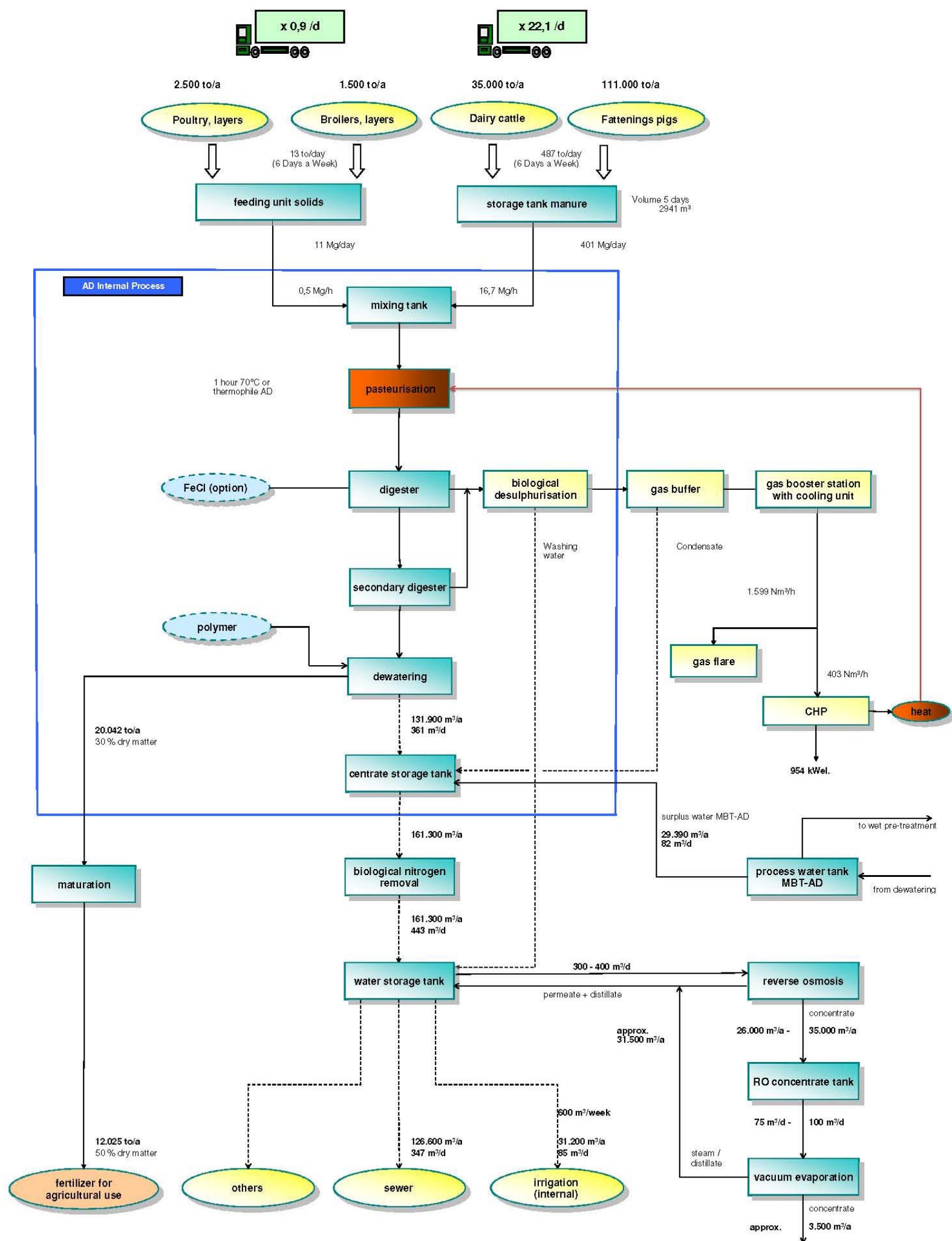


Figure 4.57: AD mass balance diagram



BGP- AD Plant North Malta

HEC
Environmental Consulting GmbH



ALTERNATIVES

Technical alternatives

- 4.282. At a strategic level, Malta's Solid Waste Management Strategy for the Maltese Islands, 2009 considered a number of technical alternatives for the Scheme before identifying a preferred option. As part of the Scheme development process, a range of technical alternatives were assessed and ranked. **Table 4.3** summarises the alternatives considered for MSW and animal husbandry waste.

Table 4.3: Assessed recycling and waste treatment alternatives

| Waste Treatment Scenario | A - MSW | B- Animal husbandry waste |
|--|------------------|---------------------------|
| Energy from waste or incineration plant (EFW) | A1 | |
| Mechanical biological treatment facility (MBT) with aerobic biological treatment | A2-1 | |
| Mechanical biological treatment facility (MBT) with <ul style="list-style-type: none"> - wet anaerobic biological treatment - dry anaerobic biological treatment | A2-2-1 A2-2-2 | |
| Biogas plant <ul style="list-style-type: none"> - with storage digestate 70,000m³ - s/l separation, storage liquor 70,000m³ | | B1-1 B1-2 |
| Biogas plant with dewatering and infiltration of process water in landfill gas wells, irrigation, use in agriculture as liquid fertiliser | | B2 |
| Biogas plant with dewatering, biological Nitrogen Removal and <ul style="list-style-type: none"> - sewage disposal, - storage water 35,000m³ | | B3-1 B3-2 |

Selection criteria

- 4.283. **Table 4.4** summarises the evaluation scheme including the aspect criteria used for assessing the technical options presented in **Table 4.4** above in selecting the preferred option.

Table 4.4: Evaluation scheme for assessing recycling and waste treatment alternatives

| Evaluation Criteria | Score | Weighting |
|---|----------|-----------|
| Environmental aspects | | |
| High negative environmental impacts | 0 points | 25% |
| Medium negative environmental impacts | 2 points | |
| Low negative environmental impacts | 4 points | |
| Economic aspects | | |
| High costs | 0 points | 25% |
| Medium costs | 2 points | |
| Low costs | 4 points | |
| Technical aspects | | |
| Low technical standard / not best practice | 0 points | 25% |
| Medium technical standard / acceptable practice | 2 points | |
| High technical standard / best practice | 4 points | |
| Adaptability / flexibility | | |
| Low adaptability / flexibility | 0 points | 10% |
| Medium adaptability / flexibility | 2 points | |
| High adaptability / flexibility | 4 points | |
| Dry recyclables | | |
| Low yield / quality of recyclables | 0 points | 10% |
| Medium yield / quality of recyclables | 2 points | |
| High yield / quality of recyclables | 4 points | |
| Compost | | |
| Low production of compost / low quality | 0 points | 5% |
| Medium production of compost / medium quality | 2 points | |
| High production of compost / high quality | 4 points | |

Preferred options

4.284. Following application of the evaluation matrix, the preferred options were:

- A2-2-1: Mechanical biological treatment with wet anaerobic digestion of MSW, 'light' equipment for the bulky waste line; and
- B3-1: Anaerobic digestion of animal husbandry waste at Ghallis or biogas plant with dewatering, biological nitrogen removal, sewage disposal or irrigation or liquid fertiliser and production of compost.

4.285. B3-1 was preferred primarily as a result of the higher degree of flexibility to handle different output product qualities rather than as a result of cost.

- 4.286. In consideration against the zero option, the Scheme is preferable because it reduces the amount of waste going to landfill in accordance with the Solid Waste Management Plan for the Maltese Islands, 2009.

Alternative sites

- 4.287. In considering solid waste management facilities, Malta's Solid Waste Management Strategy for the Maltese Islands, 2009, whilst making reference to the consideration of alternatives, identifies the Ghallis waste management complex as the preferred location for the development of a mechanical biological treatment plant to be situated towards the north of Malta. This site is preferred due its committed use for waste management operations. At project level, this fact was a primary driver in selecting the Ghallis site to include the MBT plant.

SCHEME CONSTRUCTION

- 4.288. The Scheme is a design and build project and the construction phase will be coordinated by a sub-contractor. Reference to the CMP can therefore only be made at a later stage in project management, following the issuance of planning permission, should this be granted.
- 4.289. However, at this stage an indicative timeframe for the construction of the MBT can be given as shown in **Figure 4.59**.
- 4.290. With regards to the Zwejra Closure Plan, MEPA is currently processing the IPPC application, but it is WasteServ's intention to have works completed by 2012.
- 4.291. With regards to the radioactive store, it is likely that this will be built in 2012 when all permits are secured.
- 4.292. The plant required for construction is listed in Chapter 11, Noise. The list is indicative, in order to enable the Consultants to carry out the noise assessment.

Operation time and throughput

- 4.293. Machine operating hours for the MBT are shown in **Table 4.5**.

Table 4.5: MBT machine operating hours

| | Machine operational hours Mon - Sat | Machine operational hours Sunday | Operational hours / day |
|--|--|----------------------------------|----------------------------------|
| Dry and wet pre-treatment domestic waste | 06:00-18:00 (potential extension to 20:00) | | 12h (potential extension to 14h) |
| Mechanical pre-treatment bulky waste | 08:00-16:00 (potential extension to 18:00) | | 8h (potential extension to 10h) |
| Biological treatment | 00:00-24:00 | 00:00-24:00 | 24h |

- 4.294. The MBT-AD facility is designed to achieve a throughput of 100,000 t/a domestic waste in 70 operational hours per week. The average plant availability for a properly maintained plant is 85%. Based on the proposed shift pattern the assumption is made

that any maintenance, cleaning and extension of operation due to down time will be done outside the above mentioned machine running time of 12 hours / day.

- 4.295. The MPT facility is designed to achieve the design throughput of 47,000t/a bulky waste in approximately 48 machine running hours per week.
- 4.296. Machine operating hours for the BP are shown in **Table 4.6**.

Table 4.6: BP machine operating hours

| | Machine operational hours Mon - Sat | Machine operational hours Sunday | Operational hours / day |
|----------------------|-------------------------------------|----------------------------------|-------------------------|
| Reception, feeding | 07:00-18:00 | | 11h |
| Biological treatment | 00:00-24:00 | 00:00-24:00 | 24h |

- 4.297. The Biogas Plant is designed to achieve a throughput in 66 machine running hours per week. The average plant availability for a properly maintained plant is 85%. Based on the proposed shift pattern the assumption is made that any maintenance, cleaning and extension of operation due to down time will be done during the above mentioned machine running time.

Traffic generation

- 4.298. The Project Description Statement prepared for the development (PA 2342/06) states that currently 340 vehicles per day arrive to the facilities at Ghallis. Once the Sant'Antnin Facility will be fully operational 30% of the waste will be diverted there, resulting in a decrease in 102 vehicles per day arriving at Ghallis.
- 4.299. The development of the MBT is expected to generate an additional 140 vehicles per day (100 vehicles carrying manure MBT input and output material and 40 vehicles carrying the output product from the municipal waste MBT). Considering the situation (when Sant' Antnin is operational) the net increase in traffic to Ghallis is 38 vehicles per day (140-102). However, the additional 140 vehicles will be reduced by 50 vehicles if the output (water) from the manure treatment facility is used to irrigate Maghtab and the surrounding area. This would effectively reduce to daily trips to less than 340, less than the current baseline.
- 4.300. **Figure 4.60** below also shows that new entry and exit point into the Ghallis Complex. The aim is for all vehicles to use the Trans-European Network and access the Ghallis Complex from the Coast Road. This means that the current entrance into Maghtab, located near the Maghtab village, will no longer be used as the main entrance, effectively removing the entrance away from sensitive receptors.

Figure 4.59: Preliminary construction schedule

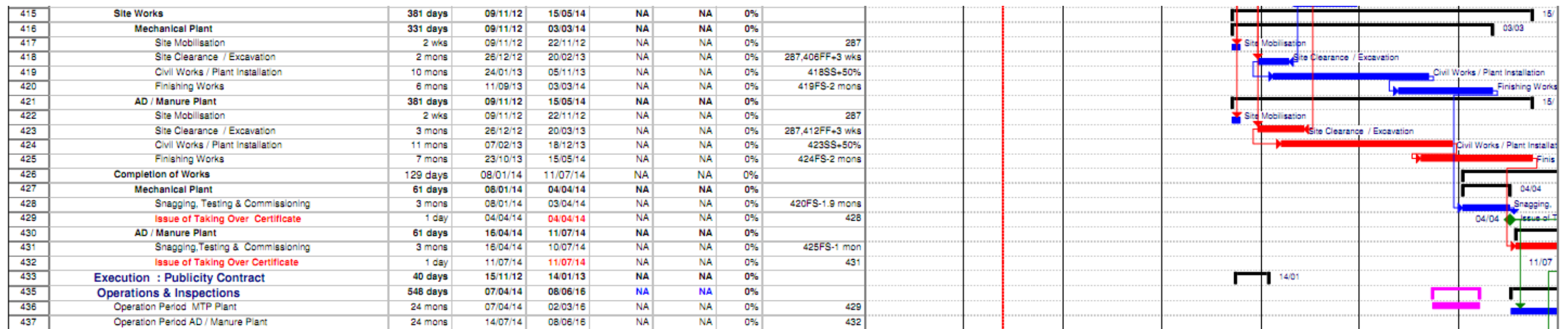
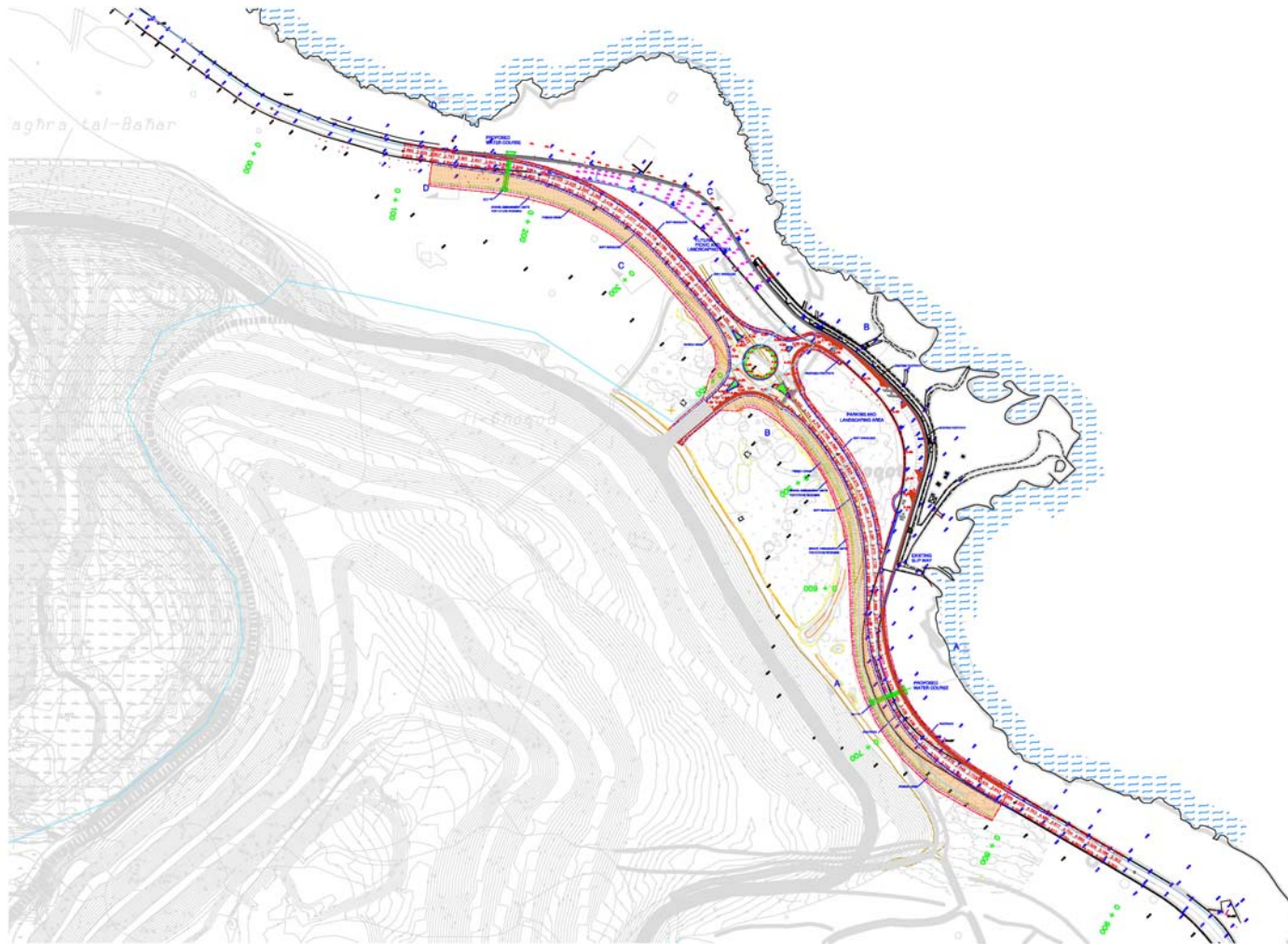


Figure 4.60 Plan showing entrance and exit to the Scheme



Pollution prevention and control measures

Control of litter

- 4.301. The facility has been designed to minimise litter generation, e.g. truck offloading in the Waste Reception is behind doors protected by air curtains, this prevents litter escaping externally. The site has limited landscaping which also helps with litter collection.

Control of vectors / pests

- 4.302. The Waste Reception Hall is designed to eliminate all pest activity through regular cleaning. The doors are provided with air curtains which should prevent / restrict access and nesting in or on the building or process structures by scavenging birds. The success of the control of vectors/pests will be largely dependent upon the operator's cleaning regime.

Noise

- 4.303. Potential noise sources will be monitored and a noise emission report will be produced. Where necessary, appropriate measures will be implemented to prevent or where that is not practicable to minimise the noise emissions. This will be regulated through the IPPC permit.

Energy efficiency

- 4.304. The Scheme will be designed to maximise energy efficiency related to both energy generation from the Scheme and energy consumption of buildings and equipment.
- 4.305. The Scheme design will incorporate all reasonable energy efficiency measures including:
- Pipework insulation;
 - Variable speed drives where appropriate; and
 - Energy efficient lighting and controls.

5. POLICIES AND LEGISLATION

INTRODUCTION

- 5.1. This chapter considers the relevance of international and national legislation, and Maltese planning policy, and the compatibility of the Scheme with this legislation / policy. It highlights and assesses the policies of Government Ministries, where relevant, and outlines those European Union (EU) Directives and Regulations and other international obligations that are applicable to the Scheme.
- 5.2. The legal basis for MEPA's request for the preparation of an Environmental Impact Assessment (EIA) stems from the Environmental Impact Assessment Regulations published in 2007 (LN 114 of 2007).

EUROPEAN LEGISLATION

- 5.3. The Treaty establishing the European Community (Article 174) indicates that members should pursue the preservation, protection and improvement of the quality of the environment, aim at a high level of environmental protection and apply policies "...based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source".
- 5.4. The relevant EU Directives include Directive 85/337/EEC (amended by Directive 97/11/EU) on the assessment of the effects of certain public and private projects on the environment, that has been promulgated by the Maltese Environmental Impact Assessment Regulations 2007, and various Directives that relate to waste, air quality, water quality and noise.
- 5.5. Since the EU's Environment Acquis has been transposed into national legislation, the Directives per se will not be assessed and, instead, the national legislation transposing the Directives is assessed below.

NATIONAL LEGISLATION

The Constitution of Malta

Declaration of Principles

- 5.6. The Constitution of Malta (Section 9) declares that the State shall safeguard the landscape and the historical and artistic patrimony of the Nation.
- 5.7. These are the only aspects of the environment referred to in the Constitution, underlining the importance of the landscape and historical heritage.

Environment and Planning Act 2010 (Act X of 2010)

- 5.8. This Act consolidates and updates the provisions of the Development Planning Act 1992 (as amended) and the Environment Protection Act 2001. Act X provides for regulation and control in the protection of the environment and in the planning and management of development.
- 5.9. The Act stipulates that *“It shall be the duty of every person together with the Government to protect the environment and to assist in the taking of preventive and remedial measures to protect the environment and manage natural resources in a sustainable manner”*.
- 5.10. Various duties fall to the Government. Those relevant to the Scheme are:
- “4(a) to manage the environment in a sustainable manner by integrating and giving due consideration to environmental concerns in decisions on socioeconomic and other policies;*
- 4(b) to take such preventive and remedial measures as may be necessary to address and abate the problem of pollution and any other form of environmental degradation in Malta and beyond, in accordance with the polluter pays principle and the precautionary principle;*
- 4(e) to apply scientific and technical knowledge and resources in determining matters that affect the environment;*
- 4(f) to ensure the sustainable management of wastes and to promote waste reduction and the proper use, reuse and recovery of matter and energy;*
- 4(g) to safeguard biological diversity;*
- 4(h) to combat all forms of pollution;*
- 4(i) to consider the environment as the common heritage and common concern of humankind; and*
- 4(j) to provide incentives leading to a higher level of environmental protection”*.
- 5.11. The Act makes provision for the establishment of an authority to implement the duties of Government under Act – the Malta Environment and Planning Authority (MEPA). MEPA’s principle duties include:
- the formulation and implementation of plans and policies relating to the promotion of sustainable development, protection and management of the environment, and the sustainable management of natural resources;
 - the promotion of proper planning and sustainable development, and the control of development in accordance with the approved plans and policies;
 - advising the Minister responsible for the Environment on environmental standards, guidelines and the making of regulations;

- issuing licences or permits as may be required to control and manage activities having an impact on the environment;
 - establishing threshold discharges;
 - monitoring the quality of the environment, and establishing methodologies and maintaining and disseminating information related to the environment; and,
 - ensuring that Environmental Audits and Environmental Assessments as may be prescribed are properly carried out.
- 5.12. In respect of waste management, The Minister can:
- prescribe rules in relation to classification of waste, in accordance with type and category;
 - regulate the management and disposal of waste, establishing quotas (quantitative and qualitative) for permitted generation of waste, as well as provide for the prevention and reduction of waste; and
 - provide for the registration and / or licensing of waste management operations.
- 5.13. In determining an application for development permission, MEPA is required to have regard to:
- Development plans;
 - Planning policies; Representations from the public; and
 - Any other material consideration the Authority deems relevant.
- 5.14. The Structure Plan Policies relevant to the Scheme are explained below, and their implications on the Scheme highlighted.
- 5.15. In making an application for development permission an applicant must certify to MEPA that he is the owner of the site, or that he has notified the owner of his intention to apply for development permission, and that the owner has granted his consent to the development, or he is authorised to carry out the development under any other law or through an agreement with the owner.
- 5.16. The Environment and Act also empowers MEPA to Schedule “*areas, buildings, structures and remains of geological, paleontological, cultural, archaeological, architectural, historical, antiquarian or artistic or landscape importance as well as areas of natural beauty, ecological or scientific value*”.
- 5.17. The Environmental Regulations Environment and Development Planning Act, relevant to the Scheme,

Environmental Management Construction Site Regulations 2007

- 5.18. The aim of these Regulations is to limit environmental degradation through construction management practices that cause least nuisance to neighbours, minimise risk to workers, and safeguard private and public property. The Regulations came into force on 1st November 2007.
- 5.19. The Regulations apply to “...any construction, water mining, or any other disturbances to the soil, including land clearing, scraping, ground excavation, land levelling, grading, cut and fill operations, and ancillary activities that include travel to the construction site, travel on access roads to and from the construction site and demolition activities”.
- 5.20. The Schedules within the Regulations provide requirements for reducing nuisance to neighbours through:
- Erection of a site notice containing details of the owner, site manager, architect and contractor;
 - Conditions for cutting of stone and bricks on site;
 - Transportation of loose material;
 - Obstruction of pavements;
 - Hazards to vehicular traffic;
 - Cleaning of the site and its immediate vicinity;
 - Rodent control;
 - Hoardings around development sites;
 - Covered ways and barricades;
 - Safe passage past the site;
 - Nuisance abatement, including construction times; and
 - Control of dust emissions.
- 5.21. Technical guidelines and specifications are also provided for minimisation of noise and vibration levels; health and hygiene, including waste management; hazardous materials handling; and point source pollution from storm water.
- 5.22. The Regulations apply to any construction site, except where the Minister has exempted such development under the provisions of Schedule VI ‘Exemptions’.
- 5.23. Regard has been given to the requirements of the Regulations in addressing the construction impacts of the Scheme.

Legal Notices

- 5.24. The Regulations in force under the Environment and Development Planning Act include the following Legal Notices that are relevant to the Scheme:

Waste Management

- **Legal Notice 337 of 2001:** *Waste Management (Permit and Control) Regulations*, **Legal Notice 797 of 2004:** *Waste Management (Activity Registration) Regulations*, **Legal Notice 106 of 2007:** *Waste Management (Activity Registration) Regulations* and **Legal Notice 184 of 2011:** *The Waste Regulations*. These Regulations regulate the production and disposal of hazardous and non-hazardous wastes. The Regulations aim to control all operations relating to the production and management of waste and promote sound waste management practices so as to safeguard human health and the environment. The Regulations also prohibit the mixing of different categories of hazardous wastes or hazardous with non-hazardous wastes.
 - The Scheme is beneficial in the context of the objectives of these Legal Notices to promote sound waste management practices. Attention to the Regulations will need to be demonstrated by the Applicant during the construction and operation of the Scheme.
- **Legal Notice 277 of 2006:** *Waste Management (Packaging & Packaging Waste) Regulations*. The Regulations are aimed at preventing the production of packaging waste and, as additional fundamental principles, reusing packaging, recycling and other forms of recovering packaging waste and, hence, at reducing the final disposal of such waste. The Regulations define recycling and recovery targets.
 - The Scheme is designed to deal with recyclable waste and is therefore in line with the objectives of this Legal Notice.
- **Legal Notice 168 of 2002, as amended by Legal Notice 289 of 2002, and Legal Notices 70, 146 and 426 of 2007:** *Waste Management (Landfill) Regulations*. These regulations provide additional measures, procedures and guidance to those in the *Waste Management (Permit and Control) Regulations* (LN 337 of 2001) to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and the global environment, including the greenhouse effect, as well as any resulting risk to human health, from the landfilling of waste, during the whole life-cycle of the landfill.
 - The Scheme is designed to treat recyclable waste and therefore will serve to reduce to amount of waste to landfill. Hence, the Scheme is beneficial in the context of the objectives of these Legal Notices.

Air Quality

- **Legal Notice 216 of 2001:** *Ambient Air Quality Assessment and Management Regulations.* The Regulations define and establish objectives for ambient air quality that are designed to avoid, prevent or reduce harmful effects on human health and the environment as a whole. The Regulations establish common methods and criteria for the assessment of ambient air quality and provide for public dissemination of information on ambient air quality. The Regulations also require assessment and monitoring of air quality, the establishment of zones and agglomerations, and the preparation of action plans as appropriate.
- **Legal Notice 291 of 2002:** *National Emission Ceilings for Certain Atmospheric Pollutants Regulations.* The Regulations stipulates that Malta must limit emissions of sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia. It is the responsibility of MEPA to ensure that the limit values laid down in the Regulations are not exceeded.
 - The implementation of the measures contained in Legal Notices 216 of 2001 and 291 of 2002 is the responsibility of National Government. Measures implemented by the Government to fulfil its obligations may affect the Scheme. It is beyond the scope of this EIA to assess further these potential measures however.
- **Legal Notice 224 of 2001**, as amended by **Legal Notice 231 of 2004** and **Legal Notice 426 of 2007:** *Sulphur Dioxide and Oxides of Nitrogen, Particulate Matter and lead in Ambient Air Regulations.*
- **Legal Notice 225 of 2001**, as amended by **Legal Notice 151** and **Legal Notice 426 of 2007:** *Limitation of Emissions of Volatile Organic Compounds Regulations.*
- **Legal Notice 163 of 2002:** *Limit Values for Benzene and Carbon Monoxide in Ambient Air Regulations.*
- **Legal Notice 292 of 2007**, as amended by **Legal Notice 426 of 2007** and **Legal Notice 478 of 2010:** *Ambient Air Quality Regulations.* The Regulations seek to control the levels of arsenic, cadmium, mercury and nickel and polycyclic aromatic hydrocarbons in ambient air.
 - Of relevance to the Scheme are emissions in the form of nitrogen oxides, particulate matter (PM10), sulphur dioxide and carbon monoxide. The thresholds set out in these Legal Notices will be used to assess the impacts of the Scheme on air quality. Attention to the Regulations will need to be demonstrated by the Applicant during the construction and operation of the Scheme. **Chapter 11** addresses impacts on air quality.

Water

- **Legal Notice 194 of 2004**, as amended by **Legal Notice 24 of 2011**: *Water Policy Framework Regulations*. These Regulations are issued under both the Environment Protection Act and the Malta Resources Authority Act. They establish a framework for the protection of inland surface waters, transitional waters, coastal waters, and groundwater. The framework is intended to prevent further deterioration, and to protect, enhance, and restore the status of aquatic systems.
 - As mentioned, the Scheme will treat agricultural waste arisings and is therefore is beneficial in the context of the objectives of this Legal Notice. Attention to the Regulations will need to be demonstrated by the Applicant during the construction and operation of the Scheme. The potential impacts on geo-environment are described in **Chapter 6**.

Noise

- **Legal Notice 193 of 2004**: *Assessment of Environment Noise Regulations* sets the scene for a survey and report on noise: it does not set levels or detail measurement / assessment methodologies. **Legal Notice 64 of 2002**: *Noise Emission in the Environment by Equipment for Use Outdoors Regulations* establishes noise limits for outdoor machinery.
 - The Legal Notices are not directly relevant to the Scheme as they do not provide guidance on the noise thresholds and guidance on how to measure it. For the assessment of noise impacts, UK guidance and standards are used as described in **Chapter 10** and instructed by MEPA.

Malta Resources Authority Act 2001

- 5.25. The Malta Resources Authority Act 2001 established the Malta Resources Authority and assigns it a number of functions in relation to the regulation of the water, minerals, and energy sector.
- 5.26. The Minister responsible for resources may, among others, also make regulations for the granting, renewal, transfer, suspensions, and cancellation of licences, permits, or other authorisations.
- 5.27. The regulations currently in force under the Malta Resources Authority Act that are relevant to the Scheme include the Legal Notices listed hereunder:
 - **Legal Notice 234 of 2002**, as amended by **Legal Notice 230 of 2004**, **Legal Notice 426 of 2007** and **Legal Notice 56 of 2008**; and **Act XV of 2009**: *Integrated Pollution Prevention and Control Regulations*. The objective of these regulations is to achieve integrated prevention and control of pollution arising from the activities listed in Schedule I, which includes waste management activities. The Regulations lay down measures designed to prevent or, where that is not practicable, to reduce emissions to air, water and land, including measures

concerning waste, in order to achieve a high level of protection of human health and the environment.

- In dealing with recyclable waste and, therefore in serving to reduce waste to landfill, the Scheme is beneficial in the context of the objectives of these Legal Notices. Attention to the Regulations will need to be demonstrated by the Applicant during the construction and operation of the Scheme as required by the IPPC regulations and the permit application the applicant will be required to submit in respect of the operation of the Scheme.
- **Legal Notice 343 of 2001:** *Protection of Waters against Pollution caused by Nitrates from Agricultural Sources Regulations* and the **Nitrates Action Programme 2010**. These regulate and control the disposal of agricultural wastes in the interests of preventing water pollution. The regulations also serve to reduce nitrous oxide (greenhouse gas) and ammonia (ozone pollutant) levels.
- **Legal Notice 23 of 2004:** *Quality of Water intended for Human Consumption Regulations*. The Regulations aim to protect human health through the provision of water that is wholesome and clean.
 - The Scheme is designed to treat agricultural waste arisings and is therefore in line with the objectives of these Legal Notices and the Nitrates Action Programme.
- **Legal Notice 139 of 2002:** *Sewer Discharge Control Regulations*. The Regulations repeal Legal Notice 8 of 1993. The Regulations control the discharge of effluents to the sewerage system and prohibit the discharge of effluents containing substances listed in Schedule A of the Regulations.
 - The Scheme is designed to treat agricultural waste arisings and is therefore is beneficial in the context of the objectives of this Legal Notice.

Energy

- **Legal Notice 538 of 2010:** *Promotion of Energy from Renewable Sources Regulations*. The Regulations seek to increase the share of energy from renewable sources.
 - The Scheme is designed to produce biogas and is therefore beneficial in the context of the objectives of this Legal Notice.

Cultural Heritage Act 2002

- 5.28. This Act provides overall protection to “...all movable or immovable objects of artistic, architectural, historical, archaeological, ethnographic, palaeontological, and geological importance...” and includes information and data relative to cultural heritage in Malta.
- 5.29. The Act specifies that “No person shall make any interventions on such cultural property or classes thereof without first having obtained a permit thereof from the Superintendence

(of Cultural Heritage)". Applications are determined subject to the results of prior investigation. There are restrictions on archaeological excavations is stated in Section 43(1) whereby excavations or explorations can only be made by the Superintendence of Cultural Heritage, or with written permission of the Superintendence. Chance discoveries of archaeological remains are also regulated and must be reported to the Superintendence.

- 5.30. **Legal Notice 160 of 1997:** Rubble Walls and Rural Structures (Conservation and Maintenance) Regulations, as amended by **Legal Notice 169 of 2004**, protects all rubble walls and non-habitable rural structures in view of their historical and architectural importance, their exceptional beauty, their affording a habitat for flora and fauna, and their vital importance in the conservation of soil and water. Walls may be sensitively repaired without MEPA's prior authorisation. Certain sensitive areas may however be declared to be Rubble Wall Conservation Areas in which no alterations to the location or construction of rubble walls and the traditional methods of their repair and maintenance will be permitted without the written approval of MEPA. In such areas, the Minister for the Environment may order the owner / occupier to repair and re-erect all the rubble walls within the area, and to continue to maintain them. The dismantling of such walls requires a permit from MEPA.

- The treatment of rubble walls and non-habitable rural structures, as relevant, within and around the Scheme Site will be considered at Full Development Application Stage. Moreover, the matters raised by these Legal Notices are considered in the landscape and visual amenity assessment, the agriculture assessment, and the cultural heritage assessment of the Scheme presented in **Chapters 7, 8 and 9**, respectively.

Other

- **Legal Notice 217 of 2001:** *Freedom of Access to Information on the Environment Regulations*, which ensures freedom of access to, and the dissemination of information held by public authorities on, the environment.
 - The EIS Update and its supporting documents fall under this Legal Notice and are to be made public.

Solid Waste Management Strategy for the Maltese Islands 2001

- 5.31. The Solid Waste Management Strategy was first prepared in 2001 but was subsequently updated in 2009 (see below). The 2001 Strategy is still relevant however. The 2001 Waste Management Strategy outlines the following concepts and vision:
- An integrated approach to waste management;
 - A reduction in the quantity and hazard of waste arisings;

- Higher levels of re-use;
 - Increased recycling and composting;
 - The possible further development of energy recovery technologies (e.g., anaerobic digestion);
 - Safe disposal of residues which cannot be otherwise managed; and
 - Greater public participation in the decision making process.
- 5.32. The Strategy introduces targets to reduce the amount of biodegradable waste that goes to landfill, and establishes a number of targets focused on waste minimisation and better management of waste streams.
- 5.33. The Scheme is beneficial in the context of the vision and direction of the 2001 Waste Management Strategy.

Agricultural Waste Management Plan for the Maltese Islands 2008

- 5.34. The Agricultural Waste Management Plan provides a recommended way forward for the treatment of animal waste. The recommended option includes provision for:
- A regional manure treatment plant in the north of Malta to treat manure generated in this catchment area. This would be combined with a Mechanical Biological Treatment (MBT) plant for municipal solid waste; and
 - A regional manure treatment plant located closest to the remaining farms to treat manures and slurries generated in the north-west, central and south of Malta.
- 5.35. The Scheme is in accordance with the recommended option for the treatment of animal waste as set out in the Agricultural Waste Management Plan.

Waste Management Plan for the Maltese Islands 2008 - 2012

- 5.36. The Waste Management Plan discusses legislation relevant to waste management in the Maltese Islands and presents a detailed picture of the waste arisings. Section 3, on Planning Procedure, identifies Government's intention to "...locate a Mechanical Treatment Plant, including a bio-digester to recover biogas, complete with all ancillary facilities, to reduce the amount of landfilling required. This ideally will be located in the North of Malta in an already committed site and will combined with the treatment of agricultural waste".
- 5.37. The Scheme is in accordance with the Government's intention for waste management as set out in the Waste Management Plan.

Solid Waste Management Strategy for the Maltese Islands 2009

- 5.38. The 2009 Solid Waste Management Strategy updates the 2001 Strategy. The Strategy identifies preferred options for solid waste management facilities. The preferred

technology mix includes the construction of an MBT plant in the north of Malta, intended to treat organic waste and animal waste from within the catchment area. The Strategy identifies the Ghallis waste management complex as a preferred site for this facility in light of its committed use for waste management operations.

- 5.39. The Scheme is in accordance with the preferred options for solid waste management facilities as set out in the 2009 Solid Waste Management Strategy.

PLANNING POLICY

- 5.40. Planning policy relevant to the Scheme comprises policies embodied in the Structure Plan for the Maltese Islands 1990; Space for Waste: the Central Malta Local Plan 2006; the Waste Management Subject Plan 2001; and the Development Control Policy & Design Guidance 2007.

Relevant Structure Plan Policies

- 5.41. This section reviews the Structure Plan Policies relevant to the Scheme.

Built environment policies

- 5.42. **POLICY BEN 1:** *Development will not normally be permitted if the proposal is likely to have a deleterious impact on existing or planned adjacent uses because of visual intrusion, noise, vibration, atmospheric pollution, unusually high traffic generation, unusual operating times, or any other characteristic which in the opinion of the Planning Authority would constitute bad neighbourliness.*
- The matters raised under policy BEN 1 are considered in **Chapters 7, 10, 11 and 12**. The EIA considers potential impacts and proposes mitigation measures to reduce significant impacts in the spirit of BEN 1. It is, however, noted that the Scheme is located within an existing waste management facility.
- 5.43. **POLICY BEN 2:** *Development will not normally be permitted if, in the opinion of the Planning Authority, it is incompatible with the good urban design, natural heritage, and environmental characteristics of existing or planned adjacent uses, and is unlikely to maintain the good visual integrity of the area in which it is located.*
- BEN 2 is applicable in respect of its reference to the environmental characteristics of the existing or planned adjacent uses, and the maintenance of good visual integrity. A landscape and visual amenity assessment of the Scheme is presented in **Chapter 7**.
- 5.44. **POLICY BEN 3:** *Permission for development will normally be given only if provision is made in the proposal for the installation of underground ducts to link electricity and telecommunications distribution networks to the development, the ducts to be utilised immediately if underground supplies are available or held in reserve for subsequent use if only overhead supplies are available at the time of the development.*

- All utilities will be underground.
- 5.45. *POLICY BEN 5: Applications for development permits outside urban areas will be judged against the policies and design guidelines of the Local Plans for Rural Conservation Areas and, in the interim period, to Structure Plan policies and the guidelines contained in the Explanatory Memorandum.*
- The Central Malta Local Plan (CMLP) 2006 is applicable to the Scheme and the Scheme is in compliance with the local plan, as described below.
- 5.46. *POLICY BEN 8: The Planning Authority advises intending applicants for permission to develop to consider applications for outline permission which establish the principles and general characteristics of a development proposal before the applicant is faced with the expense of the more detailed application for full permission to develop. Where this procedure is used, the application fee will be payable for the outline application only.*
- The Scheme is set within the context of the masterplan for the Maghtab Environmental Complex as granted under PA 4834/04. In this regard, the principles and general characteristics of the Scheme have been established.
- 5.47. *POLICY BEN 9: Conditions attached to any permit to develop will be such as to preclude unneighbourly construction procedures, unfinished surfaces, and the permanent dumping of building materials and other rubbish on or near the site.*
- The development of a Construction Management Plan and adherence to the Environmental Management Construction Site Regulations 2007 (described above), together with the development of a Construction Waste Management Plan, will ensure that the Scheme conforms with this policy.
- 5.48. *POLICY BEN 12: The Planning Authority will decide if an Environmental Impact Assessment of a form and content satisfactory to the Authority is required to accompany any application for permission to develop. The environmental impact of proposed development will be carefully assessed through development control procedures, and where development permits are granted any adverse impacts will be mitigated through permit conditions and any other necessary legal measures.*
- The application for development of the Scheme has been made in line with this policy. MEPA has requested an EIA in accordance with Article 3(7) of the EIA Regulations 2007. This EIS Update has been prepared in line with the guidelines issued by MEPA for this assessment.
- 5.49. *POLICY BEN 17: Development permit applications shall include proposals for hard and soft landscaping, and measures by which their maintenance will be undertaken.*
- A detailed landscaping scheme will be developed at Full Development Application Stage.

Agriculture policies

- 5.50. **POLICY AHF 7:** *The removal of visual intrusions in the landscape, the reinstatement and maintenance of random stone boundary walls, and the establishment of rights of way will be a condition of development permits.*
- The masterplan for the Magtab Environmental Complex envisages the significant visual enhancement of the wider area, and the treatment of stone boundary walls and rights of way in the context of the Scheme Site will also be considered at Full Development Application Stage. Moreover, the matters raised under policy AHF 7 are considered in the landscape and visual amenity assessment and the agriculture assessment of the Scheme presented in **Chapters 7** and **8**, respectively.

Transport policies

- 5.51. **POLICY TRA 2:** *The promoters of major developments will be required to prepare traffic impact statements illustrating the likely impact of their proposals on the highway network.*
- 5.52. **POLICY TRA 3:** *Agreements will be required with prospective developers for the funding of the necessary remedial highway works required to accommodate their proposals.*
- As mentioned above, the Scheme is set within the context of the masterplan for the Magtab Environmental Complex as approved under PA 4834/04. The masterplan was subject to EIA, which included a Traffic Impact Assessment.
- 5.53. **POLICY TRA 4:** *The following parking principles will be adopted in different areas for new developments:*
1. *Valletta / Floriana and other Urban Conservation Areas: restraining standards catering for operational vehicles only*
 2. *Remainder of Harbour area: moderate restraint standards*
 3. *Rest of mainland Malta: accommodating standard.*
- The Scheme will include parking provision in accordance with the relevant standard.

Rural conservation policies

- 5.54. **POLICY RCO 1:** *Rural Conservation Areas are designated as illustrated in the Key Diagram. Within such areas the following sub areas will be designated, using World Conservation Union definitions and criteria where relevant:*
1. *Areas of Agricultural Value: areas comprised of high-grade agricultural land including irrigated and partially irrigated land*
 2. *Areas of Ecological Importance: relatively large areas designated to protect typical and rare habitats*

-
3. *Sites of Scientific Importance: sites containing individual species, groups of species, and geological features*
 4. *Areas of Archaeological Importance: concentrations of valuable archaeological sites*
 5. *Sites of Archaeological Importance: individual and/or isolated archaeological sites*
 6. *National Parks: relatively large areas of national significance not materially altered by human use, with managed visitor access and amenities*
 7. *Areas of High Landscape Value*
 - The Application Site is not within a designated Area of High Landscape Sensitivity as defined by Policy CG22 of the CMLP. Areas to the south of the Site are however proposed for designation as Areas of High Landscape Sensitivity. Given the extent and visibility of the former Magtab Landfill site, it is important therefore to consider the impact of the Scheme on the wider landscape. Impacts on the landscape arising from the Scheme are assessed in **Chapter 7**.
- 5.55. **POLICY RCO 3:** *As soon as is practicable after the adoption of the Structure Plan, the Planning Authority will draw up Local Plans covering all the areas designated by the Plan as Rural Conservation Areas. The purpose of these Local Plans will be to:*
1. *Specify the precise boundaries of areas having different forms of scenic value, Areas of Agricultural Value, Areas of Ecological Importance, Sites of Scientific Importance, Areas and Sites of Archaeological Importance, National Parks, and Areas of High Landscape Value*
 2. *Specify in detail the measures of protection and enhancement to be adopted with respect to the various uses and activities*
 3. *Consider the results of the assessment of mineral deposits initiated by the Planning Authority (Policy MIN 2) and the implications for the further working of minerals and the sterilisation of land*
 4. *Resolve conflicts between the various uses and activities*
 - The Central Malta Local Plan (CMLP) was approved in 2006. The relevant local plan policies are discussed below.

Scenic value policies

- 5.56. **POLICY RCO 4:** *The Planning Authority will not permit the development of any structure or activity which, in the view of the Authority, would adversely affect scenic value because it would:*
1. *Break a presently undisturbed skyline*

2. *Visually dominate or disrupt its surroundings because of its mass or location*
3. *Obstruct a pleasant and particularly panoramic view*
4. *Adversely affect existing trees or shrubs*
5. *Introduce alien forms, materials, textures, or colours*
 - Impacts on the scenic value of the area arising from the Scheme are assessed in **Chapter 7**.

Cultural heritage policies

- 5.57. **POLICY ARC 2:** *In making the designations referred to in Policy ARC 1, the Planning Authority will give protection ratings as appropriate to local circumstances as follows:*

Class A: Top priority conservation. No development to be allowed which would adversely affect the natural setting of these monuments or sites. A minimum buffer zone of at least 100m around the periphery of the site will be established in which no development will be allowed.

Class B: Very important to be preserved at all costs. Adequate measures to be taken to preclude any damage from immediate development.

Class C: Every effort must be made for preservation, but may be covered up after proper investigation, documentation and cataloguing.

Class D: Belonging to a type known from numerous other examples. To be properly recorded and catalogued before covering or destroying.

- 5.58. **POLICY ARC 3:** *Applications for planning permission for development affecting ancient monuments and important archaeological areas and sites, including areas and sites having such potential will normally be refused if there is an overriding case for preservation. Where there is no overriding case for preservation, development of such sites will not normally be permitted until adequate opportunities have been provided for the recording and, where desirable, the excavation of such sites.*
- 5.59. **POLICY ARC 6:** *In the interim period all sites recorded in the National Protective Inventory will be protected in accordance with Development Planning Act powers and by reference to the ratings given in Policy ARC 2.*
- Impacts on the archaeology of the area arising from the Scheme are assessed in **Chapter 9**.

Waste policies

- 5.60. **POLICY PUT 3:** *A major strategy of public utilities planning will be the efficient management and conservation of resources, the recycling and reuse of waste water and waste materials, the minimisation of waste, the avoidance of land, sea, and air pollution, and protection from the dangers of hazardous substances. The water cycle from supply through*

distribution, use, disposal, treatment, and reuse will be planned and managed comprehensively.

- The Scheme is critical in the roll-out of the strategy envisaged by this policy.

5.61. *POLICY PUT 14: Applications for the handling, treatment and disposal of all waste, excepting totally inert mineral wastes, will be considered only if an Environmental Impact Assessment has been prepared for consideration by the Planning Authority. Permission will only be granted when the responsible authorities are satisfied that the nature and control of the operation will:*

1. *Protect natural resources against pollution*
2. *Protect the local environment against nuisance*
3. *Provide for an appropriate after use*

- The Scheme is in compliance with this policy.

5.62. *POLICY PUT 16: Sites will be identified at strategic locations in relation to the main areas of population, commerce, and industry for the transfer or treatment of municipal, commercial, and industrial inert / non toxic waste.*

5.63. *POLICY PUT 17: The ultimate disposal of municipal, commercial, and industrial inert / non toxic waste will normally be by controlled landfill. Sites will be identified at strategic locations, and there will be a presumption in favour of fewer, larger sites located in areas already derelict, such as voids created by quarrying operations. The Planning Authority will seek to provide for the release of suitable sites for landfilling in order to maintain sufficient capacity for a minimum of 5 years and a maximum of 20 years anticipated disposal requirements. Location and operation of landfill sites will take full account of the need to protect groundwater from pollution, and adjacent property from gas migration. Reuse and disposal of power station fly ash will be given priority.*

5.64. *POLICY PUT 18: Government will actively investigate the need for, and most appropriate facilities for, the treatment and safe disposal of hazardous and toxic wastes. Suitable safety standards will be adopted and enforced. Appropriate new facilities will be established as early as possible, and subject to environmental and public health considerations.*

- The Scheme, in the context of the masterplan for the Maghtab Environmental Complex, is in compliance with Policies PUT 16, PUT 17 and PUT 18.

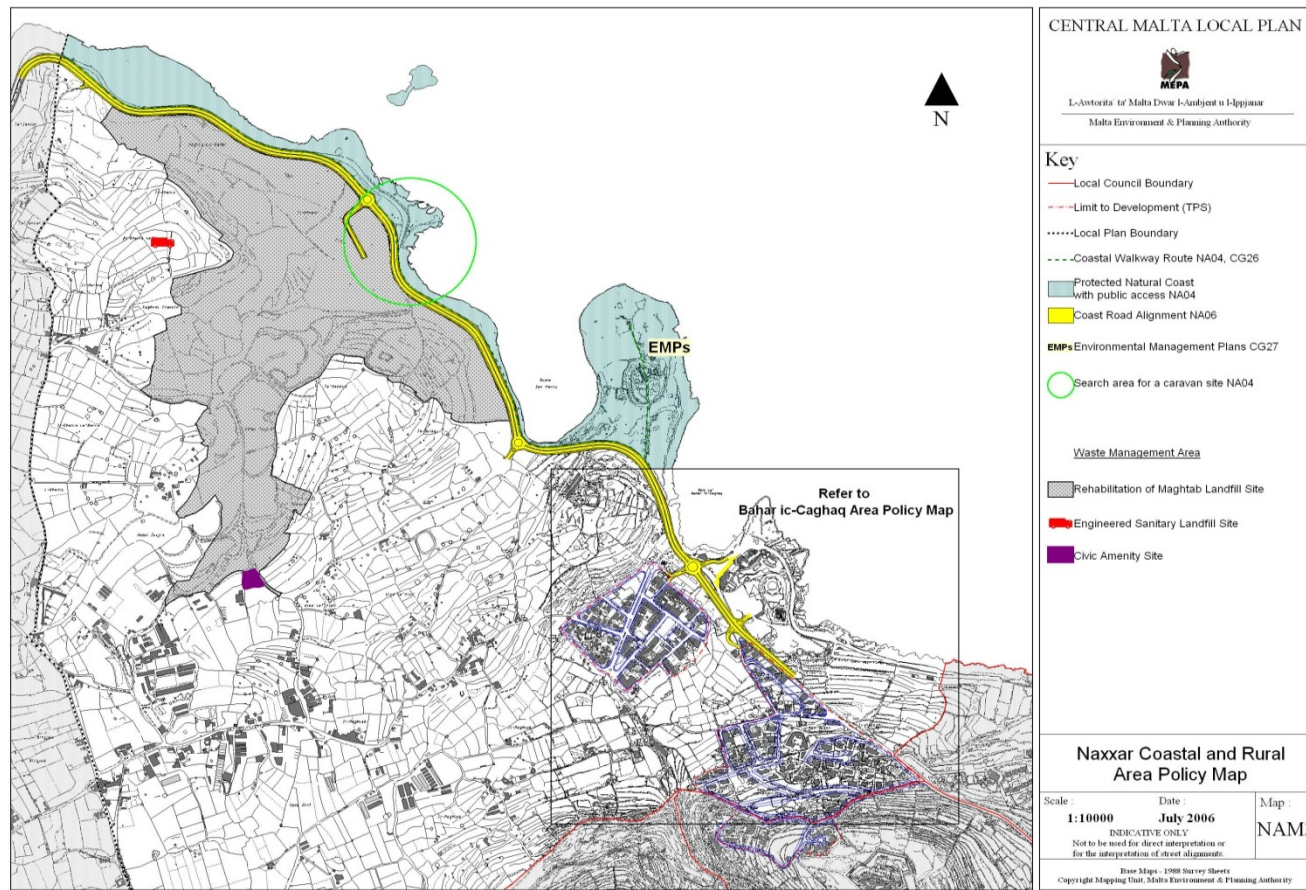
Central Malta Local Plan

5.65. The Central Malta Local Plan (CMLP) 2006 is relevant to the Scheme. The Application Site lies within the area described as the Naxxar Coastal and Rural Area in the local plan.

- 5.66. The GMLP identifies an area for the rehabilitation of the Maghtab landfill (see **Figure 5.1**). The Mechanical Treatment Plant is located within the area earmarked for rehabilitation. The biological treatment component is located in an area immediately adjacent to this, to the southeast.
- 5.67. POLICY CG 04 refers to the rural settlement of Maghtab, which is designated as a Category 2 Rural Settlement. The policy seeks to conserve, consolidate and rehabilitate the area while protecting the rural character.
- The Application Site does not all within the settlement of Maghtab as defined for the purposes of this policy.
- 5.68. POLICY CG 22: *MEPA designates Special Areas of Conservation as indicated on Maps CVM1, NAM10 and QOM4, and in accordance with LN 257/03 and GN 877/03. Areas of Ecological Importance (AEIs), Sites of Scientific Importance (SSIs) and Areas of High Landscape Sensitivity (AHLs) are indicated on the relevant Environmental Constraints Maps, and these are designated by MEPA to be conserved in accordance with Section 46 of the Development Planning Act, 1992. In these protected areas and sites development will only be permitted provided it accords with all the relevant Structure Plan Policies and Legal and Government Notices relating to SACs, AEIs, SSIs and AHLs. Proposed developments located within AHLs as indicated in Map CV2 are also to adhere to all the relevant provisions of MEPA's Supplementary Guidance document entitled 'Landscape Assessment Study of the Maltese Islands'.*
- The Application Site does not lie within any Special Area of Conservation. Areas to the south of the Site are however proposed for designation as Areas of High Landscape Sensitivity. Given the extent and visibility of the former Maghtab Landfill site, it is important therefore to consider the impact of the Scheme on the wider landscape. Impacts on the landscape arising from the Scheme are assessed in **Chapter 7**.
- 5.69. POLICY CG 23: *Areas and Sites of Archaeological Importance, and their respective Buffer Zones, are indicated on the Archaeological Features Map CVM3 and on the respective Environmental Constraints Maps. These archaeological features are listed and classified in Appendix A of this Local Plan. Where Areas and Sites of Archaeological Importance as indicated in this Local Plan are not already scheduled, MEPA will seek to schedule these features to secure their conservation in accordance with Section 46 of the Development Planning Act (1992). Proposals for development likely to adversely affect Areas and Sites of Archaeological Importance will be refused if there is an overriding case for preservation. Where MEPA, in consultation with the Superintendence of Cultural Heritage, decides that there is no overriding case for preservation, permission to develop the site will only be considered after a planning obligation has been entered into by the developer that secures a satisfactory monitoring programme of archaeological excavation, recording and conservation by a competent archaeologist. In these cases development may be considered subject to modifications as required and as directed by MEPA, in consultation with the Superintendence of Cultural Heritage, based on the mentioned assessment of the archaeological significance of the findings.*

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- There are no Areas or Sites of Archaeological Importance within or in the immediate vicinity of the Site. Impacts on the cultural heritage of the Scheme are assessed in **Chapter 9**.

Figure 5.1: Application site and Magtab landfill rehabilitation site



Space for Waste: the Waste Management Subject Plan 2001

- 5.70. The Waste Management Subject Plan provides strategic long-term direction and context to guide both Government and the private sector in waste management issues. Its policies guide the strategic planning of waste and the determination of development permit applications for developments and land use changes related to waste management facilities.
- 5.71. *POLICY SWM 1: The Planning Authority will determine proposals for new waste management facilities in accordance with the principles of sustainable development and the following waste management hierarchy:*
- (i) Reduction;*
 - (ii) Re-use and Recycling including composting;*
 - (iii) Recovery, including energy from waste;*
 - (iv) Final Disposal.*
- Preference will be given by the Planning Authority to proposals that aim to move the management and disposal of wastes further up the waste hierarchy and away from sole reliance on final disposal.*
- The Scheme is in compliance with this policy.
- 5.72. *POLICY SWM 2: The Planning Authority will support public, private and voluntary sector initiatives to reuse, recover and recycle waste in accordance with the Policies in this Plan.*
- The Scheme is beneficial in the context of this policy.
- 5.73. *POLICY SWM 4: The Planning Authority will, in having regard to the proximity principle, seek to ensure that an appropriate network of waste management facilities is provided for waste arisings in the Islands, so as to ensure self-sufficiency in treatment and disposal capacity.*
- 5.74. *POLICY SWM 5: The Planning Authority will seek to ensure that appropriate waste facilities are provided for on Malta to handle waste generated on Gozo and Comino.*
- The Scheme, which is designed to deal with waste arisings from the northern half of Malta, and including Gozo and Comino, is in compliance with this policy.
- 5.75. *POLICY SWM 6: The Planning Authority will assess the suitability of sites for new proposed waste management facilities against the site selection criteria identified in Appendix I of the Waste Management Subject Plan.*
- The suitability of the Application Site for the Scheme is supported by the site selection criteria identified in Appendix I of the Waste Management Subject Plan.

- 5.76. **POLICY SWM8:** *The Planning Authority will support proposals for the provision and erection of plant and buildings for the recycling, transfer, storage and other treatment or handling of waste provided that:*
- (i) *the proposed site is located near to the likely source(s) of waste and / or the market(s) for the recycled or recovered materials; and*
 - (ii) *the proposed site is located:*
 - *within an existing industrial site or on land which is permitted or allocated for industrial or similarly related development; or*
 - *on land previously used for waste disposal or minerals development; or*
 - *at a waste management facility provided that the proposed development is connected with the waste management operation and is for a temporary period commensurate with the operational life of the existing facility; and*
 - (iii) *the proposal will not give rise to unacceptable impact on local communities or the environment.*
- 5.77. **POLICY SWM12:** *The Planning Authority will support proposals for new household waste and recycling facilities, including small drop-off centres known as bring sites and larger household waste recycling centres provided that:*
- (i) *the proposal is suitably located in relation to the existing network of sites;*
 - (ii) *the proposal will not give rise to unacceptable impact on local communities or the environment.*
 - The choice of location for the Scheme is in compliance with Policies SWM08 and SWM 12. The impacts of the Scheme on local communities and on the environment are considered in **Chapters 6 - 12**. The EIA considers potential impacts and proposes mitigation measures to reduce significant impacts in the spirit of Policies SWM08 and SWM 12.
- 5.78. **POLICY SWM 16:** *The Planning Authority will support development proposals for composting schemes provided that the proposal will not give rise to unacceptable impact on local communities or the environment.*
- The impacts of the Scheme on local communities and on the environment are considered in **Chapters 6 - 12**. The EIA considers potential impacts and proposes mitigation measures to reduce significant impacts in the spirit of this policy.
- 5.79. **POLICY SWM 19:** *The Planning Authority will support proposals for anaerobic digestion plants provided that:*
- (i) *the proposal has a secured source of suitable waste arisings;*

- (ii) *the proposal site is located within an area which is permitted or allocated for industrial development, or is a site that has already been disturbed by permanent development, or is within or adjacent to an existing waste management facility;*
 - (iii) *the proposal will not give rise to unacceptable impact on local communities or the environment; and*
 - (iv) *the proposal would deal with residues as an integral part of the operation.*
 - The choice of location for the Scheme is in compliance with the policy and the Scheme is designed to deal with residues and an integral part of its operation. The impacts of the Scheme on local communities and on the environment are considered in **Chapters 6 - 12**. The EIA considers potential impacts and proposes mitigation measures to reduce significant impacts in the spirit of Policies SWM08 and SWM 12.
- 5.80. *POLICY WDC 1: Applications for waste management facilities should be completed in accordance with guidance contained in Appendix G. An environmental impact assessment will be required for all proposals that are likely to have significantly adverse environmental impacts. The environmental impact assessment will include details of measures to mitigate such impacts.*
- The application for development of the Scheme has been made in line with this policy. MEPA has requested an EIA in accordance with Article 3(7) of the EIA Regulations 2007. This EIS has been prepared in line with the ToR issued by MEPA for this assessment.
- 5.81. *POLICY WDC 2: Proposals for Waste Management Facilities will be required to include details of self-regulation, including monitoring of condition compliance to be carried out by the operator that facilitate the independent auditing of their effectiveness by the Planning Authority.*
- The issue subject of this policy will be dealt with at Full Development Application stage.
- 5.82. *POLICY WDC 4: Proposals for waste management facilities will not be permitted unless it can be demonstrated that:*
- (i) *there is a proven need for the development;*
 - (ii) *the proposed site is located close to and has adequate access to the strategic road network, and that the local road network or other proposed transport facilities can accommodate the anticipated traffic;*
 - (iii) *the proposed siting, design and landscaping of the development are of the highest practicable standard and are appropriate to the location of the proposal;*
 - (iv) *the engineering design of the development is technically feasible and accords with current best practice;*

- (v) *the development includes adequate measures to minimise visual and other amenity impacts;*
- (vi) *the development includes adequate measures to ensure that there would be no significant risk of pollution or danger to public health or safety, including the effects on water and air quality;*
- (vii) *where appropriate, adequate provision is made for the restoration, aftercare and management of the development to an agreed and suitable afteruse;*
- (viii) *there would not be adverse cumulative environmental effects, having regard to other similar developments which are either taking place or permitted to take place in the area.*
 - The Scheme is in compliance with this policy in all regards. The impacts of the Scheme, including the cumulative environmental impacts having regard to the development granted under PA 4834/04 are considered in **Chapters 6 - 12**. The EIA considers potential impacts and proposes mitigation measures to reduce significant impacts in the spirit of this policy.

5.83. *POLICY WDC 5: Proposals for was the management facilities will not be permitted if they would cause adverse environmental impacts in the following areas:*

- (i) *sites where there would be a significantly harmful effect on the quality of or potential yield from groundwater resources;*
- (ii) *Sites of Scientific Interest, National Parks and Areas of Ecological Importance (Pursuant to Structure Plan Policies RCO10, RCO11, RCO12);*
- (iii) *Areas of Agricultural Value, including the best and most versatile agricultural land and irrigated land, (Pursuant to Structure Plan Policy RCO7);*
- (iv) *Areas of High Landscape Value/Scenic Value (Pursuant to Structure Plan Policies RCO1 and RCO4);*
- (v) *Urban and Marine Conservation Areas (Pursuant to Structure Plan Policies UCO6 and MCO1);*
- (vi) *Areas, sites or buildings of archaeological or historic importance including their setting (Pursuant to Structure Plan Policy ARC3);*
- (vii) *Areas at risk from flooding or erosion;*
- (viii) *Other areas designated for protection in Local Plans including scheduled areas.*

In addition, proposals outside the above areas will not be permitted if they are shown to have a significant adverse environmental impact on such areas.

- The Application Site does not lie within any designated site, nor are there any areas / sites of Archaeological Importance within or in the immediate

vicinity of the Site. Areas to the south of the Site are however proposed for designation as Areas of High Landscape Sensitivity. Given the extent and visibility of the former Maghtab Landfill site, it is important therefore to consider the impact of the Scheme on the wider landscape. Impacts on the landscape arising from the Scheme are assessed in **Chapter 7**.

- 5.84. *POLICY WDC 7: The Planning Authority will require applications for waste disposal to be accompanied by proposals for high quality restoration and landscaping of the site within a reasonable timescale. Normally, this will be for agriculture, forestry, nature conservation or amenity/recreation, but the Planning Authority will support other beneficial uses that accord with the policies of the Waste Management Subject Plan.*
- 5.85. *POLICY WDC 8: A scheme of aftercare, for a period of 5 years following restoration, will be required for waste disposal sites that are restored for agriculture, forestry or amenity use.*
- The issues subject of Policies WDC 7 and WDC 8 will be dealt with at Full Development Application stage.

Policy & Design Guidance 2007

- 5.86. MEPA's Policy and Design Guidance 2007 is relevant to the Scheme in terms of building design, building height, access, parking requirements, and general amenity. These detailed design issues will be considered in the Full Development Application stage.

CONCLUSION

- 5.87. This chapter reviewed the legislation and planning policies relevant to the Scheme. It has considered the relevant laws of Malta, Government Policies, and the policies of the Structure Plan and subsidiary planning documents, as well as EU legislation.
- 5.88. It can be concluded from the review that the Scheme is in line with planning policy and includes measures to ensure compliance with relevant environmental legislation.

6. GEO-ENVIRONMENTAL RESOURCES

INTRODUCTION

- 6.1. This chapter focuses on the geomorphologic characteristics, hydrology and hydrogeology, and the structural geology of the Application Site and its surroundings.
- 6.2. The description of the geological and geomorphologic characteristics of the Application Site sets the background against which the likely effects on the Application Site and its surroundings as a result of development of the Scheme will be assessed.
- 6.3. This assessment draws on the baseline report prepared by Dr Aaron Micallef concerning geology and geomorphology.
- 6.4. The potential key issues associated with the Scheme are outlined below:

Key Issues:

- **Extraction of resources / features**
- **Impact on groundwater**
- **Impact on surface water runoff**

Terms of Reference

- 6.5. As this is an update to an existing EIA, MEPA has not issued Terms of Reference. The following guidelines have been issued by MEPA:

The EIS Update shall focus on the following:

- 1. Project description i.e. the EIS update shall include a description of the additional proposed facilities that will be included within the development site including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;*
- 2. Alternatives (sites, layouts and technologies) as relevant;*
- 3. Landscape and visual amenity assessment;*
- 4. Transport;*
- 5. Noise and vibration;*
- 6. Air quality;*

7. Waste management issues; and

8. Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.

In addition to the above, the consultant/s is to verify whether as a result of the proposal, the impact significance for the following environmental characteristics outlined below (as presented in the EIS Sections for PA 04834/04), would require an update:

1. Geology, hydrology and palaeontology;

2. Agriculture;

3. Archaeology and cultural heritage;

4. Social impact;

5. Land contamination;

6. Risk assessment; and,

7. Cumulative impacts.

ASSESSMENT METHODOLOGY

Standards and Guidance

- 6.6. The principle sources of guidance for the Impact Assessment are the *Structure Plan for the Maltese Islands*, the *Central Malta Local Plan*, and *The Earth Conservation Strategy* of the Nature Conservancy Council (UK), 1991. The relevance of each of these is described in **Chapter 5**.

Area of Influence

- 6.7. The Area of Influence (A of I) for the geology and geomorphology study is illustrated in **Figure 6.1**.

DATA AND METHODS

Competence of Surveyor

- 6.8. The Geo-environmental study was carried out by Dr Aaron Micallef, as approved by MEPA.
- 6.9. Field surveys were undertaken in August 2010 and focused on the geomorphology, hydrology and hydrogeology of the Application Site.

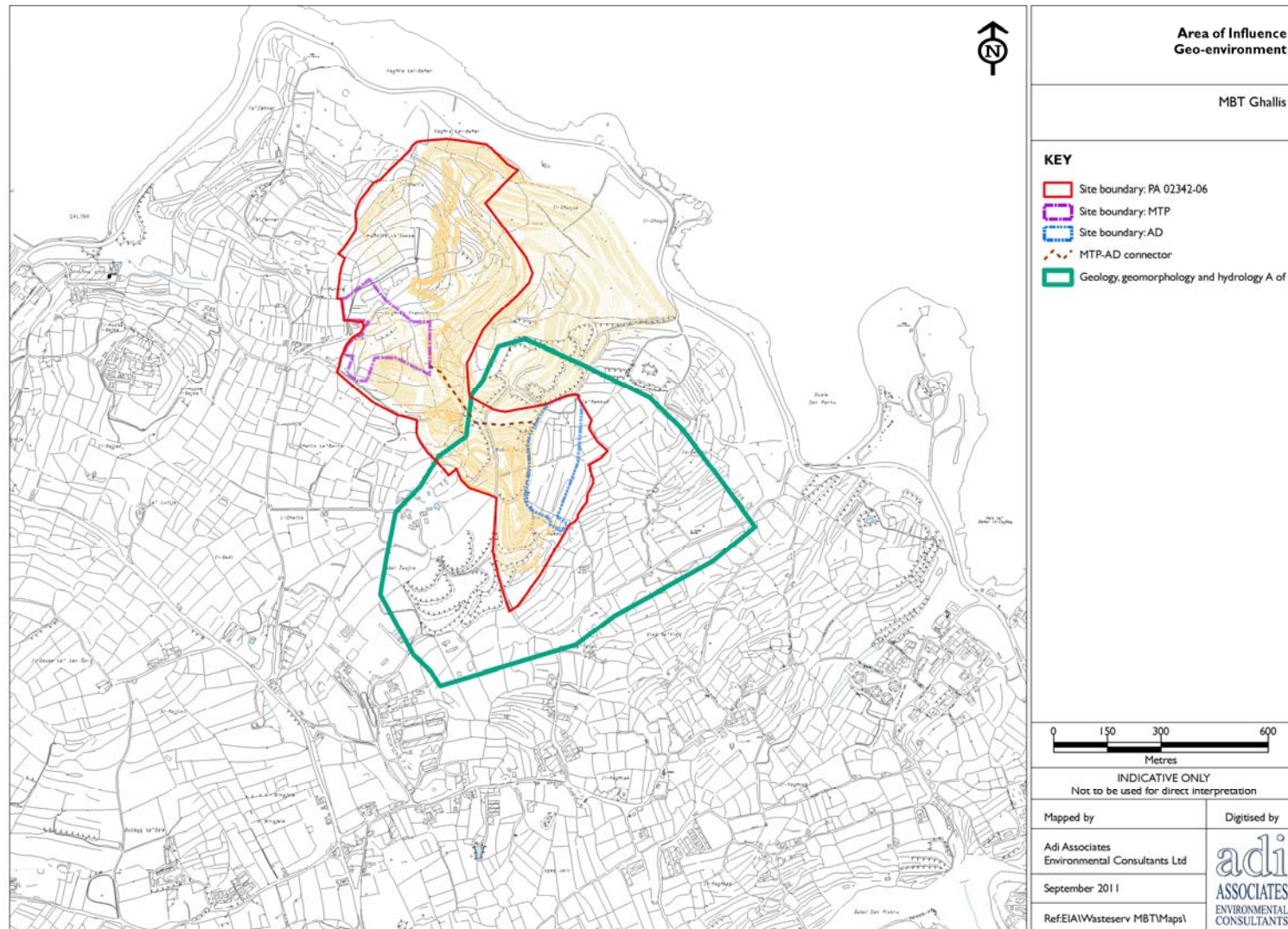
Geology and Geomorphology

- 6.10. A field survey of the area was carried out to gather baseline data on the geomorphology of the Application Site. This involved:
- Identification and description of the geomorphology of the area shown in **Figure 6.1**;
 - Identification, mapping and description of geomorphologic features; and
 - Identification of features that are protected by legislation or warrant such protection and, in the latter case, the appropriate level of protection.
- 6.11. As the EIS for the Ghallis landfill (PA 4834/04) includes an extensive geology survey (see Maps GH 7/2 and 7/3) and geology does not change over time, the same baseline as that contained in the 2005 EIS will be used.

Hydrology and Hydrogeology

- 6.12. A hydrology and hydrogeology survey was undertaken to:
- Identify and describe the following features: aquifers and their characteristics, water courses and their characteristics, drainage patterns, surface run-off, springs and wells, if any;
 - Carry out a surface water flow study to map surface water channels across the site and downstream of it as shown in **Figure 6.1**, to assess the direction and volume of surface water within the proposed site, and to calculate the water balance of the catchment area relevant to the site;
 - Determine the importance of the proposed site in recharging the mean sea level aquifer. The drainage potential of the site in accordance with the soil type and the underlying rock strata was ascertained, and groundwater protection zones were identified; and
 - Identify the current users of the surface water.

Figure 6.1: A of I for Geomorphology, Hydrology and Hydrogeology



POLICY CONTEXT

- 6.13. The principal sources of policy and legislative guidance for the Geological Study are the Structure Plan for the Maltese Islands (1990), and *The Earth Conservation Strategy* of the Nature Conservancy Council (UK), 1991.
- 6.14. Relevant policies are described in detail in **Chapter 5**.

European Union Directives

- 6.15. The European Union does not have any directive that protects the geo-environment *per se*, however Directive 92/43/EEC (the Habitats Directive) seeks to preserve and protect certain geological/geomorphologic features where these constitute important habitats including submerged caves and rocky coastlines.
- 6.16. This Directive has been transposed into national legislation (Legal Notice 311 of 2006) and is described in **Chapter 5**.

Guidance

- 6.17. Conservation profiles are intended to prevent future potential damage to sites. Since no earth conservation model exists for the Maltese Islands, it has been suggested in past studies (e.g. Debono & Scerri, 1996⁵, Mallia et al., 1999⁶) that until such a model is formulated, models used in other countries could be adopted for local use. The conservation model proposed is that adopted by the Earth Conservation Strategy of the Nature Conservancy Council (UK).

BASELINE: GEOLOGY

Lithostratigraphy

- 6.18. The five Late Tertiary formations exposed on the Maltese Islands are, from top to base:
- Upper Coralline Limestone (youngest);
 - Greensand;
 - Blue Clay;
 - Globigerina Limestone; and

⁵ Debono, G. and Scerri, S., 1996. North Harbours Local Plan Geology Survey Report. Prepared by Malta University Services for the Planning Authority, Floriana, Malta; 72pp + 210 data cards + 15 figures + 20 plates.

⁶ Mallia, A., Briguglio, M., Ellul, A.E. and Formosa, S. 1999, Population, Tourism, Land-Use and Non-Renewable Resources in the "State of the Environment Report for Malta 1998" commissioned by the Environment Protection Department, Government of Malta, Malta Council for Science and Technology, Malta.

- Lower Coralline Limestone (oldest).
- 6.19. The formations outcropping at the A of I are Globigerina Limestone and Lower Coralline Limestone (**Figure 6.2**).
- 6.20. No appreciable Quaternary continental deposits have been identified within the Application Site and A of I.

Globigerina Limestone Formation

- 6.21. The Globigerina Limestone can be sub-divided into three Members:
- Upper Globigerina Limestone Member (youngest);
 - Middle Globigerina Limestone Member; and
 - Lower Globigerina Limestone Member (oldest).
- 6.22. Only the Lower Globigerina Limestone Member is present within the A of I (**Figure 6.2**).
- 6.23. The Lower Globigerina Limestone Member consists of soft, near-horizontally-bedded, pale cream to yellow planktonic foraminiferal packstones and wackestones. The depositional environment of the Lower Globigerina Limestone Member is interpreted to be water depths in excess 200m with free access to the open sea.
- 6.24. The Lower Globigerina Limestone Member consists of 2 principal beds:
- Globigerinid bed (Franka); and
 - Soll layer.
- 6.25. The Lower Globigerina Limestone Member has a maximum thickness of 9.8m within the A of I. The bedrock of the Application Site is composed of the Lower Globigerina Limestone Member, although this is entirely covered by cultivated soil.

Lower Coralline Limestone Formation

- 6.26. The lowermost and oldest rock formation exposed on the Maltese Islands, Lower Coralline Limestone is up to 1000m thick, although only the uppermost 140m are exposed. It consists of thickly bedded, massive white limestone beds of shallow marine origin, composed of wastes of shelly debris. The latter is derived from the skeletal remains of calcareous algae, benthonic foraminifera, corals and bryozoa, among others. The Formation is characterised by rapid variation of grading and sorting, which is characteristic of deposition in shallow, agitated water conditions. The contact of Lower Coralline Limestone with the overlying Globigerina Limestone is sharp and characterised by hard ground.
- 6.27. The Lower Coralline Limestone can be divided into four members:
- Maghlaq Member (oldest);

- Attard Member;
 - Xlendi Member; and
 - Il-Mara Member (youngest).
- 6.28. Of these four members, the Attard and Xlendi Members outcrop in the Area of Influence (**Figure 6.2**).

Attard Member

- 6.29. The Attard Member consists of a compact white to light yellow, very coarse grained limestone that is composed of white algal fragments and algal rhodoliths. The Attard Member is up to 35.7m thick and it outcrops as a strongly karstified, gently sloping platform along the coast.

Xlendi Member

- 6.30. The Xlendi Member outcrops as a light brown, porous, moderately strong limestone. The Xlendi Member is up to 11.5m thick and its basal contact with the Attard Member is very sharp.

Faults

- 6.31. The Maltese Islands are traversed by two major fault systems associated to two diverse rifting episodes in the proximity of the archipelago. The first and most widespread system is Early Miocene in age, and consists of faults that are orientated east-north-east to west-south-west. The most distinct of these faults is the Great Fault, which is 11 km long and bisects the island of Malta into two blocks from Fomm ir-Rih on the western coast to Madliena tower on the east. The Great Fault has a downthrow of 90m – 180m in a north-west direction. The northern block is characterised by a series of normal faults that have resulted in horst and graben morphology. The faults in the southern block, in comparison, are less pronounced, and they have a less distinct control on topography. All of the faults of this system became dormant by the Early Pleistocene or Pliocene times. A younger system of faults (Late Miocene-Early Pliocene) is still active and consists of faults striking north-west to south-east that often cross-cut the first-generation of faults. The most extensive of these faults is the Maghlaq Fault, located along the southern coastline of the Maltese Islands.
- 6.32. A number of faults intersect the A of I (**Figure 7.2**). A SW - NE trending fault, which downthrows in a north-west direction, is located 360 m to the south-east of the Application Site. This fault is parallel to the Great Fault and belongs to the first and older system of faults. A series of minor faults are also common with the A of I; they comprise a conjugate set of faults with a general N-S orientation. One of these minor faults is located on the western boundary of the Application Site.

Mineral resource value

- 6.33. The quality of the mineral resource within the A of I has been described as 'mediocre' and not of use for the concrete construction or road construction industries (EIS for the Ghallis landfill (PA 4834/04)). The assessment is based on physical and mechanical tests carried out on core samples taken from site investigation boreholes (see **Figure 6.3**). For example, whereas good quality Lower Coralline Limestone has a compressive strength of $30 - 40 \text{ Nmm}^{-2}$, the average compressive strength of samples of Lower Coralline Limestone from the A of I was in the range of $4.7 - 24 \text{ Nmm}^{-2}$.
- 6.34. Two further samples were taken at the Application Site in December 2010 as part of the EIS Update. **Appendix I** provides the Geo-technical Investigation report. This study confirmed that the rock core samples recovered from the Lower Coralline Limestone Formation were moderately weak to weak and the bottom hole beds were very weak.

Soils

- 6.35. Two soil types can be identified within the A of I:
- The Xaghra Soil Series (associated with the Lower Coralline Limestone Formation): this consists of very shallow, red, heavy textured, decalcified soil with a strong subangular to angular blocky structure. This type of soil occurs intermittently among the Lower Coralline Limestone outcrops.
 - Tal-Inglin Complex (associated with the Lower Coralline Limestone Formation and Lower Globigerina Limestone Member): this is a pale brown to red, shallow to moderately deep, light to heavy textured man-made soil.

Figure 6.2: Geology of the site and the surrounding area

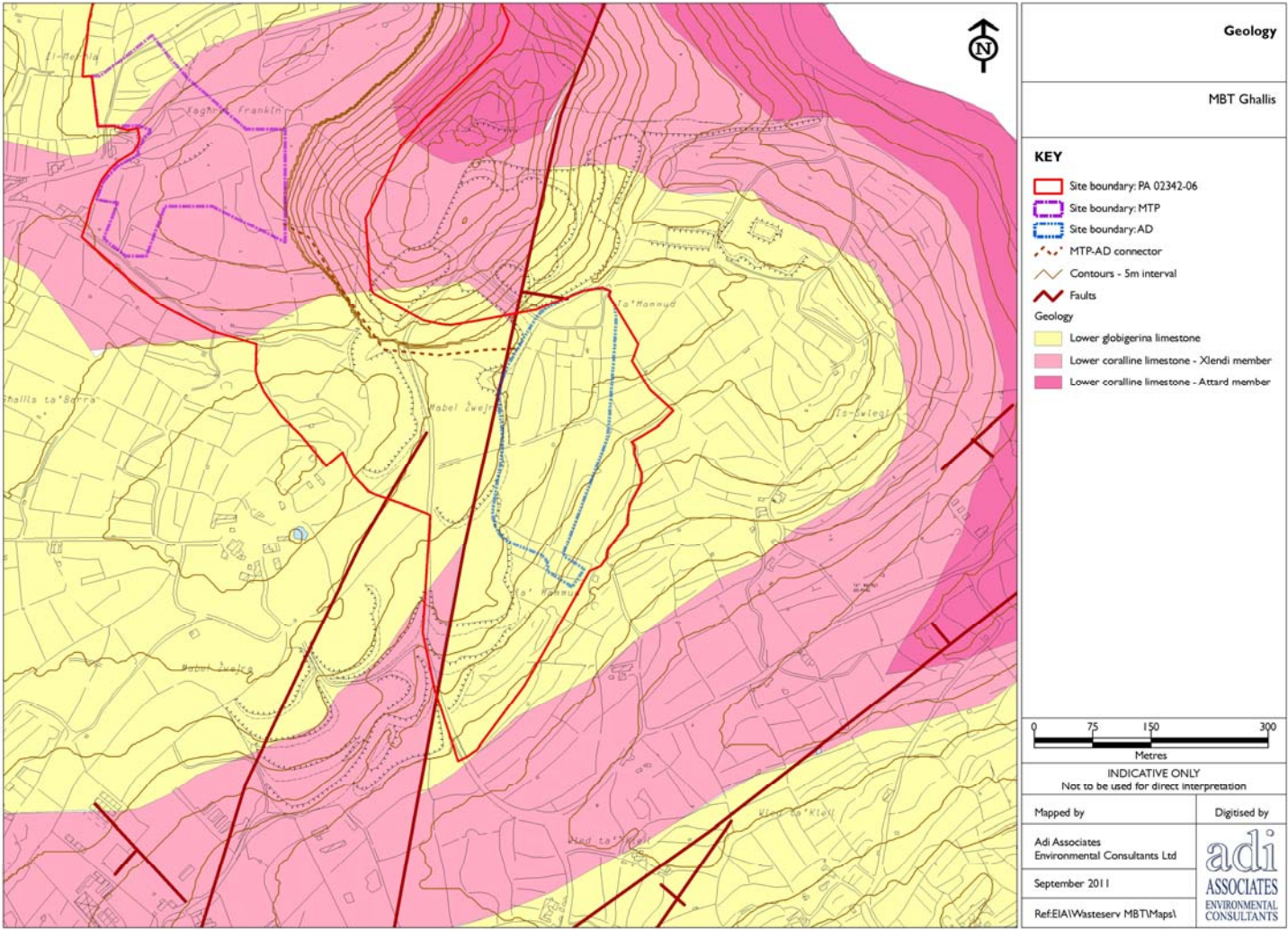
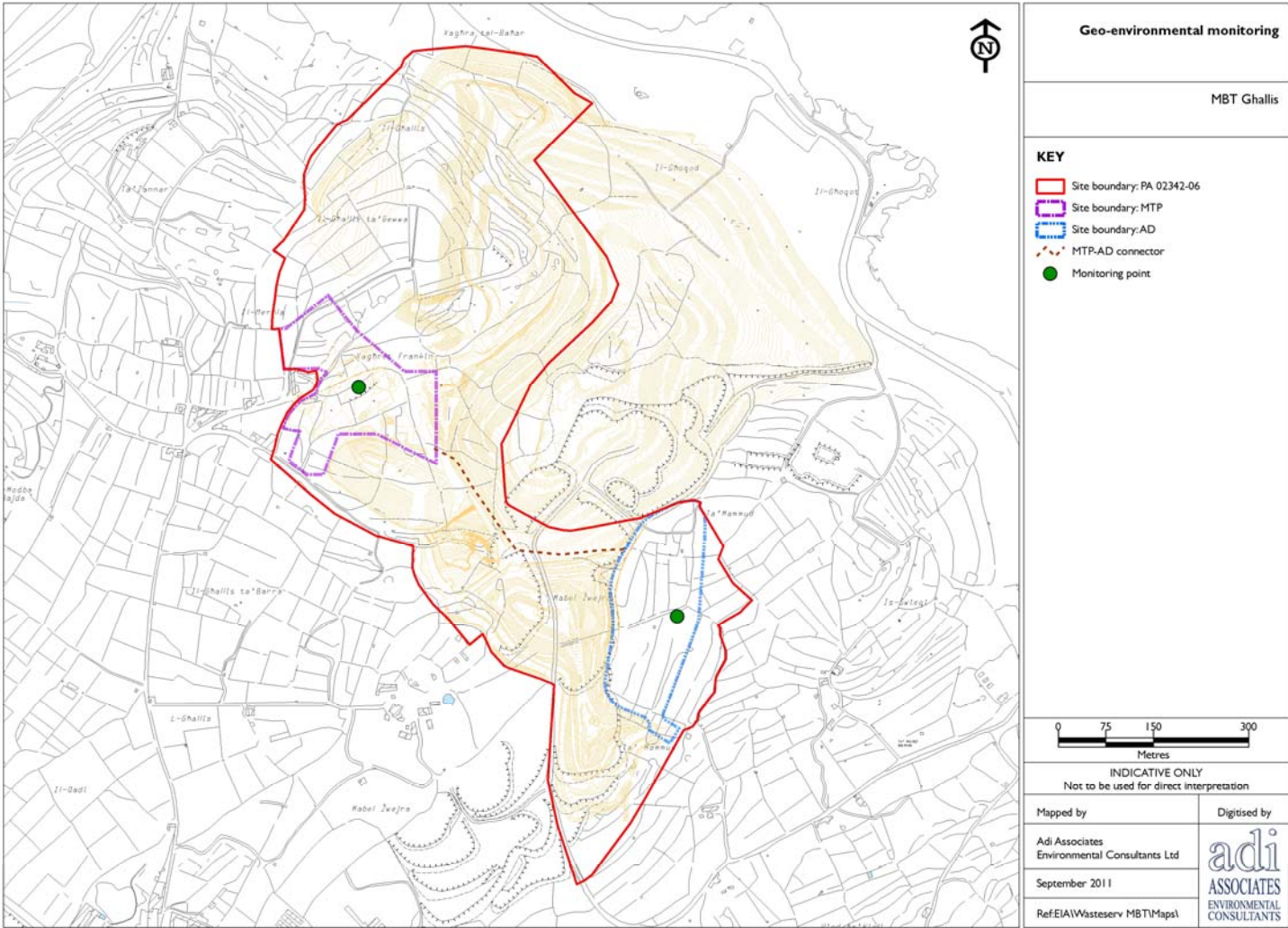


Figure 6.3: Geo-technical boreholes



BASELINE: GEOMORPHOLOGY

6.36. The relief and landforms within the Application Site and the surrounding area are predominantly controlled by lithology, fluvial erosion processes and anthropogenic influences. The principal geomorphological features within the A of I include (see **Figure 6.4** and **Figure 6.5**):

- Dry valley;
- Gently sloping landscape; and
- Former Maghtab dump.

Dry Valley

6.37. Streams flowing during a wetter climate in the Pleistocene period have formed the gentle and shallow Wied ta' Kieli valley. Nowadays, water flow within Wied ta' Kieli is ephemeral and only occurs after heavy rainfall episodes. The rise in sea level during the Quaternary has submerged the mouth of Wied ta' Kieli, resulting in the Qalet Marku Creek. The valley thalweg coincides with a SW-NE oriented normal fault. More information about the morphological and hydrological properties of this dry valley is provided in the **Hydrology and Hydrogeology** section below.

Gently Sloping Landscape

6.38. The soft Lower Globigerina Limestone Member comprising the valley sides of Wied ta' Kieli has weathered into smooth and gentle slopes covered by soil. On the north-western valley slopes of Wied ta' Kieli, the terrain falls gently towards the valley thalweg and the coastline. In the first case, the elevation decreases from 35m to 5m in a south-easterly direction; in the case of the latter, the terrain falls steadily from 40m to sea level. Here, the Lower Coralline Limestone forms a low rocky coastline characterised by a gently sloping karstified platform.

Former Maghtab dump

6.39. The former Maghtab dump, which rises steeply from the natural ground level in benches to an upper plateau 0.06km² in area, constitutes the highest topographic unit in the A of I with a maximum elevation of 100m above sea level. The south-easterly facing slopes of the dump, which are located upslope of the Application Site, comprise the steepest areas of the A of I, with a maximum slope gradient of 17.4°. The dump has buried the Ghallis ta' Gewwa and Ta' Hammud ridges and the valley in between, which were originally covered by garigue and agricultural land.

Morphology of the Application Site

6.40. The Application Site is located on the gentle slopes of Habel Zwejra, on the north-western valley side of Wied ta' Kieli. The terrain within the Application Site is generally smooth and gentle, with a mean slope gradient of 5.7° and a south-east slope aspect. The elevation of the terrain with the Application Site varies between 27m and 45m above mean sea level. The area in the Application Site is divided into fields, some of

which are fallow whereas the others have been abandoned and have naturally regenerated. There are no significant geomorphological features within the boundaries of the Application Site, although the saline marshland at Qalet Marku, 600m to the east of the Application Site, is designated as a Level 2 Site of Scientific Importance (SSI) in terms of Structure Plan Policy RCO 12.

Figure 6.4: Digital Elevation Model

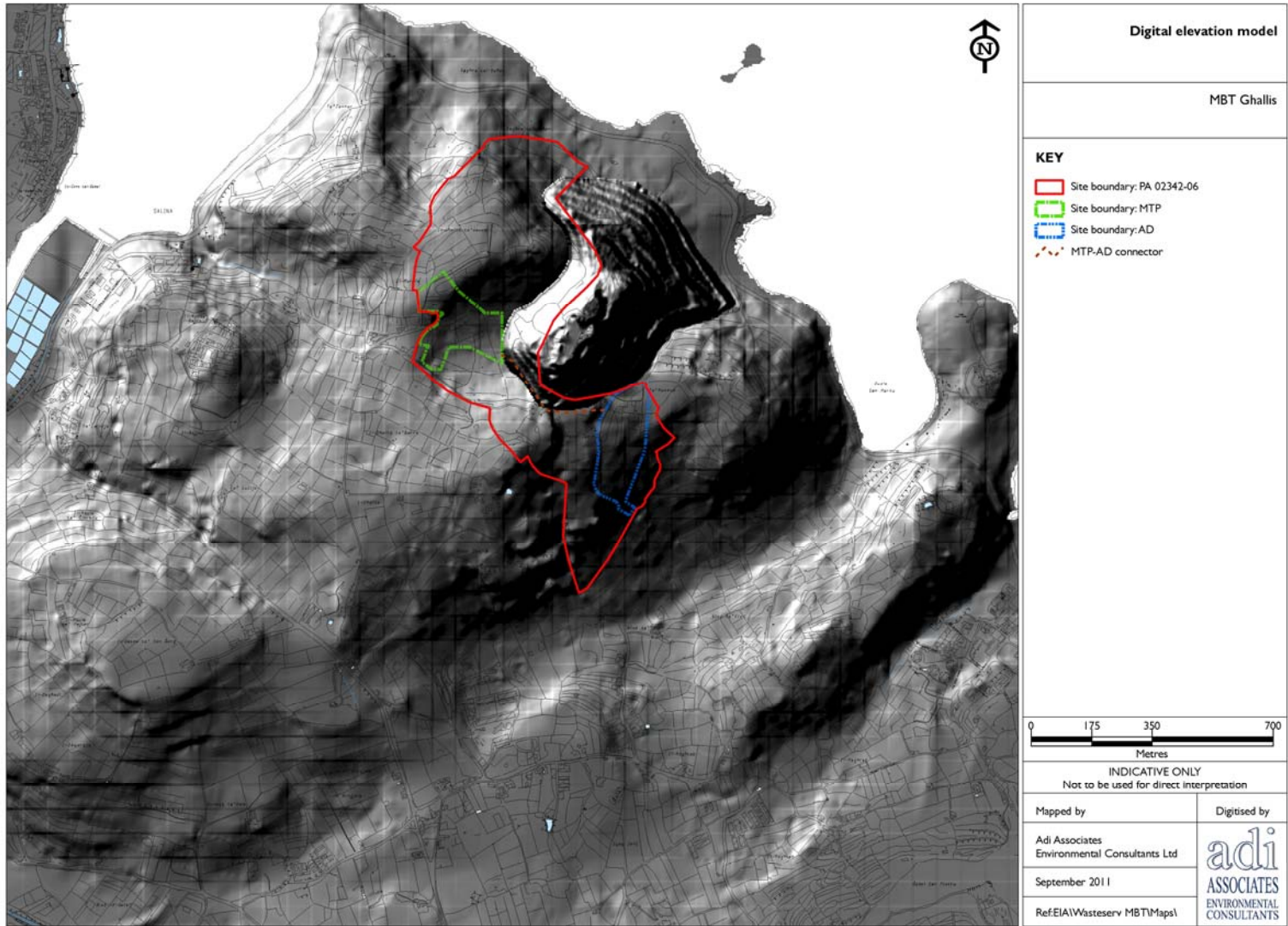
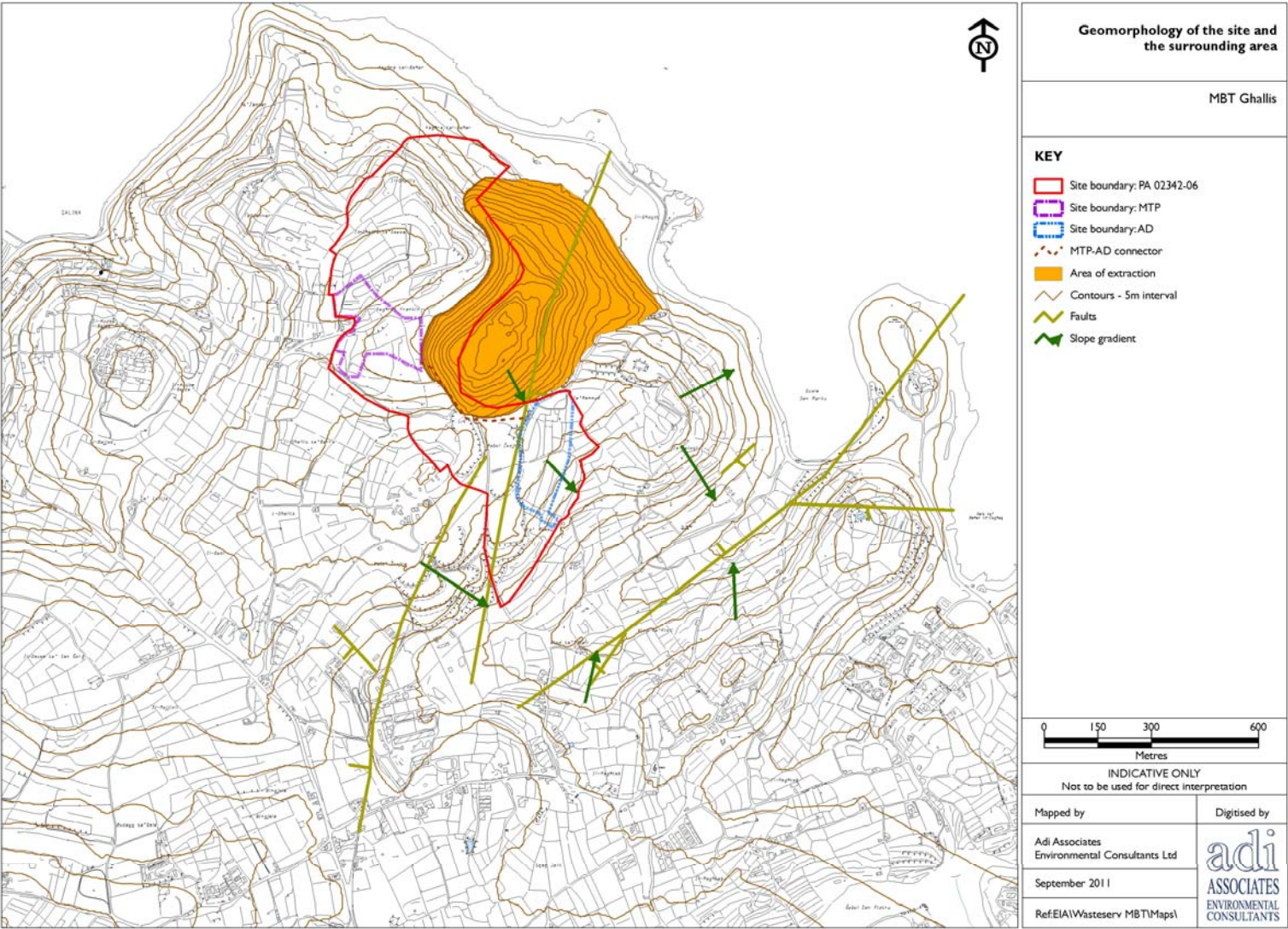


Figure 6.5: Geomorphology of the site and the surrounding area



BASELINE: HYDROLOGY AND HYDROGEOLOGY

6.41. The hydrologic and hydrogeologic features identified within the A of I comprise:

- Dry valley (Wied ta' Kieli) and associated catchment;
- Mean Sea Level Aquifer; and
- Agricultural boreholes.

Dry valley and associated catchment

- 6.42. The Application Site is located on the valley side of Wied ta' Kieli. Wied ta' Kieli is a first-order dry water course formed by stream erosion during a more humid climatic regime. Today runoff only flows along the valley during periods of prolonged rainfall or flush heavy rains.
- 6.43. The Wied ta' Kieli axial watercourse is oriented south-west to north-east; it separates Ta' Hammud ridge from Maghtab ridge, and it discharges into Qalet Marku creek. It has a general linear planform shape. The watercourse is 1.4km long, up to 1km wide and it is incised in the Lower Globigerina Limestone Member and Lower Coralline Limestone Formation. The valley floor has a mean slope gradient of 1.1°. The valley floor elevation drops from 30m to sea-level. The cross-sectional profile is broadly U-shaped, with the valley depth reaching a maximum value of 50m. The valley slopes are generally gently sloping; a maximum slope gradient of 8.5° was measured. The valley is mostly cultivated, whereas close to the valley head a few buildings are located. In proximity of the valley mouth, the north-western valley slope is characterised by kartsified limestone covered by garigue. Triq ir-Ramla runs along the thalweg of Wied ta' Kieli.
- 6.44. The A of I intersects the Wied ta' Kieli catchment, the boundary of which is shown in **Figure 6.5**. The catchment has a total area of 1.48km² and its geology is comprised of the Lower Coralline Limestone Formation and Lower Globigerina Limestone Member. The boundaries of the catchment coincide with cultivated terrain.

Mean Sea Level Aquifer

- 6.45. An aquifer is a porous layer of rock capable of storing, filtering, and releasing water. The rock layer contains many pore spaces which, when connected, make the rock permeable and allow movement of water through it. Aquifers are the Maltese Islands' primary source of natural water as there are virtually no perennial surface water streams.
- 6.46. The Mean Sea Level Aquifer lies in the pores and fissures of Lower Coralline Limestone where this formation subcrops at sea-level. A body of fresh water in the form of a 'lens' floats on saline water by virtue of its lower density. The thicker part of this 'lens' is situated in the central part of Malta, with its height decreasing towards the coastline where it levels off to zero. The aquifer is recharged by the percolation of rainwater every winter, and is dissipated to sea at the coastline or by extraction. The Mean Sea Level Aquifer has a mean thickness of 67.5m and covers an area of 216.6km². It yields 66% of the water extracted in the Maltese Islands. The aquifer has a mean annual

recharge of 34.27hm³ and water is mainly abstracted for potable supply and agricultural use.

- 6.47. The Mean Sea Level Aquifer is the principal hydrogeological feature in the area (**Figure 6.6**) and it extends over the entire A of I. The aquifer is developed within the Lower Coralline Limestone Formation; it is in free contact with sea water and is overlain by the Lower Globigerina Limestone Member. The hydraulic characteristics of the aquifer are mainly controlled by the secondary hydraulic conductivity of the Lower Coralline Limestone Formation, which has a value of 2.0×10^{-4} - 1.5×10^{-3} ms⁻¹ (Gutierrez, 1994).
- 6.48. Precipitation is the only source of groundwater recharge. The geology of the A of I is conducive to the recharge of the Mean Sea Level Aquifer because the limestone bedrock is located at the surface or underneath a thin mantle of soil and/or overburden. These conditions promote a low soil moisture deficit and rapid infiltration of rainwater into the porous Lower Globigerina Limestone Member and the permeable Lower Coralline Limestone Formation, which percolates through the unsaturated zone until it reaches the Mean Sea Level Aquifer within the Lower Coralline Limestone Formation. In comparison, the effective recharge rates upslope of the Application Site, which is comprised by the Former Maghtab dump, are expected to be very low due to the substantial adsorptive capacity of the deposited waste and the evaporation of infiltrated rainwater associated to combustion (Scott Wilson, 2004).
- 6.49. Groundwater levels in the Ghallis area range between 0 and 1 m above sea level (Axiak and Sammut, 2002). Thus, the potentiometric surface of the Mean Sea Level Aquifer is estimated to lie at a depth of about 40m below the surface of the Application Site. The hydraulic gradient of the Mean Sea Level Aquifer in the area is estimated to range between 0.0006 and 0.00083, and the direction of groundwater flow is north-east towards the coast (Axiak and Sammut, 2002; Scott Wilson, 2004). The direction of flow is affected by groundwater abstractions; however, since abstraction rates from nearby private wells are expected to be low due to low yields and saltwater intrusion, the effect of groundwater abstractions on groundwater flow direction is considered to be minimal. The estimated groundwater flow ranges between 41.5 and 1244m³ per day (EIS for the Ghallis landfill (PA 04834/04)).

Analysis of groundwater and soil samples

- 6.50. **Appendix 2** presents the results obtained from testing of groundwater and soil samples that were taken from the two boreholes sunk for geo-technical investigation, the locations of which are shown in **Figure 6.3**.
- 6.51. The results of the groundwater samples demonstrate no significant contamination other than that anticipated for the groundwater in a predominantly agricultural area, with ammoniacal nitrogen at approximately 0.2mg/l, nitrate at 120 and 26mg/l and BOD at 5 and 10mg/l. The chloride was measured at 621 and 210mg/l, indicative that the water is not very saline, consistent with the distance from the coast and the infiltration of fresh water from the land surface. No heavy metals or organic compounds were measured above the limits of detection.

- 6.52. None of the rock samples analysed had concentrations of PCBs, BTEX compounds or mineral oils indicative of contamination. Analysis of leachate test samples gave no concentrations of heavy metals or phenol index indicative of anthropogenic contamination.

Agricultural boreholes

- 6.53. There are at least six abstraction boreholes within ~750 m of the Application Site (**Figure 6.7**). These boreholes extract water from the Mean Sea Level Aquifer, which is then used for agricultural irrigation. The A of I lies outside of the Groundwater Protection Zone, which has been established to protect the islands' groundwater resources. The Application Site is located 1.1 km to the north of the Groundwater Protection Zone associated with the Wied il-Ghasel pumping station.

Surface Water Flow and Water Balance Estimations

- 6.54. Malta experiences an average of 578mm of rain per year. Precipitation occurs in sufficient quantities to produce run-off from October until February. The dry season stretches from May to September. On reaching the ground, part of the water flows as run-off (6%), whereas another part percolates downwards until it reaches an aquifer as recharge (24%). The run-off is either harvested or directly lost to sea. A substantial part of the rainfall is returned to the atmosphere via evapo-transpiration, which during the dry season is very high (70%).
- 6.55. The contributing area of run-off that flows across the Application Site is shown in **Figure 6.8**. It has an area of 0.070493 km² and includes the area of the Former Maghtab dump upslope of the Application Site. To estimate the water balance for the Application Site, the area of the contributing area and Application Site are multiplied by the rainfall, giving the amount of water that is initially available. This is then further subdivided into run-off, evapo-transpiration, and percolation.
- 6.56. The contributing area and the Application Site are characterised by different surface compositions. The contributing area consists of waste and overburden from the Former Maghtab dump; this surface has a high infiltration capacity and is attributed a run-off co-efficient of 10% (**Table 6.1**). The Application Site, with an area of 0.051093 km², consists of disused agricultural land. The permeability associated with this terrain is considered to be low because the soil was cultivated and its structure was modified by repeated ploughing. The run-off co-efficient attributed to the Application Site is 75% (**Table 6.1**).

Table 6.1: Land uses and associated run-off co-efficients for the contributing area and the Application Site

| Land use | Area (km ²) | Run-off co-efficient (%) |
|---|-------------------------|--------------------------|
| Agriculture (Application Site) | 0.051093 | 75 |
| Former Maghtab dump (Contributing area) | 0.070493 | 10 |
| Total area | 0.121586 | |

- 6.57. The direction of surface water flow in the contributing area and the Application Site is predominantly south-east towards Wied il-Kieli (**Figure 6.7**).

6.58. The estimated annual water balance for the sub-catchment is shown in **Table 6.2**. The total annual volume of percolation within the contributing area and the Application Site is 13,217m³. The volume of run-off reaching the Application Site is 1,222m³ annually, whereas the volume of run-off being drained at the downstream boundary of the Application Site is 7,867m³ annually. The total annual volume of run-off and percolation for the A of I at present is estimated at 6,654m³ and 2,216m³, respectively.

Table 6.2: Annual water balance for the sub-catchment associated with the Study Area

| Catchment | Area m ² | Run-off m ³ | Percolation m ³ | Evapo-transpiration m ³ | Total m ³ (assuming annual rainfall of 578mm) |
|--|---------------------|------------------------|----------------------------|------------------------------------|--|
| Contributing area | 70,493 | 1,222 | 11,001 | 28,521 | 40,745 |
| Application Site | 51,093 | 6,645 | 2,216 | 20,672 | 30,626 |
| Contributing area + Application Site (present) | 121,586 | 7,867 | 13,217 | 49,193 | 71,371 |

Figure 6.6: Hydrological map

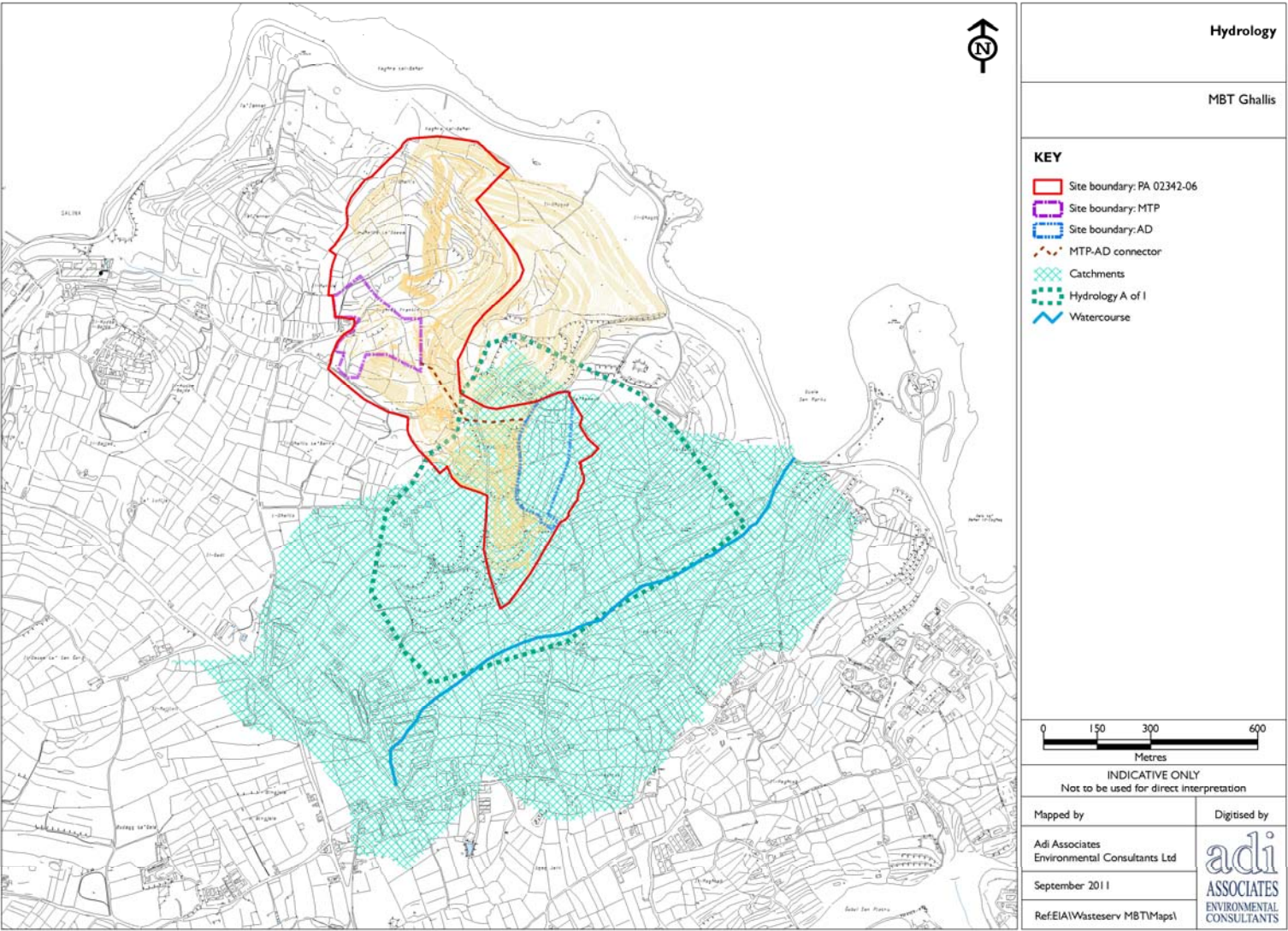


Figure 6.7: Hydrogeological map

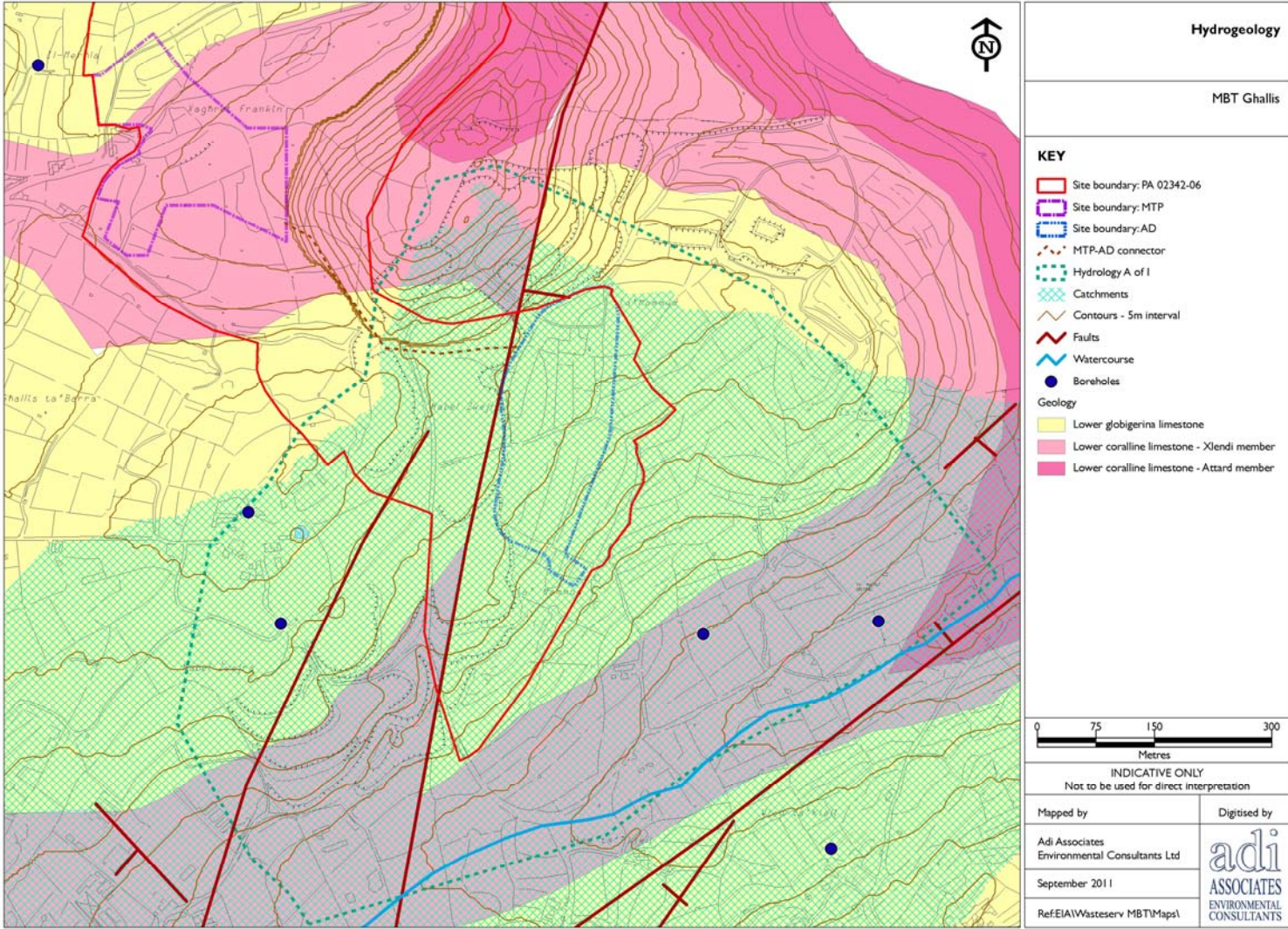
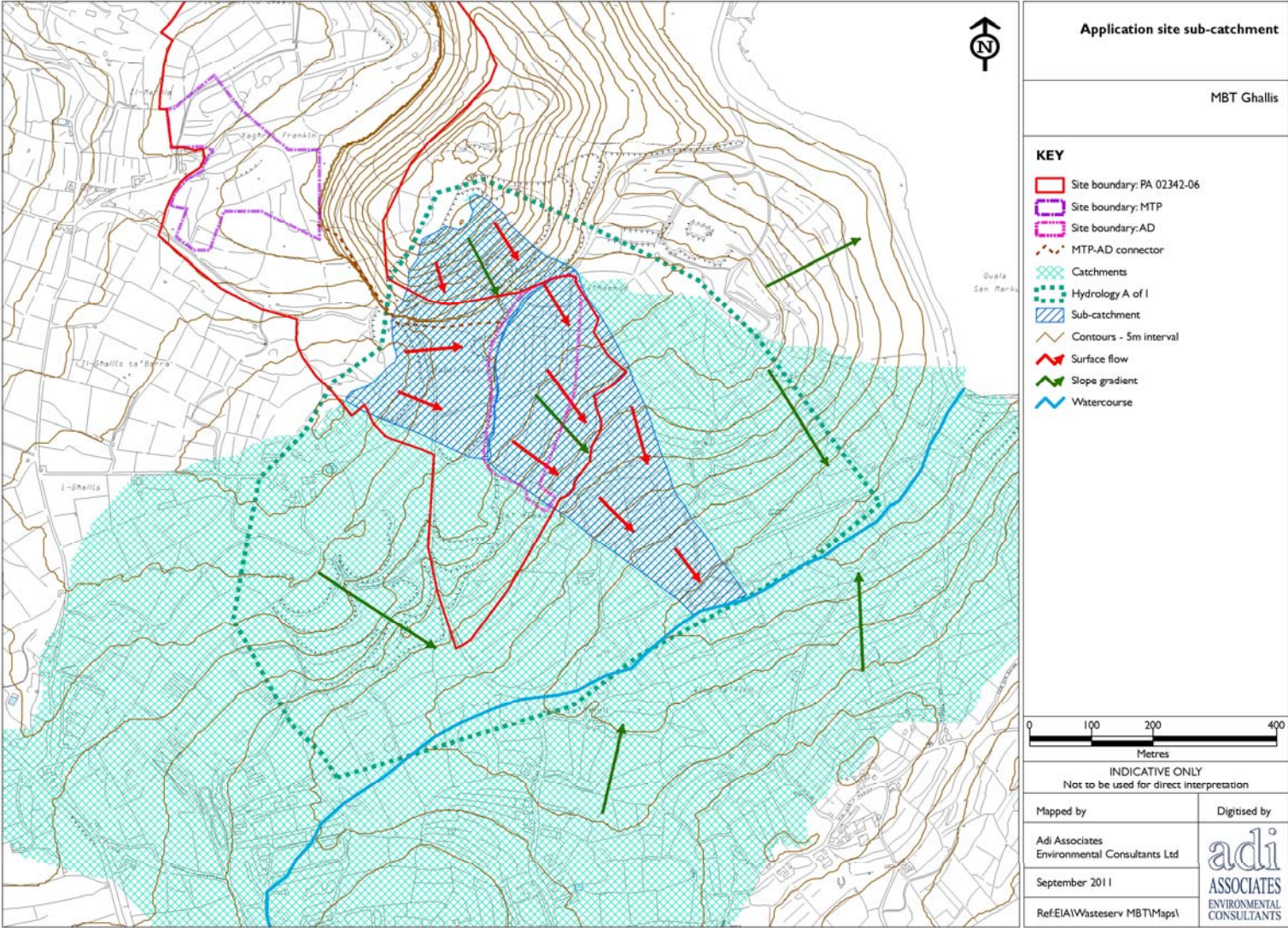


Figure 6.8: Sub-catchment of Application Site and associated surface water flow



ASSESSMENT OF IMPACTS

- 6.59. The risk assessment is presented in **Chapter 13**, which assesses risks of contamination to sensitive receptors including groundwater and surface water features. This chapter considers potential impacts under normal operation.
- 6.60. The following criteria have been used to assess the significance of the impacts on the geology, hydrogeology, and hydrology within the A of I during the Scheme's operation:
- **Not significant** – little or no change to the hydrological, geological / geomorphological regime;
 - **Minor significance** – changes to the hydrological regime but no impact on the aquifer or galleries or with potential for substantial changes to be offset by mitigation; changes to the geological or geomorphological regime involving the removal of overburden; and
 - **Major significance** – changes to the hydrological regime that impact on the aquifer with little opportunity for changes to be offset by mitigation; changes to the geological or geomorphological regime involving the extraction of mineral resources.

Prediction and Significance of Impacts

Geo-environmental resources

- 6.61. As described in **Chapter 4**, 105,000m³ will be excavated for the construction of the AD Plant. In addition the creation of the northern bund has also resulted in excavation of material, thereby resulting in major impact on the underlying geology.

Change in quality of aquifer and recharge

- 6.62. **Chapter 13** presents the risk assessment. As described, with mitigation measures in place, including bunding, installation of pipework above ground, waste handling within concrete surfaced, contained areas, and pressure monitoring equipment, change in the quality of groundwater as a result of the Scheme during operation is considered negligible. The risk is slightly higher during construction, where any spillages, if large-scale could result in large-scale contamination of the groundwater. However, implementation of an Environmental Management Plan would minimise the likelihood of any spillages occurring, and the residual impact is likely to be minor.

Change in quality of run-off

- 6.63. There are no surface water features on site. Similarly to groundwater, the risk of contamination of surface water run-off is considered to be minor to insignificant as a result of the detailed mitigation measures to be implemented.

MITIGATION

- 6.64. Mitigation measures to protect hydrogeological resources are presented in **Chapter 13**. The following list summarises mitigation measures:

- Environmental Management Plan during construction phase;
- Separate clean and foul water drainage systems;
- Installation of pipework above ground;
- Installation of volume and pressure monitoring system accompanied by alarms; and
- Pressure relief valves installed with the digestors together with a rigorous inspection system.

RESIDUAL IMPACTS

- 6.65. With these systems in place, risk of contamination of ground and surface water is minor to insignificant. Extraction of geological resources remains a major impact.

Table 6.3: Summary of Impacts on the Geo-environmental Resources

| Predicted Impact | Beneficial/ Adverse / Neutral | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Not significant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|----------------------------------|-------------------------------------|----------------------------------|------------------------------------|------------------|----------------|------------|------------------|---------------------------|---------------------------------------|--|----------------------|--|---------------------------------|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct/ Indirect | S term/ L term | Perm/ Temp | Revers/ Irrevers | (Inter / National/ Local) | (Likely, Unlikely, Remote, Uncertain) | Legislation | In context of Scheme | | (Major, Minor, Not significant) |
| Geo-environmental resources | Adverse | Constr'n | Local | Direct | L term | Perm | Irrevers | Local | Likely | DPA | Major | None | Major |
| Change in quality of groundwater | Adverse | Constr'n | Local | Direct | S/L term | Revers | Revers | Local | Likely | EPA | Minor to major | EMP | Minor |
| Change in quality of groundwater | Adverse | Oper'n | Local | Direct | S/L term | Revers | Revers | Local | Unlikely | EPA | Minor to major | Bunding; volume and pressure monitoring systems; installation of pipework aboveground; installation of pressure valves | Not significant to minor |
| Change in quality of runoff | Adverse | Constr'n | Local | Direct | S term | Revers | Revers | Local | Likely | EPA | Minor | EMP | Minor to not significant |

| Predicted Impact | Beneficial/ Adverse / Neutral | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Not significant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|-----------------------------|-------------------------------------|----------------------------------|------------------------------------|------------------|----------------|------------|------------------|-------------------|---------------------------------|--|----------------------|--|---------------------------------|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct/ Indirect | S term/ L term | Perm/ Temp | Revers/ Irrevers | | | Legislation | In context of Scheme | | |
| Change in quality of runoff | Adverse | Oper'n | Local | Direct | S term | Revers | Revers | Local | Likely | EPA | Minor to major | Bunding; volume and pressure monitoring systems; installation of pipework aboveground; installation of pressure valves; separate foul and clean water drainage systems | Minor to not significant |

7. LANDSCAPE AND VISUAL AMENITY

INTRODUCTION

- 7.1. This chapter addresses the potential impacts of the Scheme on the landscape and visual amenity. It describes the existing landscape and visual amenity of the Application Site and its surroundings, and assesses how this might change through the development of the Scheme.
- 7.2. Assessment of landscape and visual amenity involves examination of the wide range of factors that contribute to the qualities and attributes of the existing landscape, and that may contribute to the landscape of the Scheme. This involves consideration of the evolution of landscape and the factors that have led to its current condition, from the underlying geology through to anthropogenic activities.
- 7.3. Landscape and visual impacts are distinct, albeit strongly related. Landscape impacts result from the interaction between a development and the existing landscape resource, experienced through changes to any element or combination of landscape elements. Visual impacts relate to the effect that a development would have on the amenity of sensitive receptors (those experiencing views of the site), relating to the actual or perceived visible changes to the character and quality of the landscape.
- 7.4. The key issues for the assessment are:

Key Issues:

- **Effects on the landscape setting of the Scheme**
- **Changes in views of key receptors**

Terms of Reference

- 7.5. MEPA has not issued formal Terms of Reference, this being an update of the EIA carried out in 2006 in respect of PA 4834/04. The following guidelines have however been issued by MEPA:

The EIS Update shall focus on the following:

- 1. Project description, i.e., the EIS update shall include a description of the additional proposed facilities that will be included within the development site, including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;*
- 2. Alternatives (sites, layouts and technologies) as relevant;*
- 3. Landscape and visual amenity assessment;*
- 4. Transport;*
- 5. Noise and vibration;*

6. *Air quality;*
7. *Waste management issues; and*
8. *Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.*

In addition to the above, the consultant/s is to verify whether, as a result of the proposal, the impact significance for the following environmental characteristics outlined below (as presented in the EIS Sections for PA 04834/04) would require an update:

1. *Geology, hydrology and palaeontology;*
2. *Agriculture;*
3. *Archaeology and cultural heritage;*
4. *Social impact;*
5. *Land contamination;*
6. *Risk assessment; and,*
7. *Cumulative impacts.*

Objectives of the assessment

7.6. The objectives of the assessment were to:

- Undertake a baseline survey and characterisation of the landscape and visual amenity at and around the Scheme sites using desk top and field survey techniques;
- Evaluate the landscape character of the Scheme sites and their setting;
- Establish the Zone of Visual Influence (ZVI) for the Scheme and identify the key viewpoints and receptors;
- Input the potentially beneficial design measures to the Scheme;
- Predict the impacts of the Scheme on the visual amenity in the ZVI;
- Assess the significance of the impacts on the landscape and visual amenity of the ZVI; and
- Describe the mitigation measures designed into the Scheme to minimise adverse impacts and enhance any beneficial impacts on the landscape and visual amenity.

Legislation, Policies and Guidance

- 7.7. The Constitution of Malta (Section 9) declares that the State shall safeguard the landscape and the historical and artistic patrimony of the Nation. These are the only aspects of the environment referred to in the Constitution, underlining the importance of the landscape and historical heritage.

Structure Plan

- 7.8. The *Structure Plan for the Maltese Islands* identifies a number of policies that are relevant to assessing landscape and visual amenity and the impact of projects thereon. BEN 1 deals with bad neighbourliness and specifically with the visual intrusion of projects. BEN 2 indicates that applications for development permission will not be permitted if the project is unlikely to 'maintain the good visual integrity of the area in which it is located'. Structure Plan Policy RCO 1 sets the scene for the creation of Areas of High Landscape Value:

POLICY RCO 1: Rural Conservation Areas are designated as illustrated in the Key Diagram. Within such areas the following sub areas will be designated, using World Conservation Union definitions and criteria where relevant:

7. Areas of High Landscape Value.

- 7.9. Structure Plan Policy RCO 3 provides for local plans to define the precise boundaries and specify in detail the measures of protection and enhancement to be adopted with respect to the various uses and activities.

Local Plan landscape designations and relevant policies

- 7.10. The Scheme site is located within the Central Malta Local Plan area which extends northwards to include a part of the northern coastline of Malta (at *Bahar ic-Caghaq*). **Figure 7.1** shows the broad location of the Scheme site in relation to areas proposed for designation as Areas of High Landscape Sensitivity as identified in the Central Malta Local Plan. The Scheme site also lies in close proximity to the North West Local Plan Boundaries and the North Harbours Local Plan Boundaries. Given the extent and visibility of the former Magtab Landfill site and its proximity to the NHLP and NWLP areas, it is important to consider any relevant landscape designations within adjoining Local Plan areas.

Central Malta Local Plan

- 7.11. The Scheme Site does not lie within a designated Area of High Landscape Sensitivity as defined by Policy CG22 of the CMLP.
- 7.12. Areas to the south of the Scheme Site are, however, proposed for designation as Areas of High Landscape Sensitivity. These include the escarpments of the 'Great Fault' and the intervening incised valleys (*Wied Faham* and *Wied Anglu*). This area marks a sharp change of level between the Magtab Plain and the upland areas of

Naxxar and Gharghur to the east. Supporting text (Paragraph 3.7.2) to Policy CG22 states:

Development that affects AHLs will be considered by MEPA following the requirements set by the Draft Landscape Assessment Study of the Maltese Islands (2004) and relative Structure Plan Policies.

North West Local Plan

- 7.13. **Figure 7.2** shows the broad location of the Scheme site in relation to Regional Landscape Character Areas and Landscape Tracts as defined in the North West Local Plan. The Scheme site lies immediately to the east of the 'Eastern Foreland' Regional Landscape Character area and Salina Bay Landscape Tract as defined in the NWLP.

North Harbours Local Plan

- 7.14. Unlike the Central Malta and North West Local Plans, the North Harbours Local Plan area is almost entirely urbanised. **Figure 7.3** shows the areas of high and very high landscape sensitivity as defined in the North Harbours Local Plan through Policy NHCV01 (Protection of SACs, SSIs, AELs and AHLs). The major valleys are the only remaining areas of recognised landscape sensitivity. The *Wied id-Dis / Wied il-Faham* and *Wied ta'Santa Marija taz-Zellieqa* systems straddle both the eastern boundary of the Central Malta Local Plan and the western boundary of the North Harbours Local Plan area. These are the closest areas of landscape sensitivity to the Scheme Site as defined in the North Harbours Local Plan.

Landscape Assessment Study of the Maltese Islands, 2004

- 7.15. MEPA's Landscape Assessment Study of the Maltese Islands was undertaken in 2004 as part of the Structure Plan Review. The Study does not provide an assessment methodology to use in order to consider the impacts of a specific development; it does, however, provide a useful baseline assessment of the prevailing landscape character of the Maltese Islands. The primary purpose of the Study appears to have been as a topic paper to identify Areas of High Landscape Sensitivity and inform the Structure Plan Review. The following sections describe the parts of the Landscape Study that are relevant to the Scheme.

MI4 - Maghtab

- 7.16. The document defines the area around the Scheme Site the Maghtab Character Area (MI4). It does not break down this area into smaller landscape tracts. The 'Maghtab' area is described as follows:

General Landscape Description

A relatively flat area close to the eastern coast, which is partly agricultural, partly garrigue, and a number of scattered buildings. Its eastern boundary is the coastal road, which is part of the main road linking north and south. A considerable number of farms and industrial units can be found in the area.

Enhancing Features

There are a number of churches, coastal towers and other historic features scattered throughout the area and these add character especially when viewed from close quarters. There are a number of archaeological remains but since these have a low profile, they do not stand out prominently in the landscape. Well-maintained agricultural land and stands of carob trees make significant contributions in terms of the positive qualities of the area.

Detracting Features

The whole area is dominated by the Maghtab waste disposal site (See Plate 11). The mound visually influences the whole area and can be spotted from areas which are tens of kilometres away. It is possibly the worst eyesore in the Maltese Islands. Apart from being visually obtrusive, the waste tip generates obnoxious smells and choking fumes. The industrial concerns and the farms which are scattered along large tracts of the area, also contribute towards the scenic degradation of the area. In this respect, the concrete processing plant due north of the T'Alla w'Ommu escarpment is of particular significance and is absolutely visually offensive when viewed from higher ground. The active quarrying in the area is particularly visually offensive and the degrading visual influence can be perceived from long distance viewpoints to the north-west. There are other construction related or garage industry concerns which stand out quite starkly against the surrounding rural area. The Maghtab Earth Station also contributes to the negative scenic impact due to the contrast presented through the white parabolic antennae. Pockets of localized tipping can be found all over the area (including near historic or archaeological features). In a significant number of instances, obnoxious organic matter is disposed of in areas close to the animal farms.

7.17. Other Landscape Character Areas identified in **Figure 7.4** border the Maghtab area. These are identified in MEPA's Landscape Assessment Study as:

- M9 – St Paul's Bay – Bugibba – Qawra;
- M12 – Wied Qannotta Basin;
- M13 – Mgarr – Zebbiegh – Wardija Trough;
- M21 - Gharghur-San Gwann Hinterland;
- M23 – West Mosta Hinterland;
- M24 - Mosta-Naxxar; and
- M58 – North-Eastern Rocky Coast.

Figure 7.1: Scheme site in relation to designated areas of landscape sensitivity (CMLP). Red circle denotes Scheme Site

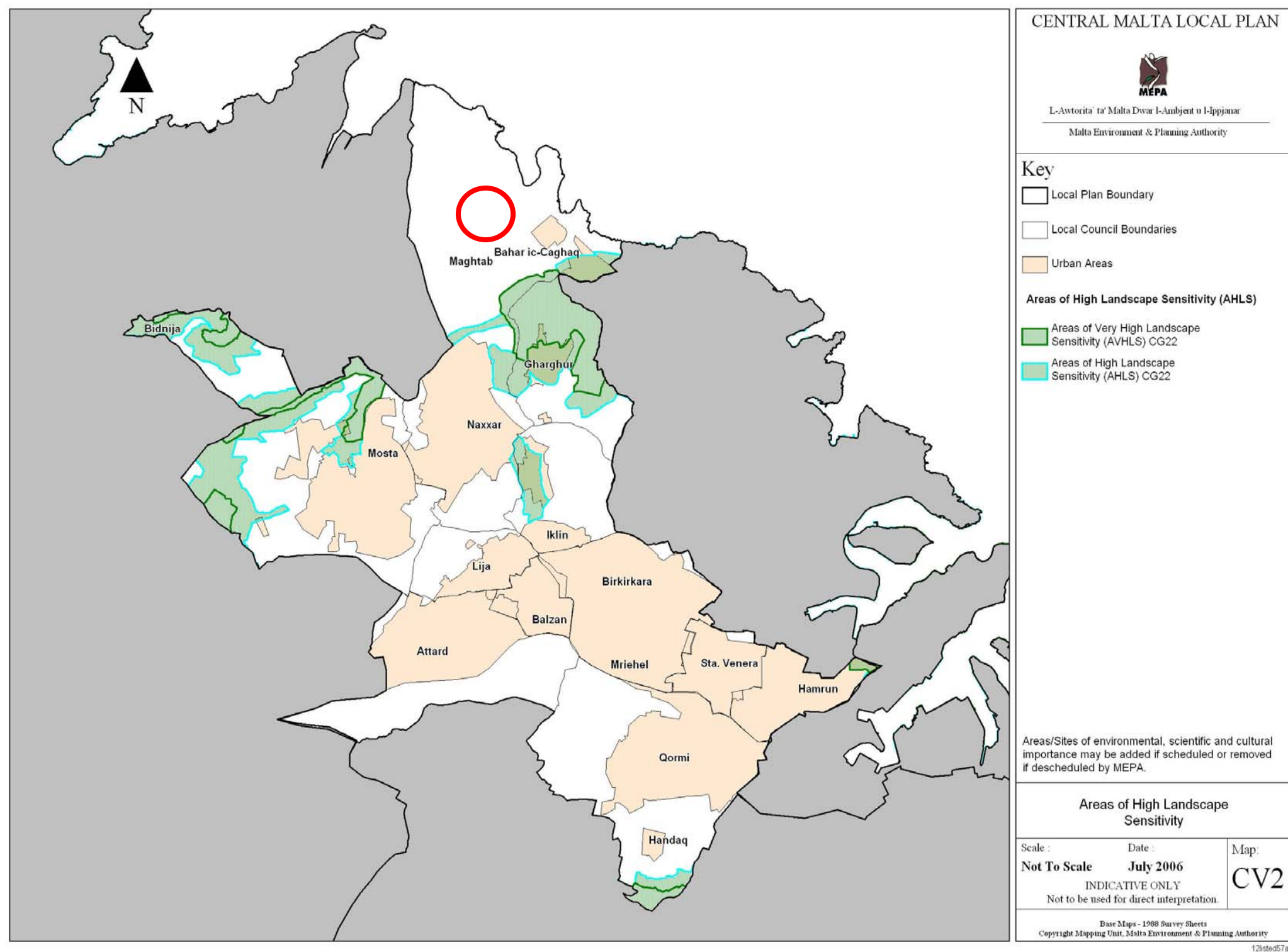


Figure 7.2: Landscape character areas as defined in the North West Local Plan. Red circle denotes Scheme Site

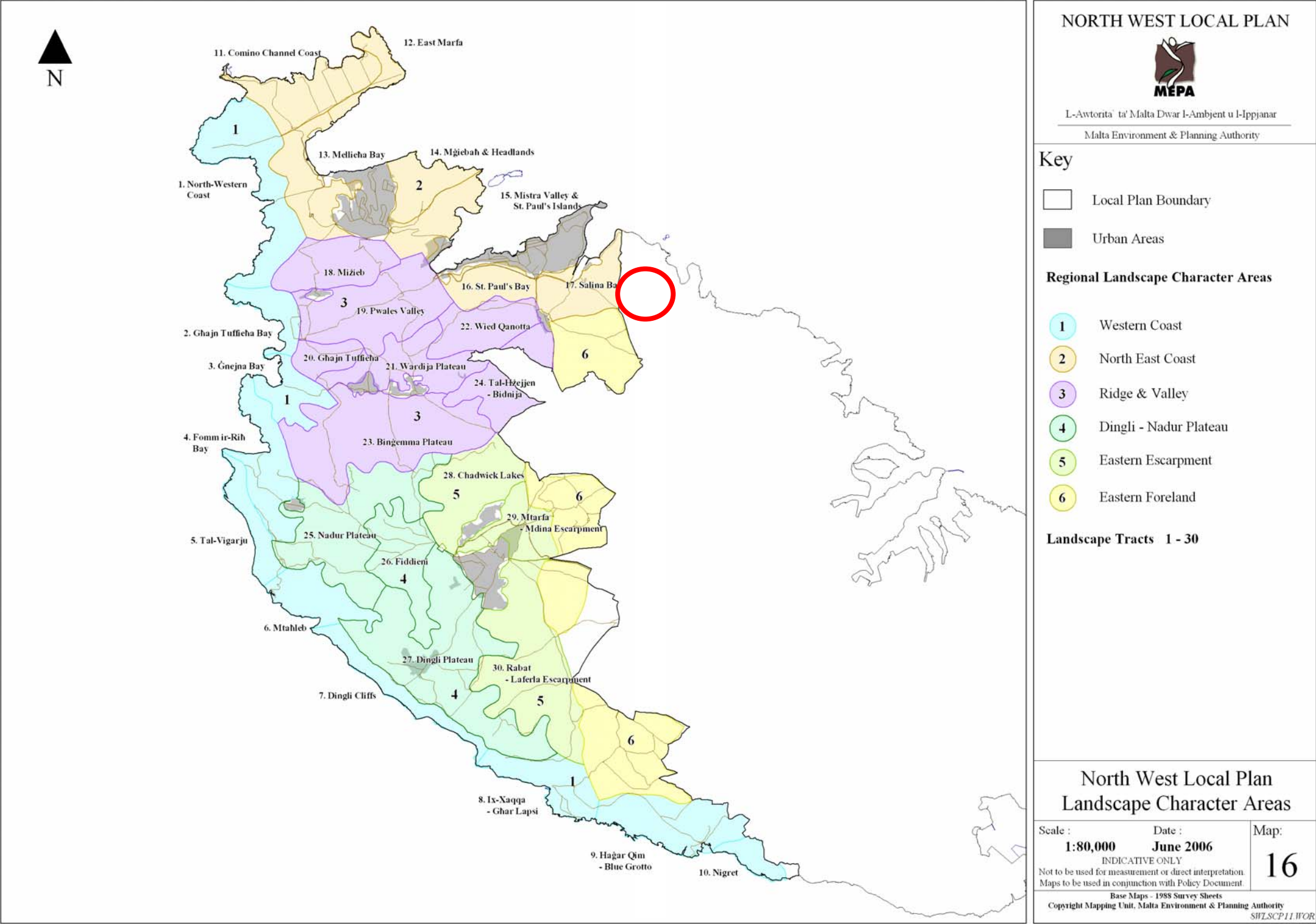


Figure 7.3: Areas of Landscape Sensitivity as defined in the North Harbours Local Plan

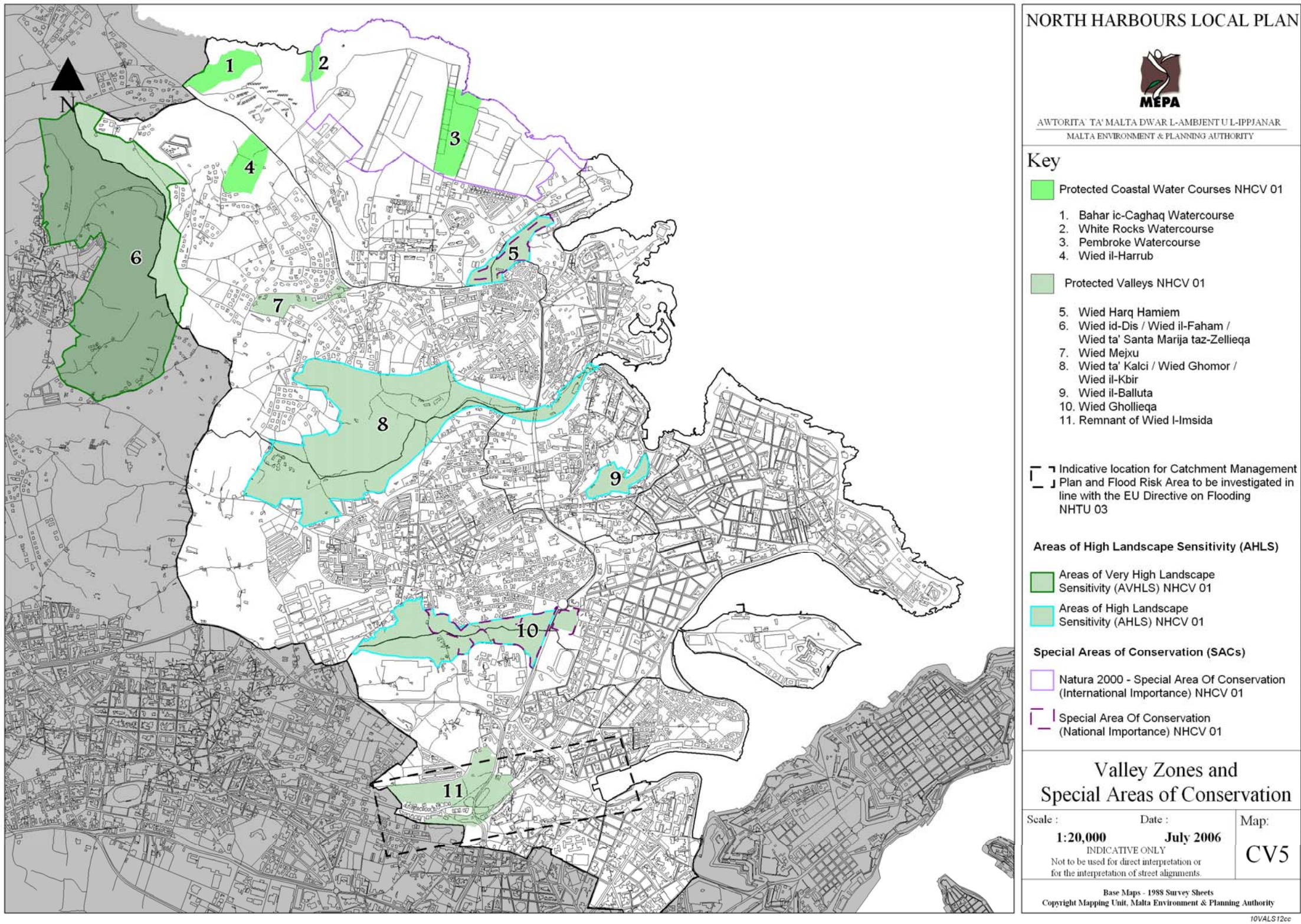
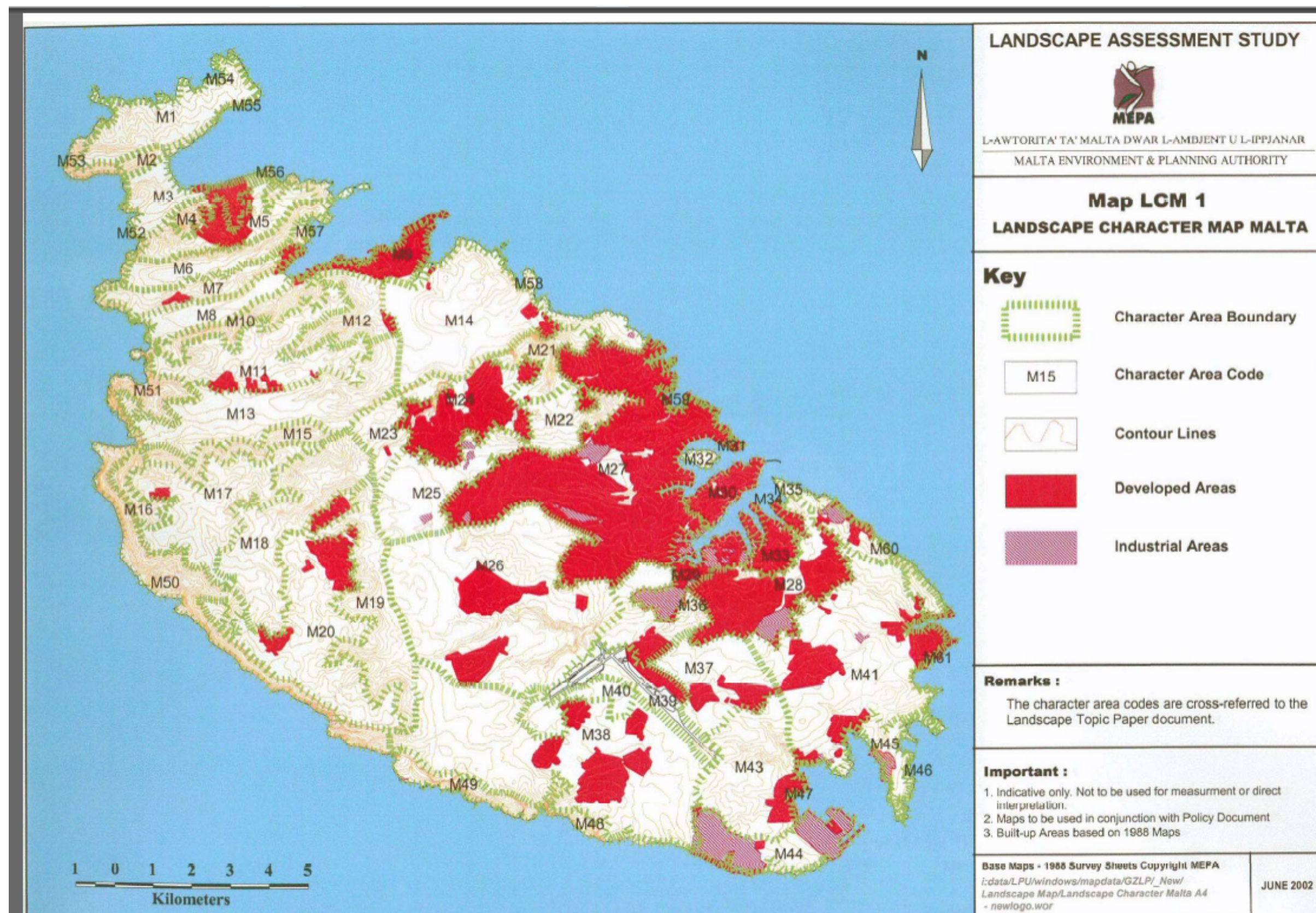


Figure 7.4: Landscape character areas as defined in MEPA's Landscape Assessment Study 2004.



Standards and guidelines

- 7.18. In view of the fact that there are no Malta-specific landscape and visual amenity assessment guidelines, MEPA normally request that landscape and visual assessments are carried out in line with UK best practice methodologies as appropriate, notably the Guidelines for Landscape and Visual Impact Assessment (2002) – Institute of Environmental Management & Assessment (IEMA) and the Landscape Institute.

ASSESSMENT METHODOLOGY

Desk study methodology

Landscape assessment

- 7.19. The landscape baseline conditions were determined through desk study and field survey. The desk study included:
- Review of the information shown on the base map of the area and reference to the maps prepared for the cultural heritage, geo-environmental and land use aspects of the EIS;
 - Analysis of aerial photographs to determine land use trends; and
 - Review of existing baseline information from:
 - Literature searches;
 - Previous environmental and planning studies undertaken in the area;
 - Historic maps; and
 - Legislation and policy documents.

Visual amenity assessment

- 7.20. The Zone of Visual Influence (ZVI) was defined using a combination of desk and field-based techniques. The extent of the viewshed (ZVI) was verified in the field along with the fourteen viewpoints that were agreed with MEPA for the visual amenity assessment (see below). The existing views from these locations were photographed, photomontages created, and the visual amenity and changes thereto as a result of the Scheme appraised.
- 7.21. MEPA's agreement to the location of the viewpoints was sought before the visual amenity study was undertaken. The viewpoints include:
- Short distance views;
 - Medium distance views from publicly accessible locations; and
 - Long distance views from high points or tourist attractions.

- 7.22. A number of views from publicly accessible locations were identified within the ZVI as shown in **Figure 7.5**. These were agreed with MEPA as a basis for assessing changes to visual amenity that may result from the implementation of the Scheme.

Field survey methodology

Landscape

- 7.23. A comprehensive field survey was undertaken in August 2010, in accordance with the *Guidelines for Landscape and Visual Impact Assessment* (The Landscape Institute and IEMA, 2002). The field survey served to record objective and subjective impressions of the landscape, and details of landscape condition, land use, and management. It provided the basis for the delineation of local landscape tracts and the identification of potentially sensitive landscape receptors in accordance with the Guidelines.
- 7.24. **Table 7.1** describes the identified landscape resources.

Table 7.1 Landscape resources

| | |
|---------------------------|--|
| Landscape elements | Upland urban development: buildings, roads and urban open spaces. |
| | Rocky coastline: the immediate coastline to the north of the site consists of rocky shoreline and small bays, urbanised in parts. |
| | The great fault running east-west to the south of the Scheme site. |
| | Incised valleys, running perpendicular to the great fault. |
| | Lowland agricultural areas (broader hinterland of Salina Bay and Qalet Marku) |
| Landscape characteristics | Rugged scenic quality of coast. |
| | The great fault running east-west to the south of the Scheme site, accommodating large scale and visible military structures such as the Victoria Lines, Fort Mosta and Fort Madliena. This fault, with its structures and perpendicular incised valleys provides a distinct backdrop for views looking south and east from the Scheme Site. |
| Landscape character | The distinct and recognisable pattern of elements that occurs consistently in the landscape, and how this is perceived. Landscape character areas have been defined and are illustrated in Figure 7.6 . |

Visual amenity

- 7.25. The extent of the visibility of the Scheme was verified during the field survey, and the ZVI and publicly accessible viewpoints confirmed (See **Figure 7.5**). The field survey also confirmed the areas from which the Scheme was not visible.
- 7.26. Potential sensitive receptors identified in the course of the field survey (in order of descending sensitivity) were:
- Recreational users of the area, walkers and hunters / trappers;
 - Tourists / visitors to the area;
 - Road users (vehicle occupants and pedestrians); and
 - Workers.

Figure 7.5: ZVI and viewpoints

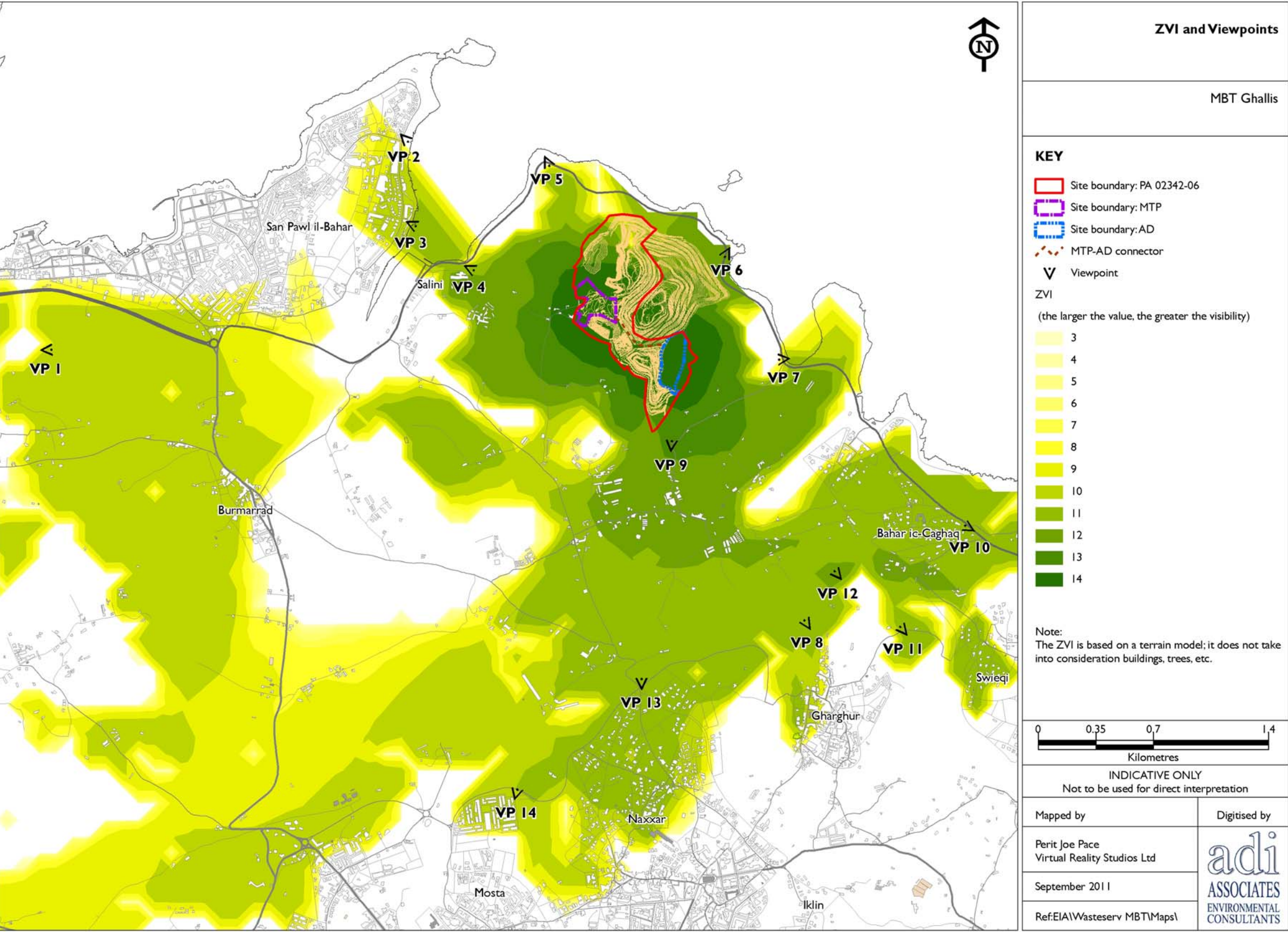
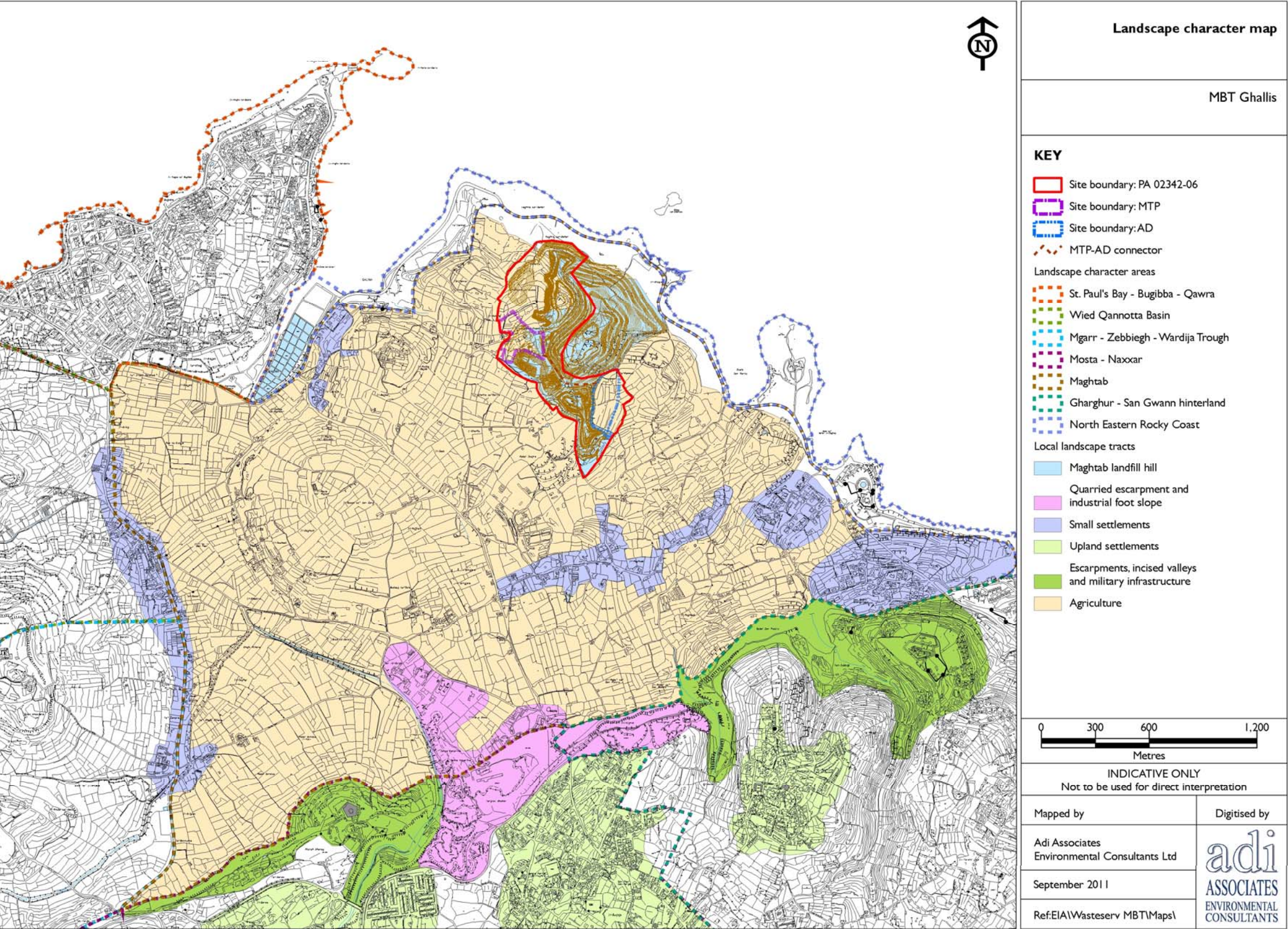


Figure 7.6: Landscape character areas and local landscape tracts



DETERMINING IMPACT SIGNIFICANCE

- 7.27. The significance of impacts on the landscape and visual amenity is dependent upon judgements about the value of the existing visual amenity compared to the new visual amenity that would be created, the number of people affected, the magnitude, duration and permanency of the changes, and subjective judgements about the degree to which these changes would matter to those concerned.

Landscape assessment

- 7.28. The significance of landscape impacts has been defined as follows:

- **Major Significance:** *Large negative changes in the landscape that are out of character with the landscape.* Where the extent of the negative impact on the landscape setting is large in scale or magnitude because of a moderate or high sensitivity to change and / or a high intrinsic value and, as a consequence, the integrity of the setting would be significantly altered. The impact would be of international or national importance and / or likely to affect a large number of people. The impact would be of a long-term nature (or very severe short-term in the case of construction impacts), irreversible, and certain or likely to occur;
- **Minor Significance:** *Some noticeable changes in the landscape that are out of character with the landscape.* Where the extent of the negative impact on the landscape setting is moderate or small in scale or magnitude because of a low sensitivity to change or a low or moderate intrinsic value. The impact would be of local importance and / or likely to affect few people. The impact would be of a long or short-term nature, and likely to occur;
- **Not Significant:** *No perceptible changes to the landscape setting.* Where the extent of the negative impact on the landscape setting is of limited importance in scale or magnitude because of a low sensitivity to change and / or a low intrinsic value. The impact would be of local importance and / or likely to affect very few people. The impact would be of a long to short-term nature, and / or unlikely to occur.

Visual amenity

- 7.29. The significance of visual impacts has been assessed in relation to:

- The number and sensitivity of receptors affected;
- The duration of the changes;
- The extent of visibility and distance from the Scheme;
- The type of view – proportion of development visible, focus on Scheme due to proximity and whether it is fixed, transient or sequential;
- The changes to the view from the identified view points as shown by the photomontages; and

- The scope for mitigation / enhancement measures to screen the development.

7.30. Based on the above criteria an assessment of the significance of the visual impact on each of the agreed viewpoints was made in terms of whether it is considered to be of:

- **Major significance** - *large changes in the view*. Where the extent of the impact on the view would be large in magnitude and affect a large number of persons of moderate sensitivity or a moderate change and affect a smaller number of viewers of high sensitivity. The view would have a high visual amenity / intrinsic value;
- **Minor significance** - *some noticeable changes to the view*. Where the extent of the impact on the view would be moderate or small in magnitude or extent, affect persons of moderate / low sensitivity to change. The view would have a low or moderate visual amenity / intrinsic value. Alternatively, the impact would be likely to affect a limited number of people and / or potentially be of major significance but with significant mitigation (e.g., screening) proposed or possible; or be
- **Not significant** - *little or no obvious changes to the view*. Where the extent of the impact on the visual amenity would be of limited importance in scale or magnitude, or affect persons of low sensitivity to change, and / or be a view of low intrinsic value. Alternatively, the impact would affect very few people, be transient and only affect a small part of the Scheme or panorama.

EXISTING CONDITIONS

Landscape

7.31. The Application Site is located at Maghtab. It includes the former Maghtab landfill, which was used for disposal of all of Malta's municipal waste, as well as construction waste, in the period between the early 1970s and 2004. Now closed, the landfill reaches a height of approximately 70m AMSL and has substantially altered the landform of the Maghtab area. It is the single most significant human intervention in the area. MEPA's Landscape Assessment Study identifies the landfill as the worst eyesore in the Maltese Islands. It states:

"By the end of 1999, the Maghtab dump has become a veritable eyesore which is visible from as far off as Mdina, which lies due south, and from certain areas in eastern Gozo. The toxic fumes which frequently emanate from the dump, add to the appearance of a dereliction and to the eyesore problem".

7.32. The landscape in the vicinity of the Site is predominantly agricultural land, with small agricultural holdings and low, partly degraded rubble walls. The primary agricultural practice is livestock farming. There are several dispersed commercial uses in the area - aggregate storage areas, concrete batching plants, vehicle storage areas, and a telecommunications installation. An SME business park is currently also being developed.

7.33. The urban coastal settlements of Bugibba, St Paul's Bay and Qawra dominate the peninsula to the west of Salina Bay. Mosta, Naxxar and Gharghur occupy the urban uplands to the east of the Application Site. The low-lying Maghtab area and the urban

uplands are separated by a distinct and continuous escarpment that results from a major geological fault (known as the 'Great Fault') running between Pembroke and Fomm ir Rih. This provides a distinct variation in elevation between the uplands (typically 120 - 140m AMSL) and the coastal hinterland of Salina Bay and Qalet Marku (around 30m AMSL).

- 7.34. The landscape to the north of the Application Site is dominated by exposed rocky coastline. This starts from the edge of the St Paul's Bay conurbation and is next broken by the urban development at Bahar ic-Caghaq.
- 7.35. Other significant human interventions that have altered the landscape around the Site include quarrying activities and large industrial uses, such as batching plants. Most quarrying activity has occurred along the escarpments of the great fault. Certain quarries such as HM28 (Ta'Birguma, Naxxar) and HM15 (Targiet Ghomor, Naxxar) are visible along the ridge from the Maghtab area.
- 7.36. The site for the installation of the Scheme is located on the southern foot slope of the former landfill. This part of the Site is approximately 40m AMSL, and is therefore considerably lower than the landfill at its highest point (approx. 70m AMSL). As a result, the site is not visible in the long distance views from the north and west.

Landscape Character Assessment

- 7.37. The landscape types / character areas that provide the landscape context to the Application Site are described below. The distinction between the types and areas is defined in the assessment as:
- *Landscape Character Types* describe distinct and homogeneous generic landscape units that share common combinations of elements (listed and described in **Table 7.2**); and
 - *Landscape Character Areas* are single unique areas and represent the discrete geographical areas of a particular type. Each Landscape Character Area may be divided into Local Landscape Tracts (LLT) that describe potential problems and pressures affecting the landscape character (illustrated in **Figure 7.6** and described in **Table 7.2**).

Table 7.2: Landscape types and character areas

| Defined area / Attribute | Summary Description |
|--------------------------|---|
| Landscape Type | |
| Urban uplands | <p>The villages of Mosta, Naxxar and Gharghur dominate areas to the south and east of Maghtab. These uplands are predominantly urban. The incised valley systems provide distinct separation between each settlement. These valleys include Wied Anglu (separating the Naxxar suburbs from Gharghur), Wied Faham (separating the village of Gharghur from Madliena) and Wied Ghasel (Mosta). The Great Fault forms a sharply defined boundary between this upland landscape type and the low-lying agricultural hinterland around Gharghur and Burrmarad.</p> <p>Upland areas include the Character Areas M21, M23 and M24 as defined</p> |

| Defined area / Attribute | Summary Description |
|---|--|
| | in MEPA's Landscape Assessment Study 2004. |
| Agricultural lowlands | <p>The Great Fault forms a sharp boundary between the urban uplands and the low lying agricultural hinterland of Qalet Marku Bay and Salina Bay. This hinterland is predominantly agricultural with dispersed farm houses and small rural settlements such as Burmarrad and Maghtab Village.</p> <p>The lowland areas include the Character Areas M12, M13 and M14 as defined in MEPA's Landscape Assessment Study 2004.</p> |
| Coastal belt | <p>This includes the urban area of St Paul's Bay – Bugibba – Qawra and north eastern rocky shoreline.</p> <p>The coastal belt includes the Character Areas M9 and M58 as defined in MEPA's Landscape Assessment Study 2004.</p> |
| Character Area: Maghtab | |
| Described in MEPA's Landscape Assessment as the 'Maghtab Character Area' (M14), this plain consists of predominantly low lying agricultural land. It also accommodates the former Maghtab landfill. This landfill has substantially altered northern parts of this Character Area (by leaving a 'man made' hill). Other anthropogenic processes, such as quarrying and industrial activities, have similarly altered the natural geomorphology of the great fault escarpment to the south of this Character Area. With the possible exception of quarrying, the former Maghtab landfill is the most significant human intervention (in terms of size and scale) to affect the landscape of the Maltese Islands. | |
| Local Landscape Tract 1: Former Maghtab Landfill | Land north of Maghtab village (west of Qalet Marku and east of Salina Bay). |
| | <p><i>Landfill site</i></p> <ul style="list-style-type: none"> o Large mixed construction and municipal waste landfill site providing man made hill. Characterised by exposed sides with little established vegetation. o Sides have been terraced for future restoration and rehabilitation to a family park. o Landfill has substantially altered the natural topography of this coastal hinterland. Silhouette of landfill is visible from many parts of Malta. o Not acknowledged as an Area of High Landscape Sensitivity in the Central Malta Local Plan (CMLP) or the North West Local Plan (NWLP). <p><i>Problems</i></p> <ul style="list-style-type: none"> o Non-geomorphologic hill within a low lying coastal hinterland. The scale of the landfill combined with the aesthetic effects of the exposed slopes, smells and perceptions of air and ground water pollution result in negative landscape associations for most receptors. <p><i>Landscape Sensitivity</i> Low</p> |
| Local Landscape Tract 2: Agricultural land | <p><i>Agricultural land</i></p> <p>Apart from the landfill, agricultural land is a dominant feature in this landscape. However, given the relatively poor quality of the land (see Chapter 8), generally features of this landscape, mainly rubble walls, apart from the fields themselves are not well maintained.</p> <p>As described in Chapter 9, a number of cultural heritage features are also present, however, given the surrounding anthropogenic alterations to the landscape, most noticeably, the Maghtab landfill, these features are largely not dominant within the landscape.</p> <p><i>Landscape Sensitivity</i> Moderate</p> |
| Local Landscape Tract 3: Quarried escarpments and industrial foot slopes | <p>Parts of Great Fault most affected by human intervention.</p> <p><i>Landscape Sensitivity</i></p> |

| Defined area / Attribute | Summary Description |
|--|--|
| | <p>Low</p> <p><i>Escarpmnts and foot slopes</i></p> <ul style="list-style-type: none"> o Parts of the escarpments of the great slopes have been intensively quarried for hardstone (Quarry No. HM15, HM22 and HM28). o Foot slopes have been developed for large scale industrial buildings to accommodate SMEs / garage industries relocating from urban areas. o Some parts of the escarpments affected by quarrying are acknowledged as within an Area of High Landscape Sensitivity in the CMLP (HM28). <p><i>Problems</i></p> <ul style="list-style-type: none"> o The natural geomorphological feature of the great fault has been substantially altered (aesthetically) through the quarrying of bedrock. The development of agricultural land for industrial activities has also affected the setting of the escarpments (particularly at the base of T'Alla w'Ommu). <p><i>Landscape Sensitivity</i></p> <p>Low to high.</p> |
| Local Landscape Tract 4: Small settlements | <p>Dispersed small settlements including Bahar ic-Caghaq, Burmarrad and Madliena.</p> |
| | <p><i>Settlements</i></p> <ul style="list-style-type: none"> o Burmarrad and surrounding uses (such as market garden centres) have developed in a 'ribbon' or linear form. This settlement geared to service agricultural sector. o Bahar ic-Caghaq is a small schemed area of predominantly residential uses (flats with some villas). o Parts of Madliena are recognised as an Area of High Landscape Sensitivity in the CMLP. o Settlements are too small to distract significantly from the predominately rural characteristics of the Maghtab Character Area. <p><i>Problems</i></p> <ul style="list-style-type: none"> o Perception that the landfill has expanded too much, given its proximity to settlements such as Bahar ic-Caghaq. <p><i>Landscape Sensitivity</i></p> <p>Low to moderate.</p> |
| Character Area: St Paul's Bay – Bugibba – Qawra | |
| <p>MEPA's Landscape Assessment describes this Character Area (M9) as a tourist coastal settlement area, as follows:</p> <p><i>"Formerly an un-built, predominantly agricultural area, it is now one of the most densely built tourist areas in the Maltese Islands. It is a peninsula flanked by Il-Bajja ta' San Pawl (St. Paul's Bay) and Il-Bajja tas-Salina (Salina Bay). Most of the development in this area consists of holiday flats, restaurants and hotels four storeys or higher. It is one of the most urbanised areas in the north-western part of mainland Malta. The core of the settlement is relatively undeveloped but this area is not appreciated from long distance views (except from the air) as it is visually secluded by higher development. The whole settlement is encircled by a system of busy carriageways (especially in summer)."</i></p> <p><i>Landscape Sensitivity</i></p> <p>Low to moderate.</p> | |
| Character Areas: Gharghur - San Gwann Hinterland' and Mosta - Naxxar | |
| <p>MEPA's Landscape Assessment describes these Character Areas as part of the 'Gharghur - San Gwann Hinterland' (M21) and 'Mosta - Naxxar' (M24).</p> <p>The Gharghur - San Gwann Hinterland includes the upland settlements of Madliena and Gharghur. It is described as follows:</p> <p><i>"An elevated area, which has its north-western flank dominated by the escarpment of the great fault, which dips suddenly on the north-western portion to merge with the Bahar ic-Caghaq area. The northern part is still relatively undeveloped with Gharghur and Madliena as the only settlements of relevance. There is also a system of very</i></p> | |

| Defined area / Attribute | Summary Description |
|--|--|
| | <p><i>picturesque valleys which flank the settlement of Gharghur. Considerable areas of moderate slope (e.g., Madliena and Iklin) have been developed for detached or semi-detached dwellings. The area of San Gwann is rather flat and is an area of former soft stone quarrying. The area is currently predominantly cultivated with the exceptions of the settlement of San Gwann. The elevated terrain has been utilized to accommodate a number of transmission lattice towers for radio, TV and telecomms facilities. A number of valleys originate from the higher areas and predominantly drain towards the Bahar ic-Caghaq area and the St. Julians area."</i></p> <p>The settlements of Naxxar and Mosta (M24) are described as follows:</p> <p><i>"The settlements of Naxxar and Mosta are located on a stretch of land which rises gently towards north-east. Significant tracts of the area have been urbanized, the predominant land-use being residential development. Areas along the perimeter of the settlements are dominated by villa development in the case of Naxxar and industrial development in the case of Mosta. Naxxar and Mosta are dominated by the respective parish church. In both cases, the historic cores have been girdled by modern development that has eventually linked the two settlements together. Blocks of higher public housing development dominate the skyline when viewed from certain angles."</i></p> |
| Local Landscape Tract 1: Upland settlements | <p>Upland settlements</p> <ul style="list-style-type: none"> o Include the urban areas of Mosta, Naxxar and Gharghur. There has been a 'blurring' of distinction of the edges of some settlements – e.g., Naxxar and Mosta merge together. o The area around Gharghur is proposed for designation as an Area of High Landscape Sensitivity through the CMLP. <p><i>Problems</i></p> <ul style="list-style-type: none"> o Difficult to orientate between settlements – lack of distinction between settlements through the incised valleys (see LLT 5) and limited remaining pockets of open countryside provide some visual breaks. <p><i>Landscape Sensitivity</i> Low to moderate.</p> |
| Local Landscape Tract 2: Escarpments, incised valleys and military infrastructure. | <p>The Great Fault, Victoria Lines and perpendicular incised valleys.</p> <p><i>Landscape Sensitivity</i> High.</p> |
| | <ul style="list-style-type: none"> o The Great Fault provides a strongly defined edge between the Gharghur and Mosta - Naxxar and Gharghur / San Gwann Hinterland Character Areas. This LLT provides numerous opportunities to overlook the Maghtab Character Area, providing views northwards towards the former landfill. o This LLT accommodates a number of incised valleys that run parallel to the fault. These also provide spectacular views towards the Maghtab area, although these are not panoramic as the valley sides frame the view. o Much of this fault accommodates numerous military buildings and infrastructure dating to the time of the Knights (16th Century) and British Period (19th Century). <p><i>Problems</i></p> <ul style="list-style-type: none"> o Pressures for quarrying, industrial activities and illegal dumping are threatening this LLT. <p><i>Landscape Sensitivity</i> High.</p> |
| Character Area: Wied Qannotta Basin and Mgarr – Zebbiegh – Wardija Trough | |
| <p>These character areas are identified in MEPA's Landscape Assessment as Wied Qannotta Basin (M12) and Mgarr-Zebbiegh-Wardija Trough (M13). They are described as follows:</p> <p><i>"A system of clay slopes girdling the Wardija uplands, being bisected by a number of V-shaped valleys which support watercourses during the wetter season. The slopes on the southern flank gradually merge with the Mgarr plains. The</i></p> | |

| Defined area / Attribute | Summary Description |
|--|--|
| | <p>area is extensively cultivated, relatively undeveloped and not easily accessible. A number of scattered animal husbandry units can also be found in the area. There are no major roads passing through the area.”</p> <p>Landscape Sensitivity High.</p> |
| Character Area: North-Eastern Rocky Coast | |
| | <p>MEPA's Landscape Assessment 2004 describes the rocky coastline between Bugibba and Tigne Point. That part of the north-eastern rocky coast near Bahar ic-Caghaq (M58) is described as follows:</p> <p>“...still relatively free from permanent residential settlements. Some of the natural coastal rock formations such as those near Salini and Ghallis are rather rugged whilst others such as those at Ghar id-Dud are much smoother.”</p> <p>Landscape Sensitivity High.</p> |

EXISTING CONDITIONS – FIELD SURVEY

Scheme Landscape

- 7.38. The field survey affords the opportunity to appreciate the intricacies of the character of the Scheme area, pick up features that are not shown on maps, and develop a deeper understanding of the landscape's rationale, and particularly to gather sensory information such as sounds, smell, etc, all of which contribute to an overall appreciation of landscape character.
- 7.39. **Figure 7.7** shows the impact of the former dump site on the skyline. This photo was taken approximately 4km to the south of the site. The hill formed by the former landfill dump is omnipresent from most views along the Victoria Lines and other elevated positions along the great fault to the south and east.
- 7.40. The Site is mostly visible from short to medium distances, particularly from areas to the east and south of the Site. The morphological context of the Site is not apparent from many parts of the Site because it is an urbanised part of the San Ġwann Industrial Estate.
- 7.41. This view confirms that, although there are numerous dispersed commercial and livestock uses around the Scheme Site, the overall landscape appears rural in nature. The distant views of the Mediterranean Sea are glimpsed far inland, although these are partially obscured by the former Maghtab landfill. **Figure 7.8** is taken from the vicinity of the Scheme Site and shows the contrast between the rocky shoreline and the in land agricultural fields surrounding the landfill site.

Figure 7.7: Long distance view of the former Maghtab landfill site from the Victoria Lines at Targa Gap



Figure 7.8 View looking east towards Qalet Marku from the vicinity of the Scheme Site



Landscape character

- 7.42. The general findings of the desk study were confirmed.
- 7.43. The character of the area affected by the Scheme is particularly important because it provides the context to the Scheme and the contrast and impact between the new landscape resulting from the introduction of the Scheme and the existing landscape would be, in part, determined by how well the Scheme is assimilated into the wider landscape.
- 7.44. Key character attributes of the surrounding landscape are provided by its mixed rural and coastal context. The surrounding landscape enjoys a spectacular setting, provided by the rocky shoreline between Bahar ic-Caghaq and St Pauls Bay and the low lying rural plain around Maghtab and Burmarrad. These are bordered by the spectacular escarpments of the great fault, although industrial development and quarrying activity

have compromised its setting. **Figure 7.9** shows the low-lying industrial area below the escarpment at Naxxar Gap, with the coastal settlements of St Paul's Bay, Bugibba and Qawra along the skyline.

- 7.45. The most significant landscape attribute is, however, the former Maghtab landfill. This man-made topographic feature will host the Scheme and is itself considered to be an 'eye sore' and of low landscape sensitivity in its current state.

Figure 7.9: View across Maghtab from the escarpments of the great fault



Visual Amenity

The Zone of Visual Influence

- 7.46. **Figure 7.1** illustrates the computer generated Zone of Visual Influence (ZVI). Whilst the ZVI appears extensive, in the field, it was ascertained that, as a result of buildings, vegetation, and distance, the Scheme was not visible from all areas within the ZVI. The field survey was carried out to select the best viewpoints and include long, medium, and short distance views from public places. The selected viewpoints were agreed with MEPA and are shown in **Figure 7.5**⁷.

Scheme site visibility

- 7.47. In assessing views there is often likely to be a continuum in the degree of visibility of the development from full view to no view. **Table 7.3** summarises the situation in respect of the Scheme.

⁷ It should be noted that where the Scheme is visible, the photomontages reflect the 20m stack height, changed as a result of the odour assessment where a minimum stack height of 15 metres was recommended (refer to **Chapter 11**).

- Extent of site visibility – full view, partial view, glimpse or no view into the site at all demonstrates the exposure of the site and the processes thereon to public view.
 - The Scheme is fully visible from Viewpoints 8, 12 and 13. The Scheme is partially visible from Viewpoints 1, 2, 3, 9, 10 and 14. The Scheme is not generally visible from the short distance viewpoints, and is not visible from Viewpoints 4, 5, 6, 7, and 11. As a result, there is no impact to assess from these viewpoints and they are not considered further in this chapter, however, all viewpoints and photomontages are shown in **Appendix 3**.
- Proportion of development visible – expresses the proportion of the development that is visible from the viewpoints: full, most, some, small amount, or none.
 - The proportion of the Scheme that is visible from the viewpoints varies depending on the location of the viewpoint. The Scheme is 100% visible from Viewpoints 8, 12 and 13.
- Focus on Scheme due to proximity – is an indicator of the distance from the Scheme and whether the viewpoint would focus on the development due to its proximity (i.e., it is the only thing to look at), or whether the Scheme is part of a panorama.
 - Both panorama and proximity views are included.
- Transient or sequential view – the principal receptors will have sequential views of the Scheme site. Transient views are those that pass quickly (like looking through a doorway as one walks past), and sequential views expose the receptor to different yet sequential views of the site. The latter allows the site to be viewed for a longer period and from different and changing perspectives.
 - **Table 7.3** describes the sequential and transient points.

Table 7.3: Summary of Application Site visibility from viewpoints

| | Viewpoints | | | | | | | | |
|---------------------------------------|------------|------------|------------|------------|------------|-----------|------------|------------|------------|
| | VP 1 | VP2 | VP3 | VP8 | VP9 | VP10 | VP 12 | VP13 | VP14 |
| Distance of viewpoint from Scheme (m) | | | | | | | | | |
| Extent of Scheme visibility | Partial | Partial | Partial | Full | Partial | Partial | Full | Partial | Partial |
| Proportion of Scheme visible | 40% | 10% | 10% | 100% | 10% | 50% | 100% | 90% | 25% |
| Focus on Scheme due to proximity | Panorama | Panorama | Panorama | Panorama | Proximity | Panorama | Panorama | Panorama | Panorama |
| Transient or sequential view | Sequential | Sequential | Sequential | Sequential | Sequential | Transient | Sequential | Sequential | Sequential |

Sensitivity of visual receptors

- 7.48. The sensitivity of visual receptors is dependent on the location from where they experience the view, their expectations, occupation or activity at the viewpoint, and the importance of the view. UK Guidelines note that the most sensitive receptors may include:
- Users of outdoor recreation facilities whose attention or interest may be focused on the landscape; and
 - Communities where the development results in changes to the landscape setting or valued views enjoyed by the community; and
 - Occupiers of residential properties with views affected by the development.
- 7.49. The Guidelines also note that other receptors could include people engaged in outdoor sport or recreation other than those involving an appreciation of the landscape, people travelling through the area, and people at their place of work. The latter are regarded as the least susceptible to changes in view.
- 7.50. The following definitions are used to categorise the sensitivity of receptors:
- High sensitivity receptors: those who repeatedly re-visit the viewpoint to partake of the view. Such views are generally highly valued by the community;
 - Moderate sensitivity receptors: itinerant visitors (mostly tourists) to the viewpoint; and
 - Low sensitivity receptors: road users, workers, etc.
39. Residents are not included above because views from private property are not protected under planning law or other public policy except in so far as the zoning of the land implies certainty as to the type of development that may be permitted. The rights of nearby residents are protected through the planning system whereby they are afforded the opportunity to object to any change of land use (or airspace). The EIA process does not assess the impacts of a project on the rights or values of individuals, but rather on the public collectively, and those rights and values are as expressed in legislation and planning policy. It is for this reason that this EIS does not address the effects of loss of views from private properties, land ownership, etc.

CHANGES IN THE LANDSCAPE AND VISUAL AMENITY

- 7.51. Changes to the landscape and visual amenity of the ZVI are anticipated because of the Scheme. This section focuses on the impacts of the Scheme as described in **Chapter 4**, on landscape and visual amenity, and points to possible mitigation measures, where relevant.

Changes in the Landscape and their Significance

- 7.52. The changes to the landscape during construction and operation are considered together. In terms of landscape character, the impacts occur as a result of the

construction of the Scheme. Hence, the assessment of the Scheme during operation is the same as that for the construction (completion of the buildings to their full height) and covers the loss of landscape features and the effects of the Scheme on those remaining. **Table 7.4** details the changes in landscape and their significance.

Table 7.4 Changes in landscape character and the significance of the impacts

| Location | Changes | Effects & Significance |
|---|---|--|
| Maghtab Character Area: LLT1: Former Maghtab landfill | Introduction of industrial plant, which is a new landscape feature, into a rural/coastal landscape. | Introduction into an LLT that has a low intrinsic value of an industrial feature that is out of character with the LLT due to the sheer bulk of the facility, and its industrial nature, which introduces tanks and buildings. Impact: Minor to major significance because it is a large change in a landscape that is judged to be of low to moderate intrinsic value. |
| Maghtab Character Area: LLT2 Agricultural land | Introduction of industrial plant, which is a new landscape feature, into a rural/coastal landscape. | Introduction adjacent to an LLT that has a moderate intrinsic value of an industrial feature that is out of character with the LLT due to the sheer bulk of the facility, and its industrial nature, which introduces tanks and buildings. Impact: Major significance because it is a large change in a landscape that is judged to be of moderate intrinsic value. |
| Maghtab Character Area: LLT3: Quarried escarpments and industrial foot slopes | No changes | No changes Impact: Not significant |
| Maghtab Character Area: LLT4: Lowland small settlements | No changes | No changes Impact: Not significant |
| St Paul's Bay – Bugibba – Qawra Character Area | No changes | No changes. Impact: Not significant |
| Gharghur – San Gwann Hinterland and Mosta-Naxxar Character Area: LLT1: Upland settlements | No changes | No changes. Impact: Not significant |
| Gharghur – San Gwann Hinterland and Mosta-Naxxar Character Area: LLT2: Escarpments, incised valleys and military | No changes | No changes. Impact: Not significant |

| Location | Changes | Effects & Significance |
|--|------------|--|
| infrastructure | | |
| Wied Qannotta Basin and Mgarr-Zebbiegh-Wardija Trough Character Area | No changes | No changes. Impact: Not significant |
| North Eastern Rocky Coast Character Area | No changes | No changes. Impact: Not significant |

- 7.53. The Scheme continues to add on to the existing waste management facility. Despite the fact that the Scheme is, therefore, in keeping with the existing use, a change in the landscape will occur because the existing landscape, though dominated by the Maghtab landfill does not include large scale plant within the Maghtab Character Area. The Scheme will therefore introduce a new feature in the landscape which is in contrast with the predominantly surrounding rural nature, rocky coast and small settlements.
- 7.54. The surrounding large Character Areas dominated by urban settlements are not expected to be affected in terms of landscape due to distance and topography.

Changes in Visual Amenity and their significance

- 7.55. The assessment of the impact of the Scheme on the visual amenity of the ZVI takes account of the scale of change resulting from the Scheme, the degree of contrast or integration resulting from the change, the duration and nature of the effect, the angle of view in relation to the main activity of the receptor, the distance of the viewpoint from the Scheme, the extent of the area over which the changes would be visible, and the number and level of sensitivity of sensitive receptors who may experience the views. The changes in visual amenity and the significance of those changes are described below for each of the viewpoints previously agreed with MEPA. **Table 7.3** describes the attributes of each viewpoint.
- 7.56. The impact of the Scheme on the visual amenity of the areas portrayed in the above photographs and photomontages from the agreed viewpoints ranges from not significant to major significance with the largest and most significant impact being affecting those viewpoints that overlook the Burmarrad lowlands with Maghtab dominating the background.

RESIDUAL IMPACTS

- 7.57. The residual impacts would be the same as the unmitigated impacts.

Viewpoint Date: 5th May 2011

| | |
|--------------|---|
| Key features | <p>Panoramic view looking over St Paul's Bay and the Burmarrad Plain in the distance. Maghtab and Ghallis are clearly visible in the centre of the photo.</p> <p>Moderate visual amenity, moderate intrinsic value.</p> |
|--------------|---|

| | |
|--------------------------|---|
| Change to Visual Amenity | Inclusion of a building mass in the distance. Barely discernible due to the distance. |
|--------------------------|---|



| | |
|--------------------------|--|
| Viewpoint 2 | Date: 5 th May 2011 |
| Location | Triq il-Qawra promenade |
| Key features | This view is dominated by sea and the Magtab landfill on low-lying ground. The tower is visible to the left-hand side Low visual amenity, low intrinsic value |
| Sensitive receptors | Recreational users – a large number of high sensitivity receptors |
| Change to Visual Amenity | A low lying building mass that does not break the skyline is introduced as a result of the Scheme. |



Viewpoint 3: Triq il-Luzzu, Qawra

| | |
|--------------------------|---|
| Viewpoint 3 | Date: 5 th May 2011. |
| Location | Triq il-Luzzu, Qawra |
| Key features | This is a panoramic view showing Magtab from a different angle. A concrete jetty is visible in the foreground. Low visual amenity, low intrinsic value. |
| Sensitive receptors | Recreational users – high number of high sensitivity receptors |
| Change to Visual Amenity | A low lying building mass that does not break the skyline is introduced as a result of the Scheme. |



Impact

A small change affecting a high number of high sensitivity viewers.
Impact: Not significant to minor significance



Viewpoint 9: Triq ir-Ramla, Magtab

| | |
|--------------------------|--|
| Viewpoint 9 | Date: 5 th May 2011 |
| Location | Triq ir-Ramla, Magtab |
| Key features | This is a proximity view, close to the boundary of the Ghallis waste management facility, a shaded parking area is visible in the foreground Low visual amenity, low intrinsic value. |
| Sensitive receptors | Road users. Moderate numbers of low sensitive viewers. |
| Change to Visual Amenity | Low-lying structures are partially visible |

Impact

A minor change affecting a moderate number of low sensitivity viewers.
Impact: Not significant



Viewpoint 10: Triq il-Kosta, Bahar ic-Caghaq

| | |
|--------------------------|--|
| Viewpoint 10 | Date: 16 th December 2007, camera at 1.7m. |
| Location | Triq il-Kosta, Bahar ic-Caghaq |
| Key features | Magtab is dominant in the background, the urban environment of Bahar ic-Caghaq is presented in the foreground. Low visual amenity, low intrinsic value. |
| Sensitive receptors | Road users. Pedestrians. Low number of moderate to low sensitive receptors |
| Change to Visual Amenity | Most of the Scheme is visible, with the palm tree providing the only screening |

Impact

A moderate change affecting a low number of moderate sensitivity viewers.
Impact: Minor significance



Viewpoint 12: Triq Ghaxqet l-Ghajn, l/o Gharghur

| | |
|--------------------------|---|
| Viewpoint 12 | Date: 5 th May 2011 |
| Location | Triq Ghaxqet l-Ghajn, l/o Gharghur |
| Key features | A panoramic view of the Burmarrad plain with Magtab clearly visible Moderate visual amenity, moderate intrinsic value. |
| Sensitive receptors | Recreational users. Low to moderate number of high sensitive receptors |
| Change to Visual Amenity | The Scheme is clearly visible and contrasts with the surrounding landscape. |

Impact

A major change affecting a low to moderate number of high sensitivity viewers.
Impact: Major significance



Viewpoint 13: Triq John Adye, T'Alla u Ommu

| | |
|--------------------------|--|
| Viewpoint 13 | Date: 5 th May 2011. |
| Location | Triq John Adye, T'Alla u Ommu |
| Key features | A sequential view from the Naxxar Entrenchment Wall onto the Burmarrad plain, a statue is visible in the centre of the photo and Magtab dominates the background. Moderate visual amenity, moderate intrinsic value. |
| Sensitive receptors | Tourists with interest in cultural features; other visitors partaking of the view. Low to moderate number of moderate to high sensitive receptors. |
| Change to Visual Amenity | The Scheme is partially visible and dominant despite the long distance view, mainly because it introduces a mass of industrial buildings into a landscape that is predominantly rural. |

Impact

A major change affecting a low number of high sensitivity viewers.

Impact: Minor to major significance



| Viewpoint 14: Triq l-Imsaqfin, Mosta | |
|--------------------------------------|---|
| Viewpoint 14 | Date: 15 th May 2011 |
| Location | Triq L-Imsaqfin, Mosta |
| Key features | <p>This viewpoint also overlooks the Burmarrad Plain and includes in the foreground a quarry and ancillary facilities as well as other industrial buildings. Magtab is present in the background.</p> <p>Moderate to low visual amenity, moderate to low intrinsic value.</p> |
| Sensitive receptors | Visitors, hikers, pedestrians. Low number of moderate sensitive receptors |
| Change to Visual Amenity | The Scheme is minimally visible at the foot of Magtab. |
| Impact | <p>A small change affecting a low number of moderate sensitivity viewers.</p> <p>Impact: Not significant to minor significance</p> |



Table 7.5: Summary of Impacts on Landscape and Visual Amenity

| | | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact | Proposed Mitigation Measures | Significance of Residual Impact |
|---|---------------------|----------------------------------|------------------------------------|--------------------|----------------|------------|--------------------|------------------------|--------------------------------------|---------------------------------------|------------------------------|---------------------------------------|
| Asset Impacted | Beneficial/ Adverse | Const'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct or Indirect | S term/ L term | Perm/ Temp | Reverse/ Irrevers. | (Inter/National/Local) | (Likely, Unlikely, Remote Uncertain) | (Major, Minor, Not significant) | | (Major, Minor, Not significant) |
| Landscape | | | | | | | | | | | | |
| Maghtab Character Area: LLT1: Former Maghtab landfill | Adverse | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Minor to Major | None | Minor to Major |
| Maghtab Character Area: LLT2: Agricultural land | Adverse | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Major | None | Major |
| Maghtab Character Area: LLT3: Quarried escarpments and industrial foot slopes | Neutral | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant | None | Not significant |
| Maghtab Character Area: LLT4: Lowland small settlements | Neutral | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Minor to Major | None | Minor to Major |
| St Paul's Bay – Bugibba – Qawra Character Area | Neutral | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant | None | Not significant |
| Gharghur – San Gwann Hinterland and Mosta-Naxxar Character Area: LLT1: Upland settlements | Neutral | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant | None | Not significant |
| Gharghur – San Gwann Hinterland and Mosta-Naxxar Character Area: LLT2: Escarpments, incised valleys and military infrastructure | Neutral | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant | None | Not significant |
| Wied Qannotta Basin and Mgarr-Zebbiegh-Wardija Trough Character Area | Neutral | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant | None | Not significant |
| North Eastern Rocky Coast Character Area | Neutral | Oper'n | Local | Direct | L term | Perm | Revers. | Local | Likely | Minor to Major | None | Minor to Major |
| Visual Amenity | | | | | | | | | | | | |
| Viewpoint 1: Wardija | Neutral | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant | None | Not significant |
| Viewpoint 2: Triq il-Qawra promenade | Adverse | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant to minor significance | None | Not significant to minor significance |
| Viewpoint 3: Triq il-Luzzu, Qawra | Adverse | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant to minor significance | None | Not significant to minor significance |

| | | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact | Proposed Mitigation Measures | Significance of Residual Impact |
|--|---------------------|----------------------------------|------------------------------------|--------------------|----------------|------------|--------------------|------------------------|--------------------------------------|---------------------------------------|------------------------------|---------------------------------------|
| Asset Impacted | Beneficial/ Adverse | Const'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct or Indirect | S term/ L term | Perm/ Temp | Reverse/ Irrevers. | (Inter/National/Local) | (Likely, Unlikely, Remote Uncertain) | (Major, Minor, Not significant) | | (Major, Minor, Not significant) |
| Viewpoint 8: Sqaq tax-Xaqquf, l/o Gharghur | Adverse | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Major significance | None | Major significance |
| Viewpoint 9: Triq ir-Ramla, Maghtab | Neutral | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant | None | Not significant |
| Viewpoint 10: Triq il-Kosta, Bahar Ic-Caghaq | Adverse | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Minor significance | None | Minor significance |
| Viewpoint 12: Triq ghaxqet l-Ghajn, l/o Gharghur | Adverse | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Major significance | None | Major significance |
| Viewpoint 13: Triq John Adye, T'Alla u Ommu | Adverse | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Minor to Major significance | None | Minor to Major significance |
| Viewpoint 14: Triq L-Imsaqfin, Mosta | Adverse | All | Local | Direct | L term | Perm | Revers. | Local | Likely | Not significant to minor significance | None | Not significant to minor significance |

8. AGRICULTURE

INTRODUCTION

- 8.1. This chapter considers the likely impacts on agricultural activities as a result of the proposed Scheme.
- 8.2. The assessment draws on the baseline report prepared by Dr Joseph Buhagiar concerning agricultural land. Most of the baseline report is reproduced in this chapter given the importance of the findings on the Scheme and its surroundings.
- 8.3. The potential key agricultural issues are outlined below:

Key Issues:

- **Loss of agricultural land**
- **Loss of protected trees**
- **Social impact on farmers**

Terms of Reference

- 8.4. As this is an update to an existing EIA, MEPA has not issued Terms of Reference. The following guidelines have been issued by MEPA:

The EIS Update shall focus on the following:

- 1. Project description i.e. the EIS update shall include a description of the additional proposed facilities that will be included within the development site including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;*
- 2. Alternatives (sites, layouts and technologies) as relevant;*
- 3. Landscape and visual amenity assessment;*
- 4. Transport;*
- 5. Noise and vibration;*
- 6. Air quality;*
- 7. Waste management issues; and*
- 8. Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.*

In addition to the above, the consultant/s is to verify whether as a result of the proposal, the impact significance for the following environmental characteristics outlined below (as presented in the EIS Sections for PA 04834/04), would require an update:

- 1. Geology, hydrology and palaeontology;*
- 2. Agriculture;*
- 3. Archaeology and cultural heritage;*
- 4. Social impact;*
- 5. Land contamination;*
- 6. Risk assessment; and,*
- 7. Cumulative impacts.*

ASSESSMENT METHODOLOGY

- 8.5. A preliminary desk study of existing maps and surveys and retrieval of existing baseline data was carried out. This was followed by standard compilation of data following surveying, photography, and on-site interviews.

Desk Study

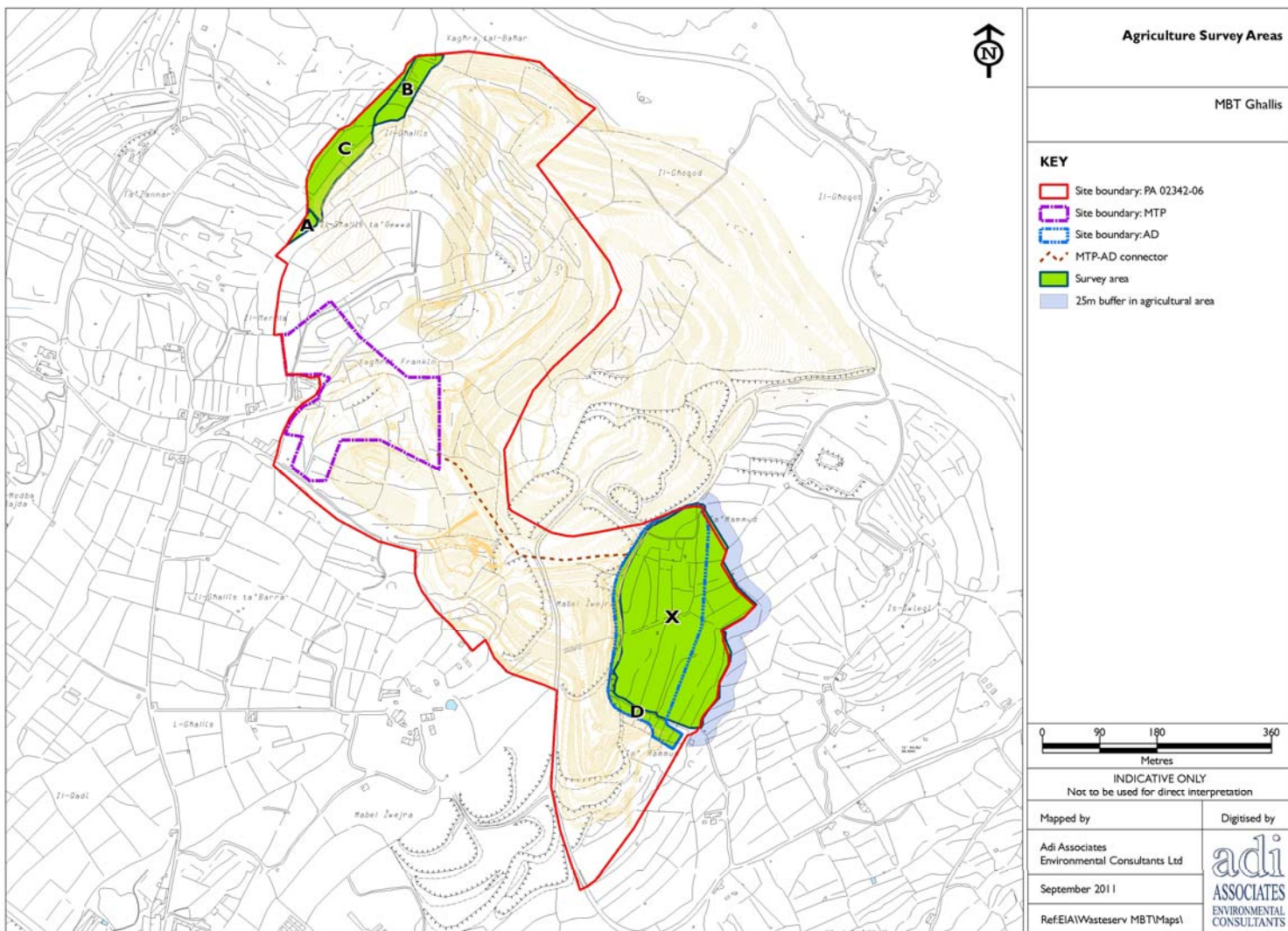
- 8.6. A literature search was carried out for previous survey work and reports related to the study area, in addition to the old ordinance survey maps that show the military installations around the Site. From the literature search, it was concluded that no previous agricultural survey work has been carried out in the area other than that carried out as part of the 2005 EIA. The sources of information used included Ordinance and Geology survey maps for the physical characteristics of the site and recent aerial photos of the site namely:

- MEPA map server site maps;
- Geological survey map (Oil Exploration Directorate, 1993);
- Aerial photographs and orthophotos of the Site (MEPA, 2004); and
- Satellite photos.

Area of Influence

- 8.7. The Area of Influence (A of I) for the agriculture study is illustrated in **Figure 8.1**.

Figure 8.1: A of I for Agriculture



DATA AND METHODS

Competence of Surveyor

- 8.8. The agriculture study was carried out by Dr Joseph Buhagiar, as approved by MEPA.
- 8.9. Field surveys were undertaken in August 2010 and March 2011 (for the extended area marked in **Figure 8.1**).

Mapping of Field Structures, Crops, and Trees

- 8.10. During the field survey, wherever possible, interviews were held with farmers or tenants. The following are the survey parameters that were observed:
- Height and condition of retaining walls;
 - Presence of field structures, reservoirs, wells, irrigation equipment, etc;
 - Standing and seasonal crops by type and variety where identifiable, quantity and stage of maturity;
 - Current cropping pattern for seasonal crops;
 - Previous cropping pattern where this could be discerned from residues or gathered from interviews; and
 - Growth condition of the crops.

FIELD SURVEY RESULTS

- 8.11. Initially, in 2010, the A of I included the area marked X in **Figure 8.1**. The A of I was extended to the areas marked A, B, C and D following further development of the Scheme, whose boundary subsequently increased in 2011.
- 8.12. The 2005 EIS for the Ghallis landfill (PA 4834/04) does include an agriculture survey of most the area. Map GH 11/2 of the 2005 EIS shows that the land comprises *shallow and very shallow terraces on globigerina*. The fields are predominantly dry agriculture or abandoned and include cereals, some potatoes and fallow land. Drawing GH 11/6 classifies the fields in the area that was surveyed as low to moderate in terms of agricultural land value.

Area X

- 8.13. The agricultural A of I contains a range of fields which are substantially large though not all of them are suitable for cultivation or were in cultivation at the time of the survey. Fields that were actively worked and had produced a crop (mostly wheat for fodder) in the previous season included several terraces in the north and south sections, with the rest either being abandoned fields, uncultivated areas given to carobs, olives and wild vegetation because of their shallow soils and exposed bedrock, or abandoned disturbed land that had been reclaimed or filled with soil but never put into agricultural production. North section terraces in active production

included fields marked N1, N3, N8, N9b, N10b and N11a on **Figure 8.2**. The remaining north section fields were either abandoned or degraded. South section terraces in active production were S3, S6, S7, S9ab and S10a of which S3, S7 and S10a are by far the largest.

- 8.14. During the present survey, no irrigated fields were noted on the survey site or in the vicinity, nor signs of any form of irrigated agriculture being practiced. It was therefore concluded that all agricultural activity is dry agriculture, completely dependent on rainfall. Remains of produce confirmed that the main activity was fodder wheat production. There were signs of one field (S6) having had broad beans sown but the remains of the vegetative growth were so poor as to be doubtful of any yield of broad beans. This field was also overgrown in the farrows with White Mustard (*Sinapis alba*) confirming that growth was so poor that the farmer did not even weed out the field.
- 8.15. During the field survey (14th August) a part-time farmer working fields S11 was encountered and interviewed about the agricultural activity on the site. His comments were that the main activity for the area was fodder production mostly wheat but for the current year this was poor due to the low rainfall. Many farmers had abandoned their poor produce because of the poor growth as was observed in the course of the survey. This particular farmer had just harvested a bagful of carob pods. He said that these were for his own farm animals and carob pods are not sold nowadays since the produce did not fetch a good price.
- 8.16. Two other farmers were also encountered on site carrying a load of prickly pear, which they had just collected in the early morning for personal consumption. The fruit production in the area was described as currently poor though the site had seen better times. They referred to the presence of a prickly pear variety in the area immediately outside S10b which had originally been imported from Australia that was favoured since the fruit had fewer spines on them. This clump is outside the area marked for development.
- 8.17. The farmers were interviewed on the general produce of the area. The fields were mostly given to fodder production where the same comments on poor harvest were made. In addition they indicated that the area was not particularly favourable because of the exposure of the terraced site to east and north east winds, which are liable to damage growth of produce. The site is afforded some protection from these prevalent winds by being partly screened by a number of mature carob, olive and mastic trees and of more recent planting Eucalyptus and Acacia trees. The farmers also mentioned that the northern part of the site was particularly suitable for capers and that these were harvested although they were reluctant to give an estimate of the amount they harvested on a daily basis or seasonally.

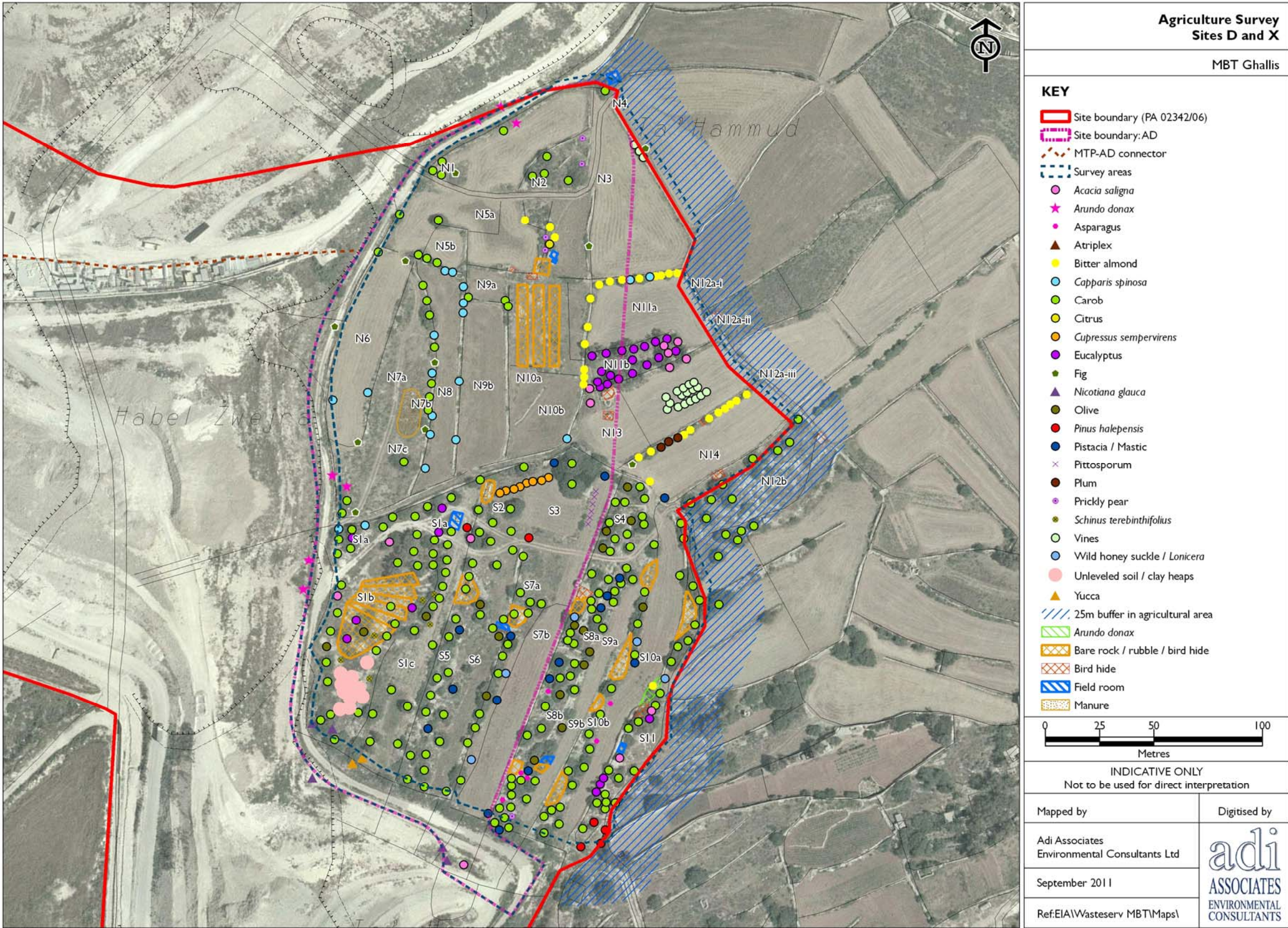
Site description

- 8.18. The A of I has the toponym of Ta' Hammud and consists of a number of fields. The entire complex comprises a substantial percentage of disturbed land that has been covered over with building industry waste, the area to the east being an area that is

still undeveloped. The remaining undeveloped area mainly comprises agricultural land with a substantial degree of disturbance.

- 8.19. For convenience the fields within the A of I have been divided into two sections – a north and south section divided almost equally by an old country path running almost east – west. The north section consists of some fifteen fields marked as NI-14 and the south section consisting of eight adjacent terraces with fields marked SI-1 on **Figure 8.2**.
- 8.20. The site measures approximately 350m long on its north-south axis and is 160m to 220m at its widest, approximately at its mid section. The total area of the survey site is calculated at around 63,000m² equivalent to 6.3 hectares or approximately 56 tumoli. Of this, about one third is in some form of low input and low income mainly fodder production, another third is land with shallow soil on which carobs had been planted and gave some financial returns in the past but currently abandoned, and the remaining third is disturbed land with sufficient soil but on which exotic trees have been planted or the soil left uncultivated for such a long time as to have become completely useless for the past several years. The accumulation of several forms of debris and rubbish has continued the deterioration of this abandoned land.

Figure 8.2: Agriculture survey map for Areas X and D



General lie of land, slope, aspect

- 8.21. The terrain of the site originally formed part of a low hill with a gentle slope running in a northwest to southeast direction for the Ta' Hammud area, though for the entire site, it has a predominantly eastern slope towards the sea. The highest contour line of the natural ground level at the extreme west end of the site (field S1b) is situated at 45m above mean sea level, whilst that at the extreme east limit of the site is at 27.5m above mean sea level for field S11. This gives a decrease of 17.5m over a distance of 180m at its narrowest or a slope of 1 in 10 (5.7°) in the south sector. In the north sector, the decrease is of 10m over a distance of 220m or a slope of 1 in 22 (2.6°). This slope is not reflected in the present lie of the land since the fields are terraced but in general they are not steep terraces with difference between terraces rarely exceeding 1.5m. The largest number of terraces is found in the south sector and these are generally made up of narrow fields. Conversely, fields in the north sector are wider and occupy fewer terraces since the land also has a lower slope.
- 8.22. The land immediately adjacent to the survey site on its western and north-western extremities now forms part of the Maghtab landfill and rises steeply over the site; due to the elevation it affords good protection from the west and northwest. The general aspect of the survey land is an east to south-east aspect for the south sector. This part of the survey area is also liable to adverse effects from exposure to strong north-east and east winds. The north sector being on flatter land does not have a predominant aspect but it is generally more exposed from the north and north east.

Geology, soil and soil depth

- 8.23. The site predominantly overlies the Lower Globigerina Limestone Member but the northern extremity is at the interface with the Xlendi member of the Lower Coralline Limestone (LCL) stratum. The latter partly explains the origin of the shallow Terra Rossa soil in part of the area, probably scrapped off the LCL and carted to the site. The rest of the site has mixtures of soils as well as what looks like an artificial attempt at increasing soil depth by mixing the soil with extraneous substrates. Where the soil is still not mixed in this way, it is a predominantly reddish brown colour in the Terra Rossa series with variable degree of stoniness. The site is overall poor in soil cover with areas where the bare bedrock is quite visible especially the inner reaches of the terraces. Several areas on the south sector of the site show the remains of unmixed sand piles. This mixing of the parent soil with unweathered sand, gives the resulting soil an unnaturally artificial colour and unweathered texture indicative of recent mixing.

Rubble walls

- 8.24. Rubble walls are in various states of repair. Some are in a good to medium condition but in their majority the rubble walls have received very little maintenance in recent years with the result that a good number are either falling apart or have completely been lost. Walls are usually not in excess of 1.5m high and this applies mostly when terraces are present with about half this height given to the lower terrace and the

remainder given as retaining wall for the upper terrace. A detailed rubble wall survey is found in **Chapter 9**.

Field rooms

- 8.25. There are a number of field rooms, some of which are distinctly associated with bird hunting. These are usually small and recently built (less than 20 years old). Others are much larger and are serving as a store room or a place for shelter. One field room in field S9b is much older and built in the traditional corbelled system.

Trees and other vegetation

- 8.26. A number of trees associated with agricultural land are growing in the A of I, namely carobs, olives, prickly pear, figs, vines, peaches, citrus, and bitter almonds. Except for the bitter almonds, the carobs and the prickly pear, none were observed in fruit and their general shape can be considered poor with some showing signs of water stress. The fruit trees did not seem to be properly maintained with a good number of trees overgrown, or having dead unpruned branches, signs of water stress and gum exudation (gummosis) typical of stone fruit trees, which could be partly physiological or due to root infection by bacteria. Some dead trees showed signs of having been infected with honey dew fungus, *Armillaria mellea*.
- 8.27. The site is very rich in carobs, some of which are very old mature trees and their orderly spacing and alignment indicates that these were intentionally planted for wind shelter from the north east and easterly winds but also served the additional function of providing pods for animal fodder. A considerable number of relatively young trees also occur haphazardly on most of the site and are the result of natural seeding and germination. These and the large quantity of male carob trees (obvious from their lack of pods which would be fully ripened at the time of the year during which the survey was carried out as was seen for female carobs) suggest that the site has not been intensively maintained during the last several decades since male trees though acting as good wind shelter are considered unproductive and would have been grafted, usually leaving one male to seven or eight female trees. Such male carobs are probably the result of spontaneous germination without subsequent grafting or loss of female scion graft without replacement. The productive carobs (females) did not show signs of pruning and pods from the previous year appear to have been left uncollected as evident from the large number of decayed pods under the tree. Despite this they did show a bountiful supply of ripe pods.
- 8.28. The olives were in their majority also untended some showing signs of considerable age, overgrown but without trace of any olives. Under some of the trees, a large quantity of olive pips was visible again attesting to the production of olives in previous seasons, which, however, went uncollected. From the size of the pips it was concluded that the olive trees were of an oil producing variety but further inferences were not possible since the actual fruit were not present on any of the trees, presumably because the current year did not have sufficient rainfall for the trees to retain and develop the fruit. A number of small (but not necessarily young) olive trees were observed on the site in the vicinity of the mature olives, and are assumed to be spontaneous germinated saplings from olives dispersed by birds.

- 8.29. The few vines that were present were growing against rubble walls with no proper trellising systems but this was limited to a few vines with most of the rubble walls left unutilised for this fruit tree. One field (N13) had around 30 ungrafted root-stock vines (American vine root stock probably *Vitis berlandieri* x *rupestris*) arranged in the form of a grid probably planted for grafting with fruit bearing varieties. Other fruit trees were conspicuous by their small number except on one field (N14) with a fairly uniform planting of almonds and peaches. One field had a citrus tree growing on it surrounded by a 1.75m high wall enclosure. Other fruit trees noted included figs where traces of fruit could be seen but these were few and must have been harvested or, more likely eaten by birds.
- 8.30. The site had a number of trees or shrubs growing on it, mostly associated with ornamental species but there was also at least two indigenous species one of which is a typical maquis species namely the Mastic tree (*Pistacia lentiscus*) growing fairly regularly on the site. Several Aleppo Pines (*Pinus halepensis*) were planted on site. A small clump of Giant Reed (*Arundo donax*) was also encountered on one of the fields (S10a). The ornamental tree species included the common Cypress (*Cupressus sempervirens*), Red Gum Eucalyptus (*Eucalyptus camaldulensis*), Blue-leafed Wattle (*Acacia saligna*), and Brazilian Pepper Tree (*Schinus terebintifolius*). These were mainly planted to attract birds for hunting and trapping but also acted as wind shelter. Two other ornamentals encountered on S11 included *Yucca elephantipes*, *Euphorbia tirucalli*, planted amongst other ornamentals such as the *Acacia saligna* and *Eucalyptus camaldulensis*.
- 8.31. Wild plants growing on the stretches of rocky ground amongst the carobs and olives included the wild Honey Suckle (*Lonicera implexa*) and Wild Asparagus (*Asparagus aphyllus*) formed dense growths in association with the dominant shrubs. Other wild plants typical of rocky garrigue were encountered, including the Giant Fennel (*Ferula communis*), the Wild Fennel (*Foeniculum vulgare*) and Asphodel (*Asphodelus aestivus*). The north sector has a substantial number of caper (*Caparis spinosa* var *inermis*) bushes that can make an economic contribution if harvested.
- 8.32. **Table 8.1** presents a list of trees recorded during the survey that feature in the Trees and Woodlands Protection Regulations, 2011 (Legal Notice 200 of 2011).

Table 8.1: List of tree species

| Species | English Common Name | Maltese Common Name | L.N. 200 of 2011 |
|---------------------------------|---------------------|---------------------|------------------|
| Protected trees | | | |
| <i>Ceratonia siliqua</i> | Carob | Harruba | Schedule II |
| <i>Pistacia lentiscus</i> | Mastic Tree | Deru | Schedule II |
| <i>Pinus halepensis</i> | Aleppo Pine | Znuber | Schedule II |
| Unprotected trees | | | |
| <i>Acacia saligna</i> | Blue Wattle | Akacja | Schedule III |
| <i>Eucalyptus camaldulensis</i> | Red Gum Eucalyptus | Ewkaliptus | Schedule III |

Water storage facilities, wells

- 8.33. The site is characterised by its sheer absence of water storage facilities possibly due to the hard nature of the bedrock in the area and consequent difficulty in digging out wells. The lack of permanent water storage facilities was evident throughout the fields surveyed though temporary water storage was encountered in the form of plastic square-type tanks used to import industrial chemicals. These were presumably used to store water hauled to the site by truck. This shortage of water storing facilities is further confirmed by the small number of fruit trees on the site and those present being mostly restricted to trees that can still produce under non irrigated conditions, namely olives, prickly pear, figs, vines and bitter almonds. A couple of mature citrus and a few peach trees present showed signs of water stress and at the time of the survey were not bearing fruit.

Evidence of irrigation

- 8.34. During the survey, no evidence of an irrigation system was encountered on the site. It is usual for intensively cultivated sites to have evidence of irrigation in the form of old stone channels or the more recent metal or plastic pipes used for irrigation. None of these were encountered indicating that the site was always given to dry land farming relying on rain water for growing produce.

Individual field by field survey

- 8.35. **Technical Appendix 3** provides a detailed field by field survey.

Land classification

- 8.36. There are several systems whereby land quality or value of agricultural land can be classified so as to assess the land capability and the land suitability for a particular management system. A distinction deserves to be made at the start, since these two terms though interchangeably used, are not equivalent. In carrying out agricultural land capability assessments, broad land use is ranked according to the limiting values of a number of soil and site properties which restrict or prevent activities under consideration. This is in contrast to land suitability assessment where a clearly defined homogenous practice (such as rainfed market gardening) on a particular site is classified on the basis of positive features associated with the success of that particular land use. For the purpose of this part of the study, agricultural land capability assessment is discussed. Land suitability is treated at a later stage when considering current and potential cropping strategies for the site.

Table 8.2: Classification of agricultural land according to the USDA system of classification

| Criterion | Class 1 | Class 2 | Class 3 | Class 4 |
|--|----------------------------|-----------------------------|-----------------------|-----------------------------|
| Permanent Physical Limitations | | | | |
| Soil textural characteristics | No/Slight | Moderate | Severe | Severe |
| Soil depth | Deep | Moderate | Moderate | Fairly good |
| Slope angle | Nearly level | Gentle slope | Moderately steep | Steep slope |
| Overflow damage & gully erosion | Not subject | Subject | Moderate | Severe |
| Temporary Physical Limitations | | | | |
| Nutrient status - fertility erosion | Need manure or fertilisers | Moderate | Low fertility | Severe erosion |
| Poor drainage - puddle erosion | Subject | Need drainage | N/A | N/A |
| Cultivation & crop production limitations | | | | |
| Land quality for agriculture | Good | Good | Restricted | Restricted |
| Risks of damage in cropland use | No/Slight | Moderate | Severe | Severe |
| Productivity | Good | Moderate | Low | Low |
| Cultivation cycle | Rotation beneficial | May need rotation | Need special rotation | Occasional cultivation only |
| Cultivation method | Ordinary | Ordinary to Special tillage | Restricted tillage | special handling needed |

8.37. The land surveyed can be classified at the lower end of CLASS II with major disability classes namely:

- Currently, there is general poor access to the fields, though this was not the situation in the past when access to field machinery was not an issue, i.e. before the Maghtab landfill commenced;
- Shallow / poor soil cover over most of the land. Terraces, when formed, did not receive adequate soil cover and the inner parts of the terraces were never excavated. The result is that the outer reaches did not get sufficient rubble fill and the terraces remained overall quite shallow. The net effect contributed to terraces where a substantial part could not be cultivated. An advantage was that sufficiently deep pockets of soil on the inner reaches had carobs and olives planted on them, which contributed some fodder for farm animals and acted as wind shelter from destructive east and north-east winds prevailing on the site;
- There are no water harvesting and storage facilities either above or below ground. Bore holes and shaft wells are not viable here because of the proximity of the site to the sea;
- There has been limited utilisation of field boundary for growing fruit trees;

- The use of unweathered substrate to increase soil depth has contributed to a general degradation of the physical and chemical properties of existing soil and reducing its agricultural value;
- General abandoned look of the site resulting from the import of low quality soil that was not properly levelled and the fields left to go to weed;
- Introduction of exotic species on the site for hunting purposes that has added to the general dilapidation of the site; and
- General lack of terrace maintenance has resulted in a considerable number of these falling apart leading to breaches from which soil is being lost.

Agricultural status

- 8.38. The current agricultural status is one of low input with corresponding low output. The net financial contribution of that part of the worked land that is given to fodder production is estimated at between €25 - €30 per tumolo. This is after deducting the expense of ploughing, fertiliser input, seed, sowing and harvesting, estimated at around €30. However, this estimate is based on a year of typical rainfall and growth, usually giving around 25 - 30 bales of fodder per tumolo. In 2010 the rainfall was low that the number of bales harvested per tumolo was less than 20 bales, lowering the net returns still further. Given that the estimated area suitable for cultivation of fodder is around 18 tumoli out of a total of 56, the net annual income from this agricultural activity is not expected to exceed €450 in a good year. It is good to note also that the economic contribution from the land given to carobs and abandoned fields is considered negligible, as is the contribution from fruit trees. However, the total contribution from capers may be substantial and could easily be in excess of that obtained from fodder. This is based on an estimate for the number of caper bushes on the north sector, given that this is harvested regularly. It is important to note that this activity is very labour intensive and ultimately if one factored in the hourly rate for harvesting, the net gain would again not be substantial.

Area D

- 8.39. Area D represents the outer boundary of the original Ta' Hammud survey (Area X) and marks the boundary between it and Habel Zwejra, where a rough dirt track divides the two. The chain link fence that surrounds Habel Zwejra marks the extreme western side of Area D. The area is highly disturbed and characterised by a heavy load of particulate dust, which is likely largely because the dirt track used by farmers in the area to access their fields is not paved nor formerly developed. The margin of this dirt track then slopes off steeply on to the Ta' Hammud side, which in most areas drops approximately 3-4m down from the dirt track. The slope sides have recently been partially planted to Aleppo Pine and Atriplex.
- 8.40. **Technical Appendix 3: Agriculture Baseline Survey** provides a detailed list of additional tree species located in Area D. No additional protected species were identified. The list of recorded species is illustrated in **Figure 8.2**.

Survey results for Areas A, B and C

- 8.41. Areas A, B and C were surveyed in 2011 to obtain agriculture baseline information.

Area A

- 8.42. Area A refers to a triangular parcel of land, formerly part of a larger rectangular field, partly given to the cultivation of wheat and partly uncultivated. Its south-east margin, which is the long side of the field, has a chain link fence delimiting it, though currently this is breached in several locations. Originally the fence served to separate the field from the Maghtab landfill across a dirt path that circumscribes the landfill, now partly obliterated with rubble that has cascaded from the coralline limestone spall heap and other inert material. This parcel of land measures 68m by 23m, giving a total area of circa 800m².
- 8.43. The parcel of land is a level field, well protected from winds by the high mound of landfill material on its south-east side. It is located slightly below the surrounding terraced fields and is therefore relatively open and unprotected on the north-west side. At the northern-most corner of this field, a large Prickly Pear (*Opuntia ficus-indica*) is growing against the wall of a field room located in the adjacent field. Some small Almond Trees (*Prunus amygdalus*) are also planted. These would have afforded some shelter to the wheat growing in the field. Surrounding terraced fields situated slightly above parcel of land A, which make up part of the field, have a number of large Carob trees (*Ceratonia siliqua*) and Red Gum Eucalyptus (*Eucalyptus camaldulensis*) trees, which afford further protection from prevalent winds. The field is surrounded by a low rubble wall, which is interrupted at intervals with gaps and has wooden pallets, rusty iron drums and other improvised material to block these gaps. The soil in this and surrounding fields is a prominent Terra Rossa soil. It appears to be in the 30 to 45cm depth range and lying directly on bedrock since there was no evidence of infill rubble, which is often used to increase depth. This could be judged from a section where the field boundary wall had been ripped in the process of building the dirt track and chain link fence.
- 8.44. At the time of the survey, field A was in a weedy fallow and overgrown state, dominated by Wild Oats (*Avena sterilis*) and Wild Fennel (*Foeniculum vulgare*). Weedy ruderal and opportunistic species, including the Crown Daisy (*Glebionis coronaria*) and the Boar Thistle (*Galactites tomentosa*), were also present, the latter named species being especially visible on the untilled part of the field subjected to disturbance and improvised paths. These species are usually indicative of a tract of land showing frequent disturbance, such as threading which encourages seed dispersal. Other species present included small pockets of Crimson Pea (*Lathyrus clymenum*), Common Vetch (*Vicia sativa*) and French Honeysuckle (*Hedysarum coronarium*), especially near the chain link fence. This type of vegetation shows that this part of the field had been cultivated in the recent past to these legumes, though the Crimson Pea usually takes time to establish and dominate an area.
- 8.45. Conversely, the adjacent land, on what formerly was the rest of the field, had a crop of wheat growing on it, some 75cm to 1m tall. At the time of the survey, the wheat

was in the heading and flowering stage with some parts of the wheat in this field already developing a seed head and yellowing.

- 8.46. No water storage facilities, such as reservoirs or wells, were noted for this area and the indications are that it was given to dry-land farming only. The absence of fruit trees, except prickly pear, also indicates that these were not unsustainable in the area, something which was also noted in other areas in the vicinity when surveyed. Site photos are presented in **Technical Appendix 3: Agriculture Baseline Survey**.
- 8.47. For the land parcel under study in area A therefore, the agricultural value of the produce present can be considered negligible, though originally the land must have been productive and could easily sustain the production of wheat for fodder and other dry land farming fodder and non-fodder crops.

Area B

- 8.48. Area B, which is located between the site known as il-Ghallis and ix-Xaghra tal-Bahar, is made up of a series of terraced fields located on land sloping towards the north-east. These fields are marked B1 – 4 in **Figure 8.3**, with B1 being the highest and B4 being the lowest. Each terrace is separated by between 1 - 1.5m difference in level. Of these fields, only one (B2) showed signs of recent cultivation to wheat for fodder production. The rest were either abandoned fallow, completely disturbed with signs of bird trapping activity in the recent past, or even uncultivated maritime garrigue. The total area of this parcel of land is approximately 3960m². The eastern margin of site B is demarcated by chain link fencing, with the Coralline limestone stock pile rising immediately behind it to an estimated height of between one to three storeys. Another stockpile, although much lower, consisting of dark brown compost material, was also located further north of the rock stockpile. A detailed description of each field is given in **Technical Appendix 3: Agriculture baseline**.

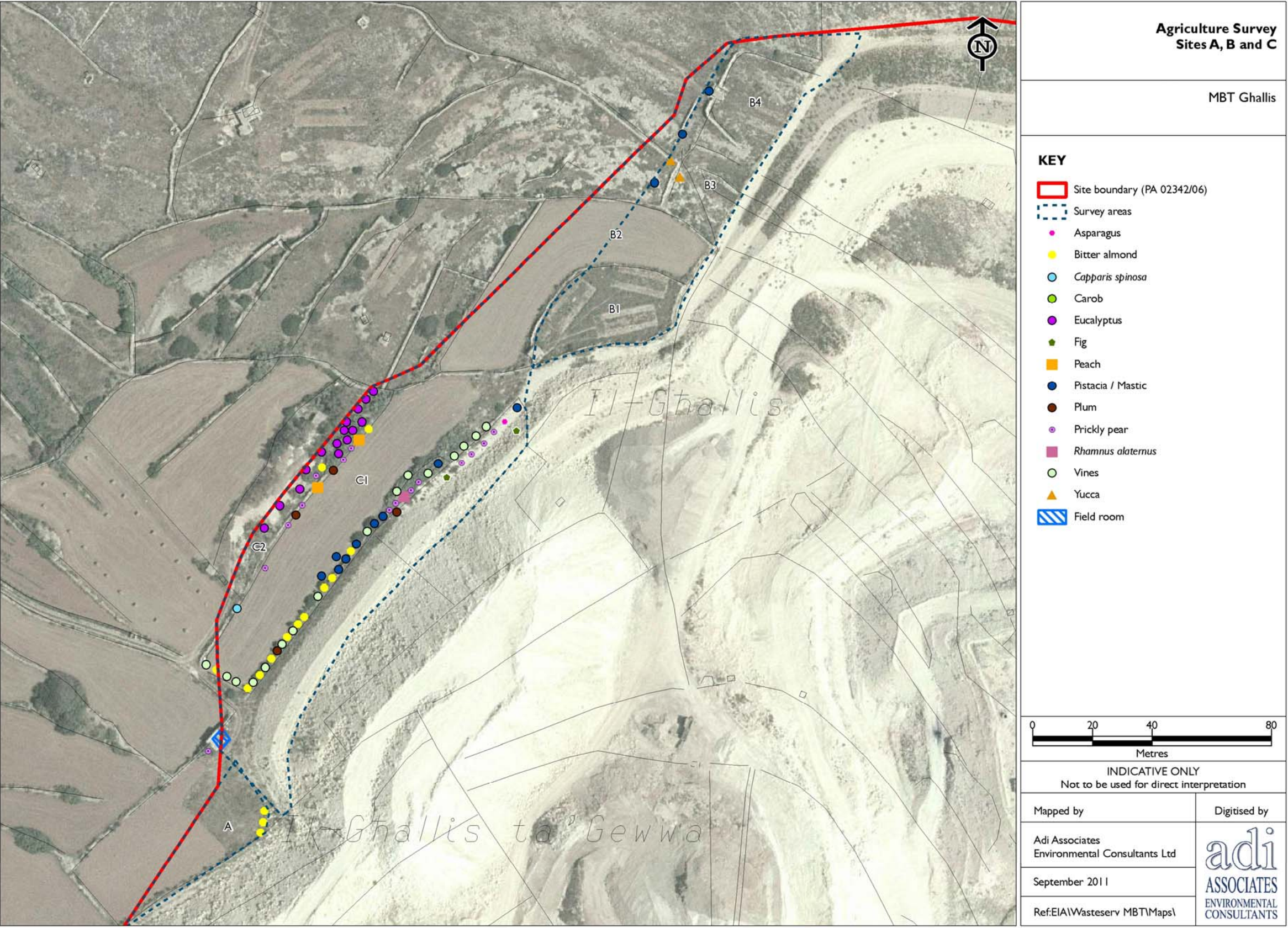
Conclusions

- 8.49. The site appears to have been used for dry land agriculture in the past though it was not necessarily very productive given the location, soil depth and absence of water storing capabilities. Over the past few years, the land use has deteriorated. This process of land abandonment has been ongoing for at least the best part of a decade, since the natural vegetation is very well established in some parts. As to the agricultural potential, this must always have been limited by the fact that it is on exposed ground and subject to strong, salt-laden winds. The stunted growth of wheat on one of the fields (B2) confirms this. The other evidence comes from the near absence of fruit trees around the field margins, indicating that past farmers would not have bothered to plant in such a harsh environment. The overall agricultural potential is therefore deemed to be quite low, at least under the present conditions, and unless considerable investment is made to overcome the current negative impacts.

Area C

- 8.50. Area C consists mainly of two long fields lying between Area A and Area B. C2 (marked in **Figure 8.3**) is a lower terrace adjacent to C1, which is highly disturbed and mostly planted to Eucalyptus where the tall trees are used to lure birds for shooting. There are also some adjacent areas to terraced plots B3 and B4, which are mainly taken up with maritime garrigue though this is highly disturbed and includes a number of exotic species.
- 8.51. Field C1 is an elongated field of roughly uniform width that on the southeast side borders the peripheral road to the existing Magtab landfill where the hard rock stockpile is located, and from which it is separated by a chain link fence.
- 8.52. **Technical Appendix 3: Agriculture Baseline Survey** provides an in-depth description of Area C. **Figure 8.3** illustrates survey results.

Figure 8.3: 2 Agriculture survey map of Areas A, B and C



ASSESSMENT OF IMPACTS

Determining Impact Significance

- 8.53. In assessing the significance of potential negative impacts, the following criteria have been used:
- **Not significant** - no material change in agricultural quality and/or extent;
 - **Minor significance** - small-scale loss/disturbance of agricultural land that is unlikely to affect the agricultural integrity of the site; and
 - **Major significance** - large/small scale loss/disturbance to agricultural land that is likely to affect the agricultural integrity of the site.

Potential Impacts

- 8.54. Potential impacts could include:
- Permanent loss of good quality agricultural land through permanent land take, leading to loss of agricultural production;
 - Loss of protected trees; and
 - Social impact on farmers.

Loss of Agricultural Land

- 8.55. As described in detail above, the agricultural land to be lost is of relatively poor productivity and, indeed, much of this land has already been abandoned, probably as a result of the difficulty involved in maintaining the land in relation to the poor yield. Nonetheless, this land will be lost, resulting in a minor to major adverse impact.

Loss of Protected Trees

- 8.56. Three protected tree species were recorded on the Application Site, namely *Ceratonia siliqua*, *Pistacia lentiscus*, and *Pinus halepensis*. These trees are protected under LN 200 of 2011; their uprooting requires a permit from MEPA. Loss of these trees from the Site is considered to be of major significance given their relative abundance (in particular *Ceratonia siliqua*) and level protection status.

Loss of Agricultural Land: Social Impact

- 8.57. The baseline study concludes that the fields are of low productivity and that much of the land is in fact abandoned, as attested by the numerous rubble walls in a poor state, abundant rupestral species, and evidence that the fields are being used for other purposes. The fact that the farmers can no longer use the land is judged to be of a minor negative impact. The impact may partially be offset given that the farmers receive compensation.

MITIGATION MEASURES

- 8.58. Loss of the agricultural land cannot be mitigated.
- 8.59. Transplantation of the protected tree species will be attempted, if advised by MEPA, rendering the residual impact minor to insignificant. If the trees cannot be transplanted, the impact cannot be mitigated and, therefore, the residual impact is also minor to major.
- 8.60. The soil still existing on the Application Site will be removed from site when dry, in order not to negatively affect its structure. The soil will be stored for use in the Landscaping Scheme.

RESIDUAL IMPACTS

- 8.61. Loss of agricultural land remains a minor to major impact if the Scheme goes ahead. Following implementation of the above list of mitigation measures, no other significant residual impacts are predicted.

Table 8.3: Summary of Impacts on Agriculture

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact | Proposed Mitigation Measures | Significance of Residual Impact |
|---------------------------|------------------------|----------------------------------|--|-----------------|---------------|-------------|------------------|----------------------------|---------------------------------|-------------------------------|------------------------------|---------------------------------|
| | | Cons/Op | Extent of impact (National/Local/Site) | Direct/Indirect | S-term/L-term | Perm / Temp | Reverse/Irrevers | (Internat./National/Local) | (Likely, Unlikely, Remote) | (Major, Minor, Insignificant) | | (Major, Minor, Insignificant) |
| Loss of agricultural land | Adverse | Cons/Op | Site | Direct | L | Perm | Reverse | National | Likely | Minor to major | None | Minor to major |
| Loss of protected trees | Adverse | Cons/Op | Site | Direct | L | Perm | Reverse | National | Likely | Major | Transplantation | Not significant to minor |
| Social Impact | Adverse | Cons/Op | Site | Direct | L | Perm | Reverse | Local | Likely | Minor | None | Minor |

9. CULTURAL HERITAGE

INTRODUCTION

- 9.1. This chapter addresses the potential impacts of the Scheme on the cultural heritage features within the Application Site and within its environs. It describes the existing man-made heritage and assesses how it might change through development of the Scheme.
- 9.2. The potential key cultural heritage issues arising from development of the Scheme are:

Key Issues

- **Loss, burial or damage to features of cultural heritage significance**
- **Alteration or degradation of the quality of the setting of the features as a result of the development**

Terms of Reference

- 9.3. MEPA has not issued formal Terms of Reference, this being an update of the EIA carried out in 2006 in respect of PA 4834/04. The following guidelines have however been issued by MEPA:

The EIS Update shall focus on the following:

- 1. Project description, i.e., the EIS update shall include a description of the additional proposed facilities that will be included within the development site, including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;*
- 2. Alternatives (sites, layouts and technologies) as relevant;*
- 3. Landscape and visual amenity assessment;*
- 4. Transport;*
- 5. Noise and vibration;*
- 6. Air quality;*
- 7. Waste management issues; and*
- 8. Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.*

In addition to the above, the consultant/s is to verify whether, as a result of the proposal, the impact significance for the following environmental characteristics outlined below (as presented in the EIS Sections for PA 4834/04) would require an update:

- 1. Geology, hydrology and palaeontology;*
- 2. Agriculture;*
- 3. Archaeology and cultural heritage;*
- 4. Social impact;*
- 5. Land contamination;*
- 6. Risk assessment; and*
- 7. Cumulative impacts.*

ASSESSMENT METHODOLOGY

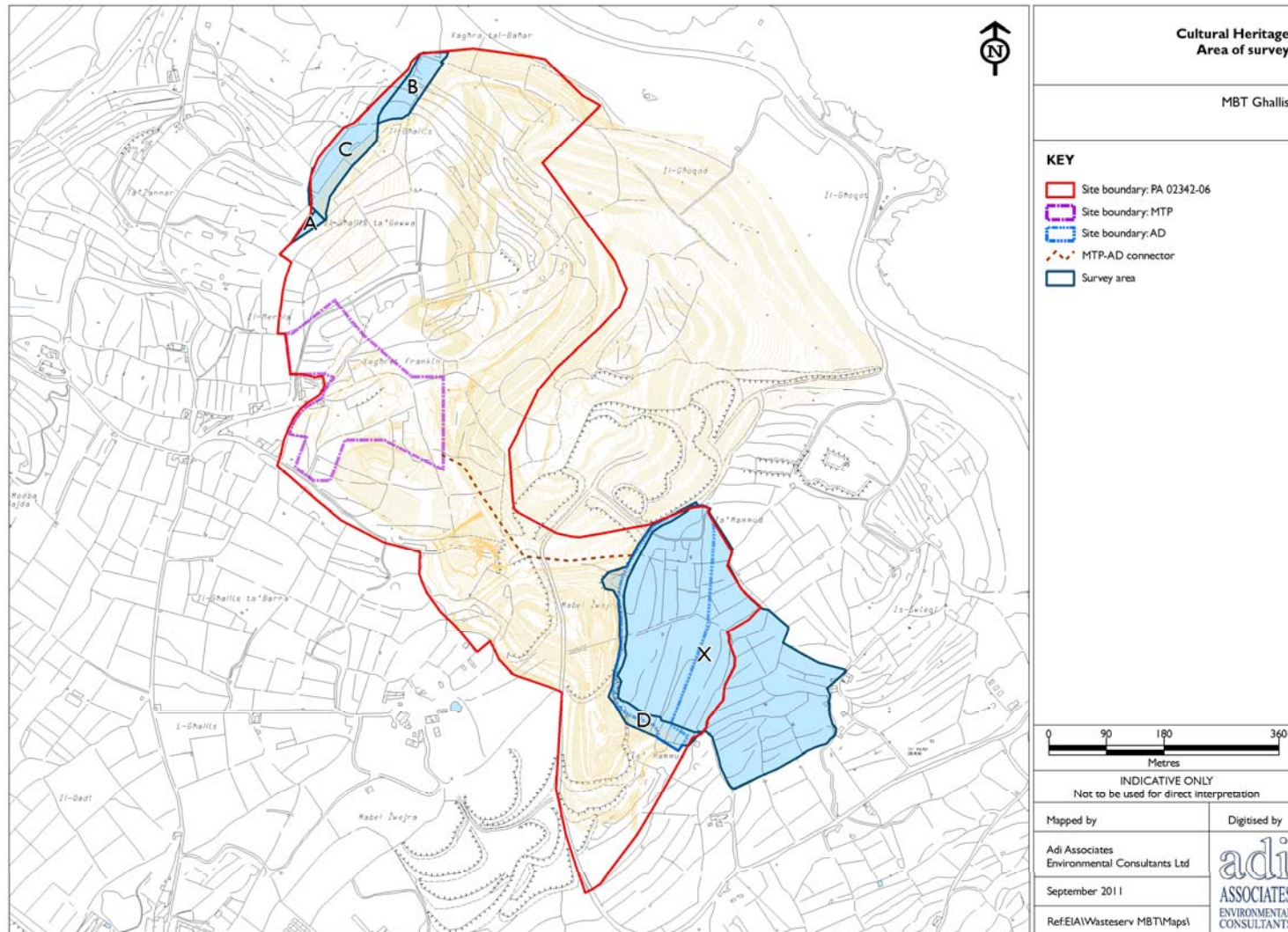
Area of Influence

- 9.4. Initially, the Area of Influence (A of I) defined the area marked X in **Figure 9.1**. The A of I was subsequently extended to include two smaller sites (A and B in **Figure 9.1**) to the north in March 2011 and two additional sites (C and D in **Figure 9.1**) that were surveyed in September 2011. .

Objectives of the Survey

- 9.5. The objectives of the Survey were to:
- Identify, document, and present all relevant information about cultural heritage assets within the A of I;
 - Assess the cultural heritage significance of each feature within the A of I;
 - Propose statutory and physical protection of the individual features, and of the site;
 - Describe and analyse the cultural landscape; and
 - Propose mitigation of impacts arising from the proposed development and a monitoring programme for during the construction and operation of the Scheme.

Figure 9.1: Application Site and Area of Influence



Survey Methodology

Literature Search

- 9.6. Based on literature searches and the consultants' knowledge of the area, a summary of previous survey work undertaken within the study area was collated as context to the results of the current survey work. This phase included research comprising:
- Study of toponomy (place names);
 - Analysis of cartographic and photographic material;
 - Analysis of conservation legislation (including proposed legislation); and
 - Analysis of published printed matter (including archival research) relating to the area.

Mapping

- 9.7. The archaeological, rural, vernacular, historical, and cultural heritage features visible within the A of I were mapped during field surveys, based on what is technically referred to as Ground Reconnaissance. This method of investigation primarily involves fieldwork, but also involves consultation of documentary sources and place name evidence [Renfrew & Bahn 1991: 63]. The fieldwork carried out consisted of a site-surface survey, or field-walking, in order to locate and record the whereabouts of sites and features. No aerial reconnaissance or sub-surface surveys, including excavations, were carried out.
- 9.8. The fieldwork for the area defined as X (see **Figure 9.1**) was carried out on 14th, 18th and 27th August 2010. The field work for the areas defined as A and B (see **Figure 9.1**) was carried out on 14th March 2011 and surveys of areas C and D were carried out in September 2011.

Cataloguing

- 9.9. Relevant information for each feature is presented on cards and digital media, in the same format as currently used by MEPA. Each feature has been individually identified with a consecutive numbered reference. The information for each feature includes:
- A short written description of the feature;
 - Co-ordinates, recorded up to 5 digits, for each Eastings and Northings based on the local UTM grid reference;
 - Locality and address;
 - Site indicated on a map to a scale of 1:2500;
 - Colour photograph(s);

- Wherever possible, a sketch of the feature showing the most significant details;
- The conservation importance of the site or feature (proposed grading following Structure Plan Urban Conservation Area (UCA) and Archaeology (ARC) policies);
- Existing and / or proposed legislative and physical protection;
- Current and proposed use / enhancement;
- References; and
- Name of surveyors and date of compilation.

Evaluation

- 9.10. An archaeological assessment and significance of the archaeological, rural, vernacular, historical, and cultural heritage features was derived from the desk-top and field studies. The importance of the conservation of the identified sites and features was identified with reference to relevant legislation, standards, guidance, and practices, as discussed below.

Standards and Guidance

- 9.11. Planning guidance on the protection of cultural heritage is provided for by the Cultural Heritage Act 2002, the Development Planning Act 1992, Government Notice 160 of 1997 (Rubble Walls Regulations), the Structure Plan for the Maltese Islands 1990, and the Central Malta Local Plan 2006. The specific relevance of these standards and guidance is discussed in **Chapter 5**.

Policy importance of cultural features

- 9.12. The classification of cultural heritage features according to their policy importance is guided by legislation, including the Cultural Heritage Act 2002, the Development Planning Act 1992, Structure Plan Policies, and Government / Legal Notices. Each of these assigns its own degree of importance and remedies. In applying these to the EIA process three categories are used:
- Features of International Importance (major importance);
 - Features of National Importance (major importance); and
 - Features of Local Importance (minor importance).
- 9.13. All other archaeological features listed in the catalogue may be included in MEPA's National Protective Inventory (NPI) and are protected under Structure Plan Policy ARC 6, which provides that all sites listed in the NPI "*...will be protected in accordance with the Development Planning Act powers and by reference to the ratings given in Policy ARC 2*".

9.14. **Table 9.1** summarises the features and indicates their policy importance. The same classification applies to rural features, as discussed below. **Technical Appendix 4: Cultural Heritage Baseline Study** provides further information.

9.15. The laws, policies, grades, etc., pertaining to the conservation of buildings or other structures have been assigned to these categories of policy importance as follows:

Features of International Importance

9.16. Archaeological features of international or national importance are protected by all of the above standards and guidance, and particularly Structure Plan **Policy ARC 2 Class A**. A feature graded as Class A in **Table 9.1** would qualify for protection under Structure Plan **Policy ARC 2 Class A**. Such features are considered to be top priority for conservation where *“No development will be allowed which would adversely affect the natural setting of these monuments or sites. A minimum buffer zone of at least 100m around the periphery of the site will be established in which no development will be allowed”*.

Features of National Importance

9.17. Archaeological features of national importance are also protected by the above legislation. They are graded as Class B, or of ‘medium’ cultural significance in **Table 9.1**. They include those referred to in Structure Plan **Policy ARC 2 Class B**, and are *“Very important to be preserved at all costs. Adequate measures to be taken to preclude any damage from immediate development”*.

Features of Local Importance

9.18. Archaeological features classified as of minor importance are protected by the Antiquities Protection Act, and other legislation mentioned above. Structure Plan **Policy ARC 3 Class C** provides for *“... development affecting ancient monuments and important archaeological areas and sites, including areas and sites having such potential, will normally be refused if there is an overriding case for preservation. Where there is no overriding case for preservation, development of such sites will not normally be permitted until adequate opportunities have been provided for the recording and, where desirable, the excavation of such sites”*. The features listed as Class C are protected in so far as *“Every effort must be made for preservation, but may be covered up after proper investigation, documentation and cataloguing. Provision for subsequent access shall be provided”*.

Remaining Features

9.19. All other archaeological features listed in the catalogue may be included in MEPA’s National Protective Inventory (NPI) and are protected under **Policy ARC 6**, which provides that all sites listed in the NPI *“...will be protected in accordance with the Development Planning Act powers and by reference to the ratings given in Policy ARC 2”*.

Table 9.1: Protection ratings and cultural significance

| Cultural Significance | Class | Grade | Protection |
|-------------------------------------|-------|-------|---|
| Major <i>National Importance</i> | A | 1 | Conserve plus 100m buffer zone |
| Medium <i>Local Importance</i> | B | 2 | Conserve |
| Minor | C | 3 | Record - may be covered |
| None | D | 3 | Record - may be covered, destroyed, or recycled |
| Uncertain | E | - | Further investigation is required |

THE BASELINE SURVEY RESULTS

- 9.20. A baseline study was initially carried out on the A of I marked X on **Figure 9.1**, in 2010. A second baseline study was conducted in 2011 in respect of the sites marked A,B, C and D in **Figure 9.1**. The 2010 field survey results are presented below. The 2011 survey results are presented subsequently as a separate section.

2010 survey results

- 9.21. The A of I surveyed in 2010 extends across the Application Site and to the southeast of it, as illustrated in **Figure 9.2**.

Historical Background

- 9.22. With the A of I being historically agricultural, and where there are no major settlements in the vicinity, the historical background of the area is hardly documented. The only documentation available is the 1899 survey sheet, which illustrates that, with the exception of the area occupied by the Maghtab landfill, the area has been largely unchanged since 1899. The survey sheet does however provide a *terminus ante quem* for some of the features identified. The cultural context and historical importance of the A of I are described in **Technical Appendix 4: Cultural Heritage Baseline Study**.

Scheduled Features

- 9.23. The Ta' Hammut Dolmens lie just outside of the A of I, to the southeast. This site has been scheduled by GN574 of 1994 as a Class A site. The buffer zone for the Dolmens marginally overlaps the A of I (see **Figure 9.3**).

Cultural Features

- 9.24. **Figure 9.4** shows the location of the cultural features within the A of I. These are described in detail in the **Technical Appendix 4: Cultural Heritage Baseline Study**. **Table 9.2** lists these features and briefly describes their proposed level of protection.

Figure 9.2: Application Site to the east and Area of Influence of study

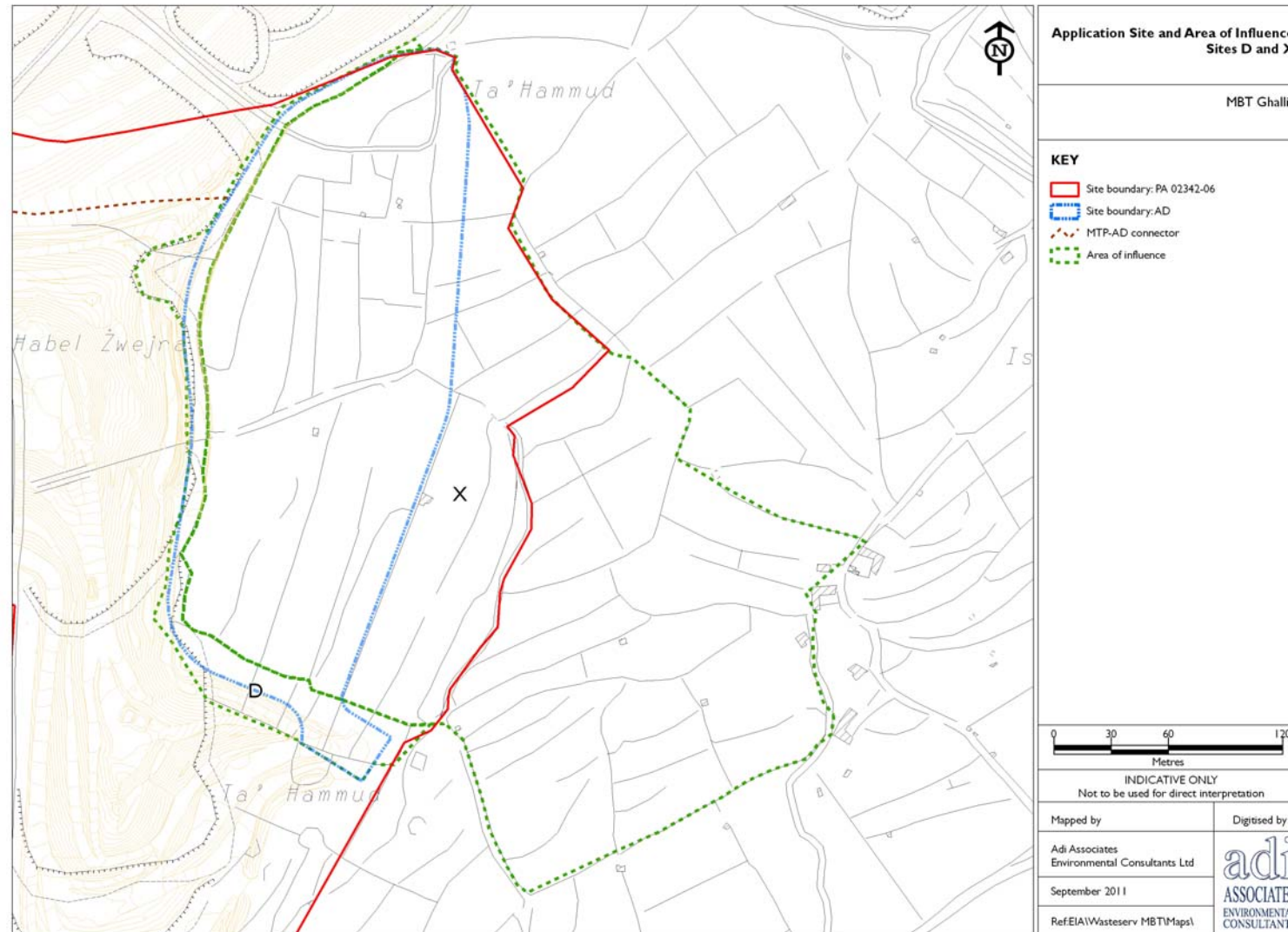


Figure 9.3: Ta' Hammud Dolmens Scheduled site and buffer zone

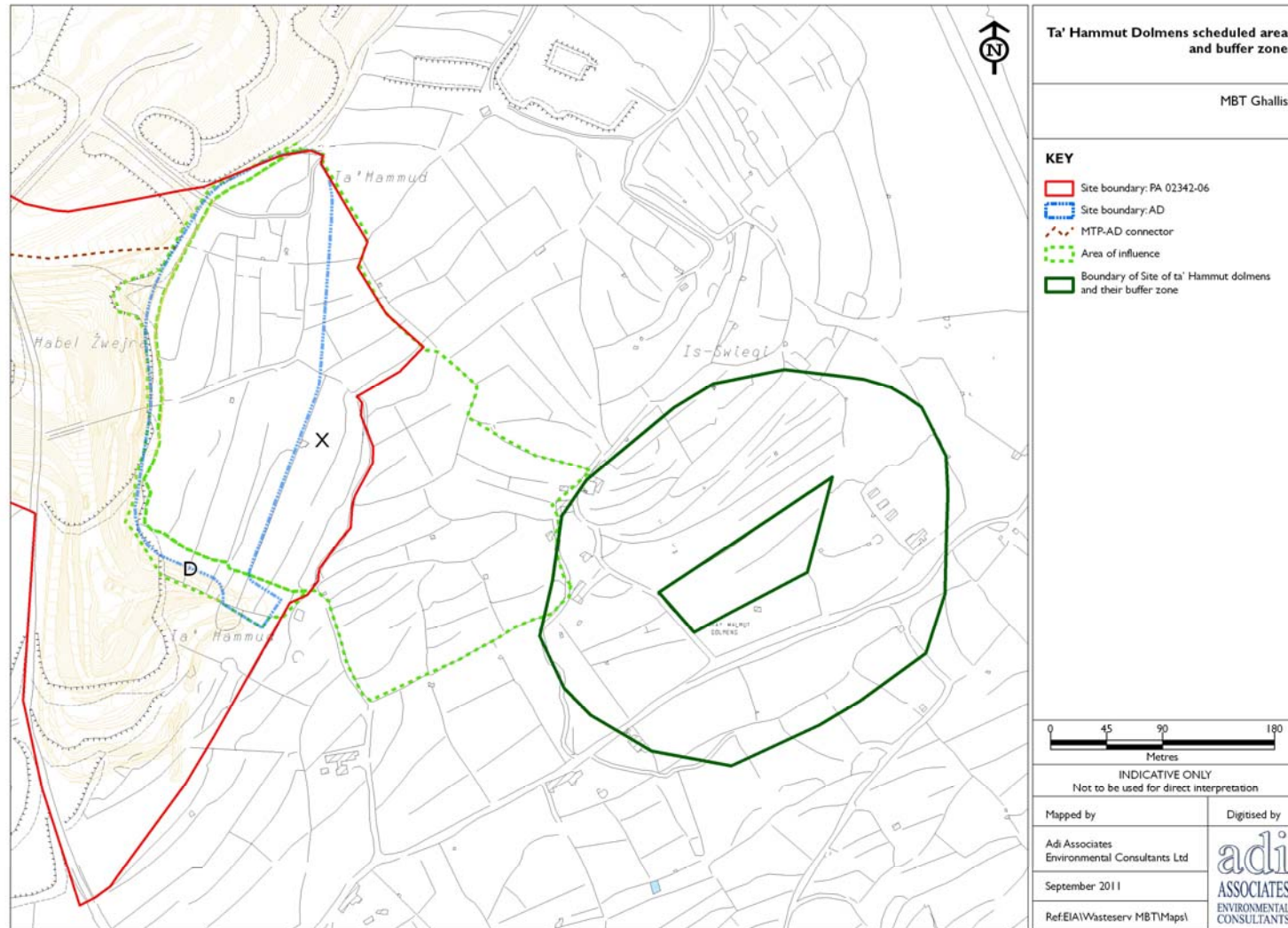


Figure 9.4: Cultural Heritage features in the Area of Influence

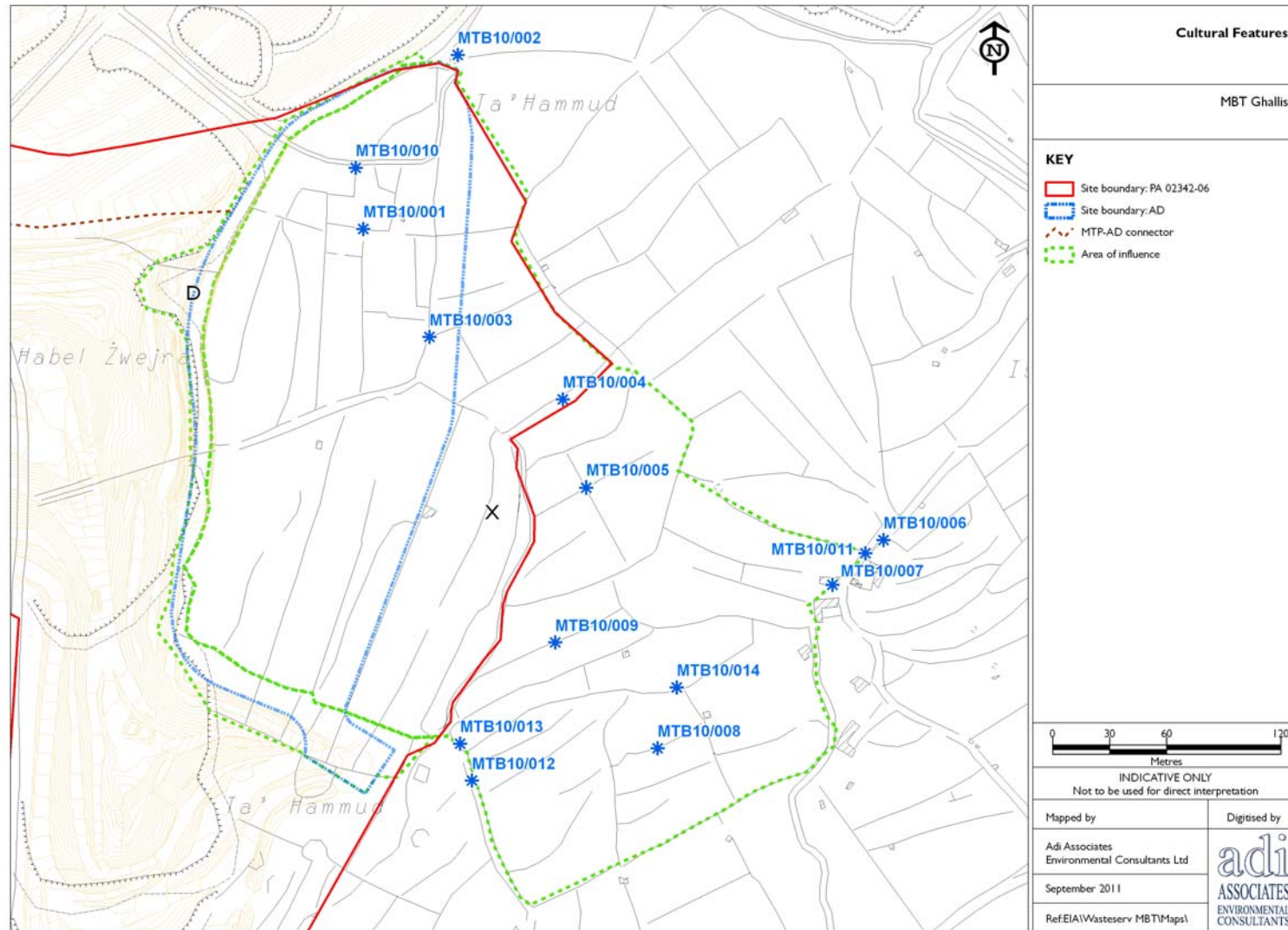


Table 9.2: Features that merit conservation: summary of policy importance

| Ref. No. | Feature | Class / Grade / Level | Merits |
|-----------|---------------------------|-----------------------|----------------|
| MTB10/001 | Field room | Grade 3 | Vernacular |
| MTB10/002 | Field room | Grade 3 | Vernacular |
| MTB10/003 | Field room | Grade 3 | Vernacular |
| MTB10/004 | Field room | Grade 3 | Vernacular |
| MTB10/005 | Field room | Grade 3 | Vernacular |
| MTB10/006 | Boundary Marker | Class B | Engineering |
| MTB10/007 | Farmhouse complex | Grade 2 | Vernacular |
| MTB10/008 | Megalithic | Class A | Archaeological |
| MTB10/009 | Megaliths and quarrying | Class A | Archaeological |
| MTB10/010 | Country road | Grade 2 | Vernacular |
| MTB10/011 | Country road | Grade 2 | Vernacular |
| MTB10/012 | Country road | Grade 2 | Vernacular |
| MTB10/013 | Field room | Grade 3 | Vernacular |
| MTB10/014 | Megalithic temple remains | Grade A | Archaeological |

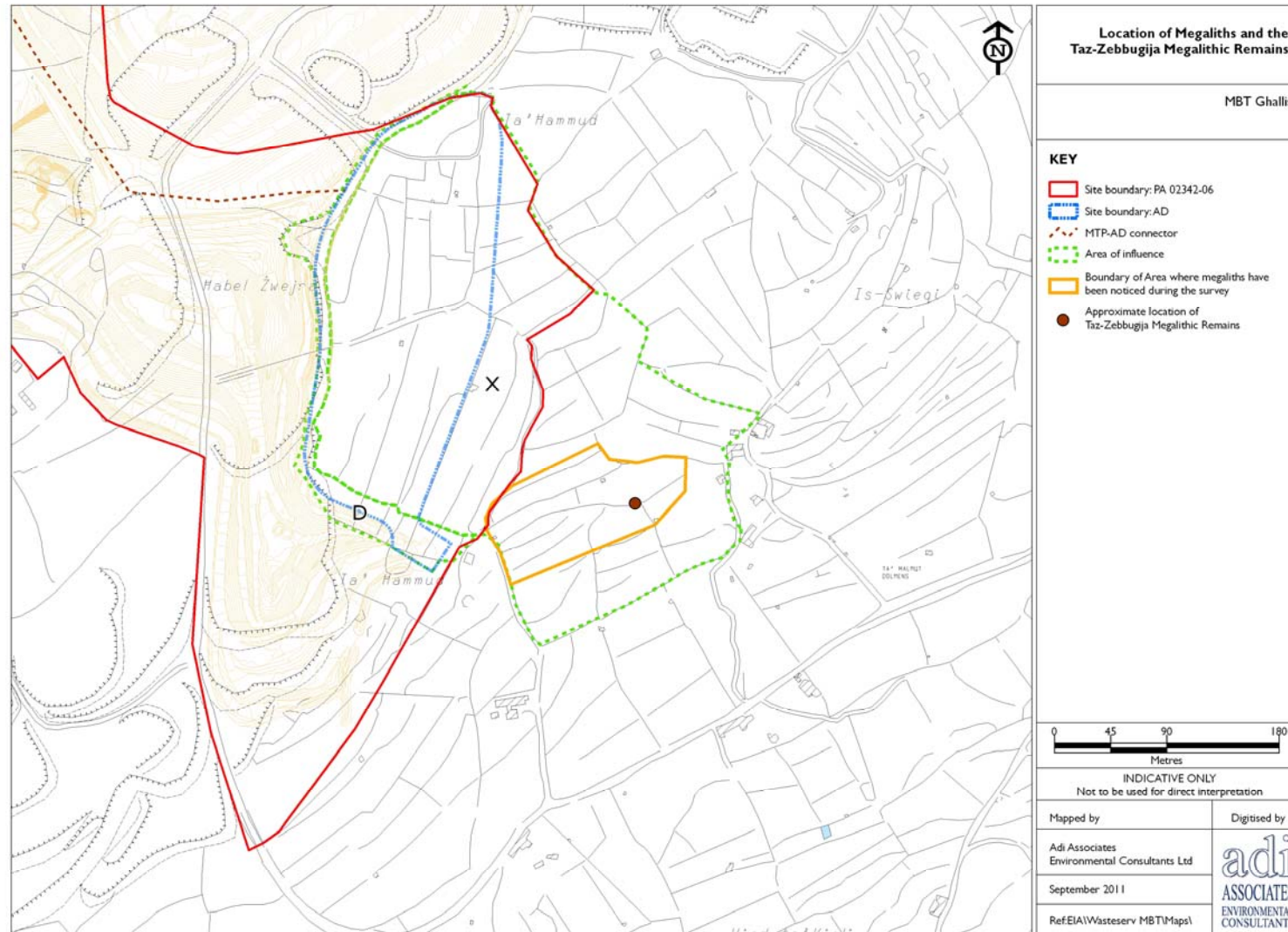
Archaeological Features

- 9.25. The Taz-Zebbugija megalithic temple remains lie within the A of I (see **Figure 9.4**). The site was recorded by MARs (MAR 1927-8:3- 4; MAR 1935-6: 18) but hasn't ever been scheduled. Since the area has been exploited for agriculture, much of the original landscape has been transformed, and some of the megaliths covered, lost or displaced. A number of large stone blocks were observed across a wide area, including in the southern corner of the Application Site, as illustrated in **Figure 9.4**. Given that a substantial element of the megalithic remains are still visible and, in line with the approach taken with similar remains of the same period and in a similar state of preservation, these remains warrant a Class A level of protection. An indicative 100m buffer zone for the remains is illustrated in **Figure 9.5**.
- 9.26. The MAR 1935-36: 18-19 records the presence of a megalithic passage somewhere in the area. Its precise location is undocumented but it is not located within the A of I.

Rural Features

- 9.27. The majority of the cultural features in the A of I are vernacular features. Some of these features are in their original state, while others have been altered in recent times.
- 9.28. **MTB10/007** is a farmhouse complex in a very good state of preservation, although it is not currently in use. It comprises both living and livestock quarters. The complex warrants a Grade 2 level of protection.

Figure 9.5: Location of Taz-Zebbugija megalithic temple remains and megaliths



- 9.29. Three country roads warrant Class 2 level of protection. **MTB10/010** has clearly been realigned after 1899 since the survey sheet shows the field pattern around it to be somewhat different. **MTB10/011** sub-divided the abovementioned farmhouse complex. It connects the fields of Ta' Hammut with Triq ir-Ramla and to a path leading to a number of fields to the south of the A of I. The upper part of the road is derelict and unusable but south of the farmhouse complex it is still in use. **MTB10/012** is in a better state of preservation, and is accessible by motorised vehicle.
- 9.30. **MTB10/001** is an abandoned field room which is was not marked in the 1899 survey sheet. It is built of rubble in the dry stone technique, with a roof of wooden planks covered with rubble. Its doorway faces east, and in front of which there is an enclosed space. Its southern wall abuts a rubble wall. Given its vernacular nature, it merits a Grade 3 level of protection. Another abandoned field room in a bad state of preservation is **MTB10/002**, which is built of dressed stones in the dry stone technique. This room is visible in the 1899 survey sheet. Given that no particular features survive however, it warrants a similar Grade 3 level of protection.
- 9.31. A similar field room is **MTB10/013** – a small room built in rubble and in the dry stone technique. Its entrance, built of unusually large stones, and probably taken from the nearby temple (see **MTB10/014**, **MTB10/008** and **MTB10/009**). Its roof is made up of stone slabs covered by small stones. Given its lack of particular features, the room deserves a Grade 3 level of protection.
- 9.32. **MTB10/003** represents two field rooms adjacent to each other. Neither is visible on the 1899 survey sheet. The smaller room is not currently used and retains its original characteristics, with rubble and stone slabs. The larger room is locked and its outer walls have been plastered. These rooms also warrant a Grade 3 level of protection. Another small field room built in rubble in the dry stone technique, **MTB10/004**, warrants the same level of protection.
- 9.33. **MTB10/005** is square-based corbelled hut which is marked on the 1899 survey sheet. It is in a very good state of preservation and warrants a Grade 3 level of protection.

Boundary Markers

- 9.34. **Figure 9.6** shows the location of the two boundary markers. **MTB10/006** lies just outside the A of I. Boundary markers are generally undocumented. The markers were used to mark government property. **MTB10/006** has a 'GR' inscription, suggesting it was erected either during the reign of King George III (between 1800 and 1820) or King George IV (between 1820 and 1830). In view of its age and historical significance, the boundary marker warrants classification as a Class B cultural feature.
- 9.35. A second boundary marker is shown on the 1899 survey sheet. This was not visible during the site survey. It should however it classified as a Class E cultural feature.

Sheet 31
Scale 2500

1000 1 2 3 4 5 6 7 8 9 10 2000 1 2 3 4 2500 Feet

inted at the School of Military Engineering, Chatham.
the direction of Capt R.A.O. Shelley, R.E.
and T. Fraser-C.B., C.M.G., R.E. Commandant.

1898.
Corrected July, 1900.

9.36. **MTBI0/008** and **MTBI0/009** represent a number of megaliths, or quarrying marks, that are related to the Taz-Zebbugjia megalithic temple remains (**MTBI0/014**). They do not follow any pattern and are included in rubble walls and field rooms and trapping huts (refer to **Figure 9.7**). As with the temple remains, the megaliths warrant a Class A level of protection.

A photograph of a stone wall made of stacked, irregular stones, surrounded by dry grass and sparse vegetation. The wall appears to be a remnant of an old structure, possibly a ruin or a boundary marker. The background shows more trees and foliage.

9.37. Rubble walls are an essential part of the Maltese landscape. They not only delineate boundaries, but are also a habitat for a wide range of wildlife and are essential soil

retainers. They are found in other areas of the Mediterranean region, but they are “...the commonest dry stone expression of the Maltese archipelago, with the corbelled stone hut and the farmhouse, they are the most distinctive landmarks of its landscape⁸”

- 9.38. Dating of rubble walls is usually difficult. Given their appearance on the 1899 survey sheet, most of the rubble walls within the Area of Influence can however be dated to at least 1899. The condition of the rubble walls varies considerably, as illustrated in **Figure 9.8**.
- 9.39. The rubble walls in the A of I can be divided into three categories, as shown in **Table 9.3**.

Table 9.3: Rubble Walls in the Area of Influence

| | Grade | Length (m / %of total) | Colour Code on Figure 9.8 |
|-----------------------------------|-------|---------------------------|------------------------------|
| Good to Fair Condition | A | 560.46m/12.5% | Red |
| Fair to Poor Condition | B | 1815.72m/40.3% | Orange |
| Bad Condition/ Slight Traces only | C | 1808.44m/40.2% | Green |
| Modern Rebuilt walls | | 315.46m/7% | Brown |

Grade A walls

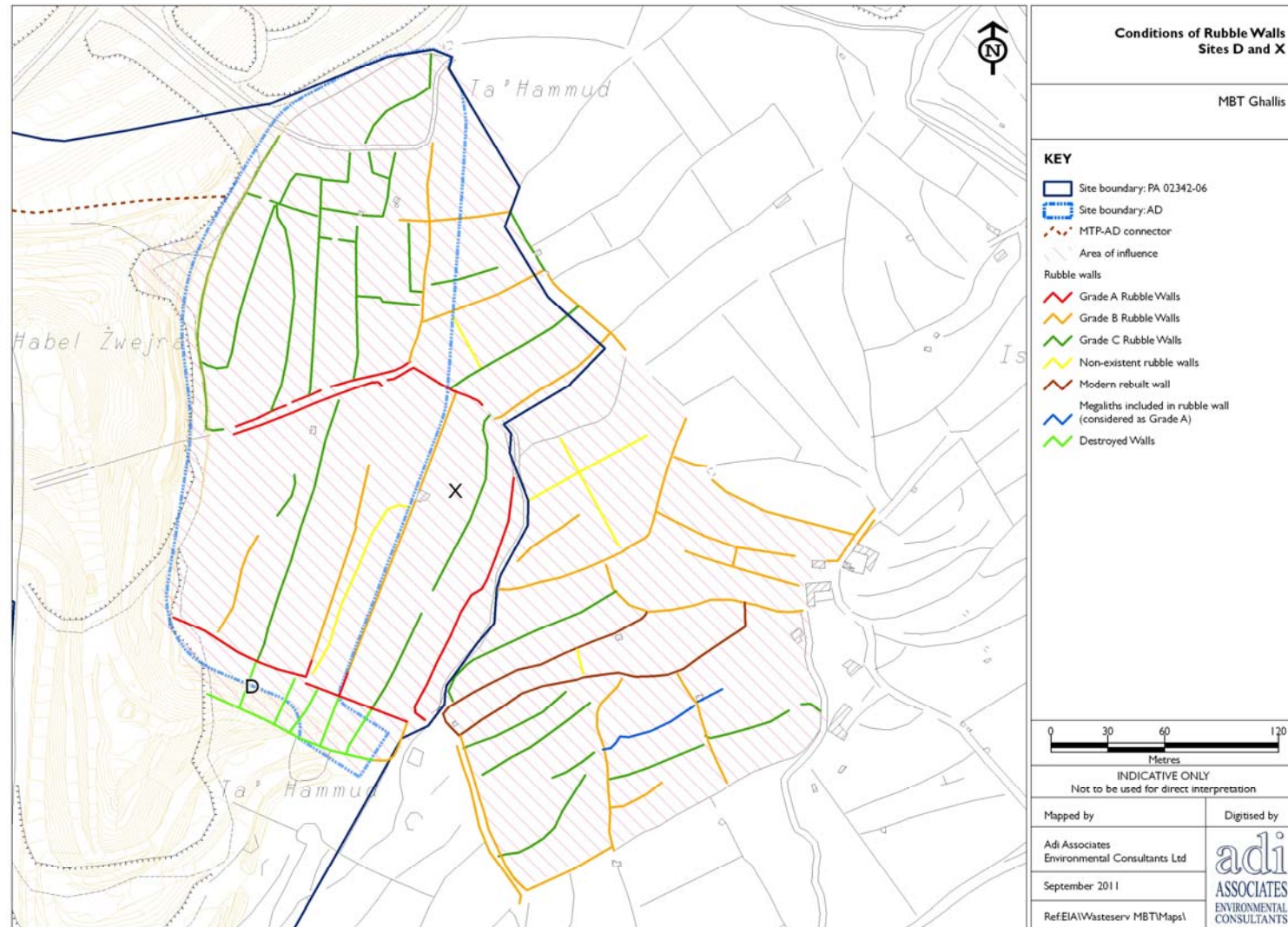
- 9.40. The state of preservation of the Grade A rubble walls ranges from good to fair condition. These walls still retain a large percentage of the original stonework, which may vary from 85% to 65% of the whole (**Figure 9.9**). In this case, this category also includes walls which have megaliths that are of an archaeological nature.

⁸ Jacarini C.J.: 1998; *Ir-Razzet – The Maltese Farmhouse*; P.E.G. Ltd, Malta

Figure 9.9: Grade A rubble wall within the Area of Influence



Figure 9.8: Condition of Rubble Walls within the Area of Influence



Grade B walls

- 9.41. Grade B walls range from fair to poor condition. These walls still contain part of the original stonework but have parts either restored with new blocks of stone or are still partly in a demolished state. The amount of original stonework varies from 64% to 35% of the whole (**Figure 9.10**).

Figure 9.10: Grade B Rubble wall within the Area of Influence



Grade C walls

- 9.42. These walls are in a bad state of repair, and in some cases they contain only slight traces of wall. The amount of original stonework varies from 34% to 10% of the whole (**Figure 9.11**).

Figure 9.11: Grade C Rubble Wall within the Area of Influence



CULTURAL LANDSCAPE

- 9.43. Virtually all landscapes have cultural associations, because most landscapes have been affected in some way by human action or perception. In keeping with this, the phrase 'cultural landscape' does not mean a special type of landscape, but rather a way of seeing landscapes that emphasises the interaction between human beings and nature over time. The importance of cultural landscapes is clearly explained in the European Spatial Development Perspective (ESDP) 1999, an integral document in the process of European integration. The report states that "*Cultural landscapes contribute through their originality to local and regional identity and reflect the history and interaction of mankind and nature*".
- 9.44. The primary value of the cultural heritage in the A of I lies in the information it yields regarding past uses and land-use patterns. The cultural heritage of the area clearly shows that it has been inhabited since prehistoric times. Little information remains as to what the landscape really looked like during this period. From the evidence that does remain however, it is clear that it was the morphology of the land which dictated the type of land use.
- 9.45. The cultural landscape is a reflection of changes which affected the landscape over the centuries. Changes were made in prehistoric times, with the extraction of stone for the building of the Taz-Zebbugija temple, and the actual construction and use of the temple and the Ta-Hammut dolmens to the southeast. It is not certain when the carob trees were introduced to the area, but some of the examples are considerably large and look as if they have been standing there for a very long time.
- 9.46. While there are no traces of other use for centuries, at a certain point the agricultural potential of the area led to its transformation into terraced fields. Soil was most probably brought from another location, covering the temple and other structures and using temple stones to build rubble walls and field rooms. Later on, a farmhouse complex and more solid field rooms were built, and access to the area was made easier with the opening of country roads.
- 9.47. The British Government left its mark in the area, with the placing of the boundary markers. More recently, there has been the use of the area as a landfill.

2011 SURVEY RESULTS

- 9.48. As described above, an additional four areas were included as part of the Application Site in 2011. These areas (marked A, B, C and D in **Figure 9.12**) were surveyed in 2011 to obtain cultural heritage baseline information.

Sites A and B

- 9.49. Sites A and B were surveyed in March 2011.

Historical background

- 9.50. There is limited historical documentation about Sites A and B. The 1899 survey sheet illustrates that, with the exception of the area occupied by the Maghtab landfill, the locality has been largely unchanged since 1899. The only evident changes are in the field patterns and rubble walls, which reflects the agricultural history of the area, and its use for hunting / trapping. Use of the area by the War Department during World War II is suggested by a number of boundary markers observed and recorded in the area.
- 9.51. Both Sites A and B were overgrown with vegetation at the time of the survey, making it difficult to read the ground surface and identify any pottery scatters. It is clear however that the landscape of the area generally has been greatly disturbed by the use of the wider area as a landfill. This activity has served to erase any cultural features.
- 9.52. The cultural context and historical importance of Sites A and B are described in ***Technical Appendix 4: Cultural Heritage Baseline Study***.

Scheduled features

- 9.53. There are no Scheduled features within either Site A or B, or in their immediate vicinity. The nearest Scheduled feature is the Ghallis Tower, which lies approximately 400m to the northwest of Site A (see **Figure 9.13**). The Tower is scheduled as a Grade I asset by GN729 of 1995.

Cultural features

- 9.54. **Figure 9.14** shows the location of the cultural features within and around Sites A and B. These are described in detail in the ***Technical Appendix 4: Cultural Heritage Baseline Study***. **Table 9.6** lists these features and briefly describes their proposed level of protection.

Table 9.6: Features that merit conservation: summary of policy importance

| Ref. No. | Feature | Class / Grade / Level | Merits |
|-----------|-----------------|-----------------------|------------|
| MTBII/001 | Field room | Grade 3 | Vernacular |
| MTBII/002 | Water channel | Grade 3 | Vernacular |
| MTBII/003 | Boundary Marker | Class B | Military |
| MTBII/004 | Well | Grade 3 | Vernacular |
| MTBII/005 | Country Road | Grade 3 | Vernacular |
| MTBII/006 | Boundary Marker | Class B | Military |

Boundary markers

- 9.55. The boundary markers within Site B suggest that the area was under the jurisdiction of the War Department during the British Period. **MTBII/003**, inscribed with the number 157, is erected on a rubble wall, supported by a triangular pillar.

MTBI I/006 is not in its original location, since it is lying horizontally on the garigue. It has the inscription 'VD 158'. In view of the relative rarity of such markers, these features warrant classification as Class B cultural features.

Figure 9.12: Sites A, B and C

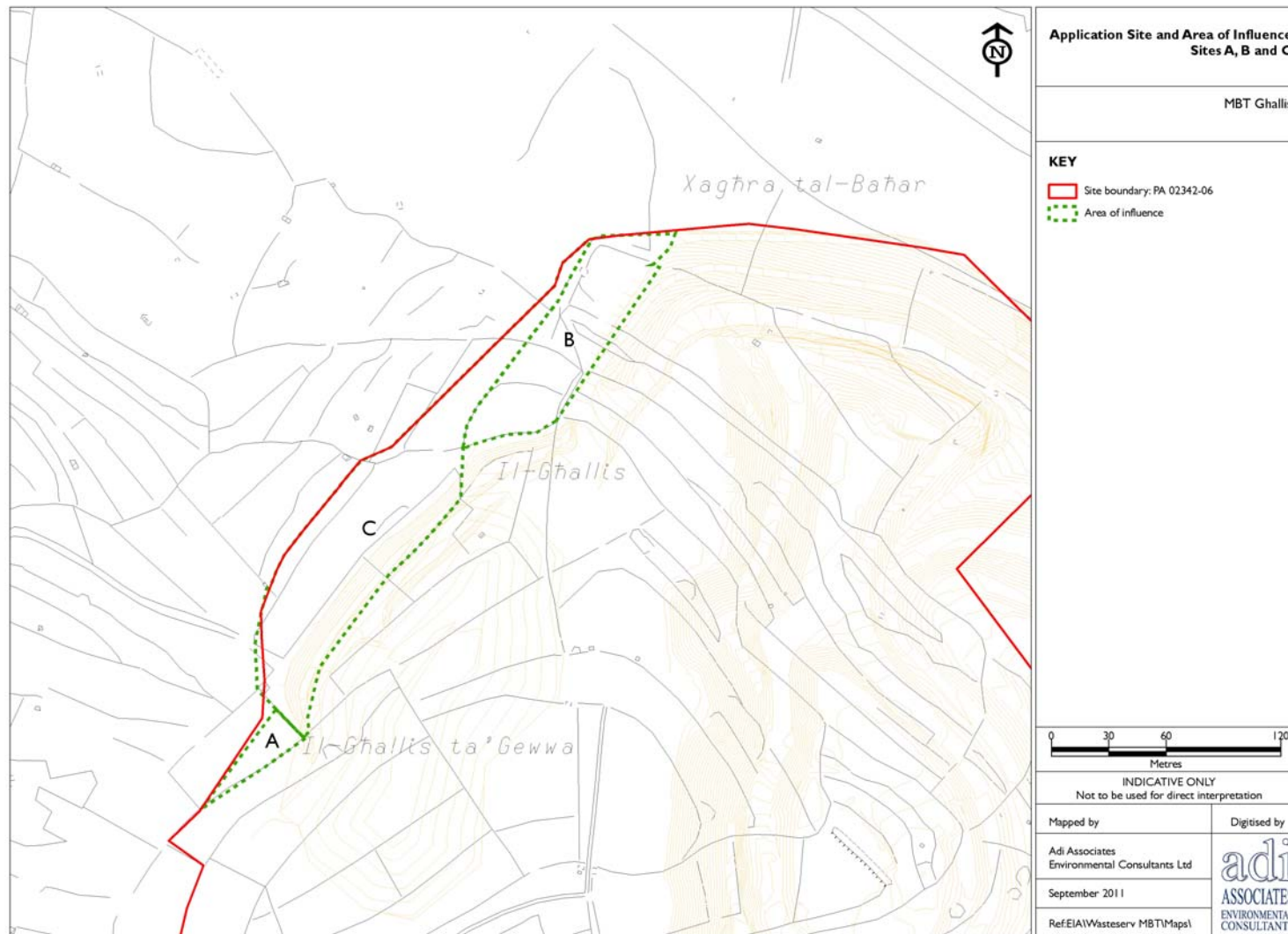


Figure 9.13: Ghallis Tower in relation to Sites A, B and C

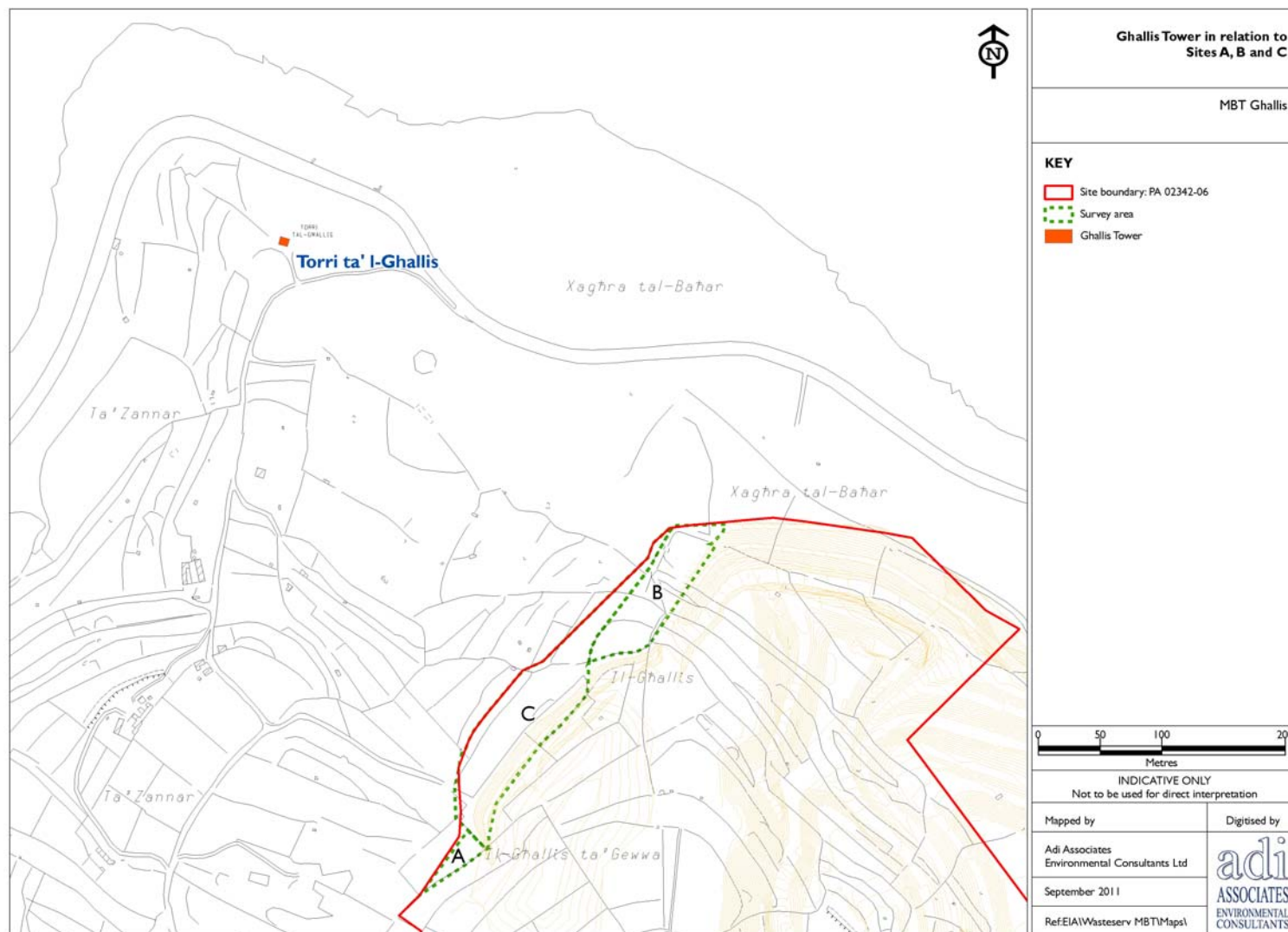
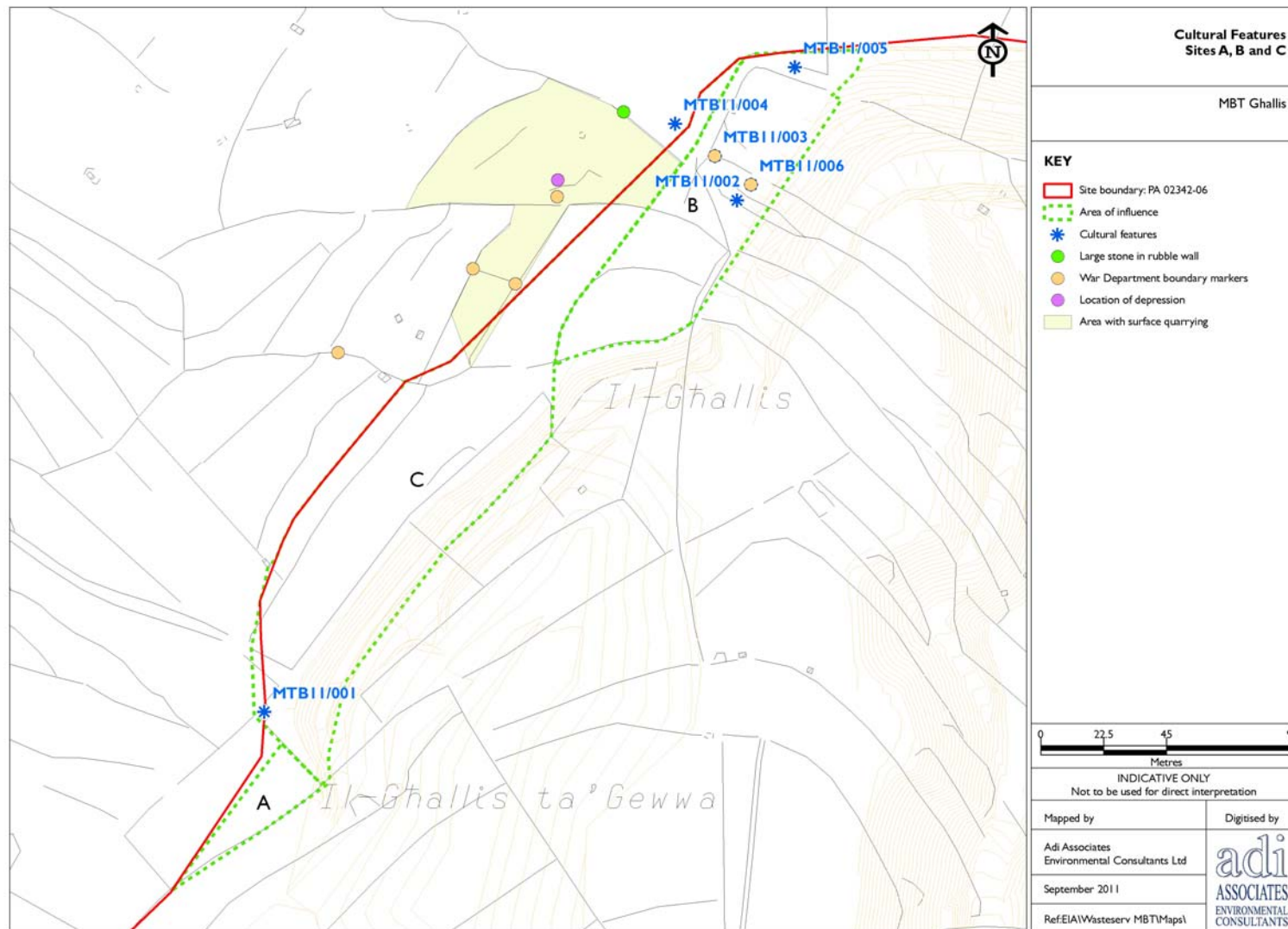


Figure 9.14: Cultural Heritage features within and around Sites A, B and C



Rural features

- 9.56. The majority of the cultural features are vernacular features. Given their vernacular nature, and accounting for the condition, **MTB I I/001**, **MTB I I/002**, **MTB I I/004** and **MTB I I/005** all warrant a Grade 3 level of protection.
- 9.57. **MTB I I/001** is a one-storey field room located just outside of Site A, and which is shown on the 1899 survey sheet. Built in dressed ashlar blocks, it is in a good state of preservation, is still in use and has been furnished with modern drain pipes for rain water collection.
- 9.58. **MTB I I/002** and **MTB I I/004** are both linked to the collection of water. **MTB I I/002** is a small rock-cut channel above which is a rubble wall. It was presumably used to collect ground water from the field above. Since the area is overgrown, it wasn't possible to determine the continuation of the channel. **MTB I I/004** is a well hewn out of the rock. It is now abandoned, however its well head is clearly marked, consisting of a circular rubble structure of a diameter of approximately 1.5m and a height of approximately 0.75m. This well is not marked on the 1899 survey sheet. A number of wells are however shown on the survey sheet, and the practice of water collection was common in the area.
- 9.59. **MTB I I/005** is a short country road bounded by two rubble walls. It is particular, since it is visible in the 1899 survey sheet but it appears to have no purpose currently.

Rubble walls

- 9.60. The majority of the rubble walls within and bounding Sites A and B can be dated to at least 1899, where they are apparent on the survey sheet. The condition of the rubble walls varies considerably, as illustrated in **Figure 9.15**.
- 9.61. **Table 9.7** shows the classification of the rubble walls in the 2 sites.

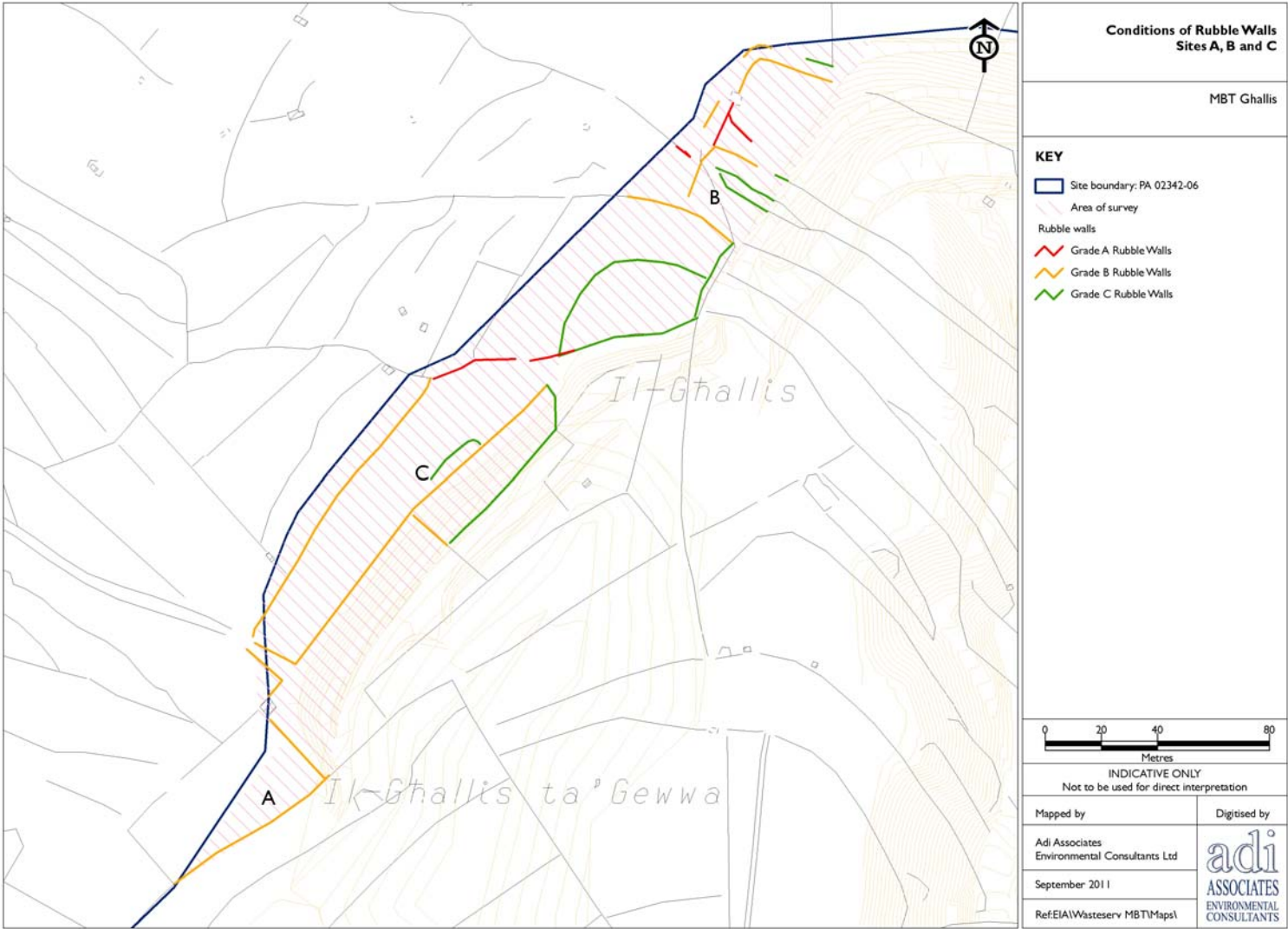
Table 9.7: Rubble Walls in Sites A and Site B

| | Grade | Length (m / %of total) | Colour Code on Figure 9.15 |
|-----------------------------------|-------|---------------------------|----------------------------------|
| Good to Fair Condition | A | 560.46m/12.5% | Red |
| Fair to Poor Condition | B | 1815.72m/40.3% | Orange |
| Bad Condition/ Slight Traces only | C | 1808.44m/40.2% | Green |

Cultural landscape

- 9.62. The primary value of the cultural heritage in Sites A and B lies in the information they yield on past uses and land-use patterns. Originally a garigue landscape, the area was transformed as it became agricultural, where there emerged the field patterns, rubble walls, water collection infrastructure and agricultural rooms which can still be observed today.

Figure 9.15: Condition of Rubble Walls within Sites A, B and C



- 9.63. The importance of the area during World War II is suggested in the existence of the boundary markers, as mentioned. Returning to agriculture after the war, the encroachment on the area of the Magtab land fill has served to considerably affect and change the landscape and cultural heritage of the area.

Sites C and D

- 9.64. Sites C and D were surveyed in September 2011.
- 9.65. The northern area (site C) is partially worked, while the rest is enclosed garrigue land, which is used for trapping. The southern area (marked B) is mainly the ring road surrounding the landfill and rubble, which has been taken from material from Magtab to form this road.

Scheduling

- 9.66. There are no scheduled sites in the area of proposed development or immediate vicinity.

Cultural features

- 9.67. No cultural features were documented in the area. Part of Area C, as well as its immediate surroundings showed signs of surface quarrying. This was practised in this area to make use of the natural fissures found in the Lower Coralline Limestone surface. One such natural fissure has led to the creation of a rock-cut depression. This may have been enlarged later to store water.
- 9.68. Another noteworthy feature is the blocked entrance to a rubble wall, which was formed by two large stones erected vertically to form a doorway. Its location is shown in **Figure 9.4**. It is not clear whether these stones formed part of a previous megalithic structure or not. It should be noted that it is common for Lower Coralline Limestone to break up into large fragments.

Rubble walls

- 9.69. The condition of rubble walls has been noted in **Figure 9.8** and **Figure 9.15**. The rubble walls in Area C are relatively well maintained since the area is being used for bird trapping as well as for agriculture. The rubble walls in Area D are in a worse state, some of which have been covered by debris by the road mentioned above.
- 9.70. **Table 9.8** shows the classification and extent of the walls recorded in Sites C and D.

Table 9.8: Rubble Walls in sites C and D

| | Grade | Length (m / % of total) | Colour code on Figure 9.8 and Figure 9.15 |
|------------------------------------|-------|-------------------------|---|
| Area C | | | |
| Good to Fair Condition | A | 50.63 m/12% | Red |
| Fair to Poor Condition | B | 288.28 m/66% | Orange |
| Bad Condition / Slight Traces only | C | 96.11 m/22% | Green |
| Area C | | | |
| Good to Fair Condition | A | 170.96 m/48% | Red |
| Fair to Poor Condition | B | 31.27 m/9% | Orange |
| Bad Condition / Slight Traces only | C | 24.73 m/7% | Green |
| Destroyed | | 129.42 m/36% | Light Green |

ASSESSMENT OF IMPACTS

Determining Impact Significance

- 9.71. The significance of the impacts of the Scheme on the cultural heritage of the A of I is dependent upon the cultural heritage importance assigned to each of the features, either through legislation and the degree of disturbance or damage likely to arise from the construction or operation of the Scheme.
- 9.72. The assessment of the significance of potential negative impacts of the Scheme on the cultural heritage aspects uses three levels: **not significant**, **minor significance**, and **major significance**. The assessment criteria applicable to each of these levels are described in **Table 9.8**, which correlates protection ratings and cultural significance with significance of impact.

Table 9.8: Impact Significance Criteria

| Potential damage or destruction to features / class or grade of feature | Cultural significance | | | |
|---|---------------------------|----------------------------|---------------------------|-------------------|
| | Major Class / Grade A / I | Medium Class / Grade B / 2 | Minor Class / Grade C / 3 | None / not graded |
| No material change to the cultural heritage feature or its setting | Not significant | Not significant | Not significant | Not significant |
| Small scale changes, such as alterations to the cultural heritage feature that are unlikely to affect the integrity of the feature or its setting | Major | Minor | Minor | Not significant |
| Loss of or disturbance to the cultural heritage feature that is likely to affect the integrity of the feature or its setting | Major | Major | Minor | Not significant |

- 9.73. In applying the above criteria Adi Associates is mindful of the fact that the disturbance of certain features is prohibited by law, in which case even small-scale changes or alterations to a legally protected feature would be a major impact. In actuality however, when assessed in the context of the Scheme, and taking account of

proposed mitigations, the potential impact on the cultural heritage may not be that significant. An example of this could be construction of a new structure next to a cultural heritage feature in a manner that does not destroy any aspect of the heritage feature and is completely reversible.

- 9.74. In order to provide clarity on the impact of the potential disturbance in the context of the Scheme, the Assessment Matrix (see **Table 9.9**) assesses the impacts both in the light of existing legislation as well as solely in the context of the Scheme (i.e., devoid of legislative considerations).
- 9.75. It is also noted that the above impact significance criteria do not take account of circumstances where changes to the feature or its setting outside the scope of the current Scheme would result in, or imply, a reclassification of its protection status.

Prediction and Significance of Impacts

- 9.76. The significance of impacts is dependent upon the importance of the cultural heritage features and the potential for damage or destruction to these features by the Scheme.

Loss of features

- 9.77. The Scheme is unlikely to have any impact on the Scheduled Ta' Hammut dolmens or on the Scheduled Ghallis Tower, given the distance between the Application Site and these features.
- 9.78. A number of cultural features lying within the Application Site identified during the baseline surveys and described above will be removed as a result of the Scheme. These features are:
- Two proposed Class B boundary markers (**MTBI I/003** and **MTBI I/006** on **Figure 9.14**)
 - A proposed Grade 2 country road (**MTBI0/010** on **Figure 9.4**);
 - Four proposed Grade 3 field rooms (**MTBI0/001**, **MTBI0/003** and **MTBI0/004** on **Figure 9.4**); and
 - A proposed Grade 3 rock-cut water channel (**MTBI I/002** on **Figure 9.14**)
- 9.79. Loss of Class A and Class B archaeological remains constitutes a major negative impact.
- 9.80. The loss of the southern section of country road **MTBI0/010** constitutes a major negative impact. Rural roads are part of the cultural landscape and are important also where flanked by rubble walls, as in this case. Notably however, as is clear from the 1899 survey sheet, **MTBI0/010** has been realigned and its character changed since 1899.
- 9.81. The loss of the Class B boundary markers constitutes a major negative impact. Notably however, **MTBI I/006** is not in its original location.

- 9.82. The loss of the Grade 3 features constitutes a minor negative impact. Notably, none of the field rooms is marked on the 1899 survey sheet, and it is clear from the survey sheet that the country road has been realigned and its character changed after 1899. The area around the water channel is overgrown, as mentioned, and it is unclear whether or how far the channel continues outside of the site.

Damage to features

- 9.83. Given their proximity to the Application Site, damage may result to the following features:
- Class A megaliths / quarrying marks (**MTBI0/009** on **Figure 9.4**);
 - A Grade 2 country road (**MTBI0/012** on **Figure 9.4**);
 - A Grade 3 country road (**MTBI1/005** on **Figure 9.10**)
 - A Grade 3 rock-hewn well (**MTBI1/004** on **Figure 9.14**); and
 - Four Grade 3 field rooms (**MTBI0/002**, **MTBI0/005** and **MTBI0/013** on **Figure 9.4** and **MTBI1/001** on **Figure 9.14**).
- 9.84. Damage to the Class A archaeological remains constitutes a major negative impact.
- 9.85. There is potential from the construction, and possibly from the operation of the Scheme, for major negative impact on the northern end of country road **MTBI0/012** which is in a good state of preservation.
- 9.86. Damage to the Grade 3 features constitutes a minor negative impact. **MTBI0/002** and **MTBI0/005** are shown on the 1899 survey sheet. The former is in a bad state of preservation, and no particular features survive, but the latter is well preserved. The entrance of **MTBI0/013** is built of unusually large stones, probably taken from the megalithic temple, but the room lacks any particular features. **MTBI1/001** is also shown on the 1899 survey sheet, is in a good state of preservation, and is still in use. The well is not marked on the 1899 survey sheet and has been abandoned. The country road is marked on the survey sheet but has no purpose currently.

Alteration of context and cultural landscape

- 9.87. The Scheme will see the introduction of a large industrial development into a landscape with a strong rural and cultural appearance and heritage, the predicted impact of the alteration of the context of the Application Site, as well as on the setting of the Taz-Zebbugija temple remains. However, the cultural landscape has been significantly altered by the presence of the Maghtab landfill. Refer to **Chapter 7** for a detailed landscape impact assessment where the impact to Local Landscape Tract 2 (which includes cultural heritage features) within the Maghtab Character Area has been judged to be of major significance.

PROPOSED MITIGATION MEASURES

- 9.88. In the event that the Scheme proceeds, little can be done to mitigate its effects on the cultural features within the Application Site and on the cultural landscape. Some mitigation measures that can be applied include:
- Relocation of significant features off-site, either to locations in the surrounding area of Maghtab or to any other suitable location, and with the agreement of and under the supervision of the Superintendence of Cultural Heritage. The megaliths and boundary markers in particular could be sensitively relocated.
 - Supervision of works generally by the Superintendence of Cultural Heritage to ensure that, in the eventuality that uncharted artefacts are encountered, works are halted and the situation assessed. In particular, there should be further, pre-development archaeological investigations in the area where the megaliths are located.
 - Features to the east of the site and the surrounding area will be maintained. WasteServ is considering managing the area as a Heritage Park for the public. This will go some way to safeguarding and preserving what is left of the cultural landscape of the area.

RESIDUAL IMPACTS

- 9.89. Loss of certain features described above will result in major residual impact. Adopting the mitigation measures, as appropriate, may reduce the scale of the residual impact.
- 9.90. The context of the rural/cultural heritage landscape will inevitably be altered if the Scheme goes ahead. Thus, a major residual impact remains.

MONITORING REQUIREMENTS

- 9.91. It is recommended that prior to excavation and construction of the Scheme, a cultural heritage monitoring plan (which would include a watching brief) is prepared and included in the Construction Management Plan. This would necessitate the presence of archaeologists on site during interventions (e.g., excavations) in areas identified to contain, or may contain, cultural heritage features.
- 9.92. Where cultural heritage features are to be removed, these should be recorded and mapped for posterity, before removal / dismantling. Wherever possible, significant features are to be salvaged. Copies of the recorded information are to be deposited with MEPA and the Superintendence of Cultural Heritage.

Table 9.9: Summary of Impacts on Cultural Heritage

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|--|------------------------|----------------------------------|---------------------------------------|------------------|----------------|------------|------------------|----------------------------|---------------------------------------|--|---|---|---|
| | | Constr'n / Oper'n | Extent of impact (Nat / Local / Site) | Direct/ Indirect | S term/ L term | Perm/ Temp | Revers/ Irrevers | (Inter / National / Local) | (Likely, Unlikely, Remote, Uncertain) | Legislation | In context of Scheme | | (Major, Minor, Insignificant) |
| Loss of features | Adverse | Constr'n | Site | Direct | L. term | Perm | Irrevers | National | Likely | Cultural Heritage Act (Major), DPA (Major) | Minor to Major (depending on features lost) | Relocation of significant features. Recording of features. Watching Brief. Use of sensitive construction methods. | Minor to Major (depending on implementation of proposed mitigation measures). |
| Damage to features | Adverse | Constr'n | Site | Direct | L. term | Perm | Irrevers | National | Likely | Cultural Heritage Act (Major), DPA (Major) | Minor to Major (depending on features lost) | Relocation of significant features. Recording of features. Watching Brief. Use of sensitive construction methods. | Minor to Major (depending on implementation of proposed mitigation measures). |
| Change in the context and cultural landscape | Adverse | Constr'n Oper'n | Local | Direct | L. term | Perm | Irrevers | National | Likely | SP | Major | None | Major |

10. NOISE AND VIBRATION

INTRODUCTION

- 10.1. This chapter considers the noise and vibration impacts arising from the construction and operation of the Scheme. The existing noise climate was established through a baseline noise survey, and the locations of sensitive receptors that may be potentially affected by changes to the noise environment were identified and agreed with MEPA.
- 10.2. Noise is likely to arise throughout the construction and operational phases. Vibrations are likely to arise during the excavation phase.
- 10.3. The potential key noise / vibration-related issues associated with the Scheme are:

Key Issues:

- Effects of noise on sensitive uses
- Effects of vibration on sensitive uses

EIS Update Guidelines

- 10.4. As this is an update to an existing EIA, MEPA has not issued formal Terms of Reference. The following guidelines have been issued by MEPA:

The EIS Update shall focus on the following:

1. Project description i.e. the EIS update shall include a description of the additional proposed facilities that will be included within the development site including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;

2. Alternatives (sites, layouts and technologies) as relevant;

3. Landscape and visual amenity assessment;

4. Transport;

5. Noise and vibration;

6. Air quality;

7. Waste management issues; and

8. Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.

In addition to the above, the consultant/s is to verify whether as a result of the proposal, the impact significance for the following environmental

characteristics outlined below (as presented in the EIS Sections for PA 04834/04), would require an update:

1. Geology, hydrology and palaeontology;
2. Agriculture;
3. Archaeology and cultural heritage;
4. Social impact;
5. Land contamination;
6. Risk assessment; and,
7. Cumulative impacts.

ASSESSMENT METHODOLOGY

Area of Influence

Noise

- 10.5. The Area of Influence (A of I) was determined based on the results of the noise monitoring survey (see **Technical Appendix 5: Noise Baseline Survey**) by taking into account the maximum noise levels predicted to arise from the construction and operation of the Scheme and the distance required for the levels to fade to 63dB(A) or 3dB(A) above the background levels, whichever is the greater.
- 10.6. The worst-case noise scenario occurs during the excavation and construction stages of the construction when noise levels at source are likely to be at their highest. The locations of the 4 monitoring points used to record baseline noise levels at the noise sensitive receptors are shown in **Figure 10.1**.

Vibration

- 10.7. Vibration levels resulting from construction activities are very dependent on ground conditions, underlying geology, and upon foundations and the techniques used to recontour, excavate or to construct a building. BS 5228: Part 4 states that the threshold for vibration perception for humans is "...typically in the peak particle velocity range of 0.15 mm / s to 0.3 mm/s at frequencies between 8 Hz and 80 Hz. Vibration levels above this value can disturb, startle, cause annoyance, or interfere with work activities. At higher levels they can be described as unpleasant or even painful".
- 10.8. **Table 10.1** details distances at which certain construction activities give rise to a level of vibration that is just perceptible; it is based on BS 5228 and other studies .

Table 10.1: Construction vibration levels

| Construction Activity | Distance from activity when vibration may just be perceptible (metres) |
|-----------------------|--|
| Excavation | 10-15 |
| Hydraulic breaker | 15-20 |

- 10.9. Such distances assume no mitigation measures that would interrupt the vibration path.
- 10.10. The A of I for impacts on humans is therefore taken to be the maximum distance where vibration is just perceptible, that is 20 metres from the boundary of the Site.

ASSESSMENT METHODOLOGY

Noise

- 10.11. The long-term noise implications of the operations on-site will be determined by the changes in ambient noise levels resulting from the Scheme.
- 10.12. The environmental impact of a development can be expressed as the change in conditions relative to the baseline conditions directly attributable to that development. The assessment is to consider the effects of changes in ambient noise levels on the occupants of sensitive properties / uses in the Area of Influence.
- 10.13. The subjective significance of a change in noise levels is generally related to the magnitude of that change. The significance of the change is also related to the number of people affected. Studies have shown that changes in broadband continuous noise, such as traffic noise, are not generally distinguishable until the change is of at least 3 dB, while a change of 10 dB represents a doubling of loudness. Changes of less than 3 dB are not, therefore, generally considered to be significant, although it should be recognised that such imperceptible changes can lead to a gradual deterioration in the quality of the environment, if further development occurs in the area.

Vibration

- 10.14. Vibration at the site will be assumed to be that of typical urban areas. The impact of vibrations on human beings and on the stability on buildings will be assessed. As described above, levels of vibration above a Peak Particle Velocity (PPV) of 0.3 mm/s are considered to disturb people, although at that level they will certainly not damage buildings.

Competence of Surveyor

- 10.15. The noise survey will be carried out by Mr John Demanuele, Grad. I.A.P., Building Services Consultant, Mediterranean Technical Services Limited as approved by MEPA. The noise and vibration assessment will be carried out by Adi Associates in consultation with Mr John Demanuele.

Standards and guidance

Noise

- 10.16. Guidance on environmental noise in the context of planning is not available specific to the situation in Malta. However, in situations where standards are not available, the Environment and Planning Review Tribunal generally makes reference to equivalent guidance from the UK. In respect of noise, therefore, it is appropriate to refer to the British Standards and UK Government Planning Policy Guidance Notes clarifying their applicability to land use planning issues. In this regard, BS 4142, BS 5228 and The UK Department for Communities and Local Government (formerly Office of the Deputy Prime Minister) Planning Policy Guidance Note, PPG24, Planning and Noise are relevant.

Vibration

- 10.17. Since guidance on vibrations in the context of planning specific to Malta is not available, British Standards are used. British Standard 7385: Part 2: 1993 'Evaluation and measurement for vibration in buildings – Guide to damage levels from ground borne vibration' and British Standard 7385: Part 2: 1993 'Evaluation and measurement for vibration in buildings – Guide to damage levels from ground borne vibration' and BS 5228: Part 4: 1992 Noise and vibration control on construction and open sites. Code of practice for noise and vibration control applicable to piling operations will be used.

Equipment and Measurements

- 10.18. The background noise level will be established by undertaking daytime and night time surveys at each of the 4 noise monitoring locations. These locations are shown on **Figure 10.1**.

- 10.19. A “Quest” integrating, logging, sound level meter will be used to take the measurements. L_{Aeq} , L_{max} , L_{A10} and L_{A90} will be reported.

- L_{Aeq} is the ‘A’ weighted average or residual noise;
- L_{max} and L_{A10} are used to assess traffic related noise; and
- L_{A90} indicates the background noise (ambient).

- 10.20. Measurements and procedures will be in accordance with BS 4142:1997.

- 10.21. Paragraphs 5.1 to 5.5 of BS 4142 give guidelines on measurement practice. These require calibration of the instrument and give guidelines in choosing measurement locations as well as on taking precautions against interference with the measurements, particularly from inclement weather.

Equipment Data

- 10.22. The following equipment will be used to undertake the survey:
- ‘QUEST’ sound level meter Model: 2900

- 'QUEST' Calibrator Model: QC-20

10.23. The sound level meter was be calibrated before each set of measurements in accordance with BS 4142: 1997 Para 5.1, and placed on a tripod stand 1.2m – 1.5m off the ground with no reflecting surfaces, or obstructing objects in the vicinity.

Monitoring Locations

10.24. Key to assessing the impacts of noise arising from the construction and operation of the Scheme is the proximity of the noise-sensitive land uses and activities. The noise monitoring locations are, therefore, set as described in **Figure 10.1**. A number of potentially sensitive receptors are located to the west, south and east of the site. Noise monitoring points 1 and 3 are similar to those used in the EIS for PA 4834/04. However, baseline data was collected separately for this EIS update given that the original EIS was carried out seven years ago. Receptors include the Coastline Hotel and a group of residences. Location 2 represents the background noise in the vicinity of the Magtab hamlet, while receptor 4 is the closest sensitive receptor to the east of the Site.

Methods for Assessing Noise Levels Arising from the Construction and Operation of the Scheme

- 10.25. BS 4142:1997 provides a method for rating external noise levels from factories, industrial premises or fixed installations of an industrial nature, to determine the likelihood of complaints from occupants of nearby residential properties. The methods are also applicable to assessing the impacts of noise on nearby residential properties arising from uses such as those proposed in the Scheme.
- 10.26. The method is based on the difference between the background noise level without the source (expressed as the LA90, the noise level exceeded for 90% of the time period of interest) and the noise level of the source at the receiver location (expressed as the LAeq, the equivalent continuous noise level, or energy average, over the period of interest). The noise level from the source (known as the specific noise level) can be weighted by 5 dB if it displays an identifiable character (such as tonality, impulsiveness, or intermittency). The background noise level is then subtracted from the rating level (the specific noise level plus any weighting for character) and the difference used to assess the likelihood of complaints, as shown in **Table 10.2** below.

Table 10.2: BS 4142:1997 Assessment Criteria

| Difference | Assessment |
|--------------------------|---|
| 10 dB or higher | Complaints likely |
| 5 dB | Of marginal significance |
| Less than 5 dB | The lower the value the less likelihood of complaints |
| - 10 dB below background | Positive indication that complaints are unlikely |

Traffic noise

- 10.27. While the Consultants recognise that the Scheme will generate traffic, it cannot be ascertained, at this stage, whether any increase is likely to give rise to a significant change in noise levels. Guidance Notes No 1 “Guidelines for the Environmental Assessment of Road Traffic” authored by the Institute of Environmental Assessment (UK), (now IEMA) indicates that in view of the logarithmic relationship between noise levels and traffic volume, the higher the level of existing traffic, the greater the increase that is required to effect a given change in noise levels. Typically, the guidelines state, a halving or doubling of flows will result in a 3dB(A) change in noise level.
- 10.28. The potential traffic generated by the Scheme has been estimated. These findings fed into the noise study to determine whether the Scheme would result in traffic generation that would significantly affect noise sensitive uses in the A of I.

Methods for Assessing Vibrations Arising from the Construction and Operation of the Scheme

- 10.29. Vibration can be expressed in terms of displacement, velocity, or acceleration, each of which varies with frequency and time. Peak Particle Velocity (PPV) is often used to assess damage risk in buildings as it correlates best with case history data and is usually measured in mm/s.
- 10.30. BS 5228: 1992 Part 4 states that the threshold for vibration perception for humans is in the PPV range of 0.15 mm / s to 0.3 mm/s at frequencies between 8 Hz and 80 Hz. **Table 10.1** details distances at which certain construction activities give rise to a level of vibration that is just perceptible.
- 10.31. British Standard 7385: Part 2: 1993 ‘Evaluation and measurement for vibration in buildings – Guide to damage levels from ground borne vibration’ gives the limit values for transient vibration, above which cosmetic damage would occur; these are presented in **Table 10.3**. Minor damage is possible at vibration magnitudes more than twice those given in **Table 10.3** and major damage to a building structure may occur at values greater than four times the tabulated values.

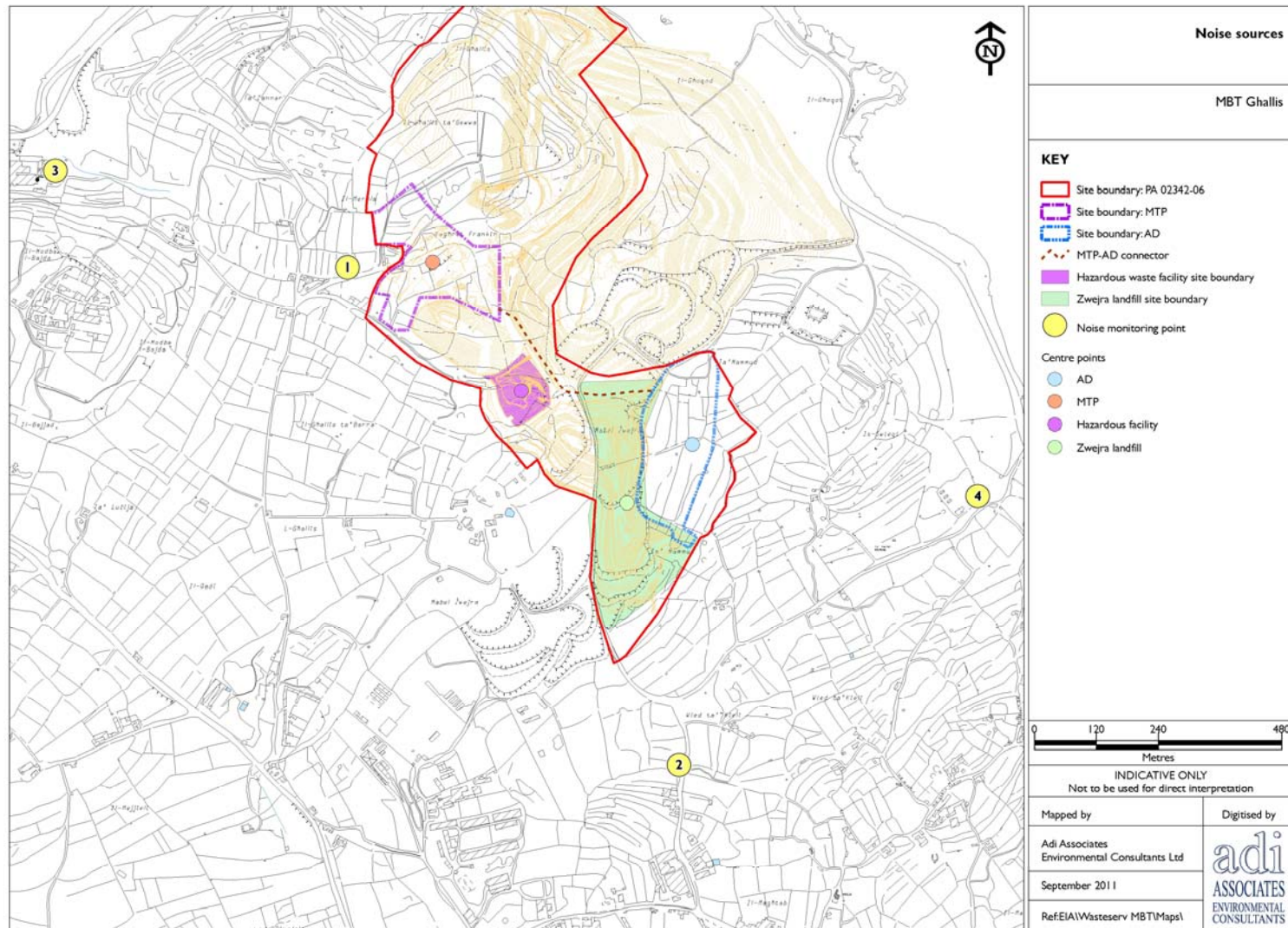
Table 10.3: Transient vibration guide values for cosmetic damage

| Type of building | Peak component particle velocity in frequency range of predominant pulse | |
|--|--|--|
| Unreinforced or light-framed structures such as residential or light commercial type buildings | 15mm/s at 4 Hz increasing to 20 mm/s at 15 Hz | 20 mm/s at 15 Hz increasing to 50 mm / s at 40 Hz |

- 10.32. For continuous vibration, the guide values given in **Table 10.3** should be reduced by 50%; cosmetic building damage could occur in residential or light commercial type buildings where levels of vibration above 7.5 mm/s from 4Hz upwards are measured.
- 10.33. MEPA makes reference to BS 6472:1984 when monitoring vibrations from excavations from neighbouring properties. This Standard assigns a threshold value of

0.3 mm/s for vibrations that are perceived by humans and peak particle values of between 12 to 19 mm/s as the threshold for cosmetic damage to buildings. These values are similar to those used in this assessment and those contained in BS 7385: Part 2: 1993.

Figure 10.1: Noise Monitoring Locations



BASELINE CONDITIONS: NOISE

Noise measurements

- 10.34. The actual sound level measurements for each location and predominant noise sources are shown in **Table 10.4**. The parameters measured were: LA_{eq} , LA_{max} , LA_{10} and LA_{90} . Although not shown in the table, $LA_{eq,60}$ (sixty minutes) is used for daytime studies while $LA_{eq,05}$ (five minutes) is used for night-time studies in accordance with BS4142:1997.

Table 10.4: Recorded sound levels

| Monitoring point | | L_{Aeq} | L_{Amax} | L_{A10} | L_{A90} | Predominant noise sources |
|------------------|-------|-----------|------------|-----------|-----------|---|
| 1 | Day | 58 | 89 | 56 | 39 | Mainly farm animals and a couple of cars |
| | Night | 39 | 53 | 40 | 35 | Distant traffic noise and dog barking |
| 2 | Day | 68 | 96 | 70 | 44 | Passing traffic |
| | Night | 56 | 77 | 56 | 38 | Traffic and distant generator or fan |
| 3 | Day | 53 | 81 | 50 | 41 | Passing traffic |
| | Night | 48 | 59 | 50 | 45 | Traffic on the Coast Road and music from across the Bay |
| 4 | Day | 70 | 95 | 73 | 40 | Passing traffic, mainly heavy vehicles |
| | Night | 58 | 79 | 54 | 34 | Local traffic |

- 10.35. The results indicate that the whole area is generally affected by traffic noise especially in locations 2 and 4.

BASELINE CONDITIONS: VIBRATION

- 10.36. Baseline vibration measurements were not undertaken for this particular assessment as this was not specifically required and was considered not to add value to the assessment. However, ambient vibration levels are anticipated to be typical for an urban location.

DETERMINING IMPACT SIGNIFICANCE

Noise

- 10.37. The following criteria have been used to assess the significance of impacts of the Scheme on the noise climate of the Area of Influence:

- **Not significant** (e.g. no material change in noise climate - a change of less than 3dB to the background noise levels);

- **Minor significance** (e.g. a change between 3 and 10dB to the background noise levels - such a change would be noticeable but would not usually give rise to widespread complaints);
- **Major significance** (e.g. a change of 10dB or higher to the background noise levels as predicted at the noise sensitive receptor - such a change is likely to adversely affect the sensitive noise receptors in the vicinity of the site, and give rise to widespread complaints).

10.38. **Table 10.5** provides an indication of the loudness of sound pressure levels measured in dB(A), in order to give an idea of typical noise levels.

Table 10.5: Equivalent dB(A) levels

| Noise environment | Typical dB(A) |
|--------------------|----------------|
| Library | 30 to 35 dB(A) |
| Living room | 40 to 45 dB(A) |
| Office | 60 to 65 dB(A) |
| Heavy road traffic | 75 to 80 dB(A) |
| Pneumatic drill | 100 dB(A) |

Source: Bruel & Kjaer chart

Vibration

10.39. The following criteria have been used to assess the significance of vibrations on the sensitive receptors of the Area of Influence:

- **Not significant** - no damage to buildings and no change to the structural integrity of the buildings and other structures; vibration levels not perceivable (PPV is less than 0.15 mm/s at the sensitive receptors);
- **Minor significance** - cosmetic damage to buildings and other structures but no change to the structural integrity of the buildings; vibration levels are perceivable for a long period of time (PPV would be between 0.15 mm/s and 0.3 mm/s - such levels would not usually give rise to complaints);
- **Major significance** - minor to major damage to buildings and other structures; vibration levels are disturbing (PPV would be greater than 0.3 mm/s - such levels are likely to give rise to complaints).

IMPACT ASSESSMENT: NOISE

Potential impacts

10.40. The potential impacts associated with the Scheme include noise disturbance during both construction and operation. It is noted that within the immediate vicinity of the site there are few sensitive receptors.

Prediction and significance of impacts

- 10.41. The modelling used to carry out noise predictions takes distance between source and receptor into consideration as an attenuation factor. It should be noted, however, that other factors such as prevalent winds and topography also play a part in noise attenuation. Thus, the EIA presents a worst case scenario in terms of noise climate at sensitive receptors.
- 10.42. The noise sources during the construction of the Scheme are:
- Plant used in the clearance and excavation of the Scheme site, including shovels, hydraulic hammers, bull dozers and HGV haulage; and
 - Plant used in the construction of the foundations and building, including tower cranes, concrete mixer trucks, mobile cranes, and HGV haulage.
- 10.43. Noise emissions occur during plant operation by delivery and treatment of waste. Sources of noise are:
- Approach and departure of waste / manure transporting vehicles;
 - Internal traffic (e. g. wheel loaders);
 - Operation of pre-treatment equipment in enclosed areas; and
 - Operation of AD equipment (e. g. agitators and blowers) and CHP.
- 10.44. Noise emissions from the Scheme site are assessed in respect of both construction and operation. Since excavation and construction will only be undertaken in daylight hours and the MBT will operate predominantly during normal working hours, consideration of night time noise emissions are not relevant.

Noise levels resulting from construction activities

- 10.45. Noise resulting from excavation and construction activities is likely to span the entire construction period that is likely to be on year. It is noted that the Scheme comprises mainly the construction at 2 separate sites, although within the boundary of the Ghallis Waste Management Complex. The construction of the MTP and the AD plant will take place concurrently. A preliminary programme indicates that site clearance and excavation will commence in August 2012 and will span 2 months for the MTP and 3 months of the AD plant. Construction on the MTP is scheduled to commence in October 2012 and end in July 2013, while the construction work on the AD plant will start in October 2012 and end in August 2013. It is noted that these dates are preliminary and will depend on the actual contractor that is assigned the tender to build the Scheme.
- 10.46. The level of sound production by construction plant is governed by EU Directive 2000/14/EC and Legal Notice 64 of 2002, which govern the maximum noise emissions in the environment by equipment used outdoors. Equipment sound-power levels must be declared, and quality-control procedures established, to ensure

continued compliance with the new legislation. Failure to comply with these Regulations may result in products being prohibited from the EU marketplace. The legislation restricts noise emissions from the type of plant likely to be deployed on the Scheme Site as set out in **Table 10.6**. It is also noted that the Environmental Management Construction Site Regulations, 2007 limit noise levels to 110dB, but do not specify whether the level relates to maximum, LAeq, or background levels, nor how the level is to be determined.

Table 10.6: Maximum noise levels for construction plant

| Source | Net installed power P (in kW) | Permissible sound power level in dB/1pW |
|---|-------------------------------|---|
| Tracked dozers, loaders and excavator loaders | $P \leq 55$ | 103 |
| | $P > 55$ | $84 + 11 \lg P$ |
| Excavators, builder's hoists for transportation of goods, construction winches. | $P \leq 15$ | 93 |
| | $P > 15$ | $80 + 11 \lg P$ |
| Hand held concrete breaker and picks | Mass ≤ 15 Kg | 105 |
| | Mass $> 15\text{Kg} < 30$ Kg | $92 + 11 \lg \text{Mass}$ |
| | Mass > 30 Kg | $94 + 11 \lg \text{Mass}$ |
| Tower crane | | $96 + \lg P$ |

10.47. The noise performance details set out in **Table 10.6** are not comprehensive and, while specifying the maximum permitted levels applicable to new plant, may not reflect the situation in Malta where plant is often purchased second hand and may no longer perform according to the manufacturer's specifications. It would be more relevant if the noise assessment took account of the noise levels usually generated by the plant. Sound power levels of used plant deployed in Malta were measured by Mediterranean Technical Services Ltd, which supplemented the EU data. These are described in **Tables 10.7 to 10.11**.

10.48. The predicted noise levels at the noise monitoring points (as agreed with MEPA) from the different facilities (MTP Plant, AD Plant, Ta Zwejra and the Hazardous Facility) are set out in **Tables 10.7 to 10.10**. In determining the distance from the noise source to the noise sensitive use, blank façades do not count. The distance is determined from the centre of the Scheme Site to the noise monitoring point. The plan distance is used and no screening is assumed. Attenuation of noise levels over distance are calculated in accordance with BS 4142:1997. Given that it is likely that works at the different facilities will be simultaneous, **Table 10.11** estimates the noise at each of the sensitive receptors assuming that works at the different facilities are concurrent.

Table 10.7: Predicted sound levels at noise sensitive receptors from construction of the MTP

| Source of Sound | S o u r c e (dB(A)) | Number on-site at one time | Estimated LAeq sound levels | | | |
|---------------------------|--------------------------|-------------------------------------|---------------------------------|----------------------------------|---------------------------------|-----------------------------------|
| | | | Assessment point 1: 165 m | Assessment point 2: 1,088m | Assessment point 3: 752 m | Assessment point 4: 1,152 m |
| | | | dB(A) | dB(A) | dB(A) | dB(A) |
| During Excavation | | | | | | |
| HGV (tipper trucks) | 109 | 5 | 71 | 55 | 58 | 54 |
| Mechanical shovel | 106 | 2 | 64 | 48 | 51 | 47 |
| Hydraulic hammers | 119 | 2 | 76 | 61 | 64 | 60 |
| Bulldozer with ripper | 109 | 1 | 64 | 48 | 51 | 47 |
| Predicted level this site | All plant simultaneously | | 77 | 62 | 65 | 61 |
| During Construction | | | | | | |
| Tower crane | 98 | 1 | 53 | 37 | 40 | 36 |
| Mobile crane | 98 | 2 | 56 | 40 | 43 | 39 |
| HGVs | 109 | 4 | 70 | 54 | 57 | 53 |
| Ready mix trucks | 100 | 3 | 60 | 44 | 47 | 43 |
| Predicted level this site | All plant simultaneously | | 71 | 55 | 58 | 54 |

Table 10.8: Predicted sound levels at noise sensitive receptors from construction of the AD plant

| Source of Sound | S o u r c e (dB(A)) | Number on-site at one time | Estimated LAeq sound levels | | | |
|-------------------------------|--------------------------|-------------------------------------|---------------------------------|--------------------------------|-----------------------------------|---------------------------------|
| | | | Assessment point 1: 752 m | Assessment point 2: 623m | Assessment point 3: 1,345 m | Assessment point 4: 563 m |
| | | | dB(A) | dB(A) | dB(A) | dB(A) |
| Removal of a number of trees | | | | | | |
| Mobile crane | 98 | 2 | 43 | 45 | 38 | 46 |
| HGV (trucks) | 109 | 4 | 57 | 59 | 52 | 60 |
| Mechanical shovel | 106 | 1 | 48 | 50 | 43 | 51 |
| Excavators (Backhoe) | 119 | 3 | 65 | 67 | 60 | 68 |
| Hand held concrete jiggers | 100 | 1 | 42 | 44 | 37 | 45 |
| Predicted level | All plant simultaneously | | 66 | 68 | 61 | 69 |
| Excavation | | | | | | |
| HGV (tipper trucks) | 109 | 8 | 60 | 62 | 55 | 63 |
| Mechanical shovel | 106 | 2 | 51 | 53 | 46 | 54 |
| Hydraulic hammers | 119 | 3 | 65 | 67 | 60 | 68 |
| Bulldozer with ripper | 109 | 1 | 51 | 53 | 46 | 54 |
| Predicted level this site | All plant simultaneously | | 66 | 68 | 61 | 69 |
| Construction | | | | | | |
| Tower crane | 98 | 2 | 43 | 45 | 38 | 46 |
| Mobile crane | 98 | 2 | 43 | 45 | 38 | 46 |
| HGVs | 109 | 4 | 57 | 59 | 52 | 60 |
| Ready mix trucks | 100 | 3 | 47 | 49 | 42 | 50 |
| Predicted level this site | All plant simultaneously | | 58 | 60 | 52 | 61 |
| Current LAeq levels | | | 58 | 68 | 53 | 70 |

Table 10.9: Predicted sound levels at noise sensitive receptors from construction of the Hazardous facility

| Source of Sound | S o u r c e (dB(A)) | Number on-site at one time | Estimated LAeq sound levels | | | |
|-----------------------|--------------------------|-------------------------------------|---------------------------------|--------------------------------|-----------------------------------|---------------------------------|
| | | | Assessment point 1: 414 m | Assessment point 2: 788m | Assessment point 3: 1,000 m | Assessment point 4: 909 m |
| | | | dB(A) | dB(A) | dB(A) | dB(A) |
| HGV (tipper trucks) | 109 | 5 | 63 | 58 | 56 | 56 |
| Mechanical shovel | 106 | 2 | 56 | 51 | 49 | 49 |
| Hydraulic hammers | 119 | 2 | 69 | 64 | 62 | 62 |
| Bulldozer with ripper | 109 | 1 | 56 | 51 | 49 | 49 |
| Predicted level | All plant simultaneously | | 70 | 65 | 63 | 63 |
| Construction | | | | | | |
| Tower crane | 98 | 1 | 45 | 40 | 38 | 38 |
| Mobile crane | 98 | 2 | 48 | 43 | 41 | 41 |
| HGVs | 109 | 4 | 62 | 57 | 55 | 55 |
| Ready mix trucks | 100 | 3 | 52 | 47 | 45 | 45 |
| Predicted level | All plant simultaneously | | 63 | 58 | 55 | 55 |
| Current LAeq levels | | | 58 | 68 | 53 | 70 |

Table 10.10: Predicted sound levels at noise sensitive receptors from construction of the Zwejra facility

| Source of Sound | S o u r c e (dB(A)) | Number on-site at one time | Estimated LAeq sound levels | | | |
|----------------------------|--------------------------|-------------------------------------|---------------------------------|--------------------------------|-----------------------------------|---------------------------------|
| | | | Assessment point 1: 711 m | Assessment point 2: 518m | Assessment point 3: 1,283 m | Assessment point 4: 681 m |
| | | | dB(A) | dB(A) | dB(A) | dB(A) |
| Vertical Boring machine | 85 | 2 | 31 | 33 | 25 | 31 |
| HGV (tipper trucks) | 109 | 1 | 52 | 54 | 46 | 52 |
| Bulldozer with ripper | 109 | 1 | 52 | 54 | 46 | 52 |
| Predicted level | All plant simultaneously | | 55 | 57 | 49 | 55 |
| Current LAeq levels | | | 58 | 68 | 53 | 70 |

Table 10.11: Cumulative impacts at noise sensitive receptors

| Source of Sound | Estimated LAeq sound levels | | | |
|--|-----------------------------|--------------------------|-----------------------------|---------------------------|
| | Assessment point 1: 711 m | Assessment point 2: 518m | Assessment point 3: 1,283 m | Assessment point 4: 681 m |
| | dB(A) | dB(A) | dB(A) | dB(A) |
| Excavation Phase | | | | |
| MTP only | 31 | 33 | 25 | 31 |
| AD only | 52 | 54 | 46 | 52 |
| Hazardous only | 52 | 54 | 46 | 52 |
| Ta' Zwejra only | 55 | 57 | 49 | 55 |
| Concurrent AD, MTP, Ta' Zwejra and Hazardous | 78 | 71 | 68 | 71 |
| Current LA_{eq} levels | 58 | 68 | 53 | 70 |
| Construction Phase | | | | |
| MTP only | 71 | 69 | 59 | 70 |
| AD only | 61 | 71 | 56 | 73 |
| Hazardous only | 64 | 68 | 57 | 70 |
| Ta' Zwejra only | 60 | 68 | 55 | 70 |
| Concurrent AD, MTP, Ta' Zwejra and Hazardous | 72 | 69 | 61 | 70 |
| Current LA_{eq} levels | 58 | 68 | 53 | 70 |

10.49. The significance of the predicted noise levels at the boundaries / buildings of noise sensitive receptors, as indicated above is determined through reference to the predicted change in background noise levels.

Impacts at each of the noise assessment points

10.50. At the noise assessment points described in **Figure 10.1**, LAeq sound levels resulting from the excavation for the MTP and AD Plant is predicted to be between 68dB(A) (at monitoring point 3) and 78dB(A) (at monitoring point 1). Noise levels during construction are likely to be lower and range between 61 dB(A) (at monitoring point 3) and 72dB(A) (at monitoring point 1).

10.51. The values given in **Table 10.11** represent a worst case scenario as they assume that excavation and construction of the MTP and AD Plant will be concurrent with the construction of the hazardous facility and the capping of Ta' Zwejra landfill; they also assume no attenuation factors other than distance. Given this the table clearly shows that during the excavation phase there is a major impact on sensitive receptors 1 and 3 that is on the hamlet to the west of the MTP and at the Coastline Hotel respectively. A similar impact would be expected at the buildings to the west of receptor 1. It is noted that the duration of the excavation phase is a maximum of 3 months. A minor impact on sensitive receptor 2 is predicted while there is no significant impact on receptor 4.

- 10.52. With regards to the construction phase of the MTP and AD Plant, a major impact is anticipated at sensitive receptor 1 a minor impact on the Coastline Hotel is predicted. There is no significant impact on receptors 2 and 4.

Operational noise

Traffic

- 10.53. The Project Description Statement prepared for the Scheme states that currently 340 vehicles per day arrive to the facilities at Ghallis. Once the Sant'Antnin Facility will be fully operational 30% of the waste will be diverted there, resulting in a decrease in 102 vehicles per day arriving at Ghallis.
- 10.54. The development of the MBT is expected to generate an additional 140 vehicles per day (100 vehicles carrying manure MBT input and output material and 40 vehicles carrying the output product from the municipal waste MBT). Considering the situation (when Sant'Antnin is operational) the net increase in traffic to Ghallis is 38 vehicles per day (140-102). However, the additional 140 vehicles will be reduced by 50 vehicles if the output (water) from the manure treatment facility is used to irrigate Maghtab and the surrounding area. This would effectively reduce daily trips to less than 340, less than the current baseline.
- 10.55. Since a doubling of traffic flows is required to effect a 3dB(A) change in background noise levels, the additional traffic from the Scheme is unlikely to result in a substantial increase in background noise levels, rendering the impact at sensitive receptors not significant.

Operations

- 10.56. **Figures 10.2 and 10.3** provide an estimate of the sound levels in the MTP and AD Plant. The cumulative sound level within the MTP shed is estimated at 80 dB(A). Given that the equipment is enclosed in a shed, an attenuation of 15 dB(A) is assumed resulting in noise at the boundary of 65 dB(A). Other machinery operating is a bulldozer and external plant that have a sound level of 75 dB(A) and 84 dB(A) respectively. The combined noise at the MTP site is therefore 85 dB(A). Given the distance of the sensitive receptors it is estimated that the operational noise dissipates to background level at each of the sensitive receptors rendering the impact not significant.
- 10.57. The noise level at the boundary of the AD Plant is estimated at 68 dB(A). The noise at the sensitive receptors as a result of the AD Plant is not significant because it dissipates to levels that are no higher than the background noise.
- 10.58. The combined noise from the operation of the AD Plant and the MTP is also below background at the sensitive receptors rendering the impact not significant.

Figure 10.2: Sound levels within the MTP

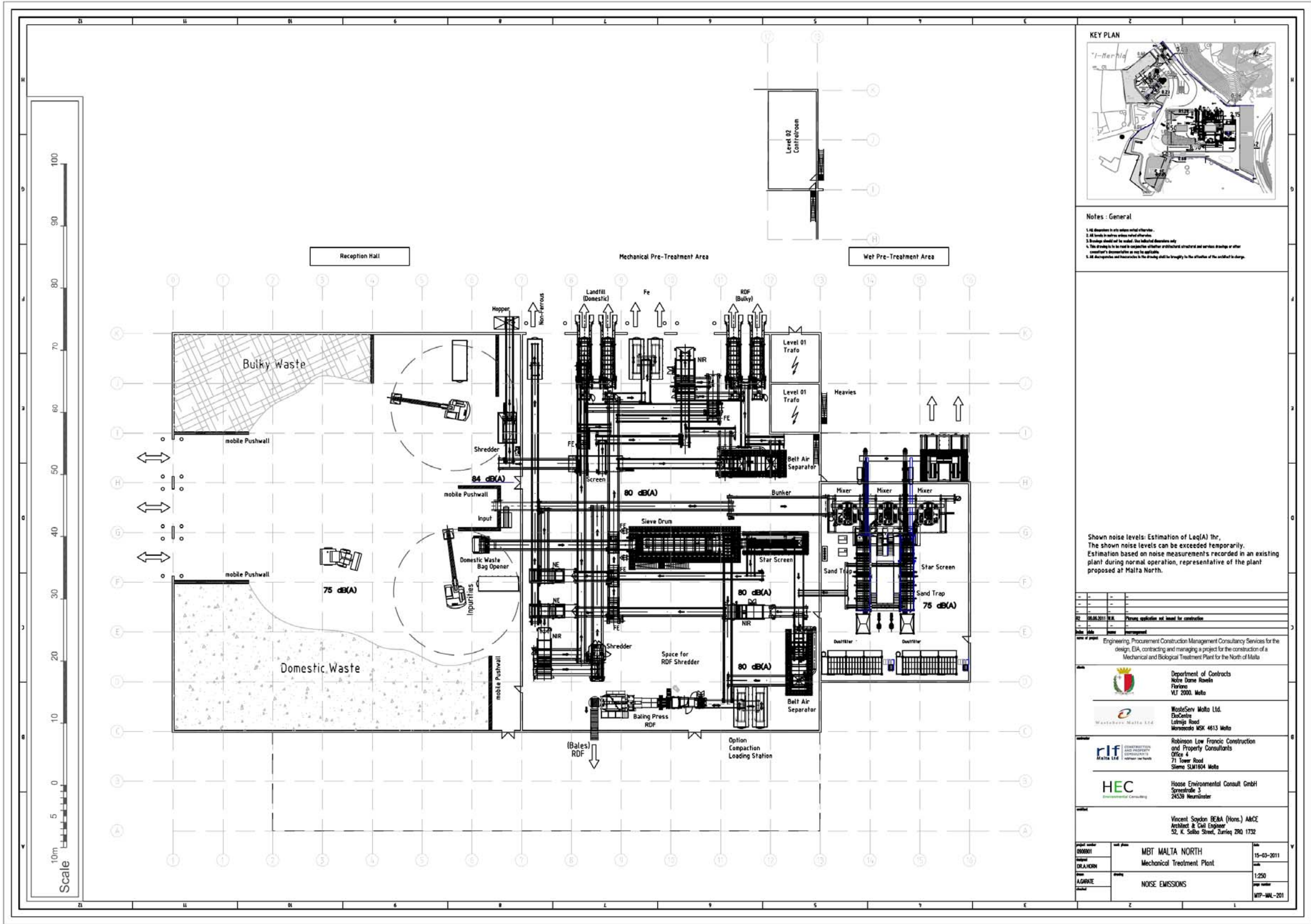
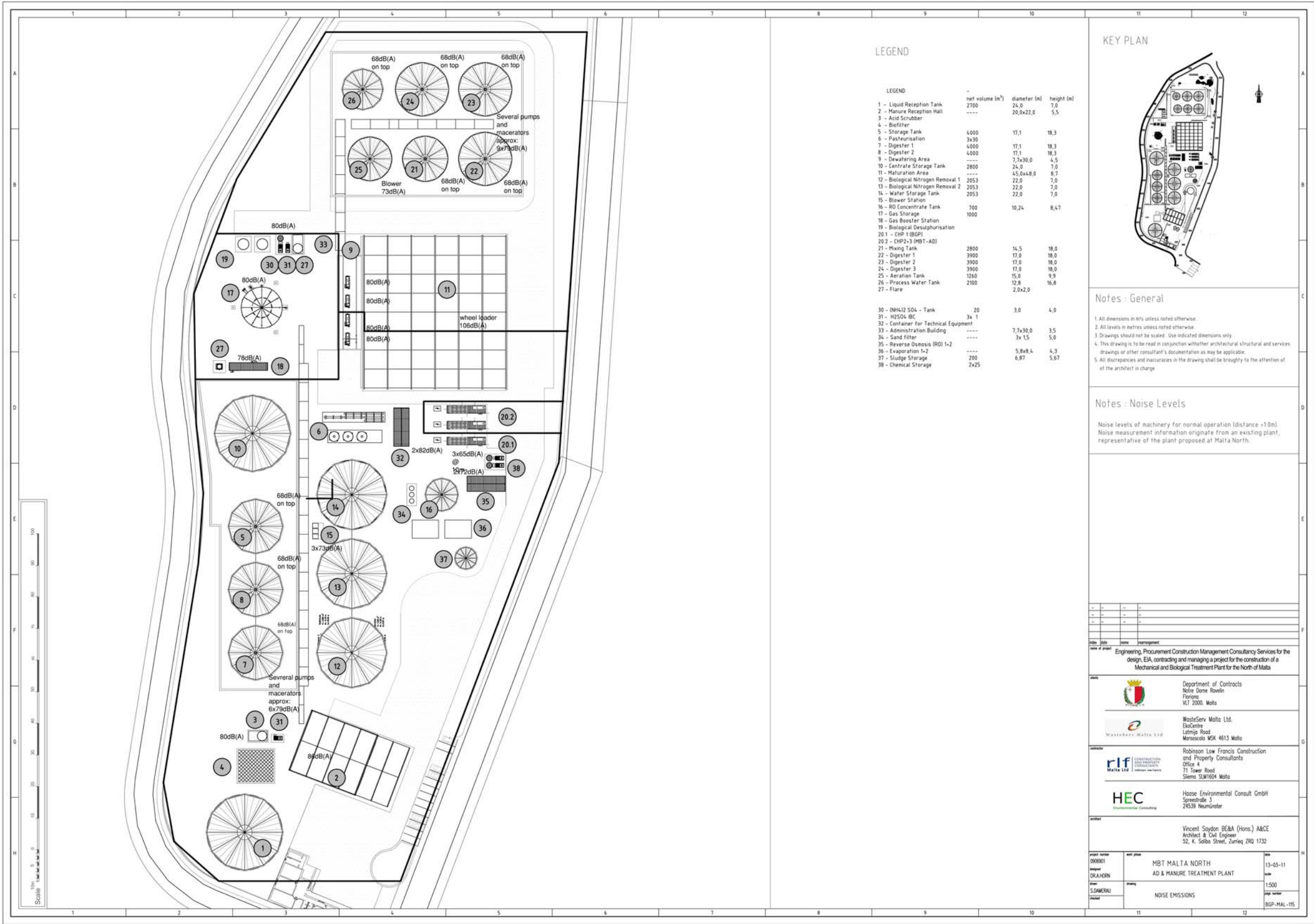


Figure 10.3: Sound levels within the AD Plant



IMPACT ASSESSMENT: VIBRATION

Potential impacts

10.59. The potential impacts associated with the Scheme include:

- Impacts on the structural integrity of surrounding buildings and structures such as boundary walls; and
- Vibration disturbance to the residents in the properties near the development during construction.

10.60. The operation of the Scheme is not expected to generate vibration additional to that which is expected in urban areas.

Prediction and significance of impacts

10.61. The vibration sources during the construction of the Scheme are similar to the noise generating ones, i.e., plant used in excavation and plant used in the construction of the foundations and the buildings.

10.62. Since construction will only be undertaken in daylight hours, the assessment of night time vibration impacts is not relevant and will not be addressed.

Impacts on the structural integrity of surrounding buildings and structures

10.63. Excavation and new foundation work are common sources of vibrations that can affect adjacent structures. The plant and methods used in such works produce vibrations that may be transmitted to adjacent structures. Vibrations may also be caused by increased truck traffic accompanying excavation and construction work. In all cases, the strength of the vibrations reaching the adjacent structure depends upon the activity generating the vibrations, the distance between the source and the existing structure, and the type of ground found between the two. The susceptibility of adjacent buildings to vibrations may be increased due to deferred maintenance and past alterations that may have produced structural weak points. Plaster walls and ceilings lack the flexibility to accommodate abnormal movement, while shallow foundations (common in old buildings) may lack the rigidity to resist vibration induced movement.

10.64. Excavation and foundation work can also cause ground displacement and movement of an adjacent building. New construction almost invariably calls for foundations much deeper than those of neighbouring buildings. This is especially true for projects that include underground parking facilities. A structure with a shallow masonry or stone foundation and wall footings may experience corresponding displacement that can result in major structural damage.

10.65. British Standard 7385:Part 2:1993 'Evaluation and measurement for vibration in buildings – Guide to damage levels from ground borne vibration' gives the limit values

for transient vibration, above which cosmetic damage, minor damage, and major damage would occur (see **Table 10.3**).

- 10.66. The potential sources of vibration are likely to be associated with excavation, which tend to generate transient peaks. Plant such as compressors, pumps, generators, and trucks can emit significant levels of low frequency noise, which can cause resonance in nearby buildings, usually perceived as vibration by occupants. Care is needed in the positioning of such equipment.
- 10.67. The Scheme lies within the boundary of the Ghallis Waste Management complex; there are no buildings immediately adjacent to the Site (of the MTP and AD Plant).
- 10.68. The general / over site excavation works will be carried out by a bulldozer-mounted ripper and two excavator-mounted pneumatic hammers each supported by a shovel. No explosives will be used.
- 10.69. Vibration monitoring data for excavations elsewhere in Malta shows that the PPV at a distance of 15 metres from the monitoring point to the impact hammer was a maximum of 2.93 mm/s; at a distance of 7 metres this increases to a maximum of 14.89 mm/s. It is noted that such measurements were taken at a site where excavation was by means of hydraulic hammers and that excavation was not preceded by the excavation of a trench either around the entire site or at least between the measurement point and the excavation point.
- 10.70. In view of the fact that at 7 metres the vibration was found to be lower than the 15 mm/s value prescribed by BS 7385:Part 2:1993, and given that there are no third party buildings within this area, the impact of vibrations on the stability of the latter buildings is likely to be not significant.

Impacts of vibrations on residents of surrounding buildings

- 10.71. The impact of vibrations on residents depends on the distance of the source of the vibration from the receptor. **Table 10.3** shows that at a distance of 20 metres between the sensitive receptor and the excavation equipment, vibration is just perceptible. Given that there are no sensitive receptors within 20 metres of the MTP site and the AD plant, then vibration arising from excavations is not likely to be perceptible at such properties, and is judged to be not significant.

MITIGATION

- 10.72. The implementation of the Environmental Management Construction Site Regulations, 2007 would help reduce noise levels. Excavation and construction activities should be detailed in a Construction Management Plan that would consider noise at the sensitive receptors.

RESIDUAL IMPACTS

- 10.73. It is anticipated that noise arising from excavation and construction activities will extend over the duration of the construction period. Such residual impacts will be

significant at sensitive receptors 1 and 3 as described above **Table 10.9** contains a summary of the impacts including residual impacts..

Table 10.12: Summary of noise and vibration impacts

| Predicted Impact | Beneficial / Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact | Proposed Mitigation Measures | Significance of Residual Impact |
|---|----------------------|----------------------------------|-------------------------------------|------------------|------------------------|------------|------------------|-------------------|---------------------------------|---|---|---|
| | | Excav'n / Constr'n / Oper'n | Extent of impact (Nat/ Local/ Site) | Direct/ Indirect | Short term / Long term | Perm/ Temp | Revers/ Irrevers | | | | | |
| Construction noise impact on sensitive receptors | Adverse | Excavation & Constr'n | Local | Direct | Short | Temp | Revers. | Local | Likely | Major to not significant depending on sensitive receptor location | Implementation of Environmental Management Construction Site Regulations, 2007 and formulation of a CMP | Major to not significant depending on sensitive receptor location |
| Impacts of operational traffic noise on sensitive receptors | Adverse | Oper'n | Local | Direct | Long | Perm | Revers. | Local | Likely | Not significant | None required | Not significant |
| Impact of operation of the Scheme | Adverse | Oper'n | Local | Direct | Long | Perm | Revers. | Local | Likely | Not significant | None required | Not significant |
| Impact of vibrations on structural integrity of surrounding buildings | Adverse | Excavation & construction | Local | Direct | Short | Temp | Revers. | Local | Likely | Not significant | None required | Not significant |

II. EMISSIONS TO AIR

INTRODUCTION

- II.1. The purpose of this chapter is to assess the impacts of the Scheme on air quality.
- II.2. This assessment draws on the report prepared by Mr David Harvey concerning air emissions and odour (see **Technical Appendix 6: Air Quality and Odour Assessment**).
- II.3. The potential key issues associated with the Scheme are outlined below:

Key Issues

- Effects of emissions arising from construction of the Scheme on sensitive receptors
- Effects of emissions arising from the operation of the Scheme on sensitive receptors

Terms of reference

- II.4. As this is an update to an existing EIA, MEPA has not issued formal Terms of Reference. The following guidelines have been issued by MEPA:

The EIS Update shall focus on the following:

- 1. Project description i.e. the EIS update shall include a description of the additional proposed facilities that will be included within the development site including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;*
- 2. Alternatives (sites, layouts and technologies) as relevant;*
- 3. Landscape and visual amenity assessment;*
- 4. Transport;*
- 5. Noise and vibration;*
- 6. Air quality;*
- 7. Waste management issues; and*
- 8. Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.*

In addition to the above, the consultant/s is to verify whether as a result of the proposal, the impact significance for the following environmental

characteristics outlined below (as presented in the EIS Sections for PA 04834/04), would require an update:

- 1. Geology, hydrology and palaeontology;*
- 2. Agriculture;*
- 3. Archaeology and cultural heritage;*
- 4. Social impact;*
- 5. Land contamination;*
- 6. Risk assessment; and,*
- 7. Cumulative impacts.*

ASSESSMENT METHODOLOGY

11.5. Emissions that are pertinent to the development of the Scheme are:

- Construction emissions – primarily dust; and
- Operational emissions – activities.

11.6. An Air Quality Method Statement was submitted to MEPA on 6th October 2010⁹ and an Odour Method Statement was submitted to MEPA on 27th May 2011¹⁰. Both Method Statements were accepted by MEPA. These Method Statements are included in **Technical Appendix I: Terms of Reference and Method Statements**.

Odour

- 11.7. Human response to odour is very subjective; some people are particularly sensitive to odours and may object at odour concentrations that other people are not able to detect.
- 11.8. The detection of an odour may or may not cause annoyance. The concentrations of any particular substance or group of substances that can be detected by an individual depends on a number of factors which vary from individual to individual and can change for each individual depending on, for example, frequency of exposure. People with no sense of smell have a condition called anosmia and those with an abnormally acute sense of smell are hypersensitive, about 2% of the population fall into each of these categories.
- 11.9. The odour detection threshold of an odour is its concentration when 50% of an odour panel are able to detect the odour. At a higher concentration, the odour

⁹ E-mail correspondence between Rachel Xuereb (Adi Associates) and Charlene Smith.

¹⁰ E-mail correspondence between Krista Farrugia (Adi Associates) and Charlene Smith.

recognition threshold is where 50% of the panel are able to describe the characteristics of the odour.

11.10. The following sensory characteristics can be used to describe odours and are factors that together with frequency and duration of odour detection determine whether an odour may cause annoyance.

- **Hedonic Tone:** this is an individual's judgement of the relative pleasantness or unpleasantness of an odour.
- **Quality/Characteristics:** This is a qualitative attribute which is expressed in terms of 'descriptors' such as 'fruity' or 'fishy'.
- **Concentrations:** The odour concentrations can be expressed as a mass or volume fraction (mg m^{-3} or ppb) if it is a single odorous compound. More frequently the odour concentration is expressed as OU or $\text{OU}_e \text{ m}^{-3}$. The 'e' subscript is reference to the European Odour Unit and reference method for its measurement. An OU is a ratio: it is the number of times an odour sample needs to be diluted such that 50% of an odour panel are unable to detect it. An $\text{OU}_e \text{ m}^{-3}$ is the equivalent odour strength of 1 OU of a reference odorant (123 μg of n-butanol) when evaporated into 1 m^3 of odourless gas at standard conditions.
- **Intensity:** This is a subjective measure of the strength or intensity of an odour. Intensity usually increases with increasing concentrations but often in a non-linear manner and the scale is usually from faint to strong.

11.11. An important characteristic of odour is odour fatigue or adaption, which can take a number of different forms, as described in the UK's Environment Agency's Odour Guidance for landfills¹¹.

At one extreme there is the action of gases such as hydrogen sulphide. In hazardous concentrations, the first action of hydrogen sulphide is to paralyse the olfactory nerves rendering the nose unable to detect its rotten egg odour, thus increasing the hazardous potential.

At a different level, it is likely that if you wear perfume or aftershave you will quickly become unaware of the perfume given off by your own toiletry. However, you are still likely to be aware of the perfume given off by the toiletry being worn by someone passing close to you and vice versa.

In the same way, people working in an odorous situation, such as a waste management facility, will quickly become unaware of their

11 Environment Agency (2002) Odour Guidance; Internal Guidance for regulation of Odour at Waste Management Facilities.

odorous surrounding possibly to the extent that they are unable to detect regular odours.

- 11.12. Odour can be detected over a time period of a few seconds and may cause annoyance if the smell is offensive and/or reoccurring. Predictions of short-time periods present significant problems for dispersion models as they are not able readily or reliably to predict concentrations with an averaging period of less than about one hour. This is in part due to the fact that the meteorological data used are hourly average data and in part due to assumptions about dispersion made by most models, which are not appropriate for short averaging periods. To overcome these difficulties, a number of approaches to the modelling of odours and determination of odour annoyance have been developed.
- 11.13. There are no legal standards for odours, the most common standard for odour annoyance is in terms of the 98th percentile of hourly average odour concentrations, which has been widely used with a threshold in the range of 1 to 10 $\text{OU}_e \text{ m}^{-3}$ set as the criterion.
- 11.14. The UK's Environment Agency's guidance on odour management advocates the prediction of the 98th percentile of hourly average odour concentrations (over a year) and suggests a range of benchmarks depending on the nature of the odour source¹². The benchmarks are thresholds of unacceptable pollution.
- 11.15. The Pollution Prevention and Control (England & Wales) Regulations 2000 (the IPPC Regulations") define *pollution as emissions as a result of human activity which may be harmful to human health or the quality of the environment, cause offence to any human senses, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment.*
- 11.16. The UK's Environment Agency suggests a range of benchmarks for unacceptable pollution as shown below.
- 1.5 $\text{OU}_e \text{ m}^{-3}$ 98th Percentile of Hourly Averages for 'most offensive' odours;
 - 3.0 $\text{OU}_e \text{ m}^{-3}$ 98th Percentile of Hourly Averages for 'moderately offensive' odours; and
 - 6.0 $\text{OU}_e \text{ m}^{-3}$ 98th Percentile of Hourly Averages for 'less offensive' odours.
- 11.17. **Table 11.1** shows the UK's Environment Agency examples a range of odours.

12 Environment Agency (March 2011) H4 – Odour Management.

Table 11.1 UK Environment Agency - odour characterisation

| Category | Examples |
|---|--|
| Most Offensive | Processes involving decaying animal or fish remains Processes involving septic effluent or sludge Biological landfill odours |
| Moderately Offensive | Intensive livestock rearing Fat frying (food processing) Sugar beet processing Well aerated green waste composting |
| Less Offensive | Brewery Confectionery Coffee roasting Bakery |
| Most odours from processes fall into the latter category i.e. any odours, which do not obviously fall within the 'most offensive' or 'less offensive' categories. | |

- 11.18. The odour emissions from the biofilters are different in character to the raw gas/pig odour and can be described as 'damp wood', which is considered to fall into the 'less offensive' category. However, for the purpose of this assessment a benchmark in the range of $3 \text{ OU}_e \text{ m}^{-3}$ 98th percentile of hourly averages is used for emissions from the biofilters. It is considered that this is a conservative assessment criterion to use.

Operational emissions

Biogas engines

- 11.19. The source of the principle operational emissions will be from the three 1.0 MWe biogas fuelled CHP engines, emitting oxides of nitrogen (NO_x).
- 11.20. **Table 11.2** presents the air quality standards and guidelines for nitrogen dioxide (NO_2) used in this assessment.

Table 11.2: EU Directive Limit Value for Nitrogen Dioxide (NO_2 , $\mu\text{g m}^{-3}$)

| Averaging Period | Annual Average | 99.8 th Percentile of Hourly Averages |
|------------------|----------------|--|
| Value | 40 | 200 (allows for 18 exceedances per year) |

- 11.21. **Table 11.3** shows the parameters that describe the physical properties of emissions from each of the three proposed biogas engines, as required for definition of the emissions in dispersion modelling terms. These data are the best estimate of the emissions rate with the units operating at their emissions limit.

Table 11.3: Biogas engines emissions and physical properties

| Parameter | Value | |
|--|----------|-----------|
| Number of stacks | 3 | |
| Number of units | 3 | |
| UTM Grid Reference (m) – Stack 1 | 449725.0 | 3977805.1 |
| UTM Grid Reference (m) – Stack 2 | 449725.0 | 3977795.1 |
| UTM Grid Reference (m) – Stack 3 | 449725.0 | 3977800.1 |
| Number of flues per stack | 1 | |
| Release height above ground level (m) | 15 | |
| Exhaust gas oxygen content (% v/v dry) | 5 | |
| Exhaust gas water content (% v/v) | 11.5 | |
| Exit diameter (m) | 0.35 | |
| Exit velocity (m s ⁻¹) | 19.9 | |
| Flue gas emission temperature (deg C) | 150 | |
| Actual volumetric flow rate for each unit (Am ³ s ⁻¹) | 1.79 | |
| Normalised volumetric flow for each unit (Nm ³ s ⁻¹) ^(a) | 1.22 | |
| Emission Concentration (mg Nm ⁻³) ^(a) | | |
| Oxides of nitrogen (NO _x as NO ₂) | 500 | |
| Pollutant Emission Rate per Unit (g s ⁻¹) | | |
| Oxides of nitrogen (NO _x as NO ₂) | 0.55 | |
| Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 5% v/v O ₂ . | | |

Biofilters

- 11.22. The location of the two biofilters on the site of the proposed facility (A1 and A3) is shown in **Figure 11.1**.
- 11.23. It is important to note that the character of the odour changes as it passes through the biofilters. The odours released to atmosphere from the biofilters smell of damp wood and are therefore much more pleasant than the odours extracted from the waste handling facility.
- 11.24. With the exception of the service building and biofilters, there are no other potential sources of routine odour emissions to atmosphere as all aspects of the process are sealed from the atmosphere. Full details of the mitigation measures that will be employed to contain odours will be presented in the application for an IPPC permit and are not reproduced here other than a brief summary presented in the mitigation section within this chapter.
- 11.25. **Table 11.4** shows the emissions data for the two biofilters.

Table 11.4 Biofilters emissions data

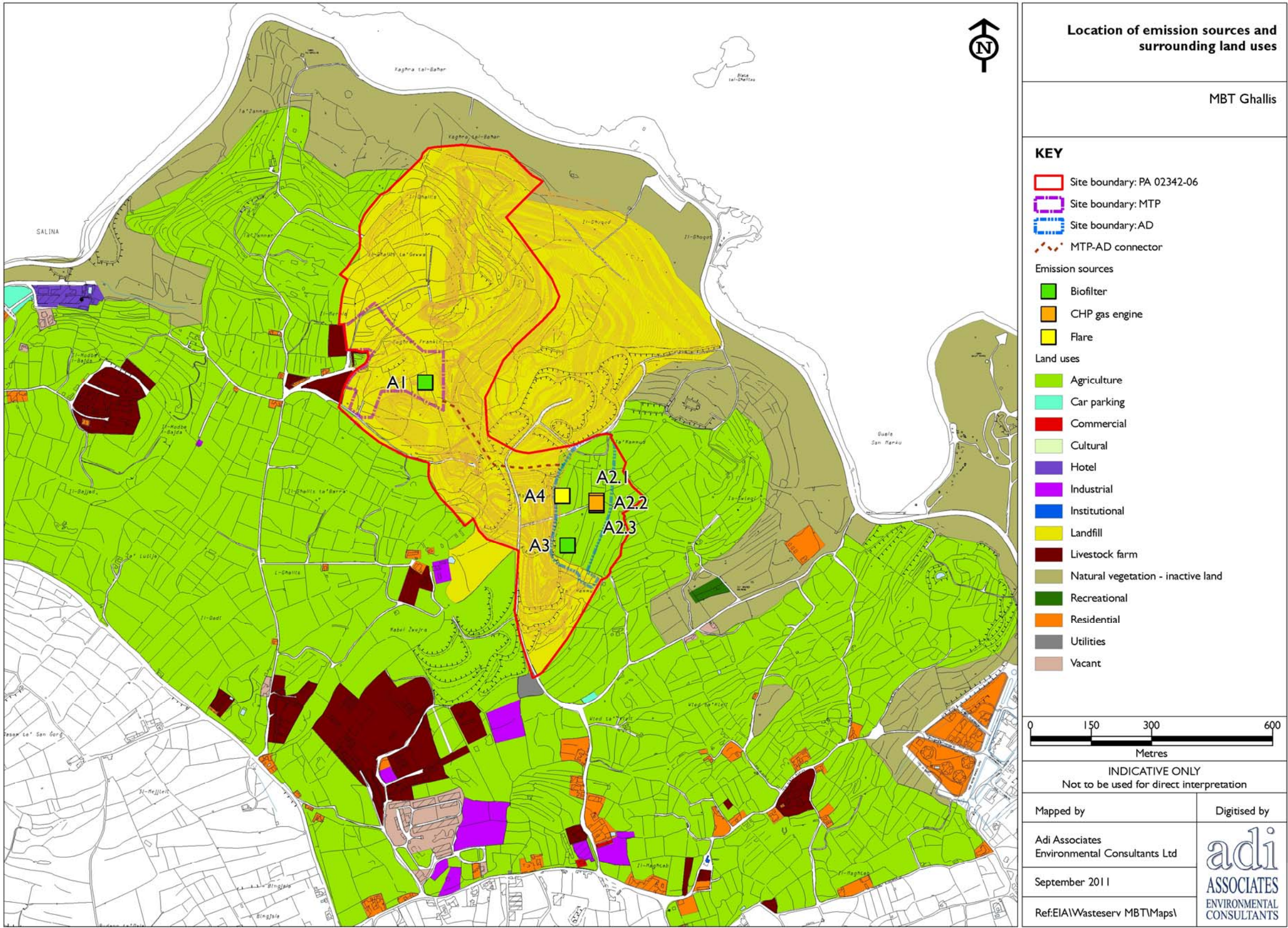
| Source Number | Dimensions (m) | Flow Rate ($\text{m}^3 \text{hr}^{-1}$) | Emission Rate Odour ^(a) | |
|---|----------------|---|------------------------------------|---|
| | | | ($\text{OU}_e \text{s}^{-1}$) | ($\text{OU}_e \text{m}^{-2} \text{s}^{-1}$) |
| A1 | 20 x 20 | 92 000 | 12 778 | 32 |
| A3 | 11 x 12 | 13 000 | 1 806 | 14 |
| Odour concentration 500 $\text{OU}_e \text{m}^{-3}$. | | | | |

-
- 11.26. It should be noted that the modelling conservatively assumes a constant flow rate whereas night time flow rate will be about 50% of the day time values shown in **Table 11.3**.

Dust emissions

- 11.27. Although dust emissions from the Scheme Site should ideally be determined in respect of background concentrations of dust (mg/m^3) and dust deposition ($\text{mg}/\text{m}^2/\text{day}$), the collection of dust data and estimation of dust entrainment present considerable difficulties, as acknowledged by MEPA in respect of a number of EIAs and other studies prepared by the consultants in the past. Assessment of dust emissions requires long term atmospheric dust concentration and deposition data; such data are not available for monitoring points in the general vicinity of the Scheme Site. Nonetheless, a discussion on dust emissions and potential sensitive receptors is presented later in this chapter.

Figure 11.1: Location of sources of emissions to atmosphere and land use



Receptors

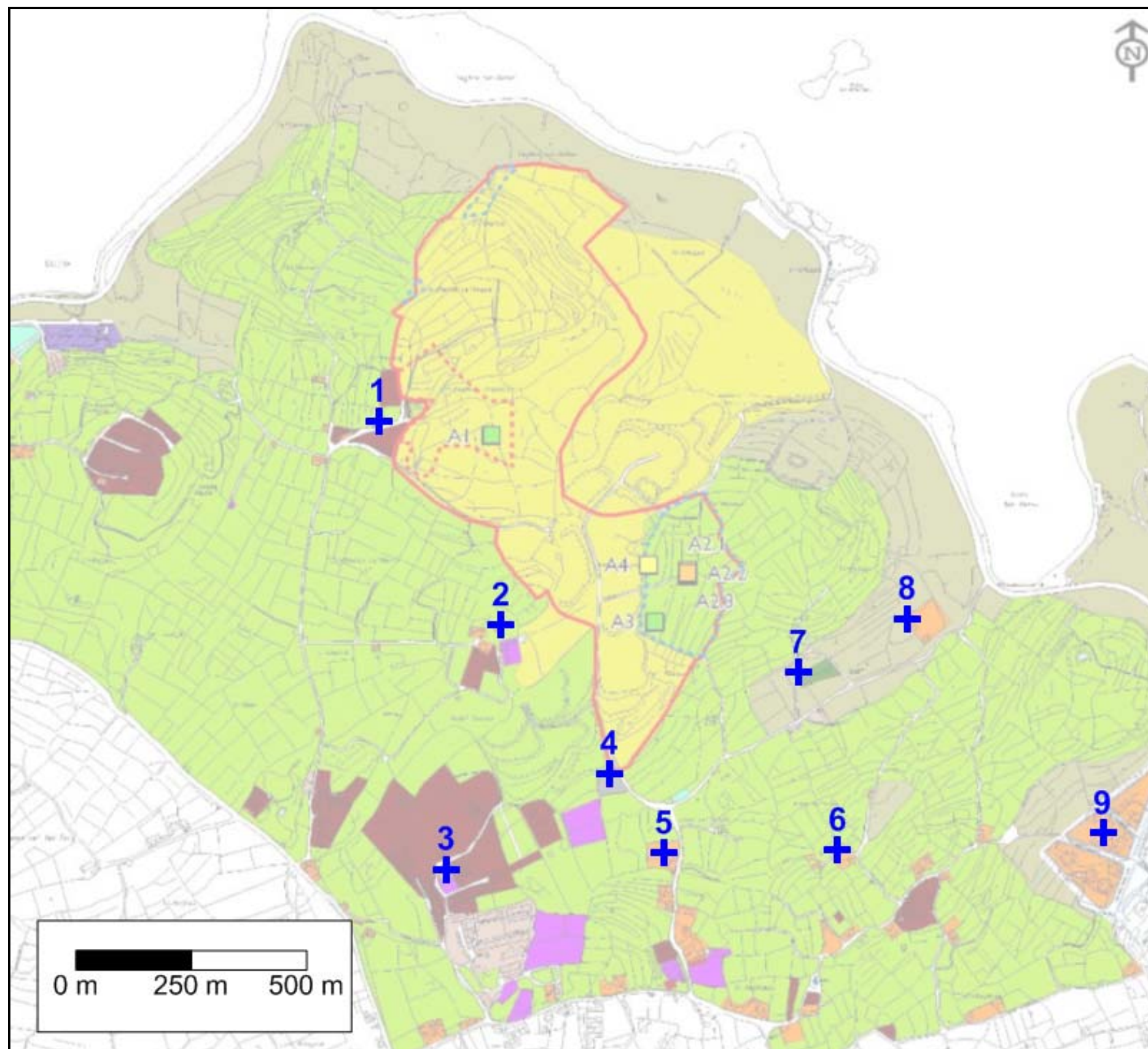
- 11.28. The focus of this assessment of the impacts of emissions from the proposed facility will be of the effects at the closest receptors, which are selected to be representative of those that will be most affected by the proposed development, and are residential, recreational and the hotel.
- 11.29. **Table 11.5** presents details of the specific receptors included in the modelling.

Table 11.5: Receptor locations

| Number | Description | UTM Grid Reference (m) | |
|--------|--------------|------------------------|---------|
| 1 | Residential | 449055 | 3978128 |
| 2 | Residential | 449321 | 3977687 |
| 3 | Residential | 449202 | 3977158 |
| 4 | Hotel | 449556 | 3977365 |
| 5 | Residential | 449674 | 3977193 |
| 6 | Residential | 450051 | 3977199 |
| 7 | Recreational | 449966 | 3977584 |
| 8 | Residential | 450202 | 3977701 |
| 9 | Residential | 450626 | 3977236 |

- 11.30. **Figure 11.2** shows the location of the specific receptors used in this assessment.
- 11.31. To determine the distribution of ground level concentrations occurring due to emissions to atmosphere from the proposed gas engines and the distribution of emissions from the biofilters, predictions are made for a grid of receptors. The receptor grid is 2,500 m by 2,300 m with grid spacing of 100 m.

Figure 11.2: Location of sensitive receptors



Factors affecting dispersion

11.32. There are a number of factors that will affect how emissions disperse once released to atmosphere. The four factors having the greatest effect on dispersion are:

- Physical characteristics of the emissions;
- Climate;
- Building downwash; and
- Nature of the surface.

Physical characteristics of the emissions

11.33. Provided that the engine exhaust gases have sufficient velocity at stack exit to overcome the effects of stack tip downwash, which is almost certainly the case for velocities of 15 ms^{-1} or more, the physical characteristics of the flue gases will determine the amount of plume rise and hence the affect on ground level pollutant concentrations. The degree of plume rise usually depends on the greater of the thermal buoyancy or momentum effects. In the case of emissions from the gas engines, with an exhaust gas exit temperature greater than 150°C , it is likely to be the thermal buoyancy effects that determine how high the plume will eventually rise.

11.34. For emissions from the biofilters, the modelling assumes no thermal or momentum driven plume rise.

Climate

11.35. The most important meteorological parameters governing the atmospheric dispersion of pollutants are:

- Wind direction: determines the broad transport of the plume and the sector of the compass into which the plume is dispersed;
- Wind speed can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise; and
- Atmospheric stability is a measure of the turbulence of the air, particularly of the vertical motions present. For dispersion modelling purposes, one method of classifying stability is by the use of Pasquill Stability categories, A to F. Another is by reference to the surface heat flux present at the ground.

11.36. Dispersion models, such as ADMS and AERMOD, do not allocate the degree of atmospheric turbulence into six discrete categories. These models use a parameter known as the Monin-Obukhov length which, together with the wind speed, describes the stability of the atmosphere.

Building downwash

- 11.37. The presence of buildings can significantly affect the dispersion of the atmospheric emissions. Wind blowing around a building distorts the flow and creates zones of turbulence that are greater than if the building were absent. Increased turbulence causes greater plume mixing; the rise and trajectory of the plume may be depressed generally by the flow distortion. For elevated releases such as those from stacks, building downwash leads to higher ground level concentrations closer to the stack than those present if a building was not there. For ground level releases such as those from the biofilters the presence of a building will increase turbulence and the mixing and hence dilution of the emissions and will therefore reduce downwind concentrations.
- 11.38. The building that will have the most significant effect on dispersion is the 45m by 48m maturation area building which is 11m high. Even though this building is open-sided for the purpose of this modelling and assessment it is conservatively assumed to be a fully enclosed building.

Nature of the surface

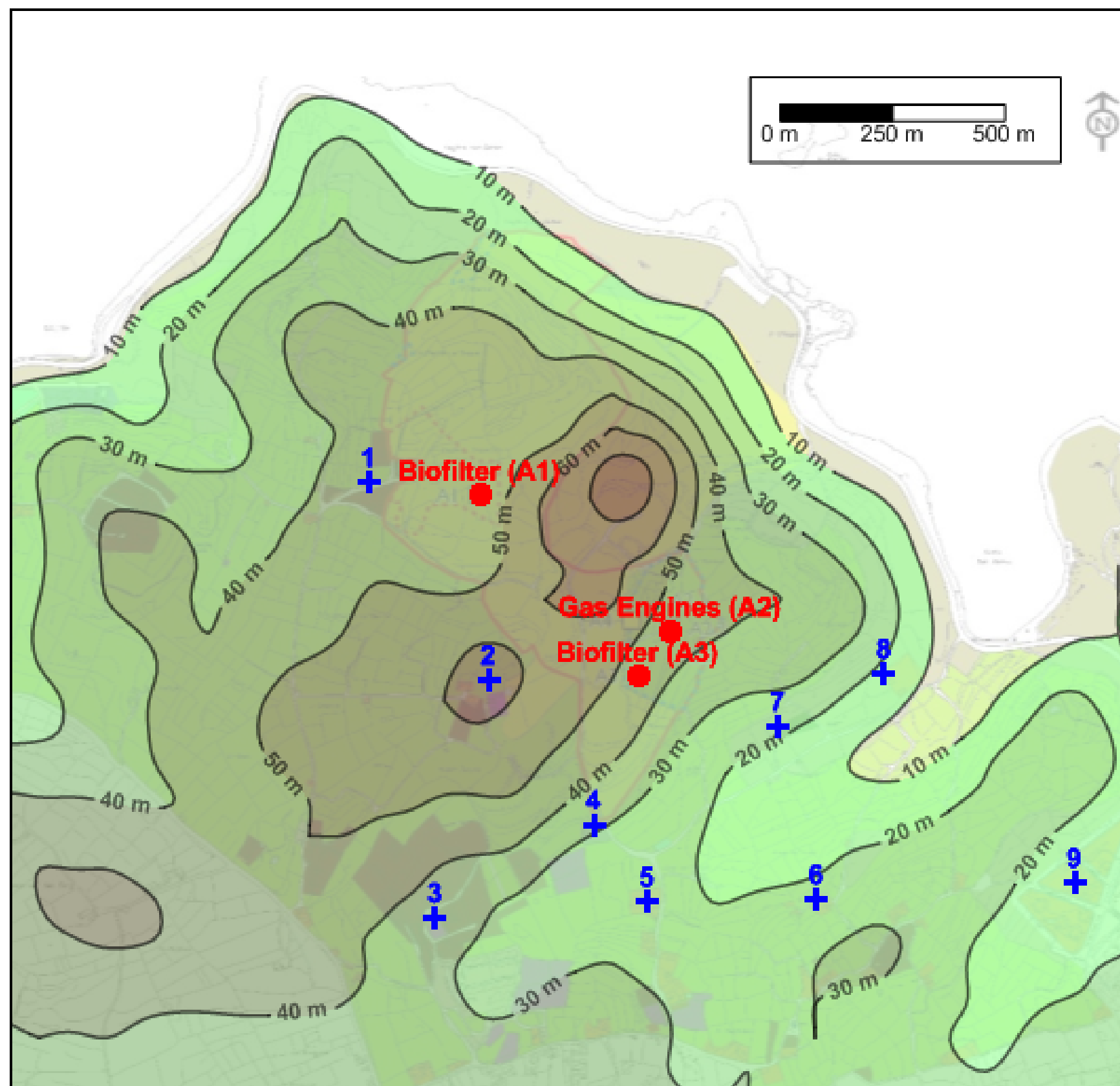
Terrain

- 11.39. The effects of terrain can effect dispersion and have been included in this assessment. **Figure 11.3** shows the terrain in the region of the facility that has been included in the modelling together with the location of the sources and receptor.

Roughness

- 11.40. The nature of the surface of the terrain can have a significant influence on dispersion by affecting the velocity profile with height and the amount of atmospheric turbulence. To account for the surrounding nature of the proposed site, a surface roughness length of 0.2m has been assumed for the dispersion modelling.

Figure 11.3: Terrain, sources and receptors



Selection of suitable dispersion model

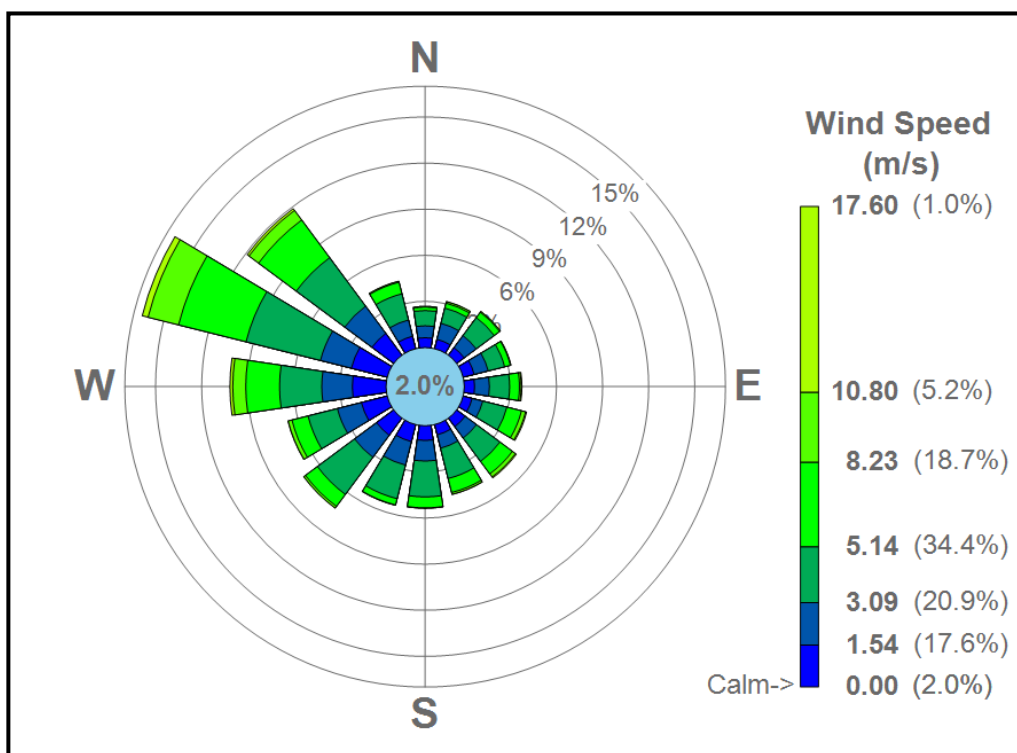
- 11.41. The dispersion models, which are widely used to predict ground level pollutant concentrations are based on the concept of the time averaged lateral and vertical concentration of pollutants in a plume being characterised by a Gaussian¹³ distribution and the atmosphere is characterised by a number of discrete stability classes. So called 'new generation' dispersion models have been developed, which replace the description of the atmospheric boundary layer as being composed of discrete stability classes with an infinitely variable measure of the surface heat flux, which in turn influences the turbulent structure of the atmosphere and hence the dispersion of a plume.
- 11.42. There are two commercially available dispersion models that are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources (i.e. stacks), and are described by the UK Environment Agency as being 'new generation'. These are:
- AERMOD: The US American Meteorological Society and Environmental Protection Agency Regulatory Model Improvement Committee developed a dispersion **MOD**del called AERMOD, which incorporates the latest understanding of the atmospheric boundary layer; and
 - Atmospheric Dispersion Modelling System (ADMS): This dispersion model was developed by the UK consultancy CERC. The model allows for the skewed nature of turbulence within the atmospheric boundary layer.
- 11.43. In many respects the models are quite similar and in some situations generate similar predictions of ground level concentrations. AERMOD was selected as the model for use in this assessment because of its greater international recognition.

Meteorological data

- 11.44. An important input to the dispersion model is the meteorological data. These data are important in determining the location of the maximum concentrations and their magnitude.
- 11.45. The closest observing station where data is available is Malta International Airport at Luqa. To allow for an understanding of the magnitude of any year-to-year variation in predicted ground level concentrations, three years of hourly meteorological data have been used in this assessment. **Figure 11.4** shows the windrose for Malta International airport for 2008-2010, used in this assessment, which shows that the prevailing wind is from the north-west west, which will transport emissions to the south east.

¹³ A Gaussian distribution has the appearance of a bell shaped curve. The maximum concentration occurs on the centre line.

Figure I I.4: Wind rose, Malta International Airport (2008-2010)



Percentage oxidation of Nitric Oxide (NO) to Nitrogen Dioxide (NO₂)

- 11.46. Oxides of nitrogen (NO_x) emitted to atmosphere as a result of gas combustion will consist largely of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, nitric oxide is oxidised to nitrogen dioxide (NO₂), which is of concern with respect to health and other impacts. The proportion of nitric oxide oxidised to nitrogen dioxide depends on a number of factors and the oxidation is limited by the availability of oxidants, such as ozone (O₃).
- 11.47. An oxidation of 35% has been assumed for oxidation of nitric oxide (NO) to nitrogen dioxide (NO₂) for short-term concentrations. For predictions of annual averages, it is assumed that 70% of the oxides of nitrogen (NO_x) are in the form of nitrogen dioxide (NO₂). These assumptions are recommended by the UK Environment Agency, extensively used and considered to be appropriate for an assessment of this nature in Malta¹⁴.

Objectives of the assessment

- 11.48. The objectives of the air quality study are to:
- Describe the emissions from the Scheme Site in terms of source, type, and quantity during operation, and assess their impacts on air quality;
 - Assess the impacts of the development on air quality-related sensitive receptors; and
 - Propose mitigation measures to reduce the impact of emissions arising from the Scheme site.

Competence of surveyor

- 11.49. The air quality assessment was carried out by Mr David Harvey.

Standards and Guidance

- 11.50. Guidance on air quality in the Maltese context is available in the following national legislation:
- Legal Notice 224 of 2001 (as amended by LN 231 of 2004): Limit values for Sulphur Dioxide, Nitrogen Dioxide and Oxides of Nitrogen, Particulate Matter and Lead in Ambient Air Regulations, 2001; and
 - Legal Notice 295 of 2007: Environmental Management Construction Site Regulations, 2007.
- 11.51. Refer to **Chapter 6** for a more detailed description.

14 Environment Agency (AQMAU): Conversion Ratios for NO_x and NO₂.

- 11.52. Dust-related nuisance is assessed against the average PM_{10} 24-hour limit value for the protection of human health as set under LN 224 of 2001 at $50 \mu\text{g}/\text{m}^3$, which is not to be exceeded more than 35 times in a calendar year. The average annual limit value for the protection of human health is $40 \mu\text{g}/\text{m}^3$. Both of these standards were to be met by 1st January 2005. By 2010, the 24-hour limit is not to be exceeded more than 7 times in a year, and the annual limit is reduced to $20 \mu\text{g}/\text{m}^3$ PM_{10} . The annual mean limit for NO_2 is also $40 \mu\text{g}/\text{m}^3$. For human health protection, maximum hourly concentrations of NO_2 must not exceed $200 \mu\text{g}/\text{m}^3$.
- 11.53. Neither the EU nor Malta has legislation governing the deposition of dust from construction operations. MEPA's Minerals Subject Plan includes policies on dust amelioration related to quarry operations. These include sheeting HGVs, wheel washing, and surfacing / sweeping / watering of internal haul roads, and siting of plant and stockpiles (Policies DC15 and DC18 refer). The Environmental Management Construction Site Regulations, 2007 include similar provisions.

BASELINE DATA

- 11.54. This section presents a description of the ambient air quality in the region of the proposed facility. Given the large degree of variation in pollutant concentrations, both with time and location, it is desirable to have measurements over a period of time that is long enough to ensure that a complete range of meteorological conditions and emissions have been experienced.
- 11.55. The assessment criteria used throughout this assessment are compared to the incremental increase and therefore an accurate determination of the prevailing concentration is not necessary.

Nitrogen Dioxide (NO_2)

- 11.56. MEPA operates a number of automatic and passive monitoring stations. Given that data from real-time measurement stations are more reliable than those from passive diffusion tubes, it is considered that the most representative data for the prevailing background concentration at the site of the proposed development is the rural background site in Gharb, Gozo. Data from this site provides an indication of the prevailing pollutant concentrations in the region of the proposed development in the absence of any local sources of pollution. **Table 11.6** shows the measured data from the Gharb, Gozo for 2009 which is the most recently available year.

Table 11.6 Measured Nitrogen Dioxide (NO_2) Concentrations at Gharb, Gozo Rural Background Site for 2009 ($\mu\text{g m}^{-3}$)

| Year | Annual Average | 99.8 %ile of Hourly Averages |
|------------------------|----------------|------------------------------|
| Measured Concentration | 3.5 | 25.5 |
| Assessment Criteria | 40 | 200 |

- 11.57. **Table 11.6** shows that the measured concentration at the rural background station was very low compared to the assessment criteria.

- 11.58. Although it is recognised that the actual concentration of nitrogen dioxide (NO_2) in the region of the development may be higher than that measured at Gharb, for the purpose of this assessment it is considered an adequate indication. It should also be noted that the focus of the assessment is the predicted increment to prevailing concentrations and how this compares to the assessment criteria and therefore an accurate determination of the prevailing background concentration is not necessary.

Odours

- 11.59. Given the proximity of the location of the proposed development to the Magtab landfill, it is likely that there will be ongoing emissions of odours from the landfill. Odour monitoring undertaken by WasteServ Malta Ltd for April and May 2011 show odours are present at both the Ghallis and Zwejra landfill site. The maximum odour intensity observed was 'strong', this was reported on two occasions. Most of the observations were that the odour intensity was 'weak' or 'distinct'.
- 11.60. Given that the odour from the biofilters will be different in character to those from the landfill there will be no cumulative odour impacts and therefore a detailed assessment of the prevailing odours in the region is not warranted. Even if this were to be available, no modelling or assessment of cumulative impacts would be possible, given the complex nature of the interaction of different odours.
- 11.61. For the purpose of this assessment and following best practice, the assessment of odour presented here considers only the incremental impacts from the proposed facility.

PREDICTIONS AND ASSESSMENT OF IMPACTS

- 11.62. This section presents the incremental increase in ground level concentrations predicted to occur as a consequence of emissions to atmosphere from the construction and operation of the proposed facility.
- 11.63. Predictions are presented and assessment made of the routine emissions to atmosphere from the following sources:
- Odours from the biofilters; and
 - Oxides of nitrogen (NO_x) from the three gas engines.

Assessment criteria: Odour

- 11.64. As discussed above, for the purpose of this assessment a benchmark in the range of $3 \text{ OU}_e \text{ m}^{-3}$ 98th percentile of hourly averages is used for emissions from the biofilters. Odour emissions greater than $3 \text{ OU}_e \text{ m}^{-3}$ will give rise to annoyance; odours less than $3 \text{ OU}_e \text{ m}^{-3}$ will not give rise to odour annoyance.

Assessment criteria: NO_x

- II.65. Air Quality Impact descriptors for NO₂ are based on the change in the annual mean concentrations. **Table II.7** describes the extent of change.

Table II.7: Changes in annual mean nitrogen dioxide

| Magnitude of change | Annual mean |
|---------------------|---|
| Large | $\Delta[P] > 4 \mu\text{g}/\text{m}^3$ |
| Medium | $2 \mu\text{g}/\text{m}^3 < \Delta[P] \leq 4 \mu\text{g}/\text{m}^3$ |
| Small | $0.4 \mu\text{g}/\text{m}^3 \leq \Delta[P] \leq 2 \mu\text{g}/\text{m}^3$ |
| Imperceptible | $\Delta[P] < 0.4 \mu\text{g}/\text{m}^3$ |

Construction

Dust

- II.66. During construction of the facility there is the potential for emissions of dust to cause a soiling nuisance. Also emissions to atmosphere from construction vehicles will affect air quality.
- II.67. Emissions of dust have the potential to affect locations within about 200m and give rise to a nuisance through soiling. Emissions of dust can be abated by mitigation measures should these be necessary.
- II.68. The closest residential receptors to the Scheme site are located about 300m to the west. Given the separation between these receptors and the construction site and the prevailing wind direction, which is from the north-west, it is considered that even without mitigation measures, dust is unlikely to cause annoyance during construction. Notwithstanding this, best practice mitigation measures will be part of a construction management plan and will be implemented during construction.
- II.69. The closest properties to the MTP site are about 50m to 300m to the west of the site. Even though the prevailing wind direction is from the north-west it is likely that without mitigation measures dust would cause annoyance during construction. It is, however, considered that with appropriate mitigation measures included in the construction management plan the likelihood of emissions of dust during construction can be minimised. If, however, annoyance were to occur during construction additional mitigation measures would be implemented.
- II.70. The measures included in the construction management plan will be agreed with MEPA prior to construction and if appropriate would include monitoring.

Emissions from construction vehicles and machinery

- II.71. The effect on air quality of emissions to atmosphere from construction vehicles and machinery will be negligible, as agreed through the Air Quality Method Statement submitted to MEPA (see **Technical Appendix I**), and has not been considered further.

Operation

Emissions from vehicles

- 11.72. The Project Description Statement prepared for the Scheme states that currently 340 vehicles per day arrive to the facilities at Ghallis. Once the Sant'Antnin Facility will be fully operational 30% of the waste will be diverted there, resulting in a decrease in 102 vehicles per day arriving at Ghallis.
- 11.73. The development of the MBT is expected to generate an additional 140 vehicles per day (100 vehicles carrying manure MBT input and output material and 40 vehicles carrying the output product from the municipal waste MBT). Considering the situation (when Sant'Antnin is operational) the net increase in traffic to Ghallis is 38 vehicles per day (140-102). However, the additional 140 vehicles will be reduced by 50 vehicles if the output (water) from the manure treatment facility is used to irrigate Magtab and the surrounding area. This would effectively reduce daily trips to less than 340, less than the current baseline.
- 11.74. The current entrance into Magtab, located near the Magtab village, will no longer be used as the main entrance, effectively removing the entrance away from sensitive receptors.
- 11.75. Emissions to atmosphere from road traffic have been screened out as being insignificant on the basis that the net increase in traffic is less than 200 vehicles per day and there are no sensitive receptors at the new proposed entrance to the Ghallis Complex.

Odour

- 11.76. Predictions of the 98th percentile of hourly average odour concentrations have been made for both a grid of receptors and at the 9 specific receptors.
- 11.77. **Table 11.8** shows the AERMOD predicted 98th percentile hourly average odour concentrations at each of the 9 specific receptors for each of the three years of meteorological data occurring as a consequence of emissions to atmosphere from the biofilters.

Table 11.8: AERMOD predicted 98th percentile of hourly average odour concentration ($\text{OU}_e \text{m}^{-3}$)

| Receptor Number/ Source | | Meteorological Data Year | | | | | | | | |
|----------------------------|--------------|--------------------------|------------|------------|------------|------------|------------|------------|------------|------------|
| | | 2008 | | | 2009 | | | 2010 | | |
| | | A1 | A3 | Both | A1 | A3 | Both | A1 | A3 | Both |
| 1 | Residential | 2.0 | 0.0 | 2.0 | 1.4 | 0.0 | 1.5 | 1.2 | 0.0 | 1.3 |
| 2 | Residential | 0.2 | 0.1 | 0.3 | 0.1 | 0.0 | 0.2 | 0.1 | 0.0 | 0.2 |
| 3 | Residential | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 |
| 4 | Hotel | 0.3 | 0.1 | 0.6 | 0.2 | 0.0 | 0.4 | 0.2 | 0.0 | 0.3 |
| 5 | Residential | 0.2 | 0.0 | 0.4 | 0.2 | 0.0 | 0.3 | 0.1 | 0.0 | 0.2 |
| 6 | Residential | 0.5 | 0.2 | 0.7 | 0.5 | 0.2 | 0.7 | 0.3 | 0.1 | 0.4 |
| 7 | Recreational | 1.3 | 1.3 | 2.2 | 1.4 | 1.2 | 2.2 | 0.8 | 1.0 | 1.8 |
| 8 | Residential | 1.6 | 0.5 | 1.8 | 1.6 | 0.6 | 1.7 | 1.1 | 0.5 | 1.3 |
| 9 | Residential | 0.5 | 0.2 | 0.7 | 0.6 | 0.2 | 0.7 | 0.3 | 0.1 | 0.4 |
| Maximum | | 2.0 | 1.3 | 2.2 | 1.6 | 1.2 | 2.2 | 1.2 | 1.0 | 1.8 |
| Assessment criteria | | 3 | | | | | | | | |

- 11.78. At each of the specific receptors the predicted 98th percentile of hourly average odour concentrations is less than the assessment criteria of $3 \text{ OU}_e \text{m}^{-3}$. The maximum predicted odour concentration at a residential receptor of $1.8 \text{ OU}_e \text{m}^{-3}$ is significantly less than the assessment criteria and therefore the concentrations are predicted to give rise to no odour annoyance.
- 11.79. **Figure 11.5** shows the distribution of the 98th percentile of hourly average odour concentration for 2009 meteorological data. 2009 was selected as this was the year that gives rise to the highest concentrations.
- 11.80. The figure shows that the predicted odour concentrations reduce rapidly with distance away from the facility and the area in which the presence of odours may give rise to annoyance is very limited and does not include any relevant exposure.

Gas engines

- 11.81. The principal pollutant released to atmosphere from the three gas engines is the oxides of nitrogen (NO_x) which will progressively oxidise to nitrogen dioxide (NO_2) in the atmosphere.
- 11.82. **Table 11.9** shows the predicted concentration of nitrogen dioxide (NO_2) at the specific receptors for each of the three years of meteorological data.

Table 11.9: AERMOD Predicted Concentrations of Nitrogen Dioxide (NO₂) at Specific Receptors (µg m⁻³)

| Receptor | Description | Annual Average | | | 99.8 th Percentile of Hourly Averages | | |
|---|--------------|----------------|------|------|--|---------------------|------|
| | | 2008 | 2009 | 2010 | 2008 | 2009 | 2010 |
| 1 | Residential | 0.5 | 0.5 | 0.6 | 11.7 | 14.1 | 19.0 |
| 2 | Residential | 0.9 | 0.6 | 0.6 | 17.6 | 15.7 | 16.3 |
| 3 | Residential | 0.3 | 0.2 | 0.3 | 8.4 | 8.0 | 8.4 |
| 4 | Hotel | 0.7 | 0.6 | 0.5 | 14.2 | 14.0 | 13.9 |
| 5 | Residential | 0.3 | 0.3 | 0.3 | 9.2 | 7.7 | 7.8 |
| 6 | Residential | 0.6 | 0.6 | 0.6 | 10.7 | 10.4 | 10.0 |
| 7 | Recreational | - | - | - | 36.5 | 35.4 | 33.0 |
| 8 | Residential | 1.7 | 2.1 | 1.9 | 14.8 | 13.6 | 13.8 |
| 9 | Residential | 0.7 | 0.8 | 0.7 | 7.1 | 7.5 | 7.0 |
| Maximum | | 1.7 | 2.1 | 1.9 | 36.5 | 35.4 | 33.0 |
| Background Concentration | | | 3.5 | | | 25.5 | |
| Maximum Increment + Background | | | 5.6 | | | 32.5 ^(b) | |
| Assessment Criteria | | | 40 | | | 200 | |
| (a) Assumes 70% oxidation for annual average and 35% for 99.8 th percentile. | | | | | | | |
| (b) UK guidance states that it is appropriate to add the predicted 99.8 th percentiles to twice the annual average concentration to estimate the total 99.8 th percentile of hourly average NO ₂ concentrations. | | | | | | | |

- 11.83. The maximum predicted increment to annual average concentrations of nitrogen dioxide (NO₂) occurs at receptor 7, which is a recreational area. Therefore, only short term exposure is of relevance at this receptor as there will be no exposure to annual average concentrations.
- 11.84. The maximum predicted increment to annual average concentration of nitrogen dioxide (NO₂) at any receptor where there is likely to be relevant exposure is 2.1 µg m⁻³ at receptor 8. This is less than the 4 µg m⁻³ and is therefore judged to be of minor significance.
- 11.85. The maximum predicted 99.8th percentile of 36.5 µg m⁻³ occurs at the recreation area, receptor 7 and can be compared to the assessment criteria of 200 µg m⁻³.
- 11.86. It is considered that both the predicted increments and the total predicted concentrations are small compared to the assessment criteria and are not of concern to human health.
- 11.87. **Figure 11.6** and **Figure 11.7** are presented to illustrate the distribution of concentrations of nitrogen dioxide (NO₂). Predictions are presented for 2009 meteorological data, which was selected as they give rise to the highest impact.
- 11.88. The figures show that peak predicted increments to ground level concentrations occur within about 250m of the gas engines at locations where there is no relevant exposure.

Figure 11.5: AERMOD predicted 98th percentile of hourly average odour concentration (OU_em^{-3}), 2009 meteorological data

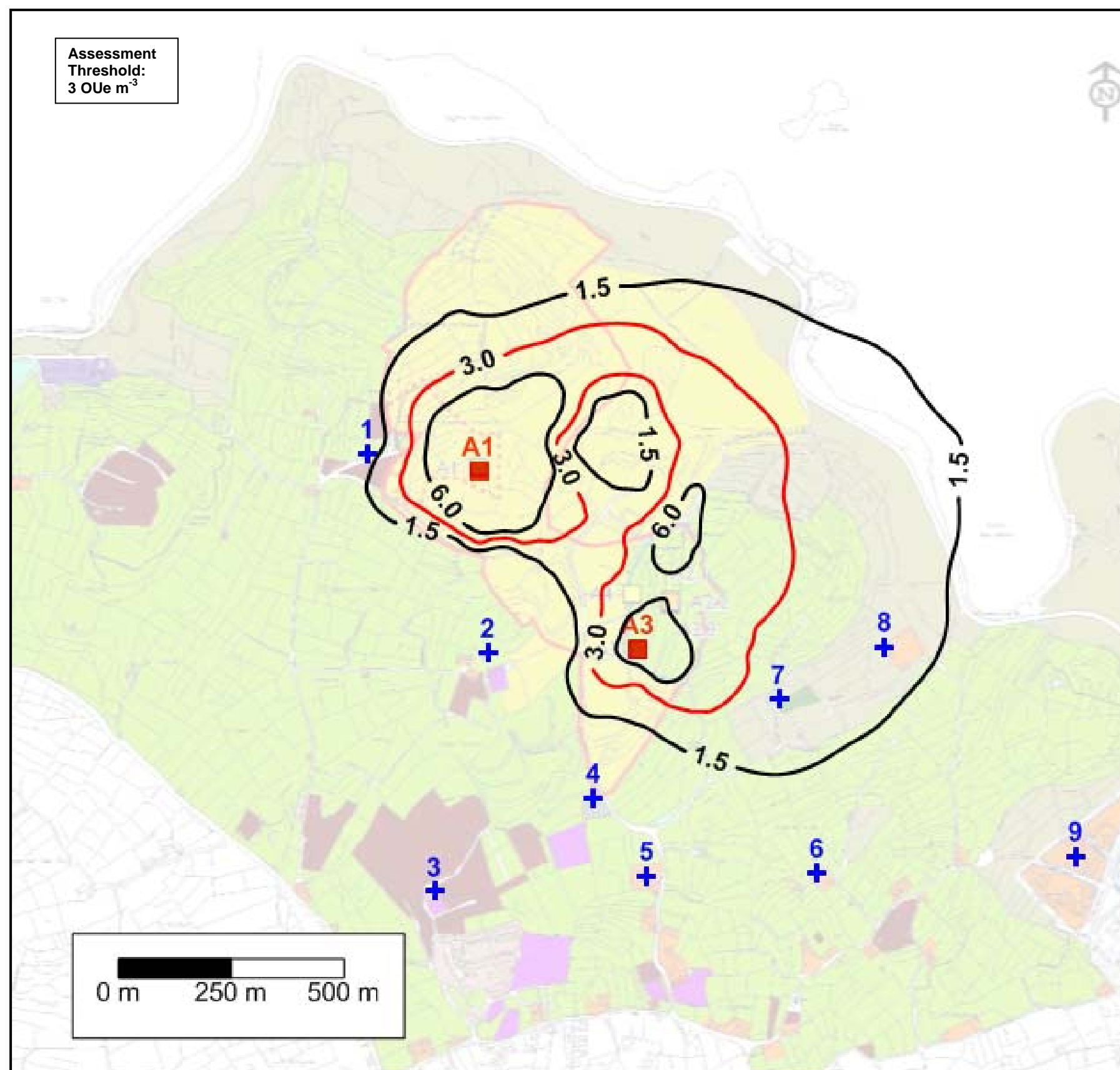


Figure 11.6: AERMOD predicted annual average ground level concentrations of Nitrogen Dioxide (NO_2), 2009 meteorological data ($\mu\text{g m}^{-3}$)

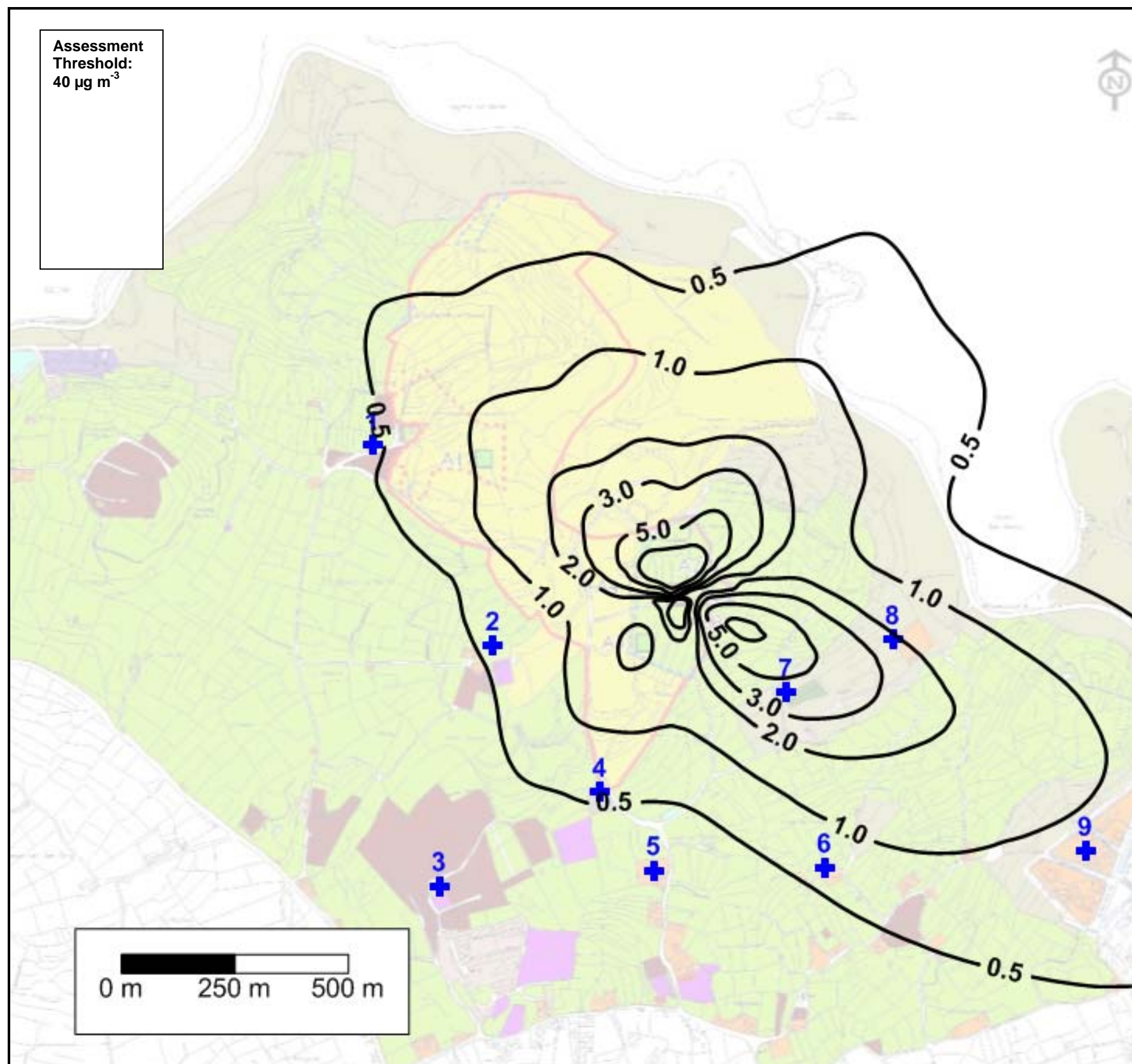
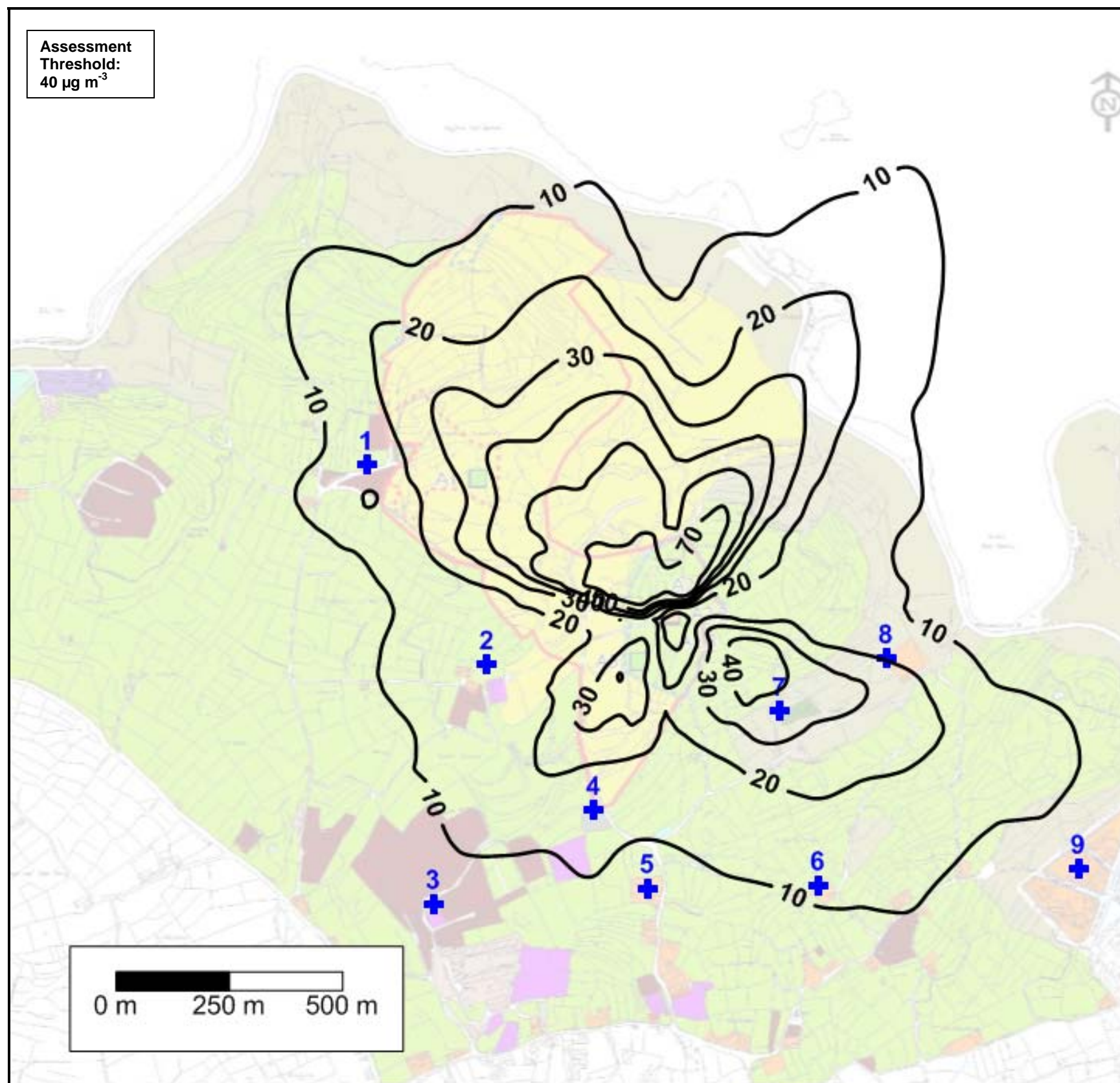


Figure 11.7: AERMOD predicted 99.8th percentile of hourly average ground level concentrations of the Nitrogen Dioxide (NO_2), 2009 meteorological ($\mu\text{g m}^{-3}$)



MITIGATION MEASURES & RESIDUAL IMPACTS

- 11.89. The assessment presented in this report assumes an appropriate level of mitigation and therefore the predicted impacts are following mitigation and therefore can be considered also to be the residual impacts.
- 11.90. It should be noted that there are aspects of the design that would allow additional mitigation if this proved to be necessary.
- 11.91. This section outlines the mitigation measures that are inherent in the design, construction and operation of the facility.

Construction mitigation

- 11.92. Emissions of dust generated during construction can be minimised through implementation of further mitigation measures should these be necessary.
- 11.93. The works will be undertaken in accordance with the Environmental Management Construction Site Regulations, 2007, including:
- A site manager will be appointed;
 - A site billboard / notice board will be erected;
 - Stone cutting will be undertaken in an enclosed area or using a dust extraction and collection system;
 - Loose building materials that are to be stored on site will be kept in sturdy, sealable containers;
 - Hoardings and barricades will be erected as described in Schedule II, Regulation 6;
 - Excavation will be carried out between Monday and Saturday, except public holidays, from 07:00 to 20:30;
 - Construction will be carried out on all weekdays, except public holidays, from 07:00 to 20:00, and 07:00 to 13:30 on Saturdays;
 - Dust emissions will be controlled as described in Schedule III of the Regulations;
 - The Site amenities (site office, waste management areas, storage areas, etc) will be located in a dedicated area on site; and
 - Pedestrian and vehicular flow along the surrounding streets will not be interrupted. All excavation and building activity will be set back from street boundaries.

Operations mitigation

Odour

11.94. The design of the facility has been focused on minimising emissions of odour to atmosphere.

11.95. With the exception of the service building and biofilters, there are no other potential sources of routine odour emissions to atmosphere as all aspects of the process are sealed from the atmosphere. Full details of the mitigation measures that will be employed to contain odours are presented in the application for an IPPC permit (April 2011) and are not reproduced here, other than the following brief summary taken from the IPPC permit application:

All areas of the MBT-plant, in which there is malodorous process air, are designed to have an air collection system to remove such odours by means of forced extraction.

The most significant area where odour is released is the Reception Hall. The entrance to the Reception Hall will be by automatic doors protected by air curtains to minimise the release of odours and dust from the waste reception area.

Exhaust air collected from the Reception Hall and source segregated air from the mechanical pre-treatment items will pass a dust filter system. Afterwards the air is treated in an acid scrubber and a biofilter. Waste air from the machines within the wet pre-treatment hall is directly sucked off to the scrubber.

The exhaust air concept shall be optimised to reduce the air flow from the process to a minimum.

Emission monitoring shall be made by the analysis of a discrete sample from the measuring point at the biofilter. The measured odour will be less than 2,000 O/U. Specific samples will be measured and tested within the agreed protocols.

The exhaust air treatment for the AD process can be reduced to a chemical scrubber system. Most of the tanks are connected to the biogas system which has only defined emission points.

11.96. With regard to emissions of odours to atmosphere from the biofilters, the modelling has shown that the concentrations at the specific receptors are less than the assessment level. The modelling assumed a specific flow rate and emission concentration for each biofilter. The input to the model is, however, the odour emission rate and therefore as long as the total odour emission rate for each biofilter is less than that assumed for this assessment the impacts will be less than those presented. This may give the providers of the biofilters some flexibility to increase the odour concentration providing that there is a corresponding reduction in odour

emission rates. For clarity, **Table 11.10** shows the odour emission rates that should not be exceeded for the final design of the facility.

Table 11.10: Biofilters: maximum odour emission rates

| Source Number | Emission Rate Odour ($\text{OU}_e \text{ s}^{-1}$) |
|---------------|--|
| A1 | 12 778 |
| A3 | 1 806 |

Gas Engines

11.97. The assessment presented here shows that the dispersion provided by the three 15m high gas engine stacks is sufficient to render the emissions harmless at ground level and therefore no further mitigation measures are required. Given that this is the minimum height recommended, the design has been changed to increase the stack heights to 20m¹⁵. It should be noted that as a result of the EIA process, the gas engine stacks were increased from the original design height of 10 m; this was to improve dispersion and reduce the impacts on air quality.

¹⁵ The visual assessment was carried out on the 20m stack height, see **Chapter 7**.

Table 11.11: Summary of Impacts

| Predicted Impact | Beneficial / Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Not significant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|--|----------------------|----------------------------------|-------------------------------------|------------------|----------------|------------|------------------|---------------------------|---------------------------------------|--|----------------------|--|---------------------------------|
| | | Constr'n / Oper'n | Extent of impact (Nat/ Local/ Site) | Direct/ Indirect | S term/ L term | Perm/ Temp | Revers/ Irrevers | (Inter / National/ Local) | (Likely, Unlikely, Remote, Uncertain) | Legislation | In context of Scheme | | (Major, Minor, Not significant) |
| Air Quality | | | | | | | | | | | | | |
| Impact of emissions from road traffic | Adverse | Constr'n | Local | Direct | Short Term | Temp | Revers. | Local | Likely | Air quality legislation | Not significant | Nil | Not significant |
| Impact of emissions from road traffic | Adverse | Oper'n | Local | Direct | Long Term | Perm | Revers. | Local | Likely | Air quality legislation | Not significant | Nil | Not significant |
| Impact of dust emissions | Adverse | Constr'n | Local | Direct | S Term | Temp | Revers | Local | Likely | Air quality legislation, Environmental Management Site Regulations, 2007 | Minor | Preparation of a CMP and taking into consideration Environmental Management Site Regulations, 2007 | Minor |
| Impact of emissions from the gas engines | Adverse | Oper'n | Local | Direct | Long Term | Temp | Revers. | Local | Likely | Air quality legislation | Not significant | None required following design changes to increase stack height from 10m to 15m | Not significant |
| Odour | | | | | | | | | | | | | |
| Odour emissions from the Scheme building | Adverse | Oper'n | Local | Direct | Long Term | Perm | Revers | National | Likely | DPA | Not significant | Building will be completely closed | Not significant |
| Odour emissions | Adverse | Oper'n | Local | Direct | L term | Perm | Revers | National | Likely | DPA | No odour | Recommended | No odour |

| Predicted Impact | Beneficial / Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Not significant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|---------------------|----------------------|----------------------------------|-------------------------------------|------------------|----------------|------------|------------------|---------------------------|---------------------------------------|--|----------------------|---|---------------------------------|
| | | Constr'n / Oper'n | Extent of impact (Nat/ Local/ Site) | Direct/ Indirect | S term/ L term | Perm/ Temp | Revers/ Irrevers | (Inter / National/ Local) | (Likely, Unlikely, Remote, Uncertain) | Legislation | In context of Scheme | | (Major, Minor, Not significant) |
| from the biofilters | | | | | | | | | | | annoyance | limits to odour emission rates as presented in Table 11.10 | annoyance |

12. SOCIAL ASSESSMENT

INTRODUCTION

12.1. The aims of the social assessment are to:

- Document the lifestyles and social activities of those who own / live in / use buildings in the vicinity of the Scheme site, or who use the surrounding urban and rural spaces;
- Through anthropological investigations to document the perceived impact of the Scheme on the existing social fabric of the surroundings;
- Identify communities, and document their present values, attitudes to living in / visiting Area of Influence (A of I) (see **Figure 12.1**); and
- Assess the impact of the Scheme on the lifestyles of the Users of the Area.

12.2. According to the respondents, the key issues for the assessment are:

- The lengthy timeline and the risk of Maghtab / Ghallis becoming a permanent Waste Management Solution;
- Lack of enforcement and monitoring during the construction and implementation phases, which would in turn increase the significance of other impacts;
- Health and Safety issues caused by the ancillary operation of the Waste Management Scheme (manure spillage; dust and air pollution etc.);
- Potential Health and Safety / risks;
- Lack of safety due to potential risks of accidents regarding gases produced by AD Plant, including gases not being burnt properly, air pollution from gas emissions and, the risk of an explosion;
- Visual impacts as a result of the Scheme ;
- Loss of agricultural land;
- An increase in traffic during both construction and operation phases;
- Impacts to tourism; and
- Social transformation of Maghtab resulting in further loss in community values.

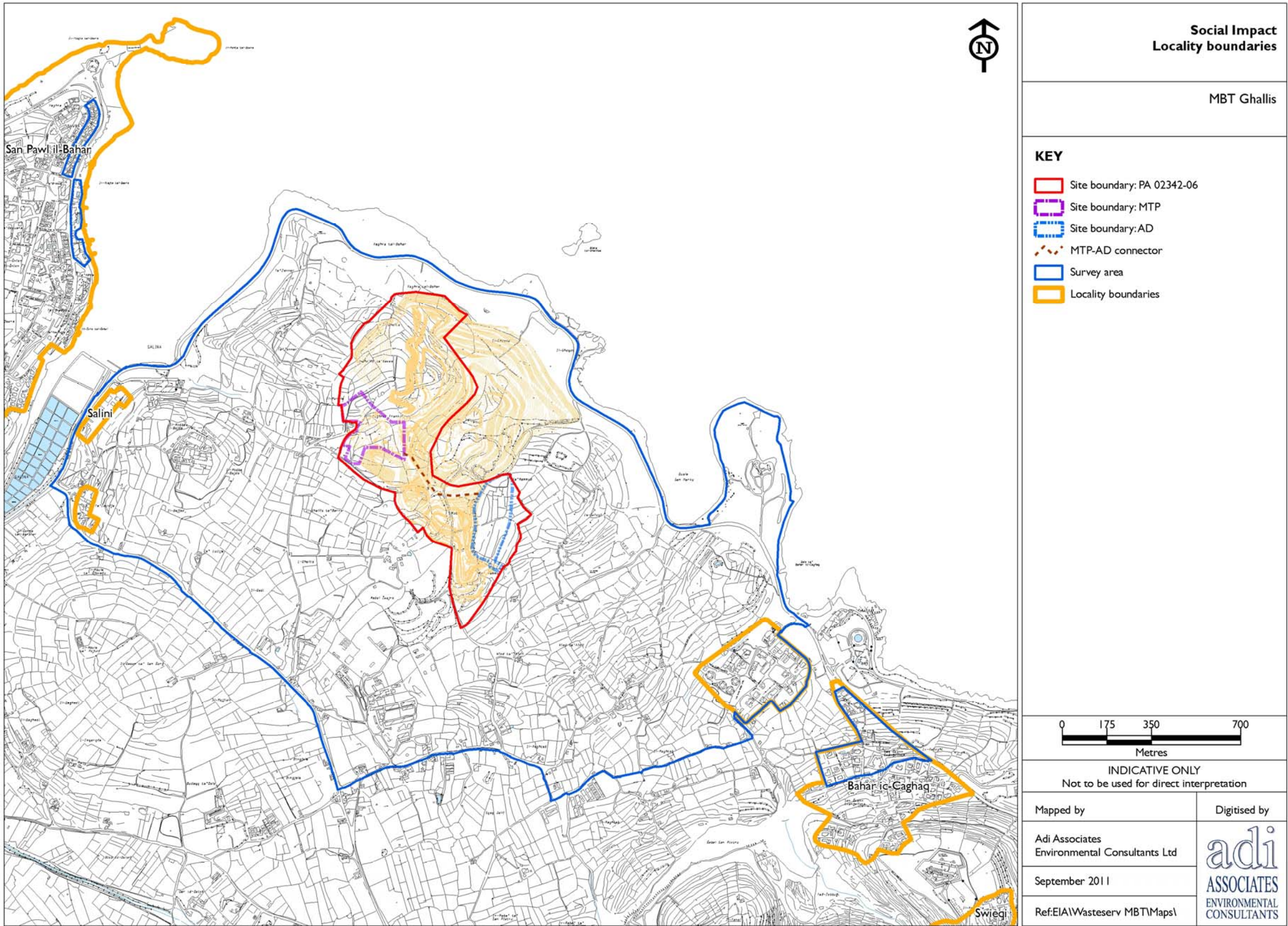
ASSESSMENT METHODOLOGY

- 12.3. The social assessment is based on the social study undertaken by social anthropologist Steven Vella B.A. (Hons.), M.A. (Econ.) (Manchester). See **Technical Appendix 7: Social Baseline Study**.

Area of Influence

- 12.4. The A of I for the local context social assessment is defined in terms of people potentially affected by the Scheme living in or visiting the area immediately around the Application Site as described below.
- 12.5. As shown in **Figure 12.1** the A of I includes:
- The locality of Magħtab;
 - The locality of Salini;
 - The locality of Baħar ic-Cagħaq; and
 - A portion of Qawra that is overlooking the Scheme site and the disused Magħtab landfill.
- 12.6. Together with the above, it was important to include the tourism industry of the area, which includes a sample of the hotels found in the area, especially at Qawra, again with a view into the Scheme site.
- 12.7. The communities (or sociospheres – see below) within the A of I include:
- The residential population (permanent and transient) around the Application Site and people using the area for other purposes, including farming; and
 - People going to the A of I for work and leisure. This includes tourists who visit the area, and those whose business or place of work is in the area.

Figure 12.1: Social Study Area of Influence showing settlements



Standards and Guidance

Legislation & Policies

- 12.8. There are no social-specific legislation or policies in the Structure Plan or the Local Plan; relevant policies are described in the subject chapters of the EIS Update.

METHODOLOGY

- 12.9. The research described in **Technical Appendix 7: Social Baseline Study** was aimed at understanding and evaluating the response to the Scheme of the people using the area. In accordance with best practice in social anthropology, qualitative research techniques were used; primarily in-depth interviews and observation at the locality.
- 12.10. Questions were asked in a non-standardised manner (in accordance with the methodological standards of anthropology), using an interview *aide-memoire* and interview key. The March 2010 version of the PA 02342/06 Project Description Statement (PDS) was used to explain to interviewees its nature and extent. The MEPA website details for the more voluminous PDS of the 2006 Masterplan for the Maghtab Environmental Complex (GF/00121/06) was also offered as supplemental reading.

Sampling

- 12.11. The non-random quota sample of around 170 people interviewed included residents - both seasonal and permanent, Maltese and foreign within the A of I; owners or managers of businesses operating in the area, and a number of their clients; formal and informal organisations / clubs with a stake in the area; farmers (mostly part-time) who work the fields in the area; and other groups that use the area, including recreational users. There also were a number of repeat and first time tourists.
- 12.12. In addition to interviews, the fieldwork included walks in the area in order to 'read' the social landscape and the activity that invariably marks it.

Gendered space

- 12.13. Gendered space was also taken into account when looking at the contestation of space. Males and females have different perceptions of space and, where possible, all the members of a household were interviewed.

Past Experience

- 12.14. Past experience is a very important factor to take into consideration, because it enables consideration of possible reactions that residents and other stakeholders of the area might have during and after the construction of the project.

Limitations

- 12.15. The first limitation of the research was sampling due to time constraints. Although every effort was made to sample as many different interest groups as possible, there were a number of constraints that kept the sample relatively small, in relation to the total population of users of the A of I. In this respect, the fieldworker opted to interview more sensitive receptors closer to the site. Therefore there are a high number of interviewees from the hamlet of Maghtab and the surrounding areas while fewer interviews were conducted at Baħar ic-Cagħaq and Salini. The fieldwork technique of in-depth interviews as opposed to the use of a survey counterbalanced this limitation. Therefore, sufficient data was gathered in the process to compile a representative and comprehensive report. During fieldwork, visits were made to the area during different times of the day and week, including the weekend, to meet as many different interest groups as possible within the same space.
- 12.16. The second limitation was project sensitivity and consequentially the respondents' initial mistrust of the social assessor and misconception of his role within the Development Application process.
- 12.17. The third limitation was seasonality. With respect to land use, seasonality is of particular relevance, and since the majority of the fieldwork was conducted in May and therefore early in the summer season, localities such as Qawra, Baħar ic-Cagħaq and Salini were lacking in summer residents, while most of the part-time farmers of the area had already harvested their fields. Qawra was also limited in the different types of tourists usually present during the summer. The first limitation was overcome as far as possible by probing interviewees on use and seasonality and by collaborating with official / unofficial organisations that have all-year-round contact with the users of the A of I and the localities that were being investigated. The second limitation was overcome by probing the tourist operators for information on the other seasons while also comparing that information with data that had been gathered and analysed by the same researcher in 2005¹⁶.
- 12.18. The fourth limitation was the magnitude and complexity of the project itself, the fact that it is a master plan with completion of its various phases taking place over an extended period of time and the Scheme ties in with various projects that are being proposed or are under way as part of the Maghtab rehabilitation project.

Determining impact significance

- 12.19. The significance of the impacts of the Scheme on the social fabric of the A of I is dependant on the values accorded to the existing urban and rural fabric and its role in formulating and maintaining such values. Judging the impacts takes account of the perception of space, the meanings and values attached to it, and the possible changes to the existing fabric that comprises or makes up the space, and how such changes

¹⁶ Falzon & Vella, PA 04591/00, SIA baseline study for a Multi-storey Complex, Triq in-Nakkri / Triq it-Tamar, Qawra, 2005)

are predicted to affect the perception, meanings, and values elicited from the communities identified in the A of I.

12.20. The significance of the impacts on the social fabric of the A of I are defined as follows:

- **Not Significant:** No or limited changes in lifestyle and / or social activities as a result of the Scheme. The impact would be of neighbourhood importance and / or likely to affect few people. The impact would be reversible;
- **Minor Significance:** Some negative changes in lifestyle and / or social activities as a result of the Scheme. The impact would be likely to moderately affect a sociosphere. The impact would be reversible and likely to occur; and
- **Major Significance:** A large negative change in lifestyle and / or social activities as a result of the Scheme. The impact would be likely to destroy or irrevocably detrimentally affect a sociosphere. The impact would be of a long-term nature, irreversible, and certain or likely to occur.

THE SOCIOSCAPE

12.21. The landscape of a particular area is made up of two distinct qualities: the physical landscape and the social landscape. When discussing the social landscape of a locality, it can be said that it forms part of a socioscape, which is then made up of various social groups, 'sociospheres', that may or may not interact with one another, directly or indirectly through time and space.

12.22. The A of I can be seen as a socioscape with different sociospheres. The same people may belong to a number of sociospheres, depending on their lifestyle and aspirations, and values are not necessarily common to all members of a sociosphere.

12.23. The following sociospheres were identified to be predominant within the A of I, the sociospheres are here placed in groups that have been called 'communities', where each community has several sociospheres. These can be summarised as follows (refer to **Technical Appendix 6: Social Study** for a more detailed description of each group):

- The Local Community: The local community is made up of sociospheres whose constituents use the A of I regularly, and therefore can be labelled 'local'. These include:
 - Well- established Maltese residents;
 - More recent permanent Maltese residents;
 - Local foreign residents, a number of whom may be married to Maltese nationals; and
 - The working community, including Business Owners and workers.
- The Transient Community: This group of sociospheres includes:

- Maltese summer residents (at the three other localities not including Maghtab)¹⁷;
 - Maltese transient residents, usually renting for a number of months;
 - Foreign visiting residents (spending short or lengthy periods of time at the locality)¹⁸, and
 - Regularly returning tourists, not at Maghtab but at the three other localities¹⁹ (usually because they have friends living in the locality).
- The Visiting Community:
 - Tourists²⁰;
 - Visitors to local residents; and
 - Visitors to the locality for leisure, including sports and recreation activities, including bars and clubs (in the case of Qawra); restaurant goers and social club goers; people going for morning walks in the countryside etc. These also include nightlife visitors: people using restaurants/ bars and other amenities²¹.
 - The farming community: These are either visitors since they do not live in the immediate vicinity (i.e. within the A of I), though a number of those interviewed lived in localities relatively close by, such as Naxxar and Mosta. Others were full-time residents of Maghtab from both categories, i.e. either part-time or full-time farmers. From the data collected from the interviews, most farmers of the area are part-time farmers and it was also explained that the reason why the fieldworker did not encounter many farmers on their fields during the fieldwork period was because the harvest period was almost closed.

¹⁷ Due to the time of fieldwork, most summer residents had not yet moved to the localities for the summer. In fact a number of houses or apartments were found vacant and neighbours and other interviewees informed the researcher that the property belonged to summer residents that had not yet arrived for the summer.

¹⁸ At Maghtab, interviewees informed the researcher that there were a number of foreigners living for part of the year in converted farmhouses but at the time of interviews these were not encountered.

¹⁹ While the researcher was informed that this group exists in the three localities excluding Maghtab, very little data was collected directly from this group due to the time of year and is not considered representative.

²⁰ It is important to note, here, that during the period of fieldwork, only a very few number of tourists outside of hotels were noticed, and at only one locality (Qawra). A few were seen walking towards particular sites at the periphery of Salina and Baħar ic-Ċaħaq.

²¹ This last group is constituted by a number of sociospheres who have associations with or pertain to other sociospheres, as has been explained above, such that visitors to residents (kin or friends) would form part of those sociospheres; bar goers are associated with businesses, and so forth. As described previously, pertinence to a particular sociosphere is by association in one way or another.

Localities within the A of I

12.24. The localities found within the A of I include:

- Maghtab hamlet;
- Bahar ic-Caghaq and Salini; and
- Qawra

12.25. **Technical Appendix 7: Social Study** provides an overview of each of the localities based on information obtained from local councils as well as interviewees.

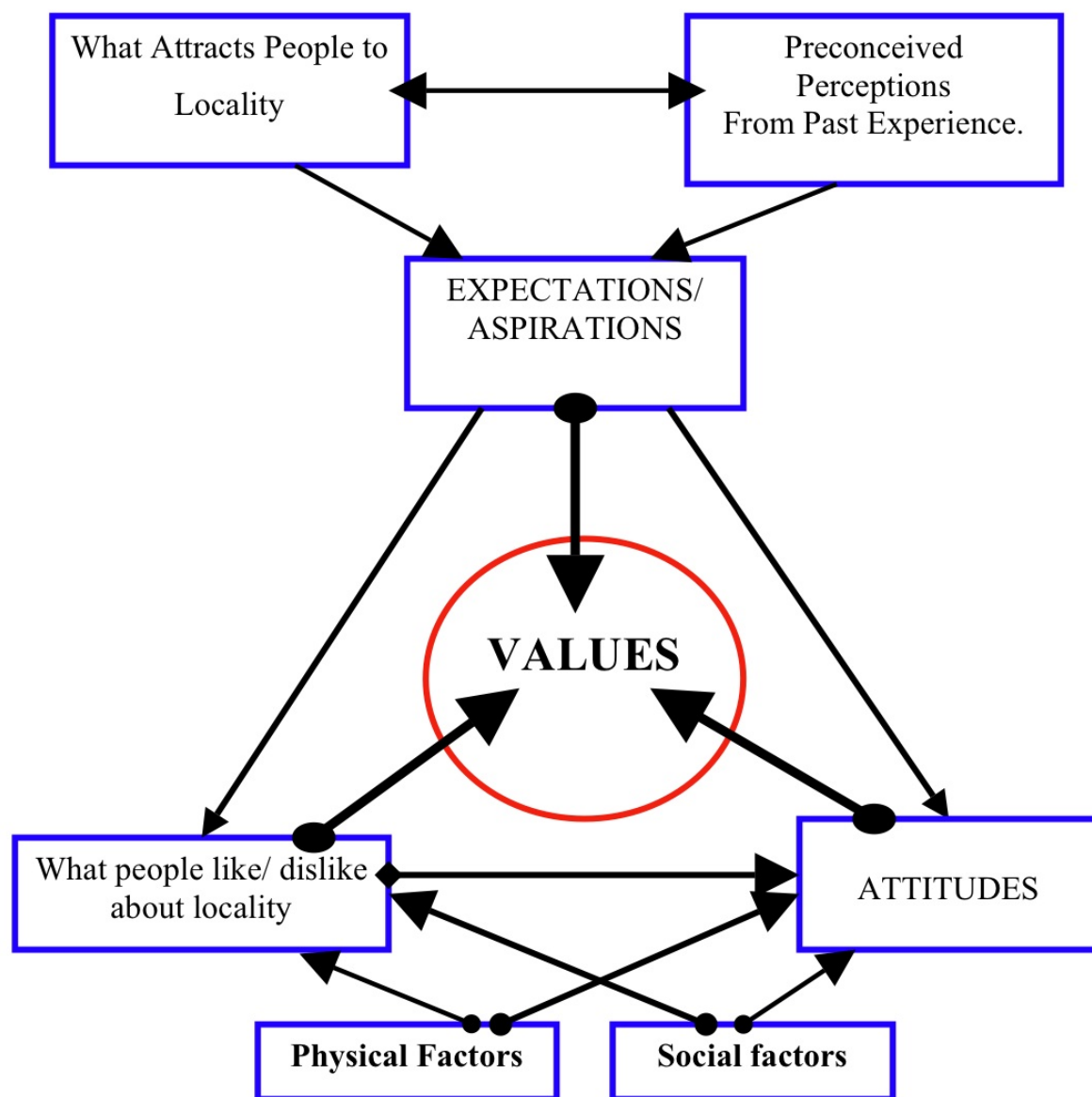
VALUES AND LIFESTYLES

12.26. This section documents what the sociospheres value about the area, the attitudes towards the proposed development and the effects that the sociosphere members believe the Scheme would have on their lifestyle. It documents:

- What the physical space (the socioscape) offers the various sociospheres;
- The attitudes of the members of the sociospheres towards the current conditions and how they affect their lifestyles;
- The attitudes that people have towards the Scheme; and
- The perceived effects of the Scheme on values and lifestyles.

12.27. **Figure 12.2** summarises the relationship between community perceptions of an area, the expectations, aspirations, attitudes, etc, of the sociospheres and the formulation of community values. **Technical Appendix 7: Social Study** provides a more detailed explanation.

Figure 12.2: Construction of values (adapted from Vella, 2005²²)



²² Environmental Planning Statement for PA 4591/00

What the socioscape offers the sociospheres

12.28. The factors that attract people towards settling in a particular locality or vice-versa can be divided into two broad but inter-related categories: physical and social factors. Both physical and social factors should not be interpreted as being stand-alone reasons why people move to a particular area or locality, it is usually the cumulative effects of a combination of physical and social factors that attract or repel people to or from a particular area.

Physical factors

12.29. Physical factors that draw in migrants (pull factors) provide natural attractiveness, as well as the possibility of recreation. Changes in the physical environment, such as pollution detract from this attractiveness and can act as a deterrent to migrants (push factors).

12.30. The following physical pull factors to the A of I were identified:

- Proximity to the sea (especially for residents of Qawra, Baħar ic-Cagħaq and Salini);
- Sea breezes / access to the shore (as above);
- Open spaces and countryside paths related to recreation and leisure;
- The countryside both as visual amenity (open space / landscape) and fertile land;
- Quiet environment; and
- Rural fields and landscape.

12.31. The physical push factors are mainly attributed to the landfill and on-going waste management operations.

12.32. While there is general consensus that since the closure of the original Maghtab landfill there has been an improvement to the physical environment of the surrounding areas, there still are a number of physical factors that are considered push or negative factors, especially when compared (by long standing Maghtab residents) to the original state of the physical environment of the Maghtab area. For those who came to the localities of Maghtab, Baħar ic-Cagħaq and Salini (and to a much lesser extent, Qawra²³) during the operation of the landfill, the positive factors usually outweighed the negative ones caused by the landfill operation in their choice

²³ Using data collected during the SIA for EIA on a highrise scheme proposal (EPS: PA 4591/00), the landfill was rarely brought up during conversations, except for those in the tourism industry. Since this SIA is about a proposed Scheme at the landfill site, interviewees were more disposed to concentrate on issues that had to do with the landfill. It must also be noted that most of the interviewees were situated on the seafront area, which are more prone to negative effects caused by the landfill, unlike the majority of the interviewees in 2005, most of whom lived further inland.

of buying property at the localities. On the other hand, most interviewees also made it clear that if they had known that the operation would have lasted as long as it has or that the area used for waste management was going to increase (including the Żwejra and Għallis operations), they would likely have reconsidered relocation to the area. Push factors resulting from operation of the waste management facility include:

- Bad or foul odours (depending on prevailing winds);
- Dust and air pollution;
- A marked change in the physical landscape;
- Vermin;
- Pollution to ground water affecting fields and crops; and
- Pollution of the sea, especially the shoreline close to the landfill along the coast road.

Social factors

- 12.33. Social factors refer to already existing human/social characteristics or aspects of the community that encourage settlement in the area. These differed according to the sociospheres and are summarised below (see **Technical Appendix 6: Social Study** for a more detailed description).

Permanent and part-time/transient residents (Maltese) and farmers (full-time and part-time), where relevant

- 12.34. Social factors that attract people to reside long term at the four localities within the A of I, include:
- Proximity or attachment to kin and land ownership (mostly Magħtab);
 - Inexpensive land / property;
 - Residence as a result of domestic problems (residents of Baħar iċ-Ċagħaq, Qawra and Salini);
 - Anonymity (including privacy) and independence (residents of Baħar iċ-Ċagħaq, Qawra and Salini);
 - Advantageous geographical position of the locality / proximity to urban centres;
 - Frequent public transportation (buses): comfortable for pensioners, offering good service that makes up for traffic congestion (only for Qawra at time of interviews);
 - A quiet (peaceful) environment in the anthropological sense; and

- The alleged closure of the Magħtab landfill operation (Predominantly for residents of Magħtab, Baħar ic-Cagħaq and Salini).

Foreign full-time residents

- 12.35. Foreign residents generally tended to list more physical than social factors that had attracted them to the area, especially Magħtab. At the same time a mixture of the two are mostly intertwined. Foreign residents from both Magħtab and Baħar ic-Cagħaq mentioned these socio-physical qualities of the area.
- 12.36. Full-time foreign residents of Qawra and Baħar ic-Cagħaq mentioned additional attractors. These included safety, economic viability, social networks (other foreigners found in the area, predominantly Qawra) and mixed marriages (when one of the couple is Maltese). While there was a higher British presence in this respect, especially in Qawra, it has been observed that in Baħar ic-Cagħaq and Salini, a number of interviewees were originally from other European countries, some of whom had been residing in Malta for a long period of time.

Livestock farmers, equestrian stable owners and other businesses

- 12.37. This is similar to residents who bought their houses because it was relatively cheap at the time of purchase. Most of the owners of businesses in the Magħtab area admitted that it was the only place they could afford at the time. It should be noted, however, that a few of the owners have since started living on the farms or at Magħtab, which meant that they appreciated the locality not just as a business opportunity. This was evident from the high standards of operations run by residents of the area. On the other hand, it was not possible to interview the owners of a number of farms whose operations were on a lower standard. Other users of the area informed the researcher that these farm owners did not reside the area and only operated from there.
- 12.38. Other business owners at Magħtab and Qawra interviewed explained that they had inherited the business from their family or had the opportunity to start the business because of land owned by the family.
- 12.39. Equestrian stables operators and owners were attracted to the area as being a predominantly rural area where clients could also take the horses out for rides.
- 12.40. Most businesses located within the area of Qawra located within the A of I were mainly concerned with the tourist industry, directly or indirectly and this was the main attractor.

Tourists

- 12.41. Tourists choose the area (especially Qawra) for a number of reasons. One of the most important factors when choosing their destination, besides cost is to be in an area that is considered or perceived as being situated outside of a mass tourism destination or season. Returning tourists also come back to Malta to visit friends, usually living in the area.

Employees of businesses and the tourist industry

- 12.42. At Qawra, many workers live close to their work place and therefore it is convenient for them to work in Qawra. Those who live elsewhere find it difficult to travel to work because, during peak hours, the area becomes congested with traffic and parking is difficult, and therefore public transportation that is relatively regular is sought though not preferred.
- 12.43. The employees interviewed at the hotel found at Salini also happened to live in Qawra or Buġibba or at localities relatively close by, such as Naxxar. Proximity to their workplace seems to be a priority. Those who live within walking distance mentioned that they like walking to and from work unless they have other commitments before or after, especially during the time of the year when the interviews were conducted.

Recreational users

- 12.44. The countryside around Baħar ic-Cagħaq is frequented by many people who go walking, especially in the morning.
- 12.45. At Magħtab, there is a shooting range and those interviewed, who were regulars of the establishment, explained that they enjoy the relaxed and outdoor environment, the company of others with the same hobby and the professionalism of the establishment's management. Since many have been returning for years, most know each other well.
- 12.46. Horse riders who keep horses at stables around Magħtab are attracted by the surrounding countryside, in the sense that they do not need to take their horses elsewhere to give the horses some outdoor exercise.
- 12.47. Qawra caters for tourism and, therefore, there are many establishments in the area that offer recreational activities for tourists, residents and visitors (both foreign and Maltese), including restaurants, nightclubs, activities organised by hotels, and so forth. Since the area is close to the sea, during the summer many recreational users go to Buġibba to swim, whilst the promenade offers people the opportunity to go for walks by the sea and, in the morning and late afternoon / evenings, people can be seen jogging.

Perceptions of community and community values

- 12.48. The factors that are considered by the locals as important factors affecting their communities, are summarised as follows (described in more detail in **Technical Appendix 7: Social Study**):
- Tensions between the indigenous population and 'outsiders' (also found in a farming context);
 - Formal Social Organization: Absence of and gaps in administration and amenities and the formation of official organisations including action groups against common threats;

- The Church is perceived as being a major factor in the formation of a community; the lack of a physical space for community interaction – no ‘piazza’ and no local feast;
- Families with children/ teenagers with the same age-groups; and
- Privacy and anonymity.

Attitudes and values towards present social and physical conditions

- 12.49. People have different and sometimes mixed attitudes towards what is currently found at the localities that they use within the A of I. Many interviewees talked about reasons why they bought or rented, in the first instance (and how things changed with time, an important factor since experience gauges their attitudes to future changes within their sociosphere, such as the proposed Scheme. This section identifies locality values and attitudes towards socio-physical changes of the area over time, identified through personal experience and lifestyle.
- 12.50. Since this baseline study is aimed to help identify the potential impacts of further waste management operations at the current waste management site at Maghtab, the section includes the experiences that the sociospheres have had over time regarding the landfill operation. It is important to understand that some experiences are not a direct effect of the landfill operation but may be indirectly caused by the operation.
- 12.51. The data is presented in summary format; more detailed information can be obtained from **Technical Appendix 7: Social Study**.

Maghtab

Full-time residents with extended families (long standing residents with roots at the hamlet); long standing families without extended families in the area although part-time / full-time farmers who have worked the fields for a long period of time; more recently established local residents and foreign full-time residents

- 12.52. The following experiences were largely homogenous for this sociosphere. The list is not in order of importance and many factors are interrelated, especially when considering changes in activities and lifestyle. In other words, activities and lifestyles may have changed because of a combination of different factors.
- The experience of the landfill operation:
 - Changes in the physical landscape, which in turn caused:
 - The experience of changes in activities (also bringing about a decrease in a feeling of community values);
 - The loss of trees and fields because of the landfill operation;
 - The experience of losing tangible heritage;
 - The experience of changes in the visual landscape;

- The experience of dirt at Magħtab, where the surrounding area of the landfill was used as a rubbish dump, 'fly-tipping'; the stigma of living at Magħtab as being associated with a rubbish dump (the experience of being 'used' as the receptacle of most of the domestic waste of Malta and especially, more recently, Gozo); and
- The stigma of living at Magħtab caused by peer pressure;
- The experience of pollution attributed to the landfill operation:
 - Change in air quality, foul smells and air pollution from the disused landfill gas extraction operation;
 - Dust;
 - Rats and other vermin; stray dogs;
 - The experience of (perceived) sea and ground water pollution; and
 - The experience of health issues (largely perceived as being a consequence of living close to the landfill);
- A general distrust in the authorities and company operating the Waste Management Site because of promises not being kept, including lack of information and enforcement; and
- Economic considerations because of the landfill operation;
- The experience of the widening of the road with the effect of an exponential increase in traffic (for Magħtab, this is in part associated with the landfill operation); and
- The experience of development with an influx of non-indigenous settlers, including more industrial use of the area: increase in population and a dichotomy between community values and unity.

More recent full-time residents

12.53. In addition to the above, this sociosphere mentioned:

- The experience of change of uses, including the increase of the livestock farms and other industrial uses;
- No public transportation; and
- An increase in equestrian facilities (stables and related activities).

Full-time and part-time farmers (including Magħtab and Salini)

12.54. The main change considered here related to the increase in livestock farms.

Visitors to the area

- 12.55. Older visitors used to visit the area when they were young, play in fields where Maghtab landfill is now situated, go swimming, etc. They have memories of goat farming, the caves and archaeological sites.
- 12.56. Younger visitors are not familiar with the area as it was in the absence of the landfill. Since 2004 they noticed a slight change for the better, however, the marine environment is still not considered to be within bathing water quality requirements and the sea in the area, therefore, cannot be used for swimming. Youngsters do not frequent the area often as a result of the presence of the landfill.

Bahar ic-Caghaq, Salina, and Qawra

- 12.57. Users of the three localities have similar experiences to change though attitudes and values may vary depending on the locality.

Residents: the local and transient communities

- 12.58. Changes that have occurred include:

- The experience of urban growth, privacy, wanted-anonymity and official representation;
- The experience of the increase in traffic and parking problems;
- The experience of noise pollution;
- The experience of dust pollution; and
- The experience of the landfill operation.

Visitors: power walkers and active users

- 12.59. This group expressed an increasing concern about pollution and safety and specifically, they are generally concerned with the increase in traffic and the resultant air pollution. This is compounded by lack of safety because of the increase in traffic, especially in the early morning when vans and trucks are servicing hotels in the area, creating noise and fumes. Another concern for early morning Qawra users is the increase in development with the ancillary operations of trucks passing through, creating dust and more fumes. The attitude of 'out of site, out of mind' though, was also observed with people walking in the evenings, when construction work would have stopped for the day and no trucks would be passing by at the time. This issue is similar for the landfill operation on the other side of the bay. In the morning, those interviewed would mention the dust produced by the landfill, usually pointing to it if it were a particularly windy day. During the evenings, unless prompted by the researcher when asked why the study was being done, none of those interviewed mentioned the dust from the landfill unless they lived in Qawra and were aware of these problems.

Visitors: tourists

- 12.60. Tourists interviewed mentioned increase in dust in the Qawra area as well as a noted increase in construction. They also referred to quaintness of the area and traditional aspects, for example, the now obsolete yellow buses.
- 12.61. Many tourists perceived the landfill to be responsible for increased dust and dirt in the area.

Hotel workers and business owners/operators

- 12.62. This group, in particular, the hotel located practically adjacent to the facility were concerned about the health implications from working so close to a landfill, in particular as a result of emitted dioxins and gas burning. The waste transportation vehicles entering and leaving the site were also cited as cause for concern.
- 12.63. Hotels located in Qawra commented on the proximity of the landfill to a popular tourist destination. Improvements following the closure of Maghtab were noted, in particular in terms of less dust, debris and odours.

Summary of factors that contribute to lifestyle

- 12.64. The baseline data shows that the A of I is attractive to the members of each sociosphere because it allows each to follow a particular lifestyle and undertake activities of their choosing in the A of I. Changes to the social and physical environment over time changes lifestyle and the perceptions people have towards the locality where they live, work or use for recreation.
- 12.65. These are summarised in **Table I** of **Technical Appendix 7: Social Study**. It is noted that the same people may belong to various sociospheres and, because each sociosphere represents a grouping of values etc, not all people in a sociosphere necessarily hold exactly the same values.

PERCEIVED EFFECTS OF THE SCHEME

- 12.66. The investigations also sought to document the perceived effects of the proposed Scheme on the lifestyles and activities of interviewees. Perceived effects are necessarily based on past experience and / or conjecture, most having not lived near a recycling plant. Some compared the proposed Scheme with the experience they had (or information from secondary sources) of the plant at Marsaskala. Others still used direct experience of visits to the recycling plants at Marsaskala, on invitation by the proponent.
- 12.67. Therefore, expectations of how the Scheme would affect a person's lifestyle depend greatly on how that person has interacted with the physical and social environment over time leading to the present. Perceived effects also depend on where within the A of I the individual lives, works or uses for recreation.

The implications that the experience of users of the Maghtab landfill operation had in formulating their general attitude and perceived impacts of the proposed Master Plan

- 12.68. The experience of the waste management operation at Maghtab (i.e. both the pre-2004 landfill and the engineered Għallies and Żwejra landfills) is a very important factor when gauging the perceived effects of the proposed Scheme. This is because the operation at Maghtab has been a great part of many of the users' lives for a very long time, especially users of the surrounding areas of Maghtab hamlet. As has been described in the earlier sections, the waste management operations at Maghtab have influenced the lifestyles of users and their perceptions of their socio-physical environment over time.
- 12.69. To date, the identified sociospheres have not felt duly informed and consulted on operations occurring at the Scheme site. In addition, lack of monitoring and enforcement was perceived to be one of the main problems with the management of the site and ancillary activities including transport. These experiences, compounded over time and including others, as mentioned above, have resulted in a negative impression of the facility and the authorities' and operator's ability to manage it to best standards even though many people generally understood the need for a waste management facility.

The general attitude towards the proposed Master Plan and the most commonly perceived impacts

- 12.70. For the reasons mentioned above the general attitude toward the Master Plan was only positive if it meant a drastic improvement in the current waste management operation and more importantly, a sizeable step forward towards the rehabilitation of the landfill site (not just those delineated by the perimeter of the proposed Master Plan) and of the Maghtab region in particular.
- 12.71. Positive effects of the Master Plan and the significance of negative effects largely depended on whether or not enforcement and monitoring were taken seriously by the authorities and the project proponents. Once assurance to that effect was given, many became rather ambivalent towards the Master Plan with individuals mentioning both positive and negative effects, effects not necessarily connected to their sociosphere. The magnitude of the Scheme also meant that factors such as transport and traffic, infrastructural aspects related to the Master Plan, different aspects of the two plants, especially the AD / manure treatment plant were seen as positive by some, and negative by others, even within the same sociosphere or group of users within the A of I.
- 12.72. Another important point is that perceived effects were mentioned more or less by various individuals from the same group of people (such as residents) of all four localities within the A of I. For this reason, the effects were grouped by sociospheres or users, rather than further sub-divided by locality, and where pertinent the locality that was most effected was highlighted. A number of perceived effects were shared by most users except for one or two particular groups. In such

cases, these potential effects were also placed in this section and the groups that did not perceive themselves as being sensitive receptors were highlighted.

12.73. The main worries that were generally felt by the users of the A of I are listed below and described in more detail in **Technical Appendix 7: Social Baseline Study**. It should be noted that points and the information therein can be inter-related and have only been separated for clarity. The first four have been discussed earlier in this section and are only mentioned below to have a comprehensive and full list:

- Accountability and trust in the Authorities;
 - Magħtab becoming a permanent waste management solution for the whole of Malta;
 - Creating a precedent for further industrial development;
 - Promises will not be kept and therefore no constant enforcement and monitoring can be expected (apart from first time tourists);
 - Feeling of marginalisation and isolation in the planning and decision-making processes related to the waste management facility and the rehabilitation of the landfill site (from official representation- local and / or national);
 - The time frame for the whole master plan is too lengthy, rehabilitation of Magħtab too long; and
 - Fear of potential cumulative negative impacts, which are currently unknown, of related projects at the waste management site;
- Perceived effects directly associated with the construction and implementation of various elements of the Master Plan:
 - Health and Safety/ risk issues + inconveniences caused by the recycling plants;
 - Fear of potential Health and Safety / risks of the hazardous waste cell;
 - Fear of lack of safety due to potential risks of accidents regarding gases produced by the AD plant, including gases not being burnt properly, air pollution from gas emissions and, the risk of an explosion;
 - Preoccupation of other health and safety issues regarding AD / manure plant, affecting their peace of mind (apart from first time and a number of returning tourists, and employees of hotels);
 - Health and safety issues caused by lack of enforcement of, or failure to use the wheel wash correctly, for the ancillary operation of the Scheme;

- Potential increase in vermin and pests (notably rats and flies) because of the recycling plants and the landfill operation. This, of course, affects quality of life. The most sensitive receptors were residents of Maghtab and Baħar ic-Ċagħaq, followed by those of Salini; the hotel employees at Salini, farmers, mostly those with fields in proximity of the site; livestock farmers at Maghtab; recreational businesses and their clientele at Maghtab;
- Effects on Quality of Life:
 - An improvement in (positive impact) or an increase in stress (negative impact) on the present infrastructure;
 - Increase in and other traffic related problems caused by the construction phase;
 - Increase in dust due to the construction phase;
 - Noise pollution during the construction phase of the project;
 - Further degradation of surrounding 'countryside' and pollution of sea during construction phase;
 - Negative visual impact of the project, during both the construction and implementation phases;
 - Potential loss of visual amenity if one or both of the recycling plants are visible;
 - Loss of agricultural land as visual and landscape amenity;
 - Loss of agricultural land implied as a decrease in quality of life and intangible heritage;
 - The potential damage to the remaining megalithic ruins (loss of tangible and intangible cultural heritage);
 - Loss of peacefulness (quiet environment due to construction phase)-- Except for a number of Qawra users and First time tourists (who would not be familiar with the area before the landfill); and
- Economic implications on tourism: depending on various factors mentioned above, including visual impact, odour, noise, safety and risk hazards, whether there will be an improvement or increased stress on the present infrastructure, and the potential further degradation, or conversely, an improvement of the physical environment could affect tourism.

Additional perceived socio-economic impacts that influence the quality of life

12.74. Various users of the A of I (mentioned below where pertinent, but mostly residents of Magħtab and in some cases the neighbouring localities closest to application site) voiced a number of perceived additional impacts besides the ones already described. These impacts are mostly related to affects to the quality of the social structure of their locality or, in the case of returning tourists, of the locality they choose to visit. These include:

- Further decrease in community values within the locality because of social tensions caused by project: In the case of Magħtab residents, especially those from Magħtab, this feeling of marginalisation has brought together a number of residents, forming the Magħtab Residents Association. While having an association organised by local residents may seem healthy in creating community cohesion, the social stratification of the locality has also created various tensions when dealing with the landfill problem, also causing some fragmentation. While the proposed plans may indeed create a newly found unity between the residents, many, on the other hand, fear that there will be further loss in community values caused by tensions between the various groups of residents;
- Social transformation and degradation in local social tapestry;
- Lack of ability to adapt to the presence of the Scheme;
- Decrease in population - people moving out of the locality as a result of the Scheme;
- Depreciation of property as a result of the Scheme: related to the first point above, however, also affected by various other perceived impacts described above, the changes brought about by the proposed plans may give way to social transformation, bringing with it a degradation in the local social tapestry. It should be pointed out that social transformation is a dynamic process and will happen regardless of the proposed Master Plan. The important point here is whether the proposed Master Plan and related ancillary operations and other related projects will positively affect the social structure of the locality or not and whether this transformation happens in a way that decreases the enjoyment and lifestyle of the people inhabiting the area, leading to people opting to move away. A number of residents from both Magħtab and Baħar ic-Ċagħaq have already voiced their resolution to move if the project is given development consent. Some were actually putting their property on the market, in the hope to receive a better price at present, since their perception of how the proposed Master Plan will affect the property market is negative. If such a trend occurs, social transformation is bound to be the result. This may further decrease community values.

Those residents with fields stated that they would remain at the locality unless their fields are taken away from them, in which case, there would be nothing keeping them at the locality any longer. Young couples with children from all

three localities also voiced their concerns about the proposed Master Plan and stated that they would consider leaving the locality depending on how the site is managed.

Returning tourists would notice a change in the social tapestry, which may affect their decision to return to the locality²⁴.

- Social marginalisation (The prolongation of the stigma associated with proximity to the landfill): As has been described earlier, Magħtab has, for a long time, had the stigma of being a 'dump' since it is associated with the old landfill. Most of its residents and other users fear that the increased lifespan of the engineered landfills because of the recycling operation and further delays in the rehabilitation of the whole landfill area will effectively prolong the stigma the area has, especially if, as some fear, the Master Plan is a precursor for a permanent waste management solution for Malta. This was also voiced by residents of Baħar ic-Ċagħaq and Salini, in some cases with reference to their own locality and in others, referring to the Magħtab area in general.
- Fear of potential cumulative negative impacts with other projects not directly related to the proposed Scheme, especially health and safety / risk issues.

Recommendations made by Users of the A of I

12.75. While discussing the proposed Master Plan with the various users of the A of I, based on their experience of the A of I, the landfill operation found at Magħtab and their areas of expertise, users made their own suggestions and recommendations. Interviews were also conducted with official organisations, including but not limited to the Local Councils. A number of these recommendations have already been embedded within the text of this report.

12.76. These are summarised below:

- The Authorities should appoint representatives from the sensitive receptors (the stakeholders) as the internal watchdog for the project. These representatives should also be involved in the decision-making process;
- Timely information transfer and sharing of issues pertaining to this Scheme and other related projects – the stakeholders should be informed and educated on the various projects being planned or going on at the site and the linkages between projects;
- An educational package or programme is set up by Wasteserv to educate the public on waste management and recycling in particular;

²⁴ Due to the already mentioned limitations during fieldwork, returning tourists were only encountered in Qawra. Making an anthropologically educated deduction, it is foreseen that returning tourists to localities such as Baħar ic-Ċagħaq and Salini would have similar views towards the change in the social make up of the localities and would react similarly.

- The site operators should have corporate economic liability towards the ancillary operations of the Scheme. Heavy vehicles that are not up to standard should not be allowed to enter the facility and should be fined outright. If the operators do not enforce such requirements, then the operators become liable and will be fined;
- With the above, the operator should employ a warden (or pay the Local Council to be able to employ a warden) to enforce the law, such as heavy vehicles not passing from residential roads and the compulsory use of the wheel wash;
- The wheel wash should be built in such a way that the whole truck is washed not just the wheels when leaving the waste management site;
- The entrance gate that is currently used (from Triq ir-Ramla) should be closed even before the construction phase. In other words, the perimeter road from the Coast Road should be the first step in the construction phase, together with any screening measures, so that the construction machinery etc, will not be visible;
- New refuse brought to the site should be treated as it arrives and not left for a whole day or more before it is moved;
- Screening measures including planting of trees should ensure that the construction site and later plant reduce the visual impact of the entire site;
- If the project goes through, MEPA should impose a planning gain that goes directly towards the improvement of the locality and the residents of the area. This is not, for example, the resurfacing of the road, which is in the competence of Central Government, but other socio-environmental issues such as cleaning and refurbishing the area (such as planting trees along roads) and monitoring the environmental situation;
- As part of the mitigation strategy and the planning gain mentioned above including Wasteserv's corporate responsibility, it is suggested that Wasteserv, together with the Residents' Associations and the Local Councils team up and apply for EU funds for a project that would improve the image of the locale and involve the residents of the locality, to improve community values. The project should involve the community from planning to execution of the project;
- On monitoring the environmental situation, it is suggested that the recycling plants should have an online monitoring system that can be scrutinised by the public. Air monitoring should be done frequently and from various distances, especially in the residential parts of the localities closest to the site and the results published quarterly online;
- SMEs should be involved and encouraged to get involved in small, targeted recycling operations, to reduce the burden on one recycling operator for the whole of Malta; and

- To decrease the amount of traffic carrying waste to the site, waste could be brought in by barge.

12.77. The perceived impacts of the Scheme are summarised below in **Table 2** of **Technical Appendix 7: Social Study**.

IMPACT ASSESSMENT

12.78. Based on the above data the following table describes the impact of the Scheme on the lifestyles and social activities of the residents of and visitors to the A of I.

12.79. The Social Impact Assessment is also informed by the assessments in the foregoing chapters.

12.80. The definitions of impact significance are:

- **Not Significant:** No or limited changes in lifestyle and / or social activities as a result of the Scheme. The impact would be of neighbourhood importance and / or likely to affect few people. The impact would be reversible;
- **Minor Significance:** Some negative or positive changes in lifestyle and / or social activities as a result of the Scheme. The impact would be likely to moderately affect a sociosphere. The impact would be reversible and likely to occur; and
- **Major Significance:** A large negative or positive change in lifestyle and / or social activities as a result of the Scheme. The impact would be likely to completely change a sociosphere. The impact would be of a long-term nature, irreversible, and certain or likely to occur.

12.81. The table below refers to the following sociospheres:

- A: Permanent Residents (Maltese and foreign);
- B: Seasonal Residents;
- C: Farmers;
- D: Businesses; and
- E: Visitors – business clientele and recreation.

12.82. The impacts of the Scheme on the different sociospheres are described in **Table 12.1**. It is important to note that significance is based on the definitions given above.

Table 12.1: Predicted social impacts and their significance

| Attribute | Sensitive Sociospheres | Phase | Change to attribute | Predicted Impact | Significance |
|---|------------------------|--------------|---|--|--|
| Monitoring of operations and effective public involvement | All | Operation | The Scheme is subject to an environmental permit (Integrated Pollution Prevention and Control, IPPC permit), which imposes a number of requirements including monitoring and implementation of effective mitigation measures, most of which have also been listed throughout this EIS. Public involvement will further improve operations management. | Compliance with permit conditions and effective, continual monitoring should ensure positive effect over previous operations. Improved public involvement would result in a positive impact on the sociospheres. | Minor beneficial sociospheres assuming improvement over previous operational management history and improved public involvement. |
| Health and safety | All | Operation | Potential risks and a risk assessment are presented in Chapter 13 . It should be understood that the risk assessment considers potential accidents outside normal operations. Therefore, events such as explosions, whilst being classified as being catastrophic in severity, is also considered very unlikely to happen in terms of probability. | Risk consideration and health and safety are complex issues that have been considered in detail in Chapter 13 , refer to Table 13.4 . | Residual risks range from minor to major, see Chapter 13 . |
| Traffic | A, B, C | Operation | As described in Chapter 11 , emissions from HGVs are not expected to result in a significant impact on air quality. Traffic to and from the site will be re-routed to enter and exit from the Coast Road. | The re-routing of the traffic passing through the main Coast Road will result in a beneficial impact to the residents and farmers of Magtab. | Minor to major beneficial impact. |
| Dust | All | Construction | Dust may result in a nuisance to | The impact is temporary and will not likely extend to | Not significant |

| Attribute | Sensitive Sociospheres | Phase | Change to attribute | Predicted Impact | Significance |
|---------------------------|------------------------|----------------------------|--|---|---|
| | | | within 200m of the site, as described in Chapter 11 . | beyond 200m of the site. Adherence to the Environmental Management Site Regulations, 2007 will further reduce any impacts from dust. | |
| Environmental degradation | All | Operation | This is related to management of operations. An increase in waste management activities will be felt, however, if these are managed to best practice standards, surrounding environmental conditions may improve when compared to the surrounding area previously managed outside environmental permit requirements. | The baseline data illustrates that general improvement in the surrounding environment has been noticed within the various sociospheres. Waste management practices that are regulated to best practice standards (in accordance with IPPC) are therefore expected to continue to ensure that the surrounding environment is improved when compared to previous, unregulated, unmonitored practices at the site. | Minor beneficial impact. |
| Visual impact | All | Operation | Visual impact is assessed in Chapter 7 . | The Scheme is only visible from one general area, resulting in negative impacts on that viewpoint. However, residents and visitors in Qawra will not be affected by the Scheme. | Not significant to major, depending on the viewpoint, refer to Chapter 7 . |
| Cultural heritage | All | Construction and operation | Impact on cultural heritage is assessed in Chapter 9 . | There will be some loss and damage to features of cultural heritage interest in the area, which may affect recreational users to the area in particular. The cultural landscape is also expected to be largely affected by the development, changing the feel of the place. The presence of the Scheme may result in visitors to the area abandoning further visits to the area altogether | Minor to major significance. |
| Peacefulness | A, B, C | Construction | Construction noise may lead to loss of peacefulness for a temporary period | Extent of works is not significant so construction period is of short duration. Impact not likely to affect lifestyles. | Not significant |
| | | Operation | Any operational noise affecting sensitive receptors will be long term and could affect lifestyle | The impact assessment in Chapter 10 shows that operational noise is not significant at the sensitive receptors, therefore it is unlikely to cause annoyance or affect lifestyle. | Not significant |
| Business | D | Operation | If correctly managed, the overall | Given that the site will remain a waste management | Not significant |

| Attribute | Sensitive Sociospheres | Phase | Change to attribute | Predicted Impact | Significance |
|-----------|------------------------|-------|---|--|--------------|
| Activity | | | amenity of the waste management facility could be improved, although large plant is now being introduced. | facility, albeit, managed to improved standards. No impact is expected to the tourism and other business activities in the area. | |

PROPOSED MITIGATION MEASURES

- 12.83. A list of all proposed mitigation measures to improve management of the facility and thus reduce nuisances is summarised in **Chapter 14**.

RESIDUAL IMPACTS

- 12.84. Visual impacts from various viewpoints will remain.

FUTURE MONITORING REQUIREMENTS

- 12.85. Monitoring requirements will be set out in detail in the IPPC permit and development planning application. It should be noted that the IPPC permit (issued by MEPA) is an operational permit and is therefore subject to regular (usually annual) renewal/revision. Given that the permit is thus of a temporary nature, any infringements on permit requirements could result in changes to permit conditions (e.g. more stringent requirements) or even failure to renew the permit.

Table 12.2: Summary of Impacts

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact | Proposed Mitigation Measures | Significance of Residual Impact |
|---|------------------------|----------------------------------|------------------------------------|------------------|----------------|------------|------------------|---------------------------|--|---------------------------------|---|---------------------------------|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct/ Indirect | S term/ L term | Perm/ Temp | Revers/ Irrevers | (Inter / National/ Local) | (Likely, Unlikely, Remote, Uncertain) | (Major, Minor, Not significant) | | (Major, Minor, Not significant) |
| Monitoring of operations and effective public involvement | Beneficial | Oper'n | Local | Indirect | Long | Perm | Revers | Local | Likely | Minor | Adherence to best practice and permit conditions / improved public involvement | Minor |
| Health and safety / Risk | Adverse | Oper'n | Local | Direct | Long | Perm | Irrevers | Local | See risk assessment, Chapter 13 | Minor to major | Mitigation measures described in Chapter 13 | Minor to major. |
| Traffic | Beneficial | Oper'n | Local | Direct | Long | Perm | Revers | Local | Likely | Minor to major | Nil | Minor to major |
| Dust | Adverse | Constr'n | Local | Direct | Short | Temp | Revers | Local | Likely | Not significant to minor | Adherence to environmental Construction Site Regulations, 2007 | Not significant |
| Environmental degradation | Beneficial | Oper'n | Local | Indirect | Long | Perm | Revers | Local | Likely | Minor | Nil | Minor |
| Visual impact | Adverse | Oper'n | Local | Direct | Long | Perm | Irrevers | Local | Likely | Minor to major | Nil | Minor to major |
| Cultural heritage | Adverse | Both | Local | Direct | Long | Perm | Irrevers | Local | Likely | Minor to Major | Relocation of certain features, protection measures against damaging features that will | Minor to major |

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance (Inter / National/ Local) | Probability of impact occurring (Likely, Unlikely, Remote, Uncertain) | Significance of Impact (Major, Minor, Not significant) | Proposed Mitigation Measures | Significance of Residual Impact (Major, Minor, Not significant) |
|-------------------|------------------------|----------------------------------|------------------------------------|------------------|----------------|------------|------------------|---|--|---|---|--|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct/ Indirect | S term/ L term | Perm/ Temp | Revers/ Irrevers | | | | | |
| | | | | | | | | | | | remain in situ. No measures to prevent or reduce impact to the cultural landscape | |
| Peacefulness | Adverse | Constr'n Oper'n | Local | Direct | Long | Perm | Revers | Local | Likely | Not significant | See Chapter 10 | Not significant |
| Business Activity | Adverse | Oper'n | Local | Direct | Long | Perm | Revers | Local | Unlikely | Not significant | None | Not significant |

13. RISK ASSESSMENT

INTRODUCTION

- 13.1. This chapter provides an assessment of risk information for the EIS update related to the development of a Mechanical Biological Treatment (MBT) plant comprising a Mechanical Treatment Plant (MTP) and Anaerobic Digestion (AD) plant and a facility for the storage of low level radioactive sources at the Ghallis waste management facility in the north east of Malta.
- 13.2. This risk assessment builds upon that presented in the original EIS²⁵ taking into account the proposed new facilities. As environmental impacts for the facilities as a result of normal operations are detailed in **Chapters 6-12**, the risk assessment provides a review of fugitive emissions and major accidents and their potential environmental effects, consistent with the earlier risk assessment.
- 13.3. The assessment is intended to form part of an Environmental Impact Statement Update and is not a basis for detailed design, or the establishment of operating procedures, for the development. The assessment does not include the assessment of occupational health and safety to employees and visitors, which will be required as part of the operational considerations for the site.

TERMS OF REFERENCE

- 13.4. In their formal communication on the Terms of Reference (ToR)²⁶ MEPA requested that WasteServ update the EIS carried out in relation to planning permit PA 04834/04, specifically updating the assessment of the relevant impacts. In particular, it requested that:

The EIS Update shall focus on the following:

- 1. Project description i.e. the EIS update shall include a description of the additional proposed facilities that will be included within the development site including the MBT, MTP, AD and any other additional facilities that were not addressed in the original EIS;*
- 2. Alternatives (sites, layouts and technologies) as relevant;*
- 3. Landscape and visual amenity assessment;*
- 4. Transport;*

²⁵ SLR, AIS Environmental, 2005 Environmental Impact Statement for a Waste Management Facility at Ghallis Ta' Gewwa, Naxxar

²⁶ MEPA, by e-mail dated 5th July 2010.

5. Noise and vibration;
6. Air quality;
7. Waste management issues; and
8. Any other environmental considerations that in the consultants' opinion may be of relevance to the said Update.

In addition to the above, the consultant/s is to verify whether as a result of the proposal, the impact significance for the following environmental characteristics outlined below (as presented in the EIS Sections for PA 04834/04), would require an update:

1. Geology, hydrology and palaeontology;
2. Agriculture;
3. Archaeology and cultural heritage;
4. Social impact;
5. Land contamination;
6. Risk assessment; and,
7. Cumulative impacts.

METHODOLOGY

- 13.5. In assessing the risk consideration has been given to guidance given by the UK Environment Agency²⁷ and in particular Annex (a)²⁸ and Annex (c)²⁹.
- 13.6. In estimating the likelihood and severity of accidents, a review has been made of case histories³⁰ of accidents at waste facilities that might be applicable to the proposed installations. Although the incidents described in the published case histories all occurred at hazardous waste facilities and the current proposed facilities are for non-hazardous wastes, some of the facilities have similarities with those proposed. In assessing the probability, for consistency, the same criteria as used in the initial risk assessment presented for Ghallis landfill, as presented in **Table 13.1**, were used.

²⁷ Environment Agency (2010). Horizontal Guidance Note H1. Environmental Risk Assessment for Permits. V2.0.

²⁸ Environment Agency (2010). Horizontal Guidance Note H1, Annex (a) - Amenity and accident risks from installations and waste operations.

²⁹ Environment Agency (2010). Horizontal Guidance Note H1, Annex (c) – Accidents.

³⁰ Environment Agency (2011). Review of Incidents at Hazardous Waste Management Facilities. V2.5.

Table 13.1: Likelihood categories

| | Category | Range |
|---|--------------------|--|
| 1 | Extremely unlikely | Incident occurs less than once in a million years |
| 2 | Very unlikely | Incident occurs between once per million and once every 10,000 years |
| 3 | Unlikely | Incident occurs between once per 10,000 and once every 100 years |
| 4 | Somewhat unlikely | Incident occurs between once per 100 and once every 10 years |
| 5 | Fairly probable | Incident occurs between once per 10 and once per year |
| 6 | Probable | Incident occurs at least once per year |

13.7. In identifying the severity of the consequences of accidents, again the same criteria as used in the original risk assessment for consistency, presented in **Table 13.2**, were applied.

Table 13.2: Severity categories

| | Category | Range |
|---|--------------|--|
| 1 | Minor | <ul style="list-style-type: none"> o Nuisance on site only (no off-site effect) o No outside complaint |
| 2 | Noticeable | <ul style="list-style-type: none"> o Noticeable nuisance off-site eg discernible odour o Minor breach of permitted emission limits, but no environmental harm o One or two complaints from the public |
| 3 | Significant | <ul style="list-style-type: none"> o Severe and sustained nuisance eg strong offensive odours or noise disturbance o Major breach of permitted emissions with possibility of prosecution o Numerous public complaints |
| 4 | Severe | <ul style="list-style-type: none"> o Hospital treatment required o Public warning and off-site emergency plan invoked o Hazardous substance released into water course with ½ mile effect |
| 5 | Major | <ul style="list-style-type: none"> o Evacuation of local population o Temporary disabling and hospitalisation o Serious toxic effect on beneficial or protected species o Widespread, but not persistent damage to land o Significant fish kill over 5 mile range |
| 6 | Catastrophic | <ul style="list-style-type: none"> o Major airborne release with serious off-site effect o Site shutdown o Serious contamination of groundwater or watercourse with extensive loss of aquatic life |

13.8. From the combination of the likelihood and severity of consequences, a risk classification is assigned to each identified scenario, using the following categories as shown in **Table 13.3**:

- Minor;
- Moderate;
- Major; and

- Catastrophic.

Table 13.3: Risk classification matrix

| Severity | Likelihood | | | | | |
|---------------------|------------|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 6 | | | | | | |
| 5 | | | | | | |
| 4 | | | | | | |
| 3 | | | | | | |
| 2 | | | | | | |
| 1 | | | | | | |
| Risk Classification | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

ASSESSMENT OF RISK

13.9. The risk assessment can be divided into three parts:

- Identification of hazards and pathways;
- Identification of receptors; and
- Risk characterisation (identifying frequency and consequence).

Summary of potential hazards and pathways

13.10. Accident hazards will vary for different phases of the development, specifically the construction phase and operational phase and vary at the different facilities due to the different materials stored and processed.

13.11. During the construction phase, there will be plant and equipment at all the facilities requiring fuel and lubricants, both potential pollutants. Whilst there is a significant unsaturated zone beneath the sites that will retard the vertical migration of hydrocarbon products, the presence of fissures may provide a pathway for liquid pollutants.

13.12. The materials stored and processed at MTP comprise solid materials including household waste and its components and stored refuse derived fuel (RDF). Solid household waste during processing has limited potential for contamination of the ground, although this would be increased if exposed to rainfall as the run-off would be likely to become contaminated. RDF has similar polluting potential when stored for long periods. Both sources of organic materials represent potential fire hazards that might lead to harm to human health and pollution of the environment.

13.13. Wet processing takes place at the end of the MTP process prior to pumping the organic fraction to the AD plant by pipeline. The fine organic fraction of household

waste suspended in water, the agricultural manures in liquid form and the waste waters from the anaerobic digestion plant will have high polluting potential due to high concentrations of ammoniacal nitrogen, BOD and COD. The escape of large volumes of highly polluting liquids would be likely to run-off and to infiltrate the rock formation in the absence of any cover of superficial deposits.

- 13.14. The anaerobic digesters produce a biogas, comprising significant concentrations of methane, a flammable and potentially explosive gas, which represents a hazard. The biogas also contains lower levels of hydrogen sulphide, which is toxic and potentially explosive, as well as being highly corrosive and odorous. Whilst the dangers associated with biogas from anaerobic digesters should not be underestimated, with the potential for fatal explosions, the magnitude of explosion or subsequent fire should not be compared with incidents from, for example, hydrocarbon storage facilities (LPG, petrol, kerosene etc). Although the biogas is at a positive pressure as it evolves in the digester, it is not pressurised like LPG (hence there is no prospect of a BLEVE, boiling liquid expanding vapour explosion), the volume held in the head space of the digesters is limited and although in the event of an explosion the tank may be ruptured, there would be no prospect of a "pool fire" as happens with petroleum product storage tanks.
- 13.15. Loss of biogas from a pipeline (such as due to leakage from a flange, or an undrained pipe being dismantled for maintenance) may result in a flash fire or an explosion if the leaking gas accumulates in a confined space. Their size of the fire would depend upon the rate of release if it is continuous, or the quantity released if it is 'instantaneous'.
- 13.16. There are a number of chemical reagents, such as sulphuric acid, that will be held in IBC drums and tanks that have the potential to cause pollution or harm to human health through either direct contact, infiltration or by wind blow of vapours.
- 13.17. The radioactive store is designed for the storage of radioactive sources, which by their very nature are hazardous. It is assumed that the sources will be packed at their point of collection into protective secondary containers; hence there will be no loose radioactive material that could be spread to the environment during transport. The accidents considered, therefore, are those arising at the storage facility. For the radioactive materials to be dispersed there must be loss of containment and/or shielding due to mechanical or fire damage, which might lead to release of radioactive materials to atmosphere or to the surrounding area.

Potential receptors

- 13.18. The principle sensitive receptors in the vicinity of the site were identified on drawing I4/1 to the original EIS. Of these, the closest is the Rabbit farm close to the western boundary, adjacent to the MTP facility. Of the other receptors identified, the next closest is a livestock farm located to the west of the access road. Of the remaining receptors identified, the majority are located to the south, near the site entrance, with two, the Coastline Hotel and Qawra beach front, located a minimum of 800m to the west or north west, upwind of the MTP.

- 13.19. The land uses in the vicinity of the site are shown on **Figure 4.2**. The land to the east of the MTP facility, downwind under prevailing wind conditions, is either landfill or the proposed AD facility occupied by WasteServ. The land to the east of the AD facility is predominantly agricultural or inactive land under natural vegetation.
- 13.20. The groundwater beneath the site represents a receptor, however, is not used for potable supply. There are a number of agricultural boreholes, however, these are located at some distance and to the south, upstream from the sites of the proposed facilities.
- 13.21. Currently, there are no surface water features on site; hence the potential impact on surface water resources is low, although surface run-off of significant quantities of contaminating liquids would be likely to give rise to ground contamination over significant areas and could lead to contamination of clean run-off water, rendering it unsuitable for use and requiring treatment
- 13.22. In addition to the public receptors, there are receptors within the Ghallis waste management facility. At the southern end of the site, there is the main reception and weighbridge. Between Ta'Zwejra and Maghtab landfills, immediately to the west of the proposed AD facility, there is landfill gas and leachate management infrastructure including the aerial emissions control system.

ASSESSMENT OF RISK

- 13.23. The assessment of risks identified is tabulated in **Table 13.4**.

Table 13.4: Risk assessment

| Reference | Accident hazard | Cause | Likelihood | Impact | Severity category | Risk classification | Mitigation | Residual risk classification |
|------------------------------------|---|--|-------------------|--|-------------------|---------------------|---|------------------------------|
| 1. Construction | | | | | | | | |
| 1.1 | Spillage of oils/lubricants during construction | Loss of containment or spilt during handling | Fairly probable | Potential for significant ground contamination and impact on groundwater | Significant | Major | All fuels kept in bunded tanks designed to contain 110% of the tanks content. Fuel gauges and refuelling pipes will be within the bunded area. Lubricants stored on drip trays to minimise spillage. Provision of spill kits and staff training. | Moderate |
| 2. Operation (MTP Facility) | | | | | | | | |
| 2.1 | Spillage of oils/lubricants | Spilt during handling | Fairly probable | Materials spilt within plant building or yard area, if outside bunded area will flow to surface drains to surface/groundwater | Noticeable | Moderate | Lubricants stored in a secure facility and either stored on drip trays or containers to minimise spillage. Provision of spill kits and staff training. | Minor |
| 2.2 | Fire | “Hot” load in incoming load leading to fire in reception hall Vandalism or spontaneous combustion in stored RDF | Somewhat unlikely | Potentially severe, hazardous/polluting substances in fire fighting water leading to contamination of surface/groundwater Spread to other facilities eg adjacent landfill. The wind direction is predominantly from the west. Any plume of smoke from a fire would rise due to thermal buoyancy but tend to bend under the influence of wind. It would expand and the much-diluted ground level concentration of pollutants at a distance would depend on wind speed, meteorological conditions, localised aerodynamic effects due to landform etc. Residents to the east at distance would have time to go indoors and close windows until the fire was extinguished. Therefore, no adverse health effects should be experienced. | Severe | Major | Inspection of incoming loads in reception hall. Security to deter unauthorised access/vandalism Drainage system top divert fire water back to fire fighting water reservoir | Moderate |
| 2.3 | Loss of containment of wet fine fraction biological waste suspension | Damage to pipe by site vehicles/vandalism/degradation of pipe or joints | Unlikely | Potential for significant ground contamination and impact on groundwater | Significant | Moderate | Site security Protective earthworks/barriers | Minor |
| 3. Operation (AD Facility) | | | | | | | | |
| 3.1 | Spillage of high strength organic liquids | Overfilling of mixing tank/digester tanks | Unlikely | Potentially severe, hazardous/polluting substances leading to contamination of adjacent agricultural land and surface/groundwater | Severe | Moderate | All tanks fitted with high level alarms and safety cut-offs All tanks located within bunded area capable of holding 110% of largest tank. All drains from bunded area to foul water system. | Moderate |
| 3.2 | Loss of containment of large volume of high strength organic liquids. Release of methane (explosive and asphyxiant in confined spaces) and hydrogen sulphide (toxic and explosive in confined spaces, odorous in low | Rupture of digester tanks due to over or under pressure | Very unlikely | Potentially severe, hazardous/polluting substances leading to contamination of adjacent agricultural land and surface/groundwater. | Major | Major | Digester tanks fitted with over- pressure safety valve and vacuum relief valve. Valves calibrated and maintained to protect the digesters from serious damage. All tanks located within bunded area capable of holding 110% of largest tank. All drains from bunded area to foul water system. Formal systems of work for routine inspection, testing and maintenance of equipment. | Moderate |

| Reference | Accident hazard | Cause | Likelihood | Impact | Severity category | Risk classification | Mitigation | Residual risk classification |
|--|--|---|---------------|--|-------------------|---------------------|--|------------------------------|
| 3.3 | concentrations Explosion in reactor Methane gas in concentrations of between 5% and 15% in air by volume is explosive. | Waste sludge withdrawn too rapidly, activating vacuum relief device drawing in air. Air drawn in at digester shutdown or decommissioning | Unlikely | Loss of containment. Potentially severe, hazardous/polluting substances leading to contamination of adjacent agricultural land and surface/groundwater Damage to equipment/facilities. Secondary fires involving adjacent tanks or equipment, injury to people, and/or other domino effects such as damage to utilities, control & communication systems, and fire protection provisions | Catastrophic | Catastrophic | Operating staff should ensure that no air is allowed to enter the digester or gasholder. All piping and equipment must be sealed properly to prevent gas from escaping to the outside. No smoking. All electrical installations, including light switches, hand-held equipment etc must be explosion protected. Stringent procedure for the commissioning and decommissioning of the digesters | Major |
| 3.4 | Fire or explosion in gas supply/transfer system | Ignition and deflagration of gas | Very unlikely | Damage to equipment/facilities. Secondary fires involving adjacent tanks or equipment, injury to people, and/or other domino effects such as damage to utilities, control & communication systems, and fire protection provisions | Catastrophic | Catastrophic | Safety fittings, deflagration/flash retarding devices. Safety analysis during detailed design. Formal systems of work for routine inspection, testing and maintenance of equipment, together with a permit-to-work system, including hot work permits. | Moderate |
| 3.5 | Fugitive emissions of biogas from gas transfer pipework | Fire | Very unlikely | Damage to equipment/facilities. Secondary fires involving adjacent tanks or equipment, injury to people, and/or other domino effects such as damage to utilities, control & communication systems, and fire protection provisions | Catastrophic | Catastrophic | The location and extent of zones where a risk of explosion exists, for example around all flanges in a gas pumping system, should be identified in site health & safety procedures, with training given on appropriate actions during any emergencies. Gas-detection devices should be installed in key locations and routine monitoring carried out. | Moderate |
| 3.6 | Failure of acid storage tanks/IBCs | Corrosion or overpressure due to chemical reaction/gas pressure | Unlikely | Damage to equipment or drainage infrastructure leading to release to groundwater | Severe | Moderate | Limited number of chemicals stored on site, limiting potential for discharge of incomparable chemicals. Clear labelling of tanks/delivery pipes and safety procedures. Formal systems of work for routine inspection, testing and maintenance of equipment. | Moderate |
| 4. Operation (Low level radioactive store) | | | | | | | | |
| 4.1 | Radioactive nuclides on surfaces and in air | Leaking sealed radioactive source – caused by corrosion or mechanical damage | Probable | Contamination of floor and air contamination within the store | Minor | Minor | Secondary containment of sources such as heavy duty polythene bags or drums Monitoring of air and surfaces to detect early signs of a problem | Minor |
| 4.2 | Radioactive nuclides on surfaces and in air | Fire within the store | Unlikely | Surface contamination and air contamination within and outside the store | Significant | Moderate | Keep area clear of combustible materials and ignition sources. Sources should not be stored in cardboard boxes or wooden crates, or be placed on wooden pallets. No smoking and no hot work. Fire detection, warning and means to extinguish small fires. | Minor |
| 4.3 | Radioactive nuclides on surfaces and in air | Explosion due to accumulation of landfill gas | Very unlikely | Surface contamination and air contamination within and outside the store | Severe | Moderate | It is noted that the basement design includes a membrane, presumed to be of low gas permeability. As a further precaution, it is recommended a permanent flammable gas alarm be installed. All electrical installations, | Minor |

| Reference | Accident hazard | Cause | Likelihood | Impact | Severity category | Risk classification | Mitigation | Residual risk classification |
|---|--|--|-------------------------------------|--|--------------------------------------|---------------------------------------|---|------------------------------------|
| | | | | | | | including light switches, hand-held equipment etc must be explosion protected | |
| 4.4 | Release of radioactive liquid | Leaking unsealed source | Probable | Surface contamination | Minor | Minor | Secondary containment of liquid sources. Provision of spill kits and implementation of spill procedures | Minor |
| 4.5 | Exposure to radiation within the store | Source not in its shielded container Shielded container damaged Shielding not adequate Accumulation of numerous gamma sources | Probable | Significant radiation dose level inside the store | Minor | Minor | Monitor dose rates, provide secondary shielding as required and consider provision of high level alarms Separate gamma sources from other sources and provide additional shielding | Minor |
| 4.6 | Exposure to radiation outside of store | Gamma sources in inadequately shielded containers | Somewhat unlikely | Significant radiation dose level outside of the store | Noticeable | Moderate | Shield gamma sources correctly Monitor dose rates and consider provision of high level alarms | Minor |
| 5 Construction (Landfill Re-profiling, capping & gas recovery system) | | | | | | | | |
| 5.1 | Leachate escape | Surface release of leachate from perched leachate bodies during excavation for re-profiling | Somewhat unlikely | Contamination of ground and surface water | Significant | Moderate | Trial excavations in advance of main excavation. Pumps/bowsers in attendance to remove free leachate | Minor |
| 5.2 | Landfill gas release to atmosphere | Exposure of wastes during excavation for re-profiling and drilling/borehole installation | Fairly probable | Release of landfill gas to atmosphere, release of odour outside boundary | Noticeable | Moderate | Minimise area of open excavation. Application of cover at end of working day. Drilling and gas well installation phased to ensure all wells are drilled, installed and sealed at the end of each working day, as far as is possible. | Minor |
| 5.3 | Fire on landfill | Increase of oxygen supply as a result of waste excavation/borehole drilling and introduction of ignition source | Very unlikely | Potential damage to basal liner system with consequential release of leachate to groundwater. Potential off-site air emissions | Significant to major | Minor to major | Minimise area of open excavation. Plant & equipment to be fitted with flash preventers etc to avoid ignition sources. Equipment subject to frequent inspection & maintenance. Installation of cover/cap at earliest opportunity | Minor to moderate |
| 6 Operation (Gas recovery system) | | | | | | | | |
| 6.1 | Fugitive gas escape | Escape from borehole annulus around gas wells Escape from pipe joints/flanges Ignition of fugitive emissions | Fairly probable Unlikely | Release of landfill gas to atmosphere, release of odour outside boundary. Fire, damage to equipment, spread of fire to other facilities | Noticeable Sever to Major | Moderate Moderate to major | Installation of a GCL "top hat" flange sealed around wellheads and sealed into landfill cap All pipework constructed of MDPE and jointed using electro-fusion or fully automatic butt-welding techniques. Construction quality assurance and pressure testing of all pipework. Plant & equipment to be fitted with flash preventers etc to avoid ignition sources. Equipment subject to frequent inspection & maintenance. Valves in system to allow rapid isolation | Minor Minor to moderate |

MITIGATION MEASURES

- 13.24. All fuels will be required to be kept in bunded tanks designed to contain 110% of the tanks content. Fuel gauges and refuelling pipes will be within the bunded area. All chemicals and lubricants used in the construction period will be stored in a secure facility and either stored on drip trays or containers to minimise spillage.
- 13.25. The MTP and AD plant will be served by complete separate foul and surface water drainage systems. Process areas, including areas used for the reception of wastes will be designed such that process effluent cannot enter the surface water drainage system. The facilities will be designed and constructed such that any process effluent or leachate arising from operations including site emergencies is not released to controlled waters without appropriate treatment to required minimum standards.
- 13.26. All tanks and reaction vessels at the AD plant will be constructed on concrete foundation within a bund wall, with the design capacity of the bund equal to 110% of the largest tank or vessel. Where tanks are linked by pipework, the capacity of the bund will be 110% of the combined capacity.
- 13.27. Anaerobic digestion vessels will be equipped with a measuring system for monitoring the level and alarms and safety cut-offs fitted to prevent over-filling. Pressure monitors will be fitted and each digester fitted with an over and under pressure safety valve to minimise the potential for rupture. A programme of inspection will be implemented to identify corrosion of tanks or digestion vessels.
- 13.28. All pipe work, valves and fittings will be made to withstand pressures in excess of the maximum pressure they will attain in service, including any surge pressure. Pipe-work shall be arranged in a manner designed to ease the dismantling and removal of pumps or major items of Plant. All pipe-work will be adequately supported with purpose made fixings. When passing through walls, pipe-work shall incorporate a puddle flange. All pipework carrying potentially contaminating fluids will be located above ground (with the exclusion of the foul drainage system), which will aid in inspection, minimising the potential for undetected leakage.
- 13.29. The installation of pipework above ground will aid in inspection and reduce the potential for unidentified leaks of polluting liquids; hence the potential impact to ground and surface water.
- 13.30. The provision of volume and pressure monitoring equipment and overflow alarms to vessels will reduce the risk of spillage.
- 13.31. The provision of pressure relief valves to the digesters and the inspection regime will reduce the risk of loss of containment. The provision of above ground tanks will provide the potential for inspection and minimise the risk of unidentified leaks of polluting liquids. This, combined with their construction within a bund wall, will reduce the potential for pollution as a result of unplanned release arising from loss of containment.

- 13.32. The design of the low level radioactive store incorporates a membrane, which will reduce the potential for the ingress of landfill gas, should it migrate from one of the adjacent landfills in the future. The potential for explosion will be further reduced by the provision of a flammable gas monitor. Landfill gas monitoring will be carried out in boreholes outside the landfill facilities to identify landfill gas migration.
- 13.33. The risk of fire in the low level radioactive store can be minimised by avoiding the accumulation of combustible materials and provision of fire fighting equipment.
- 13.34. To avoid leakage of radionuclides from corroding sources in storage, secondary containment will be provided.
- 13.35. The potential for release of leachate from the flanks of the landfill will be reduced by trial excavation to identify saturated wastes, although the probability of encountering such bodies is somewhat unlikely given the rainfall pattern in Malta, with low rainfall characterised by heavy summer events, much of which is likely to run-off. The availability of portable pumps and bowzers to collect leachate or the ability to dig “soakaways” in the waste mass to enable the leachate to drain to the basal collection system will minimise the risk.
- 13.36. The release of landfill gas and associated odours during re-profiling can be mitigated by operational control of the area of waste exposed and by covering at the end of the working day. Programming the installation of the cap to follow as soon as possible following re-profiling will reduce the potential for longer term release of landfill gas/odours.
- 13.37. The ingress of air to the landfill and the potential to cause or exacerbate fires in the waste body can also be minimised by operational control of the size of excavation and covering as soon as possible on reaching the target profile.
- 13.38. Fugitive emissions of landfill gas from gas wells and associated collection pipework can be controlled by design and construction quality assurance, including the installation of bentonite seals around the top of the well and GCL “top hats” sealed against the well pipework and into the low permeability cap. All pipework will be constructed of MDPE, jointed using electro-fusion or fully automatic butt-welding techniques, and pressure tested post-installation.

CONCLUSIONS

- 13.39. The proposed MBT development has the potential to cause contamination of the ground and groundwater during the construction phase. The preparation and implementation of an Environmental Management Plan during construction and storing and managing fuels and chemicals in accordance with good practice will minimise the potential impact on soils and water resources.
- 13.40. The design and construction of all pipework and tanks, a rigorous inspection regime and the fitting of pressure and level monitors and alarms will reduce to a minimum the potential for significant spillage arising from leakage or abnormal events including fire, explosion or over-pressure at the AD plant.

- 13.41. The design and construction of tanks and pipework within bunded areas will minimise the potential for pollution of the ground or ground and surface water arising from unplanned release from abnormal events at the AD plant.
- 13.42. The risk associated with the low level radioactive store will be significantly reduced provided adherence to rigorous precautionary procedures is maintained.
- 13.43. Escape of leachate and landfill gas during re-profiling and ingress of air to the waste can be minimised by operational control of the size of the excavation open at any time.
- 13.44. The use of MDPE pipework jointed using either electro-fusion or butt-welding techniques and pressure testing after installation will minimise fugitive emissions of landfill gas during the operation of the landfill gas control system.

RECOMMENDATIONS

- 13.45. This assessment is based upon a range of assumptions and is not for the purpose of design of, or establishment of, safe operating procedures for the development. Considerably more specific information is necessary for these functions. The following recommendations are for consideration at the appropriate times.
- 13.46. A review of the permanent containment measures for fire water run-off is considered advisable to take into account the volumes of combustible materials stored (e.g. municipal waste and RDF).
- 13.47. To avoid any possibility of the wrong product being filled, i.e. incompatible reactive reagents, a Quality Assurance Procedure is recommended. If this relies upon documentation, rather than testing, a duplicate procedure would be preferable.
- 13.48. It is recommended that detailed Standard Operating Procedures and Standard Maintenance Procedures (including 'Hot Works', Entry into Confined Spaces, Testing of Relief Valves, Work on Electrical Equipment) should be established. A permit system would be advisable to ensure all modifications that could affect health and safety are assessed prior to implementation.
- 13.49. The reliability of relief valves is dependent on the regularity of inspection and testing. A single pressure/vacuum relief valve on each vessel cannot be tested in-situ or removed whilst a tank is in service. Consideration could be given to duplication of the valve.
- 13.50. The reliability of measures for leak detection should be assessed.
- 13.51. Regular checks are advisable on bund integrity for instance to ensure that it is not breached by modifications or additional pipes which are not sealed-in.
- 13.52. An audit should be performed, and procedures introduced, to ensure all potential ignition sources are controlled (e.g. zoning of electrical equipment, no smoking, earthing and bonding to control electrostatic hazards, lightning, and vehicle entry).

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- 13.53. At the Final Design Stage, when an instrumented Flow Diagram is available, it could be advantageous to perform a Hazard & Operability Study (HAZOP) on the facility and all associated pipework, etc.
- 13.54. An integrated emergency plan should be prepared and up-dated to cover this development and any others that proceed, such as the hazardous waste facility. In particular, evacuation procedures, including “muster area” locations, should be reviewed.
- 13.55. Although there is currently no evidence of landfill gas migration in the bedrock underlying the low level radioactive store and the design incorporates a membrane, it is recommended that a permanent flammable gas alarm be fitted to the basement store.
- 13.56. It is recommended that contractors selected for the re-profiling of the landfill be asked to prepare method statements for the works designed to minimise the area of waste exposed at any time. It is recommended that emergency procedures be developed for the collection of leachate in the event that perched leachate bodies are encountered during excavation.

14. SUMMARY OF KEY IMPACTS, INTERACTIONS BETWEEN IMPACTS AND MITIGATION

INTRODUCTION

- 14.1. The purpose of this chapter is to provide a summary of the key environmental impacts, their interaction and cumulative effects, where relevant, and their mitigation. It addresses the requirements in the Terms of Reference to describe mitigation measures to “prevent, minimise and where possible offset significant adverse effects on the environment of the project” and to identify cumulative and residual impacts. The chapter concludes with a summary of the mitigation measures proposed in the EIS Update.

SUMMARY OF KEY IMPACTS

- 14.2. **Chapters 6 to 12** of the EIS Update describe the predicted impacts of the Scheme on environmental aspects, in accordance with the Terms of Reference. **Chapter 13** presents the Risk Assessment. For each predicted impact, an assessment has been made as to whether it would be of major or minor significance, or not significant. The criteria for judging significance are identified in each chapter and a summary table is included. Throughout the EIS Update, particular attention is focussed on the predicted major and minor impacts and, in the case of the negative impacts, how these would be mitigated. All the residual impacts are summarised in **Table 14.1** at the end of this chapter.
- 14.3. The potential key impacts arising from the Scheme relate to:
- Geo-environment;
 - Landscape and Visual Amenity;
 - Agriculture
 - Cultural Heritage;
 - Noise and Vibration;
 - Emissions to air; and
 - Social assessment.
- 14.4. Major impacts that have been identified relate to the impacts on geology (due to excavation) landscape and visual amenity issues, and cultural heritage impacts (due to loss / damage of cultural heritage features). The social assessment also identified a number of social impacts related to environmental aspects already assessed and other issues of concern for the various sociospheres.

INTERACTION OF IMPACTS AND CUMULATIVE EFFECTS

- I4.5. The residual impacts identified above relate to (i) loss of resources, including geological and cultural heritage features, and (ii) to impacts on sensitive receptors and the social fabric within the A of I.
- I4.6. In this case, synergistic and/or cumulative effects on sensitive receptors are particularly pertinent to the social assessment where potential impacts were identified that could result in a major change in lifestyle in any of the sociospheres identified within the A of I. The identified impacts are listed in **Table I4.1**. When considering the existing social fabric it is too complex to attempt to successfully predict at this stage the extent to which the cumulative effects from, for instance, noise, visual impact, and loss of cultural heritage that are likely to result from the Scheme, as well as consideration of effects from other projects within the area, would change any of the sociospheres although indications were identified where possible. In addition, the cumulative social impact will be very much dependant on site operations management and public involvement by the operator. As a result, cumulative effect on the social environment during operation is considered to be uncertain.

Table 14.1: Summary of Impacts

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|----------------------------------|------------------------|----------------------------------|--|---------------------|-----------------------------|-------------------|----------------------|----------------------------------|--|---|-------------------------------|--|------------------------------------|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct/ Indirect | Short term/ Long term | Per m/ Temp | Revers / Irrevers | (Inter / National / Local) | (Likely, Unlikely, Remote, Uncertain) | Legislation | In context of Scheme | | (Major, Minor, Insignificant) |
| Geo-Environmental | | | | | | | | | | | | | |
| Geo-environmental resources | Adverse | Constr'n | Local | Direct | L term | Perm | Irrevers | Local | Likely | DPA | Major | None | Major |
| Change in quality of groundwater | Adverse | Constr'n | Local | Direct | S/L term | Revers | Revers | Local | Likely | EPA | Minor to major | EMP | Minor |
| Change in quality of groundwater | Adverse | Oper'n | Local | Direct | S/L term | Revers | Revers | Local | Unlikely | EPA | Minor to major | Bunding; volume and pressure monitoring systems; installation of pipework aboveground; installation of pressure valves | Not significant to minor |
| Change in quality of runoff | Adverse | Constr'n | Local | Direct | S term | Revers | Revers | Local | Likely | EPA | Minor | EMP | Minor to not significant |
| Change in quality of runoff | Adverse | Oper'n | Local | Direct | S term | Revers | Revers | Local | Likely | EPA | Minor to major | Bunding; volume and pressure monitoring systems; installation of pipework aboveground; installation of pressure valves; separate foul and clean water drainage systems | Minor to not significant |

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|---|------------------------|----------------------------------|--|-----------------|----------------------|---------------------|---------------------------|-------------------|---------------------------------|--|---------------------------------------|------------------------------|---------------------------------------|
| | | Construction / Operation | Extent of impact (National/Local/Site) | Direct/Indirect | Short term/Long term | Permanent/Temporary | Reversible / Irreversible | | | (Inter / National / Local) | Legislation | | |
| Landscape | | | | | | | | | | | | | |
| Maghtab Character Area: LLT1: Former Maghtab landfill | Adverse | Operation | Local | Direct | Long term | Permanent | Reversible | Local | Likely | DPA | Minor to Major | None | Minor to Major |
| Maghtab Character Area: LLT2: Agricultural land | Adverse | Operation | Local | Direct | Long term | Permanent | Reversible | Local | Likely | DPA | Major | None | Major |
| Maghtab Character Area: LLT4: Lowland small settlements | Neutral | Operation | Local | Direct | Long term | Permanent | Reversible | Local | Likely | DPA | Minor to Major | None | Minor to Major |
| North Eastern Rocky Coast Character Area | Neutral | Operation | Local | Direct | Long term | Permanent | Reversible | Local | Likely | DPA | Minor to Major | None | Minor to Major |
| Visual Amenity | | | | | | | | | | | | | |
| Viewpoint 2: Triq il-Qawra promenade | Adverse | All | Local | Direct | Long term | Permanent | Reversible | Local | Likely | DPA | Not significant to minor significance | None | Not significant to minor significance |
| Viewpoint 3: Triq il-Luzzu, Qawra | Adverse | All | Local | Direct | Long term | Permanent | Reversible | Local | Likely | DPA | Not significant to minor significance | None | Not significant to minor significance |

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring (Likely, Unlikely, Remote, Uncertain) | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|--|------------------------|----------------------------------|--|-----------------|----------------------|---------------------|---------------------------|-------------------|--|---|---------------------------------------|------------------------------|---------------------------------------|
| | | Construction / Operation | Extent of impact (National/Local/Site) | Direct/Indirect | Short term/Long term | Permanent/Temporary | Reversible / Irreversible | | | (Inter / National / Local) | Legislation | | In context of Scheme |
| Viewpoint 8: Sqax-Xaqquf, l/oGharghur | Adverse | All | Local | Direct | Long term | Perm | Revers. | Local | Likely | DPA | Major significance | None | Major significance |
| Viewpoint 9: Triq ir-Ramla, Magtab | Neutral | All | Local | Direct | Long term | Perm | Revers. | Local | Likely | DPA | Not significant | None | Not significant |
| Viewpoint 10: Triq il-Kosta, Bahar l-Caghaq | Adverse | All | Local | Direct | Long term | Perm | Revers. | Local | Likely | DPA | Minor significance | None | Minor significance |
| Viewpoint 12: Triq ghaxqet l-Ghajn, l/o Gharghur | Adverse | All | Local | Direct | Long term | Perm | Revers. | Local | Likely | DPA | Major significance | None | Major significance |
| Viewpoint 13: Triq John Adye, T'Alla u Ommu | Adverse | All | Local | Direct | Long term | Perm | Revers. | Local | Likely | DPA | Minor to Major significance | None | Minor to Major significance |
| Viewpoint 14: Triq L-lmsaqfin, Mosta | Adverse | All | Local | Direct | Long term | Perm | Revers. | Local | Likely | DPA | Not significant to minor significance | None | Not significant to minor significance |
| Agriculture | | | | | | | | | | | | | |
| Loss of agricultural land | Adverse | Cons/Op | Site | Direct | L | Perm | Reverse | National | Likely | DPA | Minor to major | None | Minor to major |
| Loss of protected trees | Adverse | Cons/Op | Site | Direct | L | Perm | Reverse | National | Likely | DPA | Major | Transplantation | Not significant to minor |
| Social Impact | Beneficial | Cons/Op | Site | Direct | L | Perm | Reverse | Local | Likely | DPA | Minor | None | Minor |

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|--|------------------------|----------------------------------|-----------------------------------|-----------------|----------------------|---------------------|---------------------------|----------------------------|---------------------------------------|--|---|---|---|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/Site) | Direct/Indirect | Short term/Long term | Permanent/Temporary | Reversible / Irreversible | (Inter / National / Local) | (Likely, Unlikely, Remote, Uncertain) | Legislation | In context of Scheme | | (Major, Minor, Insignificant) |
| Cultural Heritage | | | | | | | | | | | | | |
| Loss of features | Adverse | Constr'n | Site | Direct | L. term | Perm | Irrevers | National | Likely | Cultural Heritage Act (Major), DPA (Major) | Minor to Major (depending on features lost) | Relocation of significant features. Recording of features. Watching Brief. Use of sensitive construction methods. | Minor to Major (depending on implementation of proposed mitigation measures). |
| Damage to features | Adverse | Constr'n | Site | Direct | L. term | Perm | Irrevers | National | Likely | Cultural Heritage Act (Major), DPA (Major) | Minor to Major (depending on features lost) | Relocation of significant features. Recording of features. Watching Brief. Use of sensitive construction methods. | Minor to Major (depending on implementation of proposed mitigation measures). |
| Change in the context and cultural landscape | Adverse | Constr'n Oper'n | Local | Direct | L. term | Perm | Irrevers | National | Likely | SP | Major | None | Major |
| Noise and Vibration | | | | | | | | | | | | | |
| Construction noise impact on sensitive receptors | Adverse | Excavation & Constr'n | Local | Direct | Short | Temp | Revers. | Local | Likely | DPA | Major to not significant depending on | Implementation of Environmental Management Construction Site Regulations, 2007 and | Major to not significant depending on sensitive receptor location |

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | | Policy Importance | Probability of impact occurring (Likely, Unlikely, Remote, Uncertain) | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact (Major, Minor, Insignificant) |
|---|------------------------|----------------------------------|-----------------------------------|-----------------|----------------------|---------------------|-------------------------|----------------------------|-------------------|--|---|-----------------------------|--|--|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/Site) | Direct/Indirect | Short term/Long term | Permanent/Temporary | Reversible/Irreversible | (Inter / National / Local) | | | Legislation | In context of Scheme | | |
| | | | | | | | | | | | | sensitive receptor location | formulation of a CMP | |
| Impacts of operational traffic noise on sensitive receptors | Adverse | Oper'n | Local | Direct | Long | Perm | Revers. | Local | Likely | DPA | | Not significant | None required | Not significant |
| Impact of operation of the Scheme | Adverse | Oper'n | Local | Direct | Long | Perm | Revers. | Local | Likely | DPA | | Not significant | None required | Not significant |
| Impact of vibrations on structural integrity of surrounding buildings | Adverse | Excavation & construction | Local | Direct | Short | Temp | Revers. | Local | Likely | DPA | | Not significant | None required | Not significant |
| Emissions to Air: Air Quality | | | | | | | | | | | | | | |
| Impact of dust emissions | Adverse | Constr'n | Local | Direct | Short Term | Temp | Revers | Local | Likely | Air quality legislation, Environmental Management Site Regulations, 2007 | Minor | | Preparation of a CMP and taking into consideration Environmental Management Site Regulations, 2007 | Minor |
| Social | | | | | | | | | | | | | | |
| Monitoring of | Beneficial | Oper'n | Local | Indirect | Long | Perm | Revers | Local | Likely | Minor | | Adherence | Minor | Monitoring of |

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact (Major, Minor, Insignificant) |
|---|------------------------|----------------------------------|--|---------------------|-----------------------------|-------------------|------------------------------|----------------------------------|--|---------------------------------------|--|--|------------------------------------|--|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct/ Indirect | Short term/ Long term | Per m/ Temp | Revers ible / Irrevers | (Inter / National / Local) | | | Legislation | In context of Scheme | | |
| operations and effective public involvement | | | | | | | | | | | | to best practice and permit conditions / improved public involvement | | operations and effective public involvement |
| Health and safety / Risk | Adverse | Oper'n | Local | Direct | Long | Perm | Irrevers | Local | See risk assessment, Chapter 13 | Minor to major | Mitigation measures described in Chapter 13 | Minor to major. | | Health and safety / Risk |
| Traffic | Beneficial | Oper'n | Local | Direct | Long | Perm | Revers | Local | Likely | Minor to major | Nil | Minor to major | | Traffic |
| Dust | Adverse | Constr'n | Local | Direct | Short | Temp | Revers | Local | Likely | Not significant to minor | Adherence to environmental Construction Site Regulations, 2007 | Not significant | | Dust |

| Predicted Impact | Beneficial/ Adverse | Nature, Scale and Type of Impact | | | | | | Policy Importance | Probability of impact occurring | Significance of Impact (Major, Minor, Insignificant) | | Proposed Mitigation Measures | Significance of Residual Impact |
|---------------------------|------------------------|----------------------------------|--|---------------------|--------------------------|-------------------------|------------------------------|----------------------|---------------------------------------|---|---|------------------------------------|------------------------------------|
| | | Constr'n / Oper'n | Extent of impact (Nat/Local/ Site) | Direct/ Indirect | Short term/ Long term | Permanent/ Temporary | Reversible / Irreversible | | | (Inter / National / Local) | (Likely, Unlikely, Remote, Uncertain) | | Legislation |
| Environmental degradation | Beneficial | Oper'n | Local | Indirect | Long | Perm | Revers | Local | Likely | Minor | Nil | Minor | Environmental degradation |
| Visual impact | Adverse | Oper'n | Local | Direct | Long | Perm | Irrevers | Local | Likely | Minor to major | Nil | Minor to major | Visual impact |
| Cultural heritage | Adverse | Both | Local | Direct | Long | Perm | Irrevers | Local | Likely | Minor to Major | Relocation of certain features, protection measures against damaging features that will remain in situ. No measures to prevent or reduce impact to the cultural landscape | Minor to major | Cultural heritage |

SUMMARY OF MITIGATION MEASURES

- 14.7. The various chapters in the EIS Update proposed a number of mitigation measures, these pertain to both the construction phase and the operational phase.

Mitigation measures during construction

- The implementation of the Environmental Management Construction Site Regulations, 2007;
- Formulation of an Construction Management Plan and an Environmental Management Plan for the construction phase;
- All fuels will be required to be kept in bunded tanks designed to contain 110% of the tanks content. Fuel gauges and refuelling pipes will be within the bunded area. All chemicals and lubricants used in the construction period will be stored in a secure facility and either stored on drip trays or containers to minimise spillage.
- Transplantation of the protected tree species, if possible;
- Removal of the soil still existing on the Application Site when dry, in order not to negatively affect its structure;
- Reuse of the soil in the Landscaping Scheme.
- Relocation of significant cultural heritage features off-site, either to locations in the surrounding area of Maghtab or to any other suitable location, and with the agreement of and under the supervision of the Superintendence of Cultural Heritage; and
- Supervision of works generally by the Superintendence of Cultural Heritage to ensure that, in the eventuality that uncharted artefacts are encountered, works are halted and the situation assessed.

Mitigation measures during operation

- Increase the height of the gas engine stacks from 10 metres to 20 metres;
- The MTP and AD plant will be served by complete separate foul and surface water drainage systems. Process areas, including areas used for the reception of wastes will be designed such that process effluent cannot enter the surface water drainage system. The facilities will be designed and constructed such that any process effluent or leachate arising from operations including site emergencies is not released to controlled waters without appropriate treatment to required minimum standards.
- All tanks and reaction vessels at the AD plant will be constructed on concrete foundation within a bund wall, with the design capacity of the bund equal to 110%

of the largest tank or vessel. Where tanks are linked by pipework, the capacity of the bund will be 110% of the combined capacity.

- Anaerobic digestion vessels will be equipped with a measuring system for monitoring the level and alarms and safety cut-offs fitted to prevent over-filling. Pressure monitors will be fitted and each digester fitted with an over and under pressure safety valve to minimise the potential for rupture. A programme of inspection will be implemented to identify corrosion of tanks or digestion vessels.
- All pipe work, valves and fittings will be made to withstand pressures in excess of the maximum pressure they will attain in service, including any surge pressure. Pipe-work shall be arranged in a manner designed to ease the dismantling and removal of pumps or major items of Plant. All pipe-work will be adequately supported with purpose made fixings. When passing through walls, pipe-work shall incorporate a puddle flange. All pipework carrying potentially contaminating fluids will be located above ground (with the exclusion of the foul drainage system), which will aid in inspection, minimising the potential for undetected leakage.
- The installation of pipework above ground will aid in inspection and reduce the potential for unidentified leaks of polluting liquids; hence the potential impact to ground and surface water.
- The provision of volume and pressure monitoring equipment and overflow alarms to vessels will reduce the risk of spillage.
- The provision of pressure relief valves to the digesters and the inspection regime will reduce the risk of loss of containment. The provision of above ground tanks will provide the potential for inspection and minimise the risk of unidentified leaks of polluting liquids. This, combined with their construction within a bund wall, will reduce the potential for pollution as a result of unplanned release arising from loss of containment.
- The design of the low level radioactive store incorporates a membrane, which will reduce the potential for the ingress of landfill gas, should it migrate from one of the adjacent landfills in the future. The potential for explosion will be further reduced by the provision of a flammable gas monitor. Landfill gas monitoring will be carried out in boreholes outside the landfill facilities to identify landfill gas migration.
- The risk of fire in the low level radioactive store can be minimised by avoiding the accumulation of combustible materials and provision of fire fighting equipment.
- To avoid leakage of radionuclides from corroding sources in storage, secondary containment will be provided.
- The potential for release of leachate from the flanks of the landfill will be reduced by trial excavation to identify saturated wastes, although the probability of

encountering such bodies is somewhat unlikely given the rainfall pattern in Malta,. The availability of portable pumps and bowsers to collect leachate or the ability to dig “soakaways” in the waste mass to enable the leachate to drain to the basal collection system will minimise the risk.

- The release of landfill gas and associated odours during re-profiling can be mitigated by operational control of the area of waste exposed and by covering at the end of the working day. Programming the installation of the cap to follow as soon as possible following re-profiling will reduce the potential for longer term release of landfill gas/odours.
- The ingress of air to the landfill and the potential to cause or exacerbate fires in the waste body can also be minimised by operational control of the size of excavation and covering as soon as possible on reaching the target profile.
- Fugitive emissions of landfill gas from gas wells and associated collection pipework can be controlled by design and construction quality assurance, including the installation of bentonite seals around the top of the well and GCL “top hats” sealed against the well pipework and into the low permeability cap. All pipework will be constructed of MDPE, jointed using electro-fusion or fully automatic butt-welding techniques, and pressure tested post-installation.
- All areas of the MBT-plant, in which there is malodorous process air, are designed to have an air collection system to remove such odours by means of forced extraction.
- The most significant area where odour is released is the Reception Hall. The entrance to the Reception Hall will be by automatic doors protected by air curtains to minimise the release of odours and dust from the waste reception area.
- Exhaust air collected from the Reception Hall and source segregated air from the mechanical pre-treatment items will pass a dust filter system. Afterwards the air is treated in an acid scrubber and a biofilter. Waste air from the machines within the wet pre-treatment hall is directly sucked off to the scrubber.
- The exhaust air concept shall be optimised to reduce the air flow from the process to a minimum.
- Emission monitoring shall be made by the analysis of a discrete sample from the measuring point at the biofilter. Specific samples will be measured and tested within the agreed protocols.
- Features to the east of the site and the surrounding area will be maintained and the area will be likely to be managed by WasteServ as a Heritage Park for the public. This will go some way to preserving what is left of the cultural landscape of the area.

Recommendations made by the Stakeholders

14.8. In addition to the mitigation measures recommended by the EIA Coordinators a number of recommendations were provided by the stakeholders that were interviewed during the compilation of the EIS Update. These recommendations are summarised hereunder:

- The authorities should appoint stakeholders representatives to act as “watchdogs”. These representatives should also be involved in the decision-making process;
- Stakeholders should be informed and educated on the various projects being planned or going on at the site and the linkages between projects;
- An educational programme is set up by Wasteserv to educate the public on waste management and recycling in particular;
- The site operators should have corporate economic liability towards the ancillary operations of the Scheme. Heavy vehicles that are not up to standard should not be allowed to enter the facility and should be fined;
- The operator should be required to employ a warden (or pay the Local Council to be able to employ a warden) to enforce the law, such as heavy vehicles not passing from residential roads and the compulsory use of the wheel wash;
- The wheel wash should be built in such a way that the whole truck is washed not just the wheels when leaving the waste management site;
- The entrance gate that is currently used (from Triq ir-Ramla) should be closed even before the construction phase. The perimeter road from the Coast Road should be the first step in the construction phase, together with any screening measures, so that the construction machinery etc, will not be visible;
- New refuse brought to the site should be treated as it arrives and not left for a whole day or more before it is moved;
- Screening measures including planting of trees should ensure that the construction site and later plant reduce the visual impact of the entire site;
- If the project goes through, MEPA should impose a planning gain that goes directly towards the improvement of the locality and the residents of the area. This is not, for example, the resurfacing of the road, which is in the competence of Central Government, but other socio-environmental issues such as cleaning and refurbishing the area (such as planting trees along roads) and monitoring the environmental situation;
- As part of the mitigation strategy and the planning gain mentioned above including Wasteserv’s corporate responsibility, it is suggested that Wasteserv, together with the Residents’ Associations and the Local Councils team up and apply for EU funds

for a project that would improve the image of the locale and involve the residents of the locality, to improve community values. The project should involve the community from planning to execution of the project;

- On monitoring the environmental situation, it is suggested that the facilities should have an online monitoring system that can be scrutinised by the public. Air monitoring should be done frequently and from various distances, especially in the residential parts of the localities closest to the site and the results published quarterly online;
- SMEs should be involved and encouraged to get involved in small, targeted recycling operations, to reduce the burden on one recycling operator for the whole of Malta; and
- To decrease the amount of traffic carrying waste to the site, waste could be brought in by barge.

Master Plan for the Maghtab Environmental Complex
Naxxar (GF 00121/06)

ENVIRONMENTAL IMPACT STATEMENT UPDATE
APPENDICES

Version 1: September 2011

adi
ASSOCIATES
ENVIRONMENTAL
CONSULTANTS

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Appendix 1: Geo-Technical Investigation Report

Appendix 2: Laboratory Analysis Results

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PA 02342/06

Master Plan for the Maghtab Environmental Complex, Naxxar

Appendix I

GEO-TECHNICAL INVESTIGATION REPORT

Prepared by Terracore Ltd

Supporting Documents for
Environmental Impact Statement Update

GEOTECHNICAL INVESTIGATION – FACTUAL REPORT

GHALLIS LANDFILL

JANUARY 2011



DOCUMENT CONTROL

PROJECT NAME : *Ghallis Geotechnical Investigation*

DOCUMENT TITLE : *Ghallis Subsurface investigation – Factual Report*

DOCUMENT No. : */Issues/Reports/Ghallis subsurface Investigation – Factual Report*

DOCUMENT ISSUE

| ORIGINAL | Prepared by | Reviewed by | Approved by |
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| Date: 09 January 2011 | Name: Dr Saviour Scerri | Name: | Name: Alfred Xerri |
| | Signature: | Signature: | Signature: |

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| Distribution: | <i>ADI associates</i> |
|---------------|-----------------------|

REVISIONS

| | | | |
|--------------------------|-------------------|-------------------|-------------------|
| REVISION 0 | Name: | Name: | Name: |
| Date: 25/11/55 | Signature: | Signature: | Signature: |

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1 INTRODUCTION

1.1 General

ADI Associates commissioned Terracore LTD to undertake a subsurface geotechnical investigation at the Ghallis Engineered Landfill (Figure 1). This comprised the drilling of two monitoring boreholes down to about 3m below ground level each about 45m deep.

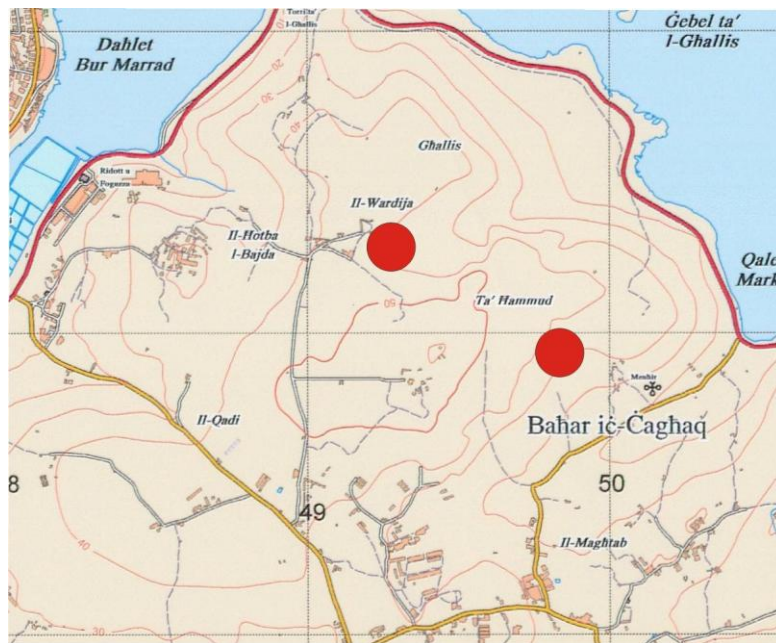


Figure 1: Map showing the location of the site at Ghallis Landfill

1.2 Scope

The information given in this report is based on actual intrusive investigations in the form of investigative coring and boreholes between the 20th and 23rd December 2010 in locations indicated in Figure 2 within the Ghallis/maghtab Landfill. The principal objectives of this investigation are:

1. To determine the sequence, thicknesses and lateral extent of the rock strata down to 45m below ground level and thereafter establish the water level.
2. To obtain representative samples of the rock for identification and classification.
3. To inspect samples for any contamination visually and odor.
4. To collect ground water from the boreholes for testing.

2 THE SITE

2.1 Geological Background

The site is the engineered landfill at Ghallis

Rock outcropping at the site and its environs include the Lower Coralline Limestone Attard and Xlendi Members and the overlying Lower Globigerina Limestone Member of the Globigerina Limestone Formation.

2.2 Standard and Guidance

The site investigation was conducted in accordance with BS 5930: 1999; Code of practice for geological site investigations and MSA EN 1997 -2: 2007 Geotechnical Design - Part 2.

3 INVESTIGATIONS

3.1 Field work

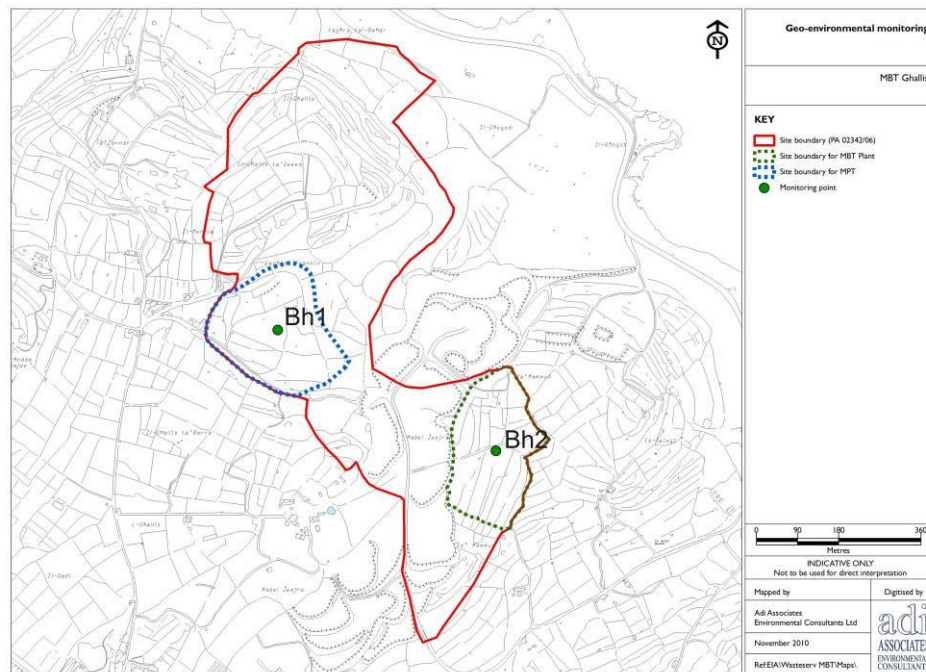


Figure 2: Map showing borehole locations

Field work was undertaken in December 2010. This comprised the drilling of two exploratory holes with continuous rock core sampling in the underlying bedrock. Drilling operations are summarised in Table 1 below. Drilling logs are found in Appendix A.

Table 1: Borehole drilling summary

| | BH 1 | BH 2 |
|----------------------|--------------|--------------|
| Coordinates | | |
| O/H | 0.0 | 0.0 |
| Bedrock | Ground level | Ground level |
| Core sampling | 0.0-40.65 | 0.0-40.0 |
| O/H | 40.65-45.0 | 40.0-45.0 |
| TD | 45.0 | 45.0 |

It is pertinent to note that depths are measured in metres (m) from ground level.

3.2 Results - Lithostratigraphy

The rock units encountered during the subsurface investigation are:

- Lower Globigerina Limestone Formation
 - Lower Globigerina Limestone Member
- Lower Coralline Limestone Formation
 - Xlendi Member
 - Attard Member

3.3 Boreholes

The results of the Borehole investigation are summarised in **Table 2** below and illustrated in **Figure 3**. Logs of the samples recovered are found in **Appendix B**. Photographs of sample recovered are attached at the end of the report.

| BH No | BH1 | BH2 | Sample description |
|------------------------------------|-----------|-----------|--|
| | | | |
| | | | |
| Lower Globigerina Limestone | 0.0-12.6 | 0.0-7.6 | Pale yellow, massive bedded bioturbated, soft medium to fine moderately weak limestone |
| Xlendi Mb | 12.6-21.3 | 7.6-15.4 | Coarse to very coarse brown to light brown faintly cross-bedded calcarenite with <i>Scutella</i> fragments |
| Attard Member | 21.3-45.0 | 15.4-45.0 | Pale brown to white chalky massive bedded algal limestone moderately weak to weak. Very weak at the bottom hole levels |
| Water level | 38.7 | 43.6 | |
| TD | 45.0 | 45.0 | |

Table 2: BH sampling summary

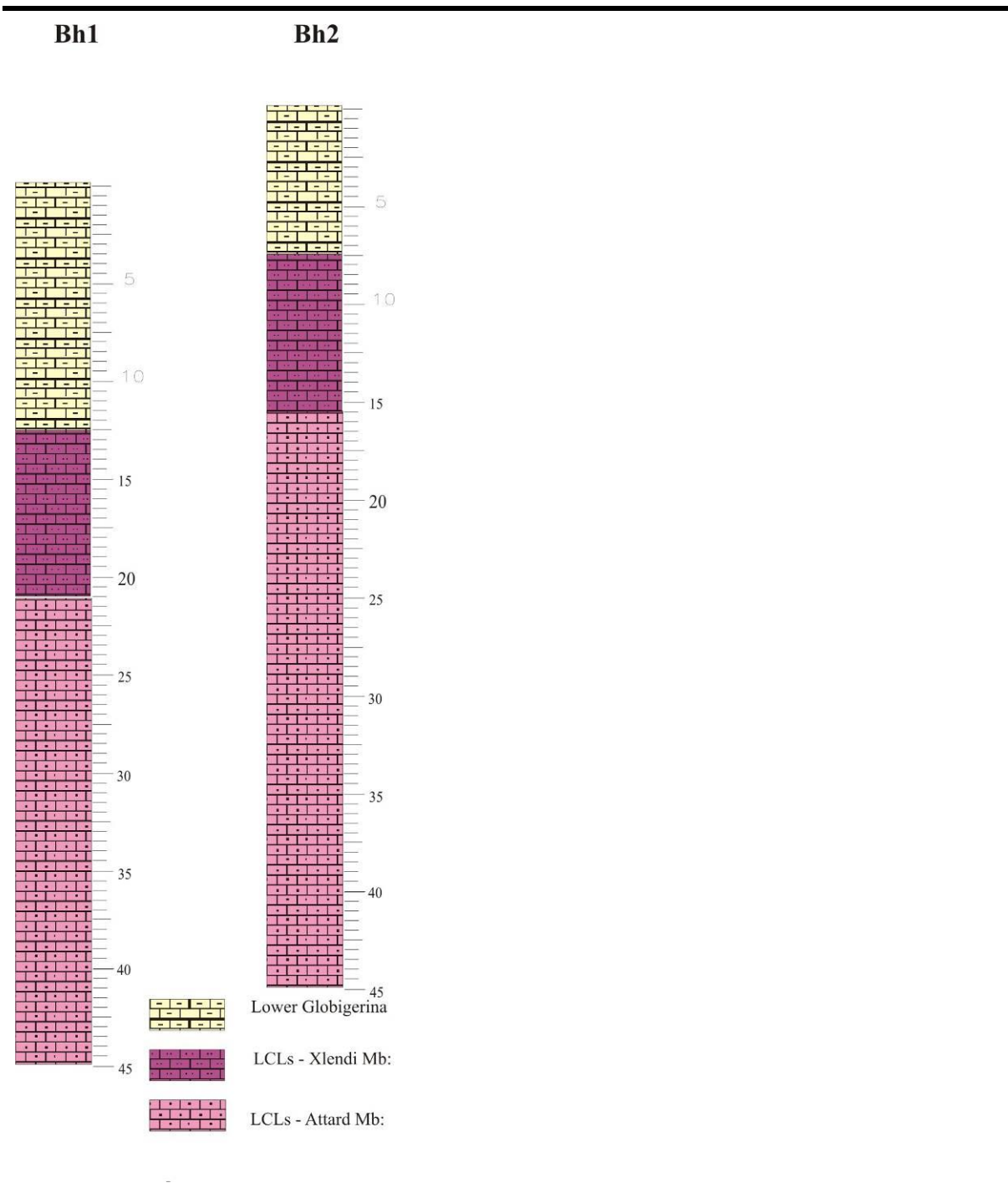


Figure 3: Borehole log correlation

3.4 Rock Quality

The quality of the core samples recovered and the solid core recovery are listed in Table 2. Generally, these were very good to excellent. However as the rock becomes very weak at depth the % SCR deteriorates in the last 3 runs. Though the rock quality is very good the Lower Coralline Limestone stone material tested makes a poor to very poor hard stone for the production of aggregate.

Table 3: Listing of Core recovery, Solid Core recovery and Rock Quality Designation

| Run No | BH 1 | | | BH2 | | |
|--------|------|-----|-----|-----|-----|-----|
| | Rec | SCR | RQD | Rec | SCR | RQD |
| | % | % | % | % | % | % |
| 1 | 67 | 25 | 33 | 100 | 100 | 95 |
| 2 | 100 | 83 | 95 | 100 | 100 | 95 |
| 3 | 100 | 100 | 100 | 100 | 100 | 100 |
| 4 | 100 | 100 | 100 | 100 | 100 | 100 |
| 5 | 100 | 100 | 100 | 100 | 100 | 100 |
| 6 | 100 | 80 | 80 | 100 | 100 | 90 |
| 7 | 100 | 100 | 93 | 100 | 100 | 87 |
| 8 | 100 | 100 | 70 | 100 | 100 | 100 |
| 9 | 100 | 100 | 100 | 100 | 100 | 100 |
| 10 | 100 | 100 | 100 | 100 | 100 | 93 |
| 11 | 100 | 100 | 100 | 100 | 100 | 87 |
| 12 | 100 | 100 | 91 | 100 | 100 | 73 |
| 13 | 100 | 100 | 97 | 83 | 83 | 63 |
| 14 | 100 | 100 | 75 | 100 | 100 | 80 |

4 CONCLUSIONS

Site investigation at Ghallis comprised the drilling of two holes BH1 and BH2 by continuous coring to 40m and 43m respectively. Final depth of 45m measured from ground level was reached by open hole drilling.

Visual examination of the rock core samples suggest that as in past investigations the rock core samples recovered from the Lower Coralline Limestone Formation were moderately weak to weak. The bottom hole beds were very weak.

PLATES

Note for scale core trays are 100cm long and core diameter is 71mm



Plate 1: Photograph showing rock core samples recovered from BH1 Run No 1 and Run No 2



Plate 2: Photograph showing rock core samples recovered from BH1 Run No 3 and Run No 4



Plate 3: Photograph showing rock core samples recovered from BH1 Run No 5 and Run No 6



Plate 4: Photograph showing rock core samples recovered from BH1 Run No 7 and Run No 8



Plate 5: Photograph showing rock core samples recovered from BH1 Run No 9 and Run No 10



Plate 6: Photograph showing rock core samples recovered from BH1 Run No 11 and Run No 12



Plate 7: Photograph showing rock core samples recovered from BH1 Run No 13 and Run No 14

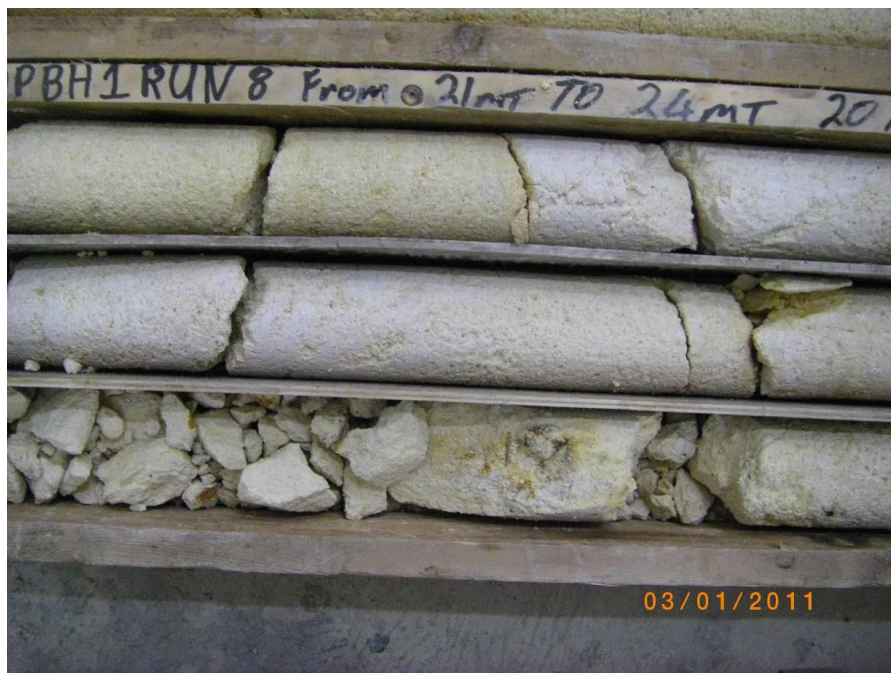


Plate 8: Photograph showing rock contact between The Xlendi and Attard Members in Run No 8



Plate 9: Photograph showing rock core samples recovered from BH2 Run No 1 and Run No 2



Plate 10: Photograph showing rock core samples recovered from BH2 Run No 3 and Run No 4



Plate 11: Photograph showing rock core samples recovered from BH2 Run No 5 and Run No 6



Plate 12: Photograph showing rock core samples recovered from BH2 Run No 7 and Run No 8



Plate 13: Photograph showing rock core samples recovered from BH2 Run No 9 and Run No 10



Plate 14: Photograph showing rock core samples recovered from BH2 Run No 11 and Run No 12



Plate 15: Photograph showing rock core samples recovered from BH2 Run No 13 and Run No 14

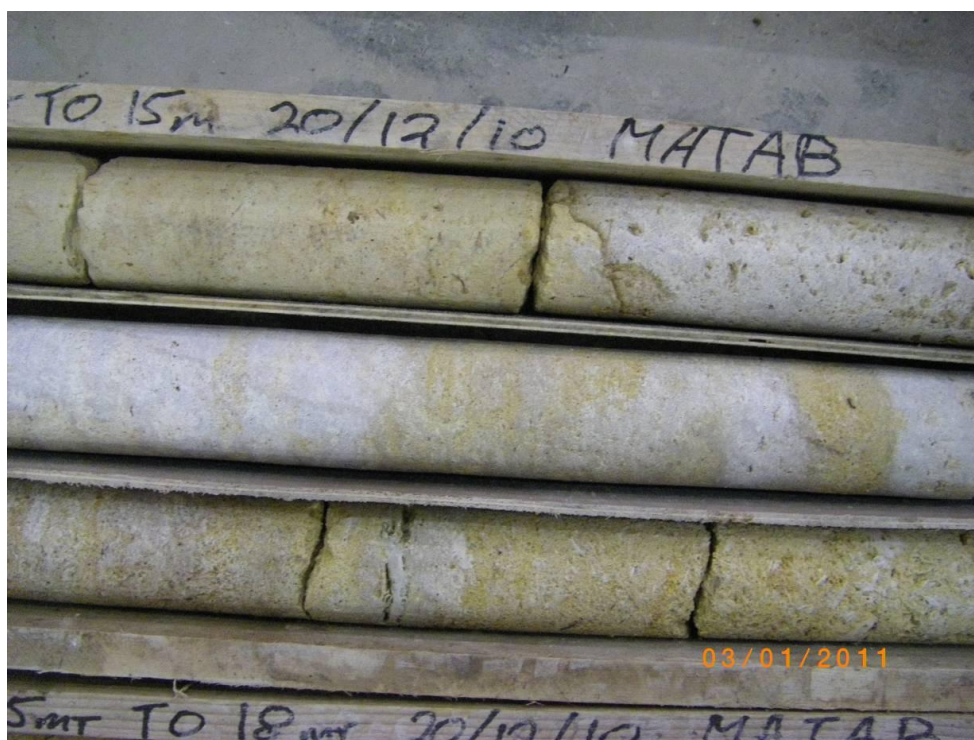



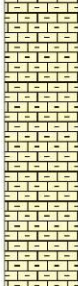

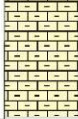




Plate 16: Photograph showing rock contact between Xlendi and Attard Members in BH2

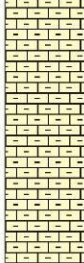






APPENDIX 01 – DRILLING LOGS





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|--------------------------|-----------|---|------------------------|--------------------------|-------------------------|------------------------|
| Location: Maghtab | | Drilling Fluid: | | | Job No: 1 | |
| Area Maghtab | | Drill: Standard Core Barrel | | | Date: 12/20/2010 | |
| From | TO | DESCRIPTION | Core Run Length | Core Run Recovery | Circulation | Core Recovery % |
| 0.00 | 3.00 | Started coring Run 1. Drilled with cream returns. Lost returns at 1m. | 3.00 | 2.00 | Lost | 67% |
| 3.00 | 6.00 | Started coring Run 2. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 6.00 | 9.00 | Started coring Run 3. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 9.00 | 12.00 | Started coring Run 4. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 12.00 | 15.00 | Started coring Run 5. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 15.00 | 18.00 | Started coring Run 6. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 18.00 | 21.00 | Started coring Run 7. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 21.00 | 24.00 | Started coring Run 8. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 24.00 | 27.00 | Started coring Run 9. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 27.00 | 30.00 | Started coring Run 10. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 30.00 | 33.00 | Started coring Run 11. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 33.00 | 36.00 | Started coring Run 12. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 36.00 | 39.00 | Started coring Run 13. Drilled with no returns. | 3.00 | 3.00 | Full | 100% |
| 39.00 | 40.65 | Started coring Run 14. Drilled with no returns. | 1.65 | 1.65 | Full | 100% |
| | | | | | Full | |
| | | | | | | |
| | | Drilled open hole from 40.65m to 45m | | | | |
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| | | Water level at 38m | | | | |
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Ghallis Geotechnical Investigation – Factual Report

APPENDIX 02 – CORE LOGS

| | Rotary Borehole Log | | | | P1 of 5 | | BH 01 | |
|---|---|-------------|---------|-------|--|-------|-------|--------------|
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | Date Started: 20/12/2010 Date Completed: | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | Coords. _____ | | | |
| Drill type B40L 22 - rotary | Drilling Fluid: Water | | | | Ground Level: +??m OD (approx) Water level: 38.7m | | | |
| Description | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns |
| Lower Globigerina Limestone Member Cream to yellow fine limestone massive bedded moderately weak with rare recrystallised bands 15 sub horizontal and 2 oblique fractures Planes coated with caliche |  | 1 2 3 | R1 3 | 67 | 25 | 33 | 5 | Full lost |
| Lower Globigerina Limestone Member Cream to yellow fine limestone massive bedded moderately weak 2 sub horizontal 7 oblique and 1 sub vertical fractures filled with terra rossa |  | 4 5 6 | R2 3 | 100 | 83 | 95 | 3 | lost |
| Cream to yellow fine limestone massive bedded moderately weak with 2 recrystallised bands each about 3cm thick 1 oblique and 1 sub vertical fractures carry a yellow stain |  | 7 8 9 | R3 3 | 100 | 100 | 100 | 0.6 | lost |
| 1 oblique fracture planes carry a yellow stain |  | 10 | R4 3 | 100 | 100 | 100 | 0.3 | lost |
| Legend | Lithology | | | | | | | |
| BGL: Below ground level f: Fracture frequency/m CR: Core recovery% SCD: Solid core recovery — End of core run Depths are measured in metres from ground level |  Lower Globigerina Limestone Mb: Medium to fine yellow, soft foraminiferal limestone, Moderately weak to moderately strong  LCLs - Xlendi Mb: Very coarse calcarenite, brown, bioclastic, porous, bedded, massive moderately weak to moderately strong  LCLs - Attard Mb: Calcirudite, Rhodalgall limestone, white to light brown or grey massive Moderately strong  LCLs - Attard Mb: Calcirudite, fragmental algal limestone, white massive moderately weak to moderately strong | | | | | | | |

| | | | | | | | | |
|---|---|--|-------------|---------|--------------------------|----------|---------|---------|
| | Rotary Borehole Log | | | | P2 of 5 | BH 01 | | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | Date Started: 20/12/2010 | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | Coords. _____ | | | |
| Drill type B40L 22 - rotary | Drilling Fluid: Water | | | | Water level: | | | |
| Description | Lithology | Depth m | Run m | | RQD % | SCR % | f/m | Returns |
| Lower Globigerina Limestone Member 10.8 to 10.9m: Phosphate pebble bed |  | 11 12 | 3 | 100 | 100 | 100 | | lost |
| Lower Coralline Limestone - Xlendi Mb Brown , massive, porous LIMESTONE Calcarenite, bioclastic very coarse, moderately weak to moderately strong, faint cross-bedding visible 1 Oblique fracture Planes coated with a green clay |  | 13 14 15 16 17 18 | R5 3 | 100 | 100 | 100 | 0.3 | lost |
| |  | 19 | R7 | 100 | 100 | 93 | 0.6 | lost |
| 2 Oblique fractures Planes clean | | | | | | | | |
| Legend | | Lithology | | | | | | |
| BGL: Below ground level f: Fracture frequency/m CR: Core recovery% SCD: Solid core recovery _____ End of core run Depths are measured in metres from ground level | |  Lower Globigerina Limestone Mb: Medium to fine yellow,soft foraminiferal limestone, Moderately weak to moderately strong  LCLs - Xlendi Mb: Very coarse calcarenite, brown, bioclastic, porous, bedded, massive moderately weak to moderately strong  LCLs - Attard Mb: Calcirudite, Rhodalgall limestone, white to light brown or grey massive Moderately strong  LCLs - Attard Mb: Calcirudite, fragmental algal limestone, white massive moderately weak to moderately strong | | | | | | |



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|---|---|---|-------|-------|--|-------|-----|---------|
| | Rotary Borehole Log | | | | P3 of 5 | BH 01 | | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | Date Started: 20/12/2010 | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | Coords. _____ | | | |
| Drill type B40L 22 - rotary | Drilling Fluid: Water | | | | Ground Level: +??m OD (approx) Water level: | | | |
| Description | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns |
| | | 21 | | | | | | lost |
| Lower Coralline Limestone - Attard Member Fragmental algal LIMESTONE very coarse, light brown to white masssive, moderately weak to , calcarenite/calcirudite moderately strong. | | 22 | | | | | | |
| | | R8 | 3 | 100 | 100 | 70 | 0.6 | |
| 1 vertical and 1 oblique fracture faces carry a yellow stain | | 23 | | | | | | lost |
| | | 24 | | | | | | |
| 1 oblique fracture faces carry a yellow stain | | 25 | | | | | | |
| | | R9 | 3 | 100 | 100 | 100 | 0.3 | lost |
| | | 26 | | | | | | |
| Calcirudite white algal weak. | | 27 | | | | | | lost |
| | | 28 | | | | | | |
| 2 oblique fractures faces clean | | | 3 | 100 | 100 | 100 | 0.6 | |
| | | R10 | | | | | | |
| | | 29 | | | | | | |
| | | 30 | | | | | | |
| Legend | | Lithology | | | | | | |
| BGL: Below ground level | |  LCLs - Wied Maghlaq Member: White to light yellow soft finelimestone weak | | | | | | |
| f: Fracture frequency/m | |  LCLs - Xlendi Mb: Very coarse calcarenite, brown, bioclastic, porous, bedded, massive moderately strong | | | | | | |
| CR: Core recovery% | |  LCLs - Attard Mb: Calcirudite, Rhodalgal limestone, white to light brown or grey massive Moderatelyweak to moderately strong | | | | | | |
| SCD: Solid core recovery | |  LCLs - Attard Mb: Calcirudite, fragmental algal limestone, white massive moderately weak to moderately strong | | | | | | |
| _____ End of core run | | | | | | | | |
| Depths are measured in metres from ground level | | | | | | | | |

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|---|---|--|---------|-------|-------|--|-----|-----------|---------|------|
| | Rotary Borehole Log | | | | | P4 of 5 | | BH 01 | | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | | Date Started: 20/12/2010 | | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | | Coords. _ | | | | |
| | Drilling Fluid: Water | | | | | Ground Level: +??m OD (approx) Water level: | | | | |
| Description | | Lith-ology | Depth m | Run m | C R % | SCR% | f/m | Drlg prog | Returns | |
| Fragmental algal limestone as above with scattered algal rhodoliths few cm diameter moderately weak to weak | |  | 31 | 3 | 100 | 100 | 100 | 0.3 | lost | |
| 1 vertical fracture | | | 32 | | | | | | | |
| | | | | 33 | 3 | 100 | 100 | 96 | 0 | lost |
| White to light brown rhodolithic limestone massive moderately weak to weak | | | 34 | | | | | | | |
| | |  | 35 | 3 | 100 | 100 | 97 | 0 | lost | |
| | | | | | | | | | | 36 |
| One subvertical fracture faces coated with yellow clay | | | | 37 | 1.65 | 100 | 100 | 75 | 0 | lost |
| | | | 38 | | | | | | | |
| | | | 39 | | | | | | | |
| | | | 40 | | | | | | | |
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
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|--|--|---|----------|----------|--|----------|-------|---------|
| | Rotary Borehole Log | | | | P5 of 5 | | BH 01 | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | Date Started: 20/12/2010 | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | Coords. _ | | | |
| | Drilling Fluid: Water | | | | Ground Level: +??m OD (approx) Water level: | | | |
| Description | Lithology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns |
| Attard Member weak rhodolithic limestone weak One subvertical fracture faces coated with yellow clay Core sampling terminated at 40.65m Borehole terminated at 45.0 BGL |  | <div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><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|--|---|--|--|----------|----------|----------|----------|-----|---------|------|
| | Rotary Borehole Log | | P1 of 5 | | BH 02 | | | | | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | Date Started: 23/12/2010 Date Completed: | | | | | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | Coords. _____ | | | | | | | |
| Drill type B40L 22 - rotary | Drilling Fluid: Water | | Ground Level: +??m OD (approx) Water level: 43.6m | | | | | | | |
| Description | | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns | |
| Lower Globigerina Limestone Member Cream to yellow fine limestone massive bedded moderately weak bioturbated | | | 1 | 3 | 100 | 100 | 95 | 1.3 | Full | |
| 4 subhorizontal fractures planes coated with pink caliche | | | 2 | | | | | | lost | |
| | | | 3 | 3 | 100 | 100 | 95 | 2 | lost | |
| 6 oblique fractures, planes coated with red brown clay | | | 4 | | | | | | | |
| | | | 5 | | | | | | | |
| | | | 6 | 3 | 100 | 100 | 100 | 1.6 | lost | |
| One vertical 2 oblique and 2 sub horizontal fractures planes coated with orange stain 3cm thick phosphate pebble bed at 15.3m BGL | | 7 | | | | | | | | |
| Lower Coralline Limestone - Xlendi Mb Brown , massive, porous LIMESTONE Calcarenite, bioclastic very coarse, moderately weak to moderately strong, faint cross-bedding visible | | | 8 | 3 | 100 | 100 | 100 | 0.3 | lost | |
| | | | 9 | | | | | | | |
| One oblique fracture planes strongly weathered and friable | | | 10 | R4 | 3 | 100 | 100 | 100 | 0.3 | lost |
| | | | | | | | | | | |
| Legend | | Lithology | | | | | | | | |
| BGL: Below ground level | | | | | | | | | | |
| f: Fracture frequency/m | | Lower Globigerina Limestone Mb: Medium to fine yellow,soft foraminiferal limestone, Moderately weak to moderately strong | | | | | | | | |
| CR: Core recovery% | | | | | | | | | | |
| SCD: Solid core recovery | | LCLs - Xlendi Mb: Very coarse calcarenite, brown, bioclastic, porous, bedded, massive moderately weak to moderately strong | | | | | | | | |
| End of core run | | | | | | | | | | |
| Depths are measured in metres from ground level | | LCLs - Attard Mb: Calcirudite, Rhodalgall limestone, white to light brown or grey massive Moderately strong | | | | | | | | |
| | | | | | | | | | | |
| | | LCLs - Attard Mb: Calcirudite, fragmental algal limestone, white massive moderately weak to moderately strong | | | | | | | | |

| | | | | | | | | | |
|--|---|------------------|----------|----------|--------------------------|----------|-----|---------|--|
| | Rotary Borehole Log | | | | P2 of 5 | BH 02 | | | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | Date Started: 23/12/2010 | | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | Coords. _____ | | | | |
| Drill type B40L 22 - rotary | Drilling Fluid: Water | | | | Water level: | | | | |
| Description | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns | |
| Lower Coralline Limestone - Xlendi Mb Brown , massive, porous LIMESTONE Calcarenite, bioclastic very coarse, moderately weak to moderately strong, faint cross-bedding visible | | 11 | 3 | 100 | 100 | 100 | | lost | |
| 1 vertical fracture planes carry a red stain | | 12 | | | | | | | |
| | | 13 | | | | | | | |
| | | R5 | | | | | | lost | |
| | | 14 | 3 | 100 | 100 | 100 | 0.3 | | |
| | | 15 | | | | | | | |
| Lower Coralline Limestone - Attard Mb White to pale brown , massive, porous LIMESTONE Algal Calcirudite, moderately weak | | 16 | | | | | | lost | |
| 2 oblique fractures planes weathered | | 17 | 3 | 100 | 100 | 90 | 0.6 | | |
| | | 18 | | | | | | | |
| 2 vertical fractures irregular planes carry a red stain | | R7 | 3 | 100 | 100 | 87 | 0.6 | lost | |
| | | 19 | | | | | | | |
| | | 20 | | | | | | | |
| Legend | | Lithology | | | | | | | |
| BGL: Below ground level | | | | | | | | | |
| f: Fracture frequency/m | | | | | | | | | |
| CR: Core recovery% | | | | | | | | | |
| SCD: Solid core recovery | | | | | | | | | |
| _____ End of core run | | | | | | | | | |
| Depths are measured in metres from ground level | | | | | | | | | |

| | | | | | | | | |
|---|---|---|--|----------|----------|----------|-----|---------|
| | Rotary Borehole Log | | P3 of 5 | | BH 02 | | | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | Date Started: 23/12/2010 | | | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | Coords. _____ | | | | | |
| Drill type B40L 22 - rotary | Drilling Fluid: Water | | Ground Level: +??m OD (approx) Water level: | | | | | |
| Description | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns |
| Fragmental algal LIMESTONE very coarse, white masssive, weak rhodolithic |  | 21 | | | | | | lost |
| | | 22 | | | | | | |
| | | R8 | 3 | 100 | 100 | 100 | 0 | |
| | | 23 | | | | | | lost |
| Fragmental algal limestone Medium to coarse calcarenite weak 2 oblique fractures planes clear |  | 24 | | | | | | |
| | | 25 | | | | | | |
| | | R9 | 3 | 100 | 100 | 100 | 0.6 | lost |
| | | 26 | | | | | | |
| |  | 27 | | | | | | |
| | | 28 | | | | | | lost |
| | | R10 | 3 | 100 | 100 | 93 | 0 | |
| | | 29 | | | | | | |
| Legend | | Lithology | | | | | | |
| BGL: Below ground level | |  LCLs - Wied Maghlaq Member: White to light yellow soft finelimestone weak | | | | | | |
| f: Fracture frequency/m | |  LCLs - Xlendi Mb: Very coarse calcarenite, brown, bioclastic, porous, bedded, massive moderately strong | | | | | | |
| CR: Core recovery% | |  LCLs - Attard Mb: Calcirudite, Rhodalgal limestone, white to light brown or grey massive Moderatelyweak to moderately strong | | | | | | |
| SCD: Solid core recovery | |  LCLs - Attard Mb: Calcirudite, fragmental algal limestone, white massive moderately weak to moderately strong | | | | | | |
| ———— End of core run | | | | | | | | |
| Depths are measured in metres from ground level | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---------|-------|--|-------|-------|-----|---------|--|
| | Rotary Borehole Log | | | | P4 of 5 | | | | BH 02 | |
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | Date Started: 23/12/2010 | | | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | Coords. _ | | | | | |
| | Drilling Fluid: Water | | | | Ground Level: +??m OD (approx) Water level: | | | | | |
| Description | | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns | |
| Attard Member weak fragmental algal limestone | |  | 31 | 3 | 100 | 100 | 87 | 0.6 | lost | |
| 1 oblique and 1 subvertical fractures | | | | | | | | | | |
| White to light brown rhodolitic limestone massive weak to very weak | | | 32 | 3 | 100 | 100 | 73 | 0 | lost | |
| | | | 33 | | | | | | | |
| | | | 34 | | | | | | | |
| | | | 35 | 3 | 83 | 83 | 63 | 0 | lost | |
| | | | 36 | | | | | | | |
| | | | 37 | | | | | | | |
| | | | 38 | 1 | 100 | 100 | 80 | 0 | | |
| | | | 39 | | | | | | | |
| | | | 40 | | | | | | | |
| Legend | | Lithology | | | | | | | | |
| BGL: Below ground level | |  LCLs - Wied Maghlaq Member: White to light yellow soft finelimestone weak | | | | | | | | |
| f: Fracture frequency/m | |  LCLs - Xlendi Mb: Very coarse calcarenite, brown, bioclastic, porous, bedded, massive moderately strong | | | | | | | | |
| CR: Core recovery% | |  LCLs - Attard Mb: Calcirudite, Rhodalgal limestone, white to light brown or grey massive Moderatelyweak to moderately strong | | | | | | | | |
| SCD: Solid core recovery | |  LCLs - Attard Mb: Calcirudite, fragmental algal limestone, white massive moderately weak to moderately strong | | | | | | | | |
| End of core run | | | | | | | | | | |
| Depths are measured in metres from ground level | | | | | | | | | | |

| | Rotary Borehole Log | | | | P5 of 5 | | BH 02 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|------------|---|----------|--|----------|-------|---------|--|-------------|------------|------------|----------|----------|----------|----------|-----|---------|--|--|--|--|--|--|--|--|------|--|--|----|-----|--|--|--|--|--|--|--|----|--|--|--|--|--|--|--|--|----|-----|--|--|--|--|------|--|--|----|--|--|--|--|--|--|---------------------------------|--|----|--|--|--|--|--|--|--|--|----|--|--|--|--|--|--|--|--|----|--|--|--|--|--|--|--|--|----|--|--|--|--|--|--|--|--|----|--|--|--|--|--|--|--|--|----|--|--|--|--|--|--|
| | Location: Ghallis ta'Gewwa Orientation: Vertical | | | | Date Started: 23/12/2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Client: AIS | Bit type/diameter: T2 86CB | | | | Coords. _ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Drilling Fluid: Water | | | | Ground Level: +??m OD (approx) Water level: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <table><thead><tr><th>Description</th><th>Lith-ology</th><th>Depth m</th><th>Run m</th><th>C R %</th><th>RQD %</th><th>SCR %</th><th>f/m</th><th>Returns</th></tr></thead><tbody><tr><td>Attard Member weak rhodolithic limestone</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>lost</td></tr><tr><td>One subvertical fracture faces coated with yellow clay</td><td></td><td>41</td><td>O/H</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>42</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>43</td><td>O/H</td><td></td><td></td><td></td><td></td><td>lost</td></tr><tr><td></td><td></td><td>44</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>Borehole terminated at 45.0 BGL</td><td></td><td>45</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>46</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>47</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>48</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>49</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>50</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table> | | | | | | | | | | Description | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns | Attard Member weak rhodolithic limestone | | | | | | | | lost | One subvertical fracture faces coated with yellow clay | | 41 | O/H | | | | | | | | 42 | | | | | | | | | 43 | O/H | | | | | lost | | | 44 | | | | | | | Borehole terminated at 45.0 BGL | | 45 | | | | | | | | | 46 | | | | | | | | | 47 | | | | | | | | | 48 | | | | | | | | | 49 | | | | | | | | | 50 | | | | | | |
| Description | Lith-ology | Depth m | Run m | C R % | RQD % | SCR % | f/m | Returns | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Attard Member weak rhodolithic limestone | | | | | | | | lost | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| One subvertical fracture faces coated with yellow clay | | 41 | O/H | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 42 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 43 | O/H | | | | | lost | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 44 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Borehole terminated at 45.0 BGL | | 45 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 46 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 47 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 48 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 49 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 50 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Legend BGL: Below ground level f: Fracture frequency/m CR: Core recovery% SCD: Solid core recovery ———— End of core run Depths are measured in metres from ground level | | | Lithology <div> LCLs - Wied Maghlaq Member: White to light yellow soft finelimestone weak</div> <div> LCLs - Xlendi Mb: Very coarse calcarenite, brown, bioclastic, porous, bedded, massive moderately strong</div> <div> LCLs - Attard Mb: Calcirudite, Rhodalgall limestone, white to light brown or grey massive Moderatelyweak to moderately strong</div> <div> LCLs - Attard Mb: Calcirudite, fragmental algal limestone, white massive moderately weak to moderately strong</div> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

PA 02342/06

Master Plan for the Maghtab Environmental Complex, Naxxar

Appendix 2

LABORATORY ANALYSIS RESULTS

Prepared by Ecoserv Ltd

Supporting Documents for
Environmental Impact Statement Update



ecoserv Ltd
12, Sir Arthur Borton Street
Mosta, MALTA

Telephone: (+356) 2143 1900
Fax: (+356) 2142 4137
Mobile: (+356) 7943 1900
e-mail: info@ecoserv.com.mt
VAT Reg no: 1623-1407

Report Reference Number: 025-11

Date of sample collection: 19 January 2011
Date of commencement of analysis: 19 January 2011
Reporting date: 25 March 2011

LABORATORY REPORT

Analysis of Groundwater & Soil Samples

Client: ADI Associates Environmental Consultants Ltd

| Groundwater samples | |
|--------------------------------------|-------------------------|
| Ecoserv Sample Reference Code | Client Reference |
| W-2256-10 | Borehole 1 |
| W-2257-10 | Borehole 2 |
| Soil samples | |
| S-480-10 | Borehole 1A |
| S-481-10 | Borehole 1B |
| S-482-10 | Borehole 2A |
| S-483-10 | Borehole 2B |

DETAILS

Client (ADI Associates) commissioned Ecoserv Ltd to carry out physico-chemical and bacteriological analysis of two samples of groundwater collected from two boreholes at Ghallis, and chemical analysis of four samples of soil collected from the same area to test for land contamination. The list of parameters analysed were those as requested in our quotation bearing reference Q-ADI-041010-GW_Soil dated 4 October 2010.

METHODOLOGY

The groundwater in-situ parameters (conductivity, dissolved oxygen and pH) were measured immediately on collection of the samples using a YSI 6820 hand-held meter connected to a multi-parameter probe unit. Samples were collected in appropriate containers depending on the type of analysis required, transported in cooler boxes and maintained at temperatures between 4 and 8°C. Analyses for chemical parameters in the groundwater and soil samples were carried out at a laboratory that is accredited to carry out chemical analysis according to the CEN/ISO 17025 standard.

RESULTS

Groundwater Bacteriology Results:

| Parameter | W-2256-10 | W-2257-10 | Units |
|--------------------------------------|-----------|-----------|--------------|
| Total coliforms | TNTC* | TNTC* | c.f.u./100mL |
| <i>Escherichia coli</i> | TNTC* | TNTC* | c.f.u./100mL |
| <i>Candida albicans</i> | Absent | Absent | - |
| <i>Bacillus stearothermophilus</i> # | Absent | Absent | - |
| <i>Listeria monocytogenes</i> | Absent | Absent | - |

* Too Numerous To Count

Growth of *Bacillus* sp. resulted in the preliminary test, however, results of the confirmatory test show that this was not *Bacillus stearothermophilus*.

Groundwater Physico-chemical Results:

| Parameter | W-2256-10 | W-2257-10 | Units |
|------------------|-----------|-----------|-------|
| Conductivity | 2505 | 1029 | µS/cm |
| Dissolved Oxygen | 84.8 | 104.0 | % |
| pH | 7.52 | 7.89 | - |

Groundwater detailed chemical analysis:

Please refer to Appendix 1 for the results of chemical analysis.

Soil detailed chemical analysis:

Please refer to Appendix 2 for the results of chemical analysis.



Analysis checked by:
Jackie Barbara BSc(Hons)
Environmental Scientist



Analysis approved by:
Sarah Debono BSc (Hons), MSc
Project Manager

Appendix 1

Results of Groundwater Chemical Analysis



Rapporto di
prova n°:

2102328-003

Descrizione:

Groundwater W-2256-10 -ECOSERV LTD.

**Spettabile:
ECOSERV LTD.
12, Sir Arthur Borton Str.
Mosta, MST 1881**

Accettazione:

2102328

Data Campionamento:

20-gen-11

Data Arrivo Camp.:

20-gen-11

Data Inizio Prova:

21-gen-11

Data Rapp. Prova:

08-feb-11

Data Fine Prova:

08-feb-11

Mod.Campionam.:

Customer's Discretion

Riferim. dei limiti:

///

| Prova | U.M | Metodo | Risultato | Incertezza | Recupero | L.Min. | L.Max. |
|----------------------------|------|----------------------------------|-----------|------------|----------|--------|--------|
| CHEMICAL PARAMETERS | | | | | | | |
| Arsenico | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Arsenic | | | | | | | |
| Calcio | mg/l | APAT CNR IRSA 3130 A Man 29 2003 | 125,8 | | | | |
| Calcium | | | | | | | |
| Cadmio | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 0,1 | | | | |
| Cadmium | | | | | | | |
| Cromo | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Chromium | | | | | | | |
| Rame | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Copper | | | | | | | |
| Mercurio | µg/l | EPA 3015A 2007 + EPA 6010C 2007 | < 0,1 | | | | |
| Mercury | | | | | | | |
| Ferro | µg/l | APAT CNR IRSA 3020 Man 29 2003 | 3 | | | | |
| Iron | | | | | | | |
| Manganese | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Manganese | | | | | | | |
| Nichel | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Nickel | | | | | | | |
| Piombo | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Lead | | | | | | | |
| Selenio | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Selenium | | | | | | | |
| Zinco | µg/l | APAT CNR IRSA 3020 Man 29 2003 | 10 | | | | |
| Zinc | | | | | | | |

(*) = Le prove così contrassegnate a fianco del risultato, non sono Accreditate da ACCREDIA
I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero.



Segue Rapporto di
prova n°: **2102328-003**

| Prova | U.M | Metodo | Risultato | Incertezza | Recupero | L.Min. | L.Max. |
|--|------|--|-----------|------------|----------|--------|--------|
| Magnesio <i>Magnesium</i> | mg/l | APAT CNR IRSA 3180 A Man 29 2003 | 32,7 | | | | |
| Cloruri <i>Chloride</i> | mg/l | EPA 300.1 1999 | 621 | | | | |
| BOD5 <i>BOD5</i> | mg/l | APAT CNR IRSA 5120 B1 Man 29 2003 | 5 | | | | |
| COD <i>COD</i> | mg/l | APAT CNR IRSA 5130 Man 29 2003 | 55,4 | | | | |
| Azoto Kieldahl <i>Kjeldahl Nitrogen</i> | mg/l | APAT CNR IRSA 5030 Man 29 2003 | 0,56 | | | | |
| Nitrati <i>Nitrates</i> | mg/l | EPA 300.1 1999 | 120 | | | | |
| Fosforo <i>Phosphorus</i> | mg/l | APAT CNR IRSA 4110 Man 29 2003 | < 0,01 | | | | |
| Solfuri <i>Sulphides</i> | mg/l | APAT CNR IRSA 4160 Man 29 2003 | < 1 | | | | |
| Solfati <i>Sulphates</i> | mg/l | EPA 300.1 1999 | 118 | | | | |
| Azoto ammoniacale <i>Ammoniacal Nitrogen</i> | mg/l | APAT CNR IRSA 4030 A1 Man 29 2003 | 0,16 | | | | |
| Potassio <i>Potassium</i> | mg/l | APAT CNR IRSA 3240 Man 29 2003 | 17,3 | | | | |
| Sodio <i>Sodium</i> | mg/l | APAT CNR IRSA 3270 Man 29 2003 | 326,4 | | | | |
| Solidi sospesi totali <i>Total Suspended Solids</i> | mg/l | APAT CNR IRSA 2090 B Man 29 2003 | 2222 | | | | |
| Fenoli <i>Total Phenols</i> | mg/l | APAT CNR IRSA 5070 A1 Man 29 2003 | < 0,01 | | | | |
| Solidi totali disciolti <i>Total Dissolved Solids</i> | mg/l | APAT CNR IRSA 2090 A Man 29 2003 | 1405 | | | | |
| Alcalinità <i>Alkalinity</i> | mg/l | APAT CNR IRSA 2010 Man 29 2003 | 218,9 | | | | |
| Fenolo <i>Phenol</i> | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |
| 2-Metil fenolo <i>2-Methyl phenol</i> | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |

(*) = Le prove così contrassegnate a fianco del risultato, non sono Accreditate da ACCREDIA
I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero.



Segue Rapporto di
prova n°:

2102328-003

| Prova | U.M | Metodo | Risultato | Incertezza | Recupero | L.Min. | L.Max. |
|---------------------------|------|--|-----------|------------|----------|--------|--------|
| 4-Metil fenolo | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |
| 4-Methyl phenol | | | | | | | |
| 2,4-Dimetil fenolo | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |
| 2,4-Dimethyl phenol | | | | | | | |
| 1,4-Diclorobenzene | µg/l | EPA 3510C 1996 + EPA 8270D 2007 | < 0,01 | | | | |
| 1,4-Dichlorobenzene | | | | | | | |
| 2-Metil naftalene | µg/l | APAT CNR IRSA 5080 Man 29 2003 | < 0,001 | (*) | | | |
| 2-Metyl naphthalene | | | | | | | |
| Dietil-ftalato | µg/l | EPA 3535A 2007 + EPA 8061A 1996 | < 0,01 | (*) | | | |
| Diethyl Phtalate | | | | | | | |
| Bis-ftalato | µg/l | EPA 3535A 2007 + EPA 8061A 1996 | < 0,01 | (*) | | | |
| Bis-(2-Ethylexyl)Phtalate | | | | | | | |
| Naftalene | µg/l | APAT CNR IRSA 5080 Man 29 2003 | < 0,001 | | | | |
| Cis-1,2-dicloroetilene | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,1 | | | | |
| Cloroformio | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,1 | | | | |
| Chloroform | | | | | | | |
| Tricloroetano | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| Trichloroethane | | | | | | | |
| 1,1,1-Tricloroetano | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| 1,1,1 Trichloroethane | | | | | | | |
| TBT | mg/l | UNI EN ISO 17353:2006 | < 0,001 | (*) | | | |
| TBT | | | | | | | |
| TPT | mg/l | UNI EN ISO 17353:2006 | < 0,001 | (*) | | | |
| TPT | | | | | | | |
| DBT | mg/l | UNI EN ISO 17353:2006 | < 0,001 | (*) | | | |
| DBT | | | | | | | |

(*) = Le prove così contrassegnate a fianco del risultato, non sono Accreditate da ACCREDIA
I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero.

Continuation of
Test Report n°:

2102328-003

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|-------|--------|--------|--------|-------------|----------|--------|--------|
|-------|--------|--------|--------|-------------|----------|--------|--------|

< Not Detectable because lower than detection limit of the method.

The sample is stored for two weeks unless particular disposition of the law

When indicated the uncertainty of the measure, it is expressed in the same unit of measurement of the test performed:

- ☐ At probability of the measure of 95% and a coverage factor $K=2$ for the chemical tests ;
- At Reproducibility Deviation SR, with uncertainty U equal to SR and a coverage factor $K=2$ for the microbiological tests on food.
- At confidence interval with probability of the measure of 95% and a coverage factor $K=2$ for the microbiological tests on water.

This Test report is relative to the sample subordinate to test and it cannot be reproduced without the permission of the Laboratory.

This Test report is relative to the sample subordinate to test and it cannot be reproduced without written approval from of the C.A.D.A s.n.c.
The records of testing of this sample are kept for a minimum of 10 years.

The records of testing of this sample are kept for a minimum period of 4 years.

Il Responsabile Tecnico del Laboratorio
(dott. Giuseppe Rocca)

Il Responsabile Tecnico del Laboratorio
(dott. Giuseppe Rocca)

Il Rappresentante Legale
(dott. Fulvio Di Vito)

Il Rappresentante

Il Direttore dell'Area Analitica
(dott.ssa Margherita Bugello)

Il Direttore dell'Area Agricoltura
(dott.ssa Margherita Bugello)

(*) = Le prove così contrassegnate a fianco del risultato, non sono Accreditate da ACCREDIA / The evidence thus marked by side with the result, are not accredited by ACCREDIA

I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero / Parameters marked with the letter 'C' have been corrected for recovery

► I parametri contraddistinti dal simbolo a lato sono fuori limite / The parameters marked with the symbol on the side are out of bounds.

● I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Test Report n°:

2102328-004

Description:

Groundwater W-2257-10 -ECOSERV LTD.

Client:

**ECOSERV LTD.
12, Sir Arthur Borton Str.
Mosta, MST 1881**

Reception n°:

2102328

Sampling Date:

20-gen-11

Sample Reception Date:

20-gen-11

Test Start Date: **21-gen-11**

Test Report Date:

08-feb-11

Test Finish Date: **08-feb-11**

Sampling Method:

Customer's Discretion

Reference for the Limits:

///

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|-------------------------------|--------|----------------------------------|--------|-------------|----------|--------|--------|
| CHEMICAL PARAMETERS | | | | | | | |
| Arsenico <i>Arsenic</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Calcio <i>Calcium</i> | mg/l | APAT CNR IRSA 3130 A Man 29 2003 | 113,9 | | | | |
| Cadmio <i>Cadmium</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 0,1 | | | | |
| Cromo <i>Chromium</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Rame <i>Copper</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Mercurio <i>Mercury</i> | µg/l | EPA 3015A 2007 + EPA 6010C 2007 | < 0,1 | | | | |
| Ferro <i>Iron</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Manganese <i>Manganese</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | 1 | | | | |
| Nichel <i>Nickel</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | 5 | | | | |
| Piombo <i>Lead</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |
| Selenio <i>Selenium</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | < 1 | | | | |

- (*) = Le prove così contrassegnate a fianco del risultato, non sono Accreditate da ACCREDIA / The evidence thus marked by side with the result, are not accredited by ACCREDIA
- ▶ I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero / Parameters marked with the letter 'C' have been corrected for recovery
- I parametri contraddistinti dal simbolo a lato sono fuori limite / The parameters marked with the symbol on the side are out of bounds
- I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Continuation of
Test Report n°:

2102328-004

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|--|--------|--|--------|-------------|----------|--------|--------|
| Zinco <i>Zinc</i> | µg/l | APAT CNR IRSA 3020 Man 29 2003 | 42 | | | | |
| Magnesio <i>Magnesium</i> | mg/l | APAT CNR IRSA 3180 A Man 29 2003 | 13,8 | | | | |
| Cloruri <i>Chloride</i> | mg/l | EPA 300.1 1999 | 210 | | | | |
| BOD5 <i>BOD5</i> | mg/l | APAT CNR IRSA 5120 B1 Man 29 2003 | 10 | | | | |
| COD <i>COD</i> | mg/l | APAT CNR IRSA 5130 Man 29 2003 | 24,4 | | | | |
| Azoto Kieldahl <i>Kjeldahl Nitrogen</i> | mg/l | APAT CNR IRSA 5030 Man 29 2003 | 1,06 | | | | |
| Nitrati <i>Nitrates</i> | mg/l | EPA 300.1 1999 | 27,6 | | | | |
| Fosforo <i>Phosphorus</i> | mg/l | APAT CNR IRSA 4110 Man 29 2003 | < 0,01 | | | | |
| Solfuri <i>Sulphides</i> | mg/l | APAT CNR IRSA 4160 Man 29 2003 | < 1 | | | | |
| Solfati <i>Sulphates</i> | mg/l | EPA 300.1 1999 | 43,6 | | | | |
| Azoto ammoniacale <i>Ammoniacal Nitrogen</i> | mg/l | APAT CNR IRSA 4030 A1 Man 29 2003 | 0,26 | | | | |
| Potassio <i>Potassium</i> | mg/l | APAT CNR IRSA 3240 Man 29 2003 | 3,7 | | | | |
| Sodio <i>Sodium</i> | mg/l | APAT CNR IRSA 3270 Man 29 2003 | 85,5 | | | | |
| Solidi sospesi totali <i>Total Suspended Solids</i> | mg/l | APAT CNR IRSA 2090 B Man 29 2003 | 1163 | | | | |
| Fenoli <i>Total Phenols</i> | mg/l | APAT CNR IRSA 5070 A1 Man 29 2003 | < 0,01 | | | | |
| Solidi totali disciolti | mg/l | APAT CNR IRSA 2090 A Man 29 2003 | 538 | | | | |
| Alcalinità <i>Alkalinity</i> | mg/l | APAT CNR IRSA 2010 Man 29 2003 | 172,7 | | | | |
| Fenolo | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |
| 2-Metil fenolo <i>2-Methyl phenol</i> | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |

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I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero / Parameters marked with the letter 'C' have been corrected for recovery
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Continuation of
Test Report n°:

2102328-004

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|--|--------|--|---------|-------------|----------|--------|--------|
| 4-Metil fenolo <i>4-Methyl phenol</i> | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |
| 2,4-Dimetil fenolo <i>2,4-Dimethyl phenol</i> | µg/l | APHA Standard Methods, ed 21 th 2005, 6410 B | < 0,01 | | | | |
| 1,4-Diclorobenzene <i>1,4-Dichlorobenzene</i> | µg/l | EPA 3510C 1996 + EPA 8270D 2007 | < 0,01 | | | | |
| 2-Metil naftalene <i>2-Metyl naphthalene</i> | µg/l | APAT CNR IRSA 5080 Man 29 2003 | < 0,001 | (*) | | | |
| Dietil-ftalato <i>Bis-phthalate</i> | µg/l | EPA 3535A 2007 + EPA 8061A 1996 | < 0,01 | (*) | | | |
| Bis-ftalato <i>Bis-phthalate</i> | µg/l | EPA 3535A 2007 + EPA 8061A 1996 | < 0,01 | (*) | | | |
| Naftalene | µg/l | APAT CNR IRSA 5080 Man 29 2003 | < 0,001 | | | | |
| Cis-1,2-dicloroetilene | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,1 | | | | |
| Cloroformio <i>Chloroform</i> | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,1 | | | | |
| Tricloroetano <i>Trichloroethane</i> | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| 1,1,1-Tricloroetano | µg/l | EPA 5030C 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| TBT <i>TBT</i> | mg/l | UNI EN ISO 17353:2006 | < 0,001 | (*) | | | |
| TPT <i>TPT</i> | mg/l | UNI EN ISO 17353:2006 | < 0,001 | (*) | | | |
| DBT <i>DBT</i> | mg/l | UNI EN ISO 17353:2006 | < 0,001 | (*) | | | |

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Continuation of
Test Report n°:

2102328-004

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|-------|--------|--------|--------|-------------|----------|--------|--------|
|-------|--------|--------|--------|-------------|----------|--------|--------|

< Not Detectable because lower than detection limit of the method.

The sample is stored for two weeks unless particular disposition of the law

When indicated the uncertainty of the measure, it is expressed in the same unit of measurement of the test performed:

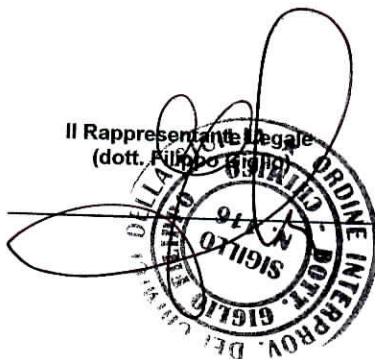
- At probability of the measure of 95% and a coverage factor $K=2$ for the chemical tests ;
- At Reproducibility Deviation SR, with uncertainty U equal to SR and a coverage factor $K=2$ for the microbiological tests on food.
- At confidence interval with probability of the measure of 95% and a coverage factor $K=2$ for the microbiological tests on water.

This Test report is relative to the sample subordinate to test and it cannot be reproduced without written approval from of the C.A.D.A s.n.c.

The records of testing of this sample are kept for a minimum period of 4 years.

Il Responsabile Tecnico del Laboratorio
(dott. Giuseppe Rocca)

Il Rappresentante Legale
(dott. Filippo Giglio)



Il Direttore dell'Area Analitica
(dott.ssa Margherita Ruggeri)



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Appendix 2

Results of Soil Chemical Analysis



Test Report n°:

2102328-005

Description:

Soil S-480-10 ECOSERV LTD.

Client:

**ECOSERV LTD.
12, Sir Arthur Borton Str.
Mosta, MST 1881**

Reception n°:

2102328

Sampling Date:

20-gen-11

Sample Reception Date:

20-gen-11

Test Start Date:

21-gen-11

Test Report Date:

08-feb-11

Test Finish Date:

08-feb-11

Sampling Method:

Customer's Discretion

Reference for the Limits:

///

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|---|--------|---|---------|-------------|----------|--------|--------|
| PARAMETRI CHIMICI | | | | | | | |
| CHEMICAL TESTS | | | | | | | |
| TOC | % | UNI EN 13137:2002 | 2,3 | | | | |
| TOC | | | | | | | |
| Sostanze volatili | % | CNR IRSA 2 Q 64 Vol 2 1984 | 6,07 | | | | |
| Loss on ignition | | | | | | | |
| Sommatoria composti organici aromatici | mg/kg | EPA 5021A 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| BTEX | | | | | | | |
| PCB (7 congeneri) | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8082A 2007 | < 0,005 | | | | |
| PCB (7 congeners) | | | | | | | |
| Idrocarburi pesanti (C10-C40) | mg/kg | EPA 3541 1994 + EPA 8270D 2007 | < 1 | | | | |
| Mineral Oil (C10-C40) | | | | | | | |
| pH | unità | CNR IRSA 1 Q 64 Vol 3 1985 | 7,38 | | | | |
| pH | | | | | | | |
| Capacità di neutralizzazione acido | mol/kg | UNI CEN/TS 15364:2006 | 0,1 | (*) | | | |
| Acid Neutralisation Capacity | | | | | | | |
| Sommatoria composti aromatici policiclici | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8270D 2007 | 0,18 | | | | |
| LEACHATE TEST | | | | | | | |
| Arsenico TC | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Arsenic LT | | | | | | | |

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● I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Continuation of
Test Report n°:

2102328-005

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|--|--------|-----------------------------------|---------|-------------|----------|--------|--------|
| Bario TC <i>Barium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,17 | | | | |
| Cadmio TC <i>Cadmium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,001 | | | | |
| Cromo TC <i>Chromium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Rame TC <i>Copper LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,1 | | | | |
| Mercurio TC <i>Mercury LT</i> | mg/kg | EPA 3015A 2007 + EPA 6010C 2007 | 0,03 | | | | |
| Molibdeno TC <i>Molybdenum LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Nichel TC <i>Nickel LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,02 | | | | |
| Piombo TC <i>Lead LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Antimonio TC <i>Antimony LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Selenio TC <i>Selenium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Zinco TC <i>Zinc LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,68 | | | | |
| Cloruro TC <i>Chloride LT</i> | mg/kg | APAT CNR IRSA 4090 A1 Man 29 2003 | 127 | | | | |
| Fluoruro TC <i>Fluoride LT</i> | mg/kg | APAT CNR IRSA 4100 B Man 29 2003 | 3,3 | | | | |
| Solfato TC <i>Sulphate LT</i> | mg/kg | APAT CNR IRSA 4140 A Man 29 2003 | < 100 | | | | |
| TDS TC <i>TDS LT</i> | mg/kg | APAT CNR IRSA 2090 A Man 29 2003 | 2350 | | | | |
| Indice di fenolo TC <i>Phenol Index</i> | mg/l | APAT CNR IRSA 5070 A2 Man 29 2004 | < 0,01 | | | | |
| DOC TC <i>DOC LT</i> | mg/kg | UNI EN 1484:1999 | 143 | | | | |

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- I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Continuation of
Test Report n°:

2102328-005

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|-------|--------|--------|--------|-------------|----------|--------|--------|
|-------|--------|--------|--------|-------------|----------|--------|--------|

< Not Detectable because lower than detection limit of the method.

The sample is stored for two weeks unless particular disposition of the law

When indicated the uncertainty of the measure, it is expressed in the same unit of measurement of the test performed:

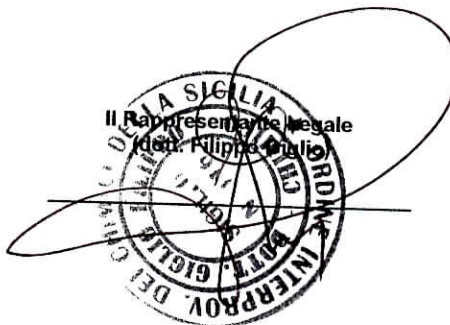
- At probability of the measure of 95% and a coverage factor K=2 for the chemical tests ;
- At Reproducibility Deviation SR, with uncertainty U equal to SR and a coverage factor K=2 for the microbiological tests on food.
- At confidence interval with probability of the measure of 95% and a coverage factor K=2 for the microbiological tests on water.

This Test report is relative to the sample subordinate to test and it cannot be reproduced without written approval from of the C.A.D.A s.n.c.

The records of testing of this sample are kept for a minimum period of 4 years.

Il Responsabile Tecnico del Laboratorio
(dott. Giuseppe Rocca)

Il Rappresentante Legale
(dott. Filippo Giglio)



Il Direttore dell'Area Area
(dott.ssa Margherita Augello)



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- ▶ I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero / Parameters marked with the letter 'C' have been corrected for recovery
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Test Report n°:

2102328-006

Description:

Soil S-481-10 ECOSERV LTD.

Client:

**ECOSERV LTD.
12, Sir Arthur Borton Str.
Mosta, MST 1881**

Reception n°:

2102328

Sampling Date:

20-gen-11

Sample Reception Date:

20-gen-11

Test Start Date:

21-gen-11

Test Report Date:

08-feb-11

Test Finish Date:

08-feb-11

Sampling Method:

Customer's Discretion

Reference for the Limits:

///

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|---|--------|---|---------|-------------|----------|--------|--------|
| PARAMETRI CHIMICI | | | | | | | |
| CHEMICAL TESTS | | | | | | | |
| TOC | % | UNI EN 13137:2002 | 2,7 | | | | |
| TOC | | | | | | | |
| Sostanze volatili | % | CNR IRSA 2 Q 64 Vol 2 1984 | 10,7 | | | | |
| Loss on ignition | | | | | | | |
| Sommatoria composti organici aromatici | mg/kg | EPA 5021A 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| BTEX | | | | | | | |
| PCB (7 congeneri) | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8082A 2007 | < 0,005 | | | | |
| PCB (7 congeners) | | | | | | | |
| Idrocarburi pesanti (C10-C40) | mg/kg | EPA 3541 1994 + EPA 8270D 2007 | < 1 | | | | |
| Mineral Oil (C10-C40) | | | | | | | |
| pH | unità | CNR IRSA 1 Q 64 Vol 3 1985 | 8,19 | | | | |
| pH | | | | | | | |
| Capacità di neutralizzazione acido | mol/kg | UNI CEN/TS 15364:2006 | 0,1 | (*) | | | |
| Acid Neutralisation Capacity | | | | | | | |
| Sommatoria composti aromatici policiclici | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8270D 2007 | < 0,01 | | | | |
| LEACHATE TEST | | | | | | | |
| Arsenico TC | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,03 | | | | |
| Arsenic LT | | | | | | | |

- (*) = Le prove così contrassegnate a fianco del risultato, non sono Accreditate da ACCREDIA / The evidence thus marked by side with the result, are not accredited by ACCREDIA
- I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero / Parameters marked with the letter 'C' have been corrected for recovery
- ▶ I parametri contraddistinti dal simbolo a lato sono fuori limite / The parameters marked with the symbol on the side are out of bounds.
- I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Continuation of
Test Report n°:

2102328-006

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|--|--------|-----------------------------------|---------|-------------|----------|--------|--------|
| Bario TC <i>Barium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,34 | | | | |
| Cadmio TC <i>Cadmium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,001 | | | | |
| Cromo TC <i>Chromium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,03 | | | | |
| Rame TC <i>Copper LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,03 | | | | |
| Mercurio TC <i>Mercury LT</i> | mg/kg | EPA 3015A 2007 + EPA 6010C 2007 | < 0,001 | | | | |
| Molibdeno TC <i>Molybdenum LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Nichel TC <i>Nickel LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Piombo TC <i>Lead LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,22 | | | | |
| Antimonio TC <i>Antimony LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Selenio TC <i>Selenium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Zinco TC <i>Zinc LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,22 | | | | |
| Cloruro TC <i>Chloride LT</i> | mg/kg | APAT CNR IRSA 4090 A1 Man 29 2003 | 218 | | | | |
| Fluoruro TC <i>Fluoride LT</i> | mg/kg | APAT CNR IRSA 4100 B Man 29 2003 | 3,8 | | | | |
| Solfato TC <i>Sulphate LT</i> | mg/kg | APAT CNR IRSA 4140 A Man 29 2003 | < 100 | | | | |
| TDS TC <i>TDS LT</i> | mg/kg | APAT CNR IRSA 2090 A Man 29 2003 | 2760 | | | | |
| Indice di fenolo TC <i>Phenol Index</i> | mg/l | APAT CNR IRSA 5070 A2 Man 29 2004 | < 0,01 | | | | |
| DOC TC <i>DOC LT</i> | mg/kg | UNI EN 1484:1999 | 187 | | | | |

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● I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



**Applicata
Depurazione
Acque S.n.c.**
di Filippo Giglio & C.

2005
- Aut. MIPAF per analisi nel Settore Vitivinicolo D.M. 14-01-2009
- Iscrizione nell'elenco Regionale n°01/LAB, dei Laboratori abilitati ad eseguire le attività di analisi nell'ambito dell'Autocontrollo Alimentare, di cui al D.A. n°478/2007
- Inserimento tra i "Tecnici Competenti" di cui al punto 7 art. n°2 della Legge Quadro sull'inquinamento acustico per la redazione dei "Piani di Risanamento Acustico"
- Inserimento tra i laboratori atti al rilevamento dei materiali e/o polveri contenenti amianto di cui al D.M. 07/07/1997



LAB N° 0439

Continuation of
Test Report n°:

2102328-006

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|-------|--------|--------|--------|-------------|----------|--------|--------|
|-------|--------|--------|--------|-------------|----------|--------|--------|

< Not Detectable because lower than detection limit of the method.

The sample is stored for two weeks unless particular disposition of the law

When indicated the uncertainty of the measure, it is expressed in the same unit of measurement of the test performed:

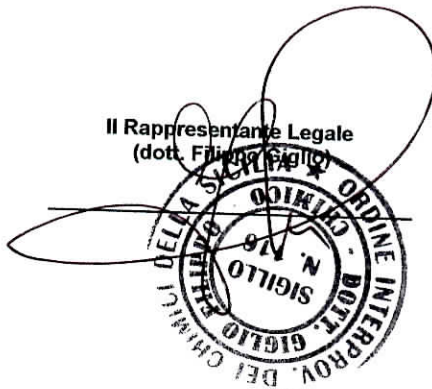
- At probability of the measure of 95% and a coverage factor K=2 for the chemical tests ;
- At Reproducibility Deviation SR, with uncertainty U equal to SR and a coverage factor K=2 for the microbiological tests on food.
- At confidence interval with probability of the measure of 95% and a coverage factor K=2 for the microbiological tests on water.

This Test report is relative to the sample subordinate to test and it cannot be reproduced without written approval from of the C.A.D.A s.n.c.

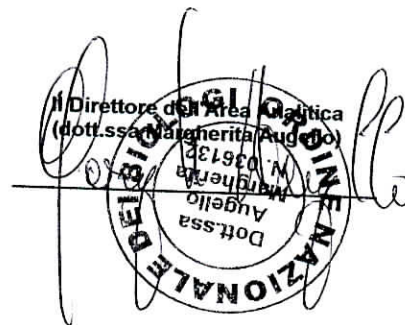
The records of testing of this sample are kept for a minimum period of 4 years.

Il Responsabile Tecnico del Laboratorio
(dott. Giuseppe Rocca)

Il Rappresentante Legale
(dott. Filippo Giglio)



Il Direttore dell'Area Qualitativa
(dott.ssa Margherita Angello)



- (*) = Le prove così contrassegnate a fianco del risultato, non sono Accreditate da ACCREDIA / The evidence thus marked by side with the result, are not accredited by ACCREDIA
- ▶ I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero / Parameters marked with the letter 'C' have been corrected for recovery
 - I parametri contraddistinti dal simbolo a lato sono fuori limite / The parameters marked with the symbol on the side are out of bounds
 - I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Test Report n°:

2102328-007

Description:

Soil S-482-10 ECOSERV LTD.

Client:

**ECOSERV LTD.
12, Sir Arthur Borton Str.
Mosta, MST 1881**

Reception n°:

2102328

Sampling Date:

20-gen-11

Sample Reception Date:

20-gen-11

Test Start Date: **21-gen-11**

Test Report Date:

08-feb-11

Test Finish Date: **08-feb-11**

Sampling Method:

Customer's Discretion

Reference for the Limits:

///

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|---|--------|---|---------|-------------|----------|--------|--------|
| PARAMETRI CHIMICI | | | | | | | |
| CHEMICAL TESTS | | | | | | | |
| TOC | % | UNI EN 13137:2002 | 0,5 | | | | |
| TOC | | | | | | | |
| Sostanze volatili | % | CNR IRSA 2 Q 64 Vol 2 1984 | 1,94 | | | | |
| Loss on ignition | | | | | | | |
| Sommatoria composti organici aromatici | mg/kg | EPA 5021A 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| BTEX | | | | | | | |
| PCB (7 congeneri) | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8082A 2007 | < 0,005 | | | | |
| PCB (7 congeners) | | | | | | | |
| Idrocarburi pesanti (C10-C40) | mg/kg | EPA 3541 1994 + EPA 8270D 2007 | < 1 | | | | |
| Mineral Oil (C10-C40) | | | | | | | |
| pH | unità | CNR IRSA 1 Q 64 Vol 3 1985 | 8,24 | | | | |
| pH | | | | | | | |
| Capacità di neutralizzazione acido | mol/kg | UNI CEN/TS 15364:2006 | < 0,01 | (*) | | | |
| Acid Neutralisation Capacity | | | | | | | |
| Sommatoria composti aromatici policiclici | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8270D 2007 | 0,03 | | | | |
| LEACHATE TEST | | | | | | | |
| Arsenico TC | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,12 | | | | |
| Arsenic LT | | | | | | | |

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I parametri contrassegnati con la lettera 'C' sono stati corretti per il recupero / Parameters marked with the letter 'C' have been corrected for recovery

► I parametri contraddistinti dal simbolo a lato sono fuori limite / The parameters marked with the symbol on the side are out of bounds.

● I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Continuation of
Test Report n°:

2102328-007

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|--|--------|-----------------------------------|---------|-------------|----------|--------|--------|
| Bario TC <i>Barium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,35 | | | | |
| Cadmio TC <i>Cadmium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,001 | | | | |
| Cromo TC <i>Chromium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,07 | | | | |
| Rame TC <i>Copper LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,02 | | | | |
| Mercurio TC <i>Mercury LT</i> | mg/kg | EPA 3015A 2007 + EPA 6010C 2007 | < 0,001 | | | | |
| Molibdeno TC <i>Molybdenum LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Nichel TC <i>Nickel LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,04 | | | | |
| Piombo TC <i>Lead LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,21 | | | | |
| Antimonio TC <i>Antimony LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Selenio TC <i>Selenium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Zinco TC <i>Zinc LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,71 | | | | |
| Cloruro TC <i>Chloride LT</i> | mg/kg | APAT CNR IRSA 4090 A1 Man 29 2003 | 25 | | | | |
| Fluoruro TC <i>Fluoride LT</i> | mg/kg | APAT CNR IRSA 4100 B Man 29 2003 | 3,9 | | | | |
| Solfato TC <i>Sulphate LT</i> | mg/kg | APAT CNR IRSA 4140 A Man 29 2003 | < 100 | | | | |
| TDS TC <i>TDS LT</i> | mg/kg | APAT CNR IRSA 2090 A Man 29 2003 | 2680 | | | | |
| Indice di fenolo TC <i>Phenol Index</i> | mg/l | APAT CNR IRSA 5070 A2 Man 29 2004 | < 0,01 | | | | |
| DOC TC <i>DOC LT</i> | mg/kg | UNI EN 1484:1999 | 154 | | | | |

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- I parametri contraddistinti dal simbolo a lato sono fuori limite considerando l'incertezza / The parameters marked with the symbol on the side are out of bounds considering the uncertainty



Continuation of
Test Report n°:

2102328-007

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|-------|--------|--------|--------|-------------|----------|--------|--------|
|-------|--------|--------|--------|-------------|----------|--------|--------|

< Not Detectable because lower than detection limit of the method.

The sample is stored for two weeks unless particular disposition of the law

When indicated the uncertainty of the measure, it is expressed in the same unit of measurement of the test performed:

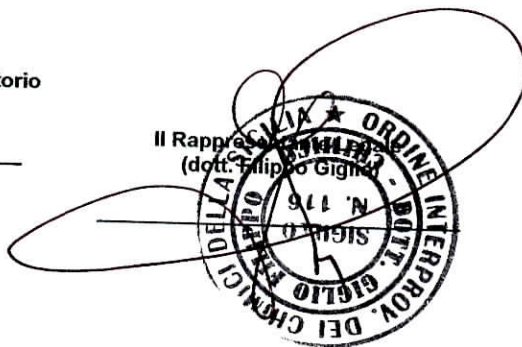
- ☐ At probability of the measure of 95% and a coverage factor K=2 for the chemical tests ;
- At Reproducibility Deviation SR, with uncertainty U equal to SR and a coverage factor K=2 for the microbiological tests on food.
- At confidence interval with probability of the measure of 95% and a coverage factor K=2 for the microbiological tests on water.

This Test report is relative to the sample subordinate to test and it cannot be reproduced without written approval from of the C.A.D.A S.n.c.

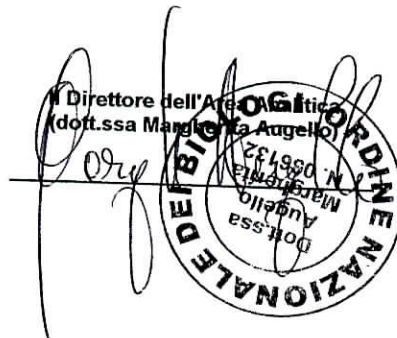
The records of testing of this sample are kept for a minimum period of 4 years.

Il Responsabile Tecnico del Laboratorio
(dott. Giuseppe Rocca)

Il Rappresentante
(dott. Filippo Giglio)



Il Direttore dell'Azienda
(dott.ssa Margherita Angello)



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Test Report n°: **2102328-008**

Description: **Soil S-483-10 ECOSERV LTD.**

Client:
ECOSERV LTD.
12, Sir Arthur Borton Str.
Mosta, MST 1881

Reception n°: **2102328**
Sampling Date: **20-gen-11**
Sample Reception Date: **20-gen-11** Test Start Date: **21-feb-11**
Test Report Date: **08-feb-11** Test Finish Date: **08-feb-11**
Sampling Method: **Customer's Discretion**
Reference for the Limits: **///**

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|---|--------|---|---------|-------------|----------|--------|--------|
| PARAMETRI CHIMICI | | | | | | | |
| CHEMICAL TESTS | | | | | | | |
| TOC | % | UNI EN 13137:2002 | 0,6 | | | | |
| TOC | | | | | | | |
| Sostanze volatili | % | CNR IRSA 2 Q 64 Vol 2 1984 | 3,34 | | | | |
| Loss on ignition | | | | | | | |
| Sommatoria composti organici aromatici | mg/kg | EPA 5021A 2003 + EPA 8260C 2006 | < 0,01 | | | | |
| BTEX | | | | | | | |
| PCB (7 congeneri) | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8082A 2007 | < 0,005 | | | | |
| PCB (7 congeners) | | | | | | | |
| Idrocarburi pesanti (C10-C40) | mg/kg | EPA 3541 1994 + EPA 8270D 2007 | < 1 | | | | |
| Mineral Oil (C10-C40) | | | | | | | |
| pH | unità | CNR IRSA 1 Q 64 Vol 3 1985 | 8,05 | | | | |
| pH | | | | | | | |
| Capacità di neutralizzazione acido | mol/kg | UNI CEN/TS 15364:2006 | 0,1 | (*) | | | |
| Acid Neutralisation Capacity | | | | | | | |
| Sommatoria composti aromatici policiclici | mg/kg | EPA 3541 1994 + EPA 3630C 1996 + EPA 8270D 2007 | 0,03 | | | | |
| LEACHATE TEST | | | | | | | |
| Arsenico TC | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Arsenic LT | | | | | | | |

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Continuation of
Test Report n°:

2102328-008

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|--|--------|-----------------------------------|---------|-------------|----------|--------|--------|
| Bario TC <i>Barium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,19 | | | | |
| Cadmio TC <i>Cadmium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,001 | | | | |
| Cromo TC <i>Chromium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,04 | | | | |
| Rame TC <i>Copper LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Mercurio TC <i>Mercury LT</i> | mg/kg | EPA 3015A 2007 + EPA 6010C 2007 | < 0,001 | | | | |
| Molibdeno TC <i>Molybdenum LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Nichel TC <i>Nickel LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,04 | | | | |
| Piombo TC <i>Lead LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,07 | | | | |
| Antimonio TC <i>Antimony LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Selenio TC <i>Selenium LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | < 0,01 | | | | |
| Zinco TC <i>Zinc LT</i> | mg/kg | APAT CNR IRSA 3020 Man 29 2003 | 0,22 | | | | |
| Cloruro TC <i>Chloride LT</i> | mg/kg | APAT CNR IRSA 4090 A1 Man 29 2003 | 31 | | | | |
| Fluoruro TC <i>Fluoride LT</i> | mg/kg | APAT CNR IRSA 4100 B Man 29 2003 | 2,5 | | | | |
| Solfato TC <i>Sulphate LT</i> | mg/kg | APAT CNR IRSA 4140 A Man 29 2003 | < 100 | | | | |
| TDS TC <i>TDS LT</i> | mg/kg | APAT CNR IRSA 2090 A Man 29 2003 | 2100 | | | | |
| Indice di fenolo TC <i>Phenol Index</i> | mg/l | APAT CNR IRSA 5070 A2 Man 29 2004 | < 0,01 | | | | |
| DOC TC <i>DOC LT</i> | mg/kg | UNI EN 1484:1999 | 133 | | | | |

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Continuation of
Test Report n°:

2102328-008

| Tests | U.O.M. | Method | Result | Uncertainty | Recovery | L.Min. | L.Max. |
|-------|--------|--------|--------|-------------|----------|--------|--------|
|-------|--------|--------|--------|-------------|----------|--------|--------|

< Not Detectable because lower than detection limit of the method.

The sample is stored for two weeks unless particular disposition of the law

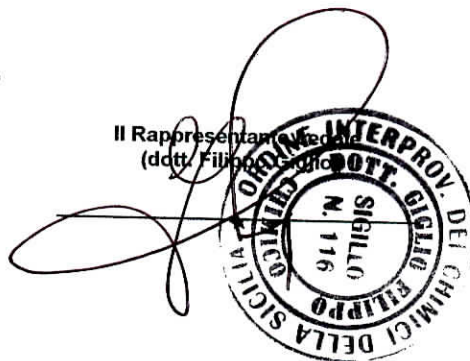
When indicated the uncertainty of the measure, it is expressed in the same unit of measurement of the test performed:

- At probability of the measure of 95% and a coverage factor K=2 for the chemical tests ;
- At Reproducibility Deviation SR, with uncertainty U equal to SR and a coverage factor K=2 for the microbiological tests on food.
- At confidence interval with probability of the measure of 95% and a coverage factor K=2 for the microbiological tests on water.

This Test report is relative to the sample subordinate to test and it cannot be reproduced without written approval from of the C.A.D.A s.n.c.
The records of testing of this sample are kept for a minimum period of 4 years.

Il Responsabile Tecnico del Laboratorio
(dott. Giuseppe Rocca)

Il Rappresentante Legale
(dott. Filippo Giglio)



Il Direttore dell'Area On-Site
(dott.ssa Mariateresa Angelino)



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PA 02342/06

Master Plan for the Maghtab Environmental Complex, Naxxar

Appendix 3

A3 PHOTOS

Prepared by Mr Joseph Pace

Supporting Documents for
Environmental Impact Statement Update

VIEWPOINT I BASE PHOTO: WARDIJA

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1533



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 45939, 78058
Height of camera above MSL: 111.2m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-1
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT I PHOTOMONTAGE: WARDIJA

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1533



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 45939, 78058
Height of camera above MSL: 111.2m
Date: 03rd August 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-1
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 2 BASE PHOTO: TRIQ IL-QAWRA PROMENADE

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1514



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48116, 79351
Height of camera above MSL: 10.36m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-2
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 2 PHOTOMONTAGE: TRIQ IL-QAWRA PROMENADE

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1514



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48116, 79351
Height of camera above MSL: 10.36m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-2
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 3 BASE PHOTO: TRIQ IL-LUZZU, QAWRA

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1519



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48159, 78828
Height of camera above MSL: 3.05m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-3
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 3 PHOTOMONTAGE: TRIQ IL-LUZZU, QAWRA

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1519



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48159, 78828
Height of camera above MSL: 3.05m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-3
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 4 BASE PHOTO: COASTLINE HOTEL

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1600



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48512, 78559
Height of camera above MSL: 11.25m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-4

VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 4 PHOTOMONTAGE: COASTLINE HOTEL

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1600



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48512, 78559
Height of camera above MSL: 11.25m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-4
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 5 BASE PHOTO: TRIQ IL-KOSTA (GHALLIS TOWER)

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1549



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48985, 79209
Height of camera above MSL: 14.84m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-5
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 5 PHOTOMONTAGE: TRIQ IL-KOSTA (GHALLIS TOWER)

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1549



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48985, 70209
Height of camera above MSL: 14.84m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-5
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 6 BASE PHOTO: TRIQ IL-KOSTA, IL-GHOQOT

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1553



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50082, 78655
Height of camera above MSL: 4.43m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-6
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 6 PHOTOMONTAGE: TRIQ IL-KOSTA, IL-GHOQOT

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1553



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50082, 78655
Height of camera above MSL: 4.43m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-6
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 7 BASE PHOTO: TRIQ IL-KOSTA, QALET MARKU

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1439



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50428, 78005
Height of camera above MSL: 4.01m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-7
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 7 PHOTOMONTAGE: TRIQ IL-KOSTA, QALET MARKU

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1439



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50428, 78005
Height of camera above MSL: 4.01m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Eilul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-7
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 8 BASE PHOTO: SQAQ TAX-XAQQUF, L/O GHARGHUR

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1420



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50568, 76389
Height of camera above MSL: 140.00m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-8
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 8 PHOTOMONTAGE: SQAQ TAX-XAQQUF, L/O GHARGHUR

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1420



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50568, 76389
Height of camera above MSL: 140.00m
Date: 03rd August 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-8
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 9 BASE PHOTO: TRIQ IR-RAMLA, MAGHTAB

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1445



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 49743, 77472
Height of camera above MSL: 18.37m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-9
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 9 PHOTOMONTAGE: TRIQ IR-RAMLA, MAGHTAB

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1445



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 49743, 77472
Height of camera above MSL: 18.37m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Vedula Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-9
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 10 BASE PHOTO: TRIQ IL-KOSTA, BAHAR IC-CAGHAQ

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1353



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 51558, 76976
Height of camera above MSL: 43.56m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-10
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 10 PHOTOMONTAGE: TRIQ IL-KOSTA, BAHAR IC-CAGHAQ

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1353



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 51558, 76976
Height of camera above MSL: 43.56m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Eilul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-10
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT II BASE PHOTO: TRIQ IL-MADLIENA, L/O GHARGHUR

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1402



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 51556, 76353
Height of camera above MSL: 100.5m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-11
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT II PHOTOMONTAGE: TRIQ IL-MADLIENA, L/O GHARGHUR

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1402



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 51556, 76353
Height of camera above MSL: 100.5m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-11
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 12 BASE PHOTO: TRIQ GHAXQET L-GHAJN, L/O GHARGHUR

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1407



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50755, 76692
Height of camera above MSL: 110.44m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-12
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 12 PHOTOMONTAGE: TRIQ GHAXQET L-GHAJN, L/O GHARGHUR

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1407



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 50755, 76692
Height of camera above MSL: 110.44m
Date: 03rd August 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-12
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 13 BASE PHOTO: TRIQ JOHN ADYE, T'ALLA W'OMMU

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1456



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 49560, 76028
Height of camera above MSL: 86.18m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-13
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 13 PHOTOMONTAGE: TRIQ JOHN ADYE, T'ALLA W'OMMU

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1456



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrs-malta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 49560, 76028
Height of camera above MSL: 86.18m
Date: 03rd August 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-13
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 14 BASE PHOTO: TRIQ L-IMSAQFIN, MOSTA

EXISTING VIEW

Date - Time of Photo: 05-May-2011 - 1500



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrsmalta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48796, 75356
Height of camera above MSL: 90.73m
Date: 12th June 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-14
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

VIEWPOINT 14 PHOTOMONTAGE: TRIQ L-IMSAQFIN, MOSTA

PROPOSED VIEW

Date - Time of Photo: 05-May-2011 - 1500



1. Photo shot using a digital equivalent of a 35mm camera with a 50mm lens.
2. An interpretation of monocular perspective could be obtained by viewing from a distance of 500mm.
3. Photomontage and perspective modelling by Virtual Reality Studios Ltd. (www.vrs-malta.com)
4. 3D modelling of terrain is subject to the accuracy or otherwise of height data information used.

OS reference: 48796, 75356
Height of camera above MSL: 90.73m
Date: 03rd August 2011
Verified Photomontages by: Virtual Reality Studios: 4 Woodland Avenue,
Nantwich, Cheshire CW5 6JE, UK / 1, Veduta Apartments, Luigi Ellul Street,
Attard ATD 3023, Malta

VIEWPOINT VP-14
VERIFIED PHOTOMONTAGES FOR
PROPOSED DEVELOPMENT AT GHALLIS

Appendices
