A FEASIBILITY STUDY CARRIED OUT FOR THE ISLAND OF HYDRA – GREECE

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Abstract

Closure and rehabilitation of the Illegal Landfill (uncontrolled solid waste disposal area) of the Island of HYDRA – Greece (1.966 inh.), appears to be a priority pursuit for the new Regional Governor of Attica.

A feasibility study, carried out by ACMAR (November 2014) managed to put in order as a whole, actions and projects that must start or even complete in the following period.

Many different considerations were taken into account. Most crucial elements-aims of the study area were:

1. The existing spatial planning of the island
2. Mainstream social-economy characteristics
3. Smooth and low scale interventions
4. Social participation
5. Changes in international level (legal-technical)
6. Small-medium scale facilities
7. Facilities of low disturbance

8. Easy to handle, by the municipality of HYDRA, facilities

Main objectives:

1. Rehabilitation of the uncontrolled solid waste disposal site of the Island of HYDRA
2. Movable waste transshipment station (set into operation imminently)
3. Compost production facilities (construction-operation)
4. Landfill site for residuals (construction-operation)
5. Promotion and finally establishment of the waste sorting method – strategy in households and in all public places (schools, public services e.tc) at least for biowaste, paper, metal, glass, plastic, wood.
6. Biodegradable waste reuse up to 438 tn/year
7. Material recycling up to 284/tn/year

Key words

Feasibility study, Hydra, rehabilitation, fine stop, small scale, low disturbance

Introduction

Closure and rehabilitation of the Illegal Landfill of the Island of HYDRA – Greece, appears to be a first priority pursuit for the new Regional Governor of Attica.

In order to achieve an immediate fine stop, imposed by the higher environmental court of EU, things must be done not only in a legal but also in a constructional level.

Fig. 1: General view

It is common sense that in order to proceed to the closure of the existing illegal landfill, a set of alternative actions and constructions should be put forward for the secure and environmentally sound solid waste management for the island of Hydra.

A feasibility study, carried out by ACMAR (of the Region of Attica) managed to put in order targeting that should start or even complete in the following period. The main goal is of course the benefit of the environment but also the rehabilitation of more than 12.000m^2 of ruined landscape. This effort achieves:

- Fine ending: since 5th of June 2015, 80.000,00 € / 6months / operating illegal landfill is imposed by the EU charged in the municipality in charge,
- Benefit from the existing EU financial funds which can be absorbed for the financing of projects and actions planed.

The overall objective of the feasibility study is the Sustainable Solid Waste Management for the island of Hydra which will take into account:

- ✓ Priorities of environmental policy and legislation which in order of importance are:
  i. Prevention
  ii. Reuse
  iii. Source separation and recycling
  iv. Other ways of recovery
  v. Appropriate final disposal practices in organized sanitary landfill sites
- ✓ The existing spatial planning of the island
- ✓ Mainstream social-economy characteristics
- ✓ Smooth and low scale interventions
- ✓ Social participation
- ✓ Local manpower utilization
- ✓ Changes in international level (legal-technical)
- ✓ Small-medium scale facilities
- ✓ Facilities of low disturbance
- ✓ Facilities with simple mechanical equipment
- ✓ Easy to handle, by the municipality of HYDRA, facilities

The Feasibility Study for the island of Hydra results in a rough budget of 5 million €s.

Materials and Methods

Today, the small historical island of Hydra is the most cosmopolitan of the Saronic Gulf. Hydra is an island with a rich maritime tradition and played an important role in the revolution of 1821, along with the islands of Spetses and Psara.

Hydras Port situated in town, is protected by a framework of laws and rules and has been declared an archaeological site, listed as a place of exceptional natural beauty.

Fig. 2: Hydra town and port

Access to the island is via regular services speedboat (Piraeus-Hydra) and small routing (Metochi-Hydra) ship. Materials and food are transported mainly by ferry-boat from the port of Ermioni.

Road network of the settlement, consists of peripheral rings, connected by transverse stepped accesses. No wheeled vehicles are allowed in the town of Hydra and internal transportation of materials is primarily taking place by wheeled carts and donkeys.

Residents and visitors can communicate with the rest of the island by boats, excursion, private or water taxis.

Because of the fact that Hydra is a touristic destination, there is a huge fluctuation of population throughout the year, meaning there is a huge fluctuation of the quality and quantity factors of waste.

According to the feasibility study, the quantity of waste ranges from 1,500 tons / year to 1,869 tons/ year. Considering the economic downturn leading to reduced production of waste and the population growth data of Hydra having a negative trend, the quantity of waste was estimated to *1870tn/year* considered fixed for 20 years future projection (a safety factor was considered).

There is no qualitative data for waste produced in Hydra. The following table presents the waste quality (composition) as estimated in the context of the feasibility study.

	PERSENTAGE IN MSW (% *ww*)
Organic fraction	*38*
Paper- Cardboard	*29*
Paper- Cardboard	*10,22*
Printed paper	*9,07*
Other types of paper	*9,70*
Plastics	*15*
Plastic for packaging	*8,66*
Other types of plastic	*5,91*
Metals	*6*
Metal packaging	*4,80*
Other types of metal	*1,20*
Glass	*3*
Glass packaging	*2,95*
Other types of glass	*0,05*
Rest	*9*
Leather – Wood – Rubber (packaging)	*0,99*
L-W-R Rest	*0,64*
Fiber	*1,58*
Rest	*5,79*
TOTAL	**100**

Table 1: Municipal Waste Composition

In order to proceed with the study, the national legislation and EU directives where taken into account in matters of qualitative and quantitative goals.

As far as the *qualitative* goals are concerned those where derived from:

- ✓ Reuse – Recycle – Recovery (RRR): operation of an integrated RRR network of Municipal Solid Waste (MSW) till 2020,
- ✓ Impetus of Source separation and recycling for MSW wherever it is environmentally and technoeconomically viable,
- ✓ Unceasing reduce of Biodegradable Materials (BM) quantities led to sanitary landfilling through suitable MSW treatment facilities,
- ✓ Prevention or reduction of MSW production: kick off of implementation from 2014,
- ✓ Expansion of on source collection/transfer network for packing and other recyclable materials,
- ✓ Establishment of separate collection/transfer network for the recovery of BMs,
- ✓ Energy recovery by the non recyclable fraction of MSW,

- ✓ Final Disposal (D): Establishment of suitable infrastructure in country level till the end of 2020,
- ✓ Completion of the program for the restoration of illegal landfills till the end of 2015.

As far as the *quantitative* goals are concerned those where derived from the existing legislation as follows:

Biodegradables (BD)		**2020**	**Reduction of sanitary landfilled waste at the level of 35% ww (estimation based on 1995 production)**	
Biowaste (BW) (N.L.N.* 4042/2012)		2015	5%	of total weight in separate collection
		2020	10%	
Municipal waste (N.L.N. 4042/2012, 2011/753/Directive)		2015	Separate collection: at least for paper, metals, plastic, glass wherever it is technoeconomically viable	
		2020	Preparation for reuse & recycle at least for paper, metals, plastic and glass at the level of 50% ww	
		Recovery	*Recycle*	
			min	max
Packaging waste (N.L.N. 9268/469/2007)	2005	50%	25%	45%
	2011	60%	55%	80%
		Minimum recycle goals: 60% ww glass 60% ww paper- cardboard 50%ww metalls κβ 22,5% ww plastics 15% ww wood κβ		

*National legislation number

Table 2: Quantitative Goals

Regarding the analysis of the current situation as presented in the preceding paragraphs as well as objectives of the study, we conclude the following:

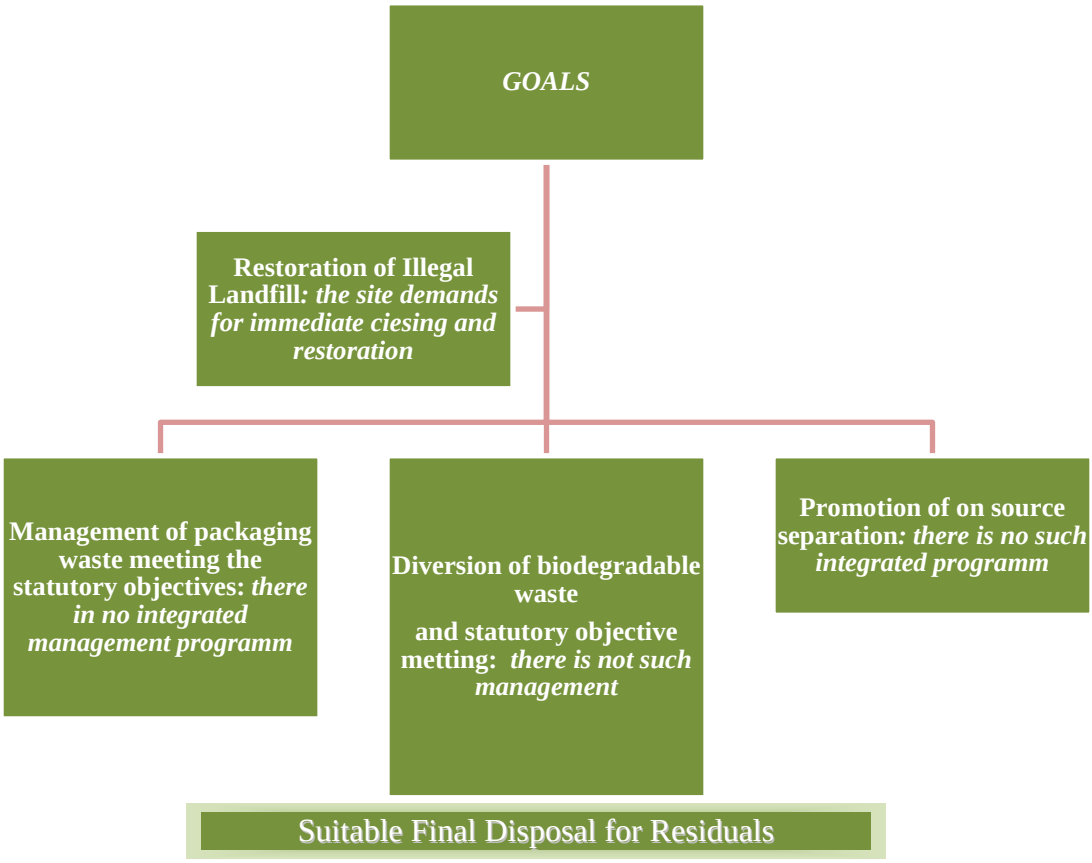


Fig. 3: Analysis of current situation and objectives of study

Having identified and quantified the minimum objectives of this study in a previous chapter, the following table shows the factors taken into account in the design and how they are assessed as to their change over time. The milestone years for design purposes are the following:

- ✓ 2016 as the year that the full implementation of integrated waste management of Hydra, will begin,
- ✓ 2020 as the year when the comparable targets are set by current legislation,
- ✓ 2030 as the year that the system is estimated to have reached its limits.

Waste composition % ww 2014		Deflection and Recovery percentage % ww for 2016-2030							
		2016		2020		2025		2030	
		Deflection %	Recovered %	Deflection %	Recovered %	Deflection %	Recovered %	Deflection %	Recovered %
Organic fraction	**38**	25	9,50	50	19,00	58	22,04	71	26,98
Paper – cardboard	**29**	35	10,15	55	15,95	65	18,85	82	23,78
Plastics	**15**	35	5,25	55	8,25	65	9,75	82	12,30
Metal	**6**	35	2,10	55	3,30	65	3,90	82	4,92
Glass	**3**	35	1,05	55	1,65	65	1,95	82	2,46
Rest	**9**	0	0,00	0	0,00	0	0,00	0	0,00
TOTAL	**100**		28,05		48,15		56,49		70,44
Residual for landfilling % ww		2016		2020		2025		2030	
		71,95		51,85		43,51		29,56	
Total Biodegradables % ww		2016		2020		2025		2030	
		19,65		34,95		40,89		50,76	

Table 3: Deflection and Recovery percentage % ww for 2016-2030

Hydras' MSW per category per set target are as follows:

- Biowaste Produced: *711 tn/year*
- Produced Biodegradables: *1.253 tn/year*
- Packaging waste: *517 tn/year*

Following the above, the targets of the feasibility study were set as below:

- *Diversion of BD from Landfill*: the target refers to the environmentally proven disposal in a landfill of the non treated MSW. For the quantity of 1.253 tn Biodegradables produced /year in Hydra, that is the 67% of waste produced, the diversion target was set to 438tn.
- *Separate collection of BW*: For the year 2020 and for the quantity of 711 tn BD / year produced in Hydra, the target is separate collection of 71 tn BA / year.
- *Packaging waste management:* For the recycling of packaging waste produced in Hydra, which is estimated at 517 tn / year, the target is to recycle 284 tn.

In order to proceed with a multicriteria tool which would help to the decision making process for actions and projects for Hydra Case, a set for applicable criteria were defined:

- ✓ The potential for disposal of end products,
- ✓ Environmental issues,

- ✓ Investment financial constraints,
- ✓ Operational financial constraints,
- ✓ Special characteristics of the interest area,
- ✓ Special characteristics of MSW produced in the area,
- ✓ Parallel actions for the utilization of MSW.

Some of the presented alternatives for the management of MSW in Hydra were ab initio rejected while some others were ab initio approved.

Ab initio rejected alternatives: mechanical separation, pyrolisys – vaporization and biological drying were rejected because they demand for much higher capacities in order to be financially viable.

Similarly, incineration is a high investment and operating cost technology particularly in small scale with no social acceptance. Note that in each case one incinerator must be accompanied by an appropriate landfill site for the disposal of hazardous solid waste, which is part of a solid waste incinerator. As the above, combustion is not an available alternative to Hydra.

Ab initio approved alternatives: restoration of illegal landfill site and the source separation process as a vital choice

Restoration of illegal landfill: The landfill occupies about 12.000 m^2 of municipal surface area. It is located 2 km east of the settlement of Hydra in Mandraki area.

The site began operating in 1967 and is active until today, serving the needs of the whole island, numbering 1966 people.

Waste disposed are not compressed in any way and are covered by demolition waste, blasting material and less from soil. Coverage is neither daily nor sufficient.

Quantitative characteristics of the existing deposits: the total volume of waste was estimated at 56.000 m^3 (2011).

Qualitative characteristics of the existing deposits: 95% Municipal Waste- 5% coverage material.

Restoration Plan for the landfill site includes the following works:

- ✓ Collecting of scattered waste
- ✓ Final coverage construction
- ✓ Leachate management
- ✓ Biogas management
- ✓ Rainwater management
- ✓ Environmental monitoring
- ✓ Green and irrigation works
- ✓ Other infrastructure (fencing, gate, etc.).

TOTAL COST OF REHABILITATION: 800.000€

Multi-criteria analysis can be defined as a systematic mathematical effort to resolve problems arising from conflicting objectives. The fulfillment of these objectives may not be complete and available options for such a problem are of excellent performance only in one or more, but never as to all targets, because in this case there would be no decision problem. It is necessary, therefore a compromise between the conflicting objectives.

The general methodology followed in the application of multi-criteria analysis includes the following steps:

1. Determination of a) the problem b) possible alternative solution scenarios.
2. Selection and classification of criteria.
3. Weight estimation of each criterion.
4. Matrix.evaluation
5. Final rating of scenarios

Criteria Selection and classification as applied for Hydra Case

- Economic Criteria

This category of criteria aims to capture the economic impact of each scenario

- Environmental Criteria

These criteria take into account the possible effects of implementing each scenario in the near and wider environment

- Technical Criteria

This set of criteria assesses scenarios technically in order to illustrate possibilities and reliability of each of them.

CRITERIA	**SIGNIFICANCE FACTOR**
FINANCIAL CRITERIA	
Investment cost	**10**
Operation cost	**12**
ENVIRONMENTAL CRITERIA	
Leachate and gas emissions	**6**
Aesthetics	**4**
TECHNICAL CRITERIA	
Operational requirements - complexity	**9**
Existing experience - reliability	**6**
Scenario Flexibility (in future legislative trends and changes in the incoming waste quantities)	**8**
Land requirements	**10**
INSTITUTIONAL CRITERIA	
Social acceptance	**10**
Compliance with EU policy	**9**
New jobs opportunities	**9**
Management autonomy of the region	**7**
T O T A L	**100**

Table 4: Estimation of criteria significance

Four (4) distinctive scenarios were developed in the feasibility study. The *optimal scenario* (with the higher grade) and the *transitional scenario (*the one that may serve the island immediately) will be presented.

Optimal scenario

- ✓ Development of on Source separation system

  The provision relates to fractions of the following streams:

  ¬ Paper,

  ¬ Cardboard,

  ¬ Plastic,

  ¬ Glass,

  ¬ Metals.

  Design basis is that the total amount of waste produced is 1.870tn / year. The estimate of diversion for target materials concerns the year 2020, a year which is taken as a milestone for all proposed Waste Management projects of Hydra.

Target material	**Diversion (%)**	**Quantities (tn/year)**
Paper – Cardboard:	15,95	298,3
Plastic	8,25	154,3
Glass	1,65	30,9
Metal	3,30	61,7

Table 5: Estimate of diversion for target materials (2020)

Fig. 4: Separation on source waste bins

TOTAL COST OF PROGRAM INVESTMENT: **150.000,00 €**

- ✓ <u>Composting plant operation</u>

Home Composting (deals with the 10% of BW **35,52 tn**). Development of project is based on compost bins distributed to households by the municipality.

Ideally the home composting can get a production of up to 75% of kitchen organics (reducing the total waste up to 35%).

TOTAL COST OF PROGRAM INVESTMENT: 4**0.000,00 €**

Composting Unit (deals with the rest 90% of BW **287,71tn**). The promoted composting option for the case of Hydra, is an open composting system where compost is rest in lines.

In open systems, the composting process occurs without the use of heavy machinery:

Fig. 5: Compost lines

TOTAL COST OF PROGRAM INVESTMENT: **280.000,00 €**

- ✓ <u>Operation of local (Hydra's) waste transshipment station and transfer of waste to the waste transshipment station of Trizina</u>

For the proper functioning of the facility an appropriate configuration of the site is necessary in order to install the new equipment, which at least includes:

Press Containers:

Fig. 6:Press container

And Hook and Lift vehicle:

Fig. 7: Hook lift vehicle

TOTAL COST OF PROGRAM INVESTMENT: **600.000,00 €**

Transfer of waste from the waste transshipment station of Trizina to landfill site of Fyli (Attica Region).

Apart from everything else, a further cost is required for marketing purposes such as information - training and most of all motivation of citizens, which is estimated at: ***12.000,00€***

Transitional scenario

Regardless of the optimal scenario there will necessarily be an interval period when no infrastructure will be ready.

During this transitional period a Local Waste Transfer Station (LWTS) should be provided for, near the illegal landfill site in a position that will not make difficult for the Restoration process to complete.

The LWTS will certainly be mobile and would have full capacity equal to the total waste generation of Hydra.

At this transitional period which is estimated around 1.5 years, LWTS will collect all waste produced, leading it through Hermione or Troizinia to Fyli Landfill site.

Results and conclusions

The Feasibility Study for the Rehabilitation and Waste Management works of Hydra island set the objective of exploring all appropriate technical solutions and proposals in order to gain a Sustainable Management Model for waste produced.

The solid data that the feasibility study took into account were:

Requirements

- environmental policy and legislation
- spatial characteristics of Hydra island
- socio-economic characteristics of Hydra island
- mild and small-scale interventions
- social participation
- utilization of human resources
- current developments at international level

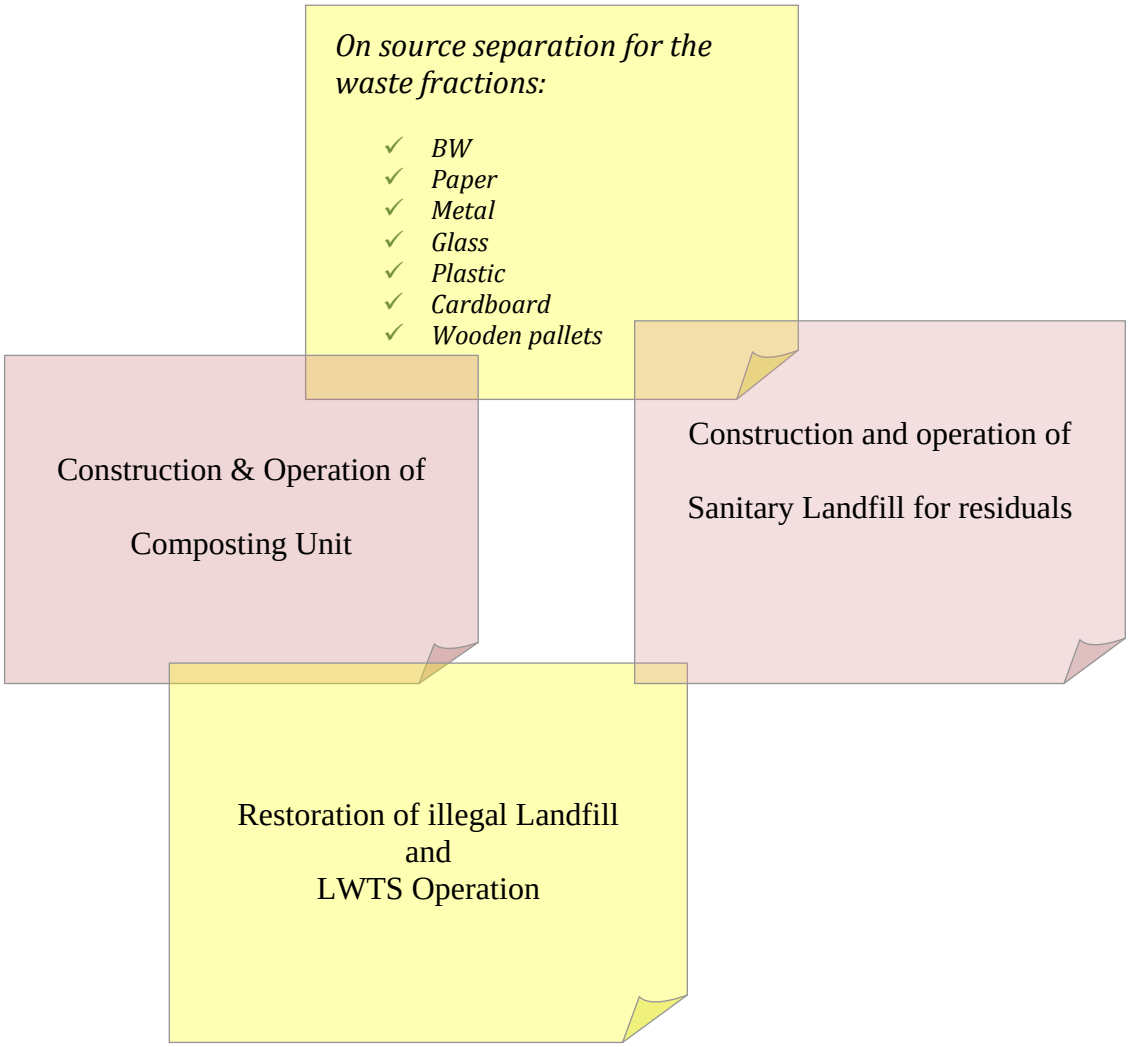
Quality objectives

- Rehabilitation of Hydra illegal landfill site
- Packaging Waste Management and statutory objectives fulfillment
- Diversion of BD and statutory objectives fulfillment
- On source separation promotion
- Secure final disposal of residuals

Quantity objectives

- BD: diversion of 438 tn/year
- BW: separate collection of 71 tn/year
- Recycle: 284 tn/year

Hydra's waste management model includes:



This Feasibility Study for the island of Hydra does not propose specific organization standards and technologies but instead presents alternatives so that during next design

stages and in cooperation with the local community, appropriate technical proposals may be chosen.

Projects and Actions will be put into effect by ACMAR through a Programmatic Agreement with the Municipality of Hydra (*active since 04/2015*) with the contribution of EU funding.

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