LOW AND INTERMEDIATE LEVEL DISPOSAL IN SPAIN (EL CABRIL FACILITY)

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ABSTRACT

El Cabril disposal facility is located in Southern Spain and was commissioned in October 1992.

The main objective of this facility is the disposal of all L&ILW produced in Spain in a disposal system (Figure 1) consisting of concrete overpacks placed in concrete vaults. A drain control system exists in inspection galleries constructed beneath the disposal vaults.

The facility also includes (Figure 2):

- A treatment and conditioning shop (with incineration, non NPP wastes segregation and conditioning, drum transfer into overpacks, supercompaction, liquid waste collection, and grout preparation and injection.

- A waste form characterisation laboratory with means for non-destructive radiological characterisation and for destructive tests on the waste forms (specimens extractions, unskinning of drums, mechanical strength, leaching tests on specimens and full size packages).

- A fabrication shop for overpacks construction.

- Auxiliary systems and buildings in support of operation, maintenance and surveillance of the facility.

The paper deals with the design, the operating experience of the facility, the waste packages characterisation and acceptance practice and the reception and transport of the wastes from the producers= facilities.

1. INTRODUCTION

On October 9th, 1992, a Ministerial Order granted the Operating Licence for the solid radioactive waste disposal facility of El Cabril, construction of which started in January 1990.

El Cabril is in the province of Cordoba, some 400 Km South of Madrid and 100 Km North of Seville.

The facilities at El Cabril are designed as a low and intermediate level waste near surface disposal facility. Consequently, they must meet two basic objectives:

* Ensure the immediate and deferred protection of the public and the environment.
* Allow free use of the site after a maximum of 300 years, without any radiological limitations.

The solution adopted provides sufficient disposal capacity for all the low and intermediate wastes that will be generated in Spain until the first decade of next century.

Two needs may be deduced from the aforementioned objectives: isolation of the waste packages from water and limitation of radioactivity levels.

Together with Man, water is the possible vehicle of dispersion of the stored radioactivity. The disposal facility must therefore be isolated from the ground water (placing the waste packages above the water table) and from surface water (avoiding flooding areas and watercourses, and protecting it from rainfall).

Moreover, by adopting pessimistic hypotheses of human intrusion at the end of the surveillance period, of a maximum of 300 years, the total activity and maximum mass activity must be limited so that the impact involved is acceptable.

In addition, the centre has the capacity to treat the institutional wastes from minor producers, reduce the volume of compactable wastes, condition wastes generated in the facility itself and recondition the waste packages in concrete containers, prior to disposal. It has also the laboratories for the verification tests of wasteforms and the ancillary systems for operation and monitoring.

2. THE DISPOSAL SYSTEM (FIG.1)

The waste packages, most of which are 0,22 m^3 steel drums, are placed inside concrete disposal containers. The drums (or pellets from supercompaction process) are them immobilised inside the container, forming a concrete block weighing some 25 tons and with external dimensions of 2.25 x 2.25 x 2.20 metres.

These containers are stored in disposal cells, each of which has a capacity for 320 containers and approximate external dimensions of 24 x 19 x 10 metres. The containers are placed in contact with each other, a central cross or strip being left to allow for container manufacturing or positioning tolerances.

Both the containers and the disposal cells are designed to withstand extreme loads, including the Site Safety Earthquake (SSE) with a ground acceleration of 0.24 g. The concrete used in the cells and containers was defined after a research programme conducted by the Instituto Eduardo Torroja, the objective of which was to optimize the durability of the concrete barriers. The concrete used is of high characteristic resistance and compactness, and sulphate and seawater resistant (despite the low concentrations of sulphates and chlorides in the site water).

Once each disposal cell has been fully loaded, the central strip is backfilled with gravel to stiffen the assembly and fill in gaps, and an upper closing slab is built. The structure is then waterproofed with a synthetic covering. The bottom plate is the main element of the storage structure. It is 0,6 metres thick at the edges and 0.5 metres thick in the centre, and is covered with a waterproof layer of polyurethane and a 10-20 cm layer of porous concrete. This forms a horizontal surface on which the containers are placed. The slab collects any seepage water and channels it to a network of pipes installed in inspection drifts located below the disposal cells.

Each structure is linked to this network, via a holding tank, so that if water is collected in the control network, it is possible to know which disposal cell it has come from, in order to repair the protective covering, and to take samples of the water collected.

This passively operating network of pipes discharges into a final control tank, with a year's collection capacity. This makes it possible to monitor the performance of the disposal system, detecting and determining the origin of abnormal amounts of seepage water, as well as its possible contamination.

During the operating phase, and with the triple objective of protecting the waste containers from the weather, minimizing the amount of water collected in the Infiltration Control Network and acting in support of the container handling system, each row of disposal cells is served by a rail-mounted sliding shelter. This auxiliary roof is placed above the disposal cell currently in operation. After the cell has been waterproofed, the roof is moved to the adjoining cell.

Rainwater falled in the platforms, is collected and directed to a rainwater pool.

When El Cabril will be closed down, the facility will be topped with a low permeability cap, formed by alternating layers of waterproof and draining material.

The multibarrier system is therefore formed by three barriers:

* The first is concrete containers with immobilizated waste inside.

* The second, formed by the disposal cells, cap and Infiltration Control Network, limits the access of water to the packages and allows any water that may have come into contact with them to be controlled and treated where necessary.

* The third, the geological barrier, is the surrounding land. This would limit the impact of a possible release in the event of an accident or in the hypothesis of total degradation of the first two barriers.

3. GENERAL DESCRIPTION OF THE FACILITY (FIG. 2)

The facility is divided into two main zones: the disposal zone, and the conditioning and auxiliary buildings zone.

28 disposal cells have been built in the disposal zone, grouped in two areas or platforms; the north platform, with 16 structures, and the south platform, with 12. The platforms are horizontal surfaces some 90 metres wide, excavated in trenches in the hillside, and side banks have been left on which to rest the final cap.

In each of these areas, the cells are half-buried with regard to the operating level and are laid out in two rows, each of which is served by a sliding shelter that moves along rails. These roofs carry a 32 tons travelling crane for handling the containers. The travelling cranes are operated by remote control from the Control Room, located in the Conditioning Building, thus minimizing doses in operation.

The disposal container transport lorries are placed in a side corridor located between the disposal cells and the shelter wall.

This zone also contains the control tanks drain systems, the rainwater collection poud, and the concrete preparation and concrete containers manufacturing plants.

Of all the possible options, ENRESA chose to construct and operate the container production plant at El Cabril, above all to be able to control the quality of the fabrication.

The buildings zone houses the auxiliary facilities for Waste Treatment and Conditioning and their control, as well as the auxiliary services needed for the operation and maintenance, and the Waste Verification Laboratories.

The accompanying figure 1 shows the auxiliary facilities and buildings, identified in order of proximity to the facility's main entrance.

* Industrial Safety Building
* Administration Building
* Technical Services Building
* Maintenance Workshop
* General Services Building
* Conditioning Building
* Inactive Waste Quality Verification Laboratory
* Active Waste Quality Verification Laboratory
* Transitory Reception Building
* Disposal cells (North Platform) (6)
* Disposal cells (South Platform) (6)
* Infiltration Control Network tank (1)
* Deep Drains System control tank (2)
* Platform Rainfall Collection Pool
* Buildings Rainfall Collection (4)
* Waste Water Treatment (3)
* Concrete Plant and Container-Manufacturing plant (5)
* Facility Transformer Centre (7)
* Trucks Parking

The functions of the different buildings are:

* Industrial Safety Building. This building houses the access control station, the central monitoring post and fire-fighting equipment.

* Maintenance Workshop. Includes vehicle, electrical and mechanical workshops.

* Administration Building. This building houses the offices of the site managing staff and the administrative services.

* Inactive Waste Quality Verification Laboratory. This building is used for testing and checking non-active samples having characteristics similar to those of the different types of package to be disposed of.

* Technical Services Building. This building houses the main equipment of the different auxiliary systems: transformer centre, electrical distribution, stand-by diesel generator, chillers and heat producing plant, and water treatment plant.

* General Services Building. Houses the radiological protection services, medical service, dressing rooms, laundry, environmental monitoring laboratory, calibration equipment, radiochemical laboratory, counting equipment, and personnel access radiological control station. All personnel, except for vehicle drivers, access the monitored zone through this building.

* Transitory Reception Building. This building contains the vehicle radiological control post and the vehicle decontamination post, as well as a transitory drum storage area for some 4.000 drums.

* Conditioning Building. All the treatment and conditioning operations described in the following sections are performed in this building. Almost all wastes pass through it. It also houses the Control Room, from which most of this building's systems, as well as the disposal zone waste handling equipment are operated. Centralised in these buildings is all information on the operation of the whole facility.
* Active Waste Quality Verification Laboratory. This building is used for performing tests to determine the characteristics of the different types of packages, on active test pieces and actual packages, and for the technical verification of some of the packages reaching the centre.

  Research and development work on the optimization of the waste solidification process is also foreseen here. A description of this Verification Laboratory is included in Section 6.

* Waste Water Plant. The waste water treatment plant, used for conventional treatment, is located next to the covered rainfall collection pool of the buildings zone.

4. WASTE CONDITIONING

Five main groups of operations are performed in the Conditioning Building:

Minor Producer Wastes (Institutional Wastes)

This facility includes the systems and equipment necessary for conditioning minor producer wastes (hospitals, research, industry).

The main systems include a glove box for waste classification, crushing, segregation and bagging, as well as a 50 Kg/h incinerator for treating biological and organic wastes.

The incinerator is of the excess air type, with a double combustion chamber. A temperature of 800 °C is reached in the first, and 1000 °C in the post-combustion chamber. At the chamber outlet there is a silicon carbide high-temperature filter. The fumes are cooled by dilution in fresh air to 140 °C. The flue gases then pass through very high efficiency filters and once filtered are discharged through the stack.

The facility also allows for storage of radioactive combustible liquids, solids and inmobilization of solid wastes.

Compactable Wastes

A drum compactor with a force of 1200 tons has been installed with which average volume reduction factors of over 3 were attained (actual volume reduction is 2, due to precompaction in Nuclear Power Plants).

With the aid of a travelling crane, the drums of compactable waste are unloaded in a warehouse specifically built for this type of package and transferred to a conveyor, then are put into the compaction equipment, passing through a series of airlocks. The equipment is kept below atmospheric pressure by the nuclear ventilation system.

The pellets are inserted by a distributor which places them in an order by manner inside a disposal container, this is then sent to the grout injection system.

Both the unloading crane and the distribution equipment work semiautomatically and are operated from the Control Room.

Conditioned Wastes

Any wastes arriving already conditioned in a solid matrix, normally of cement, are transferred to the disposal containers with a remote-controlled travelling crane. There are two similar warehouses for this type of wastes, the difference lying in the hoisting equipment. One is used for weakly irradiating packages, while the other is for unloading packages which, due to their dose rate, are transported inside additional shielding. This second warehouse has greater shielding thicknesses and is equipped with elements for opening the outer overshild and for handling its lid.

In both cases, once the container is full, it is transferred to the container handling warehouse by a carriage. From here, and once the lid is on, the container is transported by the travelling crane from the mortar injection post.

<u>Liquid Wastes</u>

Liquid wastes which can be collected are, low-level aqueous solutions, and they are collected in tanks in the building basement.

The treatment system has been selected with two objectives: not to increase the volume of wastes to be disposed of and to meet the design objective of zero release of liquid radioactive wastes.

After analysis, these liquid wastes are added to the immobilization grow which backfills the gaps between drums inside the disposal container.

In this way, storage capacity is not reduced and, as the amount of water required to prepare the mortar is greater than the expected amount of liquid effluents, the zero release objective can be met.

<u>Grout injection</u>

Once the lid has been inserted, the containers are transferred to the immobilization grout injection post.

In the injection system, the dry mortar -a mix of cement and sand- is mixed with water (or liquid wastes) and additives.

The resulting grout is injected by peristaltic pumps through a telescopic injector, backfilling the interior of the disposal container.

5. <u>TESTING OF WASTE FORMS AND PACKAGES</u>

<u>Waste acceptance criteria</u>

The stated limit for an individual disposal container is:

ACTIVITY (Bq/g)

RADIONUCLEID	PER DISPOSAL UNIT (OVERPACK)
H-3	1,00E+6
C-14	2,30E+6
Ni-59	6,30E+4
Ni-63	1,20E+7
Co-60	1,70E+8
Sr-90	9,10E+4
Nb-94	1,20E+2
Tc-99	4,30E+5
I-129	4,60E+1
Cs-137	3,30E+5
Alfa at 300 years	3,70E+3

In the current operating permit there are defined two levels of wastes, according to the following acceptance limits:

Level 1

Total alpha.- .... 1.85 10^2 Bq/g.
Beta-gamma emitters with half life > 5 y (tritium excepted) by isotope.- .... 1.85 10^4 Bq/gr
Total Beta-gamma activity for isotopes with half life > 5 y.- .... 7.4 10^4 Bq/gr
Tritium.- .... 7.4 10^3 Bq/gr

Level 2

Total alpha .... 3.7 10^3 Bq/gr
Co 60 .... 3.7 10^5 Bq/gr
Sr 90 .... 3.7 10^5 Bq/gr
Cs 137.......................... 3.7 10^5 Bq/gr

The limits applicable to radioisotopes that are not explicit are established by the multiplication of these limits by scale factors. The scale factors are periodically updated.

All wastes must be stabilised, and meet the Waste Acceptance Criteria established by ENRESA. Different characterization tests are specified for the two different levels of waste packages. These characterization tests of the different waste types and the verification tests to check the quality of the packages received, in an stylistic way, are developed in the Waste Verification Laboratory.

A new operating permit application has been submitted to the authorities in February 1996. In this application a new higher limit is proposed for level 2 wastes and a new level 3 wastes category is proposed as well. Level 2 limit is based on the maximum allowable average specific activity per container above mentioned, in such a way that if all the primary waste packages are in level 2 limits, the activity per container is not overpassed. Level 3 allows individual primary packages a higher activity while complying the said limit per container.

Waste Quality Verification Laboratory

This laboratory has two different areas in two buildings, the active one being located in the controlled area and the inactive one in the conventional part of the facility.

Active Laboratory

The layout has been designed taking into account the tests to be carried out:

a) Reception and control area.

b) Manipulation cell: for the preparation of packages for leaching tests and for the extraction of test probes to determine their mechanical and radiological properties. The cell has all the necessary equipment (crane, specimens conditioning, drum skin cutting equipment, mechanical test bench, sample extraction, etc.). All the operations are remote controlled.

c) Aliquot preparation cel.

d) Leaching area: for the introduction of full size packages without their metal casing or test probes in demineralised water at constant temperature.

e) Chemical and radiochemical laboratory.

f) Chemical and radiochemical measurement laboratory.

Tests to be carried out in the Active Laboratory

For the characterization of the matrices of real packages, a total of 50 tests are to be carried out in the Active Laboratory. These can be divided into 3 main groups:

A) Non-destructive testing. These include spectrometry.

B) Destructive testing. These include tests on the preparation and handling of real packages, physical-mechanical tests and homogeneity tests. They involve destructive treatment of the packages and therefore generate secondary wastes which must later be conditioned.

C) Tests for microstructural characterization of the matrix. These include leaching tests on real packages or specimens for which it is necessary to first carry out non-destructive, destructive and complementary chemical and radiochemical testing.

Inactive Laboratory

This building is located in a non-regulated area. It includes a laboratory for characterization tests on samples and inactive test pieces simulating the matrix.

6. RADIOLOGICAL CONTROL

The design of the facility complies with the Spanish regulations on radiological protection with a particular emphasis in the application of the ALARA criteria.

This criteria is enforced by the implementation of the following design basis:

- Remote control of the main activities involving radioactive materials. Virtually all the handling operations of waste packages, as well as the supercompaction are controlled from the control room with the assistance of a TVCC.

- Zonification of operating areas with the appropriate separation of the different operations providing biological shields sized in accordance with the associated risk and so for the required ventilation.

The reference limits used in the design to implement the ALARA criteria are the following:

- The dose rate due to external irradiation in an area with an occupation above 10 h per week, will be below 2.5 ΦSv/h.

- The dose rate due to external irradiation for an occupation of less than 10 h per week will be below 7.5 ΦSv/h or, alternatively, below 5/N mSv/h, where N is the occupancy per year in hours.

- The concentration of activity in air shall be below to 1% of the ALI for rooms with an occupancy above 10 h. per week and below 3% of the ALI for lower rates of occupancy.

7. <u>SAFETY ASSESSMENT</u>

The main items considered in the radiological impact assessment of the facility area intrusion scenarios and ground water path to the biosphere.

<u>Evaluation of human intrusion scenarios</u>

Two different studies of human intrusion scenarios have been performed. In the first one, following the French Safety Rule RFS 1.2, it is assumed that a human intrusion in the repository occurs deterministically 300 years after the closure of the facility, ic:, just after the end of the institutional control period. Two kinds of scenarios are defined: realisation of an extensive public work, and the settlement of a dwelling in the area occupied by the wastes.

In the former, are evaluated the doses received by workers due to the external irradiation and to the inhalation of contaminated dust. In the latter, it is supposed that there is a completed mix of the wastes with the non active materials man made barriers and with the natural materials present on the site; the inhabitants of the dwelling are considered exposed to the external irradiation from the soil and to the inhalation of contaminated dust; there is not considered any consumption of food produced on contaminated soil. The results obtained in the evaluation of both scenarios are below the limits set up in the national regulations on radiological protection but don't provide an objective indication of the risk associated to the deposit as the scenarios are defined in a very arbitrary way. On the other hand, the figures of doses produced may be considered high enough to deserve further evaluation.

For these reasons a second study was undertaken where a residential scenario was defined in a some how more realistic and comprehensive way.

For the definition of the scenario as well as for the methodology of evaluation, the recommendations from the Expert Group of the Nuclear Energy Agency of the OECD have been adopted; also were considered the evaluations performed in the USA for the environmental impact statement of 10 CFR 61. In this scenario it is assumed that no human intrusion progresses enough to arise significant doses within the first 500 years after the closure.

The doses found in this second study are significantly lower than in the first one, even when it includes the ingestion pathway. The main reasons for this are that on one hand, the 200 additional years to consider a human intrusion occurs first, allows for a significant decay of gamma emitters as Cs-137 which is a main contributor to the dose in the first study.

<u>Groundwater path</u>

For the analysis of the radiological impact via infiltration-ground water, two different phases are considered:

During the institutional control phase (ie. time < 300 years) it is assumed:

- Infiltration rate of 4,5 l/m^2 (3 times design objective).
- Level 2 wasteforms leaching in a diffusion model. Level 1 wasteforms leaching by surface rinse.
- Concrete barriers (overpacks and bottom slab): limiting releases due to chemical equilibrium. Flow circulation with conservative permeability values.
- Leached activity goes directly to the saturated zone. No credit is given to the disposal cell slab, control network nor unsaturated zone.

- Abnormal infiltration rates are considered as an "accident".

After the end of this period, the following conditions are assumed.

- Water infiltration rate similar of the natural percolation in the site.
- All engineered barriers, including disposal containers and waste matrices are completely degradated.
- Leaching mechanism is controlled by chemical equilibrium between water and ground concrete (K_d).
- Leached activity reaches immediately the saturated zone.

In both phases a simplified model of the geosphere is used, using "conservative" values of water velocity (compared to the three-dimensional model used in the hydrogeological studies), and retention and diffusion coefficients.

For some nuclides, due to the difficulty of determination, no retention in the rock was assumed, being this nuclides which produces higher doses.

8. OPERATIONAL EXPERIENCE

The facility operates in normal conditions with no incidents in its 3,5 years life.

The major operating data for a standard year (1995) are:

Reception of waste packages (1995)

- Number of transports: 315
  . From NPPs 251
  . From minor producers 64

- Number of packages: 11.729
  . From NPPs 9.182
  . Drums from minor producers 720
  . 25 L liquid waste containers
    from minor producers 1.827

Fabrication of concrete overpacks

- Design production: .... 4 per day
- Normal production: .... 2 per day
- Annual production: 475
- Average mechanical strength .... 511 kg/cm^2

Grout injection

- Radioactive liquid wastes used in grout preparation: 162 m^3.

- Design modification: additional injection system for reliability.

Compaction

- Annual compaction rate .... 4.021 drums (220 L)
  . From NPPS .... 2.713 ≅
  . Institutional wastes .... 1.308 ≅

- Average number of compaction
  pellets per overpack 34,33

- Average liquid wastes obtained .... 2,5 L/drum

- Design modification: improvement in pellets handling.

Incineration

- Average incineration rate .... 35 Kg/h

- Waste incinerated .... 63 m^3
  . 62% solid
  . 38% liquid

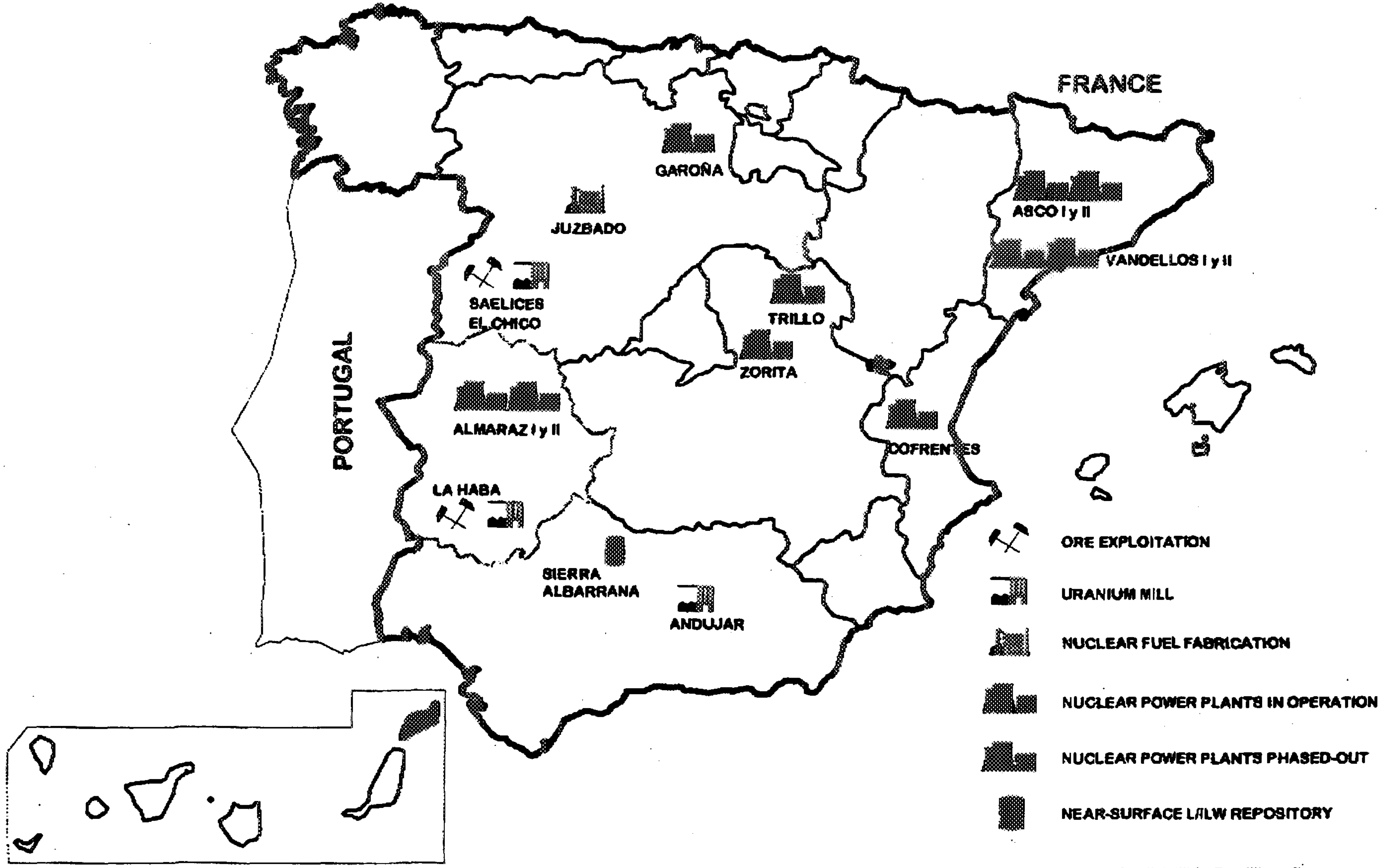
- Secondary wastes .... 6 m^3

- Design modifications: improvement in liquid filtration and solid / liquid separation in the glove-box. Change of materials of control valves.

Disposal cells

- Disposed of in the year .... 475 overpacks
- Disposed of (total) .... 1.217 overpacks
  . 16.488 .... 220 L drums
  . 66 290 L drums
  . 9.990 .... compaction pellets

NUCLEAR FUEL CYCLE INSTALLATIONS IN SPAIN



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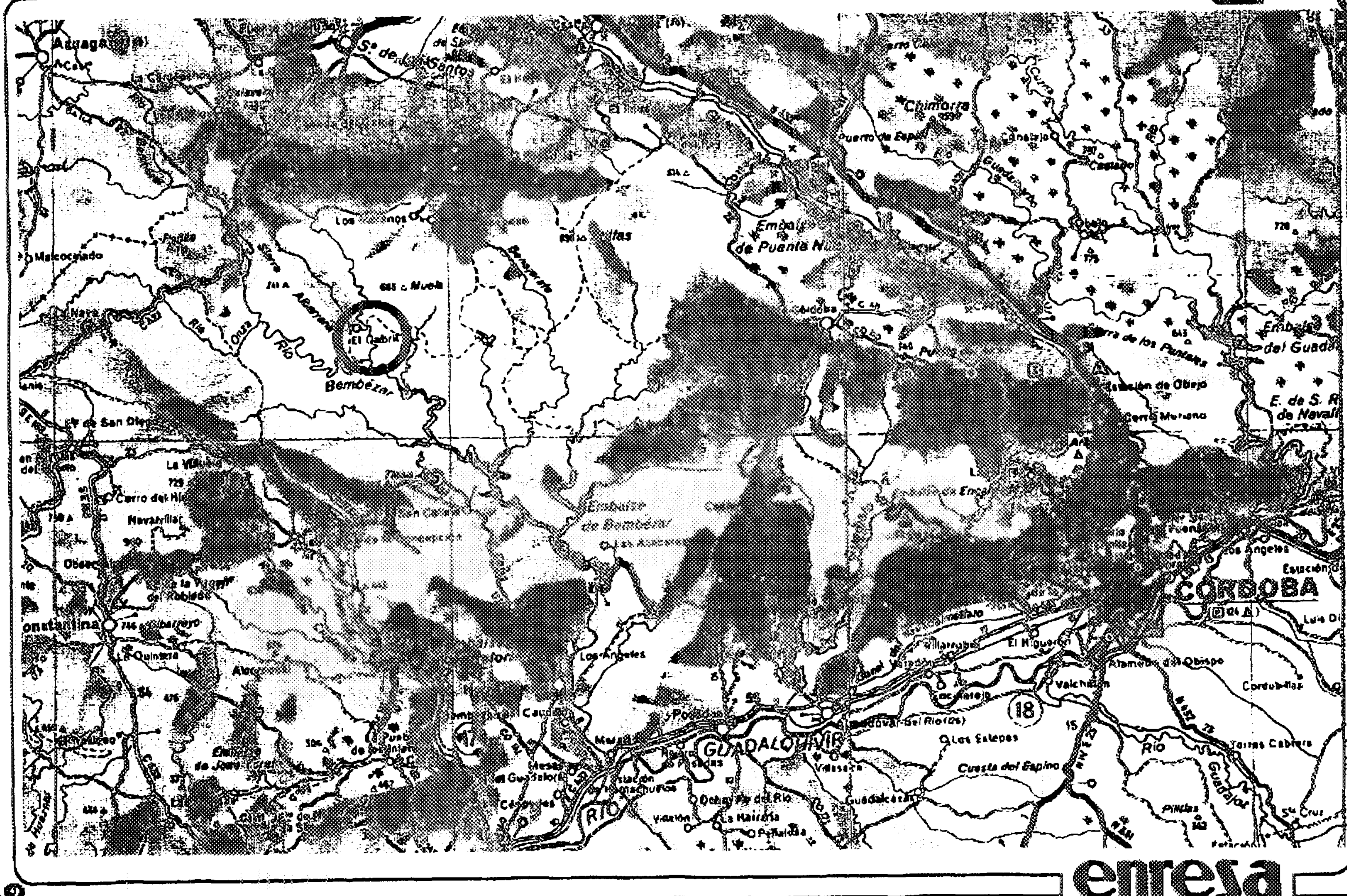
LOCATION "EL CABRIL"



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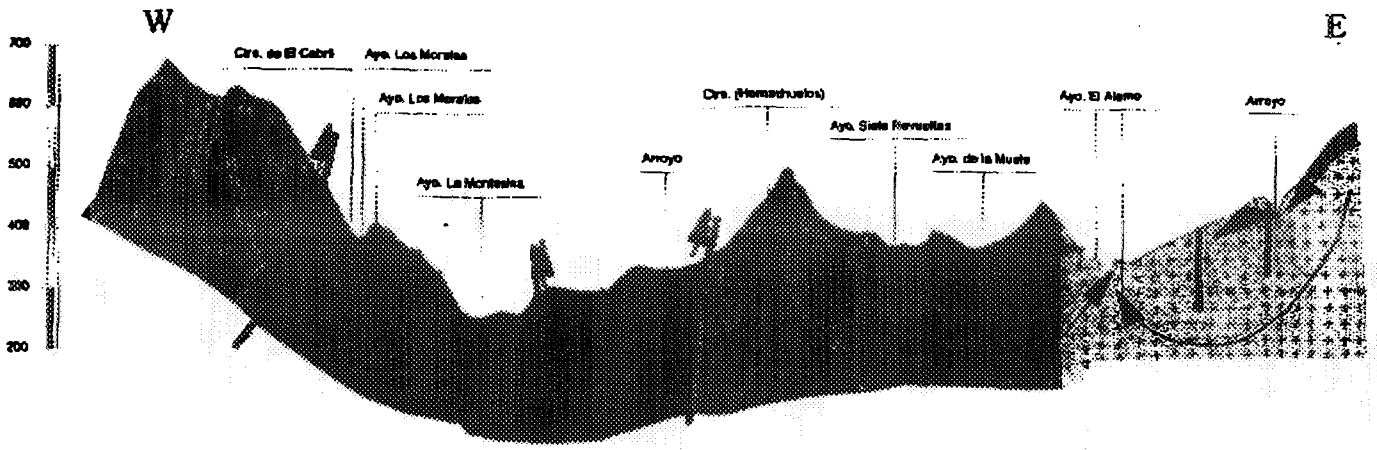
SITE SECTION



Escala vertical 1:10.000
Escala horizontal 1: 50.000

<u>LEYENDA</u>

Micaesquistos con granates Micaesquistos con biotita	Formación Albarrana
Micaesquistos con estaurolita	Corneanas
Micaesquistos con sillimanita Cuarcitas	Granitos biotíticos de grano grueso
Formación Cabril	Granitos feldespáticos alcalinos

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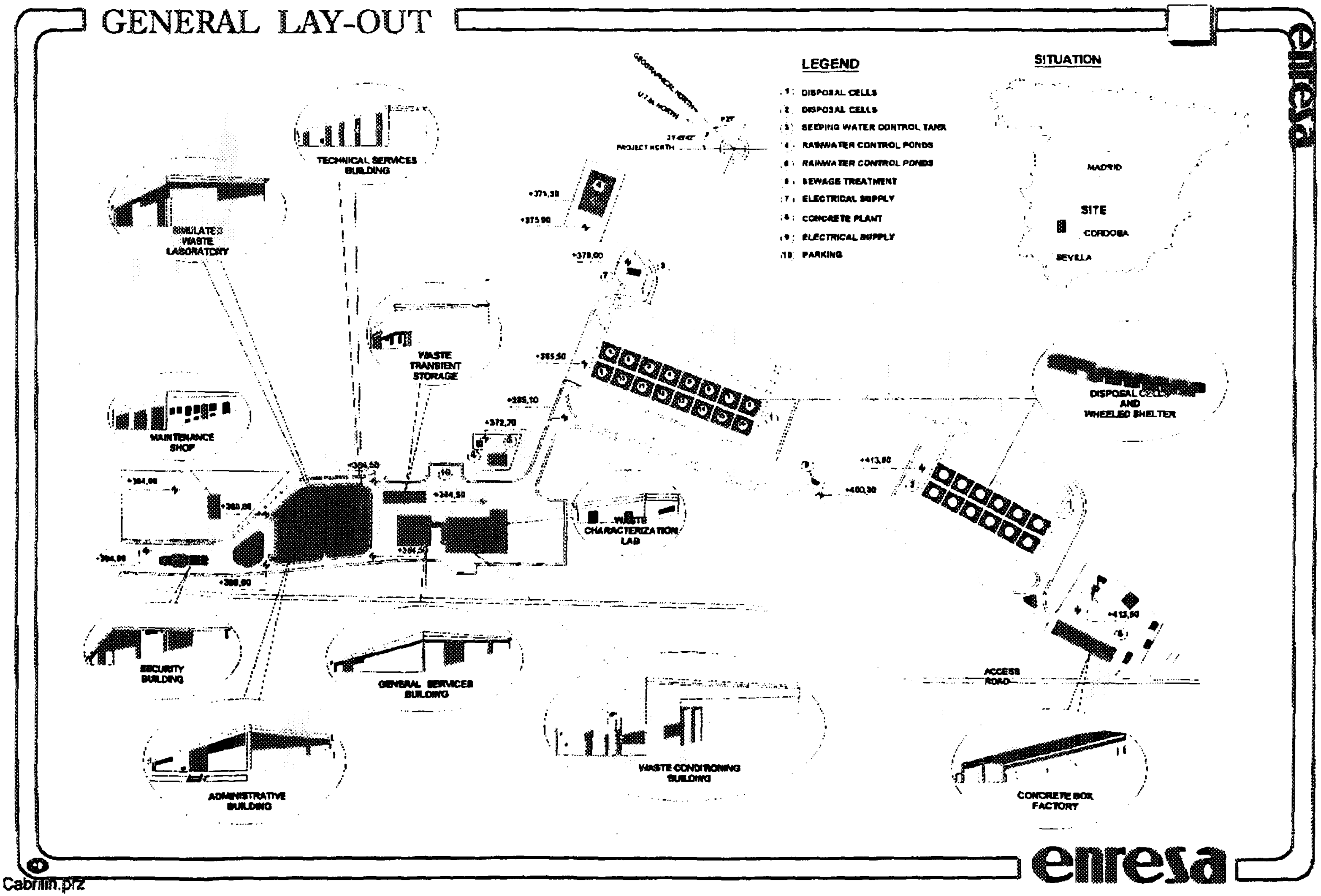
GENERAL LAY-OUT
LEGEND
1 DISPOSAL CELLS
2 DISPOSAL CELLS
3 SEEPING WATER CONTROL TANK
4 RAINWATER CONTROL PONDS
5 RAINWATER CONTROL PONDS
6 SEWAGE TREATMENT
7 ELECTRICAL SUPPLY
8 CONCRETE PLANT
9 ELECTRICAL SUPPLY
10 PARKING
SITUATION
MADRID
SITE
CORDOBA
SEVILLA
PROJECT NORTH
TECHNICAL SERVICES BUILDING
SIMULATED WASTE LABORATORY
WASTE TRANSIENT STORAGE
MAINTENANCE SHOP
DISPOSAL CELLS AND WHEELED SHELTER
WASTE CHARACTERIZATION LAB
SECURITY BUILDING
GENERAL SERVICES BUILDING
ADMINISTRATIVE BUILDING
WASTE CONDITIONING BUILDING
CONCRETE BOX FACTORY
ACCESS ROAD
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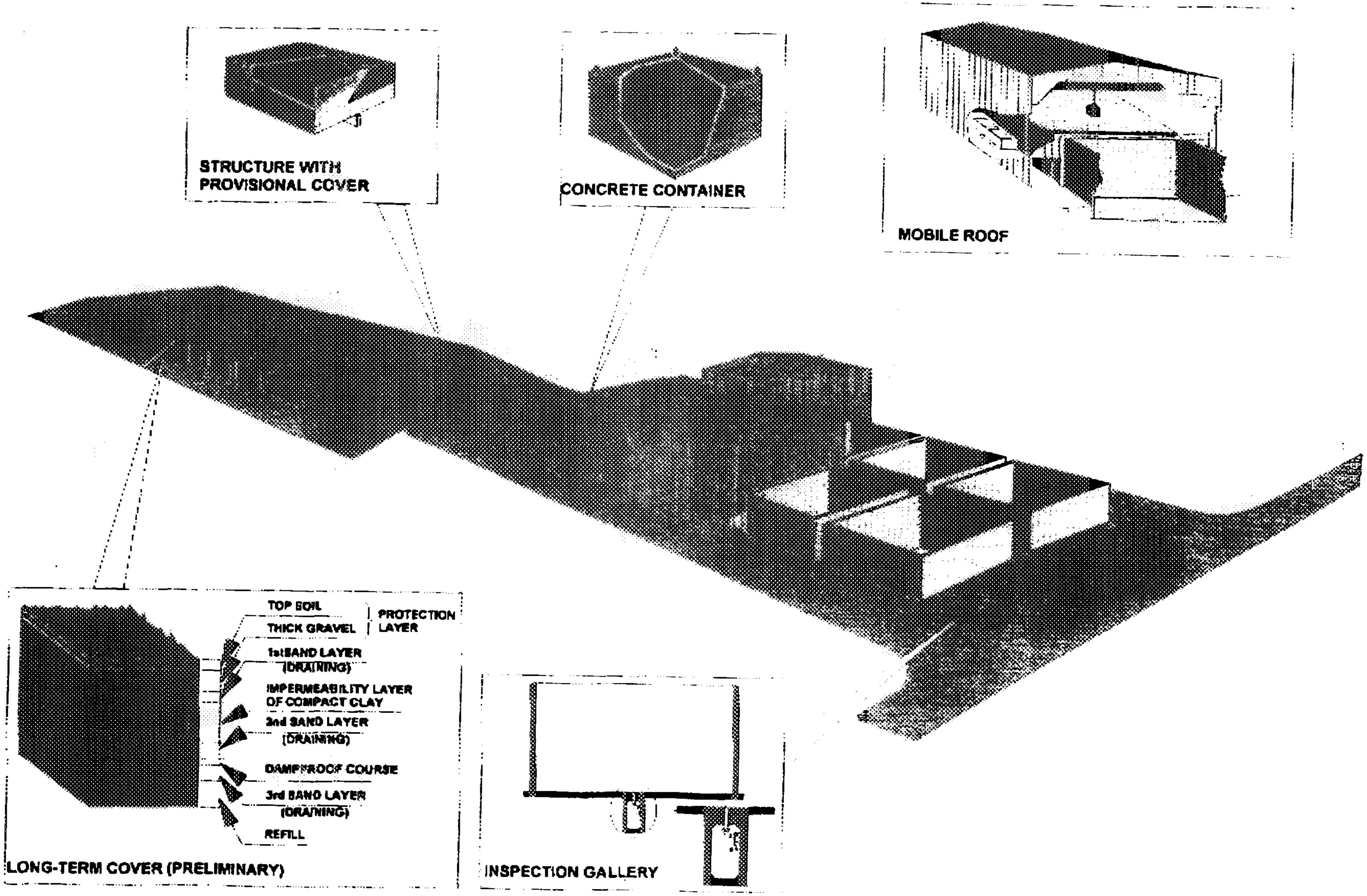
NEAR-SURFACE L/ILW "EL CABRIL"



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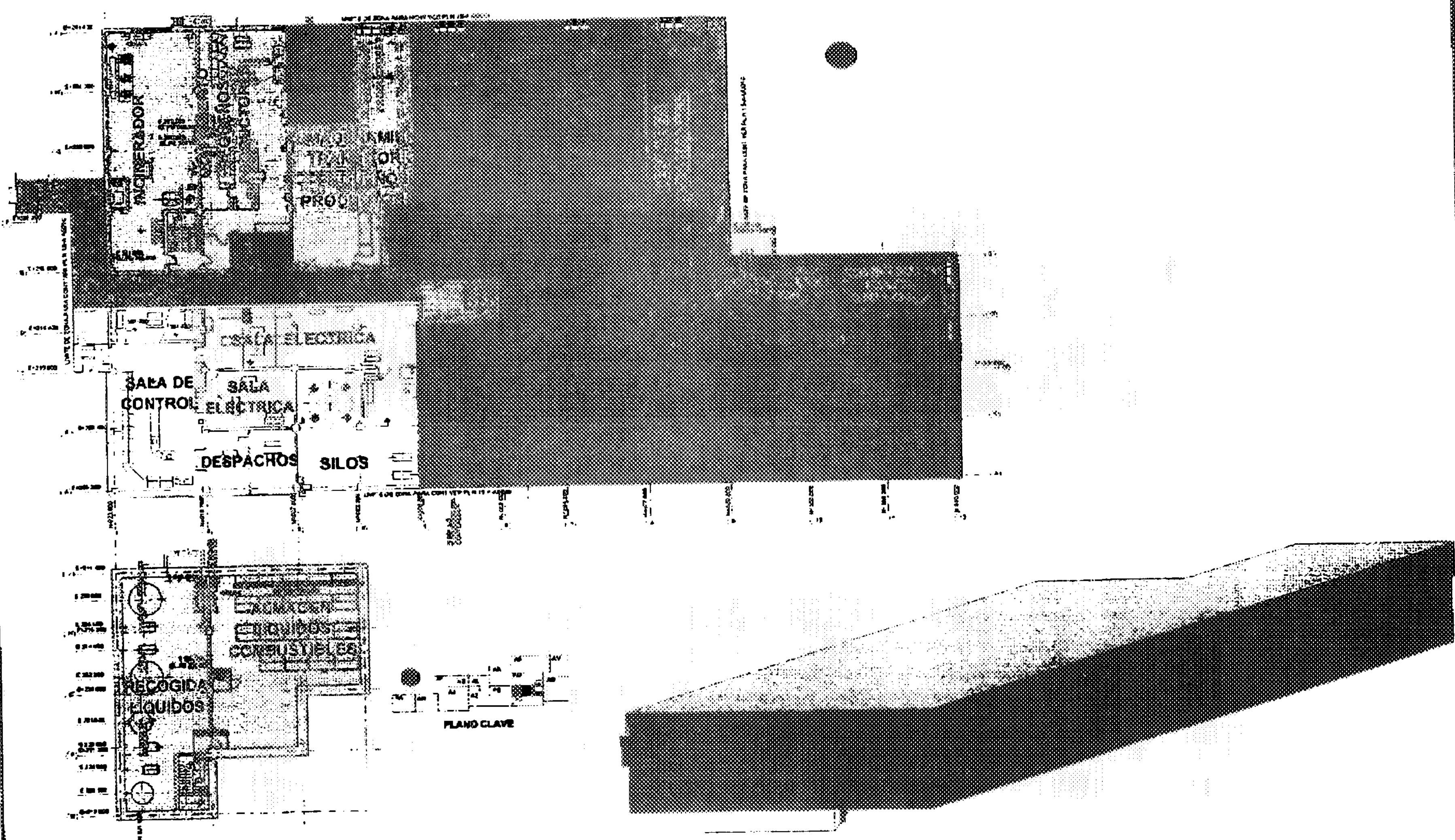
CONDITIONING BUILDING



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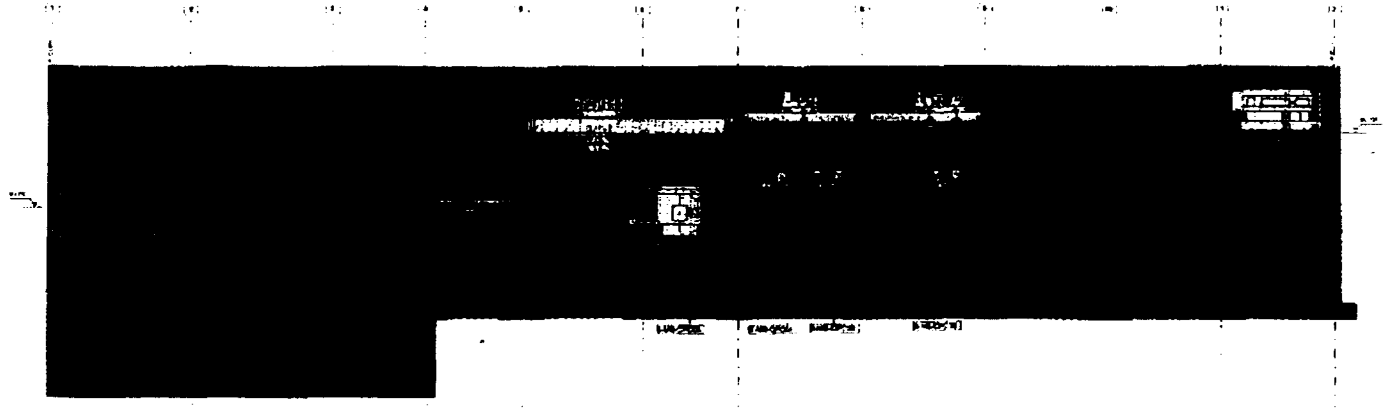
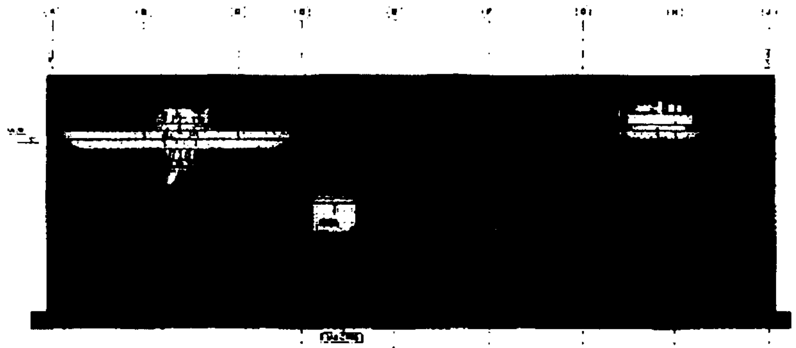
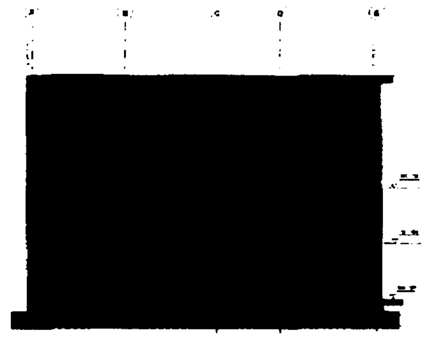
CONDITIONING BUILDING



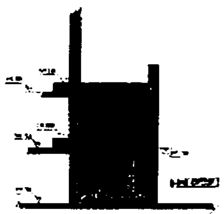
SECCION A-A



SECCION B-B

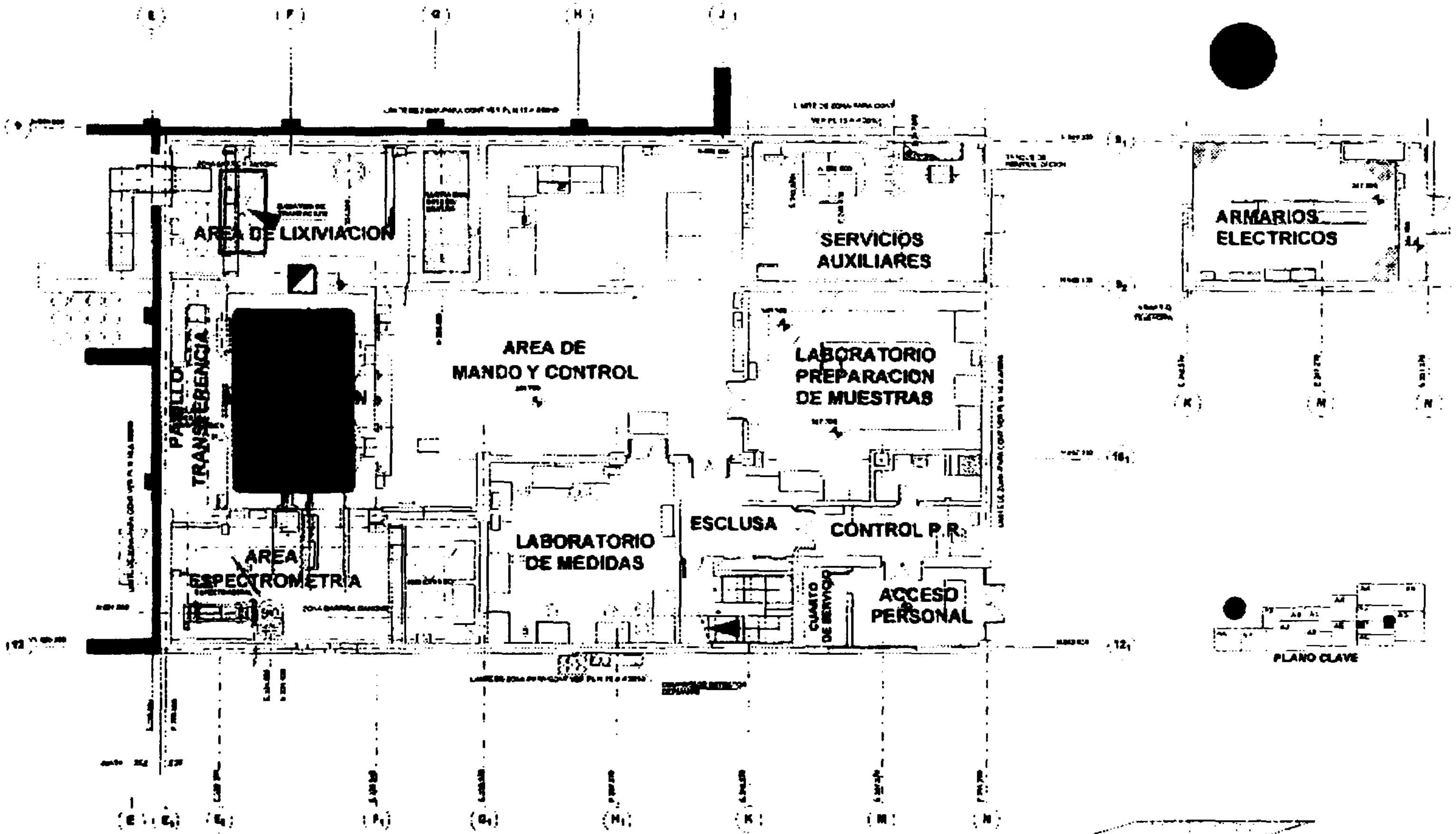


SECCION C-C



SECCION D-D

WASTE QUALITY VERIFICATION LABORATORY



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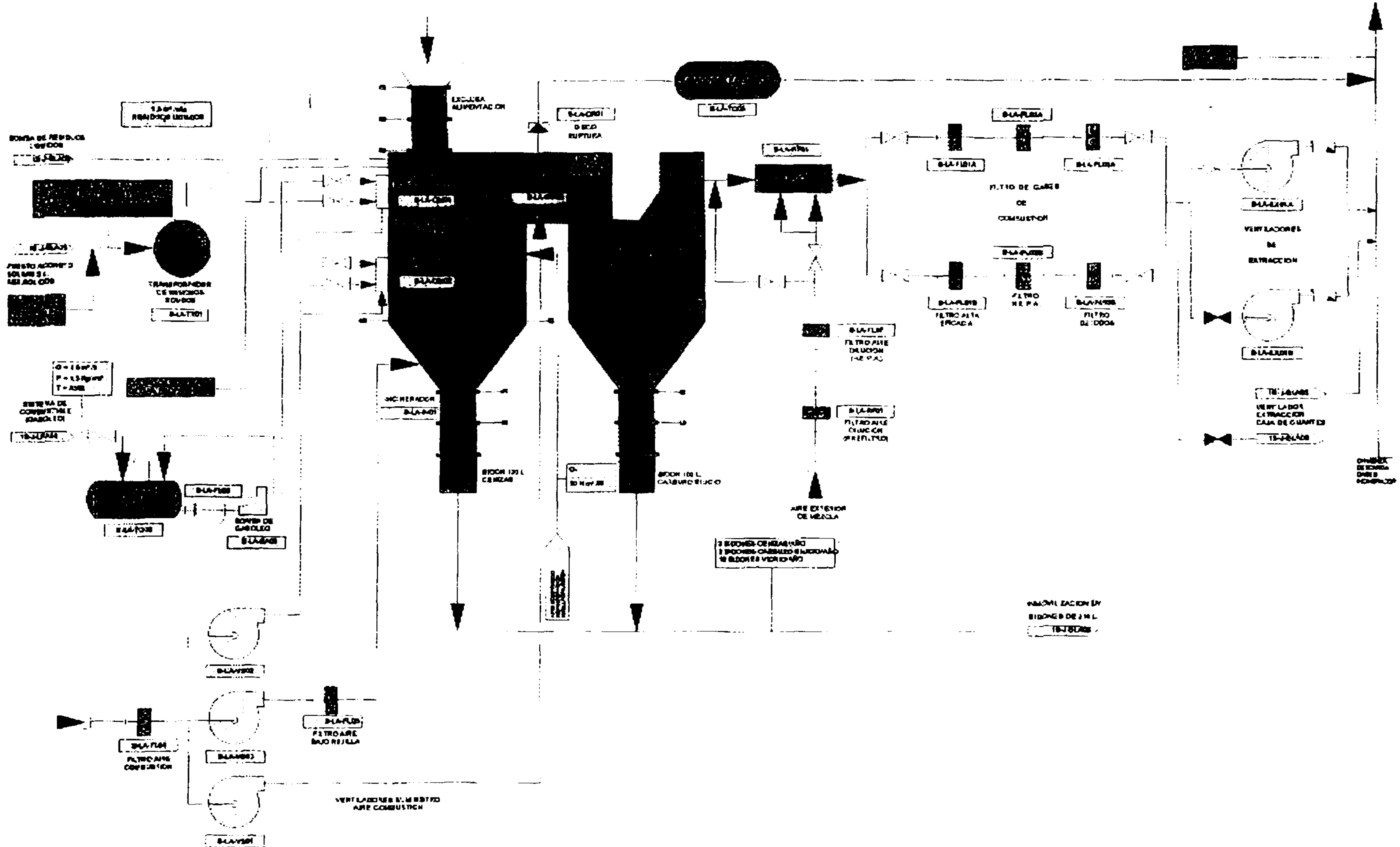
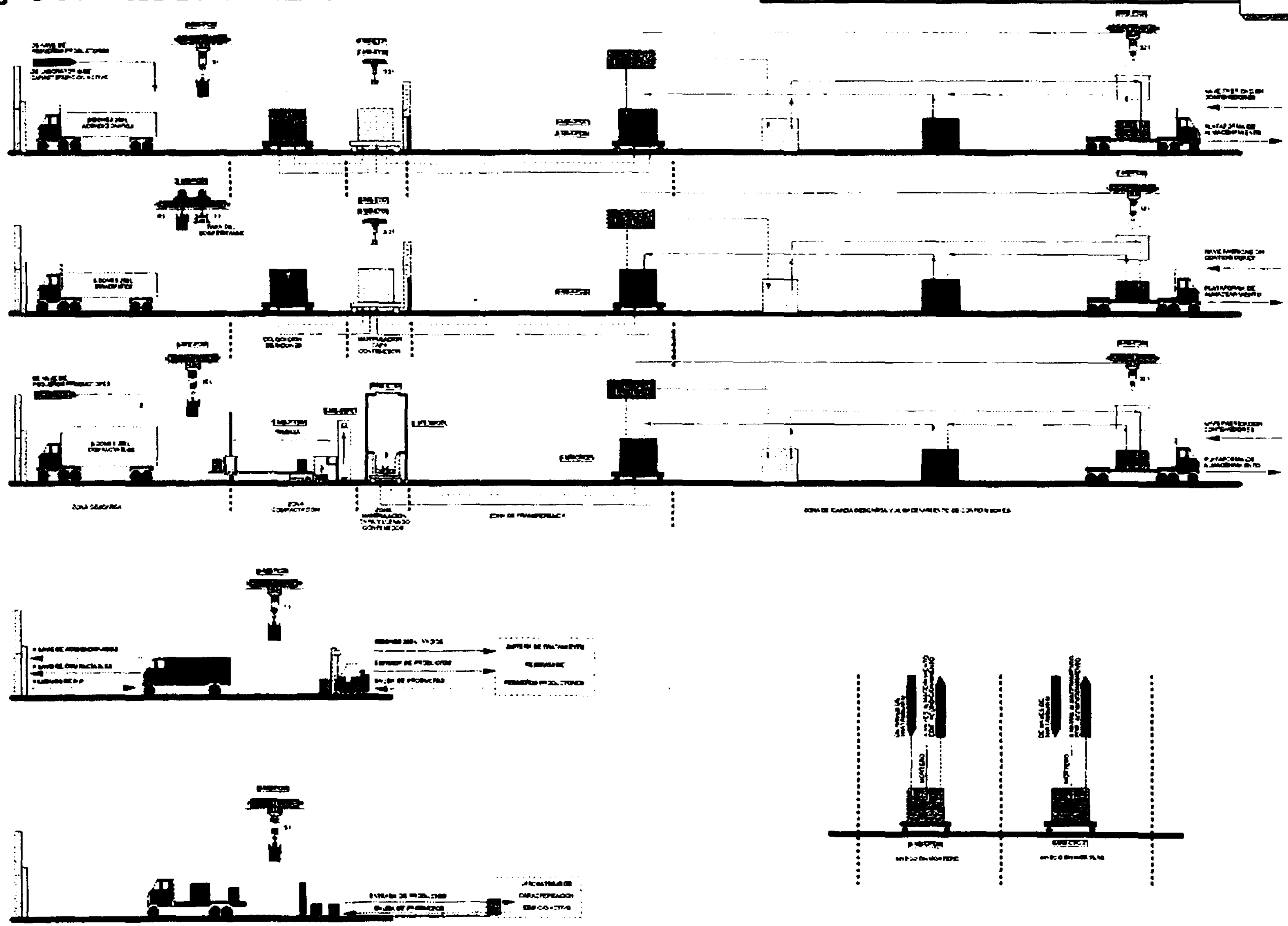
SMALL PRODUCERS TREATMENT INCINERATION



COMPACTION AND PACKAGES TRANSFER



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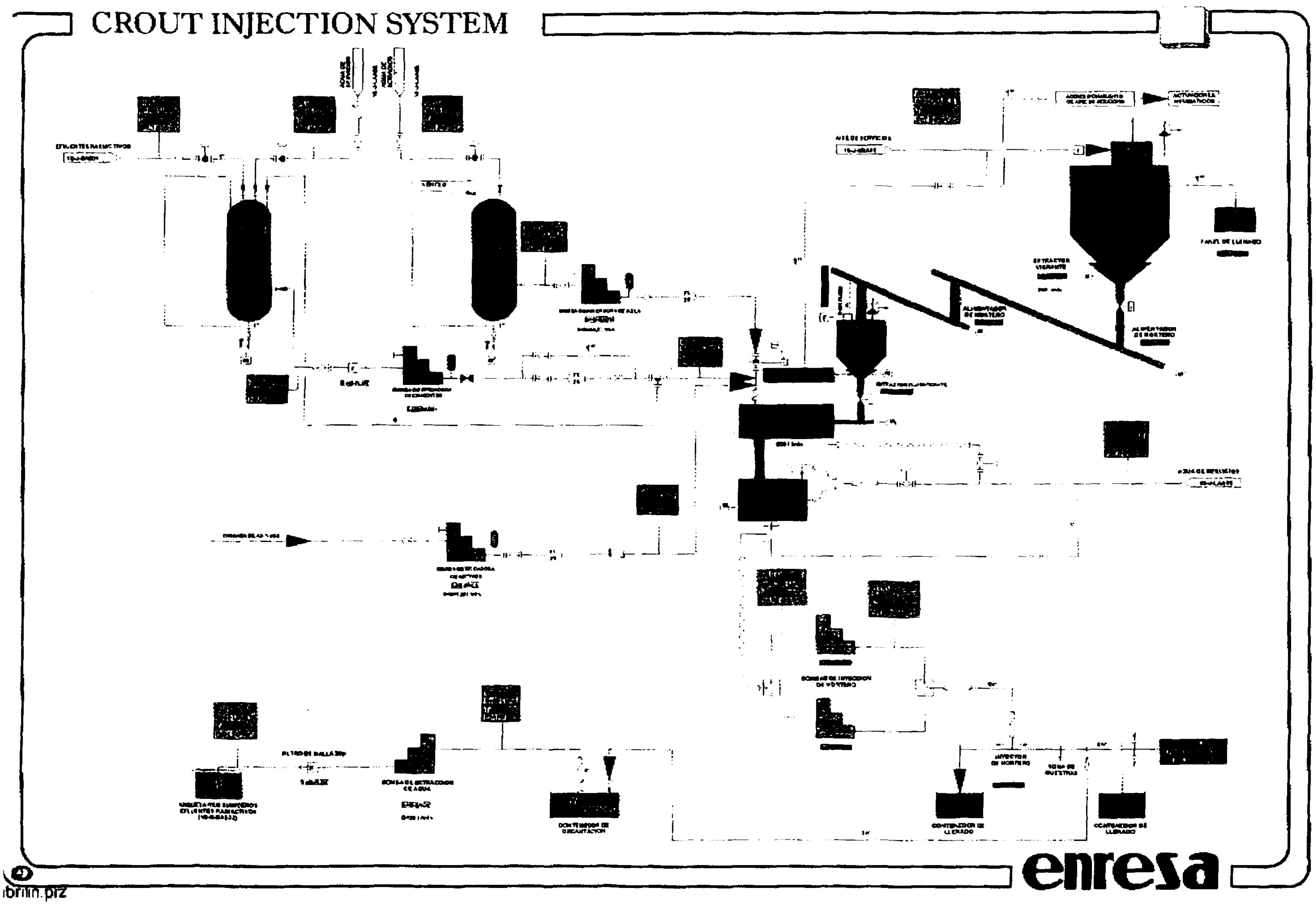
Disposal Cost $/m3

Comp. Disposal / Recovery | 937.4
| 2345.2
Total | → 3282.6/m3


CROUT INJECTION SYSTEM
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