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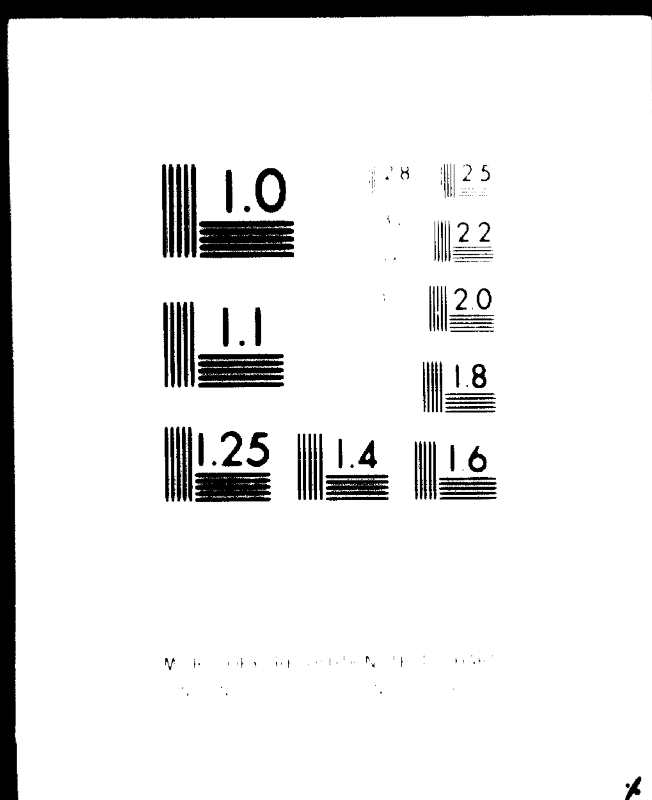

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

Greece. APPRAISAL OF EFFLUENT DISPOSAL PLAN FOR THE VOLOS INDUSTRIAL AREA.

for

HELLENIC INDUSTRIAL DEVELOPMENT BANK

April 1972

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

APPRAISAL OF EFFLUENT DISPOSAL PLAN FOR THE VOLOS INDUSTRIAL AREA

for

HELLENIC INDUSTRIAL DEVELOPMENT BANK

April 1972

Gibb-Ewbank Industrial Consultants
24 Queen Anne's Gate
London S.W.1.

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V. Poling, Esq.
UNIDO Project Manager
24 Dodecanissou
Salonika
Greece

28 April 1972

Dear Sir,

Contract No. 71/81 - Project SFGRE-26
Effluent Disposal Advice Assistance
Special Advice Order No.1
Appraisal of Effluent Disposal Plan for the Volos Industrial Area

In accordance with the above Contract signed by UNIDO on 27th January 1972 and Gibb-Ewbank Industrial Consultants on 7th February 1972 and Special Advice Order No.1 dated 30th December 1971 for the Appraisal of Effluent Disposal Plan for the Volos Industrial Area, we now have pleasure in enclosing eight copies of our report. A copy of this letter and three copies of the report are being forwarded to UNIDO Vienna.

We shall look forward to receiving your comments or approval to the report so that due consideration may be given to any revisions which may be necessary.

We regret the delay in the submission of this report but this has been unavoidably due to a number of enquiries that had to be made after completion of the fieldwork.

Yours faithfully,
For GIBB-EWBANK INDUSTRIAL CONSULTANTS

Partner

Hellenic Industrial Development Bank

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Hellenic Industrial Development Bank

Appraisal of Effluent Disposal Plan for the Volos Industrial Area

1. TERMS OF REFERENCE

The terms of reference for the appraisal of the Effluent Disposal Plan for the Volos Industrial Area were contained in UNIDO's Special Advice Order No.1 to Contract No. 71/81 and were as follows:-

"A study for an effluent treatment plant for the Volos Industrial Area has been prepared by a Greek Consulting Company. This includes a study of the effluent problems and engineering plans for the effluent treatment plant. The type of service to be provided by Gibb-Ewbank shall be:-

(a) To review the report and the engineering plans.

(b) To study the local situation at Volos in order to assess the information on which the study has been based upon, and the validity of the proposals

On the basis of the above information to determine the feasibility of the proposed plant in Volos and, if need be, to make recommendations for necessary alterations."

2. SUMMARY REPORT

2.1 Proposals for the effluent treatment plant for the Industrial Area of Volos were prepared on the basis that the average flow should be 4,600 m^3/day. This figure is appropriate for the area involved where industries have normal water consumption and effluent discharge.

The overall design of the plant has been well considered and the proposals include for the following main treatment units:

	Diameter	Number
Primary sedimentation tanks	14 m	4
Percolating filters	21 m	8
Secondary sedimentation tanks	14 m	4

In addition, four sludge drying beds, having a total area of 500 m^2 are included.

The Consultants have no significant criticism to make of the arrangement or capacity of the various units. Some economy could be effected by the omission of the sulphuric acid and lime dosing plant. The Consultants consider that this equipment should be omitted or at least deferred for the time being until it has been possible for a pilot scheme to be run to provide adequate evidence that such equipment is required.

The area proposed for the plant is suitable for the size of plant involved. It would occupy about 2.5 ha in the south-east corner of the Industrial Area.

The treated effluent would be discharged to the Karla Ditch, which has a substantial flow of water throughout the year.

2.2 The decision that the Peugeot-Renault factory should be established in the Industrial Area has made it necessary for the proposal for the effluent treatment plant to be substantially altered on account of the significantly greater quantity of discharge. Although the factory will have special processes, the type of plant originally proposed will be satisfactory, provided certain safeguards are taken to spread the concentrations of polluting constituents over periods in which the industrial effluent is discharged. The ultimate size of the plant is required to treat 20,000 m^3/day i.e. 4½ times the discharge of the original proposal. The physical size of the plant is required to be scaled up to this extent by increasing the size and number of the units. The Consultants' preliminary assessment of the size and number of treatment units for space reservation is as follows:-

	Diameter	Number
Primary sedimentation tanks	20 m	8
Percolating filters	32 m	16
Secondary sedimentation tanks	14 m	8

Provision should be made for re-circulation of sewage and for alternating double filtration.

18 No. sludge drying beds would be required, having a total area of 2,200 m^2 although some economy in space could be made by utilising sludge drying plant

The Consultants recommend that an investigation should be made into the economics of adopting in whole or in part an activated sludge plant instead of percolating filters.

The size of the plant now required to treat the effluent from the Industrial Area, including the Peugeot-Renault factory is such that it cannot be located on the land allocated without coming objectionally close to the Industrial Area and particularly to the Peugeot-Renault factory.

The Consultants recommend that an area of about 10 ha is acquired for the enlarged plant located east and downstream of the site originally proposed.

The Consultants also recommend that the HIDB should set up a Central Laboratory to analyse the various effluents discharged to the proposed treatment plant and for the control of the operation of the plant.

3. EXISTING PLANS FOR TREATMENT PLANT

The existing proposals for the treatment plant at Volos were made known to the Consultants in a note translated by Mr. Venouglou, engineer to HIDB. This note summarising the essential particulars of the plant is attached to this report in Appendix No.1. The complete report has not been made available to the Consultants.

Additional information was obtained during the visit to Athens and Volos by our Effluent Disposal Adviser from 24 January to 28 January 1972.

The proposals for the treatment plant were broadly as follows:-

3.1 Design Flow

The plant was designed on the basis of an expected dry weather flow from the drainage system of about 5600 m^3/day in summer and an average flow of 4600 m^3/day

3.2 Treatment Plant Proposals

The proposed plant layout was shown on six well-considered drawings. These drawings were obtained in Athens and have subsequently been inspected and are listed in Appendix No.2. The treatment plant consists of:-

3.2.1 Screening, comminutors, flow recorder and a pumping installation in that order at the head of the plant. Five pumping units were proposed i.e. 4 in operation and 1 standby.

3.2.2 Lime dosing plant for application to the raw sewage in a mixing sump of a dose of up to 400 mg/l.

3.2.3 Four primary sedimentation tanks each of 375 m^3 capacity giving 8 hours nominal retention for the average flow of 4600 m^3/day.

3.2.4 Sulphuric Acid Dosing plant to correct the alkaline condition of settled sewage. The plant has a storage capacity of 10 m^3, sufficient to correct an expected pH in the range 9-11 down to a pH of about 7.0.

3.2.5 Eight percolating (trickling) filters containing appropriately prepared gravel each of 700 m^3 capacity. The BOD of the settled sewage has been assumed to be in the range 100 to 150 mg/l. For a flow of 4600 m^3/day this implies a daily load on 5600 m^3 of filter capacity of 460 to 690 kg of BOD i.e. a BOD dosing of 80 to 120 g/m^3/day, the volumetric dosing being 0.82 m^3/m^3.

3.2.6 Four Secondary Sedimentation Tanks are proposed and are of comparatively large capacity being the same as the Primary Tanks each of 375 m^3 giving a nominal retention of 8 hours.

3.2.7 Provision is made for returning the settled secondary solids to the inlet of the plant and for re-circulating Secondary Sedimentation Effluent to the inlet.

3.2.8 Combined Primary and Secondary sludge withdrawn from the Primary Sedimentation Tank is conveyed to conventional drying beds divided into four units having a total area of 500 m^2.

Appendix No.3 summarises the important treatment plant data.

3.3 Treatment Plant Location

The plant is proposed to be located in a triangular area at the south east corner of the Volos Industrial Area between the confluence of the Karla Ditch and the Seskulioti stream. The site is adequate as it would occupy an area of about 2.5 ha which is about one third of the area available (see sketch No.1).

The Consultants have not made a study of the ground conditions to determine their suitability as a foundation for the proposed treatment plant.

3.4 Treatment Plant Outfall

The outfall from the treatment plant is to the Karla Ditch which has a substantial flow of water throughout the year (see Section 5 below).

3.5 Phased Construction

It was proposed that the treatment plant would be built in phases to suit the development of the industrial area. The first phase would comprise the following works:-

(i) All headworks and pumping

(ii) All lime and acid dosing equipment

(iii) A quarter of primary sedimentations, filters and secondary sedimentation capacities

(iv) Half of the sludge drying beds.

3.6 Industrial Area of Volos

The treatment plant described above was designed to treat the effluent from an industrial area of about 150 ha. At the time of the visit of the Consultants' Adviser, about one third of the roads in the northern part of the Industrial Area had been constructed and a flour mill had been built and was in operation. A textile factory dyeing cotton fabrics was expected to be built in the area being developed.

4. THE PEUGEOT-RENAULT FACTORY - SPECIAL REQUIREMENTS

4.1 The recent decision by the Peugeot-Ranault Company to set up an automobile factory on about 28 ha of the Industrial Area changed the design requirements of the treatment plant as their water requirements and effluent volumes are such that the original estimates for the Industrial Area are substantially exceeded to an extent which requires modification of the plans for the treatment plant. The requirements for quantity and types of effluent to be treated were made known to the Consultants in a note translated by Mr. Venouglou. This information is attached to the report in Appendix No.4.

4.2 Additional information about the Peugeot-Renault Co.'s water and effluent disposal requirements was obtained by our Adviser from Mr. J. Malais, their representative in Athens. This information is summarised in Appendix No.5.

The analysis of effluent referred to in paragraph 4 of Appendix No.5 is most valuable but is subject to the reservations contained in Appendix No.6.

4.3 The wastes arising in Phase I and II were investigated in detail. One foremost waste arises from washing the air in the paint spraying shops where water used is re-circulated until the resultant liquor has to be rejected as a batch. The liquor is exceedingly impure in containing a large proportion of paint and water soluble organic solvents. The Company appreciate the strength of the liquor and propose pre-treatment to remove separable paint. Coagulants will be added with separation of surviving coagulable matter and storage of the resultant aqueous liquor to allow continuous bleeding to the sewer so that the load of impurity is discharged uniformly. Spread in this way, the BOD discharged to the factory's effluent and hence to the industrial sewage should be moderate. In Phase I 200 m^3 of pre-treated liquor arising during 2 months but spread uniformly would result in 3-4 m^3/day. In the event of the BOD of the pre-treated liquor approaching 2000 mg/l (as indicated in Appendix No.4) this would entail some 6-8 kg/day of BOD or an increase of 10-20 mg/l of BOD in 600 m^3/day of total effluent.

Phase II broadly entails merely pro rata increases according to the larger volume of effluent apart from the introduction of machinery and hence the possible need to dispose of cutting oils. Waste or spoiled cutting oils would be segregated for separate disposal or for pre-treatment by cracking the emulsions to separate oil and so to pass a neutralised aqueous liquor to the sewer. No major load of impurity should then result. Swarf should be stored for disposal to preclude escape of drained oil to either surface water or trade effluent drains. Cleansing of storage areas being made a "dry" as opposed to a "washdown" procedure.

4.4 For the purpose of Phase I of the development of the factory the provisional prescription for the composition of the effluent included in Appendix No.7 is recommended to be submitted to the Company for comment and agreed amendment, if necessary.

4.5 In the case of degreasing plants using Trichlorethylene, bunding should be adopted to preclude accidental escape or disposal of spoiled solvent to the factory drains.

The composition of effluent to apply to Phase II of the factory's development can safely be deferred and decided not only in the light of the factory's requirements all the time but also in the light of the compositions of other factories' effluents which may then be firmly established and in the light of the performance of the treatment plant. The same considerations apply with greater emphasis to Phase III where the only feature to be considered is the ultimate volume of the effluent.

4.6 To make provision for the treatment of effluent from the Peugeot-Renault factory the treatment plant should be designed to have the following capacity:-

Phase I First five years of development.

Working population in the first few years has been taken at 1000 with 60 litres/head/day for domestic sewage.

Average flow for industrial and domestic sewage 12,000 m^3/day

Phase II

Ultimate industrial and domestic sewage. 20,000 m^3/day

The ultimate development allows for a working population of up to 10,000 (the population of Volos for planning purposes is understood to increase from 70,000 to 100,000 by the year 2000) and 60 litres/head/day for domestic sewage.

5. THE RECEIVING WATERS

5.1 The Karla Watercourse to which the final effluent would be discharged is artificial and is used to drain water from a swamp to the north near Larissa. The Karla Ditch forms the northern boundary of the land presently reserved for the treatment plant (see Sketch No.1).

5.2 In the past the water has been severely polluted by paper mill waste but the water is thought to be normally of good quality.

5.3 A single analysis of the Karla water is contained in Appendix No.4. On the basis of BOD the water is of good quality but further analyses are required to cover seasonal conditions especially during the dry period and some analyses should be more comprehensive in scope. In particular Ammoniacal and Organic Nitrogen should be differentiated because it appears that "organic nitrogen and ammonia" are high relative to the good BOD value. Similarly it should be confirmed that the comparatively high suspended solids are virtually wholely mineral in character in keeping with the low BOD value. Samples at about monthly intervals are recommended. A record of temperature should also be obtained.

5.4 The flow in the Karla Watercourse has been gauged by the HIDB and particulars are given in Appendix No.4. It is believed that there is a reliable minimum flow of about 0.5 m^3/sec. - an average flow of about 1 m^3/sec. and winter flows may be as much as 10 m^3/sec. This water and especially the minimum flow in dry weather is a highly valuable asset in the disposal of the Industrial Area's effluent.

5.5 At the time of the Consultants' Adviser's visit an approximate gauging showed a flow of about 3 m^3/sec and the water carried appreciable froth. A local farmer was netting fish from the stream weighing half a kilogram or more and he indicated that pollution by the paper mill was a recurrent event.

5.6 There is a second main watercourse, the Seskulioti, which forms the southern boundary of the Industrial Area and land reserved for the treatment plant. This watercourse is normally dry. The Seskulioti and the Karla Ditch flows to join the Zhpiac and thence to the sea, the distance between the Industrial Area and the coast being some 4 Km.

5.7 The lower part of the watercourse is saline but the extent of the salinity has not been ascertained. It is not thought that there is an immediate need to determine the salinity or organic quality of the water downstream of the Industrial Area.

5.8 There are a few established factories on the banks of the lower part of the watercourse to which trade waste may be discharged. In the future, it may be necessary for the HIDB to keep a watch on the composition of the water down the watercourse to the stream to record the initial condition and such influence as the Industrial Area's effluent may cause.

5.8.1 The bay to which the Zhpiac discharges is enclosed and this doubtless restricts the discharge of water to the open sea. The domestic sewage from Volos with a population of about 70,000 discharges untreated into this bay. It is understood that the present composition of wat in the bay is, as a result of receiving this sewage, of less than desirable quality and tends to carry biological nutrients conducive to overgrowth of undesirable marine growths. It is for this reason that the impact of the final treated effluent from the Volos Industrial Area will be comparatively small.

5.8.2 With an ultimate effluent flow of 20,000 m^3 and a BOD in the region of 20 mg/1 this quantity will receive at least a twofold dilution (1 part of effluent to 2 parts receiving water) in the Karla Watercourse. It will have the benefit of travelling some 4 Km to the sea when further self purification, without undue depletion of dissolved oxygen, is a reasonable expactation.

5.8.3 20,000 m^3/day of treated effluent with a BOD of 20 mg/1 results in 500 Kg/day of BOD in contrast with the domestic sewage from a population of 70,000 taken at 55 g of BOD/head/day which would result in 4000 Kg/day of BOD.

5.8.4 Provided there are no unexpected trade effluent problems, there is no reason to suppose that discharge to the bay by the effluent of biological nutrients would worsen the present position.

5.8.5 During the first five years of development of the Industrial Area only about two thirds of the ultimate flow of effluent will be discharged with the consequent reduction in effect.

5.8.6 It is considered that closer evaluation of the effect of the effluent can wait until the latter part of the five years' development programme and measures can be taken then to control undesirable features, if any.

6. RAINFALL

The rainfall in the region of Volos is 470 mm a year. About 40% of the rain falls in October to December, about 75% in September to March leaving about 25% during April to August. The driest month of August with about 1% of the annual rainfall is succeeded by September with about 9%

7. LIMITATIONS OF EXISTING PROPOSALS

7.1 The limitations of the existing design for the treatment plant are essentially a matter of size of plant. The original design was prepared on the basis of an ultimate capacity of 4600 m^3/day of industrial sewage (see Appendix No.1). Due to the Peugeot-Renault factory's discharge, the quantity to be treated in the first five years is estimated to be 12,000 m^3/day and ultimately 20,000 m^3/day (see Appendix No.4).

The effluent from the Peugeot-Renault factory would not appear to require any modifications to the existing proposals except with regard to the quantity of effluent to be treated.

8. FACTORS BEARING ON PLANT DESIGN

8.1 Principles governing the initial provisions and subsequent phased construction of the complete plant are listed below:-

8.2 Initial Provisions

The initial provisions should be such as to keep the future position fluid so as to avoid construction which might constitute wasteful expenditure and inhibit future choice of purification process. Positive features should be incorporated at the outset which allow alternatives to be adopted without costly alterations.

The initial provisions should be simple as is consistent with the production of an effluent of good quality. As the plant will be the first sizeable installation to be controlled by the HIDB it will be advantageous if management and plant operatorsdo not have to cope with irregularities which might arise in sophisticated processes.

Apart from the Peugeot-Renault factory whose effluent (600 m^3/day for first three years) should not present exceptional difficulty, the flour mill is the only other firm project apart from possible effluent from a cotton fabric processing factory. The composition of the effluent to be treated in the first five years, estimated at 12,000 m^3/day is largely unknown. It may be the case that a combination of internal control in the factories with adaption of method of operating the treatment plant will be most efficient way of dealing with the changing situations and with difficult effluents.

Consideration may have to be given to bringing forward the biochemical purification facility of the plant but this would depend on the experience gained in accommodating the effluents as they arise.

No drawings of the larger plant to treat an ultimate flow of 20,000 m^3 per day have been seen by the Consultants nor are they believed to have been prepared but based on the same retention times and biological loading, it is evident that the enlarged plant would require the following treatment units the sizes being approximate and subject to detailed consideration.

(a) Screening, comminutors, flow recorders and a pumping installation

(b) Provision of space for lime and acid dosing equipment

(c) 8 No. primary sedimentation tanks each 20 m diameter

(d) 16 No. percolating filters each 32 m diameter

(e) 8 No. secondary sedimentation tanks each 14 m diameter

(f) 18 No. conventional drying beds having a total area of 2200 m^3.

Although some economy in space could be made by adopting sludge drying plant instead of drying beds, it is doubtful whether these units can be accommodated on the area of land scheduled for the treatment plant without coming objectionably close to the Industrial Area and particularly to the Peugeot-Renault factory.

The HIDB should therefore acquire some 10 ha of land to accommodate the larger treatment plant involved. This land should be located at a more reasonable distance from the Industrial Area and be east and downstream of the area presently reserved. If difficulties should arise in acquiring such an area, it would be feasible to use the presently proposed area and extend on to a new area in the future but if the areas are not contiguous, operational difficulties will inevitably arise.

In view of the need to increase the ultimate capacity of the plant to 20,000 m^3/day, investigations should be made of the possible advantages of substituting the process of bioaeration (activated sludge) for percolation filters. Activated sludge is usually cheaper in capital cost on account of the smaller units. As the BOD loading is unknown the decision of the size of the initial unit would be difficult. Also the process is more sensitive to accidental discharge of harmful wastes.

Alternatively, the upgrading of the efficiency of the filters by arranging for them to operate either with re-circulation or with alternating double filtration may be advantageous. Should a large BOD arise pre-treatment at the factories would have to be implemented. Should it be decided that the initial provision for the plant should be based on filters it would not be necessary to continue with filters. The filters could be followed by or run parallel to an activated sludge plant.

9. RECOMMENDED REVISIONS

The recommended revisions to the existing plans for the treatment plant as as follows:-

9.1 Between 25% and 50% of the headworks and complete similar facilities for the ultimate quantity of effluent required at the outset.

9.2 The size of phases for pumping and primary sedimentation tanks should be considered in relation to the pattern of increasing flow of effluent.

9.3 Lime and acid dosing should not be installed initially but space provided in case it becomes desirable in the future. The reasons for its initial omission are:-

9.3.1 The extent of potential benefit cannot be judged. For Phase I and II of the Peugeot-Renault factory the advantage is doubtful in view of the weak effluent with no problematic metallic content.

9.3.2 The capital and running costs are very considerable and the doubtful benefit does not justify the expenditure.

9.3.3 Management and plant operatives would be involved in technical control,which would include sophisticated electronic equipment and such involvement would be best avoided in the earlier stages of operation.

9.3.4 The positive benefit of a more readily drainable sludge is offset to an extent depending on the bi-carbonate hardness of the water supply from precipitated calcium carbonate and the degree of disinfection effected by excess lime and the depleted calcium bi-carbonate in the settled sewage may place some restriction on subsequent nitrogeneous bio-chemical purification activity.

9.3.5 Allowance should be made to permit subsequent introduction of the equipment when pilot plant or improvised full-scale trials could be conducted to establish the degree of benefit and requisite doses.

9.4 The initial capacity of the filters should be in keeping with the proportion of primary sedimentation capacity referred to in paragraph 9.2 at the same hydraulic loading as applies in the existing plans. The design should allow for future introduction of such pumping facilities as would permit re-circulation of filter effluent and operation of pairs of filters on the system of alternating double filtration.

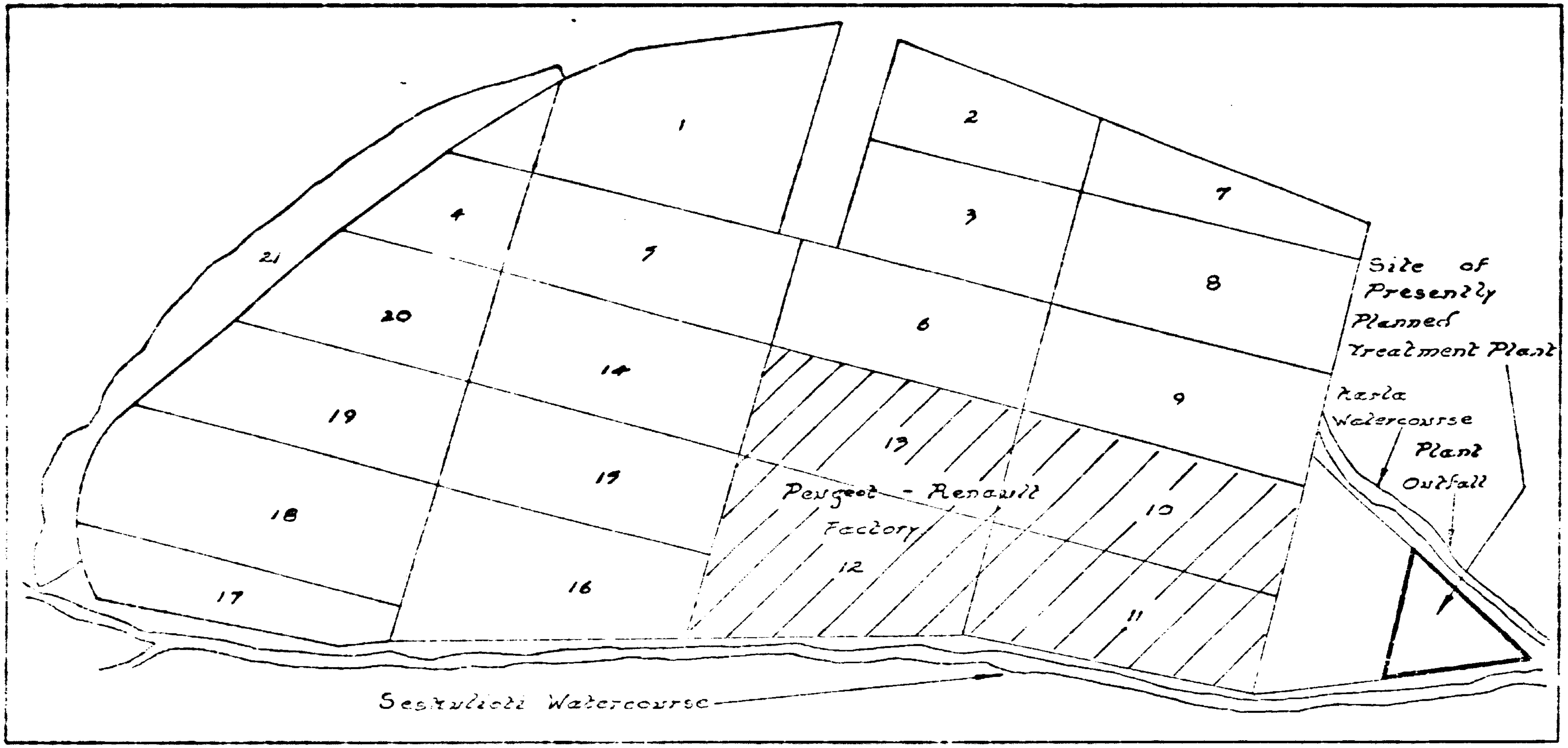
9.5 Equivalent secondary sedimentation tank capacity is required but the proportional capacity in the existing plans be halved where retention has taken account of re-circulation. This is because there may be no appreciable benefit to be gained by re-circulation during the early stages of operation of the plant if the sewage proves to be of very moderate strength. A good degree of nitrification of the filter effluent would be expected, high summer ambient temperatures will be reflected in the temperature of the sewage and long retention in the secondary tanks would entail denitrification and problems of rising secondary solids buoyed by gaseous nitrogen.

9.6 Equivalent sludge drying beds are required. Alternatively a substantial area of land could be saved by introducing some form of sludge drying plant.

9.7 Preliminary consideration has been given to the sizes of the stages to be constructed to suit the development of the Industrial Area and the preliminary recommendations are that there should be 8 stages each of 2,500 m^3/day giving a total output of 20,000 m^3/day when all stages have been constructed.

The size and number of the main treatment units has preliminarily been assessed for an overall layout aspect as follows:-

	Diameter	Number
Primary Sedimentation	20 m	8
Percolating Filters	32 m	16
Secondary Sedimentation	14 m	8



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Hellenic Industrial Development Bank

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HELLENIC INDUSTRIAL DEVELOPMENT BANK

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APPENDIX NO.1

HELLENIC INDUSTRIAL DEVELOPMENT BANK

VOLOS INDUSTRIAL REGION
Effluent Treatment Plant

BRIEF DESCRIPTION OF TECHNICAL ELEMENTS

General

The average daily water capacity of the industrial region of Volos is estimated to be approximately 6.600 m^3.

It is estimated that the 7/10 of the above-mentioned volume will be the average daily effluent volume: 0,7 x 6.600 = 4.620 m^3/day.

During summer time the effluent discharge will increase up to:
1,2 x 4.620 = 5.550 m^3/day (conversion coefficient = 1,2) or
5.550 m^3/day = 230 m^3/h = 64,00 1/sec.

It is also estimated that the peak flow will be 1,5 x 64,00 = 96,00 = 96,00 1/sec. and that the storm flow will be: 2 x 96 = 200 1/sec.

The whole plant will be divided into 4 similar parts each having a treatment capacity of 1.400 m^3/day of effluent. The entrance works, the pumping installation and the lime plant will be common for the 4 parts of the whole plant. The total area will be 25 acres approximately.

Originally only the 1/4 of the whole plant will be constructed.

Description of the Plant

It is described the part of the plant that is going to be constructed originally (for a flow capacity of 1.400 m^3/day).

Emergency Outlet

In case of disorder in the operation of the plant or in case of stormy weather, it will be possible to drive the untreated effluent to the final receiver through a by pass.

Screen

The screen is installed in order to detain big solid materials that may be carried by the effluent. It will be cleaned by hand.

Comminutors

Originally one comminutor is going to be installed. It will be also enough space for the installation of another comminutor. The capacity of each comminutor will be 100 l/sec.

Flow Recorder

A flow recorder is going to be installed to measure the total effluent capacity. The measuring range of the equipment will be from 250 l/sec. to 5 l/sec.

Pumping Plant

After passing the recorder the effluent will flow into the pumping plant's sump, where from it will be pumped and all the required load for the operation of the whole plant, equal to 7,00 m will be recovered.

The whole pumping plant provides 5 pumping units each having a capacity of 50 l/sec. The fifth pump will be of the reserve. Originally two pumping units are going to be installed

Lime Plant

The lime plant will be constituted of:

1. A delivery tank where the trucks will unload the lime.
2. A crashing device for the pulveration of the lime.
3. A mechanical conveyor for the elevation of the lime to the storing tank.
4. A storing tank made of steel with a total capacity of 20 mp.
5. Five mechanical dry-feeders each having an average capacity of 20 gr/sec.

Each feeder will be electrically connected with a pump. The corresponding feeder will provide to the coming effluent the appropriate amount of lime.

Originally two feeders are going to be installed.

6. A mixing tank with a capacity of 50 m^3 approximately. It will be supplied with two paddle-mixers.

Preliminary Sedimentation Tank

The tank will be circular, supplied from the centre and the effluent will overflow through a peripheral overflow device.

It will also be provided by a rotating sludge scaper.

The proposed dimensions are:

Capacity:	375 m^3
Depth at the periphery:	2 m
Average depth:	2,36 m
Diameter:	14,00 m
Bending of the bottom:	7^o 30'

Sulphuric Acid Installation

The alkaline effluent coming from the preliminary sedimentation tank, will be neutralised by the use of sulphuric acid. The acid quantity that will be added to the effluent, will be regulated by an automatic pH-meter device. The final pH value will be 6 to 7.

Also the installation will be supplied with a vertical mixer and an acid storing tank with an approximate capacity of 10 m^3.

Trickling Filters

Each part of the plant will be supplied with two trickling filters.
The technical characteristics for each trickling filter will be as follows:

1. Capacity: 700 m^3 of gravel with an average diameter of 5-7 cm
2. Depth: 2 m
3. Surface: 350 m^2
4. Diameter: 21,00 m

Each trickling filter is also supplied with a four-arm rotating distributor.

Secondary Sedimentation Tank

The secondary sedimentation tank will be similar to the preliminary sedimentation tank. The effluent overflow will be driven through an open channel to the final acceptor.

Sludge Tratment

The sludge from the secondary sedimentation tank will be driven by gravity to the pumping station. It will be re-cycled and re-settled at the preliminary sedimentation tank. Then it will be driven by gravity to drying beds with a total approximate surface of 500 m^2.

APPENDIX NO.2

HELLENIC INDUSTRIAL DEVELOPMENT BANK

LIST OF PLANS INSPECTED

Plan No.	Title
27 BK 411	General Layout
412	Partial Layout
415	Longitudinal Section
433	Pumping & Lime Plants - Sections EE, FF
451	Sulphuric Acid Plant
481	Sludge Drying Beds
-	Volos Industrial Area

APPENDIX NO.3

HELLENIC INDUSTRIAL DEVELOPMENT BANK

SUMMARY OF PLANT DATA

Dry Weather Flow	5600 m^3/day (summer)
	4600 m^3/day (average)
Pumping Units	4 No. + 1 No. Standby
Lime Dosing Capacity	400 mg/1
Primary Sedimentation	4 tanks each 375 m^3
Sulphuric Acid Storage	10 m^3
Percolating Filters	8 each 700 m^3
Secondary Sedimentation	4 tanks each 375 m^3
Drying Beds	500 m^2

APPENDIX NO.4

HELLENIC INDUSTRIAL DEVELOPMENT BANK

SUPPLEMENTARY INFORMATION

QUANTITY - TYPES OF EFFLUENTS

A. Quantity

New elements arising from the future foundation of the Peugeot-Renault factory, change the water demands of the estate as follows:

1. For the first five years of development

Demand: 15.000 $m^3/24$ h

Disposal: $\frac{15.00 \times 8}{10}$ = 12.000 $m^3/24$ h or

$\frac{12.000}{24}$ = 500 m^3/h or $\frac{500 \times 1.000}{3.000}$ = 140 $1/sec^{-1}$

Average flow: 140 $1/sec^{-1}$ (12.000 m^3/day)

Peak flow: 140 x 1,5 = 210 $1/sec^{-1}$

Storm flow: 210 x 2 = 420 $1/sec^{-1}$

2. Full development

Demand: 25.000 $m^3/24$ h

Disposal: $\frac{25.000 \times 8}{10}$ = 20.000 $m^3/24$ h or

$\frac{20.000}{24}$ = 840 m^3/h or $\frac{840 \times 1.000}{3.600}$ = $\frac{8.400}{36}$ = 235 $1/sec^{-1}$

Average flow: 235 $1/sec^{-1}$ (20,000 m^3/day)

Peak flow: 235 x 1,5 = 350 $1/sec^{-1}$

Storm flow: 350 x 2 = 700 $1/sec^{-1}$

B. Quality

There is not any specific information about the quality of effluents because the industrial estate is still under construction and no industry has been established there till now

Karla Ditch and Other Drainage System of Ditches

The industrial estate is located between two channels, one natural stream named Seskulioti, which is dry during the most time of the year, and Karla Ditch, which strains a swamp located near the city of Larissa.

Karla Ditch has a continuous flow of a minimum value of 0,5 m^3/sec^{-1} and of an average value of 1 $m^3/sec^{-1/n}$ winter may rise up to 10 m^3/sec^{-1}.

Karla Ditch is connected with Seskulioti 200 m downstream the elected point for the discharge of the industrial effluents.

Finally Seskulioti flows into the harbour of Volos.

The quality of the water of Karla Ditch is shown in the results of a chemical analysis.

1.	Dissolved oxygen (%)	100
2.	PH	8,0
3.	Biochemical oxygen demand	1.15 ppm
4.	Chemical oxygen demand	36 ppm
5.	Total solids	811 ppm
6.	Volatile solids (as % T S)	32.6
7.	Suspended solids	124 ppm
8.	Chloride	88 ppm
9.	Organic nitrogen + ammonia	2.8 ppm
10.	Phosphate as P	0.3 ppm

Proposed Plant Position

The proposed area for the building of the initial installation is found between Karla Ditch and Seskulioti stream near the point of their connection.

The maximum available surface is 10 acres.

Peugeot-Renault Factory

According to information given by the Peugeot-Renault authorities the effluent disposal will be as follows:

a. **Relatively clean water which will be discharged continuously.**

Phase I	60 m^3/h
Phase II	180 m^3/h
Phase III	760 m^3/h

b. Contaminated water which will be discharged discontinuously.

Phase I	200 m^3 in two months
Phase II	400 m^3 in two months
Phase III	500 m^3 in two months

The chemical characteristics will be as follows:

PH - 8 - 9

Suspended solids	:	1 - 2,2 gr/lt
B O D		1.700 mgr/lt
C O D		2.265 mgr/lt

It will be also found chronic acid in unknown concentrations. Nothing is mentioned about pre-treatment of waste water.

APPENDIX NO.5

HELLENIC INDUSTRIAL DEVELOPMENT BANK

ADDITIONAL INFORMATION ABOUT PEUGEOT-RENAULT's WATER AND EFFLUENT DISPOSAL REQUIREMENTS

The following information was obtained in discussion with Mr. J. Malais, Peugeot-Renault's representative in Athens.

Peugeot-Renault Factory

1. Phase I   Period 3 years.

   Factory population about 600. Initially 1 shift with training of personnel during first year. After first year 2 shifts and 6 days per week.

   Nature of Work Pickling, anodising and phosphating of car bodies followed by paint spraying, assembly of cars from ready-manufactured components. There will be no plating and cyanide will not be used for case hardening. Hexavalent chromium will arise from anodising. This compound will require strict control and possibly reduction to the harmless tervalent form.

   Water Requirements

   600 m^3/day for industrial use
   80 m^3/day for domestic use

   Note: 80 m^3/day is a generous allowance of 130 litres/head/day.

   Virtually all water is expected to be discharged as effluent.

   Full canteen facilities with provision of cooked meals will not be provided, provision being limited to consumption of meals brought in and to beverages.

2. Phase II Period 7 years (succeeding Phase I i.e. total 10 years)

Factory population about 1100.

Nature of Work as in Phase I. Machine shops will manufacture some components. No plating.

Water Requirements

1800 m^3/day

Virtually all discharged as effluent.

3. Phase III Period not certain.

Factory population 4000 - 5000

Nature of Work Comprehensive car manufacture with installation of foundry and plating shops.

Water Requirements

15,000 m^3/day

Cooling water will be re-circulated.

Industrial Effluent

12,000 m^3/day

4. The Peugeot-Renault Co. has completed a very similar factory in Portugal. The processes expected to be in operation during the three stages of the factory's development were described. An analysis of the effluent from the Portuguese factory presently operating at the Phase I stages is as follows:-

"Analysis of waste water continuously discharged by our assembly factory in Portugal:-

1.	C O D	248 mg/1
2.	B O D	37.6 mg/1

3.	Total Solids dried at 105°C	456 mg/l
4.	Suspended Solids	69 mg/l
5.	Organic Matter	357 mg/l
6.	Grease	60 mg/l

(depending essentially on the type of products used in operation in the factory)

7. pH — a depression of not more than 2 in the pH of the industrial water supply."

HELLENIC INDUSTRIAL DEVELOPMENT BANK

RESERVATIONS ON ANALYSIS OF EFFLUENT FROM PEUGEOT-RENAULT's FACTORY IN PORTUGAL - See Appendix No.5

The analysis of effluent from the Peugeot-Renault's factory in Portugal contained in paragraph 4 of Appendix No.5 is subject to the following reservations:-

(i) the date of analysis relative to date of sampling is not recorded and if the interval was too great this might explain an unexpectedly small BOD (compared with the COD). At face value the high COD/BOD ratio suggests organic impurity resistant to biochemical degradation but it might be that in the BOD determination a suitable bacterial flora was lacking or was not artificially inoculated to effect degradation. The doubts need to be resolved.

(ii) The "grease" content is moderate but needs to be held to a firm limit (see suggested stipulated Composition in Appendix No.7).

(iii) The depression in pH compared with that applying in the Portuguese factory depends on the Alkalinity (bi-carbonate content or buffering capacity) of the respective water supplies. An analaysis of the water to be supplied to the Volos Estate could not be made available at the time of the visit but in any event pH limits for the effluent require precise stipulation (again see suggested Composition) and internal control in the factory with pre-treatment if necessary to effect compliance.

(iv) The analysis does not include metals, notably Iron, Zinc, Copper, Lead and particularly Chromium. Hexavalent Chromium is involved in the processes and can exert bactericidal ill effect on biochemical purification. Moderate concentrations of hexavalent chromium can be reduced in sewers and during primary sedimentation to the inocuous tervalent condition but because the Peugeot-Renault effluent may be dominant during the early stage of the treatment plant's operation specification in the effluent's composition requiring reduction to the tervalent condition is recommended.

(v) The analysis does not include synthetic detergent. The proclivities of these detergents - both anionic and nonionic - notably to cause foaming in a treatment plant, to impair plant performance and, or, survive treatment to cause foaming in receiving waters, means that the detergents need to be specified as being biodegradable and a limit on the concentration discharged in the effluent should be stipulated.

(vi) The analysis does not include phosphate and the concentration is required to ensure that it is not unduly high relative to survival in the final effluent to the watercourse.

APPENDIX NO.7

HELLENIC INDUSTRIAL DEVELOPMENT BANK

PEUGEOT-RENAULT CO.

PROVISIONAL PRESCRIPTION FOR COMPOSITION OF EFFLUENT FOR COMMENT OR AGREED AMENDMENT

	For samples Compounded at hourly or half-hourly portions bulked in proportion to rate of flow throughout a working day or during 24 hours.	"Snap" or "Grab" Samples
pH	between 6.0 and 10.0	between 5.0 and 11.0
Electric Conductivity Reciprocal Megohms per cm at 20°C	(limits will depend on the composition of the water supply) say, 1500	say, 3000
Suspended Solids dried at 105°C	100 mg/1	200 mg/1
COD	300 "	600 "
BOD	200 "	400 "
Neutral Petroleum Spirit Extract	50 "	100 "
Anionic and Nonionic Synthetic Detergents		
Nonbiodegradable	prohibited	
Biodegradable	20 mg/1	40 mg/1
Iron as Fe	such limit as suits requirement provided this is not so high as to be potentially problematical, say, more than 50 mg/1	...

	For samples Compounded at hourly or half-hourly portions bulked in proportion to rate of flow throughout a working day or during 24 hours.	"Snap" or "Grab" Samples
Zinc as Zn, Copper as Cu, Lead as Pb, individually or in total	10 mg/1	20 mg/1
Hexavalent Chromium as Cr	less than 1.0 mg/1	less than 2.0 mg/1
Tervalent Chromium as Cr	such limit as suits requirement	...
Water Nonmiscible solvents including chlorinated hydrocarbons	less than 1.0 mg/1	...
Water Miscible Solvents	such limit as precludes danger of explosive or toxic atmosphere in the sewer which depends on the solvent concerned.	...
Phosphate as P	reasonable requirement	...

APPENDIX NO.8

HELLENIC INDUSTRIAL DEVELOPMENT BANK

MISCELLANEOUS OBSERVATIONS

1. Industrial Refuse Tip

One auxiliary provision is vital to the successful operation of the Industrial Area, that is the provision of an adequate industrial tip. Apart from intrinsic necessity for disposal of normal industrial refuse the ready availability of a tip can be of major value in providing for the disposal of sludges, concentrated waste liquors and potentially toxic material so relieving the load on the severage system and assisting against accidental access to the system of harmful material. It should be emphasised, however, that the tip should not consist merely of uncontrolled dump but it requires careful design with strict control of access and suitable recording of the composition and quantities of material received over the years. Primarily design should ensure that having regard to the long term neither percolation nor seepage can escape to cause pollution of adjacent underground or surface waters. Preferably tipping in conjunction with domestic refuse is desirable to take advantage of the absorption and dispersion thereby gained but, again, tipping as a whole must be systematic, consolidating and effecting permanent segregation. Due measures are also required to prevent rodent infestation.

2. Analytical Control of Flour Mill Effluent

With regard to the technical and analytical control to be exercised by the HIDB, it is recommended that the existing flour mill in the Industrial Area be made forthwith the subject of study exercise to determine the volume and character of its effluent in the manner described in Appendix No.9

3. Filter Media

Silicaceous filter media material is available as opposed to calcareous material so obtaining the equivalent of crushed gravel and should not present exceptional difficulties. The grading of suitable material is of vital importance to ensure conformity with the relevant British Standard Specification. Granite if available would also be suitable. Neither material would require testing for durability.

4. Safety Precautions

If not already acquainted with the subject, the HIDB's technical staff concerned with the Industrial Area should become familiar with the hazards which can arise in sewerage systems to men working therein and with the precautions to be taken to ensure their safety.

5. Chlorination of Final Effluent

It is understood that there is statutory legislation which might seek or stipulate disinfection of the final effluent by chlorine: in the circumstances applying to the effluent and immediate receiving water it is recommended that chlorination should NOT be carried out because it could restrict subsequent, continuing natural purification and chlorine can combine with some industrial residues to form objectionable compounds whereby residual chlorine may not be wholly and harmlessly dissipated.

6. Maintenance of Biochemical Activity

A six-day or five and a half-day week means that the treatment plant will remain idle all the week-end. Arrangements should be made to keep a sufficient quantity of re-circulated effluent passing through the filters to maintain biochemical activity

7. Charging for Disposal of Effluents

Appendix No.10 gives some suggestions for charging for disposal of effluents.

8. Technical Control of Effluents

Appendix No.11 gives some recommendations for establishing a centre control laboratory for the technical control of effluents.

APPENDIX NO.9

HELLENIC INDUSTRIAL DEVELOPMENT BANK

GENERAL CONTROL OF INDUSTRIAL EFFLUENTS

1. Because successful operation of the treatment plant - whatever form it eventually takes - depends on the adoption of certain basic principles, a requisite close degree of technical control and a number of subsiduary facilities, these important general aspects are here discussed at considerable length.

2. The Volos Industrial Area has the advantage of presently being virtually unbuilt; it has the severe handicap that, apart from an existing flour mill, the comparatively firm Peugeot-Renault project and a possible textile factory, the volume and character of the effluents to be dealt with are unknown.

3. The Volume Maximum Rate of Flow, Nature, Composition and Maximum Temperature of the individual effluents from the factories needs to be known with the best possible degree of precision. This should be ascertained as far as possible at the outset of each proposed occupation of a factory site and immediately checked as each factory commences operation.

4. The foregoing parameters and definitions are required to:

   (a) prescribe the conditions under which the effluents are accepted for disposal into the sewerage system;

   (b) determine what pretreatment, if any, is essential or economically advantageous;

   (c) determine the load (volume multiplied by concentration of impurities) imposed by the individual effluents and hence the fraction of the treatment plant's facilities occupied by an effluent;

(d) determine a fair charge for reception if the principle be adopted of charging according to the imposed load.

5. If these facts are to be established reliably and subsequently reliably monitored it is necessary to stipulate the arrangement of the drains in the factories whereby:

(a) all trade effluent is routed in a separate system to the Industrial Area's sewer and sanitary wastes, i.e. the domestic sewage from toilets, ablutions and canteens, are conveyed separately to the sewer so permitting reliable discrete sampling of the trade effluent, apart from avoiding the aesthetic objection to involving excrement in such sampling;

(b) the drain carrying the total trade effluent must have adjacent to the point of outfall to the sewer - but positioned to avoid interference with the day-to-day traffic in the factory - access for easy measurement of the rate of flow and easy sampling of the effluent.

(c) The extent to which this access was used would depend on the Volume, Nature and Composition of the effluent concerned: with an industry self-evidently incapable of imposing a big, or accidentally dangerous, load and having no big loss of water in steam or in its products, water meter readings (separate from sanitary water usage) would be sufficiently reliable and avoid unnecessary expense; with a project such as the Peugeot-Renault factory at Phase II or III, continuously recorded rate of flow and integrated daily volumes would be justified.

(d) Defining the Nature of an effluent by describing as precisely as possible the industrial processes concerned serves in some measure to prevent change in processes which might not materially affect the initially prescribed Composition of the Effluent but nevertheless introduce a new feature requiring control. For example, if a textile factory's processes were initially solely concerned with the dyeing of finished cotton fabric, introduction of keiring of raw cotton would constitute a radical change giving rise to a big increase in organic matter resistant to biochemical degradation. This particular change would doubtless be disclosed by contravention of prescribed Composition but defined Nature by the implicit requirement to notify alteration helps to prevent change being discovered after the event. As another example, a new process might introduce an unusual and unforeseen potential hazard requiring specific control under Composition, for example, say the introduction in a factory of mercurials as biocides.

(e) Theoretically all contingencies could be covered by an exhaustive Composition but this is impracticable because the items involved are innumerable. Further, and of foremost importance, prescribed Composition should seek to be as brief as possible consistent with covering expectation for the processes concerned whereby this brevity, entailing the cheapest analysis, permits the maximum number of samples to be taken for the purpose of monitoring control.

(f) The chief items to be incorporated in prescribing Composition are given below with general examples of concentrations in milligrams per litre where applicable for the purpose of illustration:

			Comment
1)	pH	Normally limited between 6.0 and 10.0	There can be certain exceptions, e.g. effluent from some fermentation industries may need the latitude of a lower limit of 5.0 because of the presence of organic acids and the concession can sometimes be allowed. Similarly, depending on the dilution afforded in the immediate sewer, a carefully judged concession raising the upper limit to, say, 11.0 can sometimes be allowed.

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ii) Electrical Conductivity (EC) (Reciprocal Megohms per cm at 20°C) not greater than say .... 2500 mg/l

EC is an inexpensive approximate analytical determination of Dissolved Solids, a limit on which prevents discharge of undue concentrations of mineral constituents. The concentration prescribed depends on the Dissolved Solids of the water supply and the industrial processes concerned. As a broad approximation EC × 0.7 = Dissolved Solids dried at 180°C, the precise factor depending on the make-up of organic and mineral salts.

iii) Sulphate as SO_4............ 1000 mg/l

Where high concentration of sulphate from, say, neutralised sulphuric acid, calcium sulphate or sodium sulphate occurs, this limit is required to protect concrete sewers from sulphate attack. Depending on dilution in the sewer, but bearing in mind the hazard to factory drains, a concession above 1000 mg/l may be possible. Where, depending on the composition of the water supply, an EC limit of 2500 mg/l is appropriate for the effluent, a sulphate limit need not be stipulated because undue concentration cannot arise within this Conductivity limit.

iv) Suspended Solids dried at 105°C (SS).. A suitable limit depends on the processes concerned.

For comparison average British domestic sewage carries some 350 mg/l of SS. Normally SS in trade effluent should be limited to, say, 1000 mg/l if the relative volume is large because concentrations in excess might mean accumulation of sludge in the sewers or that there were sludges arising in the factory capable of cheaper disposal

Comments

other than through the sewers and treatment plant. SS is one parameter required for estimating a rational charge for an effluent's disposal.

v) **Chemical Oxygen Demand (COD)**..........A suitable limit depends on the processes concerned.

For comparison average British domestic sewage has a COD in the region of 800 mg/l. COD measures virtually the whole of the organic matter in an effluent and it may be necessary to differentiate whole and settleable impurity. Depending on relative volume and hence on the load (volume times concentration) an effluent with a COD greatly in excess of, say, 2000 mg/l may mean there are cheaper means of disposal of a large proportion of the impurity other than via the sewerage system. Thus, there may be strong waste liquors or sludges capable of segregation for recovery of valuable material or for separate disposal. Alternatively pre-treatment by use of high rate percolating filters to effect a major reduction in load might be economically advantageous. As an analytical procedure COD is of good precision and a cheap determination. COD bears a relation to BOD - see below.

vi) **Biochemical Oxygen Demand in 5 days at 20°C (BOD)**..... A suitable limit depends on the processes concerned.

BOD is a partial measure of the biodegradable organic matter in an effluent, sometimes abbreviated BOD_5 to avoid confusion with ultimate demand sometimes abbreviated BOD_u. However, BOD usually means the 5-day demand and is so used here. It normally measures some 90% of the readily degradable

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carbonaceous organic matter and does not therefore include the oxygen required to oxidise nitrogenous organic matter. Determination of reliable, reproducible BOD values requires both competence and experience. Even so some industrial effluents may give a falsely low value if unknown bactericidal inclusions are present or if the standard bacterial inoculation does not happen to include specialised bacteria capable of degrading the particular organic matter, which bacteria nevertheless develop in practice as part of the biochemical processes of the treatment plant. For comparison average British domestic sewage has a BOD of about 450 mg/l and a ratio of COD/BOD for such sewage lies in the range of 1.5 to 2.0. Because the BOD of domestic sewage, and more particularly of settled sewage, can be readily reduced by biochemical degradation by some 90%, it follows that industrial effluent, and more particularly settled effluents, with COD/BOD ratios of less than 2.0 present no special difficulty. Where the ratio is greater, for example, with cotton kier liquor or conventional waste tanning liquor, biochemically resistant or biochemically nondegradable matter is present and special consideration has to be made of all relevant circumstances. Biochemically resistant or stable matter often makes itself evident as coloured matter as is the case with the aforementioned

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kiering and tannery liquors. Where an effluent is known to have a normal COD/BOD and be of constant character, the complication and expense of BOD determinations can be largely dispensed with, COD being adequate in such cases.

vii) Special Items.. Limits according to the processes concerned.

The items are mostly concerned with restrictions preventing damage to or choking of the sewerage system, preventing a hazard such as explosion or harm to men working therein, in preventing discharge of impurities incapable of removal by the treatment plant or liable unduly to impair the efficiency of the plant's treatment facilities, e.g. by poisoning bio-chemical degradation processes. It is seldom appropriate, because of impracticability entirely to prohibit particular chemicals (although petrol or other material giving rise to explosive vapour, and except by separate special agreement, Radioactive Substances should be so prohibited) but limits are made appropriately severe in the case of dangerous chemicals. The limits are decided by the relative volume of the effluent and the tolerance of the sewerage system for particular potentially harmful constituents, which tolerance has to be shared between the various effluents arising in an Industrial Area. Examples of the items in the order of the above-mentioned purposes of restriction are:

a) Sulphide, liable to cause above-water-line attack of concrete, or

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rubber latex emulsions "balling" into choking plugs, or hair from animal skin processing.

b) Undue concentration of water-miscible organic solvents sufficient to cause an inflammable atmosphere in the sewer.

c) Water non-miscible solvents including particularly chlorinated hydrocarbons such as chloroform liable to cause a poisonous atmosphere in the sewerage system and also capable of inhibiting sludge digestion.

d) Sulphate, in addition to potential attack of concrete, causing a poisonous atmosphere in the sewers. Similarly cyanide requires restriction.

e) Intractable materials such as finely-divided polyvinyl chlorine emulsions, nonbio-degradable dyes, non-biodegradable anionic or nonionic synthetic detergents, which detergents should in general be stipulated as having to be biodegradable.

f) Cyanide and the common potentially toxic metals arising from metal processing, including plating effluent. These common metals are Zinc, Copper, Nickel, Hexavalent Chromium and Cadmium. The restriction should be based on the tolerance of the treatment plant whereby it would be sought to limit the total of these metals with

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the exception of tervalent chromium to, say, 5 mg/l in the total flow to the plant. This might mean pre-treatment of some effluents unless the limit just mentioned were decidedly relaxed on the basis that it was cheaper to incur the cost of special treatment at the plant, e.g. lime treatment followed by settlement and re-correction of the created alkaline condition.

g) Where necessary restriction and perhaps severe restriction, of less usual potentially toxic metals such as Mercury, Selenium and Silver.

h) Undue concentration of water non-miscible or emulsified hydro-carbons and fats, i.e. oil, vegetable, animal or mineral grease which are determined, and a limit stipulated by, Neutral Petroleum Spirit Extract. Engineering industries effluents can carry undue oil and grease and may contain emulsified cutting oils from machining which emulsions require segregation for separate disposal or "cracking" to remove the oil. Effluent from rendering abbatoir waste, effluent from manufactured foods using vegetable and animal fat and processing of fully-grown poultry carry excess "grease" requiring restriction. For comparison, average British domestic sewage has a Neutral Petroleum Spirit Extract in the range 50 to 100 mg/l and a limit of 50 mg/l for industrial effluents should normally prove satisfactory.

		Comments
viii) General Restriction...	**Applicable to all effluents**	In an attempt to cover unforeseen potentially harmful substances and also serving the purpose of drawing manufacturers' attention to the vital necessity not to dispose of dangerous substances to the sewer, an "omnibus" clause in the Prescribed Compositions is required saying that apart from the items specifically covered by the prescription the effluent shall not contain sensible concentrations of any substance which alone or in combination with substances in the sewerage system will either damage or choke the system, create a hazard to the system or to men working therein, or render the disposal of the total sewage unduly difficult. This clause should also prohibit discharge of Radioactive Substances except by means of separate special agreement which would incorporate appropriately rigid and strict safeguards.

(g) An upper limit for Temperature of 45°C should normally be satisfactory but a big relative volume of effluent might require a lower limit in some circumstances.

(h) A logical sequence requires that industrialists should at the outset submit a formal application of their requirements for the reception and disposal of their effluent expressed in the above terms covering Volume, et cetera. The volumetric aspects of the application should not present any difficulty but requested Composition may require that the industrialist be instructed as to the technical, analytical terms in which this is expressed having regard to the Nature of the processes concerned. Where such instruction is necessary and to save time it may be possible to indicate certain restrictions which would be attached to a particular effluent.

(j) So far as any contentious aspect of the application or imposed conditions arose it would seem that in the absence of statutory legislation defining arbitration procedures resolution of any difficulty would need to rest simply between the two parties.

(k) The above formal application (finalised after any necessary discussion) would then form the central feature of a formal agreement between the two parties and, stemming from the formal application, an agreed charge would be incorporated if the principle be adopted of charging according to imposed load. This agreement should provide for possible revision at agreed appropriate intervals of, say, two years and include such arbitration provisions as are locally customary in commercial agreements.

(l) Parenthetically, water supply pipes in the factories should be divorced from and arrangement preclude accidental cross connection with process water lines, any alterations to lines being made only by agreement with the Bank.

(m) Oil and petrol storage should be bunded and feed lines sleeved or run in such manner as to preclude accidental escape to surface or foul drains.

APPENDIX NO.10

HELLENIC INDUSTRIAL DEVELOPMENT BANK

CHARGING FOR DISPOSAL OF EFFLUENTS

1. Rational charging requires that the capital and running costs of the sewerage system be broken down, say, as follows:

   i) costs related to the volumetric aspects, i.e. capacities of sewers and sedimentation tanks and to pumping;

   ii) costs related to biochemical treatment, i.e. percolating filters or bioaeration plant;

   iii) costs related to sludge disposal arising from primary solids settled in the primary sedimentation tanks and secondary solids precipitated or created in the biochemical facility of the plant;

   iv) where the relative amount and Nature of the effluent requires exceptional control by way of analytical monitoring, an appropriate charge could be made;

   v) similar to iv) a general administrative charge could be made so far as this were not incorporated in items i) to iii).

2. Charging schemes can be incorporated into a general formula applying to a particular severage system but it should be borne in mind that the complexities of a purification plant often mean that a fully rationalised elucidation of the true charge for an effluent is a practical impossibility. Moreover, much time, and hence expense, can be spent in seeking a fully rationalised charge and still leave an indeterminate area. Judgement has therefore to be exercised as to the detail on which an agreed charge should be based according to the relative importance of the load imposed and the degree of analytical monitoring required for its control. Thus, small volumes of weak effluent may merit nothing more than a flat charge and a simple agreement, big volumes and load require equivalent elaboration.

APPENDIX NO.11

HELLENIC INDUSTRIAL DEVELOPMENT BANK

TECHNICAL CONTROL OF EFFLUENTS

1. Apart from keeping cost of control to a minimum, it cannot be emphasised too strongly that the successful operation of the treatment plant at Phase 1 of its development and its subsequent development in the most efficient and economical manner possible depends on the continuous availability of reliable analytical data about the effluents discharged to the sewerage system and about the performance of the plant.

2. As the Hellenic Industrial Development Bank is concerned with the setting-up and operation of Industrial Areas other than Volos, it is recommended that the HIDB should establish a central control laboratory as soon as possible however modest its scope might be at the outset. Provision for expansion should be available. Until this facility has been established the HIDB will require in Athens the service of a laboratory with a senior analyst already knowledgeable or prepared to become expert in the technology concerned. This expertise is necessary not only for the confident production of reliable data but also to apply the principle of selective minimum analysis of the maximum number of samples yielding the best value for money spent.

3. The analysis of any sample can be no better than the reliability of the sample itself: the truly representative character of samples cannot therefore be over-emphasised in the particular field because the composition of discharges can vary widely from hour to hour and day to day. This means that when sampling at any point, first consideration should be given to the extent to which "snap" or "grab" instantaneous samples are adequate or whether as is frequently the case, a bulked sample from portions over a period is essential.

4. It is recommended that the HIDB should purchase forthwith, two automatic sampling machines so that representative samples can be obtained.

5. Should it prove possible for the HIDB to set up immediately its own central laboratory however rudimentary at the outset this would require to be under the direction of a staff member having or competent to achieve the necessary expertise.

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