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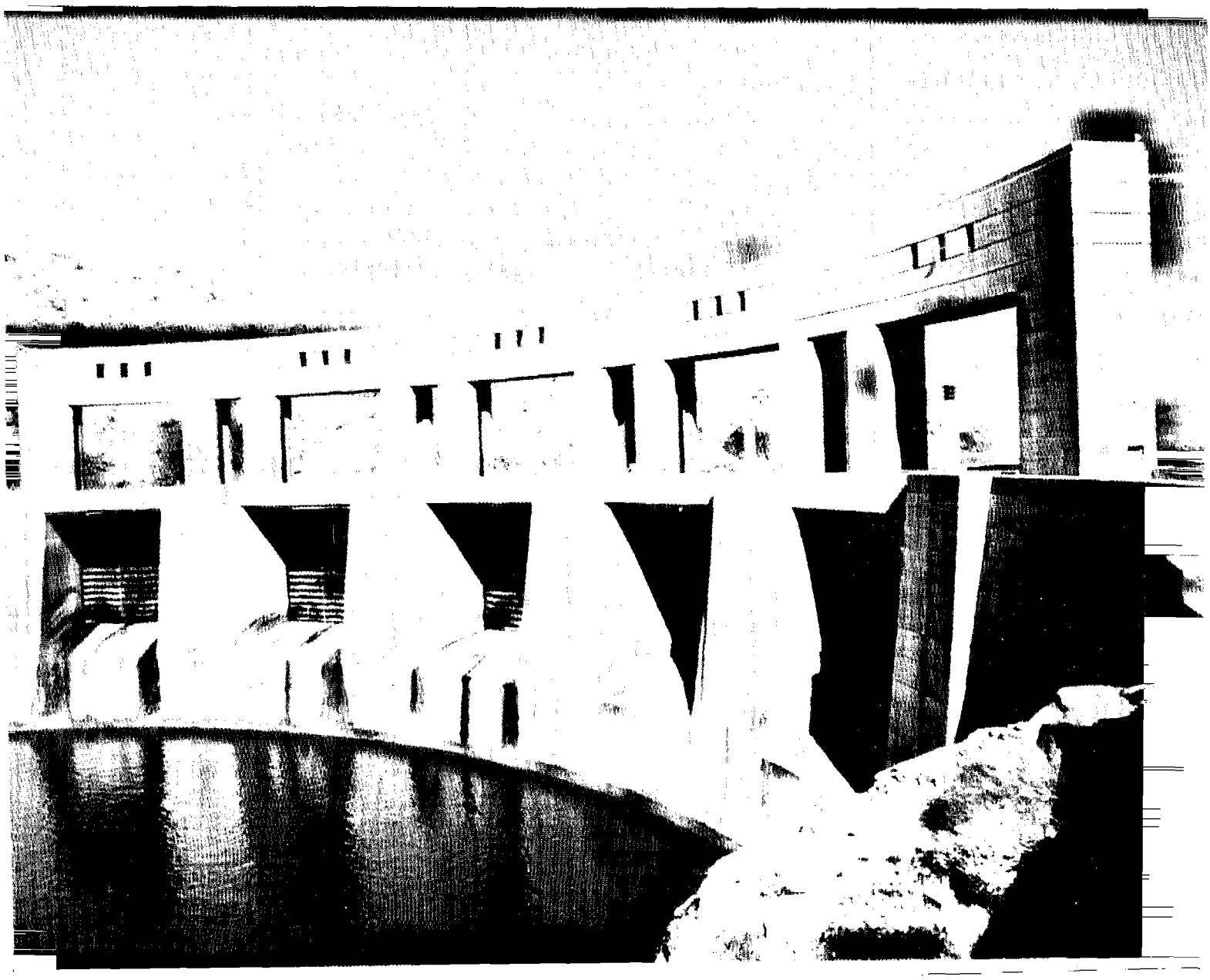

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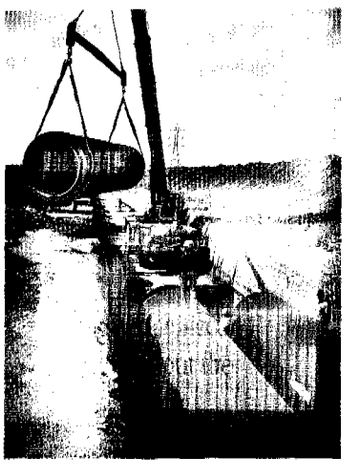

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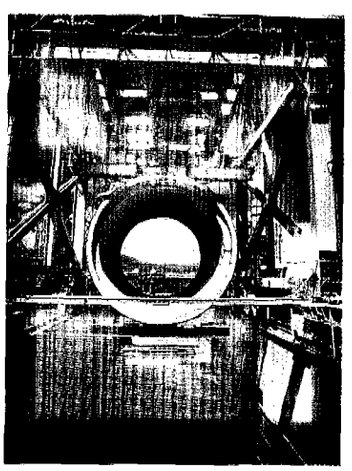

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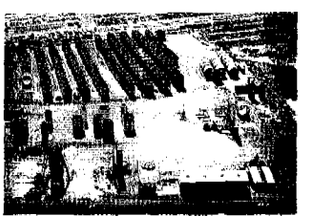

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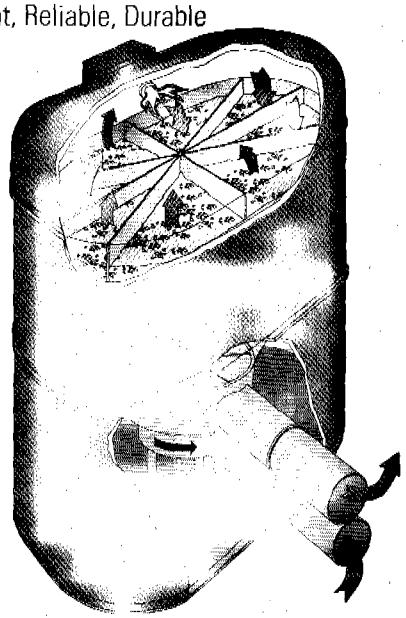

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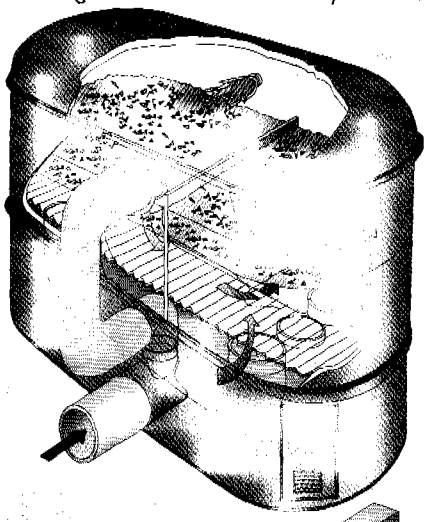

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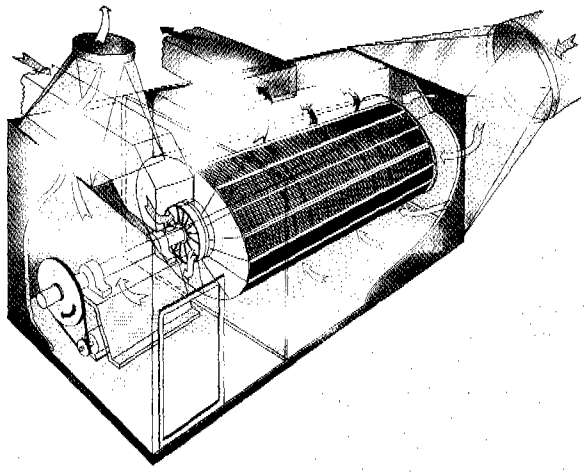

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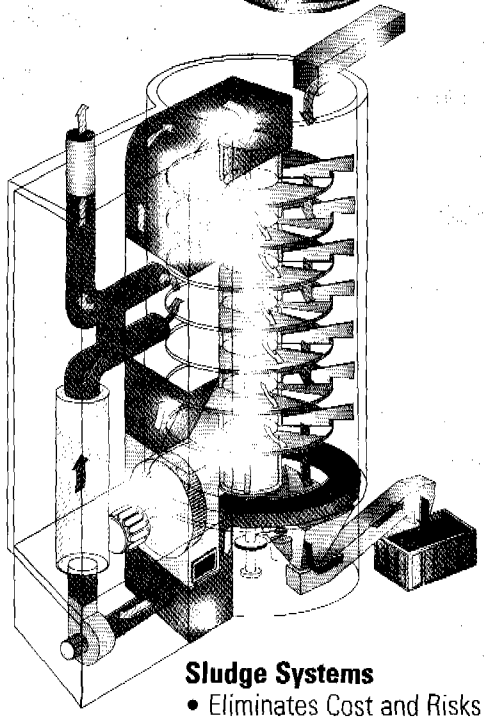

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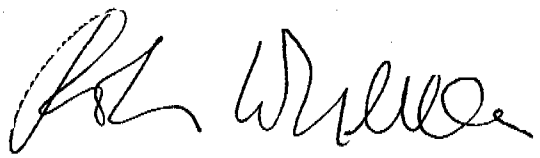
Foreword

This is the first edition of *Water Management International* following four years as *Water Management Europe*. The change of the title reflects the publication's need to reflect activities all over the developed world, many of which had to be disregarded in its previous incarnation.

To illustrate the new breadth of scope, in this edition we have an article from the Water Environment Federation, the major US wastewater association, giving a different angle to the old topic of the reuse of sewage sludge. From South Africa, Des Kerdachi of Umgeni Water, the country's second largest water supplier, describes the new process evaluation facility the company has just opened.

This is the last *Water Management International* edition I shall be editing, and I would like to issue a general thanks to all those who have contributed articles to the publication this year and in the past.



Robin Wiseman
Managing Editor

Setting strategy for Danube clean-up

David Rodda, Danube Programme Coordination Unit

In 1994, the countries around the river Danube, and the European Union, completed and signed a convention setting out protection measures for the Danube catchment. Last December, they agreed an Action Plan, the goals and priorities of which are described in this article.

The countries of the Danube River basin and international institutions met in Sofia, in September 1991, to draw up an initiative to support and reinforce national actions for the restoration and protection of the Danube River.

The countries, as a result, agreed the content of the Environmental Programme for the Danube River Basin (the 'Programme') with the sponsors of the Conference and set up a Task Force and a Programme Coordination Unit (PCU) in 1992. The PCU is now based in Vienna.

The Programme supports monitoring, data collection and assessment, emergency response systems, and pre-investment activities, which provide for an analysis of 17 tributary catchments in the basin, integrated with institutional strengthening, capacity building and activities of Non-Governmental Organisations. Major donors are the European Commission PRARE programme and the Global Environment Facility for which the implementing agency is the UN Office of Project Services.

Earlier in February 1991, the Danube countries and the European Union agreed to negotiate a Convention setting out protection measures for the Danube catchment. This was completed and signed in Sofia in 1994 and has the title 'Cooperation for the Protection and Sustainable Use of the River Danube' (the Danube River Protection Convention/DRPC). The Convention is aimed at achieving sustainable and equitable water management.

International Commission

An International Commission is being legally established to provide a framework for regional cooperation under the Convention and will be supported by a Secretariat. It is planned that the activities of the PCU will be handed over to the Secretariat once it is established with sufficient resources.

Strategic Action Plan

A major activity of the Programme has been to draw up a Strategic Action Plan (the 'Plan'): The Plan sets out the goals and priorities for improving environmental management in the catchment area. Completed and adopted in December last year, the Plan provides a comprehensive account of the action required and supports and complements the DRPC. This paper briefly describes the content of the Plan including its goals and priorities.

The Danube River is 2857km^2 long; the basin covers 817 000km^2 in 17 countries in the heart of central Europe. The population in the Danube basin is about 80 million. The basin includes many important natural areas, including the Danube delta — the second largest natural wetland area in Europe.

The basin supports the supply of drinking water, agriculture, industry, fishing, tourism and recreation, power generation, navigation, and the end disposal of waste waters. These intensive agricultural, industrial and urban uses have created problems of water quality and quantity, and reduced biodiversity in the basin.

Most important problems

From the evidence collected during the operation of the Programme since mid-1992, the most important problems (not in order of importance) affecting the health of the Danube River ecosystems and the water users in the basin are:

- High nutrient loads (nitrogen and phosphorus);
- Changes in river flow patterns and sediment transport regimes;
- Contamination with hazardous substances including oils;
- Competition for available water;
- Microbiological contamination; and
- Contamination with oxygen depleting substances.

These problems are well known in Western Europe and are generated, for example, by wastes from cities and industries, chemical fertilisers, and manure from intensive and large-scale livestock operations. Collectively they contribute to the pollution of the surface waters and the groundwater.

Of particular concern in the Danube basin is the raising of nutrient levels and resulting eutrophication which provides a critical impact: pollution on the North-West shelf of the Black Sea.

Other highly polluting activities in the Danube basin include petrochemical processing, iron and metal processing, timber, paper and pulp, and municipal waste disposal.

Microbiological contamination

As might be expected, particularly in those river reaches where wastewater treatment and animal slurry containment is limited, microbiological contamination is a problem.

Further, inadequate wastewater treatment and disposal means that urban and industrial discharges contribute significant quantities of substances causing heterotrophic growth and oxygen depletion.

Another aspect of the overall environmental problem is that the practices and policies in different sectors can be a constraint on effective action. Most of the sources of the pollution and water quantity problems result from a variety of population-based activities in cities, rural towns and villages including transportation and production activities in industry, energy generation, and agriculture.

Another aspect of the overall environmental problem is that the practices and policies in different sectors can be a constraint on effective action

Key actors

Given this situation, the overall conclusion is that the key actors for change must be the public authorities institutions, public and private enterprises, non-governmental organisations (NGOs) and the general public. Elected Governments at national, district and local levels have the responsibility to define and implement regulatory programmes and therefore can play an important role in providing incentives, removing obstacles, and creating a climate which supports effective integrated water management.

It is expected that local and international financing institutions will play a key role in providing the considerable funds to bring about the necessary actions and improvement.

The Plan is an important result of the first three-year phase of the Programme. It lays out strategies for overcoming the water-environment-related problems in the basin. It sets short, medium and long term targets and defines a series of actions to meet them over the short-term, namely within a period of three years and in the medium-term, effectively within a period of ten years.

A series of actions to achieve these targets is set out for public authorities, at central, district and local levels; municipal water companies and utilities; industrial enterprises; the general public and NGOs; and for agricultural enterprises and the farming community.

These actions build on the acceptance of the precautionary principle, the 'polluter pays' and 'user pays' principles, the use of Best Available Techniques (BAT) and Best Environmental Practice (BEP), the control of pollution at source and a regional commitment to cooperation and the sharing of information.

National Action Plans

The intention is that the actions will be implemented through National Action Plans (NAPs) to be dawn up by the Danube basin countries, assisted by the Programme where necessary. The NAPs will be crucial in identifying priority projects and preparating, funding and implementing them. In Germany and Austria significant progress has been made towards reducing pollution so that the main emphasis of the Plan is on action by those countries in transition.

The Action Plan addresses both local and regional (basin-wide) concerns and emphasises actions that have both local and regional benefits. Local needs and problems will normally be the most important criteria for actions and investments in each country.

It is clear that there is a significant resource gap between the proposed actions and the available funding

By participating in the Programme and by signing the Danube River Protection Convention, the Danube countries are committed to addressing regional and basinwide problems.

The Plan has four — equally important — goals:

- Reduce the negative impacts of activities in the Danube River basin and on riverine ecosystems and the Black Sea;
- Maintain and improve the availability and quality of water in the Danube River basin;
- Establish control of hazards from accidental spills; and
- Develop regional water management cooperation.

Key sectors and policies

Key sectors and policies which give direction to the planned action are and include:

- Phased expansion of sewerage and municipal waste water treatment capacity;
- Reduction of discharges from industry;
- Reduction of emissions from agriculture;
- Conservation, restoration and management of the wetland and floodplain areas of the tributaries and main stream of the Danube River basin;
- Integrated water management;
- Environmentally sound sectoral policies;

- Control of risks from accidents; and
- Investments.

Short-term action plan

From these, the short-term action plan covers:

- Elaboration of National Action Plans (NAPs);
- The completion of integrated tributary river basin plans and revised water allocations and water use permits;
- The completion of wetland inventory conservation and management programmes and a variety of issues such as adoption of consistent water quality objectives and criteria;
- The completion of regulatory and permitting reform programmes;
- The adoption of emission limits for polluting discharges;
- Provision of an information strategy;
- Assessment of critical loads;
- Completion of effective and comprehensive monitoring, warning and laboratory systems; and
- Capacity-building activities.

Medium-term action plan

The planned medium-term action is to:

- Complete a pollutant emission inventory;
- Adopt and implement hazardous substance control legislation;
- Introduce regulations for fertiliser storage, handling, and application;
- Draw up wastewater and sewerage investment priorities;
- Complete existing municipal wastewater treatment plants;
- Complete conservation and restoration of priority wetlands
- Invest in highest priority sewerage and municipal wastewater treatment capacity extensions;
- Introduce environmentally sound agriculture policy reforms;
- Demonstrate Best Environmental practice for use in agriculture,
- Complete pilot and demonstration projects for manure handling, storage, disposal, and application
- Introduce of phosphate-free detergents and ban phosphate-containing detergents; and
- Implement a phased application of emission limits.

Longer-term action

The above covers action which is most vital to get started with a high degree of urgency. There are, however, a range of actions which, even now, can be foreseen for the longer term — the completion of municipal and industrial wastewater treatment plants started in the medium term; a change to sustainable agricultural practices; and the restoration of the natural purification capacity of the Danube and its tributaries.

The specific problems to be addressed are highly diverse and vary from country to country. Thus, actions will also vary and they will need to be implemented by public authorities at central, district, and local levels; municipal water companies and utilities; industrial enterprises; the general public and NGOs; agricultural enterprises and the farming community.

Urban and industrial discharges provide significant quantities of substances causing heterotrophic growth and oxygen depletion

A major point of discussion during the preparation of the Plan centred on its financing. The position of the international financing community is that though they can provide some assistance to Danube countries on priority actions, long-term financing will have to be met primarily from within the countries themselves.

Significant resource gap

Although no total estimates of the costs of the actions proposed in this Action Plan have been provided, as accurate data on which to base costs were not available, it is clear that there is a significant resource gap between the proposed actions and the available funding.

The NAPs are designed to address this aspect, and it was the view of the Task Force that certain action must be taken, namely to develop a financing plan (domestic and international) in order to identify what funds are available and what funds are needed to meet the most urgent and short-term priorities. This should be coupled with discussions in governments involving the Ministry of Finance and all relevant ministries to develop a financial plan for dealing with the most urgent and short term priorities and then earmarking funds for the transfer of training and know-how.

In close association with this planning, mechanisms should be initiated for making loans so that environmental improvements may be most realistic as well as being affordable for Danube countries in transition.

Meeting targets

The three-year Environmental Programme for the Danube River Basin, set up in 1992, is meeting its targets, funds allotted are being committed, and a new phase is being discussed.

While formal decisions about continuing the funding of the priority aspects have yet to be made, there are also many other issues to be addressed. These are being made known to the financing partners and hopefully a decision will be reached this year. ■

The views expressed in this paper are those of the author and do not in any way represent the views of any member of the Task Force or the European Commission.

Biography

David Rodda is team leader of the Danube Programme Coordination Unit, based in Vienna, Austria.

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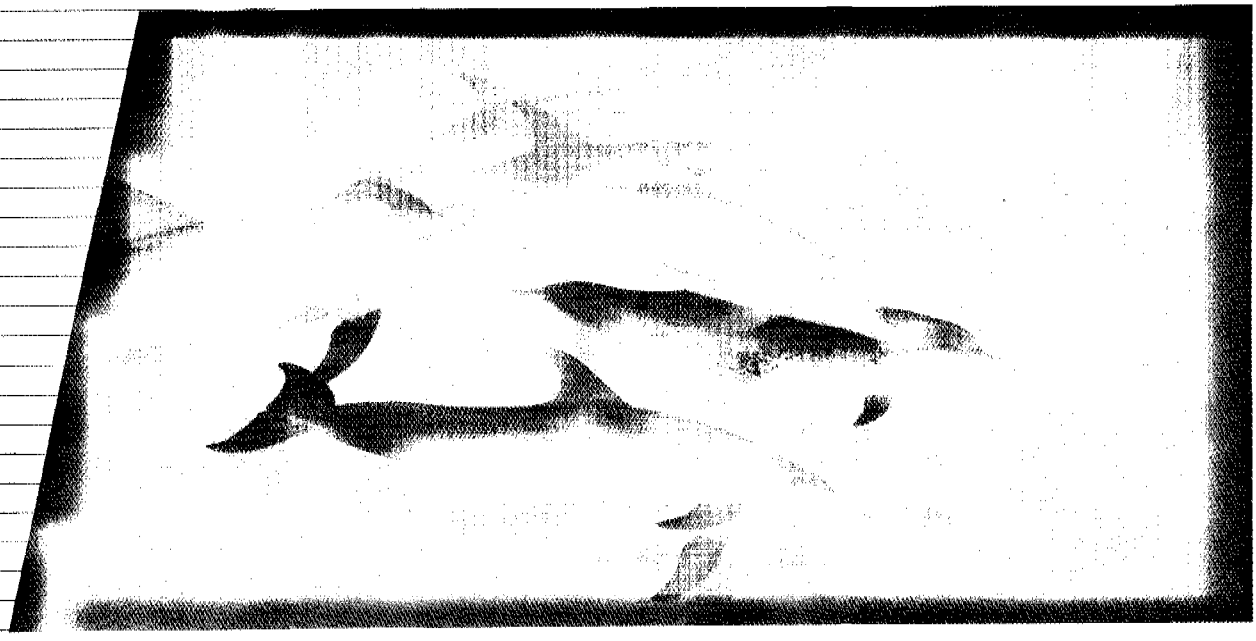

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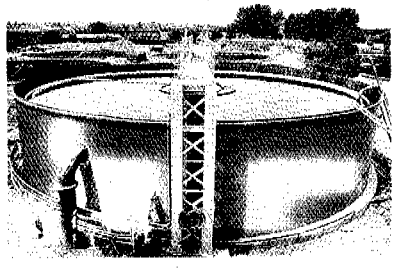

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Turkey's irrigation masterplan evolves

J van der Vliet and AJ van Achthoven, Euroconsult

Major irrigation development in Turkey up to 2001 has been given an investment strategy. The study's findings provide a good insight into public irrigation development and the way it is planned, implemented and managed in Turkey.

From 1990 to 1992, Euroconsult, combined with local expertise from DAPTA, SU-YAPI and TEMELSU, was involved in the preparation of an investment strategy for major irrigation development in Turkey, called the Irrigation Master Plan (IMP) with the following objectives:

- To provide an Indicative Investment Programme (IIP) for major irrigation development in the period 1992-2001;
- To analyse present operation and maintenance (O&M) practices; and
- To design a computerised management information system (MIS).

National economy

Turkey has a growing population (2.2 per cent each year, currently), a healthily increasing GDP (6 per cent) and significant urbanisation and industrialisation. The share of agricultural labour in the total labour force has declined steadily. While in 1950 around 75 per cent of the population lived in village areas, this percentage has decreased to 40 per cent in 1991. Economic growth, population growth and urbanisation profoundly affect and will continue to affect agriculture in several ways. Domestic demand will increase; consumption patterns will change; agricultural labour will decline in absolute numbers while shortages in cheap agricultural labour (cotton picking) will rise; agricultural mechanisation will increase; labour saving methods in irrigation will be used; in areas with sufficient rainfall the tendency of growing rainfed, rather than more labour intensive irrigated wheat may become more pronounced.

The agricultural sector

At present a third (27.7 million ha) of the total land area of Turkey (77.9 million ha) is used for agriculture.

The agricultural sector plays an important role in the Turkish economy, but its share in GDP continues to decline. In 1989, it accounted for nearly 19 per cent of GDP, 9 per cent of exports and 51 per cent of civilian employment. Future growth in output now depends on growth in agricultural productivity, since there is no more agricultural land available.

Irrigation development

Because of low and unreliable rainfall in large parts of the country, irrigation is important for agricultural production. The benefits from irrigation depend on cropping patterns, yields, input costs and crop prices. These in turn depend on the level of irrigation development, markets, agricultural extension support and the irrigation ratio.

The irrigation ratio is defined as the area actually irrigated divided by the net irrigable area of a scheme. The target is to achieve, on average, an irrigation ratio of 90 per cent within 3 years of putting the irrigation scheme into operation.In areas with sufficient rainfall farmers continue growing rainfed wheat because of its favourable returns compared with irrigated agriculture. In such areas, the full benefits of an irrigation system are generally not attained.

The creation of public irrigation infrastructure, referred to as major irrigation, has been pursued vigorously since the 1950s and continues to receive undiminished government support. It has contributed substantially to agricultural growth.

Land resources	Area (million ha)
Total area of Turkey	77.9
Agricultural area	27.7
Potential gross irr. area	8.5
Present gross irr. area	4.0
Present net irr. area constructed by DSI	1.7
Expected net irr. area to be constructed by USI up to 2001	1.1

The potential for irrigation development is estimated at 8.5 million ha. Currently some 4 million ha are under irrigation. In the period 1992-2001, it is expected that an additional area of about 1.1 million ha will be brought under irrigation by the state.

Irrigation development is carried out by both private and public sectors. The public sector, consists of USI and GDRS. The State Hydraulics Works Department, DSI, employs over 45 000 personnel and is responsible for

construction, from the dams down to the tertiary level; operation and maintenance of the schemes; and for maintaining the statistics of irrigation.

The other organisation is the General Directorate of Rural Services, GDRS, employing 30 000 staff and is responsible for on-farm works, such as on-farm irrigation and drainage and land levelling, together with the private sector, consisting of farmers and groups of farmers.

DSI has so far developed 1.7 million ha (see Table) of the 4 million ha currently under irrigation. The projects that do not require complicated civil works have already been completed. It therefore seems likely that future irrigation projects will be implemented mainly by DSI. The main irrigation area to be developed in the near future is the South-Eastern Anatolia irrigation project (GAP) of over 1 million ha.

Project costs

DSI investment cost of main irrigation works is the main cost component of irrigation. GDRS cost of on-farm development is generally less than 15 per cent of the DSI investment cost per ha.

The project costs fall into five categories:

- DSI average investment cost for major irrigation works, including dams, comes down to TL 13.0 million (Turkish Lira 1000 = US$ 0.34 (1991)) per net ha;
- On-farm development by GDRS, such as land consolidation, including reparcellation, on-farm irrigation and drainage, farm roads and land levelling with an average cost of TL 1.75 million per net ha;
- Expropriation of land and other property requires TL 0.90 million/ha on average, or 6.7 per cent of the DSI investment for major irrigation works.
- Farmers are assumed to pay for certain types of land improvement and for the installation and operation of sprinkler systems in steeply sloping areas, as heavy land levelling and terracing are considered detrimental with a view to soil conservation and erosion.
- Operation and maintenance (O&M), which is paid for by the farmers themselves, but prefinanced by DSI.

Indicative investment programme

Irrigation makes a substantial contribution to agricultural production and annually a sizeable sum of money is invested in the construction of irrigation works. As the cost of finishing ongoing and implementing new projects by far exceeds the projected budget, it is necessary to prioritise projects to be included in the DSI investment programme for 1992-2001. The IMP study was initiated to serve as a guideline for public investment in irrigation development.

In the period 1978-1990, the major irrigation projects budget of DSI averaged 29.3 per cent of agricultural sector investment, or 0.95 per cent of GDP. These two parameters were used in projecting DSI investment budgets for the period 1992-2001. The growth in GDP was projected between 5-6 per cent. The indicative investment schedule has been based on the lower range of projected growth. In real terms, available DSI budget is therefore projected to grow by 5 per cent annually.

DSI's major irrigation projects budget for the 10-year planning period is projected at TL 16 200 billion, increasing from TL 1 288 billion in 1992 to TL 1 998 billion in 2001.

The projected budgets include foreign credit, because DSI budget estimates are partly based on credit supply. In the period 1984-1991, credits of the World Bank and the European Community accounted for 13.9 per cent of the total DSI major projects budget. Credit committed for the period 1992-1995 amounts to 12.6 per cent of the budget.

For on-farm development in projects to be constructed by DSI in the planning period, GDRS would require a cumulative budget of TL 2 000 billion.

For the purpose of investment planning, three main groups of irrigation projects are distinguished:

- Earmarked projects — those under construction. They will have to be completed without regard to their economic viability. Included are projects such as the World Bank financed drainage projects (Core programme), flood control projects and projects which are nearly completed. The completion of these works will require TL 1 404 billion or 9 per cent of the DSI investment budget postulated for the ten-year period 1992-2001.
- Ongoing projects — Some of these have been fully contracted, others only partially. The contract value from 1992 onwards amounts to TL 9 515 billion (58 per cent). To complete the partially contracted budgets would require an additional TL 2 356 billion.
- New projects — Both the earmarked and the ongoing projects constitute financial obligations for DSI to the amount of TL 10 919 billion or 67 per cent of the total budget estimated for the period 1992-2001.

Project appraisal

Economic analysis was carried out for 227 projects, including 22 rehabilitation projects. Two main economic performance criteria were calculated for each project — the Internal Rate of Return (IRR) and the Benefits to Cost ratio, at 12 per cent (B/C). Projects with an IRR < 8 per cent were not considered to be economically feasible.

Out of 227 projects, only 107 projects (47 per cent) were eligible on the basis of this cut-off rate. The eligible projects were further ranked according to their multi-rank number, a composite criterion reflecting a project's status according to its economic performance and local development need. The two main factors determining economic feasibility are the cost of investment per ha and the expected irrigation ratio.

As the contractual obligations of DSI in the next few years exceed the postulated budgets, rescheduling of project funding is needed. This can be done by either continuing to fund all ongoing projects or to discontinue those shown to be not viable. From an economic point of view, the latter method is preferred.

Economic impact

Implementation of the Indicative Investment Programme will result in considerable benefits. Its overall returns to investment would be much greater than those of the existing implementation schedule. It would

induce a 5.2 per cent growth in value added and 6.4 per cent in net farm income per annum.

Aggregate net farm income is projected to increase from TL 4098 billion to 8108 billion in 2005 as a result of the Indicative Investment Programme. This implies a growth rate of about 6.4 per cent per annum with, on average, an increase of net farm income at full development of TL 3.4 million per ha.

The labour costs are already deducted. Net firm income therefore represents the factors capital, land and water and entrepreneurship. Water charges should be paid from this amount. If full operation and maintenance cost at TL 0.26 million/ha and 1 per cent of the investment cost or TL 0.13 million/ha were to be paid by the farmers, the total water and amortisation charges of TL 0.39 million/ha would be about 11 per cent of the increase in farmers' net income. By far the majority of farmers and most of the irrigated cropping systems projected appear to be able to carry the 'full' recovery rate, at the same time leaving sufficient incentive to take up irrigated farming using the public system.

Operation and maintenance

As part of IMP, an analysis was made of operation and maintenance practices with regard to DSI-operated irrigation schemes. Attention was paid to organisation, costs, available facilities, maintenance conditions, training requirements and policy options.

After completing relatively small projects, DSI transfers them to the local government or the farmer organisations. The larger schemes it continues to operate itself.

The annual cost of O&M is expected to increase considerably over the next ten years. The cost of O&M to the present irrigation system, including dams, is estimated at TL 363.9 billion, or 28 per cent of annual investment. At the present rate of irrigation development this percentage will, within 10 years, increase to 37 per cent.

To reduce the burden of DSI and to involve farmers in these activities, a number of measures are being proposed to gradually increase farmers' participation in O&M and to rationalise DSI's O&M organisation.

Responsibility for the day to day operation and maintenance needs to be transferred to Water Users' Groups or associations of such groups. The Water User organisations would collect a contribution from the farmers on the basis of the present water charge system, approved by the membership.

Much of the maintenance work would need to be tendered to local contractors, generally leading to competition between contractors, resulting in better quality at reduced costs.

In addition to reassessing the role of the O&M organisation, it is proposed to upgrade DSI's capability for water resources management. Computerised water management at the basin and project level should improve water-use planning, also in view of possible future water shortages. They are also to invest in the means of communication and transportation, to remove the backlog of maintenance and generally streamline the O&M organisation.

A number of changes have been proposed in the IMP with regard to operation & maintenance of DSI-managed irrigation schemes. Most of them should be introduced gradually. To gain experience and develop methods suited to the situation prevailing in Turkey, new methods need to be tried out in one or two pilot projects.

Management Information System (MIS)

Irrigation management and investment planning require detailed information on existing and proposed irrigation projects, including costs, benefits and technical detail. As part of IMP, a substantial database containing a large quantity of data relevant to the operation and maintenance of existing projects and benefit-cost analysis of ongoing and new projects on irrigation schemes has been assembled and existing records have been updated and improved in consistency.

The start for a computerised management information system (MIS) has been made and introduced at DSI. A main purpose of MIS is to make data readily accessible to various levels of users. The computerised system will allow much greater manipulation of the data for analysis and reporting purposes.

The development of a comprehensive management information system covering all activities of DSI would require several years of work. The present MIS is to be seen as the first phase of a more comprehensive system. The development principle chosen for the MIS will be: 'start simply; beautify later'.

The project appraisal and ranking procedures adopted for the Irrigation Master Plan prioritise certain projects and exclude others from the indicative investment schedule. Before a final investment decision is made, however, it is necessary to review each individual project carefully. The MIS will allow quick assessment of the consequences of changes in project parameters and is now used for the annual updating of the investment programme.

The IMP resulted in detailed project prioritisation and implementation schedules aimed at maximising returns to public investment in major irrigation projects. Forecasted budget limitations, technical phasing of construction and many other practical considerations were taken into account.

Emphasis was placed on a phased privatisation programme for the operation and maintenance of irrigation infrastructure, especially at the tertiary level, improved cost recovery and the improved efficiency and cost-effectiveness of DSI itself.

These last measures will result in water user groups assuming increasing financial and technical responsibility for the operation and maintenance of tertiary irrigation and drainage infrastructure created by the State. Greater efficiency in the irrigation sector will be the result. ■

Biography

J van der Vliet is Area Manager, Middle East and Southwest Asia, and AJ van Achthoven is Senior Land and Water Specialist for Euroconsult, the consulting engineers based in Arnhem, Netherlands.

Process test plant aids African supplier

● Desmond Kerdachi, Umgeni Water

South Africa's Umgeni Water is a regional water authority committed to supplying the 6.5 million people within its area with potable water by 2005. Its new Process Evaluation Facility aims to undertake evaluation and development of processes applicable to both developed and developing world environments.

Umgeni Water, with an operational area in excess of 24 000km^2 is the largest supplier of potable water in KwaZulu Natal, South Africa. It produces approximately 800 Ml of purified water daily, which on a national basis is exceeded only by Rand Water (±2500 Ml/d).

Umgeni was formed in 1974 as a bulk supplier of purified water and currently operates over a wide area of Natal including the Greater Durban/Pietermaritzburg area. It has become increasingly involved in operations such as water reticulation and wastewater purification, and is the largest catchment-based water undertaking in Southern Africa, espousing the principles of Total Water Management.

The organisation has experienced a rapid growth over the past 12 years, and manages assets, including effluent disposal and purification works, worth R1200 million, with an annual turnover of R280 million.

True regional water authority

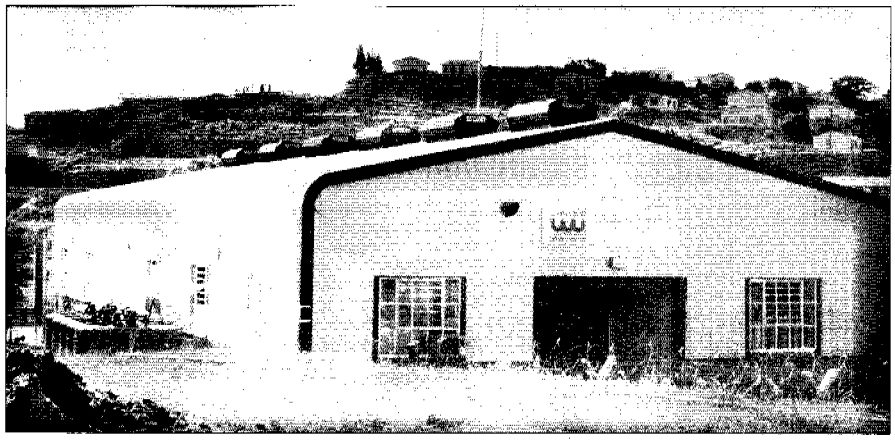
Umgeni Water is an established regional water authority in the true sense and as such has the responsibility to ensure that the most appropriate technology is utilized to meet its objective of a potable water that conforms to World Health Organisation (WHO) standards. The regional concept of bulk water supply has already streamlined services, provided economies of scale, and improved the quality of life of many people.

As a result of a major infrastructural study of the Umgeni Water supply which was completed in 1989, the Water Plan 2025 was produced. These findings, allied to a Strategic internal planning exercise, made it abundantly clear that there were vast inequities in the provision of services within the Umgeni Water area of supply. Urgent action was needed to address the problem and Umgeni Water set itself the challenging objective of supplying safe water and sanitation to all within its supply area by the year 2005.

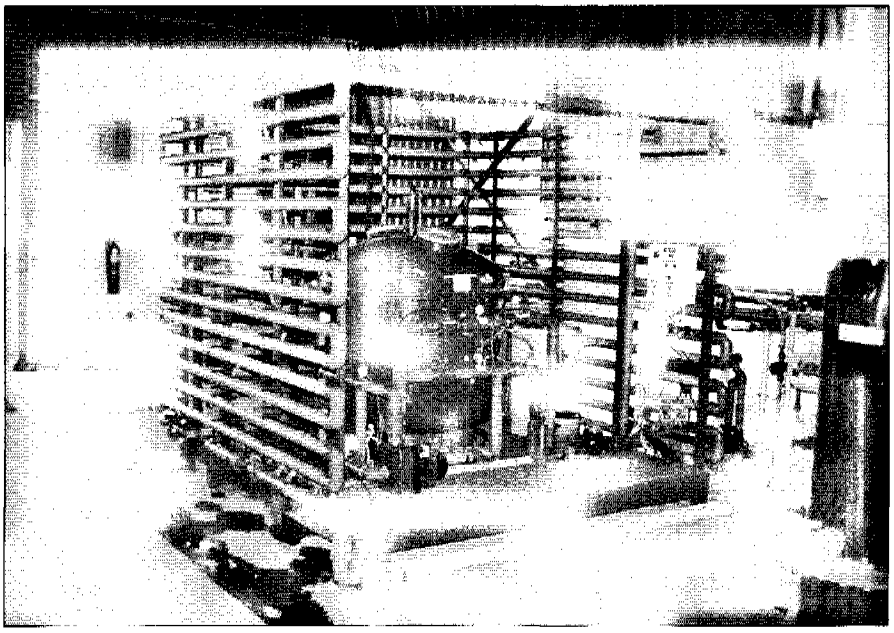
Four million without water

It should be noted that 4 million out of 6.5 million people within the area of operation do not have access to a potable water supply. Out of this objective the Rural Areas Water Supply and Sanitation Plan (RAWSP) was born.

Early in 1990, Umgeni Water's concern with the impact of eutrophication on its water treatment process at the Wiggins waterworks and its commitment in terms of RAWSP to provide potable water to the rural and semi rural community, resulted in the need for a facility where process evaluations and development, applicable to first and third world environments, could be undertaken. It was realised that with the specialist multidisciplinary expertise available within Umgeni Water and an emphasis on commercialisation, innovative water treatment technology could be developed in conjunction with other



Umgeni Water's process evaluation facility.



This small packaged water treatment plant provides treated water to feed the GAC unit.

bodies including the University of Natal and the Water Research Commission. New technology could be licensed and made available to water treatment suppliers.

The concept was further extended to embrace training and education for employees and other organisations within Southern Africa, with respect to water treatment technology.

The overall project was accepted by the executive management of Umgeni Water and in 1992 the Process Evaluation Facility was commissioned with the following prime objectives:

- Evaluate and investigate both first and third world water treatment technology of interest to Umgeni Water and other organisations in Southern Africa;
- Utilise the expertise within Umgeni Water and other relevant institutions such as the University of Natal and the Water Research Commission, to develop appropriate cost effective water treatment technology in order to cope with changing water quality in Umgeni Water's area of supply;
- Fulfil a training role both for Umgeni Water's staff and the staff of outside institutions or organisations with respect to water treatment technology. Assistance could also be provided to other Southern African water undertakings, especially those in developing areas; and
- Promote joint ventures with outside private companies where there can be a long term financial and technological benefit to both parties and to the water industry itself.

Process Evaluation Facility

The Process Evaluation Facility (PEF) which is situated on the same site as the Wiggins Water Treatment Works is a separate facility on its own and consists of an administrative block and the main test building.

Within the test building is an evaluation area consisting of ten fully serviced bays which can accommodate 10 unit processes simultaneously. Each bay has an operational area allocation of 25m^2. Additional provision is made for effluent disposal, a small workshop, storeroom, laboratory facility, and holding tanks. The raw water supply is the same as that received by the main treatment works on site.

The full-time staff consists of a manager, senior scientist (Chemical Engineering) and a chief technician (Chemical Engineering).

Part time staff consists of contract project workers as well as "trainee" chemical engineering technicians who have completed their diplomas at the local Technikon and need to complete 18 months hands-on experience at an approved organisation.

The facility has been in operation for 2^1/$_2$ years and is considered to be unique in South Africa. It is continually being visited by local, national, and visiting international practitioners in the water industry, with much attention and interest focused on the pilot plant activities and the facility itself.

Review of achievements and current projects

A small-scale computerised water treatment evaluation unit forms a permanent feature of the facility. This unit was designed by Umgeni Water staff to simulate the unit processes of the two main water treatment facilities, namely Durban Heights (600Ml/d) and the Wiggins Works (175Ml/d).

Sufficient flexibility is available to vary the coagulation and flocculation energy, adjust the sludge blanket in the pulsator clarifier, vary the filter media, and use alternate disinfectants. This system has proved invaluable to Umgeni Water in assessing the performance and cost-effectiveness of a variety of primary coagulants (inorganic salts as well as blended organic/inorganic polymers) suitable for treating impounded water characterised by low turbidity <10 NTU and low in colour.

A further benefit has been the use of the unit to assist in diagnosing process problems. Since the unit has been designed to simulate the full scale process and records all the process parameters via the computer, it has proved to be a useful tool for operators and technicians to get practical training on a real model without worrying about the consequences of their mistakes on final water quality (as on a real waterworks).

The capacity of the automated conventional water treatment pilot plant is 5m^3/hr with a rise rate range of 0-4m/hr and a filtration rate range of 0-7m/hr.

The system has a PC-based control and data acquisition system and is designed to operate in conjunction

with the pre-ozonation pilot plant.

A further permanent feature of the facility is a mobile pilot scale dissolved air flotation (DAF) unit capable of treating 1m³/h. The coagulation-flocculation compartments have a combined retention time of 16 minutes prior to flocculated water entering into the zone where dissolved air is released as fine bubbles which attach to the flocs and lift them to the surface where they form a buoyant scum which is scraped off.

This DAF unit has been used to evaluate coagulants to be used in newly constructed DAF unit of 30Ml/d at one of the Inland Waterworks, and can also be compared to full scale performance on the conventional works on site at the Wiggins Works. The particular concern about the conventional plant's ability to cope with eutrophic water is being addressed by experimentation at the PEF with algal-rich water using DAF technology.

Strong relationship

Over the past few years Umgeni Water's Scientific Services Division has built up a strong relationship with the University of Natal's renowned Pollution Research Group which is based in the Department of Chemical Engineering on the Durban Campus.

The Pollution Research Group is recognised by the Water Research Commission as a centre of expertise and the majority of the research projects undertaken by this group are financed by the Water Research Commission (WRC) on a contract basis. Mutual interaction between the Pollution Research Group and the facility is enhanced by the fact that the facility is in close proximity to the University. This cooperation has been further reinforced by post-graduate students undertaking experiments for their research grants at the PEF.

One Pollution Research Group project that has been financed by the Water Research Commission, and has occupied four bays at the facility since the commissioning of the facility, is the development of a cross-flow micro-filtration unit for rural water supply. Much importance is being attached to this system because of its potential for application in rural areas and informal urban settlements not serviced with reticulated potable water.

The process is fully automated and controlled by PLC and uses no chemicals. It has a capacity of 16kl/h and operates at a pressure of 400kPa with a tube velocity of 4m/s.

In terms of performance, the unit, which consists of two modules each consisting of two curtains each containing 70 tubes of 12mm diameter, reduces the turbidity of the raw feed from 15 NTU to < 0.05 NTU and conforms to the microbiological standards of the World Health Organisation. The power consumption of is the order of 40kW and the permeate production with two modules in operation is 0.4Ma/day with a permeate flux of 100l/m²h.

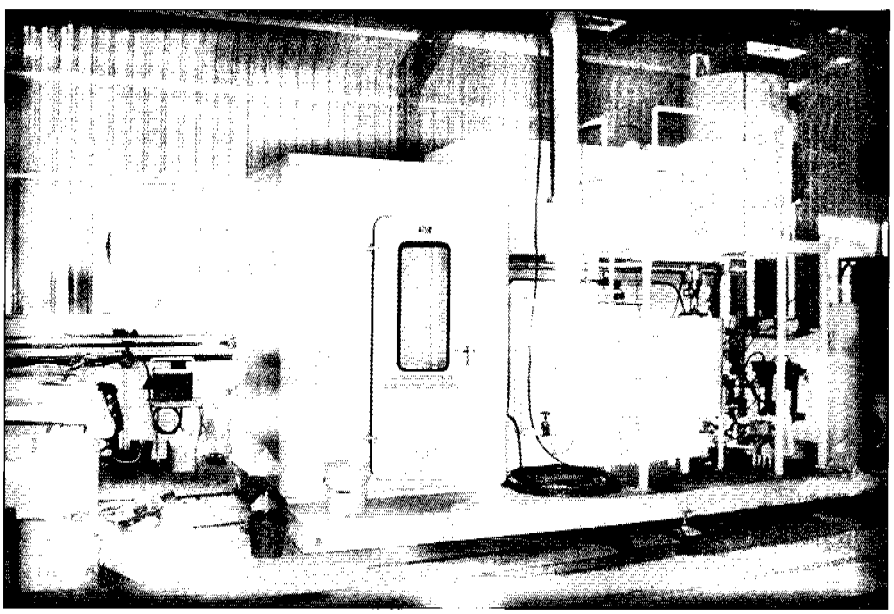
Umgeni Water has recently completed a two-year WRC-financed project on evaluating performance criteria for water treatment package plants. This project comprehensively assessed the merits of 10 different package plants and will result in a document that will be disseminated nationally, and also be available internationally.

The findings of this investigation are of particular significance to Umgeni Water and South Africa where a heavy emphasis is being placed on the Reconstruction and Development Programme (RDP) and the implementation of appropriate technology for water treatment in rural and semi-rural areas is a key component of the RDP.

The Wiggins Waterworks, which has an ozone facility is being upgraded from 175Ml/d to 350Ml/d, and attention is being given to the choice of advance treatment technology that will be able to cope with eutrophic water. Granular activated carbon (GAC) is the only technology that will simultaneously remove taste and odour compounds, organic precursors that contribute to trihalomethane formation, toxins from the predominant algae Anabaena and Microcystis, together with pesticides, herbicides and other 'undesirable' organics.

Appropriate GAC technology

In view of the large capital cost for GAC estimated to be in the region of R80 million for the Wiggins Works and cognisant of the trend in the UK where GAC is being increasingly used to meet the EC directive of 0.1 µg/l for pesticides, Umgeni Water has embarked upon an ambitious project to establish the design criteria and most appropriate GAC technology to reduce the above mentioned pollutants to acceptable limits. This is based on the assumption that the predictions of eutrophication by the



The small-scale computerised water treatment evaluation unit simultates the unit processes of two treatment plants.

water quality specialists within Umgeni Water will materialise.

Thus a fully automated GAC pilot plant has been constructed. A package water treatment unit (producing filtered quality water) and ozonation facility is followed by 4 GAC columns. A coal-based carbon (similar to F400) and wood-based carbon (PI CA) are compared with and without ozonation. The choice of PICA carbon was as a result of the French experience and the potential benefits that could be derived in the form of reduced capital costs and the extension of the life of the activated carbon.

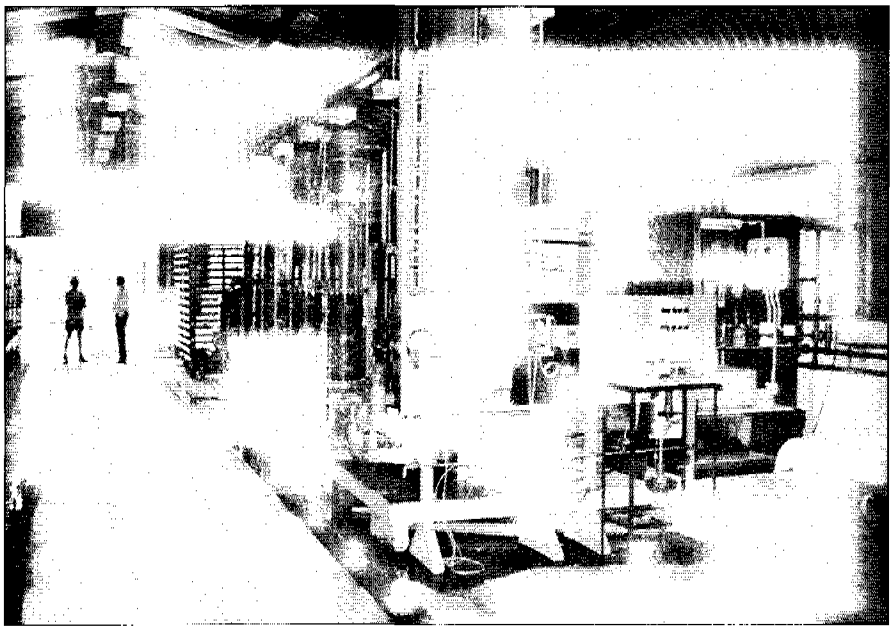
Known amounts of atrazine, geosmin and 2-methylisoborneol are being added to assess the performance of the comparative processes. As there are only low concentrations of organic matter in the water at present, little effect on biological activity has been observed.

The project has only just commenced and is being monitored closely. The Water Research Commission have also displayed much interest in this project, and have decided to finance the project which is being complemented by appropriate laboratory investigations, and the pilot scale use of peroxone as a substitute for ozone.

Marketed externally

As part of the new emphasis on commercialisation by Umgeni Water, the facility is being marketed externally. Projects have been undertaken for a number of local private organisations and include the evaluation and optimization of a ceramic ultrafilter and a direct upflow filter. Umgeni Water has already derived financial benefit from one of these joint ventures, in the form of a royalty. The business arm of Umgeni Water is a closed corporation called "Umgeni Management Consultants".

This corporation, which is still in its infancy, will handle the commercial work of Umgeni Water and a substantial financial benefit from the activities of this commercial arm, in the form of fees, royalties, joint ventures and commissions is anticipated. The most exciting aspect of this venture is that our commercial arm will be in a position to provide advice, support and back-up to organisations within and outside the borders of South Africa. "Umgeni Management Consultants" embodies a very real link between the public and private sector — a true partnership of business to the benefit of all!



The fully automated granular activated carbon (GAC) unit with (in front) the ozonation unit

Business outside South Africa

Examples of commercial business already in progress outside of South Africa are the following:

- Training work in Lesotho, in conjunction with Wessex Water (UK);
- Technician work in Botswana, in conjunction with consultants;
- Preliminary work in Lusaka, in conjunction with the Lusaka Water and Sewerage Company, with whom Umgeni Water has a "Twinning Agreement";
- Training and management advice in Zimbabwe; and
- Preliminary work in Sierra Leone.

The Process Evaluation Facility also rents out space for suppliers of new and innovative process technology to demonstrate their products to potential clients or customers. A process engineer or technician to assist with process problems or pilot scale trials related to water, wastewater and industrial effluent can also be hired out.

The use of the facility as a training centre for graduate chemical engineering technicians has also contributed towards fulfilment of Umgeni Water's affirmative action programme. Four employees originally recruited as in-service trainees have been engaged to undertake contract work.

It can be confidently reported that the Process Evaluation Facility has met it's stated objectives, and will in combination with specialist expertise from other Departments within Scientific Services, become a centre of excellence in the future. ■

Biography

Desmond Kerdachi is currently Manager, Process Evaluation Facility, for Umgeni Water. He has a BSc in Chemistry and a Specialised Diploma in Wastewater Treatment, and is a Fellow of the Water Institute of Southern Africa (WISA). He sits on eight national steering committees run by South Africa's Water Research Commission on water and wastewater topics and represents WISA on the Board of Control of the Water Environment Federation, USA, as a director.

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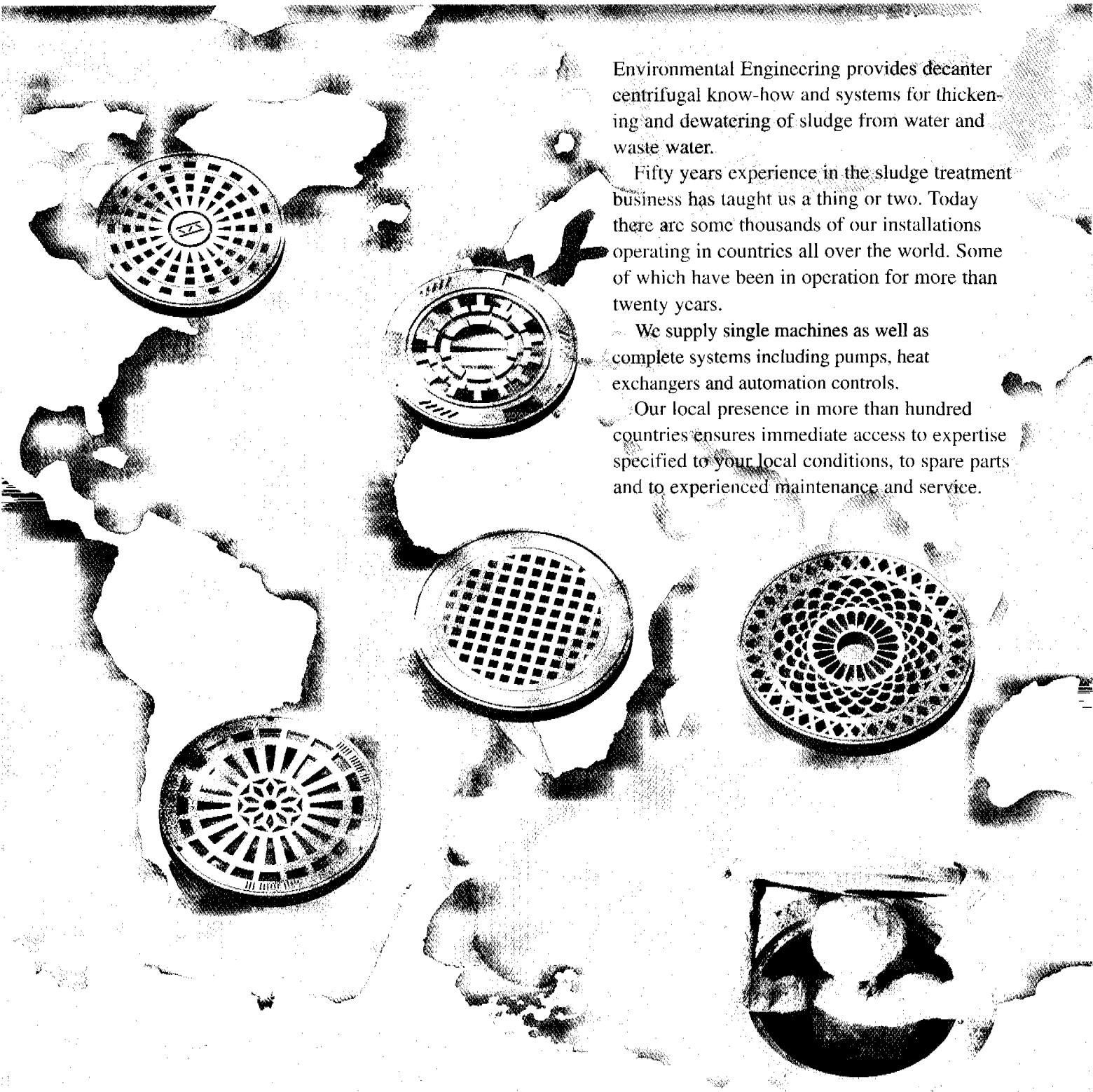

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Water management and remote sensing

Albert van Dijk and Ton Wijdeveld, NEDECO

Irrigated agriculture remains an inefficient user of precious water resources. Remote sensing techniques are often the only way to obtain information necessary to make water use more efficient, and integration with water management models and GIS systems promise real advances in areal analysis.

World food supply depends heavily on irrigated agriculture. But suitable land with nearby water sources for irrigation is scarce, so that it is becoming increasingly difficult to extend the irrigated area. As a consequence, new development schemes are faced with high and rising costs.

The performance of irrigated areas has, in general, been disappointing. The basic reason is low efficiency in the use of the available water resources. Water demand and supply rarely coincide and water supplies are often unreliable. In some projects, 60 per cent of the water diverted does not actually contribute to crop requirements.

The question of efficiency becomes even more urgent when it is realised that the rapid increase in non-agricultural water demand is now leaving less water for irrigated agriculture.

More efficient water use means more land irrigated, improved crop yields and thus more water available for non-agricultural use. It will also reduce the negative environmental effects associated with inefficient use of irrigation water (over-irrigation, drainage problems, and salinisation).

In various irrigation schemes in developing countries, a start has been made by involving water users in water management through organising farmers and reorganising scheme management agencies. The organised water users expect the irrigation scheme managers to provide a reliable, timely and adequate supply of water to their fields.

However, it is now being realised that institutional changes alone are not enough. Organised water users are becoming more vocal and beginning to question the decisions of scheme managers.

Flow of information

In order to satisfy their demands and do their job properly, scheme managers require a continuing flow of information about the overall status of their schemes. Based on this information, they can take decisions regarding the planning of the seasonal irrigation schedule, review existing schedules in the course of the season and evaluate their decisions. But the analysis of the information has become a complex affair.

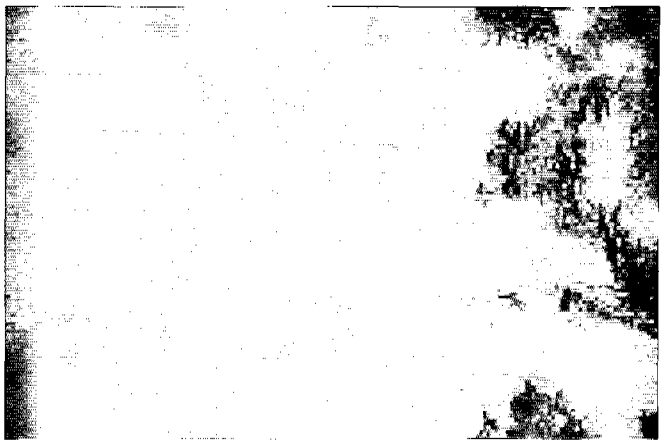
Putting computers onto the desks of managers of larger irrigation schemes has helped make water management more effective and efficient in those schemes. Several computer programs have been developed to improve the efficiency of irrigation schemes (see ILRI, 1993 for an inventory of irrigation software for microcomputers).

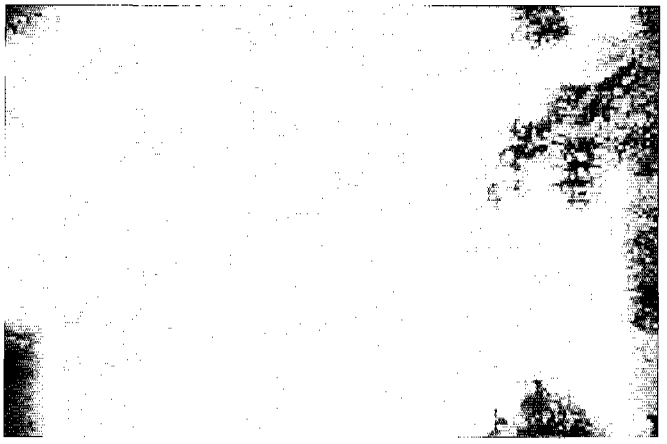
The usefulness of these models depends heavily on how up-to-date, complete and reliable the available data is. Unlike a human expert, a model cannot identify errors in the original data files. Moreover, the manipulation of the data can result in a multiplication of the errors. An important consideration is the law of limiting accuracies: the least accurate data set determines the accuracy of the new data set after data manipulation.

Information on water resources can be acquired in the conventional way by sending teams into the field to collect measurements. However, instruments often malfunction and fieldwork is frequently handicapped by considerations of time, distance, weather and the size, diversity and inaccessibility of the areas. The result is that age, quality and quantity of collected data have become primary constraints for operational management models, and in particular for those developed for real-time management (day-to-day management).

Remote Sensing

Remote Sensing (RS) can help in the collection of information. RS techniques will often be the only way to obtain accurate information quickly and economically, and the integration of water management models with RS





Figures 1 and 2. Differences in irrigated land (in black) shows up in these SPOT satellite images taken seven months apart.

image processing software and Geographical Information Systems (GIS) is especially promising for areal analysis.

Mapping of irrigated land

Landsat TM and SPOT satellites provide sharp images of land use, irrigated lands and infrastructure. Satellite data can be used to establish a database containing information on existing structures (characteristics), canals, drains, roads, and the location and size of irrigated fields. Such databases are required for aspects of management such as the planning of maintenance, cost recovery (collection of irrigation fees), determination of the net size of irrigation command areas, and so on.

Maps of the fractions of irrigated land within the command areas of the primary, secondary and tertiary canals are then easy to prepare and print. The RS data collection procedure can be repeated several times in the course of the cropping season. This is the method applied in Yemen by NEDECO Group company DHV Consultants.

Yemen study

Between 1981 and 1988, DHV Consultants conducted the Tihama Basin Water Resources study in Yemen.

The project comprised the evaluation of water resources and the formulation of development plans for the arid Tihama Coastal Plain. One problem was how to obtain accurate, recent data on the areas under spade irrigation, pump irrigation, rainfed irrigation and natural vegetation. In the case of the areas under spade irrigation, involving thousands of fields and a degree of seasonal variability, it proved impossible to gather the information through field surveys.

The satellite data provided the answer. For the actual crop monitoring, SPOT satellite imagery was used dating from November 1986, April 1987, July 1987 and November 1987, see Figures 1 and 2. The variation in irrigated land is clearly marked.

As a result of the study it was possible to obtain accurate land use estimates within a two week period of reception of the satellite images. The satellite-derived crop estimates for the pump irrigated area tallies quite well with the land use estimate produced during the well inventory.

The big difference in the area estimates occurred in the case of irrigated and rainfed agriculture. The satellite-derived irrigated area in 1986 and 1987 was only 50 per cent of the official estimates and the rainfed area only 25 per cent.

The same method of classifying land use was extended to the whole Tihama Coastal Plain using four lower resolution images of Landsat MSS. The low-cost NOAA/AVHRR data was the best tool for the year-to-year monitoring of land use on the Tihama Coastal Plain.

Crop type and crop stage

Simple crop patterns can easily be mapped from a single RS image made on an appropriate date in the growing season. However agricultural practices and crop phenology greatly increase the variability of ground cover and affect the appearance of the cultivated land. Additional information, such as the actual crop calender and field checks, are needed to distinguish the phenological differences between crops in the satellite images. Water management models require crop type and crop stage information (see study below).

Rio Tunuyan Study, Argentina

Current computer programs used for water management in irrigation schemes, such as CROPWAT, OMIS, WCAMOD and RELREG, rely mainly on traditional field observations.

The Rio Tunuyan Study, conducted in the province of Mendoza in Argentina (1988), is a good example of a project implemented by NEDECO (in association with The Winand Staring Centre, Wageningen, Netherlands) in which RS, GIS and modelling were used to demonstrate and evaluate the enhanced distribution of water in a large irrigation scheme.

A GIS involving three information layers (land use, map of irrigation infrastructure and soil map) was utilised for the geographical analysis, while hydrological models predicted potential (CRIWAR) and actual (SWATRE) evapotranspiration from all crop and crop-soil combinations.

The TM images were used to delineate the unit boundaries, the irrigation canal system, the irrigated and non-irrigated land and the total irrigated area per irrigation scheme,

see Figures 3 and 4. Satellite information was related to crop factor (Kc) through regression techniques. The conclusions of this study were that:

- Satellite RS is a satisfactory tool for determining the actual area cultivated;
- Combined with other necessary data, RS data are very useful in relation to the allocation of irrigation water and evaluation of the current irrigation water supply given different water allocation policies;
- The secondary units at the tail ends of the primary canals tend to have a lower percentage of their area cultivated than the ones located at the heads of these canals; and
- There proved to be significant discrepancies between the actual irrigated area and the official records used by the Irrigation Agency. This is important information in relation to irrigation water service fees.

Role of remote sensing in irrigation management

The projects described above show that RS is a powerful tool for the improvement of irrigation water management. In practice, however, RS is little used in irrigation water management. Feasibility studies, policy formulation, operation and management, as well as monitoring and evaluation of the irrigation scheme, can all benefit from the data RS provides.

Feasibility studies

RS makes it possible to prepare a quantitative analysis of the problems associated with poor water distribution. Inadequate distribution is clearly reflected in differences in cropping patterns, cropping intensities and crop development along the irrigation canals. Feasibility studies concerned with the modernisation and improvement of irrigation water distribution can make excellent use of this information.

Figure 3. Classified image showing the cultivated/uncultivated are of the Río Tunuyán Irrigation Scheme; the boundaries of the secondary units are overlayed in white.

Operation and management

Scheme managers need to know how much water will be required to satisfy demand and achieve optimal crop yields. RS can greatly increase the reliability of input data such as the actual cropped area and the spatial distribution of cropping patterns, and hence the accuracy of the irrigation schedules prepared.

Monitoring and evaluation

Monitoring and evaluation are part of effective management. Using the results of the RS imagery, the scheme manager can check the effectiveness of system rehabilitation or management improvements. Indicators are, for example, a reduction in waterlogging or an increase in cropped areas at the tail ends of canals, particularly during the dry season. Products derived from satellite images of irrigation schemes can also be used to keep financing agencies properly informed about the results of their investments in technical and managerial improvements.

Limitations of remote sensing

Detail

The use of RS techniques will depend mainly on the availability of images providing sufficient detail to be useful. SPOT and TM have a resolution of 10 to 30 m. This means that RS provides only semi-detailed information.

Rapid and reliable availability

The acquisition time of SPOT and TM is between 5 and 16 days. SPOT and TM require cloud-free conditions during data acquisition. It is questionable whether enough good quality images are available for real-time water management. In areas where good quality images are available and water supplies are scarce, the use of RS in water management will, however, become increasingly important.

Costs

The costs of using an RS technique include not only those of collection, processing and interpretation, but also

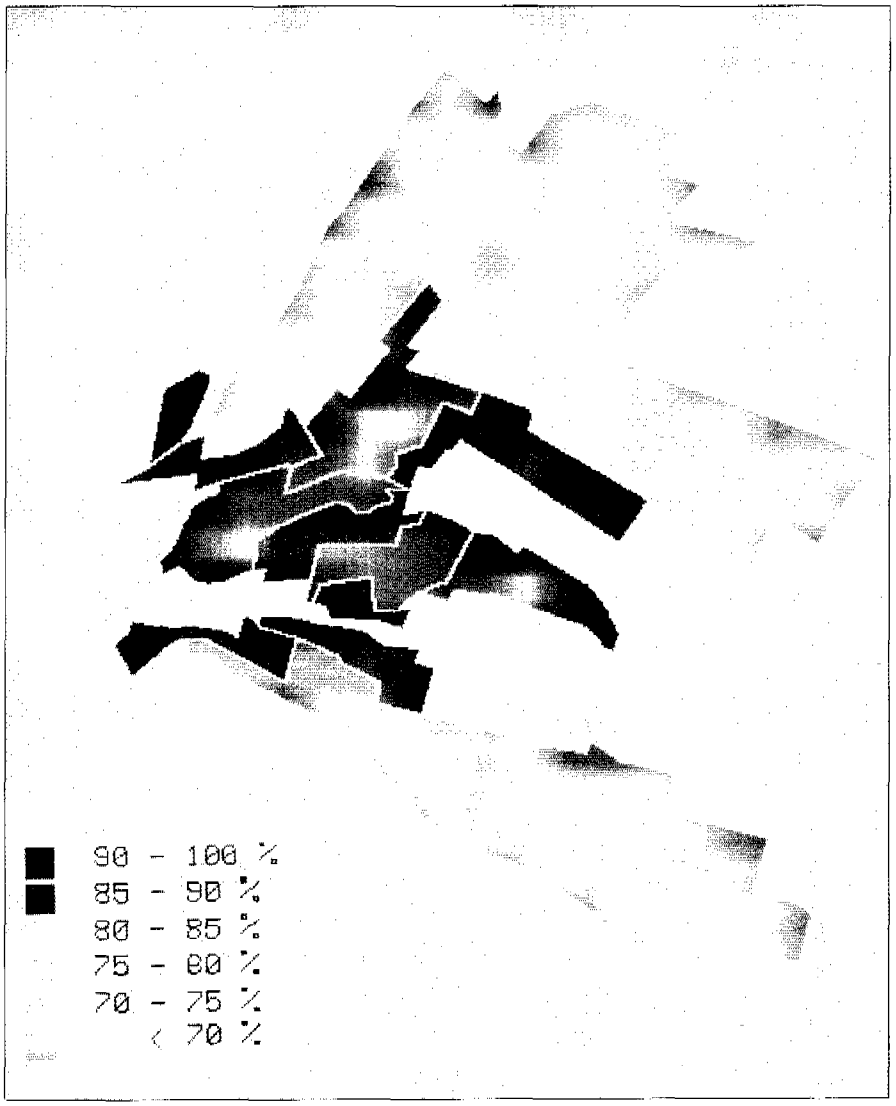


Figure 4. Image (originally in 7 colours) showing the percentage of the total irrigable area that is actually cultivated for all secondary units of the Río Tunuyán scheme.

the costs of verification or description in the field. Satellites have the capacity to image very large portions of the earth. For this reason, the cost of satellite imagery is low. Irrigation schemes normally only cover part of a satellite image. This means that RS is cost-effective for studies of medium-sized and large irrigated areas.

Technology

Water management models run on personal computers. However, processing of RS data will require more sophisticated computer equipment and more highly skilled personnel, and these may be beyond the grasp of most irrigation management organisations.

Advanced tools have to be adapted to meet the local requirements of irrigation management. Local conditions define priorities for irrigation management, which have to be taken carefully into account in order to guarantee the acceptance of advanced analysis of management tools.

Benefits of remote sensing

RS techniques are only economically viable if they contribute to the collection of valuable information in a cost-effective way. When the same information can be obtained by other less costly and equally reliable methods, the use of RS cannot be justified. As explained in the previous sections, key requirements for the use of RS are large areas, monitoring and semi-detailed surveys.

The benefits of RS can be divided into three categories:

Increased efficiency

The increased efficiency can reduce the demand for labour and accelerate the processing of products (maps and statistics). The efficiency benefits of time-savings are often reported as the time needed to do a task using RS expressed as a function of the time required to perform the same task conventionally.

By simply converting the time-saving into money values, an estimate can be made of the actual value of the benefits. An important criterion is the cost of man- power. Obviously, where labour costs are low, the monetary value of increased efficiency will be less.

Better (more effective) decisions.

RS can provide more reliable information faster, and so enable the RS user to make better decisions.

Intangible benefits

Intangible benefits to RS users may be:

- Improvement in public image through modern information management;
- Reduction in conflicts caused by contradictory data sources; and
- Increase in professionalism and improvement in employee pride and job satisfaction as a result of keeping pace with technology. ■

Further reading.

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Applied technology in supply management

John Manley, Wessex Water
John Snoxell, AquaWare Systems

The article describes some trends in applied technology within Water Supply management in the UK, illustrated by experiences in Wessex Water, which has been at the forefront of such technology for many years. Key technical areas such as telemetry, GIS and network modelling are discussed, along with innovative approaches to data integration which are currently being implemented in Wessex.

Over recent years the emphasis has been on opening up and integrating key corporate data systems, notably telemetry, GIS, network modelling, data logging and others.

Typically, telemetry systems and GIS are closed systems, doing what they are designed for very well, but often being inaccessible, complex, expensive and difficult to integrate with other systems.

It has long been recognized that telemetry data on flow, level and pressure is one of the company's most valuable assets when monitoring demand, consumption and leakage, and of great value when integrated with modelling. Network models can be kept up to date at very low cost with access to live telemetry data, making the models useful in operational management and reducing the duplication that occurs with the traditional approach.

Links to off-line systems

Wessex's telemetry now links to a number of key off-line systems, including the highly acclaimed WESNET software suite in which the data is used for routine calibration of key network models. The data also feed other key systems monitoring demand and leakage, thus reducing manual data capture and the labour intensive approach of previous systems.

GIS is another area where great strides have been made in the last two years. Like many companies in the UK, Wessex has invested heavily in GIS over the last decade and now has over 95 per cent of its water supply asset data and full background on its corporate system. However, a major problem was improving access throughout the company in a cost-effective manner and integrating the data with other systems, notably modelling, where there is a strong natural link

Development of Aquamap

The answer to this was the development of a PC-based system, Aquamap, which has moved mapping, or GIS, on to the desktop and into the field where it is now used in innumerable everyday tasks throughout the company. There are currently over 200 users throughout water supply and sewage treatment, and the number is growing. The GIS data can also be imported and integrated in modelling work using WESNET, and Wessex key models are now all fully referenced to the relevant GIS data, a feature which is now opening up many innovations in the use of other key data sources

The latest version of the software, WESNET[32] Version 6.00, exploits the GIS link in a number of ways which are unique — it is now possible to create and display polygon boundaries for any type of zone or area (for example, leakage district or demand zone) on top of the network model, with full GIS background in place. In addition, a wide variety of overlay files can be imported and displayed, such as burst main records, customer complaints and so on.

More network information

This means that it is now possible to run a network model showing high or low pressures at nodes and to display the leakage zone boundaries, full GIS background and overlay, for example, occurrences of burst mains or low pressure complaints; this is providing new insights into the operation and management of the supply network and is bringing applied technology into everyday operational management.

In a further exciting development, it is now possible to import post code data into the model for assessment of demand within the polygon area, replacing the laborious house counting approach traditionally used.

One important trend within the move to make GIS more accessible is the use of portable mapping, i.e. the use of notebook PCs which can be taken home, on site, in the van and which make field staff effectively independent of depots or administration centres. There are many staff in Wessex now using GIS in this way via Aquamap and the system has also led to major cost reductions in routine activities such as plotting, printing and so on.

The entire Wessex system can be easily accommodated on a standard notebook PC and access and display is both easy and very rapid, making it ideally suited for usage at many levels in the company.

All of these technologies are lifting Wessex to new levels of efficiency by automating routine tasks, making information available in a simple and effective way and improving understanding of the network — all easy things to theorise on, but very difficult to achieve in real-world conditions. The future will certainly see a continuation of this trend as the water industry becomes more technologically oriented — fewer people, but much more highly skilled. ■

Biographies

Ken Manley is Water Supply Director of Wessex Water Services plc — with 25 years experience in water supply management, twenty with Wessex, Ken has seen all aspects of the UK industry in both its public and privatised forms.

Aquaware Systems' John Snoxell spent 20 years in senior operational management in water supply covering water production and treatment, telemetry/ICA and, latterly, systems development in telemetry, GIS and leakage, modelling, including the Aquaware software range.

***DATA INTEGRATION** FOR WATER SUPPLY SYSTEMS- USING....*

WESNET[32] Version 6.00
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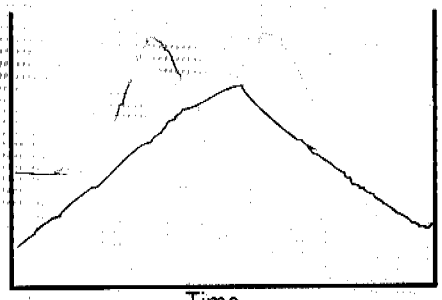

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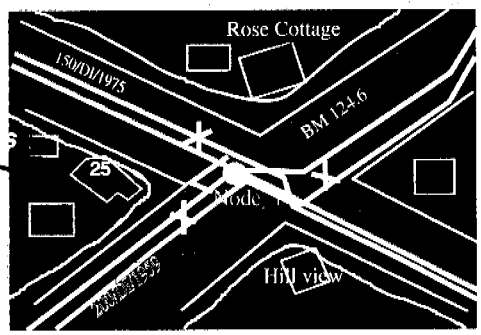

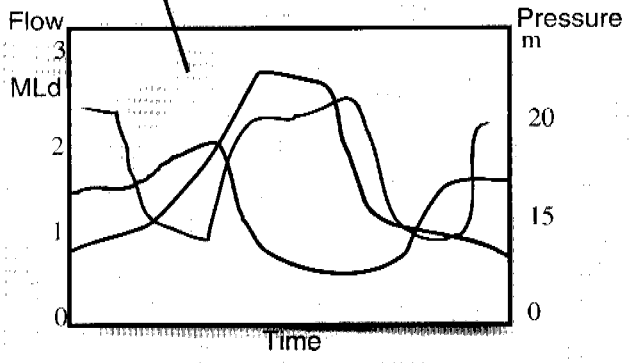

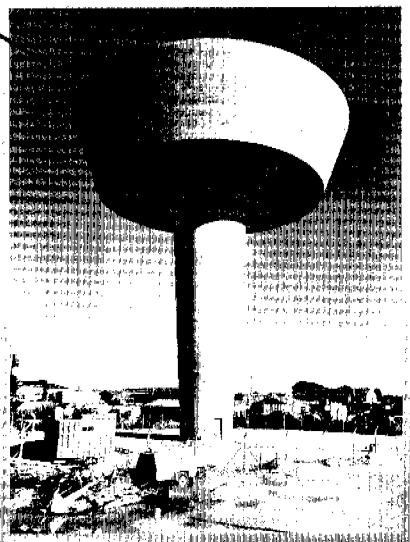

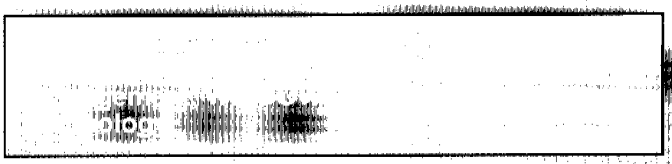

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Renewing concrete in reservoirs

Bob Groves, Thoro System Products

The UK water industry faces a challenge to comply with regulations aimed at improving drinking water standards. This report looks at methods of repair being used to bring reservoirs and other water-retaining structures up to the required standards.

In many cases, the UK's own water quality regulations, set out in the 1989 Water Act, are more stringent than those defined by the EU Directives.

These directives and regulations set down parameters that include the measure of the physical, chemical and biological characteristics of water intended for drinking, washing and cooking purposes. Many reservoirs, especially those constructed below ground more than 30 years ago, need some refurbishment to meet these objectives.

Statutory requirements

Materials selected for the refurbishment of a UK reservoir must comply with certain criteria before being approved for use. The water company concerned must ensure that all materials used meet the requirements of the Water Industry Act 1991.

The relevant regulation states that the water supplier shall not, otherwise than for the purposes of testing or research, apply any substance or product to, or introduce any substance or product into, water which is to be supplied for drinking unless it

- Has been approved by the Environment Secretary; or
- Is considered by the water undertaker to be unlikely to affect adversely the quality of water; or
- Has been used by the water undertaker during the 12 months prior to July 1989; or
- Is listed in the '15th Statement' or any supplement used by the committee on chemicals and materials of construction for use in public water supplies and swimming pools.

Other standards materials must meet are laid down by the UK Water Fittings Byelaws Scheme, which is run under the jurisdiction of the Water Research Council (WRc). Non-metallic products such as cementitious materials that are used in reservoir repairs must be tested and proven to conform to BS6920 before being listed under the scheme.

The method of repair finally selected for a scheme will, in addition to meeting statutory standards, need to satisfy other requirements including:

- Mechanical — Withstand impact, abrasion and scouring;
- Chemical — Resist chemical attack;
- Physical — Prevent ingress of contaminants and water loss;
- Biological — Not support biological growth, or taint;
- Practical — Be easy to apply and clean.

Concrete repair

Polymer-modified cement-based repair mortars are used widely for repairing erosion and deterioration of concrete reservoirs. These specially formulated products are blended in the factory and supplied in sealed bags ready for mixing on site with clean water and a bonding agent; consequently a consistent quality of mortar is always achieved.

Some types are high-build, enabling relatively large sections of concrete to be repaired in a single operation. Many are fast-setting, shrink-controlled and totally compatible with the substrate. They are extremely dense, waterproof and vapour permeable. Application can be to horizontal or vertical surfaces and soffits.

Reinforcing bars can become exposed on areas being repaired and often require the application of a rust-inhibiting primer or bonding coat prior to being reinstated. Repair mortars such as Structurite only need a slurry coat of the mortar just prior to repairing, which speeds up the remedial programme and thus saves time and money.

The mortar achieves an excellent bond with the existing concrete and reinforcement, and cures rapidly to achieve an early high strength. Its alkalinity ensures that passivity around the steel is reintroduced, thus giving long-term protection.

Expansion joints are a feature which require special consideration.

A seal is needed which forms a total barrier to water penetration of joints or cracks while coping with structural movement. Conventional sealants will do this but can break down after a few years.

Another method which can be used as a replacement or alternative to sealants is now available. Known as Thoroflex 200, it comprises a Hypalon flexible waterproof membrane in either 100mm or 200mm width, held permanently in place on the surface of the structure over the joint or crack. The membrane is bedded in or covered by a special two-component waterproof epoxy resin adhesive applied each side of the joint or crack. The adhesive firmly holds the membrane in position, leaving the central area unattached and free to flex as the structure moves.

Surface coatings also play an important role in the refurbishment of concrete and brickwork reservoirs. Cement-based coatings are compatible with the substrate and will resist positive and negative water pressure, thus creating a barrier against water loss or water ingress. In addition to preventing water loss, they stop contaminates entering stored water from external sources.

The coatings are extremely durable and will resist impact, abrasion and chemical attack. They are easy to apply by brush or spray, even directly onto damp surfaces. Because they are cement-based, the coatings have the same physical and chemical characteristics and similar co-efficient of expansion as concrete.

Cementitious coatings are easily cleaned and will accept pressure-washing, steam-cleaning and sterilisation.

A recent development in cement-based coatings is the introduction of a flexible elastomeric coating called Thoroseal FX 100. This seals over fine cracks in the concrete and copes with future crack movement through extension and recovery and has an elongation under water of 16.2 per cent. It stops water penetrating into cracks and protects the substrate from surface erosion of the lime particles present in cementitious coatings.

The coating's properties make it suitable for lining the inside of below-ground reservoirs or protecting the external surface of concrete structures. When used externally on areas such as reservoir roofs, it gives protection against the kind of erosion that can be caused by the freeze/thaw cycle.

Case Study 1

A structural survey by engineers at Anglian Water Services' Southern Division of a 1136m^3 capacity 40-year-old concrete water tower at Bradford St Clare, Suffolk, revealed deterioration of the concrete, which, if left unattended, could eventually make the structure unstable.

The porous state of the concrete had allowed carbon dioxide and water gradually to penetrate the surface, causing a reduction in alkalinity around the reinforcement. The resulting lack of protection initiated corrosion of the steel rods, leading to expansive action which cracked the concrete, causing it to spall away in places.

The engineers decided that the repair method chosen for the tower should bring the damaged areas back to optimum strength and, in addition, protect the entire structure from further damage. They selected a remedial system comprising the application of Structurite repair mortar and Thorolastic anti-carbonation coating.

An old protective paint coating was removed from the whole structure by water-jetting. The areas affected were cut back to sound concrete, then the areas reinstated with Structurite fast-setting acrylic-polymer-modified repair mortar. A protective treatment of Thorolastic anti-carbonation coating was finally applied over all of the exposed concrete surface.

Case Study 2

Below-ground concrete reservoirs usually have a covering of earth over the top to shield the concrete roof from solar heat and hence reduce thermal movement in the structure. Many older reservoirs are now having the earth removed and a sheet

The roof of a below-ground concrete reservoir at Danbury, Essex, was protected with Thoroseal FX100 flexible coating.

membrane installed over the concrete to act as a barrier against waterborne impurities leaching through the roof onto the stored water.

Thoroseal FX 100 is now being specified by water companies as an alternative for such instances as it offers advantages over sheet membranes. Because the membrane is brush-applied, it does not have the type of lap joints that occur on sheet membranes which, if not sealed correctly, can be a source of water penetration.

In addition, it is not restricted by the kind of conditions that can prevent laying a sheet membrane, as it can be applied in winter temperatures as low as 50°C and directly onto a damp substrate. The coating is elastomeric and therefore seals fine cracks in the surface of the concrete and copes with subsequent structural movement.

An example of the use of the material is at Danbury Reservoir, near Chelmsford, where Essex & Suffolk Water recently carried out a remedial programme on a 1930s-built concrete reservoir. Under the supervision of their Engineers Department, the earth was removed from the roof and the coating applied to the concrete. The area was finally covered with aggregate in preference to earth.

The work was carried out by Repcrete (UK) Ltd of Ipswich who removed the earth and then shot-blasted the exposed concrete to clean off residual materials. Existing joints in the concrete were repaired where necessary prior to the application of two brush-applied coats of Thoroseal FX 100, the first white and the second grey.

The use of two colours enabled the correct coverage to be achieved. When the treatment was fully cured, the roof area was flooded with water in order that checks could be made inside the reservoir to see if any water had penetrated through the repaired joints.

Conclusion

Polymer-modified cementitious repair mortars and cementitious coatings generally meet the needs of the Water Industry, providing a durable and cost-effective solution. Material suppliers offer a wide range of repair materials in these categories, each with their own performance characteristics. The Water Industries' own listing scheme and current regulations ensure that such materials are first thoroughly tested to make certain they meet required standards. Continual product development by material suppliers and the approvals scheme in operation combine to produce safe remedial systems which will repair and give long-term protection to water-retaining structures, thus minimising maintenance costs to the client. ■

Biography

Bob Groves is Technical Sales Manager for Thoro System Products.

HDPE mains gaining ground on others

Phillips Driscopipe

Polyethylene pipe has a successful 35-year history of water transport and handling, and is now assuming its place next to ductile-iron and PVC pipe as the alternate material of choice for rural and municipal water systems.

Polyethylene pipe is primarily joined by heat-fusion, a zero-leak-rate joint proven for the last 35 years. It is tapped and maintained by using "standard" equipment, tools, clamps and saddles.

Polyethylene pipe can offer measurable project savings versus polyvinylchloride (PVC) and ductile iron (DI) pipe, especially with No-Dig trenchless technology. The heat-fused joint eliminates gasket leakage or broken and sheared mechanical joints, thus decreasing maintenance, decreasing water "un-accountables", and increasing revenue.

The principle attributes of polyethylene pipe are that it is:

- Inert and corrosion-proof
- Economical and competitive
- Long-lasting
- Ductile, tough and durable
- Heat-fused with zero-leak-rate joints
- Hydraulically smooth
- A complete pipe and fittings systems engineered for water utilities

The Phillips Driscopipe Series 4000 water pipe system is extruded from extra-high molecular weight high-density polyethylene which possesses the optimum overall balance of performance and properties matched to the demanding requirement of today's water utility. The Driscopipe 4000 water pipe system is offered in sizes 4in (100mm) to 54in (1370mm) with a range of working pressure ratings (WPR) between 50 and 267psi matched to the operating pressure of the water utility.

Polyethylene pipe is designed differently from PVC pipe in accordance with the specification and requirements of the American Water Works Association (AWWA) Standard C906, for polyethylene pipe.The Driscopipe 4000 potable water HDPE pipe system offers a service life equivalent to PVC and DI pipe.

Savings from correct use

The savings accumulate when using polyethylene pipe properly. The working pressure rating (WPR) of the HDPE pipe allows the water utility to select the pipe dimension ratio (DR) matched to the operating pressure of the distribution or transmission pipeline.

Most frequently, the HDPE pipeline is competitive with PVC pipe on DR. Pumping operation costs are reduced due to the high flow-factor for polyethylene pipe. With "seamless:" heat-fused joints, the drop in leakage rate results in reduced maintenance, main-break avoidance and increased revenue. Additional savings related to construction also accumulate: savings from eliminated fittings, thrust-blocks, and restraint-clamps; less trench labour, narrower trenches, and less backfill; and so on.

Pipeline economics

Polyethylene pipe competes well world-wide with ductile-iron and rigid PVC pressure pipes. The best cost comparison between these pipes is a life-cycle cost evaluation, which would include factors such as pipe capitalisation, pipe installation, operating expenses, maintenance costs, leak repair and water losses.

When such a study is completed, polyethylene pipe out-performs the rest by offering competitive pipe capitalisation costs, measurable construction savings, equal pumping expense, virtually no maintenance now and in the future, and an essentially zero-leak-rate pipe network.

But water utilities still want to know if the polyethylene pipe capitalisation cost is competitive with PVC and metal ductile-iron pipe. The trend analysis chart is an appropriate tool to accomplish this task.

The trend charts shown overpage illustrate that Phillips Driscopipe Series 4000 polyethylene pipe is competitive DR for DR with PVC and is generally less expensive than mechanical-joint or slip-joint ductile-iron metal pipe.

When considering restrained-joint ductile-iron pipe and restrained-joint PVC pipe against heat-fused "self-restrained" Driscopipe polyethylene pipe, Driscopipe competes very well.

The following trend charts assume the cost of any pipe is proportional to

the pipe diameter and wall thickness, at a given price per pound.

By plotting dollars per diameter inch per foot of length versus the ductile-iron OD sizes the cost trend can be developed. While pipe economics change over time, the trend is clear: properly engineered and specified polyethylene pipe is competitive.

Heat-fusion joining

Phillips Driscopipe 4000 pipe is normally joined at the curb or street level using field-proven, zero-leak-rate heat fusion. For some connections, mechanical joints, clamps and mechanical connectors may be used. However, the specific manufacturer of those devices should warrant their compatibility with polyethylene pipe.

Heat-fusion training and qualification usually takes less than one day; it is easy to make good fusion joints by following properly the pipe manufacturers recommended procedures.

Simple and foolproof tapping

Tapping of Driscopipe 4000 Series polyethylene pipe is quick, simple and foolproof when adding a service connection or lateral main. The Driscopipe 4000 system offers sidewall fused polyethylene hot-tapping tees for 3/4in (19mm) and 1in (25mm) service lines from main sizes 3in (75mm) to 12in (100mm).

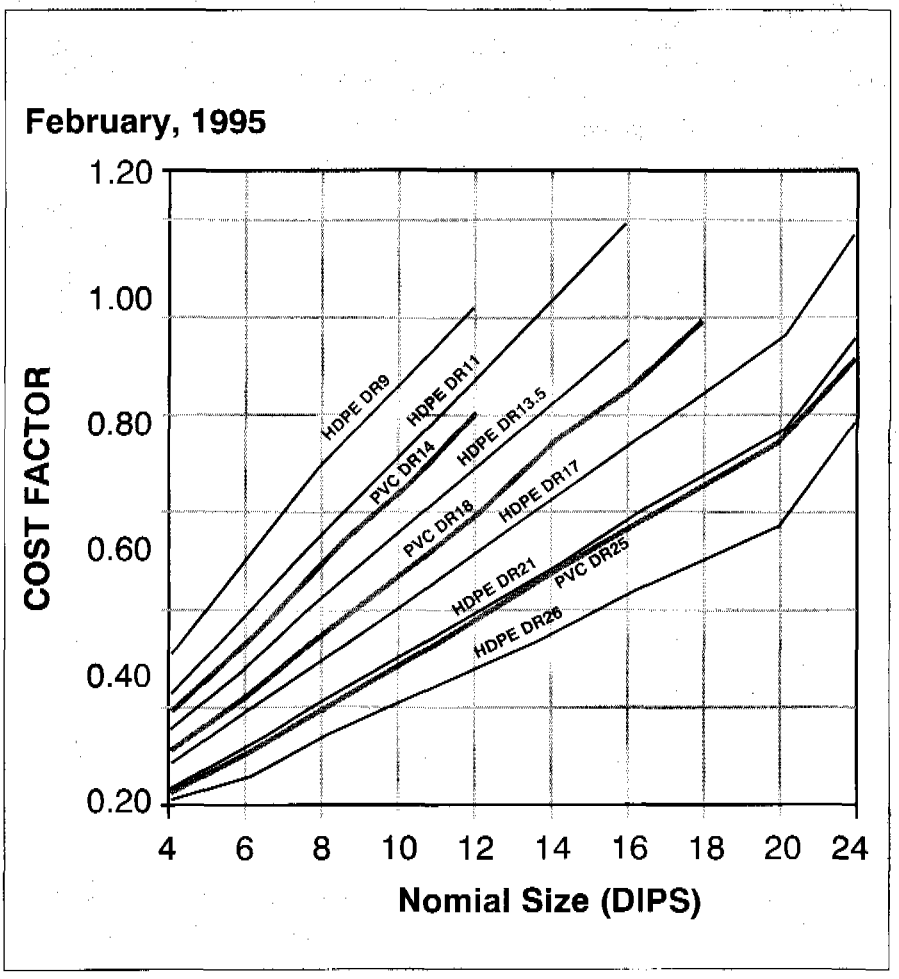
For mains sized 14in (150mm) and larger, polyethylene service saddles and branch saddles may be sidewall fused, and then tapped with a tapping tool or machine. Additionally, for larger diameter mains, mechanical tapping saddles may be used provided they are engineered for polyethylene pipe. Direct threading of polyethylene pipe is not recommended.

Repair benefits

One of the benefits of HDPE pipe is that it does not crack, shear, corrode or split under normal circumstances. It has the lowest urban repair frequency per mile of pipe per year compared with all other pressure pipe materials used for urban gas distribution. Even then, the largest contributor to that impressive record is third-party construction damage to mostly smaller diameter pipes. The larger diameter HDPE mains ring deflect or laterally distort before damage is imposed on them.

Other large diameter rigid pipes usually puncture or rupture under the same excavation contact. Polyethylene pipe is ductile, tough and strain tolerant.

Permanent repairs using clamps, gasketed sleeves, flanging or butt-fusion may be used. In most cases, current suppliers of repair devices for the water utility are adequate and offer repair clamps sufficient for repairs to third party damage to HDPE pipe.



Trend analysis chart showing HDPE competes with PVC on a DR:DR basis

Laying polyethylene pipe

Millions of feet of polyethylene pipe have been buried in thousands of cities in the USA and world-wide in urban and rural settings. All pipes require good embediment or soil compaction to at least 85 per cent Standard Proctor Density in order to support the pipe and minimise the ring deflection.

Virtually, the same embediment is required for DI, PVC and PE pipes. The appropriate guidance for plastic burial is ASTM D2321.

Rehabilitation of existing water systems is an important role polyethylene pipe can play when striving to reduce main breakage and increase the "billables" for an owner. Pipe rehabilitation can be carried out using sliplining, insert-renewal or radially compressed HDPE liners for metal pipes.

Trenchless technology may account for up to 35% of all new urban utility construction by the year 2000. Polyethylene pipe is the material of choice by contractors world-wide for water pipe "No-Dig" construction. Driscopipe Tech Note No 41 offers guidance in the use of HDPE pipe for mini-directional drilling, horizontal directional drilling and river crossings. ■

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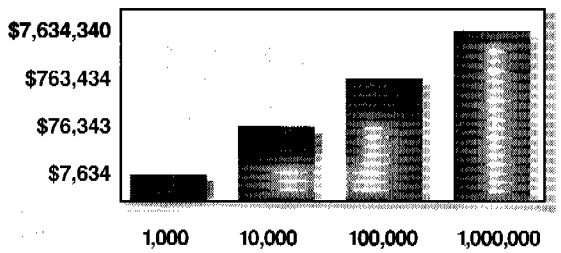

* Calculation based on the elimination of 7% water loss due to leaks and breaks using data from the AWWA-WIDB report.

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Chlorine gas v sodium hypochlorite

John Evans, Measurement & Control Services

Many water authorities, and industrial companies have devoted a great deal of time and considerable expense recently evaluating alternative methods of disinfection. The leaders are probably on-site generated chlorine gas and bulk storage of sodium hypochlorite. Which is best?

Experience has shown that health, safety and cost considerations have had a significant impact on the move away from gaseous systems and the change to sodium hypochlorite for water disinfection.

The question could quite rightly be asked, why change at all? Chlorine gas has been used as an effective and reliable disinfectant for many years. The following pros and cons may give some insight as to whether or not, as they say, the end justifies the means.

If we look at the health and safety aspect of chlorine gas, the following three areas should be addressed:

Assessment

- What hazardous substances are present?
- What are the harmful effects of the chemical?
- What is the possibility of exposure occurring?
- What is the possible extent and duration of the exposure?
- Who or what could be effected?
- What actions need to be taken?

Control

- Identify the need to use the substance;
- Redesign the process to avoid its use; and
- Substitute with another substance that is less hazardous.

If unable to carry out the above:

- Totally enclose the system;
- Restrict access;
- Reduce length of time in the hazardous area;
- Provide personal protective equipment; and
- Provide a safe means of storage of the substance.

Monitoring

- Ensure control methods are properly used;
- Plan maintenance of control methods;
- Carry out regular air monitoring; and
- Carry out health surveillance for scheduled processes.

Examination of the health and safety implications of using gas could be a prompt for looking closer at the use of sodium hypochlorite. The practical implications can be viewed in carrying out the UK regulations with respect to chlorine gas and sodium hypochlorite.

Chlorine gas

UK regulations require that gas cylinders should be stored not less than 20m from the site boundary. A gas-tight room must be constructed paying particular attention to ducts and drains. Vent fans should discharge at high level and be capable of being manually operated from outside.

There should be two rooms for the gas installation: one for equipment under pressure; and one for vacuum equipment. The vacuum room is inherently safe and all control equipment should be sited in this room. Only authorised persons with full training in breathing apparatus should have access to the gas pressure room.

Both rooms should be fitted with appropriate gas leak sensors connected to a warning lamp system over each door to indicate the status of the leak sensors and a light status test button.

An internal audible alarm should also be fitted in each room as well as a remote alarm connected to the telemetry.

Staff working on gas equipment should be provided with the appropriate safety equipment including positive pressure breathing apparatus (BA). Staff also require regular training for the use of BA sets, which themselves require regular testing and certification.

All work on gas equipment must be carried out with two fully trained staff in attendance. This includes the routine changing of gas cylinders and any form of maintenance work.

Sodium hypochlorite

Sodium hypochlorite is certainly less hazardous than chlorine gas, but is still a hazardous substance and needs to be treated with respect.

This article is mainly written assuming systems that are operated

by filling a day tank from carbuoys via a transfer pump either automatically or manually operated. It is felt that in the future we may see larger bulk tanks being used supplied by bulk delivery vehicles. This will be dependant on larger stations going over to sodium hypochlorite. Either way, the requirement remains for any tank to be bunded.

Spillage should be cleaned up immediately by using copious amounts of water to dilute the product.

Sodium hypochlorite should never be allowed to mix with any other substance that would allow the pH to be lowered and give off chlorine gas.

The following should be considered in respect of sodium hypochlorite dosing systems :

- Material selection
- Pump capacity and range
- Chemical dilution
- Injection and mixing

A problem that has been evident in some instances is the evolution of air from the sodium hypochlorite. This obviously causes a problem that needs consideration when installing the dosing pumps, though it is fair to say that most of the leading pump manufacturers have addressed this problem.

Another possible area for concern with sodium hypochlorite is the formation of chlorates. This normally occurs as the solution decays in storage and can be countered in two ways to slow down the formation of chlorates:

- Keep the storage temperature low.
- Immediate dilution with water to give around a 1 per cent chlorine available solution. Carbuoys should be date stamped and used in date rotation.

The room should be ventilated automatically at regular intervals.

Cost comparisons

The cost implications of both chlorine gas and sodium hypochlorite are broken down as follows :

Capital expenditure

The outlay required to purchase, install and commission a new disinfection scheme.

Capital Direction

The cost involved in replacing consumables and certain items of equipment that will require replacement during its life span.

Operational Expenditure

This is broken down into three areas:

- Cost of chemical;
- Planned maintenance — maintenance as recommended by the manufacturer to keep the equipment in full operational order; and
- Breakdown maintenance — an estimate, obtained from a water company, based on previous experience of unplanned maintenance repair.

The following example is based on a site that had previously been operating using chlorine gas, but where the equipment had become obsolete. All equipment and gas cylinders were in the one room.

The site has one chalk borehole and the output per year is 920Ml.

The following figures are based on like-for-like equipment, for instance, duty/standby and microprocessor controller on flow, residual and stop/start control.

Capital expenditure

£	Gas	Sodium Hypochlorite
Dosing Equipment	10853	2900
Leak Detection	2938	0
Civil Works	3500	0
Control Equipment	6000	6000
Installation	4500	3500
Design & Supervision	1500	1500
Total	**29291**	**13900**

Capital injections

Gas installation

- Leak detectors £200 @ 3 years
- Sample pump £250 @ 5 years
- Chlorine analyser £5600 @ 10 years

Sodium hypochlorite installation

- Sample pump £250 @ 5 years
- Dosing pumps £600 @ 5 years
- Chlorine analysers £5600 @ 10 years

Operational Expenditure

Chemical Costs

- Output from station = 920 Ml pa
- Chlorine gas usage = 435 kg pa
- Cost of gas @ £0.88 per kg = £383 pa
- Cost of sodium hypochlorite @ 10 per cent @ £0.17 per kg = £740 pa

Planned maintenance per annum

£	*Materials*	*Labour*
Gas Installation		
Gas installation	270	640
Leak detectors	40	240
Injectors etc	40	160
Gas installation total	**350**	**1040**
Sodium hypochlorite installation		
Pump service	160	160
PRV etc	70	50
Injectors	10	50
Sodium hypochlorite installation total	**240**	**260**

Breakdown maintenance per annum

Typical breakdown costs

	Parts £	*Labour £*	*Reliability*	*Predicted Cost £*
Gas installation	100	320	0.05	21
Sodium hypochlorite installation	30	80	1.00	110

Overall operational expenditure

£	*gas*	*sodium hypochlorite*
Chemicals	383	740
Planned maintenance	1390	500
Breakdowns	21	110
Totals	**1794**	**1350**

Comparison Analysis

Chlorine gas

- Capital outlay higher;
- Very reliable;
- Highly hazardous;
- Strenuous health and safety requirements.

Sodium hypochlorite

- Capital outlay less;
- Hazardous;
- Single-person operation;
- Cost-effective dosing for smaller sites.

Costing out in detail over a 20-year period with a net present value discount factor of 5 per cent the cost of gaseous disinfection was 38 per cent higher than that of liquid disinfection.

Control systems

The control of disinfection systems falls into two basic categories :

- Straight forward chlorine dosing of a raw water or the re-chlorinating or maintaining the desired residual level of an already treated water; and
- Super chlorination and dechlorination.

In either case the chemicals can be gaseous or liquid.

The mode of controls generally available are:

- Flow;
- Flow and residual;
- Set point trim;
- Remote set point trim;
- Stop/start; and
- Control on gaseous disinfect.

Most gaseous dosing units accept a 4-20 or voltage signal to position the gas feed device. Some require a flow signal to be fed direct to the motor positioner unit whilst the residual adjust signal is derived from a controller. This is not the ideal way to carry out this type of control.

The flow and residual signal should be fed directly to the 'Controller' and in turn the controller software algorithm should determine the correction adjustment that is required to maintain set point. The software should also allow the gas unit to respond directly and proportionally to any flow change.

As the process time can be affected by flow changes this should also be taken into account in the software.

Control on liquid disinfection

There are many and various types of pumps available on the market and they all use similar types of controls to vary the dose rate.

The dose rate of the pumps is normally carried out by:

- Varying the length of the stroke;
- Varying the speed of the pump; and
- Varying the pulse frequency of the pump.

The ideal is to have one parameter for control, mainly for the reason that less equipment is required to achieve the same result. Normally the length of stroke is changed by a stroke positioner for a residual change and the speed for a flow change. This requires in most cases the need for two controls: the residual control from a controller; and a flow signal to a speed controller to vary the speed of the pump.

The controller to give the best control configuration, versatility and flexibility is available on the market and will control/drive any of the gaseous units available on the market and virtually any dosing pumps.

Disinfection control systems

Disinfection control can range from a simple manual system to a sophisticated flow and residual control. The object of the control system is to close chlorine gas or sodium hypochlorite to achieve a required chlorine residual.

The following examples show disinfection systems using dosing pumps pumping sodium hypochlorite but the principle is equally suitable for chlorine gas.

Manual control

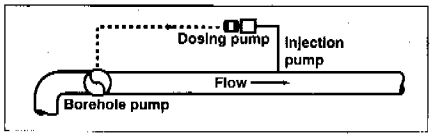


Figure 1. Manual control.

This is the simplest form of control. When the borehole pump operates the dosing pump starts and doses at a fixed rate. This system will not take into account changes in flow or changes in water quality. Therefore changes in either of the two parameters will effect the chlorine residual.

Flow control

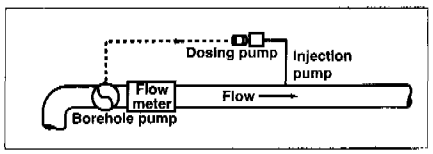


Figure 2. Flow control

This system varies the dose rate of the pump in proportion to the water flow. The output from the flowrate normally a 4-20mA signal is used to control the speed or pulse rate of the dosing pump. This provides a significant improvement over the manual system but does not take into account changes in water quality.

Residual control

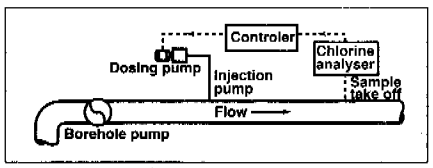


Figure 3. Residual control

This method provides a closed loop control system. The actual chlorine residual is measured using the chlorine residual analyser, this signal is fed to a controller which compares the actual residual with the required chlorine residual setpoint. The output from the controller provides a signal to the dosing pump and is increased or decreased depending on the actual residual level.

This means that the dose rate is increased if below setpoint or decreased if above setpoint.

Due to the normally long process times associated with this type of process a step type controller is normally used. The process time is the time taken for a change in dose rate to be recorded on the analyser. The step type controller would wait one process time before making a

further correction.

This type of control takes into account changes in water quality but does not respond to flow changes.

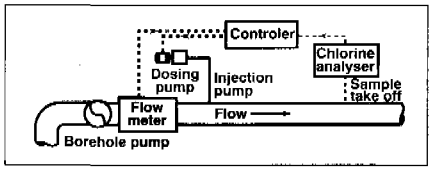


Figure 4. Flow and residual control

Flow and residual control

This method overcomes all the problems associated with the manual system, it compensates for both changes in flow and water quality. The conventional dosing pump for this type of system would be a motor driven pump with a variable speed drive and an automatic stroke positioner. The speed of the pump is varied in proportion to the flow and the position of the stroke is varied depending on the residual levels.

Measurement and Control Services Limited of Tonbridge, UK, has developed and simplified the conventional flow and residual system by using a PCS-90 Process Control System, which accepts both flow and residual signals directly. The controller computes both signals and provides one signal to the dosing pump; this signal would normally be a variable frequency pulse train. This system provides the following advantages:

- Low installation cost;
- Basic low-cost dosing pump can be used;
- Reduced commission;
- Reduced maintenance;
- Greater reliability; and
- Greater pump range.

Due to the deterioration of sodium hypochlorite with time it is more important that a residual controllers is used so it can automatically compensate for varying strength of sodium hypochlorite.

Measurement and Control Services Ltd have carried out many installations like those referred to and would be pleased to discuss any dosing problems. ■

Biography

John Evans is managing director of Measurement & Control Services, based in Tonbridge, UK. An apprentice electrician, he joined a well known manaufacturer of chemical dosing equipment as a service engineer, eventually reaching the position of manager of service and spares in the south-east. He set up Measurement & Control Services in November 1988 with four other colleagues from his previous employers. MCS is now well established in the field of water treatment.

UV widens range for effluent disinfection

William L Cairns, Trojan Technologies

Advances in ultraviolet disinfection of wastewaters has permitted its extension to effluents from very large wastewater treatment plants and also poorer quality wastewaters with lower UV transmittance and/or rapid fouling characteristics.

Ultraviolet (UV) light has been widely recognised as an effective alternative to chemicals for disinfection of potable water, wastewater and reusable wastewater.

The increasing popularity of UV for disinfection of wastewater is due to:

- The combined cost-effective and user-friendly nature of UV compared with chemical disinfection alternatives;
- Advances in UV technology, which have overcome some of the earlier limitations of UV disinfection; and
- An increased understanding of the process of UV disinfection which allows optimization of UV disinfection process and technology.

UV is effective against a broad spectrum of pathogens at UV doses that leave no concentrations of byproducts or residuals that can impact on receiving water biology.

Lower quality effluents

Lower quality effluents are particular problems for chemical disinfection because of the high background of organics which can increase disinfectant demand with production of byproducts and leave higher residuals due to the higher chemical disinfectant concentrations needed to use practical contact times.

The selectivity of UV for only those molecules which absorb UV, the strong absorption of UV by physiologically essential biomolecules (nucleic acids), and the high concentration of these biomolecules as well as the large number of UV-absorbing sites on each nucleic acid molecule contribute to the favourable ratio of high disinfection to low byproduct formation. UV dose is defined as average intensity within the reactor multiplied by the exposure time ($D = I \times t$). Increasing doses of UV result in an accumulating number of damaged sites within the nucleic acids such as DNA and RNA (genetic information molecules).

Nucleic acids are common to all life forms, and damage to the nucleic acids inhibits access to the genetic information needed for growth and cell division processes. Without access to this information, the UV irradiated microbe becomes inactivated.

The first practical ultraviolet light technology for wastewater disinfection was introduced by Trojan in 1982 using low intensity UV lamps. Since then, Trojan has continued to lead the introduction and evolution of UV technologies for municipal wastewater disinfection and now has over 1000 municipal systems (Trojan Systems UV2000 and UV3000) installed around the world for secondary, tertiary, and reusable wastewater disinfection.

With Trojan's recent 1994 introduction of a new high-intensity UV lamp system (Trojan System UV4000), the practical range of UV disinfection has been broadened to include:

- Very large wastewater treatment plants which previously would have required thousands of low intensity lamps (which would have taken considerable space and presented maintenance challenges for cleaning), and
- Poorer quality effluents (secondary, primary, combined sewer overflow, sanitary sewer overflow, stormwater and so on), which absorb UV extensively and therefore would have required numerous low intensity lamps, and/or which quickly foul the protective quartz sleeves around the lamps and therefore would have required high-cost time-consuming cleaning.

Special features

Special features of the Trojan System UV4000 allow this technology to perform where lower intensity UV lamp systems would be impractical. The most noteworthy of these features and their implications are described below:

- Use of high intensity lamps which reduce the lamp requirements by more than 90 per cent, resulting in dramatic reduction in space requirements compared with conventional UV systems, lower lamp replacement costs, and low installation costs with channel requirements reduced by up to 80 per cent;
- Use of a fully automated, physico-chemical cleaning mechanism which allows the lamps to be cleaned while they continue to disinfect, the maintenance personnel time for cleaning to be reduced to essentially zero even with rapidly fouling wastewaters, remote installations such as combined sewer overflow outfalls to be programmed for self-maintenance without operator intervention before and after events, and no additional equipment having to be included in the UV system design to allow for fouled sleeves and reduced intensity and hence dose within the UV reactor;
- Use of a unique reactor design which

allows an open channel, gravity flow configuration to and from the UV system, but at all flow rates provides a fixed water layer geometry around the lamps within the reactor for better control over dose delivery and avoidance of short circuiting of wastewater through the reactor; and

■ Use of UV dose optimisation based on continuous monitoring of effluent transmittance using Trojan's On-line UV Transmittance Monitor UVT2537, which provides feedback for system control over lamp output in order that UV dose can be more closely matched to effluent quality and disinfection demand.

Not only has there been an advance in UV disinfection technology, but an advance in understanding of the characteristics of wastewater which determine both the disinfectability of different wastewaters and the amount of equipment required to achieve that disinfectability. It has long been known that suspended solids in wastewater can present challenges to all disinfection technologies.

Particulates which contain microbes within their interior will result in a single microbial "count" if any of the interior microbes survive the disinfectant dose and can grow on the microbiologist's nutrient-rich medium to form a colony. The particle size distribution, the number of particles in each size range, and in the case of UV, the optical properties of the particle will influence the ease with which the particles can be disinfected and therefore dictate the overall disinfectability of the effluent. UV doses as low as 20mW.s/cm^2 will inactivate the free (not particle associated) coliform indicator bacteria of most treated wastewater effluents.

A need for a higher design dose is dictated by the extra time to accumulate dose within the particles so that only a target number of the largest particles "survive" to produce a count during culturing. For any given UV dose, the largest inactivated particle size at the cutoff between "surviving" and "not surviving" is the size for which the core microbes are effectively inactivated.

Since D = I x t, a decrease of I within the core of the cutoff sized particle by a factor of p can be compensated for by an increase in t by the same factor. Although the bacteria within the cutoff sized particle experience a dose (I/p x tp = I x t) which is adequate to inactivate the core microbes and hence the cutoff sized particles, the entire UV system is designed to give a dose of I x t x p where I is the average intensity within the reactor and t x p is the total exposure time (residence time) of water flowing through the reactor.

Table 1. UV disinfectability

Effluent type	Suspoended solids (mg/l)	Faecal coliform reduction (per cent)
Combined sewer overflows with physical and physico-chemical pretreatment	78-236	>99.90
Raw sewage	100	99.99
Primary effluents	96	99.99
Physico-chemical primary effluents	14	99.96
Secondary effluents	13	99.99
Tertiary effluents	<5	>99.99

The transmittance to UV of the bulk wastewater will influence the average intensity (I) within the reactor and therefore the amount of equipment necessary to compensate for UV attenuation as it passes through the bulk wastewater. The residence time (t) in the previous paragraph already has a factor added to compensate for the reduction of the average intensity (I) with different water transmittances.

The impact of UV disinfection on a given wastewater is empirically determined by a dose-response curve from which the dose to achieve a given target level of disinfection can be determined. Alternatively, the dose-response curve can be used by experienced UV manufacturers together with the wastewater characteristics to qualitatively guide the predisinfection process design engineer or treatment plant operator in optimizing the wastewater quality entering the UV system. Trojan continues to evolve a first principles UV disinfection model which can be calibrated with empirical data (dose-response, particle size distribution and so on.).

The model's advantage is in the qualitative and quantitative insight it provides for changes in UV disinfectability with changes in fundamental wastewater characteristics. This is especially useful when empirical data may be impractical to collect, such as full dose-response curves of changing wastewater qualities during a combined sewer overflow event.

The UV disinfectability of several wastewater qualities is summarised in Table 1. The absolute number of surviving counts following practical UV doses will depend on the size, optical quality and quantity of the largest particles in the wastewater; however, post-disinfection microbial counts for all the wastewaters could be reduced to at least 0.001 (3 logs reduction) of the pre-disinfection counts, and with better quality wastewaters, counts could be reduced to equal of less than 0.0001 (4 logs reduction) of the pre-disinfection counts.

The acceptability of the absolute number of surviving counts is dependent upon the quality required in the receiving water for that body of water's intended application, or upon the quality required for direct use of the disinfected wastewater (such as irrigation with reusable wastewater). Development of a cost-effective disinfection strategy involves a simultaneous optimization of both pre-disinfection and disinfection unit operations to achieve targetted disinfection objectives.

Reusable wastewater quality is not obtainable by UV or any other disinfection technology from raw sewage. However, a realistic identification of target disinfection needs, and a balancing of pretreatment and disinfection can ensure that UV disinfection can be used whenever there is a concern for cost-effective disinfection while minimizing byproduct formation, health risks, environmental risks, and risks to public/operator safety. ■

Biography

Dr Bill Cairns is Research Manager for Trojan Technologies. He has 20 years of academic, institutional and industrial experience in microbial systems, photobiology and photochemistry in several countries.

Reservoir network is drainage answer

by Alain Le Quéré, Entec Europe

A series of reservoirs has been created at Marne la Valée in France to provide a solution to a potential increase in wastewater flow and consequent water quality deterioration as a result of urban expansion. The reservoirs replace a network of underground collectors and discharge 5m³/s into the Marne river.

The latter part of the 20th century has been characterised by a new form of town planning — modern new towns have replaced programmes to restore, restructure, condense or rebuild traditional settlements. These tend to be sited on former agricultural sites, and the work of the architects, engineers and planners has been to create green, airy towns adapted to the comfort and well-being of the future residents.

In France, at Marne la Valée, Entec's engineers developed an innovative technique to provide a solution to the potential — and unacceptable — increase in flow rates and deterioration in water quality which was going to occur as the town was developed. The technique used allows investment in development to be staggered over a period of time and, at no extra cost, enhances the environment of the inhabitants of the new town.

Series of reservoirs

The answer devised by Entec was to create a series of reservoirs to regulate the run-off. These reservoirs replaced the traditional network of large, underground collectors and discharge a regulated flow of 3m³/s into the river Marne.

The creation of the reservoir system was the result of knowledge accumulated by Entec and its French company, Horizons, of the natural surroundings, water conditions, cleansing techniques and the possibilities of the water for leisure use.

Two objectives

The project meets two objectives — one quantitative, the other qualitative — of discharging water into the natural surroundings at flow rates identical to those occurring before development took place, and at a quality level which not only meets, but surpasses the standards currently set for natural surface waters.

Calculation of the run-off rates resulting from making the land impermeable, combined with statistical analysis of the precipitation levels over various periods in the Paris region, made it possible to determine the volumes of water that need to be stored at different times in order to keep discharge rates at low and acceptable levels so that no risk is posed to the downstream drainage channels.

The reservoirs have been created at the lowest points in the natural landscape and receive flows from secondary and tertiary collection networks by gravity. They store water at acceptable levels but also provide storage capacity capable of absorbing exceptional rainfall (one in 100 years event), but still without exceeding the authorised drainage quotas.

Permanent water surfaces

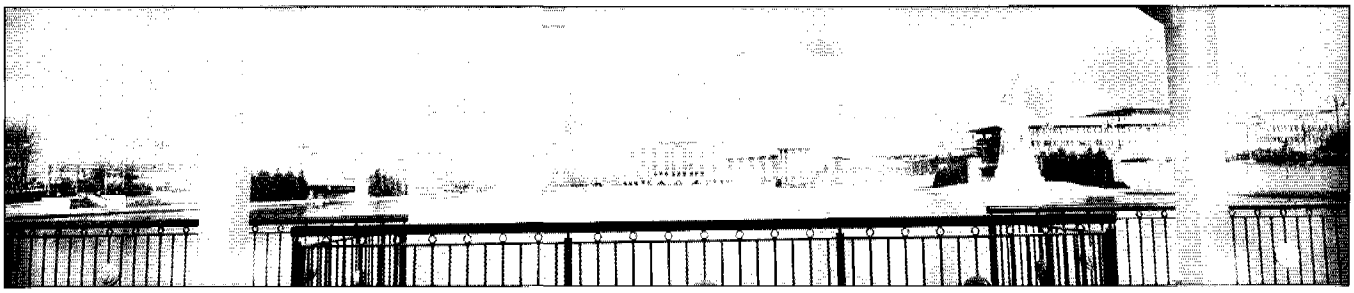
The choice of sites with favourable hydrogeological characteristics allows the creation of permanent water surfaces, which are roughly 2m deep, to be created at a reduced cost. Purification of the run-off takes place within the reservoirs without any harmful effects as the sediments which settle out naturally trap most of the pollutants. Plants, algae, plankton and fish, combined with oxygenation and the sun, either transform or eliminate any residual elements.These reservoirs, or retention basins, look attractive and discharge regenerated water back into the aquatic environment downstream.

Spatial distribution of the reservoirs, which are constructed as near to the developed areas as possible, means that it is possible for the developers to phase their investment programme and pipelines are also shorter, bringing additional cost benefits.

EuroDisney perimeter

Entec has created nearly 60 such basins in this particular project, of which 20 are on the perimeter of EuroDisney.

The concept brings the combined benefits of leisure facilities for local residents with the practical applications for which the reservoir



Retention basins adapted for leisure use at EuroDisney as part of the Marne la Valée project.

was originally designed.

The banks of the reservoirs are landscaped to make them look attractive and the brooks connecting them become, themselves elements of the urban design. The water reflects light and images; it supports water-based leisure activities and provides the opportunity for nature study.

Each reservoir is individually designed to suit its particular area and proposed function by altering shape and depth and modifying the shoreline contours with stone, logs, grass, plants, water gardens or reed beds.

They have become an integral part of the landscape architecture, complementing and extending green spaces; they can isolate or connect areas; provide areas for walking, fishing or sailing, or simply somewhere to provide a respite from a hectic, urban lifestyle where residents can relax and listen to the lap of the waves or watch a family of ducklings swim past.

Their attractiveness will be preserved since the reservoirs are subject, like any public or private installations of this type, to systematic monitoring and maintenance. By creating this system of reservoirs, Entec has found a way to not only solve a technical problem for storing and cleansing rainwater, but has given the developers an additional, attractive feature to emphasise when trying to sell properties.

Entec and Horizons have 20 years experience in protecting the natural surroundings whilst maximising the urban possibilities.

The technique described above can be adapted to different sites and combined with alternative cleansing techniques. ■

BIOGRAPHY

Alain le Quéré is an engineer working in the Paris office of Entec Headquartered in Newcastle upon Tyne, UK, the company has offices throughout the Europe, the Middle East and Hong Kong. It is a business consultancy which specialises in environmental issues.

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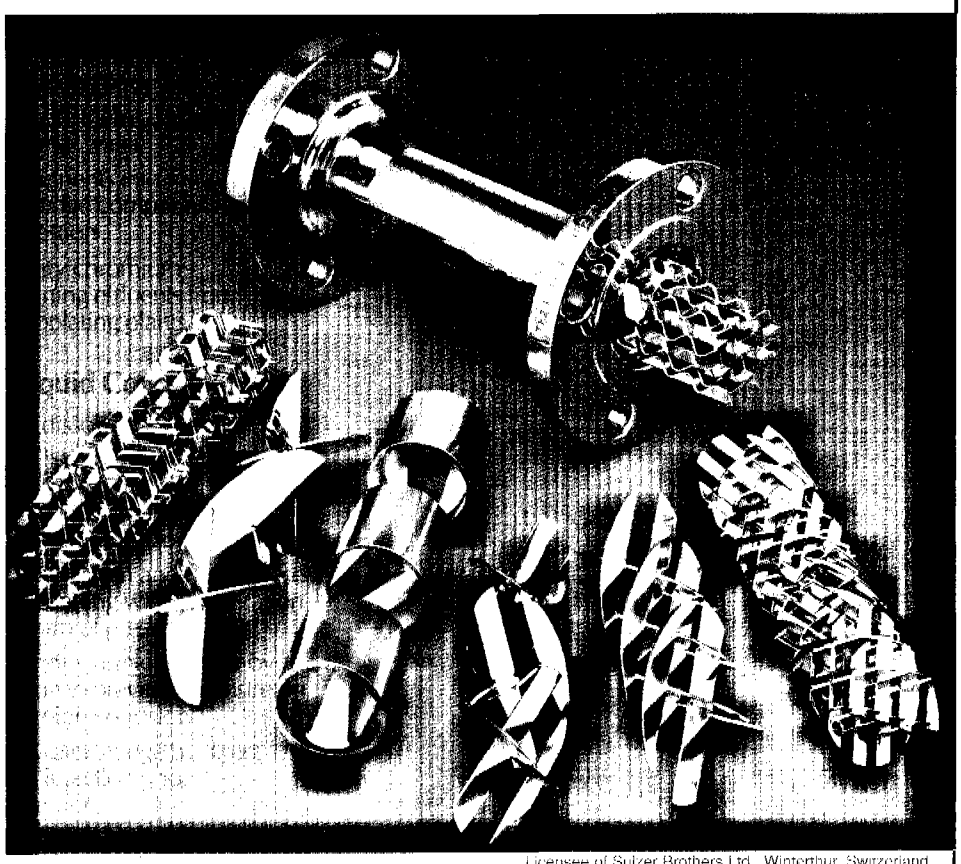

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Static Mixing Water and Waste Treatment Applications

Liquid-Liquid Mixing

- Neutralize or adjust pH value of liquid streams with acids and bases
- Mix flocculants or precipitants into water to remove suspended/dissolved solids
- De-acidify dissolved CO_2 in water by neutralizing with caustic solution
- Mix ground and surface waters to equalize hardness or pH value
- Mix streams to be sampled to assure a homogeneous, representative sample and eliminate stratification in line
- Mix nutrients (phosphorus & nitrogen compounds) with water prior to aeration
- Mix filter aid and flocculants with sludge prior to de-watering
- Eliminate thermal gradients in discharge water
- Mix nutrients into viscous scum and sludge components prior to digestion
- Detoxify chromium containing effluents from electroplating plants

Gas-Liquid Contacting

- Boost dissolved oxygen content of drinking water and waste water
- Disinfect water by chlorination, fluoridation, or ozonization
- Precipitate iron and manganese from drinking water by aeration upstream of pressure filters
- De-acidify drinking water by aeration to prevent downstream metal pipe corrosion
- Heat water/sludge by direct steam injection prior to digestion
- Scrub toxic gases from exhaust air
- Oxidize sulfite containing effluents with air

Gas-Gas Mixing

- Mix oxygen-ozone with malodorous plant ventilation air prior to discharge to atmosphere

Static mixers aid treatment process

Christopher R Isom, Koch Engineering Company

Current trends at many levels of water and wastewater treatment focus on increasing operational efficiency and minimising capital expenditure by using static mixers. Many applications normally emplying a mechanical mixer or where one could not be used can use a static mixer.

There are many types of static mixers available (see Figure 1). The two most common types required for water and wastewater treatment are those designed for simple mixing of miscible fluids, and those designed for mixing fluids that are prone to plugging due to the solids in the fluid.

Static mixers designed for simple mixing of miscible fluids usually rely on two principles: turbulence enhancement and layer generation. Layer generation refers to the ability of each element of a static mixer to divide the fluid into a number of layers (usually two to five) followed by a rotation and then repeated.

This process develops a geometric progression based on the number of layers per element and the number of elements within each mixer. Thousands of layers can easily be developed.

Turbulence enhancement is a general term referring to the increase in micromotions created by the fluid passing through the static mixer element. A common mixer type usually referred to as a corrugated plate style mixer creates this enhancement of turbulence inside each of the layers where you get multiple paths intersecting with each other. As each path crosses another path, each one loses part of itself and gains part of the other path, creating multiple micro mixing zones within each element.

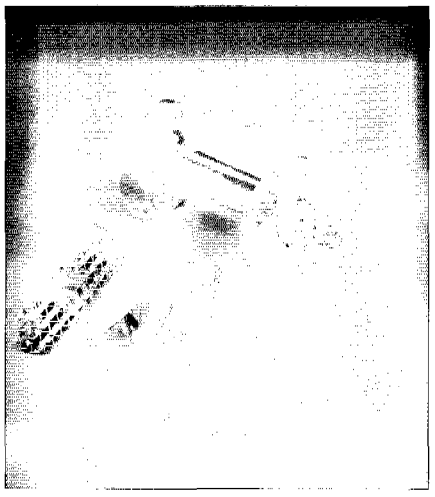

Figure 1. The Koch family of static mixers.

The combination of turbulence enhancement and layer generation allows complete mixing in very short lengths of pipe (3-5 pipe diameters). If the design of the mixing application also includes the methods for additive introduction (such as side introduction, centre-point injection or multipoint injection), the overall length and pressure drop can be minimised.

A common misconception for in-line mixing is that the additive can be injected into the main line and it will eventually mix. It can take up to 100 pipe diameters of empty pipe to get complete mixing for fluids with the same density and viscosity. Variations in viscosity and density can easily increase the length up to 1000 pipe diameters.[1]

Common applications for simple mixing of miscible fluids would be pH control, flocculant and coagulant addition, chlorination, dechlorination, ozonation, and oxygenation (see Figure 2).

pH control

The process of pH control with sulphuric acid enables understanding of the simple efficiency of a static mixer. Without a static mixer, a fluid as dense as sulphuric acid can literally slip through the entire line with no dilution effect. Gravity will immediately pull the fluid to the bottom of the pipe and treat it almost as an immiscible fluid. Common signs of this type of problem are usually thin wall pipe at the bottom and on the sides of elbow, where the acid would be flung as it turns the corner.

With a static mixer, many of these type of concerns are eliminated. Since the overall length of the mixing system is going to be less than 5 pipe diameters, this is the only section of the line where corrosion needs to be of a concern.

Most static mixers can be manufactured out of glass-fibre reinforced plastic (GRP) or even a Teflon material. By using a centre-point injector, the only material that the acid will actually touch should be the mixing element itself. Some

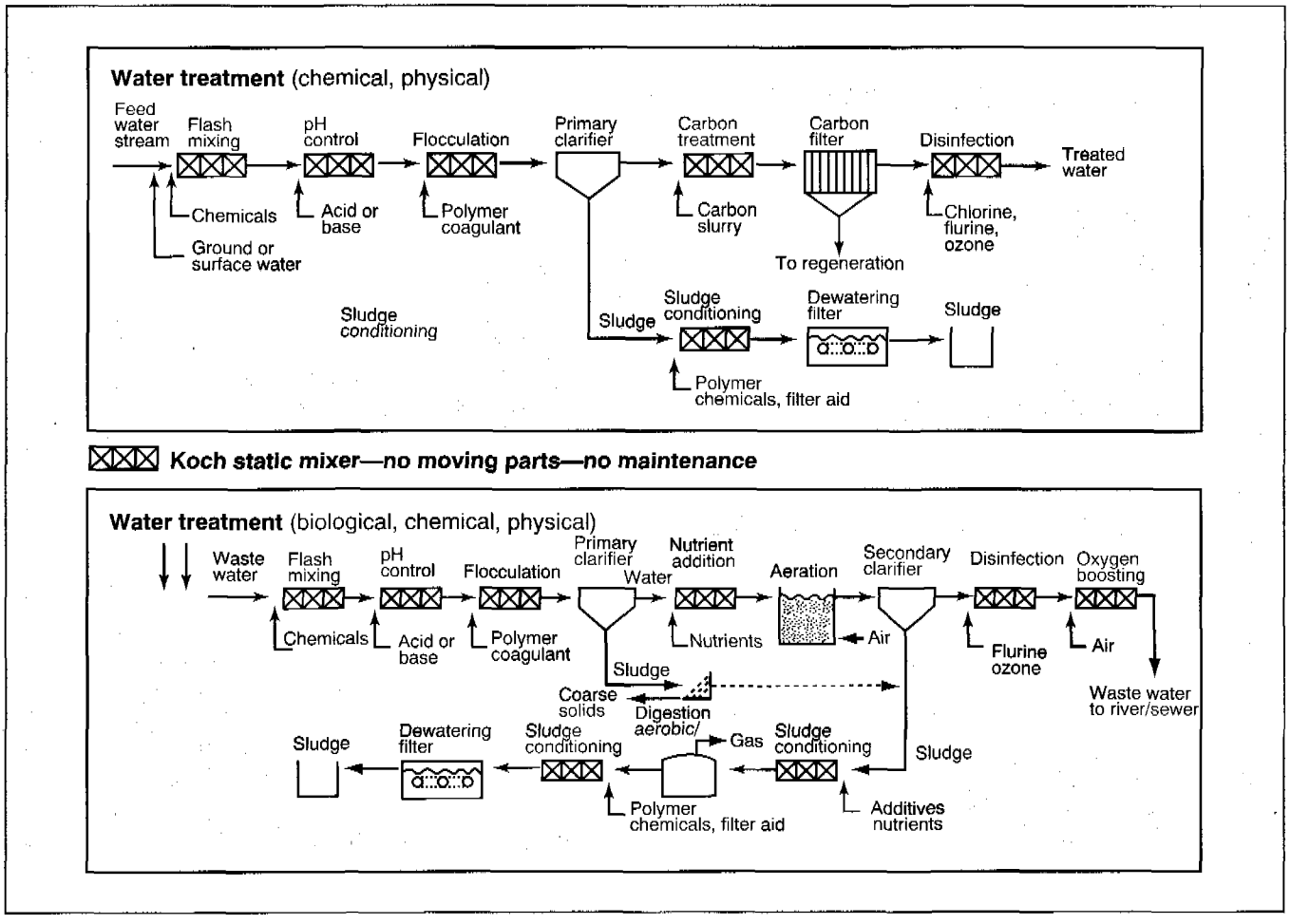

Figure 2. Typical solutions to common water treatment problems.

designs of mixing elements actually minimise this from even occurring by creating an intense mixing zone directly in the centre of the element without any of the mixer surface actually being in the centre of the element.

Not only is the concern of material minimised, but the whole concept of chemical consumption and better process control maximised. With the design of a good static mixer having a high degree of plug flow and little short- circuiting, usually the degree of chemical consumption is greatly reduced when compared with a rotation mechanical mixer.[2] This can be as much as 50 per cent depending on the design of the mechanical equipment being compared to. This is usually caused by the inherent short circuiting effect found in rotation mixing equipment.

Also, the lapse time from chemical injection to monitoring the pH has been greatly reduced with the probe located 4-5 diameters downstream of the injection point. With this type of almost instantaneous feed back it is extremely important to have a constant non varying flow rate from the chemical injection point. This can be accomplished by using a good pulsation dampener. Without this your pH control will actually be trying to control the pulsation of the injection feed pump (see figure 3).

Coagulant/flocculant addition

A typical measure for mixing efficiency when adding a polymer or coagulant chemical to a water stream is referred to as the Gt factor. The G refers to the measure of energy input per volume of fluid mixed, t refers to the residence time. Although this may have some relevance to a mechanical mixer regarding horsepower, this measure has little meaning to a static mixer.

The purpose of a static mixer is to minimise the amount of energy consumed in order to achieve good mixing. Many different designs can achieve good mixing with a wide variety of pressure drops consumed. One study showed a mechanical mixer had a Gt value between 100 000 and 150 000. The static mixer used to replace this application had a Gt value of 1000. Not only did the mixer reduce the amount of energy consumed it drastically lowered that amount of chemical required for the flocculation process improving the overall process.[3]

Mixing efficiency

Most manufacturers now rely on some type of statistical model for measuring mixing efficiency. The samples for the statistical model would be a certain number of samples pulled from the same cross section of the pipe at the same time. These measurements usually have 10-20 sample points that are placed within equal geometric areas from each other.

One frequently used measure of mixing efficiency is referred to as homogeneity. The homogeneity of

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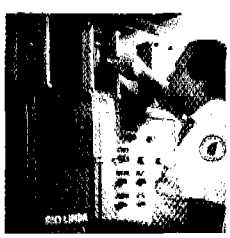

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these samples is simply the standard deviation (σ) of the sample readings divided by the mean of the samples(χ). The static mixer can be designed to achieve whatever value is required for the application. Typically values of 10 per cent-15 per cent are used for normal applications.

When mixing is extremely important to the overall process values of 1 per cent to 5 per cent are usually required. Assuming a normal distribution, there is a 95 per cent probability that all samples taken over the cross-section at any point downstream from the mixer outlet will fall within two standard deviations of the mean. Thus, the samples taken at the discharge of the mixer should have a concentration within 2 x 5 per cent or 10 per cent of the mean.

The size and pressure drop of the static mixers used for simple mixing is unlimited. One installation in the western US uses an 11ft (3.3m) x 11ft (3.3m) static mixer to mix in a dechlorination additive before the water leaves the water treatment plant. The mixer is quite capable of being able to use only the stoichiometric amount of chemical required for the dechlorination process. The pressure drop consumed was only a few inches of water column for this gravity flow system.

Static mixers for sludges

Many static mixer designs can easily plug with any type of solids present in the water or wastewater stream.

Over the last few years, static mixer designs that are specifically for sludges have been developed. These designs are based on the same type of principles but are specifically geared towards turbulence enhancement. They incorporate blades that are attached to the wall of the pipe but not to each other. This allows most solids to be able to pass directly through the mixer without any type of build up.

In most sludge dewatering applications, a polymer is fed into the stream before being passed into the belt filter press or centrifuge. Improper mixing will be indicated by poor dewatering performance, excessive chemical consumption, and can visually be detected by a film on top of the water in the open top of a belt filter press.

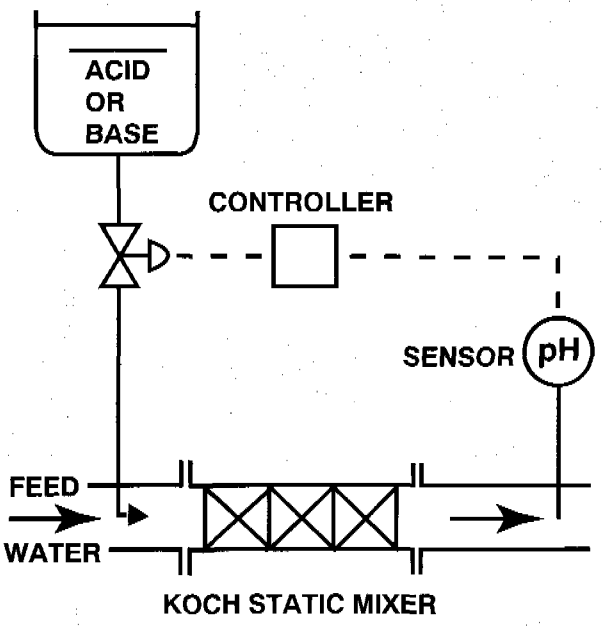

Figure 3. In-line mixer with feedback pH control system.

A successful application of a static mixer in this application will usually include an injection ring or device coupled with a mixer that has an L/D of 6-8. This will be placed directly in front of the belt filter press or centrifuge. Many installations have shown up to 50 per cent reduction in chemical consumption and/or 1 per cent to 3 per cent higher solids readings. This can drastically save on chemical and disposal costs.

Summary

As more and more plants are trying to operate more efficiently, static mixers are continually being advanced over the use of mechanical rotating mixing equipment. This is in large part due to:

- No moving parts to wear or replace;
- Energy requirements 1/10 to 1/100 that of a dynamic agitator system;
- In gravity flow, existing fluid head is adequate to accomplish most mixing tasks;
- Mixing quality is controlled and predictable;
- Low investment costs;
- Retrofit is easy in existing pipes, sumps or channels;
- Small space requirements;
- Process performance and efficiency are maximised; and
- Chemical consumption being minimised

Currently static mixers are successfully operating around the world in a wide variety of applications. The number of installations and applications will only increase as all operations strive for excellence and optimum performance. ■

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Biography

Christopher Isom is Technical Manager of the Mixing and Reaction Technology Group of Koch Engineering Company, Inc., Wichita, Kansas. He holds a Bachelor of Science in Chemical Engineering from University of Missouri - Rolla, and a Masters of Business Administration from the University of Florida. Koch is a licensee of Sulzer Brothers, Winterthur, Switzerland.

Microbiology: a science in transition

Roxanne Hook, Gelman Sciences

A major problem with microbiological testing for water quality has always been the time that standard methods have taken to produce results. Now, new technologies are allowing this process to be speeded up, pointing to an exciting future in this field.

Whether one refers to them as bacteria, microbes, or simply "bugs", microbiologists all seem to have common goals when it comes to culturing and identifying microorganisms — more specific and faster.

It is indeed astounding when you realise the number of industries dependent on accurate and efficient microbial testing. Beverage producers, such as beer, wine, juice, milk and, soon, bottled water companies, all test process water and intermediate fluids to guarantee a fresh end-product.

In the pharmaceutical industry, process water, incoming raw materials, and several intermediates involved in drug production are tested. Microelectronics industries require water free of bacteria to rinse electronic wafers and computer chips. Undetected contamination can adhere to parts and prevent coatings from bonding properly, which is an expensive problem.

Whilst these industries test frequently for various microorganisms, the environmental microbiologists have a greater responsibility for assuring quality. Municipal and regional water supplies are tested systematically to monitor for indicator organisms, commonly the Coliforms. The presence of these organisms signals contamination and the need for subsequent water treatment.

The health of hundreds of millions of people are dependent upon accurate results. Because of this, government regulations that describe how tests are performed are rather stringent and resistant to change. Recent outbreaks of illness have occurred in various world locations, the causes of which have been traced back to a contaminated water source.

One of the problems associated with microbial testing in a public water supply is the treatment delay caused by having to wait for results. For this reason, much research has been conducted to create more rapid procedures and provide real time results. Special interest has been given to Coliforms, and more specifically, *E coli*, because these organisms are accepted worldwide as water quality indicators.

Over the last 100 years, microbiological detection systems have continually evolved into sophisticated systems. In the late 1890s, the US wanted to have a uniform system of measuring bacterial contamination and other characteristics of water quality in public waters. A committee from the American Public Health Association, in cooperation with others, drafted the first edition of *Standard Methods of Water Analysis*, which was published in 1905. Today, in its 19th revision and titled *Standard Methods for Water and Wastewater Analysis*, this 9.5cm-thick book describes tests ranging from turbidity to acidity, as well as microbiological evaluation. The history of *Standard Methods* is a good reflection of the history of commonly accepted and trusted microbiological techniques.

The spirit in which *Standard Methods* was written was not one of forcing microbiologists into using irrevocable techniques. The intent was to provide common, accurate test methods until such time as improved techniques were developed. It is best stated in this quote from the original *Standard Methods for Water Analysis*, 1905:

"It is said by some that standard methods within the field of applied science tend to stifle investigations and that they retard true progress. If such standards are used in the proper spirit, this ought not to be so. The committee strongly desires that every effort shall be continued to improve the techniques of water analysis and especially to compare current methods with those herein recommended, where different, so the results obtained may be still more accurate and reliable than they are at present."

With that statement in mind, let us look at historical techniques and current research. The original recommended method for identifying Coliforms was the multiple tube fermentation technique. This involved inoculation of a lactose-containing

broth to observe for gas production. Multiple tubes were inoculated with varying amounts of the sample and incubated. Based on production/non-production of gas at varying dilutions, a statistical procedure was used to calculate the most probable number (MPN) of Coliforms present. This method was and is still used today with variation on the culture media mixture to use chromogenic indicators in lieu of gas production.

In the early 1950s, a new technique called the Membrane Filter (MF) procedure was developed and put into use. This procedure called for a 100ml sample to be filtered through a membrane to remove the sample matrix and retain the bacteria for culturing and identification. This membrane was then placed on an absorbent pad saturated with growth media and incubated in a petri dish. Though MF techniques did not make obsolete the multiple tube method, it was believed that it offered some advantage over the other procedure.

Matrix problems, which may inhibit bacterial growth or otherwise interfere with the chemical identification mechanisms in multiple tube technique, were largely eliminated because the MF technique removed the matrix from the analysis. It was also more "comforting" to count actual colony forming units on a gridded membrane surface.

Some critics of the MF methodology countered that membranes could vary in consistency, causing growth inhibition or morphological variations. This was the driving force that caused the membrane manufacturing industry to "certify" each lot of membranes to achieve 85 and, in some cases, 90 per cent recovery of challenge organisms. From start to finish, this test took up to 72 hours.

But even with some of the advantages of this test, the question of speed had not been seriously addressed. In the early 1980s, a new technique was developed that started the microbiology detection revolution.

Researchers took some biotechnology concepts and immunoassay labelling techniques and applied them to bacterial detection. Enzyme-linked immunoassays were developed based on the fact that Coliforms produce β-galactosidase.

A β-galactoside was bonded to a colorimetric indicator and incorporated in the growth media. As the Coliform produced the β-galactosidase, the bond between the β-galactoside and the colour indicator was cleaved, causing a colour to appear.

Many variations of this concept have been formulated since that time. Currently, there are presence/absence tests based on the multiple tube technique using this technology as well as MF technique-based methods with specialised media. To reduce the time involved, these methods have growth accelerators in the media as well. With products currently commercially available, it is possible to get presence/absence only or presence and enumeration within 24 hours.

The membrane filter technigue was developed in 1950

However, there are those who are looking beyond this as well. Some of the tags that are placed in these enzyme identification systems use fluorescence as an indicator. Through the use of a fluorimeter, it is suggested that a fluorescence, undetectable to the naked eye, may be visible in just a few hours to an electronic optic in the instrument. Even farther into the future are suggestions that highly sensitive electronic sensors may be able to detect charges or chemistries of bacteria within a flowing water stream and give instant results for bacterial concentrations. This would be infinitely valuable for monitoring municipal water quality.

Though some of the immunoassay techniques have been accepted by regulatory agencies, the agencies are hesitant to approve methods that do not have a long history of accuracy. Enzyme-linked assays are still relatively new in comparison to commonly accepted procedures. And, as with any test with highly increased technology, the possibility for interference increases. For instance, some have expressed concern over autofluorescing Pseudomonads that could potentially give false positive readings.

As with all new technology, there are some things yet to be perfected in the emerging technologies mentioned. However, there is an unimaginable amount of work being done on microbiological detection systems. Some industries may accept new technologies before government does, but because of rigorous regulatory standards for public water supplies, many industries accept the regulatory community's recommendation for acceptable microbiological tests. As these tests are refined and accepted, the ability to get faster results will be revolutionised.

The microbiological community has not easily accepted new technology. But, with the rapid developments that are currently occurring in the field, the future of microbiology is exciting. ■

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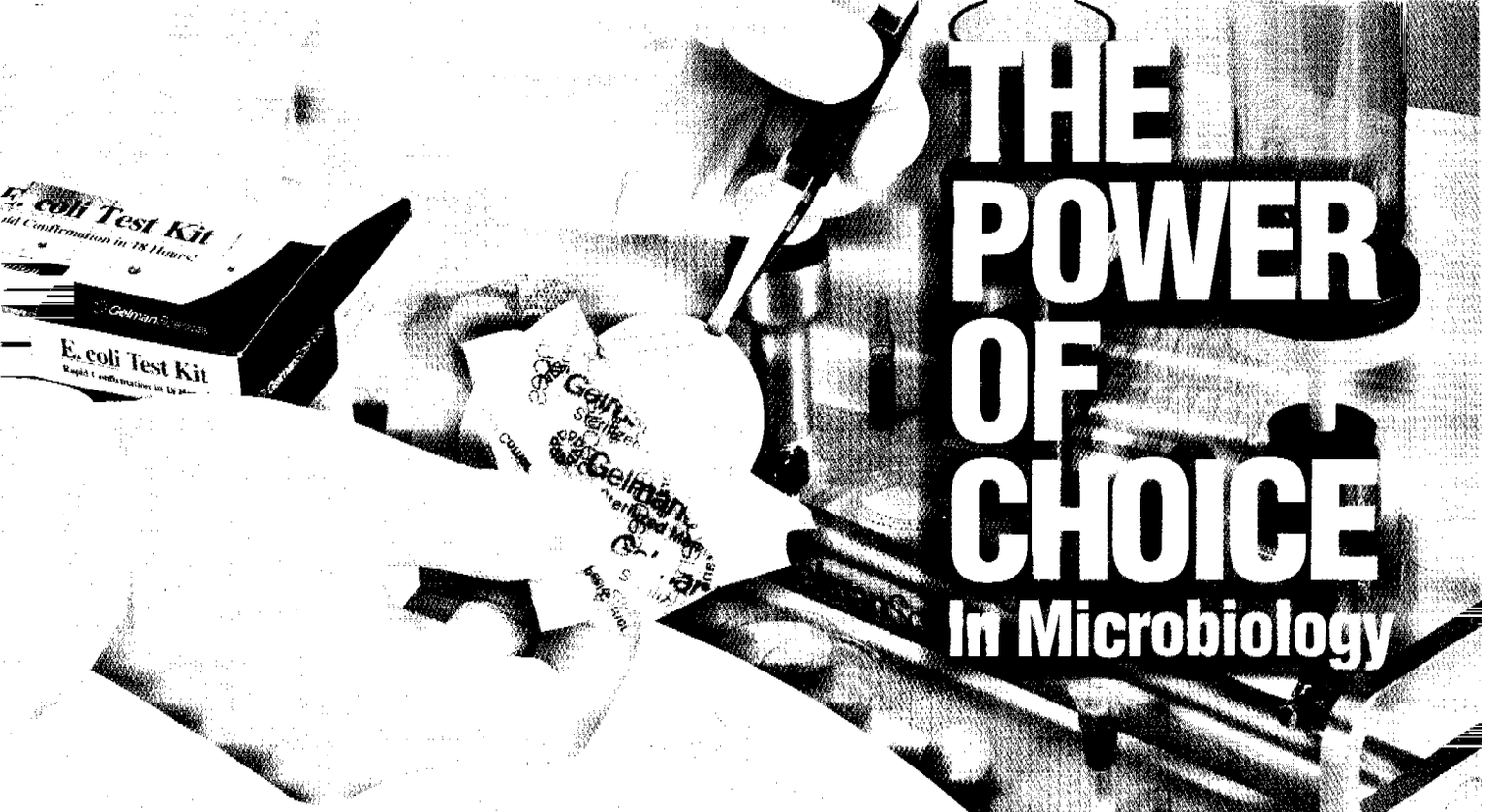
Biography

Roxanne Hook has a BSc in Biology and experience in the environmental testing industry. She is currently Manager of Environmental Marketing at Gelman Sciences in Ann Arbor, Michigan, USA.



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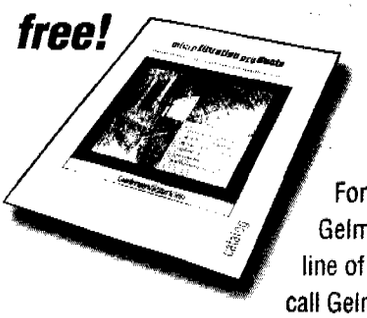

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Sum parameters in operational analysis

Margret Link, Albrecht Mattner and Gerd Probst,
Dr Bruno Lange GmbH

The increasing importance of sum parameters in water analysis is described with reference to the examples COD, TOC, BOD, toxicity, turbidity, SAC254, Total-N and Total-P. Simplified test procedures make these guide parameters directly accessible to the plant control system.

Although there is an analytical trend towards the detailed determination of individual parameters, sum parameters have maintained their position of primary importance in water analysis.

The many faceted tasks facing modern analysis make it virtually impossible to determine single parameters systematically in practice. The guide parameters used to control and monitor water treatment plants must be determined almost in real time in order to facilitate direct intervention in the treatment process.

The cumulative determination of characteristic variables is now therefore the preferred method for control and monitoring processes. Above all, newly developed methods of analysing these parameters open up new options for planning, monitoring, regulating and operationally optimizing water treatment and purification plants, as well as new applications in water pollution control.

Figure 1 shows an overview of the main sum parameters used today.

Chemical parameters for rapid determination of total loads

Scarcely any other environmental analysis parameter has acquired such a high degree of importance and simultaneously experienced such a major change of function in recent years as chemical oxygen demand (COD).

Its inclusion in EC Council Directive 91/271/EEC as a limiting value for municipal waste water treatment plants was shaped by environmental policy aims.

A meaningful and quickly determinable measured variable for the organic load of waste water was required. This variable would also have to stand up in law. The measured variables which had been traditionally used in waste water technology, such as permanganate consumption or BOD5, were not suitable: the determination took too long, or the degree of scatter associated with the measured value was too large, or the parameter was not meaningful enough. The routine determination of sum parameters such as COD (as a cumulative variable for the total waste water load) in operations laboratories made it necessary to establish alternatives to the time-consuming reference procedures.

Figure 1. Environmentally relevant parameter groups

	Biological parameters	Ghemical parameters	Physical parameters
Sum parameters	BOD Toxicity	COD TOC Total N Total P	Conductivity Turbidity SAC254
Information about	Impact	load	load
Examples	Toxicty: Ecological impact on organisms	Total load of degradable/non-degradable substances	Turbidity/SAD254: load of solid/liquid organic matter

Photometric tests

There are now a large number of alternatives available, most of which are photometric test procedures. A modern, complete measuring station includes a heating block to enable the sample to be digested, and a powerful spectrophotometer or sensor array photometer, in which all necessary preliminary settings such as wavelength, calibration curves, zero values and control values are permanently stored by the manufacturer in order to minimize errors.

In many cases the instrument

manufacturer also supplies all the chemicals needed for the analysis.

The cuvette test in particular is used in this context. This alternative analysis system is supplied by the manufacturer complete with ready-to-use reagents in individual glass cuvettes, which are directly evaluated photometrically after the sample has been added. The cuvette test system and the dispensing cap system increase user safety, because working with these closed systems ensures that there is no direct contact with chemicals. The manufacturer also accepts responsibility for disposing of the reagents, usually free of charge, so that users need not plan and implement their own disposal concepts.

The quality of these operational analysis procedures and their comparability with the reference procedures are now generally recognized.

EU directive

EU Council Directive 91/271/EEC also requires emissions of total nitrogen and total phosphorus to be restricted. These groups of substances must be largely eliminated in sewage treatment plants in order to avoid eutrophication of surface waters. These parameters are also determined with cuvette tests in present-day operational analysis.

COD, as the sum of all chemically oxidizable substances, is a measure of the maximum amount of oxygen needed to oxidize carbon compounds. TOC is a direct measure of the mass of the total organic carbon.

TOC methods costly

TOC has not yet been widely used for control purposes in the water treatment sector. This is because the currently used methods of determining TOC are very costly and labour-intensive, and moreover there is considerable controversy concerning TOC as a substitute parameter for COD.

The innovative development of a TOC cuvette test (October 1995) will inject new life into this debate, because the new test solves the problems of using TOC in operational analysis.

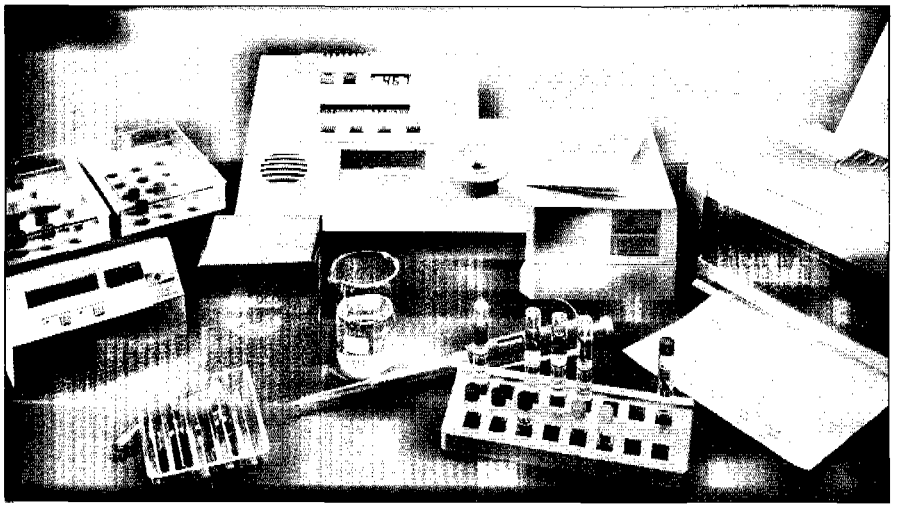


Figure 2. Universal photometric workplace for water analysis.

Figure 2 shows a universal photometric workplace for determining COD, TOC, Total-N, Total-P and all other key individual parameters for water analysis.

Biological sum parameters as ecological variables

In contrast to chemical sum parameters such as COD, TOC, etc., biological sum parameters reflect the action of waste water on living organisms.

The determination of toxicity is an example of a new biological sum parameter, which was only recently incorporated in international legislation.

The familiar BOD (biochemical oxygen demand) is also such a parameter, because it is an indicator of the effect of waste water on the oxygen consumption of organisms.

An established method for determining toxicity involves measuring the effect of samples on the bioluminescence of Vibrio fischeri NRRL-B-11177. This luminescent bacteria test is based on the fact that toxic samples impair the metabolic processes of luminescent bacteria, causing a reduction in the amount of light they emit. The harmful effect of the sample is therefore measurable.

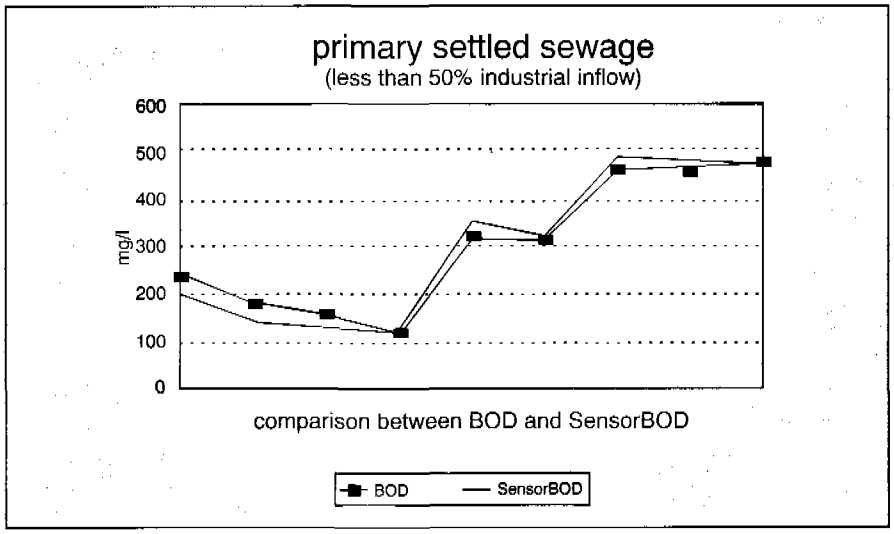
No biological know-how is needed to carry out the luminescent bacteria test because, in contrast to all other biotests, the test organisms can be preserved ready for use. The luminescent bacteria are simply thawed as needed and then used for the test. The duration of the test is 15-30 minutes and the result is available in 30-45 minutes.

Since it was introduced by the English "Royal Commission on Sewage Disposal" in the late 19th century, the parameter "biochemical oxygen demand" (BOD) has become internationally established in waste water analysis. It is a measure of the biodegradable components in waste water and is therefore a key indicator of the condition of a sewage treatment plant's biology.

Although the significance of BOD is undisputed, the parameter, in the form of BOD5 or BOD7, cannot be exploited in water purification practice. The results are irrelevant by the time they become available after an incubation period of 5 or 7 days.

New BOD method

A new method of determining BOD exploits the opportunities offered by biosensorics. This technology realizes the BOD ultimately as a miniaturisation of classical respirometric BOD_5. The "heart" of this method is a biosensor with immobilized microorganisms ('active sludge'), which is brought into contact with the sample in a thermostated measuring cell ('oxygen bottle in thermostatically controlled cabinet'). If the sample is polluted with degradable substances, the oxygen requirement of the microorganisms increases. This effect is measured



Firure 3. Comparison between SensorBOD and BOD_5 for sewage plant inflows.

with the oxygen electrode in the biosensor and is evaluated as a measure of the pollution.

The measurement is carried out in a matter of minutes. A quantity of the sample is automatically drawn into the instrument and brought to the correct temperature, then an exact amount is automatically analysed. The result is immediately available. Figure 3 shows the correlation between SensorBOD and BOD5 for a sewage treatment plant inflow.

The SensorBOD provides a new method for the rapid determination of the key parameter BOD in real time. As a consequence, this parameter is now of practical use in waste water purification applications.

Determining sum parameters for continuous mapping of purification processes

The continuous determination of guide parameters is of special importance in waste water technology when it is coupled with automatic electrical control systems. Turbidity is already measured continuously and routinely in municipal waste water treatment plants as a measure of the undissolved organic load. In future the measurement of spectral absorption coefficients at 254 nm - SAC (254) will also be of special importance. This method has long been used in the drinking water and surface water sectors to determine the organic load.

In this context the work of EDZWALD et al. on the correlation between SAC (254) and TOC deserves special mention. They demonstrated, for example, that the annual fluctuations in the UV values at 254 nm and the TOC values of the Grasse River in New York State (USA) and the Glennmore water reservoir exhibited almost identical curves. The correlation between the UV and TOC values of the raw water extracted from these waters is excellent.

Matsche and Ruider (Technical University of Vienna) were the first to go one step further. They applied the results obtained from rivers (Grasse, Elbe) to sewage treatment plants, for example the main sewage treatment plant in Vienna, the plants at Oberpullendorf and Neusiedl, and others.

Our own research confirms the conclusions of the above authors. As the graph in Figure 4 shows, there is a good correlation between the curve of the UV SAC (254) measurements and the COD curve.

In summary it can be said that UV extinction can be assumed, with certain reservations, to be proportional to concentration. The reservations relate to the fact that some organic residues do not absorb light at 254 nm. They cannot therefore be determined. This group makes up about 20 percent of total organic carbon. About 80 percent of the compounds which are present in sewage treatment plants, e.g. humic matter, tannins, lignins and proteins, can be determined.

If it is assumed that COD is a measure of all substances that can be oxidized by chromosulphuric acid, and that some of these substances are inorganic, the correlations must increase in the sequence

UV absorbance 254nm - COD
UV absorbance 254nm - TOC
UV absorbance 254nm - DOC

because DOC is a measure of the dissolved organic carbon. In this context the hydrophilic groups are often identical with the chromophoric groups.

Finally it should be pointed out that the UV method as applied in practice makes use of a sensing probe, and no chemicals or sample preparation system are needed. A simple method of continuous mapping of organic loads is therefore available for sewage treatment plant control. ■

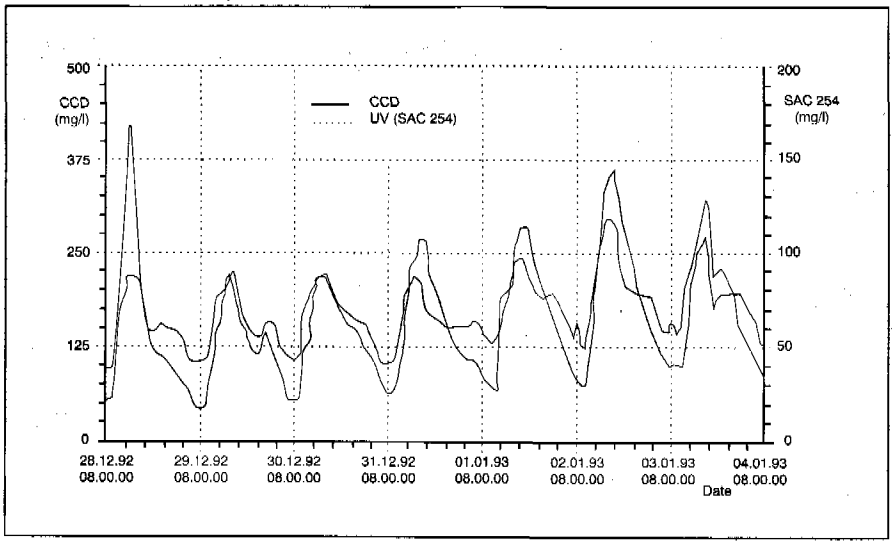


Figure 4. Correlation diagram SAC 254 /COD, effluent presettling sewage works.

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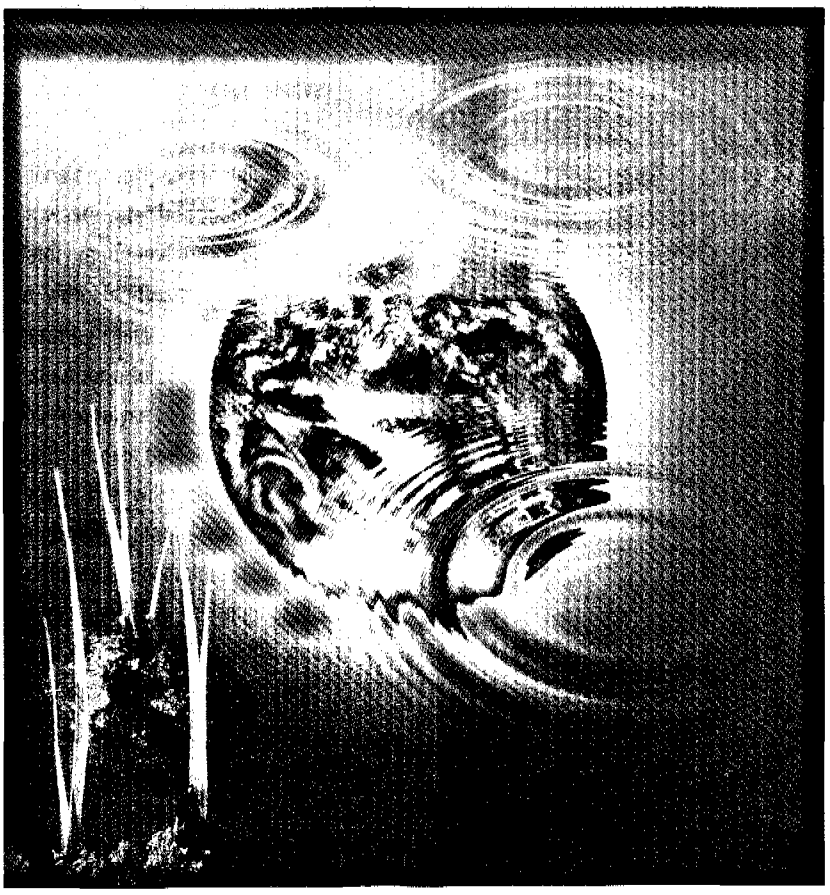

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WATER

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Oxygen treatment—three case studies

Paul Williams, BOC Gases

Use of pure oxygen in wastewater treatment plants based on the activated sludge system can bring large improvements in biomass levels, sludge age and food/microorganism ratio. Three case studies illustrate the use of this technology.

Legislative demands and the ever-spiralling costs associated with trade effluent disposal have led many industrialists to turn to on-site biological treatment of their wastewater. The activated sludge process, given the correct operating conditions, can be the most versatile and robust process for treating water and wastewater.

The success of an activated sludge plant depends on cultivating a biological community that will remove and assimilate waste material, floc together and then settle well to produce a concentrated sludge for recycling. The maximum rate at which organic material is oxidised is directly related to the rate at which dissolved oxygen is used by the micro-organisms within the reactor. This may be limited by the rate at which oxygen can be dissolved into the wastewater.

The BOC Gases Vitox system

The main requirements of an aeration system are to perform the following:

- Dissolve oxygen in wastewater;
- Rapidly mix influent flow with bacteria (sludge); and
- Maintain solid matter in suspension.

BOC's Vitox system is a high rate oxygen dissolving process. It works by injecting gaseous oxygen into the throat of a venturi dissolver on a pressurised sidestream of the process liquor (see Figure 1). Millions of fine bubbles are formed and, under pressure, they dissolve immediately. The highly oxygenated liquor is returned to the process tank through a multi-nozzle sparge system. The high-velocity jetting action of the nozzles shatters any undissolved gas into micro-bubbles and entrains the surrounding process liquor. In this way, intimate mixing of the tank contents and oxygenated liquor occurs.

On conventionally aerated plants oxygen transfer, which determines the amount of bacteria that can be supported, is limited. Oxygen transfer fixes the amount of 'work' that can be done. However, once this constraint has been lifted, considerable uprating and operational stability can be achieved, with no additional penalties for using pure oxygen. Biomass levels can be increased substantially and will rapidly adjust to extreme variations in load pattern.

Where unlimited oxygen is available, irrespective of loading, the biomass will rise to its peak operational point. At this level, sludge age will be at its longest, the Food to Micro-organism ratio (F/M) at its lowest and sludge yield very low, tending to zero. (Limited sludge yield is necessary on occasions where biologically inert toxins are present.)

The Vitox low-level jetting action rapidly mixes reactor contents, inducing a gentle roll-over action on the surface, reducing volatile emissions, aerosols, foam and noise. Heat is retained in the body of the liquid aiding the biological process, particularly in winter, by reducing the seasonal temperature gradient and improving the temperature of the chemical waste.

Control is vital to any process and

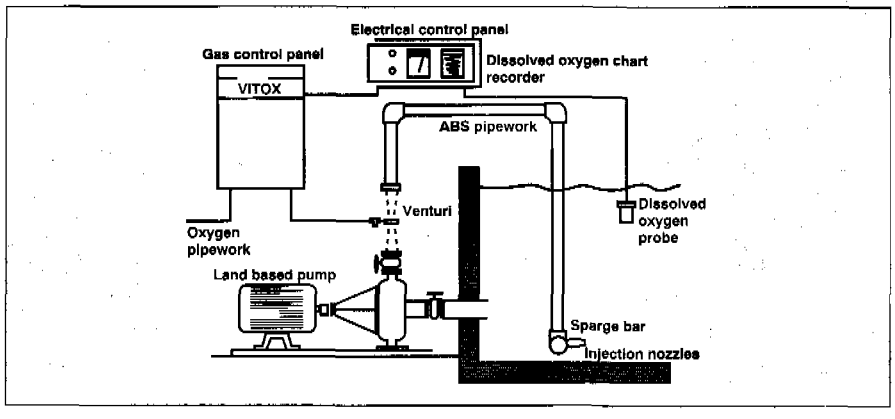

Figure 1. The VITOX Sidestream system.

with BOC's sidestream system, oxygen injection and pump operation are controlled by a probe, which continuously measures the dissolved oxygen (DO) levels in the tank. The Vitox system can, therefore, cope with varying demand occasioned by varying loads. It reacts immediately to prevailing load conditions and injects exactly the right amount of oxygen.

Coke waste

Coalite's production system at Bolsover, UK, consisted of two 2600m³ air-based biological reactors constructed of concrete, each fitted with a centrally mounted 90kW surface aerator. One of the reactors was dedicated to refinery waste and the other to treating wastewater, which was derived from the carbonising operation. Each had its own dedicated radial flow clarifier.

On occasions, the plant suffered from oxygen starvation due to high organic loads and this led to difficulty in balancing the load applied. Severe foaming was also a major problem, due to the nature of the waste. The use of anti-foam reduced oxygen transfer efficiency and added significantly to plant running costs. A BOC survey revealed that limited oxygen transfer capacity and a low threshold concentration gave the potential for poor plant performance.

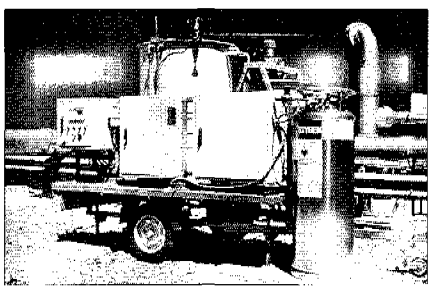

Figure 2. The VITOX system at Coalite.

In 1985, Coalite retrofitted a 4 t/day Vitox sidestream system to mix and oxygenate one of the reactors, since this would provide sufficient capacity to treat both waste streams in one reactor (see figure 2). This was extremely successful, giving a more sustained standard of treatment operating with a sludge inventory of three times that which was possible with air and using effectively half the available plant. The other half then became available for further treatment and load balancing. It was also found that by isolating the aerator and using the Vitox system alone to mix and oxygenate, the use of anti-foam was eliminated and flocculating agents could be used effectively to improve clarification.

The Vitox Bio-alarm system has provided a continuous indication of respiration rate, giving a good measure of plant performance and providing an early warning of plant stress. Sludge disposal has been reduced to a minimum with the plant running for periods of up to six months without wastage.

In 1992, Coalite decided to install a second Vitox unit into the biological reactor being used for tertiary treatment and add activated carbon. This provided an excellent nitrifying reactor, achieving 95 per cent ammonia removal.

On site pilot trials

When planning a turnkey project to design and build a new effluent treatment plant, BOC involves its customers in a three to six month pilot plant trial. This establishes the operating parameters necessary for a guaranteed full-scale plant design.

Potential industrial customers are not necessarily well versed in the operation of an activated sludge plant. By running a Vitox pilot plant trial on site, the customer understands the process and works in partnership with BOC to achieve results which are representative of full-scale and do not suffer adversely from the effects of scaling-up. Real time events are experienced by the pilot plant and biological system robustness is demonstrated by withstanding both overload and famine conditions.

Treatment plant for chemical and dye waste

The municipal plant at Pinxton, Derbyshire, UK, received a flow of mixed trade effluent comprising 100m³/d chemical waste and 1600m³/d dye waste. The problems associated with the receipt of these trade effluents were:

- Overloading of the percolator filters;
- Biological treatment inhibited by elements in the chemical waste stream;
- Trade effluent odour (one village is adjacent to the treatment plant); and
- Colour.

To relieve the organic overloading, Severn Trent Water decided to examine methods of biological pre-treatment of the trade waste. A BOC Vitox pilot plant was operated on the raw effluent for a period of 73 days. Composite samples of feed and effluent were taken daily, as well as spot samples of mixed liquor and returned sludge. Daily measurements were taken of the stirred and unstirred mixed liquor settlement, flow rates of feed and returned activated sludge (RAS), settlement tank temperature and pH and sludge depth in the final settlement tank. The reactor was maintained throughout at a dissolved oxygen level of 2 to 4mg/l.

The conclusions from the pilot study were:

- The plant performed well at a mixed liquor suspended solids (MLSS) level of 3840mg/l;
- No sludge surplussing was required;
- Nutrients were only required immediately after the commissioning period;
- Mean biological oxygen demand (BOD) removal was 86 per cent, giving an effluent BOD of 48mg/l;
- Sludge settleability was good, with stirred sludge volume index (SSVI) of 38ml/g; and
- There was no detectable odour from either the reactor or the undisturbed final settlement tank

It was therefore recommended that a BOC Vitox plant should be used for the pretreatment of the mixed trade effluent. BOC was awarded the contract in September 1992 to build the plant as a turnkey project and in December 1992 work commenced on the site with construction of the pre-treatment plant, which was to operate in parallel with the existing primary settlement tanks taking the full daily flow of 2200m³.

The plant consists of two reactors

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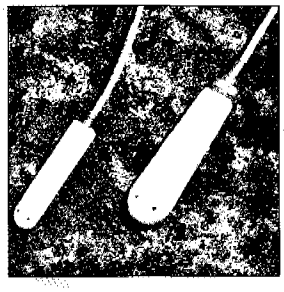

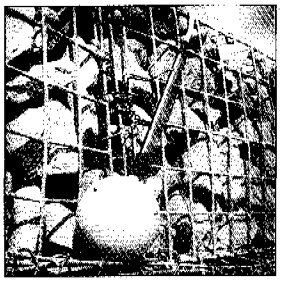

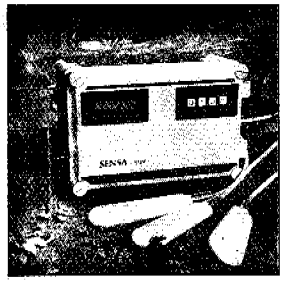

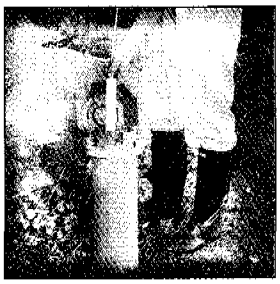

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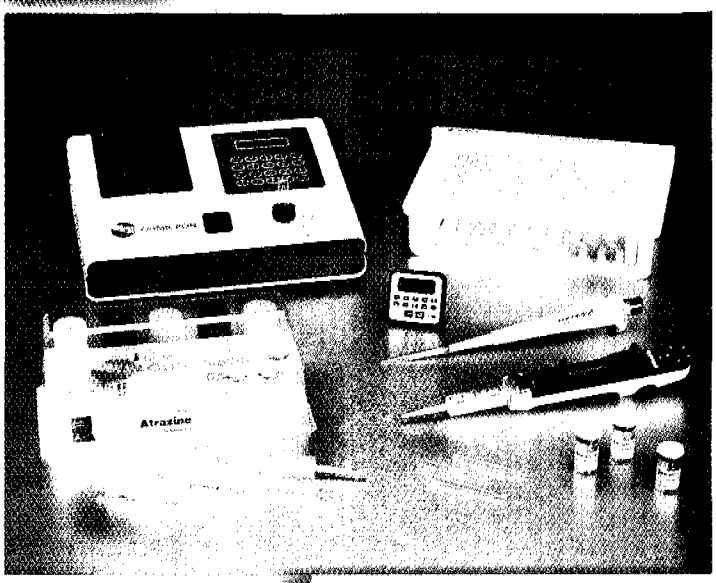

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operating in parallel, having a combined volume of 1540m³. Each reactor incorporates a sidestream system with a nominal oxygen transfer capacity of 2.0t/d. The activated sludge then flows to two secondary settlement tanks, having a total surface area of 162m², prior to discharge to the existing biological filter secondary treatment plant for nitrification. Both the reactors and the final settlement tanks were constructed of glass-coated steel panels on reinforced concrete bases. This facilitated rapid construction and commissioning commenced within 38 weeks of award of contract. Great care had to be taken during start-up of the commissioning of the plant to ensure that the performance of the existing main works was not impaired.

Start-up, therefore, was a slow process enabling the filters to be weaned off their existing food expectancy, avoiding filter sloughing and achieving a gentle conversion from a carbonaceous to a nitrifying mode of operation. So that this was achieved to the mutual satisfaction of both BOC and Severn Trent Water, it was proposed that commissioning would take one month, but full flow trade effluent was, in fact, being treated by the plant within two weeks of the initial seeding.

The BOC pretreatment plant operates automatically, the site being unmanned. A telemetry system has been installed to enable remote monitoring. To date, the plant has performed well, achieving better than required BOD removal (typical value at present is 86 per cent BOD removal).

Tanker cleaning wastewater

VVM, based in Terneuzen, Netherlands, has been operating a wastewater treatment facility treating chemical waste streams from washing chemical road tankers, containers and barrels, since February 1992.

The washings are first pre-treated with physical and chemical processes such as metal precipitation, flocculation and clarification with the pre-treated effluent being stored in a 600m³ tank before being pumped to a sequencing batch reactor (SBR) for biological treatment. SBRs are used increasingly in treating both municipal and industrial waste streams since they were first developed as a novel alternative to the conventional activated sludge system in the 1970s. Most SBR systems are oxygenated using either diffuser system surface

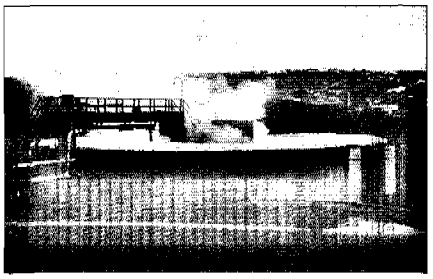

Figure 3. A VITOX pilot plant

aerators or jet mixers. The use of jet mixers has an additional advantage over the other two dissolution devices as they are able to mix the biomass in the reactor adequately without injecting oxygen during anoxic periods.

VVM installed the Vitox pure oxygen jet injection system with a capacity to deliver 3.0t/day of oxygen when needed. Control of oxygen input into the reactor is provided with the dissolved oxygen analyser system. pH is maintained at around pH7 by the stripping of carbon dioxide generated by the biomass with a 30kW air blower and diffuser system.

The VVM SBR has a diameter of 14.5m, volume of 1600m³ and a design capacity to receive 360m³/d.

Feed is pumped into the reactor containing settled biomass (mixed liquor) from the previous cycle during the feed stage. This is followed by the react stage where oxygen is fed to the biomass to enable it to utilise substrates in the feed aerobically. A quiescent condition is produced during the settle stage when all oxygenation and mixing devices are turned off and the biomass is allowed to settle for a suitable period of time. A clarified supernatant is then decanted from the top of the reactor during the decant stage at a rate which does not disturb the settled biomass. This is usually achieved by gravity using either a floating arm or discharge pipes at fixed depths. Variations to these four basic stages include oxygenation of the reactor during the feed stage and the introduction of anoxic periods during the react phase as was the case for the VVM reactor.

There are in fact two anoxic periods interspersed with the react period. Before commencement of feed to the SBR, a volume of biologically treated effluent is discharged equal to the expected volume of feed for that day. This operating procedure kept the total volume of the reactor constant at 1600m³. Measurements of the sludge blanket level during the anoxic period showed that mixing was adequate to keep the biomass in suspension throughout the reactor. The settle phase, which lasted for 3 hours, was followed by gravity discharge of the clarified supernatant through fixed outlets for a period of one hour, to a holding tank. The biologically treated effluent would be passed through activated carbon filters (when necessary) before being pumped to the river. In addition to the chemical feed from the pre-treatment phase, all discharges from the toilets and sinks on site were pumped to the SBR.

Influent parameters	
Daily flow	200 - 400m³/day
COD	3000 - 10 000 mg/l
COD to BOD ratio	4 :1
Average MLSS	7000 mg/l

Plant performance	
Average COD removal	> 90 per cent
Average BOD removal	> 98 per cent

VVM has a 2000kg/year limit on volatile organic compound (VOC) emissions from the SBR process and measurements in 1993 showed that less than 250kg/year of VOC was being emitted. It was estimated that an equivalent air fed system would deliver 19 times the gas volume of the installed Vitoxair stripper system and would cause the VOC limit to be exceeded.

Through its dedicated Water Processes Group, BOC Gases technology now supports over 350 installations worldwide, in both the industrial and municipal sectors. ■

BOD analysers for on-line control of wastewater

Michael Teutscher,
STIP Siepmann & Teutscher

On-line BOD-M3 measuring instruments operate with micro-organisms which are especially adapted to the waste water such as the BODS laboratory tests do. These micro-organisms are exhausting oxygen while consuming the pollution in the water. The laboratory test makes the information about water pollution available after 5 days, where as the continuously measuring instruments show the actual waste water load only within 3 minutes.

A special dilution system ensures that the micro-organisms respond highly sensitively and very fast to BOD deviations. Even hard industrial conditions do not interfere with thefunction of the micro-organisms.

Present types of BOD analysers operate fully reliably because of the automatic flushing and calibration programmes. Not more than 30 minutes are required for maintenance per week. The measured values can directly be taken over by automatic control and monitoring systems.

The on-line BOD measuring technique has been proven in a large variety of applications. It is used in untreated municipal waste water as well as in the discharge of sewage plants, in highly polluted effluents of chemical production or food industry, up to river monitoring stations.

Because of strict limits for nitrogen and phosphor concentrations in rivers and lakes today, many sewage plants are equipped with purification stages for nitrification, denitrification and phosphate removal. As nitrification only can take place after an extensive degredation of BOD, and as on the other side the succeeding denitrification requires a certain BOD load for total degredation of nitrate to nitrogen gas, the BOD load is an extremely important parameter for the process. On-line BOD analysers are more and more applied for reliable control and optimization of these purification stages. Therefore, the importance of BOD measurement being the sole biological parameter in the waste water treatment process will increase in the future. □

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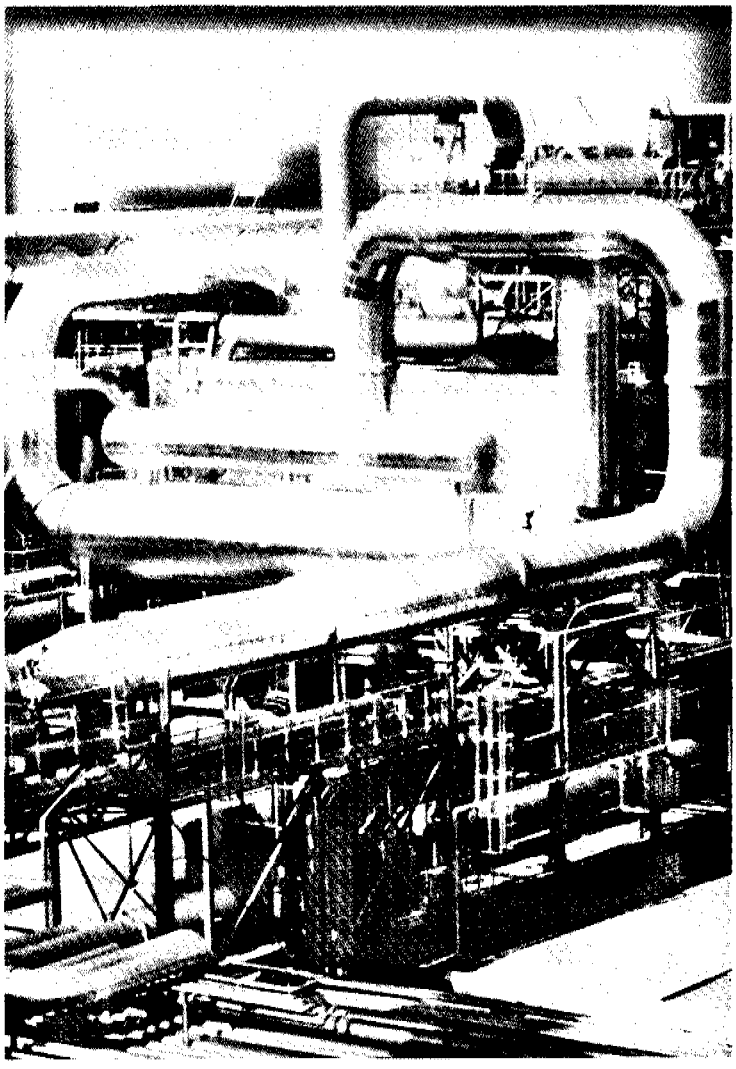

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On-line analysis of total mercury levels

● PB Stockwell and WT Corns, PS Analytical

Current legislation sets out the limits for mercury as the total mercury content, whatever the form in which the mercury may be present. A more pressing requirement may be to analyse the various species of mercury present.

Over the past decade there has been considerable concern about the levels of the so-called heavy metals in the environment, especially mercury, arsenic, selenium and antimony.

Since the authors became interested in this field levels of mercury have received by far the most attention. It is a well known fact that methylmercury is more than 1000 times more toxic than mercury in its inorganic forms. Recently Jones et al[1] have suggested a simple gas chromatographic separation system linked to a specific atomic fluorescence detector to determine such species in a range of materials including soils, sludges and effluent.

In 1988 the reorganisation of the UK water industry into privatised industrial companies and a policing facility provided by the National Rivers Authority laboratories created attention to the monitoring of mercury in drinking water particularly. The levels required and the sampling frequency dictated by the legislation required a radically new direction for instrumentation. The batch methods using atomic absorption detection available at this time provided neither the detection limits nor the throughput.

Thompson[2] had described an atomic fluorescence method for the measurement of mercury. Godden and Stockwell,[3] using an available molecular fluorescence detector with subtle modifications, designed a simple but effective commercial variation on the former with the additional potential for complete automation.

In 1989, PS Analytical introduced the world's first fully automated mercury analysis based on these developments. Since this date more than 20 commercial competitors have been introduced around the world. With each of these making various claims as to detection capabilities, it would seem to the analytical community that the determination of mercury at low levels is just a trivial matter.

Mercury analysis problems

This is very far from the truth because at the levels required, often between 10^{-10} and 10^{-12} g/l, it is very difficult to get (a) representative samples, and (b) reproducible results. With care to the sampling and methodology, levels below 1 ppt can be measured, but avoiding the problems relating to sampling, namely by taking measurements directly on-line, can provide several benefits for the agency requiring the data.

In the UK water industry particularly the atomic fluorescence measurement coupled to vapour generation techniques has become well established. The use of a hygroscopic membrane dryer tube to continuously remove moisture developed by the vapour generator has been particularly useful inlaboratory applications.[4] In addition the range of analytes and concentration levels analysed has been increased using discrete sample injection techniques.[5]

Further reduction of the detection levels has recently been repeated by Cossa et al[6] using an additional concentration step onto a gold/platinum trap. The technique, and particularly the detector configuration, is ideally suited to process application being of a simple design and rugged in construction. In particular the laboratory system described by Stockwell and Corns uses continuous flow technology which can also be translated to on-line analytical situations. Translating a laboratory instrument to a process line application with 24 hour/day operation every day does place many design constraints not visualised in normal laboratory use.

Table 1 sets out some of the most demanding of these constraints. All of these, however, require in the very first instance that a truly representative sample is presented to the sequencing system prior to any pre-treatment and analysis. This facility is not a trivial one and needs a lot of information normally from the plant operators before this will operate reliably over long periods. Extremes

Table 1. Specific considerations required to translate laboratory information to process applications

- Conversion of all mercury species to divalent mercury
- Low reagents consumption and reagent stability
- Stable and rugged detection system
- Reliable interface between sample stream and online system
- Fault diagnostics with feedback system
- Data processing via CpU's

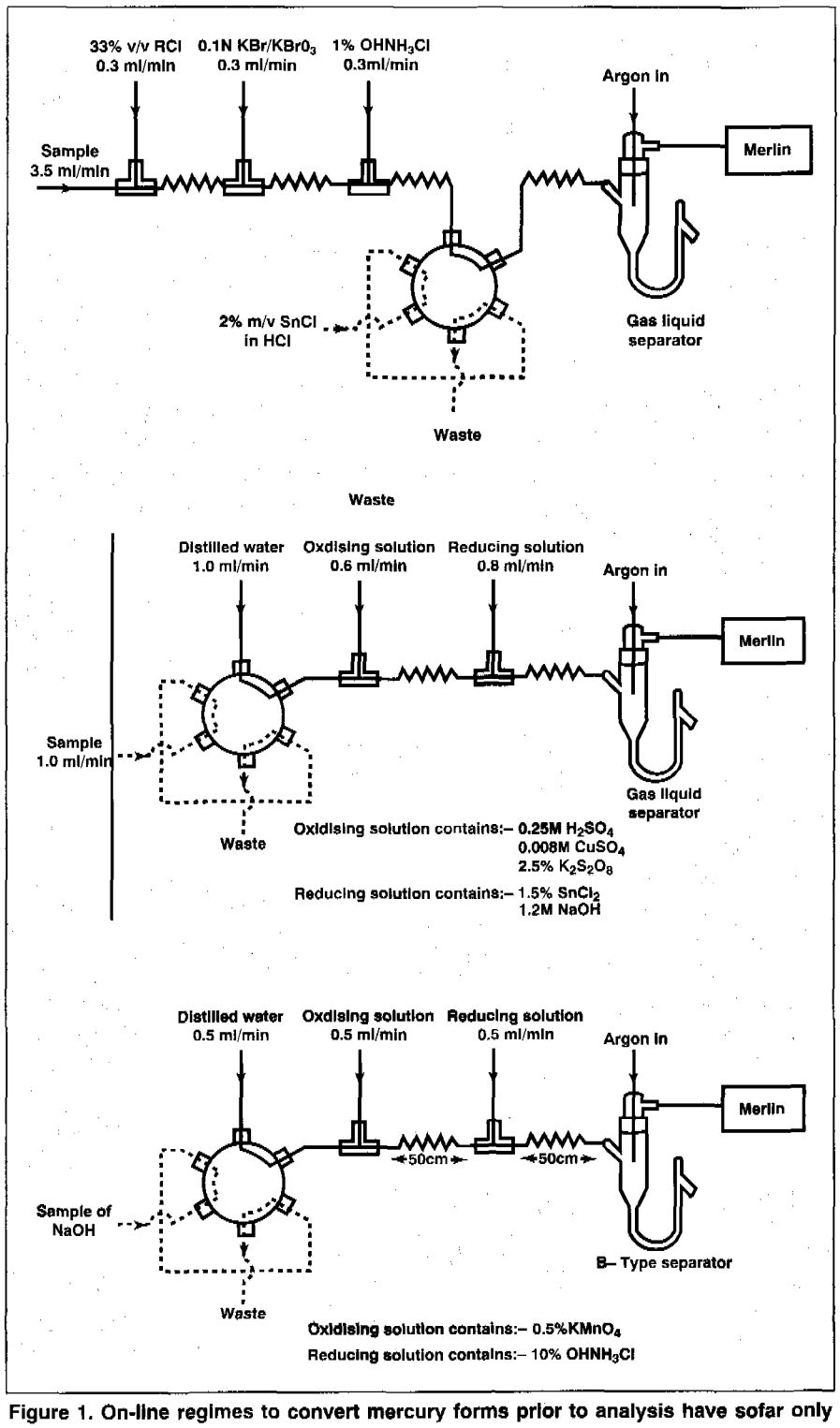


Figure 1. On-line regimes to convert mercury forms prior to analysis have sofar only been automated by matching these chemical regimes to the expedted sample type.

of climatic conditions may change the state and form of the sample, especially the mercury content, quite widely.

Several chemical regimes have been developed that convert mercury forms into the +2 valency state prior to analysis by vapour generation and AFS measurement. Successful automation has at present only resulted by matching these chemical regimes to the expected sample type.

These procedures have been tested in some detail and schematic arrangements for these are shown in Figure 1.

Reagent consumptions are minimised by using a slow-flow peristaltic pump and a discrete sample injection technique. The sample stream itself is sub-sampled by the analyser pump so that it directly represents the sample as closely as possible. Sample and reagent line sensors are incorporated into the instrument control features so that the validity of all measurements can be checked continuously.

Figure 2 shows the orientation and configuration of an on-line instrument developed in association with a wide range of customers. The chemical reagent section electronic compartment and the computer control facilities are all separate and isolated from each other to minimise cross-contamination and for ease of service and use. The system, which uses argon or nitrogen as the transfer and spurge gas prior to atomic fluorescence, uses the inherent sensitivity advantage of the Merlin detector to cope with abroad range of sample types and a wide dynamic range of mercury levels.

Unlike other process control instrumentation the PSA 10.223 on-line analyser operates using repeat analysis cycles rather than continuous set measurements. Discrete measurements are made for calibrated samples and check standards. With these approaches, many of the analytical control features developed over the last six years can be used to extend the scope of on-line applications.

A valve selection feature, in many respects similar to an autosampler

Analysing Hg, As, Se, Sb or Te?

Since 1983 PS Analytical have been working closely with experts in both academia and industry to develop new methods and instrumentation to meet the ever changing needs and legislation in the environmental market place.

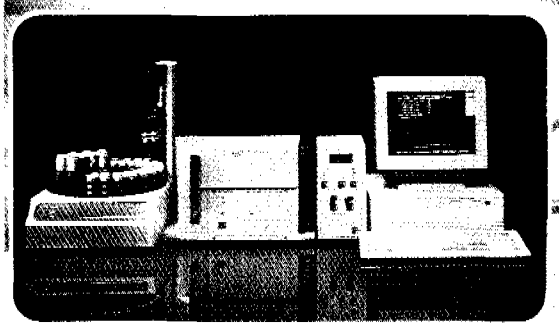
In 1989 PS Analytical introduced the first fully automated mercury detection system, The Merlin Plus, based on the principles of atomic fluorescence. This bold innovative solution to mercury detection was just one example of the benefits derived from a continued programme of research, development and customer collaboration.

Co-operation with a number of institutes world wide has since led to the introduction of an additional range of applications including solid, aqueous and gaseous samples. Further developments followed with the introduction of the Excalibur detector for arsenic, selenium, antimony and tellurium determinations.

PS Analytical is a family business that takes pride in its commitment to long term research. An ability to work closely with a wide variety of clients has ensured tailor made innovative solutions that apply the power of atomic fluorescence reliably and economically.

Merlin Detecto

The Merlin atomic fluorescence spectrometer has been specifically designed for the determination of mercury in a wide range of samples. The Merlin detector provides a wide linear dynamic range from below 1ppt to 10ppm not available from other detectors. The instrumentation is widely accepted especially by the UK water companies. Its inherent sensitivity enables the Merlin Plus system to offer simple solutions even in very difficult sample matrices.



- Routine monitoring of Hg, As, Se, Sb and Te
- Wide linear dynamic range over 7 orders of magnitude
- Analytical rates in excess of 80 samples per hour
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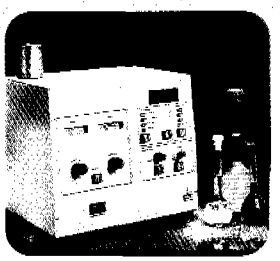
- Systems configured to precise user needs



Excalibur Detector

The Excalibur detector allows the determination of the various hydride forming elements. Using specific chemistries based on sodium tetraborohydride reactions extremely low levels of detection can be provided. The increased sensitivity enables the analysis of complex environmental samples. The Excalibur and Merlin detectors can easily be exchanged or integrated into systems.

Systems

The Merlin Plus and Excalibur systems provide complete automation and are presently installed in environmental laboratories, analytical consultancies, water laboratories, river and marine centres, medical facilities and many industrial companies.

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programming facility, allows up to 16 streams (either sample or standards) to be selected. The software allows the user to set up sampling protocols ideally suited to their needs and also to be able to change these at will to meet changing needs.

Of the several unique facilities, the time-loop feature allows a set sequence to be repeated continuously or a set time-cycle pattern. Table 2 sets out two simple programme examples.

The feature set out in Table 2.1 describes the more common sequence of operation in a conventional process control system. The sequence calibrates the analyser and then measures each of the streams in a set pattern. The sequence is then repeated after a time delay. Results can also be transmitted to an external source using the in-built D/A via a 4-20mA output.

The feature shown in Table 2.2 illustrates the flexibility of the software feature. The introduction of the check standard and the individual acceptance of this value allows the recalibration step to be avoided in all situations where the check standard remains in specification. Such a procedure allows more data relevant to the sample streams to be provided.

There are many other specific features in the software control and calculation facilities that provide advantages to the user. Weight dilution calculations can be automatically carried out so that the results passed to the central computer site exactly mirror the levels of mercury present.

Methods and programmes associated with varying sample types can be stored as library files and called down for use when circumstances change on the industrial site. This is of particular importance where one or more industries are discharging into the sample reservoirs prior to discharge from site.

Conclusion

The coupling of atomic fluorescence and vapour generation technology has enabled a simple but extremely flexible on-line instrument to be developed. By modification of the chemical regimes to suit the individual client sample profile, several on-line systems have been successfully installed and are in operation, for example in the chlor-alkali industry, for effluent analysis and the petroleum industry.

Further developments have also been made to analyse concentrated sulphuric acid for low Hg levels. Research work is being extended in a programme in association with Plymouth University to design and develop more robust chemical regimes which have a much broader range of application.

The inherent advantages of the sensitivity and range of atomic fluorescence are fully realised in this application.

The authors would like to thank the industrial clients for whom they have worked, their colleagues at PS Analytical, whose enthusiasm helped develop the instrumentation suitable for these needs and also Spinoff Technical Systems for the software capabilities that add the icing on the cake, namely the flexibility of operation and use. The speed of analysis and the quality of the data provided will allow the client industries to make quicker and better informed decisions on their effluent and mercury removal needs. ■

Table 2. Two simple programme examples.

Line	Pos	Tag	Ref	Weight	Dil
1	B	NewCal1	0.000		
2	C	NewCal2	50.00		
3	D	NewCal3	100.0		
4	E	SAMPLE	00001	1.000	1.000
5	A	Timeloop	1		

Table 2.1. Programme with repeat calibration and time loop.

Line	Pos	Tag	Ref	Weight	Dil
1	B	NewCal1	0.000		
2	C	NewCal2	50.00		
3	D	NewCal3	100.0		
4	E	SAMPLE	00001	1.000	1.000
5	C	Check2	10R1	1.000	1.000
6	A	Timeloop	4		

Table 2.2. Programme as above but with calibration and time loop that goes straight back to sampling.

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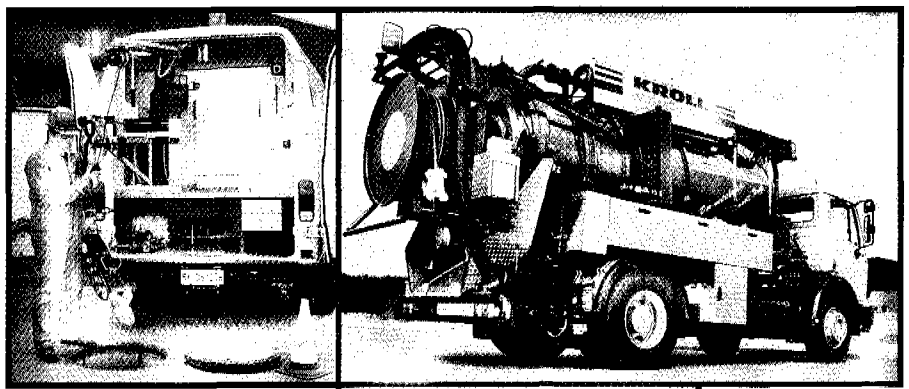

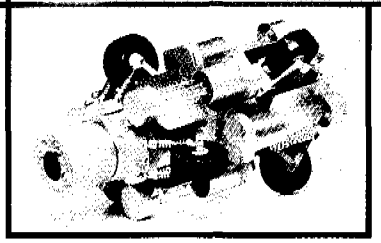

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Tanker system cuts off-site disposal

Karl-Heinz Tomaschewski, KROLL Fahrzeugbau

By replicating the simple physical wastewater separation used in underground filter units located in petrol stations, workshops and so on, a tanker unit can be used to separate oil, water and sludge, thereby reducing considerably the volume of waste for off-site disposal.

The environmental demands of today require not only new and efficient procedures to avoid wastes but also that they treat and dispose of them efficiently. New ideas are also needed for the emptying and cleaning of filter installations and for the disposal of the oil-polluted water on-site.

Kroll Fahrzeugbau offers a system which results in 80-90 per cent reduction of residual waste which have to be finally treated off-site.

Hundred of thousands of underground filter units located in petrol stations, lorry parking areas and vehicle work shops work on a purely physical separation basis and obtain a good level of water/oil/petrol/solid waste separation.

This is the reason why the Kroll-Selector mobile system works similarly, namely without the use of chemicals.

During the cleaning process, the contents of the stationary separator are pumped up into the mobile separator unit and are separated into their constituant parts; oil, water and solid wastes and stored separately inside the vehicle in individual chambers.

The light-weight particles filter unit is refilled with the recycled clean water and any excess water is returned to the filter unit to drain off into the normal drains. The sand, solid wastes, and oils remain on-board inside the vehicle and are taken away to a specialised recycling location.

It is very important that a mobile separator unit has the same characteristics as a fixed unit though it has to be installed onto a standard vehicle chassis.

The Kroll-Selector is built according to German safety standards (Explosive/dangerous products transporter) with a number of separate compartments and three independantly operating separator units within the certified suction/pressure tank. It works according to an exactly defined system, called KrollSelect and a patent for the system has been applied for.

The heart of the mobile KrollSelect system is the specially designed platen separator which separates the wastes into the constituant parts of oil, water and sludge. The special plate separator unit is manufactured completely from high-quality stainless steel and is composed of a large number of filter units, to enable the wastes to flow over the separator unit. Simple profiles are stacked into "packages" with spacers between them, and five of these packages are located inside the unit forming the three-phase separator unit.

Wastes entering the unit are evenly spread across the filters. Large oil drops accumulate on the separator almost immediately, while large solid wastes fall down into the solid-waste accumulator.

As the water/oil mixture enters the next "package" of separators the smallest oil particles and wastewater are separated. The oil droplets collect on the surface of the water and coalesce into a film. This film is removed by the skimmer unit. The wastewater which has now been cleaned and filtered to a high degree is returned to the underground filter unit on-site.

The oil-in-water-monitor constantly measures the oil content of the water during the cleaning operations which is displayed digitally in parts per million.

If the filter system of the KrollSELECT is able to reduce the oil content of the water to below 20mg/l, it is released into the water compartment for storage. Once the on-site filter unit has been cleaned by the operator, the clean water is returned to the underground unit. The remaining solid wastes, which represent only 10-20 per cent of the total volume have now been separated by the unit and can be disposed of at the local recycling plant.

If the KrollSelect is not able to reduce the oil content of the water below 20mg/l, then the water mixture is automatically pumped back into the filter unit and the cleaning process is halted. During this phase of the operations no new waste can enter the system so the system is tamper-proof.

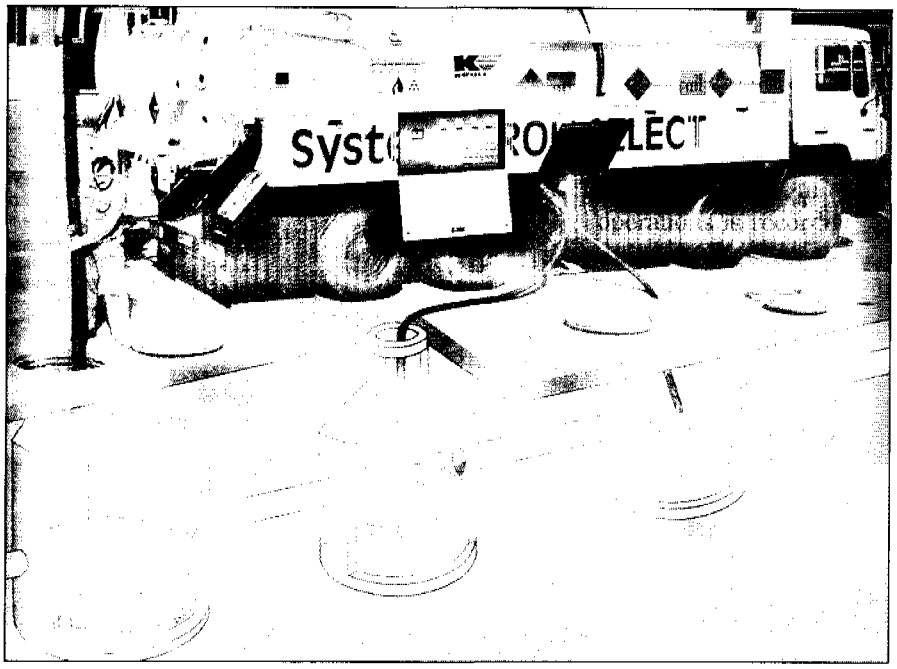
Thus the vehicle operator is forced to disengage the filtering system and to remove all the waste from the stationary underground filter unit for disposal.

All data from the cleaning operations is recorded on the printer unit installed on the vehicle. The printer is tamper-proof and the time and date of operations are automatically recorded to document the performance of the KrollSelect.

All the main adjustment values and monitoring devices are controlled from the KrollMatic programmable logic controller.

The software is designed and produced by Kroll and this ensures that every KrollSelector is delivered with, or can be upgraded to, the latest version of the software programme.

The total capacity of the vehicle tank is dependent on the vehicle chassis used, but can vary from 18 000 to 26 000 litres. Customers can also select the size of each comparment according to their own requirements.



Once the filter unit has been cleaned, clean water is returned to the underground unit.

In order to satisfy all customers the KrollSelector is available in three different versions. The basic model is available for installation onto a three-axled vehicle chassis. The two other versions are based on the KrollSelector being installed on a two or three-axled trailer unit.

The KrollSelect separator system has established itself a leading position and and set new standards for separation technology in the field. ■

Wastewater screen for all types of user

Chris Stevenson, H_2O Waste-Tec

A comparison of traditional comminution and screening systems with a new generation of screens designed for pump protection, sewage works inlets and stormwater applications. The new modular Discreen design uses one basic principle to cover many different applications.

When H_2O Waste-Tec began the development programme for the Discreen we set down a number of key design features:

- The machine should be of a modular concept that would enable maximum range of applications to be covered with one design in a small range of sizes. By using modular system build-ups, the operator/owner has significant flexibility of installation options and, when maintenance does become due, one standard range of spares will fit all installations minimising both training skills needed for maintenance staff and stockholding costs;
- The machine should be of very heavy-duty construction using where practical corrosion-resistant materials. Having been suppliers to the waste water industry for over 40 years, we know the abuse that can occur in public sewer systems. The Discreen was not designed down to a price, it was designed to do the job in a reliable way for a very long period of time. Main casing is of heavy section cast iron (stainless or bronze are alternatives) and all the discs are of stainless steel;
- The machine should be of a self-cleaning design. So many attempts at designing fine screens have ended up with machinery that is very difficult to remove the extracted screenings from; and
- The machine should be able to be retrofitted into existing screen channels or comminutor chambers with minimal or zero civil modifications. This gives the owner/operator a low cost solution to replacing old, worn out or ineffective equipment with minimum disruption to the flow or indeed incurring any civil rebuilding/reshaping costs. The modularity of the Discreen allows the benefits of standard production machines with local site customisation by the use of low cost fabricated mounting frames tailor made to suit the individual installation.

At the conceptual design stage the first thing we looked at was the fineness of screening required by European legislation and the per centage removal rates obtained on traditional bar screens (Figure 1).

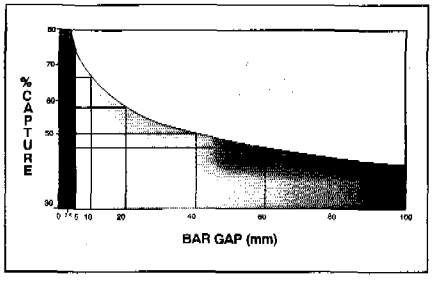


Fig 1. Percentage removal rates by conventional bar screens.

To meet the efficiency guidelines for various duties we opted to produce a range of screen apertures giving nominal 2.5, 5.0 or 9mm screen gap.

The next problem was to create a small footprint machine that met all the above design criteria on modularity ruggedness, ease of retrofit and so on — the concept of the Discreen was born.

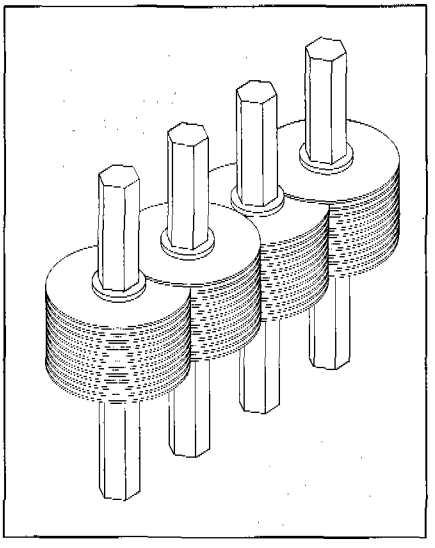


Fig 2. Shafts with intermeshing discs.

Design of Discreen

Simply, the Discreen consists of a number of shafts each fitted with overlapping and intermeshing discs (Figure 2) with an aperture distance to suit the fineness of screening required. The standards either being 2.5mm or 5.0mm. Each shaft rotates slightly faster than its 'upstream' neighbour thereby forming a gentle conveying action of solids across the face of the screen to the discharge point.

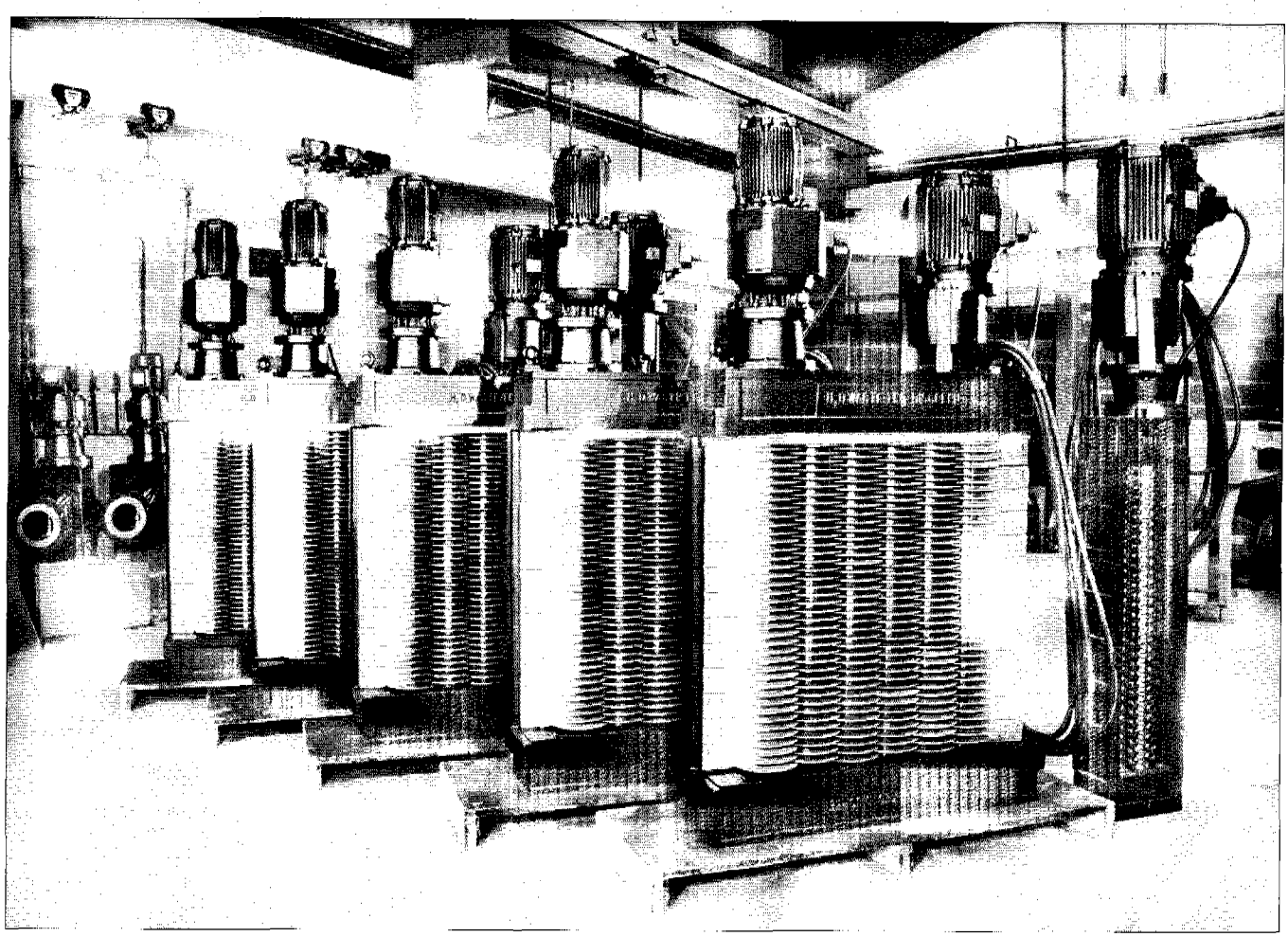


Fig 3. Discreen/Muncher system for 20 000m³/h raw sewage pump protection.

Screen gap is determined by the thickness of the disc spacer.

By using a series of shafts, normally between 3 and 6 per module, and several shaft lengths (300, 600, 800 and 1000mm) a permutation of width and depth options for the main screen module was soon established and by the use of mounting frames multi-module screen wall systems could be assembled up to practically any flow found in municipal sewage systems.

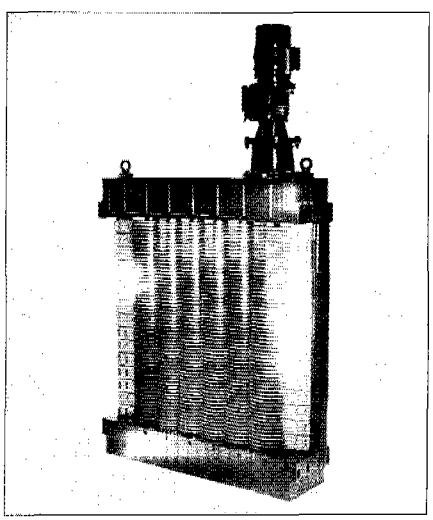


Figure 4. Discreen Model CD2106.

The diagram clearly shows the compact nature of the main screen module and the following series of diagrams show how adaptable it is to various different applications.

All these diagrams show how easy the machine is to adapt to practically any application need. The core of the installation remains standard, only the framework is custom built.

The Discreen, in just four years since its launch, has become accepted by wastewater engineers as a real problem solver. Many installations, both large and small, simple and complex in nature are working in Europe, Africa, Asia and America.

The Discreen is a unique concept in wastewater screening and in summary offers many advantages:

- Small compact installation usually below channel coping level;
- Dynamic self-cleansing screen gives low headloss and is virtually maintenance free;
- 2.5 or 5.0mm dynamic screen size gives high capture efficiency (90-95 per cent);
- Low noise levels;
- Elimination of fat build up common to many other designs of fine screen;
- Screen discs virtually impossible to damage by impact with angular solids;
- Screening aperture size can easily be changed by fitting different sizes of spacers; and
- Protected by PLC control technology. ■

Biography

Chris Stevenson is the General Manager of H_2O Waste-Tec and has worked in the water industry for some 20 years. He has always been a keen supporter of LWLC (Lowest Whole Life Cost) design principles and uses reliability as a keystone of the company's design policy.

ALL YOUR WATER AND WASTE WATER NEEDS

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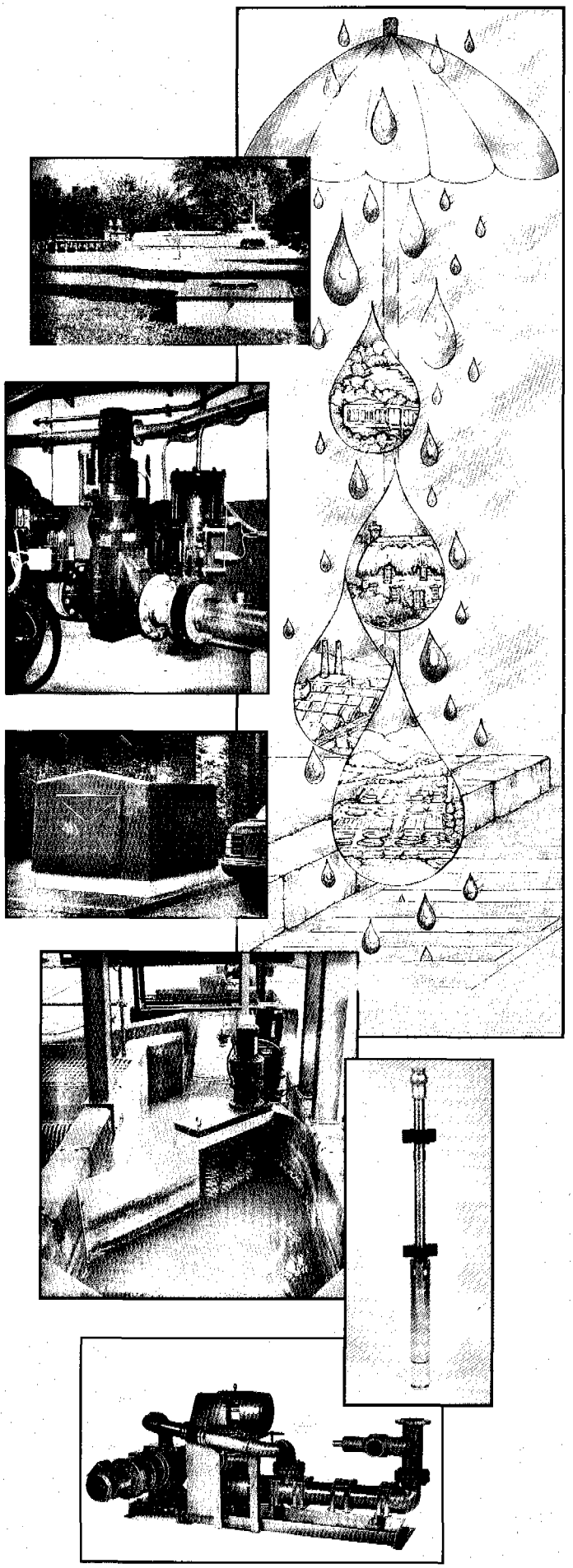
H_2O Waste-Tec's products now include borehole pumps for clean water supply and irrigation, as well as their renowned range of waste water pumps. Solve your sewage disposal, clean water and irrigation problems with one supplier.

The Subrotor, for clean water supply, is manufactured in high quality stainless steel from a minimum of components. Using the progressing cavity principle which is utilised by many of H_2O Waste-Tec's other pumps, the Subrotor will provide you with the perfect solution to your water supply needs.

As a result of continuing development of our range of pumps, Munchers and Mutrators, H_2O Waste-Tec introduced the Discreen, which is fast being recognised as an innovative answer to the problems of fine screening in modern sewage treatment works. This new screening concept also has applications in marine outfalls, pump protection and storm screening.

Let H_2O Waste-Tec solve your problems now Telephone 0161 406 7111 or Fax 0161 406 7222 and see what's under our umbrella.



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Magnesia can treat acidic effluents

Gerry Spoors, Redland Materials

The viability of using magnesium hydroxide as a safe, cost-effective alternative acid neutraliser is now being recognised. It is now being used for pH correction and metal precipitation in a wide range of effluent treatment applications.

Many industries produce acidic waste streams which have to be neutralised before discharge; in order to meet pH and metal consents. Traditionally, lime and caustic soda have been used, but these materials are difficult to handle and often create other environmental problems. Recently, the viability of using magnesium hydroxide as a safe, cost-effective alternative alkali has been recognised, and it is now being used for pH correction and metal precipitation in a wide range of effluent treatment applications.

When used in aqueous suspension, magnesium hydroxide reacts in a controlled manner to raise the pH to the desired level within the discharge consent range. In so doing, it has the following advantages over lime and caustic soda: greater alkaline efficiency; 'buffers' around pH 9.5; ease of control; produces lower metal hydroxide sludge volumes; is very safe to handle; can be delivered as a suspension ready for use; and is very cost effective.

Additionally, it does not produce a sulphate sludge (compared with lime), nor does it 'freeze' at temperatures as high as 12°C (as 50 per cent NaOH solution does).

Let us examine some of those points in more detail.

Greater alkaline efficiency

The following equations show why less $Mg(OH)_2$ is required for neutralisation, using the reaction with H_2SO_4 as an example:

i) $Mg(OH)_2 + H_2SO_4 \rightarrow MgSO4 + 2\,H_2O$

58.3kg 98 kg 120.3 kg 36 Kg

ii) $2\,NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\,H_2O$

80kg 98kg 142kg 36kg

iii) $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4.2H_2O$ (precipitate)

74kg 98kg 172kg

Thus, 1 tonne of $Mg(OH)_2$ will do the same job as 1.37 tonnes of NaOH, or 1.27 tonnes of $Ca(OH)_2$.

Buffering and ease of control

With lime or caustic soda, accidental overdosing can cause the pH to rise above consent levels, causing significant environmental damage on discharge.

This cannot happen with magnesium hydroxide which reacts in an essentially two-stop manner. This is due to its relatively low solubility which leads to a limited number of hydroxyl ions being initially present in solution. Only when those have taken part in the acid neutralisation can further hydroxyl ions become available.

Provision of hydroxyl ions takes place according to the reaction:

$$Mg(OH)_2 \rightarrow Mg^{2+} + 2\,OH^-$$

Rapid reaction with the acid at low pH gives way to a much slower reaction as the pH gradually rises and the acid is neutralised. This prevents the 'spiking' that occurs when using the other alkalies and enables the plant operator to achieve a very high degree of control.

Furthermore, even a massive overdose is unlikely to take the pH beyond 9.5.

Low sludge volumes

When used for removing metals from solution, the relatively slow reaction rate, achieved when using $Mg(OH)_2$ results in the formation of a much more granular metal hydroxide precipitate which settles faster and traps much less water. Hence there is less water to filter off and less sludge to dispose of, than when using other alkalies.

Table 1 shows the comparative sludge volumes achieved with $Mg(OH)_2$, NaOH and $Ca(OH)_2$ when precipitating copper hydroxide from solution.

With sulphuric acid based effluents, soluble magnesium sulphate is formed removing the problem of sulphate disposal resulting from the use of lime (which forms insoluble calcium sulphate).

Magnesium hydroxide in aqueous suspension is a gentle alkali that does not burn the skin or eyes, unlike lime and caustic soda, which are hazardous materials.

In fact, a pharmaceutical grade of magnesium hydroxide, milk of magnesia, has been used as an antacid for many years.

Magnesium hydroxide aqueous suspension is easily pumped and stored, and has a freezing point of 0°C, whereas 50 per cent NaOH freezes at 12°C and

has to be heated for storage and pumping accordingly.

Overall, magnesia is a safe and effective alkali for the neutralisation of acidic wastes and for the precipitation of metals.

Here is an actual case study which demonstrates some of the advantages of using magnesium hydroxide.

Case study — steel pickling

A company using sulphuric acid to clean the surface of steel rods, was using 47 per cent sodium hydroxide for effluent treatment.

Significant problems were encountered:

- Difficulty in achieving discharge consent levels, particularly for iron and suspended solids;
- Occasional overdosing leading to high pH discharges; and
- Storage and handling problems including freezing of caustic solution during cold weather.

A laboratory evaluation showed that treatment with magnesium hydroxide would allow consent levels to be achieved. Furthermore, considerable reductions in sludge volumes were possible. Very successful plant trials followed with residual iron concentrations consistently below 1ppm. This was despite iron levels of up to 12g/l in the raw effluent. After converting to $Mg(OH)_2$, the three problems shown were alleviated; and cost savings achieved were sufficient to repay the capital outlay within the first year.

Footnote

It is interesting to note that magnesium hydroxide is now attracting considerable interest as a coagulant/adsorbent for removing colour from dyeworks' effluent. Laboratory and plant trials now in progress may add one further category to the list of applications for magnesia. ■

Table 1. Laboratory evaluation of steel pickling wastewater

	pH	Residual dissolved metal concentration (mg/l)					
		Fe	Zn	Cu	Pb	Cr	Ni
Original effluent	1.14	4120	43.0	2.20	0.37	17.0	7.25
Treated effluent	5.85	0.4	<0.1	<0.1	<0.1	0.44	<0.1
Effluent treated with $Mg(OH)_2$	8.63	0.4	<0.1	<0.1	<0.1	<0.1	<0.1

BIOGRAPHY

Gerry Spoors is a Chartered Chemist and Fellow of the Royal Society of Chemistry. He is Technical Services Manager for Redland Minerals Ltd, who produce magnesium hydroxide from seawater at their Hartlepool Magnesia Works in northeast England.

Membrane filtration for strong effluents

● Carl-Erik Nielsen, Union Filtration

Membrane cross-flow filtration may be used for cleaning and recycling effluent streams from industries as difficult as textiles, galvanising and pulp and paper. The plants described in this article have different sizes and are used for various applications, such as food and beverage products, waste effluent, low and high viscous products.

Membrane cross-flow filtration techniques include reverse osmosis (RO), nanofiltration (NF), ultra-filtration (UF), and microfiltration (MF).

RO is used for almost complete removal (> 99 per cent) of organics and inorganics, and the cleaned water (permeate) can be compared with that from an ion-exchange plant, however, without the inconvenience of regeneration and chemicals. The water recovery is typically 85 to 95 per cent. Within the food and beverage industry as well as the pharma/biotech industries, RO is used for economical concentration, for instance prior to evaporation and spray-drying, or for products sensitive to temperature.

NF is regarded an "open RO membrane" basically used for separating monovalent from divalent salts. Other applications are removal of heavy metals (for example, Al, Cu and Cr) from water and acids, treatment of oil emulsions to low contents in the permeate, and removal of dyes from textile effluents.

UF is the most applied technique within a variety of applications. It is used for separation of high molecular weight (HMW) from low molecular weight (LMW) compounds. Within the pulp and paper industry UF can be used for concentrating and purifying HMW from LMW lignosulphonates.

Within wastewater treatment, UF is used for removal of proteins, starch, HMW dyes, fat and the like from salts and sugars — as a final treatment or as the ideal pretreatment prior to RO where UF reduces the fouling remarkably.

MF is a pretreatment prior to NF or RO. It reduces or removes suspended solids like fibres in order to prevent clogging of the successive spiral membranes. It also reduces the bacteria content substantially.

RO, NF, UF and MF membranes are available in three materials: organic, ceramic and metallic, as well as in various configurations — each with individual advantages. However, the spiral-wound design is strongly preferred because of its flexibility and price.

Textile waste streams

Dyeing, bleaching and washing textiles demands large quantities of water, and consequently results in large amounts of waste streams. Depending on the quality demands, a large part can be recycled for reuse.

The water amount required varies from 50 to 200 litres per kilogram of textile, depending on the operation mode — batch or continuous — and the dyeing machine type. Dyeing processes typically consist of 12-16 individual steps during which 85-90 per cent of the water is consumed for flushing.

In some cases, the degreasing makes up 10 per cent of the total water consumption. Flushing waters are therefore the most interesting to study, for three reasons:

- Largest amounts (largest recyclings);
- Lowest concentrations (highest membrane capacities; and
- Highest temperatures (energy recovery)

Union Filtration has experience in filtration of effluents from various processes, such as:

- Cloth dyeing (reactive dyes);
- Dyeing of clothes (reactive dyes);
- Stone wash (enzymes); and
- Degreasing of tissue for furniture

The reactive dyes were of the triazine and vinylsulphone types. The COD varied from 20mg/l up to 3500mg/l.

By nanofiltration with a TFC membrane and an open spacer, it was possible to reduce the COD by 95-98 per cent.

The filtration was conducted at temperatures from 30 to 90°C. As expected, it is advantageous to run at high temperature as the capacity (flux) increases by 2-3 per cent at each °C increase.

The retention depends on the dyes, though it is typically very high. The dye retention increases concurrently with rising temperature, whereas the salt retention decreases.

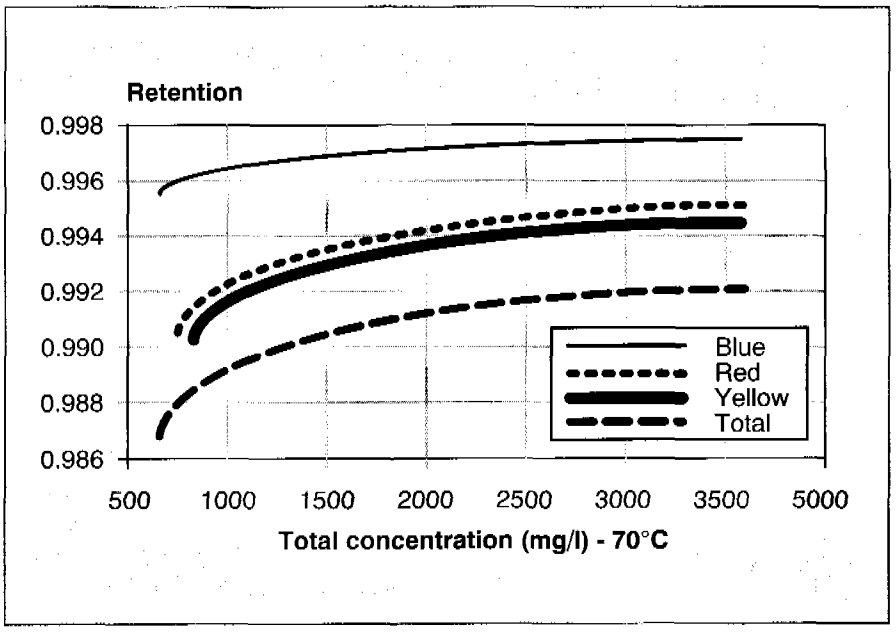


Figure 1. Retention of monoreactive triazine dyes from flushings.

Temp (°C)	Salt Retention	Dye Retention (All)
20	0.65	0.980
90	0.40	0.993

Blue, red, and yellow dyes were examined with the following results:

Dye	Molecular Weight	Retention (90°C)
Marine blue	950	99.6 - 99.7%
Red	980-1020	99.0 - 99.4%
Yellow	700-750	98.7 - 99.1%
Total		99.1 - 99.4%

The overall dye concentrations varied from 1500 to 4000mg/l. Higher concentrations can be achieved, however, on cost of the retentions and flux rates. The waters produced (permeates) were found suitable for recycling, and depending on the nature of the stream, the yield was 90-99 per cent.

The effluent from the enzymatical stone wash and dyeing process was treated by UF and RO. UF reduces the dye substantially, particularly the dark dyes, whereas the bright dyes give some permeability. Salt (NaCl) — typically in concentrations of 2-3g/l in the overall stream — was almost not affected.

The following RO process (on UF permeate) gave a high capacity which was only affected by the osmotic pressure from the salt. No fouling was observed, and the only cleaning needed was flushing with pure water.

The RO permeate was comparable with that from an ion exchanger and had a conductivity close to zero.

Effluents from degreasing containing 22000-68000mg/l COD have been treated on a NF TFC spiral membrane with an open spacer in a parallel design. The COD in the permeate varied from 2000 to 4000mg/l at a recycling rate of 90 per cent and 60-65°C. The permeability was 3-4 per cent. The pretreatment is crucial to the success of membrane filtration. Continuous prefilters were applied for removal of fibres and the like.

The plants are equipped with feed and recirculation pumps in order to set the optimal trans-membrane pressure (TMP) and recirculation flow (RF) (surface liquid velocity along the membranes) which both depend on the effluent type.

Small-size plants are typically operating in batch mode in order to maximise their capacity, whereas large plants operate continuously with 3 to 4 loops.

Waste from galvanising

Various waste streams occur from the surface treatment of metals in the galvanising industries, and large amounts of rinsing water are consumed.

Aluminium is today one of the most utilised metals, and certain properties are required, for instance:

- Decorative surfaces;
- High corrosion resistance;
- High light reflection;
- Colouring; and
- Increasing electrical insulation

The treatment of the aluminium bodies typically starts with a degreasing (soap) followed by a caustic and acid treatment. Between

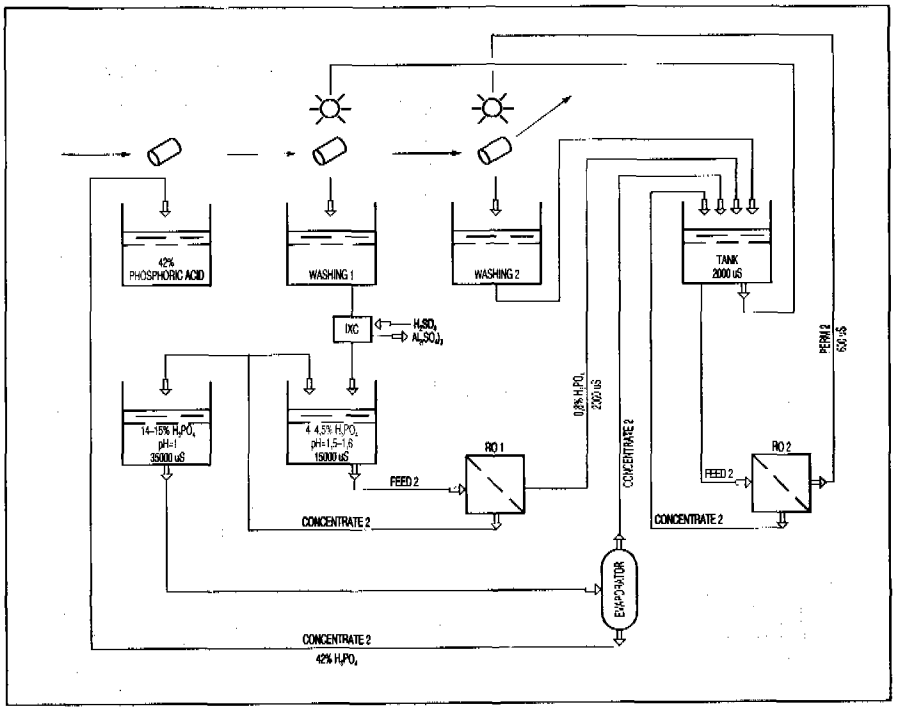


Figure 2. Recovery of phosphoric acid.

each step, one or two flushings with water will take place. These steps result in effluent streams with heavy environmental impact, such as:

- Caustic solution with aluminium;
- Acid solution with aluminium;
- Rinse water with caustic and aluminium; and
- Rinse water with acid and aluminium.

Membrane filtration with RO and NF membranes has been introduced in order to solve the environmental problems and save chemicals.

Al-reflectors are treated in phosphoric acid (42 per cent H_3PO_4) followed by two flushing steps in order to remove the acid. This results in two baths — the first one with 4-4.5 per cent H_3PO_4, and the second one with 0.8 per cent. Two independently operating RO plants have been installed.

The first RO plant is fed with the 4-4.5 per cent H_3PO_4. The acid is concentrated to about 20 per cent followed by an evaporation after which the acid is returned to the bath. The permeate is mixed into the feed tank for the second RO plant and used for the first flushing. From this tank it is fed into the second RO plant, which keeps the concentration constant at 0.8 per cent. The concentrate is returned to the first flushing bath and the permeate is — with 600 micro S — reused as water for the second flushing. The fresh water supply only amounts to the volume removed in the evaporator.

The capacity of the first RO plant is 900-1000 l/h, and the second one treats 2500-3000 l/h at 20-25°C. Both plants have been in operation for several years with a membrane life time of 1-1.5 year. The plants are running in batch mode.

By NF it is possible to separate the aluminium from the acid and thereby recycle the purified acid. Typically 18-20 per cent sulphuric acid is used in the anodising baths, and an Al-content of 5-15g/l is normally accepted.

A plant with a NF TFC spiral membrane and an open parallel spacer has been installed. The aluminium — $Al_3 + Al(HSO_4)_3 + Al_2(SO_4)_3$ — is concentrated up to 100-150g/l, and the permeate with 0.5-1.5g/l Al is recycled to the anodising bath. The recovery is typically 90 per cent.

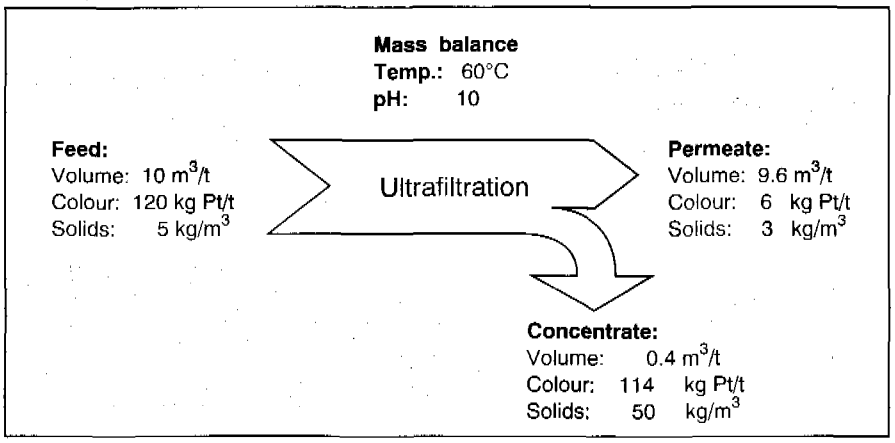


Figure 3. Ultrafiltration of bleach effluent.

Membrane filtration has the following advantages:

- Removal of Al without use of chemicals or ion exchange.
- Recycling of the purified acid (reduced costs).
- Low variation of Al in the bath (can be maintained constantly) resulting in low energy consumption and better surface quality of the bodies.
- Reduction in costs of caustic for neutralization. Only 10 per cent of the original volume need to be neutralised.

The plant is operating in semi-batch mode and removes a constant stream from the bath. Pressures are from 40-60 bar at 20-30°C.

The pulp and paper industry

Union Filtration has considerable know-how within several applications, such as SSL, KBL, and KBE. However, the most important one is ultrafiltration of KBE from the first alkali extraction step in the bleaching process.

Ultrafiltration of SSL (spent sulphite liquor) fractionates the lignosulphonates into an HMW and an LMW fraction.

Simultaneously, the concentration is increased from about 7 to 25 per cent TS (removal of 70-80 per cent water), and the lignins are purified, from 55 to 80 per cent. By diafiltration a purity of 92 per cent is possible. The HMW fraction is thereby converted from an unpleasant waste stream into a valuable product used for:

- Dye dispersant (textile industry);
- Additive to drilling mud (exploration of crude oil);
- Additive to concrete to lower the viscosity and reduce the water consumption;
- Additive to glue (production of fibre and chip boards);and
- Vanillin

RO of SSL concentrates all solids up to 20-25 per cent TS (lignins, sugars, and salts). The permeate (clean water) typically contains 0.2-2 per cent TS corresponding to 1000-2000mg/l of BOD which is comparable to evaporator condensate. The water recovery will be about 50 per cent, and the costs per m³ cleaned water are lower than by using an evaporator.

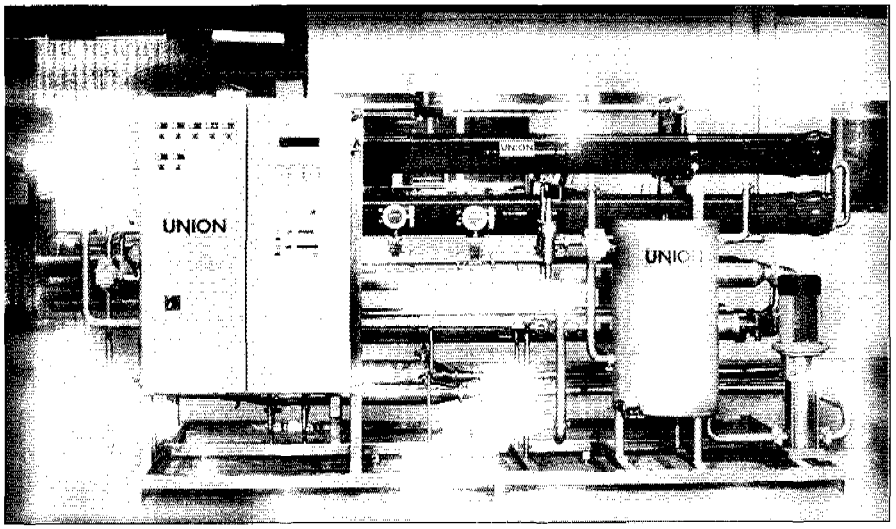
RO of UF permeate from an SSL filtration gives a clean water with a recovery rate of 90-95 per cent. The concentrate contains LMW lignins and sugars which can be used as glue additives.

The alkali lignins in KBL (kraft black liquor) are today almost exclusively used as energy sources.

UF opens the possibility of using alkali lignins in a new way. After purification by diafiltration and concentration, the KBL can partly replace ordinary phenol formaldehyde glue used for the production of, for example, water-proof plywood.

The feed is normally about 7 per cent TS. By a straightforward UF concentration, a TS of 25-27 per cent can be achieved. Of this, 80 per cent are lignins with a purity of more than 80 per cent.

Weak waste liquors are inevitable in



Reverse osmosis plant for phosphoric acid concentration.

a pulp mill. Parts of the liquors have to be concentrated by evaporation, even though the content of low solids makes it costly. RO can remove water more cheaply than evaporation. More than 5 per cent TS in the concentrate can be achieved. A water recovery of 60-80 per cent is typical. The concentrate is further evaporated, and the permeate used for pulp washing.

Wastewaters from chlorine bleaching of kraft pulp can be treated successfully by ultrafiltration. The bleach effluents constitute a severe pollution problem in this industry. This is due to the content of strongly coloured and chlorinated lignins. About 60-70 per cent of the total discharge of lignin derivates originate from the first extraction stage.

The lignin concentration is normally low (2-3g/l) and mainly consists of HMW compounds. These can be used as additions to phenol formaldehyde adhesive in the production of e.g. water-proof plywood.

By UF the waste stream is split into a pure permeate and a concentrate containing lignins and other compounds in a concentration of 50-100g/l.

The amount of permeate makes up 90-95 per cent of the feed, and colour, COD, and organic chlorine are reduced by 80-90 per cent. This gives a permeate with less than 500ppm COD. ■

Biography

Carl-Erik Nielsen, engineer BSc, has been market application manager at Union Filtration since 1993. Prior to that he worked on membrane filtration with DDS Filtration and later with Dow Denmark Separation Systems.

Choosing wastewater bubble aerators

Wilfred Pflüger, Suprafilt

Diffused air has been used in biological wastewater treatment for over 70 years. The need for energy-efficient systems has initiated new areas of research and product development, particularly of membrane and rigid plate diffusers and their application in nutrient removal.

More than half of the energy in waste water treatment is expended in the activated sludge stage, thus the actual efficiency of the installed equipment is of great importance not only in implementing the process but also financially.

Within the past few decades engineers have more and more tended to select fine bubble aeration because of the proven advantages of higher efficiency. However, it is very important for a designer to select the most appropriate technology to meet the specific requirements. Thus the use of surface or mechanical aerators, coarse bubblers or even pure oxygen systems may be adopted to meet those requirements.

System efficiency

It must be stressed that the efficiency of any aeration system is dictated by two main considerations:

- The oxygen transfer capability of a particular diffuser which is mainly influenced by the size of bubbles generated, but also on the physical dimensions and shape of an individual diffuser that contributes to the degree of bubble agglomeration, which, if significant, will decrease transfer efficiency; and
- The degree of floor coverage and diffuser spacing.

Clients wish to minimise capital costs, often without fully appreciating the working life of an installation and power consumption. This leads to disputes between him and the designer/supplier. Also a supplier's overoptimistic claims as to diffuser life or transfer capability give reason for disputes.

It is therefore of utmost importance that the user specifies clearly what he is looking for.

Table 1 summarises the performance of real plants showing the dependence of efficiency and diffuser arrangement:

So what are the implications in increased capital cost to achieve this higher efficiency?

The increased floor coverage and reduction in diffuser spacing is achieved with about 30 per cent additional diffusers and an increase of about 50 per cent in distribution pipework.

This is compensated for by a reduction in air demand leading to smaller blowers and header pipework.

Calculations on municipal plants adopting a full floor coverage layout compared with single line arrangements indicate a "payback" period of less than five years in general.

Nitrification-denitrification

Within the last decade the removal of nitrogen by biological process increasingly became standard technology and eventually mandatory in many countries.

But what does this have to do with aerators?

In a biological sewage plant with nitrification and denitrification the aeration is either run in On/Off operation or the nitrification sector is continuously aerated and, in the separate denitrification area, the waste water is merely circulated mechanically. To achieve a sufficient nitrification of the NH_4-nitrogen even at low temperatures, the aerated tank volume must be temporarily enlarged. In this case, it is most important that highly effective fine-bubble diffusers

Table 1. Performance of plants showing dependence of efficiency on diffuser arrangement

Diffuser arrangement	Specific SOTR g O_2/m^3 x m	SOTE kg O_2/kWh Roots blowers	SOTE kgO_2/kWh Turbine blowers
Spiral flow type	12-14	1.5 - 2.2	2.0 - 2.5
Floor coverage	16-20	1.8-2.8	2.8-3.6
Pilot tests	20-30	> 3.0	> 4.0

in the nitrification area and diffusers, capable of being switched off and situated in the additional volume, can be operated together from one compressed air system without expensive throttling.

For this reason, ceramic diffusers are very often installed in the nitrification zone. This is because of the longer lasting high oxygen transfer efficiency compared with membrane diffusers.

But in the additional volume membrane diffusers are used because of their ability of being switched on and off.

When designing a plant, special care has to be taken to choose the appropriate diffuser type and diffuser pattern in the tank.

Deep tank aeration

Over the past few years improvements in blower technology and a greater understanding of bubble behaviour have allowed designers to utilise deeper aeration basins leading to a significant reduction in diffuser number and land area required. Whereas in the past 4m was a normal depth and 6m exceptional, now plants are being operated at over 10m depth, with 8m being normal.

At depths much in excess of 10m, the normal single stage centrifugal blower is at its limit and any further depth increase will necessitate multistage units at a considerable increase in capital cost. For Roots type units the limiting depth would appear to be about 8m.

The present generation of fine bubble diffusers produces bubble sizes of about 1.5-3mm diameter. Research work in Germany indicates that transfer efficiencies decline at depths in excess of about 15m, probably the maximum being in the 10-12m range. This zone of maximum efficiency depends on actual bubble size, diffuser density, tendency to more or less bubble agglomeration and type of compressor, all of which need to be carefully evaluated and verified by the user

High oxygen uptake because of long bubble retention time leads to low air quantities. In plants where odour control equipment is required for example through compost filters or air washers there are savings in both investment and operational costs.

When should one consider deep tanks? Primarily when land area is limited or in extending an existing plant where the cost of many services and pipework would need to be considered. Civil engineering designers should consider the incorporation of strutted walls to reduce concrete volumes as well as non-structural curtain units on internal walls particularly in plug flow arrangements.

Tanks up to 25m depth have been developed primarily for industrial waters and are equipped with venturi type aerators rather than fine bubble systems, as in the Bayer Tower technology, for example. Perhaps the ultimate in deep tank development to date is in the "Deep Shaft" process where depths can reach 250m! It should be noted that the "Deep Shaft" may be more suitable for high rate processes, and there is some reluctance to utilise it for nitrification due to the short hydraulic residence time.

Type of diffusers

In the past the vast majority of installed diffusers were of rigid porous structure (ceramic or resin bonded quartz sand). Nowadays very often membrane diffusers are built in. It is therefore essential to know the differences in appliance and cost.

Ceramic diffusers

These are made of pure ceramic material. The corns are melted together at high temperature.

These diffusers are very solid and strong. However because of the kind of fabrication they have a very rough inner surface where sludge particles are held back and cause pressure increases. Cleaning can be carried out by heating up the diffusers and incinerating the organic matter.

Resin bonded diffusers

Quartz sand of a highly classified size is mixed with a resin bond, pressed into shape and hardened. The advantage of the very smooth inner surface of the pores this creates is the possibility of easy cleaning by high pressure water jet.

Porous plastic

Plastic balls of a certain size are sintered together in every desirable shape. These diffusers cannot be cleaned either by heating up or high-pressure water jet. So, when they become clogged they have to be replaced. Of course, their price is lower than that of the other types, so replacement may cost not much more than cleaning.

Membranes

A rubber or plastic membrane with stitches or slots is folded over a holder of plastic or stainless steel. There are many different shapes offered: tubular, domes, plates. The bubble size of the diffusers can be chosen by using different hardness of the membrane and the size and pattern of the stitches or slots.

Membrane diffusers are normally designed in a way so that they close themselves when the air throughput is stopped. This because the water outside the diffuser presses the membrane onto the supporting structure and prevents the water from flowing into the diffuser. This will work quite well as long as the membranes are new. But with time the elasticity will decrease and the return valve effect may no longer function properly. Also the bubble size gets bigger and therefore the oxygenation efficiency decreases.

Applications

Since there are so many aspects, thorough study is necessary of the advantages and disadvantages of the different types of diffusers in the particular process design.

It seems that membrane diffusers are the appropriate type for special industrial effluents (dairy, milk, cheese, paper, chemical and so on) and of course for all plants with on/off operation (mainly small plants, or plants with simultaneous denitrification). Also in plants with separate denitrification zones which

will be aerated only part time membrane diffusers will be chosen. The membrane can be used for all other applications, but rigid porous type diffusers should also be considered.

Ceramic and resin bonded diffusers are still more efficient in the long run in plants that are continually operated. This is because they do not experience the decreasing efficiency in oxygen transfer found with membranes.

Ceramic and resin bonded quartz diffusers will run for a long time without any alteration in efficiency. If clogging occurs after only a few month or one or two years, a replacement with membrane diffusers should be considered.

But in nearly every municipal plant, and in most industrial plants as well, ceramic and resin-bonded quartz diffusers run for 6 to 8 or even 10 years with no increase in pressure drop. If pressure drop does occur, the diffusers can be cleaned as explained above and will then run for many additional years.

Costs

The installation costs of a particular plant are more or less the same either with membrane or rigid porous type diffusers. It is more the running costs which should be noted.

Brand new diffusers of both the membrane and the rigid porous type have the same oxygen transfer rate. Only membrane diffusers with a high pressure loss have a slightly lower transfer efficiency.

But within months the elasticity of the membranes decreases continually. This leads to a higher power demand on the same scale, which can after some years reach 10, 20 or more per cent. To avoid this, the membranes have to be replaced after about 3 to 5 years. ■

Biography

Dipl-Ing Wilfred Pflüger is senior engineer and a director of Suprafilt GmbH and Suprafilt Ltd, specialists in the field of bubble aeration. After graduating in Mechanical and Process Engineering, he spent five years working as a design engineer and project manager in chemical plant contracting. For 20 years, he has worked as process engineer and project manager in sewage treatment, especially on the activated sludge process and aeration installation, this for clients all over the world.

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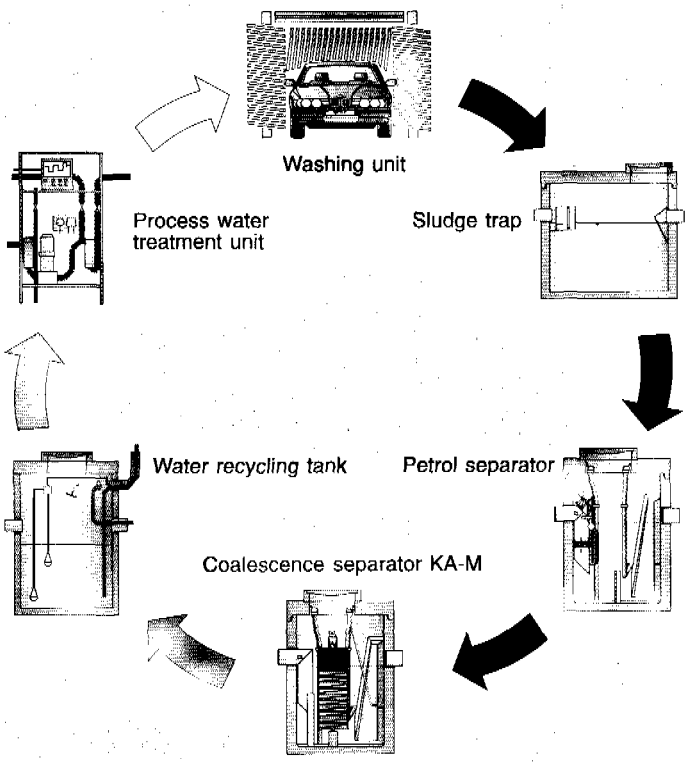

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Reusing car-wash wastewater

Uwe Barwig, Dyckerhoff & Widmann

In the next few years, the recovery of water used for washing passenger cars is going to be an important environmental topic. Dyckerhoff & Widmann has a wide range of experience in this field, which has figured largely in its research and development work for over ten years.

A high degree of technological effort is required to attain a level of purification that removes sediment, as well as hydrocarbons and other components, from the car-wash water, enabling it to be recycled. This must be carried out in an ecological and economical manner, in order to save our drinking-water resource. On 1 January 1992, there were 31 million passenger cars registered in the Federal Republic of Germany. Assuming that fresh water is consumed at a rate of approximately 150 litres per car wash, and each car is washed on average 17.5 times a year, this amounts to 81 375 000m^3 of fresh water — and the trend is rising. This corresponds to the amount of drinking water consumed annually by 1 500 000 people. This example shows just how important water recycling is in the field of car washing.

There are many possible ways of purifying car-wash water, all of them having advantages and disadvantages. One possibility is to use physico-chemical means to treat the car-wash water. This method employs flocculents or flocculent aids in liquid or solid form to cause the car-wash water to settle down or demulsify. Adding soaps during the washing process creates emulsions. Emulsions are particles negatively charged by emulsifying agents and form on the surface of oil droplets. The surface charge prevents larger droplets of oil from combining and rising to the surface of the water.

This means that emulsified hydrocarbon particles in the car wash water become evenly distributed. As destabilisation by means of cleavage agents occurs, the electrostatic forces between the particles are — to put it simply — neutralised through the accumulation of electrically opposed particles (ions or polar polymers).

This leads to a process of micro- or macro-flocculation whereby the flakes are carried off by means of

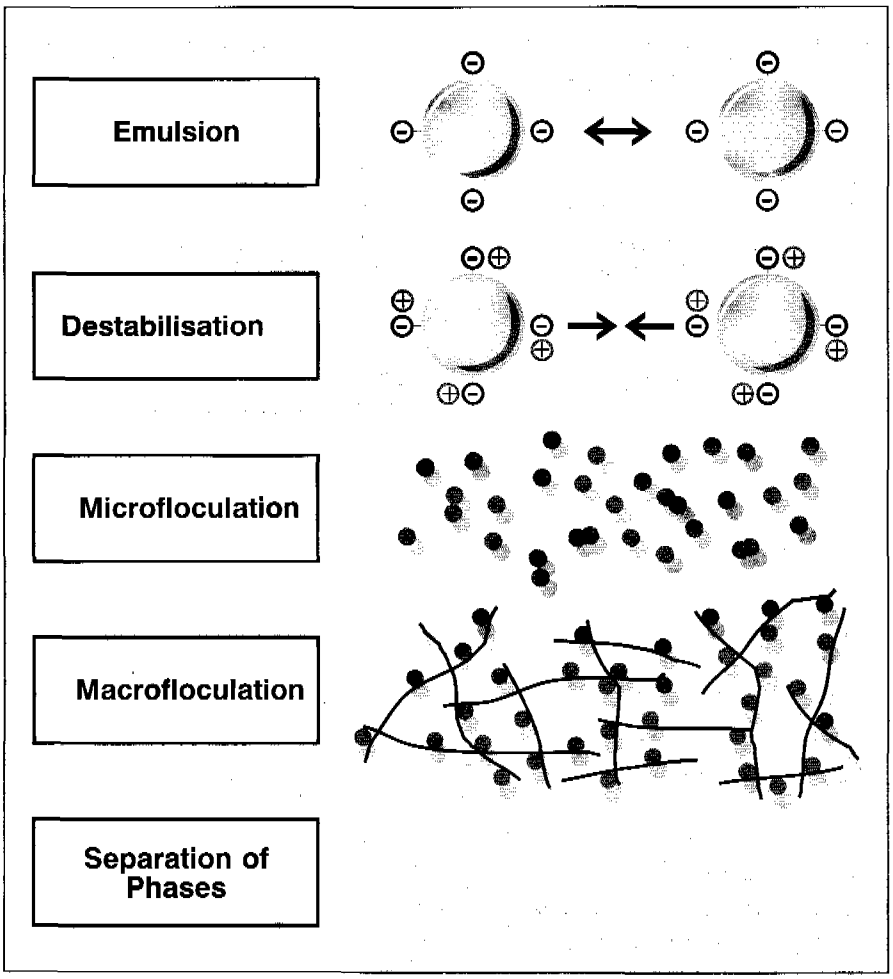

Figure 1. Physico-chemical wastewater purification method.

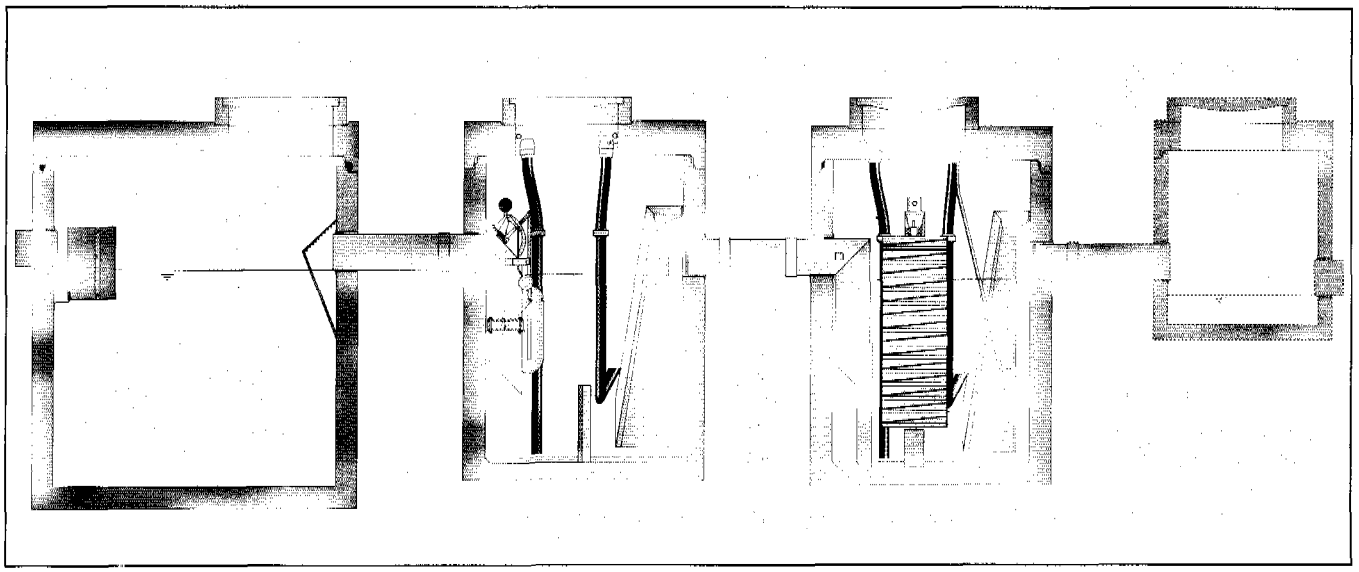

Fig 2. Three step biological separator: sedimentation, petrol separation and coalescence separator.

sedimentation or flotation. The disadvantage of this method is that it calls for very delicate machinery that requires servicing, and it forms silt, which is expensive to dispose of.

Biological purification

A further possibility can be taken from nature: biological purification. Waste water is treated and purified by means of micro-organisms and oxygen. We have copied this process. The purification of the wash water is carried out in three steps. The coarse cleaning process involves separation by means of sedimentation. Particles that are heavier than water are kept back by the silt trap.

The sediment (sand, dust, abraded tyre particles and so on) must be removed physically as far as possible, which requires optimum flow and a long time for the sediment to come to rest.

Next comes the petrol separator, which physically removes the hydrocarbons (petrol, oil, grease) that are lighter than water, by allowing them to float up to the water surface from the wash water. The petrol separator has an inlet, an automatic cut-off and an outlet. Its job is to separate over 97 per cent of the free — non-emulsified — hydrocarbons from the wash water. The automatic cut-off shuts off the petrol separator once it has exceeded more than 2/3 of its oil-storage capacity. After the automatic cut-off has been activated, the contents of the separator must be disposed of.

Adding cleaning agents to the car wash makes it more difficult for the hydrocarbons to rise to the surface of the petrol separator. The superfine hydrocarbon globules are <1µm in size, which means that they no longer have sufficient buoyancy to rise to the surface, and they are drawn through the petrol separator by the volume flow.

Here they enter the second purification stage, namely the coalescence separator, which is activated after the petrol separator.

Coalescence separator

In the coalescence separator the superfine globules are deposited on a material specifically adapted to this purpose, where they combine. Once they are large enough, their buoyancy causes them to break away from the material and they rise to the surface. In this way 99.9 per cent purification of the free hydrocarbons is achieved. The emulsified hydrocarbons are not held back in this process.

Afterwards, the water flows back into the water-recovery tank. This acts as intermediate storage for the service water, which is extracted as required. It is also the place where biological treatment is carried out by means of a natural, liquid and non-poisonous plant extract, which is 100 per cent biodegradable and bears the name Biowaterclean (BWC).

A large number of micro-organisms are able to absorb and convert organic compounds. All chemical reactions that create a change in existing compounds require a certain amount of energy to start them off.

Enzymes like BWC act as bio-catalysts. Their protein structure contains a so-called active centre that only binds certain molecules. The secret of waste-water purification is to use enzymes to decompose the waste-water ingredients and the emulsified hydrocarbons by adding atmospheric oxygen. The biologically purified water is fed back into the brush-washer plant via the service-water treatment plant which is equipped with coarse and fine filters and a booster pump.

The DYWIDAG service-water treatment plant has a base the size of a pallet. The basic version comes equipped with a RAM-programmed PC control unit and a 400µm coarse filter and a 100µm fine filter. The booster pump achieves a pressure of 4 bar at flow rate of 5m/h. Optional extras have already been provided for. These include a UV degermination facility, a conductivity meter for monitoring the salinity of the water in circulation, a pipe disconnector for emergency load supply, plus a differential pressure gauge for constantly checking the filter load. A circuit diagram displays any faults. It is also easy to upgrade later to higher flow rates of 10 or 15m/h and

pressures of 6 bar. Only approximately 10 to 15 per cent of the wash water lost on account of evaporation or ullage needs to be replaced with fresh water or rainwater, which can be collected from roofs and stored in a further container.

This form of plant engineering has proved its worth in more than 100 plants in the Federal Republic of Germany as a combination that is cost-effective, kind to the environment and reliable. ■

Biography

Uwe Barwig graduated as Diplom-Engineer and has been with Dyckerhoff & Widmann for nine years. Starting out as as sales engineer for separator and clarification plant technology in the north of Germany, he is now responsible for key-account management and marketing. Mr Barwig is deputy chairman of the German association for quality protection in separator systems.

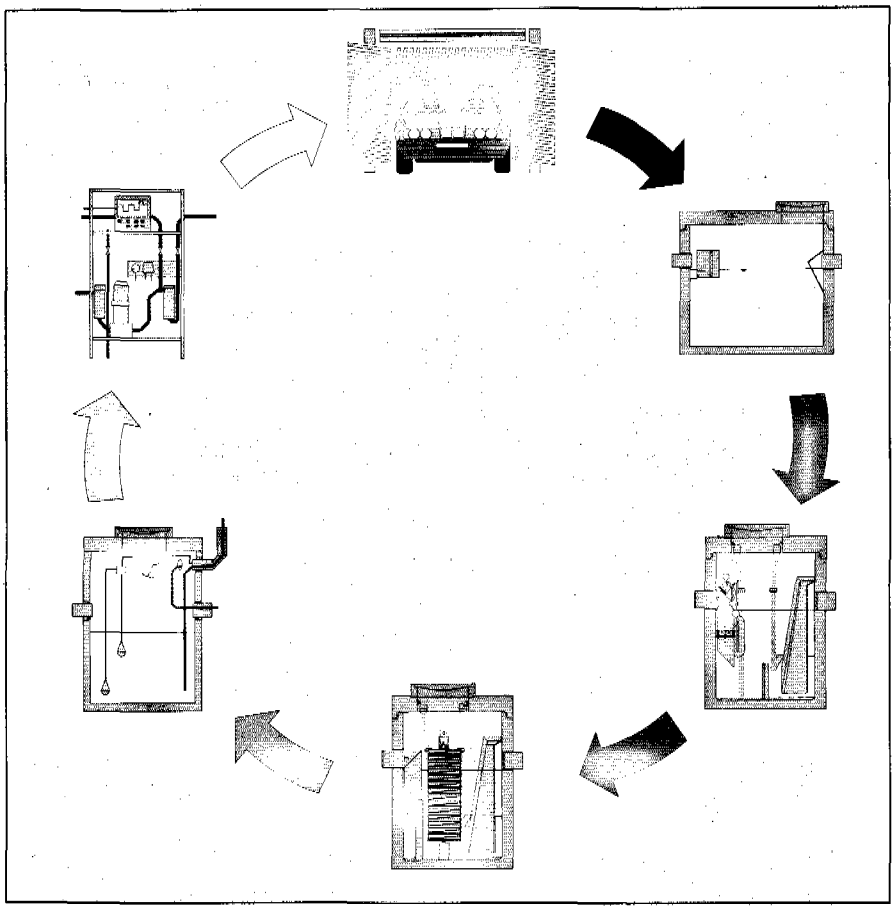

Figure 3. The DYWIDAG service water treatment system.

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Vacuum sewers can be cost-effective

Rich Naret, Airvac

Increasing water conservation and reuse is leading to decreased liquid being available in sewers to carry solids leading to operational difficulties and increased gravity-sewer costs. Could vacuum sewers now provide a cost-effective alternative in many cases?

Vacuum sewer collection systems were patented in the United States in 1888, when Adrian LeMarquand invented a system of wastewater collection by barometric depression. [1]

However, it was not until 1959 that the first commercial application of vacuum sewers were used by the Liljendahl Corporation (now known as Electrolux).[2] Three other companies soon joined this market: Colt-Envirovac, Vac-Q-Tec, and AIRVAC.

Operational problems with some of the early vacuum systems hindered substantial growth in the industry. As a result, three of these companies significantly curtailed their efforts after only a few years. Presently, almost all systems in the United States are AIRVAC systems.[3]

Since 1972, more than 100 vacuum sewer systems have been constructed in 21 different states in the US. A similar number of projects have been constructed in 11 other countries including Japan, Australia, the United Kingdom, France, Germany, Italy, Mexico, Canada, Thailand, Korea, and the Netherlands.

Experience with these operating systems has led to advancements in design, construction, and operational techniques. These factors, along with improvements in system components, have contributed to a reliable, cost-effective alternative for wastewater collection.

Certain general conditions are conducive to the selection of vacuum sewers:

- Unstable soil;
- Flat terrain;
- Rolling land with many small elevation changes;
- High water table;
- Rock;
- Restricted construction conditions; and
- Urban development in rural areas.

Another factor, water conservation measures, is likely to lead to an increased use of vacuum sewers. In the US, some states have passed regulations requiring new home construction to install low flush toilets to reduce water consumption. The goal is to reduce the standard toilet flush from 5 gallons (19 litres) to 1½gallons (6 litres).

There is some concern over the impact this reduction will have on the flow characteristics of the conventional gravity sewer, since there will be less liquid available to carry the solids. Modifications will have to be made in the design approach to gravity sewers; most likely this will mean larger lines and/or steeper slopes. The net result will be increased construction costs. Not relying on gravity flow, vacuum sewers will be unaffected.

For even more severe drought conditions, the use of a vacuum toilet may be required. Vacuum toilets require only about a quart (1 litre) of water to flush; however, a source of vacuum is required. Vacuum from the vacuum sewer main would provide this source.

The advantages of vacuum sewer systems include substantial reductions in water use, material costs, excavation costs, and treatment expenses.[3] In short, there is a potential for overall cost-effectiveness. Specifically, the following advantages are evident:

- Small pipe sizes, 3 in to 8 in (75mm to 200 mm) are used;
- No manholes are necessary;
- Field changes can easily be made;
- Wide, deep trenches are eliminated, reducing excavation costs and environmental impact;
- Trench dewatering and shoring is minimised;
- High scouring velocities are attained, reducing the risk of blockages;
- Sealed nature of system isolates maintenance personnel from harmful H_2S gases;
- Only one source of power is required;
- Treatment plant capacity and cost are reduced due to the elimination of infiltration;
- The air/sewage mixture moves at high velocity with the air providing a high degree of mixing action inside the vacuum sewers;
- The short detention times, along with the introduction of air, prevent sewage from becoming septic, thereby

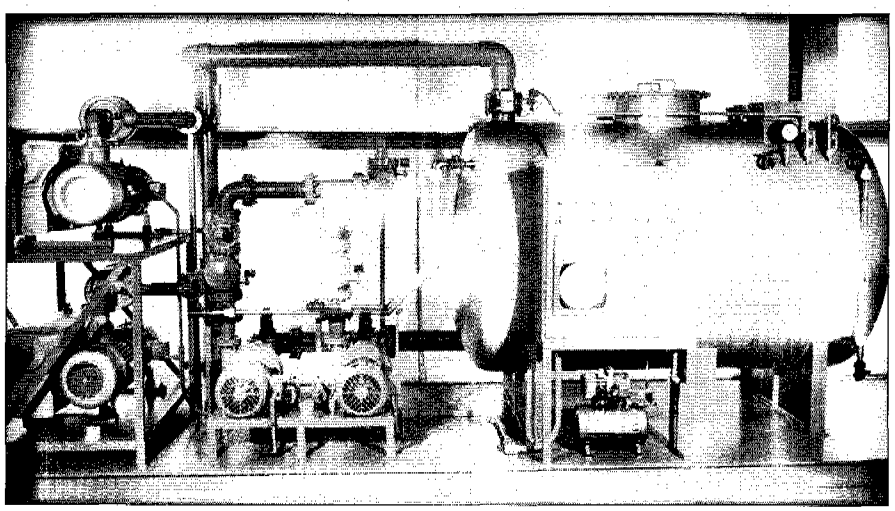

Figure 1. Vacuum station components

minimising odours.

Vacuum sewers use differential air pressure to move sewage. This requires a central source of power to run vacuum pumps, which maintain vacuum on the collection piping system. The system requires a normally closed vacuum/gravity interface valve at each entry point to seal the lines so that vacuum is maintained. These valves, located in a pit, open when a predetermined amount of sewage accumulates in the collecting sump. The resulting differential pressure between atmosphere and vacuum becomes the driving force that propels the sewage towards the vacuum station[3].

There are three major components in a vacuum sewer system: the vacuum station, the collection piping and the interface valve.

The major components of a vacuum station are vacuum pumps, sewage pumps, collection tank, and the control panel (Figure 1).

The collection piping network connects the individual valve pits to the collection tank at the vacuum station. Small diameter polyvinyl chloride (PVC) pipe is used in the US, while polyethylene (PE) pipe is used in most other countries.

Pipe fittings are used for directional changes as well as for the connection from the service line to the main line. Lifts or vertical profile changes are used for uphill liquid transport (Figure 2). These lifts are made in a sawtooth fashion. A single lift consists of two 45 degree fittings connected with a short length of pipe.

The vacuum valve provides the interface between the vacuum in the collection piping and the atmospheric air in the building sewer or sump. System vacuum in the collection piping is maintained when the valve is closed. With the valve opened, system vacuum evacuates the contents of the sump. Unlike early vacuum valves, today's are entirely pneumatic by design. Common valve sizes are 2-in (50 mm) and 3-in (75 mm), with the latter being the preferred size by most regulatory agencies.

Valve pits with sumps accept the wastes from the house. In the US, these consist of two separate chambers (Figure 3). The upper chamber houses the vacuum valve. The bottom chamber is the sewage sump into which the building sewer is connected. The combination valve pit/sump is made of glass-fibre, and is able to withstand traffic loads. Different versions of this arrangement are used in other countries, ranging from plastic valve pits to ones made from concrete.

Buffer tanks are used for large customers or when a pressure/vacuum or gravity/vacuum interface is needed, as would be the case with a combination system. Buffer tanks consist of concrete manhole sections that are modified to include sumps, multiple valves, and other miscellaneous hardware.

A 4-in (100mm) vent is installed on the homeowner's building sewer, downstream of all of the house traps. This vent is necessary to provide the volume of air that will drive the sewage in the main. Some entities require the vent to be located near a permanent structure for aesthetic and protection reasons.

Evaluation of operating systems

Some of the early vacuum systems were plagued with operational problems. Factors responsible for this were lack of hydraulic information, lack of established operating

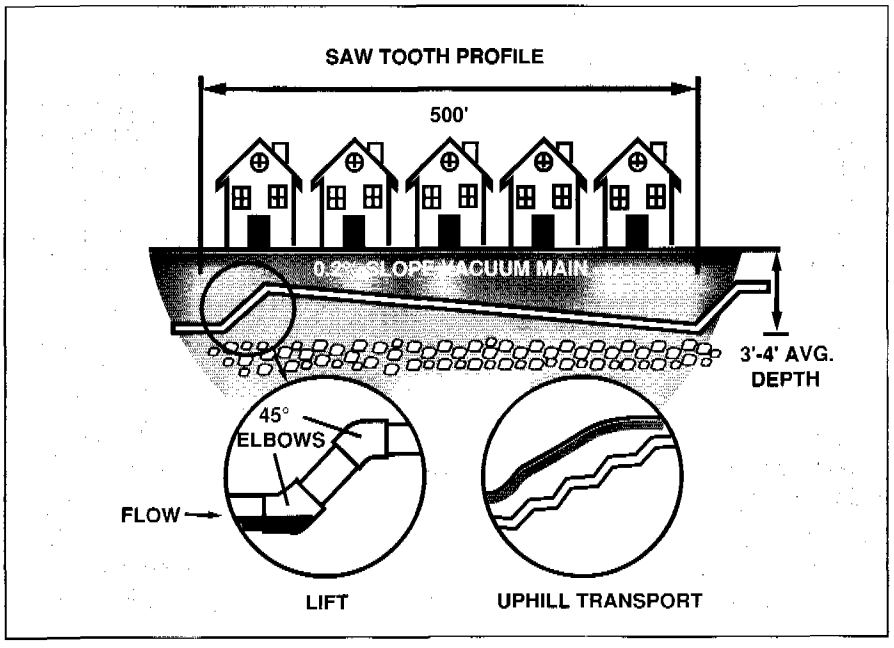

Figure 2. Vacuum sewer profile.

guidelines, lack of design standards, insufficient construction inspection, and component defects.

Some of these early systems were installed using a design philosophy based on plug flow. Movement of the plug through the pipe was attributed to the pressure differential behind and in front of the plug. Because pipe friction would eventually disintegrate this plug, a trap, called a reformer pocket, was built into the main line to allow the plug to reform and thus restore the pressure differential.

Systems installed in Maryland, Virginia and South Carolina in the 1960's were designed using this concept. Main lines as small as 3-in (75mm) in diameter were laid following the contour of the ground, resulting in cases where the bore of the pipe was completely sealed. Electronic valves, housed in 750-gallon (2800-litre) septic tanks, were used. The valves were set for a cycle volume of 300 gallons (1100 litres). This large slug of flow, introduced to a small line that was sealed in many locations, resulted in "waterlogging" problems. Waterlogging occurs when the pipeline fills with liquid, leaving insufficient levels of vacuum at the far ends of the system. Low vacuum levels lead to inconsistent transport and ultimately to many valve failures. Compounding the situation was corrosion inside the holding tanks that resulted in problems with the electronically controlled valve. The net result was an operation & maintenance (O&M) intensive system with frequent problems.

Some of the early systems of Colt-Envirovac and Vac-Q-Tec are currently being retrofitted with AIRVAC valves.[3]

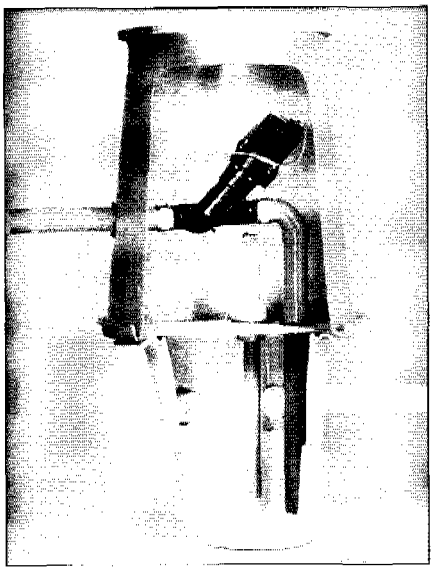

Figure 3. Valve pit components.

While this has increased system reliability, the inherit hydraulic problems caused by the small diameter pipeline and large cycle volume continue to result in less than optimum operation.

The current design concept used by AIRVAC is very much different from the early concepts. Pipe sizes are larger, usually 6-in (150 mm) and 8-in (200mm) with the use of 4-in (100mm) limited to short runs on branch lines. Line profiles are carefully controlled, with the majority of the pipeline having a positive slope. Rather than the bore of the pipe being purposely sealed, the piping network is designed to prevent this from happening. Cycle volumes, generally 10 gallons (38 litres), are much smaller than in early designs.

The combination of smaller cycle volumes, larger diameter pipelines and a controlled piping profile has led to a much improved transport situation. Preventing the pipeline from being sealed results in higher levels of vacuum at the extreme ends. These factors, along with the elimination of the electronic valve, have resulted in a much improved, more reliable system.

A study on alternative collection systems, including vacuum sewers, was done by the US Environmental Protection Agency (EPA) in 1989. One purpose of this study was to gather O&M data from operating systems, both early and recent, to see if any trends were evident. The results of this effort were published in the EPA Manual *Alternative Wastewater Collection Systems* (AWCS Manual) and are shown at the foot of the page.

Two trends are obvious from this table: recent systems are less energy intensive than their predecessors; and recent systems experience far less problems. The former is evidence that the current hydraulic design concept results in more efficient vacuum transport. The latter is a result not only of these improved hydraulics, but also is an indication of component improvements.

Since the first system went into operation almost 30 years ago, the interest in vacuum sewers has grown considerably. This trend is expected to continue into the next century, as the technology is introduced to more countries and more component manufacturers enter the market. ■

	Startup	Power Kwh/yr/conn	Service calls #/yr/100 valves
Ocean Pines, MD	1970	570	100
Westmoreland, TN	1979	460	10
Ohio Co, WV (PH 1)	1984	160	12
Lake Chautauqua, NY	1986	190	5
Ohio Co, WV(PHIIA)	1987	160	8
Central Boaz,WV	1988	230	17
White House,TN	1988	180	9
Ohio Co, WV(PHIIB)	1990	160	5

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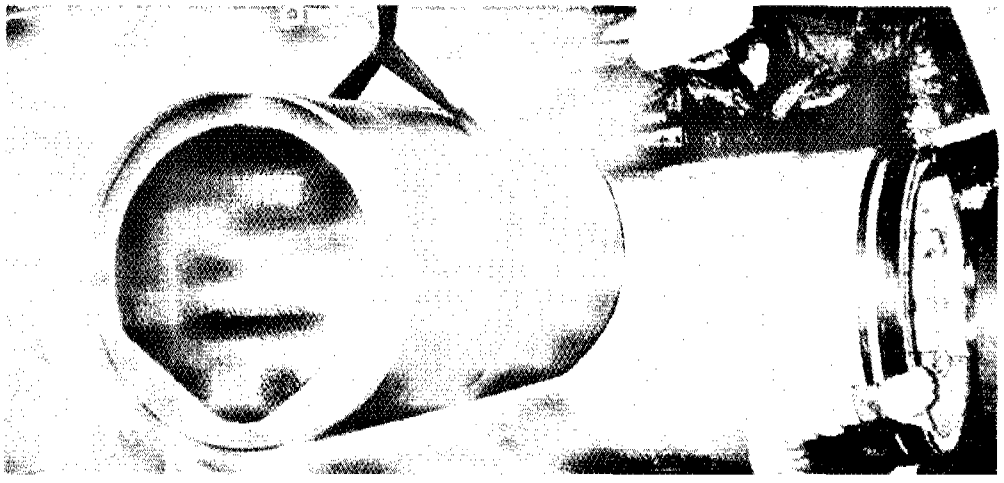
Biography

Rich Naret is a registered professional engineer with 17 years experience in wastewater. In 1988, he was selected by the EPA as an expert on vacuum sewer technology.



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Sewers and drains in polymer concrete

Thomas D Bloomfield, Meyer Pipes

Improved manufacturing has supplemented the well proven mechanical and chemical performance of polymer concrete for pipe construction. This article reviews the current state of the art with details covering the standards, approval and quality assurance in Germany.

Highly filled thermosetting resin concrete has been used for decades in the chemical industry, in engineering construction (machine foundations), in the building industry (facade products, sanitary parts) and in electrical engineering due to its favourable properties, especially its strength and elasticity as well as its corrosion resistance.

The material is also described as polymer concrete or mineral casting and is made up of the bonding agent, the thermosetting resin, and a large proportion of mostly mineral fillers.

Development of polymer concrete

The development of pipes in polymer concrete dates from the early 1960s. The aim was to achieve a "substantial increase in resistance to chemical attack from the inside and outside, and strength in respect of the stresses from external and internal loads whilst retaining the economical advantages of the pipe as a prefabricated finished part."[1]

Until 1969, around 50 000 tons of pipe had been manufactured in Germany from polymer concrete in the nominal diameters DN 300 to DN 3500 using polyester resin or epoxy resin as the bonding agent in either prestressed reinforced or plain designs. These were mainly used and tested as waste water collectors in the chemical industry, so that even then statements could be made about the reliability of the product technology.

Despite these successes and the outstanding properties of the product, pipes in polymer concrete were not permanently accepted in the market at first. Manufacturing was abandoned after some time either for cost reasons or due to the fact that aspects of the manufacturing technology had not been adequately mastered.

The processes for the production and manufacture of pipes and manholes in polymer concrete have been fundamentally improved over the past ten years, and it is now available as an economic alternative to other corrosion resistant pipe materials.

The material

Pipes in polymer concrete consist of up to 90 per cent quartzitic, oven-dried fillers, namely mineral sands and grit with a grading curve of 0 to 16 mm with polyester resin as a bonding agent. They do not contain any cement; instead the polyester resin brings about the bond between the fillers after curing and gives the pipes the additional positive properties of elasticity, safety against fracture and corrosion resistance.

Plastics are macromolecular compounds — large scale molecules that have originated from the amalgamation of smaller basic molecules. "Polymer" (Greek) means "consisting of larger molecules". Thus plastics are also described as high polymer materials and aggregates with plastic as a bonding agent are described as "polymer concrete".

Polyester, vinylester or epoxy resins are used as thermosetting bonding agents, according to the requirements set for the chemical resistance of the material.

Thermosetting plastics

These plastics are the so-called thermosetting plastics which are fully cured after a chemical reaction (polymerisation or polyaddition) and cannot be melted again. Quite the opposite to the thermoplastics, such as polyvinylchloride (PVC) and polyethylene (PE), which warp and finally melt under the effect of heat. This is caused by the different molecular structure.

With thermosetting plastics spatial grid molecules arise during the curing — three dimensional chemical compounds — whereas with thermoplastics single chain molecules form with disordered structures, which can slide against one another. In addition thermosetting plastics do not become brittle at temperatures below 0°C.

Manufacture

Polymer concrete pipes have been manufactured by various processes: by the centrifugal, centrifugal rolling and

vibrating processes both with and without reinforcement. In the vibration process currently used the materials are mixed in a computer controlled metering and preparation installation and then loaded into vertical metallic moulds, consisting of an inner core and an external mould. After compaction on the vibrating table, the pipe cures in the mould, is removed from the shell and then post cured in a tunnel kiln. Circular and oval pipes as well as special cross-sections such as manhole shaft pipes, cones and other auxiliary components can be manufactured in this way.

The pipe joint is manufactured from glass-fibre reinforced polyester resin (GRP) as a separate connector coupling by the winding process. The elastomer, sealing and spacer rings are laminated in with it. These meet the requirements laid down in DIN 4060 for "Sealing rings in elastomers for pipe joints".

Properties

The following mechanical material properties are obtained on finished pipes in polymer concrete:

- Compression strength 120N/mm²
- Modulus of elasticity 28000N/mm²
- Tensile strength 6N/mm²
- Ring bending tensile strength 20N/mm²
- Ring fatigue strength 18N/mm²
- Abrasion resistance 0.2mm per 100000 load cycles (Darmstadt procedure)
- Absolute wall roughness 0.01mm

Polymer concrete pipes with polyester resin as the binder are resistant against "very strongly corrosive and aggressive" media in accordance with DIN 4030. According to the type of resin they can even be used in environments with pH values of 1 to 13. For highly polluted wastewater polymer concrete pipes can also be manufactured with epoxy resin.

The advantages of pipes in polymer concrete lie therefore in their high corrosion resistance against aggressive wastewaters or soils, their great static load carrying capacity with their simultaneously relatively low weight, their low internal wall roughness and high abrasion resistance.

Table 1. Most commonly used diameters for jacking

DN	External diameter mm	Wall thickness mm	Construction length mm	Permitted compressive force kN
250	360	55	990 and 1990	800
300	400	50	990 and 1990	800
400	550	75	990 and 1990	1600
500	650	75	1990	2000
600	752	76	1990	2200
700	860	80	1990	2700
800	950	75	1990	2800
900	1100	100	1990	4600
1000	1180	90	1990 and 2990	3600
1200	1490	145	2990	7300

Sewer pipes

Sewer pipes in polymer concrete are manufactured with plain ends in 3000 mm construction lengths and in diameters of DN 300 to DN 2500 as standard.

There is no subdivision, for example into normal wall and reinforced wall pipes. A uniform pipe wall per nominal width simplifies stock-keeping and covers 85 per cent of all installation cases, using sand or gravel trench bedding materials.

Recommendations on the bedding provide the planner with some initial assistance and these indicate which bedding installations give sufficient safety in the specific native soil conditions. The ATV work sheet *A 127 Guideline for the Static Calculation of Drainage Channels and Pipes*, 2nd edition 1988, formed the basis of the calculations and the recommendations were checked by a certified expert. If required, a detailed static calculation can be made for the precise conditions of the project.

Manufacturing in dimensionally accurate steel casting moulds produces pipes with the lowest dimensional tolerances, which are circular over their whole length.

They are joined by means of a coupling made of GRP with a permanently integrated elastomer double lip seal with centre-stop web. The coupling is fitted on one end of the pipe in the works. The pipes and couplings are absolutely watertight when tested with a pressure of up to 2.4 bar. The elastomer seals are tightly anchored in the couplings and provide a chemical and ageing resistance which is equivalent to that of the pipes. Assembly is undertaken using standard commercial lubricants as is the case with all pushfit joints.

The pipes can also be supplied with 45° and 90° side connections.

Non-circular ≠sections

Oval or egg-shaped sections in polymer concrete are manufactured in dimensions in accordance with DIN 4263. Other dimensions, such as for example the egg-shaped sections of the "Sewer Construction Specification" of the City of Hamburg, which are split up into different "classes", can also be supplied.

The dimensions of egg-shaped sections are:

- Width/height 300/400mm to 700/1050mm; Construction length = 2.5 m; Wall thickness = 40 to 80 mm.
- Width/height 800/1200mm to 1400/2100mm; Construction length = 2m; Wall thickness = 90 to 150 mm.

The joint is made in exactly the same way as for the circular pipes with a coupling in glass fibre reinforced polyester resin with a firmly integrated elastomer double lip seal with a centre

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stop web. This coupling makes assembly just as simple as with the circular pipes. To make handling easier, transport anchors are built into the base of the egg-shaped sections.

Egg-shaped sections offer a range of advantages. They are hydraulically superior to the circular cross sections when there are marked fluctuations in the discharge rate associated with high wet weather flows and low dry weather flows. In dry weather discharge, the narrower cross-section in the base provides better drainage through its higher flow rate. The correspondingly higher scouring forces result in considerably less deposits. When there is torrential rainfall the water rises up to the top section and uses the wide reserve capacity.

Further advantages arise compared with circular pipes in respect of the carrying capacity through a lower load width and through the narrower trench width when pipelaying. Egg-shaped sections are simpler to inspect and easier to clean.

Jacking pipes

Jacking pipes in polymer concrete are manufactured with a wall thickness, which has been determined from experience to be adequate for the axial stresses of jacking. When calculating the permitted compression force, it is assumed that all the compressive forces have an eccentric effect upon half of the pipe cross-section through the steering movements of the tunnelling machine. The dimensions of the most commonly used diameters are listed in Table 1.

In special cases larger wall thicknesses can also be manufactured to take higher compressive forces.

The pipe joint consists of a mounted collar integrated into the pipe wall made of glass fibre reinforced plastic or alternatively of stainless steel, with a joint seal in microcellular expanded rubber and sealing sections on both sides, which are firmly joined to the pipe wall. A ring fitted in the works made of press board or knotless soft wood, for example spruce or pine, in a thickness of 10-25 mm, according to the pipe diameter, ensures uniform pressure transfer between the ends of adjacent pipes.

The cross-sections of jacking pipes do not have to be circular. Jacking pipes can be manufactured with egg-shaped, jaw-shaped or kite-shaped cross-sections. The pipes are locked together with bolts, in order to prevent any undesirable axial rolling of the individual pipes one against the other.

The pipe joint is similar to that of the standard jacking pipes. The jacking is trouble-free, but it must be ensured that rolling of the whole pipeline cannot occur during the jacking.

The extremely high compression strength of polymer concrete, the smooth surface of the pipes and the resulting low surface friction, as well as the flexible glass fibre reinforced plastic collar, which adjusts to the steering movements of the tunnelling machine and the movement of the following pipes, advantages the use of polymer concrete pipes in pipe jacking.

The compressive forces increase only slightly, even after long stoppage periods (for example, after a weekend) because of the smooth, nonabsorbent polymer concrete surface.

It is the "small extras" which often make pipe jacking considerably easier to carry out. For site arrangements, which make bentonite lubrication of the jacking pipes necessary, injection sockets are fitted in the pipe wall in the works with a check valve and blanking plug.

For longer tunnelling lengths the necessary intermediate pressure stations can be supplied, adjusted precisely to the pipes and into which the hydraulic presses are inserted on site.

Precisely fitting connection pieces are economically manufactured in polymer concrete for the different machines and asymmetrical pressure transfer rings can be manufactured for curved stretches.

Manholes

The basic idea when manufacturing manholes in polymer concrete was to construct a completely corrosion resistant and leak proof system together with the polymer concrete pipes for the drainage of waste water.

In doing this as much work as possible should be transferred from the installation site to the workshop: manholes should be easily transportable and capable of being laid in one piece and should be supplied to the contractor at short notice with dimensions matching precisely those required at the site. This aim has been largely achieved by special manufacturing methods. Today even complicated manholes with many varied pipe connections, floor configurations, channel bends and internal and external bottom drops can be delivered to the site ready for installation, within a few days.

The system manholes in polymer concrete correspond fully to the pipes in their material and wall design. The bottom section of the manhole consists of one piece. All types of pipes with the appropriate fittings for the respective type of pipe can be connected to it. The bottom section of the manhole is simply drilled and the appropriate fitting fixed tightly in place.

This results in the following diameter correlations in accordance with DIN 4034:

System manhole	Connections
DN 1000	up to DN 500
DN 1200	up to DN 800
DN 1500	up to DN 1000

Where there are larger connection diameters, manholes are manufactured from polymer concrete as prefabricated slabs, which are largely assembled in the works and then only have to be fixed together on site according to the transportation conditions prevailing.

The step and channel of the system manhole are manufactured to the precise size from seamless polymer concrete screed on preformed sub concrete. The smooth contoured surface is particularly beneficial to the hydraulic flow. Climbing aids such as climbing irons, stirrups or ladders are fastened in the manhole wall with stainless lock nuts.

The manhole is delivered in one piece with all the connections and with

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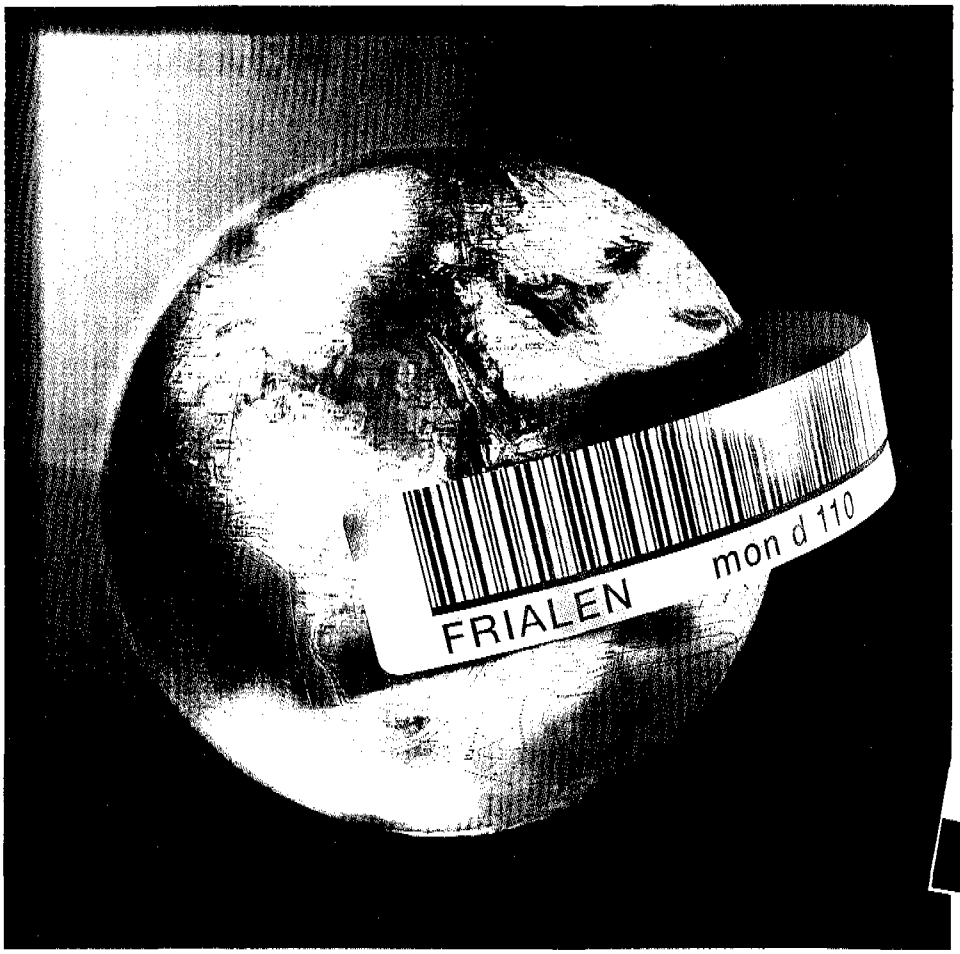

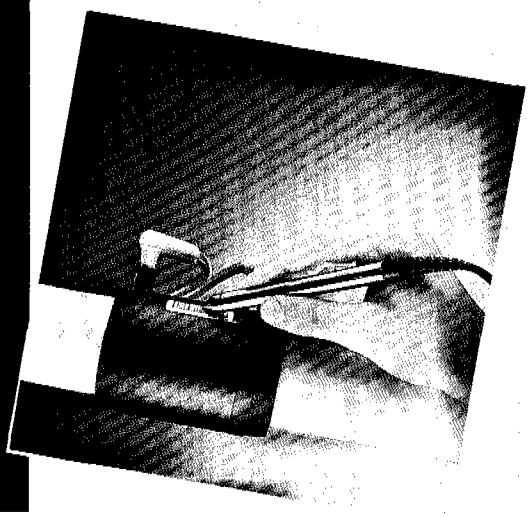

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the shaft pipe stuck on (length 3 m maximum). It is lowered into the trench attached on a transport clamp and connected to the laid pipeline like a fitting. Where there are greater assembly depths further shaft pipes are butt jointed on site. In deep installations where DN 1200 and DN 1500 manholes are being used, cost reductions can be obtained by reducing the shaft diameter to DN 1000. This diameter reduction is normally made in the shaft at heights above normal head clearance.

The manhole is securely anchored against buoyancy uplift in the ground by the projecting manhole base. Where there is a very high water table the base projection can be enlarged on manholes with a continuous shaft. Manholes with a reduced shaft are always safe against uplift.

Fitting length, side connections

Pipes and adapting pipes are manufactured to size in the works, so that no further machining is normally necessary on site. If an alteration in the route occurs at short notice or the precise manhole spacing are not fixed in time, then the manufacture of fitting lengths is possible on site.

The pipes can be shortened using an abrasive blade. Since the pipes have the same outside diameter over the whole length, the adapting pipe produced in this way after cutting and chamfering can be joined to the pipeline without any problem.

Side connections for property and road drainage with diameters DN 150 or DN 200 are manufactured in the works or on site with sockets or connections for approved pipe systems. The required bore holes for sockets or diagonal bores for 45° connection branches are performed with standard commercial core drilling instruments with a diamond drill head. 45° side connections are only required up to DN 400 as per ATV work sheet A 139. It is therefore advisable for all other connections to be at 90°.

Range of applications

Pipes and inspection chambers in polymer concrete are generally used to build sewers and drains, which are operated as nonpressure pipelines. They can however also be operated as sewage pressure pipes with a nominal pressure of PN 1.6 in accordance with the minimum requirements for sewers in zone II water protection areas, where they are open laid (see ATV draft M 142).

Maintenance and cleaning

It is not always possible to select the cross sections and falls of the channels. Discharge conditions will fluctuate and flow rates may not be high enough to remove deposits, thus cleaning work may be required. Nowadays virtually only high pressure cleaning is used for this work. It is increasingly necessary for operators to consider to what extent the individual pipe materials are stressed by the high pressure cleaning.

New test results[2] show a clear correlation between abrasion resistance and the capacity for resistance to stress from high pressure channel cleaning for various materials. It was moreover determined that a higher sand or filler content on the inner surface of the pipe wall considerably increases the resistance to high pressure cleaning.

In the case of pipes in polymer concrete a high abrasion resistance and a very good resistance to high pressure washing is guaranteed by the uniformly high content of quartzitic fillers over the whole pipe wall, i.e. also on the inner wall of the pipes.

Standards

The basic standard DIN 54 815 "Pipes and fittings in polymer concrete" is currently in preparation and is being compiled in working group 505.1 of the Plastics Engineering Standards Committee in DIN.

The following standards must be complied with when manufacturing pipes in polymer concrete: Reaction resin with the moulded material properties as per DIN 16946, part 2, at least type 1130. Quartz aggregates as per DIN 4226, part 1, table 3 (maximum grain 16 mm).

The following standards are applicable with regard to the laminate design of the connector coupling: glass according to DIN 6185055, unsaturated polyester resin as per DN 16946, part 2, at least type 1130.

The elastomer sealing sections must comply with the requirements of DIN 4060.

Approval and quality assurance

The seal of approval PAI3939 was granted for sewage pipes in polymer concrete and its couplings in GRP, by the Institut für Bautechnik (Institute for Structural Engineering), Berlin.

Pipes and components in accordance with this ruling may be used as nonpressure sewers laid underground and as pressurised sewer lines with a nominal pressure of PN 1.6 bar to drain sewage according to DIN 1986.

The pipes are subject to regular quality inspections which are subject to outside assessment by the Government Material Testing Authority (MPA) of North RhineWestphalia.

Perspectives for the Future

The well proven mechanical and chemical performance of polymer concrete has been supplemented with improved manufacturing technology which now makes the material an ideal choice for pipes for use in microtunnelling, jacking and sewer applications in general. Increasing use of this material is being seen and world-wide licensing of this new technology will continue this trend.

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Biography

Thomas Bloomfield has been Sales Manager of Meyer Pipes Engineering since 1993.

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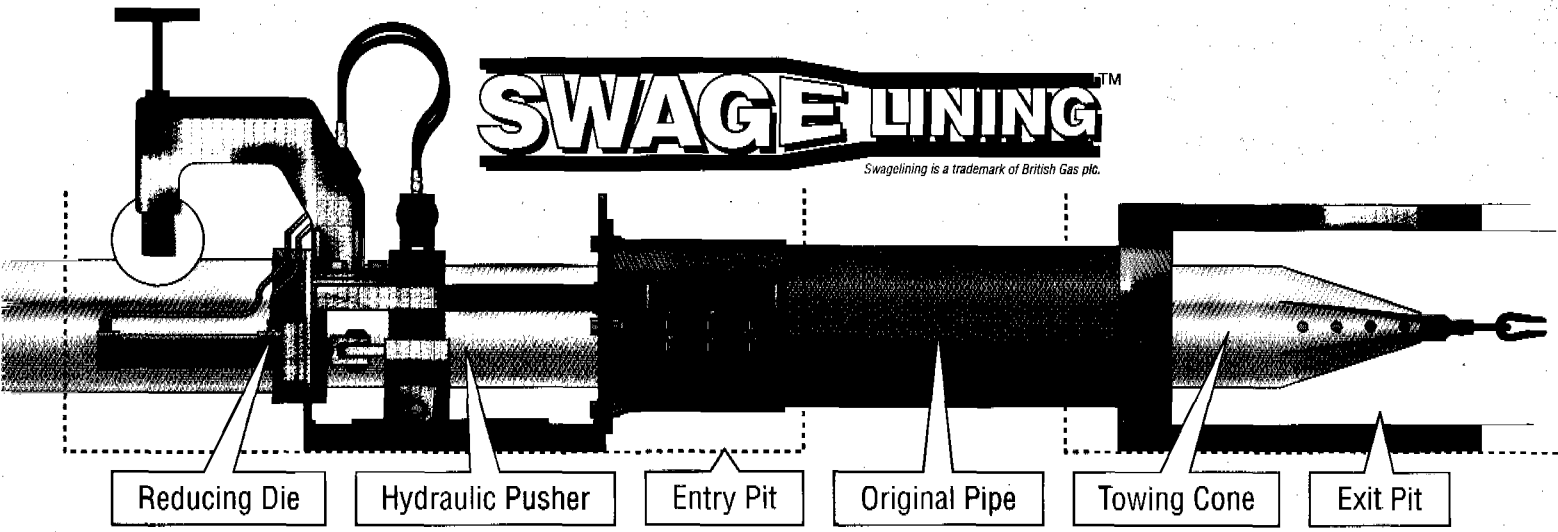

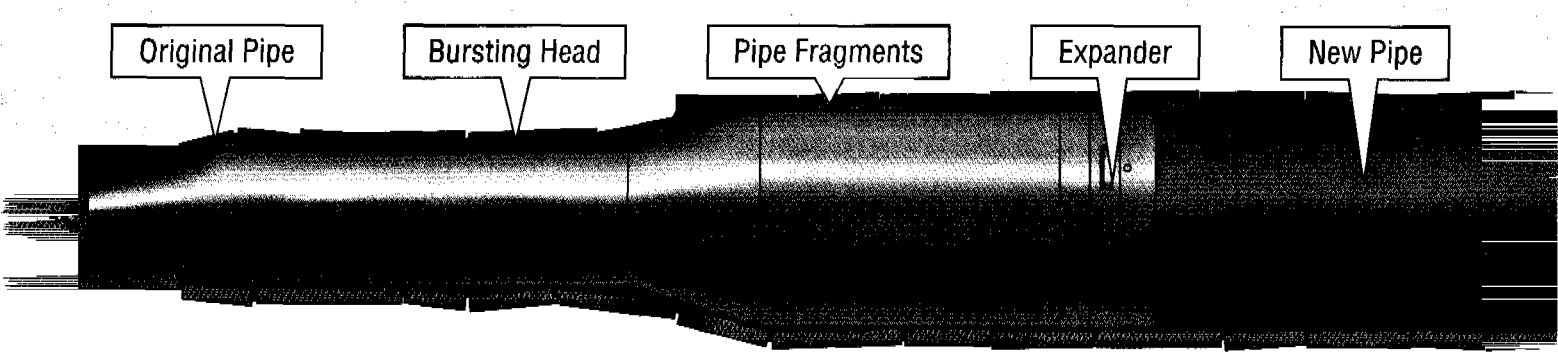

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Rehabilitation of mains and sewers in Baltic lands

Viatek Group

Viatek Group Ltd offers a wide scope of planning and consulting engineering services for the development of infrastructure, industry and construction. Since founded 1962, Viatek has grown into market leader in Finland in the field of infrastructure design, environmental planning and road, traffic and geotechnical engineering. Viatek is today working for better water supply and sewerage systems in Russia and the Baltic States.

Under the streets of St. Petersburg there is 12 500km of water mains and sewers. The networks are suffering from the lack of maintenance. Now the systematic maintenance is taking its first steps.

Viatek is involved in two major projects. The other is the rehabilitation of the sewers of Nevsky Prospect sweet, which is the main shopping mall of St Petersburg and at the same time the most important road connection through the city. According to project manager Mr Matti Ojala from Viatek, the sewers are in need of rehabilitation but their condition is better than expected. The sewers have filled with silt to a high degree which on the other hand has enabled them to keep in shape.

The other project is the rehabilitation of the sewers of the State Hermitage Museum. The project is interesting not least by its very historic nature, says project engineer Mr Kai Vakkila.

Mapping of the sewers, management of the huge amount of information about the state of the sewers and the routine parts of planning and design is made by using KureCAD software package, which is a success story of Viatek. The software package was first taken into use by Helsinki City Water Works and then in other major Finnish cities. Now KureCAD is modified and translated into English, Russian and Estonian languages. KureCAD is a member of VID-Infrastructure Design and Management software family, which also includes software for Facility Management.

The Estonian version has been taken into use within Tallinn Water Works and as a continuation of this project, Viatek is now involved as consultant in a European Commission (Phare) funded Tallinn Water Supply and Sewerage Rehabilitation project. Because of the same linguistic background, similar nordic weather conditions with Finland and the nearby location it will be a comfortable project for the Finnish expatriates, says Matti Ojala.

If we continue on the coast of the Gulf of Finland towards the Baltic Sea, we find the next Viatek project in Latvia in the tiny town of Cesis. An infiltration/leakage study of sewerage system has been started with training package.

Training is one of the key tasks of the projects. The transfer of knowhow has been arranged by giving theoretical training and on the job training.

According to deputy managing director Mr. Seppo Mäki, Viatek will be active on the growing market from Barents Sea through western Russia and Baltic States down to Poland wherewater supply and sewerage as well as the environment in general and other infrastructure isin need of immediate action. By data collection, planning and systematic maintenance the infrastructure can be brought to an international standard in order to reduce pollution and to support the economy and social life of these countries.

Through cooperation with leading contractors in the field of pipeline rehabilitation Viatek has been able to offer turn key NoDig rehabilitation contracts. There seems to be a market for this type of complete planning, design and implementation says Mr Mäki.

Financing is, of course, in key role. The Ministry of the Environment of Finland has made great efforts to promote the projects and without the Finnish funds many projects could have been left on table. Now the European money (EBRD, Phare, Tacis etc) and also World Bank money is finding its way to the area of 50 million inhabitants whose common concern is to protect the Baltic Sea and the Gulf of Finland. □

Advances in PCC pipe technology

HH Bardakjian, Ameron

New US standards for prestressed concrete cyclinder pipe (PCCP) technology have allowed manufacturers to produce pipes with better long-term durability and include consideration of environmental considerations to allow appropriate corrosion control.

In the early 1990s, significant quality enhancements were made in the design and manufacture of Prestressed Concrete Cylinder Pipe (PCCP), a product widely used in successful water transmission systems around the world for more than 50 years.

New and revised standards were introduced by the American Water Works Association (AWWA) in 1992, and these standards have become primary references for the design and manufacture of PCCP pipelines in many other countries. The AWWA C304-92 Standard governs PCCP design, and the AWWA C301-92 Standard covers manufacturing. These standards are based on state-of-the-art procedures and controls that were developed through the cooperative efforts of water agencies, consultants, and pipe manufacturers represented in the AWWA committees.

Background

There are two types of prestressed concrete cylinder pipe:

- Lined-cylinder type with a core composed of a steel cylinder lined with concrete and subsequently wire-wrapped directly on the steel cylinder and coated with cement mortar; and
- Embedded-cylinder type with a core composed of a steel cylinder encased in concrete and subsequently wire-wrapped on the exterior concrete surface and coated with cement mortar.

First manufactured in the US in 1942, the lined-cylinder type is generally furnished in sizes from 16in (410mm) to 60in (1520mm). The embedded-cylinder type, which was developed later and first installed in 1953, is commonly manufactured insizes 60in (1510mm) and larger.

The first edition of the AWWA C301 Standard governing PCCP manufacture was approved in a preliminary form in 1949; it was revised and made standard in 1952. The third edition of the Standard, issue in 1964, included combined loading procedures (Appendix A and Appendix B). The Standard was revised again in 1972, 1974 and 1984.

Prior to the development of the new standards in 1992, design of PCCP was governed by two distinct procedures, designated Methods A and B and described in Appendices A and B of AWWA C301-84. Although the two design methods produced similarly conservative results that had served the users of PCCP well for nearly half a century, it was decided that the two methods should be replaced by a unified method of design with the following features:

- It is based on state-of-the-art procedures;
- It accounts for the state of prestressing in the pipe;
- It accounts for all external and internal conditions of loading;
- It agrees with the results of 40 years of experimental data;
- It precludes the onset of visible cracking under working pressure plus transient conditions; and
- It provides adequate safety factors based on elastic and strength limit states.

PCCP structure

The main components of installed PCCP, embedded cylinder type, are shown in Figure 1. The welded steel cylinder and joint ring assembly function as a watertight membrane, provide longitudinal tensile strength, increase beam strength, and eliminate the need for longitudinal prestressing.

Prestressed concrete core

The prestressed concrete core is the principal structural element in the pipe. The core is cast in steel moulds, producing a smooth interior surface with low resistance to flow. After the concrete has attained a specified initial compressive strength, it is helically wrapped with prestressing wire under controlled tension. This induces a predetermined circumferential compressive stress in the

pipe core that offsets tensile stresses resulting from internal pressure and external loads.

The principal function of the cement-mortar coating is to prevent physical damage and corrosion of the prestressing wire. The coating also is an integral structural element that adds to the strength and rigidity of the pipe.

In the assembled joint, the rubber gasket is compressed between the bell and spigot rings, completely filling the spigot groove and forming a water-tight seal between adjacent pipe sections. The joint permits relative movement between the assembled pipe sections, within prescribed limits, without affecting the watertight status of the joint. Cement mortar that fills the interior and exterior joint spaces completes the joint and protects the steel joint rings from corrosion.

Development of AWWA C301-92 and C304-92 standards

Development of the new AWWA standards was accomplished through input and cooperation efforts of agencies, consultants, and pipe manufacturers represented in the AWWA Concrete Pressure Pipe Committee. Development of the Unified Design Procedure was started by the American Concrete Pressure Pipe Association in 1984.

While the Unified Design Procedure was being developed, an analytical model was created to predict the behaviour of PCCP subjected to combined loads (Zarghamee and Folk 1990, Ref. No 11 of Appendix B of AWWA C304). The model accounts for non-linearities of the stress-strain relationships of the constituent materials, including tensile softening and cracking of the core concrete and mortar coating, and for moment redistribution as the stiffness at sections around the pipe circumference change with load (Zarghamee 1990, Ref 10, Appendix B of AWWA C304). (The AWWA C304-92 Standard, Design Procedure Overview, is beyond the scope of this article.)

Major revisions introduced by the AWWA C301-92 standard

Major revisions and enhancements are categorised below based on the main components of PCCP: the steel cylinder, the concrete core, the prestressing wire, and the cement mortar coating. Revisions to the fittings and special pipe section and pipe design are also discussed.

Steel cylinder

- The minimum cylinder thickness for pipe 36in (910mm) and smaller was increased to 0.0598in (1.5mm, 16ga) from 0.0478in (1.2mm, 18ga).
- The minimum yield strength of the steel cylinder was increased to 33 000 psi (227MPa) from 30 000psi (207MPa).
- A qualification requirement for all welders and welding operators was added.
- Minimum physical tests and measuring frequency for steel cylinders are now required.
- A requirement for testing cylinder weld strength was added.

Concrete core

- A minimum limit for fine and coarse aggregate specific gravity was added and a minimum testing frequency for fine and coarse aggregates is now required.
- The maximum water-cement ratio of the concrete mix was reduced to 0.50 from 0.55.
- Required procedures to maintain concrete quality during hot weather were added.
- A requirement to limit the accelerated curing temperature of the enclosure during the entire 4-hour delay period to 95°F (35°C) was added; and the maximum accelerated curing temperature of the enclosure after the 4-hour delay period was reduced to 125°F (52°C) from 150°F (66°C).
- A limitation on allowable longitudinal cracksin pipe cores was added.

Prestressing wire

- The minimum diameter of prestressing wire was increased to 0.192in (4.9mm) from 0.162in (4.1mm).
- A requirement was added for wire manufacturers to audit surface temperature of the wire during the drawing process to provide assurance that the maximum does not exceed 360°F.
- All mechanical tests on prestressing wire are required to be performed by the wire manufacturer on a sample from every coil of wire, and the minimum allowable results were substantially improved.
- A criteria defining the acceptable type of break in the torsion test was added.
- All mechanical tests on prestressing wire are required to be performed by the pipe manufacturer on every tenth consecutive coil.
- Wire-relaxation test requirements were added.
- A minimum rate for application of slurry immediately prior to prestressing was added.
- The maximum allowable fluctuations in wire tension during prestressing were decreased.

Cement-mortar coating

- The minimum allowable mortar coating batch moisture content was increased to 7 per cent from 6 per cent.
- A requirement for checking mortar coating thickness on every pipe was added.
- A requirement for testing mortar coating absorption was added, establishing a maximum absorption average value of 9 per cent.
- A minimum 28-day mortar coating compressive strength requirement of 5 500psi was added.
- A requirement for checking soundness of the mortar coating on each pipe was added.
- A requirement to protect the mortar coating against excessive heat and aridity during pipe manufacture and storage was added.

Fittings and special pipe

- Allowable design stress and minimum cylinder thicknesses were added.

Pipe design

■ The design appendices were deleted since the revised design procedure for AWWA C301 pipe is now covered in the AWWA C304-92 standard.

Quality enhancements in AWWA C301-92 standard

The major revisions to AWWA C301-92 standard resulted in the following quality enhancements:

Steel Cylinder

The welding qualification requirements and additional material physical tests and weld tests ensure a watertight steel cylinder up to its tensile strength.

Concrete core

The long-term durability of the concrete core is ensured by the minimum specific gravity requirement, testing frequency required for aggregates, lower water-cement ratio of the concrete mix requirement, required procedures to maintain concrete quality during hot weather, and lowering the maximum accelerated curing temperatures.

Prestressing wire

A requirement for wire manufacturers to audit surface temperatures of the wire during the drawing process, increasing the frequency of physical tests on samples from every coil, and the substantial improvement of the minimum allowable physical test results ensure that the prestressing wire is not strain-aged during the wire drawing process and also ensure that the wire has ductile properties.

Mortar coating

Increasing the minimum moisture content of the mix, the requirement of absorption and compressive strength tests, and a mortar coating soundness test on every pipe section ensure a dense and sound mortar coating, thus enhancing the structural and corrosion-protective properties of the cement mortar.

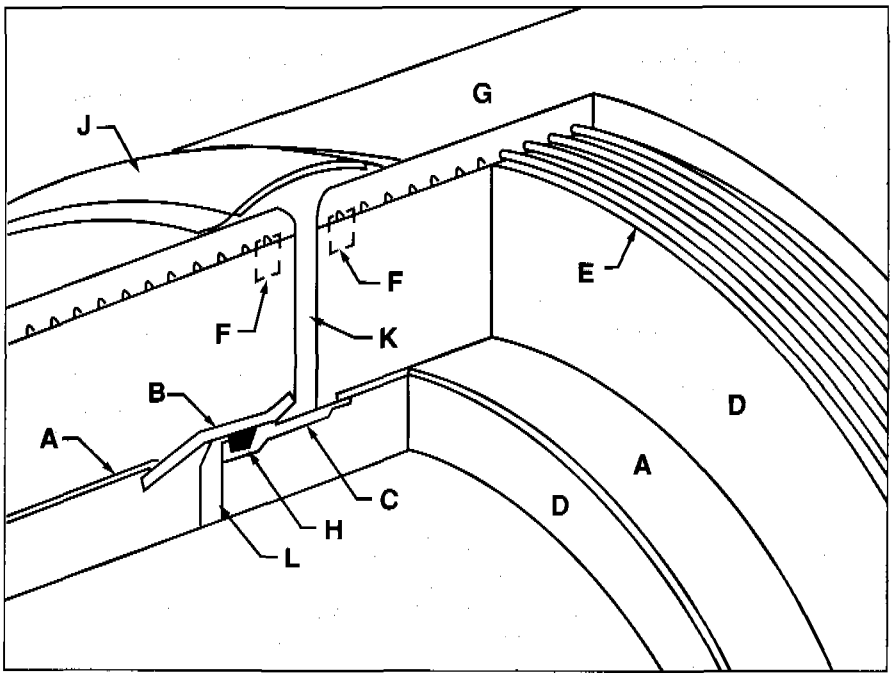

Figure 1. Components of installed prestressed concrete cylinder pipe: A steel cylinder (A) with steel bell and spigot joint rings (B) and (C) welded at the ends is embedded in the high-strength concrete core (D). High-tensile prestressing wire (E) is helically wrapped around the core and secured at each end by anchors (F) embedded in the concrete. A dense cement mortar coating (G) encases the wrapped core. A round rubber gasket (H) is placed in an annular groove in the spigot ring just prior to field assembly. A grout band (J), wrapped around the joint and firmly strapped on both sides after field assembly, serves as a mold for cement-mortar grout (K) poured in the exterior joint space. The interior joint space is pointed with cement mortar (L).

Recommended design considerations

The following design considerations are recommended:

■ Define project conditions and requirements, including diameter, internal pressures, earth cover loads, trench width, backfill soil properties, bedding and compaction requirements;

■ Conduct a soil-resistivity survey along the pipeline right of way to determine if any additional soil chemical analysis is required;

■ Design the pipein accordance with AWWA C304 and any additional project requirements;

■ Manufacture the pipein accordance with AWWA C301-92 and any additional project requirements;

■ Install and handle the pipein accordance with project specifications, appropriate safety rules and regulations and good construction and installation practices. The following are additional recommendations:

- Although mortar coating provides reasonable protection against physical damage, it is recommended that the steel cables used during unloading, handling and installation be padded.
- Most specifications include backfill material requirements, butin no case should objects or rocks that exceed 3 inchesin diameter bein backfill placed within 12 inches of the pipe.
- In case of accidental damage to the mortar coating during installation, the mortar coating should be repairedin accordance with owner's requirements or pipe manufacturer's recommendations prior to backfilling;

■ The following corrosion-control provisions are recommended as part of the manufacture and installation of all PCCP buried pipelines:

- Provide a steel shorting strap under the prestressing wire.

• Make all steel components in the pipe electrically continuous.
• Electrically bond the joints of installed pipe.
• Fill interior joint recesses with cement mortar.
• Fill exterior joint recesses with cement-mortar grout confinedin polycthylene foam lined grout bands.
• Establish a pipeline monitoring system;

■ To increase the factor of safety against corrosion, the application of a supplemental coating over the cement mortar is recommended for PCCP pipelines installed in adverse environments such as:
• Low resistivity soils with high chloride content
• Acidic soils
• Prolonged stray current electrolysis

Conclusions

■ The design procedure of AWWA C304-92 is a rational procedure based on state-of-the-art structural engineering practices for concrete structures. Using parameters established through many tests of PCCP and its constituent materials, the procedure is substantiated by an analytical model and combined load verification tests;

■ The additional controlsin AWWA C301-92, including prequalification material testing and quality enhancements to the prestressing wire and cement mortar coating, provide assurance for the long-term durability of PCCP; and

■ In addition to proper pipe design, manufacture and installation considerations, the planning and design of pipelines, including PCCP, should include consideration of environmental conditions to which the pipeline will be subjected so that appropriate corrosion-control measures can be taken, if necessary.■

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Biography
HH Bardakjian is chief engineer in the Concrete and Steel Pipe Group of Ameron, based in the company's offices at Rancho Cucamonga, California, USA.

Benefits to sewers from CCTV surveys

Robert Harley, Insight Surveys

Closed-circuit TV surveys of small-diameter sewers are now the industry standard for sewer inspection in the UK. But advances in generating and analysing the data from the surveys is significantly increasing the benefits derived from such techniques.

Internal condition surveys of sewerage networks by closed circuit television (CCTV) systems are now a water industry standard method of gaining structural and service condition information in smaller diameter sewers (typically up to 1500mm diameter).

The methods used have evolved from early monochrome inspections undertaken in the 1970s to the sophisticated, remotely controlled, colour surveys, which are today used worldwide.

High quality colour images of the sewer under inspection are provided with the modern camera's ability to pan, tilt and zoom. Intrinsically safe camera systems are now available, suitable for entry into potentially hazardous atmospheres, and sonar imaging can be attached to the CCTV unit in order to survey the portion of sewer underwater, or be used in isolation for surveying fully surcharged sewers. With more powerful self-propelled units and increased specifications in all aspects of the equipment, there are now very few sewers that cannot be inspected successfully.

Whether a client requires specific information about a particular length of sewer, for instance, prior to above ground construction over a sewer, or is undertaking a complete drainage area study, CCTV has become an essential tool in the determination and planning of the most cost effective solution available. For sewers greater than 1500mm diameter, man entry (ME) techniques are still prevalent, although where ME would be considered unsafe, sewers up to 4500mm have been inspected by CCTV.

Along with developments in CCTV hardware have come great advances in generating and analysing data resultant from CCTV surveys. In the UK, and some overseas countries, it is now mandatory for the CCTV operator to be familiar with defects observed within sewerage systems and his/her ability to code these defects to an approved standard is proven by outside certification, allied with stringent in house quality checking, in order to provide the end user with as accurate information as possible.

Data generated in the field is computer processed back at the office base, or occasionally on site for certain applications, and the final report is produced in digital format compatible with the clients' requirements.

Recently the industry has seen the arrival of survey information being recorded onto compact disc (CD ROM), this allows the end user to view parts or all of the sewerage network direct from a personal computer (PC).

With the advent of geographic information systems (GIS), the end user can now interrogate all aspects of the sewerage system by using interrelational databases. The client can, for example, call onto the screen background mapping data, overlay the sewerage network and then, by using a mouse or other pointing device, "click" on a manhole icon and see immediately the attribute data of that particular feature. The client can also "click" anywhere on a pipeline and immediately view that section of CCTV survey on screen.

This latest development has significantly increased the benefit of CCTV surveys by integrating all aspects of sewer survey and by allowing fast access to information. There is no longer a need for dedicated TV monitors and video cassette players, no longer a storage problem with VHS format cassettes, nor is costly time wasted in locating a particular section of video tape. Further, more than one user can view data simultaneously if the CD ROM is available to a network.

Now that information is held digitally comparison is possible between surveys of a particular feature undertaken at different times, thus aiding the engineer to prioritise programmed maintenance. By providing data in a nationally agreed format defects observed can be graded and each length of sewer surveyed can be ranked in decreasing order of structural deterioration, this allows the client the ability to determine where resources will be most effectively committed. The CCTV survey industry has come a long way and, by sustaining the use of the techniques developed, future developments are sure to be as beneficial as those outlined above. ■

Biography

Robert Harley is a Director of Insight Surveys and has worked for the company since 1977.

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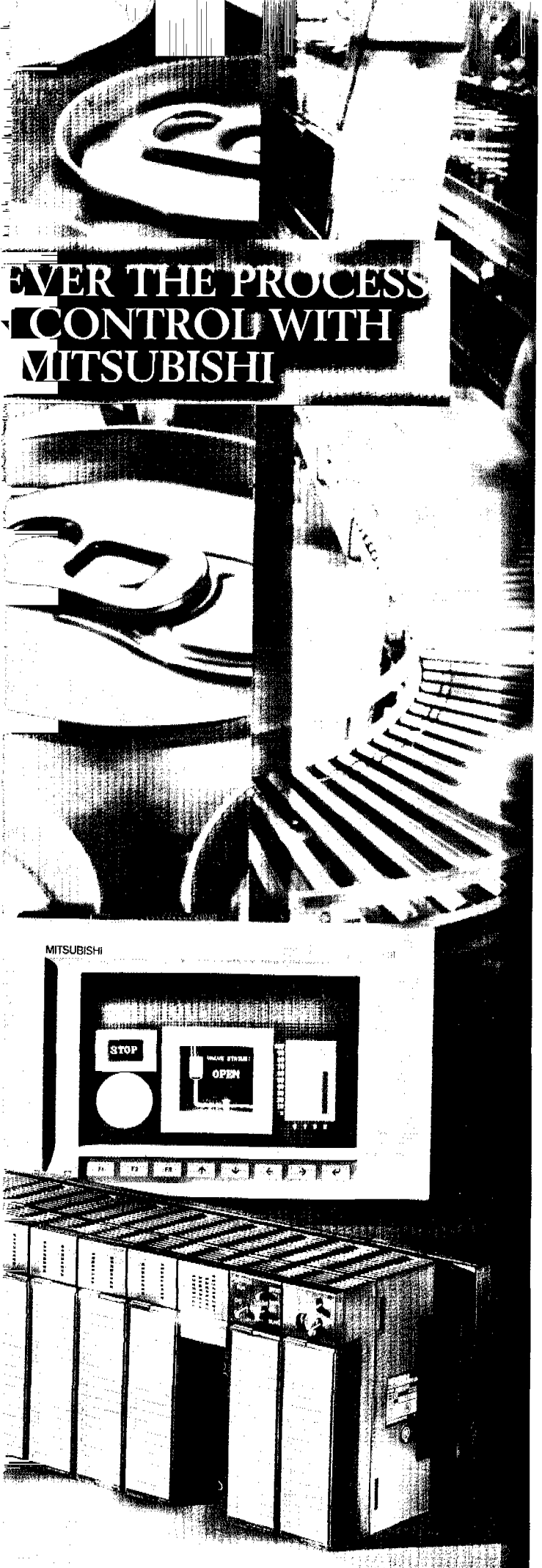

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PLCs reduce water industry costs

Mitsubishi Electric UK

By signing an agreement making Mitsubishi the approved supplier of programmable logic controller (PLC) equipment over the next two years, UK water supply company Wessex Water aims to reduce its automation costs by 15 per cent.

Wessex Water, one of the UK's major water suppliers, prides itself on its environmental performance, investing £115 million in new schemes during 1993-4.

By reducing its cost base, it is able to improve the environment and provide an excellent service for its customers. With a number of major environmental projects planned over the next two years, it aims to reduce costs even further.

Wessex Water's Engineering Services division invited the seven largest Programmable Logic Controller (PLC) manufacturers to tender for the supply of PLC equipment over the next two years. According to David Barritt, principal engineer at Engineering Services, "having a single source of PLC systems, training and support will reduce the total cost of ownership of control systems considerably".

The supplier was chosen on the following:

- Cost;
- Compliance with IEC 1131. Equipment was graded on compliance with IEC programming language, specification and immunity to electrical noise;
- Choice of peripheral equipment — A wide range of peripherals are necessary as the applications are varied. Isolated analogue inputs are mandatory to ensure reliability;
- Support and training — Ten years spares support is compulsory in addition to training and local technical support; and
- Company reputation.

Wessex Water chose the package offered by Mitsubishi Electric. "Mitsubishi offered the best deal in terms of cost, performance and support. From an engineering point of view, Mitsubishi's range best matched our requirements. They can supply small FX PLCs for low I/O stand-alone applications, and larger A Series PLCs for high-level networking and applications requiring thousands of I/O. On large water and sewage treatment works, where the control of many separate processes needs to be integrated, the AnS PLCs can be networked easily," comments David Barritt.

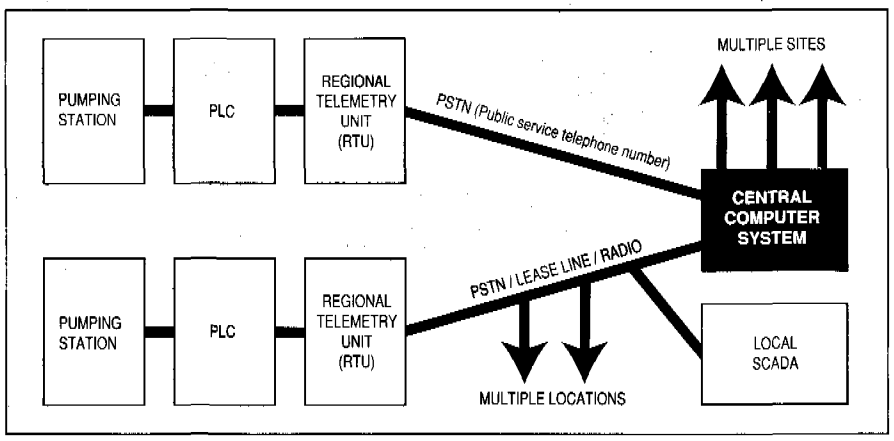
He estimates that the agreement will "reduce the total cost of our control and automation systems by 15 per cent over the next two years".

PLC systems will be used on new environmental projects such as waste water treatment plants, water supply plants, pumping stations and water quality monitoring throughout the Wessex region. Controlling such processes with PLCs, will provide cost benefits and simplify installation and operation significantly.

Networked PLCs in waste and water treatment

Numerous interrelated processes in treatment plants need to be controlled and monitored. Flow sequencing, varying pumping speeds and monitoring

PLCs can be programmed to communicate information to the control room automatically.



The role of PLCs in a telemetry system.

instruments, for instance, all need to be managed from a central point.

This is often done by a large single controller, like a dedicated microprocessor, or by hard-wired logic. Whatever the control system, it needs to handle all acquisition and processing of data from the various operations around the plant. It also must store, and then display the information, via a PC or a similar interface device, in a form that site operators can use easily.

To do this, the control system needs a huge memory and massive processing capabilities. Such units tend to be expensive, inflexible and make the whole plant dependant on one controller. Many systems require users to have specialist knowledge to operate and maintain them properly...

For treatment works to be built over the next two years, Wessex Water plans to use a decentralised network of AnS PLCs. Each PLC will be dedicated to a certain task but connected by a high-speed data link system. The data link system will transfer process information to a central point, where it can be managed via a SCADA system.

In this way, Wessex Water eliminates the risk of total plant failure from one controller since, if one PLC stops operating, the others still function. Even if the network is broken, the Dual Redundant Loop of the data link system ensures the PLCs continue to communicate and send information to the central point. Additionally, a section of plant can be taken off line for scheduled maintenance, without shutting down the whole network.

A current trend of PLC 'downsizing' adds to the efficiency of the plant. As PLCs become smaller, they use less components. With fewer components, they are more reliable and less prone to interference from outside disturbances. Therefore downtime is kept to a minimum.

However, their functionality is no less than that of larger controllers. The latest PLCs to be introduced to the market by Mitsubishi have advanced mathematical functions, such as PID, cos and tan, built in. Most have analogue, temperature sensing and high-speed counting modules and are compatible with open networks like Ethernet and Profibus. Using these networks, a wide variety of devices can be controlled on the same system.

As the PLCs in the network are dedicated to specific tasks, the majority of their processing power is concentrated on control and data collection. This gives extremely fast processing times and so improves the overall efficiency of the plant.

With this system, Wessex Water's installation costs will be reduced significantly. First, a number of small PLCs networked tends to be less expensive than a single large controller. Second, wiring costs are reduced considerably. Instead of thousands of wires running from the central controller to instruments around the plant, PLCs can be linked with a single twisted pair, fibre optic or coaxial cable.Wiring between PLC and machine is minimal as PLCs are fitted locally.

PLCs replacing telemetry

Wessex Water is planning to extend the principal of networked PLCs to replace dedicated telemetry systems.

At the moment, Wessex Water use a telemetry system which integrates outstations from several suppliers. The system receives information from outstations around the Wessex region and sends it to a central control room in Bristol. Each outstation monitors between 11 and 200 signals.

By using PLCs with serial data links, installation costs can be reduced dramatically. Instead of hundreds of wires, each outstation only needs one cable to communicate with the PLC. The PLC can then send large amounts of data rapidly to the control room when required.

It can also be programmed to communicate information automatically, such as equipment operating conditions, on a regular basis. In this way, one man can monitor the 1800 stations in the Wessex region from Bristol.

Pumping station automation

The main project planned in the near future is the automation of sewage pumping stations. Over 80 are scheduled for 1995, and a total of 800 are to be completed by the end of 1996.

Wessex Water takes away over 800 million litres of wastewater from 2.5 million people every day. A network of 14 700km of sewer and 1 178 pumping stations transport the sewage to 351 treatment works.

Wastewater flows from housing estates, factories and small towns and is collected in underground sumps. From here, it is transported to the treatment plant via unmanned pumping stations. Wessex plans to install a PLC in each pumping station to control and monitor the pumpsets. It will either link to a regional telemetry system (RTS) or communicate directly with the central control room.

Pumping stations automated so far have proved very reliable and efficient. The PLC monitors the level of the sump via a pressure sensor. When the sewage reaches a high level, the PLC starts the duty pump and when a low level is reached it stops the pump.

Most pumping stations have two pumps, a duty and a standby. The PLC runs the pumps on a 60:40 schedule, respectively. It automatically activates the standby if the duty fails to start

after 10 seconds. Should a pump fail to start more than three times consecutively, the PLC sends an alarm to the main control room via the RTS.

Pumpset performance is also monitored by the PLC. By comparing the time taken for a pump to lower the sump to the stop level against a preset maximum, the PLC obtains a reading of pumpset efficiency. When the maximum is exceeded, the PLC registers the pumpset as inefficient. If a pump registers inefficient five times consecutively, the PLC removes it from service and sends an alarm to the control room.

Wessex Water's tests have shown that by automating pumping stations in this way, maintenance costs will be reduced considerably. Engineer visits will only need to be once every two months rather than once every two weeks. Efficiency reports generated by the PLCs are sent to the control room. Here, a SCADA package can collate information from hundreds of PLCs to allow engineers to predict and hence prevent pumpset failure.

Reliability in tertiary treatment

In the tertiary stage of sewage treatment, a highly reliable control and monitoring system is essential. Here, water is pumped onto a bed of 'biological sludge', after all solid matter has been removed. Bacteria in the sludge reduce the water's Biological Oxygen Demand (BOD) to an acceptable level. (A high BOD means dissolved oxygen is removed from water, preventing most creatures from living in it.)

The bacteria must have a constant supply of waste water to survive and it must be evenly distributed throughout the bed. A distribution arm rotating once every few minutes ensures the water is spread evenly.

Wessex Water plans to control the flow onto the bed with a PLC, and so ensure a constant supply. The PLC will also monitor the operation of the distribution arm. If the arm stops, half the bed will be flooded and the other half will dry out. In both cases the bacteria die.

The beds are external to the treatment plants and the PLCs will be installed locally with a high-speed data link to the control room. Any halt in wastewater supply or operation of the distribution arm, will produce an alarm in the control room. Process engineers will know exactly what is causing the alarm and be able to take the necessary corrective action

Future projects

Wessex Water plans to increase spending on environmental projects over the next few years. Major water treatment and water supply plants will be opened during the next few years, all requiring PLC-based control systems.

Its agreement with Mitsubishi Electric will reduce costs significantly and allow Wessex to maintain its environmental performance, while further improving its service to customers. ■

CCTV can improve borehole surveys

Kim Beesley, European Geophysical Services

Close-circuit TV surveys and new geophysical logging techniques are transforming the way engineers inspect new wells and boreholes, or old boreholes in need of renovation, providing a great deal of information on geological strata and the condition of the borehole.

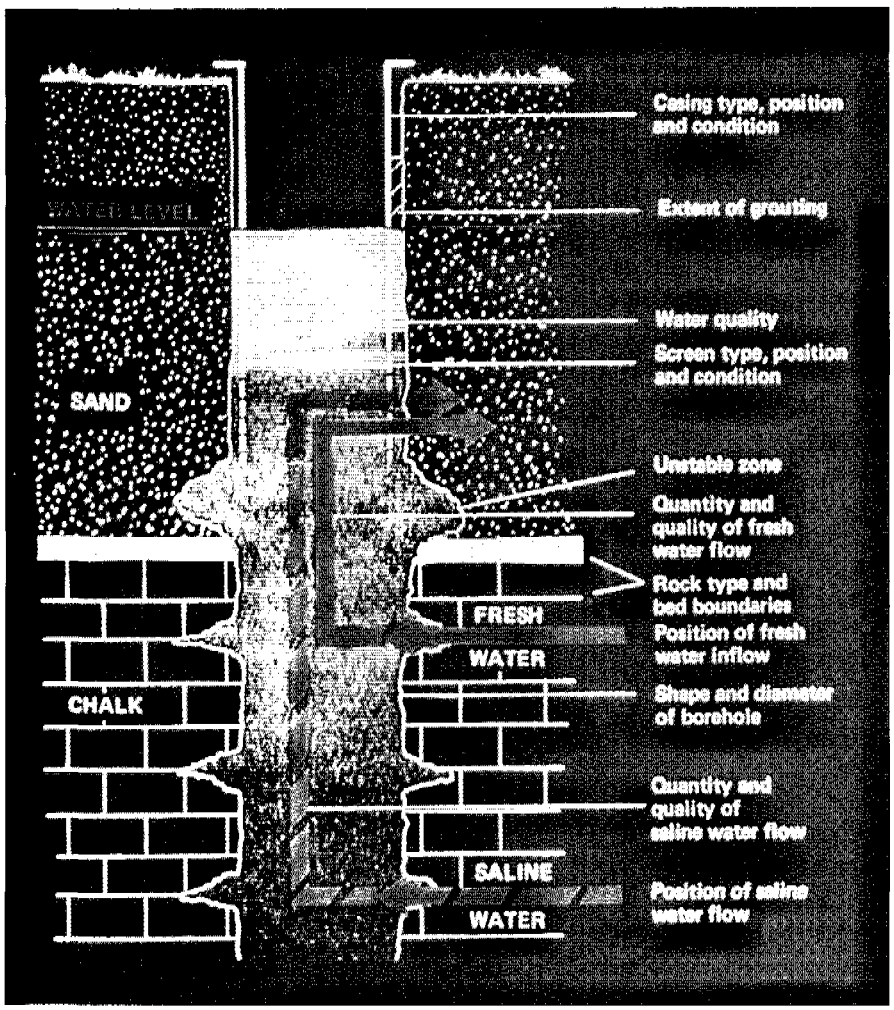
Borehole television (CCTV) surveys using versatile colour systems are now increasingly used for the inspection of boreholes and wells. By using a variety of lenses and lighting attachments, a general to very detailed inspection of the borehole's condition may be made, and visible information on the geological strata can be obtained to enhance the driller's or geologist's log.

For general and preliminary inspections a wide angle forward-view lens is used, often with multiple lights. For a detailed inspection of the borehole wall or lining a side-view attachment is used which is fully rotatable to enable the whole of the circumference of the bore at any depth point to be viewed.

It is common practice to record the survey in standard VHS format along with site, date, depth and other important details via a screen writing device.

CCTV surveys play an important role in the final checks on recently completed boreholes, and this service can be provided by independent specialists thus ensuring impartiality.

In these days of economic restraint, renovation of old boreholes may be a viable proposition and a television survey is often one of the first steps in determining the feasiblity of such work. One of the most important applications of CCTV is in the assessment of biological deposition and encrustation which can have a serious impact on the performance of a production borehole. Similarly the technique may be initially applied where contamination problems are suspected. The "eyes" of a downhole television have proved useful on many occasions in the retrieval of broken or trapped drilling equipment or other subsurface plant. For the sake of a few hours work and a relatively small



Summary of the application of television surveys and geophysical logging.

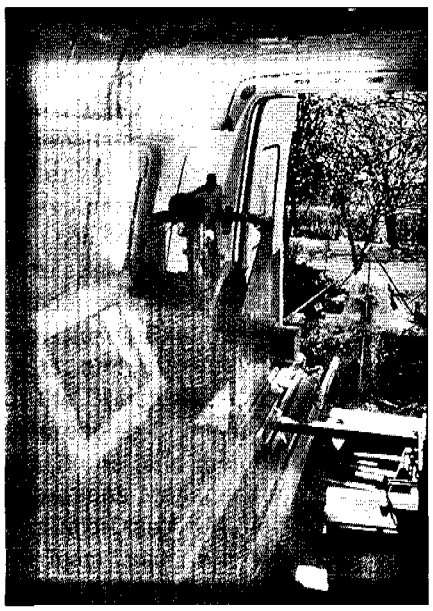
financial outlay, it is now becoming common practice upon removal of pumps to take the opportunity to check the condition of the borehole.

Television techniques, however,do have some limitations. They are affected by the clarity of the borehole's fluid and cannot see behind well linings. Television surveys alone are not always sufficient on their own to identify the exact nature of some downhole problems.

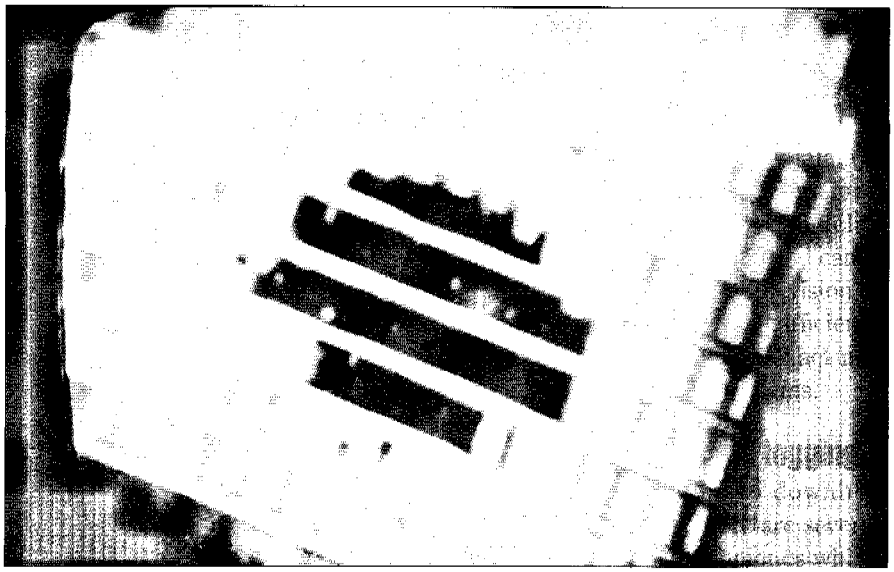
Geophysical logging

In addition to downhole television surveys, there are several geophysical logging techniques which have a wide application in water wells and site investigation boreholes. Geophysical logs are obtained from electronic probes lowered into a borehole. These provide an independent and continuous in-situ record of the borehole's construction and the properties of the geological formations and fluids. The selective use of such logging techniques aids, clarifies and augments television data. As well as providing quantitative data some of the techniques can "see" through linings and dirty fluid. Measurement of the effectiveness of the bonding of cement grouts behind linings is possible using acoustics (cement bond log).

The detection of voiding or channelling in materials around the lining is possible using gamma-gamma techniques (density logs). Such measurements are vital in determining the effectiveness of the protection of the production boreholes.



Geophysical logging of a water well.



Hole in a well screen located by a television survey.

Caliper logging can be employed to measure accurately the internal diameter of the borehole and its linings. Measurement to within a few millimetres is possible, thus zones of corrosion and gaps in linings may be readily identified. In unlined (open - hole) sections unstable areas of rock may be measured and located.

There are a number of geophysical logs that measure the properties of the fluid within the borehole, commonly temperature, electrical conductivity and velocity.

These logs not only provide basic and essential hydrogeological information in exploration boreholes,such as identification of inflow/outflow points and indications of water quality, but provide a baseline with which future measurements may be compared should the characteristics of the borehole or aquifer change.

Physical properties of the strata, such as clay content, density, porosity, porewater quality and rock strength may be obtained via various formation logs which are primarily run in exploration boreholes to aid the design and development of production boreholes and well fields. However, such measurements are also important in geotechnical and environmental site investigations by providing accurate, quantative continuous geophysical data important to the understanding of the geological environment.

A complete borehole survey

It is now possible to carry out television surveys and geophysical logging by a single specialist employing the latest digital data acquisition techniques allowing a high quality integrated presentation of all the borehole data in a manageable and convenient form. ■

Biography

Kim Beesley is currently managing director of European Geophysical Services Ltd, UK. He is a geophysicist with 21 years international experience, primarily in the water, environmental and mineral exploration fields specialising in borehole geophysical logging and television techniques He is a member of the European Association of Exploration Geophysicsts and currently a member of the British Standard Wells and Boreholes Committee. Previous positions held include Logging Operations Manager for Hydrotechnica and Diasol, UK, and Geophysicist Team Leader with the Water Research Centre.

AMR systems make meter reading easy

Donald H Strobel, Badger Meter

Present-day automatic meter reading (AMR) systems employ the latest in communications and microelectronics technologies. This paper summarises the migration from the traditional meter reader to modern AMR technologies with a detailed description of TRACE, a two-way radio frequency automated reading system.

During the last 30 years, water utilities have witnessed the evolution of meter reading from the manual entry of readings in a route book or having the customer post the meter reading to highly sophisticated automatic meter reading systems. However, there were several important milestones in this migration from the basic system to the fully automatic system.

The first was the development of the remote-reading systems that eliminated the sporadic "lock-out" access problem experienced by the meter reader when meters were located indoors. The first remote-reading system was introduced to the water industry in 1960 by Badger Meter of Milwaukee, USA. It consisted of a self-generating pulse register and a remotely located electro-mechanical register. After a specific amount of water is registered, a pulse is generated and sent to the remote register. Other types of remote-reading systems include encoder remotes and other types of hybrid remotes for water meters.

The next step in the evolutionary process was the introduction of handheld computers (data collectors) to allow the meter reader to enter readings directly into computer memory. Readings are transferred directly into the utility's computer billing system, thereby improving productivity, accuracy, information gathering and customer service while eliminating manual data-entry and shortening the read-to-bill cycle.

The next development was automatic entry of the reading into the handheld device (probe, wand, etc.). This was accomplished with the addition of an adapter to the handheld device.The meter reading is obtained by inserting the adapter into a remotely located socket or pad connected to a meter encoding register.

Automatic meter reading

The final development was automatic meter reading. These systems are fully automatic with little or no human intervention and are controlled from a central location of the water utility. The communication link can be telephone networks, cable TV systems, electrical power mains, or radio frequency based systems.

Automatic meter reading is not new; it was first introduced in the United States in the 1960s using network telephone systems as the communications link. What is new, however, is the current wave of new technology products and systems for automatic meter reading using the public switched telephone network, the air waves (radio frequency). and electric power mains to transmit data between the meter and a data collection computer. Radio frequency (RF) meter reading is the fastest growing AMR technology today based upon the accelerating rate of new installations. There are over four million RF AMR units installed in the United States, most of which are in the gas utility industry. One of the major RF AMR systems is TRACE automated systems.

American Meter Company of Philadelphia. US subsidiary of Ruhr Gas, a world leader in gas metering technology. introduced their TRACE RF reading system to the gas industry in 1988. TRACE is a two-way RF system operating in the frequency band of 450 MHz.TRACE began with the initial research of meter reading systems using RF by Northern

Illinois Gas Company (NIGas). NiGas successfully tested RF meter reading on both electric and gas meters, and in 1986 licensed all rights to the technology to American Meter Company. The product was redesigned and repackaged, using custom microprocessors, surface mount (SMD) technology, and high-energy long-life lithium batteries by American.

TRACE is the only RF meter reading technology that is deployed throughout the water industry at the present time. TRACE was introduced to the water industry by Badger Meter in 1991 as a result of a business agreement with American Meter in

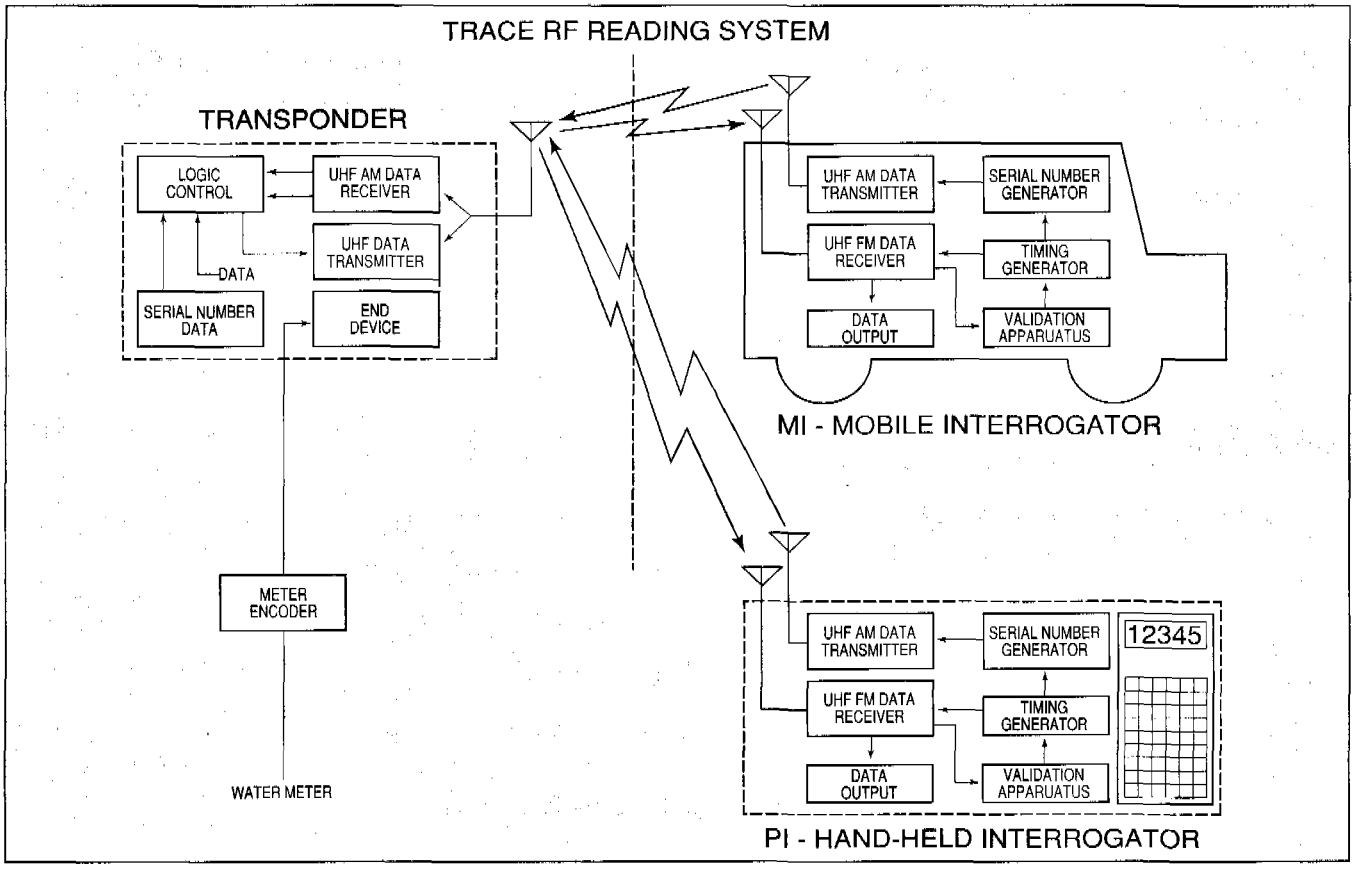


Figure 1. The TRACE RF reading system.

1990. Badger Meter — an independent American producer of flow meters, control systems, and a meter-reading technology leader — re-engineered TRACE for the water utility industry.

Over 60 per cent of the water utility meters in the United States are in external meter boxes, and RF AMR is one of the more viable methods to read these meters. (The balance of meters are located in homes/buildings.) The key to TRACE's success in reading meters in these difficult installations is its *patented* two-way method of communication. The scheme allows the transponder unit to be kept in a low current mode condition conserving battery power until an interrogation signal is received by either a mobile or handheld interrogator. An advantage over a one-way RF system that transmits continuously is that TRACE transmits only when it receives an interrogation signal containing its individual ID number.Another advantage of the two-way communication is that it ensures the accuracy of the reading at the time the meter is read by giving a positive indication that a good reading was obtained during interrogation. It also gives an immediate tamper alert at the time of reading thus eliminating the need for a return trip to investigate the cause of tamper.

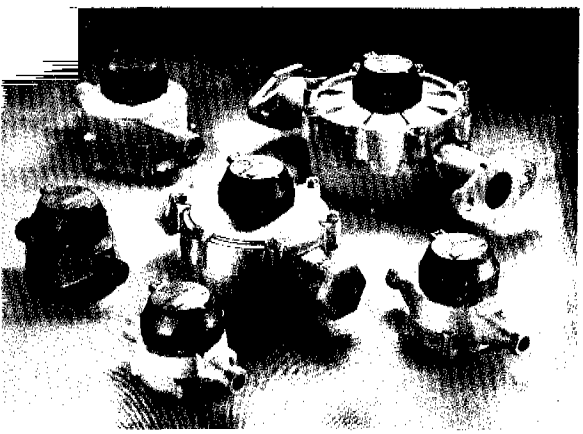
The TRACE system consists of two elements: a transponder unit and the interrogator device. The transponder module is mounted at the meter for in-house sets or in the meter box cover lid for external meter box applications. The transponder has several basic elements relevant to continuous and reliable performance of the system. These are:

- A UHF transmitter and receiver;
- A micro-controller to manage the transmitting and receiving, data collection and storage, transponder ID functions,and so on;
- A transducer to convert mechanical movement of the meter into an electrical format;
- A battery; and
- A transducer input lines integrity "tamper" monitor.

The Interrogator is available either as a portable handheld data collector (PI) or as a mobile vehicle (MI). Each consists of an UHF transmitter and receiver and a microcomputer to manage interrogation activities, database input and output, and other operations.

The Transponder is periodically "awakened" by the micro-controller to sense transducer input activity, update its memory if transducer output has changed, and to "listen" for interrogation transmission requests from the MI or PI. The interrogation signal includes a preamble sync code and ID number, and if either the sync code or the ID number is incorrect (for example, it does not match the individual transponder's ID), the transponder returns to a "sleep" mode.

If both sync code and ID are correct, the Transponder will then interpret the type of interrogator command and initiate an appropriate response. For example, in response to a meter-read command, a Transponder will transmit the meter reading, a tamper indicator bit,and a checksum bit. Other commands and responses are also available for use.



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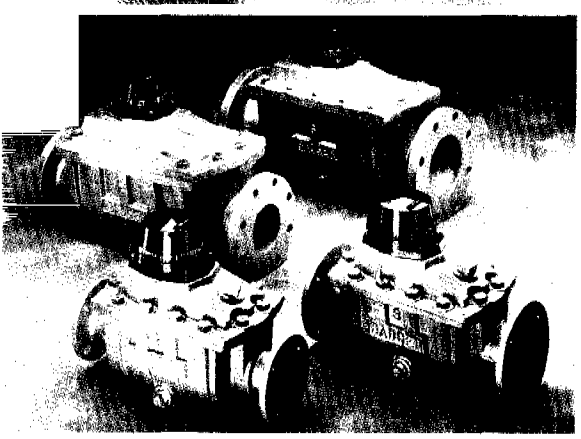

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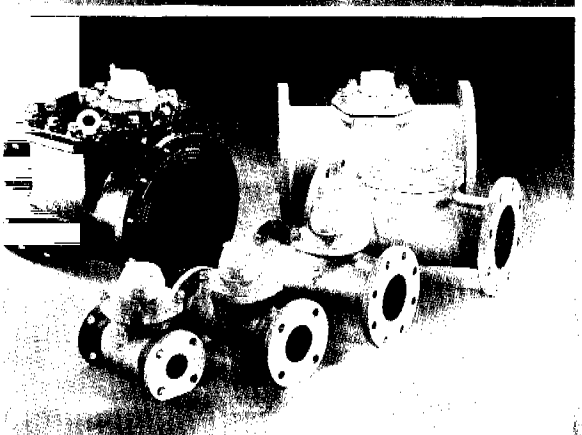

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When an interrogation is initiated, the Interrogator listens for a response from the correct Transponder. If the response includes a meter reading, a valid checksum, and no indication of tampering, the meter reading is added to the database. If the Transponder response is corrupt in any way, then the reading is not accepted and the Transponder is repolled.

For all practical purposes, the Transponder is immune to data corruption by external means. In order to corrupt transponder information, an individual would need detailed knowledge of unique interrogator data, format, frequency, tamper mechanisms, and printer circuit board jumper information, plus physical access to the meter. In addition, transponder power dissipation is not measurably affected by RF transmissions that do not meet TRACE modulation tone, format and tinting criteria. Therefore any attempts to deplete battery energy in order to corrupt data memory in this manner will not be successful.

Simple shielding mechanism (for example, a tin foil wrap) will not disrupt operation of the transponder. The TRACE transponder was specifically designed to function under severe signal attenuation conditions. For example, it is routinely used to read meters in underground pits with metal covers. In addition, interrogator operators have the option of moving closer to an unresponsive transponder. It is also important to note that shielding does not impair accurate readings by the transponder.

A sophisticated individual determined to cheat a utility is more likely to try to bypass a utility meter rather than tamper with it. In meter bypass cases, manual or automated methods of (RF) reading are irrelevant to the problem.

Because the TRACE system operates on different frequencies, it will not be jammed by nearby broadcasts from TV and radio stations, nor amateur radio and citizen's band radio equipment. Nevertheless, virtually all existing radio communication systems are subject to the so-called "near-far" problem, whereby signals from a strong nearby transmitter can overwhelm signals from relatively far away transmitters. In the case of TRACE, it is extremely unlikely that an individual or group would be able to jam communications for a number of reasons. First of all, while RF emissions at TRACE system frequencies could block communications, these frequencies are generally licensed for commercial operation. Any unauthorised transmissions could be monitored, triangulated to locate the source (if necessary) and prosecuted as required.

Secondly, unless the jammed level is extremely high or located very close to the transponder(s), the MI or PI operator can always move closer to the transponder to gain a signal strength advantage. Furthermore, any increase in jamming signal strength makes that signal easier to detect and locate. Thirdly, TRACE interrogator and transponder transmissions are very brief.

The basic radio frequency communications technology in the TRACE system is a robust communications media for automated meter reading applications. At both transponder and interrogator ends of the system, TRACE incorporates a hierarchy of fail-safe mechanisms to insure that meter data and transmission of that data cannot be inadvertently or willfully corrupted.

Portable interrogator

The portable interrogator handheld device (PI) serves two basic functions: testing and programming of the transponders during installation; and collecting meter readings. Three modes of operation are available through the keypad, data collection, load and unload, and editor. A fourth mode, the remote mode, is used to load and unload data from the PI to a personal computer running the RMSplus software. The PI can also be used for manual data entry for manual meter reading applications of meter registers and remote registers.

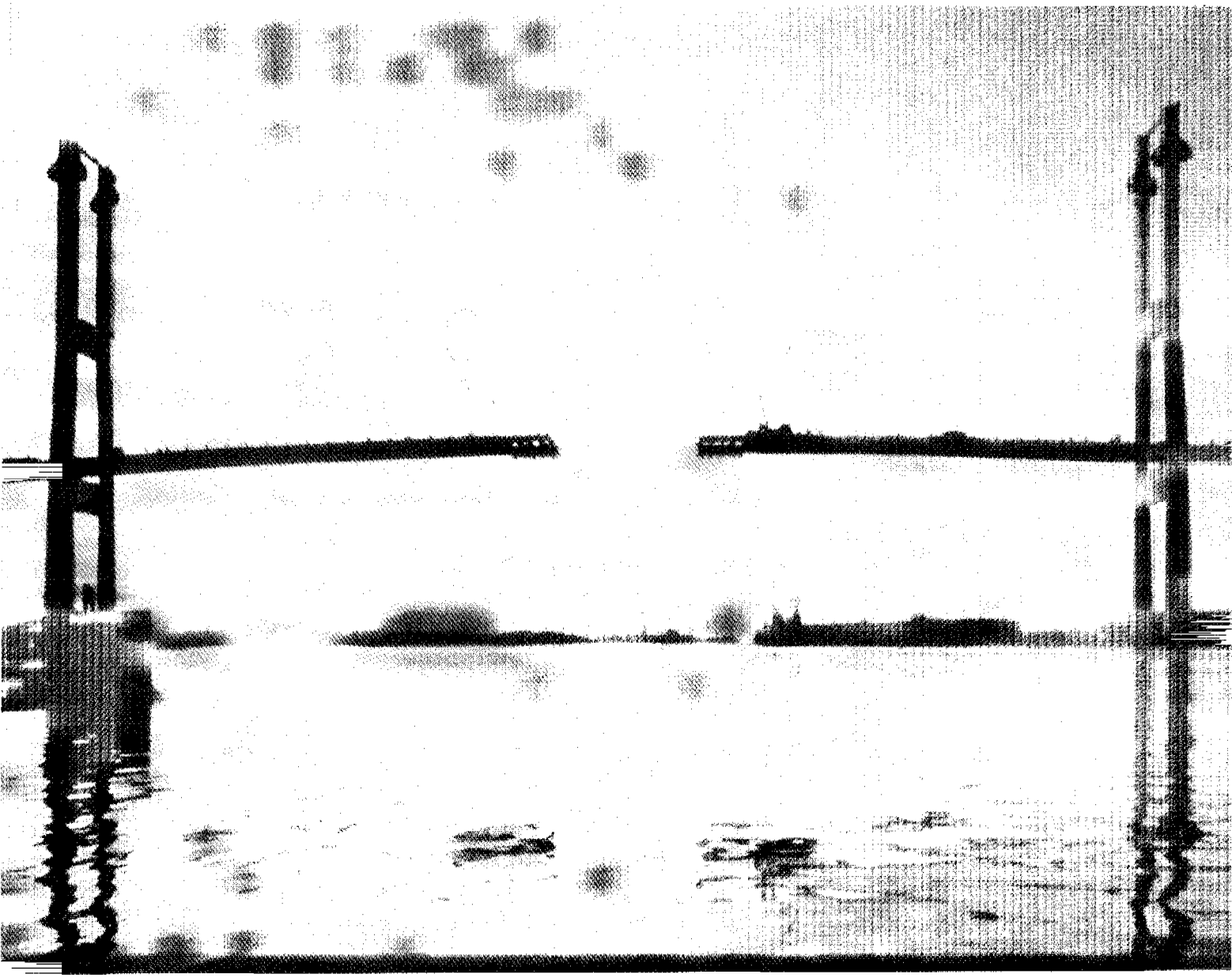
The TRACE mobile interrogation unit (MI) is a data retrieval and storage system, designed to provide remote meter reading in conjunction with the TRACE meter transponders. The system reads each transponder on either a First-in first-out (FIFO) basis or on a latitude/longitude basis. The MI is provided with a disk containing the street address, latitude and longitude, and a serial number of each transponder that is to be read. The MI uses an onboard land navigation system that tracks the vehicle position and displays its location on an electronic map of the surrounding area. If the LAT/LON mode of interrogation has been selected, whenever the MI comes into the user's selected range of the transponder, it begins to send an interrogation for that unit. When the transponder receives a signal with the correct ID number, it transmits its stored electronic meter reading, tamper status and error detection code.

The MI listens for each transponder's reply, using a 20-channel receiver. Matching transponder data on at least three channels and passing error detection code analysis will validate the reply. The meter reading along with transponder status, receiver channel activity, time of read and vehicle position at the time of read is stored in an output file on floppy disks. Once the MI has been initialised with the appropriate route data, the system will collect readings automatically.

As a two-way RF system, the mobile and handheld interrogator (MI and PI) may require a licence from a government agency. A licensed type of system insures that the communications will not be interfered with by other legal users thus ensuring system performance. ■

Biography

Donald H Strobel is Vice President of Engineering at Badger Meter, Inc, Milwaukee, Wisconsin. He is a member of AWWA Standards Committee, ASTM, IEEE and ISA. He is a registered professional engineer in the State of Wisconsin.



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IT asset-care helps water management

David Pitt, TSW International

Information technology (IT), increasingly used in water company managment, is now being used for asset care, looking after equipment and facilities, as well as applications and information. Bristol Water, a UK water supplier, is one company to employ such a solution.

To succeed and prosper in a challenging and turbulent business environment with unrelenting competitive pressures demands that organisations adopt the most advanced business practices, together with a real commitment to add value for customers. This forces managers to look at the organisation from the outside in and to focus on the management of the processes which serve those customers.

Many organisations have moved away from traditional functions and hierarchies to process-based structures as a means of making significant business improvements possible. Central to a more process-based organisation is the integration of information.

The benefits derived from information integration, such as increasing productivity and reducing operational expenses, have driven the need for streamlined information flows across the organisation. This requires changes in most aspects of the company, including systems and technology and these also need to be aligned to the company's strategy and goals.

As part of these changes, asset-care information technology (IT) solutions, which focus on the care of both hard (equipment, facilities) and soft (applications, information) assets, are emerging as an integral part of an enterprise information structure. These are replacing the stand-alone maintenance management systems of the past.

For many early users of computerised maintenance management systems, the challenges of increasing efficiency and productivity were associated with the simple automation of paperwork related to the reactive management of equipment and facilities. Recently, a new perspective has emerged regarding the best way to increase asset productivity.

Optimising work practices

This approach operates on the basis that solutions must concentrate on optimising work practices — practices that offer the broadest opportunities for productivity improvements. Asset care focuses on maintaining assets in a way that optimises overall productivity while simultaneously reducing costs.

Numerous performance-driven factors are influencing asset care's rise to the enterprise level.

For example, asset-care gains are well-suited to the growing demands of corporate 'stretch' goals, which set productivity improvement targets that are considerably greater than typical incremental gains. As the benefits of stretch goals proliferate, dramatically improving companies' bottom-lines, the practice of setting stretch targets challenge organisations to go beyond what is typically expected.

Furthermore, the shift from stand-alone systems towards integrated supply chains involving the seamless operation of all processes, has heightened the critical nature of asset-care information. A broader level of integration is also pervading the enterprise where asset-care systems share information with complementary applications such as human resources and financial management.

Towards proactive methods

The result of these trends is a need for revised asset-care systems and work processes that move from reactive to proactive methods and facilitate the sharing of information across geographic and functional boundaries. By combining asset-care systems into the enterprise framework, corporate employees and asset care professionals are provided with transparent access to vital information across applications, databases and networks, enabling a more informed decision process and more effective work process.

With asset care, organisations are driven to employ a 'best practices' approach that utilises practical expertise in selecting appropriate methodologies (based on industry and inhouse developed techniques) to design unique methods that meet specific organisational goals.

Systems (software and complementary technologies) are then used to support the best-practices methods. This combination of asset care methodologies and systems enables organisations to extend the benefits of efficiently managing corporate assets throughout the enterprise.

Case study — Bristol Water

Improving customer service through systems integration

Bristol Water has always been fully commited to effective asset maintenance. Maintenance is seen as crucial in terms of overall business strategy because of its effect on customer service.

Stan Bessey, water services director, explains: "The customer has become king in almost every form of business since the eighties. It is no different for us and our whole strategy for IT solutions in the nineties is focused on improving customer service while maintaining profitability."

While Bristol Water was already private, it was affected by the UK privatisation legislation, particularly with regards to the regulation of its affairs.

"The company has never been state-owned and has always been accountable to shareholders and customers. The main affect of the changes in the industry has been the need to maintain profitability while meeting the rigorous customer service, quality and resources requirements of the principal industry regulators," says Bessey.

"In terms of maintenance, our biggest responsibility is to keep all our water mains as 'tight' as possible to ensure water gets to the customer rather than leaking away somewhere underground," says Bessey.

"If money is not available to replace pipes in some areas, then clearly the maintenance profile has to increase to ensure they stay in good working order. We have a replacement programme which is geared to what we can charge for our services, but the greatest economies are to be achieved through effective maintenance."

Apart from the mains, there is also plant and buildings that need to be maintained. Bessey says, "Most of our water has to be pumped at some stage and all the pumping stations have plant which is electronically controlled and monitored. We have lots of monitoring equipment which is constantly sending information back to our control room."

What Bristol Water wants most from its IT systems is integration.

"We want to be able to exchange information between asset management, accounts, GIS and customer service and we are striving hard to achieve this. This means being able to look up any information we need on a particular customer and making it available to all other departments," says Bessey.

To this end, the company has selected Oracle as its core database and is purchasing and developing Oracle-based applications in order to build an enterprise-wide solution to its IT needs.

"We have selected applications on an 80/20 basis. That is, the package provides 80 per cent of the solution and 20 per cent would come through enhancements," Bessey calculates.

En Garde selected

After careful evaluation Bristol Water selected the En Garde asset maintenance management system from TSW International (formerly known as SQL Systems International).

"En Garde met all the selection criteria in terms of functionality and integration. Also, it has the ability to cope with our vast number of assets," Bessey claims. Indeed, the Bristol Water area encompasses over 400,000 properties each containing at least 4 or 5 assets such as service pipes, stop taps, meters and meter boxes.

Having selected its works management system, Bristol Water could then commence work on developing a customer service system that was fully integrated with En Garde.

"Just about every significant development within the water industry has been focused on the customer. The Customer Charter states that if customer service does not meet certain standards, the Water Company has to pay the customer a £10 fine. We have met this head-on by integrating the customer service system with En Garde which means that the progress and status of all jobs are visible to the customer service operator. This ensures that the operator has all the information they need to answer customers' queries thoroughly and accurately," Bessey maintains.

The En Garde system went live on 1 December 1994 after nearly a year of preparation.

"At the moment we have the entire water distribution department working on the system which is recognised as the hardest section to automate. We expect to bring additional departments on board and are getting data onto the system as quickly as we can by entering all new information gleaned from customer installations and repairs," he says. "I firmly believe that we are implementing a solution for our business that is making us work smarter. With the information we now have available we can provide a better service to our customers, and the savings we are making in administrative and practical areas can be used to ensure our inventory of pipes, pumps and other plant can be replaced and maintained to serve the Bristol area for another 150 years," he concludes. ■

Biography

David Pitt is managing director of TSW International Ltd based in Woking, UK.

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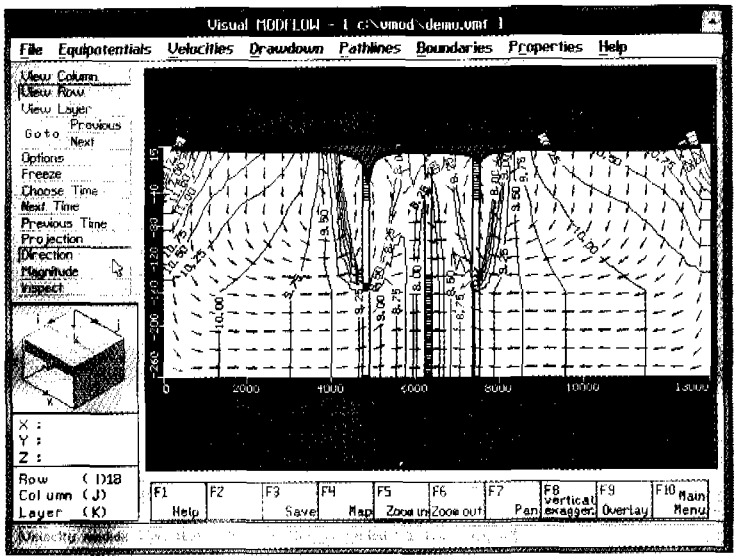

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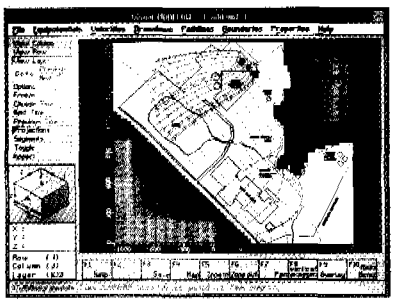

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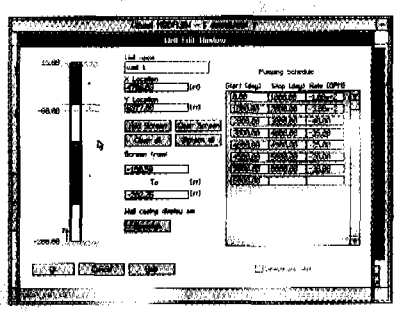

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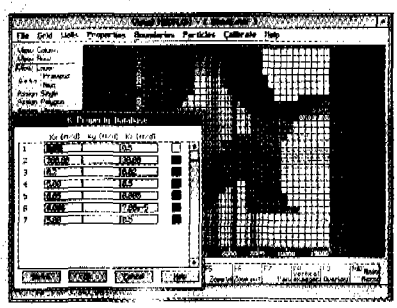

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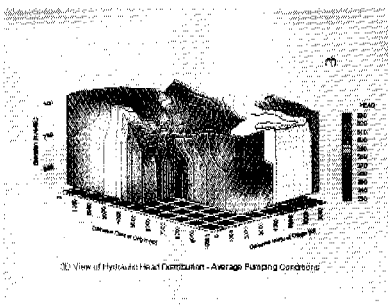

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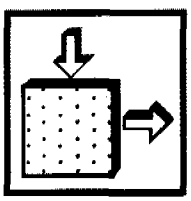

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Selecting the right pump for the job

Caprari Pumps UK

There is a fine balance between the advantages of one type of deep well pump over another for most applications. The modern line shaft pump is still a viable alternative to the submersible borehole pump for wells with a pump set at 40m or less.

At the turn of the century, the means of raising water from deep wells was by the use of a centrifugal pump submerged below the water level and driven through a line of shafts connecting the pump to the motive power at the surface.

In rural areas, wind power provided the motive force until the avent of the internal combustion engine and the ready availability of electrical power. The line shaft pump, as it became known, was dominant in this field for a great many years, especially where the water table was high and a deep well, rather than a deep borehole, could by constructed.

30-year service

The line shaft pump proved extremely reliable. Pumps in service for over 30 years are not uncommon. The disadvantage of this pump lay not with the pump itself, but with the drive arrangement. Once the water table was found beyond a certain depth, it became well nigh impossible to produce a straight borehole

The line of shafts found difficulty in accommodating a curved borehole. In addition, the line shaft pump needed some form of building to offer protection to the electric motor drive and controls, and the pump assembly was thought somewhat difficult to install and remove from a deep well.

The development of the submersible or 'wet' motor dramatically changed the method of deep well pumping

The development of the submersible or 'wet' motor dramatically changed the method of deep well pumping. The motor was now coupled directly, and the pump shaft and the whole assembly submerged into the pumped liquid. Very deep boreholes could be easily accommodated and the pump unit required no expensive building to house and protect the motor and head works.

It would be true to say that, as population density lowered the water table in Europe, so the majority of deep-well pumping applications turned to submersible motor borehole pumps, while in the USA, the line shaft pump is even to this day the favoured method for raising water from underground.

Submersible less reliable

Although the submersible motor pump unit has a number of advantages over the line shaft unit — easier to install, the elimination of buildings and so on — it is recognised as being less reliable than the line shaft unit. The majority of submersible borehole pumps were at one time designed for four-pole operating speed, but economic pressures have driven the market and the suppliers towards smaller boreholes, high-speed pumps and two-pole operation. This has a deleterious effect on the overall reliability of this type of pumping unit.

While most of Europe was moving towards deep-well pumping by submersible motor pump units, the conventional electric motor was being developed by manufacturers and by application to other industrial drives to become more efficient and suitable for the most difficult outdoor applications. Advantages like total enclosure, flame proofing, weather proofing were beginning to tip the balance once more in favour of the line shaft unit.

Profitability pressures

Immediately before and after the privatisation of the UK water industry, the pressures to improve the industry profitability, through

both a reduction in the labour force and improved efficiency of operation, increased.

In an industry that is subject to regulation restricting price increases, regulations requiring improved water quality and shareholders expecting a return on investment, improvements in the operating efficiency of plant assume increasing importance.

The line shaft pump with its surface-mounted electric motor can be serviced, repaired or replaced in hours compared with days for a submersible motor

The two major items of expenditure facing the industry are the cost of labour and electrical power. The past few years have seen major reductions in the manning levels in all areas of the water industry. The cost of electricity has to be tackled with equal vigour.

The industry is in business to supply water to all its customers. A major way of reducing supply costs is to use more energy efficient equipment, or at least to give greater emphasis to the energy-efficient aspects of new or replacement equipment.

Major resource

Water extraction from deep wells is a major resource of the water industry. It is an area that is worth consideration in the context of improvement of energy usage. Although the submersible borehole pump is without doubt initially cheaper than a line shaft pump of equivalent hydraulic performance, it can be argued that, in some cases, purchasing the more expensive item can save considerably on both operating and maintenance costs.

If, when specifying a pump for a deep well application, the pump setting depth is at or less than 40m, then a line shaft pump is an energy-efficient option. If one assumes a constant pump hydraulic efficiency for both the line shaft and submersible borehole pump, then the efficiency of the electric motor becomes a deciding factor.

The borehole motor will have an efficiency of between 86 and 87 per cent, whereas today's energy-efficient surface-mounted line shaft pump motor may be as high as 95 per cent efficient. At a hydraulic efficiency of 78 per cent, one has an overall efficiency for the submersible unit at 68 per cent compared with 74 per cent for the line shaft.

Over a modest period of time, this difference in efficiency can provide significant energy cost savings, and, as this improved efficiency relates to the electric motor, it will be maintained.

Benefit of enclosed motors

The use of modern totally enclosed electric motors avoids the necessity for a building in which to house and protect the unit. This is evidenced by the worldwide application of such motors to pumps in the petro-chemical industry.

The majority of faults of deep well pumping equipment relates to the submersible electric motor. The motor is directly coupled to the pump and is the first part to enter the well and the last to be removed. In some cases, it can cost as much to remove and reinstall a deep well borehole unit as it did to purchase the unit.

Greater emphasis

These costs, added to the heavy cost of downtime, place greater emphasis on reliability. The line shaft pump with its surface-mounted electric motor can be serviced, repaired or replaced in hours compared with days for a submersible motor.

It can be seen that there is a fine balance between the advantages of one type of deep well pump over another for most applications. The water industry now has viable options, and engineers should seek to select equipment not merely on the basis of lowest first cost, but also installation cost, reliability, servicing aspects and long-term energy costs.

Not direct alternatives

The modern line shaft pumping unit and the submersible borehole pump should not be considered as directly competing alternatives. They are complementary; the line shaft cannot replace the borehole unit for really deep wells, mineshafts and similar, but it is a viable option for shallow wells with a pump set at 40m or less. The initial extra cost of the line shaft unit is more than offset by the energy cost saving and the labour cost saving in reduced repairs and maintenance.

Engineers should seek to select equipment not merely on the basis of lowest first cost, but also installation cost, reliability, servicing aspects and long-term energy costs

It has been said by engineers that the line shaft pump is an old-fashioned concept. This seems a strange conclusion.

To someone who has been in the pumping business for 40 years, it is hard to realise that pump application selection may be based on narrow preferences.

The diversity of pump design concepts are a challenge to the applications engineer. New technology can enhance an old design concept and take it forward to provide solutions to tomorrow's problems. The art is in selecting the best equipment for the job. ■

Dose pump progress gives more control

F Charrier, Dosapro Milton Roy

Recent progress in the field of dosing pumps and their peripherals (servomotor, frequency variator, pH transmitter-controller, Redox meter, conductivity meter) makes available reliable approaches suited to all applications in the field of water treatment.

The use of dosing pumps in industrial processes is not recent — such pumps have been in widespread use for more than half a century.

A dosing pump can be compared to a syringe, the role of which is to inject, with the pressure of the thumb (notion of pressure), a certain volume of liquid, and this in a period of time which can be withstood by the patient (notion of flow rate). Today, the performance levels of pumps have made great progress with flow rates ranging from 1cm³/h to some 30 000 l/h, and pressures which can go up to 600 bars.

These two notions — pressure and flow rate — define the two basic parameters of a dosing pump and determine as well the auxiliary energy to be expended (notion of power), be it electric (the most common), pneumatic or mechanical.

To meet with the needs of industrial processes, these two parameters of flow and pressure, taken alone, are not sufficient.

We must have equipment which satisfies such quality criteria as:

- Accuracy — Accuracy can reach plus or minus 0.5 per cent, with guarantees of linearity, repeatability and reliability as per standards in force (Example: API);
- Reliability — Depending upon the conditions under which they operate — use of a dosing pump for a few hours a day or under extreme conditions (24 hours a day, tropical climates and so on) — technological choices will differ but will still be suited to these environments for guaranteed reliability.
- Versatility — Dosing pumps are designed for and suited to a very wide range of applications (water treatment and purification, petroleum and gases, chemistry, food processing, agriculture, paper making and so on).

The wide diversity of fluids (acids, bases, oxidizers, solvents) physico-chemical conditions (pressure, acidity, viscosity) necessitate adapting technologies, in particular as regards the engineering of the liquid ends.

- Safety — All precautions were taken in the design of dosing pumps to ensure total safety for users (EC "machines" Standard and ISO 9001 procedures).

Numerous internal adaptations and peripheral accessories protect the dosing pump and downstream equipments from any incident. These components are internal safety valves, diaphragm rupture detectors or flow rate detectors. These safety components will not be discussed in this paper.

- Flexibility — Proportional flow rate on demand.

For a decade now, it has been seen that dosing pumps are more and more an integral part of control loops.

If, in earlier times, most flow rate control used to take place by manual control of stroke, or, when automatic, by simply turning the motor on and off, there are today four main methods in use to transform dosing pumps into real, particularly well suited controlling devices.

These methods are:

- Control by variable pulses;
- Control by variable speed of motor rotation (frequency variator);
- Control by variable stroke using servomotors; and
- Double control involving both a servomotor and a frequency inverter.

Control by variable pulses

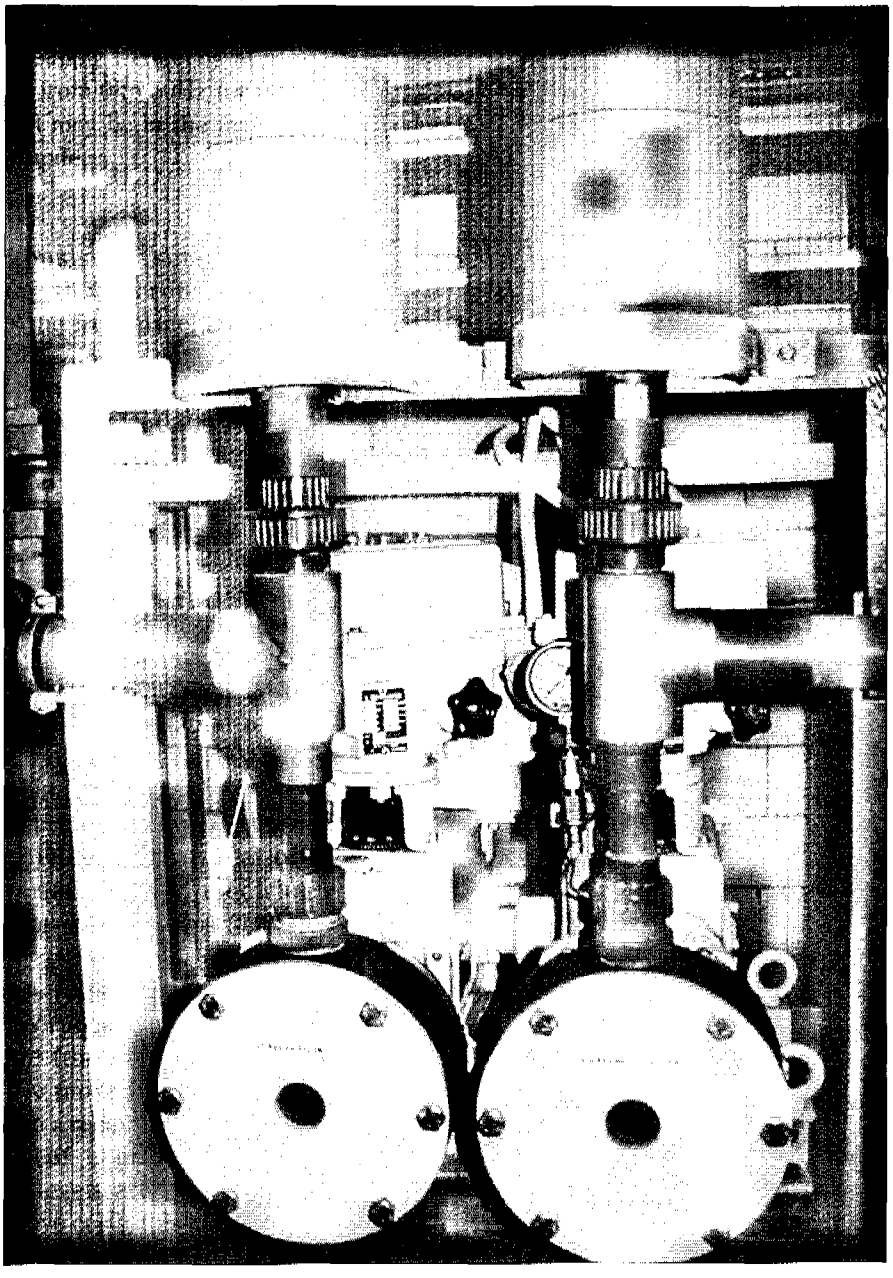
Water meters, flow meters, pH meters, Redox meters, conductivity meters — all emit electronic pulses or dry contact pulses.

The frequency of these pulses is proportional to the measured magnitude (water meters) or proportional to the difference between the measured value and a set point value (pH meters, Redox meters).

Each emitted pulse causes the liquid end diaphragm to make one round trip; a volume is then injected for each received pulse.

This technique is commonly chosen for simple applications of dosing proportional to a main flow rate. Example: injection of reagents in water treatment (chlorination, injection of corrosion inhibitors and so on).

This method can be applied to electromagnetic or electromechanical



A metering pump with two liquid ends and two servomotors.

pumps equipped with suitable electronics ("D Pulse") for flow rates ranging from 1cm³/h up to 150 l/h.

To be better adapted to operating conditions, analogue dosing pumps can self-supply pulse dividers, multipliers or analog signal converters (4-20mA generates 0 to 100 pulses). The advent of microprocessor-controlled electromagnetic pumps now ensures unequalled flexibility of use.

The dosing pump takes analog signals (0-20mA / 4-20mA), a fraction of which can be programmed for a partial or total range of flow in a direct or reciprocal mode. In other words, the measuring signal of a pH meter (for example 4-20mA equals a pH of 2 to 12) can control two dosing pumps for bilateral acid-base neutralisation.

Bilateral pH adjustment in a strictly proportional mode is only technically acceptable if conditions are favourable (buffer tank, sufficient dwell time,...). In other cases, a PID controller (or two controllers in the case of bilateral adjustment) must be used.

Control by variable speed of motor rotation (frequency inverter)

This technology acts on pump flow rate by modulating the speed of the asynchronous electric motor.

The flow rate of the dosing pump varies in a proportional manner by changing the supply frequency of the electric motor from 0 to 50Hz (or 0 to 60Hz). Control may be in the manual or automatic mode.

Manual mode

Control consists simply of programming the microprocessor variator with the front panel console. An example is a dosing pump with a maximum flow rate of 600 l/h at 50Hz will have a flow rate of 300 l/h at 25Hz.

Automatic mode

An analog signal (4-20mA, 0-20mA or 0-10V) will deliver a frequency proportional to the value of the input signal. Example: a dosing pump with a maximum flow rate of 600 l/h at 50Hz controlled by an input signal of 4-20mA will deliver a flow rate of 300 l/h with an input signal of 12mA.

Present day microprocessor inverters provide a great deal of flexibility for all types of electric motors used for dosing pumps (0.2 to 30kW).

And in fact, these variators will carry out proportional type controls in a direct mode (the more the signal increases, the more the frequency increases) or in a reciprocal mode.

Because of present day performance levels are achieved at more competitive costs, this technique is being used more and more. Some precautions must be taken with respect to the minimum speed of the pump to maintain an adequate dosing accuracy.

Control by variable stroke using servomotors

Servomotors fitted to dosing pumps provide automatic control of pump flow rate by actuating the stroke control system.

For applications in explosive atmospheres, pneumatic servomotors may be particularly well suited.

Those in most widespread use are especially electric servomotors with single phase (48 to 250V, 50/60Hz) or three phase (24 to 660V, 50/60Hz) power supply. They come in two main versions:

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Watts Ocean BV, with its offices in Eerbeek, is the Dutch subsidiary of an American concern and distributes both European and American products in the Benelux countries and Scandinavia. The range of products distinguishes itself by a high quality level and its advanced and innovative character. Operating under a single name, Watts Ocean offers you international market experience and a wide range of top quality products.

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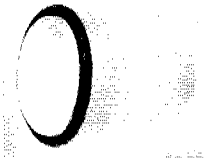

Snap-in check valve

COMPLYING WITH EUROPEAN STANDARDS
Watts Ocean only introduces its products onto the market following extensive testing and once they have demonstrated their quality in practice. The objective is to deliver products which can satisfy today's standards and regulations, as well as tomorrow's. All accessories therefore comply with all current and future standards known in the various European countries. Watts Ocean is a KIWA-ISO 9001 certificated company.

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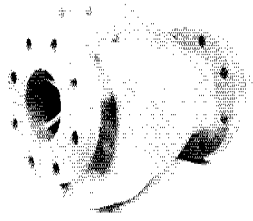
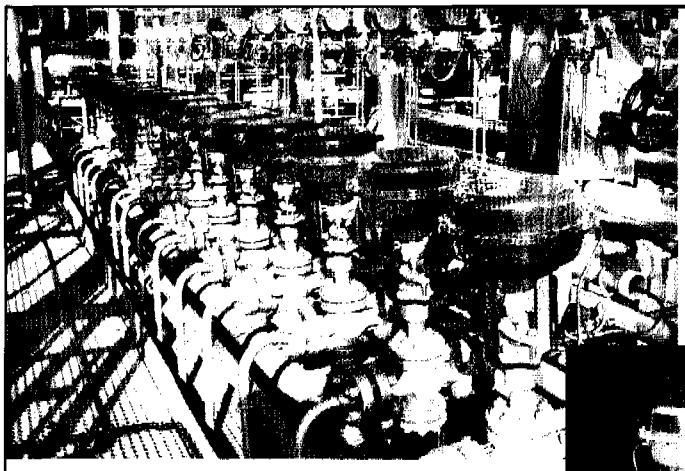
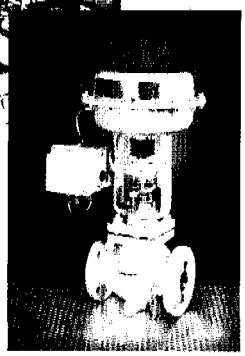
Brass non-return valve type 2.2



Silent type check valve

WATTS OCEAN





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- Enclosed servomotors, protection IP 65; or
- Explosion-proof servomotors (with an E Ex motor of II CT 5) designed for explosive atmospheres.

Each servomotor needs a control box that plays the role of a controller and supplies the servomotor with electric power according to the difference between the measured value and the set point value.

Over these past two years, a new generation of very compact servomotors has been developed: electronic servomotors (Type ECC).

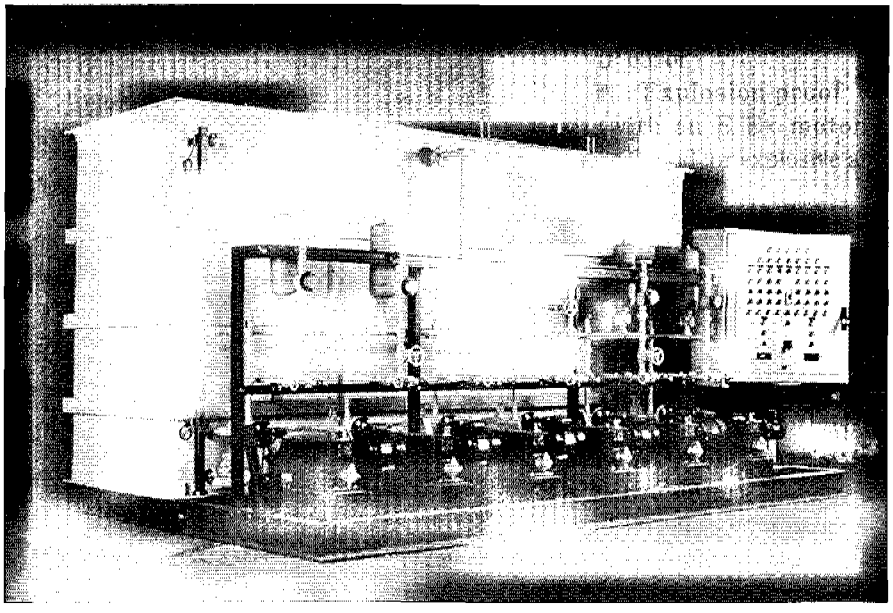
Such electronic servomotors have unquestionable advantages:

- Flexibility of use;
- Compactness;
- Reduced response time; and
- Accuracy.

Flexibility

With a 4-20mA input signal, the servomotor can work in the direct mode (4-20mA = 0-100 per cent of flow rate) or in the reciprocal mode (4-20mA = 100-0 per cent of flow rate).

By way of example, it is possible to carry out bilateral proportional adjustment of pH (acid-base) with one single 4-20mA measuring signal of a pH meter (4-20mA = pH of 2 to 12) by supplying two servomotors in series.



A polymer preparation unit for water potabilisation.

Compactness

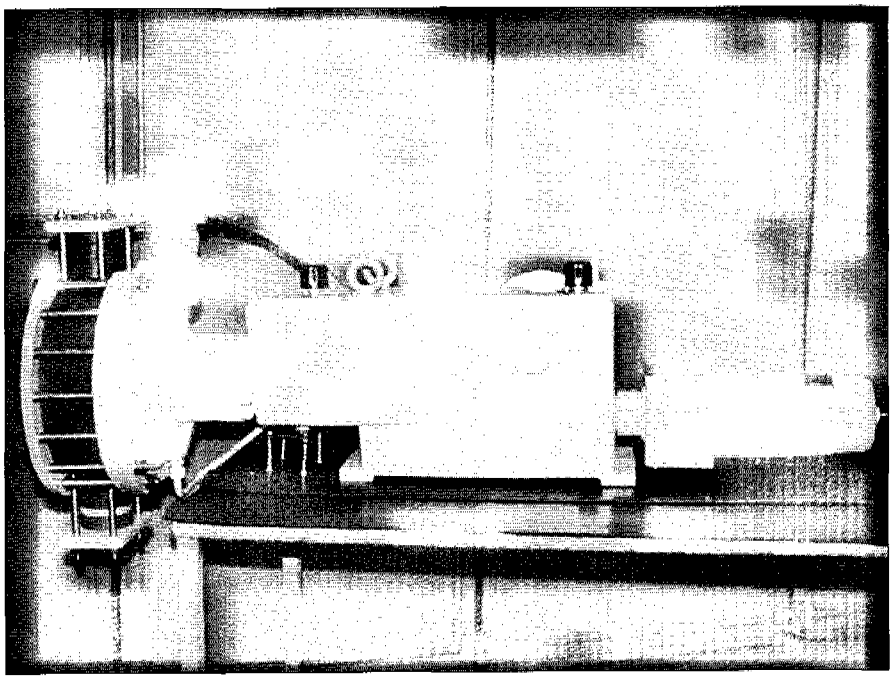
These electronic servomotors no longer need separate, costly and bulky control boxes.

Response time

These electronic servomotors have very short response times (a few seconds) and are thus well suited to water treatment processes.

Accuracy

The merit of this technology is to provide continuous injection with an accuracy of plus or minus 0.5 per cent of flow rate over the entire range.



An industrial metering pump with one ECC.

Double control involving both a servomotor and a frequency inverter

In some applications, there may be numerous disturbing variables (quality, water flow rate and so on). It may be judicious, if a fast response of the system is sought, to modulate pump flow rate on the basis of two variables.

By way of example, if a variation of water flow rate in a ratio of 1 to 20 and a variation of water quality of 1 to 10 are seen, the resolution of the dosing pump must be from 1 to 200, which can not be achieved with a dosing pump equipped with just one single control device. In this case, it is possible to obtain a very good resolution by acting on two control devices:

- The flow rate meter controls the frequency inverter; and
- A transmitter (or controller, depending upon the measured parameter) controls an electric or electronic servomotor. ■

Biography

F Charrier has achieved Masters degrees in Science and Technology in water treatment and industrial nuisances. He also has a Business Administration diploma. He is currently head of water quality and physico-chemical instrumentation at Dosapro Milton Roy in Pont Saint Pierre, France.

Demand grows for environment courses

Carolyn E Morning, EERO Training and Assessment

The European Environmental Research Organisation, based in Wageningen, Netherlands, has a training and assessment arm dealing with the three environmental elements: water, soil and air. For 1996, it is starting a major course on Restoration of Freshwater Ecosytems.

The Training and Assessment Foundation of the European Environmental Research Organisation (EERO) has two parts: the Training Centre and the Assessment Unit. Both are dedicated to development of a sustainable society in Europe and support for improvement of Europe's economic and industrial performance in ways that protect human health, safeguard natural resources and enhance the quality of the environment.

EERO Foundation Training & Assessment is a non-political, non-profit organisation that aims to spread the knowledge from natural sciences and mathematics that underlie environmental problems, to support effective dissemination and exploitation of that knowledge and to enlarge the pool of appropriately trained research workers, regulators and managers in science, industry, government and nature conservation.

The programme offered by the Training Centre focuses on two types of participants: those who have received a natural science training and those who work on a comparable level in practice. Its activities, though centrally organised, take place throughout Europe and are both theoretical and practical, varying from symposia and workshops to a series of multi-day courses based on a modular structure.

The EERO Assessment Unit was established in order to make authoritative scientific assessments of specific environmental problems. Each assessment is based on an international meeting of leading experts, the outcome of which results in a document representing the consensus view of the entire group. The final document is refereed by independent experts whose comments are attached to the scientific publication in order to help the reader in judging its value.

This year, the EERO Training Centre is meeting growing demand by increasing its training programme with the development of a major course in the water sector on Restoration of Fresh Water Ecosystems. It will also be launching three others: Ecology and the Impact of Stress on Ecosystems; Applied Soil Sanitation and Remediation; and Risk Assessment and Risk Management.

The course on Restoration of Fresh Water Ecosystems was developed due to the current widespread European interest in restoring river, lake and flood plain ecosystems for the benefit of humans and wildlife.

Reinstating naturally functioning river flood plain and lake systems may bring catchment management benefits, particularly by giving increased nutrient retention, ameliorating low flows, increasing flood-storage capacity, reducing river and lake maintenance costs and providing better facilities for amenity and recreation. Restoration of fresh water ecosystems has great potential as a tool for Integrated Catchment Management.

The aim of this course/workshop is to give the latest developments on restoration of damaged rivers and their flood plain and lake systems. The course lasts 4 days and is intended for graduates who are already engaged in (integrated) water management work of one kind or another (research, regulatory work in government and industry). Bursaries are available for PhD researchers and other participants in need of support.

The course covers all major topics in the field such as:

- Restoration of streams and lakes;
- Demonstration projects and conservation value;
- River restoration techniques applied in the county of Southern Jutland, Denmark;
- Experiences in Switzerland and future needs;
- Overview on lake restoration — physical-chemical and biological methods;
- Lake Restoration in the Netherlands phosphorous control and biomanipulation;
- Italian, Norwegian and Swedish experiences;
- European Union policy on biodiversity and ecosystem restoration;
- Policy and strategy for restoration of aquatic ecosystems; and
- The work of the European Environment Agency (EEA) on biodi-

versity and environmental quality in aquatic ecosystems.

The course will take place in the Freshwater Centre, Silkeborg Denmark, and two excursions are planned on restoration, one on lakes and the other on rivers.

The Course directors and lecturers come from throughout Europe and have each been chosen for their particular expertise.

Course directors are Prof B Moss, Liverpool University, United Kingdom; and Dr I-M Lorenzen, Danish Environmental Protection Agency, Copenhagen, Denmark.

In its preliminary programme for 1996, the EERO Training Centre has more than doubled its activities.

In the Spring, it will run courses on:

- Environmental Technology (Belgium);
- Environmental Chemistry Of Inorganic Pollutants (France);
- Ecotoxicology (Netherlands);
- European Environmental Policy (Belgium);
- Risk Assessment & Risk Management (Luxembourg); and
- Estuarine Ecology & Coastal Management (France).

In the autumn, the programme will include:

- Environmental Chemistry of Organic Pollutants (Switzerland);
- Ecology and the Impact of Stress on Ecosystems (United Kingdom);
- Soil Pollution and Risk Assessment (Germany);
- Applied Soil Sanitation and Remediation (Germany);
- General Toxicology (Germany); and
- Introduction of Genetically Modified Organisms (Netherlands).

In addition, the foundation presents an EERO Environmental Education Award every three years as proof of recognition and appreciation of efforts made to improve the quality of our environment. On 15 June 1994, the first presentation of the EERO Environmental Education Award took place in the Auditorium of the Agricultural University of Wageningen in the Netherlands. The recipient was the environmental journal Ambio and its editor, Elizabeth Kessler, in view of the journal's major achievements over the past three years in the field of information dissemination.

The award will be presented again in 1997 to an institution, organisation, private individual or company that during the last three years has made a substantial contribution to disseminating the transfer of environmental knowledge in ways that protect human health, safeguard natural resources and/or enhance the quality of our environment. ■

Biography
Carolyn Morning is Project Manager with EERO Training and Assessment, based in the Netherlands. She is responsible for the PR and Marketing of EERO activities throughout Europe.

Safety control in the water industry

Steve Langley, Castell Safety International

There are many potential hazards within the water industry, ranging from the use of potentially dangerous machinery to the use of hazardous chemicals. This article explains how one simple safety device, the interlock, could provide the solution to many safety problems.

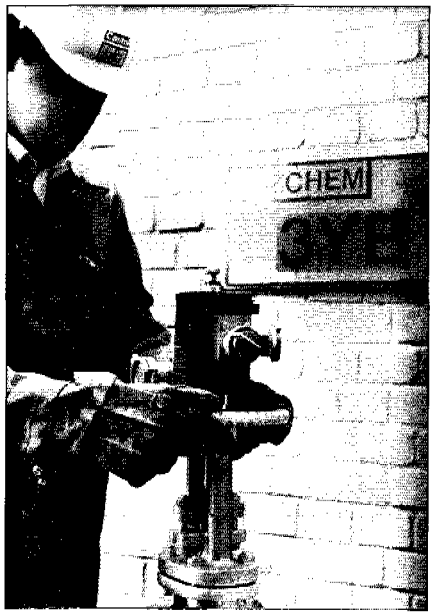
There can be few industries that face such a wide range of potential safety problems as the water industry. Involved in activities ranging from construction of new trunk mains and renovation of sewers to the processing of clean and dirty water, the water industry's safety responsibilities must take into account protection of personnel, control of hazardous substances and pollution prevention.

Legal requirements

New UK regulations stipulate that it is an offence under the Supply of Machinery (Safety) Regulations to supply a new machine which does not bear the CE mark of conformity. By 1 January 1997, all users of machinery will have a similar duty of care to ensure adequate maintenance, training and safety procedures are in place for all types of work equipment. This will include the fitting of interlocks where necessary.

The interlock principle

When considering any safety precautions it is important to ensure that the controls in place are simple to understand and use, do not compromise existing safe working practices or interfere with normal operations and cannot be overridden or by-passed. In addition, it is preferable that safety devices are not wholly dependent on a power supply. There is one device which fulfils all these criteria: the mechanical interlock.



Interlocks can be used to ensure that valves are opened and closed in the correct sequence

The principle of interlocking is very simple: actions performed in the correct sequence are safe, but are potentially lethal if the incorrect sequence is followed. In a typical system, a specially constructed lock mechanism traps the operating key when machinery or plant is in a predetermined condition.

One key is supplied to operate two or more locks. By removing the key from the first lock, the status of the equipment to which it is fitted is altered and the key can then be transferred to the next lock.

Interlock systems can impose a single, safe and pre-determined sequence of events upon the operator. Because the interlock is such a simple device, comprising a lock body and key, it is highly adaptable. Interlocks can be applied to virtually any piece of plant, from electrical cabinets to raking machines and valves.

They are also easy to operate; no extra training is involved when operation is a matter of turning a key in a lock. Being mechanical, they do not rely on an external power source and so are particularly reliable when considering the safe operation of remote pieces of plant. In addition, interlocks do not add to the amount of time it takes to perform normal operations.

Hazardous machinery

Safety interlock systems can be applied to virtually any potentially hazardous process or machine to prevent misuse and protect personnel. One application is the control of access to sand cleaning equipment.

Sand is commonly used as a filter layer in water settlement tanks. To ensure its effectiveness in removing particles from the water, the sand bed must be periodically cleaned. This involves removing the top layer of

sand and loading it into a large hopper. A conveyor then transports the impure sand to the top of a gravity feed tower and into a primary cleaning drum to remove large waste particles.

The sand cleaning drums are normally operated automatically from a control room at ground level. Workers require access to the drums periodically to clear blockages and carry out maintenance checks. Unless a safe system of work is ensured, personnel could be injured by plant being operated while they are in contact with the drums.

Interlocks can be used to ensure that the drums are switched from automatic operation to local control before any maintenance work can begin. The interlock safety system also takes into account the requirement for "inching" the drums so that inspection and local adjustment can take place.

To obtain access to the drums, the maintenance worker must first remove the primary key from the control room. Removal of this key automatically disables the control panel. The operator can then proceed to the access gantry around the drum where the local controls are situated. At this stage, the drum can be inched into the desired position using pushbutton controls.

Once the drum is correctly sited, the operator inserts the primary key into an exchange box adjacent to the inching controls. Inserting the primary key releases the access keys to the drum guard doors and isolates all power to the drum. While the guards are open, the drum cannot be activated by either automatic or local controls.

By controlling every stage of the maintenance process, the interlock system ensures that personnel cannot come into contact with moving machinery by making isolation of the power supply a pre-requisite for gaining access.

Other applications for interlock systems on hazardous machinery include sewage compactors and overhead travelling cranes. Interlocks can also be used on switchgear to prevent paralleling of supplies at pumping stations and water treatment plants, or to prevent access to electrical cabinets until the power supply is safely isolated.

Valve control

Potable water treatment involves the use of potentially hazardous chemicals such as chlorine, sulphur dioxide and ammonia. All three gases are highly toxic and ammonia also presents a flammable risk. Clearly any spillage, inadvertent mixing or other misuse of these chemicals can cause a danger, not only to water industry personnel, but also to the general public.

If released in quantity into water courses or as gas into the air, there is also the potential for environmental damage.

The transport of hazardous chemicals must therefore be strictly controlled. Interlocks can again be used to ensure that valves are opened and closed in the correct sequence, starting at the point of delivery. Using safety interlocks it is possible to govern each stage of the loading and unloading process at storage sites and water treatment plants.

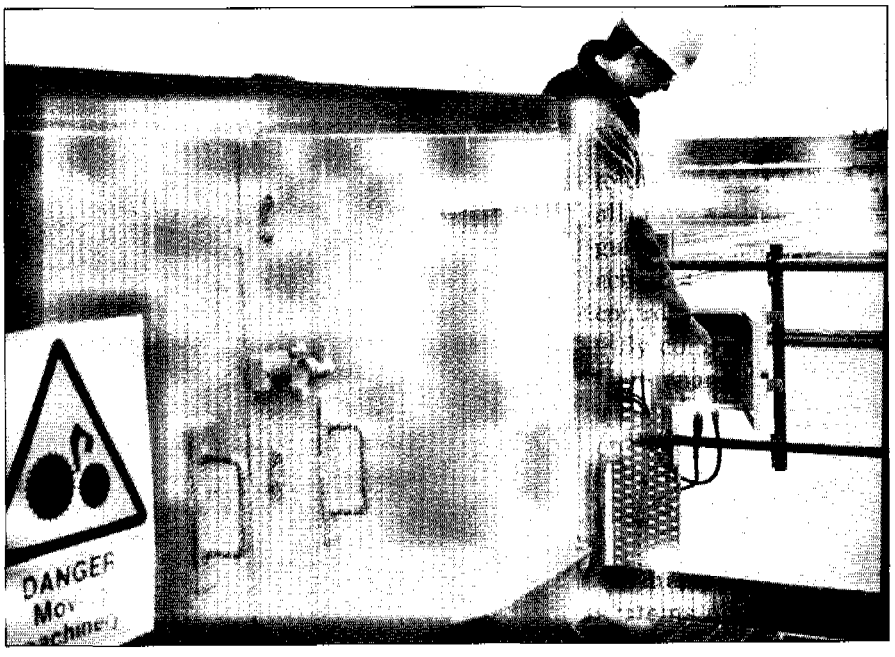
Tanker bay interlock systems prevent operators filling tanks with the wrong liquids, unloading into the wrong tank, or driving off while the tanker is still connected to a hose. This type of interlock system basically comprises interlocked safety barriers and interlock units and fittings for each hose and valve. Ancillary equipment such as pumping gear can also be incorporated into the safety sequence.

Valve interlock systems can also be designed to control the discharge of effluent into sewers at chemical tank farms. When applied to digesters, a valve interlock system can ensure that an open relief path is maintained at all times to avoid gas build-up and over-pressure explosion.

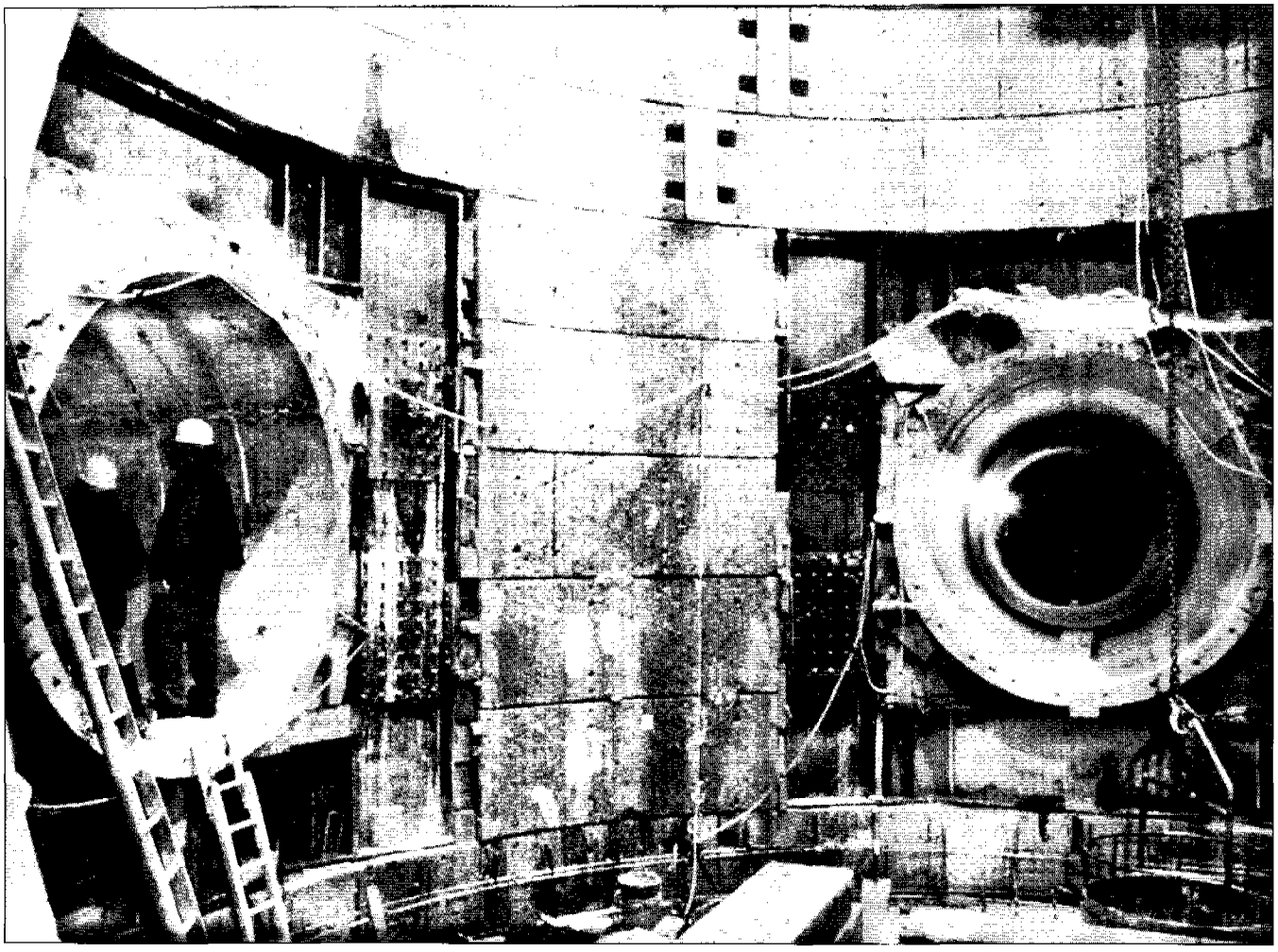
Safe and secure

There are some situations within the water industry in which the dividing line between safety and security becomes blurred. With remote valves, for example, or electrical cabinets, the equipment may not require any change in operational status for considerable periods of time. While authorised personnel may have no need to visit, this circumstance can simply encourage the presence of unauthorised persons. There is therefore a risk of vandalism or tampering.

In these applications, it is particularly important that safety equipment cannot be overridden or defeated. Interlocks can be supplied



One application for an interlock is the control of access to sand cleaning equipment during maintenance of filters.



Castell interlock safety systems are currently in use on the London Water Ring Main. Fitted to hatches on the access shafts, the interlocks ensure that maintenance personnel cannot enter access shafts until the air has been purged of any dangerous gases.

with a variety of locking mechanisms, including non-masterable versions. In addition, lock bodies can be manufactured from brass, stainless steel or to offshore specification. Depending on the material chosen, interlocks can therefore not only be relied on to defeat any malicious or accidental attempts at tampering, but also to withstand years of exposure to arduous weather conditions and exposure to corrosive atmospheres.

Added value

It can be seen from the examples above that interlocking systems can provide the solution to process control and personnel safety problems within the water industry. There are secondary advantages to using interlock safety control solutions, in addition to the obvious benefits of simplicity of installation and use and the product's reliability over many years.

Most reputable interlock companies will also offer a project management and consultancy service. This ensures that, through site visits and consultation with water company personnel, an interlock system is designed to exactly meet customer requirements. Project management can include everything from design, installation and manufacture of the system to regular annual maintenance. Specialist interlock companies like Castell will also liaise with the relevant certification and classification authorities on a client's behalf. The interlock company can therefore relieve much of the administrative burden from the water company, as well as freeing water company maintenance personnel for other tasks.

Conclusion

The strength of interlocks is in their simplicity. Because the basic product has not changed much in its seventy year history, established safety interlock companies like Castell have been able to concentrate their efforts on developing new services to meet the changing needs of their customers. Within the water industry in particular, interlock systems can be applied to virtually any situation where the protection of personnel, plant or the environment is paramount.

As an example of the interlock's continuing relevance to water industry safety requirements, Castell interlock safety systems are currently in use on the London Water Ring Main, probably the most ambitious and prestigious water engineering project this century. Fitted to hatches on the Ring Main access shafts, the interlocks ensure that maintenance personnel cannot enter access shafts until the air has been purged of any dangerous gases. ■

What makes a good consultant?

Tom Chapman, GU Projects

How will you choose your next Engineering Consultant? Will it be a firm whose representative impressed you with the force of his personality and his glossy brochures, or the friend of a friend or a big name in the consultancy world? Here are some tips to help you.

You are looking for a consultant because you have a problem to solve and lack the expertise, or perhaps the time, to deal with it yourself. Ideally, consultants have the expertise, and the time, to deal with your problem. But, how do you know?

Consultancy is a knowledge business, and a good consultant will actually make a useful and cost-effective contribution to helping you to run your business.

Over the years, consultancies and their services have developed enormously, to the general benefit of their clients. Today's consultant in the water industry is likely to be foremost a problem solver, assessing current performance to compare with present and future needs, rather than producing grand designs. Finding out what is wrong and being able to correct it, operationally as well as technically, is often more important than starting from scratch, and, as well as conventional design and supervision expertise, the consultant must have tools and skills rare even 10 years ago.

Investigating a problem frequently starts with a calibrated computer model of the installation, soundly constructed, using mathematical formulae to represent interaction between components, today often in proprietary software or spreadsheet format rather than the tailor-made programming languages of the 70s and 80s. Flows, pressures and quality variation through water and wastewater networks are now sufficiently well understood to be routinely modelled. Dynamic models, configured to reflect operational practices, can now examine effectiveness and possible improvements to a system, without time and cost uncertainties, before trying it in practice.

A computer model is only as good as the sophistication of the software and the accuracy of the calibration data. Experience and expertise are necessary to assess how sensibly the model reflects performance in practice. Nevertheless, a model as an evaluation tool is a great advance on basic design codes, and is definitely the way of the future when backed by practical design and operational experience.

Assurance of consultancy skills comes from implementation of formal quality assurance (QA) procedures. Traditionally, client output from a consultant's office was subject to checking and peer review, if only to satisfy the requirements of professional indemnity insurance, but this often relied on the checker's view of the designer's competence, rather than a detailed audit of the work. A good QA system requires proper checking, and a quality-aware culture that will encourage more careful design or analysis.

New UK regulations have placed greater onus on designers to design out health and safety risks to personnel during construction and maintenance. Avoidance of risk is preferred to personnel protection, and this means knowing how the intended works will be operated and maintained. Designers therefore need a good understanding of operational methods and practices.

Ensuring that consultancy staff are and remain competent is important to satisfy the varied needs of clients. Training and development of professional and technical staff with specialist and general skills is a continuous process, not just during a post-academic structured training period, but throughout their career. A consultancy's particular knowledge and skills comes from the employment of specialist staff who have the necessary background and reputation, with motivation and personal interest to remain in touch with current thinking and practices. General knowledge including basic computer literacy, project management, project procurement, presentation skills, etc., all improve the ability to perform well. The enhancement and maintenance of knowledge and skills must be deliberate, strongly encouraged and well supported.

Today's consultant must be knowledgeable, skillful, well organised, useful and cost-effective. He (or she) must combine the qualities of engineer, scientist, investigator, analyst, designer, project manager, economist, lawyer, safety manager, operations manager, contractor, quantity surveyor, personnel manager, customer services manager, business development manager, professional advisor and friend.

A good consultant is hard to find, and hard to beat! ■

Biography

Eur Ing Tom Chapman BSc CEng MICE FCIWEM MIMgt is a Senior Manager with GU Projects, responsible for projects, quality assurance, professional training and client care.

Saur International in the UK

Saur UK is part of Saur International, an international group of companies serving thousands of communities on four continents. Our philosophy of service excellence is at the heart of our success story both here in the UK and in our activities worldwide.

Saur UK serves over 3 million people within the UK providing services which are vital to everyday life. We treat our clients and customers as partners, listening to their concerns and providing a flexible service to tackle their problems.

Water Supply

400 million litres of drinking water are provided each day to more than 1.3 million people in the South of England by Mid Southern and South East Water, the water supply companies within Saur UK.

To ensure that all the water supplied by Saur UK complies with the water quality regulations, 150 000 samples are taken each year from customers' taps, treatment works, distribution systems, reservoirs and towers. These are analysed using over 120 chemical and bacteriological parameters.

Over 99% of the water supplied by Saur UK surpasses all water quality requirements set by the British government and the EC.

Environmental and Community Services

Ecovert offer a comprehensive range of environmental services to local authorities, commerce and industry, including: domestic refuse collection, trade waste services, street cleansing, recycling, beach cleansing, grounds maintenance and private management of local authorities DSO's.

Across the UK 16 local authorities as well as more than 400 000 households rely on Ecovert to manage and run the environmental services they need.

Environmental Consultancy

Dynamco is the environmental consultancy within Saur UK. Within the UK, Dynamco is actively involved in a wide range of schemes, including investment appraisal resources, treatment works, pipelines, services reservoirs, domestic metering and the provision of scientific services.

Mains Rehabilitation and Refurbishment

From a background of experience and diversity of skills within the water industry, Pipeway was established in 1990 to provide a total management and contracting service for the water supply and distribution functions of the water industry.

The Company is staffed by personnel experienced in the water industry and has the ability to carry out any aspect of maintenance, upgrading or rehabilitation of the distribution network from the service reservoir to the customer's tap.

SAUR UK

22/30 Sturt Road,
Frimley Green, Camberley
Surrey GU16 6HZ
Telephone: (01252) 837639
Telefax: (01252) 838370

A member of the saur group

History and projects of the Dynamco consultancy

Dynamco Ltd

Dynamco Limited is the water and environmental consultancy owned by SAUR UK. It has expanded rapidly since 1990 and now employs over 100 people.

It is a part of the major SAUR International utilities group, which includes Mid Southern Water plc and South East Water Limited in England. Based in Haywards Heath and with a new scientific laboratory in Frimley Green, Dynamco is managing about 100 projects of total value around £60 million.

The total annual turnover exceeds £7 million, including over £5 million from consultancy services.

Dynamco provides a full range of consultancy, project management and scientific services to the water industry. Specific services include the preparation of Strategic Business Plans for water companies, planning and development of water based projects, including feasibility and strategic studies; investigation and development of water resources; design and project management of water supply and wastewater projects; electrical, mechanical, instrumentation and telemetry design and implementation; operational management for all aspects of the water cycle and for solid waste.

Recent projects include an operational feasibility study of municipal services for a new city in Thailand; fixed assets revaluation in Ghana; a water supply tariff study in Benin; asset management planning in Turkey and in the UK; design, construction management and complete operation of the new laboratory in Frimley Green; design and project management for a variety of water treatment plants; hydraulic modelling using the WESNET, GINAS or WATNET software packages; consumer metering.

The parent SAUR Group, founded in 1933, is the third largest private company in the water supply and sewerage sector in France.

International activities in the management of public services have expanded over 35 years, starting on the African continent and developing more recently in Eastern and Western Europe, Asia, Pacific, North and South America.

In Europe, the Group is particularly strong in France, the UK, Spain, Italy, Poland, Bulgaria and Russia.

During 1995, Dynamco and SAUR International have carried out a feasibility study for water supply and sewerage for Daugavpils, the second city of Latvia. The ex-Eastern Bloc countries are regarded as particularly important areas in Dynamco's continued growth and development in Europe.

Active marketing on the continent during the last year has mainly involved Scandinavia, the Baltic countries, Poland and Bulgaria, but other countries on the continent will remain under close scrutiny for the future. □

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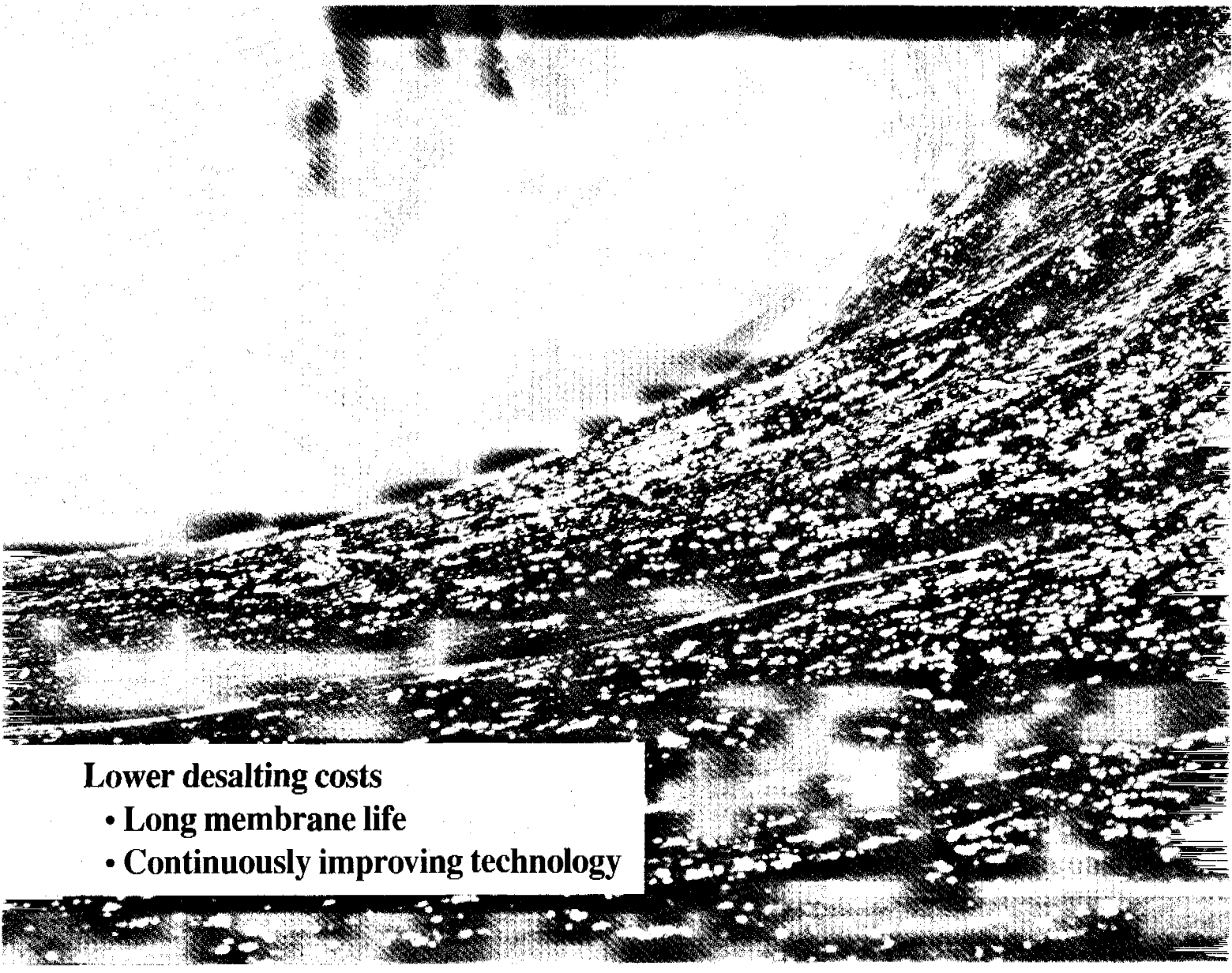

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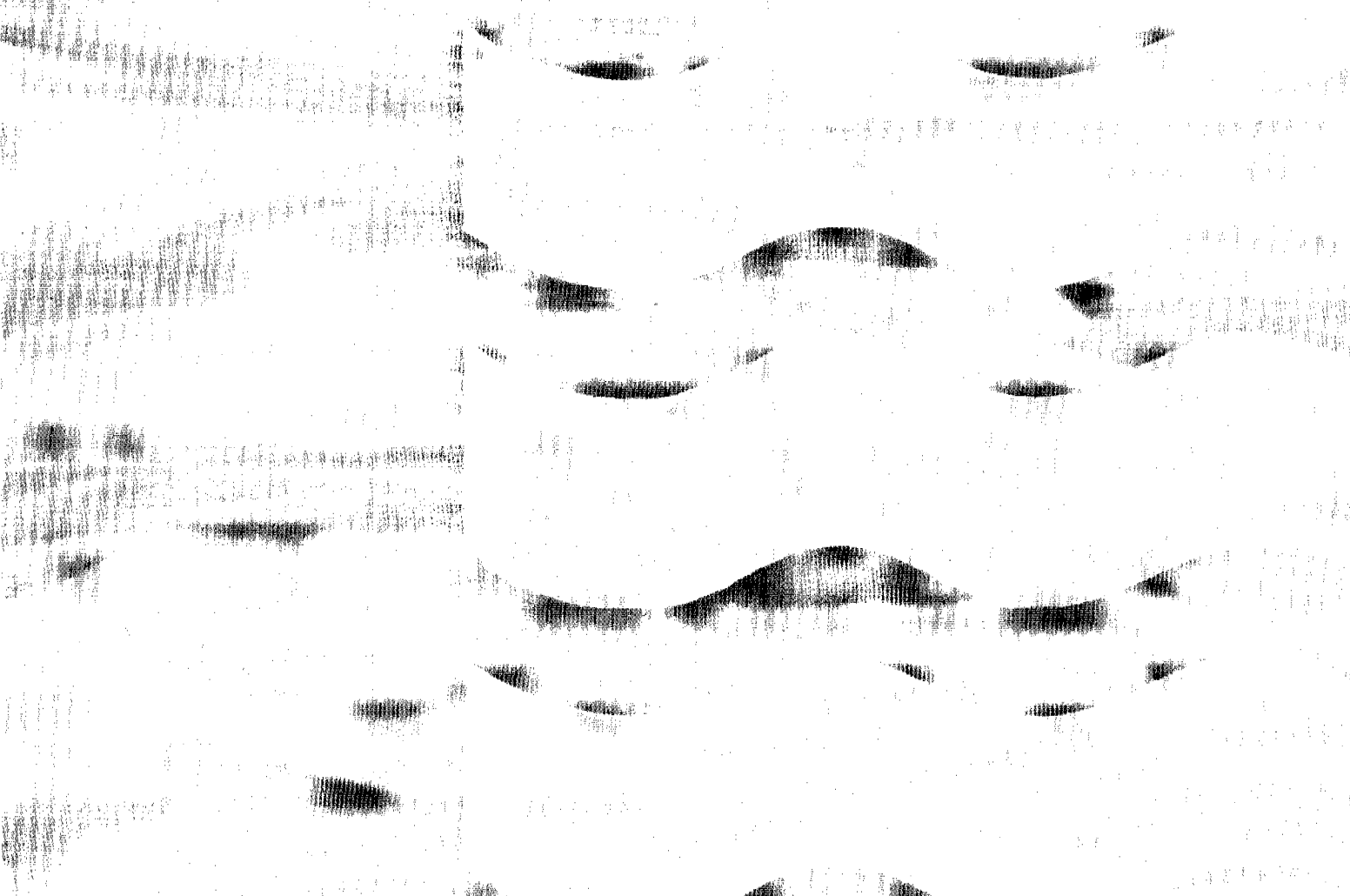
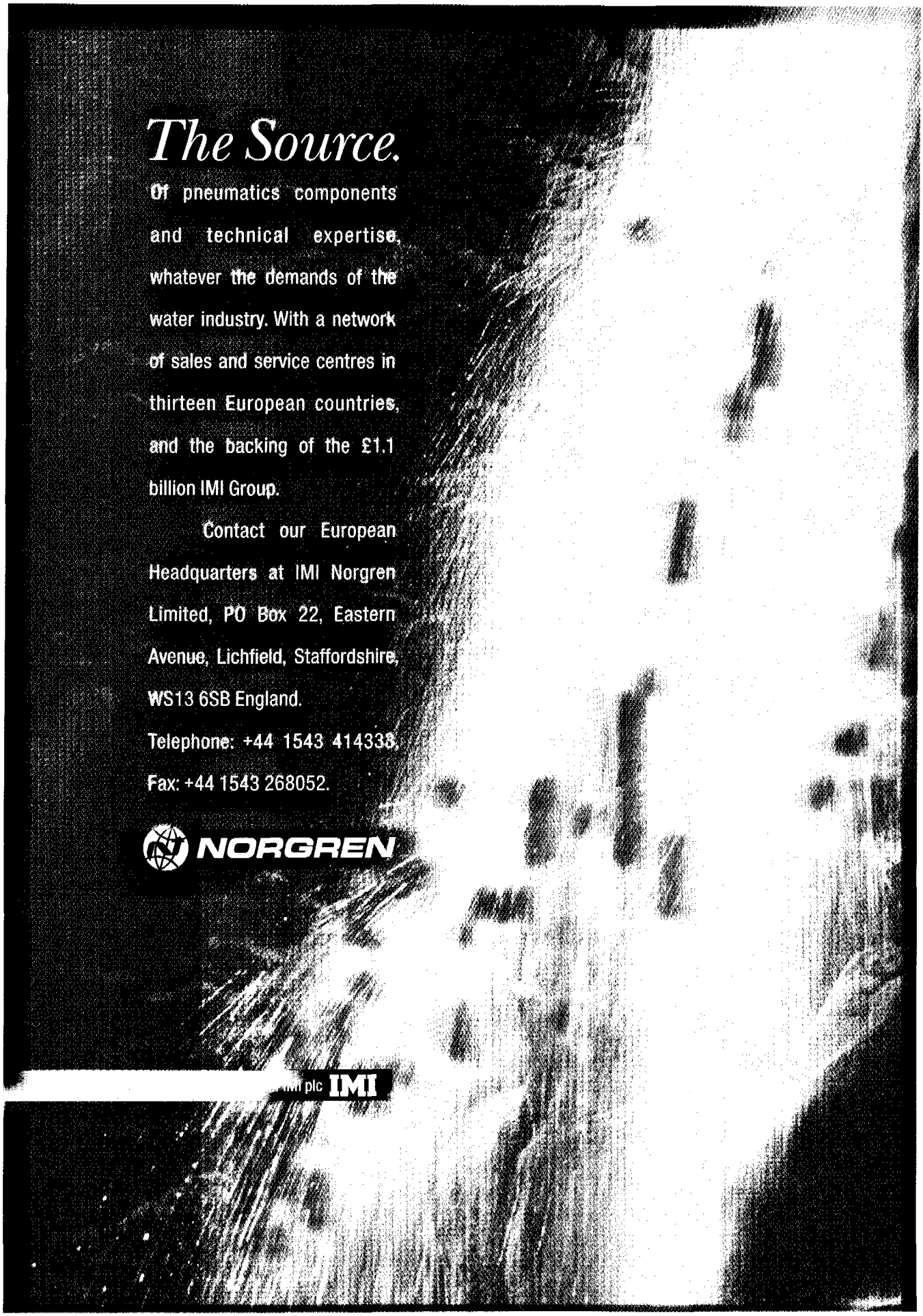
Who's Who in European water



1996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Foreword

In a Community whose citizens are mobile, and in a Community where there is a commitment to a level playing field for business and industry, it is essential that we set standards for water quality at the European level, so that the environment may be protected and public health maintained across the 15 member countries.

At the same time, it is important that we should devise a system that has the flexibility to find solutions on implementation and enforcement within the European framework, but based on more local cultural and traditional characteristics.

The European Union's involvement in water policy is based on the recognition that we have a duty to protect natural resources, a duty to protect human health and a duty to ensure that the Community's competition policy is not violated by the existence of differing water quality standards in different member states.

We need a holistic approach to water quality and this requires a broad analysis of all aspects of water resource management from coastal zones to licences for groundwater abstraction, from agricultural effluent to urban waste water. This year, the Commission has come forward with proposals to update the major water quality directives and the European Parliament's Environment Committee has taken the initiative of holding a public hearing to examine the various proposals altogether. In this way, we can ensure that uniform high standards will be achieved for all water, be it bathing or drinking water, and that overall Community water policy forms a coherent body of legislation.

We are also concerned to ensure that responsibility for managing our common water resources is sensibly shared between different levels of government and other relevant bodies. The EU has its own role but so, also, do national governments, regional governments, local authorities and, in some cases, private enterprise. Deciding who is responsible for what action is important, not only to ensure effective implementation and enforcement of water legislation, but to ensure there is public confidence in the system and the legislation. If the public are unaware of where responsibility lies, this confidence will be lacking and the best intentions to provide the best quality water will be undermined as a result.

The most effective system for providing this accountability is one where decisions are taken on the basis of allocating responsibility to the level of competence where action can be taken most effectively. This will also ensure that cultural and legal variety across member states is preserved. This should not mean that such variations are used as an alibi for failures to implement or enforce legislation. Only if implementation and enforcement are taken seriously can the primary aims of European environment policy be achieved.

This book is an essential guide for industry, governmental bodies, non-governmental organisations and the general public. It provides a comprehensive list and description of the relevant organisations and individuals involved in all aspects of European water resource management. It is a valuable resource which should be consulted widely and indeed regularly by those hoping to have an influence in the many facets of water resources management.

Ken Collins MEP, Chairman,
European Parliament's Committee on the Environment,
Public Health and Consumer Protection

Life needs water...

...water needs our technology!

PURAQUA

UMWELTANLAGEN

WATER / SEWAGE TREATMENT PLANTS
EQUIPMENT FOR WASTE WATER TREATMENT PLANTS

PURAQUA UMWELTANLAGEN GMBH, Lembockgasse 49, 1234 Vienna, Austria,
Phone: 0043/1/86647-0, Fax: 0043/1/86647-201

Government departments and regulating bodies

Bundesministerium für Gesundheit und Konsumentenschutz
(Federal Ministry of Health, Sports and Consumers' Protection), Sektion II, Radetzkystrasse 2, A-1030 Wien
Tel +43 1 711 720
Fax +43 1 713 8614

Bundesministerium für Land- und Forstwirtschaft
(Federal Ministry of Agriculture and Forestry), Stubenring 12, A-1010 Wien
Tel +43 1 711 00 2855
Fax +43 1 711 00 2900
General Director: Prof Dr Wolfgang Stalzer

Bundesministerium für Umwelt, Jugend und Familie
(Federal Ministry of Environment, Youth and Family), Radetzkystrasse 2, A-1030 Wien
Tel +43 1 711 580
Fax +43 1 711 584221
Minister: Maria Rauch-Kallat

Umweltförderung des Bundes
Abt III/7 des Bundesministeriums für Umwelt, Untere Donaustrasse 11, A-1020 Wien
Tel +43 1 211 32 5213
Dept 30. Water supply: Dipl-Ing Manfred Doleisch

Österreichische Kommunalkredit AG
Abt Wasserwirtschaft, Türkenstrasse 9, A-1092 Wien
Tel +43 1 310 77 25310
Contact: Dipl Ing Fras

Institutes and associations

Institute for Water Quality and Waste Management
Technische Universität Wien, Karlsplatz 13, A-1040 Wien
Tel +43 1 58801 3147
Fax +43 1 504 2157
Head of Institute: Prof Dr H Kroiss

Österreichische Vereinigung für das Gas- und Wasserfach (ÖVGW)
Schubertring 14, A-1010 Wien
Tel +43 1 5131 5880
Fax +43 1 5131 58825
Geschäftsführer: Dip Ing Robert Köck

Österreichischer Wasser- und Abfallwirtschaftsverband
Marc Aurel-Strasse 5, A-1010 Wien
Tel +43 1 535 5720
Fax +43 1 535 4064
Geschäftsführer: Dipl-Ing Reinhard Weiss

Water suppliers and sewage water treatment/disposal plant

Amstetten
Stadtwerke Amstetten, Hauptplatz 29, A-3300 Amstetten
Tel +43 7472 609-0
Fax +43 7472 609-82
Direktor:
Ing Herbert Peninger
Population: 21 000
Vol water supplied: 1.9*
No. reservoirs: 8
No. sewage plants: 1

Ansfelden
Wasserwerk Haid, Haid Wasserwerkstr. 10, A-4052 *Ansfelden*
Tel +43 7229 87513

Bregenz
Stadtwerke Bregenz, Gas- und Wasserwerk, Reutegasse 33, A-6900 Bregenz
Tel +43 5574 34100

Bruck an der Mur
Stadtwerke Bruck an der Mur, Mitterg. 13, A-8600 Bruck an der Mur
Tel +43 3862 51581-0
Fax +43 3862 51581-43
Betriebsdirektor:
Ing Wolfgang Decker
Population: 16 000
Vol water supplied: 1.2*
No. reservoirs: 6
No. sewage plants: 1

Dornbirn
Wasserwerk der Stadt Dornbirn, A-6850 Dornbirn
Tel +43 5572 65476

Eisenerz
Stadtwerke Eisenerz GmbH, Gsollstr. 13, A-8790 Eisenerz
Tel +43 3848 2219

Enns
Wasserwerk Enns, A-4470 Enns
Tel +43 7223 218133

Feldkirch
Wasserwerk Feldkirch, A-6800 Feldkirch
Tel +43 5522 21521

Fellxdorf und Sollenau
Wasserwerk der Gemeinden Felixdorf und Sollenau, *A-2603 Felixdorf*
Tel +43 2628 2236

Fischamend
Wasserwerk Fischamend, Am Damm 6, A-2401 Fischamend
Tel +43 2232 236

Fuerstenfeld
Waserwerk Fuerstenfeld, Uferweg 19, A-8280 Fuerstenfeld
Tel +43 3382 2552

Gartenau
Wasserwerksgenossenschaft, Almhauptkanal Wehrstr. 6, A-5083 Gartenau-St Leonhard
Tel +43 6246 2326

Graz
Grazer Stadtwerke AG, Postfach 848, Andreas-Hofer-Platz 15, A-8010 Graz
Tel +43 316 887-222
Fax +43 316 887-786
Direktor:
Dipl-Ing Helmut Nickl
Population: 250 000
Vol water supplied: 18*
No. reservoirs: 20
Vol sewage treated: 0

Groedig
Salzburger Stadtwerke, A-5082 Groedig
Tel +43 6246 3219

Hainburg
Städtisches Wasserwerk, Hauptplatz 23, A-2410 Hainburg an der Donau
Tel +43 2165 3121

Hallein
Wasserwerk Hallein, *Schöndorferplatz 14*, A-5400 Hallein
Tel +43 6245 83322
Fax +43 6245 83322-60
Betriebsleiter:
Ing Anton Holzer
Population: 19 047
Vol water supplied: 3.54*
No. reservoirs: 4
No. sewage plants: 0

Hard
Wasserwerk Hard-Fussach, A-6971 Hard
Tel +43 5574 77245
Fax +43 5574 77245-6
WW-Leiter:
Kurt Hagen
Population: 15 000
Vol water supplied: 1*
No. reservoirs: 0
Vol sewage treated: 1.2*
No. sewage plants: 1

Herzogenburg
Wasserwerk der Stadtgemeinde Herzogenburg, *Oberndorf an der Ebene*, St Poeltner Str NB, A-3130 Herzogenburg
Tel +43 2782 3346

Hoechst
Wasserwerk Hoechst, A-6973 Hoechst
Tel +43 5578 5683

Horn
Wasserwerk der Stadtgemeinde Horn, Doberndorfer Strasse, A-3580 Horn
Tel +43 2982 2656
Fax +43 2982 2656 22
Direktor:
Ing Otto Rint
Population: 8000
*Vol water supplied: 0.75**
No. reservoirs: 3
Vol sewage treated: 1.2*
No. sewage plants: 1

Imst
Stadtwerke Imst, Tirol, Malchbachgasse 1, A-6460 Imst
Tel +43 5412 3324
Fax +43 5412 3755
Direktor:
Mantl, Gebhart
Population: 7122
Vol water supplied: 0.74*
No. reservoirs: 5
Vol sewage treated: 1.4*
No. sewage plants: 1

Innsbruck
Stadtwerke Innsbruck, Salurner Str 11, A-6010 Innsbruck
Tel +43 0512 502 5400
Fax +43 0512 502 5408
Direktor:
Dipl-Ing Herwig Herbert
Population: 129 720
Vol water supplied: 16*
No. reservoirs: 13
Vol sewage treated: 18*
No. sewage plants: 7

Kapfenberg
Stadtwerke Kapfenberg, A-8605 Kapfenberg
Tel +43 3862 23516
Fax +43 3862 23516-238
Obr Direktor:
Dipl-Ing Christian Wohlmuth
Population: 24 000
Vol water supplied: 2.15*
No. reservoirs: 8

Klagenfurt
Wasserwerk Klagenfurt, *Pischeldorfer Strasse 31*, A-9020 Klagenfurt
Tel +43 463 55510-0
Fax +43 463 55510-470
Betriebsleiter:
Ing Kramer
Population: 87 000
Vol water supplied: 8.86*
No. reservoirs: 23

Krems
Wasserwerk der Stadt Krems, Dr Bertschinger-Str 13, A-3500 Krems
Tel +43 2732 83144
Fax +43 2732 831449
Population: 23 000
Vol water supplied: 3.1*
No. reservoirs: 14

Kufstein
Stadtwerke Kufstein, Ob. Stadtpl. 15, A-6330 Kufstein
Tel +43 5372 4807-0

Lackendorf
Wasserverband Mittleres Burgenland, A-7321 Lackendorf
Tel +43 2619 400

*million m³/year

Lambach
Wasserwerk Lambach,
Badgasse 19, A-4650
Lambach
Tel +43 7245 2348

Langenlois
Stadtgemeinde Langenlois,
A-3550 Langenlois
Tel +43 2734 2405

Leibnitz
Leibnitzerfeld
Wasserversorgungs-GmbH,
Wasserwerkstrasse 33,
A-8430 Leibnitz
Tel +43 3452 82522
Fax +43 3452 86257
Geschäftsführer:
Ing Ultes
Population: 80 000
Vol water supplied: 160 l/s
No. reservoirs: 30

Leoben
Stadtwerke Leoben,
Kerpelystr. 21, A-8700
Leoben
Tel +43 3842 23024

Lienz
Wasserwerk Lienz, Fanny
Wibmer Pedit-Str 6, A-9900
Lienz
Tel +43 4852 2772-0

Lustenau
Marktgemeindeamt Lustenau,
Rathausstrasse 1, A-6890
Lustenau/Vorarlberg
Tel +43 5577 8181-0
Fax +43 5577 8181-80
Direktor:
Michael Bösch
Population: 19 000
Vol water supplied: 1.8*
No. reservoirs: 0

Mariazell
Stadtbetriebe Mariazell
GesmbH, Wiener Str 19,
A-8630 Mariazell
Tel +43 3882 2546

Moedling
Wasserwerk der
Stadtgemeinde Moedling,
Quellenstrasse 15,
A-2340 Moedling
Tel +43 2236 24233
Fax +43 2236 242336
Technischer Leiter:
Freidrich Panny
Population: 23 000
Vol water supplied: 2.5*
No. reservoirs: 3
No. sewage plants: 1

Purkersdorf
Wientalwasserwerk der Stadt
Wien, An der Stadtheutte 3,
A-3002 Purkersdorf
Tel +43 2233 2223

Salzburg
Salzburger Stadtwerk,
Strubergasse 21, A-5200
Salzburg
Tel +43 662 4480-0
Fax +43 662 4480-2108
Vorstandsdirektor:
DI Dr Jörn Kaniak
Vorstandsdirektor:
DI Günther Lurf
Direktor Wasserwerke:
DI Heinrich Gernedel
Population: 150 000
Vol water supplied: 12.4*
No. reservoirs: 2 large +
several smaller

Steyr
Stadtwerke Steyr,
Ennserstrasse 10, A-4400
Steyr, Oberösterreich
Tel +43 7252 899 200
Fax +43 7252 899 299
Direktor:
Ing Wolfgang Wein
Population: 52 000
Vol water supplied: 3.6*
No. reservoirs: 6
Vol sewage treated: 3.4*
No. sewage plants: 1

Ternitz
Wasserleitungsverband
Ternitz und Umgebung,
Pottschach, Ternitzer Str 4,
A-2630 Ternitz
Tel +43 2630 7305

Villach
Städtisches Gas- und
Wasserwerk, Klagenfurter Str
66, A-9500 Villach
Tel +43 4242 27516-0

Wien (Vienna)
Wasserwerk der Stadt Wien,
Grabnergasse 4-6, A-1060
Wien
Tel +43 1 59959

Wiener Neustadt
(Vienna new town)
Leitha-Fischa-
Wasserwerksverein,
Hauptplatz 1, A-2700 Wiener
Neustadt
Tel +43 2622 32228

Wöllersdorf
Grundwasserwerk
Wöllersdorf der Stadt Wien,
Feuerwerksanstalt Objekt 38,
A-2752 Wöllersdorf
Tel +43 2622 23641

***million m³/year**

Government departments and regulating bodies

Ministerie van de Vlaamse Gemeenschap
Aminal, Belliardstraat 14-18,
B-1040 Brussel
Tel +32 2 507 31 11
Fax +32 2 507 67 05
Director General:
A Denteneer

Ministerie van het Brusselse Gewest
Trierstraat 49, B-1040 Brussel
Tel +32 2 231 12 55
Fax +32 2 230 88 15
Eerste Adviseur: E Laurent

Ministère de l'Environnement
rue de la Loi 56, B-1040
Bruxelles
Tel +32 2 238 2811

Ministère de la Région Wallonne
L'Espinois, Avenue Albert 1er
187, B-5000 Namur
Tel +32 81 24 66 11
Inspector General: J Binet

Institutes and associations

Belgaqua
(Belgian Federation of Water Suppliers), Chaussée de Waterloo 255, 5e étage, b 6,
B-1060 Bruxelles
Tel +32 2 537 4302
Fax +32 2 539 21 42
President: A Desmed

Institute of Hygiene and Epidemiology
Ministry of Public Health and Environment, Juliette Wytsmanstraat 14, B-1050 Bruxelles
Tel +32 2 642 5623
Fax +32 2 642 5001
Water Programme Chief:
P Dehavay

Water suppliers and sewage water treatment/disposal plant

Water suppliers

Antwerpen
Intercommunale Vennootschap Antwerpse Waterwerken (AWW),
Mechelsesteenweg 64,
B-2018 Antwerpen
Tel +32 3 238 7830
Fax +32 3 237 9766
Directeur Generaal!
Dhr ir G Merckx
Population: 1 000 000
Vol water supplied: 151*
No. reservoirs: 19
No. sewage plants: 4

Provinciale en Intercommunale *Drinkwatermaatschappij der* Provincie Antwerpen (PIDPA) cv, Desguinlei 246, B-2018 Antwerpen
Tel +32 3 238 9840
Fax +32 3 248 6395
Directeur Generaal:
Jef Cells
Population: 1 007 123
Vol water supplied: 68.7*
No. reservoirs: 61
No. sewage plants: 11

Beersel
Gemeentebestuur
Waterbedrijf Beersel,
Hoogstraat 1, B-1650 Beersel
Tel +32 2 378 0515
Schepen:
Dhr. J Mosselmans
Vol water supplied: 0.995*

Brabant Vlaams
Intercommunale voor Waterbedeling in Vlaams Brabant (managed by Aquinter SA), Gemeetehuis,
B-1640 Sint-Genesius-Rode
Tel +32 2 510 7457
Fax +32 2 510 7444
Voorzitter:
Dhr N Beke
Population: 220 000
Vol water supplied: 10.4*

Brabant Wallon
Compagnie Intercommunale de la Distribution d'Eau du Haut Plateau du Brabant Wallon, rue Inchebroux 2,
B-1325 Chaumont-Gistoux
Tel +32 10 688084
Secrétaire:
G Deprez
Vol water supplied: 0.704*

Brabant Zuid-Oost
Intercommunale Watervoorzieningsmaatschappij voor Zuid-Oost-Brabant (IWZO), Ossenwegstraat 1 A,
B-3440 Zoutleeuw
Tel +32 11 78 2433
Directeur:
Dhr. J Claes
Vol water supplied: 1.0*

Bredene (Ostend)
Electrabel, Exploitatiezetel
Middenkust, Pr Elisabethlaan 47, B-8450 Bredene
Tel +32 59 340411
Fax +32 59 340467
Manager:
Ir D Van Damme
Population: 30 000
Vol water supplied: 4.1*
No. reservoirs: 3

Bruxelles
Compagnie Intercommunale Bruxelloise des Eaux (CIBE)/Brusselse Intercommunale Watermaatschappij (BIWM), rue aux Laines 70, B-1000 Bruxelles
Tel +32 2 518 8111
Fax +32 2 518 8306
Directeur Général:
A Desmed
Population: 2 100 000
Vol water supplied: 139*
No. reservoirs: 12

Intercommunale Bruxelloise de Distribution d'Eau (IBDE)/ Brusselse Intercommunale voor Waterdistributie (BIWD), rue aux Laines 70, B-1000 Bruxelles
Tel +32 2 511 9570
Fax +32 2 518 8306
Président du Conseil d'Admin.:
C D'Hoogh
Population: 949 301
Vol water supplied: 65.7*
No. reservoirs: 0

Vlaamse Maatschappij voor Watervoorziening (VMW), Trierstraat 11-21, B-1040 Brussel
Tel +32 2 238 9411
Fax +32 2 230 9798
Directeur Generaal:
Dr S Beernaert
Population: 2 500 000
Vol water supplied: 134*
No. reservoirs: 155
No. sewage plants: 81

Diest
Stedelijk Waterbedrijf Stad Diest, Grote Markt 1, B-3290 Diest
Tel +32 13 31 2121
Secretaris:
Dhr. R Timmermans
Vol water supplied: 0.529*

Gent
Watervoorzieningsbedrijf Stad Gent, Bomastraat 11, B-9000 Gent
Tel +32 91 35 9811
Hoofd Exploitatiezetel Gent:
Dhr. J L Martens
Vol water supplied: 13.8*

Hoeilaart
Waterbedrijf Gemeente Hoeilaart, Ruusbroecpark, B-1560 Hoeilaart
Tel +32 2 657 9050
Verantwoordelijke:
Dhr. de Witte
Vol water supplied: 0.552*

La Calamine
Regie des Eaux de la Commune de La Calamine, Maison Communale, rue de l'Eglise 31, B-4720 La Calamine (Neu-Moresnet)
Tel +32 87 65 9767
Fax +32 87 65 7484
Responsable:
P Mennicken
Population: 10 000
Vol water supplied: 0.56*
No. reservoirs: 2
No. sewage plants: 2

Limburg
Vereniging van Limburgse Waterbedrijven (VLW), Groenplein, Stadhuis, B-3500 Hasselt
Tel +32 11 22 7782
Voorzitter:
Dhr. R Onkelincx
Vol water supplied: 6.9*

Namur
Association Intercommunale des Eaux du Nord de la Province de Namur (AIENPN), Château d'Eau, rue de Vedrin, B-5080 Emines
Tel +32 81 21 2206
Directeur:
A Botilde
Population: 8 136
Vol water supplied: 0.34*
No. reservoirs: 1

Oost-Vlaanderen
Intercommunale voor Watervoorziening in Oost-Vlaanderen (managed by Aquinter SA), Franzkurtens Straat, B-9200 Dandesmonde
Tel +32 52 22 55 75
Fax +32 52 22 56 26
Voorzitter:
Dhr M Dierick
Population: 56 000
Vol water supplied: 2.5*

Oudenaarde
Regie Waterdienst Stad Oudenaarde, Tussenmuren 17, B-9700 Oudenaarde
Tel +32 55 31 4601
Fax +32 55 30 1345
Afgevaardigde-Schepen:
Dhr Peter Simoens
Population: 12 677
Vol water supplied: 0.80*
No. reservoirs: 3

Verviers
Société Wallonne des Distributions d'Eau, rue de la Concorde 41, B-4800 Verviers
Tel +32 87 342 811
Fax +32 87 342 800
Directeur Général:
Marc Deconinck
Population: 1 900 000
Vol water supplied: 147*
No. reservoirs: 882

Veurne-Ambacht
Intercommunale Waterleidingsmaatschappij van Veurne-Ambacht (IWVA), Doornpanne 1, B-8670 Koksijde
Tel +32 58 52 1555
Fax +32 58 52 1604
Directeur Generaal:
Dhr Ing F Vanlerberghe
Population: 50 000 (winter), 250 000 (summer)
Vol water supplied: 5.5*
No. reservoirs: 6

Vilvoorde
Bedrijf voor Watervoorziening Stad Vilvoorde, Rondeweg 48, B-1800 Vilvoorde
Tel +32 2 251 2070
Fax +32 2 252 3103
Directeur:
Dhr Indigne
Population: 30 000
Vol water supplied: 2.2*
No. reservoirs: 3

Vlaanderen
Tussengemeentelijke Maatschappij der Vlaanderen voor Waterbedeling (TMVW), Stropkaai 14, B-9000 Gent
Tel +32 92 40 0211
Fax +32 92 22 9111
Directeur Generaal:
Dr Jr Ch Demeester
Population: 1 400 000
Vol water supplied: 80*
No. reservoirs: 25

Walloon Region
Association Régionale Wallonne de l'Eau (Aquawal), Chaussée de Lodelinsart 325, B-6060 Gilly
(Aquawal is a group of 20 companies in the Walloon region)
Tel +32 71 420290
Fax +32 72 423560
Président:
S Cokaiko

*million m³/year

Sewage water treatment/ disposal plant

AIDE
(Association Intercomm. pour le Démergem. et l'Epuration des Communes de la Province de Liège), Liège
Tel +32 41 33 7860
Fax +32 41 35 6349
Directeur Général:
L Wilmotte
Population: 250 000
Vol sewage treated: 9*
No. sewage plants: 30

IBW
rue de la Religion 10, B-1400 Nivelles
Tel +32 67 21 7111
Fax +32 67 21 6928
Directeur Général:
C Pasture
Population: 340 000
Vol sewage treated: 20*
No. sewage plants: 16

IDEA (Intercommunale de Développement Economique et d'Aménagement de la Région Mons-Borinage-Centre)
rue de Nimy 53, B-7000 Mons
Tel +32 65 66 5701
Fax +32 65 66 5709
Technical Head:
Alain Tabart
Vol water supplied: 6.37*
No. reservoirs: 4
Vol sewage treated: 21.8*
No. sewage plants: 7

Idelux-Aive
Avenue Nothomb 8, B-6700 Arlon
Tel +32 63 22 0484
Directeur:
Bernard Antoine
Vol sewage treated: 0.180*
No. sewage plants: 50

IEGSP
Bld de l'Yser 44, B-6000 Charleroi
Tel +32 71 32 2259
Adm Directeur Général:
M Sohet

IGRETEC
Boulevard Mayence 1, B-6000 Charleroi
Tel +32 71 27 2811
Fax +32 71 33 4236
Administrateur-Gérant:
G Vaniekaut
Directeur:
F Leroy
Population: 500 000
Vol water supplied: 12.3 (total)*
No. reservoirs: 25
No. sewage plants: 5

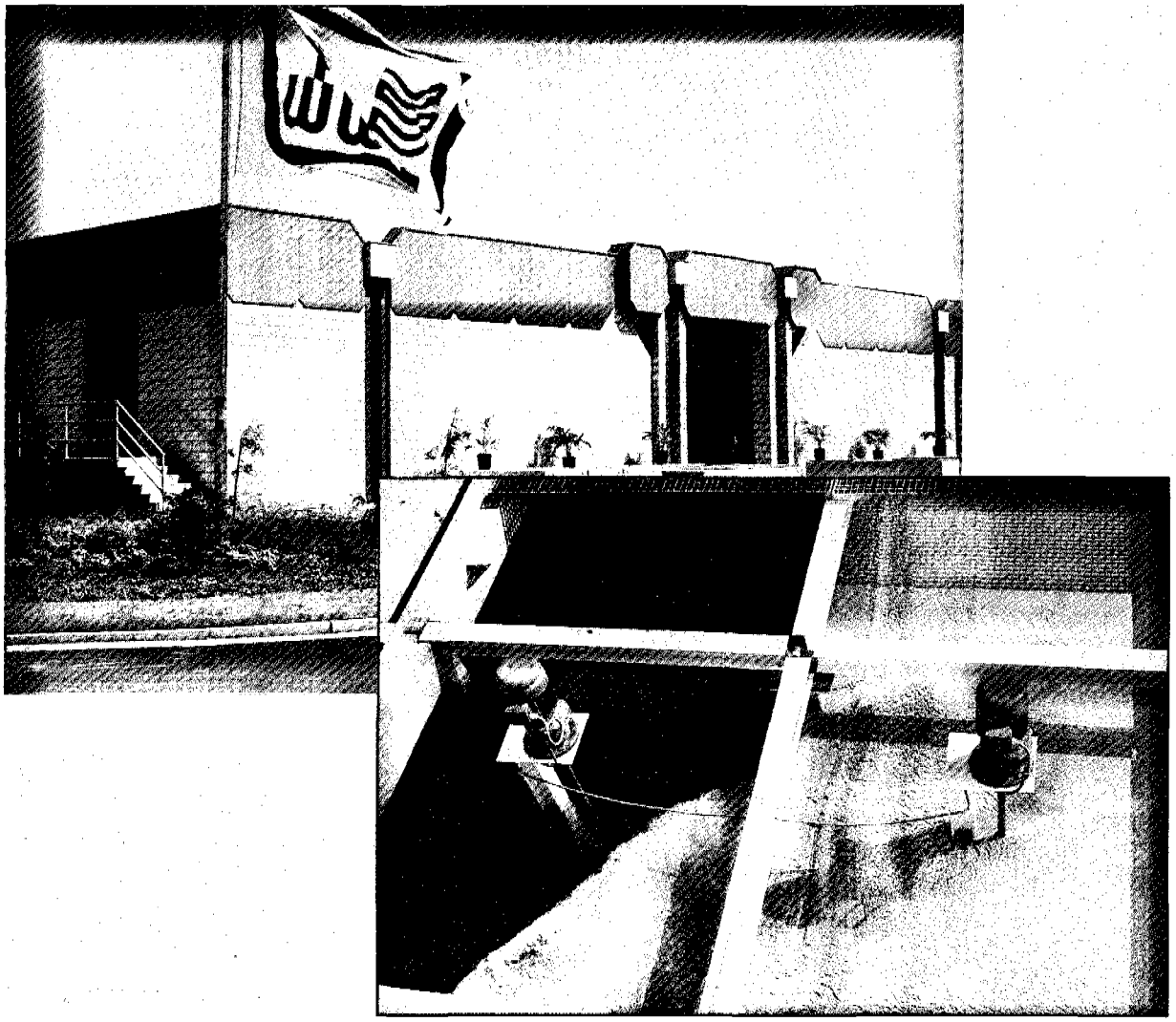
IPALLE(Intercommunale de Propreté Publique)
14 rue des Corriers, B-7500 Tournai
Tel +32 69 21 6754
Fax +32 69 21 6757
Directeur Général:
Jean Evrard
Population: 320 000
Vol sewage treated: 4.84*
No. sewage plants: 16

Vlaamse Milieu Maatschappij
Administratief Centrum, Graanmarkt 2, B-9300 Aalst
Tel +32 53 78 6129
Fax +32 53 71 1078
Inspecteur-Generaal:
M de Roeck
No. sewage plants: 115

***million m³/year**

ALGOFLOT ®

the adequate technology for algae removal based on dissolved air flotation



Flotation plant Antwerp - 200 000 m^3/day

Antwerpse Waterwerken
Mechelsesteenweg 64
B 2018 Antwerpen - Belgium

☎ +32 3 244 0500 Fax +32 3 244 0599

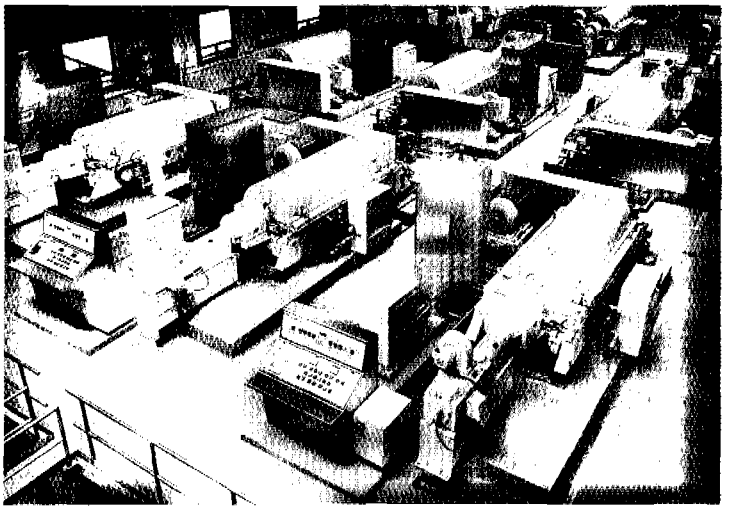
Separation technology for cost-efficient sludge management

Alfa Laval

Alfa Laval offers a full line of separation systems and equipment for dewatering and thickening of sludges from waste water treatment plants and potable water processing.

Massive quantities of waste products from treatment plants and the disposal of these products creates its own problems. Because of these increasing quantities, and the effects on the environment cost-efficient waste water management is crucial.

Alfa Laval has long experience in process techniques designed to reduce waste volumes so that they can be disposed of in an efficient manner.



Installation in a midwest american city

Decanters in waste water treatment plants

The dewatering decanters offered by Alfa Laval constitute the most advanced and complete range of equipment offered by any company in the world.

Decanters available for waste water applications include:

- ❑ Dewatering of sludge with polymer addition
- ❑ Thickening of waste activated sludge without polymer addition
- ❑ Machines for both dewatering and thickening
- ❑ Dewatering decanters for extra high dry solids (DS) sludge

Options includes automation for unattended operation, delivery of pumps, piping, poly-electrolyte systems, and sludge handling equipment.

Installation in Germany.

Alfa Laval Separation A/S
Environmental Engineering
Maskinvej 5, DK-2860 Søborg, Denmark
Telephone: +45 31 67 03 11
Telefax: +45 31 67 21 06

Alfa Laval

Government departments and regulating bodies

Milj og Energiministeriet
(Ministry of the Environment and Energy), Højbro Plads 4, DK-1200 København
Tel +45 33 92 76 00
Fax +45 33 32 22 27
Minister: Svend Auken

Miljøkontrollen
(Agency of Environmental Protection, City of Copenhagen), Flaesketorvet 68, DK-1711 København V
Tel +45 33 66 58 00
Fax +45 33 66 71 33
Director: Ib Larsen

Institutes and associations

Dansk Vandvaerkers Forening
(Danish Water Supply Association), Vilh Becksvej 60, DK 8260 Viby J
Tel +45 86 112333
Fax +45 86 117939
Director: Anders Baekgaard

Faellesrepraesentationen for Private Vandvaerker i Danmark
(The Joint Organisation of Private Waterworks in Denmark), Solrod Center 22C, DK 2680 Solrod Strand
Tel +45 53 144242
Fax +45 53 146776
Managing Director: NEA Hörup

Technical University of Denmark
Dept of Environmental Engineering, Building 115, DK-2800 Lyngby
Tel +45 45 933908
Fax +45 45 932850
Head of Institute: Jens Chr Tjell

VKI Water Quality Institute
Agern Allé 11, DK-2970 Hørsholm. (Regional Office: Gustav Wieds Vj 10, DK-8000 Aarhus C, Tel +45 86 20 20 11 Fax +45 86 19 75 11)
Tel +45 42 86 52 11
Fax +45 42 86 72 73
Managing Dir - Head Office (Horsholm): Torkil Jønch-Clausen

Water suppliers and sewage water treatment/disposal plant

County Councils

Århus Amt
Lyseng Allé 1, 8270 Højbjerg
Tel +45 89 44 66 66
Fax +45 89 44 69 82
Principal Officer:
Jytte Heslop
Population: 600 000
Vol water supplied: 100*
Vol sewage treated: 100*
No. sewage plants: 200

Bornholms Amt
Østre Ringvej 1, 3700 Rønne
Tel +45 56 95 21 23
Fax +45 56 95 21 42
Head of environmental division:
Jørgen Jespersen
Population: 45 000
Vol water supplied: 5*
No. reservoirs: 15
Vol sewage treated: 4*
No. sewage plants: 8

Frederiksborg Amt
Amtsgården, Kongens Vænge, 3400 Hillerød
Tel +45 42 26 66 00
Fax +45 42 26 37 13
Forvaltningschef:
Finn Hansen
Population: 345 000
Vol water supplied: 57*
Vol sewage treated: 46*
No. sewage plants: 60

Fyns Amt
Amtsgården, Ørbækvej 100, 5220 Odense Sø
Tel +45 66 15 94 00
Fax +45 66 15 45 59
Head of Division:
Harley B Madsen
Population: 460 000
Vol water supplied: 67*
Vol sewage treated: 94*
No. sewage plants: 145

Københavns Amt
Stationsparken 27, 2600 Glostrup
Tel +45 43 22 22 22
Fax +45 43 22 28 99
Forvaltningschef:
Bent Høi Jensen
Population: 604 762
Vol water supplied: 49*
Vol sewage treated: 60*
No. sewage plants: 11

Nordjyllands Amt
Forvaltningen for Teknik og Miljø, Niels Bohrs Vej 30, Postbox 8300, 9220 Ålborg Øst
Tel +45 96 35 10 00
Fax +45 98 15 65 57
Teknisk Direktor:
Jørgen Riisager
Population: 486 993
Vol water supplied: 129.6*
No. sewage plants: 125

Ribe Amt
Amtsgården, Sorsigvej 35, 6760 Ribe
Tel +45 75 42 42 00
Fax +45 75 42 05 68
Director:
Steen Salomonsen
Population: 220 721
Vol water supplied: 51*
Vol sewage treated: 40*
No. sewage plants: 77

Ringkjobing Amt
Damstrædet 2, 6950 Ringkøbing
Tel +45 97 32 08 66
Forvaltningschef:
Knud Birkegaard

Roskilde Amt
Køgevej 80, 4000 Roskilde
Tel +45 46 32 32 32
Fax +45 46 32 47 87
Forvaltningschef:
Hans Chr Olsen
Population: 222 604
Vol water supplied: 50*
No. reservoirs: 1-3
Vol sewage treated: 30*
No. sewage plants: 43

Storstroms Amt
Parkvej 37, 4800 Nykøbing F
Tel +45 54 82 32 32
Fax +45 54 82 21 71
Teknisk Direktor:
Svend W. Jensen
Population: 250 000
Vol water supplied: 17*
Vol sewage treated: 25*
No. sewage plants: 270

Sønderjyllands Amt
Jomfrustien 2, 6270 Tønder
Tel +45 74 33 50 50
Fax +45 74 33 50 01
Head of Wastewater Dept:
Henrik G Jørgensen
Head of Groundwater Dept:
Poul Frederik Christensen
Population: 250 000
Vol water supplied: 30*
No. reservoirs: 235 (groundwater works)
Vol sewage treated: 38*
No. sewage plants: 225

Vejle Amt
Damhaven 12, 7100 Vejle
Tel +45 75 83 53 33
Fax +45 75 83 55 71
Forvaltningschef:
Egon Dall
Population: 332 207
Vol water supplied: 53*
No. sewage plants: 95

Vestsjællands Amt
Alléen 15, 4180 Sorø
Tel +45 57 87 25 33
Fax +45 57 87 28 00
(Note: administrative organisation. The figures below relate to permits given to water and sewage works)
Miljøchef:
Jørgen Hübertz
Population: 286 000
Vol water supplied: 44*
No. reservoirs: 3
Vol sewage treated: 44*
No. sewage plants: 168

Viborg Amt
Skottenborg 26, 8800 Viborg
Tel +45 86 62 33 00
Forvaltningschef:
Uffe Holm Christensen

Local Councils

Aakirkeby Kommune
Ravnsgade 5, 3720 Åkirkeby
Tel +45 56 97 47 47
Fax +45 56 97 56 58
Forvaltningschef:
Jan Harvest
Population: 7000
Vol water supplied: 0.6*
No. reservoirs: 6
Vol sewage treated: 1*
No. sewage plants: 4

Aalborg Kommune
Vesterbro 14, 9000 Ålborg
Tel +45 99 31 21 00
Fax +45 98 11 42 46
City Engineer:
Kurt Markworth
Population: 185 000
Vol water supplied: 14.5*
No. reservoirs: 46
Vol sewage treated: 25.7*
No. sewage plants: 15

Aars Kommune
Himmerlandsgade 27, 9600 Års
Tel +45 98 62 12 11
Fax +45 98 62 20 70
Afdelingsingeniør:
Bent Skærlund
Population: 10 000
Vol water supplied: 1.7*
Vol sewage treated: 1.7*
No. sewage plants: 2

Ærøskøbing Kommune
Statene 2, 5970 Ærøskøbing
Tel +45 62 52 11 26
Fax +45 62 52 15 26
Forvaltningschef:
Bent Svane
Population: 4153
Vol water supplied: 0.33*
No. reservoirs: 6
Vol sewage treated: 0.69*
No. sewage plants: 2

Allerød Kommune
Rådhusvej 1, 3450 Allerød
Tel +45 48 10 01 00
Fax +45 48 14 02 08
Technical Director:
Anders Bille
Population: 23 000
Vol water supplied: 2.13*
No. reservoirs: 11
Vol sewage treated: 3.6*
No. sewage plants: 3

Århus Kommune
Orla Lehmanns Allé 3, postboks 539, 8100 Århus C
Tel +45 89 40 44 33
Fax +45 89 40 44 40
Chief City Engineer:
Michael R Jacobsen
Population: 270 000
Vol water supplied: 22*
No. reservoirs: 10
Vol sewage treated: 20*
No. sewage plants: 19

Ballerup Kommune
Hold-an Vej 7, 2750 Ballerup
Tel +45 44 77 20 00
Fax +45 44 77 27 17
Engineer:
Sven Møller
Population: 55 000
Vol water supplied: 4.5*
Vol sewage treated: 2.7*
No. sewage plants: 1

Brøndby Kommune
Park Alle 160, 2605 Brøndby
Tel +45 43 28 28 28
Fax +45 43 28 24 50
Forvaltningschef:
Vagn Tovgaard
Population: 33 700
Vol water supplied: 2.6*
No. reservoirs: 17
Vol sewage treated: 2.6*
No. sewage plants: 1 (part)

Dragør Kommune
Stationsvej 5, 2791 Dragør
Tel +45 32 89 01 00
Fax +45 32 53 06 48
Områdeschf:
Flemming Borch
Population: 12 400
Vol water supplied: 0.8*
No. reservoirs: 2
Vol sewage treated: 2.3*
No. sewage plants: 1

Fanø Kommune
Skolevej 5-7, 6720 Fanø
Tel +45 75 16 31 00
Fax +45 75 16 29 81
Ingeniør:
Hanne Kristensen
Population: 3800
Vol water supplied: 0.5*
Vol sewage treated: 0.5*

Farum Kommune
Frederiksborgvej 3, 3520 Farum
Tel +45 42 95 06 01
Fax +45 42 95 28 33
Teknisk Direktør:
Mogens Norup Thomsen
Population: 30 000
Vol water supplied: 1.4*
No. reservoirs: 10
Vol sewage treated: 1.8*
No. sewage plants: 1

Fjends Kommune
Iglsøvej 5, 7850 Stoholm Jyll
Tel +45 97 54 14 22
Fax +45 97 54 10 69
Bygningskonstruktør:
Harry Frandsen

*million m³/year

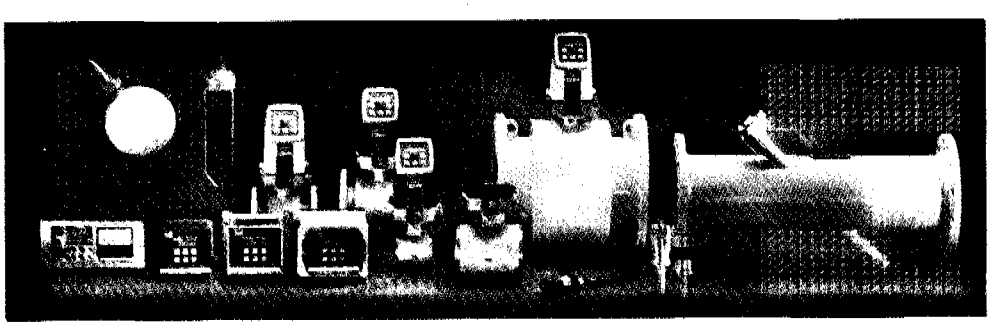
SIMPLY MORE CONVENIENT

At Danfoss we're not satisfied making accurate flowmeters. Our real goal is to make accurate flow-metering easy. That's why we've refined our flowmeters to the point where non-technical personnel can operate and, if need be, even replace them.

For instance, let's say you want to customize one of our meter settings. The signal processor can be removed from the sensor simply by loosening two screws. It could be brought off-site to your office where a series of uncomplicated menus would help you make the correct adjustments. Once your adjustments are made just screw the signal processor back onto the sensor and walk away. All the meter's electronics are automatically re-calibrated to your new specifications.

And once you've seen one Danfoss signal processor you've seen them all. That's because all our flowmeters use the same signal processor technology. Once you are familiar with one, you'll feel right at home with the rest.

No flowmeter is more convenient than that. So why complicate things? For accuracy and convenience the choice is simple. Danfoss.



Danfoss Instrumentation. *Simply Better.*

Danfoss

Danfoss A/S · DK-6430 Nordborg · Denmark
Telephone: +45 74 88 22 22 · Telefax: +45 74 49 09 49 · Telex: 50 599 danfss dk

Population: 8100
Vol water supplied: 1.06*
No. reservoirs: 15
Vol sewage treated: 0.08*

Fredensborg-humleb~aek Kommune
Tinghusvej 6, 3480
Fredensborg
Tel +45 42 28 14 01
Fax +45 42 28 32 66
Forvaltningschef:
Ralph Kapper Hansen
Population: 18 000
Vol water supplied: 1.2*
No. reservoirs: 5
Vol sewage treated: 3*
No. sewage plants: 4

Fredericia Kommune
Gothersgade 20, 7000
Fredericia
Tel +45 79 21 21 21
Fax +45 79 21 26 91
Teknisk Direktør:
Jørgen Nepper-Christensen
Population: 46 000
Vol water supplied: 7.4*
No. reservoirs: 10
Vol sewage treated: 11.6*
No. sewage plants: 4

Frederiksberg Kommune
Frederiksberg Rådhus, 2000
Frederiksberg
Tel +45 31 19 21 21
Fax +45 38 88 10 04
Forvaltningschef:
Preben Kolringen
Population: 85 000
Vol water supplied: 7.5*
Vol sewage treated: 7.4*
No. sewage plants: 1

Frederikshavn Kommune
Rådhuset, Rådhus Alle'100,
9900 Frederikshavn
Tel +45 98 42 82 00
Fax +45 98 42 83 80
Ingeniør:
Tage Sønderby
Population: 35 000
Vol water supplied: 3.3*
No. reservoirs: 5
No. sewage plants: 2

Gentofte Kommune
Bernstorffsvej 161, 2920
Charlottenlund
Tel +45 31 63 21 21
Fax +45 31 63 06 50
Vice Manager:
E Tønne Andersen
Population: 180 000
Vol water supplied: 12*
No. reservoirs: 5

Gjern Kommune
Søndergade 54, 8883 Gjern
Tel +45 86 87 52 66
Fax +45 86 87 57 09
Forvaltningschef:
Konstitueret: Knud Pedersen
Population: 7321
No. reservoirs: 15
Vol sewage treated: 0.3*
No. sewage plants: 7

Gladsaxe Kommune
Rådhus Allee, 2860 Søborg
Tel +45 39 66 33 66
Fax +45 39 66 33 95
Afd ingeniør:
John Jensby
Population: 60 000
Vol water supplied: 5.5*
No. reservoirs: 1
No. sewage plants: 2

Gørlev Kommune
Kirkevangen 11 B, 4281
Gørlev
Tel +45 58 85 56 11
Fax +45 58 85 62 74
Afd ingeniør:
Sten Mundt Hansen
Population: 5888
No. reservoirs: 6
Vol sewage treated: 2.2*
No. sewage plants: 3

Græsted-gilleleje Kommune
Esrum Hovedgade 17, 3230
Græsted
Tel +45 48 38 85 46
Fax +45 48 38 85 54
Forvaltningschef:
Vacant
Population: 25 000 (total)
Vol water supplied: 1.2*
No. reservoirs: 13
Vol sewage treated: 1*
No. sewage plants: 6

Greve Kommune
Holmeagervej 2, 2670 Greve
Tel +45 43 97 97 97
Fax +45 43 97 90 94
Forvaltningschef:
Gert Pedersen
Population: 47 000
*Vol water supplied: 3.1**
Vol sewage treated: 6.6*

Gundsø Kommune
Sognevej 50, Postboks 1055,
4000 Roskilde
Tel +45 46 73 13 13
Fax +45 42 38 20 58
Forvaltningschef:
Jørgen Agger
Population: 13 000
Vol water supplied: 1.2*
Vol sewage treated: 1.6*
No. sewage plants: 2

Hals Kommune
Borgergade 39, 9362
Gandrup
Tel +45 99 54 99 99
Fax +45 99 54 99 00
Technical Chief:
Anders Pinstrup
Population: 11 000
Vol water supplied: 1.4*
No. reservoirs: 12
Vol sewage treated: 0.9-1*
No. sewage plants: 1

Hasle Kommune
Toftelunden 1, 3790 Hasle
Tel +45 56 96 40 93
Fax +45 56 96 49 73
Forvaltningschef:
Poul Kyhn
Population: 2 000 000
Vol water supplied: 0.47*
No. reservoirs: 3
No. sewage plants: 3

Helle Kommune
Toften 2, 6818 Årre
Tel +45 75 19 22 00
Fax +45 75 19 25 56
Afdelpugsleder:
N Gregersen
Population: 8500
Vol water supplied: All water supplied by private organisation)
Vol sewage treated: 0.9*
No. sewage plants: 8

Helsingør Kommune
Mørdrupvej 15, 3060
Espergærde
Tel +45 49 21 13 00
Fax +45 42 22 20 77
Teknisk Direktør:

Peter Clausen
Population: 52824
Vol water supplied: 4.07*
No. reservoirs: 2
Vol sewage treated: 7.8*
No. sewage plants: 6

Herlev Kommune
Herlev Bygade 90, 2730
Herlev
Tel +45 44 94 06 33
Fax +45 42 91 38 39
Forvaltningschef:
Ib Skovgaard
Population: 27 000
Vol water supplied: 2.5*

Hjørring Kommune
Nørregade 2, 9800 Hjørring
Tel +45 99 23 23 23
Fax +45 99 23 24 99
Sectional Engineer:
Jon E Lemming
Population: 26 890
Vol water supplied: 2.5*
No. reservoirs: 24
Vol sewage treated: 3.4*
No. sewage plants: 6

Hobro Kommune
Nordre Kajgade 1, 9500
Hobro
Tel +45 98 52 12 00
Fax +45 98 51 16 38
Forvaltningschef:
Per Graversen
Population: 1400
Vol water supplied: 1.5*
No. reservoirs: 7
Vol sewage treated: 3.5*
No. sewage plants: 1

Høje-taastrup Kommune
Bygaden 2, 2630 Tåstrup
Tel +45 42 52 31 33
Fax +45 43 71 37 10
Forvaltningschef:
Børge Larsen
Population: 38 000
*Vol water supplied: 2.8**
No. sewage plants: 2

Holbæk Kommune
Teknisk Forvaltning,
Jernbanevej 6, 4300 Holbæk
Tel +45 53 43 93 11
Fax +45 53 43 97 10
Sektionsleder:
Ole Andersen
Population: 22 000
Vol water supplied: 2*
No. reservoirs: 4
Vol sewage treated: 2*
No. sewage plants: 1

Holeby Kommune
Toftevej 1, 4960 Holeby
Tel +45 53 90 60 56
Fax +45 53 90 60 10
Contact:
Gitte Andersen
Contact:
Mogens Mygind
Population: 4000
Vol water supplied: 0.5*
Vol sewage treated: 0.4*
No. sewage plants: 9

Holstebro Kommune
Rådhuset, 7500 Holstebro
Tel +45 97 41 12 00
Fax +45 97 41 33 71
Forvaltningschef:
Jørgen Udby
Population: 39 000
Vol water supplied: 4.5*
No. reservoirs: 7
Vol sewage treated: 6.5*
No. sewage plants: 1

Hørsholm Kommune
Adalsparkvej Nr 2, 2970
Hørsholm
Tel +45 45 17 75 75
Fax +45 45 76 01 14
Forvaltningschef:
Hanne Jespersen
Population: 23 500
Vol water supplied: 1.7*
No. reservoirs: 1
Vol sewage treated: 5.0*
No. sewage plants: 1

Hvidovre Kommune
Hvidovrevej 278, 2650
Hvidovre
Tel +45 36 39 35 00
Fax +45 36 39 36 58
Afd.ingeniør:
Carsten Raad Petersen
Vol water supplied: 4*
Vol sewage treated: 4*
No. sewage plants: 2

Ishøj Kommune
Ishøj Store Torv 20, 2635
Ishøj
Tel +45 43 57 74 75
Fax +45 43 57 74 80
Forvaltningschef:
H. Egholm Jensen
Population: 21 000
Vol water supplied: 1.5*
Vol sewage treated: 1.5*

Juelsminde Kommune
Rådhuset, Tofteskovvej 4,
7130 Juelsminde
Tel +45 79 83 30 00
Fax +45 75 69 37 72
Teknisk Chef:
Tom Laursen

Københavns Kommune
Miljøkontrollen, Stormgade
20, 1555 København V
Tel +45 33 15 38 00
Forvaltningschef:
Ib Larsen

Københavns Kommune
Copenhagen Water Supply,
Studiestraede 54, Postbox
372, København V
Tel +45 33 42 52 62
Fax +45 33 42 59 10
Managing Director:
Gert Fischer
Population: 1 000 000
Vol water supplied: 67*
No. reservoirs: 2

Kolding Kommune
Teknisk Forvaltning,
Ålegården 2, 6000 Kolding
Tel +45 75 50 15 00
Fax +45 75 50 84 25
Forvaltningschef/Technical Director:
H J Bøgesø
Vandforsyningschef/Water supply mgr:
J S Bach
Population: 60 000
Vol water supplied: 5.6 (total)*
No. reservoirs: 21
Vol sewage treated: 11*
No. sewage plants: 7

Korsør Kommune
Rådhuset, 4220 Korsør
Tel +45 53 57 08 00
Fax +45 53 57 11 41
Forvaltningschef:
Kai Lauridsen
Population: 20 000
No. reservoirs: 4
No. sewage plants: 4

Løgstør Kommune
Torvegade 15, PO Box 208,
9670 Løgstør
Tel +45 99 66 60 00
Fax +45 98 67 35 37
Ingeniør:
Poul Helledi
Population: 10 000
Vol water supplied: 1*
No. reservoirs: 10
Vol sewage treated: 1*
No. sewage plants: 2

Lyngby-taarbæk Kommune
Rådhuset, 2800 Lyngby
Tel +45 45 87 30 00
Fax +45 45 87 28 32
Forvaltningschef:
Tarquini Mårtensson
Population: 50 000
Vol water supplied: 4*
No. reservoirs: 28
Vol sewage treated: 12*
No. sewage plants: 1

Nakskov Kommune
Axeltorvet, 4900 Nakskov
Tel +45 54 95 12 66
Fax +45 54 95 03 68
Technical Director:
Tonny Pedersen
Population: 16 000
Vol water supplied: 1*
No. reservoirs: 4
Vol sewage treated: 2*
No. sewage plants: 1

Nexø Kommune
Møllevænget 1, 3730 Neksø
Tel +45 56 49 30 00
Fax +45 56 49 41 70
Afd leder, biol:
Torben Jørgensen
Population: 9000
Vol water supplied: 1*
Vol sewage treated: 1*
No. sewage plants: 3

Nyborg Kommune
Torvet 7, 5800 Nyborg
Tel +45 65 31 19 00
Fax +45 65 31 26 17
Forvaltningschef:
Peter Dansholm
Population: 50 000
Vol water supplied: 2.6*
Vol sewage treated: 3.8*
No. sewage plants: 1

Nykøbing-rørvig Kommune
Vesterlyngvej 8, 4500
Nykøbing sj
Tel +45 59 98 01 40
Fax +45 59 98 01 59
Principal Officer:
Hans Lambek
Population: 7100
Vol water supplied: 1*
No. reservoirs: 3
Vol sewage treated: 1.8*
No. sewage plants: 2

Næstved Kommune
Brogade 2, 4700 Næstved
Tel +45 53 73 99 00
Fax +45 53 73 21 85
Teknisk Direktør:
Erik Kryger Kaas
Population: 40 000
Vol water supplied: 4*
No. reservoirs: 2
Vol sewage treated: 3*
No. sewage plants: 3

Randers Kommunale værker
Agerskellet 7, 8900 Randers
Tel +45 86 42 48 11
Fax +45 86 41 30 70
Driftsingeniør:

***million m³/year**

Kaj Eriksen
Population: 42 000
Vol water supplied: 4*
No. reservoirs: 5
Vol sewage treated: 2*
No. sewage plants: 3

Ringsted Kommune
Ole Hansens Vej 8, 4100 Ringsted
Tel +45 53 61 20 50
Fax +45 57 67 15 69
Teknisk Direktør/Tech Director:
Jens Sparre
Population: 28 850
Vol water supplied: 5*
No. reservoirs: 9
Vol sewage treated: 4.8*
No. sewage plants: 6

Rødovre Kommune
Rødovre Parkvej 150, 2610 Rødovre
Tel +45 31 70 41 11
Fax +45 36 72 13 11
Forvaltningschef:
Jens Christensen
Population: 35 000
Vol water supplied: 2.7*
No. reservoirs: 1
Vol sewage treated: 2.7*
No. sewage plants: (Waste water is treated at two treatment plants belonging to several municipalities.)

Roskilde Kommune
Sankt Ols Stræde 3, 4000 Roskilde
Tel +45 42 37 33 00
Fax +45 42 35 27 19
(Water supply):
Su Nakskov
(Sewage transport and treatment):
Hans Chr Jensen
Population: 50 000
Vol water supplied: 4*
No. reservoirs: 3
No. sewage plants: 6

Sæby Kommune
Rådhusvej 1, 9300 Sæby
Tel +45 98 46 11 11
Fax +45 98 46 73 06
Kommuneingeniør:
Karsten Thorn

Silkeborg Kommune
Søvej 1, 8600 Silkeborg
Tel +45 86 82 20 00
Fax +45 86 82 30 31
Afd ingeniør:
Søren Dall
Population: 48 000
Vol water supplied: 5*
No. reservoirs: 3
Vol sewage treated: 7*
No. sewage plants: 4

Skanderborg Kommune
Vand- & Kloakforsyningen
Driftsafdeling, Døjsøvej 1, Postboks 534, 8660 Skanderborg
Tel +45 86 52 13 70
Fax +45 86 52 37 77
Driftsleder:
Jørgen Hermann
Population: 24 000
Vol water supplied: 1.1*
Vol sewage treated: 1.7*
No. sewage plants: 4

Skive Kommune
Østergade 29, 7800 Skive
Tel +45 97 52 18 00
Fax +45 97 52 50 80
Afdelingsingeniør:
Richard Malmose
Population: 20 000
Vol water supplied: 3*
No. reservoirs: 2
No. sewage plants: 2

Slagelse Kommune
Rådhuspladsen 11, 4200 Slagelse
Tel +45 53 52 36 00
Fax +45 53 52 07 90
Forvaltningschef:
Karsten Brandt
Population: 35 000
Vol water supplied: 3.2*
No. reservoirs: 6
No. sewage plants: 1

Solrød Kommune
Solrød Center 1, 2680 Solrød Strand
Tel +45 56 14 77 11
Fax +45 56 14 77 06
Direktør:
Benny H Würtz

Sønderborg Kommune
Rådhuset, 6400 Sønderborg
Tel +45 74 42 93 00
Fax +45 74 43 49 12
Afd leder:
Erling Holst Nissen
Contact:
30 000
Vol water supplied: 3*
No. reservoirs: 3
No. sewage plants: 1

Sorø Kommune
Rådhusvej 8, 4180 Sorø
Tel +45 57 87 01 00
Fax +45 53 63 31 39
Forvaltningschef:
Erik Laugesen
Population: 15 000
Vol water supplied: 0.6*
No. reservoirs: 3
Vol sewage treated: 1.8*
No. sewage plants: 2

Svendborg Kommune
Gåsestræde 14 B, 5700 Svendborg
Tel +45 62 21 19 04
Fax +45 62 22 88 10
Forvaltningschef:
Jørgen Steen Knudsen
Population: 41 000
Vol water supplied: 3.6*
No. reservoirs: 2
Vol sewage treated: 8*
No. sewage plants: 2

Tårnby Kommune
Amager Landevej 76, 2770 Kastrup
Tel +45 31 50 15 01
Stadsingeniør:
Jørn Gettermann
Population: 40 000
Vol water supplied: 4*
No. reservoirs: 1
Vol sewage treated: 8*
No. sewage plants: 1

Tølløse Kommune
Hjortholmvej 9, 4340 Tølløse
Tel +45 59 18 55 00
Fax +45 59 19 40 77
Ingeniør:
L P Andersen
Population: 15 000
Vol water supplied: 0.9*
No. reservoirs: 10
Vol sewage treated: 2.5*
No. sewage plants: 3

Tommerup Kommune
Møllebaken 22, 5690 Tommerup
Tel +45 64 76 14 79
Fax +45 64 76 23 79
Driftschef:
Palle Stokholm
Population: 7 630
Vol sewage treated: 1.13*
No. sewage plants: 3

Tønder Kommune
Kongevej 57, 6270 Tønder
Tel +45 74 72 18 10
Fax +45 74 72 08 72
Forvaltningschef:
Leif Olsen
Population: 12 500
No. sewage plants: 1

Vallensbæk Kommune
Vallensbæk Nærcenter 50, 2665 Vallensbæk Str
Tel +45 43 73 08 05
Fax +45 43 73 41 13
Forvaltningschef:
Flemming Olesen
Population: 12 100
Vol water supplied: 0.72 *(delivered by Copenhagen Water)*
Vol sewage treated: (Sewage is treated by the municipal treatment plant Avedøre Kloakværk.)

Vamdrup Kommune
Idrætsvej 1, 6580 Vamdrup
Tel +45 75 58 15 66
Fax +45 75 58 39 22
Forvaltningschef:
Erik Tornøe
Population: 35 000
Vol water supplied: 1.5*
No. sewage plants: 4

Varde Kommune
Forsyningsafdelingen, Bytoften 2, 6800 Varde
Tel +45 79 94 65 65
Fax +45 75 22 11 73
Contact:
Kaj Hansen
Population: 18 000
Vol water supplied: 1.8*
No. reservoirs: 3
Vol sewage treated: 3*
No. sewage plants: 3

Viborg Kommune
Sct Mogens Gade 3, 8800 Viborg
Tel +45 87 25 25 25
Fax +45 86 62 54 22
Forvaltningschef:
Henrik Fog
Population: 40 000
Vol water supplied: 2.9*
No. reservoirs: 42
Vol sewage treated: 5.9*
No. sewage plants: 9

Vojens Kommune
Rådhuscentret 7, 6500 Vojens
Tel +45 74 20 32 00
Fax +45 74 20 32 06
Forvaltningschef:
Jørgen Appel
Population: 17 000
Vol water supplied: 1.6*
No. reservoirs: 19
Vol sewage treated: 3.25*
No. sewage plants: 13

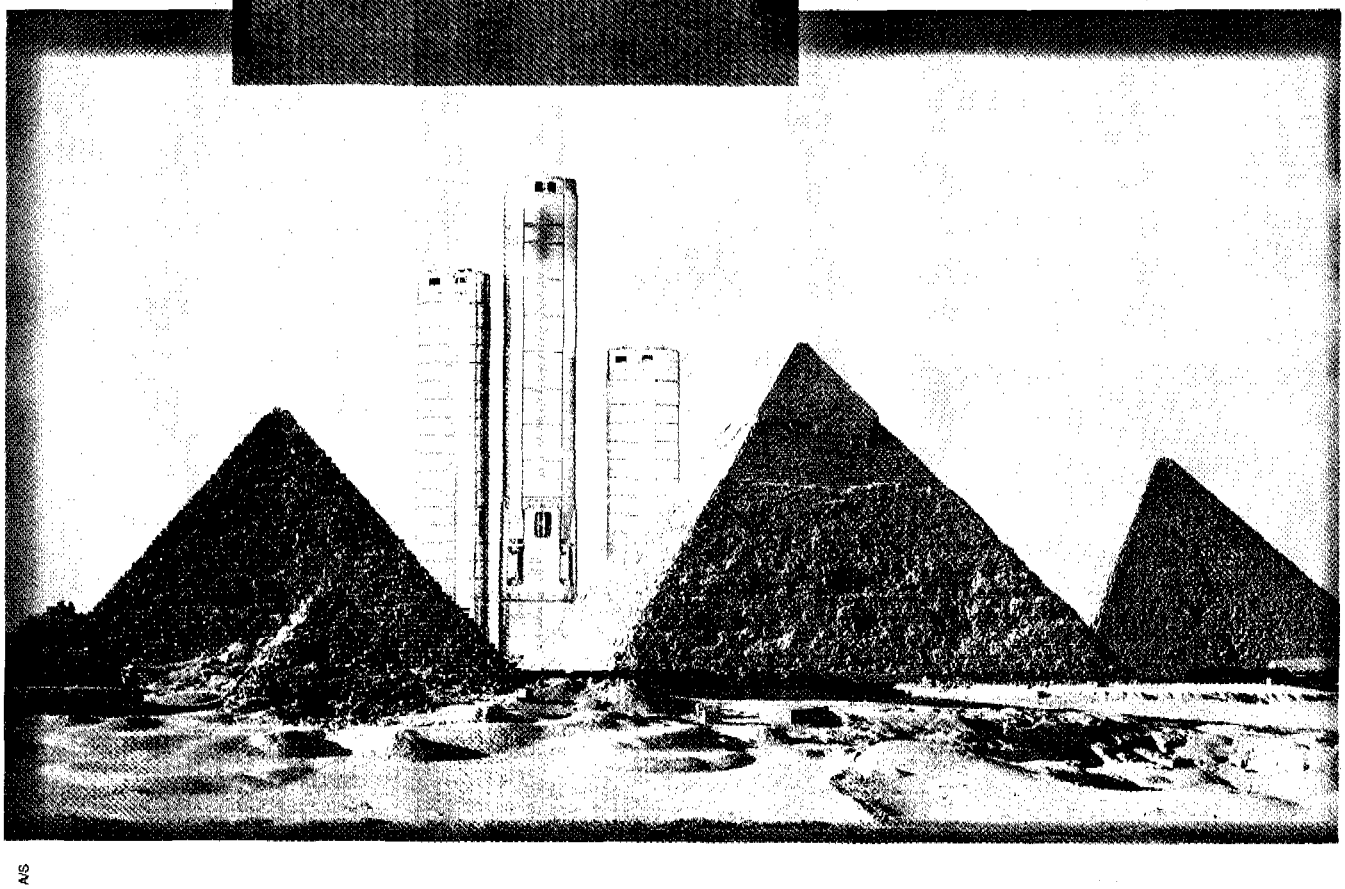
Vordingborg Kommune
Valdermarsgade 43, 4760 Vordingborg
Tel +45 53 77 14 01
Fax +45 55 34 05 51
Stads- & Havneingeniør:
Klaus Roos
Population: 20 000
Vol water supplied: 2*
Vol sewage treated: 3.2*
No. sewage plants: 2

Iceland

Reykjavik
Vatnsveita Reykjavikur (Reykjavik Municipal Water Works), Briedhofdi 13, 112 Reykjavik
Tel +354 1 69 70 00
Fax +354 1 67 21 19
Director:
Gudmundur Thoroddsson
Population: 126 000
Vol water supplied: 27*
No. reservoirs: 5

*million m³/year

DURABILITY IN PERSPECTIVE...



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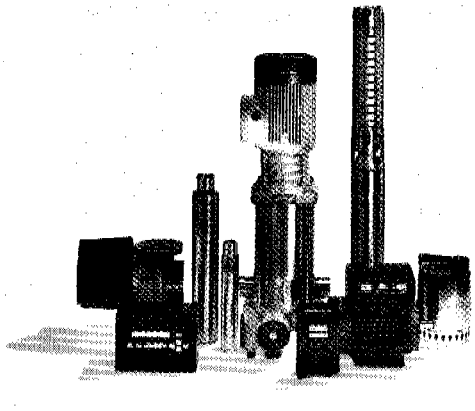

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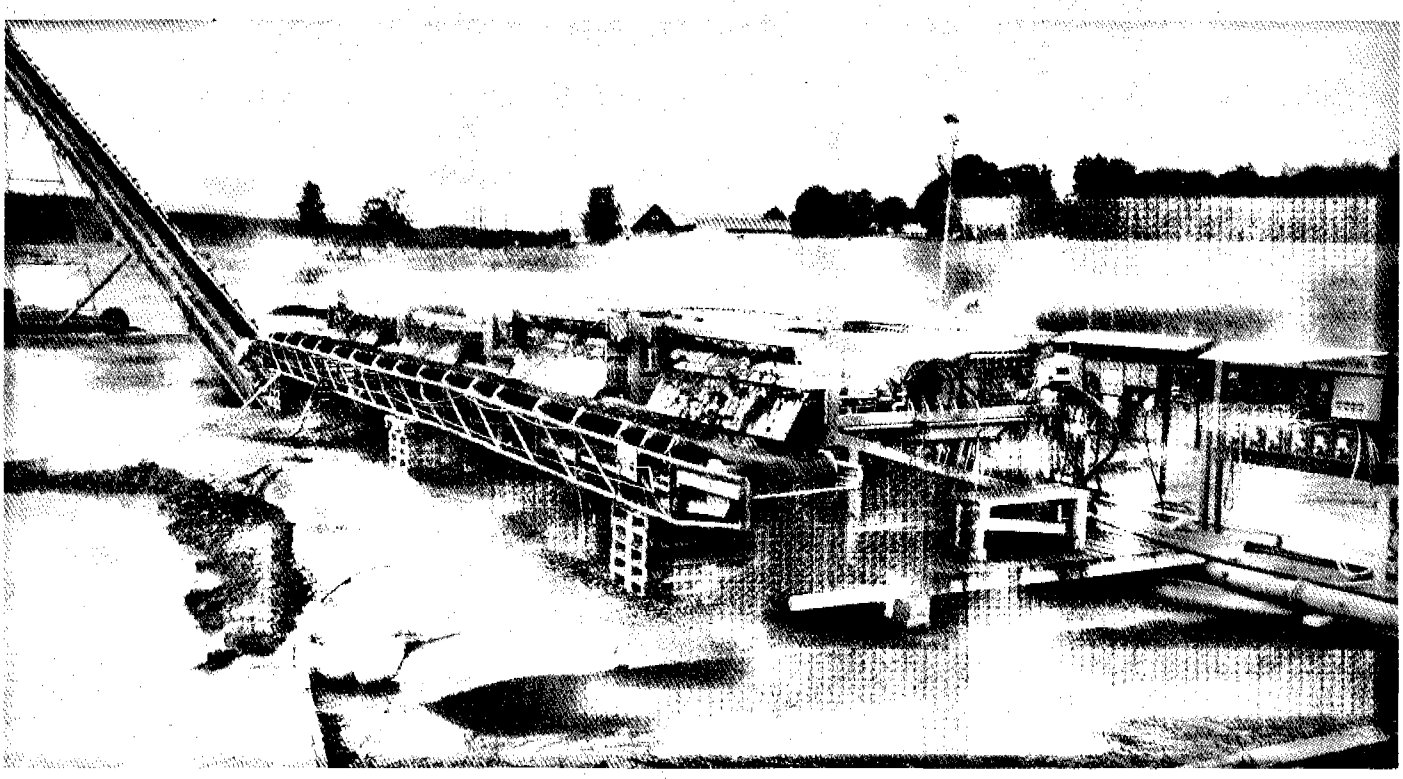
WATER AND ENVIRONMENT PIRINEN LTD



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- wine industry
- pectin production
- waste water treatment
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WATER AND ENVIRONMENT PIRINEN LTD.
Tehtaankatu 4, 26100 Rauma, Finland
Phone: +358 38 822 7225/8227244 Fax: +358 38 8227225

Government departments and regulating bodies

Ministry of the Environment
POB 399, FIN 00121 Helsinki
Tel +358 0 1991 9300
Fax +358 0 1991 9307
Minister of the Environment:
Sirpa Pietikäinen

Water and Environment Research Institute
National Board of Waters and the Environment, PO Box H436, SF 00101 Helsinki
Tel +358 0 19 29 1
Fax +358 0 19 29 577
Contact: Prof S Mustonen

Institutes and associations

Finnish Municipal Association
PO Box 200, 400101 Helsinki
Tel +358 0 131 121
Fax +358 0 1311 2400

Finnish Water and Waste Water Works Association
Ratavartijankatu 2 A, SF 00520 Helsinki
Tel +358 0 148 4748
Fax +358 0 148 4750
Managing Director: Rauno Püppo

Water Association
PO Box 721, SF 00101 Helsinki

Water suppliers and sewage water treatment/disposal plant

Espoo
Water and Sewage management:
Espoon Kaupungin Vesilaitos/Viemärilaitos, Virastopiha 2 c, Espoo 02770
Tel +358 90 806 5520
Fax +358 90 806 5567
Chief Exec:
Juha Valtakari
Population: 190 000 (waterworks) 245 000 (sewage plant)
Vol water supplied: 17*
No. reservoirs: 4
Vol sewage treated: 27*
No. sewage plants: 1

Helsinki
Water management:
Pääkaupunkiseudun Vesi Oy, Ilmalantori 1 A E, Helsinki 00240
Tel +358 90 14 14 66
Chief Exec:
Ilkka Hirsto
Population: 900 000
Vol water supplied: 82*

Helsinki
Water and Sewage management:
City of Helsinki Water and Sewage Works, PO Box 19, SF-00241 Helsinki
Tel +358 0 47341
Fax +358 0 4734 2010
Managing Director:
Jorma Tsubari
Population: 650 000
Vol water supplied: 70*
No. reservoirs: 8
Vol sewage treated: 90*
No. sewage plants: 3

Hollola
Water and Sewage management:
Hollolan Kunnan Vesihuoltolaitos, Virastotie 3, Hollola, 15870
Tel +358 18 880 1461
Fax +358 18 880 1474
Chief Exec:
Risto Koivisto
Population: 120 000
Vol water supplied: 2.3*
No. reservoirs: 1
Vol sewage treated: 1.1*
No. sewage plants: 2

Joensuu
Water and Sewage management:
Joensuun Kaupungin Vesilaitos/Viemärilaitos, Pl 148, Joensuu 80101
Tel +358 973 161 3555
Fax +358 973 161 3530
Chief Exec:
Erkki Kettunen
Population: 47 400
Vol water supplied: 4*
No. reservoirs: 3
Vol sewage treated: 6.5*
No. sewage plants: 1

Jyväskylä
Water management:
Jyväskylän Kaupungin Vesilaitos, Vapaudenkatu 65, Jyväskylä 40100
Tel +358 941 625420
Fax +358 941 625474
Chief Exec:
Esko Ahlgren
Population: 71 000
Vol water supplied: 7.3*
No. reservoirs: 4
Vol sewage treated: 8.9*
No. sewage plants: 1

Jyväskylä
Water management:
Jyväskylän Mlkn Vesilaitos, Puistokatu 35, Jyväskylä 40200
Tel +358 941 200 250
Fax +358 941 200 350
Chief Exec:
Erkki Hämäläinen
Population: 25 400
Vol water supplied: 1.4*
No. reservoirs: 3
Vol sewage treated: 2.5*
No. sewage plants: 5

Jyväskylä
Sewage management:
Jyväskylän Seudun Jätevedenpuhdistamo Oy, Lampitie 30, Jyväskylä 40520
Tel +358 941 641 642
Fax +358 941 641 583
Chief Exec:
Kirsi Laamanen
Vol sewage treated: 13.75*
No. sewage plants: 1

Kajaani
Water and Sewage management:
Kajaanin Kaupungin Vesilaitos/Viemärilaitos, Pl 132, Kajaani 87101
Tel +358 86 1552 58
Fax +358 86 1555 90
Chief Exec:
Olavi Hustari
Population: 35 000
Vol water supplied: 2.5*
No. reservoirs: 6
Vol sewage treated: 5*
No. sewage plants: 2

Kotka
Water and Sewage management:
Kotkan Kaupunki, Vesihhuotto-osasto, PL 5, 48201 Kotka
Tel +358 952 274819
Fax +358 952 274764
Managing Director:
Timo Kulmala
Population: 56 000
Vol water supplied: 5*
No. reservoirs: 4
Vol sewage treated: 9*
No. sewage plants: 2

Lahti
Water and Sewage management:
LV Lahti Vesi OY/LV Lahti Water Ltd, PL 427, Lahti 15141
Tel +358 18 814 2481
Fax +358 18 814 2602
Managing Director:
Karl Ratinen MSc (CEng)
Population: 100 000
Vol water supplied: 10*
No. reservoirs: 5
Vol sewage treated: 12*
No. sewage plants: 2

Lappeenranta
Water management:
Lappeenrannan Kaupungin Vesilaitos, Pl 38, Lappeenranta 53101
Tel +358 953 518751
Fax +358 953 518885
Chief Exec:
Hannu Mäkelä
Population: 45 000
Vol water supplied: 4.7*
No. reservoirs: 1
Vol sewage treated: 5.7*
No. sewage plants: 5

Lappeenranta
Water management:
Partek Minerals OY Ab, Lappeenranta 53500
Tel +358 953 67 17 219
Fax +358 953 67 17 651
Chief Exec:
Seppo Salmi
Population: 630
Vol water supplied: 0.9*

Lappeenranta
Sewage management:
Partek Minerals OY Ab, Lappeenranta 53500
Tel +358 953 67 17 300
Fax +358 953 41 52 096
Chief Exec:
Hannu Venäläiuan
Population: 630
Vol water supplied: 0.9*

Mikkeli
Water and Sewage management:
Mikkelin Kaupungin Vesilaitos/Viemärilaitos, Pl 278, Mikkeli 50101
Tel +358 955 194 1
Fax +358 955 194 506
Chief Exec:
Hannu Rautio
Population: 34 000
Vol water supplied: 2.8*
No. reservoirs: 2
Vol sewage treated: 4*
No. sewage plants: 1

Nivala
Water management:
Nivalan Vesihuolto OY, Vesitie 5, Nivala 85500
Tel +358 983 440225
Chief Exec:
Keijo Immonen

Nivala
Water management:
OY Vesikolmio Vesitie 5 2.krs, 85500 Nivala
Tel +358 983 440266
Fax +358 983 442616
Chief Exec:
Esa Harju
Population: 41 100
Vol water supplied: 3*
No. reservoirs: 12

Nivala
Sewage management:
Nivalan Kaupungin Viemärilaitos, PL 10, 85501 Nivala
Tel +358 983 44911
Fax +358 983 449 1348
Chief Exec:
Lauri Ahola
Population: 11 300
Vol water supplied: 0.45*
No. reservoirs: 2
Vol sewage treated: 0.95*
No. sewage plants: 1

Oulu
Water management:
Pikkaralan Vesiosuuskunta, Pikkaralantie, Oulu 90310
Tel +358 981 419157
Chief Exec:
Kalle Perttunen

Oulu
Water and Sewage management:
Oulun Kaupungin Vesihuoltolaitos, Box 230, Oulu 90101
Tel +358 81 314 2060
Fax +358 81 314 2150
Director:
Juhani Herva
Population: 110 000
Vol water supplied: 10*
No. reservoirs: 2
Vol sewage treated: 17*
No. sewage plants: 1

Pori
Water and Sewage management:
Porin Kaupungin Vesilaitos/Viemärilaitos, Pl 5, Pori 28101
Tel +358 939 892500
Fax +358 939 412242
Chief Exec:
Marja Luntamo
Population: 73 000
Vol water supplied: 7.7*
No. reservoirs: 5
Vol sewage treated: 12.5*
No. sewage plants: 6

Porvoo
Water management:
Saksanniemen, Vesilaitos, Pl 112, Porvoo 06101
Tel +358 915 1811
Chief Exec:
Börge Alden

Porvoo
Water management:
Noriken Vesilaitos, Pl 112
Porvoo 06101
Tel +358 915 1811
Chief Exec:
Börge Alden

Porvoo
Water and Sewage management:

*million m³/year

Porvoon Kaupungin Vesilaitos/Viemärilaitos, Porvoo, 06100
Tel +358 915 582600
Fax +358 915 582001
Chief Exec:
K-G Björkell
Population: 21 000
Vol water supplied: 1.8*
No. reservoirs: 1
Vol sewage treated: 2.9*
No. sewage plants: 1

Porvoo
Water and Sewage management:
Neste OY, Pl 310, Porvoo 06101
Tel +358 915 1782315
Chief Exec:
Erkki Naumanen

Rauma
Water management:
Rauman Kaupungin Vesi- Ja Viemärilaitos, Pumpputie 2, Rauma 26660
Tel +358 938 83411
Fax +358 938 822 0113
Chief Exec:
Aija Jantunen
Population: 34 683
Vol water supplied: 2.4*
No. reservoirs: 2
Vol sewage treated: 2.3*
No. sewage plants: 1

Tampere
Water and Sewage management:
Tampereen Kaupungin Vesilaitos/Viemärilaitos, Puutarhakatu 2 B, Tampere 33210
Tel +358 31 196346
Fax +358 31 196500
Chief Exec:
Vesih Pääll Esko Haume
Population: 200 000
Vol water supplied: 20*
No. reservoirs: 5
Vol sewage treated: 29*
No. sewage plants: 2

Turku
Water management:
Turku Water & Sewage Works, Halistentie 4, 20540 Turku
Tel +358 21 270311
Fax +358 21 270 3123
Chief Exec:
Esko Pohjanen
Population: 160 000
Vol water supplied: 19*
No. reservoirs: 4
Vol sewage treated: 30*
No. sewage plants: 1

Turku
Sewage management:
Turun Kaupungin Viemärilaitos, Katurak. osasto, Linnankatu 55, Turku 20100
Tel +358 921 624111
Chief Exec:
I Leino

Vaasa
Water and Sewage management:
Vaasan Kaupungin Vesilaitos, Pl 2, Vaasa 65101
Tel +358 961 325 1111
Fax +358 961 325 4045
Chief Exec:
Ilkka Mikkola
Population: 55 000
Vol water supplied: 5*
No. reservoirs: 2
Vol sewage treated: 7*
No. sewage plants: 1

*million m³/year

Government departments and regulating bodies

Ministère de l'Environnement
Direction de l'Eau, 20 avenue de Ségur, 75302 Paris 07 SP
Tel +33 1 42 19 12 01
Fax +33 1 42 19 12 06
Water Management Director: Jean-Luc Laurent

Institutes and associations

ACORE
Association Interprofessionelle de Conseil et Relations pour l'Environnement, 4 rue Léonard-Danel, 59800 Lille
Tel +33 20 51 25 77
Président: Robert Sacre

AFPE
Association Française pour la Protection des Eaux, 82 bis, avenue de Paris, 78000 Versailles
Tel +33 1 39 51 88 94
Président: P-L Tenaillon

AIDE
Association Internationale des Distributions d'Eau, (French National Committee of IWSA), 83 Avenue Foch, 75116 Paris
Tel +33 1 53 70 13 56/58
Fax +33 1 53 70 13 40
President: René Coulomb
General Secretary: Alain Lasalmonie

Office International de l'Eau
21 rue de Madrid, 75008 Paris
Tel +33 1 44 90 88 60
Fax +33 1 40 08 01 45
Président: Jean Renard
Directeur-Général: Jean-François Donzier

Water suppliers and sewage water treatment/disposal plant

Regional agencies

Bassin Adour Garonne
Agence de l'Eau Adour-Garonne, 90 rue du Férétra, 31078 Toulouse Cedex
Tel +33 61 36 37 38
Fax +33 61 36 37 28
Directeur:
Jean-Luc Redaud
Population: 6 000 000

Bassin Artois Picardie
Agence de l'Eau Artois-Picardie, BP 818, 764 boulevard Lahure, 59508 Douai
Tel +33 27 99 90 00
Fax +33 27 99 90 15
Directeur:
Michel Boulan
Population: 4 600 000
Vol water supplied: 330*
No. sewage plants: 340

Bassin Loire Bretagne
Agence de l'Eau Loire-Bretagne, Avenue de Buffon, BP 6339, 45063 Orléans Cedex 2
Tel +33 38 51 73 73
Fax +33 38 51 74 74
Directeur:
Franck Villey
Population: 10 800 000

Bassin Rhin Meuse
Agence de l'Eau Rhin-Meuse, Rozérieulles, BP 19, 57161 Moulins-les-Metz
Tel +33 87 34 47 00
Fax +33 87 60 49 85
Directeur:
Bruno Verlon
Population: 4 051 176
Vol water supplied: 9.6*
Vol sewage treated: 17.4*
No. sewage plants: 680

Bassin Rhône-Méditerranée-Corse
Agence de l'Eau Rhône-Méditerranée-Corse, 31 rue Jules-Guesde, 69310 Pierre-Bénite
Tel +33 72 39 48 48
Fax +33 78 51 64 71
Ingénieur en Chef des Ponts et Chaussées:
Patrick Guilhaudin

Bassin Seine-Normandie
Agence de l'Eau Seine-Normandie, 51 rue Salvador-Allende, 92027 Nanterre Cedex
Tel +33 1 41 20 16 00
Fax +33 1 41 20 16 09
Directeur:
Pierre-Frédéric Tenière Buchot
Population: 17 000 000

Principal Water Companies

CFSP
29 rue Lenoir, 72046 Le Mans cedex
Tel +33 43 84 68 10
Fax +33 43 72 25 46

CISE
(Compagnie Internationale de Services et d'Environnement), 250 route de l'Empereur, 92508 Reuil-Malmaison Cedex
Tel +33 1 47 52 50 00
Fax +33 1 47 52 58 03
Directeur Général:
Jean-François Verjat
Population: 3 000 000
Vol water supplied: 200*
No. reservoirs: 600
Vol sewage treated: 150*
No. sewage plants: 350

Compagnie des Eaux de Paris
5-7 av Percier, 75008 Paris
Tel +33 1 42 89 29 83
Fax +33 1 45 63 34 56
Directeur Général:
Bernard Franck
Population: 1 448 759
Vol water supplied: 160*
No. reservoirs: 6

Compagnie des Eaux et de l'Ozone
4 rue du Général-Foy, 75381 Paris Cedex 08
Tel +33 1 42 94 03 03
Fax +33 1 45 22 58 05
Directeur général:
André Morange

Compagnie Générale des Eaux
52 rue d'Anjou, 75384 Paris Cedex 08
Tel +33 1 49 24 49 24
Fax +33 1 49 24 69 99
Président:
Guy Dejouany
Population: 25 000 000
Vol water supplied: 2000*
No. sewage plants: 1700

Lyonnaise des Eaux
52 rue de Lisbonne, BP 28908, 75360 Paris Cedex 08
Tel +33 1 40 75 70 00
Fax +33 1 45 62 42 70
Administrateur Directeur général:
Guy de Panafieu

SADE
28 rue de La Baume, 75008 Paris
Tel +33 1 40 75 99 11
Fax +33 1 40 75 07 10
Président-Directeur Général:
Jean-Claude Douvry
Population: 666 200
Vol water supplied: 36.4*
No. reservoirs: 359
Vol sewage treated: 55.1*
No. sewage plants: 171

SAUR
(Société d'Aménagement Urbain et Rural), Challenger, 1 av Eugne-Freyssinet, 78064 St Quentin-en Yvelines Cedex
Tel +33 1 30 60 22 60
Fax +33 1 30 60 27 89
Président-Directeur Général:
Martin Bouygues
Population: 35 000 000
Vol water supplied: 450*
No. reservoirs: 3000
No. sewage plants: 900

Société d'Exploitation de Réseaux d'Eau Potable Intercommunaux
67-69 rue de la République, 69288 Lyon Cedex 2
Tel +33 78 37 24 03
Fax +33 72 40 27 67

Société des Eaux de Marseille
25 rue Edouard Delanglade, 13006 Marseille
Tel +33 91 57 60 60

Société des Eaux du Nord
127 boulevard de la Liberté, BP 329 59020 Lille Cedex
Tel +33 20 49 40 00
Fax +33 20 49 40 22
Président-Directeur Général:
Jean-Bernard Laborie
Population: 1 120 000
Vol water supplied: 87*
No. reservoirs: 29
No. sewage plants: 45

Société Parisienne des Eaux
11 Blvd Brune, 75014 Paris
Tel +33 1 40 44 95 59
Fax +33 1 40 44 92 34

SOGEA
Société SOGEA, 280 avenue Napoléon-Bonaparte, 92506 Rueil-malmaison Cedex
Tel +33 147 52 40 00
Président-Directeur général:
Serge Michel

Départements

Ain
La Préfecture, Service de l'Eau et de l'Assainissement, 45 avenue Alsace-Lorraine, 01012 Bourg-en-Bresse
Tel +33 74 32 30 00
Population: 470 757

Aisne
La Préfecture, Service de l'Eau et de l'Assainissement, 2 rue Paul-Doumer, 02011 Laon
Tel +33 23 21 82 82
Population: 536 500

Allier
La Préfecture, Service de l'Eau et de l'Assainissement, 2 rue Michel-de-l'Hospital, 03016 Moulins
Tel +33 70 48 30 00
Population: 356 500

Alpes-de-Haute-Provence
La Préfecture, Service de l'Eau et de l'Assainissement, 8 rue du Dr Romieu, 04016 Digne-les-Bains
Tel +33 92 31 06 00
Fax +33 92 32 44 48
Population: 130 883
Vol water supplied: 11.5*
No. sewage plants: 175

Alpes-Maritime
La Préfecture, Service de l'Eau et de l'Assainissement, Centre administratif départemental, Route de Grenoble, 06026 Nice
Tel +33 93 72 20 00
Population: 975 900

Ardennes
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 08011 Charleville-Mézires
Tel +33 24 37 22 11
Population: 300 947

Ardèche
La Préfecture, Service de l'Eau et de l'Assainissement, rue Pierre-Filliat, 07007 Privas
Tel +33 75 66 50 00
Population: 278 900

Aube
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Libération, 10025 Troyes
Tel +33 25 73 48 01
Population: 289 200

Aude
La Préfecture, Service de l'Eau et de l'Assainissement, 52 rue Jean-Bringer, 11012 Carcassonne
Tel +33 68 77 45 11
Population: 298 712

Aveyron
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Libération, 12007 Rodez
Tel +33 65 68 30 40
Population: 271 900

Bouches-du-Rhône
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 13282 Marseille
Tel +33 91 57 20 00
Population: 1 761 000

Bouches-du-Rhône
Ville de Marseille, Direction de l'Assainissement, 27 Bd Joseph Vernet, 13008 Marseille
Tel +33 91 55 48 01
Fax +33 91 55 48 12
Directeur:
Yves Morice
Population: 899 000

*million m³/year

Vol water supplied: 55*
No. reservoirs: 3
Vol sewage treated: 100*
No. sewage plants: 2

Bouches-du-Rhône
Société du Canal de Provence, Le Tholonet, 13603 Aix en Provence
Tel +33 42 66 70 00
Fax +33 42 66 70 80
Directeur-Général:
Michel Jean
Population: 3 000 000
Vol water supplied: 180*
No. reservoirs: 63
Vol sewage treated: 25*
No. sewage plants: 13

Calvados
La Préfecture, Service de l'Eau et de l'Assainissement, rue Saint-Laurent, 14038 Caen
Tel +33 31 30 64 00
Population: 618 468

Calvados
Services Techniques, Hôtel de Ville, Esplanade Jean-Marie Louvel, 14027 Caen Cedex
Tel +33 31 30 42 33
Fax +33 31 30 41 22
Directeur-Général des Serv Tech:
M Jean-Pierre Dauxerre
Population: 115 000 (clean water), 200 000 (sewage treatment)
Vol water supplied: 13*
No. reservoirs: 12
Vol sewage treated: 14*
No. sewage plants: 1

Cantal
La Préfecture, Service de l'Eau et de l'Assainissement, 1 place F D Roosevelt, 15006 Aurillac
Tel +33 71 48 22 17
Population: 158 300

Charente
La Préfecture, Service de l'Eau et de l'Assainissement, 7-9 rue de la Préfecture, 16017 Angouleme
Tel +33 45 95 37 00
Population: 341 900

Cher
La Préfecture, Service de l'Eau et de l'Assainissement, place Marcel-Plaisant, 18014 Bourges
Tel +33 36 24 14 95
Population: 321 900

Corrèze
La Préfecture, Service de l'Eau et de l'Assainissement, rue Souham, 19011 Tulle
Tel +33 55 20 25 05
Population: 237 859

Corse du Sud
Direction Régionale de l'Environnement, Service de l'Eau et des Milieux Aquatiques, BP 605, 20601 Bastia Cedex
Tel +33 95 30 13 70
Fax +33 95 30 13 89
Ing en Chef du Génie Rural des Eaux et des Forêts (IGREF)
Jean-Louis Inial

Cotes-d'Armor
La Préfecture, Service de l'Eau et de l'Assainissement, 3 place du Général de Gaulle, 22024 Saint Brieuc
Tel +33 96 62 44 22
Population: 537 700

Côte-d'Or
La Préfecture, Service de l'Eau et de l'Assainissement, 53 rue de la Préfecture, 21041 Dijon
Tel +33 80 44 64 00
Population: 493 700

Côte-d'Or
Compagnie Générale des Eaux, Secteur Côte d'Or Franche Comté, 7 bis Fg St-Jean, BP 17, 21201 Beaune Cedex
Tel +33 80 24 07 07
Fax +33 80 24 14 78
Chef de Secteur:
Pierre Thomas
Population: 390 000
Vol water supplied: 21.6*
No. reservoirs: 231
Vol sewage treated: 18.7*
No. sewage plants: 36

Dordogne
La Préfecture, Service de l'Eau et de l'Assainissement, rue Paul-Louis-Courier, 24016 Périgeux
Tel +33 53 09 84 11
Population: 377 356

Doubs
La Préfecture, Service de l'Eau et de l'Assainissement, 8 bis rue Charles Nodier, 25031 Besançon
Tel +33 81 81 80 80
Population: 484 300

Drome
Bureau de la Protection de l'Environnement, Boulevard Vauban, 26030 Valence
Tel +33 75 79 26 00
Fax +33 75 42 87 55
Contact:
Direction des Collectivités Publiques et de l'Environnement
Population: 413 097
No. sewage plants: 170

Essonne
La Préfecture, Service de l'Eau et de l'Assainissement, boulevard de France, 91010 Evry
Tel +33 1 60 77 92 50
Population: 988 306

Eure
La Préfecture, Service de l'Eau et de l'Assainissement, boulevard Georges Chauvin, 27022 Evreux
Tel +33 32 33 25 00
Population: 513 907

Eure-et-Loir
La Préfecture, Service de l'Eau et de l'Assainissement, 19 place de la République, 28019 Chartres
Tel +33 37 27 72 00
Population: 395 154

Finistre
La Préfecture, Service de l'Eau et de l'Assainissement, quai Dupleix, 29320 Quimper
Tel +33 98 76 29 29
Population: 838 200

Gard
La Préfecture, Service de l'Eau et de l'Assainissement, 10 avenue Feuchres, 30031 Nimes
Tel +33 66 67 70 21
Population: 584 000

Garonne (Haute)
La Préfecture, Service de l'Eau et de l'Assainissement, place Saint-Etienne, 31038 Toulouse
Tel +33 61 33 40 00
Population: 925 958

Garonne (Haute)
Service des Eaux, Ville de Toulouse, 32 rue Valade, 31000 Toulouse
Tel +33 61 22 24 72
Fax +33 61 11 39 00
Directeur Général des Travaux:
Georges Guizard
Population: 500 000
Vol water supplied: 40*
No. reservoirs: 8
Vol sewage treated: 30*
No. sewage plants: 2

Gironde
La Préfecture, Service de l'Eau et de l'Assainissement, Esplanade Charles de Gaulle, 33077 Bordeaux
Tel +33 56 90 60 60
Population: 1 211 000

Hauts-de-Seine
La Préfecture, Service de l'Eau et de l'Assainissement, 167 avenue Frédéric et Irne Joliot Curie, 92013 Nanterre
Tel +33 1 40 97 20 00
Population: 1 387 039

Hérault
La Préfecture, Service de l'Eau et de l'Assainissement, place des Martyrs de la Résistance, 34062 Montpellier
Tel +33 67 61 61 61
Population: 793 400

Hérault
Service Eau-assainissement, Mairie, 34064 Montpellier Cedex 2
Tel +33 67 34 72 01
Fax +33 67 22 58 72
Ingenieur en chef:
Jean-Claude Hemain
Population: 250 000
Vol water supplied: 30*
No. reservoirs: 7
Vol sewage treated: 30*
No. sewage plants: 2

Hérault
Services Techniques, Mairie de Montpellier, 1 place Francis-Ponge, 34064 Montpellier Cedex 2
Tel +33 67 34 71 38
Fax +33 67 65 82 56
Directeur-Général:
D G S T Robequain
Population: 260 000
Vol water supplied: 29*
No. reservoirs: 10
Vol sewage treated: 27.5*
No. sewage plants: 1

Ile-et-Vilaine
La Préfecture, Service de l'Eau et de l'Assainissement, 3 avenue de la Préfecture, 35026 Rennes
Tel +33 99 02 82 22
Population: 798 715

Ile-et-Vilaine
CR Bretagne de la Compagnie Générale des Eaux, 11 rue Kléber, 35020 Rennes Cedex
Tel +33 99 87 14 14
Fax +33 99 87 14 25
Directeur Régional:
Dr Yvon Mogno
Population: 1 116 000
Vol water supplied: 81.5*
No. reservoirs: 276
Vol sewage treated: 19.9*
No. sewage plants: 89

Indre
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Victoire-des-Alliés, 36019 Chateauroux
Tel +33 54 27 00 28
Population: 273 300

Indre-et-Loire
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 37032 Tours
Tel +33 47 60 46 15
Population: 527 190

Isère
La Préfecture, Service de l'Eau et de l'Assainissement, place de Verdun, 38201 Grenoble
Tel +33 76 54 81 31
Population: 1 015 000

Isère
Services Techniques du Syndicat Intercommunal des Eaux de la Region Grenobloise, 1 rue de Normandie, 38130 Echirolles
Tel +33 76 33 57 00
Fax +33 76 23 27 12
Directeur Général:
Antoine Cortes
Population: 220 000
Vol water supplied: 20*
No. reservoirs: 45

Jura
La Préfecture, Service de l'Eau et de l'Assainissement, 55 rue Saint-Désiré, BP 648, 39021 Lons-le-Saunier
Tel +33 84 24 19 64
Population: 248 600

Landes
La Préfecture, Service de l'Eau et de l'Assainissement, 24-26 rue Victor Hugo, 40011 Mont de Marsan
Tel +33 58 06 58 06
Population: 311 000

Loir-et-Cher
La Préfecture, Service de l'Eau et de l'Assainissement, 1 place de la République, 41018 Blois
Tel +33 54 81 54 81
Population: 301 000

Loire
La Préfecture, Service de l'Eau et de l'Assainissement, 2 rue Charles de Gaulle, 42022 Saint Etienne
Tel +33 77 33 42 45
Population: 745 000

Loire (Haute)
La Préfecture, Service de l'Eau et de l'Assainissement, place du Breuil, 43011 Le Puy
Tel +33 71 09 24 12
Population: 206 200

Loire (Haute)
Direction Départementale des Affaires Sanitaires et Sociales, 8 ruede Vienne, 43000 Le Puy-en-Velay Cedex
Tel +33 71 07 24 00
Fax +33 71 02 91 25
Directeur:
Danielle Pinat
Population: 206 568
Vol water supplied: 15*
No. reservoirs: 1100
Vol sewage treated: 19.09*
No. sewage plants: 314

Loire-Atlantique
La Préfecture, Service de l'Eau et de l'Assainissement, quai Ceineray, 44035 Nantes
Tel +33 40 47 39 80
Population: 1 051 000

Lot-et-Garonne
La Préfecture, Service de l'Eau et de l'Assainissement, rue Etienne-Dolet, 47016 Agen
Tel +33 53 96 49 47
Population: 305 000

Maine-et-Loire
La Préfecture, Service de l'Eau et de l'Assainissement, 49034 Angers
Tel +33 41 81 81 81
Population: 705 500

Manche, La
Préfecture de la Manche, Direction de l'Administration Générale et de la Réglementation, Bureau de l'Environnement et du Cadre de Vie, BP 419, 50009 Saint-Lo Cedex
Tel +33 06 50 50
Fax +33 57 36 66
Directeur:
Claude Peant
Population: 479 074
Vol water supplied: 42*
No. reservoirs: 352
Vol sewage treated: 15*
No. sewage plants: 173

Marne
La Préfecture, Service de l'Eau et de l'Assainissement, 38 rue Carnot, 51036 Chalons-sur-Marne
Tel +33 26 70 32 00
Population: 556 008

Marne (Haute)
La Préfecture, Service de l'Eau et de l'Assainissement, 89 rue de la Victoire de la Marne, 52011 Chaumont
Tel +33 25 32 65 00
Population: 203 500

Mayenne
La Préfecture, Service de l'Eau et de l'Assainissement, place Jean-Moulin, 53024 Laval
Tel +33 43 53 92 00
Population: 278 000

Meurthe-et-Moselle
La Préfecture, Service de l'Eau et de l'Assainissement,

***million m³/year**

1 rue Maurice-Barrs, 54035 Nancy
Tel 33 83 34 26 26
Population: 711 005

Meurthe-et-Moselle
Services Techniques, District Urbain de Nancy, 24 Viaduc Kennedy, 54035 Nancy Cedex
Tel +33 83 91 83 91
Fax +33 83 91 83 96
Directeur Général Adjoint des Services Techniques du District:
René Badot
Population: 300 000
Vol water supplied: 36*
No. reservoirs: 20
Vol sewage treated: 40*
No. sewage plants: 2

Meuse
La Préfecture, Service de l'Eau et de l'Assainissement, 40 rue du Bourg, 55012 Bar-le-Duc
Tel +33 29 77 55 55
Fax +33 29 79 64 49
Directeur de l'Admin. Générale:
Jean-Paul Saget
Population: 196 256
Vol water supplied: 11*
No. reservoirs: 400
Vol sewage treated: 2*
No. sewage plants: 34

Morbihan
La Préfecture, Service de l'Eau et de l'Assainissement, place du Général de Gaulle, 56019 Vannes
Tel +33 97 42 67 67
Population: 618 700

Moselle
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 57034 Metz
Tel +33 87 34 87 34
Population: 1 010 700

Nivre
La Préfecture, Service de l'Eau et de l'Assainissement, 62 rue de la Préfecture, 58019 Nevers
Tel +33 86 57 80 25
Population: 232 712

Nord
La Préfecture, Service de l'Eau et de l'Assainissement, place de la République, 2 rue Jacquemars Giélée, 59039 Lille
Tel +33 20 30 59 59
Population: 2 530 033

Oise
La Préfecture, Service de l'Eau et de l'Assainissement, 1 place de la Préfecture, 60030 Beauvais
Tel +33 44 48 48 20
Population: 724 000

Orne
La Préfecture, Service de l'Eau et de l'Assainissement, 39 rue Saint-Blaise, 61018 Alençon
Tel +33 33 26 74 00
Population: 293 900

Paris
@address:La Préfecture, Service de l'Eau et de l'Assainissement, 17 Bd Morland, 75915 Paris Cedex 04
Tel +33 1 49 28 40 00
Population: 2 146 692

Pas-de-Calais
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 62020 Arras
Tel +33 21 55 22 62
Population: 1 433 000

Puy-de-Dome
La Préfecture, Service de l'Eau et de l'Assainissement, 18 boulevard Desaix, 63033 Clermont-Ferrand
Tel +33 73 92 42 42
Population: 597 200

Pyrénées (Haute)
La Préfecture, Service de l'Eau et de l'Assainissement, place Charles-de-Gaulle, 65013 Tarbes
Tel +33 62 93 75 40
Population: 224 100

Pyrénées-Atlantiques
La Préfecture, Service de l'Eau et de l'Assainissement, 2 rue du Maréchal Joffre, 64015 Pau
Tel +33 59 27 60 00
Population: 579 900

Pyrénées-Orientales
La Préfecture, Service de l'Eau et de l'Assainissement, 4 rue Lazare-Escarguel, BP951, 66020 Perpignan
Tel +33 68 51 22 50
Population: 362 000

Rhin (Haut)
La Préfecture, Service de l'Eau et de l'Assainissement, 7 rue Bruat, 68020 Colmar
Tel +33 89 23 99 51
Population: 671 000

Rhin (Haut)
Colmarienne des Eaux, 10 rue des Bonnes-Gens, BP 187, 68004 Colmar
Tel +33 89 20 17 70
Fax +33 89 20 17 79
Directeur Général:
Christian Mennesson
Population: 150 000
Vol water supplied: 9*
No. reservoirs: 3
Vol sewage treated: 7*
No. sewage plants: 1

Rhin (Haut)
Service des Eaux de la Ville de Mulhouse, 11 av du Pdt-Kennedy, 68200 Mulhouse
Tel +33 89 32 59 26
Fax +33 89 32 68 45
Ingénieur en chef:
Jean-Daniel Gsell
Population: 170 000
Vol water supplied: 14*
No. reservoirs: 3
Vol sewage treated: 30*
No. sewage plants: 1

Rhône
Communauté Urbaine de Lyon, Direction de l'Eau et de l'Assainissement, 215 rue André Philip, 69421 Lyon Cedex 03
Tel +33 78 95 89 00
Fax +33 78 60 24 20
Directeur:
Jean-Pierre Bué
Population: 1 400 000
Vol water supplied: 120*
No. reservoirs: 64
Vol sewage treated: 250*
No. sewage plants: 9

Rhône
Saur, 41 Quai Fulchiron le Highway, 69245 Lyon Cedex 05
Tel +33 78 42 66 58
Fax +33 72 41 06 67
Directeur Technique:
Mr Richard
Population: 800 000
Vol water supplied: 75*
No. reservoirs: 670
Vol sewage treated: 18*
No. sewage plants: 65

Sarthe
La Préfecture, Service de l'Eau et de l'Assainissement, place Aristide-Briand, 72017 Le Mans
Tel +33 43 84 96 00
Population: 514 000

Sarthe
Compagnie Fermière de Services Publics, 29 rue Lenoir, 72046 Le Mans Cedex 9
Tel +33 43 84 68 10
Fax +33 43 72 25 46
Président-Directeur Général:
G Gouesbet
Population: 800 000
Vol water supplied: 45*
No. reservoirs: 400
Vol sewage treated: 16*
No. sewage plants: 210

Savoie
La Préfecture, Service de l'Eau et de l'Assainissement, Château des ducs de Savoie, 73018 Chambéry
Tel +33 79 62 93 00
Population: 348 000

Savoie (Haute)
La Préfecture, Service de l'Eau et de l'Assainissement, avenue d'Albigny, 74011 Annecy
Tel +33 50 52 81 31
Population: 568 000

Savoie (Haute)
DDASS de Haute-Savoie, Cite administrative, Rue Dupanloup, 74040 Annecy
Tel +33 50 88 41 33
Fax +33 50 88 42 88
Ing Sanitaire Dept:
Paule Lagrasta
Population: 1 100 000
Vol water supplied: 70*
Vol sewage treated: 40*
No. sewage plants: 82

Saône
La Préfecture, Service de l'Eau et de l'Assainissement, 1 rue de la Préfecture, BP 429, 70013 Vesoul
Tel +33 84 76 22 11
Population: 230 000

Saône-et-Loire
La Préfecture, Service de l'Eau et de l'Assainissement, 196 rue de Strasbourg, 71021 Mâcon
Tel +33 85 38 61 00
Population: 558 662

Seine-et-Marne
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 77010 Melun
Tel +33 1 64 71 77 77
Population: 1 074 091

Seine-et-Marne
Ste Des Eaux de Melun, 198 Rue Foch, 77005 ZI, Melun-Vaux-le-Penil
Tel +33 64 71 41 00
Fax +33 64 71 41 10
Ingénieur:
Jean-Luc Salle
Population: 350 000
Vol water supplied: 31.5*
No. reservoirs: 110
Vol sewage treated: 16.5*
No. sewage plants: 35

Seine-Maritime
La Préfecture, Service de l'Eau et de l'Assainissement, cours Clemenceau, 76036 Rouen
Tel +33 35 03 50 76
Population: 1 222 500

Seine-St-Denis
La Préfecture, Service de l'Eau et de l'Assainissement, avenue Paul-Vaillant-Couturier, 93007 Bobigny
Tel +33 1 48 95 60 60
Population: 1 324 301

Somme
La Préfecture, Service de l'Eau et de l'Assainissement, 51 rue de la République, 80027 Amiens
Tel +33 22 97 80 80
Population: 545 500

Sèvres (Deux)
La Préfecture, Service de l'Eau et de l'Assainissement, 4 rue Du-Guesclin, 79021 Niort
Tel +33 49 24 96 51
Population: 346 000

Tarn
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 81013 Albi
Tel +33 63 45 61 61
Population: 341 800

Tarn-et-Garonne
La Préfecture, Service de l'Eau et de l'Assainissement, 82013 Montauban
Tel +33 63 03 50 00
Population: 200 001

Val d'Oise
La Préfecture, Service de l'Eau et de l'Assainissement, 95010 Pontoise-Cergy (ville nouvelle)
Tel +33 1 34 25 25 25
Population: 927 376

Val-de-Marne
La Préfecture, Service de l'Eau et de l'Assainissement, avenue du Général de Gaulle, 94011 Créteil
Tel +33 1 42 07 25 00
Population: 1 193 655

Val-de-Marne
Ville de St-Maur-des-Fossés, Hôtel de Ville, 94107 St Maur Cedex
Tel +33 48 86 11 20
Fax +33 48 86 86 69
Ingenieur - Chef du Service:
Daniel Arnault
Population: 80 000
Vol water supplied: 5.7*
No. reservoirs: 1

Var
La Préfecture, Service de l'Eau et de l'Assainissement, Hôtel de la Préfecture, Bd du 112e RI, 83070 Toulon
Tel +33 94 89 90 40
Population: 814 731

Var
Conseil Général Environnement, BP 1303, 83076 Toulon Cedex
Tel +33 94 92 27 27
Fax +33 94 91 25 32
Directeur de l'Environnement:
Gérard Dubois
Population: 150/km2
Vol water supplied: 130*
No. reservoirs: 300
Vol sewage treated: 60*
No. sewage plants: 180

Vaucluse
La Préfecture, Service de l'Eau et de l'Assainissement, 71 rue Joseph-Vernet, 84905 Avignon Cedex 9
Tel +33 90 82 11 11
Population: 466 900

Vendée
La Préfecture, Service de *l'Eau et de l'Assainissement*, 5 bis, rue Delille, 85020 La Roche-sur-Yon
Tel +33 51 36 70 85
Population: 509 500

Vienne
La Préfecture, Service de l'Eau et de l'Assainissement, place Aristide-Briand, 86021 Poitiers
Tel +33 49 55 70 00
Population: 380 557

Vienne (Haute)
La Préfecture, Service de l'Eau et de l'Assainissement, place Stalingrad, 87031 Limoges
Tel +33 55 44 18 18
Population: 353 586

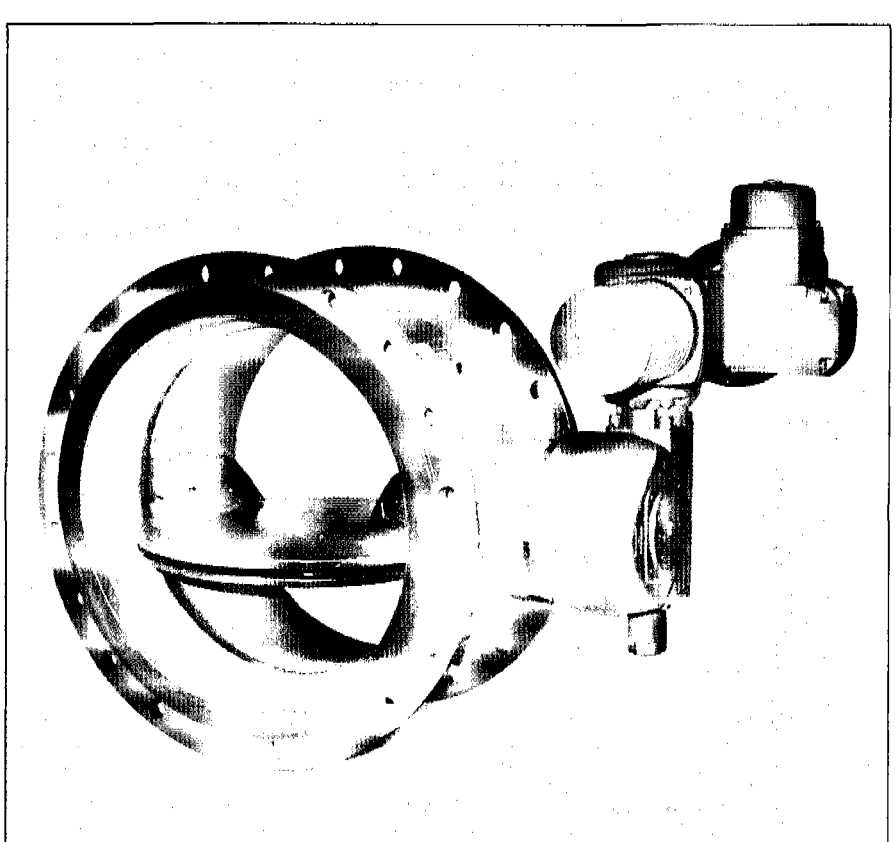
Vosges
Bureau de l'Environnement, Préfecture des Vosges, Place Foch, BP 586, 88021 Epinal Cedex
Tel +33 29 82 98 88
Fax +33 29 82 42 15
Directeur de Préfecture:
D Ulrich
Population: 386 260
Vol water supplied: 30*
No. reservoirs: 600
Vol sewage treated: 20*
No. sewage plants: 50

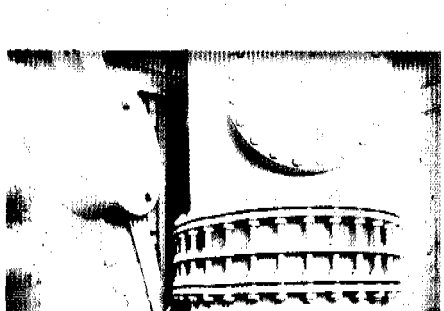
Yonne
La Préfecture, Service de l'Eau et de l'Assainissement, place de la Préfecture, 89011 Auxerre
Tel +33 86 52 61 89
Population: 311 019

Yvelines
La Préfecture, Service de l'Eau et de l'Assainissement, 2 place André Mignot, 78010 Versailles
Tel +33 1 39 49 78 00
Population: 1 306 400

***million m³/year**

TH. JANSEN +RHEINHÜTTE VALVES





Above:
Combined safety-shut-off, non-return, butterfly valve DN 1200 with FAIL-SAFE function.

Below:
Combined safety-shut-off, non-return, butterfly valve DN 600 with electro-hydraulic actuating device.

The FRIASEAL®-Butterfly Valve Series 410 – Water-proof!

Decades of experience in the production of large valves, especially for the water industry, have provided valuable know-how in the development of the FRIASEAL®-Butterfly Valve – Series 410. The result is a thoughtfully constructed valve which complies with the latest user demands.

The optimum design features provide long life with a minimum maintenance and installation in any position.

In short: A water proven design!

Arm 342 e

For further information please contact:
FRIATEC-Th. Jansen Armaturen GmbH · Postfach 42 40 · Theodor-Jansen-Straße · D-66377 St. Ingbert-Rohrbach
Telefon (0 68 94) 5 93-0 · Fax (0 68 94) 59 31 00 · Telex 4429401 jans d

FRIATEC

Government departments and regulating bodies

BGW/DVGW-Landesgruppen
Berlin/Brandenburg, Alt Schönow 2a, D-14165 Berlin
Tel +49 30 815 9760
Fax +49 30 815 9960
Geschäftsführer: Dipl-Ing Klaus-Peter Petersen

BGW/DVGW-Landesgruppen, Hamburg
Nordost, Heidenkampsweg 101, D-20097 Hamburg 1
Tel +49 40 230015
Fax +49 40 230099

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
Postfach 120629, D-53048 Bonn
Tel +49 228 305 2546
Fax +49 228 305 3225
Federal Minister for the Environment: Dr Angela Merkel

Der Bundesminister für Gesundheit
D-53108 Bonn
Tel +49 228 941-0
Fax +49 228 941-4900
Bundesminister: Horst Seehofer

Ministerium fur Umwelt
Kernerplatz 9, D-70182 Stuttgart, (PO Box 103439 D-70029 Stuttgart)
Tel +49 711/126-0
Fax +49 711/126 2881
Umweltminister: Harald B Schäfer

Ministerium für Umwelt, Raumordnung und Landwirtschaft des Landes Nordrhein-Westfalen
Schwannstrasse 3, D-40476 Düsseldorf 30
Tel +49 211 4566-0
Fax +49 211 4566-388
Head of Department: Dr Hans Joachim Pietrzeniuk

North Rhine-Westphalia State Environment Agency
Wallneyer Str 6, D-45133 Essen
Tel +49 201 7995-0
Fax +49 201 7995 446/447
President: Dr Harald Irmer
Vice President: Dr Davids

Umweltbundesamt
(Federal Environmental Agency), Bismarckplatz 1, D-14191 Berlin 33
Tel +49 30 8903-0
Fax +49 30 8903-2285
President: Dr Heinrich Freiherr von Lersner

Institutes and associations

Abwassertechnische Vereinigung e.V (ATV)
Markt 71, Postfach 1160, D-41460 St Augustin 1
Tel +49 2241 232-0
Fax +49 2241 23235
Executive Director: Dr Ing S van Riesen

BGW (Bundesverband der Deutschen Gas- und Wasserwirtschaft b.o. - Federal Association of the German Gas and Water Industries
Josef Wirmer Strasse 1, D-53123 Bonn 1; Postfach 140154, D-53056 Bonn
Tel +49 228 2598-0
Fax +49 228 2598-120
President: Dr Hans-Otto Schwarz
Chief Executive Officer: Herbert Oster
Managing Director: Dr Wolf Pluge

BGW/DVGW-Landesgruppen Ost
Geschäftsstelle Wasser, Räcknitzhöhe 27, D-01217 Dresden
Tel +49 351 471 0988
Fax +49 351 471 0945
Office Manager: Dr-Ing L Saitenmacher

Deutscher Verband fur Wasserwirtschaft und Kulturbau e.V (DVWK)
Hauptgeschaftsstelle, Gluckstrasse 2, D-53115 Bonn
Tel +49 228 98387-0
Fax +49 228 98387-33
Chief Executive: Dr-Ing Wolfram Dirksen

DVGW Deutscher Verein des Gas- und Wasserfaches e.V
Josef-Wirmer-Strasse 1-3, D-53123 Bonn
Tel +49 61 96 7017-0
Fax +40 61 96 48 1152
President: Dipl-Berging P Scherer
General Secretary: Dr-Ing W Merkel

Water suppliers and sewage water treatment/disposal plant

Aachen, (Brand) 52078
Wasserwerk des Kreises Aachen GmbH, Trierer Str 652/654
Tel +49 29 19 92 00
Fax +49 29 19 92 01 8
Director:
Dipl-Kfm K Bordfeld
Population: 345 000
Vol water supplied: 43*

Aachen, 52070
STAWAG, Stadtwerke Aachen AG, Lombardenstr. 12-22, Postfach 1248
Tel +49 2 41/18 10
Fax +49 2 41/18 18 68
Director:
Dipl-Ing W Petry
Population: 169 000
Vol water supplied: 15*

Aalen, 73430
Stadtwerke, Marktplatz 30, Postfach 1740
Tel +49 73 61 50 01
Director:
Dipl-Ing E L Bullinger
Population: 64 500
Vol water supplied: 5*

Albstadt, 72461
Stadtwerke Albstadt, Goethestr 91
Tel +49 7431 1600
Fax +49 7431 1603844
Direktor:
Dipl Ing Vogel
Population: 50 000
Vol water supplied: 4*
No. reservoirs: 30
Vol sewage treated: 5*
No. sewage plants: 2

Alpirsbach, 72275
Zweckverband Wasserversorgung, Kleine Kinzig, Berneckstrasse 100, Reinerzau
Tel +49 74 44 612-0
Fax +49 74 44 61266
Director:
J Rapp
Population: 250 000
Vol water supplied: 6*
No. reservoirs: 6
No. sewage plants: 1

Ansbach, 91501
Stadtwerke, Postfach 1053
Tel +49 981 89 04-0
Fax +49 981 89 04-89
Direktor:
Dieter Rathsam
Population: 53 000
Vol water supplied: 3.5*
Vol reservoirs: 12 600 m3~super
Vol sewage treated: 6*
No. sewage plants: 10

Aschaffenburg, 63739
Stadtwerke Aschaffenburg, Postfach 9
Tel +49 6021 391-0
Fax +49 6021 391-202
Direktor:
H Elster
Population: 115 000
Vol water supplied: 8*
No. reservoirs: 7

Augsburg, 86014
Stadtwerke, Hoher Weg 1, Postfach 10 24 40
Tel +49 8 21 324-551
Fax +49 8 21 324-4360
Direktor:
Dr W Pusinelli
Population: 279 000
Vol water supplied: 21.4*
No. reservoirs: 3
No. sewage plants: 1

Babenhausen/Hess.3, 64832
Zweckverband Gruppenwasserwerk Dieburg, Wasserwerk Hergershausen
Tel +49 60 73 603-0
Fax +49 60 73 603 58
Verbandsvorsitzender:
Gunter Schledt
Population: 107 900
Vol water supplied: 9.5*
No. reservoirs: 4

Bad Hersfeld, 36251
Stadtwerke, Kleine Industriestr. 1, Postfach 2008
Tel +49 66 21 16 60
Fax +49 66 21/1 66-43
Direktor:
Dipl-Ing H Wachholz
Population: 32 600
Vol water supplied: 2.2*
Bad Homburg v.d.H., 61348
Stadtwerke, Louisenstr 148
Tel +49 6172 40130
Fax +49 6172 489442
Kaufm Direktor:
B Eller
Techn Direktor:
Dipl Ing A Dorn
Population: 51 300
Vol water supplied: 4*
No. reservoirs: 7

Bad Kreuznach, 55529
Stadtwerke Gmbh Postfach 578
Tel +49 6 71 99-0
Fax +49 6 71 99-211
Director:
Dipl-Wirtsch-Ing Ralf P Zechel
Population: 59 000
Vol water supplied: 4.9*
No. reservoirs: 22

Bad Nauheim, 61231
Hessisches Staatsbad, Gruppenwasserversorgung, Ludwigstr. 20, Postfach 1760
Tel +49 60 32 3 44-212
Direktor:
Rainer Brill
Population: 42 700
Vol water supplied: 3.6*
No. reservoirs: 1
Vol sewage treated: 0.8*
No. sewage plants: 1

Bad Oldesloe, 23832
Stadtwerke, Postfach 1236
Tel +49 45 31 162 0
Fax +49 45 31 673 73
Direktor:
G Hacker
Population: 25 000
Vol water supplied: 1.6*
No. reservoirs: 14
Vol sewage treated: 1.65*
No. sewage plants: 4

Bad Pyrmont, 31812

*million m³/year

Stadtwerke, Waisenhof 5/6, Postfach 1645
Tel +49 52 81 60 53-0
Fax +49 52 81 60 53 45
Direktor:
Herr Boldt
Population: 24 000
Vol water supplied: 1.7*
No. reservoirs: 2

Bad Rappenau, 74906
Zweckverband Wasserversorgung Mühlbach, Hinter dem Schloss 10
Tel +49 7264 7063
Fax +49 7264 4139
Direktor:
Bernd Steeb
Population: 32 000
Vol water supplied: 2*
No. reservoirs: 17

Beckum, 59249
Wasserversorgung Beckum GmbH, Postfach 1951
Tel +49 2521 843-0
Fax +49 2521 843-50
Geschäftsführer:
Dipl Ing Clemens Lüffe
Population: 130 000
Vol water supplied: 7*

Bergisch Gladbach, 51432
Bergisch Licht-, Kraft- und Wasserwerke (BELKAW) GmbH, Hermann-Loens-Str 131-133, Postfach 200220
Tel +49 22 02 16-1
Fax +49 22 02 1 63 33
Director:
Dipl-Ing G Beckmann
Population: 110 000
Vol water supplied: 11*

Berlin, 10631
Berliner Wasserbetriebe, Hohenzollerndamm 45, Postfach 31 01 80
Tel +49 30 86 44-0
Fax +49 30 86 44-28 10
Direktor:
H Dr Bertram Wieczorek
Population: 3 461 000
Vol water supplied: 261*
No. reservoirs: 14
Vol sewage treated: 237*
No. sewage plants: 8

Bersenbrück, 49593
Wasserbeschaffungsverband, Liebigstr. 8
Tel +49 54 39 7 51
Fax +49 54 39 7 53
Vorstandsvorsitzender:
W Kreft
Geschäftsführer:
Dipl-Ing Usselmann
Population: 90 000
Vol water supplied: 4.5*

Bielefeld, 33526
Wasserwerk Muehlgrund GmbH, Schildescher Str 16, Postfach 7940 10 26 92
Tel +49 521 51 4342
Fax +49 521 51 4337
Director:
kfm Franz Deimel
Vol water supplied: 2*
No. reservoirs: 1

Bielefeld, 33611
Stadtwerke GmbH, Schildescher Str 16, Postfach 7940
Tel +49 5 21 5 11
Director:
Dr W Ueberhorst
Population: 316 000
Vol water supplied: 22*

Bingen am Rhein, 55411
Stadtwerke, Saalandstr 364
Tel +49 67 21 97070
Fax +49 67 21 970750
Direktor:
Dipl-Ing Gunter Herzner
Population: 22 000
Vol water supplied: 1.6*
No. reservoirs: 6
Vol sewage treated: 2.2*
No. sewage plants: 1

Bochum, 44722
Stadtwerke GmbH, Massenbergstr. 15/17, Postfach 1022 50
Tel +49 2 34 61 81
Fax +49 6 18-2 85
Director:
Dr G Schmidt
Population: 400 500
Vol water supplied: 33*

Bonn 1, 53032
Stadtwerke, Theaterstr 24, Postfach 1802 40
Tel +49 228 711 1
Fax +49 228 711 770
Stadtdirektor:
R Schreiber
Population: 314 000
Vol water supplied: 24.5*
No. reservoirs: 9
Vol sewage treated: 36.8*
No. sewage plants: 4

Brake, 26919
Oldenburgish-Ostfriesischer Wasserverband, Georgstrasse 4
Tel +49 4401 16 0
Fax +49 4401 5398
Verbandsvorsteher:
Heinz zu Jührden
Population: 780 000
Vol water supplied: 62*
No. reservoirs: 15

Braunschweig, 38106
Stadtwerke GmbH, Taubenstr. 7, Postfach 5149
Tel +49 531 383-2200
Fax +49 531 383-3307
Direktor:
Herr Probst
Population: 238 000
Vol water supplied: 17*

Bremen, 28215
Stadtwerke AG, Theodor-Heuss-Allee 20, Postfach 1078 03
Tel +49 4 21 35 90
Fax +49 3 59-24 99
Director:
Dr G Czichon
Population: 545 000
Vol water supplied: 35*

Bremerhaven, 27568
Stadtwerke AG, Fährstr 20-22
Tel +49 4 71 477-0
Fax +49 4 71 477-1109
Direktor:
A Benetten
Population: 129 000
Vol water supplied: 11*
No. sewage plants: 1

Brilon, 59929
Stadtwerke Brilon, Keffelker Str 27, Postfach 1660
Tel +49 2961 79 400
Fax +49 2961 79 408
Director:
Dipl-Ing J Niggemeier
Population: 27 000
Vol water supplied: 1.6*
No. reservoirs: 10
Vol sewage treated: 1.3*
No. sewage plants: 7

Cadolzburg, 90553
Zweckverband zur Wasserversorgung Dillenberggruppe, Postfach 29
Tel +49 9103 2014
Fax +49 9103 5468
Direktor:
H Beigel
Population: 45 000
Vol water supplied: 2*
No. reservoirs: 4

Darmstadt, 64293
Sudhessische Gas und Wasser AG, Frankfurter Str 100, Postfach 4117
Tel +49 61 51 7 01-0
Fax +49 61 51 7 01-4 60
Director:
Dipl-Ing H Reisser
Population: 370 000
Vol water supplied: 20*

Deggendorf, 94469
Wasserversorgung Bayerischer Wald, Pater-Fink-Str 8
Tel +49 9 91 2 10 81
Director:
Helmut Feuchtinger
Population: 120 000
Vol water supplied: 7*

Dollern, 21739
Trinkwasserverband Stader Land, Immengrund 5
Tel +49 4163 818 0
Fax +49 4163 818 282
Direktor:
D Hammann
Population: 115 000
Vol water supplied: 8*
No. reservoirs: 3

Dortmund 1, 44047
Vereinigte Elektrizitatswerke Westfalen AG, Rheinlanddamm 24, Postfach 1050 56
Tel +49 2 31 4 38-1
Director:
Prof K Knizia
Population: 7000
Vol water supplied: 0.307*

Dresden, 01097
Wasserversorgung und Abwasserbehandlung Dresden GmbH, Palaisplatz 2b, Postschilessfach 548
Tel +49 37 51-5 24 31
Director:
K Grunwald
Population: 1 713 000
Vol water supplied: 151*

Düsseldorf 40215
Stadtwerke AG, Luisenstr. 105, Postfach 1136
Tel +49 2 11 82 11
Fax +49 2 37 36 41
Direktor:
M Lause
Population: 633 000
Vol water supplied: 65*
No. reservoirs: 5

Eckernfoerde, 24340
Stadtwerke GmbH, Bornbrook 1-3, Postfach 1440
Tel +49 4351 90 50
Fax +49 4351 90 5199
Direktor:
Dipl-Ing W Poetzsch
Population: 22 500
Vol water supplied: 1.5*
Vol sewage treated: Waste water treatment is handled by Stadt Eckernförde

Emden, 26702
Stadtwerke Emden GmbH, Martin-Faber-Str 11-13, Postfach 2245
Tel +49 49 21 83-0
Fax +49 49 21 83 285
Direktor:
Dipl-Ing Remmer Edzards
Population: 50 000
Vol water supplied: 4*

Emsdetten, 48282
Stadtwerke GmbH, Moorbruckenstr 30, Postfach 12 65
Tel +49 2572 2020
Fax +49 2572 20289
Direktor:
H Lehmann
Population: 61 000
Vol water supplied: 3*
No. reservoirs: 2
Vol sewage treated: 3.5*
No. sewage plants: 2

Erfstadt, 50374
Stadtwerke, Postfach 2665
Tel +49 2235 40 98 41
Fax +49 2235 40 98 37
Direktor:
E-D Boesche
Population: 37 200
Vol water supplied: 2*
Vol sewage treated: 3.5*
No. sewage plants: 1

Erkrath, 40671
Stadtwerke, Gruitener Str 27, Postfach 1161
Tel +49 2104 430 81-85
Fax +49 2104 430 86
Direktor:
P Schroeder
Population: 49 500
Vol water supplied: 3.1*
No. reservoirs: 3
Vol sewage treated: 2.9*
No. sewage plants: 1

Eschwege, 37269
Stadtwerke, Niederhoner Str 36
Tel +49 5651 807-0
Fax +49 5651 807-45
Director:
Dipl-Ing E Heibert
Population: 24 000
Vol water supplied: 2*
No. reservoirs: 9

Essen 1, 45117
Stadtwerke, Aktiengesellschaft, Ruttenscheider Str 27-37, Postfach 1037 42
Tel +49 2 01 79 93-1
Fax +49 2 01 7 99 33 34
Director:
M Arenz
Population: 605 900
Vol water supplied: 49*

Frankenthal, 67211
Stadtwerke Frankenthal GmbH, Wormser Str. 111, Postfach 2154
Tel +49 6233 602-0
Fax +49 6233 602 115
Geschäftsführer:
Dipl-Ing K Sauer
Population: 70 000
Vol water supplied: 4*
No. reservoirs: 4

Frankfurt (Oder), 15230
Märkische Wasserversorgung und Abwasserbehandlung GmbH, MWA, Oderallee 226
Tel +49 37 30 37 60
Fax +49 37 30-37 61 48
Director:

U Seeger
Population: 706 000
Vol water supplied: 63*

Frankfurt aM, 60021
Stadtwerke, Postfach 10 21 32
Tel +49 69 213-0
Fax +49 69 213-22740
Direktor:
J Wann
Population: 758 310
Vol water supplied: 73.45*

Freiburg, 79020
Freiburger Energie- und Wasserversorgungs AG, Tullastr. 61, Postfach 5369
Tel +49 7 61 2 79-1
Fax +49 7 61 50 82 83
Director:
Dipl-Ing R Funk
Population: 204 100
Vol water supplied: 18*

Friedrichsdorf, 06382
Stadtwerke, Hugenottenstrasse 55/Max-Planck-Str 28
Tel +49 6172 731 226
Fax +49 6172 731 288
Direktor:
G Merkert
Population: 24 400
Vol water supplied: 1*
Vol sewage treated: 1*
No. sewage plants: 1

Fuerth/Bay, 90763
Stadtwerke Furth, Leyher Str 69
Tel +49 9 11 7 04-1
Fax +49 9 11 7 04-4 09
Director:
Dipl-Ing H Staackmann
Population: 102 400
Vol water supplied: 8*

Fulda, 36009
Gas- und Wasserversorgung Fulda GmbH, Rangstr. 10, Postfach 926
Tel +49 6 61 2 99-0
Fax +49 6 61 2 99-1 19
Direktor:
P Solf
Population: 73 000
Vol water supplied: 5*

Garding, 25836
Wasserbeschaffungsverband Eiderstedt, Nordergeestweg 19
Tel +49 4862 1007-0
Fax +49 4862 1007-22
Geschäftsführer:
U Back
Population: 22 000
Vol water supplied: 2.2*
No. reservoirs: 5

Gelsenkirchen, 45809
Gelsenwasser AG, Balkenstr 26, Postfach 1009 44
Tel +49 2 09 7 08-0
Fax +49 2 09 7 08-6 50
Chairman:
P Scherer
Population: 2 648 000
Vol water supplied: 273.5*
No. reservoirs: 13

Gera, 07504
Ostthuringer Wasserversorgung und Abwasserbehandlung GmbH, Gaswerkstrasse 10, Postfach 452
Tel +49 0 37 78-48 70
Fax +49 0 37 78-2 08 33
Director:

*million m³/year

Galfitec

Galvano- und Filtertechnik Güntersberge GmbH

Innovative Engineering

for clean products and a healthy environment

Galfitec Galvano- und Filtertechnik Güntersberge GmbH was founded in 1966 under the name VEB Industrieofen- und Anlagenbau Güntersberge and was privatised in 1992.

The company employs 107 workers for project engineering, manufacturing, construction and servicing of: surface finishing equipment, filter equipment, waste water and waste air treatment, disposal and recycling, environmental equipment (e.g. ground clear systems, fixed-bed reactors, concrete clean and clear systems, microfiltration plants, asbestos abolition systems, waste water systems, separate water processing systems, high pressure cleaners, vacuum evaporators), switch cabinets including software, industrial safety devices and the delivery of chemicals.

Integrated surface systems including sewage and environmental equipment as well as special filter units for liquid media are the main lines of production.

To implement this strategy, there are concrete co-ordination procedures with market leaders for common development activities in the field of environmental engineering. Due to the close co-operation between Galfitec and chemical suppliers, environmental, recycling specialists, experts on sewage and waste air engineering, Galfitec is able to offer a cost favourable system concept which is synchronised in all details.

The ratio between the costs of procurement, operation and waste disposal of Galfitec plants is particularly beneficial. Using Galfitec plants, the customer is able to meet the legally specified limit values of environmental control. The present market share which was gained by an innovative development ensures the turnover required for the economic recovery of Galfitec GmbH.

Increasing and lasting operating results can be reached by constantly improving the product structure and thus decisively decreasing the product costs.

The company has established itself on the market in line with the market leaders.

Georg-Freitag-Straße 160, 06507 Güntersberge, Germany
Tel.: +49 (39488) 205 Fax: +49 (39488) 200

Dipl-Ing H Wolf
Population: 709 900
Vol water supplied: 93*

Geretsried, 82538
Stadtwerke, Kolbenheyerstr 1
Tel +49 8171 9802 0
Fax +49 8171 9820 21
Werkleiter:
Detlef Liss
Population: 25 000
Vol water supplied: 2*
No. reservoirs: 1
Vol sewage treated: 1.6*

Germering, 82110
Stadtwerke Germering, Wasserwerk, Gabriele Hünter Str. 3
Tel +49 89419 225
Fax +49 89419 285
Direktor:
Dipl-Ing R Schmid
Population: 35 000
Vol water supplied: 2.1*
No. reservoirs: 2

Giessen, 35356
Stadtwerke, Lahnstrasse 31, Postfach 1111 49
Tel +49 6 41 7 08-0
Fax +49 6 41 7 08-4 80
Director:
H Hanau
Population: 72 600
Vol water supplied: 6*
No. reservoirs: 5
Vol sewage treated: 6*
No. sewage plants: 1

Giessen, 35359
Zweckverband Mittelhessische Wasserwerke, Teichweg 24, Postfach 1114 20
Tel +49 6 41 50 60
Director:
W Froneberg
Population: 312 000
Vol water supplied: 18*

Gifhorn, 38505
Wasserwerk Gifhorn GmbH, Konrad-Beste-Str 1, Postfach 1510
Tel +49 53 71 802 150
Direktor:
Hans-Jurgen Heinze
Population: 45 000
Vol water supplied: 2.4*

Goettingen, 37028
Stadtwerke Goettingen AG, Hildebrand-Str 1, Postfach 3834/35
Tel +49 5 51 3 01-0
Fax +49 5 51 3 01-201
Vorst Vors Kaufm Vorstand:
N Liekmeier
Techn Verstand:
R Kraft
Population: 133 000
Vol water supplied: 10*
Vol sewage treated: Waste water treatment is by Stadt Göttingen

Grevenbroich 1, 41486
GWG Gas- und Wasserwerk Grevenbroich GmbH, Nordstrasse 36, Postfach 1002 45
Tel +49 21 81 30 01
Director:
H Schikora
Population: 40 500
Vol water supplied: 3*

Griesbach i. Rottal, 94086
Zweckverband Wasserversorgung, Ruhstorfer Gruppe, Schlosshof 1
Tel +49 85 32 20 71
Fax +49 85 32 25 45
Director:
S Hatz
Population: 30 000
Vol water supplied: 2*
No. reservoirs: 5

Gronau (Westf.), 48579
Stadtwerke Gronau GmbH, Laubstiege 19, Postfach 1840
Tel +49 25 62 7 17-0
Fax +49 25 62 7 17 666
Director:
H Burgardt
Population: 40 300
Vol water supplied: 2.2*

Gummersbach, 51624
Der Aggerverband, Sonnenstr 40, Postfach 3402 40
Tel +49 22 61 36-0
Fax +49 22 61 36270
Director:
H Richter
Population: 387 000
Vol water supplied: 25*
No. reservoirs: 3
Vol sewage treated: 31.6*
No. sewage plants: 43

Hagen, 58042
Stadtwerke AG, Hohenzollernstr. 3/7, Postfach 4261
Tel +49 23 31 20 80
Fax +49 23 31 2 08-2 38
Director:
F Tenne
Population: 208 000
Vol water supplied: 14*

Halle (Saale), 06010
Mitteldeutsche Wasser und Abwasser GmbH - MIDEWA - Postfach 200956
Tel +49 345 8730
Fax +49 345 873204
Geschäftsführer:
Dr Ing R Heck
Population: 964 000
Vol water supplied: 74.7*
No. reservoirs: 329
Vol sewage treated: 21.6*
No. sewage plants: 46

Hamburg 26, 20531
Hamburger Wasserwerke GmbH, Billhorner Deich 2
Tel +49 40 78 88-0
Fax +49 40 78 88-25 13
Managing Director:
Dr-Ing H Hames
Population: 1 865 000
Vol water supplied: 136*
No. reservoirs: 20

Hameln, 31760
GWS Stadtwerke Hameln GmbH, Hafenstr 14, Postfach 10 10 44
Tel +49 5151 788-0
Fax +49 5151 788 120
Direktor:
K Arnold
Population: 50 000
Vol water supplied: 4*
No. reservoirs: 2
Vol sewage treated: Stadt Hameln treats the sewage

Hamminkeln-Mehrhoog, 46499
Wasserwerke Wittenhorst, Schillerstr 2
Tel +49 2857 9130-0
Fax +49 2857 9130 30
Geschäftsführer:
Manfred Pröhl
@address:Population: 56 000
Vol water supplied: 3*
No. reservoirs: 3

Hann Münden, 34335
Stadtwerke, Postfach 1530
Tel +49 55 41 70 70
Fax +49 55 41 70 777
Direktor:
Herr Brockhoff
@address:Population: 27 000
Vol water supplied: 1.6*
No. reservoirs: 20

Hannover 1, 30057
Stadtwerke Hannover AG, Ihmeplatz 2, Postfach 5747
Tel +49 511 430 1
Fax +49 511 430 2770
Kaufmännische Direktion:
Dr E Deppe
Technische Direktion:
Dr Hans-Jürgen Ebeling
Population: 769 000
Vol water supplied: 49.5*

Hannover, 30025
Hannover-Braunschweigische Stromversorgungs-AG, Humboldtstr 33, Postfach 2569
Tel +49 511 916-0
Fax +49 511 916-1880
Director:
Dr Dieter Henze
Director:
Horst-Dieter Heuer
Population: 184 000
Vol water supplied: 13.9*

Hassloch, 67454
Gemeindewerke Hassloch, Gottleib-Duttenhöfer-Str 27, Postfach 1251
Tel +49 6324 5994-0
Fax +49 6324 5994-66
Werkdirektor:
Ludwig Schuh
Population: 34 258
Vol water supplied: 1.84*
No. reservoirs: 3
Vol sewage treated: 2.08*
No. sewage plants: 1

Heidelberg, 69045
Stadtwerke AG, Kurfuersten-Anlage 42-50, Postfach 1055 40
Tel +49 62 21 51 30
Fax +49 62 21 51 35 13
Director:
H Conrads
Population: 155 700
Vol water supplied: 13*

Heilbronn a.N., 74076
Stadtwerke Gas u. Wasserwerk, Weipertstr. 49
Tel +49 71 31 56 25 00
Fax +49 71 31 56 25 79
Direktor:
W Grau
Population: 127 000
Vol water supplied: 8*
No. reservoirs: 20
No. sewage plants: 1

Hellenthal, 53938
Wasserverband OLEFTAL, Postfach 86
Tel +49 2482 9500 0
Fax +49 2482 9500 95
Gemeindedirektor:
H Zawada
Population: 36 500
Vol water supplied: 3.4*
No. reservoirs: 46
Vol sewage treated: 3*

Hildesheim, 31106
Harzwasserwerke des Landes Niedersachsen, Postfach 1006 53 / Nikolaistr. 8, 31137 Hildesheim
Tel +49 5121 404-0
Fax +49 5121 404-220
Direktor:
Bauass H Mantwill
Population: Delivery to suppliers
Vol water supplied: 92*
No. reservoirs: 6

Hildesheim, 31113
Stadtwerke AG, Postfach 10 13 41
Tel +49 51 21 5 08-0
Fax +49 51 21 5 08-222
Direktor:
Dipl-Ing W Staudinger
Prokurist:
Dipl-Ing E-A Brandes
Population: 108 000
Vol water supplied: 7*
No. reservoirs: 6
Vol sewage treated: Waste water treatment is by Tiefbauamt der Stadt Hildesheim

Hof (Saale), 95028
Stadtwerke Hof, Unterkotzauer Weg 25
Tel +49 9281 812-0
Fax +49 9281 812290
Direktor, Werkleiter:
Dipl-Ing Manfred Schön
Population: 51 813
Vol water supplied: 4*
No. reservoirs: 3

Horst, 25358
Wasserbeschaffungsverband Krempermarsch, Am Wasserwerk 5
Tel +49 41 21 5 00 61
Fax +49 41 21 52 43
Director:
H Schroeder
Population: 22 700
Vol water supplied: 2.1*
No. reservoirs: 2

Hürth, 50332
Stadtwerke Hürth, Friedrich-Ebert-Str 40, Postfach 15 30
Tel +49 2233 53614
Fax +49 2233 53627
Dipl Finanzwirt:
Christian Meger
Population: 53 000
Vol water supplied: 3.5*
No. reservoirs: 4

Ingolstadt, 85057
Stadtwerke, Ringlerstr 28, Postfach 2830
Tel +49 8 41 8 00
Fax +49 8 41 80-3 09
Director:
Dipl-Ing H Meck
Population: 115 000
Vol water supplied: 9.6*
No. reservoirs: 5
Vol sewage treated: 19.4*
No. sewage plants: 4

Iserlohn, 58638
Stadtwerke GmbH, Stefanstr. 4-8, Postfach 376
Tel +49 23 71 2 17-1
Director:
Dipl-Ing G Meister
Population: 102 600
Vol water supplied: 8*

Jockgrim, 76746
Zweckverband fur Wasserversorgung Germersheimer Sudgruppe, Koerperschaft des Oeffentlichen Rechts, Woerther Str, Postfach 1264
Tel +49 72 71 5 10 03
Fax +49 72 71 52 338
Verbandsvorsteher:
H Seiter
Verbandsdirektor:
H Mühlstädter
Population: 56 000
Vol water supplied: 4*
No. reservoirs: 4

Kaiserslautern, 67605
Stadtwerke, Burgstr. 11, Postfach 1660
Tel +49 6 31 71 07-0
Fax +49 6 31 71 07-3 33
Director:
W Herzog
Population: 102 000
Vol water supplied: 8*

Karlsruhe, 76185
Stadtwerke Karlsruhe, Daxlander Str 72, Postfach 6169
Tel +49 721 599 5001
Fax +49 721 599 5074
Director:
Dipl-Ing J Ulmer, Prof
Population: 270 000
Vol water supplied: 25*
No. reservoirs: 11
Vol sewage treated: 51*

Kassel, 34112
Städtische Werke AG, Postfach 10 36 09
Tel +49 5 1 782-0
Fax +49 561 782-2121
Direktor:
Dipl-Ing Martin Kiok
Population: 202 500
Vol water supplied: 15.4*

Kaufbeuren, 87577
Stadt Wasserwerk, Postfach 1752
Tel +49 83 41 83 64
Fax +49 83 41 1 63 73
Techn Werkleiter:
Klaus Scheidl
Kauf Werkleiter:
Fritz Baumann
Population: 44 034
Vol water supplied: 2.4*
No. reservoirs: 9

Kempen, 47906
Stadwerke Kempen GmbH, Am Bahnhof 8
Tel +49 21 52 14 96-0
Fax +49 21 52 14 96-47
Geschäftsführer:
Herwig Eichelberger
Population: 35 000
Vol water supplied: 2.3*

Kiel, 24040
Stadtwerke Kiel AG, Knooper Weg 75, Postfach 4160
Tel +49 431 594-1
Fax +49 431 594 2348
Direktor:
Dr-Ing Bernd Kregel-Olff
Population: 335 000
Vol water supplied: 21*
No. reservoirs: 18

Koblenz, 56020
Vereinigte Wasserwerke Mittelrhein GmbH, Rathaus, Postfach 2065
Tel +49 2 61 3 70 86-8
Director:
G F Grosser
Population: 151 000
Vol water supplied: 10*

Koenigsbrunn, 86343
Wasserwerk, Marktplatz 7
Tel +49 82 31 60 6-152

*million m³/year

Fax +49 82 31 60 6-161
Director:
Rolf-Peter Reinhardt
Population: 25 000
Vol water supplied: 1.5*
No. reservoirs: 2
Vol sewage treated: 1.4*

Korntal-Muenchingen, 70810
Zweckverband Strohgasu-Wasserversorgung, Postfach 1405
Tel +49 7 11 83 67-0
Fax +49 7 11 83 67-300
Direktor:
Herr Stritzelberger
Population: 31 500
Vol water supplied: 2*
No. reservoirs: 8

Kronach, 96317
Zweckverband Fernwasserversorgung Oberfranken (FWO), Ruppen 30
Tel +49 92 61 50 70
Fax +49 92 61 50 750
Verbandsvorsitzender:
@name:Dr Heinz Köhler
Verbandsdirektor:
Gerhard Seuling
Population: 380 000
Vol water supplied: 12.1*

Köln 30, 50606
Gas-, Elektrizitats- und Wasserwerke Koeln AG, GEW-Koeln AG, Parkgurtel 24, Postfach 1008 90
Tel +49 2 21 1 78-0
Fax +49 1 78-33 22
Director:
G Ludemann
Population: 624 920
Vol water supplied: 53*

Köln 51, 50945
RHENAG, Rheinische Energie AG, Bayenthalguertel 9, Postfach 5109 20
Tel +49 2 21 3 77 70
Fax +49 37 77-1 70
Director:
Dipl-Ing P Kallscher
Population: 157 000
Vol water supplied: 12*

Köln 91, 51076
RGW Rechtsrheinische Gas- und Wasserversorgung AG, In den Reihen 16, Postfach 9106 52
Tel +49 2 21 82 76-1
Fax +49 2 21 82 76-2 05
Director:
V Moritz
Population: 368 000
Vol water supplied: 32*

Lampertheim, 68623
Stadtwerke Lampertheim, Gas- u Wasserversorgung, Industriestr. 40
Tel +49 62 06 9284 0
Fax +49 62 06 5236 1
Werkleiter:
Hans Wetzel
Population: 31 590
Vol water supplied: 2*
Vol sewage treated: 2*
No. sewage plants: 2

Langen, 63206
Stadtwerke Langen GmbH, Liebigstr. 9-11, Postfach 1680
Tel +49 61 03 2 06-0
Fax +49 61 03 2 06-2 20
Direktor:
Dipl-Ing Norbert Breidenbach
Population: 43 600
Vol water supplied: 3*

Langenfeld, 40764
Verbandswasserwerk Langenfeld-Monheim, Langforter Str 7, Postfach 2239
Tel +49 21 73 979-0
Fax +49 21 73 979-179
Director:
Dipl-Ing G Schwarz
Population: 100 000
Vol water supplied: 6.45*
No. reservoirs: 1

Leer/Ostfr., 26789
Stadtwerke Leer GmbH, Hafenstrasse 4, Postfach 1946
Tel +49 4 91 927 700
Geschäftsführer:
Dr Manfred Pühl
Population: 29 100
Vol water supplied: 2*

Leinfelden-Echterdingen 1, 70771
Zweckverband Filderwasserversorgung, Rathaus/Postfach
Tel +49 711 1600 226
Fax +49 711 1600 350
Direktor:
R Haussler
Population: 122 000
Vol water supplied: 7.5*
No. reservoirs: 16

Leinfelden-Echterdingen, 70771
Stadtwerke, Kochenmühlenstr 6, Postfach 10 03 51
Tel +49 711 94786-0
Fax +49 711 94786-30
Kfm Betriebsleiter:
Herr Bocher
Techn Betriebsleiter:
Herr Ambros
Population: 35 000
Vol water supplied: 2*
Vol sewage treated: 2*
No. sewage plants: 2

Leverkusen, 51311
Energieversorgung GmbH, Overfeldweg 23, Postfach 1011 60
Tel Tel +49 2 14 35 80
Fax +49 2 14 35 84 43
Director:
Dip-Kfm Alfons Michels
Population: 161 000
Vol water supplied: 907*

Lippstadt, 59555
Stadt Lippstadt, Ostwall 1
Tel +49 2941 980425
Fax +49 2941 78111
Direktor:
Dr Hagemann
Population: 70 000
Vol water supplied: 3.7*
No. reservoirs: 3
Vol sewage treated: 6.5*
No. sewage plants: 5

Ludwigshafen am Rhein, 67012
Technische Werke Aktiengesellschaft, Industriestr. 3, Postfach 2112 23
Tel +49 6 21 50 5206
Fax +49 6 21 50 5760
Direktor:
M Vogt
Population: 170 00
Vol water supplied: 13.5*

Lübeck, 23558
Stadtwerke, Moislinger Allee 9, Postfach 1406
Tel +49 4 51 8 88-0
Fax +49 4 51 8 88-17 17
Direktor:
Dr K-J Henkel
Population: 222 000
Vol water supplied: 14*
No. reservoirs: 19

Magdeburg, 39104
Magdeburger Wasser- und Abwassergesellschaft mbH, MAWAG, Listemannstr. 14, Postfach 279
Tel +49 0 37 91 5 67 (0)
Fax +49 0 37 91 5 18 16
Director:
Dipl-Ing. R Huebscher
Population: 1 200 00
Vol water supplied: 85*

Mainz 1, 55028
Stadtwerke AG, Rheinallee 41, Postfach 3809
Tel +49 61 31 112
Fax +49 61 31 126 045
Direktor:
H-B Dickmann
Population: 241 500
Vol water supplied: 22*

Mannheim 68159
Energie- und Wasserwerke Rhein-Neckar AG, Luisenring 49, Postfach 2204
Tel +49 6 21 2 90-0
Fax +49 6 21 2 90 2324
Vorständer:
Klaus Curth
Vorständer:
Roland Hartung
Population: 376 000
Vol water supplied: 28*
No. reservoirs: 4

Mannheim 68159
Mannheimer Versorgungs- und Verkehrsgesellschaft mbH (MVV), Luisenring 49, Postfach 2204
Tel +49 6 21 2 90-110
Fax +49 6 21 2 90-2324
Geschäftsführer:
Klaus Curth
Geschäftsführer:
Roland Hartung
Population: 376 000
Vol water supplied: 28*
No. reservoirs: 4

Mannheim 68159
Stadtwerke AG (SMA), Luisenring 49, Postfach 2204
Tel +49 6 21 2 90-0
Fax +49 6 21 2 90-2324
Vorständer:
Klaus Curth
Vorständer:
Dr Hans Schelasky
Population: 338 000
Vol water supplied: 24*

Meiningen, 98617
Sudthuringer Wasserversorgung und Abwasserbehandlung GmbH, Steinweg 23
Tel +49 0 37 6 76-8 70
Director:
M Grahmann
Population: 548 500
Vol water supplied: 55*

Meschede, 59872
Wasserwerk Meschede, Gewebegebiet Enste, Auf'm Brinke 11
Tel +49 291 9920 0
Fax +49 291 9920-18
Werkleiter:
Dipl Ing Robert Dietrich
Population: 33 000
Vol water supplied: 2.4*

Minden, 32388
Stadtwerke GmbH, Hansastr 29, Postfach 3120
Tel +49 5 71 8 86 00-0
Fax +49 5 71 8 86 00-10
Techn. Geschf.:
K Attig
Kaufm Geschäftsführer:
U Stahl
Population: 78 000
Vol water supplied: 4.4*
No. reservoirs: 2

Moerfelden-Walldorf, 64546
Stadtwerke, Kirchgasse 18,
Tel +49 6105 938-822
Fax +49 6105 938-888
Direktor:
Dipl-Ing G Durda
Population: 31 000
Vol water supplied: 2*
No. reservoirs: 3
Vol sewage treated: 2.6*
No. sewage plants: 2

Moers 1, 47441
Stadtwerke GmbH, Uerdinger Str 31, Postfach 2106
Tel +49 28 41 1 04-0
Director:
H - H Eickschen
Population: 100 000
Vol water supplied: 6*

Moers, 47441
Kreiswasserwerk Wesel GmbH, Homberger Str 113, Postfach 1940
Tel +49 28 41 2 05-0
Fax +49 28 41 2 05-670
Direktor:
Dr G Brückner
Population: 55 000
Vol water supplied: 4*
No. reservoirs: 3
Vol sewage treated: 4*
No. sewage plants: 1

Muelheim a.d. Ruhr, 45416
RWW Rheinisch-Westfalische Wasserwerksgesellschaft mbH, Am Schloss Broich 1-3, Postfach 1016 63
Tel +49 2 08 44 33-1
Fax +49 2 08 44 33-2 33
Director:
Dipl-Kfm. Gerd Mueller
Population: 950 000
Vol water supplied: 95*

München 81, 81902
CONTIGAS, Deutsche Energie Aktiengesellschaft, Effnerstrasse 93, Postfach 8102 40
Tel +49 89 92 20 96-0
Director:
Dr K - D Meyer
Vol water supplied: 3*

München, 80287
Stadtwerke, Werkbereich Versorgung Gas- und Wasserversorgung, Badebetriebe, Unterer Anger 3
Tel +49 89 2361 1
Fax +49 89 2361 2019
Werkleiter Versorgung:
Dipl-Ing Enno Ihnken
Population: 1 334 000
Vol water supplied: 132*

Münster, 48043
VEW, Vereinigte Elektrizitätswerke Westfalen AG, Postfach 8060
Tel +49 231 438 1
Fax +49 231 438 2147
Direktor:
F Ziegler
Population: 8 000
Vol water supplied: .351*

Mönchengladbach 41004
Stadtwerke Mönchengladbach GmbH, Postfach 100448
Tel +49 2161 277-0
Fax +49 2161 277-753
Vorsitzer der Geschäftsführung:
Friedhelm Kirchhartz
Population: 266 000
Vol water supplied: 18*
No. reservoirs: 11

Neckarsulm, 74172
Stadtwerke, Hafenstr. 59
Tel +49 71 32 3 52 90
Fax +49 71 32 35-3 63
KWL:
Werner Barels
TWL:
Sigbert Efferberger
Population: 22 000
Vol water supplied: 2.2*
No. reservoirs: 10

Neubrandenburg, 17033
Neubrandenburg Wasser AG, John-Schehr-Str 1-5, Postfach 250
Tel +49 0 37 90 59 80
Director:
Dipl-Ing G Lange
Population: 620 000
Vol water supplied: 62*

Neuss 1, 41460
Stadtwerke, Versorgungs-und Verkehrsbetriebe, Hammer Landstr. 45
Tel +49 2131 90 02
Fax +49 2131 90 8199
Direktor:
Dr R Ludwig
Direktor:
H Runde
Population: 114 000
Vol water supplied: 8.5*

Niebuell, 25894
Zweckverband Wasserversorgung Drei-Harden, Gotteskoogstr 46, Postfach 1406
Tel +49 4661 96 22-0
Fax +49 4661 96 2222
Verbandsvorsteher:
Herr Ewaldsen
Population: 31 000
Vol water supplied: 2.7*
No. reservoirs: 1

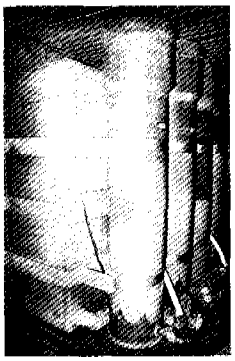
Niederkassel, 53859
Stadtwerke Niederkassel, Rathausstr. 19
Tel +49 22 08 50 20
Fax +49 22 08 73 545
Director:
Franz Haverkamp
Population: 30 500
Vol water supplied: 2*
Vol sewage treated: 1*
No. sewage plants: 1

Nienburg (Weser), 31582
Wasser- und Bodenverband Kreisverband f. Wasserwirtschaft i. Nienburg, Sandstrasse 27
Tel +49 50 21 30 66
Fax +49 50 21 30 60
Verbaudsvorsteher:
Fritz Luehring
Direktor:
Diethard Mücke
Population: 60 000

*million m³/year

BALTIC KLÄR-TECHNOLOGIE GmbH

Lambrechtshäger Weg 2, D-18198 Klein Schwass, Germany
Tel: +49 38 207 229 Fax: +49 38 207 441



Reactor group of a system for 75m³/d sewage (500 people)

Reactor of a system for 225m³/d sewage (1500 people)

Baltic Klär-Technologie GmbH was established in the Federal Republic of Germany in 1993.

The company plans, builds and operates compact sewage plants in modular design.

Biological columnar high capacity reactors developed by the company with a biologically active surface of 20 000m²/m³ carrier material and a fuzzy logic controlled oxygen feed system enable aerobic decomposition capacities of up to 120 kg BOD5 /d per m³ reactor volume.

Using the same technology, sewage from 4 people or 500 litres of sewage/d can be treated.

Because of the consistent modular design, each system can easily be adapted for all required capacity stages at low cost and without any problem.

Performance-enhancing developments from our Research and Technology department are constantly being integrated within a small space.

ATLANTIS

effluent treatment and recycling equipment

ATLANTIS equipment is based on the principle of a multi-stage evaporation and release process, combined with heat recovery. Ideally, the power requirements of the equipment are obtained from heat exchangers or other sources of industrial waste heat i.e. a supply which costs nothing.
A special feature of the new technology is the automatic regulating system of the multi-stage evaporator. This permits the use of heat energy of varying temperature and quantity. It also permits variation in concentration levels (with heat removal) and, more important still, in cleansing capacity.
Thanks to the basic design, the equipment can be used in the most diverse ways, irrespective of the quality and quantity of the water supply. With this process, it is just as easy to deal with heavily polluted industrial effluents (heavy metals, salts, hydrocarbons, phenols, etc) as with complex effluents from household waste dumps (ammonia, organic matter, phenols, heavy metals, carcinogenic substances, etc).
The first low-temperature stage in the treatment of the effluent is generally sufficient to concentrate most of the pollutants (e.g. 95% pure water and 5% liquid concentrate).
In the second stage, a specially developed process is used to convert the liquid concentrate into solid material, irrespective of its chemical composition.
If, for example, the waste water contains volatile substances such as ammonia, a preliminary treatment stage is recommended (to bring about a reduction in the pH level and conversion of the gas into non-volatile ammonium salt). If other volatile substances still remain in the effluent, they can be selectively treated during a subsequent stage. As a rule, however, the residues of such substances in the distillate are extremely low, i.e. below the permitted ceilings.

ATLANTIS
Energie-und Verfahrenstechnik GmbH
Gewerbepark Keplerstr. 26-28
07549 Gera GERMANY
Tel: (0049) 365 710 68 26 Fax: (0049) 365 710 68 27

Vol water supplied: 4*
No. reservoirs: 4
Vol sewage treated: 3*
No. sewage plants: 7

Nürnberg 90247
EWAG Energie- und Wasserversorgung AG, Hochhaus, Am Plaerrer 43, Postfach 8102 20
Tel +49 9 11 27 10
Fax +49 9 11 271-37 80
Director:
Dr Wolfgang Krüg
Population: 519 000
Vol water supplied: 40.02*
No. reservoirs: 3

Nördlingen, 86720
Bayerische Rieswasserversorgung, (K.d.ö.R), Oskar-Mayer-Str 55
Tel +49 9081 2102-0
Fax +49 9081 2102-26
Verbandsvorsitzender:
Paul Kling
Population: 90 000
Vol water supplied: 5.53*
Vol reservoirs: 25.600 m3~super

Oberursel, 61440
Stadtwerke Oberursel (Taunus) GmbH, Lessingstrasse 7-9
Tel +49 61 71 509-0
Fax +49 61 71 509-129
Geschäftsführer:
Jürgen Funke
Population: 45 000
Vol water supplied: 3*
No. reservoirs: 8
Vol sewage treated: 4*
No. sewage plants: 1

Oeversee, 24988
@address:Wasserverband NORD, Wanderuper Weg 23
Tel +49 46 38 8955 0
Fax +49 46 38 8245
Direktor:
H-W Iversen
Population: 82 300
Vol water supplied: 6.3*
Vol sewage treated: 1.5*
No. sewage plants: 28

Offenbach aM, 63067
Energieversorgung AG, Andrestr. 71, Postfach 1004 63
Tel +49 69 80 60-0
Fax +49 69 80 60-4 45
Director:
O Busch
Population: 110 000
Vol water supplied: 8*

Offenbach aM, 63019
Stadtwerke GmbH, Postfach 1019 23
Tel +49 698 00 58-0
Fax +49 698 00 58-1 90/352
Direktor:
Dr Claus Steinberg
Population: 120 000
Vol water supplied: 8.3*
No. reservoirs: 1

Olching, 82140
Zweckverband zur Wasserversorgung der Ampergruppe (WVA), Körperschaft d. öffentlichen Rechts, Hauptstr. 82
Tel +49 8142 302-0
Fax +49 8142 30210
Geschäftsleiter:
Dipl Kfm J Karl
Population: 68 000
Vol water supplied: 4*
No. reservoirs: 2

Oldenburg, 26015
Verkehr und Wasser GmbH, Wasserversorgung, Energieversorgung Weser-Ems AG, Tirpitzstr. 39, Postfach 2540
Tel +49 4 41 8 03-0
Director:
Dr R Berger
Population: 139 000
Vol water supplied: 9*

Osthofen/Rhh., 67568
Zweckverband Wasservergung fur das Seebachgebiet Osthofen, Postfach1562
Tel +49 62 42 5005 0
Fax +49 62 42 5005 46
Direktor:
H J Pfitzmer
Population: 46 000
Vol water supplied: 2.6*
No. reservoirs: 6

Ottweiler, 66558
Wasserversorgung Ost-Saar GmbH, In der Etzwies 6, Postfach 1130
Tel +49 6824 9002-0
Fax +49 6824 6476
Direktor:
R Kuehn
Population: 145 000
Vol water supplied: 6*
Vol reservoirs: 19 000 m3~super

Ottweiler, 66558
Zweckverband Wasserversorgung d. Stadt-u. Land-gemeinden des Kreises Neunkirchen in Ottweiler, In der Etzwies 4, Postfach 1130
Tel +49 68 24 20 75-20 77
Director:
R Kuehn
Population: 145 000
Vol water supplied: 6*

Paderborn, 33054
Stadtwerke Paderborn GmbH, Postfach 24 28
Tel +49 5251 502-0
Fax +49 5251 502-299
Direktor:
H Behringer
Population: 175 000
Vol water supplied: 12*
No. reservoirs: 14

Passau, 94014
Stadtwerke Passau, Postfach 2460
Tel +49 851 560 0
Fax +49 851 560 145
Director:
Dipl-Ing Alois Pohmann
Population: 54 000
Vol water supplied: 4*
No. reservoirs: 14

Peine, 31208
Wasserbeschaffungsverband, Horst 6, Postfach 1820
Tel +49 51 71 58 41-0
Fax +49 51 71 58 41 57
Director:
H A Depner
Population: 149 000
Vol water supplied: 10*

Pforzheim, 75116
Stadtwerke Pforzheim, Sandweg 22
Tel +49 7231 39-0
Fax +49 7231 39-1374
Direktor:
D Brünner
Direktor:
R Dupont
Population: 115 000
Vol water supplied: 8*
No. reservoirs: 30
Vol sewage treated: 17*
No. sewage plants: 1

Poing, 85582
Wasserversorgung Zornedinger Gruppe, Postfach 1366
Tel +49 81 21 701-0
Fax +49 81 21 701-40
Direktor:
R Lauterbach
Population: 51 000
Vol water supplied: 3*

Poppenhausen, 97490
Zweckverband zur Wasserversorgung der Rhoen-Maintal-Gruppe, Bergstrasse 4
Tel +49 97 25 6 80
Fax +49 97 25 68 86
Direktor:
Karl Beck
Population: 82 000
Vol water supplied: 4.45*

Potsdam, 14473
Potsdamer Wasserversorgungs- und Abwasserbehandlungsuntern ehmen GmbH, Friedrich-Engels-Str 22
Tel +49 331 3791-0
Fax +49 331 3791-120
Aufsichtsratvors.:
Bernd Schulze
Geschäftsführer:
Gerd Danneberg
Population: 903 303
Vol water supplied: 79.3*
No. reservoirs: 121
Vol sewage treated: 55.1*
No. sewage plants: 80

Quickborn, 25442
Stadtwerke, Pinneberger Str 2, Postfach 1125
Tel +49 4106 6160
Fax +49 4106 616161
Direktor:
Dipl-Ing Dieter Suck
Population: 27 300
Vol water supplied: 2*
Vol sewage treated: 2*

Ravensburg, 88191
Stadtwerke, Gas- u. Wasserwerk, Georgstr. 25, Postfach 2126
Tel +49 7 51 8 04-0
Fax +49 7 51 80 41 42
Direktor:
Kfm. G Volz
Population: 40 200
Vol water supplied: 2.8*
No. reservoirs: 11
No. sewage plants: 1

Regensburg, 93055
REWAG Regensburger Energie- und Wasserversorgung AG & Co KG, Greflingerstr 22, Postfach 11 05 55
Tel +49 941 7975-0
Fax +49 941 7975-402
Direktor:
Dieter Baldauf
Population: 149 600
No. reservoirs: 2
Vol sewage treated: 11.2*

Remscheid, 42853
Stadtwerke GmbH, Aleestr. 72
Tel +49 21 91 3 60-1
Director:
Dipl-Kfm W Roth
Population: 123 000
Vol water supplied: 8*

Rendsburg, 24756
SCHLESWAG AG, Kieler Str 19, Postfach 260
Tel +49 43 31 2 01-1
Fax +49 43 31 2 01 21 66
Director:
K H Buhse
Population: 103 000
Vol water supplied: 6*

Rhauderfehn-Collinghorst, 26817
Wasserversorgungsverband, Overledingen
Tel +49 52 92 95 0
Fax +49 52 39 60
Direktor:
Herr Reisack
Population: 40 000
Vol water supplied: 2*
No. reservoirs: 2
Vol sewage treated: 2.2*

Rotenburg (W.), 27347
Stadtwerke Rotenburg (Wuemme) GmbH, Mittelweg 19, Postfach 1720
Tel +49 42 61 6 75-0
Fax +49 42 61 6 75-33
Direktor:
Dipl-Ing Peter Möhl
@address:Population: 20 000
Vol water supplied: 1*

Saarbruecken, 66115
Saarbergwerke AG (Wasserwirtschaft), St. Johanner Str 101, Postfach 1030
Tel +49 6 81 4 05-1
Fax +49 6 81 4 05-37 15
Director:
Dr Doerrenbacher
Population: 390 000
Vol water supplied: 12*

Saarbruecken, 66117
Stadtwerke AG, Hohenzollernstr. 104-106, Postfach 408
Tel +49 6 81 58-70
Fax +49 6 81 5 87-22 03
Director:
Dipl-Ing W Leonhardt
Population: 189 000
Vol water supplied: 14*

Salzgitter 38208
Wasser- und Energieversorgungsges. mbH, Albert-Schweitzer-Str 7-11, Postfach 1008 40
Tel +49 53 41 40 80
Fax +49 53 41 40 82 00
Director:
Hagen Reese
Population: 115 000
Vol water supplied: 6*

Salzgitter 38239
Preussag Stahl AG, Eisenhüttenstrasse 99
Tel +49 5341 21 2417
Fax +49 5341 21 2943
Betr Direktor:
Dipl-Ing D Gante
Population: 300 000
Vol water supplied: 36*
No. reservoirs: 3
Vol sewage treated: 15*
No. sewage plants: 1

Schleswig, 24825
Stadtwerke Schleswig, Poststr. 8, Postfach 1445
Tel +49 46 21 80 1-0
Fax +49 46 21 8 01-66
Direktor:
Karl-Heinz Zellinger
Contact:
Günther Erichsen
Population: 28 100
Vol water supplied: 2*
Vol sewage treated: 3.3*
No. sewage plants: 1

Schwaebisch-Gmund, 73509
Stadtwerke, Burgerstr 5, Postfach 1960
Tel +49 71 71 6 03 83
Fax +49 71 71 60 38 99
Director:
Dipl-Ing H-J Jacobi
Population: 62 000
Vol water supplied: 4*
No. reservoirs: 14

Schweinfurt, 97421
Stadtwerke, Bodelschwinghstr. 1
Tel +49 9721 931 0
Fax +49 9721 931 231
Direktor:
Dipl-Ing Dr K Feneberg
Population: 68 555
Vol water supplied: 6.16*
No. reservoirs: 6
Vol sewage treated: 5.6*
No. sewage plants: 1

Schwerin, 19055
Stadtwerke Schwerin GmbH, Bereich Wasser, Bornhövedstr 71, Postfach 345
Tel +49 0 37 84 7 30
Director:
Dipl-Ing G Theile
Population: 529 100
Vol water supplied: 54*

Seevetal 1 (Hittfeld), 21218
Wasserbeschaffungsverband Harburg, Am Schützenplatz 13
Tel +49 41 05 50 04-0
Fax +49 41 05 50 04-42
Direktor:
H Schneemann
Population: 134 500
Vol water supplied: 8.5*
No. reservoirs: 6

Seligenstadt, 63500
Zweckverband Wasserversorgung Stadt. u. Kreis Offenbach (ZWO), Am Bahndamm 2
Tel +49 61 82 89 04-0
Fax +49 61 82 89 04 50
Director:
Dr-Ing W Ribbeck
Population: 320 000
Vol water supplied: 22*

Siegburg, 53707
RHENAG Rheinische Energie AG Werkgruppe Sieg, Bachstr. 3, Postfach 1762
Tel +49 22 411 07-0
Fax +49 22 411 07 388
Director:
Dipl-Ing Wolfgang Fey
Population: 143 000
Vol water supplied: 10*

Siegburg, 53709
Wahnbachtalsperrenverband, Kronprinzenstr 13, Postfach 1933
Tel +49 22 41 128 0
Fax +49 22 41 526 90
Oberkreisdirektor:
F Kühn
Population: 680 000
Vol water supplied: 47.3*
No. reservoirs: 15

Siegen, 57009
Siegener Versorgungsbetriebe GmbH, Morleystr. 29-37, Postfach 1009 09

*million m³/year

Director:
S Heinemann
Population: 112 000
Vol water supplied: 7*

Siegen, 57032
Wasserverband Siegerland, Postfach 2108 53
Tel +49 2 7170 96 0
Fax +49 2 7171 09 8
Manager:
Dipl-Ing H-W Möller
Population: 300 000
Vol water supplied: 18*
No. reservoirs: 25

Solingen, 42601
Stadtwerke, Beethovenstr. 210, Postfach 1001 46
Tel +49 2 12 2 95-0
Fax +49 2 12 29 52 08
Director:
Dipl-Ing. Osenroth
Population: 161 000
Vol water supplied: 13*

Stade, 21660
Stadtwerke GmbH, Hansestr. 18, Postfach 2009
Tel +49 41 41 4 04-0
Fax +49 41 41 4 04 102
Geschäftsführer:
Dipl-Ing. Lueder Scholz
Population: 36 000
Vol water supplied: 2.44*
No. reservoirs: 6

Stuttgart, 70049
Technische Werke der Stadt Stuttgart AG, Lautenschlagerstr. 21, Postfach 1060 38
Tel +49 7 11 2 89-1
Fax +49 2 89-32 20
Director:
Dr-Ing Prof. H Bruederlin
Population: 565 000
Vol water supplied: 53*

Stuttgart, 70511
Zweckverband Bodensee-Wasserversorgung, Hauptstr 163, Postfach 8011 80
Tel +49 7 11 973-0
Fax +49 7 11 973-2280
Techn Geschäftsführer:
Dr-Ing Prof G Naber
Kaufm Geschäftsführer:
Dipl-Volkswirt Schneider
Population: 3 500 000
Vol water supplied: 136.5*
No. reservoirs: 26

Stuttgart, 70048
Zweckverband Landeswasserversorgung, Postfach 1055 52
Tel +49 7 11 2175-0
Fax +49 7 11 2175-202
Tech Director:
Dr-Ing Prof D Flinspach
Administration Director:
E Mueller
Population: 2 500 000
Vol water supplied: 82*

Tecklenburg, 49538
Wasserversorgungsverband Tecklenburger Land, Bahnhofstr. 1, Postfach 1266
Tel +49 54 82 4 74
Director:
H Jacobi
Population: 146 000
Vol water supplied: 7*

Timmendorfer Strand, 23669
Zweckverband Ostholstein, Strandallee 112-114
Tel +49 4503 6030
Fax +49 4503 603285

*million m³/year

Verbandsdirektor:
Hans-Joachim Berner
Population: 110 000
Vol water supplied: 8.4*
No. reservoirs: 8
Vol sewage treated: 4.7*
No. sewage plants: 4

Tirschenreuth, 95634
Zweckverband zur Wasservers. der Steinwaldgruppe, Landratsamt, Postfach 12 49
Tel +49 9631 88328
Fax +49 9631 2391
Direktor:
H Binner
Population: 55 000
Vol water supplied: 1.9*
No. reservoirs: 10

Torgau, 04860
Fernwasserversorgung Elbaue/Ostharz GmbH, Naundorfer Str. 46
Tel +49 3421 757 0
Fax +49 3421 757 235
Geschäftsführer:
Ing Henning Stiewe
Geschäftsführer:
Dipl-Ing Wilfried Foltan
Population: 3 250 000
Vol water supplied: 103*
Vol reservoirs: 640 500 m3-super/d
No of employees 390

Trier, 54224
Stadtwerke, Ostallee 7-13, Postfach 3440
Tel +49 6 51 71 70
Fax +49 6 51 7 71-4 87
Director:
Dipl-Ing P Lipps
Population: 105 000
Vol water supplied: 8*

Uffenheim, 97210
Fernwasserversorgung Franken, Postfach 11 40
Tel +49 9842 938-0
Fax +49 9842 938-150
Landrat:
R Pfeifer
Population: 265 000
Vol water supplied: 17.5*
No. reservoirs: 54

Ulm (Donau), 89028
Stadtwerke Ulm/Neu-Ulm GmbH, Karlstr 1, Postfach 3867
Tel +49 7 31 16 60
Fax +49 1 66-12 09
Direktor:
Dr König
Direktor:
Dr Stuckel
Population: 160 000
Vol water supplied: 14*

Verden (Aller), 27283
Trinkwasserverband Landkreis Verden, Weserstrasse 9a
Tel +49 4231 768 0
Fax +49 4231 768 55
Geschäftsführer:
Dipl-Ing Hans H Zeidler
Population: 104 200
Vol water supplied: 14*
No. reservoirs: 4

Viernheim, 68519
Stadtwerke, Industriestr. 2
Tel +49 62 04 989 0
Fax +49 62 04 989 250
Direktor:
Dipl-Ing H Dhein
Population: 31 495
Vol water supplied: 1.87*
No. reservoirs: 4

Vol sewage treated: 4.66*

Viersen, 41707
Stadtwerke GmbH, Rektoratstr. 18, Postfach 1007 08
Tel +49 21 62 3 71-0
Fax +49 21 62 3 71-1 00
Director:
P Schade
Population: 76 900
Vol water supplied: 6*

Voelklingen-Ludweiler, 66333
Wasserzweckverband Warndt, Am Burgermeisteramt 1
Tel +49 68 98 49 66/67
Fax +49 68 98 43 9804
Verbandsvorsteher:
Wolfgang Flohr
Verbandsvorsteher:
Hans Netzer
Population: 20 000
Vol water supplied: 0.9*

Waiblingen, 71307
Stadtwerke Waiblingen GmbH, Schorndorfer Str 67, Postfach 1747
Tel +49 71 51 1 31-0
Fax +49 71 51 1 31-2 09
Direktor:
Dipl-Ing G Ortloff
Population: 50 000
Vol water supplied: 3.4*
No. reservoirs: 4
Vol sewage treated: Waste water treatment by Stadtbauamt Waiblingen

Waldshut-Tiengen, 79761
Stadtwerke Waldshut-Tiengen, Peter Thumb Str. 1
Tel +49 7741 833 601
Fax +49 7741 833 622
Director:
Kfm K-H Schilling
Population: 21 000
Vol water supplied: 1.47*
No. reservoirs: 33
Vol sewage treated: 1.3*
No. sewage plants: 2

Wegberg, 41844
Kreiswasserwerk Heinsberg Uevekoven, Am Wasserwerk 5
Tel +49 24 34 8070
Fax +49 24 34 807299
Werkleiter:
G Voigtmann
Population: 96 000
Vol water supplied: 5*
Vol reservoirs: 9 500 m3-super

Weil am Rhein, 79576
Stadtwerke Weil am Rhein, Schillerstr 1
Tel +49 7621 70 42 26
Fax +49 7621 70 41 23
Kaufm Werkleiter:
U Gramer
Techn Werkleiter:
U Prötel
Population: 27 000
Vol water supplied: 2*
No. reservoirs: 1
Vol sewage treated: 3*

Weilerbach, 67683
Zweckverband Wasserversorgung Westpfalz, Postfach 54
Tel +49 6374 2088/21 44
Fax +49 6374 4679
BGM:
Herr Habermann
Population: 76 000
Vol water supplied: 4.5*

No. reservoirs: 113

Weinheim, 69469
Stadtwerke Weinheim, Postfach 10 09 47
Tel +49 6201 106-0
Fax +49 6201 106-179
Direktor:
Dipl-Ing E Menzel
Population: 65 000
Vol water supplied: 5*
No. reservoirs: 6

Werdohl, 58777
Stadtwerke, Grasacker 7, Postfach 1740
Tel +49 23 92 917 0
Fax +49 23 92 2078
Direktor:
Dipl-Ing P Stiller
Population: 22 500
Vol water supplied: 1.42*
Vol sewage treated: 1.5*
No. sewage plants: 1

Wermelskirchen, 42929
@address:Stadtwerke GmbH, Berliner Str 135
Tel +49 2196 3003
Fax +49 2196 82480
Direktor:
G Friedrichs
Population: 29 000
Vol water supplied: 1.5*

Wiesbaden, 65045
ESWE-Stadtwerke Wiesbaden AG, Kirchgasse 2, Postfach 5540
Tel +49 61 21 36 91
Fax +49 3 69-53 75
Director:
Dipl-Ing D Sammet
Population: 168 000
Vol water supplied: 20*

Wilhelmshaven, 26382
Stadtwerke, Luisenstr 8
Tel +49 4421 291-0
Fax +49 4421 291-202
Managing Director:
Dipl-Ing G Reiche
Population: 104 000
Vol water supplied: 10*
No. reservoirs: 7

Wilhelmshaven, 26382
Industriewasserversorgungsgesellschaft Nordwest-Niedersachsen mbh, Luisenstr 8
Tel +49 4421 291-0
Fax +49 4421 291-2 02
Geschäftsführer:
Dipl-Ing G Reiche
Population: Industrial use
Vol water supplied: 2*

Wingst, 21789
Wasserbeschaffungsverband Wingst, Hasenbeckallee 3
Tel +49 4778 8080
Fax +49 4778 80850
Geschäftsführer:
Dipl-Ing Alfred Warnke
Population: 34 000
Vol water supplied: 3*
No. reservoirs: 2

Wirges, 56418
Verbandsgemeindewerke Wirges, Wasserversorgung/Abwasserbeseitigung, Postfach 1140
Tel +49 26 02 6 89-1 83
Fax +49 26 02 6 89 277
Director:
G Schwaderlapp
Population: 18 155
Vol water supplied: 1.08*
No. reservoirs: 11
Vol sewage treated: 4.97*

No. sewage plants: 5

Wissen-Niederhoevels, 57537
WKA Zweckverband Wasserversorgung, Krs. Altenkirchen, Wingertshardt
Tel +49 2742 9316 0
Fax +49 2742 9316 16
Direktor:
Dipl-Ing H-D Scharenberg
Population: 89 000
Vol water supplied: 5*
No. reservoirs: 5
Vol sewage treated: 8*
No. sewage plants: 2

Witten, 58412
Stadtwerke GmbH, Ruhrstr. 43, *Postfach 2260*
Tel +49 23 02 1 71-0
Fax +49 23 02 17 12 22
Director:
Kfm J Witte
Population: 113 000
Vol water supplied: 12*

Wolfsburg, 38409
Stadtwerke Wolfsburg AG, Hesslinger Str 1-5, Postfach 1009 54
Tel +49 53 61 1 89-0
Fax +49 53 61 1 89-3 03
Director:
Dipl-Ing J Strickrodt
Population: 102 000
Vol water supplied: 11*

Worms, 67510
Stadtwerke, Klosterstr 16, Postfach 2045
Tel +49 62 41 8 58-0
Fax +49 62 41 8 85 84
Director:
Kfm F Floegel
Population: 106 000
Vol water supplied: 8*

Wuppertal, 42216
Wuppertaler Stadtwerke AG, Bromberger Str 39-41, Postfach 2016 16
Tel +49 2 02 5 69-1
Fax +49 2 02 51 16 03
Director:
Dr-Ing K Sunkel
Population: 444 000
Vol water supplied: 31*

Würzburg, 97018
Stadtwerke AG, Bahnhofstr. 12-18, Postfach 6880
Tel +49 9 31 3 61
Director:
Dipl-Ing K H Utschig
Population: 149 000
Vol water supplied: 12*

Würzburg, 97070
Zweckverband Fernwasserversorgung Mittlemain (FWM), Ludwigstr 3
Tel +49 931 50286
Fax +49 931 50288
Direktor:
Dr G Schreier
Population: 212 000
Vol water supplied: 5*
No. reservoirs: 7

Zirndorf, 90513
Stadtwerke, Schuetzenstrasse 12
Tel +49 9 11 6 08 06-0
Direktor:
Dipl-Ing G Arndt
Population: 25 000
Vol water supplied: 2*

Government departments and regulating bodies

Ministry for Environment and Regional Policy
H-1394 Budapest, PO box 351
Tel +36 1 201 3843
Fax +36 1 201 2846
Director, Dept for Int'l Co-operation: István Tokés

Ministry of Transport, Communications & Water Management
Dob u. 75-81, H 1077 Budapest
Tel +36 1 322 0220
Fax +36 1 322 8695
Deputy State Secretary (water): Dr Bela Hajos

National Water Authority POB 213, H 1410 Budapest
Tel +36 1 201 7405
Fax +36 1 212 0775
General Director: G Kolossvary
Institutes and associations

Institute for Environmental Management
POB 352, H-1369 Budapest
Tel +36 1 1329 940
Fax +36 1 1115 826
Director General: Dr István Endrédy

Water Resources Research Centre Plc (VITUKI Plc)
POB 27, H 1453 Budapest
Tel +36 1 215 2617
Fax +36 1 216 1514
Director General: Dr Ödön Starosolszky

Water suppliers and sewage water treatment/disposal plant

Budapest, H-1056
Budapest Sewerage Works, V Március 15 tér 3
Tel +36 1 118-2866
Fax +36 1 118 1676
Director:
Ferenc Vörös

Budapest, H-1134
Budapest Waterworks, XIII Váci út 23-27
Tel +36 1 140 1342
Fax +36 1 120 9649
Deputy Director General:
Ferenc Szdke
Vol water supplied: 254*
No. reservoirs: 52

Budaörs, H-2040
Pest County Waterworks and Sewerage Company, Komáromi u. 16
Tel +36 1 185 2322
Director:
Béla Doszpod

Békéscsaba, H-5600
Békés County Waterworks & Sewerage Company, Dobozi út 5
Tel +36 66 441255
Fax +36 66 441589
Contact:
Hosszu Szilárd
Population: 291 000
Vol water supplied: 22*
No. reservoirs: 76
Vol sewage treated: 10*
No. sewage plants: 14

Danubian Regional
Waterworks Company
Tel +36 27 11622
Fax +36 27 12199
Director:
Vince Farkas

Debrecen 1, H-4001
Hajdu-Bihar Self Government Waterworks Co, Hetvezer út 21
Tel +36 52 441126
Fax +36 52 442932
General Manager:
Dr László Kovács
Population: 143 500
Vol water supplied: 5*
No. reservoirs: 59
Vol sewage treated: 0.4*
No. sewage plants: 9

Debrecen, H-4025
Debrecen Waterworks and Spas Company, Hatvan u 12-14
Tel +36 52 19488
Fax +36 52 13609
Director:
Dr Nádasdy Gábor
Population: 200 000
Vol water supplied: 20*
No. reservoirs: 8
No. sewage plants: 1

Dunaújváros, H-2400
Dunaújváros Water and Sewerage Works, Épitok útja 7
Tel +36 25 16953
Fax +36 25 13623
Director:
György Neszmélyl
Population: 60 000
Vol water supplied: 5.6*
No. reservoirs: 2

Eger, H-3300
Heves County Waterworks Company, Hadnagy u. 2
Tel +36 36 13633
Director:
Dr Sándor Kovács

Gyula, H-5700
Gyula Waterworks (Gyulai Vizmuvek), Szt László u 16
Tel +36 66 362 377
Fax +36 66 362 647
Director:
Ferenc Kneifel
Population: 34 200
Vol water supplied: 3.3*
No. reservoirs: 6
Vol sewage treated: 2.4*
No. sewage plants: 1

Györ, H-9025
Györ and Vicinity Waterworks and Public Baths Company, Országút 4-6
Tel +36 96 26566
Fax +36 96 10833
Director:
József Déry

Kazincbarcika, H-3700
Eszakmagyarországi Vizmüvek (North Hungary Regional Waterworks Company), Tardonai út 1
Tel +36 48 310811
Fax +36 48 310015
Director:
Jozsef Orban
Population: 650 000
Vol water supplied: 26.5*
No. reservoirs: 6
Vol sewage treated: 2*
No. sewage plants: 12

Kecskemét, H-6000
Bácsviz, North Bács-Kiskun County Waterworks Joint-Stock Company, Izsáki ut 13
Tel +36 76 482 392
Fax +36 76 481 282
Director:
István Szekeres
Financial Director:
Varju Tamas
Population: 195 316
Vol water supplied: 15.6*
No. reservoirs: 37
No. sewage plants: 5

Kiskunhalas, H-6400
South Bács-Kiskun County Waterworks Co., Brinkus Lajos u.1
Tel +36 77 22555
Director:
Dr Péter Nemere

Komló, 7300
Baranya County Waterworks and Sewerage Company, Kossuth L ut 9
Tel +36 72 482414
Fax +36 72 481064
Managing Director:
Dr Zoltán Karancsi
Population: 219 273
Vol water supplied: 8.7*
No. reservoirs: 252
Vol sewage treated: 3.4*
No. sewage plants: 19

Miskolc, H-3527
Miskolc Waterworks, Public Baths and Sewerage Works, I József A.u. 78
Tel +36 46 38740
Fax +36 46 17433
Director:
László Vojtilla

Nagykanizsa, H-8800
South Zala Waterworks, Sewerage and Public Baths Company, Kisfaludi u. 15/a
Tel +36 92 73224
Director:
Antal Kovács

Niskolc, H-3527
Borsod County Waterworks Company, Tömösi u.2.
Tel +36 46 18030
Director:
Gábor Báthori

Nyiregyháza, H-4400
Szabolcs-Szatmár County Waterworks and Sewerage Company, Stadion ut 5
Tel +36 42 14133
Fax +36 42 43537
Director:
Fesztory Tibor
Population: 500 000
Vol water supplied: 13*
No. reservoirs: 200
No. sewage plants: 30

Pécs, H-7601
Pécsi Vizmo, Pf 165
Tel +36 72 314633
Fax +36 72 315684
Director:
Hainess Jenö
Population: 180 000
Vol water supplied: 16*
No. reservoirs: 49
Vol sewage treated: 11*
No. sewage plants: 2

Siófok, H-8600
Transdanubian Regional Waterworks Company, Tanácsház u 7, PO Box 5
Tel +36 84 311-022
Fax +36 84 312-114
General Director:
Imre Szanto
Population: 1 800 000
Vol water supplied: 66*
No. reservoirs: 396
Vol sewage treated: 21*
No. sewage plants: 25

Sopron, H-9400
Sopron és Környéke viz és Csatornamü Vállalat (Sopron and Vicinity Waterworks and Sewerage Company), Sopron Bartók Béla út 42, PF 41
Tel +36 99 314130
Fax +36 99 311380
Director:
Hegedüs László
Population: 100 000
Vol water supplied: 6*
No. reservoirs: 39
Vol sewage treated: 5*
No. sewage plants: 6

Szeged, H-6720
Szeged Waterworks and Public Baths, Tisza Lajos krt 88
Tel +36 62 312 721
Fax +36 62 321 559
General Executive Manager:
Gábor Mészáros
Population: 180 000
Vol water supplied: 24.5*
No. reservoirs: 14
No. sewage plants: 0

Szekestenervar, H-8000
Fejér County Waterworks, Elmunkas u. 5-15
Tel +36 22 315490
Fax +36 22 315598
General Director:
István Kis
Population: 249 000
Vol water supplied: 14.2*
No. reservoirs: 144
Vol sewage treated: 8.61*
No. sewage plants: 9

Szekszárd, H-7100
Tolna County Waterworks and Sewerage Company, Toldi u. 6
Tel +36 74 12611
Director:
János Mayer

Szentes, H-6600
Csongrád County Waterworks and Sewerage Company, Berekhát 11
Director:
Károly Tonnes

Szolnok, H-5000
Tisza Valley Waterworks Company, Kossuth Lajos út 5
Tel +36 56 372 522
Fax +36 56 373 029
General Director:
Mihály Makrai
Population: 484 000
Vol water supplied: 48*
No. reservoirs: 15
Vol sewage treated: 2*
No. sewage plants: 5

Szolnok, H-5000
Szolnok County Waterworks and Sewerage Company, Vizmú út 1
Tel +36 56 44444
Fax +36 56 35705
Director:
Dr Kázmér Kaposvári

Szombathely, H-9700
Vas Megyei Viz- és Csatornamú Vállalat (Vas County Waterworks), Rákóczi F utca 19
Tel +36 94 313480
Fax +36 94 324366
Director:
József Pintér
Population: 270 000
Vol water supplied: 17*
No. reservoirs: 195
Vol sewage treated: 11.5*
No. sewage plants: 8

Tatabánya, H-2800
North Transdanubian Regional Waterworks Company, Sárberek 100
Tel +36 34 311766
Fax +36 34 311595
Director:
Mátyás Sugár
Population: 344 000
Vol water supplied: 18.5*
No. reservoirs: 90
Vol sewage treated: 9.99*
No. sewage plants: 10

Veszprém, H-8200
Veszprém County Waterworks and Sewerage Company, Budapesti út 5
Tel +36 80 23222
Fax +36 80 28061
Director:
József Bendicsek
Population: 240 000
Vol water supplied: 17*
No. reservoirs: 102
No. sewage plants: 9

Zalaegerszeg, H-8900
North Zala Waterworks, Sewerage and Public Baths Company, Balatoni út 8
Tel +36 92 313385
Fax +36 92 311452
Director:
György Bein
Population: 522 000
Vol water supplied: 7.5*
Vol sewage treated: 5*
No. sewage plants: 5

*million m³/year

Government departments and regulating bodies

General Directorate of Public Hygiene
Via Listz 34, 00144 Roma
Tel +39 6 5916 941

Istituto Superiore di Sanita
Viale Regina Elena 299, 00161 Roma
Tel +39 6 49 90
Contact! Prof De Fulvio

Ministero Ambiente
Direzione Servizio Prevenzione Inquinamenti e Risanamento Ambiente,Via Ferratella in Laterano 33, 00153 Roma RM
Tel +39 6 709 6232
Fax +39 6 702 7184
Dirigent Generale! Dott Gianfranco Mascazzini

Ministero della Sanita
(Ministry of Health), Viale dell'Industria 20, 00100 Roma EUR
Tel +39 6 59 94 4205
Fax +39 6 59 94 4256
Acting Director! Dr Biagio d'Alba
Institutes and associations

ANDIS
(Associzione Nazionale d'Ingegneria Sanitaria), Piazza Sallustio 24, 00187 Roma
Tel +39 6 46 91

ANFIDA (Associazione Nazionale fra gli Industriali degli Acquedotti)
Piazza Galeazzo Alessi 2/1, 16128 Genova GE
Tel +39 10 589753/4/5
Fax +39 10 532858
Contact! Avv Angelo Tarditi

ANIDA (Associazione Nazionale Imprese Difesa Ambiente)
Via Vittor Pisani 22, 20124 Milano MI
Tel +39 2 6671 4700
Fax +39 2 6671 4691
General Manager! Dott Francesco Ferrante

Associazione Idrotecnica Italiana
Viale Regina Margherita 239, 00198 Roma
Tel +39 6 440 4493/8
Fax +39 6 440 4493
Secretary General! Dr Ing Pasquale Penta

Federgasacqua
(Federazione Italiana Imprese Pubbliche Gas, Acqua e Varie), Piazza Cola di Rienzo 80/A, 00192 Roma RM
Tel +39 6 6860 3551/3
Fax +39 6 6860 3565
Secretary General! Dr Fulvio Meucci

IRSA, Istituto Ricerche sulle Acque
CNR, Via Reno 1, 00198 Roma RM
Tel +39 6 884 1451
Fax +39 6 841 7861
Director! Prof Ing R Passino

Istituto Superiore Prevenzione e Sicurezza Lavoro
Via Fontana Candida, 0040 Monteporzio Catone, Roma
Tel +39 6 9449 081

UIDA
(Unioni Imprese Difesa Ambiente), Piazza diaz 2, 20123 Milano
Tel +39 2 50 9006

Water suppliers and sewage water treatment/disposal plant

Ancona, AN 60100
Azienda Municipalizzata Servizi, Via Senigallia 18
Tel +39 71 84251
Fax +39 71 871393
Direttore:
Dott Giancarlo Canonici
Population: 140 000
Vol water supplied: 17.5*
No. reservoirs: 29
Vol sewage treated: 8.9*
No. sewage plants: 2

Ascoli Piceno, AP 63100
Consorzio Idrico Intercomunale del Piceno, Via D Alighieri 18
Tel +39 736 2721
Fax +39 736 272247
Segretario Generale:
Dott Lanfranco Magnanimi
Population: 300 000
Vol water supplied: 38*
No. reservoirs: 400

Bari, BA 70121
Ente Aut Acq Pogliese, Via Guiseppe Bozzi 20
Tel +39 80 572 3111
Fax +39 80 523 2217
Direttore Generale:
Dott Alessandro Camassa
Population: 4 722 167
Vol water supplied: 332*
No. reservoirs: 439
No. sewage plants: 167

Bari, BA 70123
Azienda Municipalizzata Gas, Via Accolti Gil
Bergamo, BG 24124
Bergamo Ambiente e Servizi SpA, Via Codussi 46
Tel +39 35 351111
Fax +39 35 231420
Presidente:
Prof Francesco Tagliarini
Direttore Generale:
ing Guglielmo Battaglia
Population: 240 000
Vol water supplied: 34*
No. reservoirs: 14
Vol sewage treated: 24*
No. sewage plants: 1

Bologna, BO 40133
Gestof Com. di Bologna, Via Della Certusa 18
Bologna, BO 40121
COSER, Via Independenza 74

Bologna, BO 40127
ACOSER - Azienda Consorziale Servizi Reno, Viale Berti Pichat 2/4
Tel +39 51 287111
Fax +39 51 250312
Condirettore Generale:
Dott Ing R Drusiani
Population: 819 325
Vol water supplied: 71.11*
No. reservoirs: 896
Vol sewage treated: 4.41*
No. sewage plants: 41

Brescia, BS 25124
ASM - Azienda Servizi Municipalizzati, Via Lamarmora 230
Tel +39 30 3500 1
Fax +39 30 3500 204
Direttore Generale:
Dott ing Pasquale Gavi
Population: 323 000
Vol water supplied: 38.1*
No. reservoirs: 46
Vol sewage treated: 9.2*
No. sewage plants: 18

Brunico, BZ 39031
Azienda Elettrica e Acquedotto Municipalizzata, Anello Nord 19
Tel +39 474 33160
Fax +39 474 553038
Direttore:
Dr ing Norbert Kosta
Population: 11 000
Vol water supplied: 3*
No. reservoirs: 2
No. sewage plants: 1

Campobasso, CB 86100
ERIM (Ente Risorse Idriche Molise), Via A. Depretis 15
Tel +39 874 4201
Fax +39 874 420215
Director:
Dott Ing Matteo Pasquale
Population: 500 000
Vol water supplied: 60*
No. reservoirs: 225

Cantu, CO 22063
Azienda Canturina Servizi M. Li, Via Vittorio Veneto 10
Tel +39 31 712113
Fax +39 31 720511
Direttore:
Ing Giuseppe Stancanelli
Population: 40 000
Vol water supplied: 5*
No. reservoirs: 3

Cassino, FR 03043
Consorzio Acquedotti Riuniti Degli Aurunci, Via G Pascoli 118
Tel +39 776 26623
Fax +39 776 23948/23858
Secretary General:
Dott Giuseppe Parlavecchio
Population: 350 000
Vol water supplied: 25*
No. reservoirs: 550
Vol sewage treated: 15*
No. sewage plants: 30

Castelfranco Ven., TV 31033
Servizi Gas Acquedotto, c/o Comune
Tel +39 423 721155
Fax +39 423 495226
Direttore:
Ing Mario Zuanelli
Population: 29 950
Vol water supplied: 2.25*
No. reservoirs: 3
Vol sewage treated: 2.3*
No. sewage plants: 2

Castelnuovo Rangone, MO 41051
Servizi Com. Gas Acquedotto, c/o Comune
Tel +39 59 535568
Fax +39 59 537203
Direttore:
p i Paolo Montorsi
Population: 10 000
Vol water supplied: 0.9*
No. reservoirs: 2
Vol sewage treated: 1*
No. sewage plants: 1

Chioggia, VE 30015
Azienda Servizi Pubblici, St Mad Na Marina 400
Tel +39 41 554 0748
Fax +39 41 554 0763
Direttore:
Dott Giancarlo Veronese
Population: 55 000-150 000
Vol water supplied: 8*
No. reservoirs: 5
Vol sewage treated: 3*
No. sewage plants: 1

Codigoro, FE 44021
Consorzio Acque Delta Ferrarese, Via Alfieri 3
Tel +39 533 713127
Fax +39 533 712561
Direttore:
Dott Ing Mario Veronesi
Population: 111 581
Vol water supplied: 15*
No. reservoirs: 20

Cuneo, CN 12100
Cons Racc Dep Acque Reflue, Via Basse S Sebastiano 24
Tel +39 171 602047
Fax +39 171 698754
Direttore:
Geom Renato Aimar
Population: 93 000
No. reservoirs: 3
Vol sewage treated: 8*
No. sewage plants: 1

Desio, MI 20063
Azienda Municipalizzata Servizi Pubblici, Via Giusti 38
Tel +39 362 630630
Fax +39 362 308480
Direttore f f:
Frigerio dr Aldo
Population: 34 411
Vol water supplied: 4*
No. reservoirs: 1

Erba, CO 22036
Azienda Servizi Municipalizzati, Via Volta 45

*million m³/year

Tel +39 31 641152
Fax +39 31 610721
Direttore Generale:
Ing Marco Molteni
Population: 16 311
Vol water supplied: 2.36*
No. reservoirs: 6

Faenza, RA 48018
Servizi Comunale Acquadotto, c/o Comune
Tel +39 546 22442
Fax +39 546 665111
Direttore:
Dott Ing P Domenico Casadio
Population: 51 000
Vol water supplied: 3.2*
No. reservoirs: 4
Vol sewage treated: 5*
No. sewage plants: 6

Ferrara, FE 44100
AMGA - Azienda Municipalizzata Gas e Acqua, Via Bologna 13/a
Tel +39 532 762111
Fax +39 532 761330
Director:
Dott Ing A Musacci

Ferrara, FE 44100
Consorzio Acosea, via Marconi 39/41
Tel +39 532 788311
Fax +39 532 54078
Contact:
Ing Ivano Graldi
Population: 250 000
Vol water supplied: 26.3*
No. reservoirs: 31
Vol sewage treated: 20*
No. sewage plants: 71

Finale Emilia, MO 41034
Consorzio Acquedotto Foscaglia-Fontanina, Piazza Verdi 1
Tel +39 535 91985
Fax +39 535 91196
Direttore:
Dott Angelo Masi
Population: 36 000
Vol water supplied: 4.5*
No. reservoirs: 4

Firenze, FI 50123
Consorzio Risorse Idriche, Via Della Scala 91
Tel +39 55 230 2471
Fax +39 55 289 500
Presidente:
Dott Maurizio Mancianti
Population: 600 000
No. reservoirs: 1
Vol sewage treated: 4*
No. sewage plants: 2

Foligno, PG 06034
Azienda Servizi Municipalizzati Foligno, Via IV Novembre 20
Tel +39 742 355258
Fax +39 742 359746
Direttore:
Dott Ing Carlo Marconi
Population: 54 000
Vol water supplied: 4*
No. reservoirs: 59
Vol sewage treated: 6*
No. sewage plants: 12

Forli, FO 47100
Consorzio Acque per le Province di Forli'e Ravenna, P.zza del Lavoro 35,

Tel +39 543 24971
Fax +39 543 25250
Direttore Tecnico:
Ing P P Marini
Population: 900 000
Vol water supplied: 59*
No. reservoirs: 18

Forli, FO 47100
Romagna Acque SpA, Plazza del Lavoro n. 35
Tel +39 543 24971
Fax +39 543 25250
Direttore Generale:
Ing Pier Paolo Marini
Population: 1 000 000
Vol water supplied: 63*
No. reservoirs: 20

Genova, GE 16122
AMGA - Azienda Municipalizzata Gas e Acqua, Via SS Giacomo e Filippo 7
Tel +39 10 83431
Fax +39 10 834 3284
Direttore:
Dott Ing R Bazzano
Population: 400 000
Vol water supplied: 65*
No. reservoirs: 50
Vol sewage treated: 20*
No. sewage plants: 4

Genova, GE 16124
Azienda Com. Trasp. Fun. Cimti, Piazza Della Meridiana 5/R
Tel +39 29 57 48
Fax +39 29 58 89
Population: 690 000

Gorgonzola, MI 20064
Gasdotto & Acquedotto, Via Italia 62
Tel +39 2 957 011
Fax +39 2 953 01230
Direttore:
Dr Giuseppe Morgante
Population: 16 500
Vol water supplied: 2*

Gorizia, GO 34170
Aziende Municipalizzate, Via IX Agosto 15
Tel +39 481 533156
Fax +39 481 532771
Direttore:
Ing Carlo Mistretta
Population: 38 022
Vol water supplied: 10*

Imperia, IM 18100
Azienda Mun Acqua e Trasporti, Piazza Dante 4
Tel +39 183 23760
Fax +39 183 273611
Direttore:
Dott Alberto Vaccari
Population: 200 000
Vol water supplied: 18*
No. reservoirs: 15

Livigno, SA 23030
Azienda Promotines Indistrice, Via dele Jesa 55
Tel +39 342 996008
Fax +39 342 997194
Ufficio Tecnico:
Geom Biancotti
Population: 20 000
Vol water supplied: 3*
No. reservoirs: 5
Vol sewage treated: 1.5*
No. sewage plants: 1

Livorno, LI 57100
Azienda Servizi Municipalizzati, Via Gazometro 9
Tel +39 586 822 511
Fax +39 586 822 632
Direttore:
Dott Alessandro Poli
Population: 244 000
Vol water supplied: 31*
No. reservoirs: 33
Vol sewage treated: 13*
No. sewage plants: 2

Mar. di Pietrasanta, LU 55044
Consorzio Acquedotto, Via Donizetti 16
Tel +39 584 21066
Fax +39 584 745543
Director:
Ing Francesco di Martino
Population: 30 000/120 000
*Vol water supplied: 5**
No. reservoirs: 1

Marina di Carrara, CN 54033
Azienda Municipalizzata Igiene Urbana e Acquedotto, Viale D Zaccagna 18/A
Tel +39 585 788305
Fax +39 585 786578
Direttore:
Dott Ing Roberto Vercelli
Population: 70 000
Vol water supplied: 6*
No. reservoirs: 15

Milano, MI 20121
Acquedotto Comunale, Via Pirelli 39
Tel +39 2 8951 5365
Fax +39 2 8951 5357
Director:
Dott Ing Raimondo Campisi
Population: 1 500 000
Vol water supplied: 270*

Milano, MI 20122
Aziende Energ. Ca Municipale, C. Porta Vittoria 4

Milano, MI 20122
Consorzio Dep. Ne Acque Nord, Viale Maino 7
Tel +39 2 780114
Dott Giovanni di Bella:
+39 2 781419
Population: 735 000
Vol sewage treated: 41.4*
No. sewage plants: 3

Milano, MI 20142
Consorzio per l'Acqua Potabile ai Comuni della Provincia di Milano, Via Rimini 34/36
Tel +39 2 895201
Fax +39 2 846 7444
Segretario Generale:
Dott Cesare Giordano
Population: 1 800 000
Vol water supplied: 250*
No. reservoirs: 850
Vol sewage treated: 36*
No. sewage plants: 350

Modena, MO 41100
Azienda Municipalizzata Comune Modena, Via Cesare Razzaboni 80
Tel +39 59 407111
Fax +39 59 407040
Direttore:
Ing Paolo Barozzi
Population: 176 000
Vol water supplied: 23*
No. reservoirs: 7

Monza, MI 20052
Azienda Municipale Acqua Gas, Via Bergamo 21
Tel +39 39 839117
Fax +39 39 380356
Direttore:
Ing Mario Valera
Population: 125 000
Vol water supplied: 18.5*
No. reservoirs: 1

Mozzanica, BG 24050
Servizi Comunale Gas, c/o Comune
Tel +39 363 321177
Fax +39 363 828122
Sindaco:
Giovanni Carlo Capetti
Population: 3522
Vol water supplied: 0.3*
No. reservoirs: 1
Vol sewage treated: 0.2*
No. sewage plants: 1

Napoli, NA 80138
AMAN - Azienda Municipalizzata Acquedotto, Via Constantinopoli 98
Tel +39 81 459634
Director:
Ing Giacinto Lo Prejato

Novi Ligure, AL 15067
Azienda Municipalizzata Gas, Via Trieste 8

Parma, PR 43100
AMNU Servizi Dep. A.Re., Via le Piacenza 6

Parma, PR 43100
Azienda Municipalizzata Pubbl. Servizi, Via S Margherita 6/A
Tel +39 521 248306
Fax +39 521 248310
Dirigente:
Dott Luigi Morestori
Population: 170 000
Vol water supplied: 30*
No. reservoirs: 7

Parma, PR 43100
Cons Parm Appr Acq Pot, Via Verdi 14
Tel +39 521 289923
Fax +39 521 281310
Segretario Facenti Funzioni:
Dr Ferdinando Bussolati
Population: 110 000
Vol water supplied: 6.5*
No. reservoirs: 2

Perugia, PG 06100
Cesap Costr Acq Perugia, Strade di S Lucia
Tel +39 75 756141
Fax +39 75 755110
Direttore:
Ing Roberto Bacoccoli
Population: 300 000
Vol water supplied: 35*
No. reservoirs: 55
Vol sewage treated: 10.2*
No. sewage plants: 4

Pesaro, PS 61100
Azienda Municipalizzata Gas Acqua, Via Lazzaretto 32
Tel +39 721 65240/65340
Fax +39 721 370186
Direttore:
Ing Ivo Monteforte
Population: 180 000
Vol water supplied: 19*
No. reservoirs: 46
Vol sewage treated: 7*
No. sewage plants: 6

Prato, FI 50047
CONSIAG - Azienda Consorziale Acqua e Gas, Via F Targetti 26
Tel +39 574 4571
Fax +39 574 457499
Direttore:
Dott Ing Claudio Morosi
Population: 415 000
Vol water supplied: 26.5*
No. reservoirs: 50
Vol sewage treated: 0.4*
No. sewage plants: 3

Reggio Emilia, RE 42100
AGAC - Azienda Gas Acqua Consorziale, Via Gastinelli 12
Tel +39 522 2971
Fax +39 522 286246
Direttore:
Ing Uris Cantarelli
Population: 423 397
Vol water supplied: 31.29*
No. reservoirs: 509
Vol sewage treated: 51.83*
No. sewage plants: 53

Rimini, FO 47037
Azienda Municipalizzata Industriale, Via D. Campana 65
Tel +39 541 772350
Fax +39 541 777550
Director:
Ing Giorgio Giuliani
Population: 145 000
Vol water supplied: 18*
No. reservoirs: 10

Roma, RM 00153
ASCOROMA, Lungotevere Sanzio 15

Roma, RM 00153
Pubblitechnica S.p.A, Via di Porta Lavernale 26

Roma, RM 00154
ACEA - Azienda Comunale Energia e Ambiente, Piazzale Ostiense 2
Tel +39 6 57991
Fax +39 6 5758095
Director:
Prof Ing P Martini

Roma, RM 00198
Cons. Acquedotto Simbrivio, Via Dora 2

Rovereto Trentino, TN 38068
Azienda Servizi Municipalizzati, Via Manzoni 24
Tel +39 464 433454
Fax +39 464 434120
Direttore:
Dott ing Walter Giordani
Population: 40 000
Vol water supplied: 6*
No. reservoirs: 15

Rovigo, RO 45100
Azienda Servizi Municipalizzati, Via D Alighieri 4
Tel +39 425 33322
Fax +39 425 410219
Dirigente Tecnico:

*million m³/year

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The heart of the system is the special filtering bag. The bags are mounted on a special stainless steel frame, designed to optimise sludge distribution into the bags.
The system is controlled by a programmable electric panel, ensuring correct process operation.
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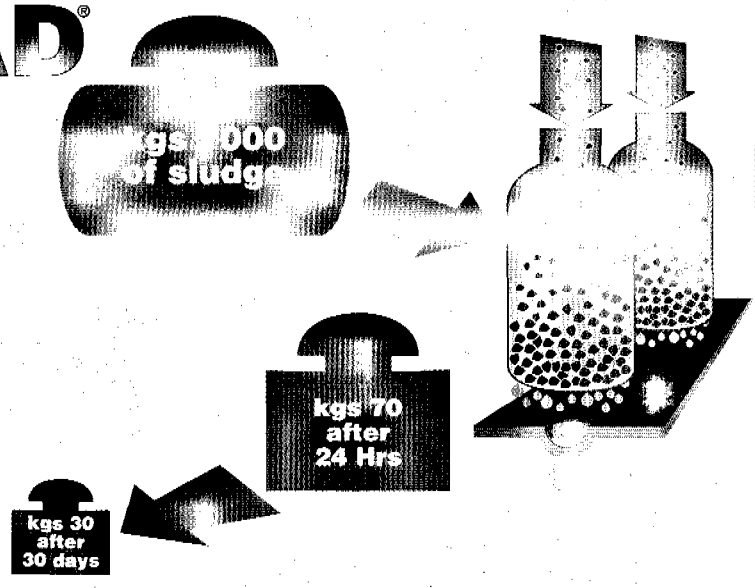
This system is suitable for sludge quantities up to 30m3/day.



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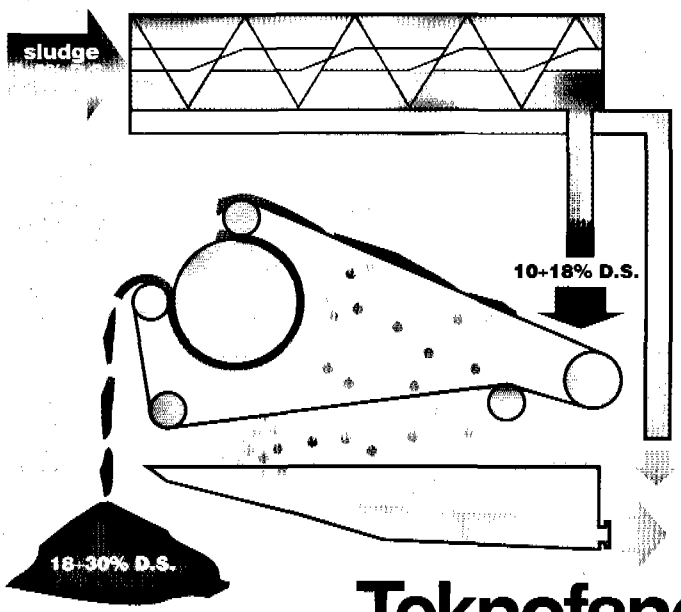

For large applications, Teknofanghi has patented a new generation of belt presses named Monobelt. The unit comprises a pre-thickener and a single belt filter press.
The initial solid/liquid separation takes place in the pre-thickener, where sludge concentrations are raised from 1-3% to 10-18% D.S. The pre-thickened sludge is then distributed onto the single filter belt by means of a series of baffles.
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acea AZIENDA COMUNALE ENERGIA & AMBIENTE

Acea, a company responsible for running the capital city's major public energy, water and environmental services, was set up in 1909 as a Municipal Electricity Corporation, but on taking over the water service and other activities it was first changed into the Municipal Water and Electricity Corporation and in 1989 was given its present name of Municipal Corporation for Energy and Environment.

RESOURCES

Acea has 4,200 employees, an annual turnover of 1,000 billion lire and invests annually a figure of about 250 billion lire.

Acea has four large interlinked aqueducts and a water network with 5,400 kilometres of pipes linked to seventy stations in order to ensure that the water is drinkable at all times. The drinking water distributed in Rome comes almost exclusively from springs and guarantees a daily supply of 500 litres per head and a total output of 17,000 litres per second. A further 2,000 litres per second of non-drinking water are supplied by three ancient aqueducts. Acea also supplies water to over 50 municipalities in the vicinity.

Since 1985 Acea has been responsible for depurating waste water coming from the city's sewerage network and a part of the sewerage network itself. By operating four large depurators and further minor plants, over 400 million cubic metres of waste water are treated, thus accounting for about 70% of the city's waste water and 85% of the water to the plants themselves. Acea also has a fully equipped chemical and bacteriological laboratory for controlling the quality of drinking water and the efficiency of depuration and purification installations. The laboratory also carries out any examinations required in order to control the quality of water purified by minor water companies in the Latium region, as well as analyses on the quality of the water of the river Tiber.

A · C · E · A
PIAZZALE OSTIENSE 2
ROMA 00154, ITALY
TEL: 39 6 57991 FAX: +39 6 57994146

Ing Stefano Back
Capo Servizio:
Ing Francesco Pasqualini
Population: 52 000
Vol sewage treated: 5*
No. sewage plants: 3

Rubano (Padova) 35030
Consorzio Acquedotto Euganeo Berico, Via Galvani 1/A
Tel +39 35 444 822100
Presidente:
Dott Renzo Padovan
Population: 140 000
Vol water supplied: 13*
No. reservoirs: 21

S. Giuliano Mil. Se., MI 20098
Azienda Servizi Municipalizzati, Via Resistenza 5
Tel +39 2 984 4315/6
Fax +39 2 984 4316
Contact:
Ing Gianpaolo Ciprian
Population: 33 000
Vol water supplied: 5.5*

Sanremo, IM 18038
Azienda Aut Acq Impianti El, Via Nino Bixio 5
Tel +39 184 5831
Fax +39 184 573141
Direttore:
Dr ing Nicola Cavaliere
Population: 80 000
Vol water supplied: 22*
No. reservoirs: 33

Schio, VI 36015
Servizi Acqua Gas di Schio, c/o Comune
Tel +39 445 691311
Fax +39 445 531075
Direttore:
Arch Agostino Toniolo
Population: 36 000
Vol water supplied: 4*
No. reservoirs: 25
Vol sewage treated: 3.5*
No. sewage plants: 1

Selvino, BG 24020
Azienda Mun *Idroelettrica ed* Acquedotto Selvino, Corso Milano 19
Tel +39 35 763524
Fax +39 35 763624
Direttore:
P E Bertocchi Pierangelo
Population: 5750
Vol water supplied: 0.6*
No. reservoirs: 5

Seriate, BG 24068
Consorzio Servizi Bacino del Serio, via Machiavelli 1
Tel +39 35 294257
Fax +39 35 301305
Direttore Generale:
Dott Ing Marco Milanesi
Population: 132 000
Vol water supplied: 15.5*
No. reservoirs: 15

Stradella, PV 27049
Azienda Cons Acq Oltrepo Pav, Via Nazionale 53
Tel +39 385 245200
Fax +39 385 43978
Direttore:
Dr Ing Francesco Girmenia
Population: 60 000
Vol water supplied: 5*
No. reservoirs: 86

Terni, TR 05100
Azienda Servizi Municipalizzati, Via S. Antonio 3
Tel +39 744 3911
Fax +39 744 391306
Contact:
Mauro Latini
Population: 120 000
Vol water supplied: 15*
No. reservoirs: 48

Tolentino, MC 62029
Azienda Spec Servizi Municipalizzati, Corso Garibaldi 78
Tel +39 733 968030
Fax +39 733 974195
Direttore:
Ing Pietro Pisciotta
Population: 18 000
Vol water supplied: 1.8*
No. reservoirs: 8

Torino, TO 10122
Citta di To Servizi Cim., Via Giulio 22

Torino, TO 10123
Azienda Po-Sangone, Via Pomba n. 29
Tel +39 11 5151 1
Fax +39 11 5151 207
Direttore Generale:
Ing Paolo Romano
Population: 3 000 000
Vol sewage treated: 202*
No. sewage plants: 1

Trento, TN 38100
S.I.T. SpA, Via Alfieri 2
Tel +39 461 217721
Fax +39 461 234728
Presidente:
Dott Marco Giovannini
Population: 100 000
Vol water supplied: 18*
No. reservoirs: 40

Trieste, TS 34121
Azienda Com. Elettrica Gas Acqua, Via Genova 6

Trieste, TS 34122
Servizi Trasporti Funebri, Via Della Zonta 7/C

Udine, UD 33100
Azienda Municipalizzata Gas Acqua, Via Trento 6

Udine, UD 33100
Cons per l'Acquedotto del Friuli Centrale, Via Duchi D'Aosta 2
Tel +39 432 517311
Fax +39 432 505379
Segretario Generale:
Dott Tommaso Olivieri
Population: 300 000
Vol water supplied: 45*
No. reservoirs: 53

Venezia, VE 30135
ASPIV - Azienda Servizi Pubblici Idraulici e Vari, S Croce 494
Tel +39 41 521 8111
Fax +39 41 521 8260
Direttore Generale:
Ing Antonio Rosa
Vol water supplied: 63.9*
No. reservoirs: 21
Vol sewage treated: 53.1*
No. sewage plants: 4

Verona, VR 37133
Azienda Gen. Servizi Municipalizzati, Lungad. Galtarossa 8
Tel +39 45 867 75 11
Fax +39 45 867 75 03
Direttore Generale:
Dott Ing Augusto Severi
Population: 280 000
Vol water supplied: 55*
Vol sewage treated: 28*

Viareggio, LU 55049
Azienda Municipalizzata Acquedotto e Gas, Via XX Settembre 3
Tel 39 584 962742-3
Fax +39 584 963939
Direttore:
Dott Ing Amedeo Angeli
Population: 60 000
Vol water supplied: 7*
No. reservoirs: 2
Vol sewage treated: 7*
No. sewage plants: 1

Vignola di Modena, MO 41058
Servizi Com. Gas Acqua, Via Bellucci 1
Tel +39 59 777503
Fax +39 59 764129
Ingegnere:
Norberto Carboni
Population: 20 104
Vol water supplied: 1.5*
No. reservoirs: 3
Vol sewage treated: 2*
No. sewage plants: 1

Villanova Marchesana (RO) 45030
Cons Acquedotto M Polesine, Via Abbazia 14
Tel +39 425 770939
Fax +39 425 770609
Direttore Amm/vo:
Rag Renzo Rigolin
Direttore Technico:
Pl Giuseppe Crepaldi
Population: 13 215
Vol water supplied: 1.3*
No. reservoirs: 4
No. sewage plants: 6

Zocca, MO 41059
CO.I.ME.PA. (Consorzio Intercomunale Metanodotto Panaro)
Via Mauro Tesi N. 963
Tel +39 59 986201
Fax +39 59 986445

*million m³/year

Government departments and regulating bodies

Ministerie van Verkeer en Waterstaat, Rijkswaterstaat
(Ministry of Transport, Public Works and Water Management), Directorate-General for Public Works and Water Management, Postbus 20906, 2500 EX Den Haag
Tel +31 70 3745 745
Fax +31 70 3744 335
Minister: Mrs A Jorritsma-Lebbink
Director-General: Mr G Blom

Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer
(Ministry of Housing, Physical Planning and Environment), Postbus 30945/IPC 630, 2500 GX Den Haag
Tel +31 70 3394 279
Fax +31 70 3391 317
Minister: Mrs M de Boer
Section head, water: A G van Malenstein
Dir of Int Environment Affairs, head: Prof drs W J Kakebeeke

National Institute for Coastal and Marine Management/RIKZ
Postbus 20907, 2500 EX 's-Gravenhage
Tel +31 70 311 4311
Fax +31 70 311 4321
Contact: Library

RIZA
Institute for Inland Water Management and Waste Water Treatment, Postbus 17, 8200 AA Lelystad
Tel +31 3200 70411
Fax +31 3200 49218
General Director: Prof dr J de Jong

Institutes and associations

IRC International Water and Sanitation Centre
Postbus 93190, 2509 AD 's-Gravenhage
Tel +31 70 3314 133
Fax +31 70 3814 034
Director: Drs J M G van Damme

KIWA
(The Netherlands Waterworks' Testing and Research Institute), Postbus 70, 2280 AB Rijswijk
Tel +31 70 395 3535
Fax +31 70 395 3420
Principal Director: dr E J M Kobus

Nederlandse Vereniging voor Waterbeheer NVA
(Netherlands Association for Water Management), Sir Winston Churchill-laan 273, Postbus 70, 2280 AB Rijswijk
Tel +31 70 395 35 35
Fax +31 70 395 34 20
Chairman: ir A W van der Vlies
Secretary: dr ir H H Tolkamp

RIVM
(Governmental Institute for Public Health and Environmental Hygiene), Postbus 1, 3720 BA Bilthoven

Unie van Waterschappen
(Union of Water Boards), Postbus 80200, 2508 GE Den Haag
Tel +31 70 3519 751
Fax +31 70 3544 642
Director: dr ir E E Bolhuis
General Director: Eppo Bolhuis

VEWIN
(The Netherlands Waterworks Association), Postbus 70, 2280 AB Rijswijk
Tel +31 70 395 3535
Fax +31 70 395 3420
Director: Th G Martijn

VVW
Vakorganisatie voor Watertechnologie, Scheveningsweg 52, Postbus 5200, Den Haag

VWN
(Association of Netherlands Water Engineers), Postbus 70, 2280 AB Rijswijk
Tel +31 70 395 3535
Fax +31 70 395 3420
Chairman: ir J Th H Koelink

Water suppliers and sewage water treatment/disposal plant

Water undertakings

DRENTHE

NV Waterleiding-maatschappij, Overcingellaan 19, 9401 LAM Assen; Postbus 18, 9400 Assen
Tel +31 5920 11727
Fax +31 5920 15259
Director:
ir W G Beeftink
Population: 394 600
Vol water supplied: **34.2***

FLEVOLAND

Lelystad
Flevolandse NV, Drinkwater Maatschappij Grietenij 17-05, 8233 BP Lelystad; Postbus 1090, 8200 BB Lelystad
Tel +31 3200 59211
Fax +31 3200 59299
Managing Director:
ir E J J Cals
Population: 200 000
Vol water supplied: 13*
No. reservoirs: 4

FRIESLAND

NV Waterleiding, Zaailand 106, 8911 BN Leeuwarden; Postbus 400, 8901 BE Leeuwarden
Tel +31 58 945594
Fax +31 58 945300
Director:
ir J C van Winkelen
Population: 599 000
Vol water supplied: **45.8***

GELDERLAND

Arnhem/Renkum
NV NUON, Distributiebedrijf Arnhem, Utrechtseweg 68, 6812 AH Arnhem
Tel +31 85 574111
Fax +31 85 574100
Manager:
Ir H van Vulpen
Population: 130 200
Vol water supplied: **11.8***
No. reservoirs: 8

Gelderland
NV Waterleiding-maatschappij, Arnhemsestraatweg 29, 6881 NC Velp; Postbus 23, 6880 BC Velp
Tel +31 85 690111
Fax +31 85 648444
Director:
Ir P W Langendijk
Vol water supplied: **52.2***

Nijmegen
Zuidgelderse Nutsbedrijven NV, Winselingseweg 10, 6541 AK Nijmegen; Postbus 120, 6500 AC Nijmegen
Tel +31 80 719111
Fax +31 80 783165
Director:
Ir J Mol
Population: **144 700**
Vol water supplied: 12.9*
No. reservoirs: **4**

Oostelijk Gelderland
NV Waterleidingmij, Terborgseweg 136, 7005 BD Doetinchem; Postbus 15, 7000 AA Doetinchem
Tel +31 8340 28111
Fax +31 8340 28234
Director:
ir J Bruyn
Population: **461 600**
Vol water supplied: **36.9***

Veluwe, Apeldoorn
NV NUON VNB, Deventerstraat 46, 7311 LX Apeldoorn; Postbus 250, 7300 AG Apeldoorn
Tel +31 55 285590
Fax +31 55 285505
Chairman:
ir W M Harinck
Director:
ir A J R Feijen
Population: **450 000**
Vol water supplied: **27.2***
No. reservoirs: 10

GRONINGEN

NV Waterleiding-maatschappij voor de provincie, Phebensstraat 1, 9711 BL Groningen; Postbus 24, 9700 AA Groningen
Tel +31 50 182311
Fax +31 50 122534
Director:
Ir J Th H Koelink
Population: 396 700
Vol water supplied: **32.6***

Groningen and Drenthe
Gemeentelijk Waterbedrijf, Van Kerckhoffstraat 2, 9714 BN Groningen; Postbus 1554, 9701 BN Groningen
Tel +31 50 678090
Fax +31 50 716536
Director:
Ir M J Smit
Population: 157 000
Vol water supplied: **13.2***
No. reservoirs: 3

LIMBURG

Limburg
NV Waterleiding Maatschappij-, Prins Bisschopsingel 2, 6211 JX Maastricht; Postbus 1060, 6201 BB Maastricht
Tel +31 43 282828
Fax +31 43 253230
Director:
drs J P B Huberts
Population: 1 025 000
Vol water supplied: **80***
No. reservoirs: 100

NOORD-BRABANT

's-Hertogenbosch
NV Regionaal Nutsbedrijf, paardskerkhofweg 14, 5223 AJ 's-Hertogenbosch; Postbus 400, 5201 AK 's-Hertogenbosch
Tel +31 73 292911
Fax +31 73 292319
Director:
Ir M van den Boomen
Population: 157 000
Vol water supplied: 12.3*
No. sewage plants: 2

Brabantse Biesbosch
NV Waterwinningbedrijf Brabantse Biesbosch, Postbus 61, 4250 DB Werkendam
Tel +31 1835 2144
Fax +31 1835 4906
Director:
drs G Oskam
Population: 1 500 000

*million m³/year

Vol water supplied: 170*
No. reservoirs: 3

Eindhoven
NV Nutsbedrijf Regio-Eindhoven, Nachtegaallaan 15, 5613 CM Eindhoves 2005, 5600 CA Eindhoven
Tel +31 40 389333
Fax +31 40 444107
Director:
drs N W van Heeswijk
Population: 250 000
Vol water supplied: 27.1*
No. reservoirs: 6

Noord-West Brabant
NV Waterleiding Maatschappij, Doornboslaan 37, 4816 CZ Breda; Postbus 3444, 4800 DK Breda
Tel +31 76 791791
Fax +31 76 791400
Director:
drs G J van Nuland
Population: 780 000
Vol water supplied: 73*
No. reservoirs: 12

Oost-Brabant
NV Waterleidingmaatschappij, Verwersstraat 64, 5211 HX 'Hertogenbosch; Postbus 1068, 5200 BC 's-Hertogenbosch
Tel +31 73 875911
Fax +31 73 875710
Director:
ir W Visscher
Population: 950 000
Vol water supplied: 82*

Tilburg and Goirle
NV Tilburgsche Waterleiding-Maatschappij, Bredaseweg 207, 5038 NE Tilburg; Postbus 158, 5000 AD Tilburg
Tel +31 13 352325
Fax +31 13 352321
Managing Director:
ir LMJI Stok
Population: 182 344
Vol water supplied: 13.3*
No. reservoirs: 7

West-Brabant
NV Waterleidingmaatschappij, Noord West Brabant, Postbus 3444, 4800 DK Breda
Tel +31 076 791791

NOORD-HOLLAND

Amsterdam
Gemeentewaterleidingen, Condensatorweg 54, 1014 AX Amsterdam; Postbus 8169, 1005 AD Amsterdam
Tel +31 20 580 2911
Fax +31 20 684 1991
Managing Director:
ir M K H Gast
Population: 720 100
Vol water supplied: 92*
No. reservoirs: 10

Noord-Holland
NV PWN Waterleidingbedrijf Noord-Holland, Essenlaan 10, 2061 GB Bloemendaal; Postbus 5, 2060 BA Bloemendaal
Tel +31 23 223344
Fax +31 23 256105
Managing Director:
ir EGH Vreedenburgh
Population: 1 200 000
Vol water supplied: 82.4*
No. reservoirs: 11

Rijn-Kennemerland NV
Watertransportmaatschappij, Kabelweg 21, (Einsteingebouw), 1014 BA Amsterdam; Postbus 8614, 1005 AP Amsterdam
Tel +31 20 580 2355
Fax +31 20 688 1641
President-Director:
ir M K H Gast
Population: 2 500 000
Vol water supplied: 136*

Zuid-Kennemerland
Waterleidingbedrijf Zuid-Kennemerland NV, Stephensonstrat 38, 2014 KD Haarlem; Postbus 6085, 2001 HB Haarlem
Tel +31 23 240424
Fax +31 23 247492
Director:
ir J Louwe Kooijmans
Population: 240 600
Vol water supplied: 15.6*
No. reservoirs: 7

OVERIJSSEL

Almelo and Oldenzaal
Gemeentelijk Waterleidingbedrijf, Rohofstraat 83, 7605 AT Almelo; Postbus 71, 7600 AB Almelo
Tel +31 546 836 666
Fax +31 546 811 267
Director:
Ir J A de Keuninck
Population: 100 000
Vol water supplied: 10*

Enschede/Hengelo
NV Waterleidingbedrijf Oost-Twente, Weth Beversstraat 185, 7543 BK Enschede; Postbus 221, 7500 AE Enschede
Tel +31 53 826900
Fax +31 53 307143
Director:
Ing H G Bruinings
Population: 225 000
Vol water supplied: 15*

Overijssel NV
Waterleiding-maatschappij, Oude Veerweg 1, 8019 BE Zwolle; Postbus 10005, 8000 GA Zwolle
Tel +31 38 276111
Fax +31 38 276276
Director:
Ir H Lemstra
Population: 772 000
Vol water supplied: 69*
No. reservoirs: 50

UTRECHT

Midden-Nederland
NV Waterleidingbedrijf Midden-Nederland (WMN), Reactorweg 47, 3542 4, 3500 GC Utrecht
Tel +31 30 487211
Fax +31 30 414955
Director:
Ir F A van Dam
Population: 1 132 600
Vol water supplied: 82*
No. reservoirs: 18

ZEELAND

Zuid-West Nederland
NV Delta Nutsbedrijven, Postbus 5048, 4330 KA Middelburg;
Poelendaelesingel 10, 4335 JA Middelburg
Tel +31 1180 92111
Fax +31 1180 38818
General Director:
ir P Stoter
Population: 444 560
Vol water supplied: 50.0*

ZUID-HOLLAND

Meerkerk
Drinkwaterleiding de Alblasserwaard en de Vijfheerenlanden NV, Burg Sloblaan 20, 4231 AB Meerkerk; Postbus 4, 4230 BA Meerkerk
Tel +31 1837 6600
Fax +31 1837 6606
Director:
A B I M Vos de Wael
Population: 187 100
Vol water supplied: 14.2*

Oost-IJsselmonde
Waterleidingbedrijf, Kievitsweg 123, 2983 AD Ridderkerk; Postbus 262, 2980 AG Ridderkerk
Tel +31 1804 60200
Fax +31 1804 12677
Director:
ing J Smit
Population: 107 200
Vol water supplied: 7.5*

Rijnland
NV Energie- en Watervoorziening-, Langegracht 70, 2312 NV Leiden; Postbus 111, 2300 AC Leiden
Tel +31 71 240240
Fax +31 71 240251
Director General:
H J Groen
Population: 411 800
Vol water supplied: 28.2*

Rotterdam and surroundings
NV Waterbedrijf Europoort, Zuiderparkweg 300, 3085 BW Rotterdam; Postbus 59 999, 3008 RA Rotterdam
Tel +31 10 293 50 00
Fax +31 10 293 59 80
President Director:
Ing C J Willems
Population: 1 500 000
Vol water supplied: 150*
No. reservoirs: 6

Tien Gemeenten
NV Duinwaterbedrijf Zuid-Holland, District De Tien Gemeenten, Postbus 34, 2270 AA Voorburg, Stationsplein 4, 2275 AZ Voorburg
Tel +31 70 357 75 00
Fax +31 70 387 18 94
Director:
Drs P Jonker
Population: 184 900
Vol water supplied: 15*

Vlietstreek
Drinkwaterleiding de-, Spoorlaan 6, 2267 AN Leidschendam; Postbus 521, 2270 AM Voorburg
Tel +31 70 399 1188
Fax +31 70 399 6136
Director:
H van der Knaap
Population: 121 100
Vol water supplied: 8.5*

Western area
NV Duinwaterbedrijf Zuid-Holland, Postbus 34, 2270 AA Voorburg, Zuid-Holland
Tel +31 70 357 7500
Fax +31 70 387 1894
Director General:
J Hieter
Population: 1 250 000
Vol water supplied: 55*
No. reservoirs: 8

Zuid-Holland Oost
Watermaatschappij Zuid-Holland Oost (WZHO), Postbus 122, 2800 AC Gouda
Tel +31 1820 93311
Fax +31 1820 93333
Director:
Ir ABIM Vos de Wael
Director:
Ing HEJ Boon
Population: 647 715
Vol water supplied: 55.5*
Vol sewage treated: 45.7*
No. sewage plants: 12

Water Boards

DRENTHE

Waterschap 't Suydevelt
Postbus 330, 7740 AH Coevorden
Tel +31 5240 18040
Fax +31 5240 18765
Chairman:
L Rabbers

Waterschap Meppelerdiep
Postbus 75, 7900 AB Hoogeveen
Tel +31 5280 90111
Fax +31 5280 90199
Chairman:
F Wemmenhove
Population: 150 000

Zuiveringsschap Drenthe
Postbus 231, 9400 AE Assen
Tel +31 5920 92666
Fax +31 5920 56856
Chairman:
R Vos
Population: 668 775
No. sewage plants: 23

FLEVOLAND

Flevolandse Waterschapsbond (Union)
Zuiderwagenplein 1, 8224 AD Lelystad; Postbus 229, 8200 AE Lelystad
Tel +31 3200 74911
Fax +31 3200 47919
Secretary to the Board:
B J Douwes
Population: 330 000
Vol sewage treated: 16.6*
No. sewage plants: 7

Heemraadschap Fleverwaard
Postbus 229, 8200 AE Lelystad
Tel +31 3200 74911
Fax +31 3200 47919
Chairman:
Mr O van der Heide
Population: 190 500
Vol sewage treated: 12.4*
No. sewage plants: 6

FRIESLAND

Provincie Friesland
Postbus 20120, 8900 HM Leeuwarden
Tel +31 58 925925
Fax +31 58 925225
Director Water Management:
J Sj Sipkema
Population: 950 000
No. sewage plants: 29

Waterschap Friesland
Postbus 36, 8900 AA Leeuwarden
Tel +31 58 233 9933
Fax +31 58 233 9966
Chairman:
E H Togtema
Population: 603 996
Vol sewage treated: 82*
No. sewage plants: 30

Waterschap It Marnelan
Postbus 30, 8700 AA Bolsward
Tel +31 5157 5155
Fax +31 5157 4835
Chairman:
J Speerstra
Population: 50 000

GELDERLAND

Polderdistrict Tieler- en Culemborgerwaarden
Postbus 247, 4190 CE Geldermalsen
Tel +31 3455 76696
Fax +31 3455 76984
Dike-Reeve:
J A de Jongh
Population: 120 000
Vol water supplied: 70*

Waterschap van de Oude IJssel
Postbus 28, 7060 AA Terborg
Tel +31 8350 23641
Fax +31 8350 30341
Chairman:
A J A M Gerritzen

Zuiveringsschap Oostelijk Gelderland (Water quality management)
Postbus 148, 7000 AC Doetinchem
Tel +31 8340 70111
Fax +31 8340 43258
Chairman:
ir A van den Ende
Population: 900 000
Vol sewage treated: 73*
No. sewage plants: 16

Zuiveringsschap Rivierenland
Postbus 599, 4000 AN Tiel
Tel +31 3440 75911
Fax +31 3440 75700
Chairman:
D B F A Serrée
Population: 793 000
Vol sewage treated: 55*
No. sewage plants: 25

Zuiveringsschap Veluwe
Postbus 9030, 7300 EN Apeldoorn
Tel +31 55 272911
Fax +31 55 272704
Chairman:
A Th te Bokkel
Population: 1 000 000
Vol sewage treated: 75*
No. sewage plants: 20

GRONINGEN

Provincie Groningen
Postbus 833, 9700 AV Groningen
Tel +31 50 164911

***million m³/year**

Fax +31 50 164633
Director Waste Water Treatment:
C Bras
Population: 720 000
No. sewage plants: 35

Waterschap Noorderzijlvest (water quantity and water control)
Postbus 100, 9959 ZH Onderdendam
Tel +31 5900 48911
Fax +31 5900 48226
Chairman:
T E Willems

LIMBURG

Zuiveringschap Limburg
(Limburg Water Pollution Control Authority) Kapelaan Sarsstraat 2, 6043 CW Roermond
Tel +31 4750 94444
Fax +31 4750 11605
Chairman:
Ir G C van Wijnbergen
Population: 1 100 000
Vol sewage treated: 132*
No. sewage plants: 21

NOORD-BRABANT

Hoogheemraadschap West-Brabant
Postbus 2212, 4800 CE Breda
Tel +31 76 631000
Fax +31 76 652082
Chairman:
Th A G M van der Weijden
Population: 1 200 000
Vol sewage treated: 90*
No. sewage plants: 20

Noord-Brabantse Waterschapsbond
(Union of 9 waterboards in Brabant) Postbus 419, 5201 AK -sHertogenbosch
Tel +31 73 128622
Fax +31 73 122130
Chairman:
Th A G M van der Weijden
Waterschap De Aa
Postbus 419, 5201 AK 's-Hertogenbosch
Tel +31 73 128622
Fax +31 73 122130
Chairman:
ir A J A M Segers
Population: 320 000
Vol sewage treated: 43*
No. sewage plants: 6

Waterschap De Dommel
Postbus 10001, 5280 DA Boxtel
Tel +31 4116 57911
Fax +31 4116 82977
Chairman:
ir A J A M Segers
Population: 1 400 000
Vol sewage treated: 80*
No. sewage plants: 10

Waterschap De Maaskant
Postbus 309, 5340 AH Oss
Tel +31 4120 33331
Fax +31 4120 36415
Chairman:
drs L P M van den Berg
Population: 350 000
Vol water supplied: 15*
No. reservoirs: 25
Vol sewage treated: 35*
No. sewage plants: 3

Waterschap De Mark-Vlietlanden
Bosstraat 30-32, 4704 RL *Roosendaal*
Tel +31 1650 52960
Fax +31 1650 48907
Chairman:
A J M Kongings
Population: 100 000

NOORD-HOLLAND

Dienst Riolering en *Waterhuishouding* Amsterdam
Postbus 40098, 1009 BB Amsterdam
Tel +31 20 596 4151
Fax +31 20 596 4130
Director:
W A Faber
Population: 1 100 000
Vol water supplied: 50*
*Vol sewage treated: 80**
No. sewage plants: 4

Hoogheemraadschap Amstel en Vecht
Postbus 97, 1190 AB Ouderkerk Aan de Amstel
Tel +31 2963 3153
Fax +31 2963 5503
Chairman:
ir J H van der Vlist
Director:
Mr P I Hatzmann
Population: 750 000

Hoogheemraadschap van de Uitwaterende Sluizen in Hollands Noorderkwartier
Postbus 15, 1135 ZH Edam
Tel +31 2993 60611
Fax +31 2993 69851
Chairman:
dr ir J IJff
Population: 1 200 000
Vol sewage treated: 96*
No. sewage plants: 22

Waterschap Hollands Kroon
Postbus 23, 1770 AA Wieringerwerf
Tel +31 2272 6600
Fax +31 2272 6611
Chairman:
S P *Steltenpool*
Population: 116 500
Vol water supplied: 750*

Zuiveringschap Amstel- en Gooiland
Postbus 1061, 1200 BB Hilversum; Larenseweg 30, 1221 CN Hilversum
Tel +31 35 881611
Fax +31 35 832884
Management Board:
Mr J W de Jong
Management Board:
Ir C H Kuggeleyn
Population: 500 000
Vol sewage treated: 40*
No. sewage plants: 7

OVERIJSSEL

Waterschap Benoorden de Dedemsvaart
Conradsweg 3, 7954 DV Rouveen
Tel +31 5225 1397
Fax +31 5225 1044
Chairman:
M Knol
Population: 30 000

Waterschap Regge en Dinkel
Postbus 5006, 7600 GA Almelo
Tel +31 546 832525
Fax +31 546 821176
Chairman:
Ir P A E van Erkelens
Population: 570 000
No. sewage plants: 25

Waterschap Salland
Postbus 42, 8100 AA Raalte
Tel +31 5720 41144
Fax +31 5720 41111
Director:
G van Elk
Population: 200 000
Vol water supplied: 15*

Zuiveringschap West-Overijssel
Postbus 60, 8000 AB Zwolle
Tel +31 38 218803
Fax +31 38 211233
Chairman:
S Schaap
Population: 735 000
Vol sewage treated: 45*
No. sewage plants: 18

UTRECHT

Provincie Utrecht
Postbus 80300, 3508 TH Utrecht
Tel +31 30 589111
Fax +31 30 522564
Director Water/Environment:
B A Herfst
Population: 1 200 000
Vol sewage treated: 114*
No. sewage plants: 26

ZEELAND

Waterschap Noord- en Zuid-Beveland
Postbus 114, 4460 AC Goes
Tel +31 1100 41000
Fax +31 1100 27528
Chairman:
Ir P J Gruijters
Population: 80 000
Vol sewage treated: 10.4*
No. sewage plants: 5

Waterschap Schouwen-Duiveland
Postbus 20, 4300 AA Zierikzee
Tel +31 1110 12551
Fax +31 1110 17271
Technician:
J R H Scheele
Population: 30 000 (4 000 000 summer)
Vol sewage treated: 6*
No. sewage plants: 5

Waterschap Walcheren
Postbus 179, 4330 AD Middelburg
Tel +31 1180 71500
Fax +31 1180 33233
Chairman:
jhr mr K F H Schorer
Population: 145 000
Vol sewage treated: 9.5*
No. sewage plants: 1

Zeeuwse Waterschapsbond (Union)
Groenmarkt 10, 4331 BH Middelburg; Postbus 179, 4330 AD Middelburg
Tel +31 1180 71580
Fax +31 1180 33233
Chairman:
Ir P J Gruijters
Population: 360 000
Vol sewage treated: 60*
No. sewage plants: 20

ZUID-HOLLAND

Hoogheemraadschap van *Delfland*
Postbus 3061, 2601 DB Delft
Tel +31 15 608108
Fax +31 15 124968
Chairman:
drs P Zevenbergen
Population: 1 800 000
Vol water supplied: 50*
Vol sewage treated: 125*
No. sewage plants: 5

Hoogheemraadschap van Rijnland
Postbus 156, 2300 AD Leiden
Tel +31 71 259125
Fax +31 71 123916
Director:
Ir E H baron van Tuyll van Serooskerken
Population: 1 400 000
*Vol sewage treated: 123**
No. sewage plants: 45

Waterschap Goeree-Overflakkee
Postbus 67, 3240 AB Middelharnis
Tel +31 1870 88888
Fax +31 1870 83910
Chairman:
H L van Kampenhout
Population: 45 000
Vol water supplied: 2.4*

Zuiveringsschap Hollandse Eilanden en Waarden
Postbus 469, 3300 AL Dordrecht
Tel +31 78 397100
Fax +31 78 311871
Chairman:
Ir J Boeve
Population: 1 400 000
Vol sewage treated: 145*
No. sewage plants: 47

***million m^3/year**

Government departments and regulating bodies

Norwegian Pollution Control Authority
P O Box 8100 Dep, N-0032 Oslo
Tel +47 22 573400
Fax +47 22 676706
Director: Harald Rensvik

The Ministry of the Environment
PO Box 8013 Dep, N-0030 Oslo
Tel +47 22 349090
Fax +47 22 349560
Secretary General: Oddmund Graham
Dept for Water Resources Management: Håvard Hom

Institutes and associations

Folkehelsa (The National Institute for Public Health)
Geitemyrsveien 75, N-0462 Oslo
Tel +47 22 042200
Fax +47 22 353605
Director: Bodolf Hareide
Head of Section for Water Hygiene: Truls Krogh

Jordforsk (Centre for Soil and Environmental Research)
Jordforsk, N-1432 Ås
Tel +47 64 94 81 00
Fax +47 64 94 81 10
Director: Arnor Nj~/os

NORVAR (Norwegian Water and Waste Water Works Association)
Vangsvn 143, N-2300 Hamar
Tel +47 62 528650
Fax +47 62 534006
President: Odd Aspeli
Secretary: Svein Erik Moen

Norwegian Institute for Water Research (NIVA)
PO Box 173 Kjelsås, N-0411 Oslo
Tel +47 22 185100
Fax +47 22 185200
Director General: Haakon Thaulow

NRF (Norwegian Association of Public Cleaning and Solid Waste Management)
c/o Oslo Renholdsverk, Gunnar Schjelderups vei 11, N-0485 Oslo
Tel +47 2 227150
Fax +47 2 227150 ext 114
President: Gunnar Værnes

Rogaland Research Institute
P O Box 2557, N-4004 Stavanger
Tel +47 51 875000
Fax +47 51 875200
Director: Kaare Netland

Rogaland University Centre
P O Box 2557, N-4004 Stavanger
Tel +47 51 874100
Fax +47 51 874300
Director: Karstein Forsvoll

SINTEF NHL (Norwegian Hydrotechnical Laboratory)
N-7034 Trondheim
Tel +47 73 59 23 00
Fax +47 73 59 23 76
General Manager: Kjetil A Vaskinn

County Environmental Administrations

The County Municipality of Akershus
Department for Environmental Affairs, P O Box 6888 St Olavs Plass, N-0130 Oslo
Tel +47 2 365600
Fax +47 2 365955
County Co ordinator for Environment!
Jan Terjer Hansen

The County Governor of Aust-Agder
Department for Environmental Affairs, Fylkeshuset, N-4800 Arendal
Tel +47 41 17300
Fax +47 41 22326
County Co-ordinator for Environment:
Aud Castberg

The County Governor of Buskerud
Department for Environmental Affairs, Haugesgt. 89, N-3000 Drammen
Tel +47 3 808850
Fax +47 3 808880
County Co-ordinator for Environment:
Jan Rognebakke

The County Governor of Finnmark
Department of Environmental Affairs, Damsvn. 1, N-9800 Vads~/o
Tel +47 78 95 03 00
Fax +47 78 95 19 30
County Co-ordinator for Environment:
Bente Christiansen
Population: 75 000
Vol water supplied: 0.02*
No. reservoirs: 10
Vol sewage treated: 0.004*
No. sewage plants: 10

The County Governor of Hedmark
Department for Environmental Affairs, Fylkeshuset, N-2300 Hamar
Tel +47 6251 4400
Fax +47 6251 4557
County Co-ordinator for Water Environmental Affairs:
Ivar Helleberg
Population: 150 000
Vol water supplied: 20*
No. reservoirs: 108
Vol sewage treated: 18*
No. sewage plants: 70

The County Governor of Hordaland
Department for Environmental Affairs, Walckendorfsgt. 6, N-5012 Bergen
Tel +47 5 237760
Fax +47 5 237782
County Co-ordinator for Environment:
Terje Aasen

The County Governor of M~/ore and Romsdal
Department for Environmental Affairs, Fylkeshuset, N-6400 Molde
Tel +47 71 25 80 00
Fax +47 71 25 85 09
County Co-ordinator for Environment:
Per Fredrik Brun

The County Governor of Nord-TrØndelag
Department of Environmental Affairs, Statens Hus, 7700 Steinkjer
Tel +47 77 68000
Fax +47 77 68339
County Co-ordinator for Environment:
Svein Karlsen
Population: 130 000
No. reservoirs: 25
No. sewage plants: 60

The County Governor of Nordland
Department of Environmental Affairs, Moloveien 10, 8002 Bod~/o
Tel +47 755 31580
Fax +47 755 31680
County Co-ordinator for Environment:
Ola Bjerkaas
Population: 240 000

The County Governor of Oppland
Department for Environmental Affairs, Statsetatenes Hus, N-2600 Lillehammer
Tel +47 62 66051
Fax +47 62 66167
County Co-ordinator for Environment:
Per Suardal
Population: 182 000
No. sewage plants: 100

The County Governor of Oslo and Akershus
Department for Environmental Affairs, P O Box 8111 Dep., N-0032 Oslo
Tel +47 2 429085
Fax +47 2 422265
County Co-ordinator for Environment:
Aasmund Saether
The situation in the County of Oslo and Akershus is special. Whereas the County Governor's responsibilities cover the whole area, there is one County Co-ordinator for Environmental Affairs for Oslo, subordinate to the County Governor, and a corresponding Co-ordinator for the County municipality of Akershus, subordinate to the chief Administrator of the County Municipality.)

The County Governor of Østfold
Department for Environmental Affairs, P O Box 325, N-1501 Moss
Tel +47 9 254100
Fax +47 9 253832
County Co ordinator for Environment:
Inge Elkeland

The County Governor of Rogaland
Department for Environmental Affairs, P O Box 59, N-4001 Stavanger
Tel +47 51 568900
Fax +47 51 529027
Head of Environm. Protection Dept:
Sigmund Hatløy
Population: 350 730
Vol water supplied: 70*
No. reservoirs: 48
Vol sewage treated: 35*
No. sewage plants: 14

The County Governor of Sogn and Fjordane
Department for Environmental Affairs, N-5840 Hermansverk
Tel +47 56 55000
Fax +47 56 55055
County Co-ordinator for Environment:
Anders Andersen

The County Governor of SØr-TrØndelag
Department for Environmental Affairs, Statens Hus, 7005 Trondheim
Tel +47 7 949011
Fax +47 7 949350
County Co-ordinator for Environment:
Terje Klokk
Population: 245 000
Vol water supplied: 35*
No. reservoirs: 65
Vol sewage treated: 18*
No. sewage plants: 60

The County Governor of Telemark
Department for Environmental Affairs, P O Box 289, N-3701 Skien
Tel +47 3 586110
Fax +47 3 530773
County Co-ordinator for Environment:
Sigmund Tvermyr

The County of TromsØ Environmental Protection
Department, P O Box 595, N-9001 Troms~/o
Tel +47 76 68 75 30
Fax +47 76 61 11 43
County Co-ordinator for Environment:
Ben Schei
Population: 148 000
Vol water supplied: 50*
No. reservoirs: 100
Vol sewage treated: 4.6*
No. sewage plants: 39

The County Governor of Vest-Agder
Department for Environmental Affairs, Tinghuset, 4600 Kristiansand
Tel +47 42 76570
Fax +47 42 26144
County Co-ordinator for Environment:
Tom Egerhei

The County Governor of Vestfold
Department for Environmental Affairs, Stoltenberggt. 38, N-3100 T~/onsberg
Tel +47 33 12835
Fax +47 33 18309
County Co-ordinator for Environment:

*million m^3/year

Water suppliers and sewage water treatment/disposal plant

Bjørn Strandli

FREVAR
P O Box 1115, N-1631 Gml
Fredrikstad
Tel +47 69 322920
Fax +47 69 323433
General Manager:
Jens P Egeberg
Population: 95 000
Vol water supplied: 14*
No. reservoirs: 4
Vol sewage treated: 12*
No. sewage plants: 3

HIAS
(Inter-municipal sewage company serving municipalities, central Eastern Norway)
Vangsv 134, 2300 Hamar
Tel +47 62 534100
Fax +47 62 534093
General Manager:
Odd Kr Gaarde
Population: 75 000
Vol water supplied: 7.5*
No. reservoirs: 1
Vol sewage treated: 8*
No. sewage plants: 1

IVAR
(Inter-municipal water supply, sewage and waste handling company for eight municipalities in the Stavanger region, Western Norway)
Forusbeen 3, N-4033 Forus
Tel +47 51 575577
Fax +47 51 571072
General Manager:
Roald BØe
Population: 220 000
Vol water supplied: 40*
No. reservoirs: 3
Vol sewage treated: 30*
No. sewage plants: 5

NRV
(Inter-municipal water company serving six municipalities, approximately 25km east of Oslo)
PO Box 25, N-2011
Str~/ommen
Tel +47 6381 5050
Fax +47 6380 0551
General Manager:
Ivar T Henriksen
Population: 110 000
Vol water supplied: 12*
No. reservoirs: 4
Vol sewage treated: 16*
No. sewage plants: 1

RA-2
(Inter-municipal sewage company serving three municipalities approximately 25km east of Oslo)
Strandvn 22, N-2010
Str~/ommen
Tel +47 6381 5050
Fax +47 6380 0551
General Manager:
Ivar T Henriksen
Population: 90 000
Vol sewage treated: 16*
No. sewage plants: 1

VEAS
(Inter-municipal sewage company serving part of Oslo and three neighbouring municipalities)
N-3471 Slemmestad
Tel +47 66 798660
Fax +47 66 796755
Managing Director:
Paul Sagberg
Population: 450 000
Vol sewage treated: 118*
No. sewage plants: 1

VIV
(Inter municipal waterworks serving five municipalities, in south-east Norway)
N-3270 Nanset
Tel +47 33 11 1095
Fax +47 33 11 1529
General Manager:
Sverre Mollatt
Population: 120 000
Vol water supplied: 25*
No. reservoirs: 1

The City of Bergen
Technical Department
P O Box 805, N-5002 Bergen
Tel +47 55 56 6129
Fax +47 55 56 6296
General Manager:
Ivar D Kalland
Population: 210 000
Vol water supplied: 46*
No. reservoirs: 9
Vol sewage treated: 92*
No. sewage plants: 16

Oslo Water and Sewage Works
Herslebs gt 5, N-0561 Oslo
Tel +47 2 266 2020
Fax +47 2 266 4082
Director:
Finn Johansen
Population: 478 000
Vol water supplied: 114*
No. reservoirs: 20
Vol sewage treated: 107.9*
No. sewage plants: 2

Trondheim Water and Sewage Works
Holtermanns vei 1, N-7030
Trondheim
Tel +47 7 546561
Fax +47 7 547018
General Manager:
Finn BjØrgum
Population: 140 000
Vol water supplied: 29*
No. reservoirs: 4
Vol sewage treated: 35*
No. sewage plants: 4

***million m³/year**

Government departments and regulating bodies

Ministry of Environment Protection and Natural Resources
ul Wawelska 52/54, 00-922 Warszawa
Tel +48 22 251133
Director: Mr Nowakowski

Department of Water Management
(Departament Gospodarki Wodnej), ul Wawelska 52/54, 00-922 Warszawa
Tel +48 22 258478
Fax +48 22 258478
Director of Water Management Dept: Leszek Baginski

State Inspectorate of Environmental Protection
(Panstwowa Inspekcja Ochrony Strodowiska) ul Wawelska 52/54, 00-922Warszawa
Tel +48 22 253325
Fax +48 22 250465
Chief Inspector: A Walewski

Chief Flood Control Committee
(Glowny Komitet Przeciwpowodziowy), ul Wawelska 52/54, 00-922 Warszawa
Tel +48 22 254749
Fax +48 22 252704
Chairman: Stanislaw Zelichowski (+48 22 253355)
Deputy Chairman: Dr Janusz Zurek (+48 22 254716)
Secretary: Richard Egler (+48 22 258537)

Regional Water Development Authorities (RZGW)

Gdansk
Regionalny Zarzad Gospodarki Wodnej w Gdansku, ul Uphagena 27, 80-237 Gdansk
Tel +48 58 471040
Fax +48 58 471705
Director: M Ostojski

Katowice
Regionalny Zarzad Gospodarki Wodnej w Katowicach, ul Jesionowa 9A, 40-159 Katowice
Tel +48 32 580917
Fax +48 32 599642

Krakow
Regionalny Zarzad Gospodarki Wodnej w Krakowie, ul Marszaika J Pilsudskiego 22, 30-109 Krakow
Tel +48 12 212909/232111
Fax +48 12 212909
Principal Director: Tomasz Walczykiewicz
Deputy Director: Maciej Mendera

Poznan
Regionalny Zarzad Gospodarki Wodnej w Poznaniu, ul Grunwaldska 21, 60-703 Poznan
Tel +48 61 656956
Fax +48 61 656953

Szczecin
Regionalny Zarzad Gospodarki Wodnej w Szczecinie, ul Pocztowa 12/12, 70-360 Szczecin
Tel +48 91 844075
Fax +48 91 844075
Director: Andrzej Kreft

Warszawa
Regionalny Zarzad Gospodarki Wodnej w Warszawie, ul Wspolna 1/3, 00-529 Warszawa
Tel +48 02 625 5028
Fax +48 02 625 5028

Wroclaw
Regionalny Zarzad Gospodarki Wodnej w Wroclawiu (Wroclaw Regional Water Management Authority), ul Norwida 34, 50-375 Wroclaw
Tel +48 71 213030/224138
Fax +48 71 221339
Director: Andrzej Nalberczynski M Sc Eng

Regional Water Management Administration (Okregowa Dyrekcje Gospodarki Wodnej)

Gdansk
Okregowe Dyrekcje Gospodarki Wodnej w Gdansku, ul Zalogowa 6, 80-557 Gdansk
Tel +48 58 432276
Fax +48 58 432276
Director: Wieslaw Stefaniak Msc Eng

Gliwice
Okregowa Dyrekcja Gospodarki Wodnej w Gliwicach, ul Sienkiewicza 2, 44-100 Gliwice
Tel +48 32 310581
Fax +48 32 310028

Krakow
Okregowa Dyrekcja Gospodarki Wodnej w Krakowie, ul Marszalka J Pilsudskiego 22, 31-109 Krakow
Tel +48 12 232141
Fax +48 12 232153
General Director: Tadeusz Lagosz

Poznan
Okregowa Dyrekcja Gospodarki Wodnej w Poznaniu, ul Szewska 1, 61-760 Poznan
Tel +48 61 529 401
Fax +48 61 525 731
Principal Director: Wojciech Orlowski

Szczecin
Okregowa Dyrekcja Gospodarki Wodnej w Szczecinie, ul Jagiellonska 32, 70-382 Szczecin
Tel +48 91 843457
Fax +48 91 841384
Principal Director: Andrzej Kwapiszewski

Warszawa
Okregowa Dyrekcja Gospodarki Wodnej w Warszawie, ul Mokotowska 63, 00-950 Warszawa
Tel +48 22 292239
Fax +48 22 214281

Wroclaw
Okregowa Dyrekcja Gospodarki Wodnej we Wroclawiu, ul Norwida 34, 50-375 Wroclaw
Tel +48 71 224138
Fax +48 71 221339

Ministry of Health and Social Welfare
(Ministerstwo Zdrowia I Opieki Spolecznej) ul Miodowa 15, 00-246 Warszawa
Tel +48 22 313441
Fax +48 2 6359245
State Sanitary Inspectorate (Panstwowa Inspekcja Sanitarna), ul Miodowa 15, 00-246 Warszawa
Tel +48 22 260728
Fax +48 22 260966

Ministry of Agriculture and Food Economics
(Ministerstwo Rolnictwa i Gospodarki Zywnosciowej), ul Wspolna 30, 00-930 Warszawa
Tel +48 22 628 8783
Fax +48 22 623 2750/2751
Director: Jerzy Grzesik

Ministry of Building and Spatial Economics
(Ministerstwo Gospodarki Przestrzennej i Budownictwa), ul Wspolna 2 00-926 Warszawa
Tel +48 22 210351

Ministry of Physical Planning and Construction
Wspólna 2, 00-926 Warszawa
Tel +48 2 661 81 58
Fax +48 2 628 40 30
Minister: Barbara Blida

National Fund for Environmental Protection
Konstruktorska 3a, 02-673 Warszawa
Tel +48 22 79 72 82
Fax +48 22 79 72 72
President: Kazimierz Chlopecki
Head of Int'l Department: Wojciech Bienkowski

Voivodship Environmental Testing and Control Centre
Aleje Jerozoumskie Str 30, OO-024 Warszawa
Tel +48 22 27 21 44
Fax +48 22 27 04 65

*million m^3/year

Principal Director: Michal Sosnkowski

Institutes and associations

Institute of Meteorology and Water Management
(Instytut Meteorologii i Gospodarki Wodnej), ul Podlesna 61, 01 673 Warszawa
Tel +48 22 341851
Fax +48 22 341801
State Geological Institute (Panstwowy Instytut Geologiczny), ul Rakowiecka 4, 00-975 Warszawa
Tel +48 22 495096
Fax +48 22 495342

Institute of Land Amelioration and Grassland
(Instytut Melioracji i Uzytkow Zielonych), Falenty IMUZ, 05-090 Raszyn k, Warsaw
Tel +48 2 628 3763
Fax +48 2 628 3763
Dyrektor: Edmund Kaca

Institute of Environmental Engineering Systems
Warsaw University of Technology, Ul Nowowiejska 20, 00-653 Warszawa
Tel +48 2 621 8993
Fax +48 2 625 4305
Director: Prof Marek Nawalany

Institute of Environmental Protection and Management
Al Mickiewicza 30, 30-053 Krakow
Adjunct Professor: Wlodzimierz A Wojcik

Institute of Water Supply and Hydraulic Construction
Warsaw University of Technology, pl Politechniki 1, 00-661 Warszawa
Tel +48 22 250954/215995
Fax +48 22 292962/295968
Director: Professor Marek Roman PhD

Technical University of Krakow
24 Warszawska Street, 31-155 Krakow
Director: Piotr Mizgalewicz

Chamber of Commerce and Industry 'Polish Water Works'
(Izba Gospodarcza 'Wodociagi Polskie'), J Wyssenhoffa 11, 85-072 Bydgoszcz
Tel +48 52 226294

PZITS
Polskie Zrzeszenie Inzynierow i Technikow Sanitarnych, Zarzad Glowny ul Czackiego 3/5, 00-043 Warszawa
Tel +48 26 28 94
Fax +48 27 02 62
Secretary General: R Parusewski

Other organisations

Programme on Water Resources Development
PR 7, ul Podlesna 61, 01-673 Warszawa
Tel +48 22 341864
Contact: E Karlak

Water suppliers and sewage water treatment/disposal plant

Biala Podlaska
Wojewódzkie Przedsiebiorstwo Wodociagów i Kanalizacji, ul Narutowicza 35a, 21-500 Biala Podlaska
Tel +48 801 35236

Bialystok
Wojewódzkie Przedsiebiorstwo Wodociagów i Kanalizacji, ul Mlynowa 52, 19-950 Bialystok
Tel +48 85 422852
Fax +48 85 427332
Contact:
mgr inz Jozef Iwaniuk
Population: 280 000
Vol water supplied: 30.5*
No. reservoirs: 2
Vol sewage treated: 34.3*
No. sewage plants: 1

Bielsko Biala
Przedsiebiorstwo Komunalne Aqua SA, ul 1 Maja 23, 43-300 Bielsko Biala
Tel +48 30 24011

Bydgoszcz
Miejskie Przedsiebiorstwo Wodociagów i Kanalizacji, ul Torunska 103, 85-817 Bydgoszcz
Tel +48 52 719264
Fax +48 52 711297

Bytom
Rejonowe Przedsiebiorstwo Wodociagów i Kanalizacji, ul Zabrzanska, 41-902 Bytom
Tel +48 32 814085

Chelm
Miejskie Przedsiebiorstwo Gospodarki Komunalnej, ul Wolynska 57, 22-100 Chelm
Tel +48 82 56461

Chorzow
Rejonowe Przedsiebiorstwo Wodociagów i Kanalizacji, ul Skladowa 1, 41-500 Chorzow
Tel +48 32 413277/410154

Ciechanów
Zaklad Wodociagów i Kanalizacji, ul Gostkowska 81, 06-400 Ciechanów

Czestochowa
Wojewódzkie Przedsiebiorstwo Wodociagów i Kanalizacji, ul Jaskrowska 14/44
Tel +48 34 42344/47021
Fax +48 34 641582

Dabrowa Górnicza
Rejonowe Przedsiebiorstwo Wodociagów i Kanalizacji, ul Powstancow 13, 41-300 Darowa Gornicza
Tel +48 3 162 2210
Fax +48 3 162 2210
Principal Officer:
mgr inz Andrzej Malinowski
Population: 250,000
Vol water supplied: 17.8*
No. reservoirs: 2
Vol sewage treated: 10.5*
No. sewage plants: 2

Elblag
Rejonowe Przedsiebiorstwo Wodociagow i Kanalizacji, ul Rawska 2-4, 82-300 Elblag
Tel +48 50 314038-42

Gdansk
Saur-Neptun Gdansk SA, ul Walowa 46, 80-958 Gdansk
Tel +48 58 313091-7
Fax +48 58 314513

Gdynia
Przedsiebiorstwo Wodociagów i Kanalizacji Spolka z o o, ul Witominska 21, 81-963 Gdynia
Tel +48 58 218041-5
Fax +48 58 203221

Gliwice
Rejonowe Przedsiebiorstwo Wodociagów i Kanalizacji, ul Dolnych Walow 11, 44-100 Gliwice
Tel +48 32 314493

Gorzów Wielkopolski
Przedsiebiorstwo Wodociagów i Kanalizacji Spolka z o o, ul Kosynierów Gdynskich 47, 66-400 Gorzów Wielkopolski
Tel +48 95 24241
Fax +48 95 23793

Grudziadz
Przedsiebiorstwo Wodociagów i Kanalizacji Spolka z o o, ul Mickiewicza 28/30, 86-300 Grudziadz
Tel +48 51 24321
Fax +48 51 22241
Principal Officer:
mgr Zenon Augustyniak
Population: 90 000
Vol water supplied: 10*
No. reservoirs: 32
Vol sewage treated: 9.7*

Jastrzebie Zdrój
Rejonowe Przedsiebiorstwo Wodociagów i Kanalizacji, ul Marklowicka, 44-300 Wodzislaw Slaski
Tel +48 36 554665

Jelenia Góra
Przedsiebiorstwo Zwiazku Wodociagów i Kanalizacji 'Wodnik', plac Piastiwsju 12, 58-560 Jelenia Góra
Tel +48 75 52091
Fax +48 75 52093 (w. 313)
Principal Officer:
mgr Jadwiga Bielowka
Population: 120 000
Vol water supplied: 13.4*
No. reservoirs: 7
Vol sewage treated: 12.5*
No. sewage plants: 5

Kalisz
Przedsiebiorstwo Wodociagów i Kanalizacji Spólka z o o, Nowy Swiat 2a, 62-800 Kalisz
Tel +48 62 74597
Fax +48 62 74597
Contact:
Ing roman Wiertelak
Population: 100 000
Vol water supplied: 9.6*
No. reservoirs: 9
Vol sewage treated: 10.4*

Katowice
Górnoslaskie Przedsiebiorstwo Wodociagów, ul Wojewódska 19, 40-030 Katowice
Tel +48 32 156 1245
Fax +48 32 156 1181

Katowice
Rejonowe Przedsiebiorstwo Wodociagów i Kanalizacji, ul Obroncow Westerplatte 130, 40-334 Katowice
Tel +48 3 156 4385
Fax +48 3 155 5278
Director:
inz Tadeusz Zuber
Population: 531 506
Vol water supplied: 54*
Vol sewage treated: 47*
No. sewage plants: 10

Kielce
Zwiazek Komunalny Wodociagów i Kanalizacji, ul Krakowska 64, 25-701 Kielce
Tel +48 41 684402
Fax +48 41 55220
Environment Protection:
Jerzy Adamski
Population: 178 000
Vol water supplied: 19.88*
No. reservoirs: 10
Vol sewage treated: 20.56*
No. sewage plants: 2

Konin
Przedsiebiorstwo Wodociagów i Kanalizacji, ul Poznanska 49, 62-510 Konin
Tel +48 631 25075
Fax +48 631 24254

Koszalin
Miejskie Wodociagi i Kanalizacja Spólka z o o, ul Wojska Polskiego 14, 75-711 Koszalin
Tel +48 94 22938/26260
Fax +48 94 22938
Director:
M Jan Zdunek
Population: 120 000
Vol water supplied: 11.3*
No. reservoirs: 2
Vol sewage treated: 11.5*
No. sewage plants: 2

Krakow
Miejskie Przedsiebiorstwo Wodociagów i Kanalizacji, ul Senatorska 1, 30-106 Kraków
Tel +48 22 00 08
Fax +48 21 44 12
Principal Officer:
mgr inz Wojciech Studnicki
Population: 702 000
Vol water supplied: 83*
No. reservoirs: 13
Vol sewage treated: 59*
No. sewage plants: 3

Krosno
Miejskie Przedsiebiorstwo Gospodarki Komunalnej, ul Fredry 3, 38-400 Krosno
Tel +48 131 25311

Legnica
Legnickie Przedsiebiorstwo Wodociagów i Kanalizacji SA, ul Scinawska 1, 59-220

*million m³/year

Legnica
Tel +48 76 25014-5
Leszno
Wojewódskie
Przedsiebiorstwo
Wodociagów i Kanalizacji,
ul Lipowa 76, 64-100 Lipowa
76
Tel +48 65 205701/206686
Fax +48 65 202534

Lomza
Miejskie Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Zjazd 25, 18-400 Lomza
Tel +48 86 6277

Lublin
Miejskie Przedsiebiorstwo
Wodociagów i Kanalizacji w
Lublinie, Al Pitsudskiego 15,
20-407 Lublin
Tel +48 81 23756
Fax +48 81 21910
Principal Officer:
inz Tadeusz Fijalka
Population: 340 000
Vol water supplied: 33.8*
No. reservoirs: 13
Vol sewage treated: 35.9*
No. sewage plants: 1

Lódz
Zaklad Wodociagów i
Kanalizacji, ul Wierzbowa 52,
90-133 Lódz
Tel +48 42 781879/781590
Fax +48 42 788761

Nowy Sacz
Rejonowe Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Wincentego Pola 22, 33-300
Nowy Sacz
Tel +48 18 22889/20361
Fax +48 18 23793

Olsztyn
Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Oficerska 16a, 10-218
Olsztyn
Tel +48 89 264081
Fax +48 89 266606
Dyrektor:
Katarzyna Puchalska
Population: 180 000
Vol water supplied: 18.2*
No. reservoirs: 4
Vol sewage treated: 18.8*
No. sewage plants: 1

Opole
Wodociagi i Kanalizacja
Spólka z o o, ul Oleska 64,
45-052 Opole
Tel +48 77 36495

Ostroleka
Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Kurpiowska 21, 07-400
Ostroleka
Tel +48 29 3261/3262

Pile
Miejskie Wodociagi i
Kanalizacja w Pile Spótka z o
o, ul Chopina 2,64-920 Pila
Tel +48 67 122974
Fax +48 67 125930
Director:
Bogumila Stawinska
Population: 75 000
Vol water supplied: 5.2*
No. reservoirs: 5
Vol sewage treated: 6.1*
No. sewage plants: 1

Piotrków Trybunalski
Miejski Zaklad Gospodarki
Komunalnej, ul 3 Maja 31, 97-
300 Piotrków Trybunalski
Tel +48 44 478061/478119

Plock
Miejski Zaklad Wodociagów i
Kanalizacji, ul Harcerza
Antolka Gradowskiego 11, 09-
402 Plock
Tel +48 24 625627-9/640723
Fax +48 24 629461

Poznan
Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Grobla 15, 60-967 Poznan
Tel +48 61 772511/529657

Przemysl
Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Rokitnianska 4, 37-700
Przemysl
Tel +48 10 783259
Fax +48 10 783259
Principal Officer:
mgr inz Miroslaw Nodzak
Population: 72 000
Vol water supplied: 6.3*
No. reservoirs: 1
Vol sewage treated: 9.2*
No. sewage plants: 1

Radom
Wodociagi Miejskie w
Radomiu Spólka z o o, ul
Filtrowa 4, 26-600 Radom
Tel +48 48 41091
Fax +48 48 41863
Chairman:
MSc Eng Leszek Trzeciak
Population: 219 800
Vol water supplied: 0.02*
No. reservoirs: 5
Vol sewage treated: 0.02*
No. sewage plants: 1

Ruda Slaska
Przedsiebiorstwo
Wodociagów i Kanalizacji
Spolka z o o, ul Pokoju 13,
41-709 Ruda Slaska 9
Tel +48 32 487051/487644
Fax +48 32 486824
President:
eng Edmund Podstawski
Population: 169 000
Vol water supplied: 15.4*
Vol sewage treated: 8.77*
No. sewage plants: 10

Rybnik
Rejonowe Przedsiebiorstwo
Wodociagów i Kanalizacji, 44-
270 Rybnik Niedobczyce
Tel +48 36 23681
Principal Officer:
mgr inz Alojay Nikel
Population: 350 000
Vol water supplied: 29*
No. reservoirs: 11
Vol sewage treated: 14*
No. sewage plants: 6

Rzeszów
Miejskie Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Naruszewicza 18, 35-050
Rzeszów
Tel +48 17 35231/36728

Siedlce
Przedsiebiorstwo
Wodociagów i Kanalizacji
Spólka z o o, ul Lesna 8, 08-
110 Siedlce
Tel +48 25 26493

Sieradz
Miejskie Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Lezna 8, 98-200 Sieradz
Tel +48 43 26493

Skierniewice
Zaklad Gospodarki
Komunalnej i Mieszkaniowej,
ul Czerwona 7, 96-100
Skierniewice
Tel +48 40 2664/3826

Slupsk
Wodociagi Slupsk Spólka z o
o, ul Orzeszkowej 1, 76-200
Slupsk
Tel +48 59 26051/22963
Fax +48 59 22207

Sosnowiec
Rejonowe Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Ostrogórska 43, 41-200
Sosnowiec
Tel +48 32 663177/660404

Suwalki
Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Gen Sikorskiego 14, 16-400
Suwalki
Tel +48 87 676053
Fax +48 87 675022
Principal Officer:
inz Witallasz Rychlik
Population: 65 000
Vol water supplied: 4.5*
No. reservoirs: 4
Vol sewage treated: 5.1*
No. sewage plants: 1

Szczecin
Zaklad Wodociagów i
Kanalizacji, ul
Szymanowskiego 2, 71-416
Szczecin
Tel +48 01 221261-7/220639

Tarnobrzeg
Przedsiebiorstwo Gospodarki
Komunalnej i Mieszkaniowej,
ul Mickiewicza 2, 39-400
Tarnobrzeg
Tel +48 15 232295/232203
Fax +48 15 233124
Dyrektor:
Inz Tadeusz Zych
Z-ca dyrektora:
Mgr inz Antoni Sikon
Population: 50 000
Vol water supplied: 2.8*
No. reservoirs: 2
Vol sewage treated: 2.2*

Tarnów
Wojewódskie
Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Narutowicza 37, 33-100
Tarnów
Tel +48 14 211111/212720
Fax +48 14 218644

Torun
Wojewódzkie
Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Rybaki 31, 87-100 Torun
Tel +48 56 24934/25422

Tychy
Rejonowe Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Sadowa 4, 43-100 Tychy
Tel +48 32 270271

Walbrzych
Walbrzyski Zwiazek
Wodociagów i Kanalizacji, Al
Wyzwolenia 39, 58-300
Walbrzych
Tel +48 74 23051

Warszawa
Miejskie Przedsiebiorstwo
Wodociagów i Kanalizacji
m.st. Warszawy, Plac
Starynkiewicza 5, 02-015
Warszawa
Tel +48 2 628 5567
Fax +48 22 297438

Warszawa
Oczyszczalnia Scieków
Poludnie Spólka z o o, (Waste
Water TreatmentPlant
Warsaw South (under
construction) Company
Limited), ul Bernardynska
14A, 02-904 Warszawa
Tel +48 2 642 20 61
Fax +48 2 642 55 19
Director General:
Jan Cebertowicz
Population: 461 000
Vol sewage treated: 40*
No. sewage plants: 1

Wloclawek
Miejskie Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Torunska 152, 87-800
Wloclawek
Tel +48 54 364073/363345
Fax +48 54 365452

Wodzislaw Slaski
Rejonowe Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Marklowicka 15, 44-300
Wodzislaw Slaski
Tel +48 36 554665

Wroclaw
Miejskie Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Na Grobli 14/16, 50-421
Wroclaw
Tel +48 71 447421
Fax +48 71 446515

Zabrze
Rejonowe Przedsiebiorstwo
Wodociagów i Kanalizacji, ul
Wolnosci 215, 41-800 Zabrze
Tel +48 32 716441/7116474

Zamosc
Przedsiebiorstwo Gospodarki
Komunalnej, ul Krucza 10,
22-400 Zamosc
Tel +48 84 6415
Fax +48 84 5458

Zielona Góra
Zaklad Wodociagów i
Kanalizacji, Al Zjednoczenia
110a, 65-005 Zielona Góra
Tel +48 68 72021/2957
Fax +48 68 22615

*million m^3/year

Government departments and regulating bodies

Ministry of Public Works and Regional Planning
17 Apolodor, Bucharest
Tel +40 1 312 3583
Fax +40 1 312 0894
Project Manager: Dana Craciunescu

Water suppliers and sewage water treatment/disposal plant

Alba
Regia Autonomá de Apá - Ctta, 3 Vasile Goldis St, Alba-Iulia 2500
Tel +40 968 26760
Population: 71 254
Vol water supplied: 12*

Arad
Regia Autonomá de Apá - Canal, 2-4 Bucura St, Arad 2900
Tel +40 966 30124
Population: 254 826
Vol water supplied: 71*

Bacau
Regia Autonomá Gospodárie Comunalá, 14 Narciselor St, Bacau 5500
Tel +40 931 32720
Population: 204 495
Vol water supplied: 27*

Balan
Gos Loc Regia Autonoma, Revolutiei
Bihor
Regia Autonomá Gospodarie Comunalá, 3 Duiliu Zamfirescu St, Oradea 3700
Tel +40 991 36909
Population: 220 248
Vol water supplied: 33*

Borsec
Gosb Regia Autonoma, Nadasa Nr 1

Brasov
Regia Autonomá Apá, 13 Vlad Tepes St, Brasov 2200
Tel +40 68 113770
Fax +40 68 150816
Director:
Dipl Ir Vasile Ciocodan
Population: 324 210
Vol water supplied: 51.5*
No. reservoirs: 1
Vol sewage treated: 55.3*
No. sewage plants: 2

Bráila
Regia Autonomá Apaterm, 1 Uzinei St, Bráila 6100
Tel +40 946 32745
Population: 234 706
Vol water supplied: 42*

Bucharest
Regia Generalá de Apá Bucuresti, 78721-Str Aristide Demetriad Nr 2 Sector 1, Bucuresti
Tel +40 1 613 2810
Fax +40 1 312 1318
General Manager:
Dip Ing Costin Berevolanu
Population: 2 064 476
Vol water supplied: 529.2*
No. reservoirs: 66
Vol sewage treated: 630.7* (Transported)
No. sewage plants: 1

Buzáu
Regia Autonomá Goscom, St Unirii Bloc 8F, Buzáu 5100
Tel +40 974 33356
Population: 148 247
Vol water supplied: 22*

Cluj
Regia Autonoma Apá - Canal, St 22 Decembrie 79, Cluj-Napoca 3400
Tel +40 951 11371
Population: 328 008
Vol water supplied: 61.5*

Constanta
Regia Apá - Canal, St Calarasi, 22-28 Constanta 8700
Tel +40 4166 4040
Fax +40 4166 2577
Director General:
Dr Ing Pitu Nicolae
Population: 700 000 (max.)
Vol water supplied: 165*
No. reservoirs: 42
Vol sewage treated: 118*
No. sewage plants: 7

Cralova
Regia Autonomá Apá - Canal Termoficare, St Brestei 101, Craiova 1100
Tel +40 51 115748
Fax +40 51 119263
General Manager:
Leonida Nicolaescu
Population: 350 000
Vol water supplied: 64*
No. reservoirs: 8

Cristuru Secuiesc
Acatel Regia Autonoma, Libertatii Nr 16

Deva
Regia Autonomá Gospodárie Comunale, St Depozitelor 2, Deva 2700
Tel +40 956 15852
Population: 78 366
Vol water supplied: 19*

Dimbovita
Regia Autonomá Gospodárie Comunalá Judeteaná, St Dr Marinoui 4, Târgoviste 0200
Tel +40 926 11524
Population: 175 000
Vol water supplied: 53*

Doly
Regia Autonomá Apá - Canal Termoficare, St Brestei 101, Craiova 1100
Tel +40 941 15748
Population: 303 520
Vol water supplied: 64*

Galati
Regia Autonomá Judeteaná de Gospodárie Comunalá, St C Bráncoveanu 2, Galati 6200
Tel +40 934 36040
Population: 325 788
Vol water supplied: 78*

Gheorgheni
Go Regia Autonoma, Gabor Aron Nr 5

Harghita
Regia Autonomá Gospodárie Comunalá, St Salcámi 1, Miercurea-Ciuc 4100
Tel +40 958 14835
Population: 160 000
Vol water supplied: 30*

Iasi
Regia Autonomá Judeteaná Apá - Canal, St M Costáchescu 6, Iasi 6600
Tel +40 981 41685
Population: 342 994
Vol water supplied: 83.1*

Maramores
Regia Autonomá Vital - Gospodárie Comunalá, St Gheorghe Sincai 21, Baia Mare 4800
Tel +40 994 11824
Population: 148 815
Vol water supplied: 37.1*

Miercurea Ciuc
Goscom Regia Autonoma, Salcimi nr 1
Tel +40 66 114835
Fax +40 66 113614
Works Manager:
ing Pall Arpad
Population: 45 000
Vol water supplied: 10.4*
No. reservoirs: 2
Vol sewage treated: 5.2*
No. sewage plants: 1

Mures
Regia Autonomá Gospodárie Comunalá, Str Fabricilor 1, Târgu Mures
Tel +40 65 115263 x 67
Fax +40 65 165557
Director:
Otto Daraban
Population: 164 314
Vol water supplied: 29.2*
No. reservoirs: 14
Vol sewage treated: 26.6*
No. sewage plants: 1

Odorheiu Secuiesc
Urban Gos Regia Autonoma, Huaz Rezso Nr 4

Oradea
Regia Autonoma De Gospodarie Comunala Si Locativa Oradea, 3 Duiliu Zamfirescu St, Oradea 3700
Tel +40 991 35051
Fax +40 991 32576
General Director:
Ing Ioan Ciursas
Population: 220 248
Vol water supplied: 33*
No. reservoirs: 5
Vol sewage treated: 48*
No. sewage plants: 1

Pitesti
Regia Autonomá Regocom, 17 Victoriei St, Pitesti 0300
Tel +40 976 23550
Population: 179 476
Vol water supplied: 61.3*

Prahova
Regia Autonomá Gospodárie Comunalá, St Ana Ipatescu 8, Ploiesti 2000
Tel +40 971 41975
Population: 262 371
Vol water supplied: 40*

Praid
Com -Gos Regia Autonoma, Principala Strada

Satu-Mare
Regia Autonomá Apá - Canal, St Gara Ferastrau 9, Satu-Mare 3900
Tel +40 997 22206
Population: 131 859
Vol water supplied: 24.3*

Sibiu
Regia Autonomá Gospodárie Comunalá, St Eschile 6, Sibiu 2400
Tel +40 69 415252
Fax +40 69 411768
General Director:
Dipl Ing Mircea Niculescu
Population: 170 528
Vol water supplied: 40.75*
No. reservoirs: 7
Vol sewage treated: 28.1*
No. sewage plants: 1

Timis
Regia Autonomá Aquatim, St SF Gheorghe 1, Timis 1900
Tel +40 961 30712
Population: 334 278
Vol water supplied: 64.8*

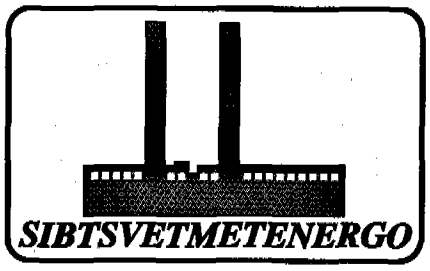
Timisoara
Regia Autonoma Apa Si Canal "Aquatim", Piata Sf Gheorghe nr 1, Timosoara
Tel +40 96 130440
Fax +40 96 132712
General Manager:
Dipl Ing Aurelian Balini
Population: 333 500
Vol water supplied: 81.818*
No. reservoirs: 9
Vol sewage treated: 64.56*
No. sewage plants: 1

Toplita
Ediltop Regia Autonoma, Apelor Nr 1

Tusnad Bai
AC Regia Autonoma, Ciucas Nr 44

Vlahita
Regia Autonoma Ac, Tellor Nr 2

*million m³/year



JOINT STOCK COMPANY SIBTSVETMETENERGO

A. Minyayev - Director
P. O. Box 36, Sayanogorsk, Republic of Khakassiya, Russian Federation
Tel: + 7 (39130) 7 34 29, 7 31 07, 7 34 29, 7 39 81

The company"Sibtsvetmetenergo" was founded in Sayanogorsk in 1984.

The company works in the following fields:

Instalment and repairs of the heat and power supply equipment to the industrial enterprises

Instalment and repairs of sanitary and electrotechnical systems at the industrial and civil buildings and structures

Manufacture of non-standard equipment and tools

Repairs of electric motors of low and medium power capacity

The number of employees is 200.

The annual turnover of the company is US $ 1 800 000.

Government departments and regulating bodies

Committee for Water Management of the Russian Federation (ROSKOMVOD)
3 Orlikov Pereulok, Building B1, Moscow 107130
Tel +7 095 207 6575
Fax +7 095 975 1613
Head of Foreign Relations/Interrepublic: Evgenii Zybin

Department for communal economic affairs of the State Committee for Architecture & Construction
Furkasovsky ruelle 12/5, 101815 Moscow.
Activity: Co-ordination of development and scientific and technical progress in municipal water supply and sewerage systems of Russian Federation
Tel +7 095 925 7546
Fax +7 095 924 6749
Department Director/VP of State Committee: V Avdeev

Institutes and associations

Mosvodokanalniiproject
(Moscow Scientific Research and Design Institute)
Pleteshkovsky per 4, Moscow 107005
Activity: Research, development, engineering design in water supply and sewerage in Moscow
Tel +7 095 261 5384
Fax +7 095 261 7775
Director: Petr P Palgunov

Municipal Water Supply and Water Treatment Research Institute
87 Volokolamskoye Shosse, Moscow 123371
Activity: Research and development in the area of water supply and sewerage in Russian Federation and other republics
Tel +7 095 491 69 69
Fax +7 095 491 55 03
General Director: Dr E Razumovsky

Rosvodokanalproject
35 Volodarsky Str., Moscow 109172
Activity: Engineering design in water supply and sewerage in Russian Federation
Tel +7 095 923 79 78
Fax +7 095 924 95 08
Director: Y Koutyin

Russian Association of Water Supply and Sewerage
6 Chaplygina, 103082 Moscow
Tel +7 095 923 33 86
Fax +7 095 923 32 78
President: Cand Sc (Eng) I Nefyodov

Water suppliers and sewage water treatment/disposal plant

Krasnoyarsk, 660017
Krasnoyarsk Water Supply and Sewerage Administration, 10 Dict. Proletariata Str
Director:
Y Pavlov
Population: 900 000
Vol water supplied: 0.500*
Vol sewage treated: 0.600*

Moscow, 107005
Mosvodocanal, Moscow Municipal Enterprise for Water and Wastewater Management, 4 Pleteshkovsky Pereulok
Tel +7 095 261 67 20
Fax +7 501 940 23 10
General Director:
Stanislav V Khramenkov
Population: 10 000 000
Vol water supplied: 7.2*
No. reservoirs: 12
Vol sewage treated: 6*
No. sewage plants: 3

Nijny Novgorod, 603600
Nijny Novgorod Vodokanal, 15 Kerchenskaia St. Nijny Novgorod 603600
Tel +7 8312 445624
Fax +7 8312 441787
Director:
Jury Anatolievitch Garanin
Chief Engineer:
Alexander Nickolaevich Lukov
Population: 1 500 000
Vol water supplied: 215*
No. reservoirs: 20
Vol sewage treated: 325*
No. sewage plants: 5

Novosibirsk, 630093
Gorvodokanal Novosibirsk (Novosibirsk Water Supply and Sewerage Administration), ul Revolutsii 5, r/s, 630093 Novosibirsk 93
Tel +7 3832 983655
Fax +7 3832 981423
Director:
V Grebaev
Population: 1 700 000
Vol water supplied: 299*
No. reservoirs: 1
Vol sewage treated: 271*
No. sewage plants: 1

St Petersburg, 193015
Vodokanal, St Petersburg Water Supply and Sewerage Territorial Service Administration, 42 Kavalergardskaya Street, St Petersburg 193015
Tel +7 812 274 1090/91
Fax +7 812 274 1361
General Director:
F Karmazinov
Population: 5 000 000
Vol water supplied: 1200*
No. reservoirs: 60
Vol sewage treated: 1200*
No. sewage plants: 12

Volgograd, 400066
Volgograd Water Supply and Sewerage Administration, 15 Chuikov Str
Director:
G Pantin
Population: 1 004 000
Vol water supplied: 287*
No. reservoirs: 18
Vol sewage treated: 146*
No. sewage plants: 2

*million m^3/year

NPO "TEKHENERGOKHIMPROM"

3 Shcherbakovskaya Street, Moscow, 105318, Russian Federation
Российская Федерация 105318 г. Москва ул. Щербаковская, 3
НПО "Техэнергохимпром"
Tel: + 7 (095) 369 32 64 Fax: + 7 (095) 369 33 89

NPO "Tekhenergokhimprom" specialises in the research, design and manufacture of the following components, equipment and technology:

- PVC block packing designed for use in biological water filters and cooling towers with closed water - circulation systems
- Light-weight easy assembly PVC water-intercepting sections for cooling towers capable of reducing water leakage to 0.1 %
- Technology and reagents for water treatment in closed water circulation systems
- High speed self-cleaning filters for the purification of the river, technical and reclaimed water as well as industrial waste with a productivity of 500, 1 000 and 2 000 m^3 per hour
- Continuous action ion exchange plants with a productivity 250 m^3 per hour. These plants consume 30 times less resin than conventional devices.

"BELGORODASBESTOTSEMENT"

The joint stock company "Belgorodasbestotsement" is one of the major Russian manufacturers of a range of asbestos cement pressure pipes (0.6 ÷ 1.5 MPa) with diameters of 100, 150, 200, 250, 300, 400 and 500 mm and 4 and 6 m in length, non - pressure pipes with diameters of 100 mm and 4 m in length and corrugated sheeting of a standard and medium shape.

The annual volume of production is 7 000 km of pipes and 36 million m^2 of corrugated sheeting.

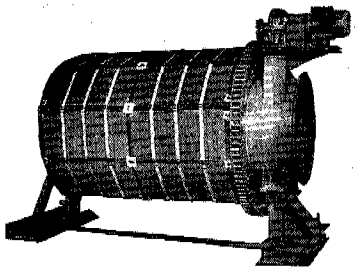
Our products are among the highest grade and cheapest in Russia and they are in great demand with the Russian and foreign customers.

The asbestos cement pipes are used for laying technical and drinking water pipelines, pressure and self-flow sewerage, meliorative systems, drainage collectors, chimneys, for laying cable lines, casing for various wells and for rubbish shoots in blocks of flats. Owing to their low heat conductivity, the pipes are used in heating supply systems. The asbestos cement pipes that were coated with polymers are used for construction of the gas pipelines. These pipes have a number of advantages: they are easy to install, are highly reliable and are resistant to harsh environments. The period of usage exceeds that of metal pipes by several times. These pipes are not subjected to electrochemical corrosion and they have a long service period when put in the soil and also have negligible hydraulic resistance. The pressure asbestos cement pipes are supplied with sets of connecting pieces of the CAM type and rubber rings. The CAM type connecting pieces consist of one asbestos cement coupling with grooves and two rubber rings that work on the self - sealing principle. The pressure affects the walls of the cylinder-shaped concaves of the rubber rings and tightly presses them against the sealing surfaces of the pipes and the couplings. The CAM type connecting pieces provide the absolute air - tightness of the connecting piece.

The asbestos cement corrugated sheets of the standard 54 / 200 shape with 1 750 X 1 125 mm dimensions and the medium 40 / 150 shape with 1 750 X 1 130 mm and 1 750 X 980 mm dimensions are used for roofing as well as sections of fencing.

In addition, AO "BELATSI" has a separate workshop with a manufacturing area of 7 000 m^2 fitted with engineering communications and the company is ready to set up joint ventures of any type with the exception of food processing and medical ones.

104 Michurina Street, Belgorod, 308002, Russian Federation
Tel: +7 (07222) 62673
Fax: +7 (07222) 6 16 68



Send your business proposals to the following address:
111, Truda Ave,
Voronezh,
394646,
The Russian Federation
Tel: +7 (0732) 160200,
160038
Fax: +7 (0732) 161933
Teletype: 153241 KANAL

"VODMASHOBORUDOVANIYE"

"Vodmashoborudovaniye", a plant specialising in the manufacture of various appliances for water supply and sewage systems and consumer goods made from plastic, is interested in the development of business contacts with foreign companies which need the above equipment.

The plant manufactures the following products:

* For the purification of waste water:
— micro-filters and drum nets with a capacity of 0.14 - 4.2 000 m³ per day
— hammer crushers with a capacity of 300 - 600 kg per hour
— grates and crushers with a capacity of 60 - 2000 m³ per hour
— mechanical grates with a capacity of 833 - 5717 m³ per hour
— compact installations with a capacity of 200 m³ per day
— scraper mechanisms for primary and secondary settlers with a capacity of 550 - 1290 m³ per hour
— mechanical rakes with a capacity of 18 000 - 100 000 m³ a day
— plunger pumps with a capacity of 28 - 50 m³

*For water selection for domestic and fire-brigade use
— Water hydrants with a working pressure of 0.6 MPa
— fire hydrants with a working pressure of 1 MPa
— electrically pumped wells with a feed of 25m³ per hour and 100m head

*For the mechanisation of water pipeline repair works and the transportation of radioactive waste
— the water pipeline repair vehicle RVM - 3 (chassis GAZ- 5312 or ZIL-4314)
— the water pipeline maintenance vehicle OVM (chassis UAZ-3741 or GAZ - 5208)
— radioactive waste transportation vehicle (chassis ZIL- 130D1)

"Vodmashoborudovaniye" guarantees
* reliability and the high quality of the equipment
* delivery and installation
* manufacture of the equipment in accordance with the customer's specifications

THE **POLYMER** JOINT STOCK COMPANY OF THE OPEN TYPE (AO POLYMER)

1, Izhevskaya
Penza, 440031
Russia.
Tel: (841-2) 33-72-80
Fax: (841-2) 46-24-93

AO Polymer was founded in 1982 as a company processing polymer waste and manufacturing polymer products from raw materials and waste.

The plant is equipped with Krauss-Muffy machinery imported from Germany for the regeneration of polymer film into granules and with Italian Olmas machinery for the regeneration of large sized waste into granules, and other necessary equipment such as:

- equipment for the manufacture of smooth surface pipes with outer diameters between 25 and 160 mm;
- equipment for the manufacture of polyethylene film with tube widths between 1000 and 1500 mm and thickness between 80 and 250 microns (0.08 - 0.25 mm);
- casting equipment for the manufacture of products of up to 3 kg in weight.;
- blowing equipment with capacities between 20 and 60 litres.

The company offers its products for sale and is looking for partners to set up a joint venture.

Government departments and regulating bodies

Direccion General de Ordenacion Ambiental
Ministerio de Obras Publicas y Transportes, Nuevos Ministerios, Madrid
Tel +34 1 553 1600
Director General: D Enrique Clemente Cubillas

Direccion General de Politica Ambiental
Ministerio de Obras Publicas y Transportes, Nuevos Ministerios, Madrid
Tel +34 1 553 1600
Subdirector General de Cooperacion Int: D Luis Carlos Mas Garcia

Institutes and associations

AERRES
(Asociacion de Empresas de Recuperacion y Reciclaje de Residuos), Alameda Recalde 60, 48008 Bilbao
Tel +34 4 444 4054
Fax +34 4 443 6171

Aqua Espana
aptdo 21067, 08080 Barcelona
Tel +34 3 307 7956
Fax +34 3 309 3364
President: Lorenzo Macías

Centro de Estudios e Investigaciones del Agua
Po de San Juan, 08009 Barcelona

Water suppliers and sewage water treatment/disposal plant

Alicante, 03007
Aguas Municipalizadas de Alicante, Alona 31
Tel +34 6 522 51 41
Fax +34 6 512 69 26

Astigarraga, 20014
Planta de Tratamiento de Aguas del Añarbe, Po de Petritegui s/n, 20014 Astigarraga (Gipuzkoa)
Tel +34 43 47 05 88
Fax +34 43 45 61 92
Ind. Engineer:
A Lete
Population: 300 000
Vol water supplied: 41*
No. reservoirs: 16

Badajoz
Ayuntamiento de Badajoz, Servicio Depuracion de Aguas, Camino de Sta Engracia s/n
Tel +34 24 21 00 75
Jefe Servicio:
Juan José Gomez Garcia
Population: 140 000
Vol water supplied: 13-15*
No. reservoirs: 1
Vol sewage treated: 13.5*
No. sewage plants: 2

Barcelona, 08009
Sociedad General de Aguas de Barcelona, Passeig de San Joan 39
Tel +34 3 265 30 11
Fax +34 3 265 11 36
Presidente Ejecutivo:
D Ricardo Fornesa
Population: 3 000 000
Vol water supplied: 300*
No. reservoirs: 2

Bilbao, 48001
Consorcio de Aguas del Gran Bilbao, Edificio Albia 1
Tel +34 4 487 3100
Fax +34 4 487 3110
Chairman:
Jesus Ma Dunabeitia Vidal
Managing Director:
J M Eizaguirre Basterrechea
Population: 1 000 000
Vol water supplied: 136*
No. reservoirs: 9
Vol sewage treated: 37*
No. sewage plants: 4

Burgos, 09080
Servicio de Aguas Municipal de Burgos, Avda del Cid 12, Apartado deCorreos 152
Tel +34 47 27 30 00
Fax +34 47 26 00 11
Director Gerente:
José Carracedo del Rey
Population: 170 000
Vol water supplied: 25*
No. reservoirs: 3
Vol sewage treated: 32*
No. sewage plants: 1

Cadiz, 11009
Sercicio Municipalizados de Agua, Avda Maria Auxiliadora 4
Tel +34 56 28 11 00
Fax +34 56 27 20 04
Director Gerente:
Juan Sales Márquez
Population: 154 000
Vol water supplied: 20*

Cordoba, 14006
Empresa Municipal de Aguas de Cordoba, Cronista Rey Diaz 2
Tel +34 57 27 51 50
Fax +34 57 28 18 32
Director:
D Antonio Jimenez Medina
Population: 350 000
Vol water supplied: 27*
No. reservoirs: 2
Vol sewage treated: 33*
No. sewage plants: 2

Huelva, 21003
Empresa Municipal de Aguas de Huelva, Alonso Sánchez 2
Tel +34 55 24 72 76
Fax +34 55 25 96 14
Gerente:
Luis Manzano Barrero
Population: 140 000
Vol water supplied: 15*
No. reservoirs: 1
No. sewage plants: 1

Jerez, 11402
Aguas de Jerez Empresa Municipal SA, Cadiz 1
Tel +34 56 32 18 11
Fax +34 56 32 29 50
Gerente:
Francisco Hidalgo Mota
Population: 190 000
Vol water supplied: 14.6*
No. reservoirs: 2
No. sewage plants: 2

La Coruna, 15006
Aguas de La Coruña, Avda Fernandez de la Torre 64-66
Tel +34 81 24 23 22
Fax +34 81 24 34 81
Director-Gerente:
José Antonio Orejon
Population: 300 000
Vol water supplied: 31*
No. reservoirs: 1
No. sewage plants: 4

Las Palmas de Gran Canaria, 35003
Empresa Municipal de Aguas de Las Palmas SA, Plaza de la Constitución 2
Tel +34 28 45 41 00
Fax +34 28 45 41 30
Director Tecnico:
Juan Betancort López
Population: 375 000
Vol water supplied: 27.38*
Vol sewage treated: 18.25*
No. sewage plants: 12

Logrono, 26071
Unidad Tecnica de Aguas, Ayuntamiento de Logroño, Avda de la Paz 11
Tel +34 41 24 32 22
Fax +34 941 23 13 97
Ingeniero Jefe:
Juan José Gil Barco
Population: 123 848
Vol water supplied: 14.4*
No. reservoirs: 1
Vol sewage treated: 14.4*
No. sewage plants: 1

Madrid, 28003
Canal de Isabel II, Santa Engracia 125
Tel +34 1 445 10 00
Fax +34 1 447 93 93
Presidente:
Agapito Ramos Cuenca
Population: 4 707 417
Vol water supplied: 522*
No. reservoirs: 15
Vol sewage treated: 96.86%
No. sewage plants: 10

Madrid, 28004
Seccion de Explotacion de Estaciones Depuradoras, Barcelo 6
Tel +34 1 588 8780
Fax +34 1 445 0848
Director:
J A Heras
Population: 4 000 000
Vol sewage treated: 500*
No. sewage plants: 7

Murcia, 30008
Empresa Municipal de Aguas SA, Plaza Circular 9
Tel +34 68 24 43 11/24 44 24
Fax +34 68 23 70 79
Director:
José Luis Hervas Martin
Population: 332 597
Vol water supplied: 32.14*
Vol sewage treated: 12.44*
No. sewage plants: 1

Oviedo, 33007
Consorcio de Aguas, Santa Susana 6 entresuelo
Tel +34 85 21 00 03
Fax +34 85 20 30 24
Director Gerente:
Ing D Alberto Alvarez Rea
Population: 700 000
Vol water supplied: 44*
No. reservoirs: 2
No. sewage plants: 1

Pamplona, 31002
Mancomunidad de Aguas de Pamplona, Hermanos Imaz 1
Tel +34 48 10 31 00
Fax +34 94 22 99 31
Presidente:
D Carlos Bea Gil
Population: 270 000
Vol water supplied: 26.6*
No. reservoirs: 2
Vol sewage treated: 36.4*
No. sewage plants: 3

San Sebastian, 20004
Mancomunidad de Aguas del Anarbe, Camino 1-4 dcha
Tel +34 43 42 21 95
Fax +34 43 43 10 13
Director Gerente:
Fco Javier Larrea Mendizábal
Population: 300 000
Vol water supplied: 39*
No. reservoirs: 1

Santander, 39007
Servicio de Aguas, General Davila 330
Tel +34 42 33 83 31
Fax +34 42 34 18 16
Director:
***Manuel Rodriguez* Rodriguez**
Population: 230 000
Vol water supplied: 26*
No. reservoirs: 6
Vol sewage treated: 10.4*
No. sewage plants: 2

Sevilla, 41003
Empresa Municipal de Abastecimiento y Saneamiento de Aguas de Sevilla SA, Escuelas Pias 1
Tel +34 5 459 04 08
Fax +34 5 422 65 11
Director Gerente:
Sr D José Pedro Jiménez Gómez
Population: 1 400 000
Vol water supplied: 175*
No. reservoirs: 4
Vol sewage treated: 95*
No. sewage plants: 4

Teruel, 44001
Tedesa, Cl. Tomas Nougués 4
Tel +34 78 607751
Fax +34 78 609723
Contact:
Jesus M Pardos
Population: 30 000
Vol water supplied: 4*
No. reservoirs: 1

Valencia, 46005
Compañia de Aguas Potables de Valencia, Gran Via Marques del Turia 19
Tel +34 6 386 06 00
Fax +34 6 286 05 67
Consejero Delegado:
Alvaro Aguirre
Population: 1 500 000
Vol water supplied: 140*
No. reservoirs: 12
Vol sewage treated: 80*
No. sewage plants: 2

Zaragoza, 50012
Servicio Municipal de Aguas de Zaragoza, Via Hispanidad 45-47
Tel +34 76 75 02 50
Fax +34 76 75 14 46
Jefe Serv Infr Hidráulica:
José Ramón Entralgo Layunta
Population: 600 000
Vol water supplied: 75.3*
Vol sewage treated: 0.79*

*million m^3/year

Government departments and regulating bodies

Statens Livsmedelsverk
(National Food Administration), Drinking Water Division, Box 622, S 751 26 Uppsala
Tel +46 18 17 5500
Fax +46 18 10 5848
Head of Division: Bitte Erlandsson

Statens Naturvardsverk
(Swedish Environmental Protection Agency), Smidesvägen 5, S 171 85 Solna
Tel +46 8 698 10 00
Fax +46 8 20 29 25
Director General: Rolf Annerberg
Institutes and associations

Svenska Kommunförbundet
(The Swedish Association of Local Authorities), Jan Söderström, S-118 82 Stockholm
Tel +46 8 772 4505
Fax +46 8 642 6654
Director: Jan-Ake Björklund

Svenska Vatten & Avloppsverksföreningen (VAV)
(The Swedish Water & Wastewater Works Association), Regeringsgatan 86, S 111 39, Stockholm
Tel +46 8 23 2935
Fax +46 8 21 3751
Managing Director: Hakan Westerlund

Water suppliers and sewage water treatment/disposal plant

Älvsborg county

Alingsås
Population: 25 679
Vol water supplied: 3*
No. sewage plants: 4

Borås
Population: 88 580
Vol water supplied: 10*
No. sewage plants: 16
Lerum
Tel +46 302 50212
Fax +46 302 50388
Contact:
Jan Söderberg
Population: 27 315
Vol water supplied: 2.1*
No. reservoirs: 7
Vol sewage treated: 3-4*
No. sewage plants: 6

Mark
Population: 23 150
Vol water supplied: 2*
No. sewage plants: 10
Trollhättan
Tekniska Verken VA, S 461 83

Trollhättan
Tel +46 520 87505
Fax +46 520 87534
VA-Verkschef:
Ronald Svensson
Population: 45 800
Vol water supplied: 7*
No. reservoirs: 3
Vol sewage treated: 15*
No. sewage plants: 2

Ulricehamn
Ulricehamns kommun, Teknisk Kontoret, S -52386 Ulricehamn
Tel +46 321 27056
Fax +46 321 27085
Drift-ing:
Ingemar Pettersson
Population: 15 400
Vol water supplied: 1.4*
No. reservoirs: 14
Vol sewage treated: 3.5*
No. sewage plants: 15

Vänersborg
Population: 29 450
Vol water supplied: 3*
No. sewage plants: 5

Blekinge county

Karlskrona
Va-verket, Karlskrona Kommun
Tel +46 455 83000
Fax +46 455 82233
Director:
Anders Jaryd
Population: 50 000
Vol water supplied: 5*
No. reservoirs: 8
Vol sewage treated: 8*
No. sewage plants: 20

Sölvesborg
Energi Och Vatten AB, Av 701 Box 30
Tel +46 456 16098
Fax +46 456 10160
Director:
Lars Åkesson
Population: 16 000
Vol water supplied: 1.7*
No. reservoirs: 3
Vol sewage treated: 2.5*
No. sewage plants: 6

Gävleborgs county

Bollnäs
Population: 21 259
Vol water supplied: 2*
No. sewage plants: 13
Gävle
Gävle Vatten & Dolopp
Tel +46 26 178400
Fax +46 26 184640
Head of Water & Wastewater Dept:
Ing Marl Douhan
Population: 89 000
Vol water supplied: 11*
No. reservoirs: 10
Vol sewage treated: 15.5*
No. sewage plants: 4

Sandviken
Vattenreningsverk
Tel +46 26 240000
Fax +46 26 270472
Population: 36 203
Vol water supplied: 6*
No. reservoirs: 6
Vol sewage treated: 5.5*
No. sewage plants: 10

Söderhamn
Vol water supplied: 4*
No. sewage plants: 10

Göteborgs o Bohus county

Göteborg
Göteborgs Va-Verk, Box 123, 424 23 Angered
Tel +46 31 627000
Fax +46 31 627050
Director:
Sven-Eric Kristenson
Population: 430 000
Vol water supplied: 62*
No. reservoirs: 18
Vol sewage treated: 91*
No. sewage plants: 3

Mölndal
Population: 47 700
Vol water supplied: 5*
No. sewage plants: 2

Partille
Tel +46 313 61295
Fax +46 314 45980
Contact:
Roland Brandshage
Population: 30 900
Vol water supplied: 2*
No. reservoirs: 5
Vol sewage treated: 2*

Sotenäs
Sotenäs Kommun, S-456 80 Kungshamn
Tel +46 523 39557
Fax +46 523 38100
Principal Officer:
Conny Stensson
Population: 7900
Vol water supplied: 2*
No. reservoirs: 3
No. sewage plants: 4

Uddevalla
Population: 35 300
Vol water supplied: 5*
No. sewage plants: 4

Gotlands county

Gotlands
Vattenreningsverk
Tel +46 498 269000
Fax +46 498 247744
Drift Chef:
Goran Blomgren
Population: 38 000
Vol water supplied: 5*
No. sewage plants: 31

Hallands county

Halmstad
Västra Stranden Sewage Treatment Plant, Box 246
Tel +46 3513 8035
Fax +46 3511 5892
Manager:
Lars Ohlsson
Population: 72 350
Vol water supplied: 8*
No. reservoirs: 15
Vol sewage treated: 11.5*
No. sewage plants: 10

Kungsbacka
Population: 44 180
Vol water supplied: 4*
No. sewage plants: 6

Varberg
Population: 35 654
Vol water supplied: 6*
No. sewage plants: 19

Jämtlands county

Krokom
Krokoms kommun, S 835 80 Krokum
Tel +46 640 16441
Fax +46 640 16445
Contact:
Kenth Blom
Population: 9000
Vol water supplied: 1.4*
No. reservoirs: 10
Vol sewage treated: 1.6*
No. sewage plants: 22
Strömsund
Population: 12 891
Vol water supplied: 1*
No. sewage plants: 16

Jönkopings county

Eksjö
Eksjö Kommun Va-Verket
Tel +46 381 36000
Driftchef:
Sven-Erik Johansson
Population: 15 700
Vol water supplied: 2*
No. reservoirs: 7
Vol sewage treated: 3*
No. sewage plants: 7

Gislaved
Population: 22 900
Vol water supplied: 2*
No. sewage plants: 13

Jönköping
Jönköping kommun, Tekniska Kontoret, VAF-avdelningen, S 551 89 Jönköping
Tel +46 36 105000
Fax +46 36 165085
Driftingenjör:
Lars Hakeman
Population: 100 900
Vol water supplied: 12*
No. reservoirs: 25
Vol sewage treated: 17*
No. sewage plants: 15

Nässjö
Nässjö Affärsverk AB, VA-verket, S 571 80 Nässjö
Tel +46 380 78000
Fax +46 380 14390
VA-chef:
Wallis Karlsson
Population: 25 400
Vol water supplied: 2*
No. reservoirs: 12
Vol sewage treated: 6*
No. sewage plants: 9

Sävsjö
Sävsjö kommun, Tekniska Förvaltningen, S 576 80 Sävsjö
Tel +46 382 15247
Fax +46 382 15210
Diector:
Björn Svensson
Population: 8708
Vol water supplied: 1*
No. reservoirs: 5
Vol sewage treated: 2*
No. sewage plants: 8

Tranås
Va-Verket
Tel +46 140 68100
Fax +46 140 17650
Teknisk Chef:
Per-Erik Lingh
Population: 15 700
Vol water supplied: 2*
No. reservoirs: 3
Vol sewage treated: 3*
No. sewage plants: 4

Vetlanda
Vattenreningsverk
Tel +46 383 97343
Fax +46 383 19181

*million m^3/year

Contact:
Göran Nilsson
Population: 22 779
Vol water supplied: 2*
No. reservoirs: 20
Vol sewage treated: 3-4*
No. sewage plants: 19

Värnamo
Vattenreningsverk
Tel +46 370 40150
Fax +46 370 40179
Driftschef:
Nils Jansson
Population: 24 900 (1991)
Vol water supplied: 2.3*
No. reservoirs: 16
Vol sewage treated: 3*
No. sewage plants: 16

Kalmar county

Kalmar
Miljö & Vatten Kalmar Vatten och Renhallning AB, Kalmar, Kalmar County, Sweden
Tel +46 480 83000
Fax +46 480 83226
Principal Officer:
Hans Dahl
Population: 50 000
Vol water supplied: 6*
No. reservoirs: 10
Vol sewage treated: 8*
No. sewage plants: 5

Mönsterås
Mönsteras Kommun, PO Box 54, S038322 Mönsteras
Tel +46 499 17170
Fax +46 499 13695
Principal Officer:
Jens Falkman
Population: 10 130
Vol water supplied: 0.9*
No. reservoirs: 6
Vol sewage treated: 1.5*
No. sewage plants: 3

Nybro
Population: 16 500
Vol water supplied: 1*
No. sewage plants: 11

Oskarshamn
Vattenreningsverk
Tel +46 491 88243
Fax +46 491 88159
Tekniska Kontovet:
Jan Sandberg
Population: 23 230
Vol water supplied: 2*
No. reservoirs: 6
Vol sewage treated: 6*
No. sewage plants: 4

Västervik
Population: 36 780
Vol water supplied: 4*
No. sewage plants: 22

Kopparbergs county

Borlänge
Borlänge Gatukontor VA-avd, S-78181 Borlänge
Tel +46 243 74000
Fax +46 243 66030
Avd. chef:
Lars Norman
Population: 44 500
Vol water supplied: 7*
No. reservoirs: 9
Vol sewage treated: 6*
No. sewage plants: 3

Falun
Population: 43 000
Vol water supplied: 6*
No. sewage plants: 10

Ludvika
Ludvika Kommun
Tel +46 240 86776
Fax +46 240 86380
Driftingenjör:
Sven-Erik Söderberg
Population: 28 580
Vol water supplied: 4*
No. reservoirs: 5
Vol sewage treated: 5.3*
No. sewage plants: 6

Kristianstads county

Bromölla
Vattenreningsverk
Tel +46 456 22000
Fax +46 456 22200
Gatuchef:
Stefan Apelros
Population: 10 000
Vol water supplied: 1*
No. reservoirs: 2
Vol sewage treated: 1.3*
No. sewage plants: 2

Båstad
Båstads kommun, Tekniska Kontoret, S 269 80 Båstad
Tel +46 431 77000
Fax +46 431 44021
Contact:
Sigvard Petersson
Contact:
Hans Ramhorn
Population: 14 500
Vol water supplied: 1.97*
No. reservoirs: 5
Vol sewage treated: 1.55*
No. sewage plants: 1

Hässleholm
Vattenreningsverk
Tel +46 451 88000
Fax +46 451 89760
Drift-ing:
Percy Petersson
Population: 41 400
Vol water supplied: 4.15*
No. reservoirs: 17
Vol sewage treated: 6.7*
No. sewage plants: 14

Kristianstad
Vattenreningsverk
Tel +46 44 135140
Fax +46 44 129689
Gatuchef:
Ove Gustavsson
Population: 52 200
Vol water supplied: 7*
No. reservoirs: 31
Vol sewage treated: 9*
No. sewage plants: 14

Simrishamn
Population: 14 860
Vol water supplied: 2*
No. sewage plants: 7

Ängelholm
Vattenreningsverk
Tel +26 431 87000
Fax +46 431 87596
Director:
Civ Ing Steen Bjerggaard
Population: 26 000
Vol water supplied: 3*
No. reservoirs: 2
Vol sewage treated: 5.5*
No. sewage plants: 3

Kronobergs county

Alvesta
Population: 13 685
Vol water supplied: 1*
No. sewage plants: 7

Lessebo
VA verken, Lessebo Kommun, 36050 Lessebo
Tel +46 478 12500
Fax +46 478 31317
Gatuchef:
Nils-Erik Carlström
Population: 3000
Vol water supplied: 0.94*
No. reservoirs: 1
Vol sewage treated: 1.9*
No. sewage plants: 4

Ljungby
Vattenreningsverk
Tel +46 372 89000
Fax +46 372 12088
Va-Chef:
Stig Gustavsson
Population: 19 100
Vol water supplied: 2.1*
No. reservoirs: 17
Vol sewage treated: 3.7*
No. sewage plants: 12

Växjö
Population: 58 199
Vol water supplied: 6*
No. sewage plants: 14

Malmöhus county

Lund
Tel +46 35 50 00
Fax +46 14 68 65
Overingenj~/or:
Yngue Darte
Population: 90 000
Vol water supplied: 10*
No. reservoirs: 16
Vol sewage treated: 16*
No. sewage plants: 9

Malmö
VA-Verket Sydvatten
Tel +46 40 255000
Fax +46 40 301822
Managing Director:
Oerjan Cronström
Population: 600 000
Vol water supplied: 63*
No. reservoirs: 3

Malmö
Population: 55 000
Vol water supplied: 7*
No. sewage plants: 2

Vellinge
Vattenreningsverk
Tel +46 40 451739
Fax +46 40 420477
Director:
Arvid Soederlindh
Population: 27 500
Vol water supplied: 2.5*
No. reservoirs: 3
Vol sewage treated: 2*
No. sewage plants: 1

Ystad
Ystads kommun, Gatukontoret, VA-avdelningen, 271 80 Ystad
Tel +46 411 77156
Fax +46 411 14792
VA chef:
Anders Nilsson
Population: 22 000
Vol water supplied: 2.6*
No. reservoirs: 2
Vol sewage treated: 7.3*
No. sewage plants: 5

Norrbottens county

Boden
Vattenreningsverk
Tel +46 921 62178
Fax +46 921 17092
Va-Chef:
Ove Andersson
Population: 27 400
Vol water supplied: 4*
No. reservoirs: 3
Vol sewage treated: 5*
No. sewage plants: 31

Kiruna
Kiruna Kommun, Byggnadskontoret, 981 85 Kiruna
Tel +46 980 70000
Fax +46 980 17692
Teknisk chef:
Håkan Spett
Population: 25 100
Vol water supplied: 4*
No. reservoirs: 22
Vol sewage treated: 4*
No. sewage plants: 22

Luleå
Vattenreningsverk, Tekniska Kontoret, S-951 87 Lulea
Tel +46 920 293167
Fax +46 920 18603
Director:
Stefan Marklund
Population: 65 000
Vol water supplied: 8*
No. reservoirs: 3
Vol sewage treated: 10.3*
No. sewago plants: 11

Piteå
Tel +46 911 96226
Fax +46 911 13145
Population: 37 948
Vol water supplied: 4*
No. reservoirs: 4
Vol sewage treated: 6*
No. sewage plants: 22

Örebro county

Karlskoga
Population: 32 600
Vol water supplied: 7*
No. sewage plants: 5
Lindesberg
Population: 20 000
Vol water supplied: 2*
No. sewage plants: 11

Örebro
Vattenreningsverk
Tel +46 19 211000
Fax +46 19 211584
Director - water supply:
Royne Larsson
Director - sewage treatment:
Leif Eriksson
Population: 101 800
Vol water supplied: 15*
No. reservoirs: 12
Vol sewage treated: 17*
No. sewage plants: 14

Östergötlands county

Finspång
Population: 19 192
Vol water supplied: 3*
No. sewage plants: 5

Linköping
Tekniska Verken i Linköping AB, Box 1500, S-58115 Linköping
Tel +46 13 20 81 28
Fax +46 13 20 80 11
Director:
Sven-Erik Kreij
Population: 120 000
Vol water supplied: 14.7*
No. reservoirs: 17
Vol sewage treated: 16.8*
No. sewage plants: 9

Motala Kommun
Vattenreningsverk
Tel +46 141 25116
Fax +46 141 16925
Va-Chef:
Gillis Ulmstedt
Population: 36 600
Vol water supplied: 4*
No. reservoirs: 4
Vol sewage treated: 5*
No. sewage plants: 12

Norrköping
Norrköpings Kommun, Va-verket (Water Supply), 60181 Norrköping
Tel +46 11 151541
Fax +46 11 170685
Director (Head office):
Lennart Forsell
Water works manager:
Arne Kristensson
Population: 120 800
Vol water supplied: 15*
No. reservoirs: 11

Norrköping
Norrköpings Kommun, Va-verket (Sewage treatment), 60181 Norrköping
Tel +46 11 151558
Fax +46 11 104143
Director (Head office):
Lennart Forsell
Sewage treatment works manager:
Rolf Kvarfordt
Population: 110 400
Vol sewage treated: 16*
No. sewage plants: 11

Skaraborgs county

Mariestad
Mariestads Kommun, Tekniska Kontoret, Driftenheten, S-54286 Mariestad
Tel +46 501 63000
Fax +46 501 63072
Department Manager:
Ove Ekberg
Population: 18 889
Vol water supplied: 1.96*
No. reservoirs: 8
Vol sewage treated: 2.6*
No. sewage plants: 5

Stenstorp
Kommunalförbundet Skaraborgsvatten
Tel +46 500 451272
Fax +46 500 451272
Director:
Kent Karlsson
Population: 100 000
Vol water supplied: 9*
No. reservoirs: 8

*million m^3/year

Södermanlands county

Eskilstuna
Population: 81 700
Vol water supplied: 10*
No. sewage plants: 7

Nyköping
Va-Verket
Tel +46 155 248117
Fax +46 155 248098
Va-Chef:
Anders Karlsson
Population: 42 000
Vol water supplied: 4.5*
No. reservoirs: 3
Vol sewage treated: 7.5*
No. sewage plants: 16

Strängnäs
Population: 20 900
Vol water supplied: 3*
No. sewage plants: 8

Stockholms county

Botkyrka
Population: 33 340
Vol water supplied: 3*

Haninge
Vattenreningsverk
Tel +46 8 606 7000
Fax +46 8 606 8717
Va-Chef:
Ronny Tarnestedt
Population: 60 000
Vol water supplied: 3*
No. reservoirs: 3
Vol sewage treated: 1.8*
No. sewage plants: 3

Norvatten
Kommunal Förbundet Norrvatten (Stockholm District Water Board), Skogsbacken 6, Sundbyberg, Box 2093, 17102 Solna
Tel +46 8 627 3700
Fax +46 8 627 5330
Executive Director:
Tore Burtus
Population: 425 000
Vol water supplied: 50*
No. reservoirs: 7

Stockholm
Stockholm Vatten AB / Stockholm Water Co, S 106 36 Stockholm
Tel +46 8 736 2000
Fax +46 8 736 2002
Managing Director:
Sven-Erik Skogsfors
Population: 987 237
Vol water supplied: 136.5*
No. reservoirs: 8
Vol sewage treated: 151.7*
No. sewage plants: 3

Södertälje
Vattenreningswerk
Tel +46 8 550 23111
Fax +46 8 550 23108
Teknisk Direktor:
Mats BO Larsson
Population: 80 000
Vol water supplied: 11*
No. reservoirs: 7
Vol sewage treated: 3*
No. sewage plants: 3

Uppsala county

Enköping
Vattenreningsverk
Tel +46 171 25537
Fax +46 171 25018
Verksingenjor:
Viking Walgeborg
Population: 24 250
Vol water supplied: 3*
No. reservoirs: 2
Vol sewage treated: 4.5*
No. sewage plants: 6

Uppsala
Population: 144 100
Vol water supplied: 21*
No. sewage plants: 21

Värmlands county

Arvika
Population: 17 275
Vol water supplied: 3*
No. sewage plants: 12

Karlstad
Population: 75 000
Vol water supplied: 9*
No. sewage plants: 10

Kristinehamn
Vattenreningsverk
Tel +46 550 88000
Fax +46 550 10590
Head of Water Supply Section:
Kjell Levin
Population: 21 900
Vol water supplied: 3*
No. reservoirs: 10
Vol sewage treated: 5*
No. sewage plants: 3

Säffle
Säffle Kommun
Tel +46 533 81750
Fax +46 533 10276
Contact:
Nils-Erik Einarssum:
Population: 11 946
Vol water supplied: 2*
No. reservoirs: 4
Vol sewage treated: 6*
No. sewage plants: 3

Västerbottens county

Skellefteå
VA Verket
Tel +46 910 58000
Fax +46 910 11345
VA-chef:
Sture Bergström
Population: 67 000
Vol water supplied: 8.4*
No. reservoirs: 21
Vol sewage treated: 8.5*
No. sewage plants: 16

Umeå
Umeå Kommun, Technical Department, Water Supply/Sewer & Waste Disposal, S 901 84 Umeå
Tel +46 90 161000
Fax +46 90 161347
Director:
Birgitta Fritzdotter
Population: 95 000
Vol water supplied: 10*
No. reservoirs: 10
Vol sewage treated: 12*
No. sewage plants: 22

Västernorrlands county

Härnösand
Härnösands kommun, Box 1005, S 871 29 Härnösand
Tel +46 611 28225
Fax +46 611 28222
Teknisk direktor:
Lennart Berggren
Population: 25 375
Vol water supplied: 3*
No. reservoirs: 7
Vol sewage treated: 3.8*
No. sewage plants: 8

Sollefteå
Tel +46 620 82000
Fax +46 620 82291
VA-Chef:
Bo Berglund
Population: 21 175
Vol water supplied: 3*
No. reservoirs: 15
Vol sewage treated: 3*
No. sewage plants: 17

Sundsvall
Sundsvall Vatten AB, Box 823, 85123 Sundsvall
Tel +46 60 191000
Fax +46 60 127519
Director of Waterworks:
Sune Källström
Population: 82 500
Vol water supplied: 16*
No. reservoirs: 35
Vol sewage treated: 20*
No. sewage plants: 30

Örnsköldsvik
Vattenreningsverk
Tel +46 660 88407
Fax +46 660 88445
Director:
Börje Lindgren
Population: 51 465
Vol water supplied: 6.3*
No. reservoirs: 52
Vol sewage treated: 9*
No. sewage plants: 30

Västmanlands county

Västerås
Tekniska Verken/Va-Verket, Carl Hennings Gata 2
Tel +46 21 161171
Fax +46 21 115860
Population: 115 000
Vol water supplied: 18*
No. reservoirs: 4
Vol sewage treated: 20*
No. sewage plants: 6

*million m³/year

Government departments and regulating bodies

Bundesamt für Gesundheitswesen (Federal Office of Public Health)
Bollwerk 27, Postfach 2644, CH 3001 Bern
Tel +41 31 322 9511
Fax +41 31 322 9507
Director: Prof Dr med Thomas Zeltner

Bundesamt für Wasserwirtschaft
Postfach, CH 3001 Bern
Tel +41 31 322 5411
Fax +41 31 322 5451
Director: Dr A Lässker

BUWAL
(Bundesamt für Umwelt, Wald und Landschaft),
Monbijoustrasse 43, CH 3003 Bern
Tel +41 31 322 9320
Fax +41 31 371 2583
Head of Water Protection and Fishery Div: Dr H U Schweizer

Institutes and associations

Aqua Suisse
(Swiss Federation of Water Treatment Professionals),
Advokaturbüro P Wüthrich, Schloesslistr. 9A, Postfach 8915, 3001 Bern
Tel +41 31 382 2100
Fax +41 31 382 2089
Secretary: P Wüthrich

EAWAG
(Swiss Federal Institute for Environmental Science and Technology)
Ueberlandstrasse 133, CH 8600 Dübendorf
Tel +41 1 823 54 49
Fax +41 1 823 53 98
Contact: Prof A J B Zehnder

Schweizerischer Verein des Gas- und Wasserfaches (SVGW)
(Swiss Gas and Water Industry Association),
Grütlistrasse 44, 8002 Zürich
Tel +41 1 288 3333
Fax +41 1 202 1633
Director: Dr A Kilchmann

Verband Schweizerischer Abwasserfachleute (VSA)
(Sewage treatment industry),
Strassburgstrasse 10,
Postfach, CH 8026 Zürich
Tel +41 1 241 2585

Water suppliers and sewage water treatment/disposal plant

Aarau, 5000
Industrielle Betriebe Aarau,
Obere Vorstadt 37, 5000 Aarau
Population: 18 223
Vol water supplied: 4.4*

Adliswil, 8134
Stadtverwaltung Adliswil,
Werke, Zürichstrasse 13,
8134 Adliswil
Population: 15 766
Vol water supplied: 1.6*

Affoltern a A, 8910
Wasserversorgungs-Genossenschaft,
Zürichstrasse 98, 8910 Affoltern a A
Tel +41 1 761 1242
Fax +41 1 761 1416
Betriebsleiter:
W Kleiner
Population: 9413
Vol water supplied: 1.4*
No. reservoirs: 5

Altdorf, 6460
Wasserversorgungs Altdorf,
Gemeindebauamt, Tellsgasse 25, 6460 Altdorf
Tel +41 44 214 44
Fax +41 44 315 39
Population: 8600
Vol water supplied: 2.9*
No. reservoirs: 2
Vol sewage treated: 4*
No. sewage plants: 1

Amriswil, 8580
Techn Gemeindebetriebe Gas und Wasser,
Egelmoosstrasse 1, 8580 Amriswil
Population: 10 735
Vol water supplied: 2.4*

Arbedo, 6517
Azienda comunale acqua potabile, 6517 Arbedo
Tel +41 92 29 17 03
Fax +41 92 29 35 93
Capodicastero:
Bruno Pellandini
Population: 3988
Vol water supplied: 0.8*
No. reservoirs: 2
Vol sewage treated: 0.4*
No. sewage plants: 1

Arbon, 9320
Wasser- und Elektrizitätswerk,
Hauptstrasse 12, 9320 Arbon
Tel +41 71 46 32 32
Fax +41 71 46 90 44
Betriebsleiter:
Heinz Benz
Population: 11 256
Vol water supplied: 4*
No. reservoirs: 1
Vol sewage treated: 3.5*
No. sewage plants: 1

Arisdorf, 4422
Einwohnergemeinde
Arisdord, 4422 Arisdorf
Tel +41 61 816 90 40
Fax +41 61 816 90 41
Gemeinderat:
Alfred Gruber
Population: 1151
Vol water supplied: 0.13*
No. reservoirs: 2
Vol sewage treated: 0.13*
No. sewage plants: 1

Arth, 6415
Gemeindewerke Arth, Abt Wasser, Gotthardstrasse 21, 6415 Arth
Tel +41 82 11 62
Fax +41 82 47 10
Betriebsleiter:
E Burkart
Population: 7650
Vol water supplied: 0.8*
No. reservoirs: 3

Baar, 6340
Korporation Baar,
Wasserversorgung,
Schutzengelstrasse 25, 6340 Baar
Population: 13 800
Vol water supplied: 1.6*

Basel, 4008
Industrielle Werke Basel,
Postfach, 4008 Basel
Tel +41 61 275 52 66
Fax +41 61 275 51 80
Vizedirektor:
W Ashwanden
Population: 212 000
Vol water supplied: 32.5*
No. reservoirs: 13

Bellinzona, 6500
Aziende Municipalizzate,
Sezione acqua, Vicolo Muggiasca 1 A
Tel +41 92 26 08 11
Fax +41 92 26 08 40
Director:
Ing Raffaele Tognacca
Population: 18 000
Vol water supplied: 2.9*
No. reservoirs: 5
Vol sewage treated: 7.7*
No. sewage plants: 1

Belp, 3123
Gemeindebetriebe Belp,
Güterstrasse 13, 3123 Belp
Tel +41 31 818 22 22
Fax +41 31 818 22 59
Betriebsleiter GBB:
E Maurer
Population: 8000
Vol water supplied: 0.56*
No. reservoirs: 2
Vol sewage treated: 0.56*
No. sewage plants: 1

Bern, 3001
Gas-und Wasserversorgung der Stadt Bern, Schloesslistr. 9A, Post fach 8615, 3001 Bern
Tel +41 31 382 2100
Fax +41 31 382 2089
Direktor GWB:
Dr K Egger
Population: 134 690
Vol water supplied: 24.6*
No. reservoirs: 4

Bex, 1880
Service des eaux, 1880 Bex
Tel +41 25 63 02 70
Fax +41 25 63 02 72
Ingénieur Communal:
Eric Maendly
Population: 5500
Vol water supplied: 0.7*
No. reservoirs: 5
Vol sewage treated: 0.5*
No. sewage plants: 1

Biel, 2501
Gas-und Wasserversorgung,
Rennweg 62, Postfach 779, 2501 Biel
Tel +41 32 21 27 53
Fax +41 32 21 27 49
Direktor:
R Jordan
Population: 57 000
Vol water supplied: 7.1*
No. reservoirs: 8
Vol sewage treated: 29.8*
No. sewage plants: 1

Bioggio, 6934
Azienda Acqua Potabile Comunale, 6934 Bioggio
Tel +41 Bioggio 59 55 81
Fax +41 Bioggio 50 55 81
Aiuto-tecnico:
Degiorgi Wandro
Population: 1360
Vol water supplied: 0.43*
No. reservoirs: 5
No. sewage plants: 1

***Birr-Lupfig*, 5242**
Wasserversorgung Birr,
Postfach, 5242 Birr-Lupfig
Tel +41 56 94 01 11
Fax +41 56 94 86 39
Gemeinderat:
Arthur Pajarola
Population: 3450
Vol water supplied: 0.75*
No. reservoirs: 2

Birsfelden, 4127
Einwohnergemeinde,
Wasserwerk, Hardstrasse 21, 4127 Birsfelden
Population: 11 931
Vol water supplied: 1.7*

Breganzona, 6932
Azienda acqua potabile, 6932 Breganzona
Tel +41 91 57 18 22
Fax +41 91 57 35 56
Director:
Sig Vuerich Gilberto
Population: 5158
Vol water supplied: 0.65*
No. reservoirs: 2
Vol sewage treated: Waste water treatment by IDA, Consozio Depurazione Acque, Bioggio

Brugg, 5200
Industrielle Betriebe der Stadt Brugg, 5200 Brugg
Population: 10 002
Vol water supplied: 1.5*

Buchs SG, 9471
Wasser-und Elektrizitätswerk der Gemeinde Buchs,
Grünaustrasse 31, Postfach, 9471 Buchs SG
Tel +41 81 756 11 38
Fax +41 81 756 19 45
Direktor:
E Tanner
Population: 10 000
Vol water supplied: 1.6*
No. reservoirs: 5
No. sewage plants: 1

Bülach, 8180
Wasserversorgung der Stadt, 8180 Bülach
Population: 13 324
Vol water supplied: 1.7*

Bulle, 1630
Services Industriels, Service des eaux, Rue de Vevey 29, 1630 Bulle
Population: 10 584
Vol water supplied: 5.4*

Büren a A, 3294
Gemeindebetriebe, Wasserversorgung,
Ringmauerweg 32, 3294 Büren a A
Tel +41 32 81 23 17
Fax +41 32 81 49 70
Betriebsleiter:
Fritz Schori
Population: 3200
Vol water supplied: 0.45*
No. reservoirs: 3
Vol sewage treated: 0.3*
No. sewage plants: Regionale Kläranlage Grenchen

Burgdorf, 3400
Industrielle Betriebe Burgdorf,

*million m³/year

Bernstr 102, Postfach 608,
3400 Burgdorf 1
Population: 14 587
Vol water supplied: **3.1***

Bützberg, 4922
Sekretariat Kommission Gemeindebetriebe
Thunstetten, 4922 Bützberg
Tel +41 63 43 18 63
Fax +41 63 43 12 25
Präsident der Gemeindebetriebe:
Ernst Iseli
Population: 3600
Vol water supplied: **0.49***
No. reservoirs: 2
Vol sewage treated: 0.75*
No. sewage plants: 1

Cossonay, 1304
Commune de Cossonay, Service des eaux, Rue Neuve 1, 1304 Cossonay
Tel +41 21 861 2761
Fax +41 21 861 3739
Chef du Service des Eaux:
Gilbert Rapin
Population: 2458
Vol water supplied: 0.35*
No. reservoirs: 1
Vol sewage treated: 0.3*
No. sewage plants: 1

Davos-Platz 7270
Gemeindewasserversorgung, Rathaus, 7270 Davos-Platz
Tel +41 81 44 31 11
Fax +41 81 43 75 57
Gemeindeingenieur:
Kurt Eberle
Population: 12 000
Vol water supplied: **3.1***
No. reservoirs: 9
Vol sewage treated: 6.5*
No. sewage plants: 4

Delémont, 2800
Services Industriels, Route de Bâle 1, 2800 Delémont
Population: 11 500
Vol water supplied: 2.0*

Dietikon, 8953
Wasserversorgung Dietikon, Schöneggstrasse 30, 8953 Dietikon
Tel +41 1 744 3535
Fax +41 1 741 5016
Werkvorstand:
Arthur Hess
Population: 21 357
Vol water supplied: 2.87*
No. reservoirs: 3
No. sewage plants: 1

Dübendorf, 8600
Genossenschaft Wasserversorgung, Sunnhaldenstrasse 28 B, 8600 Dübendorf
Tel +41 1 821 96 65
Fax +41 1 821 66 07
President:
Hansjörg Schöpf
Population: 20 000
Vol water supplied: 2.56*
No. reservoirs: 3
Vol sewage treated: 4*
No. sewage plants: 1

Ebikon, 6030
Wasserversorgung Ebikon, Dorfstrasse 2, 6030 Ebikon
Tel +41 41 30 33 11
Fax +41 41 33 10 18
Chef Wasser und Gas:
Franz Bründler
Population: 10 000
Vol water supplied: 2.1*
No. reservoirs: 3
No. sewage plants: 1

Elm, 8767
Wasserversorgung, Postfach 32, 8767 Elm
Tel +41 58 86 1721
Fax +41 58 86 2325
Betriebsleiter:
Walter Frei
Population: 658
Vol water supplied: 0.23*
No. reservoirs: 6
Vol sewage treated: 0.35*
No. sewage plants: 1

Emmenbrücke 6021
Gemeinde Emmen, Wasserversorgung, Postfach 1441
Tel +41 41 59 01 11
Fax +41 41 55 00 00
Ingenier:
H Gantenbein
Population: 32 500
Vol water supplied: **3.34***
No. reservoirs: 2
Vol sewage treated: 3*
No. sewage plants: 1

Fällanden, 8117
Wasserversorgung Fällanden, Postfach, 8117 Fällanden
Tel +41 825 12 36
Fax +41 825 29 18
Betriebsleiter:
Herrn Köhl
Population: 6635
Vol water supplied: 0.6*
No. reservoirs: 4
Vol sewage treated: 4.08*
No. sewage plants: 1

Fleurier, 2114
Services Industriels, Service des eaux, Grenier 2, 2114 Fleurier
Tel +41 38 61 10 59
Fax +41 38 61 12 49
Director:
Michel Niederhauser
Population: 3714
Vol water supplied: 0.28*
No. reservoirs: 1
No. sewage plants: 3

Frauenfeld, 8500
Gas-und Wasserwerk, Gaswerkstrasse 13, 8500 Frauenfeld
Population: 19 700
Vol water supplied: **4***

Genève, 1211
Services Industriels, 12 rue du Stand, 1211 Genve 11
Tel +41 22 320 8811
Fax +41 22 343 9230
Director:
P Giacasso
Population: 390 503
Vol water supplied: **87***
No. reservoirs: 12
Vol sewage treated: **87***
No. sewage plants: 5

Geroldswil, 8954
Gemeinde Geroldswil, Abt Wasserversorgung, 8954 Geroldswil
Population: 10 135
Vol water supplied: **1.4***

Giubiasco, 6512
Azienda acqua potabile, Piazza Girande, 6512 Giubiasco
Tel +41 92 27 33 55
Fax +41 92 27 38 00
Contact:
Paolini Tiziano
Population: 7051
Vol water supplied: 0.94*
No. reservoirs: 1
Vol sewage treated: **1.4***
No. sewage plants: 1

Glattbrugg, 8152
Wasserversorgung Opfikon, Oberhauserstrasse 25, 8152 Glattbrugg
Population: **11 730**
Vol water supplied: **1.7***

Gossau, 9202
Technische Betriebe Gossau, Säntistrasse 6, 9202 Gossau
Population: 14 200
Vol water supplied: 2.35*

Grenchen, 2540
Gas- und Wasserwerk, Brühlstrasse 9, Postfach 422, 2540 Grenchen
Population: 16 314
Vol water supplied: **2.3***

Herisau, 9100
Dorfkorporation Herisau, Wasserversorgung, Kasernenstrasse 36, 9100 Herisau
Population: 15 000
Vol water supplied: **1.8***

Hirzel, 8816
Gemeindewasserversorgung, Dorfstrasse 69, 8816 Hirzel
Tel +41 1 729 95 22
Fax +41 1 729 97 75
Director:
Beat Bürgler-Albisser
Population: 1650
Vol water supplied: 0.3*
No. reservoirs: 3
Vol sewage treated: 0.49*
No. sewage plants: 3

Hombrechtikon, 8634
Gemeindewasserversorgung, Beislerstrasse 10, 8634 Hombrechtikon
Tel +41 1 451 17 21
Vice-President:
Peter Dubs
Population: 7500
Vol water supplied: 0.67*
No. reservoirs: 4
Vol sewage treated: 1.5*
No. sewage plants: 1

Horgen, 8810
Gemeindewerke Horgen, Bahnhofstrasse 10, 8810 Horgen
Tel +41 1 728 43 33
Fax +41 1 725 58 30
Abteilungsleiter:
A Gut
Population: 50 000
Vol water supplied: 4*
No. reservoirs: 2
Vol sewage treated: 6*
No. sewage plants: 4

Horw, 6048
Wasserversorgung, 6048 Horw
Population: 11 552
Vol water supplied: **1.3***

Interlaken, 3800
Bahnen der Jungfrau-Region, Direktion, Höhenweg 37, 3800 Interlaken
Population: 13 700
Vol water supplied: 1.7*

Ittigen, 3063
Wasserversorgung Ittigen, Bauverwaltung, Rain 7, 3063 Ittigen
Population: 11 123
Vol water supplied: 1.0*

Klagenfurt, 9010
Stadtwerke Klagenfurt, St. Veiter Strabe 31, 9010 Klagenfurt
Tel +41 46 3 521-0
Fax +41 46 3 52 17 35
Population: 86 000
Vol water supplied: 8.5*
No. reservoirs: 16

Klosters, 7250
Klosters-Serneus, Wasserversorgung, Rathaus, 7250 Klosters
Tel +41 81 69 28 66
Fax +41 81 69 20 15
Wassermeister:
R Renner
Population: 3500
Vol water supplied: 3.7*
No. reservoirs: 11
Vol sewage treated: 3.01*
No. sewage plants: 2

Kloten, 8302
Städtische Werke Kloten, Wasserversorgung, Flughafenstrasse 25, 8302 Kloten
Tel +41 11 815 15 15
Fax +41 11 815 15 03
Betriebsleiter:
Stephan Föllmi
Population: 16 388
Vol water supplied: 3.09*
No. reservoirs: 4

Köniz, 3098
Einwohnergemeinde Köniz, Abt Wasserversorgung, Sonnenweg 19, 3098 Köniz
Tel +41 31 970 9285
Fax +41 31 970 9279
Abteilungsleiter:
Heinrich Müller
Population: 38 000
Vol water supplied: 3.2*
No. reservoirs: 8
Vol sewage treated: 3.2*

Kreuzlingen, 8300
Gas- und Wasserversorgung, Nationalstrasse 27, 8380 Kreuzlingen
Population: 16 548
Vol water supplied: **4.5***

Küsnacht ZH, 8700
Gemeindewerke, Wasserversorgung, Tobelweg 4, 8700 Küsnacht ZH
Tel +41 1 913 1313
Fax +41 1 910 3016
Betriebsleiter Gemeindewerke:
R Müller
Abt Leiter Gas und Wasser:
A Schmahl
Population: 12 210
Vol water supplied: 1.6*
No. reservoirs: 6
No. sewage plants: 1

La Chaux-de-Fonds, 2300
Services Industriels, rue du Collège 32, 2300 La Chaux-de-Fonds
Tel +41 39 27 66 51
Fax +41 39 28 28 54
Ingénieur en chef:
Jean-Gérald Agustoni
Population: 37 571
Vol water supplied: 5.2*
No. reservoirs: 5
Vol sewage treated: **8.1***
No. sewage plants: 1

La Neuveville, 2520
Service des eaux, Municipalité de la Neuveville, Grand-Rue 2, 2520 La Neuveville
Tel +41 38 51 39 53
Fax +41 38 51 55 92
Directeur:
Hubert Rossier
Population: 3368
Vol water supplied: 0.65*
No. reservoirs: 3
No. sewage plants: 1

Lachen, 8853
Elektrizitäts- und Wasserwerk, Winkelweg 7, 8853 Lachen
Tel +41 55 63 13 32
Fax +41 55 63 56 03
Betriebsleiter:
Leopold Schmuki
Population: 6200
Vol water supplied: 0.88*
No. reservoirs: 2
Vol sewage treated: 2.68*
No. sewage plants: 1

Langenthal, 4900
Industrielle Betriebe, Thalstrasse 29, 4900 Langenthal
Population: 14 338
Vol water supplied: **2.3***

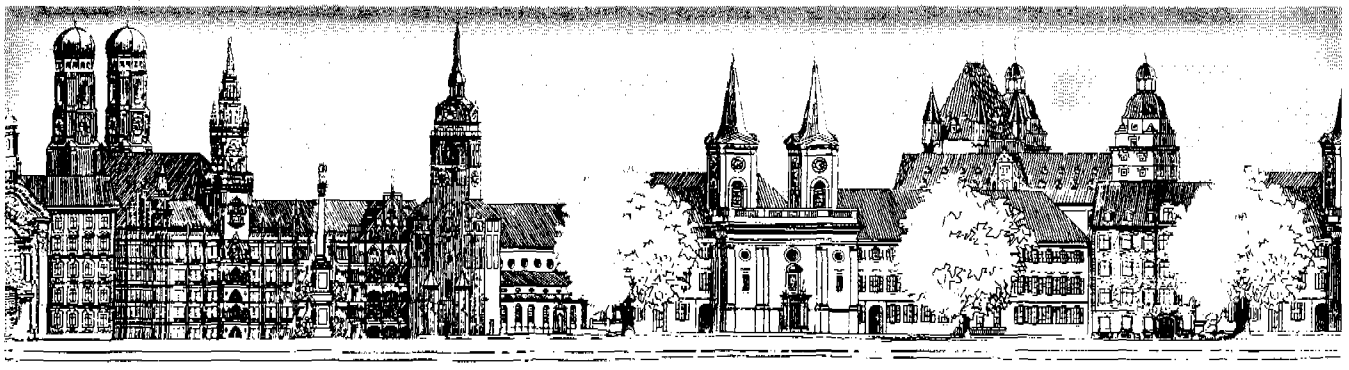
Langnau a A, 8135
Wasserversorgung Langnau, Birkenstr. 1, 8135 Langnau a A
Tel +41 1 713 3383
Betriebswarf:
P Stoll
Population: 6700
Vol water supplied: 0.625*
No. reservoirs: 7

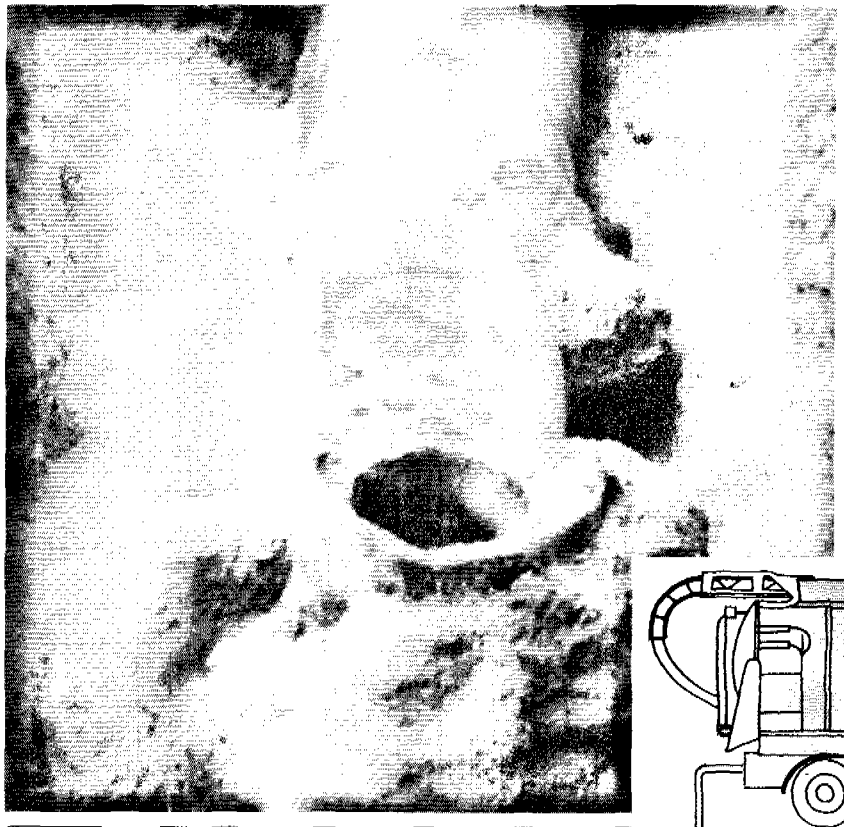
Lausanne, 1000
Services Industriels, Service eaux, Case postale 836, CH 1000 Lausanne 9
Tel +41 21 315 83 10
Fax +41 21 315 83 45
Director:
H Burnier
Population: 202 625
Vol water supplied: 41.6*
No. reservoirs: 24
Vol sewage treated: 25*
No. sewage plants: 3

Le Châble, 1934
Services Industriels de Bagnes, 1934 Le Châble
Tel +41 26 37 11 50
Fax +41 26 37 11 99
Director:
André Besson
Population: 5000-40 000
Vol water supplied: 2*
No. reservoirs: 41
Vol sewage treated: 3.7*
No. sewage plants: 2

Le Locle, 2400
Services Industriels, Service gaz et eaux, Case postale, 2400 Le Locle
Tel +39 39 31 63 63
Fax +39 39 31 44 85
Ingénieur en chef:
P Siegrist
Population: 10 760
Vol water supplied: 1.1*
No. reservoirs: 3
Vol sewage treated: 5.5*
No. sewage plants: 1

***million m³/year**





We have the solution:

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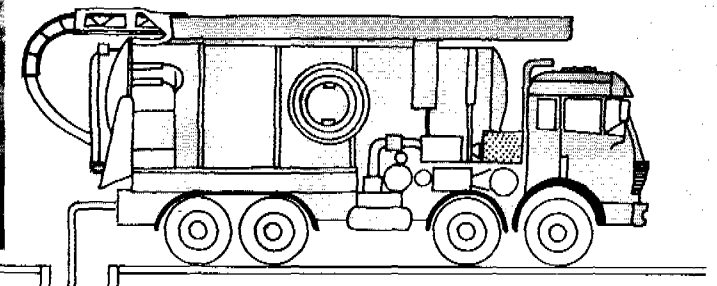
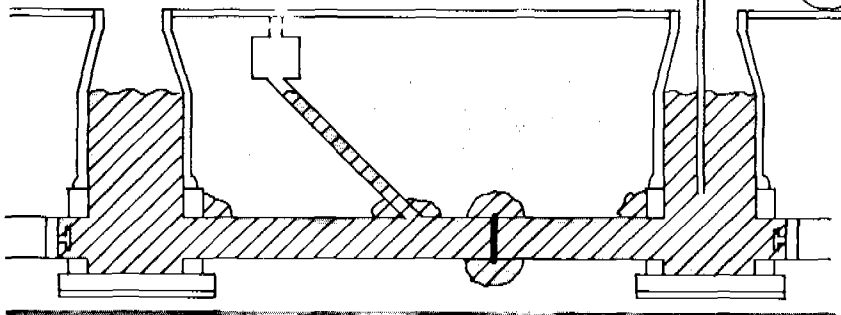
Flood grouting for sewer repairs.





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Lenzburg, 5600
Städtische Werke, Abt Gas und Wasser, Ungeligraben 10, 5600 Lenzburg
Tel +41 64 52 05 05
Fax +41 64 51 37 17
Direktor:
Dr Hans-Peter Müller
Population: 7501
Vol water supplied: 2.8*
No. reservoirs: 2
Vol sewage treated: 2.9*
No. sewage plants: 1

Lichtensteig, 9620
Wasserversorgung, 9620 Lichtensteig
Tel +41 74 71094
Fax +41 74 76554
Stadtammann:
Fridolin Eisenring
Population: 2100
Vol water supplied: 0.22*
No. reservoirs: 2
Vol sewage treated: 0.32*
No. sewage plants: 1

Liestal, 4410
Wasserversorgung Liestal, Rathaus, 4410 Liestal
Tel +41 61 921 2026
Fax +41 61 921 0828
Werksleiter:
Hans A Flüeler
Population: 12 430
Vol water supplied: 2.0*
No. reservoirs: 6
No. sewage plants: 1

Locarno, 6601
Azienda comunale, Gas-Acqua, Via della Posta 34, 6601 Locarno
Tel +41 93 32 94 11
Fax +41 93 31 21 82
Direttore:
Ing S Bonta
Population: 22 810
Vol water supplied: 7.1*
No. reservoirs: 3

Lugano, 6900
Aziende Industriali, Gas-Acqua, Via della Posta 8, 6900 Lugano
Tel +41 91 20 78 11
Fax +41 91 22 89 07
Director:
F Bonoll
Population: 60 000
Vol water supplied: 14.3*
No. reservoirs: 16

Luzern, 6005
Städtische Werke Luzern, Industriestrasse 6, 6005 Luzern
Population: 62 754
Vol water supplied: 12.4*

Lyssach, 3421
Vennersmühle-Wasserversorgung, Moserstrasse 1, 3421 Lyssach
Population: 21 235
Vol water supplied: 3.5*

Männedorf, 8700
Gemeindewerke, Wasserversorgung, Saurenbachstrasse 6, 8708 Männedorf
Tel +41 1 920 43 43
Fax +41 1 920 11 09
Betriebsleiter:
Victor Leimgruber
Population: 25 100
Vol water supplied: 2*
No. reservoirs: 8
Vol sewage treated: 0.7*
No. sewage plants: 1

Martigny, 1920
*Service des Eaux, Gd St-*Bernard 8, 1920 Martigny
Tel +41 26 21 25 00
Fax +41 26 21 25 18
ETS:
J M Revaz
Population: 15 000
Vol water supplied: 2.1*
No. reservoirs: 2
Vol sewage treated: 2.3*
No. sewage plants: 1

Meilen, 8706
Gemeindewerke Meilen, Wasserversorgung, Schulhausstrasse 18, 8706 Meilen
Population: 10 700
Vol water supplied: 1.7*

Mendrisio, 6850
Azienda acqua potabile, Via Vela 9, 6850 Mendrisio
Tel +41 91 646 18 26
Fax +41 91 646 43 83
Director:
Renato Salvi
Population: 7000
Vol water supplied: 1.2*
No. reservoirs: 6

Morges, 1110
Direction des Travaux, Services Industriels, Place Hôtel de Ville 1, 1110 Morges
Tel +41 21 803 0711
Fax +41 21 801 2236
Ingenieur:
Roberto Ubaldi
Population: 17 000
Vol water supplied: 2.5*
No. reservoirs: 6
Vol sewage treated: 4.4*
No. sewage plants: 1

Moutier, 2740
Services Industriels, Service des eaux, Ave de la poste 20, 2740 Moutier
Tel +41 32 941 222
Fax +41 32 941 220
Directeur:
J C Crevoisier
Chef de Service:
F Gobat
Population: 8000
Vol water supplied: 1.6*
No. reservoirs: 4
Vol sewage treated: 5*
No. sewage plants: 1

Muri bei Bern, 3074
Gas und Wasserversorgung, Thunstrasse 74, 3074 Muri bei Bern
Population: 12 733
Vol water supplied: 2.5*

Neuchâtel, 2000
Services Industriels, Gaz et eau, rue Jaquet-Droz 3, 2000 Neuchâtel
Population: 31 532
Vol water supplied: 11.5*

Nyon, 1260
Services Industriels, Eau et gaz, Place du Château 3, 1260 Nyon
Population: 17 178
Vol water supplied: 3.7*

Olten, 4603
Städtische Werke Olten, Gas- und Wasserversorgung, Dornacherstrasse 1, 4603 Olten
Population: 17 971
Vol water supplied: 3.2*

Orbe, 1350
Commune d'Orbe, Service des eaux, Hôtel de Ville, 1350 Orbe
Tel +41 24 41 21 74
Fax +41 24 41 31 51
Chef de Service:
Paul Segessenmann
Population: 4700
Vol water supplied: 1.1*
No. reservoirs: 3
Vol sewage treated: 1.3*
No. sewage plants: 1

Ostermundigen
Wasserversorgung, Postfach 27, 3072 Ostermundigen
Population: 17 100
Vol water supplied: 18.4*

Pieterlen, 2542
Bürgergemeinde, Wasserversorgung, Kirchgasse 6, 2542 Pieterlen
Tel +41 32 87 24 53
Fax +41 32 87 24 53
Präsident:
H R Schneider
Population: 3390
Vol water supplied: 0.309*
No. reservoirs: 3

Porrentruy, 2900
Service des eaux, Route d'Alle 58, 2900 Porrentruy
Tel +41 66 66 17 56
Fax +41 66 66 42 60
Ingenieur:
Jean-Paul Kuenzi
Population: 7500
Vol water supplied: 1.5*
No. reservoirs: 4
Vol sewage treated: 3*
No. sewage plants: 1

Port, 2562
Elektrizitäts- und Wasserversorgung, 2562 Port
Tel +41 32 51 88 10
Fax +41 32 51 25 07
Betriebschef:
G Loosli
Population: 2676
Vol water supplied: 0.27*
Vol sewage treated: 0.21*

Pratteln, 4133
Wasserversorgung, Schlossstrasse 34, 4133 Pratteln
Population: 15 541
Vol water supplied: 2.8*

Pratteln, 4133
Hardwasser AG, Rheinstrasse 87, Postfach, 4133 Pratteln

Pully, 1009
Services Industriels, Service des eaux, Chemin de la Damataire 13, 1009 Pully
Population: 15 534
Vol water supplied: 2.0*

Richterswil, 8805
Gas- und Wasserversorgung, Glarnerstrasse 33, 8805 Richterswil
Tel +41 1 784 05 21
Fax +41 1 784 14 56
Werkleiter:
Werner Gamper
Population: 9996
Vol water supplied: 0.85*
No. reservoirs: 6
Vol sewage treated: 1.8*
No. sewage plants: 1

Roggwil, 4914
Gemeindebetriebe Roggwil, 4914 Roggwil
Tel +41 63 48 40 30
Fax +41 63 48 40 39
Betriebsleiter:
Paul Schüpbach
Population: 3600
Vol water supplied: 0.4*
No. reservoirs: 1
Vol sewage treated: 0.4*
No. sewage plants: 1

Romanshorn, 8590
Wasser- und Elektrizitätswerk, Bankstrasse 6, 8590 Romanshorn
Director:
P Hauri
Population: 10 350
Vol water supplied: 1.9*

Rüshclikon, 8803
Wasserversorgung Rüschlikon, Pilgerweg 29, 8803 Rüschlikon
Tel +41 724 72 22
Betriebsleiter:
Mathias Trachsel
Population: 4760
Vol water supplied: 0.7*
No. reservoirs: 3

Rütl, 8630
Gemeindewerke Rüti, Gas- und Wasserversorgung, Werkstrasse 27, 8630 Rüti
Population: 10 387
Vol water supplied: 1.4*

Saanen, 3792
Wasserversorgung Saanen, 3792 Saanen
Tel +41 30 4 54 54
Fax +41 30 4 64 05
Betriebsleiter:
Peter Trosch
Population: 25 000 (Out of season: 6000)
Vol water supplied: 2.8*
No. reservoirs: 9
Vol sewage treated: 2.7*
No. sewage plants: 3

St Margrethen, 9430
Wasserversorgung, Hauptstrasse 117, 9430 St Margrethen
Tel +41 71 71 22 70
Fax +41 71 71 57 34
Betriebsleiter:
Tscharner Gaudenz
Population: 5500
Vol water supplied: 0.75*
No. reservoirs: 4
Vol sewage treated: 0.7*

St Moritz, 7500
Wasserversorgung Gemeinde, Via Maistra 12, 7500 St Moritz
Tel +41 82 3 08 88
Fax +41 82 2 12 22
Betriebsleiter:
K Strasser
Population: 22 000 (Water)
Vol water supplied: 1.8*
No. reservoirs: 8
Vol sewage treated: 4.5*
No. sewage plants: 1

Schlieren, 8952
Gas- und Wasserversorgung, Freiestrasse 6, 8952 Schlieren
Population: 13 079
Vol water supplied: 2.5*

Sierre, 3960
Services Industriels, Service des eaux, Ch de l'Industrie 29, 3960 Sierre
Tel +41 27 57 11 21
Fax +41 27 55 73 91
Directeur des Services Industriels:
Gilbert Fellay
Population: 14 550
Vol water supplied: 3.6*
No. reservoirs: 5
Vol sewage treated: 12*
No. sewage plants: 2

Sion, 1950
Services Industriels, Service des eaux, Rue Industrie 43, 1950 Sion
Tel +41 27 240 111
Fax +41 27 222 934
Directeur:
Raphael Morisod
Population: 25 000
Vol water supplied: 6*
No. reservoirs: 5

Solothurn, 4500
Städtische Werke Solothurn, Gas- und Wasserwerk, Roetistrasse 17, 4500 Solothurn
Tel +41 65 219 444
Fax +41 65 228 953
Direktor:
R Pfund
Population: 25 000
Vol water supplied: 2.8*
No. reservoirs: 3

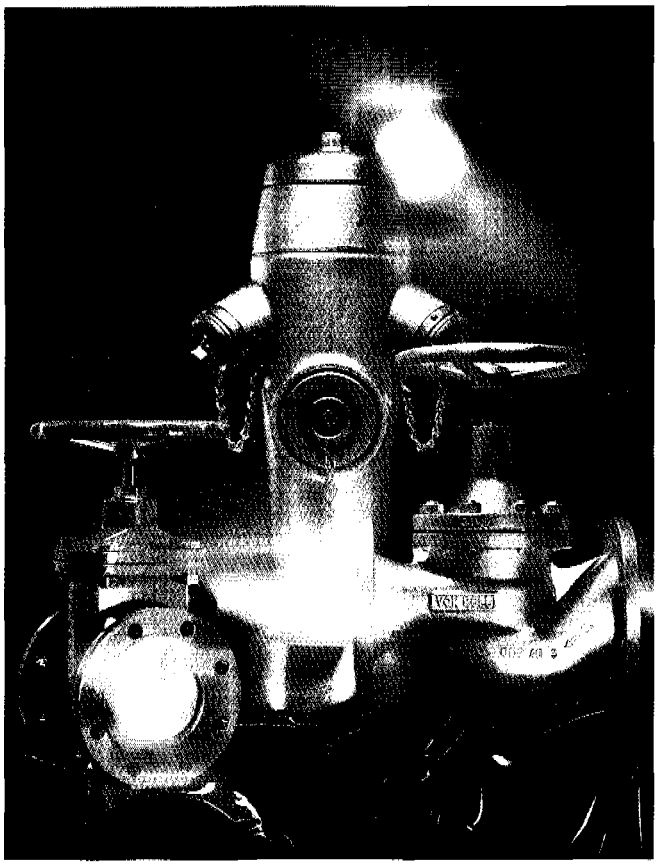
Spreitenbach, 8957
Bauverwaltung Spreitenbach, Wasserversorgung, Poststrasse 13, 8957 Spreitenbach
Tel +41 56 72 86 30
Fax +41 56 72 02 82
Bauverwalter:
Leo Peterhans
Population: 8850
Vol water supplied: 1.6*
No. reservoirs: 1
Vol sewage treated: 2.55*
No. sewage plants: 1

Stans, 6370
Wasserversorgung Stans, Fronhofenstrasse 8
Tel +41 41 61 11 29
Werkleiter:
Christen Thedy
Population: 8260
Vol water supplied: 1.9*
No. reservoirs: 3
Vol sewage treated: 2.7*
No. sewage plants: 1

Steckborn, 8266
Wasserversorgung, Seestrasse, 8266 Steckborn
Tel +41 54 612494
Fax +41 54 612480
Director:
Ernst Fischer
Population: 3540
Vol water supplied: 0.43*
No. reservoirs: 3
Vol sewage treated: 0.45*
No. sewage plants: 1

Sursee, 6210
Wasserversorgung Sursee, Stadtbauamt, Luzernstrasse 1, 6210 Sursee
Tel +41 45 23 25 25
Fax +41 45 21 94 07
Population: 8230
Vol water supplied: 1.2*
No. reservoirs: 2
Vol sewage treated: 1.2*

***million m³/year**



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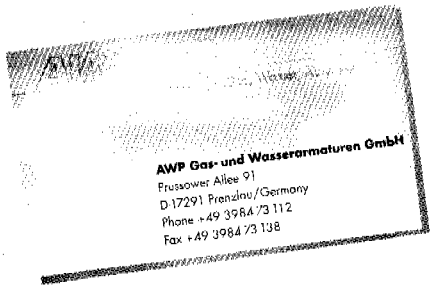
After focusing its attention on the needs and requirements of the home market for many years, Von Roll, Switzerland's leading manufacturer of superior quality valves and hydrants, is now moving up a gear on the export front. The acquisition of AWP Gas- und Wasserarmaturen GmbH (AWP gwa), a new subsidiary in eastern Germany, firmly underlines the seriousness of its long-term objective to establish a much broader geographical base embracing Europe – east and west.



vonRoll

Von Roll Ltd, Valves Division, CH-4702 Oensingen/Switzerland
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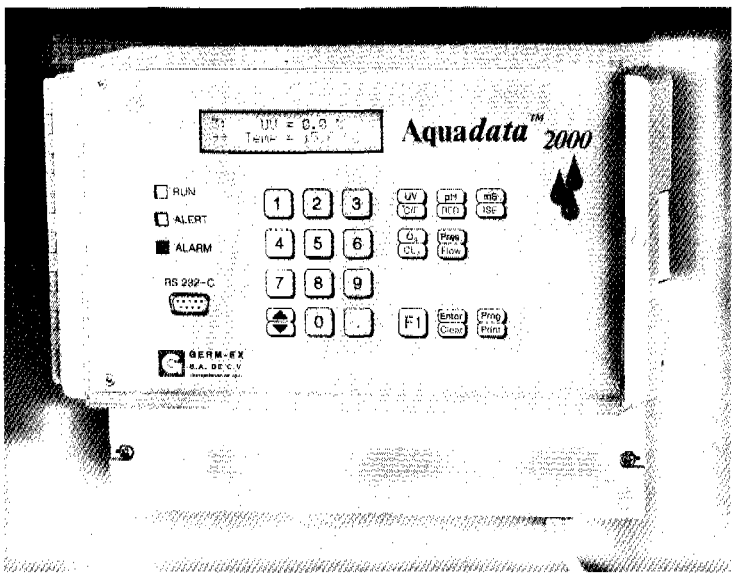

STL Technology Systems

Ettenbergstrasse 18, 8907 Wettswil a.A Switzerland
PHONE: +41 1 701 11 37 FAX: + 41 1 701 19 18

No. sewage plants: 1

Teufen, 9503
Wasserversorgung, Gemeindehaus Dorf 9, 9053 Teufen
Tel +41 71 33 34 07
Fax +41 71 33 00 15
Betriebsleiter:
W Hohl
Population: 5000
Vol water supplied: 0.53*
No. reservoirs: 8
Vol sewage treated: 0.6*
No. sewage plants: 2

Thalwil, 8800
Gemeindewerke Thalwil, Gas- und Wasserversorgung, Dorfstrasse 10, 8800 Thalwil
Population: 15 776
Vol water supplied: 1.8*

Thun, 3601
Energie- und Verkehrsbetriebe, Gas- und Wasserversorgung, Scheibenstrasse 9, Postach 1085, 3601 Thun
Tel +41 33 25 85 02
Fax +41 33 25 85 30
Direktor:
Peter Frey
Population: 39 975
Vol water supplied: 5.17*
No. reservoirs: 5
No. sewage plants: 1

Uster, 8610
Städtische Werke Uster, Gas- und Wasserversorgung, Oberlandstrasse 78, 8610 Uster
Population: 25 931
Vol water supplied: 3.4*

Vervey-Montreux, 1800
Service des eaux de Vevey-Montreux, Quai Maria-Belgia 18, 1800 Vevey
Population: 55 800
Vol water supplied: 11.7*

Viganello, 6962
Azienda Acqua potabile, Via S Frontini 1, 6962 Viganello
Tel +41 91 51 16 92/93
Fax +41 91 51 37 75
Direttore:
Fabrizio Blanchl
Population: 6101
Vol water supplied: 0.85*
No. reservoirs: 4

Volketswil, 8604
Gemeindewasserversorgung, Zentralstrasse 5, 8604 Volketswil
Population: 12 437
Vol water supplied: 1.4*

Vouvry, 1896
Commune de Vouvry, Service des eaux, 1896 Vouvry
Tel +41 25 81 11 11
Fax +41 25 81 28 47
Chef des Services Techniques:
Paul Coppex
Population: 2760
Vol water supplied: 0.41*
No. reservoirs: 6
Vol sewage treated: 0.34*
No. sewage plants: 1

Wädenswil, 8820
Städtische Werke Wädenswil, Eintrachtstrasse 24, 8820 Wädenswil
Tel +41 1 780 0277
Fax +41 1 780 6985
Betriebsleitung:
H P Kämpfer
Population: 19 674
Vol water supplied: 2.38*
No. reservoirs: 7
Vol sewage treated: 3.7*
No. sewage plants: 1

Wallisellen, 8304
Gemeindewerke, Gas- und Wasserversorgung, Zentralstrasse 9, 8304 Wallisellen
Director:
M Wiget
Population: 11 422
Vol water supplied: 1.4*
Vol sewage treated: 3.4*

Wettingen, 5430
Elektrizitäts- und Wasserwerk, Landstrasse 89, 5430 Wettingen
Tel +41 56 26 62 55
Fax +41 56 26 62 01
Betriebleiter:
B Bruggisser
Population: 17 946
Vol water supplied: 2.3*
No. reservoirs: 5

Wettswil, 8907
Gruppenwasserversorgung Amt, z Hd Herrn Josef Meier, Kirchgasse 55, 8907 Wettswil
Tel +41 1 700 0468
Präsident:
Josef Meier
Population: 28 000
Vol water supplied: 2.2*
No. reservoirs: 2

Wetzikon, 8620
Gemeindewerke Wetzikon, Gas- und Wasserversorgung, Farbstrasse 5, 8620 Wetzikon 2
Population: 17 672
Vol water supplied: 2.4*

Widnau, 9443
Gemeinschafts-Wasserwerk Au-Balgach-Rebstein-Widnau, Diepoldsauerstrasse 18, 9443 Widnau
Tel +41 71 72 18 74
Präsident:
Walter Giger
Betriebsleiter:
Alb Heule
Population: 21 000
Vol water supplied: 2.6*
No. reservoirs: 7
Vol sewage treated: 6.5*
No. sewage plants: 1

Wil, 9500
Technische Betriebe Wil, Gas und Wasser, Werkstrasse 1, 9500 Wil
Population: 16 122
Vol water supplied: 2.3*

Winterthur, 8402
Städtische Werke Winterthur, Postach 126, 8402 Winterthur
Tel +41 52 267 61 61
Fax +41 52 267 61 10
Director:
C Jaquet
Population: 89 000
Vol water supplied: 12*
No. reservoirs: 21
Vol sewage treated: 21*
No. sewage plants: 1

Wohlen b Bern, 3033
Gemeindebetriebe Wohlen, 3033 Wohlen b Bern
Wollerau, 8832
Wasserversorgung der Korporation, Hungerstrasse 1, 8832 Wollerau
Tel +41 1 784 0332
Fax +41 1 786 3074
Betriebsleiter:
Mathias Kalin
Population: 13 000
Vol water supplied: 1.6*
No. reservoirs: 7

Worben, 3252
Seeländische Wasserversorgung SWG, Hauptstrasse 12, 3252 Worben
Tel +41 32 84 04 44
Fax +41 32 84 15 83
Verwalter:
F A Bleuer
Population: 24 989
Vol water supplied: 3.7*
No. reservoirs: 10

Yverdon-Les-Bains, 1401
Services Industriels, Eau Electricité et Gaz, Ancien Stand, Case 401 Yverdon-les-Bains
Tel +41 24 23 65 55
Fax +41 24 21 06 28
Director:
A Rosselet
Population: 24 000
Vol water supplied: 3.6*
No. reservoirs: 3
Vol sewage treated: 3.5*
No. sewage plants: 1

Zollikon, 8702
Gemeindewerke Zollikon, Gas und Wasser, Rietstrasse 38, 8702 Zollikon
Population: 11 618
Vol water supplied: 2.0*

Zug, 6300
Wasserwerke Zug AG, Abt Gas und Wasser, Poststrasse 6, 6300 Zug
Population: 37 828
Vol water supplied: 5*

Zürich, 8023
Wasserversorgung Zürich, Hardhof 9, Postfach, 8023 Zürich
Tel +41 1 435 21 11
Fax +41 1 435 25 57
General Manager:
Dr Hans-Peter Klein
Population: 360 900
Vol water supplied: 69*
No. reservoirs: 20

*million m³/year

WESNET 32 Version 6.00 FROM AquaWare Systems

Water Supply Network Modelling and management Software

NEW FEATURES

*** Major increases in performance using state-of-the-art 32-bit processing power.**

*** Major increases in capacity — all mains modelling**

*** User interface redesign and improvement**

*** Major improvements in features and functionality**

*** A suite of complementary data and software, including post code data — another first for WESNET**

*** HELP and support via the Electronic Superhighway**

*** Completely rewritten and updated documentation**

*** Comprehensive Demo model including full linkage with GIS, telemetry, data loggers, WQ modelling and much more.**

*** WESNET WORKSTATION option includes Pentium PC for optimum efficiency.**

AquaWare WESNET 32

Water Supply Network Modelling Processor

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Overlays: Overlay any point data on your model-bursts, low pressure complaints, leaks, wq failures, etc.

Correlate against results from modelling.

Drawings: Integrate key data within the modelling environment with this unique new feature.

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Major improvements in performance and capacity whch are unrivalled in any network simulation package; virtual memory management and latest 32-bit platform

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WESNET Version 6.00..

for more details contact AquaWare Systems on

UK 0345 69358 (tel) or UK 01594 516066 (fax)

AquaWare Systems

Government departments and regulating bodies

Department of the Environment
Romney House, 43 Marsham Street, London SW1P 3PY
Tel +44 171 276 3000

Water Directorate
Tel +44 171 276 8259
Fax +44 171 276 8639
Director: Dr N W Summerton

Water Environment B (WEB)
(Sewage treatment, sludge disposal, bathing water), Room A414
Tel +44 171 276 8189
Fax +44 171 276 8639
Director: C Byrne

Water Quality Division (WQ)
Room A414
Tel +44 171 276 8632/8802
Fax +44 171 276 8639
Director: John Vaughan

Water Services Division (WSD)
Room A425
Tel +44 71 276 8617
Fax +44 71 276 8639
Divisional Head: Hilary Chipping
Customer installations, European standardisation:
Tel +44 171 276 8227
Fax +44 171 276 8639
Director: M Williamson

Water Sponsorship and Navigation Division (WSN)
Room A406
Tel +44 71 276 8888
Fax +44 71 276 8463
Head of Division: Marcus Nelson

Water Resources and Marine Division (WRM)
Room B446
Tel +44 71 276 8398
Fax +44 71 276 8639
Director: Alan Simcock

Directorate of Pollution Control and Waste
Tel +44 71 276 8080
Fax +44 71 276 8800
Director: R Dudding

Drinking Water Inspectorate (DWI)
Tel +44 171 276 8199
Fax +44 171 276 8405
Chief Inspector: M J Rouse

Ministry of Agriculture, Fisheries and Food

River and Coastal Engineers Section
Eastbury House, 30-34 Albert Embankment, London SE1 7TL
Tel +44 171 238 6640
Fax +44 171 238 6665
Chief Engineer: R G Purnell

Environmental Protection Division
Novel House, 17 Smith Square, London SW1P 3JR
Tel +44 171 238 5654
Fax +44 171 238 6700
Director: I Armstrong

ADAS Environmental
Gleadthorpe Grange, Meden Vale, Mansfield, Notts NG20 9PD
Tel +44 1623 846742
Fax +44 1623 847424
Head of Land Development: Chris Stansfield

ADAS Eastern Region
Block C, Government Buildings, Brooklands Avenue, Cambridge CB2 2DR
Tel +44 1233 462762
Director: Roger Turner

ADAS Midlands and Western Region
Wergs Road, Wolverhampton, West Midlands WV6 8TQ
Tel +44 1902 754190
Director: Colin Brown

ADAS Newcastle
Kenton Bar, Newcastle-upon-Tyne, Tyne and Wear NE1 1YA
Tel +44 191 286 9811
Senior Consultant: Martin R Holcombe

ADAS South Eastern Region
Winchester Area Office, Cromwell House, 15 Andover Road, Winchester, Hants SO23 7EN
Tel +44 1962 63500
Director: John Gregory

ADAS South Western Region
Government Buildings, Burghill Road, Westbury on Trym, Bristol, Avon BS10 6NJ
Tel +44 1272 59100
Director: Alan Parker

ADAS Welsh Region
St Agnes Road, Gabalfa, Cardiff
Tel +44 1222 586000
Fax +44 1222 586228
Consultancy Centre Manager: Chris Horne

Department of Industry
Laboratory of the Government Chemist
Queen's Road, Teddington, Middlesex TW11 0LY
Tel +44 181 943 7000
Fax +44 181 943 2767
Government Chemist: Dr Richard Worswick

National Rivers Authority
Chairman: Lord Crickhowell
Chief Executive: Edward Gallagher

Head Office - Bristol
Rivers House, Waterside Drive, Aztec West, Almondsbury, Bristol BS12 4UD
Tel +44 1454 624400
Fax +44 1454 624409

Office of Water Services (OFWAT)
Centre City Tower, 7 Hill Street, Birmingham B5 4UA
Tel +44 121 625 1300
Fax +44 121 625 1400
Director General: Ian Byatt

Institutes and associations

British Water
1 Queen Anne's Gate, London SW1H 9BT
Tel +44 171 957 4554
Fax +44 171 957 4565
Chief Executive: David Neil-Gallacher LVO
Director & Secretary: John S Hills
Director - Overseas: Anthony V Nockles

CIWEM (The Chartered Institution of Water and Environmental Management)
15 John Street, London WC1N 2EB
Tel +44 171 831 3110
Fax +44 171 405 4967
Executive Director: Tony Bispham

The Institution of Civil Engineers
1-7 Great George Street, London SW1P 3AA
Tel +44 171 222 7722
Fax +44 171 222 7500
Director General and Secretary: Roger Dobson OBE

The Institution of Water Officers
12 Summerhill Terrace, Newcastle upon Tyne NE4 6EB
Tel +44 191 230 5150
Fax +44 191 230 2880
General Manager: Eric Porter

Water Companies' Association
1 Queen Anne's Gate, London SW1H 9BT
Tel +44 171 222 0644
Fax +44 171 222 3366
Chairman: Jim McGown
Director & Secretary: M A Swallow

Water Services Association
1 Queen Anne's Gate, London SW1H 9BT
Tel +44 171 957 4567
Fax +44 171 957 4666
Chairman: Keith Court
Director: Janet Langden

Other organisations

BETWI (Board for Education and Training in the Water Industry)
1 Queen Anne's Gate, London SW1H 9BT
Tel +44 171 957 4517
Fax +44 171 957 4641
Chairman: Ged Fisher
Chief Executive: I C Bryan

British Waterways
Willow Grange, Church Road, Watford, Herts WD1 3QA
Tel +44 1923 226422
Fax +44 1923 226081
Chief Executive: B C Dice

CABWI (The Certification and Assessment Board for the Water Industry)
1 Queen Anne's Gate, London SW1H 9BT
Tel +71 957 4517
Fax +91 957 4641
Chairman: Bill Fraser

*million m³/year

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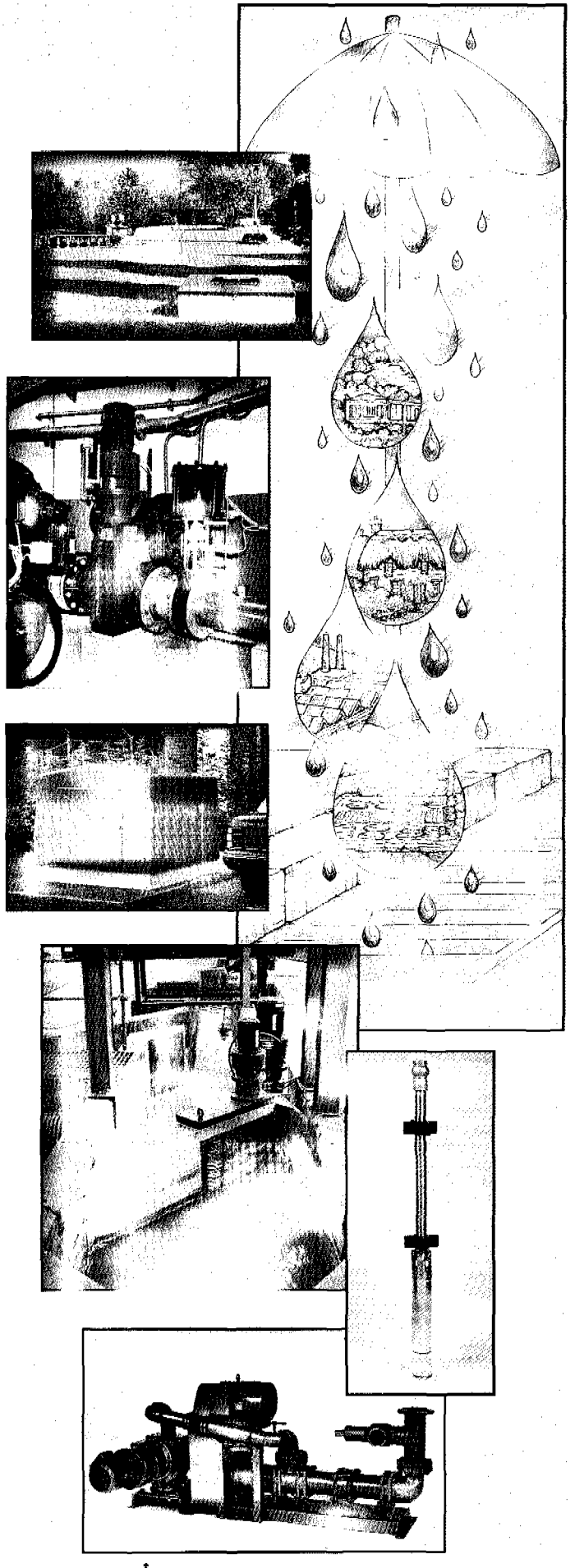

H_2O WASTE-TEC

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Water Research Centre (WRc)
Medmenham, Marlow, Bucks
SL7 2HD
Tel +44 1491 571531
Fax +44 1491 579094
Managing Director: Dr John Moss

WRc plc
Frankland Road, Blagrove,
Swindon SN5 8YF
Tel +44 1793 511711
Fax +44 1793 511712
Business Development Director: David Field

Water Training International
Tadley Court, Tadley Common Road, Tadley, Basingstoke, Hampshire RG26 6TB
Tel +44 1734 813011
Fax +44 1734 817000
Managing Director: Robert Hodge

Water suppliers and sewage water treatment/disposal plant

Water service companies

Anglian Water plc
Ambury Road, Huntingdon, Cambs PE18 6NZ
Tel +44 1480 443000
Fax +44 1480 443115
Chairman:
Bernard Henderson CBE
Group Managing Director:
Alan Smith
Population: 5 850 000
Vol water supplied: **408***
No. reservoirs: 8
No. sewage plants: 1082

Anglian Water Services Ltd
Compass House, Chivers Way, Histon, Cambs CB4 4ZY
Tel +44 1223 372000
Fax +44 1223 372271
Chairman:
Alan Smith
Managing Director:
John Simpson
Population: 5 600 000
Vol water supplied: 415*
No. reservoirs: 13
Vol sewage treated: 480*
No. sewage plants: 1122

Subsidiaries:

Alpheus Environmental Ltd
Cambridge Road, Bedford MK42 0LL
Tel +44 1234 270344
Fax +44 1234 357088
General Manager:
Mike Everest

American-Anglian
Anglian House, Ambury Road, Huntingdon, Cambs PE18 6NZ
Tel +44 1480 443000
Fax +44 1480 443115
Joint Venture

Anglian Water International Ltd
Anglian House, Ambury Road, Huntingdon, Cambs PE18 6NZ
Tel +44 1480 443000
Fax +44 1480 443115
Managing Director:
David Latham

Anglian Water Process Engineering Ltd
Anglian House, Ambury Road, Huntingdon, Cambs PE18 6NZ
Tel +44 1480 443000
Fax +44 1480 443115
Chairman:
Alan Smith
Managing Director:
Goran Wijkmark

Gibb Anglian Ltd
Anglian House, Ambury Road, Huntingdon, Cambs PE18 6NZ
Tel +44 1480 443000
Fax +44 1480 443115

Grafham Carbons Ltd
Grafham Water Treatment Works, Perry, Huntingdon, Cambs PE18 0BW
Tel +44 1480 811911
Fax +44 1480 812184
Joint Venture

North West Water Group plc
Dawson House, Great Sankey, Warrington WA5 3LW
Tel +44 1925 234000
Fax +44 1925 233160
Chairman:
Sir Desmond Pitcher
Chief Executive:
Brian Staples

North West Water Ltd
Dawson House, Great Sankey, Warrington WA5 3LW
Tel +44 1925 234000
Fax +44 1925 233360
Managing Director:
Derek Green
Population: 6 800 000
Vol water supplied: 900*
No. reservoirs: 168
Vol sewage treated: 990*
No. sewage plants: 616
No. water treatment plants: 127

North West Water International Ltd
Oakland House, Talbot Road, Old Trafford, Manchester M16 0QF
Tel +44 161 886 2000
Fax +44 161 886 2038
Principal Officer:
R J Ferguson
Population: 21 000 000 customers worldwide
No. reservoirs: 168 supply 590 service
No. wastewater plants: 619

North West Water Process Equipment Division
Oakland House, Talbot Road, Old Trafford, Manchester M16 0QF
Tel +44 161 886 2000
Fax +44 161 886 2038
Managing Director:
John Beckitt

North West Water Environmental Engineering Group
Chadwick House, Warrington Road, Risley, Warrington WA3 6AE
Tel +44 1925 857000
Managing Director
Bob Boland

Northumbrian Water Group plc
PO Box 4, Regent Centre, Gosforth, Newcastle upon Tyne NE3 3PX
Tel +44 191 282 3151
Fax +44 191 284 0378
Chairman:
Prof Sir Frederick Holliday
Chief Executive:
David Cranston

Northumbrian Water Ltd
Abbey Road, Pity Me, Durham DH1 5FH
Tel +44 191 383 2222
Fax +44 191 384 1920
Chairman:
David Cranston
Managing Director:
Dr Jon Hargreaves
Population: 1 200 000 (water supply) 2 600 000 (waste water)
Vol water supplied: 156/80*
No. reservoirs: 132
Vol sewage treated: 195*
No. sewage plants: 385

Severn Trent plc
2308 Coventry Road, Sheldon, Birmingham B26 3JZ
Tel +44 121 722 4000
Fax +44 121 722 4800
Chairman:
Richard Ireland
Chief Executive:
Vic Cocker
Population: 8 250 000
Vol water supplied: 759 930 megalitres/year
No. reservoirs: 41
No. sewage plants: 1014

Severn Trent Water Ltd
2297 Coventry Road, Sheldon, Birmingham B26 3PU
Tel +44 121 722 4000
Fax +44 121 722 4800
Chairman:
Roderick Paul
Chief Executive:
Vic Cocker

Severn Trent Water International
Managing Director:
Rennie Quinn

Severn Trent Property
Managing Director:
Paul Ludlow

Severn Trent Systems
Managing Director:
Jim Oliver

Severn Trent Technology
Managing Director
Ian Hislop

Biffa Waste Services
Coronation Road, Cressex, High Wycombe, Bucks HP12 3TZ
Tel +44 1494 521221
Fax +44 1494 473023
Managing Director:
Martin Bettington

Severn Trent Laboratories
General Manager:
Rachael Cumyn

Southern Water plc
Southern House, Yeoman Road, Worthing, W Sussex BN13 3NX
Tel +44 1903 264444
Fax +44 1903 262185
Chairman:
W J W Courtney CBE
Group Managing Director:
M R Webster

Southern Water Services Ltd
Southern House, Yeoman Road, Worthing, W Sussex BN13 3NX
Tel +44 1903 264444
Fax +44 1903 262100
Managing Director:
W Cutting
Population: 2 172 000 (water supply 4 118 000 (waste water)
Vol water supplied: 226*
No. reservoirs: 4
*Vol sewage treated: 480**
No. sewage plants: 367

South West Water plc
Peninsula House, Rydon Lane, Exeter, Devon EX2 7HR
Tel +44 1392 446688
Fax +44 1392 434966
Chairman and Chief Executive:
K W Court
Managing Director:
W H Fraser
Population: 1 500 000
Vol water supplied: 178*
No. reservoirs: 26
Vol sewage treated: 146*
No. sewage plants: 599

South West Water Services Ltd
Peninsula House, Rydon Lane, Exeter, Devon EX2 7HR
Chairman and Chief Executive:
K W Court
Managing director:
Bill Fraser
Population: 1 500 000
No. reservoirs: 37
No. sewage plants: 610

Thames Water plc
14 Cavendish Place, London W1M 9DJ
Tel +44 171 636 8686
Fax +44 171 436 6752
Chairman:
Sir Robert Clark
Group Chief Executive:
Mike Hoffman
Population: 7 200 00 (water) 11 700 000 (sewerage)
Vol water supplied: 954*
No. reservoirs: 22
Vol sewage treated: 1387*
No. sewage plants: 377

Thames Water Utilities
Nugent House, Vastern Road, Reading, Berks RG1 8DB
Tel +44 1734 591159
Chairman & Chief Executive:
Mike Hoffman
Managing Director:
Bill Alexander
Population: 11 500 000
Vol water supplied: 1000*
No. reservoirs: 24
Vol sewage treated: 1400*
No. sewage plants: 389

Welsh Water plc
PO Box 295, Alexandra Gate, Rover Way, Cardiff CF2 2UE
Tel +44 1222 500600
Fax +44 1222 585600
Chairman:
Iain Evans
Chief Executive:
Graham Hawker
Managing Director:
Brian Charles

Dwr Cymru Welsh Water
Plas y Ffynnon, Cambrian Way, Brecon, Powys LD3 7HP
Chairman
Graham Hawker
Managing Director:
Brian Charles
Population: 2 800 000
Vol water supplied: 429.6*
No. reservoirs: 91
No. sewage plants: 844

Wessex Water plc
Wessex House, Passage Street, Bristol BS2 0JQ
Tel +44 117 929 0611
Fax +44 117 929 3137
Chairman:
Nicholas Hood CBE
Group Chief Executive:
Colin Skellett

Wessex Water Services Ltd
Wessex House, Passage Street, Bristol BS2 0JQ
Tel +44 117 929 0611
Fax +44 117 929 3137
Chairman and Chief Executive as for Wessex Water plc
Director of Water Supply Services:
Ken Manley
Director of Waste Water Services:
Peter Try
Population: 1 100 000 (water) 2 500 000 (sewerage)
Vol water supplied: 146 600

*million m^3/year

megalitres/year
No. reservoirs: 13
Vol sewage treated: 292 000 megalitres/year
No. sewage plants: 350

Yorkshire Water plc
2 The Embankment, Sovereign Street, Leeds LS1 4BG
Tel +44 113 234 3234
Fax +44 113 234 2322
Chairman (Yorks Water plc): **Sir Gordon Jones**
Chairman (Yorks Water Services Ltd): Trevor Newton
Population: 4 540 000
Vol water supplied: 522*
No. reservoirs: 105 (impounded) 479 (service)
Vol sewage treated: 416*
No. sewage plants: 630

Yorkshire Water Services Ltd
West Riding House, 67 Albion Street, Leeds LS1 5AS
Tel +44 1532 448201
Fax +44 1532 443071
Managing Director of Water Services: **Tony Ward**
Population: 4 500 000
No. reservoirs: 115
No. sewage plants: 591

Water supply companies

Bournemouth Water plc
George Jessel House, Francis Avenue, Bournemouth BH11 8NB
Tel +44 1202 591111
Fax +44 1202 599333
Chairman, non-executive: **W K Gardener**
Managing Director: **A R F Cooke**
Population: 409 000
Vol water supplied: 58.09*
No. reservoirs: 14
No. sewage plants: 6

Bristol Water plc
PO Box 218, Bridgwater Road, Bristol BS99 7AU
Tel +44 117 966 5881
Fax +44 117 963 4576
Chairman: **Sir John Wills Bt TD**
Managing Director: **J R Browning**
Population: 1 049 000
Vol water supplied: 119.48*
No. reservoirs: 153
Vol sewage treated: 0

Cambridge Water Company
41 Rustat Road, Cambridge CB1 3QS
Tel +44 1223 403000
Fax +44 1223 214052
Chairman: **P G Shaw**
Managing Director: **Robert Burgin**
Population: 278 500
Vol water supplied: 26.4*
No. service reservoir compartments: 24 (Towers: 11)
Vol sewage treated: 0

Chester Waterworks Company
Aqua House, 45 Boughton, Chester CH3 5AU
Tel +44 1244 320501
Fax +44 1224 316102
Chairman: **J A Musgrave**
Eng Director/General Manager: **D L Hall**
Population: 116 000
Vol water supplied: 10.32*
No. reservoirs: 7
Vol sewage treated:

Cholderton and District Water Company Ltd
Estate Office, Cholderton, Salisbury, Wilts SP4 0DR
Tel +44 1980 64203
Fax +44 1980 629307
Chairman and Managing Director: **H A Edmunds**
Director: **F S Edmunds**
Population: 2100
Vol water supplied: 0.011*
No. reservoirs: 5

The Colne Valley Water Company plc
Blackwell House, Aldenham Road, Watford, Herts WD2 2EY
Tel +44 1923 223333
Fax +44 1923 249395
Managing Director: **James McGown**
Population: 766 000
Vol water supplied: 79*
No. reservoirs: 13

East Surrey Water plc
London Road, Redhill RH1 1LJ
Tel +44 1737 772000
Fax +44 1737 766807
Chairman: **J A Fooks**
Managing Director: **P B Holder**
Population: 326 000
Vol water supplied: 37.7*
No. reservoirs: 1
Vol sewage treated: 0

Essex and Suffolk Water plc
Hall Street, Chelmsford, Essex CM2 0HH
Tel +44 1245 491234
Fax +44 1245 212345
Chairman: **Mark Farrer**
Managing Director: **A J Harding**
Population: 1 662 000
Vol water supplied: 171.7*
No. reservoirs: 50
Vol sewage treated: 0

Folkestone and Dover Water Services Ltd
The Cherry Garden, Cherry Garden Lane, Folkestone, Kent CT19 4QB
Tel +44 1303 276951
Fax +44 1303 276712
Chairman: **John Bonomy**
Managing Director: **David Dunks**
Population: 145 000
Vol water supplied: 20*
No. reservoirs: 23

Hartlepools Water Company
3 Lancaster Road, Hartlepool TS24 8LW
Tel +44 1429 274405
Fax +44 1429 278961
Chairman: **Jeremy Ropner**
Director, Engineer & Manager: **Keith Hall**
Population: 90 000
Vol water supplied: 15*
No. reservoirs: 2
Vol sewage treated: 0

Lee Valley Water plc
PO Box 48, Bishops Rise, Hatfield, Herts AL10 9HL
Tel +44 1707 268111
Fax +44 1707 277333
Chairman/Managing Director: **James McGown**
Population: 1 034 000
Vol water supplied: 105*
No. reservoirs: 61

Mid Kent Water plc
High Street, Snodland, Kent ME6 5AH
Tel +44 1634 240313
Fax +44 1634 242764
Chairman: **Geoffrey L Baldwin**
Managing Director: **Michael J Clark**
Population: 525 000
Vol water supplied: 35* (average)
No. reservoirs: 74
Vol sewage treated: 0

Mid Southern Water Company
Frimley Green, Camberley, Surrey GU16 6HZ
Tel +44 1252 835031
Fax +44 1252 836066
Chairman: **Patrick O Packham**
Managing Director: **John Mitchell**
Population: 722 604
Vol water supplied: 80.33*
No. reservoirs: 47
Vol sewage treated: 0

North East Water plc
PO Box 10, Allendale Road, Newcastle upon Tyne NE6 2SW
Tel +44 191 265 4144
Fax +44 191 276 6612
Chairman: **Sir Derek Bradbeer**
Managing Director: **J A Cuthbert**
Population: 1 350 000
Vol water supplied: 150*
No. reservoirs: 10
Vol sewage treated: 0

North Surrey Water Company
Millis House, The Causeway, Staines, Middlesex TW18 3BX
Tel +44 1784 455464
Fax +44 1784 451260
Chairman/Managing Director: **J Jeffery**
Finance Director: **D Hewitt**
Population: 458 000
Vol water supplied: 63*
No. reservoirs: 19
Vol sewage treated: 0

Portsmouth Water plc
PO Box 8, West Street, Havant, Hants PO9 1LG
Tel +44 1705 499888
Fax +44 1705 453632
Chairman: **George Slater**
Managing Director: **John Batty**
Population: 643 000
Vol water supplied: 67*
No. reservoirs: 39
Vol sewage treated: 0

Rickmansworth Water Ltd
London Road, Rickmansworth, Hertfordshire WD3 1LB
Tel +44 1923 776633
Fax +44 1923 777413
Managing Director: **James McGown**
Operations Manager: **Mike Pocock**
Population: 556 000
Vol water supplied: 47.45*
No. reservoirs: 21

South East Water Ltd
(incorporates Eastbourne Water plc, Mid-Sussex Water plc & West Kent Water plc)
14 Upperton Road, Eastbourne, East Sussex BN21 1EP
Tel +44 1323 411411
Fax +44 1323 411412
Chairman: **Dick Barnhoorn**
Managing Director: **Ray Tennant**
Population: 614 000
Vol water supplied: 60.30*
No. reservoirs: 83
Vol sewage treated: 0

South Staffordshire Water plc
Green Lane, Walsall, West Midlands WS2 7PD
Tel +44 1922 38282
Fax +44 1922 725542
Chairman: **John Richard Harris**
Managing Director: **T J McAllister**
Population: 1 250 000
Vol water supplied: 129*
No. reservoirs: 38
Vol sewage treated: 0

The Sutton District Water plc
59 Gander Green Lane, Cheam, Sutton, Surrey SM1 2EW
Tel +44 181 643 8050
Fax +44 181 634 4461
Chairman: **Andrew D Kennedy**
Managing Director: **Chris Loring**
Population: 281 000
Vol water supplied: 22.96*
No. reservoirs: 8

Tendring Hundred Water Services Ltd
Mill Hill, Manningtree, Essex CO11 2AZ
Tel +44 1206 392155
Fax +44 1206 395541
Chairman: **Sir William Dugdale**
Managing Director: **John Rayner**
Population: 250 000 (summer)
Vol water supplied: 12*
No. reservoirs: 9

Three Valleys Water plc
PO Box 48, Bishops Rise, Hatfield, Herts AL10 9HL
Tel +44 1707 277211
Fax +44 1707 277377
Chairman: **Sir John Page**
Managing Director: **James McGown**
Population: 2 356 000
Vol water supplied: 256*
No. reservoirs: 95

Wrexham Water plc
Packsaddle, Wrexham Road, Rhostyllen, Wrexham, Clwyd LL14 4DS
Tel +44 1978 846946
Fax +44 1978 846888
Chairman: **Brian Jenkins**
Managing Director: **S B Howarth**
Population: 149 600
Vol water supplied: 17*
No. reservoirs: 8
Vol sewage treated: 0

The York Waterworks plc
Lendal Tower, York YO1 2DL
Tel +44 1904 622171
Fax +44 1904 611667
Chairman: **Richard Stanley**
Managing Director: **Graham Wilford**
Population: 175 000
Vol water supplied: 17*
No. reservoirs: 5
Vol sewage treated: 0

Other water authorities

Ardleigh Reservoir Committee
This committee is an equal partnership of Anglian Water Services Ltd and Tendring Hundred Water Services Ltd
Council of the Isles of Scilly
Town Hall, St Mary's, Isles of Scilly TR21 0LW
Tel +44 1720 422537/8
Fax +44 1720 422202
Chief Technical Officer: **Brian Lowen**
Population: 1800
Vol water supplied: 0.14*
No. reservoirs: 4
Vol sewage treated: 0.1*
No. sewage plants: 1

Isle of Man Water Authority
Tromode Road, Douglas, Isle of Man
Tel Douglas (0624) 624414
Fax +44 624 662437
Engineer and Manager: **Norman Davies**
Population: 70 000
Vol water supplied: 10.22*
No. reservoirs: 43

States of Guernsey Water Board
PO Box 30, South Esplanade, St Peter Port, Guernsey
Tel +44 481 724552
Fax +44 481 715094
Engineer and Manager: **Colin Gaudion**
Population: 60 000
Vol water supplied: 5*
No. reservoirs: 15

The Jersey New Waterworks Company Limited
Mulcaster House, Westmount Road, St Helier, Jersey, Channel Islands
Tel Jersey (01534) 32501
Fax +44 1534 37786
Director: **John Michael Somerset Hobbs**

THE WATER INDUSTRY IN SCOTLAND

Government departments and regulating bodies

Central Scotland Water Development Board

*million m³/year

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For further information contact:

Glynwed Plastics International

De Montfort House, High Street, Coleshill, Birmingham, B46 3BP, United Kingdom
Tel: +44 (0) 1675 467557 Fax: +44 (0) 1675 465977

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Balmore, Torrance by
Glasgow G64 4AJ
Tel +44 1360 620511
Fax +44 1360 620267
Director:
Alexander McCredie
Population: Supplement supplies to 4 500 000
Vol water supplied: 94*
No. reservoirs: 2
Vol sewage treated: 0

The Scottish Office Environment Department
New St Andrews House, Edinburgh EH1 3TG
Tel +44 131 556 8400
Fax +44 131 244 4822

Other organisations

Engineering Water and Waste Directorate
27 Perth Street, Edinburgh EH3 5RB
Tel +44 131 244 3035
Fax +44 131 244 6902
Director and Chief Engineer:
Alasdair C Paton

Scottish River Purification Boards' Association
c/o Tay River Purification Board, 1 South Street, Perth PH2 8NJ
Tel +44 1738 627989
Fax +44 1738 630997
Secretary/Treasurer:
Robert L Cowan

River Purification Boards

Clyde River Purification Board
Rivers House, Murray Road, East Kilbride, Glasgow G75 0LA
Tel +44 1355 238181
Fax +44 1355 264323
Director and Clerk:
Mr Hugh Smith
Chairman:
Councillor Alex MacLean

Forth River Purification Board
Heriot Watt Research Park, Avenue North, Riccarton, Edinburgh EH14 4AP
Tel +44 131 449 7296
Fax +44 131 449 7277
Director:
W Halcrow

Highland River Purification Board
Strathpeffer Road, Dingwall IV15 9QY
Tel +44 1349 862021
Fax +44 1349 863987
Director:
D Buchanan

North East River Purification Board
Greyhope House, Greyhope Road, Aberdeen AB1 3RD
Tel +44 1224 248338
Fax +44 1224 248591
General Manager/Clerk:
Prof D W Mackay

Solway River Purification Board
Rivers House, Irongray Road, Dumfries DG2 0JE
Tel +44 1387 720502
Fax +44 1387 721154
Director:
Dr David J Tervet

Tay River Purification Board
3 South Street, Perth PH2 8NJ
Tel +44 1738 627989
Fax +44 1738 630997
Director:
R Allcock
Population: 448 115

Tweed River Purification Board
Burnbrae, Mossilee Road, Galashiels
Tel +44 1896 752425/754797
Fax +44 1896 754412
Director and River Inspector

Local Authorities

Borders Regional Council
Directorate of Water and Drainage Services, West Grove, Waverley Road, Melrose, Roxburghshire TD6 9SJ
Tel +44 1896 822056
Fax +44 1896 822702
Director:
Robert Fraser OBE
Population: 103 000
Vol water supplied: 0.002*
No. reservoirs: 5
Vol sewage treated: 17.8*
No. sewage plants: 40

Regional Headquarters
Newtown St Boswells, TD6 0SA
Tel +44 1835 23301
Chief Executive:
Kenneth Clark

Central Regional Council
Viewforth, Stirling FK8 2ET
Tel +44 1786 442000
Chief Executive:
Douglas Sinclair

Water Services
Woodlands, St Ninians Road, Stirling FK8 2HB
Tel +44 1786 443000
Fax +44 1786 463841
Director:
Jim Brown
Population: 380 700 (water) 272 900 (sewerage)
Vol water supplied: 80.3*
No. reservoirs: 93
Vol sewage treated: 25.5*
No. sewage plants: 45

Dumfries and Galloway Regional Council
Council Offices, Dumfries DG1 2DD
Tel +44 1387 61234
Chief Executive:
Neil McIntosh CBE

Water and Sewerage Department
Marchmount House, Marchmount, Dumfries DG1 1PW
Tel +44 1387 61234
Fax +44 1387 60780
Director:
Charles Schooling
Population: 147 000
Vol water supplied: 26.5*
No. reservoirs: 22
Vol sewage treated: 10.5*
No. sewage plants: 186

Fife Regional Council
Fife House, North Street, Glenrothes, Fife KY7 5LT
Tel +44 1592 414141
Fax +44 1592 414142
Chief Executive:
Dr John Markland
Population: 353 000
Vol water supplied: 50.5*
Vol sewage treated: 23.25*
No. reservoirs: 15
No. sewage plants: 72

Department of Engineering
Fife House, North Street, Glenrothes, Fife KY7 5LT
Tel +44 1592 414141
Fax +44 1592 415059
Director:
John Rowson

Grampian Regional Council
Water Serives Department, Woodhill House Annexe, Westburn Road, Aberdeen AB9 2LU
Tel +44 1224 682222
Fax +44 1224 664044
Director of Water Services:
James M T Cockburn
Population: 480 000
Vol water supplied: 170 megalitres/year
No. reservoirs: 302
No. sewage plants: 176

Highland Regional Council
Regional Buildings, Glenurquhart Road, Inverness IV3 5NX
Tel +44 1463 702542
Fax +44 1463 702549
Director:
J M C Johnstone
Population: 205 600
Vol water supplied: 31.4*
No. reservoirs: 31
Vol sewage treated: 27.7*
No. sewage plants: 340

Lothian Regional Council
Regional Headquarters, George IV Bridge, Edinburgh EH1 1UQ
Tel +44 131 469 3588
Chief Executive:
Tom Aitchison

Department of Water and Drainage
55 Buckstone Terrace, Edinburgh EH10 6XH
Tel +44 131 445 4141
Fax +44 131 445 5040
Director:
W R Ferguson
Population: 750 600
Vol water supplied: 106*
No. reservoirs: 17 (supply) 7 (compensation) 92 (service)
Vol sewage treated: 133*
No. sewage plants: 42

Orkney Islands Council
Council Offices, School Place, Kirkwall KW15 1NY
Tel +44 1856 3535

Department of Engineering and Technical Services
Director:
Richard Campbell

Shetlands Islands Council
Town Hall, Lerwick, Shetland ZE1 0HB
Tel +44 1595 693535
Fax +44 1595 694349
Chief Executive:
Malcolm Green

Department of Environmental Services
Greenhead, Lerwick ZE1 0PY
Tel +44 1595 696789
Fax +44 1595 692605
Director:
Martin R Hall
Population: 23 000
Vol water supplied: 4.38*
No. reservoirs: 28
Vol sewage treated: 0

Strathclyde Regional Council
Chief Executives Department, Strathclyde House, 20 India Street, Glasgow G2 4PF
Tel +44 141 204 2900
Fax +44 141 227 2870
Chief Executive:
Sir Robert Calderwood

Strathclyde Water
419 Balmore Road, Glasgow G22 6NU
Tel +44 141 355 5333
Fax +44 141 355 5146
Director:
Ernest Chambers
Population: 2 300 000
Vol water supplied: 387*
Vol sewage treated: 365*
No. reservoirs: 122
No. sewage plants: 105

Strathclyde Sewerage
20 India Street, Glasgow G2 4PF
Tel +44 141 227 3721
Fax +44 141 227 2485
Director:
Prof Thomas A Anderson
Population: 2 300 000
Vol sewage treated: 399.67*
No. sewage plants: 104

Tayside Regional Council
Tayside House, 28 Crichton Street, Dundee DD1 3RA
Tel +44 1382 23281
Fax +44 1382 303030
Director
Crawford J Langley

Water Services Department
Bullion House, Invergowrie, Dundee DD2 5BB
Tel +44 1382 562581
Fax +44 1382 561602
Director:
Roderick Rennet
Population: 363 000
Vol water supplied: 45*
No. reservoirs: 142
Vol sewage treated: 18*
No. sewage plants: 73

Western Isles Islands Council
Comhairle Nan Eilean, Council Offices, Sandwick Road, Stornoway PA87 2BW
Tel +44 1851 3773
Fax +44 1851 5349
Chief Executive:
Brian W Stewart
Population: 30 000
Vol water supplied: 0.66*
No. reservoirs: 44
Vol sewage treated: 0.11*
No. sewage plants: 153

THE WATER INDUSTRY IN NORTHERN IRELAND

Government departments and regulating bodies

Department of the Environment for Northern Ireland
Water Service HQ
3 Frederick Street, Belfast BT1 2NS
Tel +44 1232 244711
Fax +44 1232 330790
Chief Executive:
J Cowan
Population: 1 577 836
Vol water supplied: 243.5*
No. reservoirs: 556
Vol sewage treated: 237*
No. sewage plants: 940

includes

Environmental Protection Division
Calvert House, 23 Castle Place, Belfast BT1 1FY
Tel +44 1232 230560
Assistant Secretary:
R W Rogers

Other organisations

Water Service Headquarters
Northland House, 3 Frederick Street, Belfast BT1 2NS
Tel +44 1232 244711
Fax +44 1232 330790
Chief Executive:
H R F Plester
Population: 1 600 000
Vol water supplied: 249.3*
No. reservoirs: 55 (impounding) 500 (service)
Vol sewage treated: 238.71*
No. sewage plants: 965

Divisions

Eastern
1 College Square East, Belfast BT1 6DR
Tel +44 1232 328161
Fax +44 1232 248105
Divisional Manager:
D Logan
Population: 740 000
Vol water supplied: 110*
No. reservoirs: 22
Vol sewage treated: 125*
No. sewage plants: 81

Northern
Academy House, 121a Broughshane Street, Ballymena BT43 6BA
Tel +44 1266 653655
Divisional Manager:
J T Haslett
Population: 300 675
Vol water supplied: 40.88*
No. reservoirs: 156
Vol sewage treated: 20.07*
No. sewage plants: 294

Southern
Marlborough House, Central Way, Craigavon BT64 1AD
Tel +44 1762 341100
Fax +44 1762 344083
Divisional Water Manager:
J R Cummings
Population: 284 495
Vol water supplied: 50.01*
No. reservoirs: 127
Vol sewage treated: 32.39*
No. sewage plants: 343

Western
1a Belt Road, Altnagelvin, Londonderry BT47 2LL
Tel +44 1504 312221
Fax +44 1504 310330
Divisional Manager:
J S McKee
Population: 267 600
Vol water supplied: 46.5*
No. reservoirs: 131
Vol sewage treated: 12.2*
No. sewage plants: 214

***million m³/year**

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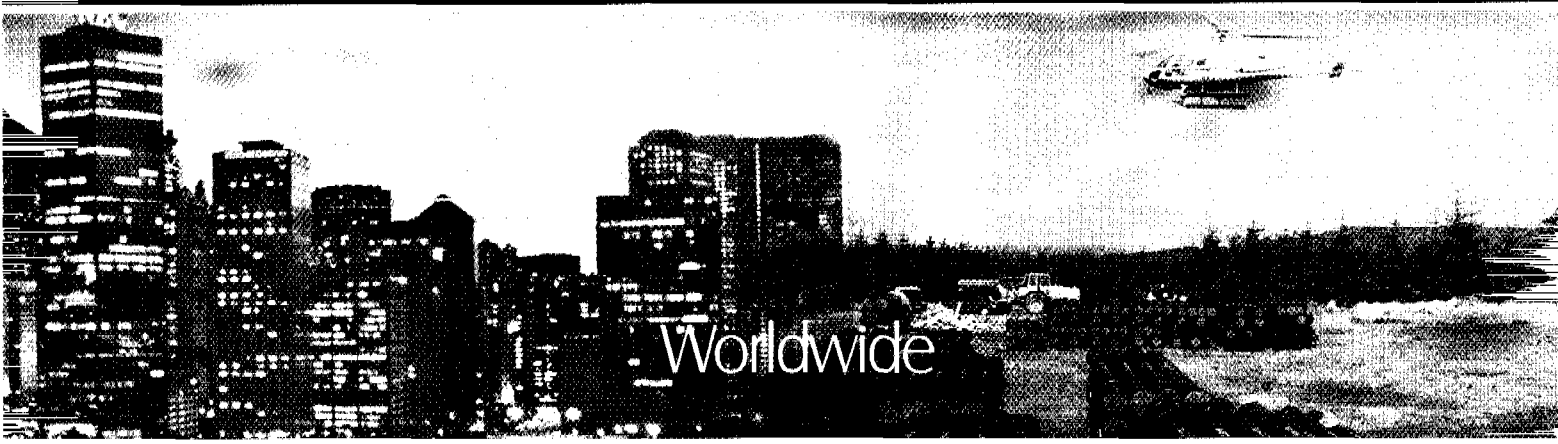

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Buyers' guide – Addresses

ACEA (Azienda Comunale Energia & Ambiente)
P. Le Ostiense 2
I-00154 Roma, Italy
Tel +39 6 579 91
Telex 622653
Fax +39 6 575 8095
Contact: Franciotti Eros
Position: Chief/Marketing Dept

Advanced Separation Technologies
5315 Great Oak Drive
Lakeland
FL 33801, USA
Tel +1 813 687 4460
Fax +1 813 687 9362
Contact: Kimberley Harrell
Position: Marketing Co-ordinator

Agropromtechnika
42a Tolebi Str
Jambul 484039
Kazakhstan
Fax +7 3262 44517
Contact: Ormbeg Dlubaev
Airvac Inc
4217 N Old US 31
Rochester
IN 46975, USA
Tel +1 219 223 3980
Fax +1 219 223 5566
Contact: Mr Rich Naret
Position: Sales Manager

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PO Box 247
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Netherlands
Tel +31 33 676 846
Fax +31 33 676 132
Contact: Mrs H Romp

Akzo Nobel Chemicals (Water Treatment) bv
PO Box 247
NL-3800 AE Amersfoort
Netherlands
Tel +31 33 676 365
Fax +31 33 676 157
Contact: Mr W van Dorst
Position: Product/Sales Manager

Akzo Nobel NV (MPP Systems)
Velperweg 76
NL-6824 BM Arnhem
Netherlands
Tel +31 85 66 3378
Fax +31 85 66 5819
Contact: Mr D Th Meyer
Position: General Manager

Akzo-PQ Silica (Sanipor Chemical Supplier)
PO Box 247
NL-3800 AE Amersfoort
Netherlands
Tel +31 33 67 6777
Fax +31 33 67 6169
Contact: Ms Antoinette M Bär
Position: Account Manager

Alfa-Laval Separation A/S
Maskinvej 5
DK-2860 Soborg
Denmark
Tel +45 31 67 03 11
Fax +45 31 67 21 06
Contact: Mr Anders Penielius
Position: Marketing Manager

Allgemeine Industrie Vertriebs- und Beratungs GmbH (Sanipor Agent)
Ölbergring 32b
D-83620 Feldkirchen-Westerham
Germany
Tel +49 8063 77 07
Fax +49 8063 78 87
Contact: Mrs Csilla Pall

AllMax Professional Solutions Inc
22 North Main Street
Kenton
OH 43326, USA
Tel +1 419 673 8863
Fax +1 419 673 8864
Contact: Mr Russell Maxwell
Position: President

Ameron
10681 Foothill Blvd
Suite 450
Rancho Cucamonga
91730 3857, USA
Tel +1 818 683 4000
Contact: Ms J Daleo

Ansaldo
Public Relations Dept
Via Sp Caboto
Corsico
Milano, Italy
Contact: Mr Pierzuigi Scotti

Apma Production Company
Nijnesulskii Tupik No 5
Moscow 103064, Russia
Contact: Mr Samsonov

Applied Biochemists (Div Gt Lakes Biochemists)
6120 W Douglas Avenue
Milwaukee
WI 551107, USA
Tel +1 414 464 8450
Contact: Mr James C Schmidt

Aqua Data Services Ltd
Aquatec House
Lineham
Chippenham
Wilts SN14 4PP, UK
Tel +44 1249 890724
Fax +44 1249 891329
Contact: Ms A Gavrilovic-Peel
Position: Company Secretary

Aqua-Spec
90 Ostend Road
Island Park
New York
NY 1158, USA
Tel +1 516 431 8973
Contact: Mr Mark Sylvani

Atlantis GmbH
Gewerbepark 26-28
D-07549
Germany
Contact: Mr Walter

Badger Meter Inc
4545 West Brown Deer Road
Milwaukee
WI 53223, USA
Tel +1 414 355 0400
Fax +1 414 355 2544
Contact: Mr Charles L Porter Jr
Position: Marketing Manager

Bailey-Fischer & Porter Co (a unit of Elsag Bailey Process Automation)
125 E County Line Road
Warminster
PA 18974, USA
Tel +1 215 674 6000
Fax +1 215 674 6740
Contact: Mr Jon R Oliver
Position: General Manager

Baltic Klär Technologie GmbH
Lambrechtshåger Weg 2
D-18198 Klein Schwass
Germany
Tel +49 38207 229
Fax +49 38207 441
Contact: Mr Henning Siebert
Position: Tech Geschäftsführer

Barnstead/Thermolyne GmbH
Saarbrückenerstr 248
D-38116 Braunschweig
Germany
Tel +49 531 55545
Fax +49 531 577276
Contact: Ms Rosemarie Pauleweit
Position: Secretary

Barnstead: Distributors (address details can be found in alphabetical listings):
Austria: Bartelt GmbH
Belgium: Van der Heyden
Bulgaria/Hungary/Romania: Cheminst GmbH (Chemie u. Hütte)
Czech Republic: Wilhelm Werner
Denmark: Struers KEBO Lab
Ireland: Unitech Ltd
Finland: G W Berg & Co
France: Bioblock Scientific
Germany: IDL & Wilhelm Werner
Great Britain: Sanyo Gallenkamp plc
Greece: C D Kakavoulis
Italy: International PBI
Netherlands: Richard van Seenus Almere BV
Norway: Dan Meszansky A/S
Poland: LABO-Plus
Portugal: Izasa SA, Portugal
Spain: Izasa SA, Spain
Sweden: Struers/Kebo Lab AB
Switzerland: Skan AG
Turkey: Medikal-Endustriyel Sistemler

Bartelt GmbH (Distributor for Barnstead)
Neufeldweg 42
A-8010 Graz
Austria
Tel +43 316 475328
Fax +43 316 463828

Barthauer Software GmbH
Schreberweg 26
D-38108 Braunschweig
Germany
Tel +49 531 23533 0
Fax +49 531 353600
Contact: Ms Monike Heuster
Position: Marketing

Belgorodskii Kombinat Asbestocementnih
104 Michurin Str
Belgorod 308002, Russia
Fax +7 07222 6 2365
Contact: Jakov Lvov Pevzner

G W Berg & Co (Distributor for Barnstead)
Vapaalantie 8
FIN-01650 Vantaa
Finland
Tel +358 6154 4154
Fax +358 6154 4222

Bioblock Scientific (Distributor for Barnstead)
PO Box 111
F-67403 Illkirch Cedex, France
Tel +33 88 67 14 14
Fax +33 88 67 11 68
Contact: Mr Pierre Block
Position: PDG

BOC Gases
Water Processes Group
Deer Park Road
London SW19 3UF, UK
Tel +44 181 543 3911
Fax +44 181 540 6557
Contact: Mr Paul H Williams
Position: Marketing Manager

Bormet Maschinenbau GmbH & Co Kg
Ausserhalb 24
D-64331 Weiterstadt
Germany
Tel +49 6150 5098 0
Fax +49 6150 5098 31
Contact: Mr E Fink
Position: Technical Director

British Gas
Global Gas
3 Floor Commercial Licensing Dept
59 Bryanston Street
London W1A 2AZ, UK
Tel +44 171 723 7030
Contact: Mr A S Parkes

Campipe Technologies plc
Hoogstraat 33
B-3665 As
Belgium
Tel +32 89 658 486
Fax +32 89 659 146
Contact: Mr Ronald van Knippenberg
Position: General Manager

Caprari Pumps (UK) Ltd
Caprari House
Bakewell Road
Orton Southgate
Peterborough PE2 6XU, UK
Tel +44 1733 371 605
Fax +44 1733 371 607
Contact: Ms Jane Broughton
Position: Admin Manager

Castell Safety International Ltd
Kingsbury Road
Kingsbury
London NW9 8YR, UK
Tel +44 181 700 1000
Contact: Mr John Smith

Chemie GmbH Bitterfeld-Wolfen
Bereich Ionenaustauschen
Postfach 1139
D-06733 Bitterfeld
Germany
Tel +49 3493 76329
Telex 31980-32
Fax +49 3493 77716
Contact: Dr Rüdiger Seidel

Cheminst Ges.m.b.H
Laudongasse 40
A-1080 Wien
Austria
Tel +43 1 406 59 08 0
Telex 114415 CHWIE A
Fax +43 1 406 44 83
Contact: Mr Walter Vincze (Dipl. Ing)

Corroprot AG
Binzmuhlenstr 48a
CH-8050 Zürich
Switzerland
Contact: Mr Weinmann

Crosfield Gottardi Silica (Sanipor Chemical Supplier)
Via de Cipressi 10
I-37033 Verona, Italy
Tel +39 45 88 40 504
Fax +39 45 48 10 099
Contact: Mr F Coatti

Cytec Industries
Botlekweg 175
Botlek
NL-3197 IC Rotterdam
Netherlands
Tel +31 1819 95400
Contact: Mr Cyril Wekilsky

Dan Meszansky A/S (Distributor for Barnstead)
Holstgate 6
N-4 Oslo Torshov, Norway
Tel +47 2 370788
Fax +47 2 379585

Danfoss A/S
DK-6430 Nordborg
Denmark
Tel +45 74 88 22 22
Telex 50599 danfss dk
Fax +45 74 49 09 49
Contact: Ms Lisa V Pilgaard

Die Media GmbH
Werner Heisenberg Str 8-10
D-68509 Vieinheim
Germany

Djambulvodstroy JSC
11a Suleimanov Str
Djambul 484000
Kazakhstan
Fax +7 3262 44517
Contact: Mr Imashev

Dosapro Milton Roy
10 Grande Rue
BP 5
F-27360 Pont St Pierre,
France
Tel +33 32 683 000
Contact: Mr F Charrier

Drillwell Ltd
Unit 3
Rotherham Close
Killmars
Sheffield, UK
Fax +44 1379 870530

DuPont Permasep RD Products
Glasgow Site
Building 200
PO Box 6101
Newark
DE 19714-6101, USA
Tel +1 302 451 9309
Telex 65034 30365 MCIUW
Fax +1 302 451 9686
Contact: Mr Len Stevens
Position: Commercial Manager

Ebert Ingenieure GmbH
Platanenstrasse 5
D-07549 Gera
Germany
Fax +49 365 737 1618
Contact: Mr Kutschke

El-O-Matic International
PO Box 223
NL-7550 AE Hengelo
Netherlands
Tel +31 74 432045
Fax +31 74 910938
Contact: Mr H W Hajonides
Position: Marketing Director

Elektolyse Project BV
De Nieuwe Vaart 38
NL-1401 GS Bussum
Netherlands
Tel +31 2159 43474
Contact: Mr Tholen

L' Entreprise Industrielle
30 rue de la Poudrette
F-69627 Villeurbanne Cdx,
France
Tel +33 72 36 10 10
Telex 340113
Fax +33 72 36 11 99
Contact: Mr Philippe Deprez
Position: Chef de Service

European Geophysical Services SA
2028 rue de Hamm
L-1713 Hamm
Luxembourg
Tel +352 425 321
Contact: Mr Martin Drake

Fischer & Porter Company
(See Bailey-Fischer & Porter Co), UK

Franken Plastik GmbH
Balbierstrasse 11
D-90763 Fürth/Bayern
Germany
Tel +49 911 787 0770
Fax +49 911 787 0777
Contact: Mr Harald Fürst
Position: Marketing Manager

Friatec Ag
Postfach 710261
D-68222 Mannheim
Germany
Tel +49 621 486 0
Fax +49 621 486 1609
Contact: Mr Jens Ehret
Position: Advertising Assistant

Galfitec-Galvano Filtertechnik GmbH
Georg Freitag Str 160
D-6507 Güntersberge
Germany
Fax +49 39 488 200/221
Contact: Mr Hartmann

Gamma-Service Produktbestrahlung GmbH
Bautzner Strasse 67
D-04347 Leipzig
Germany
Tel +49 341 242 1597
Fax +49 341 242 1687
Contact: Dr Gerhard Hübner
Position: Managing Partner

Gelmans Sciences Inc
Ann Arbor
Michigan, USA
Tel +1 313 665 0651
Contact: Ms R Hook

General Signal Pump Group (a unit of General Signal)
800 Airport Road
North Aurora
IL 60542, USA
Tel +1 708 859 7000
Fax +1 708 859 7060
Contact: Ms Karen Blaski
Position: Marketing Services Manager

Glynwed Plastics International
De Montfort House
Coleshill
Birmingham B46 3BP, UK
Tel +44 1675 467 557
Fax +44 1675 465 977
Contact: Mr M D Hopkinson
Position: Marketing Development Executive

Grundfos A/S
DK-8850 Boerringbro
Denmark
Tel +45 86 681 400
Fax +45 86 684 245
Contact: Mr Poul Hesselby
Position: Advertising Manager

GU Projects Ltd
Blackwell House
Aldenham Road
Watford
Herts WD2 2LG, UK
Tel +44 1923 248831
Fax +44 1923 814239
Contact: Mr T R Chapman
Position: Head of Quality Assurance

Hydraulic Engineering Metal
2 Promishlenaya Str
Hersonskou Distr No 2
Novaya Kahovka
Ukraine
Contact: Mr V Evosifovich

H~2O Waste Tec (A Division of Mono Pumps Ltd)
Horsfield Way
Bredbury Park
Stockport SK6 2SU, UK
Tel +44 161 406 7111
Telex 669707
Fax +44 161 406 7222
Contact: Ms Andrea Davies
Position: Marketing Assistant

IDL GmbH & Co KG (Distributor for Barnstead)
Robert-Bosch Str 3
D-61130 Nidderau
Germany
Tel +49 6187 22022
Fax +49 6187 24523

IMI Norgren Ltd
Litchfield (UK)
Balterswil (Switzerland)
Alpen (Germany)
Most other European countries
Contact: Mr J S Stebler

Intercommunale Vennootschap Antwerpse Waterwerken (AWW)
Mechelsesteenweg 64
B-2018 Antwerpen
Belgium
Tel +32 3 244 05 00
Telex 32139
Fax +32 3 244 05 99
Contact: Ir G Merckx
Position: General Manager

International PBI SpA (Distributor for Barnstead)
Via Novara 89
I-20153 Milano, Italy
Tel +39 2 404 7941
Fax +39 2 400 90010
Contact: Mr Roberto Ligugnana
Position: Managing Director

ITT Flygt AB
PO Box 1309
S-17125 Solna, Sweden
Tel +46 8 627 6808
Fax +46 8 627 6900
Contact: Mr Bj^rn von Euler
Position: Corporation Commercial Manager

Izasa SA (Distributor for Barnstead)
Rua Cordeiro Ferreira
No 9
Codex 1750 Lisboa
Portugal
Tel +351 1 757 07 40
Fax +351 1 759 92 29

Izasa SA (Distributor for Barnstead)
Aragoneses 13
Poligono Industrial
Alcobendas
E-28100 Alcobendas
Madrid, Spain
Contact: Mr Jose Foster
Position: Analytical Divisional Manager

C D Kakavoulis and Co (Distributor for Barnstead)
10-12 Rapsanis Street
PO Box 14092
GR 115 27 Athens, Greece
Tel +30 1 770 9474
Telex 210434 COMA GB
Fax +30 1 775 6090
Contact: Mr Costas Kakavoulis
Position: General Manager

Keystone Valve Europe BV
Mijkenbroek 22
NL-4824 AB Breda
Netherlands
Tel +31 76 549 1000
Fax +31 76 541 7870
Contact: Mr P J Dekker
Position: Marketing

KIK Kunststoff Technik
Alten Kesselerstr 17
D-66115 Saarbrücken
Germany
Tel +49 681 9762 460
Fax +49 681 9762 461
Contact: Mr Alfons Kessler

Koch Engineering
161 42nd Street
New York
NY 10017, USA
Tel +1 212 682 5765
Contact: Mr Mike Mutsakis

Labo-Plus Ltd (Distributor for Barnstead)
Ul. Pogonowskiego 38
01-564 Warszawa, Poland
Tel +48 22 39 37 14
Fax +48 22 39 59 12
Contact: Mr Andrzej Korniluk
Position: Director

Dr Bruno Lange GmbH
Willstaetter Str 11
D-40549 Düsseldorf
Germany
Tel +49 211 5288 214
Fax +49 211 5288 231
Contact: Mr Probst
Position: Export Manager

Measurement & Control Services Ltd
Unit 5 Ashby's Yard
Medway Wharf Road
Tonbridge
Kent TW9 1RE, UK
Tel +44 1732 770885
Fax +44 1732 770886
Contact: Mr R J Evans
Position: Managing Director

Medikal-Endustriyel Sistemler Ltd (Distributor for Barnstead)
Halk Sokak 13/2 Sihhiye
Ankara 06410, Turkey
Tel +90 312 431 7969/433 0233
Fax +90 312 435 0488
Contact: Hasan Peksen
Position: Director

Mitramas Private Ltd (Sanipor Agent)
190 Middle Road
11-06 Fortune Center
Singapore 0718
Singapore
Tel +65 336 07 88
Fax +65 336 83 36
Contact: Mr Alan Kong

Mitsubishi Electric UK Ltd
Travellers Lane
Hatfield
Herts AL10 8XB, UK
Tel +44 1707 278 6100
Contact: Mr Dave Robinson

MWA GmbH
Postfach 44
D-77871 Renchen
Germany

Napredak-NPI Ltd
87 Slatinska Str
Sofia
Bulgaria
Contact: Vili Dimitrov

Nopon Oy
Turvekuja 6
FIN-00700 Helsinki
Finland
Tel +358 351 5700
Fax +358 351 5620
Contact: Mr Magnus Hasto
Position: Managing Director

NPO 'Tekhenergokhimprom'
3 Shcherbakovskaya Street
Moscow 105318
Russian Federation
Tel +7 95 369 32 64
Fax +7 95 369 33 89
Contact: Mr Vladimir V Zhizhin
Position: General Director

Pannonpipe Müanyagipari Uft
Bajaky F u 1
H-1211 Budapest
Hungary
Tel +36 1 277 4345
Fax +36 1 277 0767
Contact: Dr Christian Hemerka
Position: Managing Director

Derek Parnaby Cyclones International Ltd
Chilton Ind Estate
Chilton
Ferryhill
Co Durham DL17 0SH, UK
Tel +44 1388 720849
Fax +44 1388 721415
Contact: Mrs P I Telford
Position: Office Manager/Director

Pennsylvania Insert Corporation
PO Box 199
Spring City
PA 19475, USA
Tel +1 610 948 9688
Contact: Ms J Miller

Phillips Driscopipe
2929 N Central Expressway
Suite 300
Richardson
TX 75080, USA
Tel +1 214 783 2666
Contact: Mr Bill Nicol

Polimer JSC
No 1
1 Yevskaya Str
Penza 440031, Russia
Fax +7 8412 462493
Contact: Mr Valentin V Petrov

PS Analytical Ltd
Arthur House, Unit 3
Crayfields Ind Est
Main Road

St Paul's Cray
Orpington
Kent BR5 3HP, UK
Tel +44 1689 891211
Fax +44 1689 896009
Contact: Prof P B Stockwell
Position: Managing Director

Puraqua Umweltanlagen GmbH
Lembˆckgasse 49
A-1234 Wien
Austria
Tel +43 1 866 47 0
Fax +43 1 866 47 201
Contact: Ms Susanne Blaha
Position: Marketing Director

R.S. Technical Services Inc
1327 Clegg Street
Petaluma CA 94954
PO Box 750579
Petaluma
CA 94975-0579, USA
Tel +1 707 778 1974
Fax +1 707 778 1981
Contact: Mr FrÉdÉric Libet-Descorne
Position: International Sales Co-ordinator

Rem-Wod
ul Legnicka 28
PO Box 736
25-324 Kielce 25, Poland
Tel +48 4141 448
Contact: Mieczysk Stawecki

Rothenberger AG
Gutleutstrasse 175
D-60327 Frankfurt-am-Main
Germany
Tel +49 69 2400 0854
Contact: Detlev Baumanns

Salem Engelhard
245 S Mill Street
South Lyon
MI 48178, USA
Tel +1 810 437 1400
Contact: Mr Lyman Thornton

Sanipor International Ltd
Obere Gasse 41
CH-7000 Chur
Switzerland
Tel +41 81 257 0193
Fax +41 81 257 0191
Contact: Ms Csilla Pall

Sanipor: Distributors (address details can be found in alphabetical listings)
Australia: A C Tipping
Belgium: Akzo PQ-Silica
France: L'Entreprise Industrielle
Germany: Ai-Allgemeine Industrie Vertriebs- und Beratungs- GmbH
Great Britain: Sanipor UK Ltd
Hungary: Sanitechnik Kft
Italy: Crosfield Gottardi Silica
Middle East: Sanipor Middle East
New Zealand: Works Civil Construktion
Singapore: Mitramas Private Ltd
South Africa: SCI-Silicate and Chemical Industries Ltd
Switzerland: Sanipor International AG
USA/Canada: Sanipor North America

Sanipor Middle East (Sanipor Agent)
PO Box 4043
Doha, Qatar
Tel +974 32 23 39/32 26 69
Fax +974 42 43 51
Contact: Mr George Hore

Sanipor North America (Sanipor Chemical Supplier)
A Division of Crosfield Company
101 Ingalls Avenue
Joliet
IL 60435, USA
Tel +1 815 727 3651
Contact: Mr Ron Galbraith

Sanipor UK Ltd (Sanipor Licensor for UK)
Gatcombe House
Hilsea
Portsmouth
Hants PO2 0TU, UK
Tel +44 1705 69 49 00
Fax +44 1705 69 06 06
Contact: Mr Ian Riches

Sanitechnik Ltd (Sanipor Licensee)
Lisznyai utca 15
H-1016 Budapest
Hungary
Tel +36 1 156 93 91
Fax +36 1 156 93 91
Contact: Dr Gyˆrgy Fabry
Position: Sanipor Consultant

Sanyo Gallenkamp plc (Distributor for Barnstead)
Park House
Meridian East
Meridian Business Park
Leicester LE3 2UZ, UK
Tel +44 116 263 0530
Telex 347269
Fax +44 116 263 0353
Contact: Ms Julie French
Position: Marketing Services

Saur UK Ltd
22-30 Sturt Road
Frimley Green
Camberley
Surrey GU16 6HZ, UK
Tel +44 1252 837 639
Contact: Mr H T Barnhuorn

Wolfgang Schenk GmbH
Arthur Schnitzler Str 10a
D-06886 Lutherstadt-Wittenberg
Germany
Tel +49 3491 4469 0
Fax +49 3491 4469 19
Contact: Mr Wolfgang Schenk

SCI-Silicate and Chemical Industries Ltd (Sanipor Agent)
14016 Wadeville 1422
South Africa
Tel +27 11 824 1973
Fax +27 11 827 6922
Contact: Mr Tex Murray

Sibzvetmetenergo Joint Stock Company
PO Box 36
Krasnoyarsskii Krai
Respublika Khakass
Sayanogorsk, Russia
Fax +7 39130 22710

Sierra Construction & Civil Engineering (UK) Ltd
Unit 10 Station Yard Ind Units
Wilbraham Road
Fulbourn
Cambridge CBQ 5ET, UK
Tel +44 1223 881222
Fax +44 1223 881199
Contact: Mr Richard Johnson
Position: Sales Manager

Siv GmbH
Am Muehlenberg 8a
D-18334 Bad Suelze
Germany
Tel +49 38229 7080
Fax +49 38229 80687
Contact: Mr Joerg Sinnig
Position: Geschäftsführer

Skan AG (Distributor for Barnstead)
Postfach
CH-4009 Basel
Switzerland
Tel +41 61 481 4444
Fax +41 61 481 5755

Stanton plc
Lows Lane
Stanton by Dale
Ilkeston
Derbyshire DE7 4QU, UK
Fax +44 115 932 9515

STL Technology Systems
Ettenbergstrasse 18
CH-8907 Wettswil aA
Switzerland
Tel +41 1 701 1137
Fax +41 1 701 1918
Contact: Mr Alejandro Schnyder
Position: President

Struers/Kebo Lab A/S (Distributor for Barnstead)
Roskildevej 16
DK-2620 Albertslund
Denmark
Tel +45 43 868788
Fax +45 43 868794

Struers/Kebo Lab AB (Distributor for Barnstead)
Domnarvgatan 4
S-163 94 Spanga, Sweden
Tel +46 8 621 3400
Fax +46 8 760 3732

Suprafilt Gesellschaft für Umwelttechnik mbH
Hauptstrasse 4-6
D-74321 Bietigheim
Germany
Tel +49 7142 42001
Contact: Mr W Pflueger

Teknofanghi Srl
Via Ponchielli 2
I-20063 Cernusco S/N
Milano, Italy
Tel +39 2 924 5872
Fax +39 2 924 5873
Contact: Mr G Lagreca
Position: General Manager

Telecation Inc
19423 N Turkey Creek
Morrison
Colorado 80465, USA
Tel +1 303 697 8080
Fax +1 303 697 8085
Contact: Leigh Richardson
Position: President

Thoro NV
Berkebossen Laan 6
B-2400 Mol
Belgium
Tel +32 14 82 99 30
Fax +32 14 81 32 10
Contact: Mr Ph Fourneau
Position: Marketing Manager Europe

Thunderline SA
BP 11
F-67340 Ingwiller, France
Tel +33 88 89 62 62
Contact: Mr D Herault

A C Tipping Maintenance Pty Ltd (Sanipor Licencee)
30 Oramzi Road
Girraween
NSW 2145
Australia
Tel +61 2 631 12 00
Fax +61 2 688 14 58
Contact: Mr Robert G Tipping

Tour & Andersson AS
PO Box 85
N-3601 Kongsberg, Norway
Tel +47 32 73 29 00
Fax +47 32 73 29 99
Contact: Mr Oddmund Johnrud
Position: Sales Manager

Trojan Technologies Inc
3020 Gore Road
Ontario, Canada
Tel +1 519 457 3400
Contact: Ms Jona Swain

Tytronics Inc
25 Wiggins Avenue
Bedford
MA 01730-2323, USA
Tel +1 617 275 9660
Fax +1 617 275 9665
Contact: Teri Olsen
Position: Marketing Admin

Union Filtration a/s
Sandvikenvej 7
DK-4900 Nakskov
Denmark
Tel +45 54 9513 00
Fax +45 54 9513 01
Contact: Ms Dorte Frederiksen
Position: Secretary

Unitech Ltd (Distributor for Barnstead)
United Drug House
Belgard Road
Tallaght
Dublin 24
Ireland
Tel +353 1 459 8877
Fax +353 1 459 6919
Contact: Ms Niamh Sheridan
Position: Operations Manager

Utek GmbH
PO Box 1754
D-06815 Dessau
Germany
Tel +49 340 213454
Fax +49 340 213889
Contact: Mr Andreas Piehler
Position: Manager

Van Der Heyden (Distributor for Barnstead)
rue du Marais 49-55
B-1000 Bruxelles
Belgium
Tel +32 2 212 0611
Fax +32 2 218 6979
Contact: Mr Eric Bettens

Richard van Seenus Almere BV (Distributor for Barnstead)
Bolderweg 6
NL-1332 AT Almere
Netherlands
Tel +31 36 532 0450
Fax +31 36 532 1308
Contact: Mr S van de Molengraft
Position: Sales Engineer

Vodmachoborudovanie Strukturnoe Podraz
111 Prospekt Truda
Voronej, Russia
Fax +7 0732 161933

Von Roll Ltd
Valves Department
CH-4702 Oensingen
Switzerland
Tel +41 62 78 11 11
Fax +41 62 78 11 88
Contact: Mr Burkhard
Position: Marketing Director

Von Roll Pressure Pipe Ltd
Rue Principale
CH-2764 Choindez
Switzerland
Tel +41 66 351 111
Fax +41 66 351 351
Contact: Ms Karsten Bach
Position: Sales Director

Water & Environment Perinen Ltd
Tehtaankatu 4
FIN-26100 Rauma
Finland
Fax +358 38 822 7225
Contact: Mr Jarmo

Wilhelm Werner GmbH (Distributor for Barnstead)
Buchholzstr 73
D-51469 Bergisch-Gladbach
Germany
Tel +49 2202 51054
Fax +49 2202 54690

Wessex Water plc
Wessex House
Passage Street
Bristol BS2 0JQ, UK
Tel +44 117 929 0611
Fax +44 117 929 3137
Contact: Mr Ken Manley
Position: Director of Water Supply Services

Works Civil Construction (Sanipor Agent)
PO Box 13-031
135A Main South Road
Green Island
Dunadin
New Zealand
Tel +64 3 488 42 55
Fax +64 3 488 23 67
Contact: Mr Harold Norden

Buyers' guide – Categories

Activated sludge plants
Alfa-Laval Separation
BOC Gases

Aeration systems, miscellaneous
BOC Gases
H~2O Waste Tec
Nopon Oy

Aerators
ITT Flygt
KIK Kunststoff Technik
Nopon Oy

Aluminium sulphate
Akzo Nobel Chemicals (Water Treatment)

Analytical measuring devices
Cheminst
Danfoss
Labo-Plus
PS Analytical
Tytronics
Unitech

Analytical testing services
GU Projects

Application software for water supply and disposal/sewage plant
AllMax Professional Solutions
Barthauer Software
Siv
Telecation
Von Roll Pressure Pipe

Automatic control valves
Tour & Andersson

Ball valves - plastic
Glynwed Plastics

Biological, thermal and electrical treatment of water and sewage, treatment of sewage and sludge
Baltic Klär Technologie
KIK Kunststoff Technik

Booster pumps for buildings
General Signal Pump Group

Borehole logging equipment
Aqua Data Services

Borehole pumps
H~2O Waste Tec

Boring pipes, tools and rods for drilling and vertical wells
Sierra Construction

Brackish water treatment
DuPont Permasep RD Products

Butterfly valves
Friatec
Glynwed Plastics
Tour & Andersson
Von Roll

Camera inspection systems
Campipe Technologies

Candle filter
KIK Kunststoff Technik

Cast iron pipes and accessories
Von Roll Pressure Pipe

Cement mortar lining
Thoro

Centrifugal pumps
General Signal Pump Group
ITT Flygt

Centrifuges
Alfa-Laval Separation
Labo-Plus
Sanyo Gallenkamp
Unitech

Check valves - plastic
Friatec
Glynwed Plastics

Chemical feed apparatus
Bailey-Fischer & Porter

Chemical handling and storage
Akzo Nobel Chemicals (Water Treatment)

Chemical transfer pumps
Friatec

Chemical treatment of water and sewage
Measurement & Control Services

Chemicals for treatment of water and sewage
Akzo Nobel Chemicals (Water Treatment)
Akzo-PQ Silica

Chlorination equipment
Bailey-Fischer & Porter

Chlorine dioxide chemicals
Akzo Nobel Chemicals (Water Treatment)

Chlorine residual measuring devices
Bailey-Fischer & Porter
Cheminst
STL Technology Systems
Tytronics

Circulating pumps
Bioblock Scientific
Friatec
General Signal Pump Group

Clamps, pipe joint
Tour & Andersson

Clamps, pipe repair
Tour & Andersson

Clarifiers
Derek Parnaby Cyclones

Coagulators
Akzo Nobel Chemicals (Water Treatment)
Akzo-PQ Silica

Coating and lining, metal protective: cement mortar
Von Roll Pressure Pipe

Coating and lining, metal protective: PUR (polyurethane)
Thoro
Von Roll Pressure Pipe

Compression fittings
Glynwed Plastics
IMI Norgren
Tour & Andersson

Condensate treatment
Chemie GmbH

Conductivity meters
Cheminst
STL Technology Systems
Unitech

Construction of chemical plants for water treatment and sewage purification
GU Projects

Consultants
Airvac

Contractors, water and sewage treatment
Airvac
BOC Gases

Control devices
El-O-Matic
IMI Norgren

Control/data processing systems
GU Projects
STL Technology Systems

Cooling towers
NPO 'Tekhenergokhimprom'

Corrosion inhibitors - scale control agents
Akzo Nobel Chemicals (Water Treatment)
Akzo-PQ Silica
NPO 'Tekhenergokhimprom'

Data processing
Siv
STL Technology Systems

Dechlorination plants
Bailey-Fischer & Porter

Demineralisation
Advanced Separation Technologies
Barnstead/Thermolyne
Chemie GmbH
Cheminst
Medikal-Endustriyel Sistemler
Richard van Seenus Almere

Devices for analysis
Cheminst
Izasa (Spain)
Dr Bruno Lange
Richard van Seenus Almere

Dewatering equipment
Derek Parnaby Cyclones

Diaphragm valves
Glynwed Plastics
Von Roll

Disinfection units and systems
Bailey-Fischer & Porter
STL Technology Systems

Domestic water filters
KIK Kunststoff Technik

Domestic water meters
Badger Meter

Domestic water pumps
General Signal Pump Group
Grundfos

Drilling
Sierra Construction

Drilling and drilled wells, mechanical equipment and construction
Sierra Construction

Ductile cast iron pipes and fittings
Tour & Andersson
Von Roll Pressure Pipe

Ductile iron pipes and fittings
Tour & Andersson
Von Roll Pressure Pipe

Effluent water treatment plant
Advanced Separation Technologies
Akzo Nobel NV (MPP Systems)
Alfa-Laval Separation
BOC Gases
H_2O Waste Tec

Electrical processes for water and sewage treatment
Barthauer Software
GU Projects

Engineering
Airvac
L' Entreprise Industrielle
Sierra Construction

Fecal pump units
General Signal Pump Group

Ferrous sulphate
Akzo Nobel Chemicals (Water Treatment)

Filter aids
Labo Plus

Filter media
KIK Kunststoff Technik

Filter media: granular activated carbon
KIK Kunststoff Technik

Filter media: sand
Cheminst

Filter plant equipment
NPO 'Tekhenergokhimprom'
Richard van Seenus Almere

Filter presses
Derek Parnaby Cyclones

Filters and accessories, miscellaneous
Barnstead/Thermolyne

Filters, pressure
Glynwed Plastics

Flange adaptors
Tour & Andersson

Float valves
Tour & Andersson

Flow measurement
Aqua Data Services
Badger Meter
Bailey-Fischer & Porter
Bioblock Scientific
Danfoss
STL Technology Systems
Richard van Seenus Almere

Flow recorders
Aqua Data Services
Badger Meter
Danfoss

Foot and non return valves
Von Roll

Gate valves
Friatec
Tour & Andersson

Hand pumps
H_2O Waste Tec

High pressure pumps
Friatec
General Signal Pump Group
Grundfos
ITT Flygt

Hydrants, fire
Tour & Andersson
Von Roll

Hydrogen peroxide
Akzo Nobel Chemicals (Water Treatment)

Indicating and control systems
STL Technology Systems

Industrial water/sewage treatment
Akzo Nobel NV (MPP Systems)
Alfa-Laval Separation
Chemie GmbH
GU Projects
Von Roll Pressure Pipe

Inhibitors, corrosion
Akzo-PQ Silica

Instrumentation
Badger Meter
Danfoss
IMI Norgren
Izasa (Spain)

Tytronics
Unitech

Intake screens
H_2O Waste Tec

Ion-exchange equipment
Advanced Separation Technologies
Barnstead/Thermolyne
Cheminst
Richard van Seenus Almere

Ion-exchange materials
Akzo Nobel Chemicals (Water Treatment)
Chemie GmbH
Richard van Seenus Almere

Ion-exchange resins
Chemie GmbH
Labo-Plus
Medikal-Endustriyel Sistemler
Richard van Seenus Almere

Ion-exchange/ neutralisation/stabilisation, miscellaneous equipment for
Advanced Separation Technologies

Iron removal plants
Gamma-Service

Laboratory equipment
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Bioblock Scientific
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Friatec
Izasa (Spain)
Labo-Plus
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Sanyo Gallenkamp
Unitech

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Izasa (Spain)
Dr Bruno Lange
Unitech

Lapofloc pac
Akzo Nobel Chemicals (Water Treatment)

Level measuring systems
Danfoss

Macerators
H_2O Waste Tec

Measurements and analysis, instruments for
Cheminst
Dr Bruno Lange
PS Analytical
Tytronics

Mechanical treatment of water and sewage
Alfa-Laval Separation
Bormet Maschinenbau

Mechanically operated fixed screens
Bormet Maschinenbau

Membrane filters
Labo-Plus
Richard van Seenus Almere

Membrane filtration equipment
Labo-Plus
Medikal-Endustriyel Sistemler
Richard van Seenus Almere

Membranes for ultrafiltration
Cheminst
Labo-Plus

Meter reading and immediate billing
Badger Meter

Meters
Badger Meter
Danfoss

Meters, water recording
Badger Meter

Meters, water turbine
Badger Meter

Meters, water, current
Aqua Data Services

Meters, water, displacement
Badger Meter

Meters, water, flow, electromagnetic
Aqua Data Services
Bailey-Fischer & Porter
Danfoss

Meters, water, flow, ultrasonic
Danfoss

Meters-flow indicating, integrating and recording
Aqua Data Services
Badger Meter

Mobile water desalting plants
Akzo Nobel NV (MPP Systems)

Mobile water treatment plants
Measurement & Control Services
Medikal-Endustriyel Sistemler

Monitoring equipment
Aqua Data Services
Cheminst
Dr Bruno Lange
PS Analytical
STL Technology Systems
Tytronics
Richard van Seenus Almere

Non return valves and foot valves in brass, cast iron, plastic
Tour & Andersson

Odour control and abatement
Akzo Nobel Chemicals (Water Treatment)

Odour control equipment
BOC Gases

Oil separators
Akzo Nobel NV (MPP Systems)

Oxygen meters
Bioblock Scientific
Cheminst
Danfoss
Dr Bruno Lange

Ozonisers & ozonisation plants
BOC Gases

Packaged sewage treatment plant
Alfa-Laval Separation
Baltic Klär Technologie
H_2O Waste Tec

pH and oxidation reduction recorders
Bioblock Scientific
Dr Bruno Lange

pH control using carbon dioxide
BOC Gases

Pipe cleaning
Sanitechnik

Pipe distribution, ductile iron
Von Roll Pressure Pipe

Pipe distribution, polybutylene
Sierra Construction

Pipe distribution, polyethylene
Airvac
Sierra Construction

Pipe distribution, pvc
Airvac

Pipe fittings, distribution
Von Roll Pressure Pipe

Pipe fittings, service
Sierra Construction
Tour & Andersson

Pipe flanges
Von Roll Pressure Pipe

Pipe jointing seals/gaskets
Sanitechnik
Von Roll Pressure Pipe

Pipe, pipe joints and fittings
Von Roll Pressure Pipe

Pipes
Von Roll Pressure Pipe

Plastic pipes and fittings
Friatec
Glynwed Plastics

Pollution control measurement
Dr Bruno Lange

Polyaluminium chloride
Akzo Nobel Chemicals (Water Treatment)

Polyethylene sheeting - high density
Utek

Potabilisation plants
ACEA

Pressure indicators
Aqua Data Services

Pressure reducing valves
Tour & Andersson

Programmable logic controllers
STL Technology Systems

Progressing cavity pumps
H_2O Waste Tec

Propeller pumps
Friatec
General Signal Pump Group
ITT Flygt

Pump column pipe
Caprari Pumps (UK)
General Signal Pump Group

Pumping plant
Grundfos

Pumps
Caprari Pumps (UK)
Friatec
General Signal Pump Group
Grundfos
H_2O Waste Tec

Pumps for reverse osmosis
Grundfos

Pumps for solar heating
Grundfos

Pumps for special purposes
General Signal Pump Group
Grundfos

Pumps, centrifugal
Caprari Pumps (UK)
Friatec
General Signal Pump Group
Grundfos
ITT Flygt

Pumps, chemical feed & dosing
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Grundfos

Pumps, deep well
Caprari Pumps (UK)
General Signal Pump Group
Grundfos
H_2O Waste Tec

Pumps, drives
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Pumps, metering
Teknofanghi

Pumps, portable
Grundfos
ITT Flygt

Pumps, submersible
Caprari Pumps (UK)
General Signal Pump Group
Grundfos
H_2O Waste Tec
ITT Flygt
Teknofanghi

Pumps, sump
Caprari Pumps (UK)
Friatec
General Signal Pump Group
Grundfos

Pumps, turbine
Caprari Pumps (UK)
General Signal Pump Group

PUR (Polyurethane) lining
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PVC and PE fittings
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Glynwed Plastics

PVC gate valves
Friatec

Regeneration salt for water softening
Akzo Nobel Chemicals

Relief valves
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Repair clamps
Tour & Andersson

Reverse osmosis
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DuPont Permasep RD Products
Sanyo Gallenkamp
Richard van Seenus Almere

Reverse osmosis equipment
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Reverse osmosis systems
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River water intakes
H_2O Waste Tec

Rotating biological contactors
Baltic Klär Technologie

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Bioblock Scientific

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Bormet Maschinenbau
H_2O Waste Tec
Derek Parnaby Cyclones

Self priming pumps
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Sewage pumping stations
Airvac
H_2O Waste Tec
ITT Flygt

Sewage pumps

Friatec
General Signal Pump Group
H_2O Waste Tec
ITT Flygt

Sewage treatment plants
Alfa-Laval Separation
Baltic Klär Technologie
BOC Gases
H_2O Waste Tec

Sewer flood grouting
Sanipor International

Sludge beneficial re-use
Akzo Nobel Chemicals (Water Treatment)

Sludge dewatering
Alfa-Laval Separation
Derek Parnaby Cyclones
Teknofanghi

Sludge fixed and mobile treatment plants
Derek Parnaby Cyclones

Sludge pumps
General Signal Pump Group
ITT Flygt
Teknofanghi

Sludge recycling
Akzo Nobel Chemicals (Water Treatment)

Sludge thickening
Alfa-Laval Separation
Derek Parnaby Cyclones
Teknofanghi

Sludge treatment equipment
Alfa-Laval Separation
Bioblock Scientific
Derek Parnaby Cyclones
Teknofanghi

Sluice valves
Tour & Andersson

Slurry pumps
General Signal Pump Group
ITT Flygt

Sodium chloride for water softening
Akzo Nobel Chemicals

Softeners, ion-exchange
Advanced Separation Technologies
Chemie GmbH
Cheminst
Richard van Seenus Almere

Softening chemicals
Akzo Nobel Chemicals (Water Treatment)

Solenoid valves
Bioblock Scientific
Glynwed Plastics
IMI Norgren

Solid/liquid separation
Bormet Maschinenbau
Derek Parnaby Cyclones

Stabilisation plants
Gamma-Service

Sterilisation and oxidation plants miscellaneous
Gamma-Service

Sterilising equipment and chemicals oxidation plants
Gamma-Service

Strainers
Badger Meter
Tour & Andersson

Submersible centrifugal pumps, deep well pumps
General Signal Pump Group
ITT Flygt

Sulphuric acid
Akzo Nobel Chemicals (Water Treatment)

Sump pumps
Friatec
General Signal Pump Group
Grundfos

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Akzo Nobel Chemicals (Water Treatment)

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STL Technology Systems

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R.S. Technical Services

Temperature controls
STL Technology Systems

Temperature measurement equipment
Labo-Plus
STL Technology Systems

Treatment of odours from sewage systems
BOC Gases

Treatment of portable water/disinfection; sodium chlorite/hydrogen peroxide
Chemie GmbH
Measurement & Control Services

Treatment of sewage sludge
Baltic Klär Technologie

Turbidimeters
Bioblock Scientific

Turnkey plants
BOC Gases
GU Projects

Ultrafiltration
Barnstead/Thermolyne
Cheminst
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Labo-Plus
Medikal-Endustriyel Sistemler

Ultrapure water systems
Barnstead/Thermolyne
Cheminst
Labo-Plus
Medikal-Endustriyel Sistemler
Richard van Seenus Almere

Ultraviolet disinfection
Bailey-Fischer & Porter
Cheminst
International PBI
STL Technology Systems

Vacuum pumps
Airvac
Friatec
Labo-Plus

Vacuum sewer systems
Airvac

Valve actuators, valve automation for drinking water & waste water
El-O-Matic
IMI Norgren
Keystone Valve Europe

Valves
Airvac
Bioblock Scientific
Friatec
Keystone Valve Europe
Von Roll

Valves, actuators
El-O-Matic
IMI Norgren
Keystone Valve Europe

Valves, air relief
Tour & Andersson

Valves, ball
Keystone Valve Europe

Valves, butterfly
Friatec
Keystone Valve Europe
Tour & Andersson

Valves, cast-iron, ductile iron, bronze
Keystone Valve Europe
Tour & Andersson
Von Roll

Valves, check
Franken Plastik
Friatec
Keystone Valve Europe
Tour & Andersson

Valves, control
Keystone Valve Europe
Tour & Andersson

Valves, electrically operated
El-O-Matic
Keystone Valve Europe
Von Roll

Valves, float
Tour & Andersson

Valves, gate
Friatec
Keystone Valve Europe
Tour & Andersson
Von Roll

Valves, hydraulically operated
Tour & Andersson
Von Roll

Valves, plastic
Glynwed Plastics

Valves, pressure regulating
Tour & Andersson

Valves, tapping
Von Roll
Von Roll Pressure Pipe

Variable speed drive
General Signal Pump Group

Waste pumps
Friatec
General Signal Pump Group
Grundfos

Waste water treatment (elimination of heavy metals)
Advanced Separation Technologies
Akzo Nobel Chemicals (Water Treatment)
Chemie GmbH

Waste water treatment processes (general)
ACEA
Advanced Separation Technologies
Akzo Nobel Chemicals (Water Treatment)
Akzo Nobel NV (MPP Systems)
Alfa-Laval Separation
Baltic Klär Technologie
Barthauer Software
Nopon Oy
Puraqua

Waste water/sewage treatment (removal of odours detoxication)
Akzo Nobel Chemicals (Water Treatment)
Akzo Nobel NV (MPP Systems)

Water analysis equipment
Cheminst
Dr Bruno Lange
Tytronics

Water jet pumps
Grundfos

Water management and sanitary engineering
Gamma-Service
Sierra Construction

Water measurement
Aqua Data Services
Badger Meter
Barnstead/Thermolyne
Danfoss
STL Technology Systems

Water meters and water gauges
Badger Meter
Danfoss

Water plant engineering
NPO 'Tekhenergokhimprom'

Water purification
Akzo Nobel Chemicals (Water Treatment)
Akzo Nobel NV (MPP Systems)
Cheminst
Labo-Plus
Medikal-Endustriyel Sistemler
NPO 'Tekhenergokhimprom'
Sanyo Gallenkamp

Water softeners
Akzo Nobel Chemicals (Water Treatment)
Chemie GmbH
Cheminst
Medikal-Endustriyel Sistemler

Water supply systems
Barthauer Software
Grundfos
Sierra Construction

Water supply, distribution and treatment
ACEA
GU Projects
Intercommunale Vennootschap Antwerpse
Sierra Construction
Von Roll Pressure Pipe
Wessex Water

Water testing equipment - chemical analysis
Cheminst
Dr Bruno Lange
PS Analytical
Tytronics

Water treatment and waste water purification, miscellaneous special chemical
Akzo Nobel Chemicals (Water Treatment)
Chemie GmbH

Water treatment monitors
Dr Bruno Lange
STL Technology Systems

Water treatment plants
Akzo Nobel NV (MPP Systems)
BOC Gases
GU Projects
Measurement & Control Services

Water/sewage treatment plant operations
ACEA

Waterproof membranes
Utek

Weatherproof computers and data capture units
STL Technology Systems

Wedge gate valves
Friatec
Tour & Andersson

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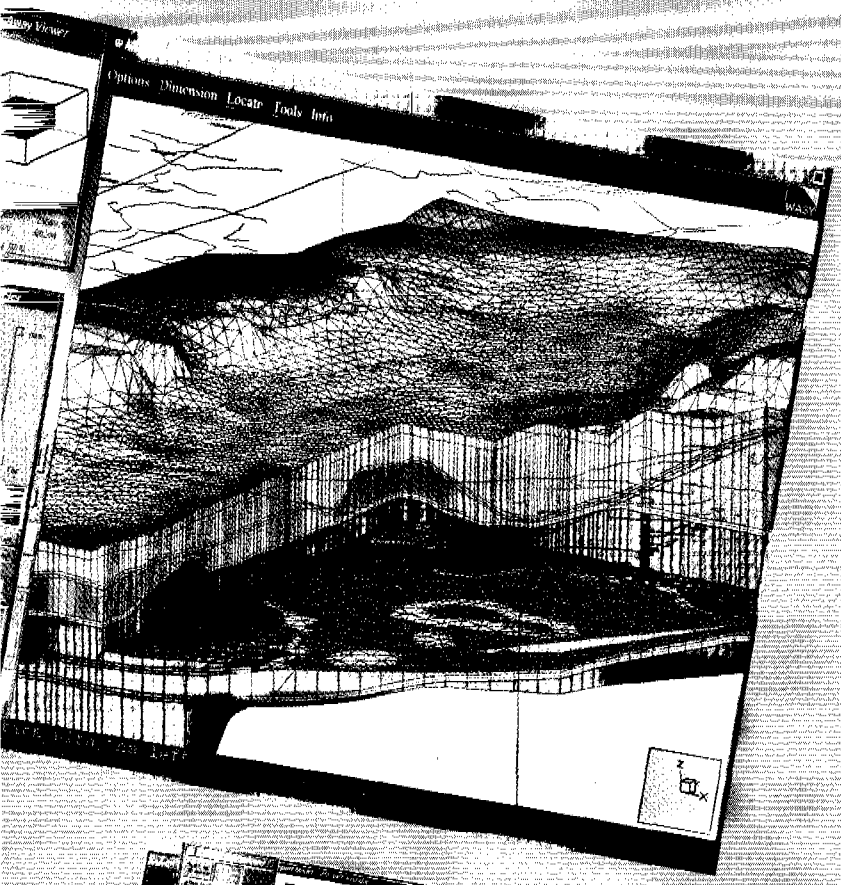
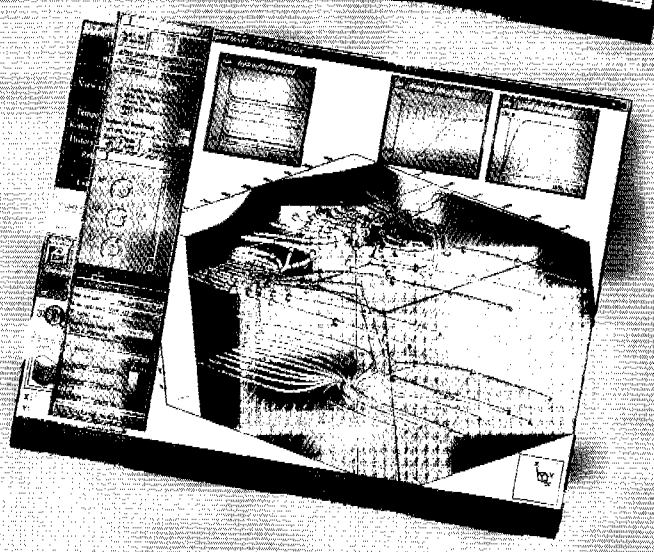
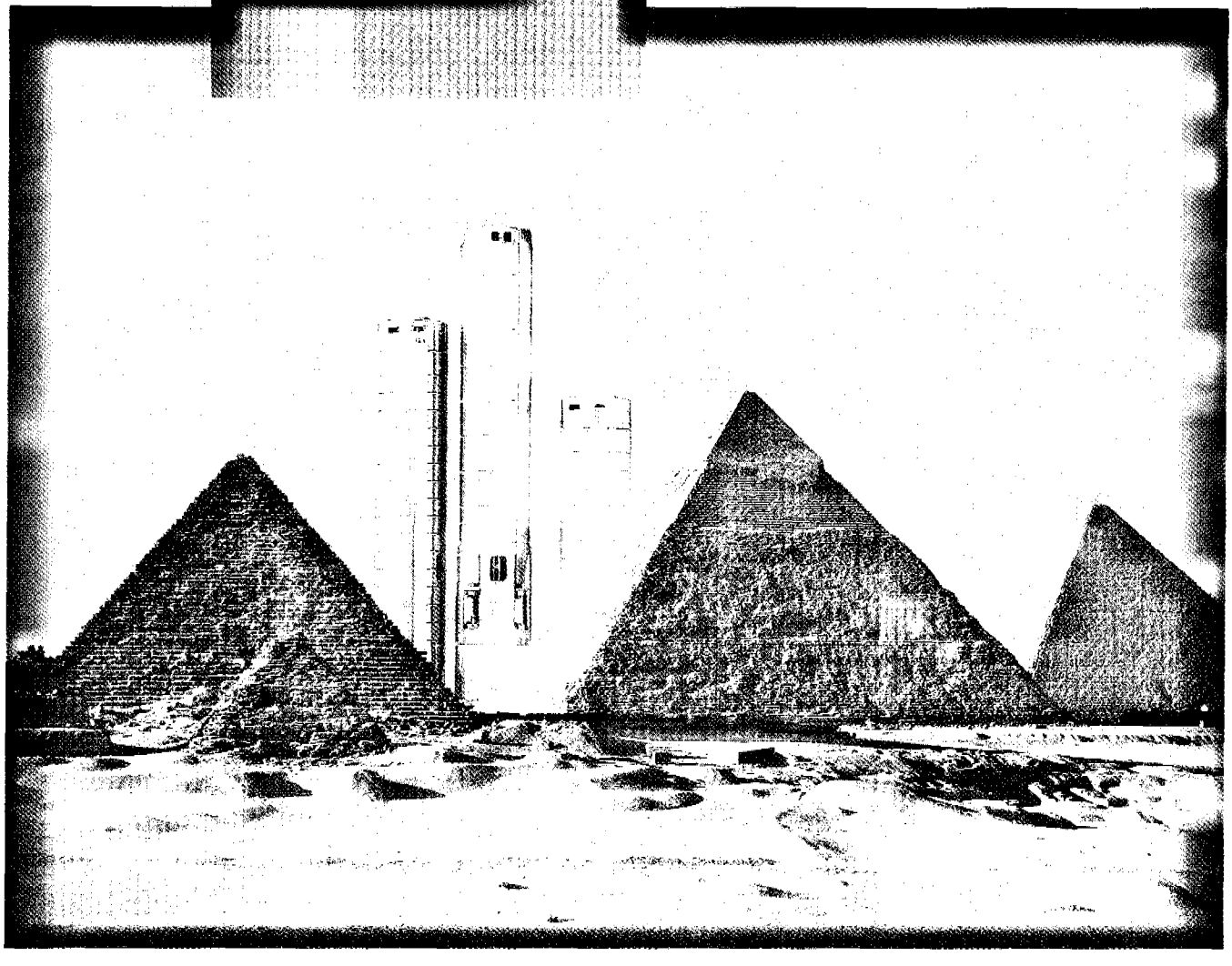




WASY

DURABILITY IN PERSPECTIVE...



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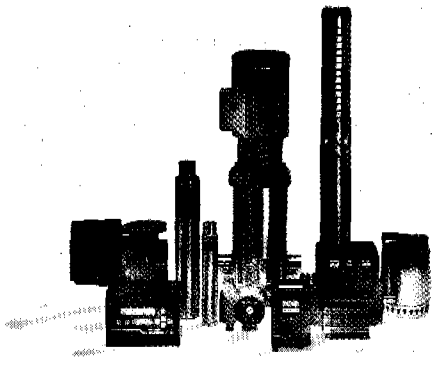

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