

行政院及所屬各機關出國報告  
(出國類別：參訪)

## 園區有害事業廢棄物回收再利用

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## 摘要

本次奉派出國參訪歐洲環保先進國家荷蘭、丹麥及英國，參訪荷蘭著名水處理設計公司 DHV 公司與國際知名半導體公司 PHILIPS 公司晶圓廠，丹麥 KOGE-EGNENS 污水處理廠與離心式脫水機製造大廠 Alfa Laval 公司，英國 Oxford 污水處理廠與 Didcot 污水處理廠及英國最大，亦為全球第三大之從事自來水廠建設營運、供水系統管理、污水下水道維修管理與污水處理廠設置操作之國際性公司的 Thames Water 公司。參訪有關污水處理技術、污水處理廠設施與營運管理、污泥處理與廢棄物處理。

在參訪單位的悉心安排與相關負責人員詳實的解說，及與相關負責人員討論，並實地參觀瞭解設計理念與實際操作情形，獲得以下心得：

### 一、 在廢水處理方面：

1. 污水處理廠應之處理設施容量應保有裕度，以因應排放水水質提高或設施保養維修時，仍可維持污水處理廠正常穩定操作。
2. 為方便日常檢視與清理作業，將污水處理設施採地下化設計，可降低視覺衝擊增加親合力，減低對於景觀的衝擊。
3. 污水處理廠前處理設施以機械設施運送並絞碎後以垃圾子車收集，方便收集與運輸處理，亦可節省作業空間與清除攔污柵污物之作業人力。
4. 污水於下水道經長距離運輸難免產生異味，調節池採密閉設計並設強制曝氣及排氣設施與空氣清淨裝置，可有效降低異味逸，避免造成附近居民困擾。
5. 應鼓勵民眾參與無害性污泥再利用，降低民眾對於污水處理廠之疑慮，增進社會和諧。
6. 於污水處理廠區內設置污泥乾燥設施將污泥予以減積以利污泥最終處置為值得推廣之處置方式。
7. 污水處理廠應朝向自動化操作努力。

### 二、 在廢棄物處理方面

應鼓勵並建立可回收再利用之資源性廢棄物回收再利用體系，可回收再利用資源性廢棄物如廢溶劑、廢酸與廢五金類之廢棄物經回收再使用，可有效減少廢棄物量。

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## 壹 目的

科學工業園區已開發之區域六百零五公頃土地跨越新竹縣、市，在園區管理局長期努力經營，篩選三百餘家高科技產業於此設廠，在創造高產值的同時也希望將生產活動所產出之廢棄做到妥善處置，善盡社會責任，雖然在園區管理局長期努力推動用資源回收再利用工作，事業單位也積極配合推動與落實廢棄物分類回收再利用、廢溶劑、廢酸回收再利用與廢污水回收再利用工作，但因生產活動所產生之廢水、廢棄物及廢酸、廢溶劑量仍隨著園區產業發展迅速提昇，因廢水量陡增致園區污水處理廠之處理水量大幅增加，每日處理污水所產生之污泥量亦隨之增加，但國內整體廢棄物處理體系仍未完備，尚無法滿足最終妥善處置之殷切需求。本次奉派出國參訪之目的即在了解荷蘭、丹麥和英國等歐洲環保先進國家在污泥處置與廢積體電路處置的作法與成果，作為園區未來推動最終妥善處置工作之參考。

## 貳 參訪行程與過程

本次奉派赴歐洲觀摩學習環保先進國家廢棄物處理技術期間(六月七日至十八日)，適逢國內端午節(六月六日)和歐洲盃足球賽(六月十日至十七日)期間，擬拜訪廠商建議將原排定之參訪行程提前，故利用端午節假期提前成行。

六月五日(星期一)

於下班後即趕赴中正機場，搭乘晚上 9:47 之長榮航空 BR075 班機前往本次參訪的第一站——荷蘭。飛機於飛往荷蘭阿姆斯特丹途中於泰國曼谷停留加油後，直飛阿姆斯特丹。

六月六日(星期二)

飛機於當地時間下午到達阿姆斯特丹 Schiphol 國際機場，Schiphol 國際機場的一樓設有捷運和公共汽車的售票櫃檯，地下室即為捷運車站，對於搭機或進入市區非常方便。

因所預訂之旅館位於阿姆斯特丹市區，距離 Schiphol 國際機場約 30 分鐘車程，搭乘捷運至阿姆斯特丹中央車站，再轉搭公共汽車即可至旅館附近。因阿姆斯特丹所處緯度較高，夏季晝長夜短，夜間近十時才天黑，因係第一次到此，所以先了解相關位置與當地交通，以利往後幾天的行程。

六月七日(星期三)

今日與本次參訪之 DHV 公司與 PHILIPS 公司人員聯絡，經與 DHV 公司之營業部門主管 RONALD P. NIERMANS 和 PHILIPS 公司 ESH 部門經理 Leo Klerks 於電話中確定六月八日拜訪 DHV 公司，六月九日拜訪 PHILIPS 公司位於 Nijmegen 之晶圓廠。

六月八日(星期四)

今日拜訪 DHV 公司由該公司營業部門主管 RONALD P. NIERMANS 親自接待，DHV 公司為表示歡迎特於公司門口升起

我國國旗。DHV 公司設於 Amersfoort，為 PHILIPS 公司之子公司，成立於 1917 年，目前全球共有 50 家分公司或代理商，執行中之工作計劃超過 10000 件，員工總數達 3000 人，1998 年之營業額為 500 億荷蘭幣(約 250 億美金)。DHV 公司長期以來從事與水(自來水與廢污水)有關之工程設計、製作，經營與管理業務，再廢水處理方面該公司並擁有氟化鈣精煉技術及廢污水中重金屬去除之相關技術與套裝處理設施，並參與 PHILIPS 公司晶圓廠之設廠工程，協助設置超純水製作設備與污水處理設施。NIERMANS 先生原服務於該公司工程部門，對於相關產品非常熟悉，對於我們提出的半導體晶圓廠氫氟酸處理應用該公司氟化鈣精煉技術與廢水中銅離子去除技術，NIERMANS 先生除提供相關資料(如附件)，並請該公司製程技術(process technology)經理 ANDERAS GIESEN 先生就處理技術之細節作說明，GIESEN 先生表示不同重金屬之操作條件不同，如酸鹼值( pH )、濃度等，所達到的去除效率會有極大差異，對於重金屬去除技術，該公司建議套裝設施於設置時以去除單一金屬為設置考量，較有利於操作及調整操作條件達到最佳化與最適化；若以一套處理設施以批次方式去除廢水中不同重金屬亦屬可行，但需設針對不同重金屬設置需要之附屬設施，然而設置多種附屬設施與設置多套套裝設施之費用相近，因操作條件需依將處理之重金屬不斷調整，較不易達到最佳化操作，且去除效果較不易掌握。以園區半導體產業所需之除氟與除銅的技術，該公司均有套裝設備，但因除氟設備所產生之結晶物顆粒太小，無法符合園區事業擬將氟化鈣結晶送中鋼作為煉鋼爐之爐渣助溶劑所需之顆粒體積，該公司將進行研究使處理方式能符合需求，對於該公司所擁有之套裝處理設施與處理技術，將透過該公司台灣代理商雄菱公司來園區辦理技術說明會。拜訪行程至下午四時結束，由 NIERMANS 先生開車送我們至 Amersfoort 車站，搭火車回阿姆斯特丹。

因次日早上七時需至 Eindhoven 與 PHILIPS 公司 ESH 部門經理 Leo Klerks 會合，故回旅館後即收拾行囊，再搭火車至 Eindhoven，於火車站附近之旅館過夜。

六月九日(星期五)

今日參觀之 PHILIPS 公司晶圓廠距 Eindhoven 一小時許之車程，故 PHILIPS 公司 ESH 部門經理 Leo Klerks 先生建議早上七時自 Eindhoven 出發，約八時三十分至 Nijmegen 之 PHILIPS 公司晶圓廠，由主管 Display Components 部門的環保業務主管 Ton Remmen 先生和晶圓廠的環保主任工程師 Sasja Gulickx 小姐接待並就晶圓廠的整體環保工作簡報。Nijmegen 為 PHILIPS 公司晶圓廠之大本營，在此共有五座晶圓廠，最早的一座建於 1950 年代，該公司從二吋晶圓發展到目前八吋晶圓，產品內容涵蓋各層面，從家電，通訊，資訊，航太，儀器設備都有產品展示於展示櫃中。PHILIPS 公司在 Nijmegen 地區晶圓廠於 1988 年取得 ISO 14001 認證。

Nijmegen 地區晶圓廠每年約產生 3800 噸廢棄物，有害廢棄物約 2600 噸(佔 60%)，一般廢棄物約 1200 噸；每年之處理費用約為 272 萬荷蘭幣(約合美金 140 萬)，其中有害廢棄物之處理費約 223 萬荷蘭幣(佔總處理費用之 82%)，一般廢棄物處理費約 22 萬荷蘭幣(8%)，而運輸費用約為 27 萬荷蘭幣(10%)。目前除分類回收紙類、塑膠、金屬(鐵、鋁、銅)、廢硫酸(純度 80%)和異丙醇(純度 90%)，廢硫酸和廢異丙醇以回收系統收集後由槽車送其他公司使用。廢五金則委由新加坡之 Cityraya 公司處理，Cityraya 將廢積體電路絞碎後回收貴金屬及銅等，包裝用寶麗龍則回收於公司內再使用。該公司在廢水部分僅作酸鹼中和後，排入市區下水道系統由市鎮污水處理廠集中處理。

參觀廠區時，由廠區之環保工程師 Jan Holsbrink 先生帶領，參觀廠區之廢棄物分類貯存場及廢硫酸收集系統，該廠區之廢棄物以有蓋垃圾子車分類回收廢金屬及廢塑膠，回收區域並以圍籬完全區隔；廢硫酸收集系統設於廠房週邊之隔離室內，與園區晶圓廠之設計相同，進出門採用安全門但於外側加裝手把及上鎖，方便作業及管制，雖然廢硫酸收集室的門上有很清楚的標示與作業說明，但引領我們進入廢硫酸收集貯存室的 Jan Holsbrink 先生並未提供口罩供使用，濃濃的硫酸味迎面而來，且作業場所內並

未設至排氣設施，且廢酸外洩致硫酸收集室內充斥硫酸刺鼻味。所以落實相關規定為管理工作最重要的一環。

六月十日(星期六)

今天是週末因為廠商都不上班所以沒有安排參訪行程。除整理參訪廠商資料外亦利用假期參觀荷蘭風情。由於今日適值 2000 年歐洲杯足球賽開幕前一日，而 Eindhoven 的飛利浦足球場正是 2000 年歐洲杯足球賽第一場比賽的球場，且是地主國荷蘭隊出賽，所以 Eindhoven 市區街道都掛滿了代表荷蘭皇家的橘色旗幟，當地為此盛事也舉行遊行和演唱會等慶祝活動，一直熱鬧到夜間十點天黑。

荷蘭給人們印象最深的風車，趁今日風和日麗，依飯店的觀光資料搭車到 Sloten 參觀風車，實地了解其構造與運作。Sloten 風車為荷蘭目前少數妥善保存仍可實際運作之風車之一，荷蘭風車是設置再一座約五層樓高的塔上，塔頂為一可 360 度轉動的機構，風車即裝設於此一機構，可隨風向調整運用風力產生動力。義務解說員介紹從前和現在荷蘭人使用的風車形式與分佈情形，早期使用風車除排水外並兼具推動石磨功能，替代許多勞力，後來還利用作為發電，發電量雖不大但足供風車塔內之電力使用。解說員並以風車模型解說設計原理與操作方式，然後由風車操作人員實際操作給大家看，雖然現在風車抽水的功能都被馬達取代了，但風車仍保養的很好，還可以發揮排水功能。

六月十一日(星期日)

今日由 Eindhoven 搭捷運至 Schiphol 國際機場，搭機至丹麥 Kobenhavn 國際機場，自 Kobenhavn 國際機場外即可搭公共汽車至所預訂之旅館，因所訂旅館位於市中心區，利用下午時間熟悉環境，並與將參訪之 Alfa Laval 公司環保部門之生產經理 IVAR MADSEN 先生聯繫，約定次日上午八時於旅館大廳見面，IVAR MADSEN 先生安排一處使用該公司污泥脫水機之污水處理廠實地瞭解污泥脫水機使用情形，



十三日則安排參訪 Alfa Laval 公司。

哥本哈根(Copenhagen)是著名童話作者安徒生創作的地方，著名的小美人魚銅像坐落於哥本哈根港邊，哥本哈根港邊時導遊特別介紹小美人魚銅像的不幸遭遇，銅像頭部曾三次遭人砍斷並取走，手臂亦曾二次遭人鋸斷，所幸均妥善修復。

六月十二日(星期一)

今日由 Alfa Laval 公司環保部門之生產經理 IVAR MADSEN 先生安排參觀使用該公司污泥脫水機之污水處理廠實地瞭解污泥脫水機使用情形，參訪之 KOGE-EGNENS RENSEANLAEG 污水處理廠位於海邊，距哥本哈根市區約一個半小時車程，為一服務 17 萬人之都市污水處理廠，主要污水來自約 14 萬人的都市及一家木材工廠與一家農藥工廠產生的污水，該廠採生物處理，處理後之排放水直接排入海域，每年均需依規定實施海域生物調查。各處理單元所產生之污泥經調理後以 Alfa Laval 公司所生產之離心式脫水機脫水，所產生之污泥餅含水率約為 74%。因離心式脫水機操作時係採高速旋轉，所產生的噪音約為 82~85 分貝，現場操作人員可於一密閉隔音控制室中監視離心脫水機運轉，或至室外從事其他工作，故離心式脫水機於正常操作時非常穩定，若於脫水機附近作業時，操作人員應使用聽力防護具確保作業安全。

KOGE-EGNENS RENSEANLAEG 對於脫水後之污泥餅以焚燒方式減積處理，脫水後之污泥經焚燒後僅剩 5%之體積，焚燒後之污泥餅成為乾燥的沙，可再利用於鋪路或製造行道磚用，亦可以太空包收集後方便最終處置，在丹麥對於體積龐大之濕污泥餅處理亦已面臨最終處置場所不易取得與處理費用不貲問題。KOGE-EGNENS RENSEANLAEG 之污泥焚燒設備為自動控制設計，每小時可處理 4 噸經脫水之污泥餅，污泥餅採自動送料進入焚燒設備，經焚燒後之灰渣以抽氣系統及除塵設施去除，除塵設施包括旋風分離器(CYCLONE 用於去除較大顆粒)、袋式集塵氣(BAG FILTER 由 160 個濾袋組成，用於去除較小顆粒)與活性炭吸附塔(用於去除異

味)，經處理後排放之廢氣無異味、溫度不高且排氣量不大。由於焚燒設備為自動控制設計，於夜間或假日運轉時若發生異常狀況，可自動將訊息以電話傳送至操作人員家中，由操作人員依狀況決定是否回廠處理，情況嚴重時焚化設施可自動關閉停止運轉，無人監控時操作安全性非常高，以該廠之處理設施僅配置三人，非常精簡。在設施用地面積方面，全部設施約需 30 公尺 X 15 公尺之土地即可供設置。若以焚燒乾燥方式將目前園區污水處理廠污泥餅予以再減量，除可降低因國內合法掩埋場不易取得，運出掩埋價格大幅提昇之壓力，經焚燒乾燥後之砂可利用於鋪路或製造行道磚供污水廠或園區內使用，亦可免除尋找掩埋處所不易之壓力，應為園區污水處理廠污泥妥善最終處置可參酌之處理方法。

六月十三日(星期二)

今天拜訪之 Alfa Laval 公司為一專業製造離心式脫水機公司，仍由 IVAR MADSEN 先生負責接待，Alfa Laval 公司為表示歡迎特於公司門口懸掛我國國旗。IVAR MADSEN 先生首先介紹該公司設廠至今以有 35 年，所生產之離心式脫水機系列產品在全球有超過 2000 個污水處理廠使用，並介紹脫水機之原理與保養工作要領，由於離心式脫水機對於任何濃度之污泥均可達到一定之脫水功能，所以可設置離心式脫水機以取代污泥濃縮池。污泥濃縮池係以重力濃縮方式提高污泥濃度至 2%~4%，佔地面積較廣；以離心式脫水機濃縮污泥可提昇污泥濃度至 10%，且用地節省頗多。經脫水後再使用離心式脫水機進行二次污泥脫水，可濃縮污泥至 35%(含水率 65%)，較帶濾式脫水機之脫水效率(含水率 75%~80%)為佳，對於場地受到限制的污水處理廠，可考慮採用二段式離心脫水方式處理污泥，達到污泥減積的目的。下午 IVAR MADSEN 先生帶領我們參觀離心式脫水機製造工廠，解說製造離心式脫水機的步驟，與離心式脫水機試車設施。據 IVAR MADSEN 先生表示該公司原採自給自足式生產方式，廠內可製造離心式脫水機的所有零組件，所以工廠內有全部生產所需的工具機與量測設備，因應整體工業型

態改變為分工專業製造型態，現已將部分零組件委外製造，所以有部分機器設備閒置，備於必要時仍可自行生產所需之零組件。

參觀過程中 IVAR MADSEN 先生特別就回廠檢修中之脫水機解說離心式脫水機可能發生損壞部分及回廠檢修作業情形，因回廠檢修的脫水機必須整體回廠，就損壞的部分修復後需就脫水機整體作動平衡校準，確保使用時高速迴轉不發生偏心情形。檢修作業的工作人員解說造成損壞的主要因離心機長期高速旋轉與固體物磨擦所致的磨損，使離心機與腔體間產生間隙造成功能降低，經檢修後之離心機必須重新作整體測試，確定高速迴轉時仍維持平衡與密閉才可以重新出廠使用。為方便離心式脫水機整體試驗，脫水機整體試車之作業區域設置於一很大貯水池上方，新裝配完成之脫水機放入測試箱內，接上欲觀測數據之相關儀器進行試驗，通常一部脫水機組都會經過幾次修正與檢驗，才能完成功能檢測出廠。IVAR MADSEN 先生亦建議離心式脫水機應以廿四小時連續運轉較佳，維持一定轉速可產出較佳之污泥餅亦較節省操作時間，另設置時應考量損壞維修須時較長，設置備用機組於檢修或定期保養時可供替換。在參觀過程中，我們發現廠內的工作人員都依照規定，於工作時使用耳罩或面罩保護自己免於受傷害，由此可以了解這個國家的人民非常尊重生命。

六月十四日(星期三)

結束丹麥的參訪行程，今天需再搭飛機轉赴英國，由旅館赴哥本哈根火車站搭火車直達機場，搭機至英國倫敦 Heathrow 國際機場。因飛機航班關係預計到達倫敦時間較晚，於整理在丹麥參觀的相關資料後，即與 Thames Water 公司負責聯繫工作之 Bill Murphy 先生聯繫，確定十五日與十六日英國之參觀行程與十五日早上見面時間。

於當地時間近傍晚時到達倫敦 Heathrow 國際機場，由機場內購票直接轉搭地下鐵至預訂之旅館附近地下鐵車站再步行約五分鐘即達預訂之旅館，可以算是交通非常方便的。

六月十五日(星期四)

今天由 Thames Water 公司 Bill Murphy 先生帶領參觀二處污水處理廠- Oxford 污水處理廠與 Didcot 污水處理廠，此二座污水處理廠均由 Thames Water 公司操作管理。Thames Water 公司原為政府部門後改為民營化，但仍負責有關自來水供水、自來水管線維修、下水道維修管理、污水處理與客戶服務(Customs service)等工作，為英國國內十家公營轉民營自來水公司中最大的公司，負責供水與污水處理工作之區域亦最大，並於 1967 年開始負責 Thames river(泰吾士河)整治工作，積極找出 Thames river 之污染源加以去除，並恢復河中魚類之生機，至目前已恢復包括鮭魚等魚類與其他物種超過百種於河中生活。

早上八時 Bill Murphy 先生即至旅館大廳與我們會合，驅車前往位於牛津大學城附近約 1.5 小時車程的 Oxford 污水處理廠參觀。污水處理廠介紹及參觀活動由負責該廠操作管理的經理 Simon Lockwood 先生親自解說與帶領，Lockwood 先生表示該廠設立於 1956 年，服務人口數約為 20 萬，處理水量約 90000CMD，進流水質之 SS 為 340mg/L、BOD 為 200mg/L、NH<sub>3</sub>-N 為 40 mg/L；為符合自 1998 年元月起實施之 Thames river 新放流水排放水質標準(SS:45mg/L、BOD:15mg/L、NH<sub>3</sub>-N:5 mg/L)，該廠投入五百萬英鎊進行設施更新與改善工作。Oxford 污水處理廠主要污水來源為 Oxford 及附近地區，其中牛津大學城約有 10 餘萬人，主要為教職員生及商店所產生的生活污水，另外附近一家食品廠與 Oxford 科學園區內廠商之污水亦排入此污水處理廠處理。因大學城所居住的教職員生產生的污水包含生活污水與洗衣服產生的污水，因生活污水含氮，清潔劑中含磷，所以該廠特別加含氯藥液去除污水中所含氮、磷。

Oxford 污水處理廠之處理程序與園區污水處理廠相似，污水經前處理→調節池→初沉池→生物處理→終沉池→放流。惟該廠前處理以輸送機將污物送入剪切機，將所攔截之污物切碎後即送入離心分離機將污物與污水分離，污水回流至調節池，切碎後之污物則以垃圾子車收集送都市垃圾處理場處理。由於污水流經長距離下水道系統收集，

污水處理廠之調節池容量為 40000CMD，採密閉設計並設置異味去除系統，確保污水處理廠操作時不會造成異味困擾。初沉池共有八座圓形池與六座矩形池(約 30 公尺 X10 公尺)，沉澱有機固體；生物處理單元共設置三座活性污泥氧化渠，污水流入氧化深渠中褐色之活性生物污泥分解其中之有機質；終沉池共設置十二座圓形池，沉澱經生物處理後之污水中生物污泥；各處理單元所產生之生物性污泥經管路排入消化槽於 35°C 經 12 日消化，消化處理所產生之甲烷氣體則用於發電，該廠每日所發電量約值 800 英鎊之電量，以消化污泥所產生之甲烷氣體發電應屬「綠色能源」值得推廣。經消化後之污泥以 polymer 調理後經三座濾帶式脫水成為污泥餅，該廠之污泥脫水機每小時約可處理 25 噸(含水率 80%)之污泥餅，操作速度快且污泥餅成型良好。由於 Oxford 污水處理廠污泥消化槽處理容量夠大，該廠亦代為處理食品廠污水前處理設施(沉澱處理)所產生之污泥，經脫水後之深褐色污泥餅提供附近農家作為有機肥料，深受農家喜愛且常有供不應求情形。另因該廠區範圍夠大，所設置之處理設施容量遠超過日常處理水量所需，於參觀時該廠仍有三座矩型初沉池閒置，對於設施維修與提昇處理水質有極大幫助；該廠設置之圓形初沉池與終沉池，均採池面與地面平之地下化設計，對於經常性維護工作之作業人員與維修作業較方便工作，於圓形初沉池與終沉池區域採鐵絲網圍籬保護，可通視亦可避免閒雜人等靠近發生危險。

Oxford 污水處理廠已完成自動控制操作，操作人力非常精簡，在十五位操作人員中，除一位屬兼職外，有六位負責維修工作，另六位為行政管理，流程控制及駕駛等。下午參觀另一處污水處理廠-Didcot 污水處理廠，Didcot 污水處理廠設置於工業區內，服務人口數約六萬人，處理水量約 20000CMD，主要污水來源為附近小城鎮居民與工業區污水故處理水量較少，處理流程與 Oxford 污水處理廠相同，生物處理亦採活性污泥氧化渠法處理，經處理後之放流水直接排入附近河川。該廠所產生之生物性污泥依規定須於消化槽內於 35°C 經 12 日消化處理，消化處理所產生之甲烷

氣體則用於發電，如產氣量不足以發電則以燃燒器燃燒處理，經消化後之污泥經調理後以濾帶式脫水機脫水，脫水後之污泥餅亦分送附近農民作有機肥料。

由於本廠已採自動化控制，操作員於控制室內即可掌控權廠之處理狀況，負責管理之經理亦可透過控制室內之電腦了解廠內狀況，可精簡操作管理人力為值得學習之處。

六月十六日(星期五)

今天拜訪英國最大的水公司-Thames Water 公司，該公司不僅為英國最大的自來水公司，負責供水與污水處理工作之區域最大，亦為全球第三大之自來水廠、供水系統管理、污水下水道維修管理與污水處理廠設置操作之國際性公司，年營業額約 19 億美元，全球員工約 5600 人，於全球經營 54 處自來水廠，自來水供水管線達 31000 公里，每日供應約 3000 萬噸自來水，目前經營之最大自來水廠位於中國大陸的大慶，每日供應約 55 萬噸自來水。在美國、澳洲、南非、埃及(開羅)及歐洲地區均有該公司經營之自來水廠，亞洲地區之菲律賓、泰國與新加坡亦有該公司設置之自來水廠供應該地區使用之自來水，而正執行中之最大的供水計劃為於土耳其 Izmit 興建每日供水量 200 萬噸之自來水廠及供水系統。於英國國內該公司於倫敦地區負責自來水供應與自來水供水管線維護工作每年之營業額約為 4 億美金，於 Beckton & Crossness 地區污水處理廠之操作管理工作之營業額每年約 400 萬美金。

今日參觀 Thames Water 公司仍由 Bill Murphy 先生帶領，參觀該公司水質檢驗中心(The Water Quality Centre)與研發部門，Thames Water 公司辦公室設於 Reading Berkshire，距離倫敦市區約一小時車程。

參觀水質檢驗中心由 Principle Scientist Anthony H Tyler 先生帶領我們進入實驗室，介紹實驗室內正進行之檢驗工作，由於該實驗室負責檢驗該公司於倫敦附近之自來水廠與污水處理廠每日採集之樣品分析工作，所以每日之樣品數量超過 4000 個水樣，對於水樣之酸鹼值( pH )、懸浮固體物(SS)、電導度及化學需氧量(COD)等之檢驗採用機

器人自動化處理，檢驗設備所檢測數值直接連線進入電腦資料庫，所以可以廿四小時連續操作，完全滿足每日之大量水樣需檢驗。由於該公司亦負責自來水廠操作，所以對於大腸菌檢驗非常專業，亦與美國之分析實驗室共同發明呈色反應之大腸菌檢驗法 Colilert<sup>®</sup>-18 Test Kit，使用時僅需將固定之試藥加入已裝入欲檢驗之 100cc 自來水之大腸菌數檢驗袋中，經密封後自然於檢驗袋中分為 200 個水樣小囊，再置入 35°C ± 0.5°C 之恆溫箱中反應 18 個小時後取出，取出後檢驗袋以 6 watt 365nm 之紫外光照射，並依呈現黃色反應之水樣小囊數目，即可判定自來水中大腸菌數是否超標準，且可達 95% 之可信賴度，為一種簡易且可行之檢驗方法。但經密封後之檢驗袋如置於 35°C ± 0.5°C 之恆溫箱中反應超過 22 個小時，則無法用於判定自來水中大腸菌數是否超標準。

今日另一參觀行程為拜訪該公司研發部門，由該公司研發部門經理 Michael Andrews 先生與顧問服務部門經理 Brian Allum 先生共同接待，二為經理除表示歡迎外，亦告知該公司目前正與台灣省自來水公司接洽合作事宜，對於我們所提出有關污水中異味及高電導度之處理技術，願提供相關研究報告供參考，亦提供該公司網址 [www.thames-water.com](http://www.thames-water.com) 及 E-mail 地址供聯繫取得相關研究報告。

六月十七日(星期六)

經過二日之參訪行程，今日整理參訪資料收拾行囊搭機返國，搭倫敦地鐵至 Heathrow 國際機場搭乘長榮 BR068 班機返國。

六月十八日(星期日)

飛機於晚間 9 時許順利落地返國。

## 參 心得與建議

本次奉派赴歐洲荷蘭、丹麥與英國參訪，學習歐洲環保先進國家廢水與廢棄物處理做法之心得如下：

### 一、 在廢水處理方面：

1. 因應國人對生活品質之要求日益提昇，對於經污水處理廠處理後之排放水水質要求亦將提高，為此污水處理廠應之處理設施容量應保有裕度，以因應排放水水質提高或設施保養維修時，仍可維持污水處理廠正常穩定操作。並可因應服務客戶排放量或排放水質發生變化時，可以足夠空間增加處理停留時間達到妥善處理目的。
2. 為方便日常檢視與清理作業，將污水處理設施採地下化設計，可降低視覺衝擊增加親合力，若再配合整體綠美化作業，將可使污水處理廠公園化，減低對於景觀的衝擊。
3. 污水處理廠前處理設施以機械設施運送並絞碎後以垃圾子車收集，方便收集與運輸處理，亦可節省作業空間與清除攔污柵污物之作業人力。
4. 污水於下水道經長距離運輸難免產生異味，調節池採密閉設計並設強制曝氣及排氣設施與空氣清淨裝置，將排出異味妥善處理後排放，除可有效降低污水處理廠異味逸散造成環境衝擊，亦可避免造成附近居民困擾。
5. 應加強宣導民眾瞭解對於無害性污泥再利用之觀念，並鼓勵民眾參與再利用，增加與社區居民間互動，增進民眾對污水處理廠之認知，降低民眾對於污水處理廠之疑慮，增進社會和諧。
6. 由於污泥最終處置場所難覓，污水處理廠正常操作所產生之污泥予以減積處理以利污泥最終處置，為污水處理廠之重要課題之一，於污水處理廠區內設置污泥乾燥設施將污泥體積減至最小，並將乾燥後所產生之固體物妥善利用於鋪設道路或製造成各式建築用磚均為值得推廣之最終處置方式。
7. 污水處理廠自動化操作技術已發展成熟，除可穩定操作處理設施亦可減少操作人力，節省操作成本，為未來



污水處理廠提昇操作功能時努力的方向。

## 二、在廢棄物處理方面

1. 將可回收再利用之資源性廢棄物回收再利用為全球對廢棄物處置之共識之一，亦為使有限資源充分被使用，並可有效減少需處理之廢棄物量之具體可行方式之一。半導體產業所產生之可回收再利用資源性廢棄物如廢溶劑與廢酸，回收後可供其他產業作為原料使用，除可減少需處置之廢棄物量，亦可使資源再使用達到有限資源充分使用，並可減少需處理廢棄物量的目的。
2. 廢五金類之廢棄物經專業回收再利用事業機構處理後，除將可再利用之金、銅等貴金屬重新再使用，亦可減少廢棄物量。廢五金類廢棄物經回收再利用妥善處置亦可避免遭任意棄置造成二次污染危害環境之風險。

對於本次出國參訪針對園區污水處理廠及園區廢棄物處置提出以下建議：

1. 科學園區於規畫實應保留較大土地作為污水處理設施建設使用，並於規畫設施時保留較大處理容量裕度，供因應國家提昇排放水質標準時需調整操作流程使用，或事業單位增加產能，或工業區增加開發面積新增事業單位致處理量增加時，仍可有效因應妥善處理廢污水。
2. 污水處理廠於規畫實應朝自動化操作方向規畫，以利操作維護。調節池及處理設施設置應考量異味產生對周遭影響情形，採密閉設計或室內化設計，並輔以排氣設施與空氣清淨裝置，消除異味困擾。
3. 廢棄物應以再利用方式為最優先處理方式，並建立上下游再利用體系，使可再利用資源性廢棄物能充分再使用，使有限自然資源有效充分使用，有效減少需最終處置之廢棄物量。
4. 特殊廢棄物處置宜交由專業處理機構回收可用資源再利用，並妥善處置無法再利用之廢棄物，使有限自然資源有效充分使用亦避免因未妥善處置造成的二次污染，避免對環境之衝擊。

附件一 考察行程

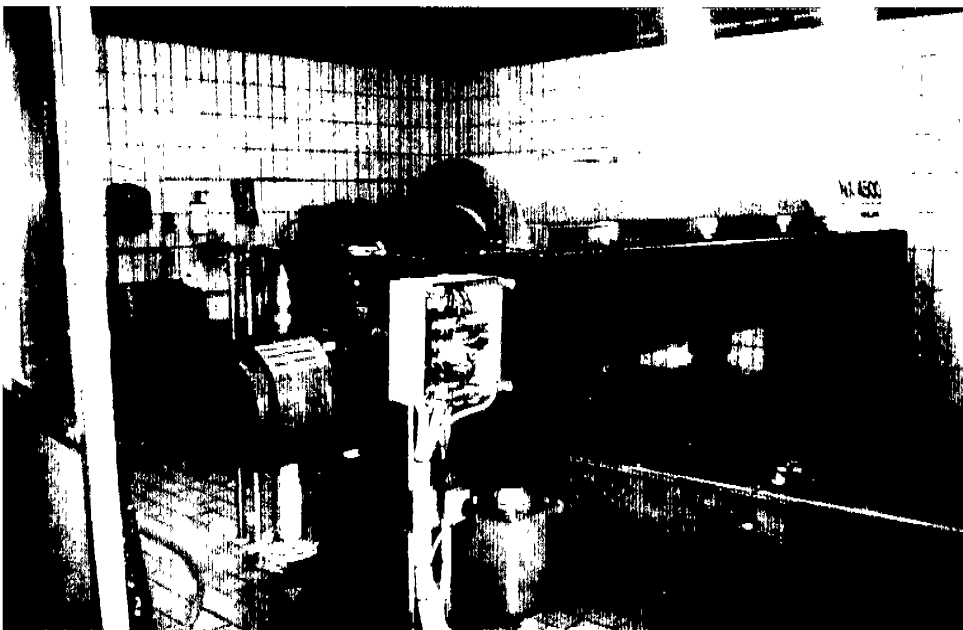
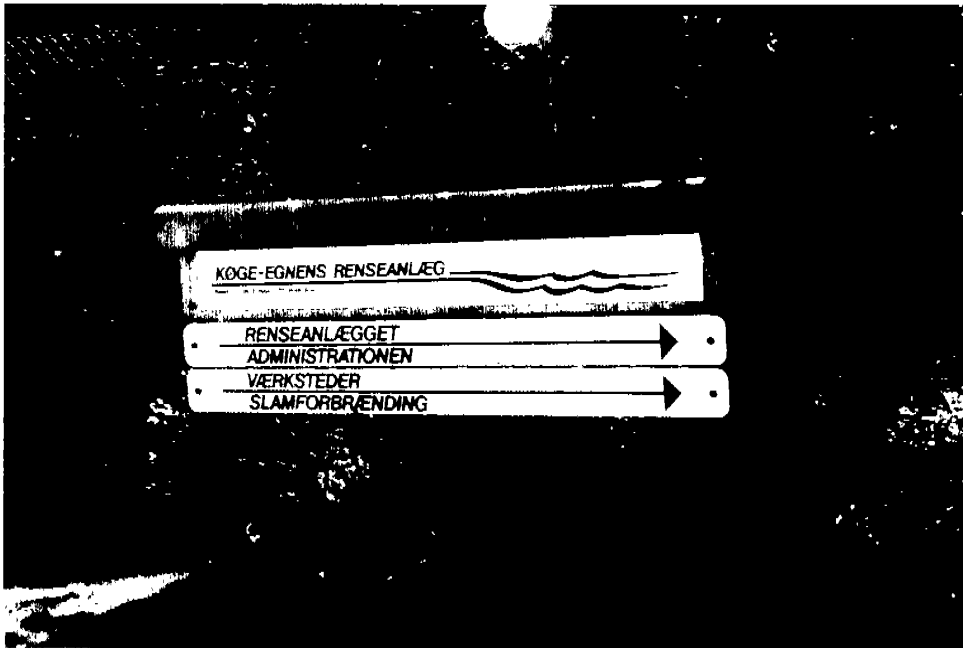
日期(星期)	行程
六月七日(星期三)	啟程 台北→荷蘭(阿姆斯特丹)
六月八日(星期四)	阿姆斯特丹(拜訪 DHV 公司)
六月九日(星期五)	阿姆斯特丹(參觀飛利浦公司)
六月十日(星期六)	阿姆斯特丹
六月十一日(星期日)	荷蘭(阿姆斯特丹)→丹麥(哥本哈根)
六月十二日(星期一)	哥本哈根(參觀污水處理廠)
六月十三日(星期二)	哥本哈根(拜訪 Alfa Laval 公司)
六月十四日(星期三)	丹麥(哥本哈根)→英國(倫敦)
六月十五日(星期四)	倫敦(參觀污水處理廠)
六月十六日(星期五)	倫敦(拜訪 Thame Water 公司)
六月十七日(星期六)	返程 英國(倫敦)→台北
六月十八日(星期日)	返程 英國(倫敦)→台北



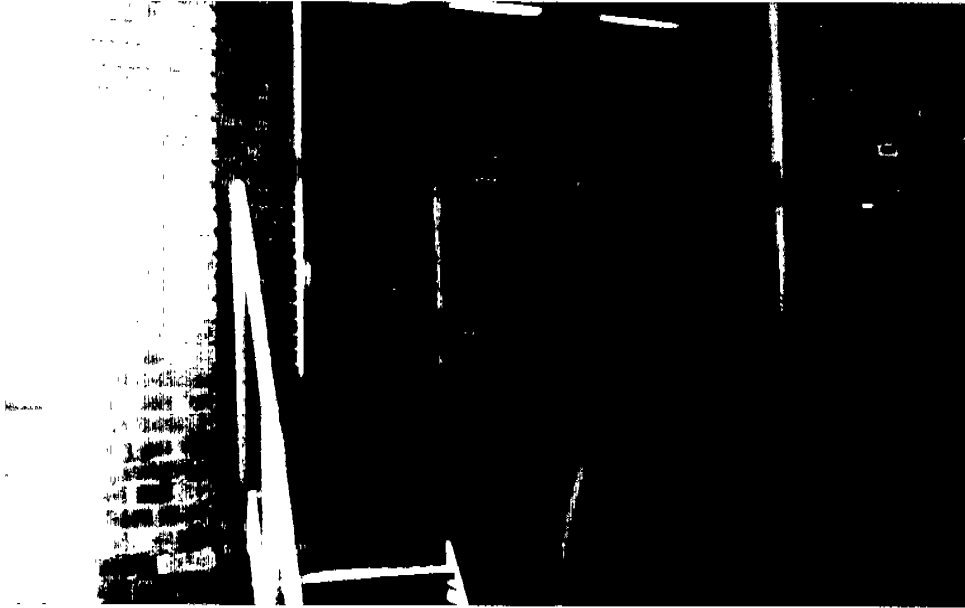
參訪 DHV 公司 該公司升國旗表示歡迎



參訪 Alfa Laval 公司 該公司升國旗表示歡迎



參觀 KØGE-EGNENS 污水處理廠污泥處理設施—離心式脫水機



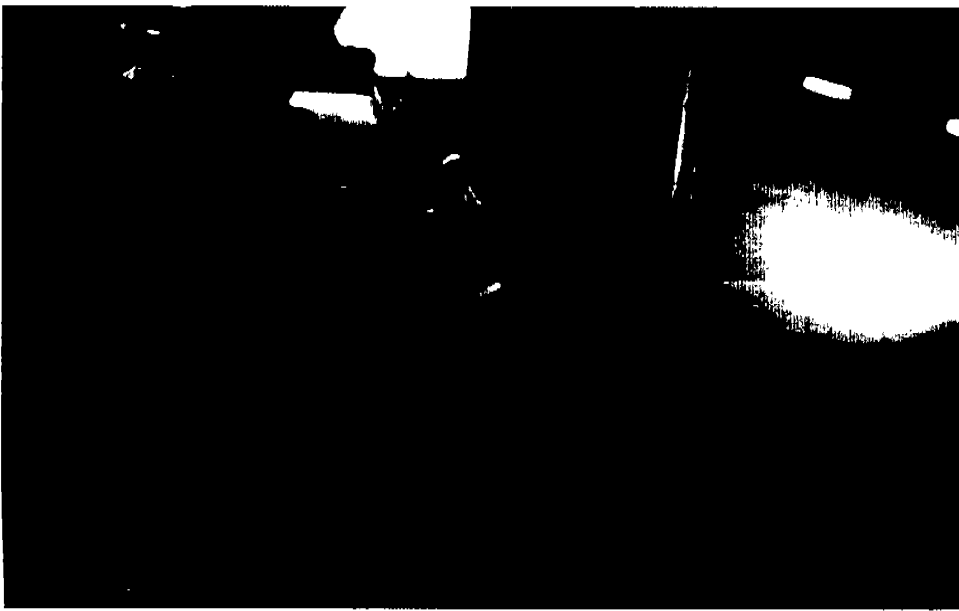
KOGE-EGNENS 污水處理廠污泥脫水機房內有隔音操作室



經離心式脫水機脫水後之污泥



脫水後之污泥以輸送帶送至乾燥設施處置



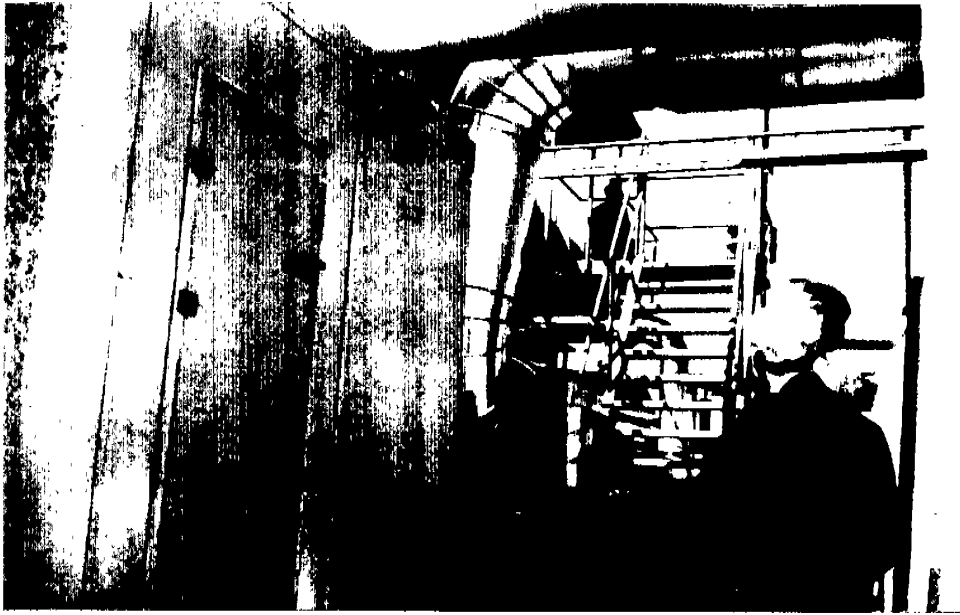
污泥乾燥設施



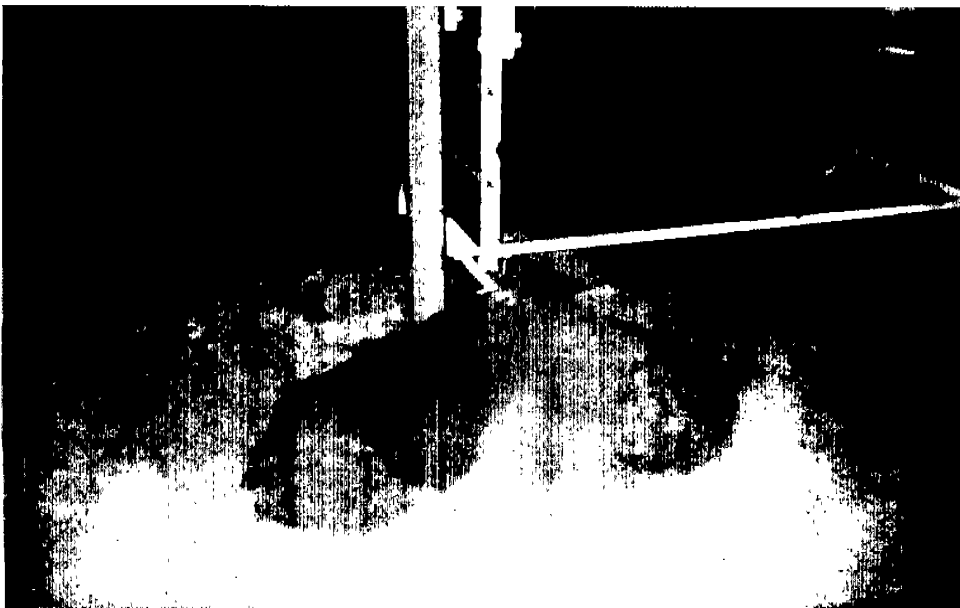
乾燥設施之空氣清靜裝置之一 旋風集塵器



乾燥設施之空氣清靜裝置之二 袋式集塵器



乾燥設施之空氣清靜裝置之三 活性炭吸附床



經乾燥後之污泥成細砂狀

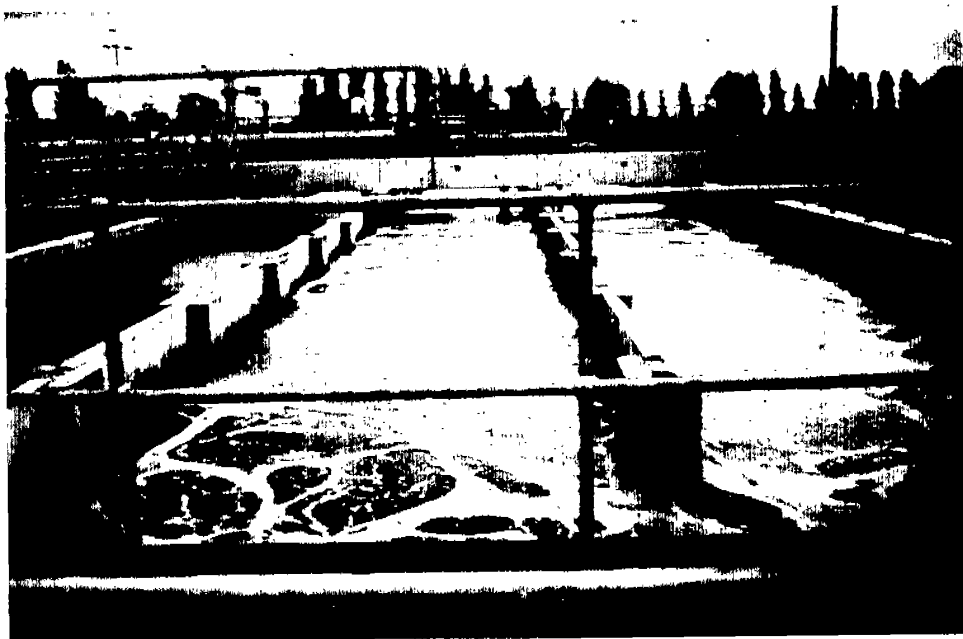




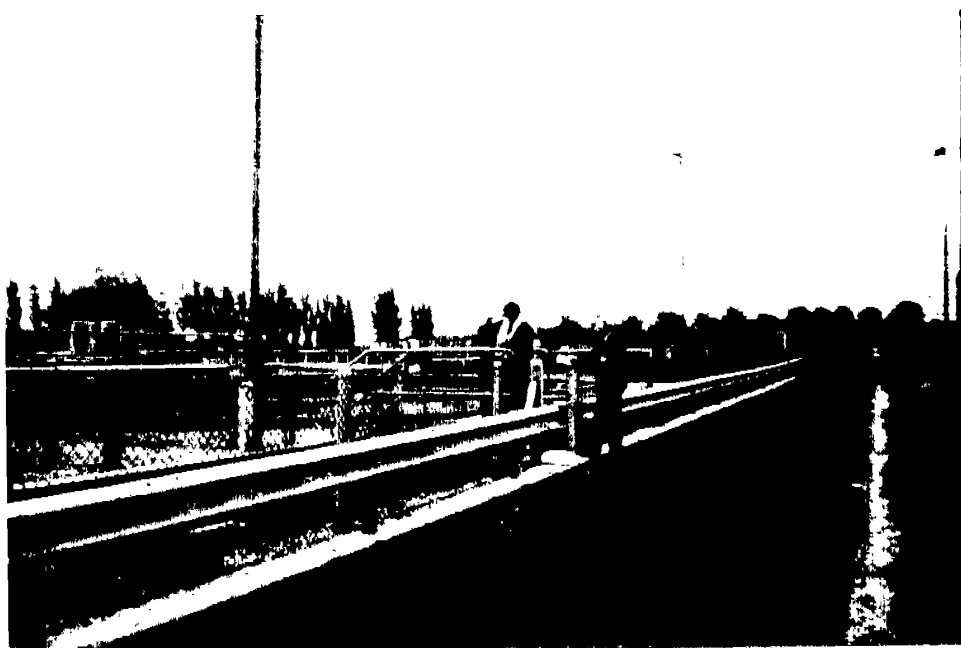
英國 Oxford 污水處理廠初沉池採地下化設計



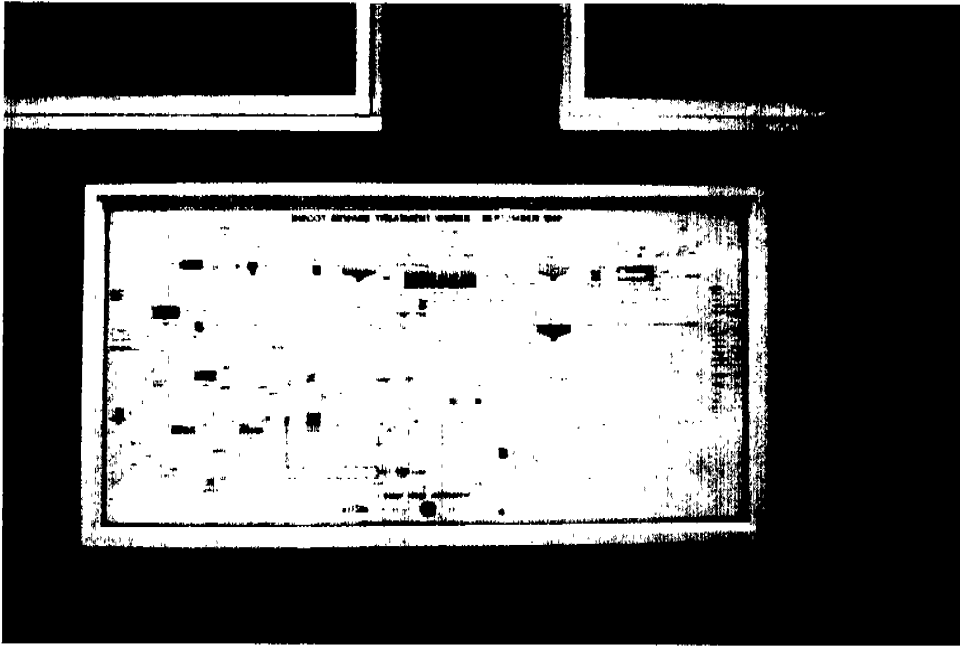
英國 Oxford 污水處理廠初沉池圍籬上之警告標示



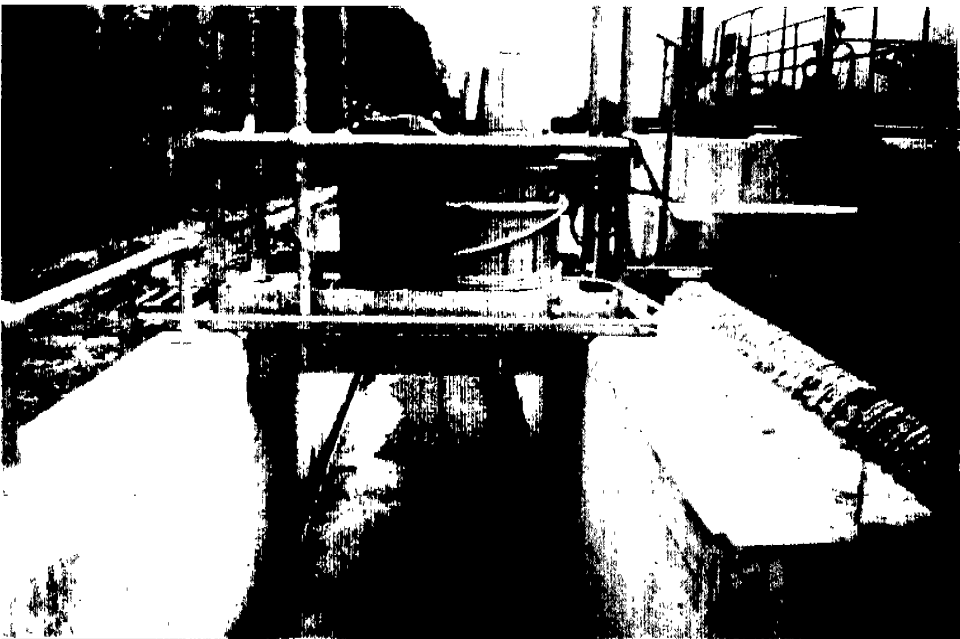
英國 Oxford 污水處理廠之活性污泥氧化渠



英國 Oxford 污水處理廠終沉池採地下化設計



Didcot 污水處理廠處理流程圖



Didcot 污水處理廠放流口以自動採樣器監測水質



## **Dutch upgrade with submerged membranes**

*Water 21, magazine of the international water association  
November-December 1999*

# Dutch upgrade with submerged membranes

● An established biological process has been used to provide wastewater treatment at one of the two centralised rendering plants in The Netherlands. Now the installation has been upgraded by adding submerged membranes. **ARNOLD ZILVERENTANT** reviews performance of the combination so far.

The Netherlands, famous among other things for its large agricultural industry, has centralised its rendering activities at two locations. The wastewater generated by the rendering process is highly concentrated and needs intensive treatment before discharge. At the rendering plant for the north of The Netherlands, the wastewater is treated using the Carrousel process, in two units operated in parallel. For many years these Carrouseles achieved very high removal efficiencies, both for COD and total nitrogen (often exceeding 99% removal). However, in mid-1996, the treatment plant started experiencing problems with sludge bulking.

After in-process measurements, the sludge settleability initially improved, but this was followed by a further deterioration in sludge-water separation, accompanied by a drastic increase in the load to the Carrouseles which meant additional structural improvement was needed.

Pilot testing showed that using submerged membranes in place of the secondary clarifiers was feasible. A configuration was designed in which use of the existing units, such as clarifiers and belt presses, was maximised, thus keeping to a minimum the membrane unit's capacity requirements. The final membrane unit was supplied by DHV as a turnkey contract. Project completion took only five months, and the end result was the largest membrane-supported Carrousel in The Netherlands.

## Original system configuration

Wastewater generated by the rendering plant is highly concentrated, with a COD ranging from 5000 to 15,000mg/l and a Kjeldahl nitrogen content ranging from 400 to 1200mg/l. The fairly large seasonal

characteristic. In summer the pollution load is high, while in winter the load is low. The reason for this fluctuation is that animal parts decay more rapidly at higher temperatures, meaning that the raw material to be processed becomes more liquefied, thus automatically generating higher pollution levels in the wastewater.

In the early 1970s, a Carrousel unit was installed to treat the wastewater. An increase in the scale of rendering activities saw the wastewater treatment extended with a second Carrousel in 1989. After this extension the plant had a capacity of maximum 3800m<sup>3</sup> a day, with a pollution load of 270,000 PE (The Dutch pollution load is defined as:  $PE = \text{Flow (m}^3/\text{d)} \cdot [\text{COD (mg/l)} + 4.57 \cdot \text{Nkj (mg/l)}]/136$ ). The main dimensions of the plant are given in Table 1.

The plant operated virtually without problems for a number of years. One notable feature was the exceptionally high MLSS (mixed liquor suspended solids) that could be maintained. At a sludge volume index (SVI) of <100 ml/g, MLSS concentrations in the range of 10 to 15g/l were achieved, generating the following effluent quality: COD 50 to 150 mg/l; BOD <10 mg/l; N-total 5 to 30 mg/l; SS <20 mg/l.

During 1996 the SVI sharply increased, because of 'traditional' sludge bulking due to the explosive growth of filamentous bacteria. This resulted in periodic loss of sludge in the effluent. Since biomass contributes to the COD and nitrogen concentration, the effluent quality deteriorated significantly.

A number of actions were undertaken to restore the excellent effluent quality. A prerequisite to this was the legal obligation to ensure the rendering activities and wastewater flow continued at all times.

Table 1 Main dimensions, original Carrousel configuration

Parameter		Carrousel 1	Carrousel 2
Reactor volume	m	7500	6250
Aeration capacity	kgO <sub>2</sub> /h	955	628
Clarifier surface	m	113 + 283	254

a: Carrousel 1 was originally fitted with one clarifier, but subsequently a second was installed during an expansion

- transporting a highly concentrated sidestream to a digester at a municipal wastewater treatment plant
- substantially lowering the MLSS in the Carrouseles. At peak loads this resulted in an incomplete nitrification
- applying belt filtration on one of the Carrouseles to achieve sludge/water separation

On evaluation, it was discovered that the main cause for the filamentous growth was an increased concentration of fats in the raw wastewater. By taking in-process measures the initial fat discharge to the plant was greatly reduced. This gave the sludge an improved settleability, resulting in a more normalised effluent quality (see Figure 1).

In 1997 the concentration of fat increased again, and at the same time the pollution load increased due to an outbreak of classical swine fever. Again, settleability decreased and periodic loss of sludge occurred. The effects were minimised by applying belt filtration on both Carrouseles. There were however a number of disadvantages to this

- the operational costs (chemicals, energy,

- given optimal control of the belt press, the suspended solids concentration is still in the range of 30 to 100 mg/l,
- the dewatering polymer accumulating in the Carrousel results in a jelly-like structure, with virtually no settling characteristics, despite the reduced presence of filamentous bacteria,
- minimal changes in the operation of the belt presses can result in the discharge of sludge to the effluent.

It was believed that the use of membranes would provide a more structural control of the biomass. In order to check whether they would work, a pilot test was undertaken.

#### Pilot research

Before the test run, a choice was made between conventional pressure and submerged membranes. The two types of membrane have different characteristics: with conventional units, the membrane tubes are placed outside the bioreactor. To minimise obstruction and fouling of the membranes the wastewater/sludge mixture is recirculated at high velocities through the membrane tubes. Since the membranes are pressurised the membrane tubes are mounted in a rigid and relatively expensive skid.

Submerged membranes consists of strong, flexible hollow fibres which are either placed in the activated sludge unit or in a separate, unpressurised vessel fed by recirculating a portion of the activated sludge flow. The permeate is drawn from the bioreactor by applying a slight negative

pressure to the interior of the fibres ( $<0.6$  bar). Fouling of the membrane modules is prevented by keeping the membrane fibres in motion through coarse bubble aeration and periodic back pulsing with permeate.

For the experiments, submerged membranes were selected in preference to pressure membranes. The selection was based on the following arguments.

- longer expected membrane life,
- low energy consumption,
- shear forces are more consistent, so there is less damage to flocs, so the settling characteristics are maintained. This makes combined separation with the existing clarifiers possible.

The experiments were conducted using a pilot unit containing two submerged Zenon Zeeweed ZW 150 membranes, with an effective surface of 27.5m<sup>2</sup>. These membranes were installed in a 1m<sup>3</sup> container, and were fed 3-4 m<sup>3</sup>/h of sludge from the Carrousel. With a maximum permeate flow of 1.5m<sup>3</sup>/h, the concentration inside the vessel was at most twice as high as the MLSS concentration in the Carrousel.

Before testing the actual sludge, the unit was run using clean water at a temperature of 25°C to establish the normalised clean water flux (CWF or permeability). As depicted in Figure 2, this test showed that for a membrane pressure in the range of 0.25 to 0.55 bar, the permeability remained virtually unchanged at approximately 150 l/(m<sup>2</sup>.h.bar).

In testing the actual sludge, the most important parameters are the sludge concentration outside the membranes and the operating temperature. During most of the test runs the concentration was kept fairly constant at 15 to 20g/l, while the temperature varied between 27°C and 34°C.

The performance of the unit was tested by introducing a series of fixed permeate flows. If membrane fouling takes place, this means an increased pressure difference is needed to maintain the flux. Figure 3 depicts the resulting normalised flux for the two highest fluxes being tested. This result indicates that maintaining a flux of 46 l/(m<sup>2</sup>.h) will generate a stable normalised flux of approximately 110 l/(m<sup>2</sup>.h.bar). At higher fluxes the normalised flux did not stabilise, indicating progressive fouling of the membranes.

A special test was undertaken when the Carrousel experienced a peak load of fat in the influent.

It was proven that the effect of the fouling could be minimised by applying a higher air flux on the membranes (see Figure 4). Once the fat was degraded in the Carrousel a normalised flux was restored at the standard value of 110 l/(m<sup>2</sup>.h.bar), indicating that the fouling was completely reversible.

Besides the flux, the effluent quality is, of course, of vital importance to determining the applicability of membrane separation.

Table 2 Effluent characteristics, membrane unit

Parameter	Unit	
COD	mg/l	65
Total Nitrogen	mg/l	<10
BOD	mg/l	<10
Suspended solids	mg/l	0

During the test runs the plant experienced extremely high loads. Nitrification was therefore incomplete, at 'only' 95% efficiency, corresponding to an ammonium concentration in the effluent of approximately 60mg/l. Additionally, the problem with sludge bulking created more suspended solids in the effluent and thus an increased COD.

The effluent in the test unit was, by its nature, free of suspended solids and had a COD concentration of < 100 mg/l. Thanks to the aeration some additional nitrification also took place, lowering the ammonia concentration to approximately 40 mg/l.

#### Full-scale work

The most secure way to use the membrane-supported Carrousel treatment (MSC<sup>TM</sup>) system would simply be to install enough capacity for the total flow. This would, however, make both the clarifiers and the belt press obsolete. A configuration was therefore designed which would maximise the application of the existing units, thus minimising the required membrane unit capacity.

The original plant design was based on a substantially higher flow than exists at present, thanks to substantial measures applied to the process itself. This results in a very long hydraulic residence time in the Carrousel (one to two weeks) and in the clarifiers (18 to 36 hours). This meant the surface loading rate for the clarifiers is extremely low ( $<0.2$  m<sup>3</sup>/(m<sup>2</sup>.h)). By treating part of the wastewater in the new membrane

Figure 1 Course of the removal efficiency and SVI in 1995/96

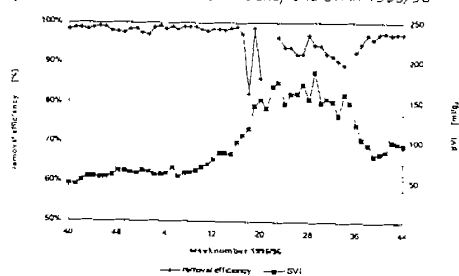
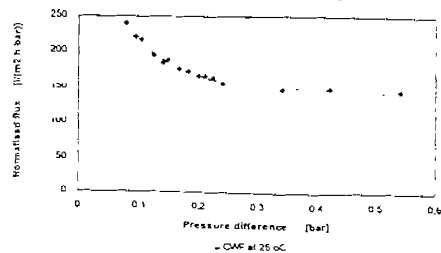


Figure 2 Normalised clean water flux as a function of the pressure difference over the membranes



the remaining flow, resulting in even lower surface loading rates. Alternatively one of the clarifiers can be used to buffer a temporary higher influent flow.

Recent experience has proved that although the effluent quality is somewhat limited and the operational costs will be high, the belt press is capable of producing around 40-60 m<sup>3</sup>/h of effluent. The present average flow amounts to approximately 70m<sup>3</sup>/h, with a maximum short-term flow (less than a day) of 100m<sup>3</sup>/h. Based on the above observations, it was concluded that a membrane unit with an average capacity of 40m<sup>3</sup>/h would be sufficient. The remaining wastewater could then be treated conventionally (and/or with belt presses), resulting in a total flow which meets effluent requirements.

To minimise the membrane surface needed for this flow, the temperature should be as high as possible. In this respect there was a marked difference between both Carrousel. Since the new Carrousel was equipped with covered aerators, the temperature was on average 8-10°C higher than in the old uncovered one. The minimum process temperature for the membranes is set at 17°C, with a maximum temperature of 38°C.

For the full scale implementation, a container-like vessel 3m by 9m and 3m high was installed next to Carrousel 2. This container was equipped with 24 ZW500 modules (with a membrane surface equal to 1120m<sup>2</sup>) and coarse bubble aeration. The container was fed with biomass from this Carrousel at a flow of 200m<sup>3</sup>/h. The excess flow was fed back to Carrousel 2 by gravity.

A normalised flux of 110 l/(m<sup>2</sup> h.bar) would result in an average pressure over the membranes of 0.3 bar, achieving an effluent flow of 40m<sup>3</sup>/h. It is also possible to run the membranes at higher pressures of up to 0.6 bar for a limited time. This design is therefore flexible enough to cope with upsets such as peak fat loads, reduced temperatures or higher fluxes if need be. The unit is however

completely prepared (blower capacity, container volume, etc) to house an additional amount of 48 modules in case a large permeate flow is needed.

The theoretically obsolete clarifier for Carrousel 2 has been modified to run as:

- a buffer for the excess effluent from Carrousel 2: by maintaining the normal sludge return line, any excess of influent flow over permeate flow will result in activated sludge being stored in the clarifier. It will take around three days to fill the clarifier if the excess flow is 10m<sup>3</sup>/h.
- as an additional clarifier to Carrousel 1: with the addition of a limited amount of piping, the clarifier has been connected to Carrousel 1, making it possible to incorporate it in the treatment process for this Carrousel.
- partial membrane treatment for sludge from Carrousel 1: At very high loading rates, the flow to Carrousel 2 is limited not by the permeate flux but by the biological capacity. By using the clarifier and sludge recirculation, part of the flow from Carrousel 1 (either before or after clarification in the other two clarifiers) can be used to maximise the permeate flux, independent to the biological capacity of Carrousel 2.

After four months in operation, the membrane unit was judged to be a success. At an average influent flow of around 32m<sup>3</sup>/h, the initial pressure difference needed to discharge this as permeate was only 0.2 bar. After two months' operation the pressure difference gradually increased to 0.4 bar, but simple chemical cleaning with a mild acid quickly removed the reversible fouling, lowering the pressure difference to 0.2 bar again.

The effluent quality was measured separately for approximately a month (see Table 2). The other Carrousel (still using clarifiers), running at an average flow of 48 m<sup>3</sup>/h, produced a comparable effluent quality, apart from a limited amount of suspended solids (<20 mg/l).

Figure 3 Normalised flux as a function of the applied permeate flux

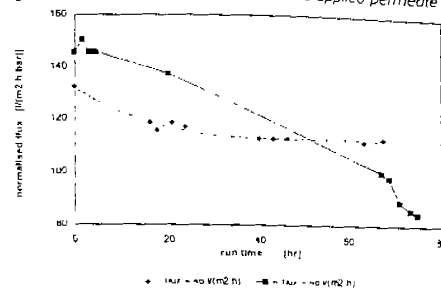
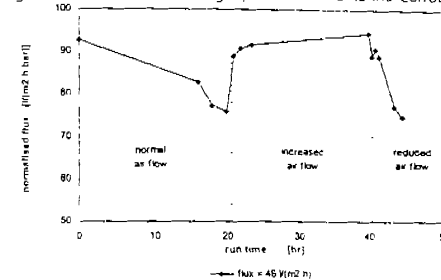


Figure 4 Normalised flux during a peak load of fat to the Carrousel



### Conclusions

Long-term experience has shown the Carrousel to be an extremely efficient treatment process for highly concentrated wastewater from a rendering plant. In its original configuration, using clarifiers, the excellent effluent quality only deteriorated when sludge bulking led to the discharge of sludge into the effluent.

Pilot research showed that even under sludge bulking conditions the excellent effluent quality could be guaranteed if the clarifiers were replaced by submerged membranes. For the large rendering plant in The Netherlands a configuration was designed in which just one of its two Carrousel had to be converted into a membrane-supported Carrousel treatment (MSCT).

It took only five months to implement this plant, which is the largest MSCT in The Netherlands. The first evaluation of the full scale results show it enjoyed a successful start-up. The effluent produced is free of suspended solids and contains virtually no biologically removable components. Both COD and total nitrogen removal frequently exceed 99% efficiency.

Our conclusion is that membrane-supported Carrousel treatment (MSCT), as shown in the photograph, combines the best of both worlds: the excellent biological performance of the Carrousel with the solids-free effluent quality achieved in membrane separation. ●

### The author:

Arnold Zilverentant is a senior water expert



# General

DHV Water is specialised in Water Management, Water Transport, Drinking Process Water Treatment and Wastewater Treatment. DHV Water offers a wide range of services, varying from strategic advice, policy analysis, research and feasibility studies, to design and engineering, project management, operational management, trouble shooting and general contracting.

DHV Water works for a multitude of public and private clients world-wide. DHV Water is an operating company of the DHV Group

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## More information?

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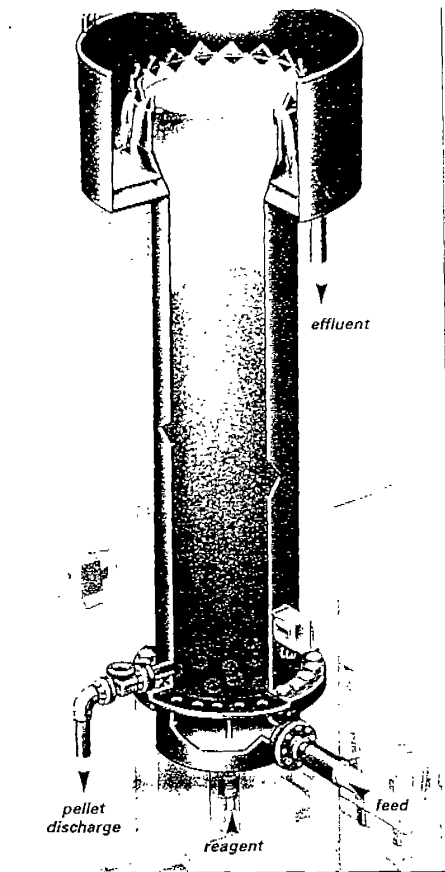
DHV Water BV  
P.O. Box 484  
3800 AL Amersfoort  
The Netherlands  
Telephone +31 33 468 22 00  
Telefax +31 33 468 23 01





**The Crystalactor®**  
**... efficient water treatment**  
**without waste**

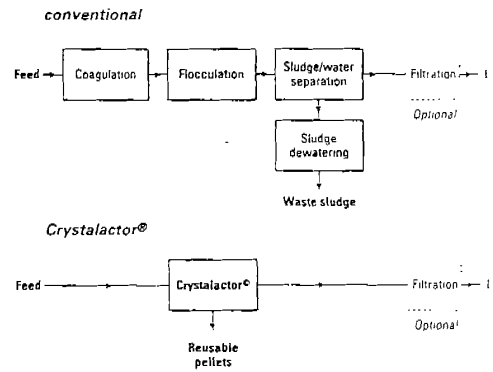




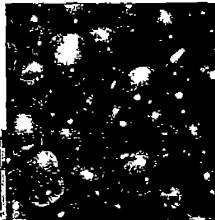
## How it works

The Crystalactor is a fluidized-bed type crystallizer for the treatment of water and wastewater.

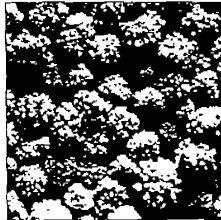
The heart of the treatment plant is the so-called pellet reactor, partially filled with a suitable seed material like sand or minerals. The wastewater is pumped in an upward direction maintaining the pellet bed in a fluidized state. In order to crystallize the target component on the pellet bed, a driving force is created by a reagent dosage and pH-adjustment. By selecting the appropriate process conditions, co-crystallization of impurities is minimized and high-purity crystals are obtained. The pellets grow and move towards the reactor bottom. At regular intervals, a quantity of the largest fluidized pellets is discharged from the reactor and fresh seed material is added. After atmospheric drying, readily handled and virtually water-free pellets are obtained.



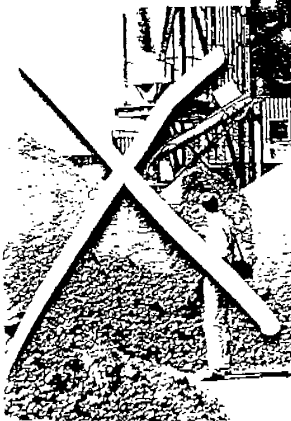
No copious amounts of waste sludge, but compact reusable pellets (shown magnified)



NiCO<sub>3</sub> pellets



CaF<sub>2</sub> pellets



## No Residual Waste

A major advantage of the Crystalactor is its ability to produce highly pure, nearly dry pellets. Due to their excellent composition, the pellets can normally be recycled or reused in other plants, resulting in no residual waste for disposal. In the rare event that pellets have to be disposed of by other means, the advantage of low-volume secondary waste production still remains: water-free pellets, not bulky sludge.

## Four in One

The four steps found in conventional treatment processes - coagulation, flocculation, separation and dewatering - are combined into one by the Crystalactor. Because of the production of water-free pellets, troublesome sludge dewatering is eliminated.

Furthermore, the unit is compact due to the high surface loadings (40-120 m/h).

3	DHV already has experience with the removal										9						
Li	of a large number of heavy metals and anions,										10	CO <sub>2</sub>	11	NH <sub>4</sub> <sup>+</sup>	12	F <sup>-</sup>	
	12	while the number of applications keeps growing.										13	Al	14	PO <sub>4</sub> <sup>3-</sup>	15	SO <sub>4</sub> <sup>2-</sup>
	Mg																
19	20		23	24	25	26	27	28	29	30							
K	Ca		V	Cr	Mn	Fe	Co	Ni	Cu	Zn							
37	40		42					47	48		50		52				
Sr	Zr		Mo					Ag	Cd		Sn		Te				
								80			82						
								Hg			Pb						

successfully recovered

## Applications

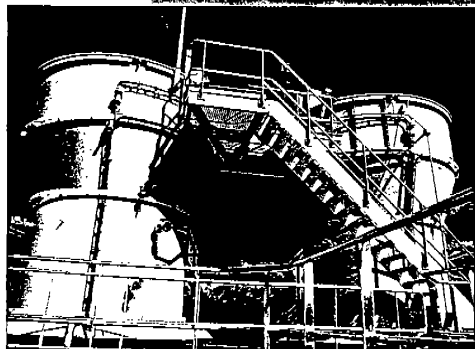
All crystalline salts can potentially be removed from wastewater. DHV has extensive experience in removing most heavy metals and major

anions, and the number of applications continues to grow. Metals are generally removed as hydroxide, carbonate or sulphide compounds. In some cases it has proved to be attractive to form metal phosphates. Anions are usually removed as calcium salts. Occasionally it is more desirable to form complex salts. For example phosphate can be removed as NH<sub>4</sub>MgPO<sub>4</sub> while simultaneously reducing the wastewater nitrogen content.

Ask DHV for the best alternatives for your specific situation.

## Project Approach

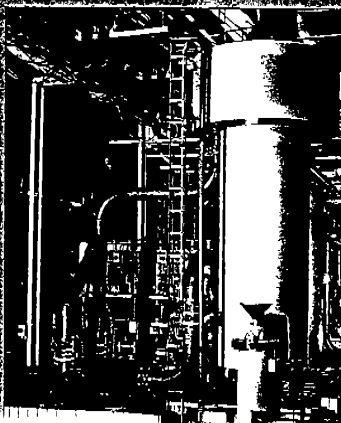
We can offer all the services you need to determine and prove the advantages of the Crystalactor in your specific situation and to provide you with an efficient, easy-to-operate plant that fully meets all relevant environmental regulations. Our services don't end with the construction of the plant. We also take full responsibility for start-up, and if desired we can take care of its general operation and maintenance.



Sewage Treatment Plant

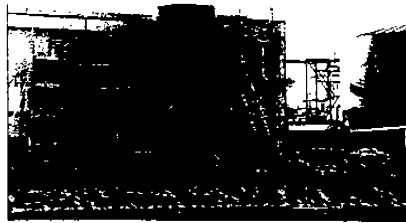
Crystalactor for phosphate removal  
at Giessemerambacht, the Netherlands.  
Capacity: 250 m<sup>3</sup>/d, 10 kg PO<sub>4</sub>/h.

Crystalactor for fluoride removal  
at Pottum, Soest, the Netherlands.  
Capacity: 20 m<sup>3</sup>/d.





Bench-scale tests



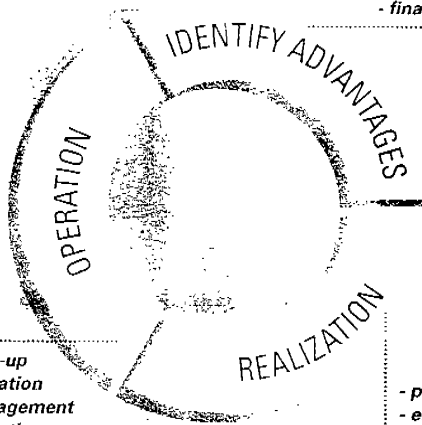
Semi-technical Crystalactor unit for phosphate removal, AVEBE BA, De Krim, the Netherlands. Capacity: 150 m<sup>3</sup>/h.



Our research laboratory is at your service



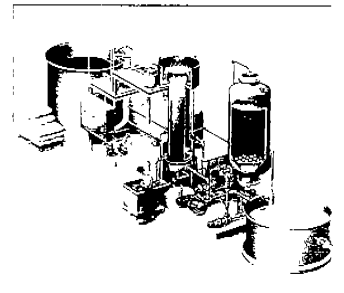
- feasibility study
- system selection
- bench tests
- pilot tests
- demonstration plants
- finance



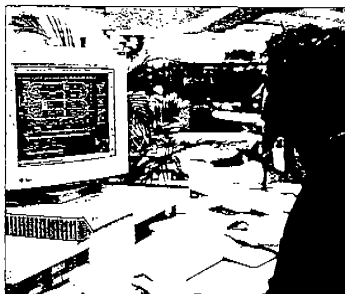
- start-up
- operation management
- operation
- maintenance

- project management
- engineering
- procurement
- construction
- commissioning
- supervision

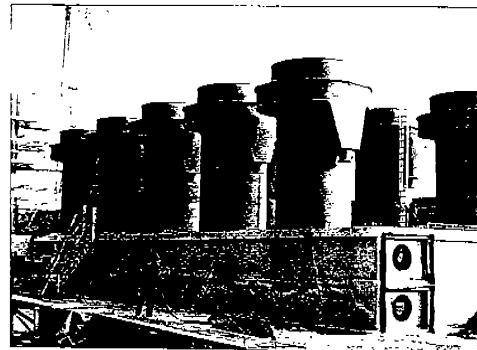
The treatment of wastewater is a complex biological/chemical process. Dealing with wastewater is made even more difficult by no two wastewaters being the same. We make full use of 75 years experience when developing pilot procedures to facilitate the determination of the optimum configuration, and dimensions and to ensure that no unexpected factors can come into play later



A small Pre-assembled Unit or turnkey plant with a huge capacity. Each project receives dedicated attention from our experts.



Engineering using the most up-to-date and cost-effective tools



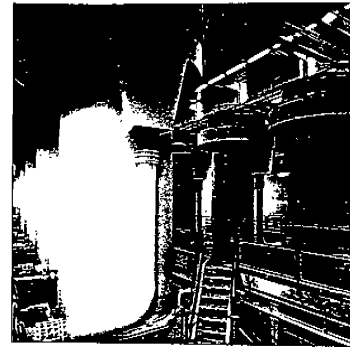
## The Crystalactor® ... efficient water treatment without waste

Industry needs cost-effective, compact and reliable technology to reduce waste emissions. Moreover, this technology has to provide a sustainable solution to the problem of secondary emissions. Secondary emissions such as waste sludges represent a growing environmental liability for those producing them.

More importantly, they will increasingly be subject to ever-rising charges levied by the authorities, and ultimately their disposal will be prohibited altogether.

Consequently, industry has embarked on a new strategy to tackle environmental load problems. Alongside waste recovery - often referred to as reuse or recycling - waste prevention is now a key feature.

DHV's commitment to the development of client-oriented waste remediation technology has resulted in the application of the Crystalactor® technology: now being operated without creating extra waste, and to the full satisfaction of a growing number of clients using it for water softening and for the removal or recovery of a large number of heavy metals and anions.



*Pellet reactors for softening drinking water,  
Municipal Drinking Water Company  
of Amsterdam, the Netherlands.  
Capacity: 8,500 m<sup>3</sup>/h.*

### Applications

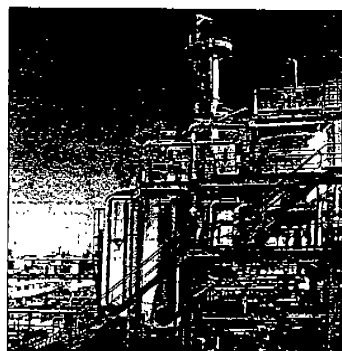
- Heavy Metal
- Fluoride
- Phosphate
- Sulphate
- Water Softening
- Others (under development)

### Advantages

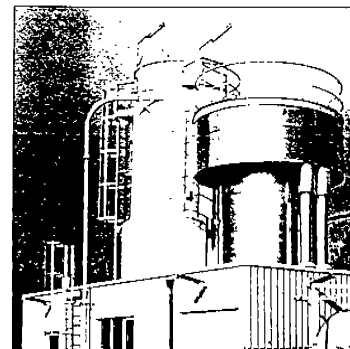
- Compact Industrial Units
- No Sludge Production
- Water-free Pellets with High Purity
- Raw Materials Recovery / Recycling
- No Mechanical Dewatering Equipment
- Easy Handling of Pellets
- Modular Set-up

### Product Range

- Field Erected Units or Pre-assembled Units
- Standard reactor diameters: 0.4, 0.6, 0.8, 1.0, 1.25, 1.5 .... 3.5 m
- Flow rates: 0.1 - 10,000 m<sup>3</sup>/h
- Removal capacity: up to 100 kg metal or anion per hour per unit
- Tailor-made Materials Selection



*Crystalactor for nickel  
and aluminium removal,  
Shell Chimie, Berre, France.  
Capacity: 21 m<sup>3</sup>/h.*



*Crystalactor for  
phosphate removal,  
the Netherlands.  
Capacity: 200 m<sup>3</sup>/h.*

## Services

- TurnKey Projects
- Feasibility Studies and System Selection
- Bench-scale and Pilot Testing on-site or in the DHV Water Research Lab.
- Industrial Water and Wastewater Treatment Consultancy
- Process and Basic Design
- Engineering, Procurement and Construction
- Detailed Engineering, Tender Documents, Tender Selection and Construction Supervision
- Commissioning and Start-up
- Operator Training
- Plant Operation Management
- Project Finance
- Licences

## DHV Water

DHV Water is specialized in Water Management, Water Transport, Drinking and Process Water Treatment and Wastewater Treatment. DHV Water offers a wide range of services, varying from strategic advice, policy analyses, research and feasibility studies, to design and engineering, project management, operational management and general contracting. DHV Water works for a multitude of public and private clients worldwide. DHV Water is an operating company of the DHV Group.

The DHV Group is one of the largest international engineering companies. DHV's activities focus on Transport & Infrastructure, Water & Environment, and Accommodation Building. The Group has 2.300 employees working in more than 40 locations worldwide.

For more information on the Crystalactor® contact:  
Andreas Giesen,  
Ronald Niermans  
George Onderdelinden.

## DHV Water BV

P.O. Box 484  
3800 AL Amersfoort  
The Netherlands  
Tel + 31 33 4682220  
Fax + 31 33 4682301  
e-mail: info@WA.DHV.NL



The Quality Management System of DHV Water BV has been approved against ISO 9001

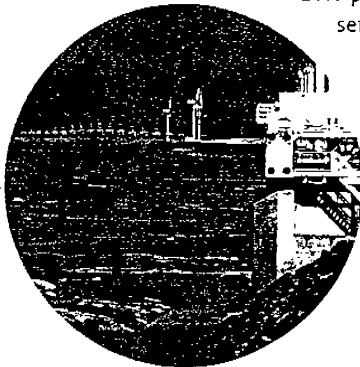
*Water, the source of life*



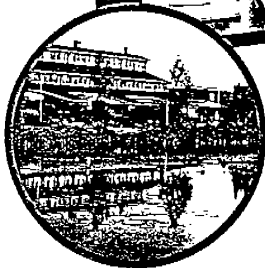
*gateway to solution*

*The world has become a place of ongoing and accelerating change. Globalisation, industrial development and explosive urban expansion are all exerting extreme pressure on our living environment. Fresh water, once available in abundant quantities, has now become a scarce resource in many parts of the world. Safeguarding our water resources and providing safe drinking water for all people has perhaps become the biggest challenge of the 21<sup>st</sup> century.*

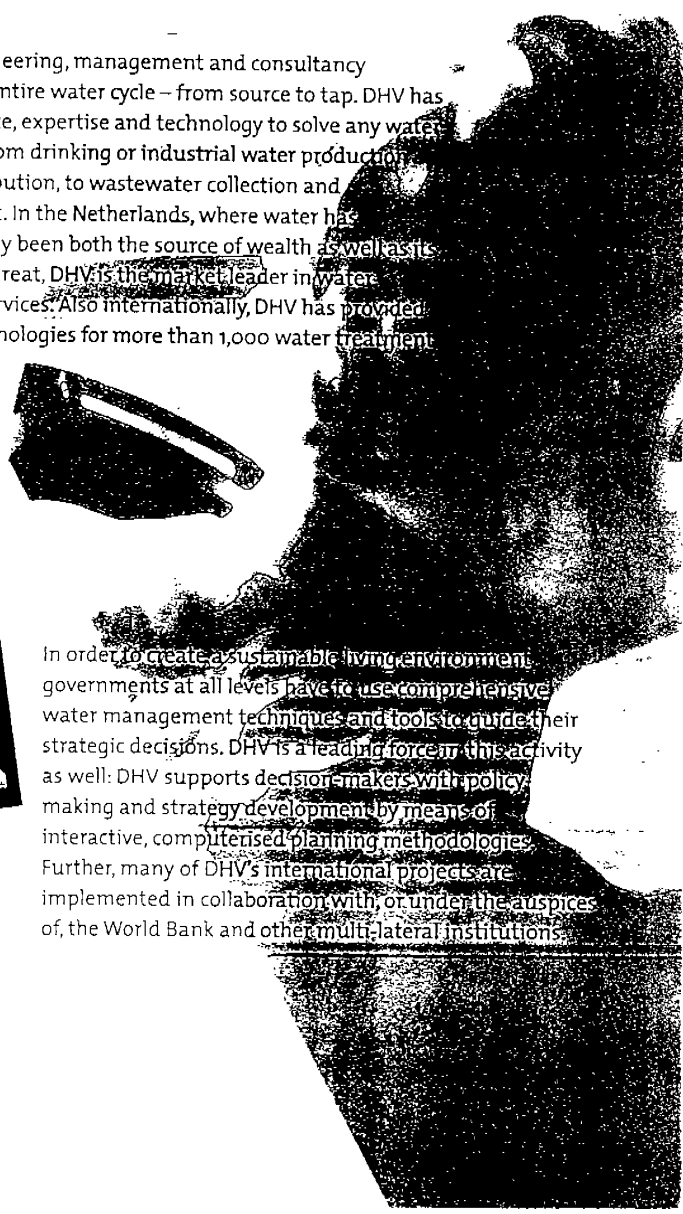
## Creating a sustainable living environment



DHV provides engineering, management and consultancy services in the entire water cycle – from source to tap. DHV has the experience, expertise and technology to solve any water problem: from drinking or industrial water production and distribution, to wastewater collection and treatment. In the Netherlands, where water has historically been both the source of wealth as well as its biggest threat, DHV is the market leader in water related services. Also internationally, DHV has provided water technologies for more than 1,000 water treatment plants.



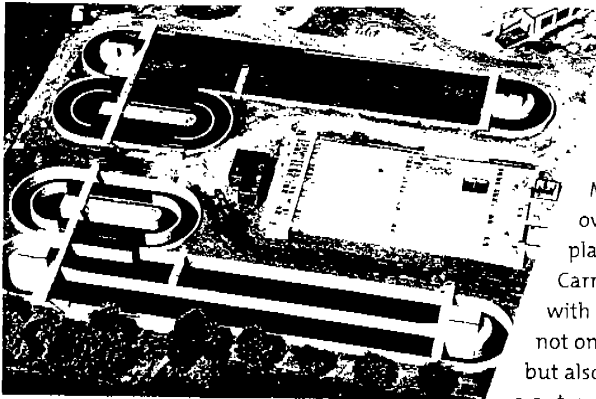
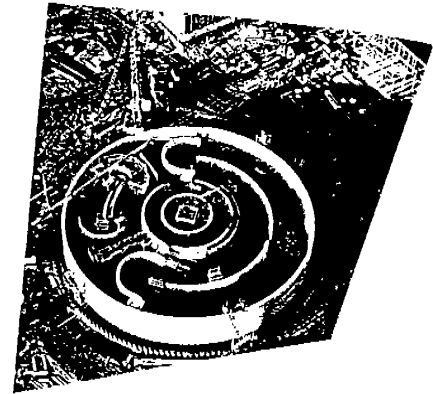
In order to create a sustainable living environment, governments at all levels have to use comprehensive water management techniques and tools to guide their strategic decisions. DHV is a leading force in this activity as well: DHV supports decision-makers with policy making and strategy development by means of interactive, computerised planning methodologies. Further, many of DHV's international projects are implemented in collaboration with or under the auspices of, the World Bank and other multi-lateral institutions.





## Public Private Partnership (PPP) for wastewater treatment in The Hague

DHV has been engaged as a key partner to design and manage all technical aspects of the Design, Build, Finance, Operate and Transfer (DBFOT) contract for the largest WWTP ever built in the Netherlands. Together with the retrofit of the Houtrust WWTP, which forms part of this PPP project, the new combined wastewater treatment capacity will amount to 1.7 million population equivalent (p.e.).



## New technologies for wastewater treatment

DHV's Carrousel® 2000 technology and other innovative technology concepts – such as Deep Tank Aeration, Membrane Bio Reactors – are being used in many plants all over the world. Examples can be found in China (several plants up to 80,000 m<sup>3</sup>/day), the U.S.A. (more than 450 Carrousel® plants with various capacities), and France (Macon, with a capacity of 160,000 p.e.). For many of these projects, DHV not only acts as the process developer/engineering consultant, but also as a process contractor under varying contract models – e.g., turnkey, design-build, BOT.

## The Huaihe River Basin Pollution Control Project, Peoples Republic of China

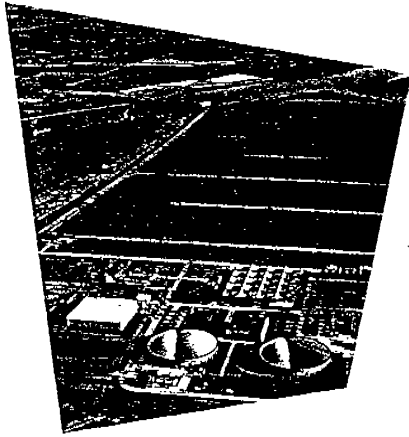
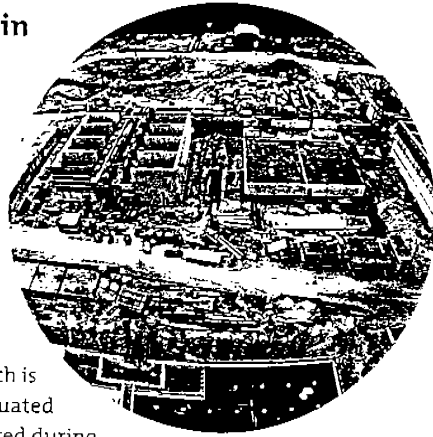
The Huaihe River basin, which covers the Chinese provinces of Henan, Anhui, Jiangsu and Shandong, has a drainage area of 270,000 km<sup>2</sup> and is home to about 154 million people. Industrial pollution has caused an unacceptable deterioration of water quality in the area, a process that is aggravated by the artificial storage of water in the river stretches, controlled by more than 4,200 hydraulic structures. Using various water quantity and water quality models, DHV is developing solutions for municipal as well as industrial pollution control.



## Drinking water treatment technology in The Netherlands

Because of concerns related to dropping groundwater levels, a shift to surface water from groundwater as the source for drinking water is being implemented. Water Company Limburg, has engaged DHV to plan, design and manage the construction of a new drinking water facility, with a design capacity of 40 million m<sup>3</sup> per year and investment costs of US \$ 200 million.

The new plant uses water from the River Meuse, which is pumped into a large natural reservoir. Well fields, situated along the banks of the reservoir, abstract water filtered during its passage through the ground, and pump it to the treatment plant, where it is treated by cascade aeration, rapid sand filtration, active-carbon filtration and UV-disinfection.



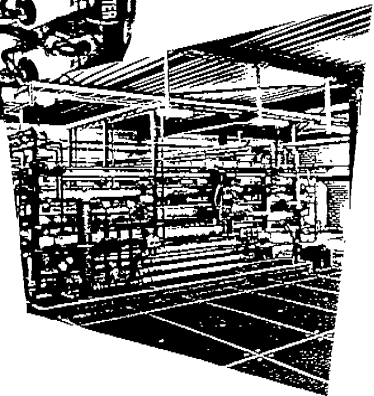
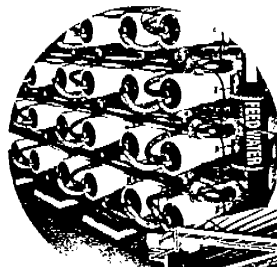
The Berenplaat WTP is the largest drinking water treatment plant in the Netherlands, and provides drinking water to the city of Rotterdam. The plant, with a capacity of 100 million m<sup>3</sup> per year, is being renovated and extended to comply with stricter environmental regulations and to further improve water quality and security of supply. In the new process, chlorine disinfection will be replaced by ozone thus eliminating potential harmful by-products.

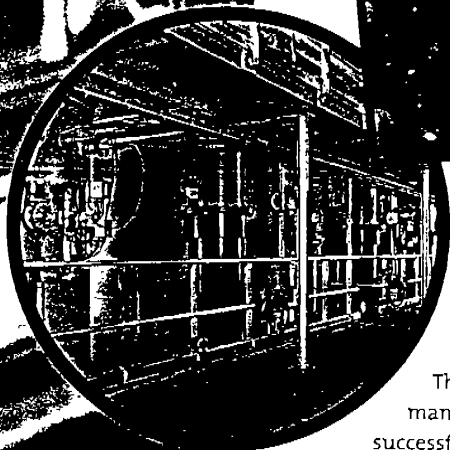
## Membrane filtration

Membrane filtration is becoming a crucial technology in the treatment of all kinds of raw water for the production of drinking and process water, as well as for the treatment of wastewater.

DHV has developed several new products that improve the performance of membranes at lower costs.

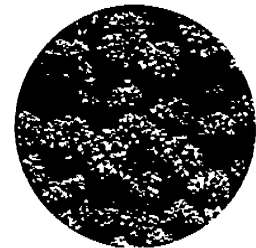
For nanofiltration and reverse osmosis, DHV designed a new pressure vessel, which reduces membrane surface by 15-20 percent. For tubular and capillary ultrafiltration, nanofiltration and RO membranes, DHV developed its Airflush™ cleaning technology, which saves energy and chemical consumption. The Airflush™ technology also allows direct nanofiltration, without pre-treatment, of surface water or wastewater.





## DHV's Crystalactor® technology

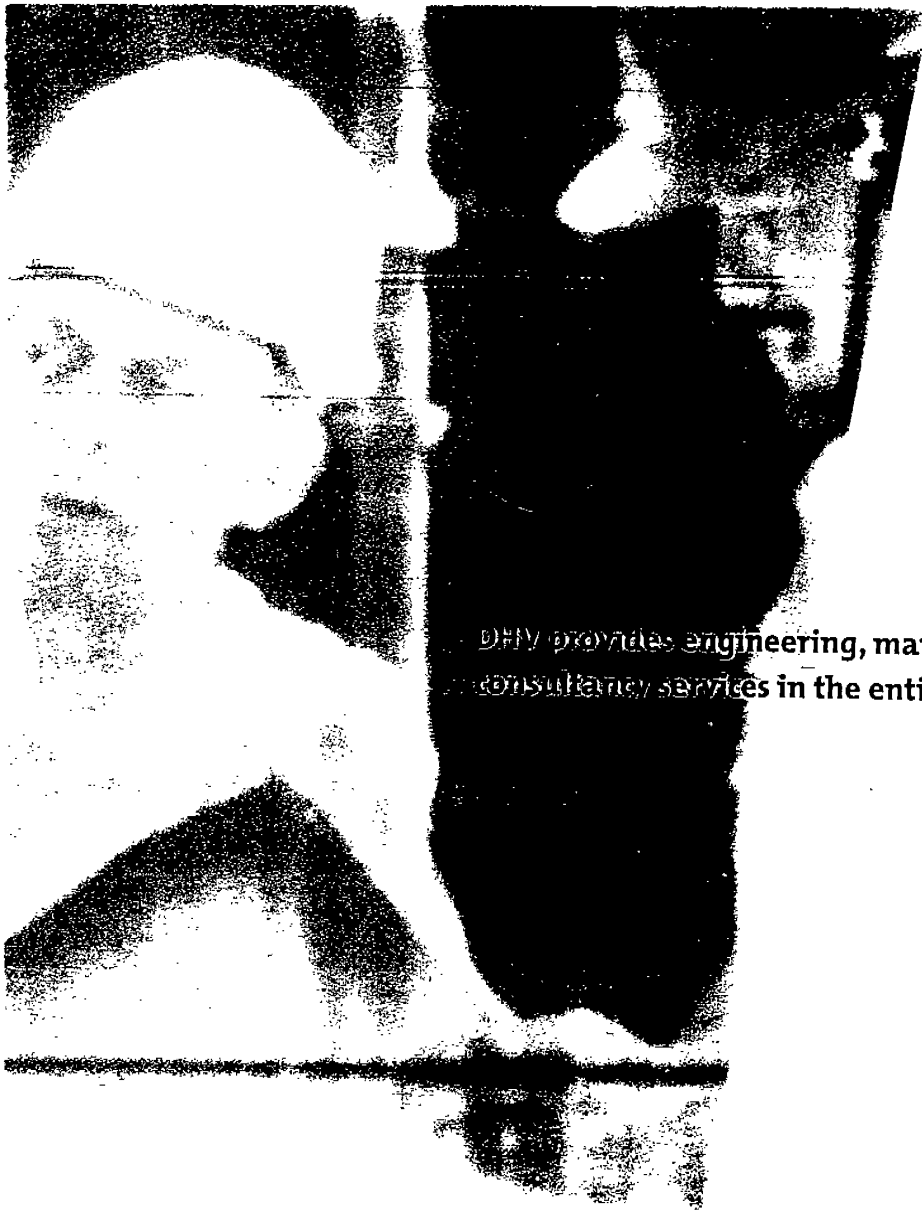
Together with the Water Company of Amsterdam, DHV has developed a patented process for the softening of water. The technology, called Crystalactor®, has been applied in many drinking water treatment plants, but has also been successfully used in a variety of industrial applications, where the removal of heavy metals or fluoride is important. DHV's design of a second-stage treatment process for the Water Company of Zuid Holland also includes Crystalactor® softening technology. Five process reactors, with diameters of 3.40 m, provide a total treatment capacity of 5,500 m<sup>3</sup> per hour.



DHV knows about water. This is evidenced by the wide range of water-related services that DHV provides its public- and private-sector clients worldwide:

- policy and strategy formulation
- master-planning and feasibility studies
- design and engineering
- project management and procurement
- general contracting
- operation and maintenance
- institution development and training

The DHV Group is one of the world's largest engineering and consultancy companies. Established in 1917, DHV provides professional services worldwide to governments, public utilities, financing agencies, industry and the private sector. With almost 3,500 professional staff, DHV has an extensive track record in more than 65 countries. International business accounts for almost 50 percent of the Group's turnover, which is realised through a network of some 35 national companies and representative offices. The added value of the DHV Group is based on the principle of local presence in combination with centralised knowledge centres. DHV provides services related to Water and Environment, Transport and Infrastructure, Accommodation and Real Estate, and International Development.



**DHV provides engineering, management and  
consultancy services in the entire water cycle**

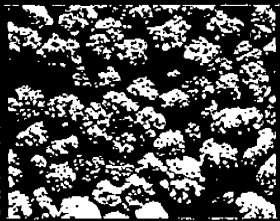
**DHV**

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DHV

# Removal of amorphous components in a fluidized bed reactor : The Crystalactor<sup>®</sup>



Ronald P. Niermans

February 2000

## DHV Group

DHV

- consulting engineers / founded in 1917
- # 8 in Europe / # 18 worldwide in turnover
- t.o. in 1999 : 275 m US\$ (added value : 85%)
- 45% of t.o. outside NL
- 3,300 employees worldwide
- 4 core activities:
  - infrastructure
  - industrial building & accomodation
  - ODA
  - water & environment

## **DHV Head Office in Amersfoort (NL)**

*DHV*



## **The Crystalactor ... efficient water treatment without waste**

*DHV*

- softening of process and drinking water
- metal recovery from process and wastewater
- phosphate recovery from wastewater
- fluoride recovery from process and wastewater

## Softening

MAN

- Applications
  - *process water*
  - *drinking water*
  - *approx. 30 plants worldwide*
- Stand-alone or pre-treatment for ion exchange and membrane filtration
- Production of  $\text{CaCO}_3$

## Softening

MAN

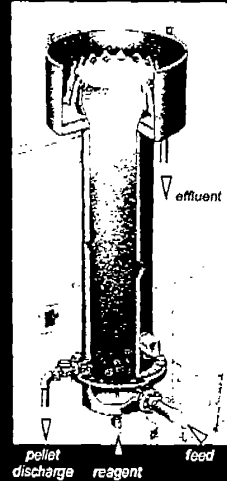
- chemical applied :
  - *NaOH*
  - *NaHCO<sub>3</sub>*
  - *Ca(OH)<sub>2</sub>*
  - *depending on alkalinity*



# Crystalactor®



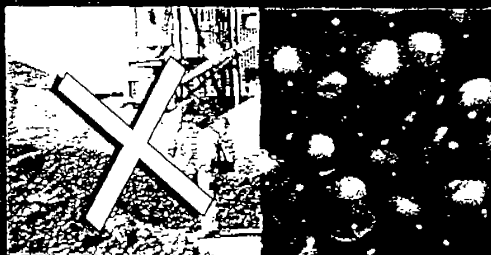
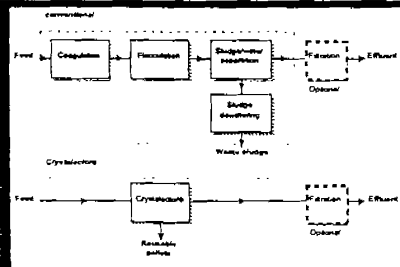
- crystallization in a fluidized bed reactor
- separate nozzles for feed and chemicals
- seed material 0.2 - 0.5 mm diameter
  - *classified sand particles (garnet)*
  - *crushed pellets*
- with or without post-filtration



# Advantages



- compact / small footprint
  - *four steps in one*



- zero or minimum waste
  - *extremely low water content (90-95%-d.s.)*
  - *high purity crystals with re-use potential*



## Phosphate recovery

DAV

- Applications
  - *in industrial process water treatment*
  - *for treatment of effluent from anaerobic reactor*
  - *in combination with bio-P removal in municipal plants*
    - main stream (tertiary treatment)
    - side stream (bypass operation)
- Production of crystals :
  - $Ca_3(PO_4)_2$        $Mg_3(PO_4)_2$
  - $MgNH_4PO_4$  \*

## Heavy metals recovery

DAV

- Examples of applications :
  - *recovery from wastewater*
  - *recovery of spent catalyst*
  - *process integrated operation*
- Experience (pilot-scale trials) :
  - *Ag, Al, Cd, Co, Cr, Cu, Fe, Hg, Li, Mg, Mn, Sn, Te, Ni, Pb, V, Zn, Zr*
- Plants in operation :
  - *Al, Mn, Ni, Te, Zn, Zr*

## Heavy metals recovery

ENV

### ■ Reactions

- $Ni^{2+} + CO_3^{2-} \rightarrow NiCO_3 \downarrow$
- $Co^{2+} + 2 OH^- \rightarrow Co(OH)_2 \downarrow$

### ■ Production of metal containing crystals as :

- *hydroxides*
- *carbonates*
- *sulphides (esp. mercury)*
- *phosphates*

## Re-use metal containing pellets

ENV

### ■ Sell as raw material

- *as raw material metal production (high purity)*

### ■ Recovery as metal from concentrates

- $NiCO_3 + 2H_2O \rightarrow Ni_2 + + CO_2 + 3H_2O$

### ■ Transformation to metal catalyst

- $CoCO_3 \rightarrow Co_2(CO)_8$

## Re-use example phosphate pellets



- sell as fertilizer
- sell to agro-industry
- use in animal food
- use in thermal phosphor production
- use in wet phosphate production

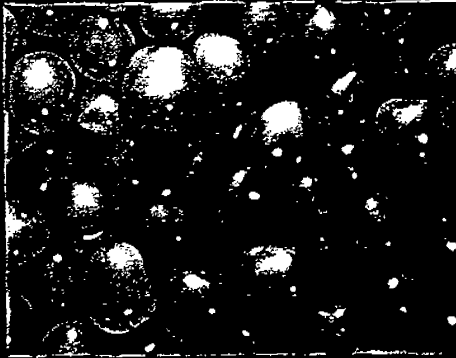
## Re-use fluoride pellets



- HF-production
- pelleted fluorspar flux in steelmaking
- filler in concrete

## Pellets

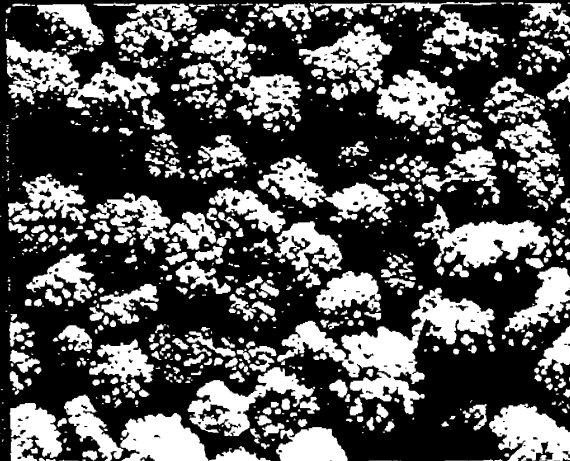
*WV*



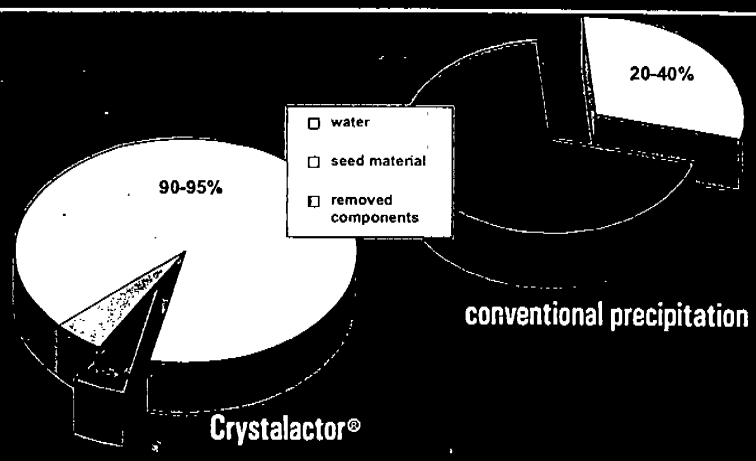
- Very compact pellets are produced
- Easy handling
- Low water content (< 5%)
- High purity
- Reusable
- Often: Negative or zero disposal costs

## Calcium fluoride pellets (mix with Zirkonium hydroxide)

*WV*



# Composition by-products



# Successfully recovered



- crystallization as
  - carbonates (e.g. NiCO<sub>3</sub>, CaCO<sub>3</sub>, CoCO<sub>3</sub>)
  - sulphides (e.g. HgS, NiS, PbS, ZnS)
  - calcium salts (e.g. CaF<sub>2</sub>, Ca<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>)

## Softening : Amsterdam

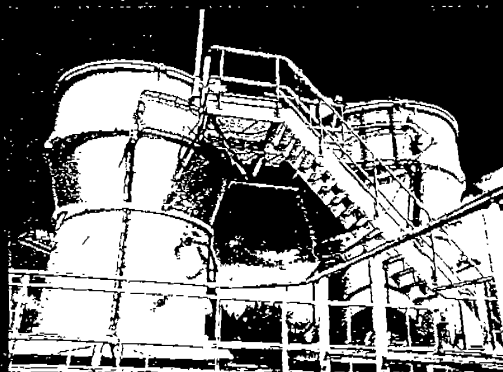
*WAV*



- Drinking water
- 2 centralized plants
- Number of reactors: 10
- Capacity: 8,500 m<sup>3</sup>/h
- Pellets sold for 8 \$ct / kg
- Approx. 40 plants worldwide

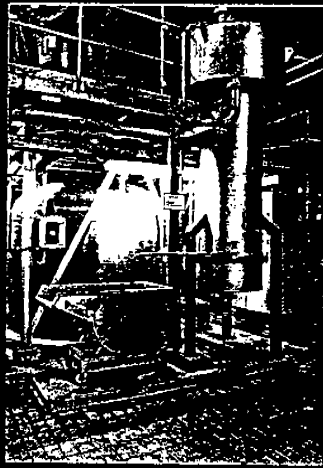
## P-removal : Geestmerambacht

*WAV*



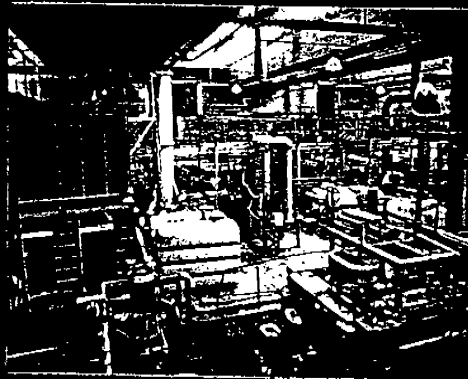
- Phosphate recovery from municipal WWTP
- Capacity: 16 MGD
- bypass operation
- chemical : milk of lime

## Metal-recovery : AKZO Chemicals



- Multi-purpose
- Batch productions
- Zn, Ni, Te-recovery
- Reactor diameter = 800 mm

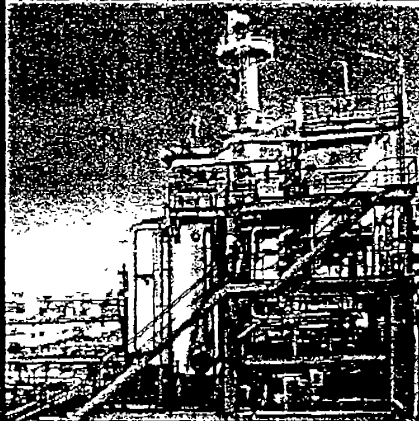
## Metal-recovery : Chroomwerk



- Plating industry
- Ni recovery
- 1000 ppm Ni  $\rightarrow$  < 1 ppm
- pellets recycled in process bath

## Metal-recovery : Shell Chemical

*DHV*



- Recovery of catalysts from polymer production
- Simultaneous Ni and Al recovery (mixed crystal)
- Process integrated
- Turn-key project by DHV

## Fluoride-removal : Du Pont Howson

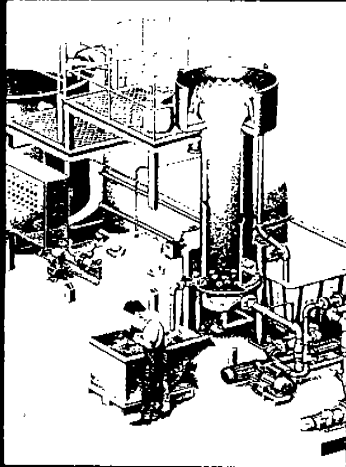
*DHV*



- Fluoride recovery from Printing Industry
- Reactor diameter = 1000 mm
- 700 ppm F → < 10 ppm

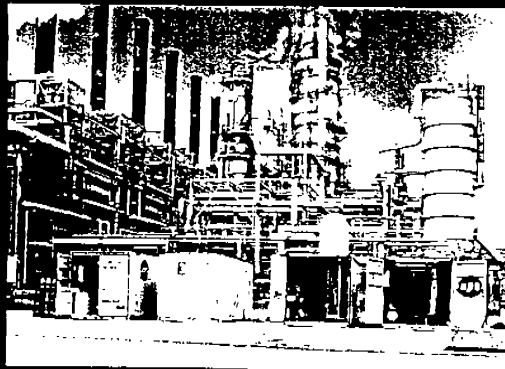


## Skid-mounted units



- For small and medium size units
- Easy to operate
- Short construction period
- Tailor-made: if wanted incorporation of any site-specific requirements

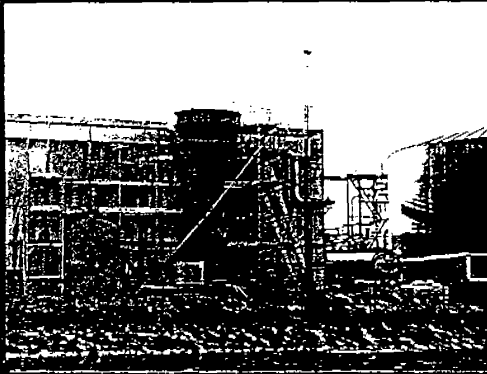
## Pilot facilities



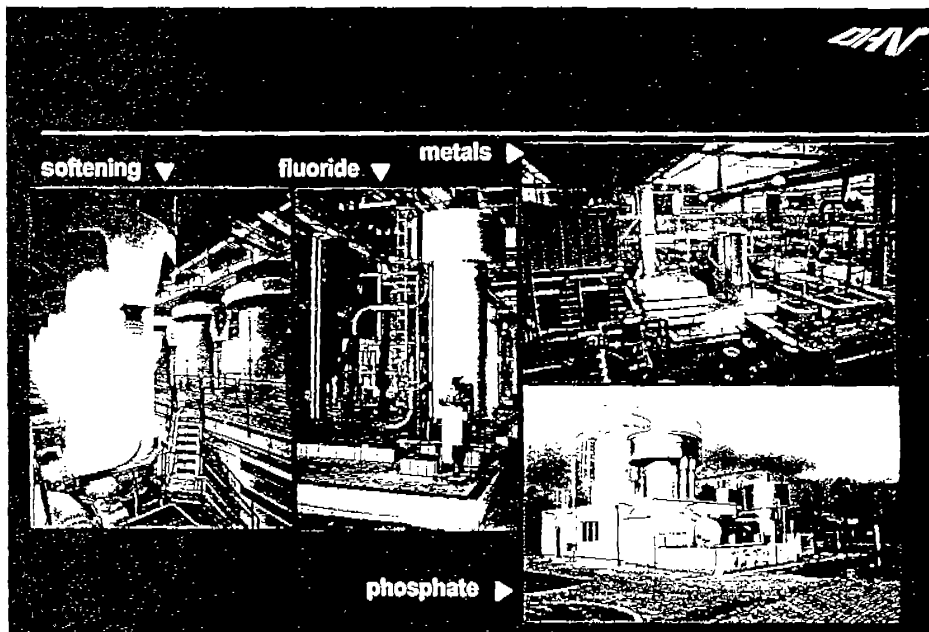
- All facilities available for tests in our own Water Research Lab (The Netherlands) or on site

## Pilot plant potato starch

WV



- $\text{MgNH}_4\text{PO}_4$  crystallization
- Scaling prevention
- Lower levies by N-removal
- Pellets are slow release fertilizer





*MVA*

---

***Gateway to solutions***



## Moving Bed Trickling Filter: Cost-effective treatment of air, water and air/water mixtures

*Product:*

Moving Bed Trickling Filter (MBTF)

*Process:*

Sludge-on-carrier aerobic treatment

*Application:*

Treatment of:

- waste water
- waste gases and air
- air/water mixtures

### **Moving Bed Trickling Filter enjoys many technical and economical advantages**

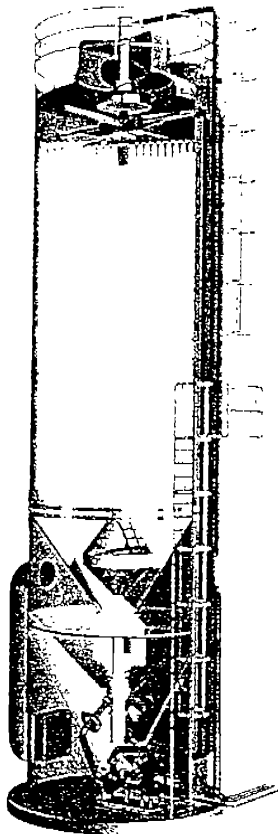
The MBTF is a biologically filter that can be used for treatment of both waste water and air. A unique feature is the possibility of treating waste water and air simultaneously: a separate investment for air treatment equipment is unnecessary, whilst the filter costs are made up for by the reduced waste water charges. So there is even a return-on-investment. But even if you wish to treat "only" waste water or "only" air, this filter offers attractive advantages and good economics.

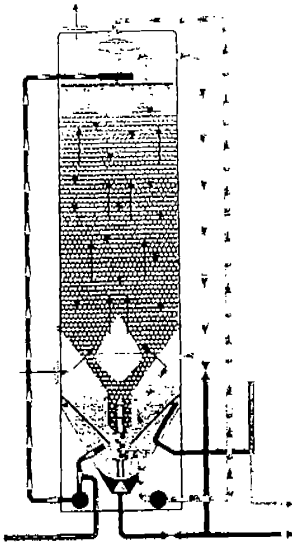
### **Earn money with fresh air**

Unfortunately, the treatment of waste water and polluted air and other gases always costs money. Luckily, the costs of water treatment are compensated for by reduced charges and lower waste removal costs. Previously the costs for treatment of polluted air and other gases could not be compensated, however: the treatment is compulsory, and there are no "advantages" in the form of lower taxes. The combined treatment of water and air/gas is therefore economically very attractive. After all, with combined treatment, there is no need to invest in separate air/gas treatment, whilst the costs of combined treatment are usually more than compensated for by the waste water treatment advantages.

### **High capacity**

Compared to other systems for treatment of air/gas or waste water, the MBTF is characterised by a high efficiency and high capacity. These advantages result in a low investment. Thus, a filter with a diameter of only 4 m, for example, is sufficient for treating of a highly polluted 12 m<sup>3</sup>/h waste water flow. A flow of 30,000 Nm<sup>3</sup>/h of air can also be treated in the same filter, *at the same time* as the 12 m<sup>3</sup>/h of waste water.

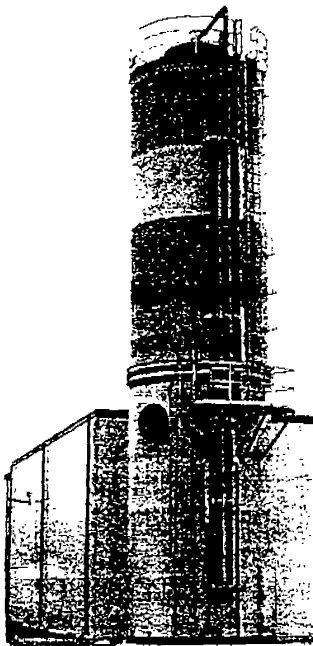




### Principle

The MBTF comprises a cylindrical tank filled with plastic spheres. The spheres, which are made of durable material, act as a carrier material for bacteria. The waste water is fed into the filter at the top, whilst the air flows through the filter parallel or counter-current to the water. Intensive mixing takes place in the filter, and the contaminations in the water and air are broken down by the bacteria.

A special feature is the fact that a number of the bacteria-carrying spheres are periodically removed from the bottom of the filter and cleaned. The bacteria removed from the spheres are thickened to a compact sludge in the cone of the filter. The cleaned spheres are returned to the top of the filter. This unique integrated cleaning procedure makes it possible to control the amount of bacteria and makes clogging of the filter impossible.



### The advantages at a glance

- small footprint
- non-clogging
- high separation efficiency
- low energy consumption
- universally applicable for air and/or water treatment
- integrated sludge separation and thickening
- easy to operate
- robust and stable
- low operating and investment costs—

### Want to know more?

The following are willing to provide you with more information:

- Arnold Zilverentant, tel: +31 33 4682410
- Andreas Giesen, tel: +31 33 4682497
- George Onderdelinden, tel: +31 33 4682211
- Wim Jansen, tel: +31 33 4682424
- Fax: +31 33 4682301
- E-mail: [info@wa.dhv.nl](mailto:info@wa.dhv.nl)

## New generation membrane bioreactors

**Product:**  
Membrane bioreactors (MBR)

**Application:**  
Wastewater treatment

**Users:**  
Industries and waste processing companies

### Compact wastewater treatment concept

Activated sludge systems are applied on a large scale for the treatment of wastewater. In these systems the active bacteria are present in the bioreactor as biomass. Using gravity, the sludge is separated from the treated wastewater by sedimentation. The conventional system can have the following disadvantages:

- The treatment efficiency is strongly dependent of the sludge sedimentation properties. In case the sludge sedimentation properties are deteriorating strongly during operation (production of "bulking sludge") a part of the biological active biomass is washed out and the treatment efficiency decreases significantly;
- Commonly a relative low biomass concentration (3 - 6 kg/m<sup>3</sup>) is applied to reduce risk of bulking sludge. Subsequently area consumption is high.

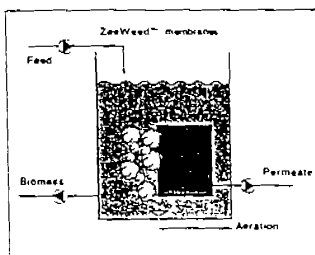
To take away above disadvantages, a few years ago the membrane bioreactor (MBR) has been developed. In a MBR, separation of active biomass and treated wastewater takes place by membrane filtration instead of sedimentation. In this case a much higher biomass concentration (factor 3 - 10 higher) can be maintained and wash out of sludge is fully prevented. However, application of the conventional membrane filtration technology resulted in high energy requirements.

### New generation membrane bioreactors

Conventional membranes consist of membrane tubes placed outside the bioreactor. The wastewater/ sludge mixture is recirculated with high velocity through the membrane tubes to prevent obstruction and fouling.

The new generation membrane bioreactors uses a new type of membrane module (Zeeweed®). This module consists of strong, flexible hollow fibres. The modules are placed in the activated sludge. The treated wastewater is withdrawn from the bioreactor by applying a slight underpressure to the inner side of the fibres. Fouling of the unique membrane modules is prevented by keeping the membrane fibres in motion by means of coarse bubble aeration. Subsequently no energy intensive recirculation is necessary and the new membranes are characterised by a much lower energy consumption.

Figure 1  
Principle of MBR



### Minimisation of waste production

In biological wastewater treatment, sludge is generated as a wasteproduct. Discharging and dumping this sludge is becoming more and more difficult and accounts for an important part to the overall operational costs of treatment. Therefore it is desirable to minimise the sludge production. With the membrane bioreactor this ambition can be realised. Since sludge production is related to the sludge loading of the wastewater treatment plant (WWTP) at a lower loading less sludge is produced. Because the sludge concentration of MBR's is much higher than conventional activated sludge systems, it is possible to apply very low sludge loadings and minimise sewage sludge production. Cost calculation shows that as a result of lower waste processing costs, the pay back period for upgrading an existing conventional wastewater treatment plant to a MBR in many cases is 1 - 3 years.

### Advantages

The new generation MBR's enjoy the following advantages:

- Compact installation thanks to high biomass concentration, no use of clarifiers and integrated membrane modules;
- High effluent quality thanks to the combination of membrane filtration in combination with an extreme biological degradation;
- Minimum sludge production thanks to low sludge loading;
- A guarantee for not exceeding discharge limits of suspended solids thanks to absolute filtration;
- Partial disinfection is achieved;
- Energy consumption is low in comparison with MBR's equipped with conventional membranes.

Figure 2  
MBR in container



### Applications:

The new generation MBR's is very suitable for the treatment of wastewater from industrial origin or dumping sites and provides a compact treatment system at low costs. Besides it can be very interesting to use MBR technology for upgrading existing WWTP's. Without using more space, the capacity of the existing WWTP can be raised 3 - 10 times at relatively low costs.

### Attractive for you?

Are you disposing medium to high concentrated wastewater and are you paying a high fee?

Are you paying highly for disposing sludge produced in your WWTP?

Do you need to improve the effluent quality of your biological WWTP or extent its capacity at low costs and without consuming lots of space?

Then there is a great chance that application of a MBR is technically and economically very interesting in your situation. Besides, we also offer lease constructions.

Do you want to know more about the new generation MBR, please do not hesitate to contact us.



### Engineering and project realisation



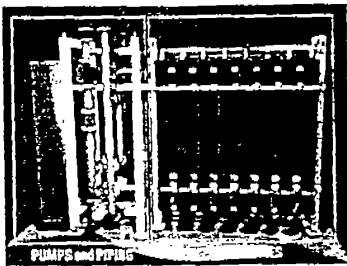
DHV is not only consulting you, but also executes measures accomplished and complete. The most state-of-the-art tools together with decades of experience guarantee efficient engineering and realisation, resulting in a perfect functioning production plant, building, process equipment and/or water treatment plant.

### Process water, boiler feed water and cooling water



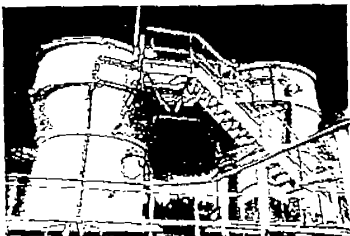
DHV has a large experience in design, engineering and operation of water preparation plants. In our designs, the availability of sufficient amounts of water with the right quality and attractive cost are leading.

### Membrane filtration



By now membrane filtration is an important technology in process water preparation and wastewater treatment. DHV has excellence knowledge in this field and initiates new membrane technologies and treatment techniques. Further we have developed engineering concepts resulting in high flexibility and low operational- and investment costs.

### Crystalactor®



A crystallisation process for the softening of process water and removal of heavy metals, phosphates, fluoride and sulphate from wastewater. The process is characterised by low costs and a limited occupation of space. In stead of sludge the process produces reusable, dry pellets. For example, the process can be applied to prevent scaling in process equipment in case of extreme water reuse.





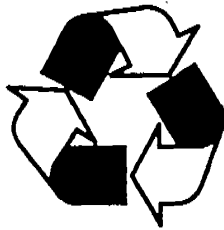
## DHV, your Water Partner

The DHV Group has over 3,000 employees working world-wide in the field of water, environment, industrial accommodation and logistics.

As an experienced water consultant we are traditionally strongly involved in the production of water for industry. Our water experts work out daily creative and cost-effective solutions for the preparation of process and cooling water, distribution and sewerage, wastewater treatment and water recycling. Our service cover the complete field from consultancy, design, pilot-plant, engineering, building supervision to turn-key delivery, plant start-up and operation. We can also be of use looking after your management and maintenance (out-sourcing)

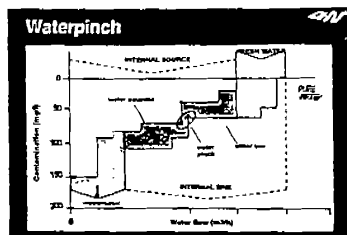
Below is a summary of various services and products.

### Watersources, water reuse and closed-loops



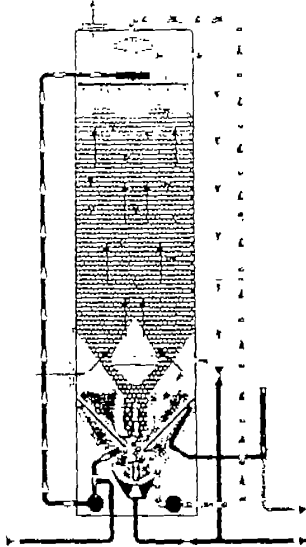
The governments policy aims to close water loops on a short term. Further, increasing costs of water necessitate more efficient use of water. This is why a stringent water reuse or use of other water sources is getting more important. As no one else DHV is able to reach these objectives with acceptable costs without losing practise and reality from sight. In this, our technological key position in the field of water treatment and membrane filtration is an important surplus value.

### WaterScan en WaterPinch



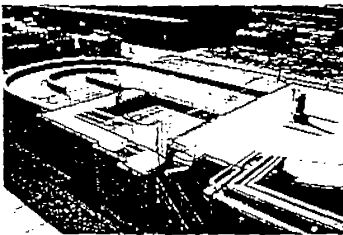
In cost saving and closed water loops the WaterScan is an important tool. The WaterScan methodology has been developed by order of Novem (The Netherlands agency for energy and the environment) and has proven in practise to yield considerable savings in money, water and energy. The methodology is supported with convenient tools. When it is necessary within the framework of the WaterScan, also a pinch-study can be performed.

### (Thermophilic) aerobic treatment processes



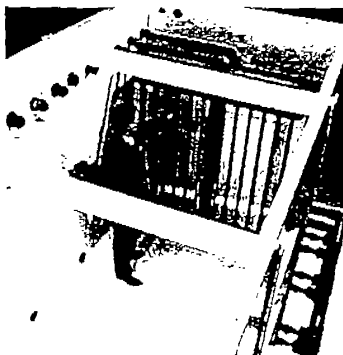
For every situation we try to implement the best applicable biological treatment technique. For small wastewater flows we prefer to apply the cost effective aerobic Sequencing Batch Reactors. In this system the activated sludge process has been integrated with the sludge-water separation, so the investments costs are limited. Further, Moving Bed Trickling Filters (MBTF) are applied: a system to treat wastewater and off-gasses simultaneously. Different from other techniques, an MBTF is free of clogging. Also aerobic treatment at high temperatures is one of the possibilities. In this way considerable energy savings can be achieved.

### Carrousel®



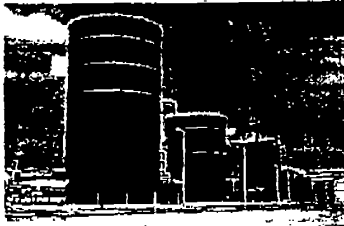
The Carrousel is a well known, proven and robust activated sludge system for biological wastewater treatment, applicable for both small and large wastewater flows. Besides degradation of organic components, an extreme nitrogen- and phosphate removal can be achieved. Worldwide more than 900 of this installations are in operation.

### New generation membrane bioreactors



Membrane bioreactors are extremely compact activated sludge systems guaranteeing an excellent effluent quality and minimal sludge production as a result of membrane filtration application. DHV can offer membrane bioreactors, using a new generation membranes with a significant lower energy use. Your existing activated sludge installation can be transformed easily to a membrane bioreactor, offering the possibility of reuse because of the high wastewater treatment results.

### Anaerobic treatment systems



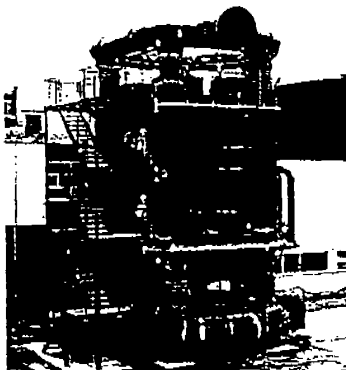
We possess a thorough knowledge of anaerobic treatment techniques. This independent knowledge can be important for you in selecting the technological and economical most attractive treatment principle. Besides we develop anaerobic treatment processes characterised by lower investment costs.

### Scaling prevention



DHV has large experience in detecting the cause of scaling and preventing it.

### Energy and heat



Industrial processes are in general energy intensive, often with water as energy carrier. DHV has state-of-the-art knowledge of possibilities for heat- and energy recovery in relation with water economy, total energy (combined electricity and heat generation) and related engineering.

### Legionella



DHV has developed a method to protect industrial water and cooling systems from outbreaks of Legionella Pneumoniae bacteria. This method consists of two, consecutive, steps: a unique "Legionella Scan" followed by the elaboration of a control protocol to ensure that also in future the risk for a Legionella outbreak is minimised. Especially if collective sanitary facilities, warm water systems, cooling towers, etc. are in use on your premises, execution of the DHV method will help you to ensure a safe and healthy environment for your employees and your surrounding.

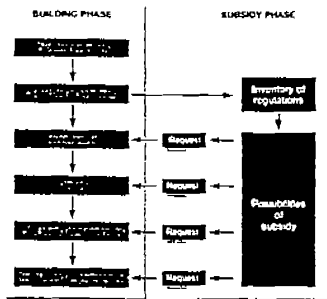


## Environment and licenses



Environment and licenses are important core competencies of DHV. All know-how and experience are within one company. This expertise guarantees an efficient support of our principals in environmental aspects and license application. Examples of our services are: environmental annual reports, environmental planning, waste, emission reduction, noise, labour conditions, environmental effect reporting and discharge licenses.

## Subsidy



In many cases it is possible to lower the investment costs to apply for subsidy, especially when the investment aims innovation and environment. We have great experience in subsidy application and many times we have been successful in acquiring subsidies for our principals.

## (Sustainable) accommodation



The experience on accommodation varies from a simple warehouse, a completely fitted production plant to state-of-the-art, image strengthening sustainable constructions.

Do you want to know more, do not hesitate to contact us:

Andreas Giesen tel.: +31 33 468 2497

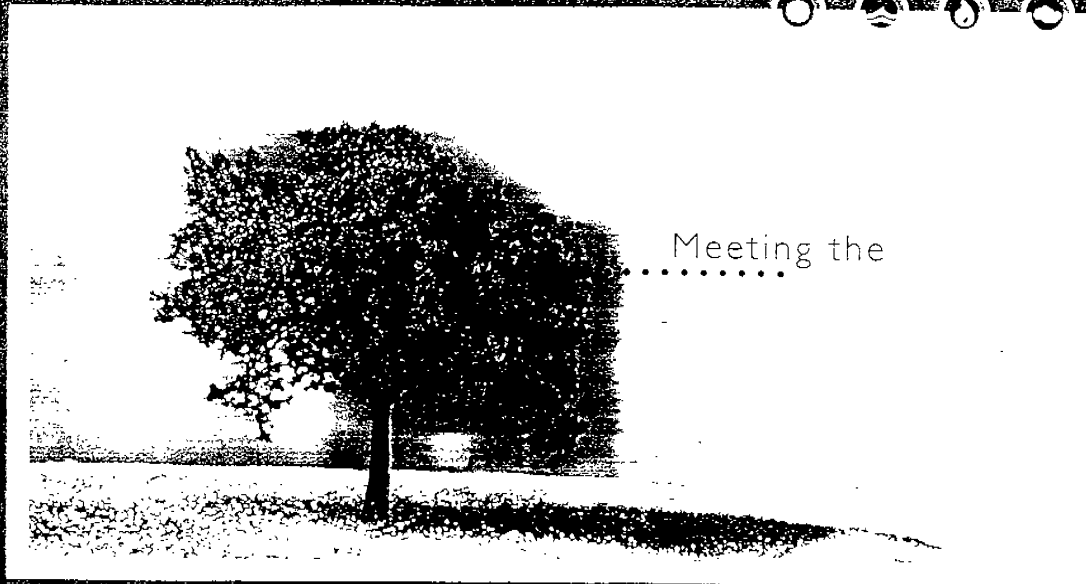
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Philips Semiconductors



Philips Semiconductors gains full  
ISO 14001 approval

Philips  
Semiconductors



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## ISO 14001 milestones

Nijmegen, The Netherlands July 1, 1998

Zurich, Switzerland April 1, 1998

Brussels, Belgium March 1, 1998

Sunnyvale, CA, USA February 12, 1998

Southampton, UK January 28, 1998

Caen, France December 30, 1997

Albuquerque, NM USA December 19, 1997

Hong Kong December 15, 1997

Manila Philippines December 15, 1997

Hazelgrove, UK June 25, 1997

Kaohsiung, Taiwan May 12, 1997

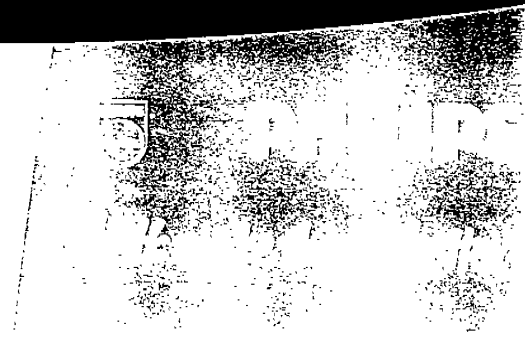
Stadskanaal, The Netherlands January 1, 1997

Hamburg, Germany October 1, 1996

Bangkok, Thailand September 10, 1996

IZNC: 9397 750 04907

Philips  
Semiconductors



## Meeting the 'Green' Standard





July 1, 1998 goes down as a milestone in Philips Semiconductors' history of environmental achievement. That was the month we were able to announce that all our manufacturing centres worldwide had achieved ISO 14001 certification.

This achievement confirms our commitment to environmental protection and to the fact that EMS (Environmental Management System) principles are now fully integrated into our worldwide working practices.

The achievement signals good news, not just for us but for all our customers. It confirms to them that using Philips Semiconductors in their equipment is the surest way of minimizing environmental impact...minimum material waste, minimum use of hazardous substances, minimum energy consumption. It also brings our parent company Philips Electronics a big step closer to realizing its ambitious goal of achieving ISO 14001 in all its 350 production plants before the year 2000.

## Philips Semiconductors and ISO 14001 - a story of success

Philips Semiconductors' history with ISO 14001 goes back to the roots of this highly demanding standard. We were, in fact, the first company in the world to receive ISO 14001 certification...for our plant in Bangkok, Thailand, *only three days after the standard was introduced in September 1996*. Since then, the story has been one of continuous success, culminating in July 1998 in the certification of Philips Nijmegen, Europe's largest IC manufacturing centre.

The bottom line of these achievements is a whole series of product and process improvements coming directly from our campaign to gain worldwide ISO 14001 approval:

- **Hamburg** reduced its consumption of fuming nitric acid in 1997 to 30% of its 1995 figure
- **Nijmegen** received the Dutch energy award in 1998 for a 55% energy reduction compared with the reference year 1989
- **Bangkok** achieved significant reduction of chemicals required in waste water treatment
- **Manila** developed a method for using the epoxy plastic waste as a fuel in cement kilns, thus preventing landfill
- **Albuquerque** received the 1997 Gold pre-treatment award from the city of Albuquerque and reduced its water consumption by 20%
- **Caen** significantly reduced the amount of photoresist and NF<sub>3</sub> etching gas used in its wafer manufacturing (66% and 43% respectively)
- **Hazelgrove** reduced the chemical consumption of n-butyl-acetate by 50% by extending the useful life of the chemical
- **Hong Kong** reduced water consumption by 38% compared with the 1993 figure and as a result it also reduced the chemicals consumed for waste water treatment by more than 50%  
The plant's performance won it the PSCE certificate of merit in environmental performance from the Hong Kong authorities
- **Kaohsiung**, besides reducing chemical consumption including cyanide, started a program of using recycled trays and reels to pack their products. The plant received several awards from the Taiwanese government for its achievements which included pollution control and waste recovery
- **Stadskanaal** reduced the consumption of blast powder by 40%.





## ISO 14001 - demonstrating a commitment to environmental care

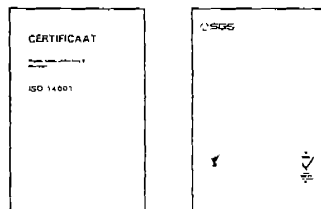
ISO 14001 is the latest in a long series of environmental standards published by ISO (International Organization for Standardization) over the past 20 years. By applying for ISO 14001, manufacturers can provide a concrete demonstration to their customers of their commitment to environmental care.

To win ISO 14001 certification, a company must set up an Environmental Management System (EMS) for raising the profile of environmental issues throughout its organization and for deciding on quantifiable improvement actions. The Management System has many principles in common with those of the ISO 9000 Quality Standard. But where ISO 9000 deals with customer needs, ISO 14001 addresses the needs of a broader range of interested parties and the evolving needs of society at large for a better environment.

Essential elements of an EMS meeting ISO 14001 requirements are:

- an *organization* and well-defined *procedures* for handling environmental issues
- clearly-defined *areas of responsibility* within the organization and a *framework* for setting up and reviewing environmental objectives
- *awareness* of environmental factors plus a clear *improvement plan* prioritizing actions on reducing environmental impact
- a published policy of *continuous improvement* on environmental issues

As with Quality standards, companies must be annually or semi-annually *audited* by an external party to verify that they are complying with the requirements.



ISO 14000 certificates

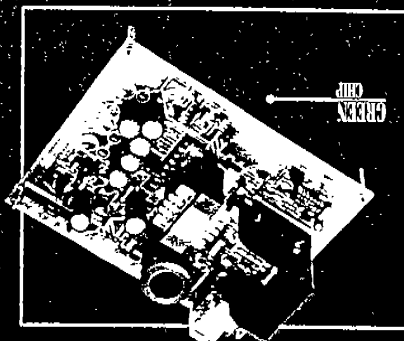
Looking to the future - **EcoVision**

Building on this success, we're now expanding our commitment to environmental care with the new Philips-wide 'EcoVision' programme.

Concentrating ever more closely on EcoDesign principles, setting new aggressive targets for energy, water, waste and emission reduction and expanding our recycling programmes, we plan to lead the way in eco-efficient manufacturing over the coming years.

To support our EcoVision strategy, we have recently introduced our GreenChip™ family of power-control ICs which drastically reduce standby power consumption in TVs and VCRs by as much as 99%.

GreenChip is just one of a new generation of products from Philips Semiconductors designed and manufactured with the environment in mind. In the coming years you can expect to see further fruits of our EcoVision programme as we continue to build on our ISO 14001 success by setting and arguing ever more ambitious targets and adopting ever more environmentally-conscious business practices.



*Modern TV sets embodying Philips Semiconductors new GreenChip consume virtually no power in standby.*

SNW-SE/120-03



**PHILIPS**

*Let's make things better.*

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The contents of this publication are subject to change without notice and in the event of a change to the contents, the original controlled document will be automatically updated. As this printed version is not automatically reprinted after every change, MISD can be contacted to confirm its validity.

## General

Philips Semiconductors is a global company committed to achieving industry leading competitiveness through continuous improvement in new product development, technology, manufacturing excellence, customer service and to the reduction of impact on the environment.

Environmental care is an integral part of the business policy of Philips Semiconductors. The intention of this manual is to stimulate awareness of our policy and to outline the responsibilities and tasks of the people involved. The aim is to comply with all relevant governmental rules and legislation or preferably to be pro-active. Managers at all levels of the organizational units are responsible for ensuring that the environmental policy is deployed, understood, implemented and maintained.

## Vision

“Philips Semiconductors will be a recognized top class eco-efficient semiconductor manufacturer in 2002”



*Arthur van der Poel  
Chairman and CEO  
PD Semiconductors*



*Narayan Sankara  
PD Environmental  
Manager*

The terms and conditions of this policy are subject to national and local laws and regulations.

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## 0 Introduction

The purpose of this manual is to ensure that Philips Semiconductors' processes and products meet the latest specific rules and regulations as established by governmental legislation relating to the environmental aspects of the production, use and disposal of products and processes. Secondly, the aim of this manual is to ensure Philips Semiconductors implements Corporate environmental policies. The manual describes all environment-relevant aspects concerning the policy and procedures, the organization, and the responsibilities and tasks of the people and departments concerned within Philips Semiconductors. The manual serves as a framework for Philips Semiconductors Plant Environmental Management Systems (EMS). The plants are responsible for effectuation and maintaining their own management system in line with the policy rules set by Philips Semiconductors management. EMS at Philips Semiconductors is based on the international standard ISO 14001.

# 1 Philips Semiconductors environmental policy

Philips Semiconductors is a global company committed to achieving a leading competitive position in the electronics industry through continuous improvements in product innovation, manufacturing excellence, customer service and environmental care.

*Our basic principles:*

**Sustainable development** - to produce without unacceptable harmful ecological impacts occurring either now or in the future.

**Prevention is better than cure** - avoiding problems at the outset.

**Life cycle approach** - from raw materials, to manufacturing, to use and disposal.

**Cooperation** - with governmental and non-governmental organizations.

We set technically and economically viable objectives to continuously optimize the environmental performance of our products, services and activities,

- In product development to include eco-design and life cycle assessment study (using the green focal areas and the eco-indicator)
- To reduce or if possible to eliminate environmental hazardous substances from our products (e.g. compounds of beryllium, lead, antimony and bromine (organic)).
- In manufacturing processes to reduce consumption of water and energy, and to reduce emissions to air and water, and waste disposal.

**To support these principles, all plants worldwide:**

- Maintain certified environmental management systems, audited by means of a systematic, documented verification process to ensure continuous improvement
- Commit to complying with all applicable laws and regulations, to the Philips Global Environmental Policy and to the Philips Eco-vision program.
- Adhere to the corporate standards and directives in all countries, where they have been accepted.
- Communicate our environmental policy to employees and other stakeholders, and publish the results in environmental reports.
- Educate our employees to work within the framework set by the Philips Semiconductors environmental policy

Arthur van der Poel,  
*Chief Executive Officer*



## 2 Planning

### 2.1 Environmental aspects

All plants evaluate the environmental effects of their activities/services in normal and abnormal operating conditions on a regular basis. A summary of these environmental effects is reported to PD management.

The plants report annually balance sheets on the consumption of restricted substances from the PD Environmental Checklist, SNW-SE/120-10. This information will be collected in a register that is part of the Philips Semiconductors annual report.

The chemical content of semiconductors will be registered in a database. The data are maintained by the local MISD groups based on the information supplied by development departments at RFS. See the Environmental Product Qualification procedures, SNW-SE/120-06 and its Instructions for Use, SNW-SE/120-07.

### 2.2 Legal and other requirements

The Corporate Environmental & Energy Office sees to the collection and recording of applicable regulatory and European legislative requirements at corporate level pertaining to environmental aspects.

CEEEO and CSD communicate relevant rules, directives, decisions, guidelines and information to their network. MISD and the PD Environmental Coordinator transfer this information within their own PD-network.

The local laws and regulations are recorded by the National Organizations and communicated by the N.O. Environmental Coordinator to the plants within his organization.

### 2.3 Objectives and targets

Based on the Corporate program "Ecovision" the PD has set for itself the following minimum targets for manufacturing improvement by the year 2002:

- Energy saving : 35%
- Waste reduction: 50%
- Water consumption: 50%
- Emissions to air/water: - cat 1 98%
- cat 2 50%
- cat 3 20%

#### 2.3.1 Energy saving

The target is to reduce the energy consumption in MJ per weighted production volume, by at least 35% in the year 2002, compared to 1994. The "PD Energy task force" promotes the organization of Energy Potential Scans in the plants to identify potential energy saving options. This is done in cooperation with CFT and CEEEO.

#### 2.3.2 Waste reduction

Hazardous and non-hazardous waste has to be reduced by 50% in weight per weighted production volume in the year 2002, compared to the reference year 1994. The definition for hazardous/non-hazardous should be based on local legislation. Options for reduction are: re-use, recycle, process optimization.

### 2.3.3 Water consumption

Water consumption has to be reduced by 50% in liters of water-intake per weighted production volume (e.g. for waferfabs in liters per m<sup>2</sup> Silicon).

Options are water re-cycling, rinse optimization. The Water Scan method as offered by DHV is recommended to identify options in a specific plant.

### 2.3.4 Emissions to air/water

For emissions to air and water, targets are set for 3 categories of environmentally relevant substances (SNW-SE/120-10; Philips Semiconductors Environmental Checklist):

Cat 1: Environmentally restricted substances have to be reduced by 98% by the year 2002 compared to 1994.

Cat 2: Environmentally hazardous substances by 50% Perfluorinated compounds, PFCs, are added to category 2 for Philips Semiconductors.

Cat 3: Environmentally relevant substances by 20% Fluoric acid, HF is added to category 3 for Philips Semiconductors.

### 2.3.5 Ecodesign

The percentage of eco-designed products should increase to 75% by the year 2002.

Five "green focal areas" have been indicated for a quick assessment in the design phase.

For a more scientific approach life cycle assessment and evaluation with the "Eco-indicator" should be used.

### 2.3.6 Green flagships

Each BU should present annually at least one "green flagship" product. Distinction is made between "selected" and "launched" flagships.

### 2.3.7 Packing reduction

The target for reduction of packing materials is 15% per weighted production volume by the year 2002, compared to the reference year 1993.

### 2.3.8 Internal network

Environmental information is communicated through the internal network. To improve the network meetings of network-groups will be organized at regular intervals. PD newsletters, magazines, bulletin boards, etc. will be used to communicate to all PD employees.

### 2.3.9 Supplier requirements

We require all our strategic suppliers to present their environmental policy statement and evidence of an environmental improvement program. For suppliers of some vital materials, we will ask their cooperation to calculate the total environmental effect of our products.

## 2.4 Environmental management program

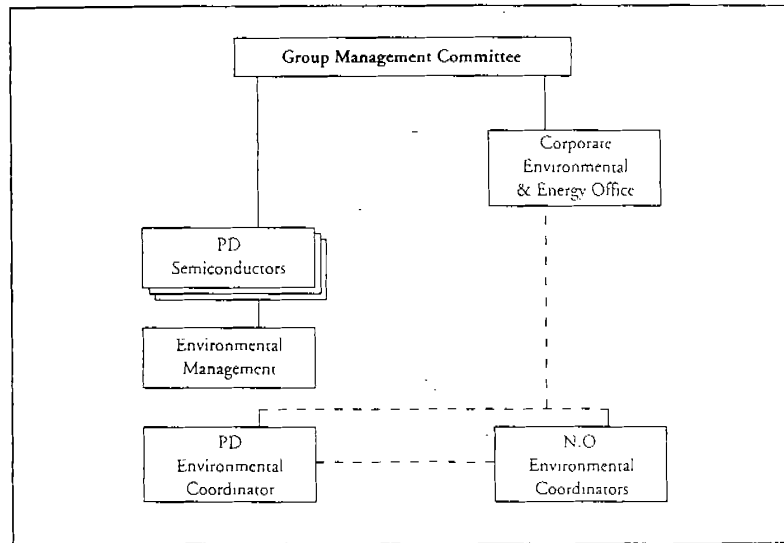
A Philips Semiconductors environmental program is drafted at least once every 2 years, which is authorized by SESC. The PD Environmental Coordinator reviews implementation and progress of the PD environmental program in the organization and reports on this in the SESC.

### 3 Implementation and Operation

#### 3.1 Structure and responsibility

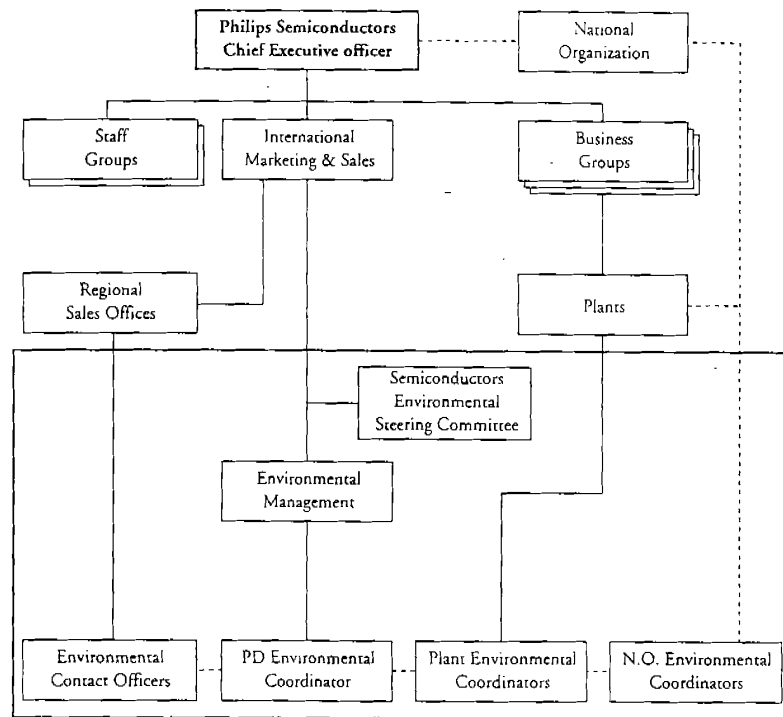
##### 3.1.1 Organization of Royal Philips Electronics

This section shows the organizational structure of Royal Philips Electronics as far as relevant for this Environmental Manual.



### 3.1.2 Organization of Philips Semiconductors

This section shows the organizational structure of Philips Semiconductors as far as relevant for this Environmental Manual. The gray box covers the so-called "Environmental network". The names and addresses are available from document SNW-SE/120-08 and on the Intranetsite: <http://www.sc.philips.com/env/>



### 3.1.3 PD Management

#### *Responsibilities*

The Chief Executive Officer (CEO) of Philips Semiconductors is responsible for implementing the Corporate environmental policy. The CEO ratifies the PD environmental policy on technical and commercial activities. NO Environmental Coordinators are consulted and relevant NO-policy is taken into account.

#### *Tasks*

The CEO has delegated his tasks to the manager of the Quality Management Semiconductors; the Environmental Manager.

### 3.1.4 PD Environmental Manager

#### *Responsibilities*

The Environmental Manager is responsible for implementing the Corporate environmental policy by delegation of the CEO.

*Tasks*

- To nominate a PD-Environmental Co-ordinator
- To describe the tasks of the PD Environmental Co-ordinator
- To chair the Semiconductors Environmental Steering Committee (SESC) at least two times a year

**3.1.5 Semiconductors Environmental Steering Committee (SESC)***Responsibilities*

It is the responsibility of the SESC to support the Environmental Program in the Marketing and Sales Organization in the widest sense.

*Tasks*

- Act as a communication center in the environmental network (the plant environmental co-ordinators and the ECOs in the RSOs)
- Pick-up information, signals and trends from the network and from discussions with NO environmental co-ordinators and from competitions and customers
- Disseminate environmental information and instructions to the network
- Define information systems for the network and for other possible users to deal with customer environmental questions
- Provide inputs for a PD environmental policy and program
- Inform the relevant group of NO environmental co-ordinators

**3.1.6 PD Environmental Coordinator***Responsibilities*

The PD Environmental Coordinator (PDEC) reports to the Environmental Manager.

*Tasks*

- To provide for an environmental product qualification procedure.
- To co-ordinate and initiate investigations for necessary adjustment of Philips Semiconductors processes to comply with Corporate and PD policy.
- To advise on environmental appropriation requests.
- To prepare a PD Environmental Program and report the result annually.
- To co-ordinate activities of the Semiconductors plant environmental co-ordinators (PECs).
- To make sure that Environmental Contact Officers are nominated and the information network maintained.
- To keep a record of environmentally relevant substances present in products or used in their manufacturing processes according to the Philips definitions and policy.
- To be aware of and inform the CEEO on environmental aspects of production processes and marketing activities in co-operation with NO environmental co-ordinators.
- To maintain contact with environmental experts from other (multi-national) industries, federations of industry and supra-national bodies.
- To have available information on legislation and public perception that is specific to Philips Semiconductors.
- To coordinate contact to customers, public officials or other parties on environmental aspects.
- To ensure that the necessary environmental documentation is available.
- To co-ordinate activities on environmental marketing and on duty of care of end-of-life products.
- To act as the secretary of the Semiconductors Environmental Committee.

### 3.1.7 Development

#### *Responsibilities*

It is the responsibility of the development manager to ensure that the relevant environmental aspects receive adequate attention during the development stages or change proposal evaluation.

#### *Tasks*

- To identify in each new design the environmental aspects relevant for materials management, production and other departments.
- To report the relevant environmental information of material, sub-components and components for new processes in qualification meetings, according to procedure SNW-SE/120-06 and 07.
- To consult the PEC about the environmental aspects of the product.
- To submit all change proposals dealing with changes of material with environmental aspects to the PEC.

### 3.1.8 Purchasing

#### *Responsibilities*

It is the responsibility of the purchasing manager to strive that the relevant environmental information is provided by the supplier of materials, substances, sub-components, components, assembly subcontracting and other services before any purchase decision is taken.

#### *Tasks*

To ensure that the supplier of the product submits a completed, updated (not older than 2 years) environmental certificate or a Materials Safety Data Sheet (mandatory in certain countries). To assist in obtaining the relevant information three questionnaires are available. See annex II. To send a copy of all environmental certificates or Materials Safety Data Sheets to the PEC. To inform the PEC of any material or process, including changes, that will be introduced into the plant.

### 3.1.9 Quality Management

#### *Responsibilities*

It is the responsibility of the quality manager to ensure the proper application of the qualifications and change procedures on environmental aspects.

#### *Tasks*

To audit on request of the PDEC the effectiveness of the plant environmental management system. To check on the fulfilling of environmental requirements during change proposals and qualification procedures

### 3.1.10 Business Group

#### *Responsibilities*

It is the responsibility of the BG management to implement the PD policy on environmental management systems as an integral part of the business policy and processes.

#### *Tasks*

To support the implementation of the PD environmental policy in the operations and in the RSOs/ASOs.

### 3.1.11 Plant Manager

#### *Responsibilities*

The plant manager is responsible for formulating and executing the Plant Environmental Program within the boundaries of Corporate, PD and NO policy in compliance with all applicable laws and regulations.

Environmental affairs must be placed explicitly and regularly on the agenda of the plant management team or a special committee must be appointed for this purpose.

#### *Tasks*

- To formulate and execute a Plant Environmental Program within the framework of Corporate, Philips Semiconductors and additional NO environmental policy.
- To appoint a Plant Environmental Co-ordinator (PEC).
- To provide the plant with a well described environmental management system.
- To give a temporary waiver (if necessary) of materials which contain chemicals from the PD Environmental Checklist in consultation with the Plant Environmental Co-ordinator, the Local Chemical Contact Officer and the PD Environmental Co-ordinator.

### 3.1.12 Plant Environmental Co-ordinator

#### *Responsibilities*

The PEC reports directly to the plant manager or in large plants to the facility manager.

#### *Tasks*

- To advise and report on preparation and implementation of the environmental program.
- To monitor the situation and to report deviations to the responsible Product Group Managers.
- To improve or develop the tools for this monitoring.
- To maintain a good relationship with local authorities.
- To communicate with the PD Environmental Co-ordinator and the NO Environmental Co-ordinator.
- To oversee the environmental aspects of chemical substances in production processes, based on information received from purchasing and development.

### 3.1.13 Sales Environmental Contact Officer

#### *Responsibilities*

The manager responsible for sales of Philips Semiconductors products is also responsible for the environmental aspects involved.

In each region or area an Environmental Contact Officer (ECO) is appointed. He reports to the person who is responsible for sales and marketing of the products concerned

#### *Tasks*

- To advise and report on relevant product policy and decision making
- To monitor the market with regard to the environmental situation.
- To maintain good relationship with other semiconductor companies and associations.
- To react to questions and questionnaires from customers.
- If necessary with the support of the PDEC as described in procedure SNW-SE/120-11.
- To maintain good contacts with colleague ECOs and with the PD Environmental Co-ordinator.
- To communicate with the NO Environmental Coordinator on relevant legislation and public perception to anticipate future developments and trends.

### 3.2 Training, Awareness and Competence

All personnel performing tasks which can cause significant environmental impacts shall be competent on the basis of education, appropriate training and/or experience.

### 3.3 Communication

Good communication is maintained through the internal environmental network by the use of electronic mail, a fast and environmental friendly system. The members of the environmental network are listed in SNW-SE/120-08. Communication to all employees of Philips Semiconductors will be improved by assessment through Intranet pages. At regular intervals (at least annually) meetings between the Semiconductors Plant Environmental Coordinators are organized. Due to the nature of the activities separate Assembly-PEC meetings and Waferfab-PEC meetings are organized.

A procedure for handling customer questionnaires on environmental issues is described in SNW-SE-120/11. General information to customers, employees and third parties is communicated by means of brochures: Philips Semiconductors and the environment (9397 750 02345); Chemical content of Semiconductor devices (9397 750 04906).

### 3.4 Environmental Management System Documentation

The core elements of the environmental management system are described in the EMS-manual (this manual, document SNW-SE/120-03). In chapter 6 reference to other Corporate and PD environmental documents is made.

### 3.5 Document Control

#### 3.5.1 Manual

This Environmental Management Manual has been authorized by the CEO of Philips Semiconductors.

The authority for the composition, publication and modification has been delegated to the PD Environmental Coordinator. The distribution of this manual is controlled by Philips Semiconductors Divisional MISD. Subscribers of the manual are listed in SNW-SE/120-02. This list is updated prior to each revision of any environmental document. The status and adequacy of the Environmental Management Manual for the PD Philips Semiconductors is reviewed at SESC-meetings. The minimum frequency of review being annually. Revisions will be noted on the revision sheet in this document.

#### 3.5.2 Other documents

Philips Semiconductors Divisional MISD is responsible for document control. The list of environmental documents is registered under SNW-SE/120-01. The minimum frequency of review is bi-annually.



**3.6 Operational Control**

The responsibilities are defined in chapter 3 of this manual. The procedures as documented in this manual are installed to ensure effective and systematic control on the environmental effects of Philips Semiconductors operations. SESC verifies annually the performance of the Environmental Program as executed by the plants. The SESC bases its judgement on the annual environmental reports submitted by the plants against the preset targets.

**3.7 Emergency preparedness and response**

Every plant shall establish and maintain procedures to identify potential for and respond to accidents and emergency situations, and for preventing and mitigating the environmental impacts that may be associated with them.

## 4 Checking and Corrective Action

### 4.1 Monitoring and measurement

The plants will submit an annual environmental report using the intranet monitoring facilities offered by CEEO. This information will be used to compose the Corporate Environmental report and to monitor progress and compliance with the PD environmental program.

### 4.2 Non-conformance and corrective and preventive actions

Non-conformances to PD targets are detected by monitoring the Plant Environmental Program and by checking the plant environmental report. The plants in question are advised by letter of the Environmental Manager on their non-conformance and requested to improve their performance.

### 4.3 Records

Records are kept by the PD Environmental Coordinator for a period of 3 years in order to demonstrate compliance with the requirements of the environmental management system, and to what extent planned environmental objectives and targets have been met. The records are filed in an appropriate way in the PD-archive.

### 4.4 Audits

A program for audits of the plant environmental management system is available. Internal audits are carried out by the PD Environmental Coordinator and/or environmental experts within Philips. External audits are commissioned to authorized auditors with the objective to obtain and maintain a ISO 14001 certificate.

The PD Environmental Coordinator is in charge for organizing the audits. He prepares the internal audit program. The program itself is reviewed annually by the SESC.

## 5 Management Review

The Environmental Management System of Philips Semiconductors is reviewed annually.

As a result of the review it may be necessary to amend the Philips Semiconductors Environmental Policy Statement or the text of the manual and/or of the procedures.

## 6 Glossary

### 6.1 Abbreviations

ASO	Area Sales Organization
BG	Business Group
CEEO	Corporate Environmental & Energy Office
CEO	Chief Executive Officer
ECO	Environmental Contact Officer
ICC	International Chamber of Commerce
IMS	International Marketing & Sales Department
LCCO	Local Chemical Contact Officer
MDP	Marketing, Development and Production (team)
NO	National Organization
PD	Product Division
PDEC	PD Environmental Co-ordinator
PEC	Plant Environmental Co-ordinator
SESC	Semiconductors Environmental Steering Committee
RSO	Regional Sales Organization
CFC	Chlorofluorocarbon
HCFC	Partially halogenated hydrocarbon
MISD	Manufacturing Instruction and Standardization Department
MSDS	Materials Safety Data Sheet
ODC	Ozone Depleting Chemical
ODP	Ozone Depleting Potential

### 6.2 Definitions

#### **Packing**

The combination of a carrier and a box to protect semiconductor products during transport.

#### **Carrier**

Plastic tube, tray or tape with cavities which can contain semiconductor products.

#### **Package**

The envelope with leads containing a semiconductor chip.

#### **Packaging**

The encapsulation of assembled semiconductor chip to produce a package.

#### **Qualification**

Procedure to approve or release a process for production or a product for sale (e.g. Product Release Procedure SNW-SQ-002).

### 6.3 Corporate Environmental Documents

- TUX-MH-183 Philips Global Environmental Policy Statement
- TUX-MH-150 Philips Environmental Management System

**6.3.1 Corporate Mandatory Standards**

UD-D 1597	Cadmium
UD-D 1675	PCBs, PCTs, UGILEC (121 or 21; 141) and DBBT
UD-D 1785	Flame retardants
UD-D 1787	Halogenated hydrocarbons
UD-D 1796	Real property transactions

**6.3.2 Corporate Environmental Standards**

UD-D 1668	Code of practice for chemical substances within the Philips organization in the EC
UN-D 1773	Packaging and the environment
UN-D 1773/02	Environmental requirements for the packaging of industrial products
UD-D 1786	Industrial products after their useful life
UN-D 1790	Registration of environmental information within the TPD system
UN-D 1790/01	Related to products
UN-D 1790/02	Related to the use or disposal of a product
UN-D 1790/03	Related to manufacturing processes of a product
UD-D 1792	Environmental marks, labels and symbols
UN-D 1792/01	Recycling marks and material marks for packaging
UD-D 1800	Framework, environmental relevant substances

**6.3.3 Philips Semiconductors Environmental Documents**

SNT-SE/120-01	Survey of environmental documents
SNT-SE/120-02	Distribution list for environmental documents
SNW-SE/120-03	Environmental management manual
SNT-SE/120-04	Questionnaire regarding product information of chemical preparations or composites
SNT-SE/120-05	Questionnaire regarding product information of plastics
SNW-SE/120-06	Environmental Product Qualification Procedures
SNW-SE/120-07	Registration of environmental information on products and processes
SNW-SE/120-08	PD Semiconductors Environmental Network
SNW-SE/120-09	Requirements for environmental marking of packing materials
SNW-SE/120-10	Philips Semiconductors Environmental Checklist
SNW-SE/120-11	Procedure for customer questionnaires on environmental issues.
SNW-SE/120-12	Document Control of Environmental Standards
SNW-SE/120-13	Rules for the Registration of environmental data of packing materials
SNT-SE/120-14	Coding of packing materials for the purpose of environmental registration
SNW-SE/120-15	Philips Semiconductors Environmental Policy Statement
9397 750 04906	Chemical content of semiconductor devices
9397 750 02345	Brochure; Working with nature; it's elementary
9397 750 04907	Leaflet; Meeting the Green standard
9397 750 03419	Poster; We work with nature; it's elementary/Earth
9397 750 03421	Poster; We work with nature; it's elementary/Fire
9397 750 03422	Poster; We work with nature; it's elementary/Water
9397 750 03423	Poster; We work with nature; it's elementary/Air
9397 750 06003	Sticker; Reduce energy consumption by 35%, Let's do it
9397 750 06004	Sticker; Reduce air emission by 50%, Let's do it
9397 750 06005	Sticker; Reduce water consumption by 50%, Let's do it
9397 750 06006	Sticker; Reduce waste by 50%, Let's do it
9398 652 90011	IC Package Data Handbook IC26
9397 750 05011	Discrete Semiconductor Packages Data Handbook SC18

## 6.4 Correspondence to ISO 14001

Subject	ISO 14001	this manual
<b>General</b>	4.0	0
<b>Environmental Policy</b>	4.1	1
<b>Planning</b>		
environmental aspects	4.2.1	2.1
legal and other requirements	4.2.2	2.2
objectives and targets	4.2.3	2.3
environmental management programme	4.2.4	2.4
<b>Implementation and Operation</b>		
structure and responsibility	4.3.1	3.1
training, awareness & competence	4.3.2	3.2
communications	4.3.3	3.3
environmental documentation	4.3.4	3.4
document control	4.3.5	3.5
operational control	4.3.6	3.6
emergency preparedness & response	4.3.7	3.7
<b>Checking and Corrective Action</b>		
monitoring and measurement	4.4.1	4.1
non-conformance, corrective & preventive action	4.4.2	4.2
records	4.4.3	4.3
system audit	4.4.4	4.4
<b>Management Review</b>	4.5	5

## Annex I Philips Global Environmental Policy

The Philips Global Environmental Policy, which focuses on the next century, is a core element for the operations of the entire Philips organization. Since 1970 the Board of Management of Philips Electronics has formulated several guidelines for environmental performance. A general environmental policy was issued in 1987 and updated in 1991. The Philips Global Environmental Policy is a living document - it is part of the fabric of the organization from the Board of Management to the shop floor - and is reviewed and updated to meet the needs of our stakeholders and the environment.

### Philosophy

Philips believes that sustainable development is one of the most challenging issues facing the world. The company is committed to continuously exploring solutions to successfully balance economy and ecology.

### Basic principles

Sustainable development - finding the optimal balance between ecological impact and economical growth. Prevention is better than cure - avoiding problems at the outset.

Life cycle approach - from raw materials, to manufacturing, to use and disposal.

Cooperation - with governmental and non-governmental organizations.

### Policy

- Philips establishes technically and economically viable objectives to optimize the environmental performance of the organization's products, services and activities.
- Product development objectives include evaluating the environmental impact over the total life cycle of a product, taking steps toward more efficient use of materials, including packaging; reducing, or eliminating, hazardous substances; reducing energy consumption; and contributing to improving recycling and disposal.
- Manufacturing objectives include environmentally related aspects of Philips activities such as emissions into air and water, use of energy and water, and waste disposal.
- Philips establishes and maintains environmental management systems and audits them by means of a systematic, documented verification process to ensure continuous improvement.
- Philips is committed to complying with all applicable laws and regulations, and will promote international harmonization of applicable laws and regulations, and is prepared to enter into voluntary agreements.
- Philips communicates its environmental policy to employees and other stakeholders and publishes its results in environmental reports.
- Philips educates its employees to work within its environmental policy.

Cor Boonstra

*President, Philips Electronics N.V.*

*TUX-MH-183*

## Annex II Supplier Questionnaires

To assist the PD Semiconductors Purchasing organization in obtaining the required information on chemicals, preparations and plastics from suppliers three questionnaires are available.

**chemicals:** questionnaire regarding product information of chemical substances:  
Purchasing Directive (nr. IN 01-017 EU).

**preparations:** questionnaire regarding product information of chemical preparations or  
composites (nr. SNT-SE/120-04).

**plastics:** questionnaire regarding product information of plastics (nr. SNT-SE/120-05).





**PHILIPS**

*Let's make things better.*

# Goals

## Goals of the Ecovision Program 1999-2002

Having introduced a certified Environmental Management System in all our plants, our commitment to continuous improvement in our environmental performance leads to a specific program of objectives and to the allocation of resources to achieve them. For the coming years we have set ourselves the following *minimum* goals:

- Reduce the specific energy consumption of our plants with 35%.
- Reduce the specific water consumption with 50%.
- Reduce the generation of waste and emissions of environmentally hazardous substances (category 2) by 50%.
- New products shall be eco-designed, taking the green focal areas into account:
  - materials intensity/weight
  - recycling and disposal
  - environmentally relevant substances
  - reduction of packing, logistics & transportIn this way the percentage of eco-designed products will increase to 75% by 2002.

The reference year is 1994 and the goals are indexed for the production volume.

Eindhoven, 16 August 1999



Arthur van der Poel  
*Chief Executive Officer*

Philips  
Semiconductors



PHILIPS

*Let's make things better.*

# Policy

## Philips Semiconductors' Environmental Policy

Philips Semiconductors is a global company committed to achieving a leading competitive position in the electronics industry through continuous improvements in product innovation, manufacturing excellence, customer service and environmental care.

### Our basic principles:

**Sustainable development** - to produce without unacceptable harmful ecological impacts occurring either now or in the future.

**Prevention is better than cure** - avoiding problems at the outset.

**Life cycle approach** - from raw materials, to manufacturing, to use and disposal.

**Cooperation** - with governmental and non-governmental organizations.

We set technically and economically viable objectives to continuously optimize the environmental performance of our products, services and activities:

- In product development to include eco-design and life cycle assessment study (using the green focal areas and the eco-indicator).
- To reduce or if possible to eliminate environmental hazardous substances from our products (e.g. compounds of beryllium, lead, antimony and bromium (organic)).
- In manufacturing processes to reduce consumption of water and energy, and to reduce emissions to air and water, and waste disposal.

### To support these principles, all plants worldwide:

- Maintain certified environmental management systems, audited by means of a systematic, documented verification process to ensure continuous improvement.
- Commit to complying with all applicable laws and regulations, to the Philips Global Environmental Policy and to the Philips Eco-vision program.
- Adhere to the corporate standards and directives in all countries, where they have been accepted.
- Communicate our environmental policy to employees and other stakeholders, and publish the results in environmental reports.
- Educate our employees to work within the framework set by the Philips Semiconductors environmental policy.

Eindhoven, 16 August 1999



Arthur van der Poel  
Chief Executive Officer

Philips  
Semiconductors



PHILIPS

Let's make things better.

we work with nature

it's elementary



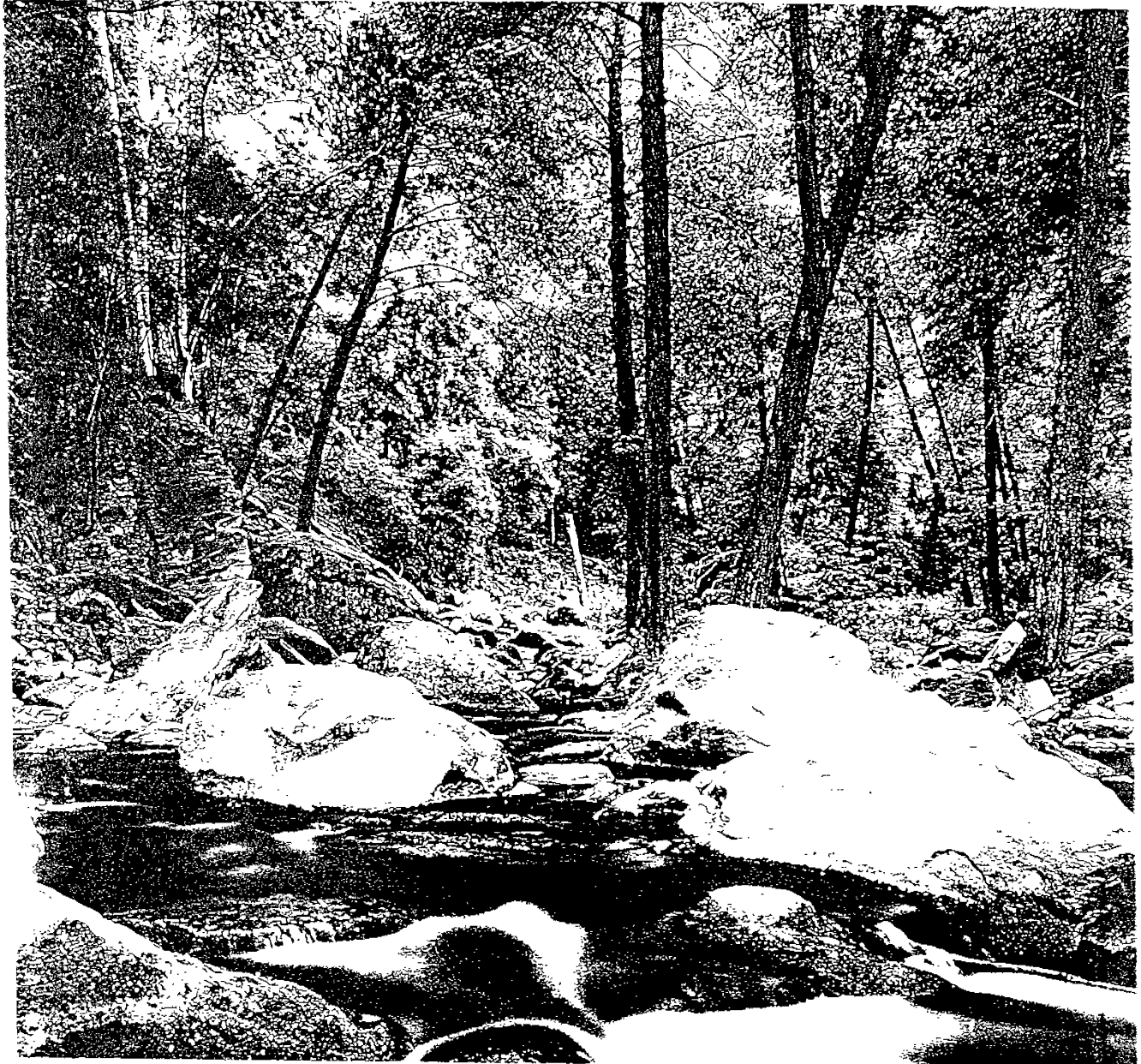
Philips  
Semiconductors



**PHILIPS**

*Let's make things better.*

# Clear solutions *for a* *clean environment*



Alfa Laval



## *Cut costs and* **preserve the environment...**

Environmental legislation has increased the need for environmentally sound sludge disposal. Efficient sludge thickening and dewatering helps solve the problem by reducing the volume of the sludge.

A medium-sized wastewater treatment plant serves a population of 100,000 people and generates up to 700 m<sup>3</sup> of sludge per day. Sludge thickening and digestion reduces this amount to about 250 m<sup>3</sup> per day. Disposing of this huge volume puts a strain on your finances — and the environment.

### **Direct sludge disposal — increasingly difficult**

Although tightening environmental legislation makes it increasingly difficult, many plants still directly dispose of sludge by dumping it at sea or spreading it on farmland.

Dumping at sea endangers already polluted oceans. Spreading on farmland requires huge tracts of land

Drying beds need lots of space and the right weather. Expensive to construct, they must also be dug out every few years.

### **The best way to thicken and dewater**

Sludge disposal affects both your operating budget — and the environment — in a big way.

To lessen this impact, lessen the amount of sludge you have to dispose of. Use Alfa Laval sludge equipment to thicken and dewater water and wastewater sludges.

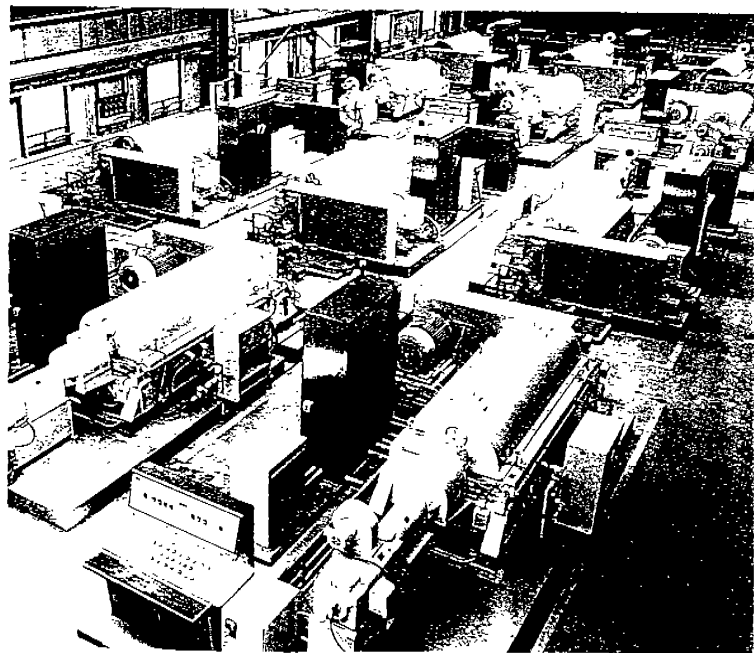


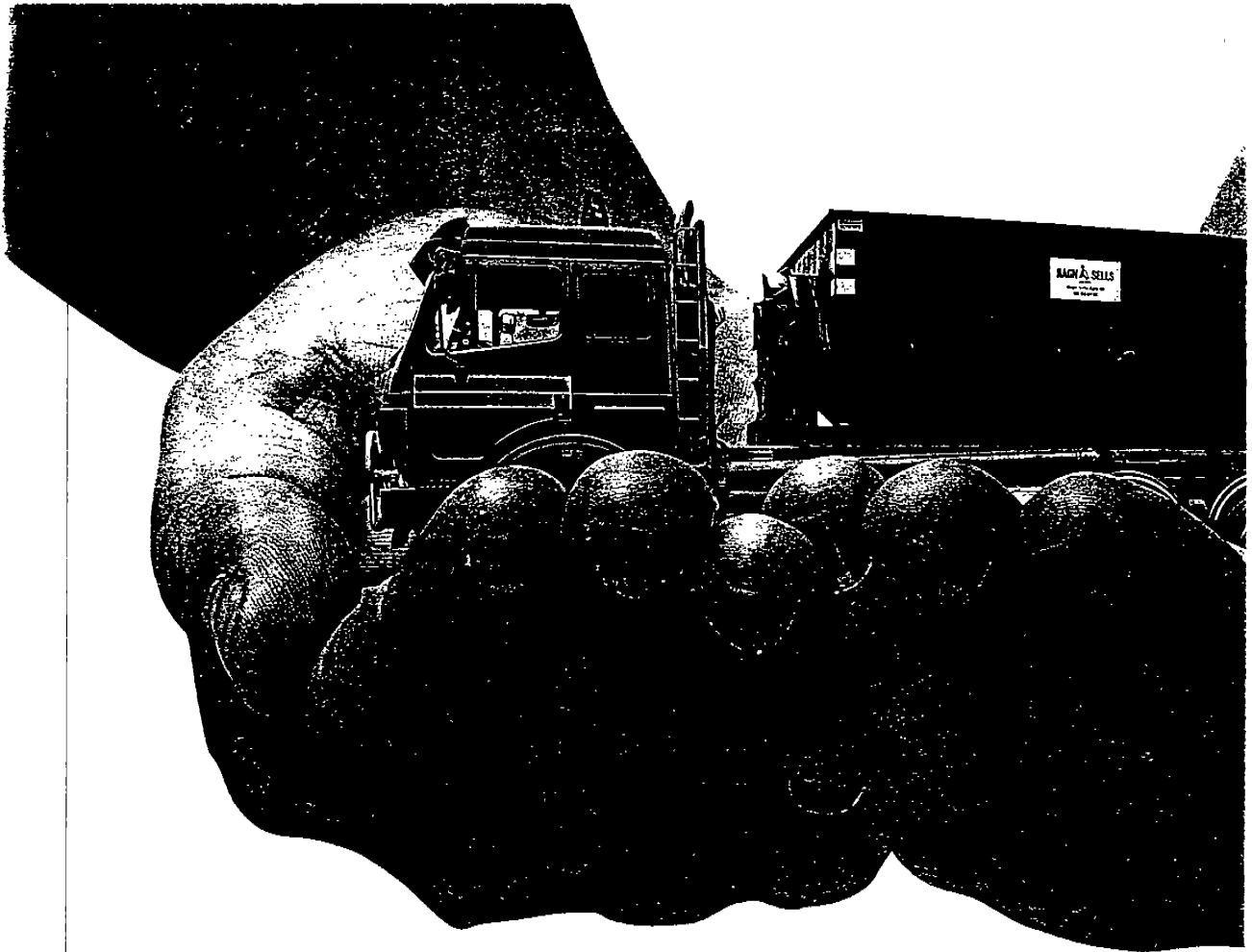
*...install Alfa Laval*  
**decanter systems**

**A**lfa Laval has been helping treatment plants stay ahead of growing populations and changing environmental laws for 35 years. Over 2000 wastewater treatment plants around the world use Alfa Laval centrifuges.

Alfa Laval gives you more to choose from ... more decanter systems ... more capacities ... more performance ... than any other centrifuge manufacturer.

Only Alfa Laval has the experience and the technology to make sure you get the optimum solution for your plant.





# Reduce sludge volume *by more than 90 percent!*

## **Alfa Laval decanters for thickening**

Wastewater sludges are mostly water. Thickening dramatically reduces their volume.

**G**ravity thickeners, the traditional way to thicken sludge, require a lot of space. At best, they thicken sludge to just 2 percent dry solids content for a 50 percent reduction in sludge volume.

### **Decanters save space**

You'll need less space when you replace your gravity thickener with an Alfa Laval centrifuge. And they're easy to use, requiring minimal operator attention.

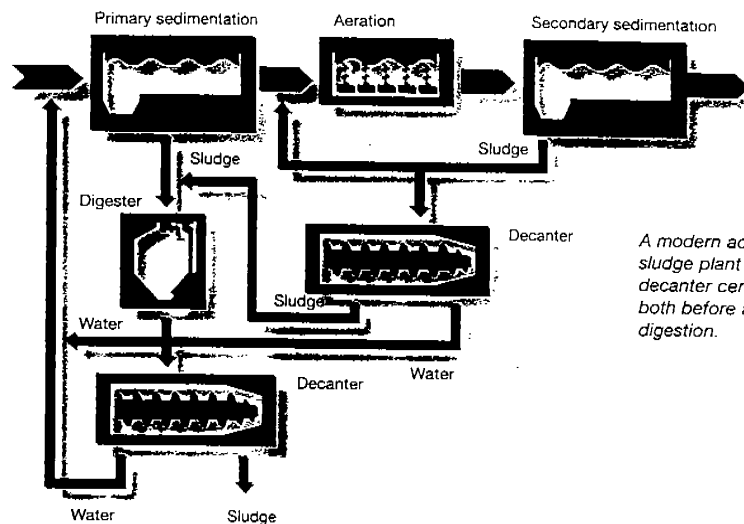
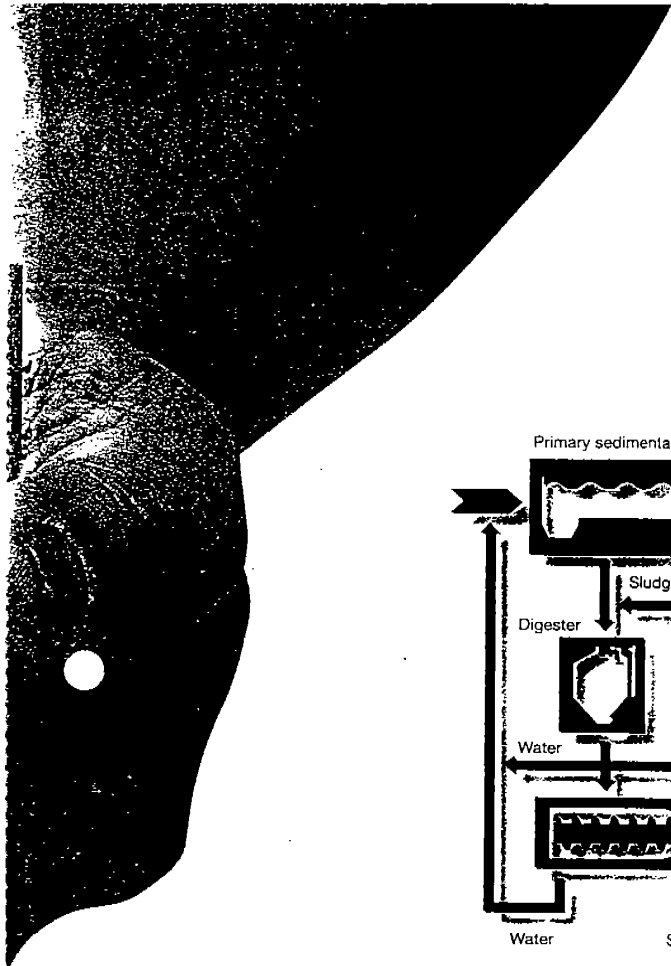
What's more, a centrifuge gives you better control over the thickening process. You can concentrate sludge to the dry solids content you need, reducing sludge volume up to 90 percent.

Whether you dispose of sludge directly or pass it on to digestion, an Alfa Laval centrifuge saves big.

### **Use smaller digesters**

You can use dramatically smaller digesters if you thicken sludge first. Thickening reduces the equipment and heating costs for the digestion phase of the process and improves digester performance.





*A modern activated sludge plant with decanter centrifuges both before and after digestion.*

## *Up to* 35 percent dry solids!

### **Alfa Laval decanters for dewatering**

For even less volume and drier cake, add dewatering to your sludge treatment process.

Achieve the cake dryness you need with Alfa Laval centrifuges for dewatering. Our range of high-quality decanters with performance-enhancing features can produce cake with 20 to 35 percent dry solids content.

With decanter centrifuges, you add flocculating agents at the feed inlet. This maximizes the separation effect.



# At least 20 percent *less to own and operate*

**Alfa Laval decanter centrifuges save on more than sludge disposal.**

Compared to older technologies like filters and presses, centrifuges cost less to operate and maintain. They're safer . . . cleaner . . . and take less floor space. Overall, Alfa Laval decanter centrifuges cost you 20 to 30 percent less than filters or presses.

## **1/3 the floor space**

Alfa Laval centrifuges take up a fraction of the floor space needed for belt filter presses. A centrifuge can increase your plant capacity without new construction.

## **1/3 the manhours**

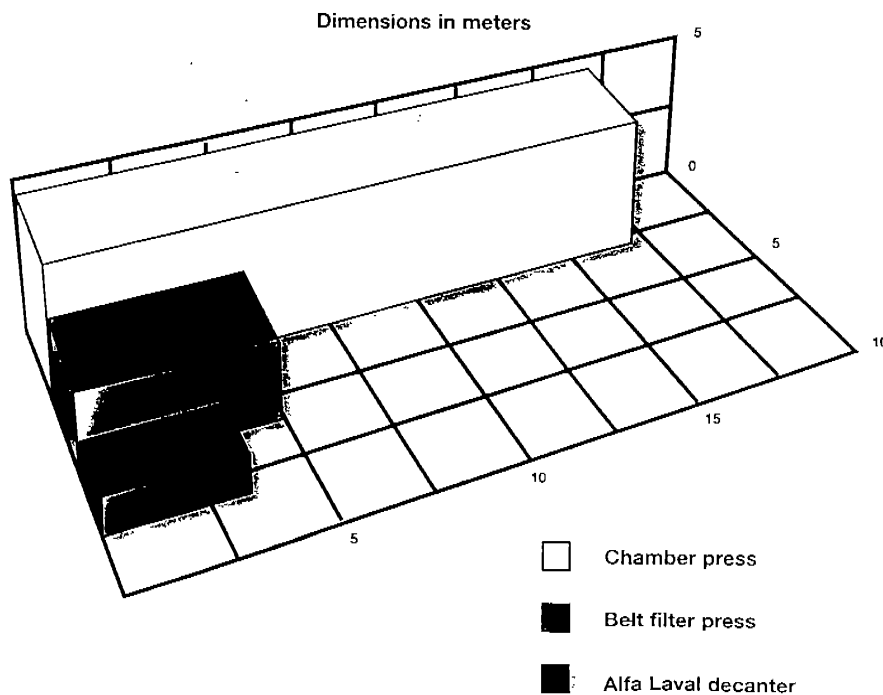
Alfa Laval centrifuges run almost unattended. Switching to a centrifuge eliminates most of the labor budgeted to run a filter or press.

Filters and presses need frequent shutdown for cleaning and rinsing. If sludge feed changes, operators must stop the operation and make up to six adjustments.

Alfa Laval decanter centrifuges adjust automatically to changes in feed. Our self-cleaning centrifuges often go years between shutdowns.

## **Built to minimize maintenance**

Easy access to the rotor and drive system. No hydraulics and no pumps. Parts you can replace on-site. Alfa Laval centrifuges make maintenance fast and easy.





# Technology at work *for a cleaner environment*

**T**hink of the spinning centrifuge as a rotating settling basin. The quickly spinning bowl increases the force of gravity thousands of times.

This centrifugal force separates out solids in a fraction of the time they would take to settle in basins. What's more, the resulting sludge is highly concentrated — about a tenth of the volume basins would produce.

lubrication, and vibration dampening systems provide reliable high-G operation.

## **All critical surfaces in stainless steel**

Strong and flexible, stainless steel resists corrosion. That's why Alfa Laval uses stainless steel for all surfaces that come in contact with sludge.

Alfa Laval decanter centrifuges accelerate nature's own sedimentation process.

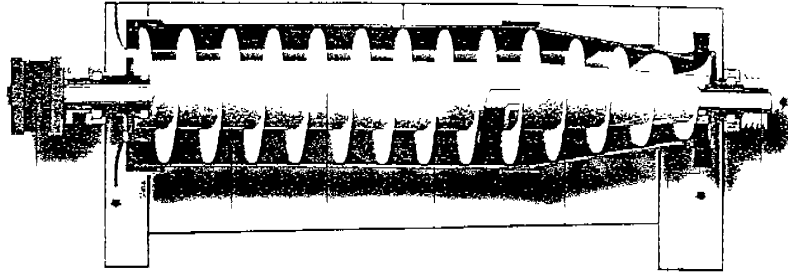
## **Rugged construction**

Alfa Laval centrifuges have been operating almost continuously for over thirty years. They prove that Alfa Laval's quality construction,



## How does a decanter work?

1. The feed pipe brings sludge into the centrifuge.
2. The bowl and screw conveyor rotate quickly in the same direction -- but the screw conveyor rotates a little slower. The centrifugal force separates out solids and throws them against the wall of the bowl. The liquid centrate -- mostly water -- forms an inner ring.
3. The settled solids are conveyed towards the small end of the bowl by the screw conveyor. On the way to the solids discharge ports, the solids are lifted up along the dry beach, allowing liquid to drain off and flow back into the pond.



1. Feed pipe brings sludge into the centrifuge. 2. Bowl and screw conveyor rotate quickly in the same direction -- but the screw conveyor rotates a little slower. Centrifugal force separates out solids and throws them against the wall of the bowl. The liquid centrate -- mostly water -- forms an inner ring. 3. Settled solids are conveyed towards the small end of the bowl by the screw conveyor. On the way to the solids discharge ports, the solids are lifted up along the dry beach, allowing liquid to drain off and flow back into the pond.

4. The conveyor pushes solids out the discharge ports.
5. Water flows out the large end of the bowl.



# Choose the right solution for your plant

Whether your plant treats sewage water at 2000 or 200,000 m<sup>3</sup>/d, there's an Alfa Laval decanter for you. Only Alfa Laval decanters offer you the power and flexibility to choose the right solution for your performance and investment goals. It's the best selection available.

## **Priced and sized for all capacities**

Alfa Laval's family of decanter centrifuges deliver drier cake than a belt filter press . . . and typically costs 20 to 30 percent less to own and operate!

Compared to belt filter presses, decanters are compact, and pack more performance into less space.

Our high-quality, decanter centrifuges typically thicken sludge from 4 to 8 percent dry solids content. The standard dewatering models can be used on any type of sludge and produce constant cake dryness between 20 and 30 percent.

## **Performance-enhancing features**

Alfa Laval offers a tremendous choice of unique design features to enhance the performance of your decanter. Whether you want to reduce solids disposal volume or improve plant efficiency, you can choose the right decanter to achieve your goals.

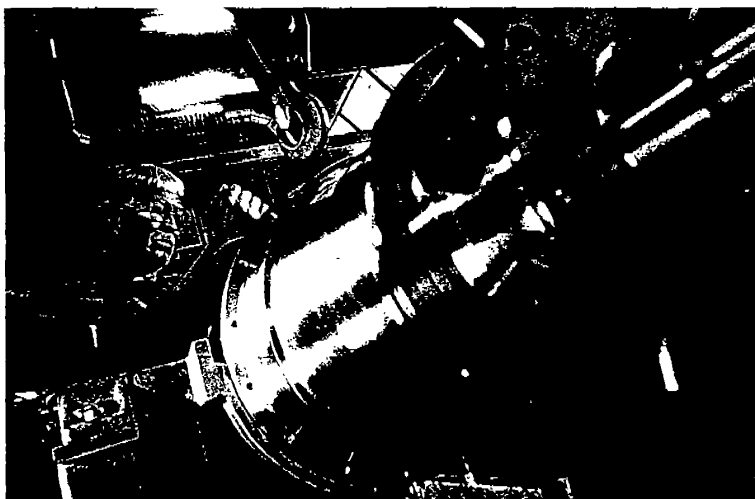
## **Dewatering technology for up to 35 percent dry solids!**

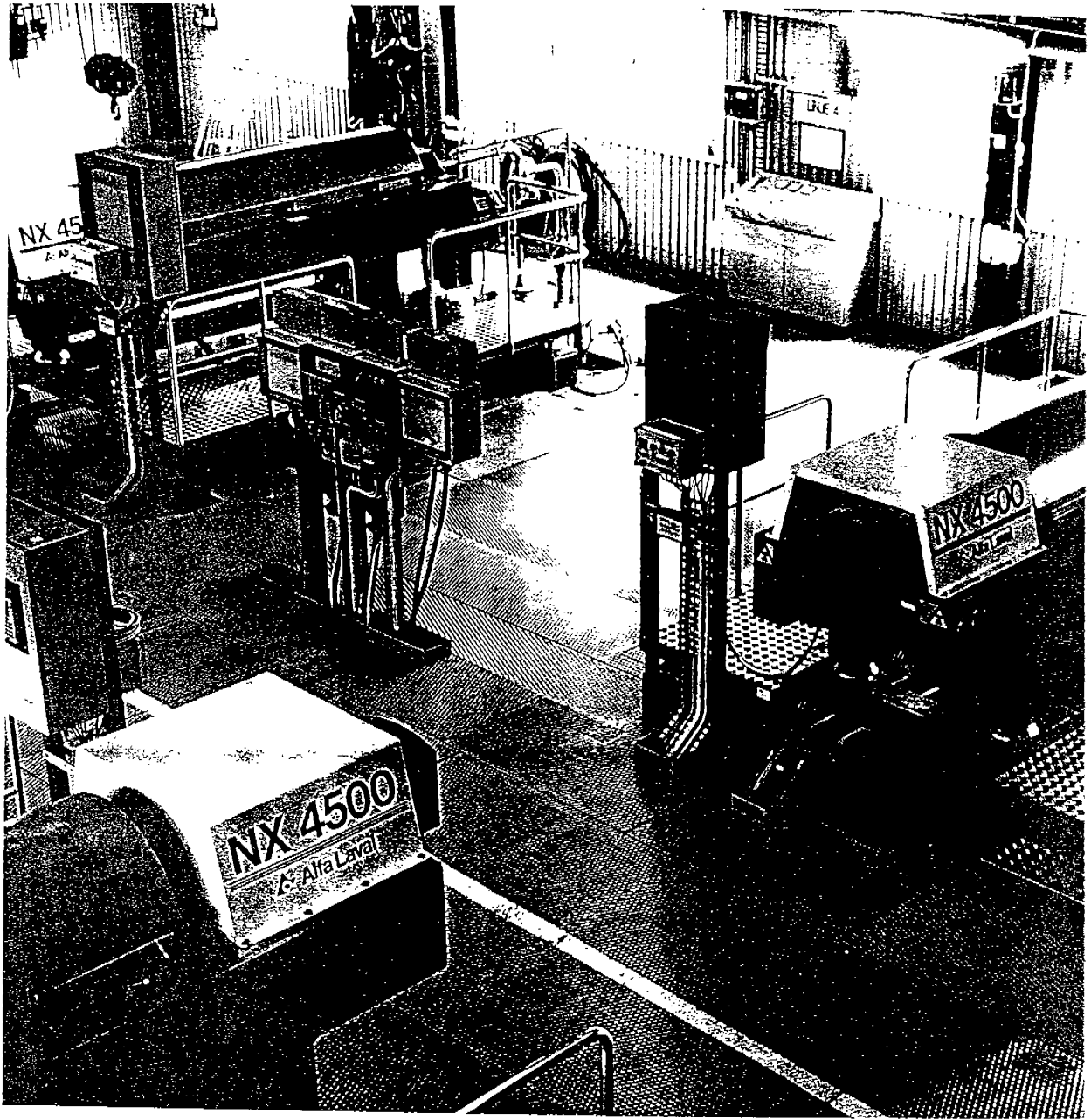
With Alfa Laval's proprietary dry solids technology, our decanter centrifuges can produce cake 10 percent drier than other technologies. Our high-efficiency feed zone accelerates gently. An advanced weir design helps liquids flow evenly through the hub. Solids leave the centrifuge faster through 360° discharge ports.

Performance-enhancing options help you maximize throughput. Our high-G models generate the equivalent of 45 bar . . . more than six times the pressure of a belt filter press. A special screw conveyor exerts more pressure, squeezing solids drier than other centrifuges.

## **Thicken with less polymer**

Handle more waste-activated sludge without adding digesters or dewatering equipment. A baffle disk reduces turbulence and improves the efficiency of the conveyor. Many plants achieve sludge concentrations of 6 or 7 percent without polymer.





*The compact, modular design makes installation fast and easy.*



*"Why Alfa Laval?  
Out of all the decanters available, Alfa Laval  
units were the most cost-efficient."*

— Claus Aaltonen  
Manager West District Operations & Maintenance Dept  
Stockholm Water Company



# Helping *customers like you*

## **Alfa Laval at Stockholm Water Company**

Every year Stockholm Water Company provides 1,100,000 people with their drinking water . . . 131,000,000 m<sup>3</sup> of it. Three waste water treatment plants process 150,000,000 m<sup>3</sup> of waste. Stockholm's decanter of choice? Alfa Laval.

Stockholm's wastewater operations wanted to boost their 18 to 20 percent cake dryness to 30 percent. That way, they could save 4,000,000 SEK (500,000 U.S. dollars) a year on sludge disposal. They chose Alfa Laval decanters for their long-term cost-efficiency and easy maintenance.

## **Alfa Laval in America**

A large midwestern city doubled cake dryness in one of its wastewater plants. Thanks to the variable speed backdrives in Alfa Laval's high-performance dewatering centrifuges, the plant increased cake dryness from 15 to 30 percent. Recovery went from 85 to 97 percent.

## **Round-the-clock dewatering at potable water plants**

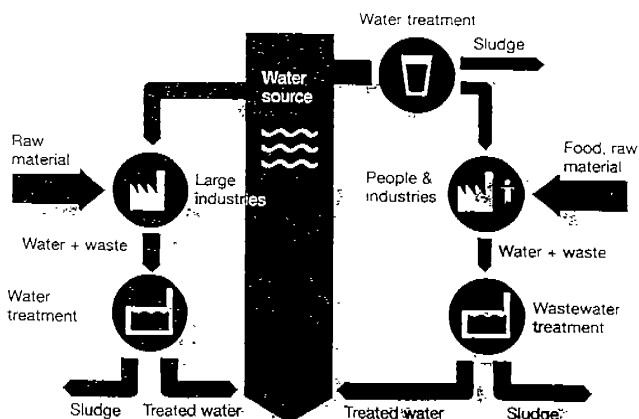
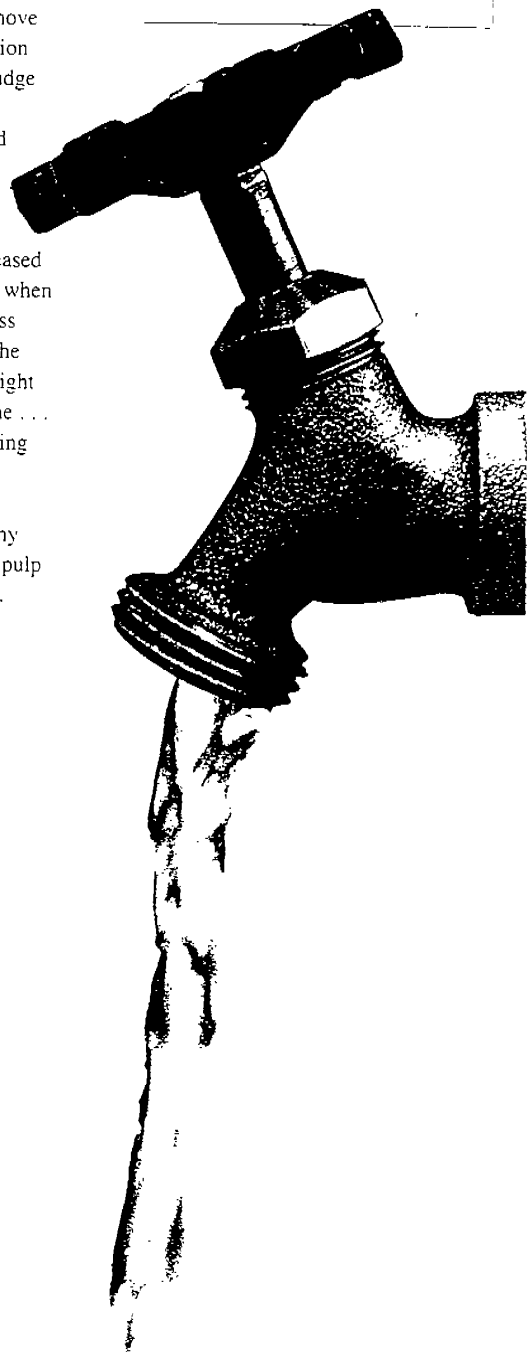
Alfa Laval centrifuges can slash the cost of treating surface and ground water residues. They remove 20 to 50 percent solids in a fraction of the time and space it takes sludge to settle in lagoons. Alfa Laval centrifuges also process lime and alum sludges.

## **Treating industrial waste**

DuPont Polyester Films increased cake dryness by over 40 percent when they replaced their belt filter press with an Alfa Laval centrifuge. The new centrifuge also eliminated eight hours a week of planned overtime . . . hours that used to be spent washing down the filter press.

Alfa Laval has tackled tough waste treatment processes in many industries, with special focus on pulp and paper, chemical, and mining.

Over 2000 water treatment plants around the world use Alfa Laval . . . that's more than 5000 centrifuges helping to keep the world's water clean.



*Alfa Laval has been applying expertise throughout water and wastewater systems*

# Total sludge management *on a worldwide basis*

Alfa Laval offers a huge reservoir of process and engineering experience from more than 30 years of supplying decanter centrifuges for municipal and industrial wastewater treatment. Alfa Laval is the world's largest manufacturer of decanter centrifuges.

## Try before you buy

Alfa Laval's test facilities can help you predict the performance of your new centrifuge.

First let Alfa Laval analyze your sludge and help you select the right centrifuge. Then do a test run. You can gauge cake dryness, polymer dosage, or flow rate — whatever's important to your treatment process.

Alfa Laval has pilot plants and mobile test units. We can run tests at your plant or ours.

## Containerized units

Cut construction costs and startup to an absolute minimum with a containerized centrifuge. There's no new building . . . the centrifuge comes housed in a standard container. It's easy to install and easy to move.

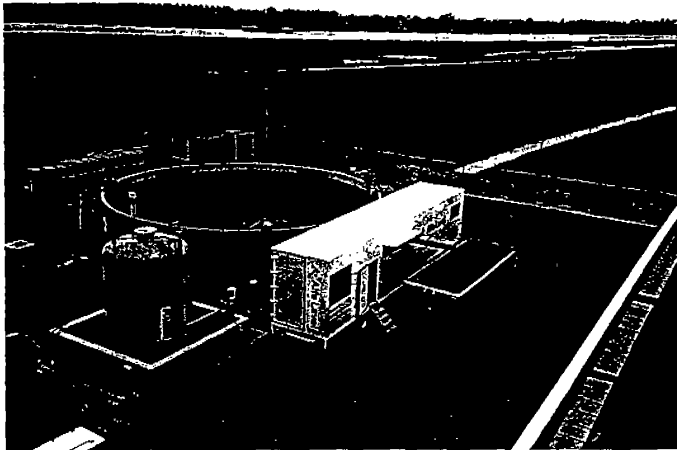
## From feed to sludge removal in one complete package

Alfa Laval can do it all . . . feed and effluent handling . . . control instrumentation . . . even shaftless screw conveyors for removing up to 20 m<sup>3</sup>/h of dewatered cake. We'll specify, install, and start the entire system.

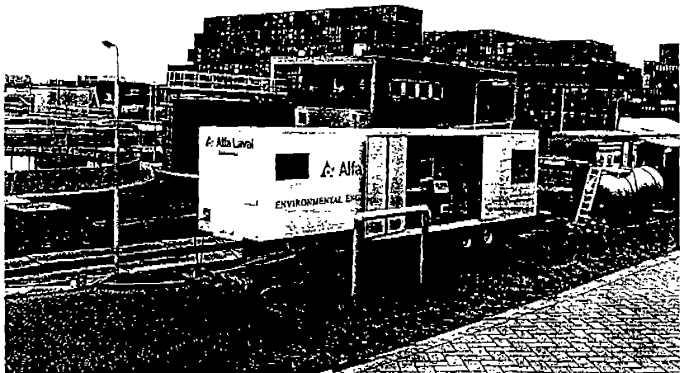
Alfa Laval also supplies lime conditioning systems, with silo, metering equipment, and paddle mixers.

## Training

Alfa Laval will help you optimize sludge treatment and centrifuge performance. We'll review your maintenance logs to recommend preventive maintenance and spare parts inventories.



Alfa Laval offers completely self-contained units for industrial and municipal wastewater treatment plants.



# Global partners

With thousands of decanters installed worldwide, Alfa Laval is your global partner for water and wastewater treatment. Thanks to you, we're the largest manufacturer of decanter centrifuges in the world.

Only Alfa Laval has the experience and the people to tackle tough treatment processes anywhere in the world. Our global team of 2000 engineers and technicians is at your service.

Alfa Laval's core competencies are separation, thermal and flow techniques. A conscious focus on research and development make us market leaders in the areas in which we operate. Many of Alfa Laval's customers are found in the process industries from chemicals to food, and within oil and energy utilization.

Find out more about Alfa Laval. Visit our corporate website at [www.alfalaval.com](http://www.alfalaval.com).

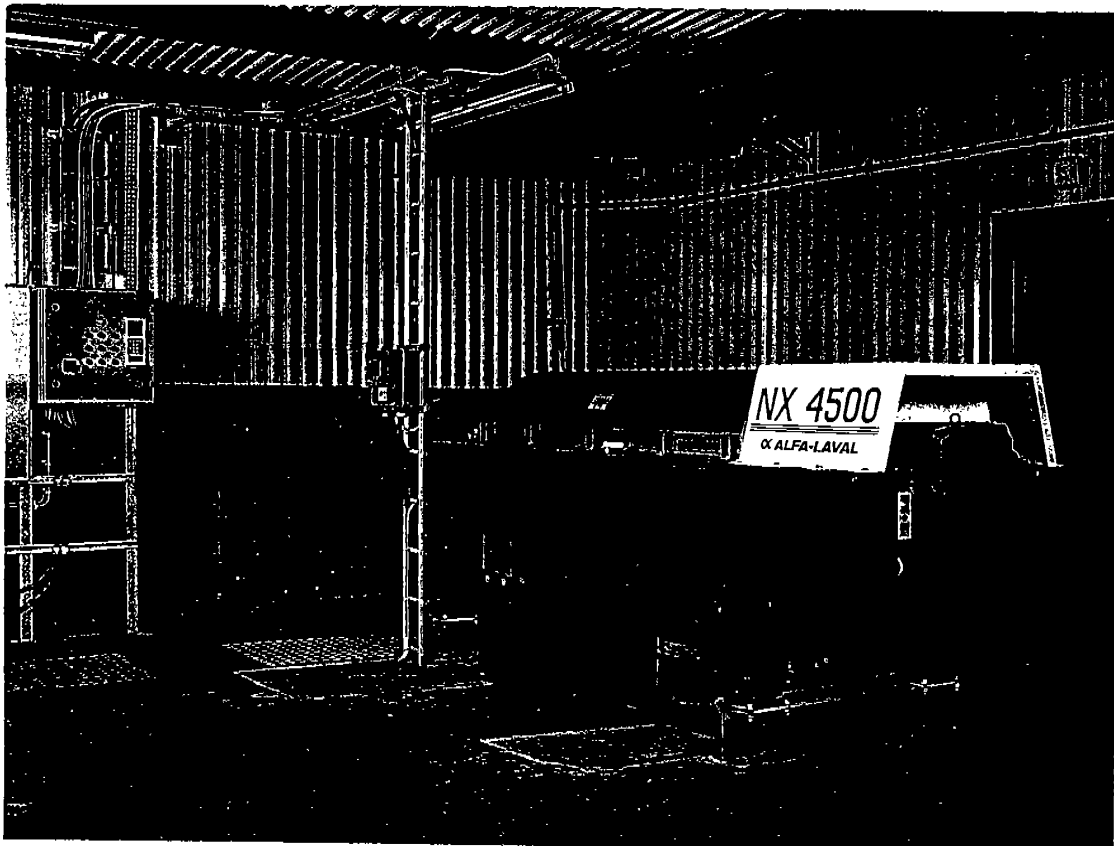


**Alfa Laval Separation A/S**

**Alfa Laval**

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# NX 4000 and NX 4500 Series Decanter Centrifuges for Sludge Treatment



 Alfa Laval

# Alfa Laval Sharples NX 4000 and NX 4500 series Decanter Centrifuges

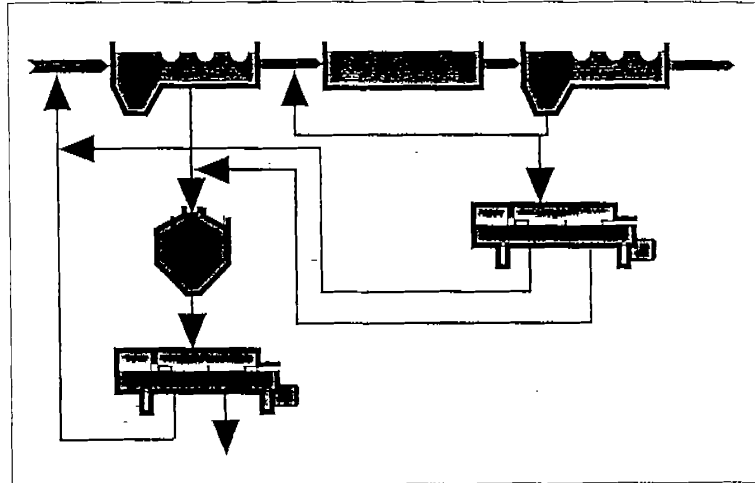
Available for

- standard dewatering duties
- for waste activated sludge concentration, and
- for dual function operation = dewatering and thickening

## Dewatering

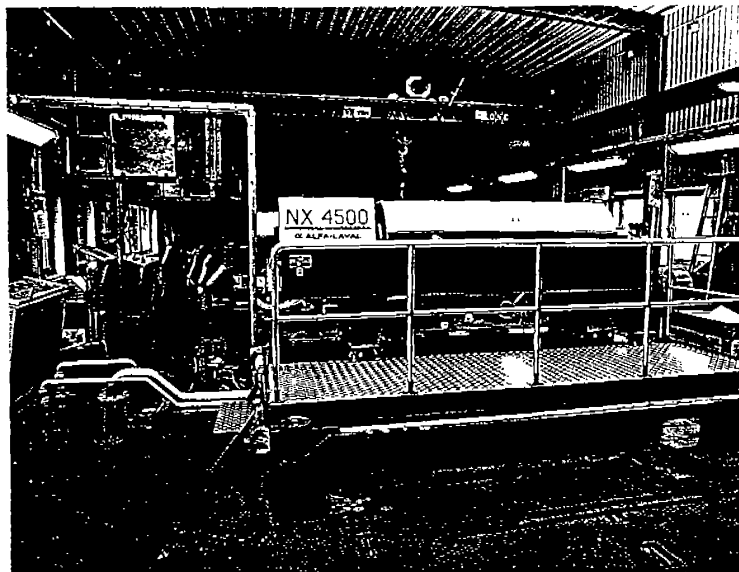
Centrifugal sedimentation is a quick and effective method of dewatering sludge to manageable volume and consistency. Many municipal and industrial waste water treatment facilities have chosen Alfa Laval Sharples decanter centrifuges for this duty, because

- Decanters operate efficiently and continuously – round the clock if necessary – with minimum supervision.
- They can be tuned for optimum performance according to the characteristics of the feed.
- They are not subject to blinding or clogging, and do not normally need cleaning.
- They are compact in themselves and need relatively little in the way of peripheral equipment.
- They can be supplied as complete plug-in dewatering units.
- A decanter is a closed system: no splashing or odors.

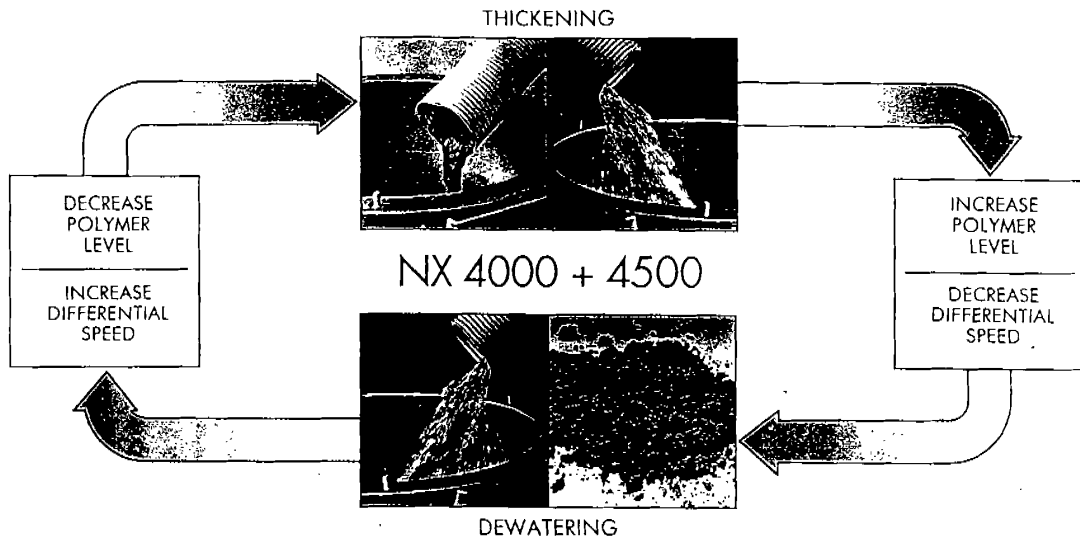


## Sludge thickening

Waste activated sludge is one of the most difficult kinds to thicken, even by centrifugation. But Alfa Laval Sharples offer decanters specially tailored to the physical characteristics of waste activated sludge. They are so effective that they can reach concentrations three to five times higher than conventional thickeners. Better still, they can do this without using the expensive polyelectrolyte flocculants that inflate the cost of such methods as dissolved air flotation.



# Dual Function = Thickening to dewatering and back ... in minutes

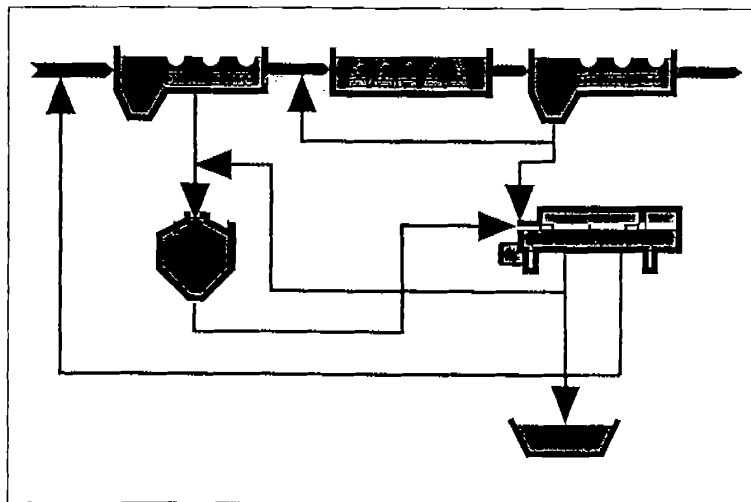


## Dewatering

The NX 4000 and 4500 series decanters are purpose-built for round the clock dewatering of primary, mixed and chemical sludges, both aerobically and anaerobically stabilized. It has wide openings for cake discharge to prevent blockages. Surfaces subjected to wear are coated with tungsten carbide material for protection.

## Thickening

The NX 4000 and 4500 series decanters provide you with added operational flexibility because it can both thicken and dewater. When additional thickening capacity is needed you can change from dewatering to thickening in a matter of minutes. Thickening can be made with or without polymers.



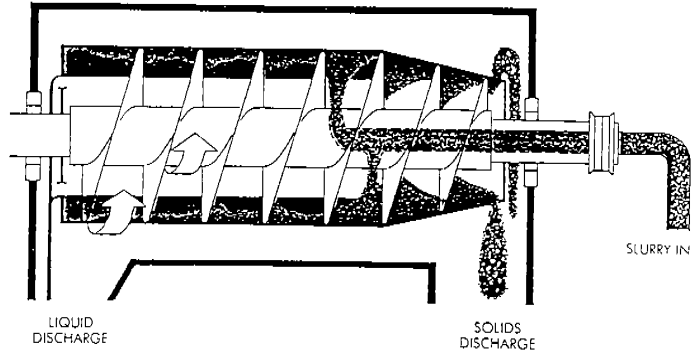
# How the centrifuge works

Separation takes place in a horizontal conical-cylindrical rotor containing a screw conveyor rotating in the same direction as the rotor but at a slightly different speed.

The feed enters the machine at the narrow end of the rotor through a central inlet pipe in the hollow conveyor shaft. On leaving the pipe, the feed is propelled by centrifugal force into the rotor cavity.

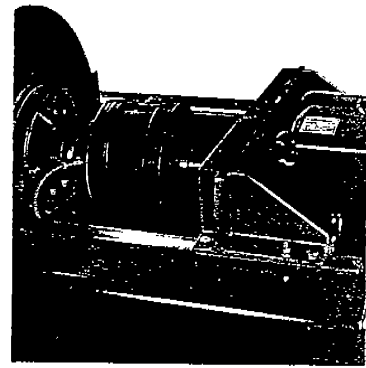
The solids in the feed are deposited as a layer on the rotor wall, leaving the liquid to form an inner ring, the thickness of which is determined by the positions of adjustable effluent weirs at the wide end of the rotor. The conveyor transports the solids towards the narrow end where they are discharged by centrifugal force through outlet ports situated around the rotor. The liquid overflows through the weirs at the wide end.

Both the liquid and solids are collected in special covers surrounding the rotor and are discharged from the machine by gravity.

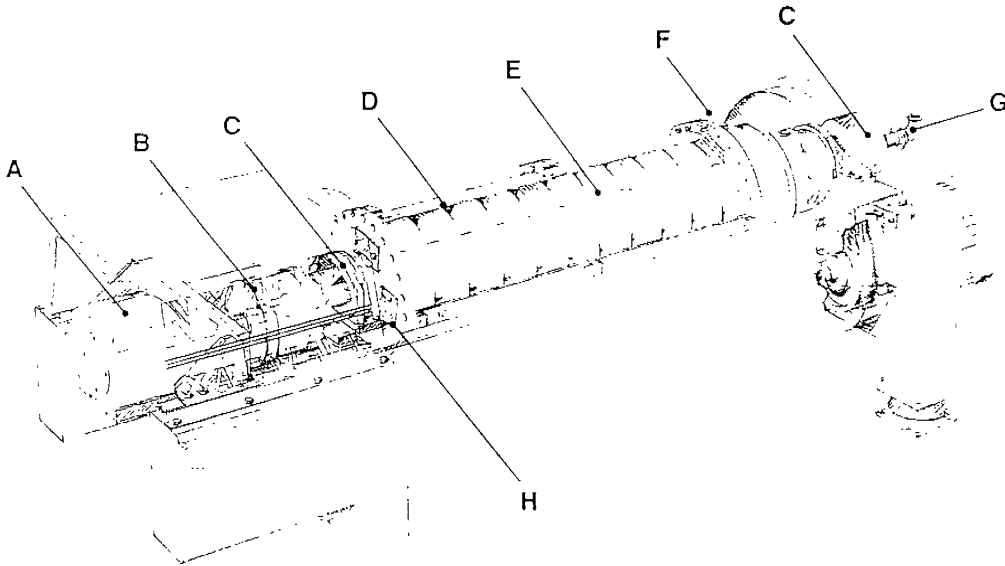


## Round the clock operation

An installation can be automated to work round the clock with a minimum of operator attention. Power transfer to the conveyor is by means of a planetary gear box which is supplied with an eddy-current brake (ECB), connected to the advanced brake controller (ABC) for automatic operation and control of the differential speed. Overload protection of the gearbox is provided throughout the ABC.



Hood removed to show gear box and Eddy-Current Brake (ECB)



Cutaway illustration showing the main parts of a decanter.

- |                            |                          |
|----------------------------|--------------------------|
| A. Eddy Current Brake      | E. Conveyor              |
| B. Planetary gear box      | F. Casing                |
| C. Pillow block bearing    | G. Feed tube             |
| D. Centrifugally cast bowl | H. Adjustable plate dams |



## Erosion protection

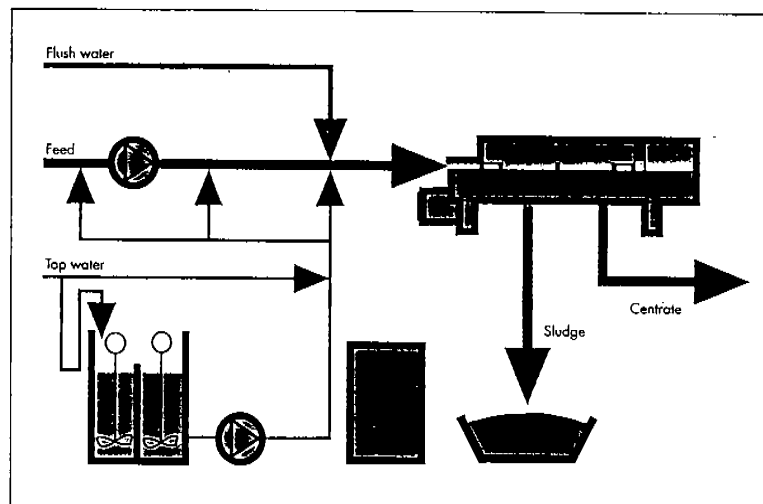
Liquid-wetted parts are made of carbon or stainless steel depending on model. Extra erosion protection is added at sensitive spots as needed.

- Conveyor flights hardfaced with a coating of a tungsten carbide alloy or, for heavy duty applications, tungsten carbide tiles.
- Overdimensioned distributor with a wear reserve of 20 mm.
- Strips of hardwearing metal welded to bowl wall.
- Replaceable bushings in solids discharge ports.

## Polymer preparation and dosing

Alfa Laval supplies packaged systems for batch preparation and continuous metering of polymer solutions. A complete unit comprises vacuum-fed hopper with dissolver, maturing tank with agitator and supply tank with metering pump.

- Automatic replenishment and metering
- Three sizes are available, for 1.7, 3.4 or 5.0 kg/h of polymers.



## After-sales Service

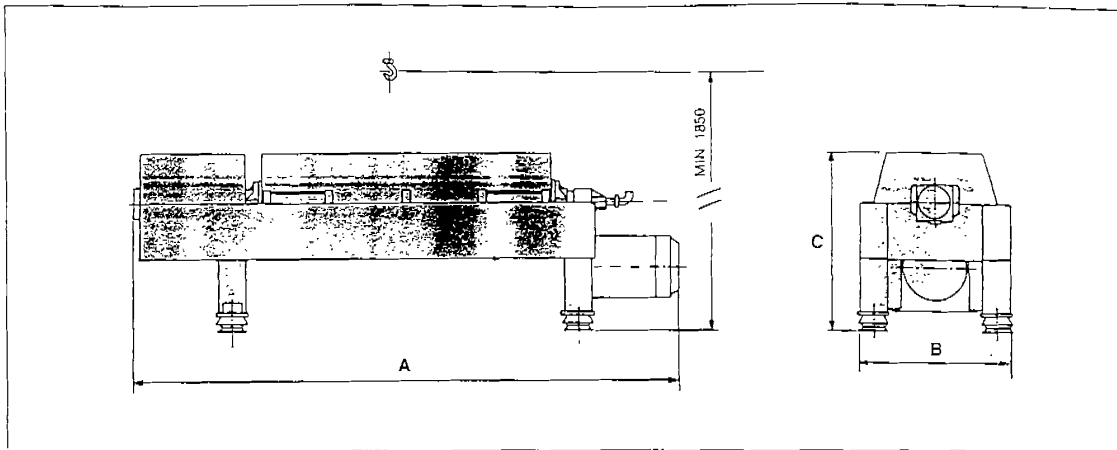
The Alfa Laval Decanter Service Centres operate a global service network that offers Alfa Laval decanter users:

- Spare parts supplies from local and central depots with fast delivery to minimize stoppages
- Repairs on site, at local work-shops or at our specialized factories
- Field service on call or on a regular contract basis.
- Exchange scheme. We take worn-out decanter bowls, screw conveyors, gearboxes, etc., in part exchange for factory-reconditioned replacements.





## Dimension drawing



## Weights and dimensions

	Net weight		Length A		Width B		Height C	
	kg	lbs	mm	in	mm	in	mm	in
NX 4045	1700	3750	3192	126	970	38	1225	48
NX 4055	1950	4300	3492	137	970	38	1225	48
NX 4545	2000	4410	3486	137	1090	43	1270	50
NX 4555	2500	5510	3936	155	1090	43	1270	50
NX 4565	2750	6060	4386	173	1090	43	1270	50

## Optional Equipment

- Vibration switch
- Adjustable main speed
- Starter
- Special tools
- In- and outlet compensators
- Spares

The manufacturer reserves the right to change specifications without notice.

Alfa Laval Separation A/S

 **Alfa Laval**

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PB 41255en/9505

SANDSTRÖM & SÖRENSEN

**HOW TO WIN  
THE BIOSOLIDS BATTLE.**



**SWISS COMBI  
TECHNOLOGY**

## COMPLETE THE LOOP.

As higher standards of waste water treatment are demanded, effective sludge management is becoming the major challenge. **The drive towards beneficial re-use can only be achieved through the correct selection of the treatment process.**

Sludge from sewage treatment works is presently disposed of in the following ways:

### As a liquid

Sludge in this condition is applied to agricultural land as a fertilizer but for example has the disadvantage of:

- transportation of large volumes
- odours during loading and spreading
- rapid nutrient run-off to water courses
- reducing access to suitable land
- high bacterial counts

In some places, sewage sludge is still disposed of directly into the ocean.

### Dewatered

By mechanically reducing the water content, agricultural application together with landfill are the main options. However, the disadvantages of this route remain:

- difficult mechanical handling and storage
- odours
- unstable material
- high bacterial counts

Incineration achieves the maximum volume reduction but the problems of the product are transferred to the process in the form of difficult emission and operating costs. Whilst approval for incineration plants is a protracted process, the disadvantages of ash is:

- no beneficial re-use
- attracts landfill charges
- high investment and operating costs

**The SWISS COMBI drying process** makes all these problems a thing of the past. Apart from the reliable and environmentally compatible drying technology used, great attention is also paid to the characteristics of the end product.

By this process, dewatered sewage sludge becomes a **dry and pasteurised granulate suitable for a wide variety of uses.** It can be transported easily in bulk or bags.

### In the dry condition

Dry granulate is ideal for marketing in all known ways, for example:

+ In agriculture (trouble-free spreading with normal equipment)

+ As lawn fertilizer for golf courses, parks etc.

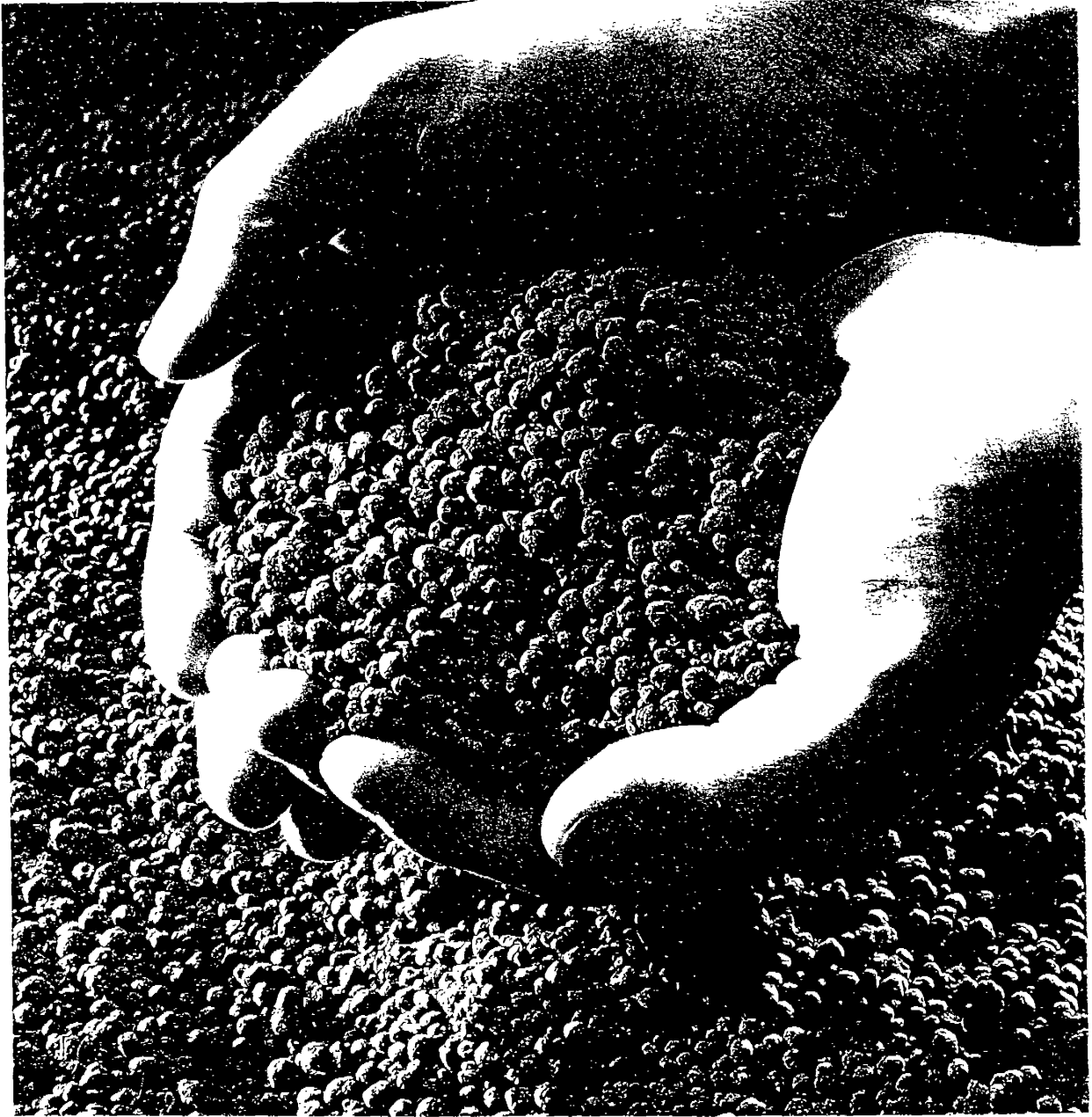
+ As coverage for sowing grass on landfills, quarries, open-cast coal mines etc.

+ As additional fuel in cement works, coal-fired power stations, refuse incineration plants etc.

+ Only the biosolids drying process enables the full potential utilization of this valuable resource.

**SWISS COMBI  
TECHNOLOGY**

**FROM LIABILITY TO ASSET.**



## CLOSING THE LOOP.

The **SWISS COMBI** system not only ensures the best possible recycling of resources, but also works with a **closed-circuit drying system**, thus complying easily with the stringent regulations governing odours and other emissions.

### From dewatered sludge to dry granulate

Before loading into the drier drum, the mechanically dewatered sludge is mixed with previously dried product to form an easily flowing material.

This is then dried in the drum with hot air which evaporates the water.

After leaving the drum, the dry sludge is separated from the air and screened. Excessively fine and coarse particles are passed back to the mixer drum, while the final product is delivered as **dust-free homogeneous granulate suitable for immediate storage.**

### The closed-circuit drying air system

The drying air is warmed in a heat exchanger by the exhaust from oil or gas-fired burners. It then flows through the drum drier to evaporate the water in the sludge, cooling down in the process. The air/steam mixture is separated from the dry sludge after leaving the drum, and returned by closed circuit to the heat exchanger.

Part of the drying air is continuously extracted and the water vapour condensed out. The remaining non-condensable air is used as combustion air for the burners, thus completely incinerating the odorous gases at the temperature of 800°C.

### Measurement, regulation and control system

The entire drying plant is regulated and monitored by a computerized control system. Thanks to smooth, trouble-free plant operation and the high degree of automation, supervision is minimised.

### The SWISS COMBI drying plant—your safeguard

A great deal of attention has been paid to plant operating safety. Testimonials by fire and safety experts confirm that **SWISS COMBI driers comply with the latest**

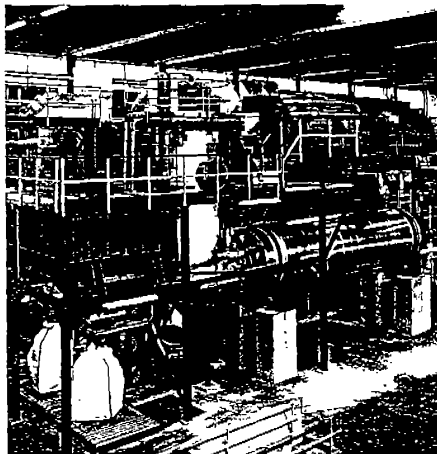
**technical requirements for protection against fire and explosion.** Since the granulate is dust-free, no particular fire-prevention measures have to be taken for product storage and handling.

### Our standard product line includes:

- + stationary drying plants for biosolids and other sludges from 1000 up to 6000 kg of water evaporation per hour,

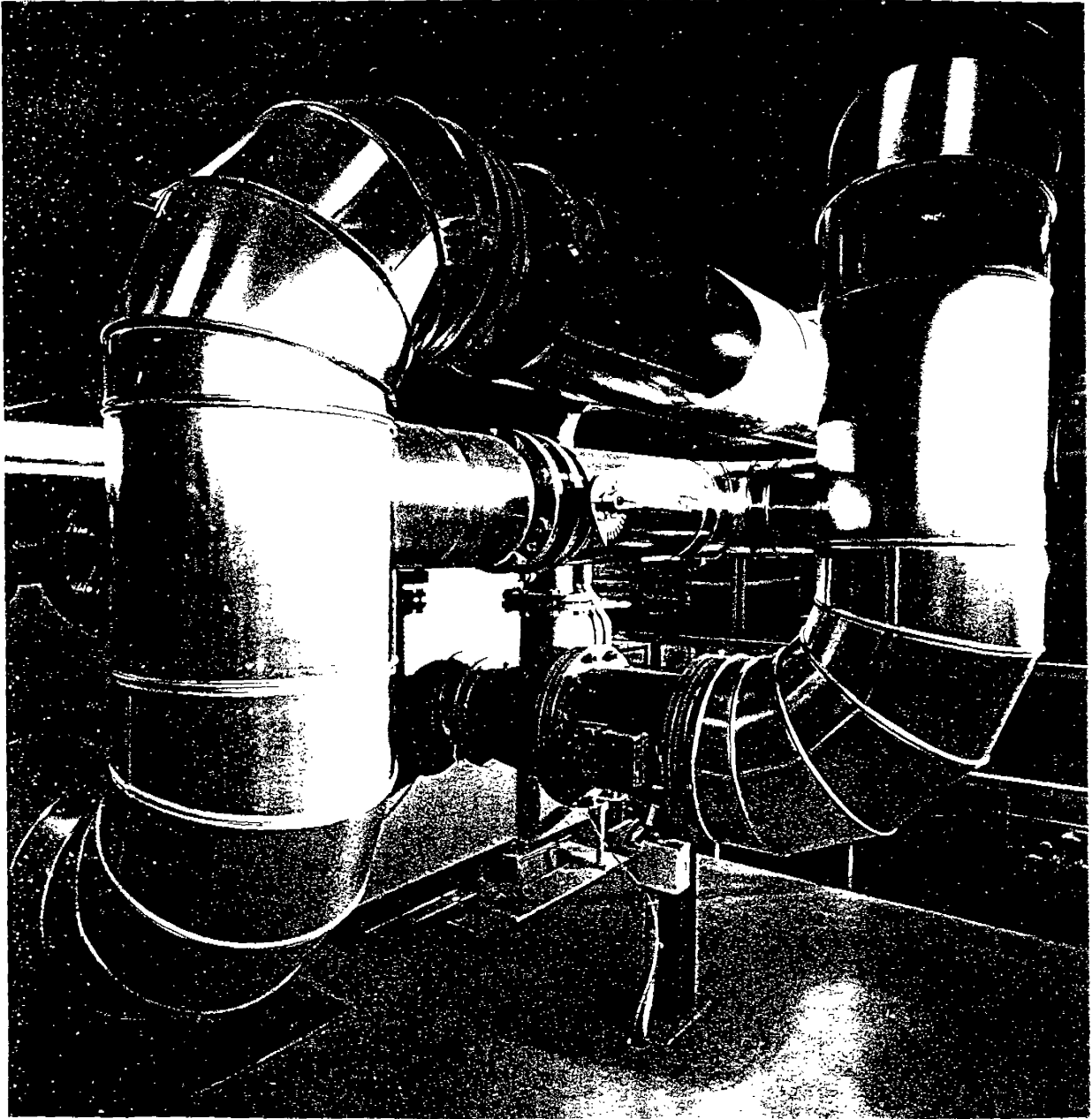
- + mobile units with a water evaporation of 1000 kg/h (mounted on two or three flat-bed trailers),

- + semi-mobile skid-mounted units of 500 or 1000 kg H<sub>2</sub>O/h.



**SWISS COMBI  
TECHNOLOGY**

**THE QUALITY OF OUR PROCESS  
SPEAKS FOR ITSELF.**



## ALMOST TOO GOOD TO BE TRUE?

The SWISS COMBI system has so many advantages:

+ The end product is a **dust-free, homogeneous and easily flowing granulate** of defined grain size.

+ The dry granulate can be stored for **unlimited periods**.

+ Trials with various kinds of sludges from different sources have confirmed **trouble-free plant behaviour and flexibility**. Adjustment and regulation is fast and simple.

+ Apart from sewage sludge, other types of sludge such as in the fruit juice or paper industry etc. can be processed **without any mechanical modifications**.

+ **Short start-up and shut-down times** easily allow single or double shift working. As a result, drying plant operating times can be adjusted to sewage plant requirements.

+ **Low maintenance** thanks to sturdy, uncomplicated plant components.

+ **High availability** thanks to the well-proven drum drier system.



+ **Minimal personnel requirements** thanks to largely automatic operation and simple plant control.

+ **practically no environmental pollution**. Emission measurements on existing plants confirm **full compliance with legal limits**, with much lower values in some cases.

+ **No odours**, because all drying air is recirculated to the combustion chamber.

+ **Dust-free operation**, because all possible dust sources are kept under vacuum.

+ **High thermal efficiency**. The plant design allows for maximum reutilization of condensate heat.

+ **Years of experience** in drier plant operation using this new concept confirm trouble-free operation, high availability, first class product quality and ultra-low emissions.

... that only seeing is believing. Let us show you one of our plants.

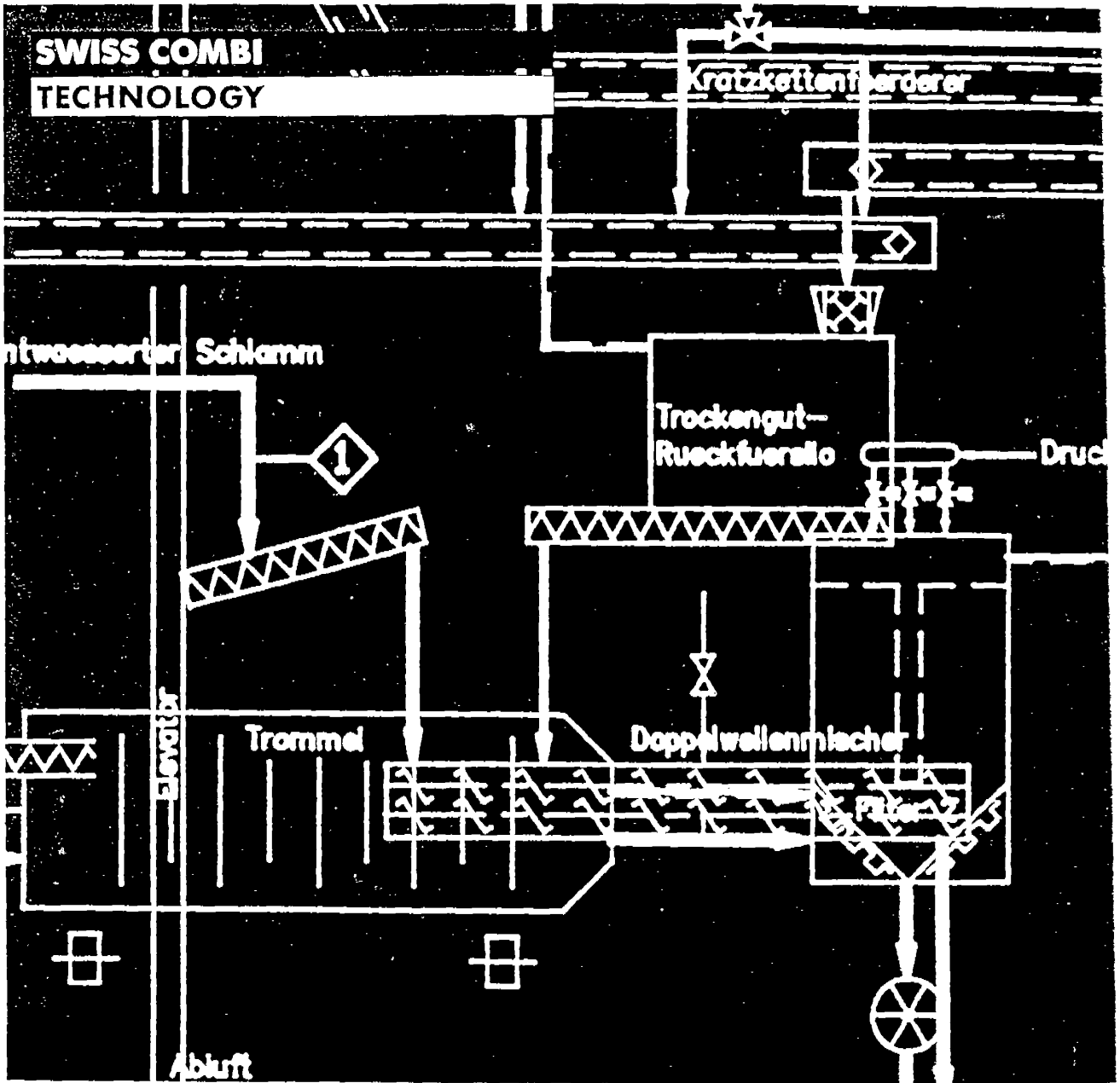
**SWISS COMBI  
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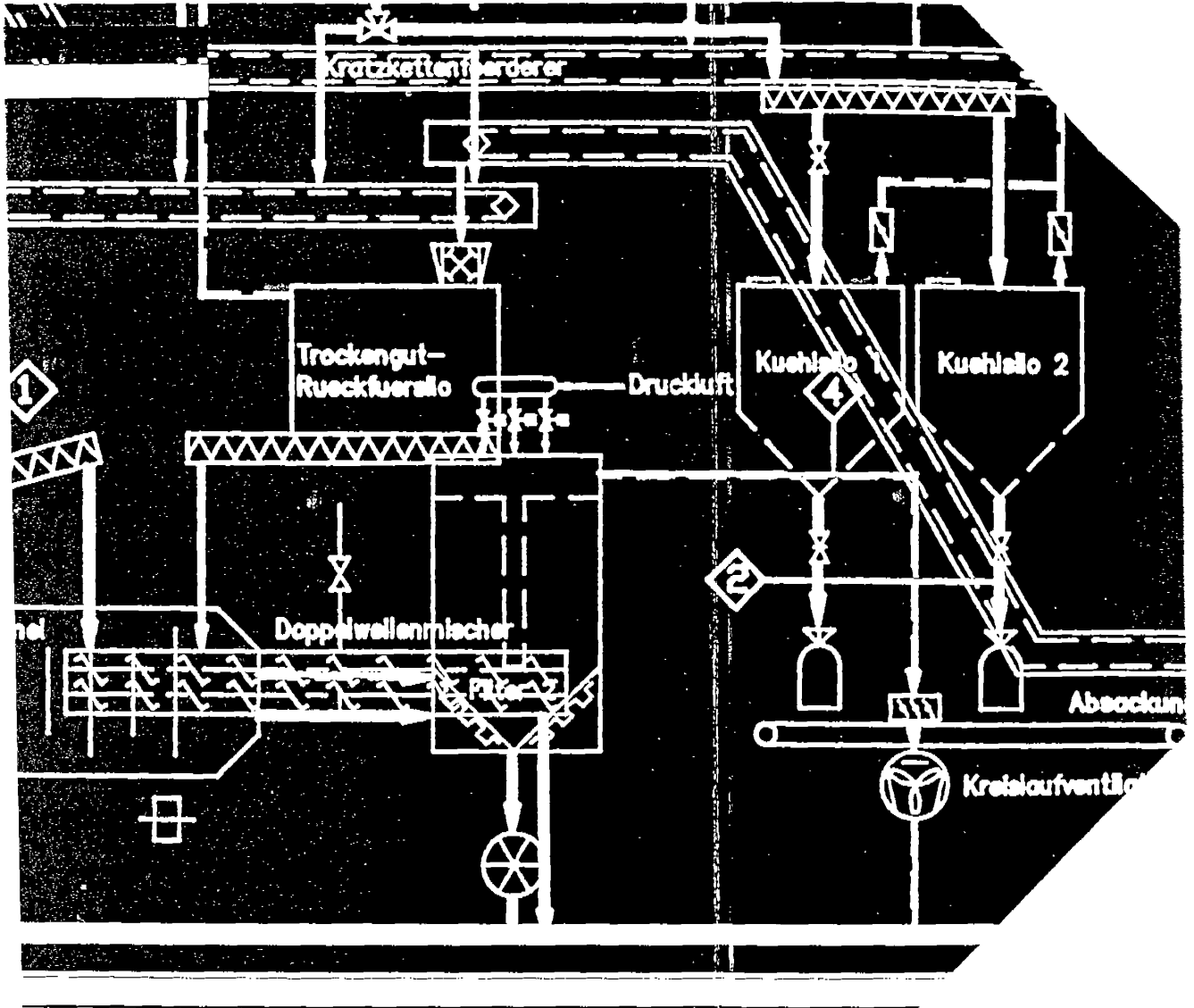
FROM CONCEPT  
TO REALIZATION.





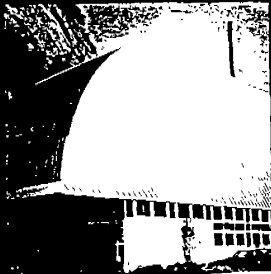
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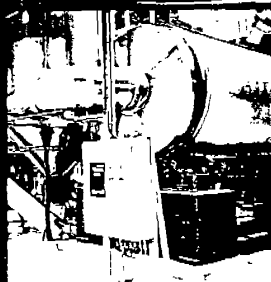
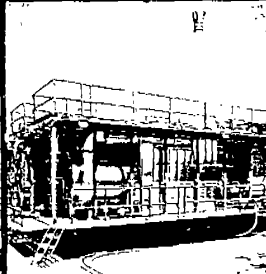


**THE PROOF.**

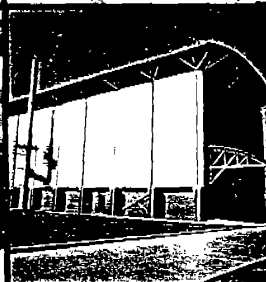
**Roche (CH)**



**Type Mobile (D)**



**Quebec (CAN)**



**Avonmouth (GB)**

**SWISS COMBI  
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# Research and Technology

*Solutions*  
*Knowledge*  
*Understanding*  
*Research*



## Research and Technology

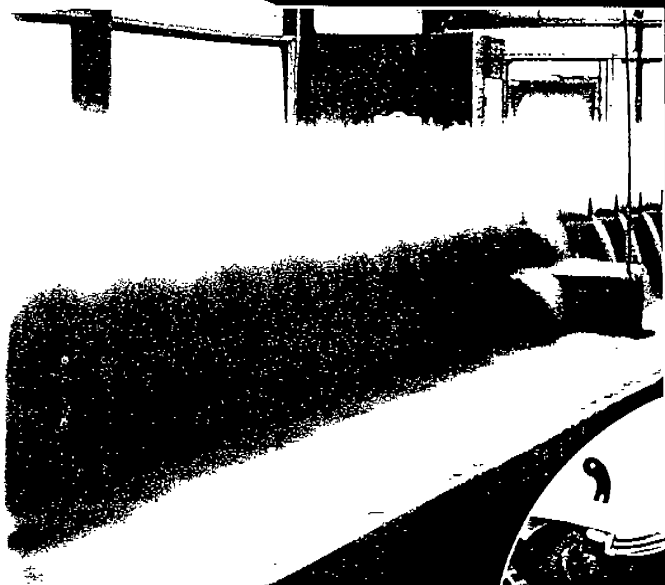
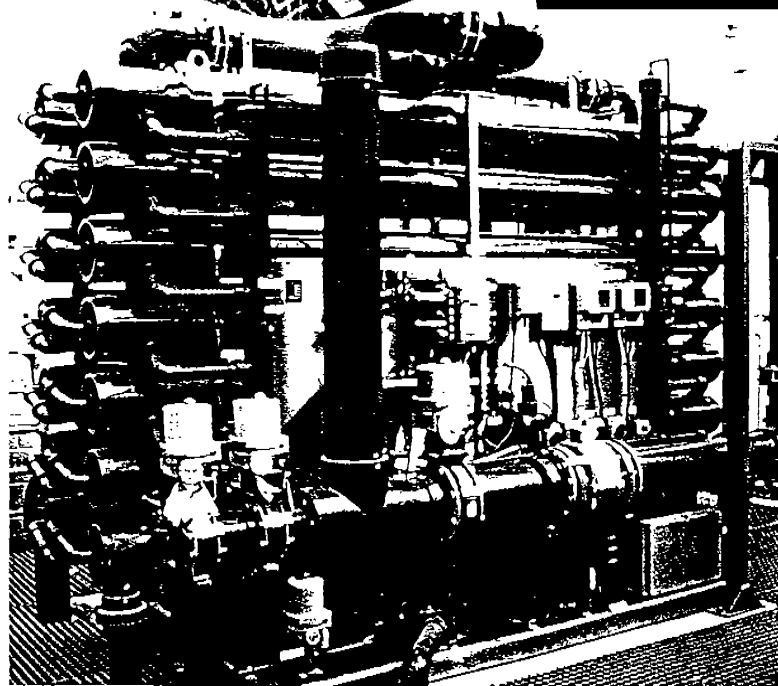
**Thames Water** provides water and wastewater treatment services to nearly 20 million customers worldwide. We also own companies that provide products and services, ranging from membrane treatment process technologies to robotic pipe inspection and relining systems.

As part of the Thames Water group, Thames Water Research and Technology plays a key role in developing and supporting innovation and technical excellence in serving our global customers.

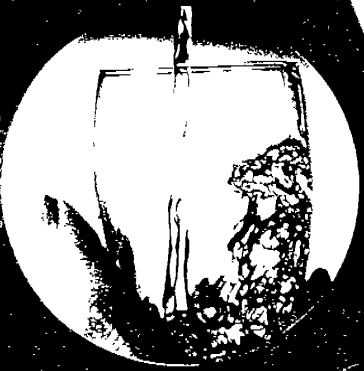
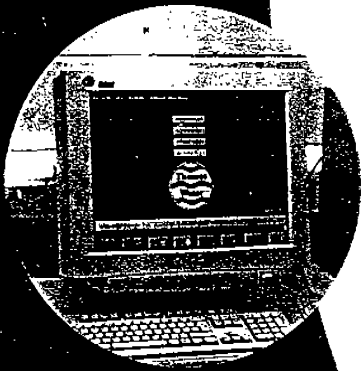
Our research facilities are based in the UK, the Americas and Asia - Pacific regions. We employ the skills of more than 100 research scientists and technologists, linked to a knowledge sharing network which includes many universities and research organisations.

They make use of our state of the art laboratories, pilot plant and field testing equipment to provide innovative solutions and expert technical advice to customers around the world.

Research, innovation and knowledge management are essential in helping water and wastewater utilities to meet the changing environmental, regulatory, customer and business needs that we will face in the 21st century.



## Our Challenge from our clients



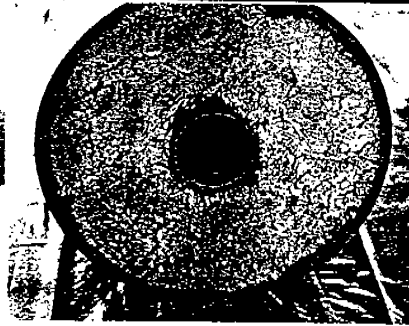
- *Predicting and planning for the potential impact of climate change on the water cycle.*
- *Understanding and providing for the needs, demands and behaviour of our global water customers.*
- *Creating sensing and information systems to manage huge pipe networks, monitoring condition, performance and service to customers in real time.*
- *Developing novel technologies to access, repair and replace pipe networks with minimal disturbance to city life and the environment.*
- *Improving product quality and process efficiency for water and wastewater treatment plant.*
- *Developing economic and sustainable solutions for recycling water and waste products.*
- *Creating a global knowledge sharing and learning organisation.*





## WATER RESOURCES

Increases in population and water use are leading to heavier demands on water resources around the world. In Thames Water we are identifying environmentally sustainable and cost effective water sources to ensure supplies to our customers are maintained. We have developed a major aquifer storage and recovery scheme for London. During the winter months, surplus water resources are treated and stored in the chalk aquifer below the city. In the Summer, where water resources are in shorter supply and demand is increased, water is recovered from the aquifer to supplement conventional surface water sources.



Alternative water sources and treatment processes for potable and non-potable use are also under investigation. A trial of desalination options for brackish water sources has been carried out.

## ADVANCED WATER TREATMENT

In conjunction with Leopold Membranes we have developed a new hollow fibre ultra-filtration membrane system for turbidity and pathogen removal from surface and groundwater sources. The process is also being developed for filter wash water recovery.

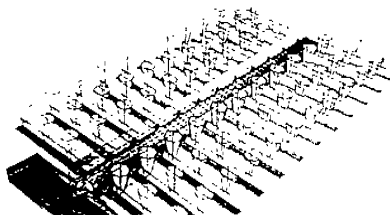
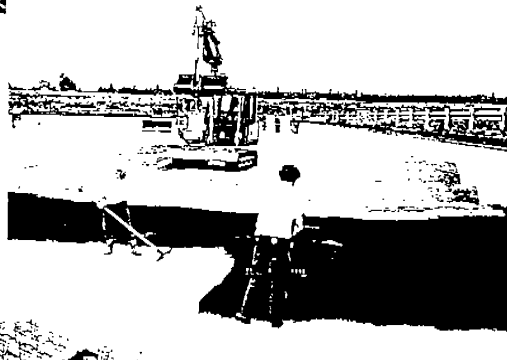
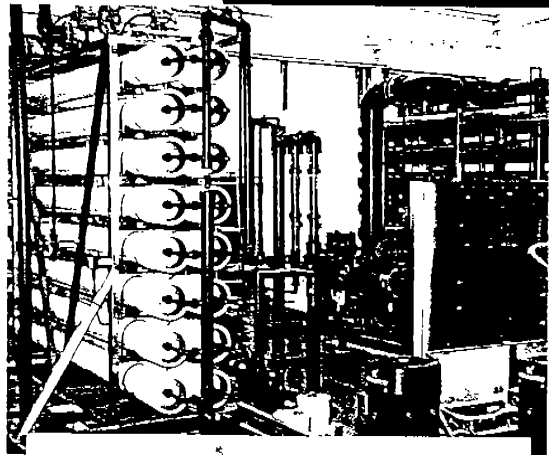
Membrane integrity is a key issue in process performance. A new membrane integrity monitoring system has been developed to check for effective removal of pathogens such as Cryptosporidium and Giardia.

Research carried out using ozone and activated carbon has been used by Thames Water Utilities in its successful Advanced Water Treatment Programme.

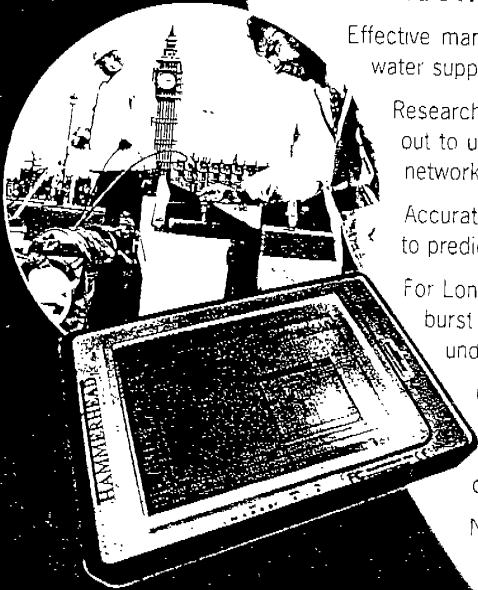
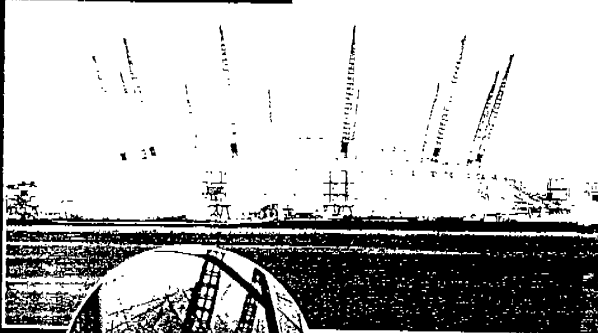
The GAC Sandwich Filter uses a layer of granular activated carbon between layers of sand in an existing slow sand filter. Thames Water and other water companies have successfully installed this process to remove pesticides and other trace organic compounds and achieve compliance with strict water quality regulations.

A new counter-current Dissolved Air Flotation/ Filtration process, known as CoCoDAFF, has been developed as a compact, front-end treatment for algal laden waters.

Further research on these and other advanced water treatment processes is being carried out at our facilities in London (UK), Adelaide (Australia), and Pittsburgh (USA).



# ... To Tap



## CONSERVATION AND RE-USE

A major conservation and re-use research project is underway at the Millennium Dome in London. Water from three sources, groundwater, rainwater and grey water from the hand wash basins, is treated with a combination of processes including reed beds, biological aerated filters, and membranes. The treated water is recycled for toilet flushing.

Inside the Millennium Dome water saving devices have been installed. Data on water usage and customer behaviour is collected by a comprehensive metering system.

The project will provide information on the viability of large scale recycling schemes and customer behaviour for Thames Water's future water resources strategy.

## DISTRIBUTION MANAGEMENT

Effective management of the water distribution network is an essential part of the water supply chain.

Research using a 1.4 km long experimental distribution system has been carried out to understand and predict the potential changes in water quality in the pipe networks between treatment and the customer tap.

Accurate assessment of the condition of the distribution system and the ability to predict and respond to problems that may occur are key factors.

For London, predictive models have been developed to forecast the number of burst pipes that could occur under cold temperature conditions and to understand the risks and consequences of bursts and leaks.

Ground penetrating radar technology and global positioning systems, combined with "key-hole" excavation techniques are being developed to provide a "quick find - quick fix" capability to minimise costs and disruption in major city streets.

Novel technologies to reline existing water mains have been developed with Subterra, a Thames Water Services company.

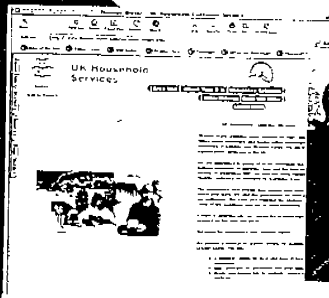
New Thames Water "visted" technologies using ruggedised hand held computers, are being developed to provide rapid access to Geographical Information Systems and Network models and improve data capture capabilities for our technicians and engineers in the streets.

## CUSTOMERS

We work closely with our global customers to understand and provide for their needs, demands and behaviours.

Research is underway with partners in the UK and USA to understand customer perception of water quality and taste. Other work on the risk, reliability and customer receptivity of technologies appropriate to different water reuse scenarios is being carried out with academic and water service company partners in the UK and Australia.

We are testing new concepts of communicating with our customers, including web based information.

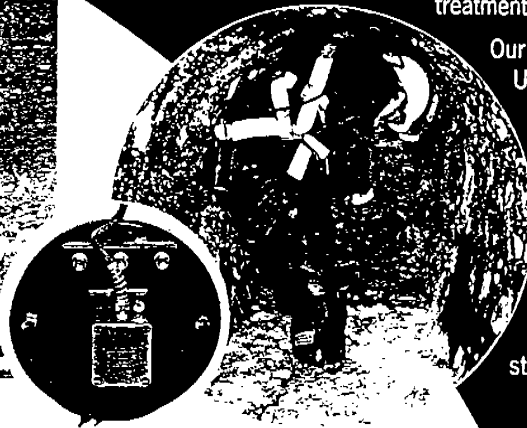
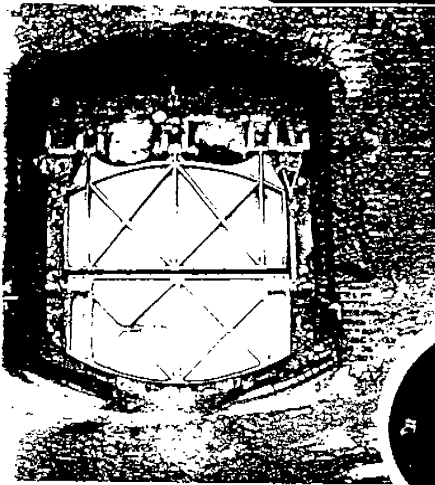


## SEWERAGE NETWORKS

The drains and sewers that collect wastewater from our domestic and industrial customers are an integral part of an efficient and cost effective wastewater treatment service.

Our research with Thames Water Utilities has helped develop a range of tools to understand and manage large city scale sewerage networks.

Methods for the use of biochemical solutions to the major problem of fat blockage of sewers have been developed on real applications beneath the streets of London.



A matrix assessment model, combined with ground penetrating radar, is being used to identify sewers that require repair or are in danger of collapse.

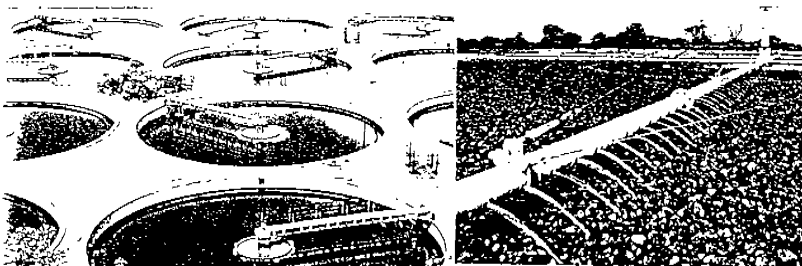
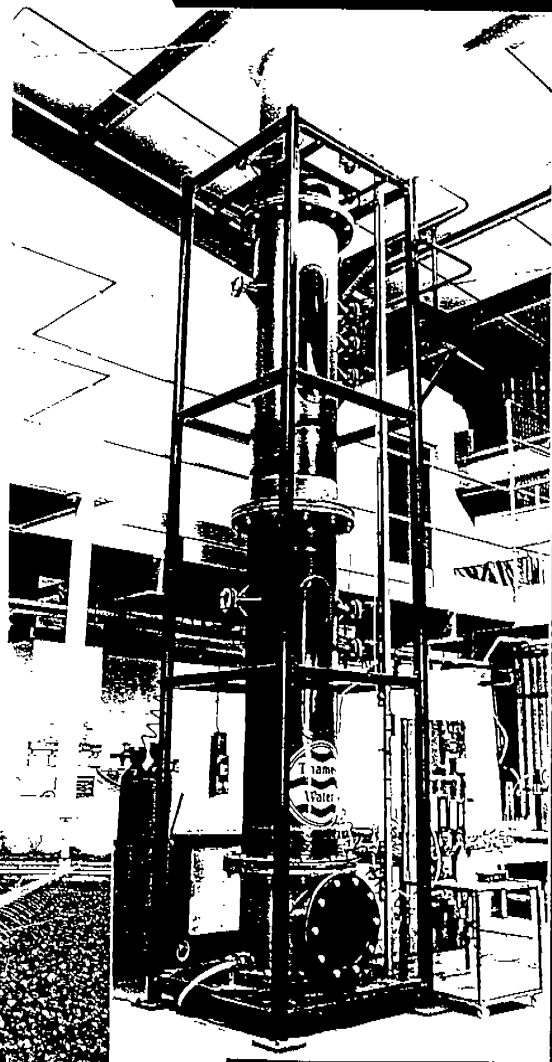
A novel in-sewer flow monitor, the Flow-Stick has been developed with Simon Hartley. Surveys of flows in the London sewerage system have shown how to optimise pump operation, minimise sewer overflows into the environment and maximise the storage capacity of the sewerage network.

## WASTEWATER TREATMENT

Thames Water operates approximately 400 wastewater treatment plants worldwide. Our research is focused on reducing the capital and operating costs of these plants whilst maintaining the required effluent quality standards.

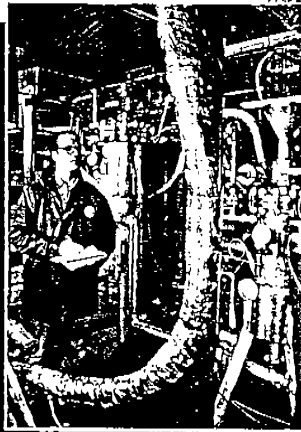
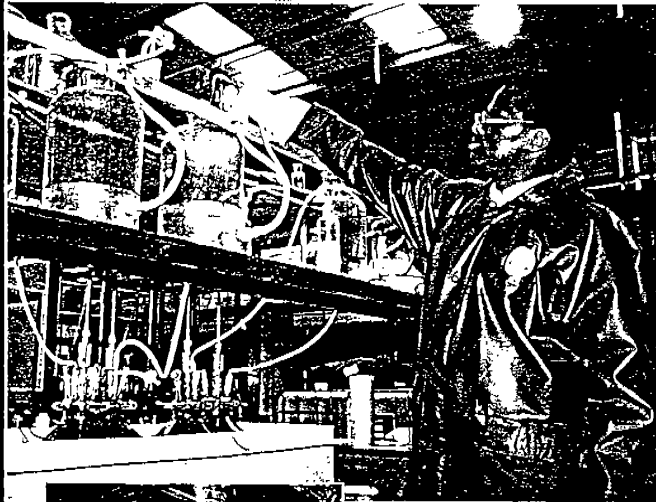
Key areas of research include reducing aeration costs, the development of small footprint processes such as inclined tube settlers and Biological Aerated Filters, the optimisation of biological phosphorous removal in activated sludge processes, and the use of computational fluid dynamics to optimise settlement tank and lagoon design.

Further work has been carried out on the treatment and disinfection of wastewater effluents for industrial reuse or irrigation, with dissolved air floatation, membrane microfiltration and Ultra Violet radiation.





## Recycling Waste . . .



In the USA we are co-operating with the Ashbrook Corporation to develop an enhanced drying capability for the successful Ashbrook belt press dewatering plant. Other work has been carried out to optimise sludge dewatering through real time control of poly-electrolyte dosing and mixing energy in presses and centrifuges.

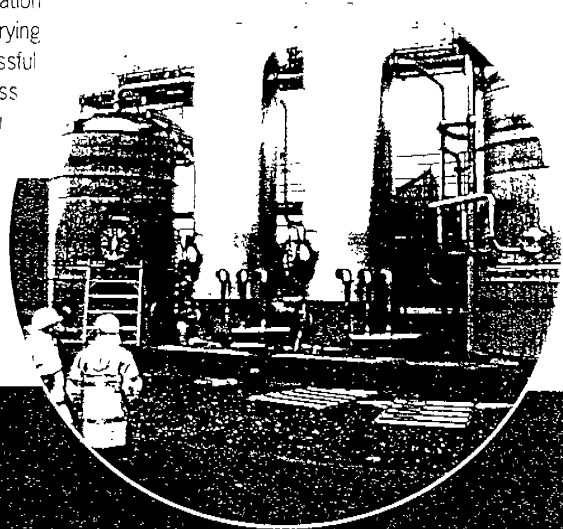
## WATER AND WASTEWATER SLUDGE TREATMENT AND DISPOSAL

Research in the area of water and wastewater sludge treatment and disposal has focused on the key issues of safety and cost.

Beneficial use of wastewater biosolids can be achieved through recycling to agricultural land, for land remediation, or for use as a fuel to produce energy.

Work has been carried out to develop cost effective processes that ensure the required reductions in pathogens are met prior to disposal and that the product does not generate odours or leach nutrients into the environment.

A new thermal hydrolysis process for enhanced pathogen reduction has been developed with Simon Hartley Ltd. and installed at Thames Water's Chertsey Wastewater Treatment Plant.



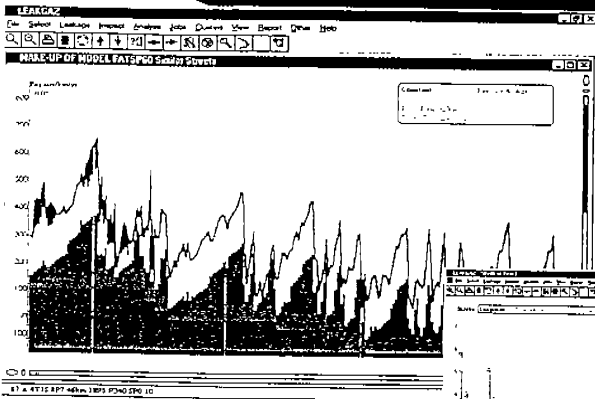
## GREEN ENERGY

New sludge powered generators at the Beckton and Crossness treatment plants in London burn waste sludges to generate "green" electricity. Known as "Ecotricity", this novel power source reduces demands on conventional fossil fuel systems.

Research has been carried out with Thames Water Utilities and Thames Waste Management to ensure these plants comply with strict environmental emission controls. In other work with Thames Waste Management we have developed a process for the co-digestion of sewage sludge and municipal solid waste to enhance gas and energy production.

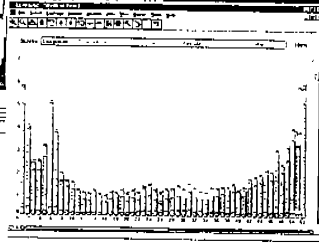


## MODELLING AND DECISION SUPPORT



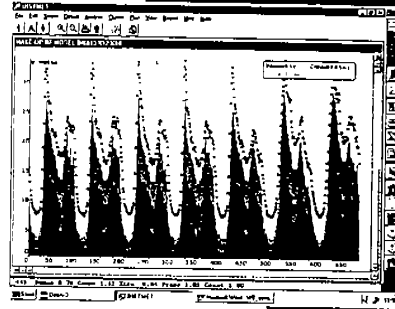
Research and Technology's decision support capability is being used by Thames Water to provide practical solutions to complex operational and strategic challenges. Working closely with our customers, with accurate analysis of data and an understanding of the real issues, we have developed a range of predictive cause and effect models that offer real savings both now and in the future.

Within the scenario of climate change around the world, a Water Balance Model has been developed. This provides a better understanding of customer water demand and the influence of other factors, such as weather and leakage, on the volume of water into supply.



Other models, which accurately target repairs, modifications and future investment, have been developed to help manage the large underground pipe networks that Thames Water operates in large cities, such as London.

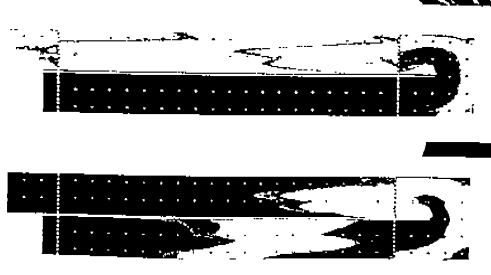
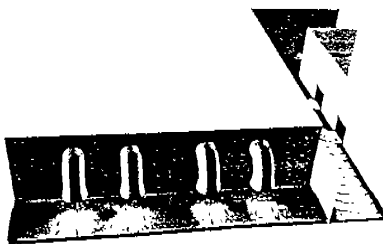
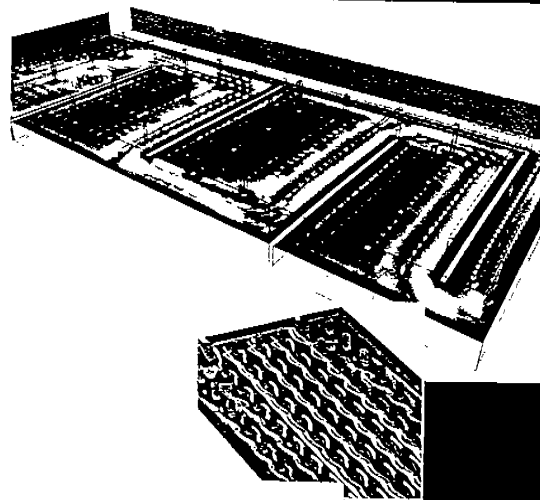
The development and use of the award winning NETSCED pump scheduling model has resulted in significant operational savings through the more efficient use of pumps on the Thames Water Ring Main, a 2m diameter 70 km long treated water distribution tunnel around London.



## COMPUTATIONAL FLUID DYNAMICS (CFD)

Thames Water Research and Technology utilises CFD simulation to optimise process design of water and wastewater treatment plants prior to construction, to assess the effects of scale up from pilot to full scale, and to troubleshoot problematic operational plants. The physics of water treatment processes can involve complex air, water and solid flows in pipes, channels and tanks. Geometries range from simple rectangular tanks to more complex baffle/plate/pipe arrangements and detailed nozzle design.

Processes investigated so far include dissolved air flotation, disinfection contact tanks, service reservoirs, inclined tube settlers and tertiary lagoons. CFD has proved a powerful tool to achieve a greater understanding of best practice process design.



# Protecting Quality...



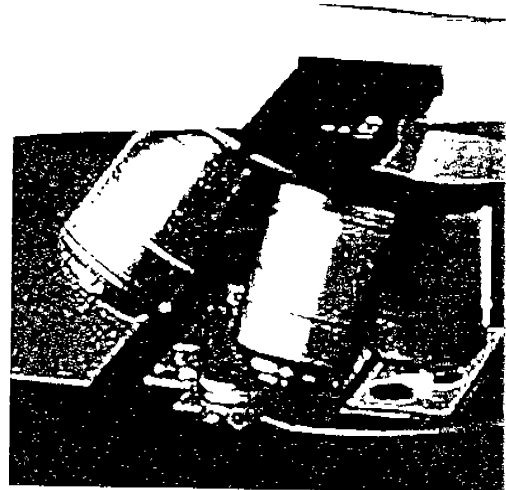
## FILTRATION AUDITS

Rapid gravity filters are a common feature of water treatment plants around the world. Many of these plants have been installed for a number of years and may not benefit from the new technology and greater understanding of process design and operation available today.

Research has shown that, unless plants are operated correctly, micro-organisms such as *Cryptosporidium* which are resistant to chlorination, can pass through the filter and enter the water supply, causing a potential risk to public health.



Using our expertise in filter design and operation, analytical method development and pathogen morphology, Thames Water's Research and Technology Group has carried out a number of filtration audits for customers around the world to assess process performance and recommend where appropriate, plant modifications and improvements to operating practice to minimise the risk of pathogen breakthrough.

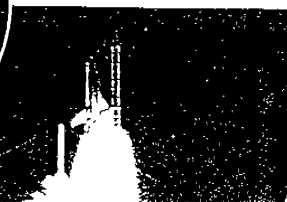
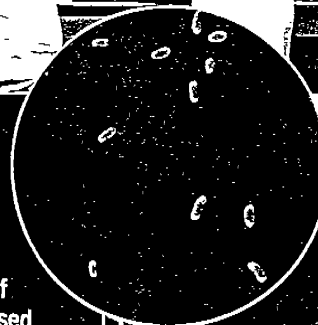


## RAPID 'BUG' TESTING

Thames Water's customers worldwide receive the benefits of microbiological analytical method developments carried out by Research and Technology's Development Microbiologists.

New, faster methods for monitoring and confirming the presence of pathogens, such as *E.Coli*, have been developed and put into practice as routine in our water service companies.

Application of this work does not stop with our earthly customers. Work has been carried out with NASA to test the water supplies on the Space Shuttle and the MIR Space Station. Such research will provide a greater understanding of disinfection requirements and bacterial growth in earth based recycling systems and the confined pipe networks of orbiting and interplanetary spacecraft.



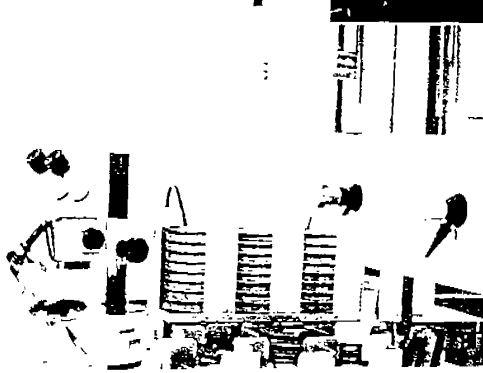
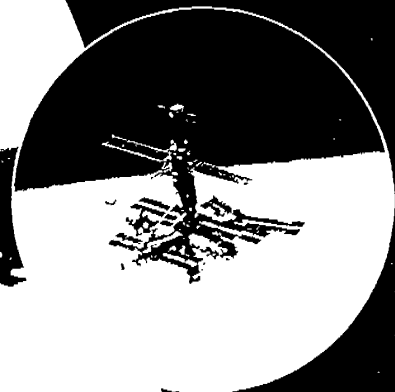
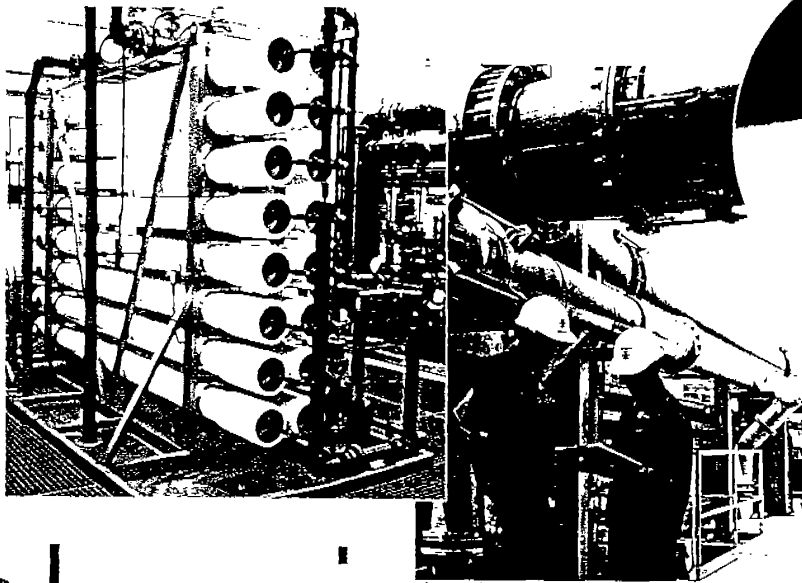
partnership  
creative listening

thinking  
innovation

practical  
solutions

technical  
excellence

- To work and learn in partnership with our customers
- To apply creative thinking to deliver innovative and practical solutions
- To ensure technical excellence underpins all of our activities

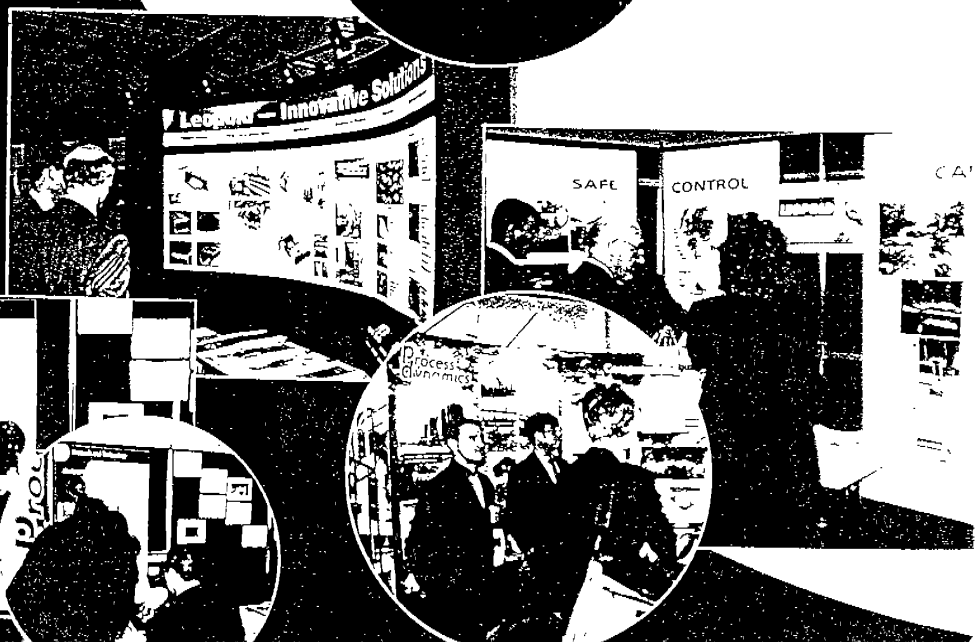


# Our Global Knowledge Sharing Network

Thames Water Research and Technology supports research, develops understanding, shares knowledge and learns with its many global partners.



The  
Oxford Centre  
for Water  
Research



*If you would like to join our global family talk to us at*

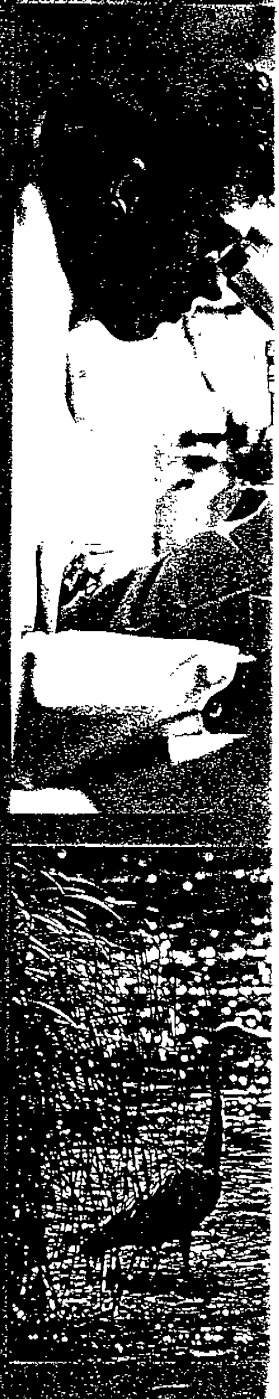
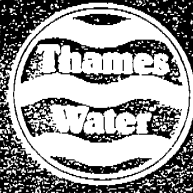
Thames Water Research and Technology  
Spencer House, Manor Farm Road, Reading, Berks, UK, RG2 0JN  
Phone: +44 (0)1189 236 271  
Fax: +44 (0)1189 236 402  
Email: [global.research@thameswater.co.uk](mailto:global.research@thameswater.co.uk)  
Web: [www.Thames-Water.com](http://www.Thames-Water.com)



*R&T  
Global Water Club*

*Re-T Centre*

*Growing Re-T Centre with co...*



**Environmental  
solutions for  
industry  
and commerce**

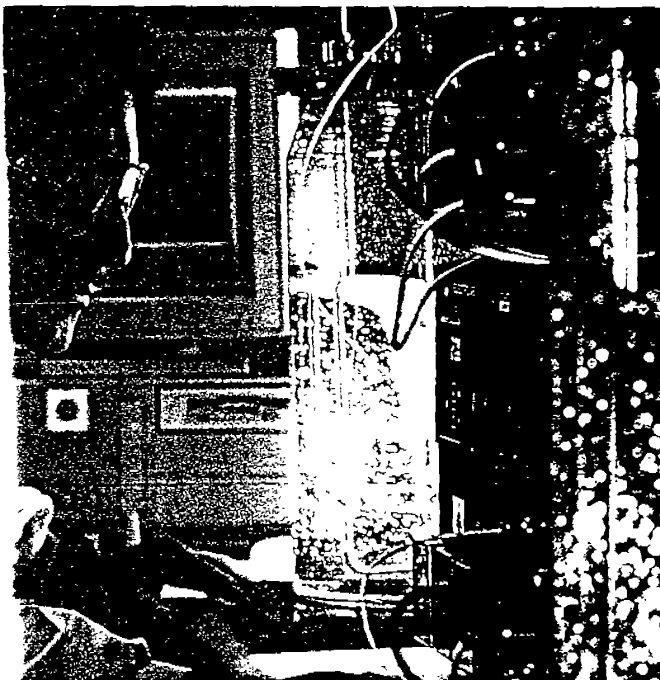
## Environmental solutions for industry and commerce

The Thames Water Group has environment related businesses throughout the world. Its turnover exceeds £1 billion and it employs over 10,000 people.

Thames Water offers a comprehensive range of services. They include operational management of water and waste water systems, the supply of water treatment products, water process engineering as well as specialist environmental services.

Thames Water Utilities Limited, the largest of the ten UK water and sewerage companies, forms the core business within the Thames Water Group. It supplies quality water to more than 7 million customers and carefully treats the waste from almost 12 million.

Providing solutions to environmental problems, we draw on the depth of expertise and experience in the Utility business and combine relevant skills of other companies in the Thames Water Group. In total these companies have sales in excess of £150 million, making the Thames Water Group one of the UK's largest providers of environmental consultancy and contracting services.



NAMAS accredited laboratories

## Consultancy

We are able to offer independent advice on the environmental issues faced by business, industry and municipal authorities throughout the UK.

- **Design of water and wastewater systems for cities, towns and businesses**  
Using our experience as a supplier of drinking water and processor of wastewater for over 11m people
- **Water storage**  
Design of bulk water storage and transfer systems
- **Process design and optimisation**  
Technical design of water treatment systems and the efficiency upgrading of existing systems
- **Geographical information systems (GIS)**  
Supply and implementation of software to record, manage and update asset data bases. Includes prediction of specific conditions using modelling techniques
- **Land and hydrographic surveys using GPS**  
Surveys of sites, assets and areas using satellite technology surveying equipment
- **Ground water extraction**  
Evaluation of the hydro-geological regime and geotechnical surveys for private water sources
- **Water re-use**  
Advice on technical options and legal framework for water recycling and the treatment and re-use of waste water
- **Water quality**  
Consultancy on water quality in factories and other buildings, particularly on process water and the prevention of Legionnaires Disease, together with on-going monitoring and analysis
- **Water meter selection**  
Advice on the most appropriate system and use of the latest technology
- **Trade effluent**  
Guidance on cost minimisation including cost/benefit analysis between disposal to public sewer, in-house treatment and transport to external treatment
- **Odour mapping**  
Quantitative assessment of the spread of odour from a given source, aiding in planning matters and the selection of appropriate remediation

## Laboratory services

Through our in-house NAMAS accredited laboratories we are able to provide comprehensive and competitively priced analytical services.

### Chemical and microbiological testing

This covers drinking and process water for the food and beverage industries. Analysis of non-potable water, trade effluent and toxicology can also be provided.

### Soils and sludge analysis

Contaminated land can be tested to fully characterise the site and assess the potential risk to the environment.

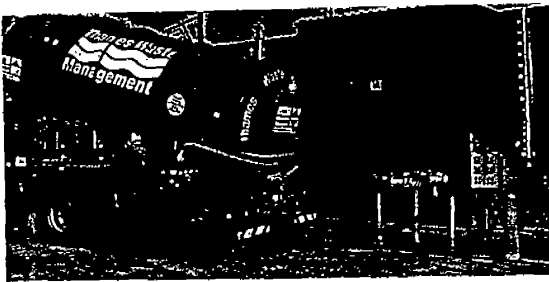
### Materials testing

Accelerated testing service for checking the suitability of materials for use in contact with drinking water.

### Specialist services

Our water treatment and effluent sewerage treatment plant consultants can provide a wide range of specialist services.





Safe disposal of clients' liquid and sludge wastes

## Waste management

Thames Water offers a wide range of waste management services to major industrial and commercial companies and local authorities in the south of England.

- **Dry waste**  
Strategically located landfill disposal sites in the London area suitable for industrial and municipal waste, together with a dry waste collection fleet.
- **Transfer stations and waste recycling facilities**  
Development and operation of modern, fully enclosed transfer stations for local authority wastes. Recycling can be incorporated and waste pulverised to extract the organic fraction for anaerobic digestion with sewage sludge.
- **Liquid haulage and disposal**  
Transport of a broad range of industrial liquid and sludge wastes from the food and drink, cosmetics, pharmaceutical, detergents, oil and gas, paper and textile industries. We have a specialist fleet of road tankers and provide transport and disposal of packaged and drummed chemicals and waste.
- **Liquid waste treatment**  
Operation of liquid waste treatment facilities for disposal of biological wastes from food processing, brewing, paper and textile, cosmetics and pharmaceutical industries. Oily and inorganic liquid waste can also be handled.
- **On-site waste treatment facilities**  
As an alternative to tankering, in-house waste treatment plants can be designed and installed on the waste producer's premises. Membrane technology can be used, for example, to recover process water for re-use or treat waste waters to meet discharge contents. Similar processes are also available for leachate treatment.
- **Contaminated land**  
A complete service is available for contaminated land remediation including site sampling, design and soil analysis and their interpretation, evaluation of remediation alternatives, site excavation and waste transport and disposal, leachate treatment and site restoration.
- **Materials handling and industrial cleaning**  
Speciality vacuum recovery and pumping equipment, operated by skilled professionals, provides individual solutions to many material handling problems. We can recover liquids, solids and sludge from confined spaces, transfer thixotropic sludge and manage dewatering lagoons. We specialise in tackling unique waste problems in hostile environments.

These services comply with all current legislation and ensure that wastes are handled and disposed of in an environmentally responsible manner.

## Maintenance services

In Mechanical, Electrical, Instrumentation control and automation and associated disciplines, we offer a comprehensive Asset Maintenance service. In partnership with our customers we can provide:

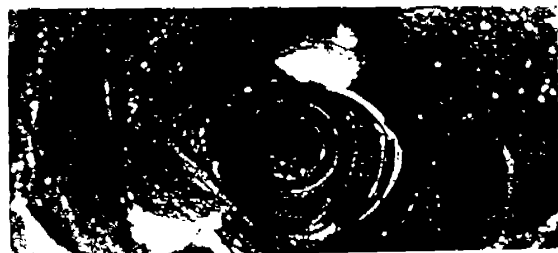
- *Formalization and implementation of maintenance strategies*
- *Mechanical, electrical and instrumentation contracts*
- *Asset repairs and refurbishment*
- *Product development*
- *Spares support*
- *Training*
- *Total health and safety management*

## Underground pipeline services

We provide specialist services for all aspects of pipework in industry and large estate holders such as hospitals, government departments and the MoD. We cover water supply, drainage, sewers, gas and underground cables. The range of services includes inspection, implementation of new and remedial works, rehabilitation, and aftercare.

- **New services**  
We can design and install, including metering. Considerable savings and reduced disruption can be achieved by allowing us to provide a multi-utility new service package.
- **Utility tracing**  
On older sites, the location of underground services is often uncertain. We provide a comprehensive service for the locating and mapping of water mains, gas pipes, cables, drains and sewers.
- **Leakage detection and repair**  
We can investigate on-site leakage and implement all necessary repairs to achieve significant reductions in water loss. As part of this service, full flow surveys can be provided, which can result in pressure and flow improvement to critical use areas.
- **Quality improvement**  
Poor quality water on large sites is frequently caused by deterioration of underground service pipes. We provide inspection, analysis and remedial work to return quality to statutory levels. Secondary chlorination can be incorporated as an additional safeguard.
- **Blockage removal**  
We provide a nationwide 24 hour blockage removal service, either on an emergency call-out basis or as part of an on-going preventative maintenance package.

Where problems in underground pipelines have been identified, we will undertake remedial work either by traditional excavation or by innovative "trenchless" technology. The latter, in which Thames Water has unique world class expertise, minimises disruption and can save on costly excavation beneath access roads or operational buildings. In either case we provide a full utility contracting capability, incorporating design, implementation and full reinstatement including guaranteed fulfilment of all statutory obligations.



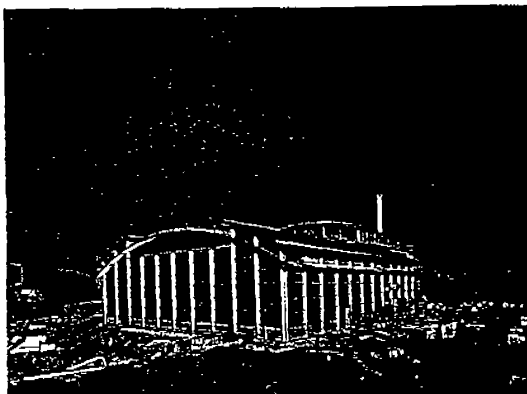
Condition of underground and process pipes and drains can



*Our experienced grounds maintenance teams work nationwide*

## Grounds maintenance

Nationwide we provide a landscape and grounds management service for local authorities, government departments, hospitals, MoD sites and other land owners. This includes grass cutting and sports ground upkeep, tree and woodland maintenance as well as the traditional skills of large scale flower bed and shrub management. We work with clients to ensure sound management of grounds and all year-round displays



*Thames Water's Crossness and Beckton incinerators provide the best environmental solution for London's sludge*

## Water/waste facilities management

Our specialist skills in consultancy, laboratory services, waste management and pipeline services are available to solve individual problems which may arise. In addition, Thames Water can supply a facilities management package bringing some or all of these together, either for an individual project or to provide a complete long term environmental solution.

- **Project management**  
We can manage a project from initial consultancy, through client cost approval to final completion. Engineering resources are available to design and manage the construction of new pipeline and sewer networks for municipal housing, commercial and industrial developments.
- **Operations**  
We provide a full service to operate water and waste treatment facilities on clients' premises, including the TUPE transfer of existing staff. Such contracts can be on a labour-only basis or a fixed price annual sum including all materials and maintenance costs.
- **Water cycle management**  
For complex or extensive sites we offer a comprehensive environmental management capability. This covers the complete cycle of water usage from initial supply to waste and effluent disposal. It transfers a complex chain of diverse responsibilities into the hands of a single competent organisation. Conformity with the rapidly expanding scope of environmental legislation is assured, leaving clients free to concentrate on their own activities.

## Resources

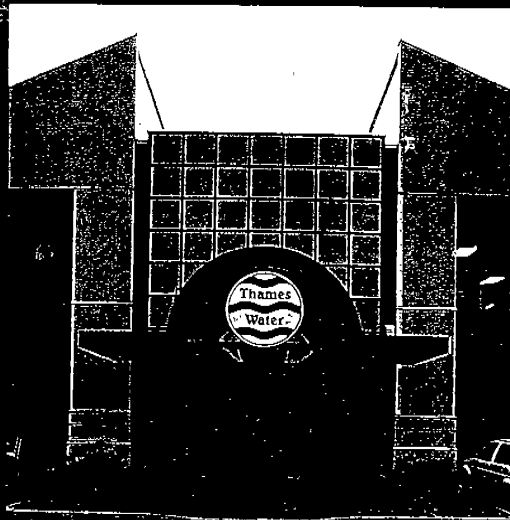
The Thames Water Group has the financial resources and stability which major clients require before entering into substantial or long term commitments. Investment, for example, in analytical equipment and capital plant, ensures that proper facilities are made available.

Thames Water companies also have the benefit of the Group's personnel policies. A long running graduate recruitment programme and emphasis on continuing management development give our clients access to well-qualified and experienced professionals in all the necessary environmental and contracting disciplines. This is complemented by the Group's Research & Development programme to ensure that Thames Water continues in the forefront of technology.

Great stress is laid on Health & Safety matters. All Thames Water companies conform to Thames Water's strict procedures in this critical field, with qualified full time Health & Safety staff.

Thames Water Commercial Services  
Napier Court 6, Nugent House,  
Vastern Road, Reading, Berkshire RG1 8DB  
Tel. 0118 9399393 Fax: 0118 9399390





**The Water Quality Centre  
Spencer House  
Manor Farm Road  
Reading  
Berkshire  
RG2 0JN  
ENGLAND**

**Telephone 01189 236214  
Fax 01189 236373**



## Undertaking

## special

## assignments

The Water Quality Centre has tackled all kinds of special projects for companies. These range from design evaluation of water system drawings, evaluation and commissioning of new water systems, trials of new plant and technologies and research projects. As we can draw upon the resources of Thames Water a broad consultancy service can be provided to clients in all aspects relating to both clean and dirty water.

### **CASE HISTORY: EVALUATING A NEW COOLING TOWER TREATMENT SYSTEM**

THE WATER QUALITY CENTRE WAS ASKED TO DESIGN AND RUN AN INDEPENDENT TRIAL TO TEST A PROTOTYPE ELECTROLYTIC ION GENERATOR IN A COOLING TOWER SYSTEM.



THE CLIENT DEVELOPED THE SYSTEM AS AN ALTERNATIVE TO CONVENTIONAL BIOCIDES DOSING. A SIX MONTH TRIAL WAS DEvised IN ASSOCIATION WITH THE COMPANY AND THE RESULTS WERE PUBLISHED IN A SCIENTIFIC JOURNAL. SINCE THE TRIAL, THE PROTOTYPE HAS BEEN MODIFIED AND THE COMPANY IS ABOUT TO EMBARK ON FULL-SCALE MANUFACTURE.

SIMILAR TRIAL WORK HAS ALSO BEEN UNDERTAKEN WITH ULTRA-VIOLET DEVICES IN GREENHOUSE SPRAY-MISTING SYSTEMS, WET EVAPORATIVE COOLING TOWERS AND HUMIDIFIERS.

BY EMPLOYING THE WATER QUALITY CENTRE, CLIENTS CAN BE CONFIDENT THAT THEY WILL RECEIVE A SPECIALIST AND WHOLLY INDEPENDENT ASSESSMENT.

### **CASE HISTORY: A DESIGN EVALUATION TASK**

THE WATER QUALITY CENTRE WAS ASKED BY A CLIENT TO REVIEW THE DESIGN OF A DOMESTIC WATER SYSTEM FOR A NEW MULTI-STOREY OFFICE BLOCK DEVELOPMENT.

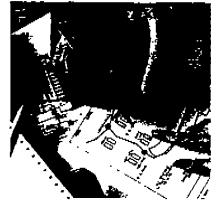
BY EXAMINING THE DRAWINGS WE WERE ABLE TO HIGHLIGHT SEVERAL POTENTIAL WATER QUALITY PROBLEMS:

WE ADVISED MODIFICATIONS TO THE DRINKING WATER SUPPLY TO THE VENDING MACHINES. THE ORIGINAL PLANS PROPOSED

FITTING MACHINES AT THE ENDS OF THE DISTRIBUTION PIPEWORK ON EACH FLOOR.

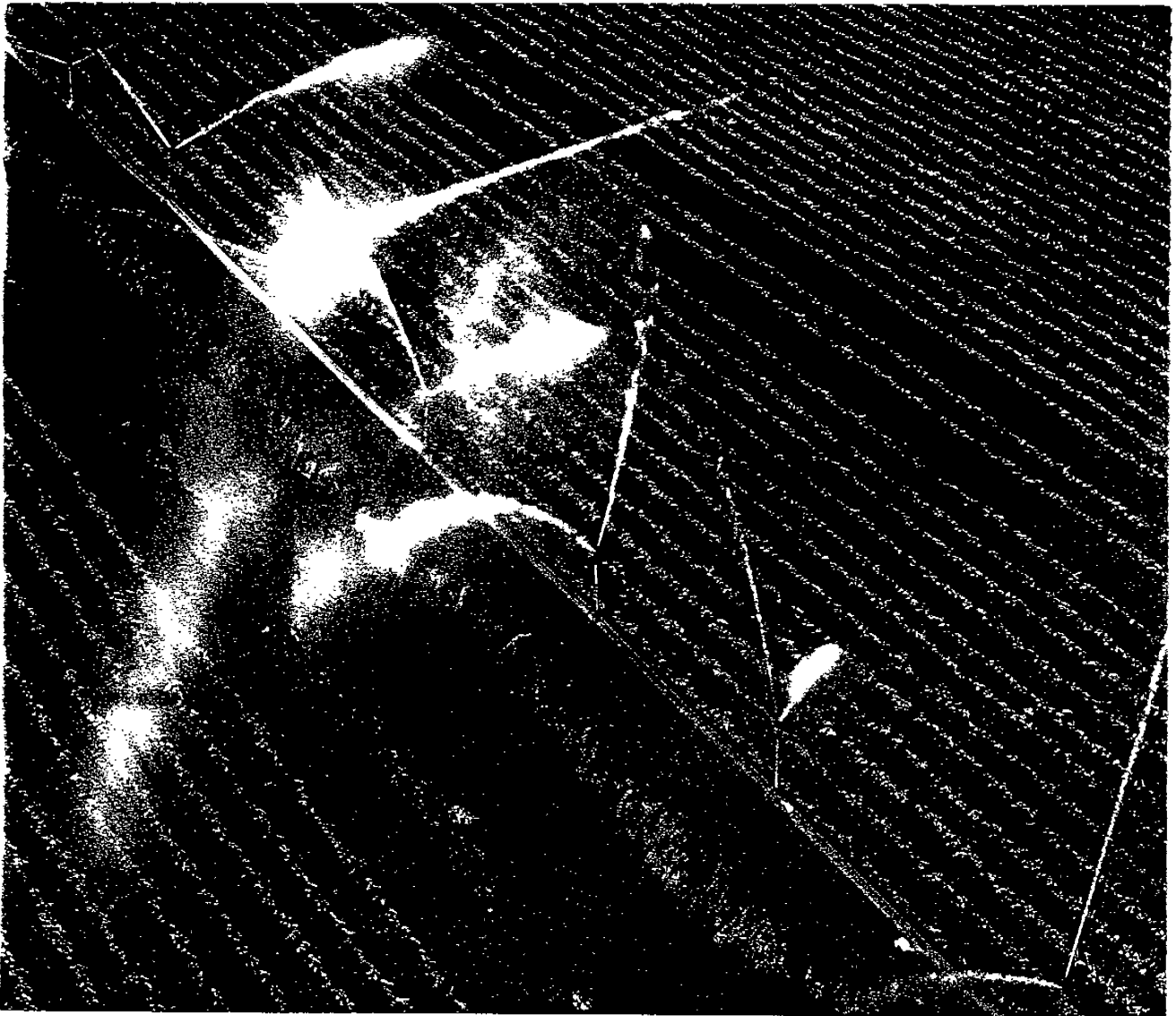
TO PREVENT WATER FROM STAGNATING IN THE PIPEWORK, WE ADVISED THE INSTALLATION OF HIGH USE FITTINGS (SUCH AS TAPS IN THE KITCHEN AREAS) BEYOND EACH VENDING MACHINE.

TO PREVENT WARMING OF WATER WHILST HELD IN THE DISTRIBUTION PIPEWORK, RE-ROUTING OF THE COLD WATER AND DRINKING WATER PIPES WAS ADVISED TO ENSURE THAT THEY WOULD NOT RUN NEAR HEAT SOURCES SUCH AS RADIATORS AND HOT WATER PIPES.



RECOMMENDATIONS WERE MADE TO INSTALL INSTANTANEOUS WATER HEATERS AT THE FAR POINTS OF THE HOT WATER DISTRIBUTION SYSTEM TO PREVENT HEAT LOSS AND STAGNATION

## Special projects



**CASE HISTORY:**  
COMMISSIONING A  
NEW DEIONISATION  
PLANT

THE WATER QUALITY  
CENTRE WAS ASKED BY A  
MANUFACTURING COMPANY  
TO PERFORM INDEPENDENT  
BI-WEEKLY SAMPLING OF A  
LARGE NEW DEIONISATION  
PLANT BEFORE BRINGING IT  
ON-LINE

A SAMPLING PROGRAMME  
INVOLVING THE COLLECTION  
OF WATER SAMPLES FROM  
STRATEGIC POINTS IN THE  
SYSTEM WAS DEvised

AFTER INITIAL TEETHING  
PROBLEMS AND MINOR

ADJUSTMENTS, THE PLANT  
WAS SUCCESSFULLY  
COMMISSIONED.

MONITORING PLANT  
PERFORMANCE IS NOW PART  
OF THE ROUTINE



**Providing a  
comprehensive  
analysis  
service**



We provide a full analysis service for microbiology and physico-chemical testing of water, soil, sludge, sediment and effluent.

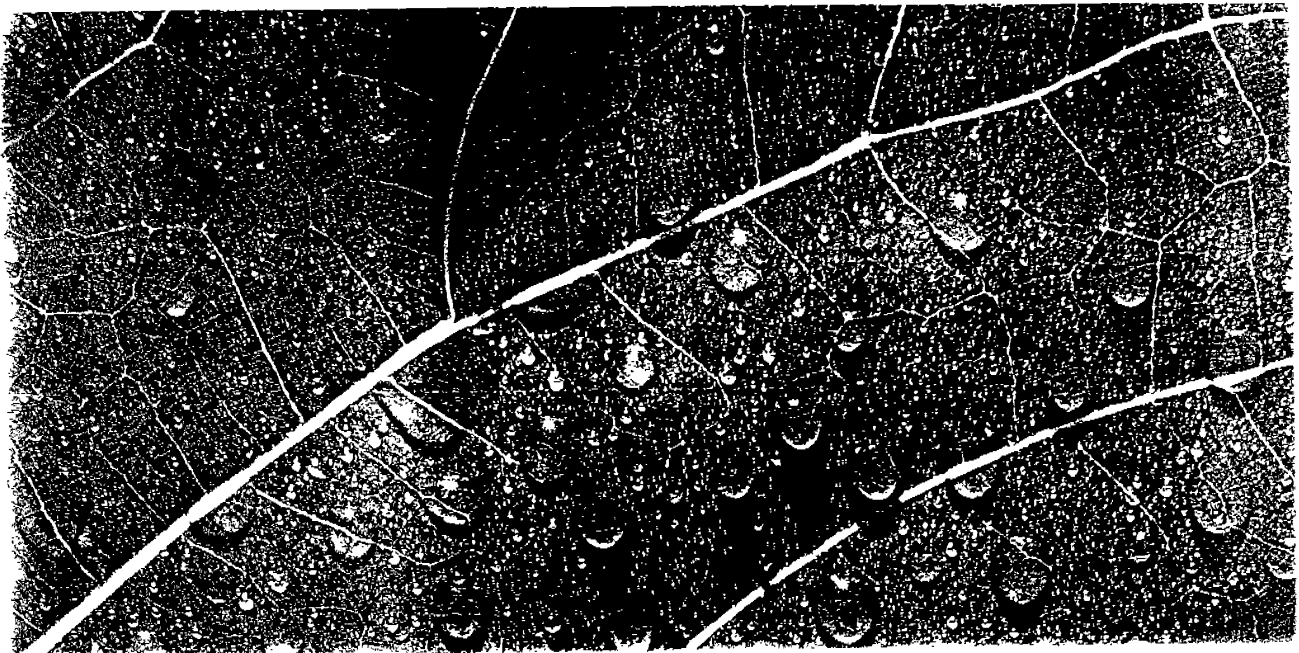
In addition we offer specialist and research services including electron microscopy, flow cytometry, biodegradation studies, biofilm examination and material testing.

All samples are analysed in our new, advanced purpose designed laboratories located in Spence House, Reading and in a London Docklands. Both laboratories offer approximately 500 different analyses of a comprehensive range of sample types. We analyse some 300,000 samples annually requiring over two million individual tests.

We operate our laboratories to maintain high standards of quality control and are fully accredited by NAMAS.

Our analytical services are detailed in separate brochures. Please visit us on [www.fox.com](http://www.fox.com)

**Laboratory analysis**



DESIGNED BY LLOYD NORTHMOLE LIMITED BY DAYLAB PLC

THE WATER QUALITY CENTRE | consultancy



WQ

**THE WATER QUALITY CENTRE**  
*Materials Testing & Consultancy*



### The Water Quality Centre

The Water Quality Centre is the largest laboratory in the UK testing materials for compliance with BS6920 and the Water Byelaws Scheme. Our work is carried out for British and international clients that vary from large multinational companies to small businesses. Our clients are guaranteed a professional, competitive and confidential service testing the suitability of materials that come into contact with drinking (potable) water.

### Why testing began

During the 1950s and '60s awareness grew that materials such as sealants, solder fluxes, lubricants, coatings and rubbers were affecting the quality of water in both supply and distribution systems. Some of these materials can:

- produce off-tasting water
- affect the appearance of water
- promote the growth of bacteria in the water
- leach harmful substances into the water

This awareness led directly to the development of testing methods to protect drinking water

### Development of materials test methods

This work in the 1950s led us to develop test methods to identify potentially unsuitable materials for drinking water use. These methods became the basis for the listing of materials and products by the National Water Council.

At the request of the water industry the British Standard Institute (BSI) published standard DD82 to cover the testing of materials. Further development of testing methods in our laboratories then became the basis of both the "Water<sup>Q</sup>" Byelaws Scheme Tests of Effect on Water Quality" and BS6920.

Currently the UK is the only European country with such comprehensive methods of testing. At Thames Water we play a leading role in Europe in the development of standards for materials used with drinking water.

### Test Facilities

All testing is undertaken in our United Kingdom Accreditation Service (UKAS) laboratories which are fully equipped to deal with any aspect of materials testing. These facilities include:

- Sophisticated curing cabinets for site applied products
- Inductively coupled plasma optical emissions spectroscopy (ICP-OES) for metals analysis
- Gas chromatography mass spectroscopy (GCMS) for organic compounds

### Testing of Site Applied Products

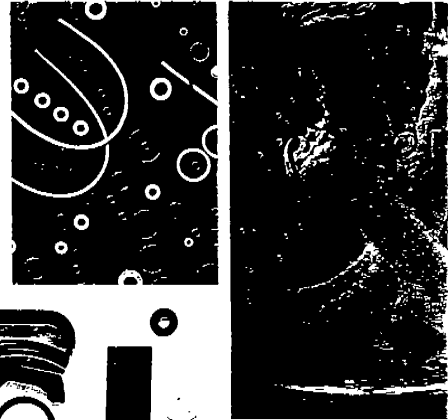
Even with the best controlled procedures on site, it can be difficult to ensure that products are correctly cured. To ensure that site applied products are realistically prepared BS6920 gives two approaches

- 1) Samples are prepared and cured in our test laboratory using special cabinets in which humidity and temperature can be controlled
- 2) Samples are prepared on site under the supervision of a member of staff and then cured in our test laboratory



*Clockwise from top left,  
Taste assessment  
Microbial growth on a tap splash spout,  
Biofilm on a sealant  
Application of a spray coating*

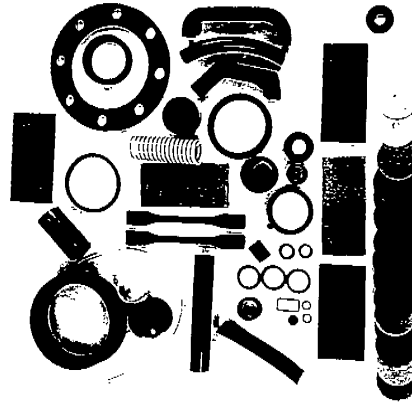
*ISO 10221:1993  
 Braided packings for valves  
 Typical non-metallic materials*



**Drinking Water (Water for Domestic Use) (DWI) Regulations 1989 testing**

Materials that are used within buildings are tested under the Water Byelaws Scheme to ensure they do not contaminate the water supply within the building or present any danger to the mains supply through back siphonage.

There is a greater risk to the water supply and public health from toxic chemicals being leached from materials used in treatment plants and mains distribution systems. As a result additional tests may have to be undertaken before such materials can be used.



**Tests Required**

The tests you will need are specified for each product by a DWI committee. We can help you liaise with the committee to find out what tests will be needed.

When you know what your specific requirements are we will be pleased to discuss them with you and provide a detailed quotation for the work.

**Specialised testing**

The Water Quality Centre offers a number of specialised tests:

- 1. Water Byelaws Scheme Tests of Effect on Water Quality and BS6920 "Suitability of non metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water"

- 2. ISO 10221:1993 "Ductile iron pipelines carrying potable water".
- 3. German KTW recommendations "Hygienic assessment of plastics and other non-metallic materials with respect to the "Law for food and Requisites" in the range of contact with drinking water"
- 4. BS7766:1994 "Assessment of the potential for metallic materials to affect adversely the quality of water intended for human consumption"

**Consultancy Services**

At The Water Quality Centre we provide a comprehensive Consultancy Service for all aspects of materials testing.

We can help you understand why materials fail the requirements set down by BS6920 and also help with the development of new materials for use with drinking water.

For further details please call us on:

Telephone: 01189 236214

Fax: 01189 236373

WQ<sup>c</sup>

THE WATER QUALITY CENTRE | consultancy

THAMES WATER UTILITIES LIMITED

Wq<sup>c</sup>

THE WATER QUALITY CENTRE

#### **SURVEYS**

WATER QUALITY SURVEYS OF BUILDING WATER SYSTEMS, DOMESTIC HOT AND COLD WATER SYSTEMS, PROCESS WATERS, AIR CONDITIONING SYSTEMS, FIRE SYSTEMS, EFFLUENT TREATMENT PLANTS, PRIVATE WATER SUPPLIES.

FOOD HYGIENE SURVEYS  
ADVICE ON CLEANING AND PREVENTION OF CONTAMINATION IN FOOD PRODUCTION PREMISES AND RETAIL OUTLETS.

SPECIFIC SURVEY WORK  
TAILORED TO CLIENT REQUIREMENTS.

#### **MONITORING**

INDEPENDENT REGULAR QUALITY ASSURANCE TESTING OF WATER SYSTEMS

A SERVICE WHICH PROVIDES THE CLIENT WITH PEACE OF MIND BY ENSURING THAT SYSTEMS ARE OPERATING SAFELY AND EFFECTIVELY.

#### **TROUBLE SHOOTING**

PROBLEM SOLVING  
A RAPID AND DISCREET SERVICE WHEN THINGS GO WRONG. PRACTICAL ADVICE TO HELP SOLVE PROBLEMS WITH CLEAN AND DIRTY WATER SYSTEMS.

#### **TRAINING**

REGULAR COURSES ON A WIDE RANGE OF WATER QUALITY ISSUES

BESPOKE COURSES  
TAILORED TO SPECIFIC CLIENT REQUIREMENTS CAN ALSO BE ARRANGED.

#### **SPECIAL PROJECTS**

SPECIAL WATER RELATED PROJECTS AND RESEARCH PROGRAMMES  
NEW WATER SYSTEM DESIGN EVALUATION, NEW PRODUCT DEVELOPMENT TESTING, FIELD TRIAL WORK.

#### **ANALYSIS**

COMPREHENSIVE MICROBIOLOGICAL AND PHYSICO-CHEMICAL ANALYSIS SERVICE  
CLEAN WATERS, RECREATIONAL WATERS, PRIVATE WATER SUPPLIES (INCLUDING WELLS AND BOREHOLES), DIRTY WATERS, SLUDGES, SEDIMENTS, SOILS, FOODSTUFFS, MATERIALS TESTING AND ELECTRON MICROSCOPY.

ALL ANALYSIS WORK IS PERFORMED IN OUR NAMAS ACCREDITED LABORATORIES IN LONDON AND READING.

FULL DETAILS ARE PROVIDED IN OUR ANALYSIS BROCHURE.

**The**

**Water Quality**

**Centre**

The Water Quality Centre is a specialist organisation offering consultancy, training and analysis services in water quality. Our particular expertise is in creating and maintaining water quality, and especially in the prevention of Legionnaires' Disease.

We are a division of Thames Water staffed by trained and experienced consultants with professional backgrounds in chemistry, microbiology and environmental science. We can draw on Thames Water's extensive resources and facilities, including its Research and Development Department, Operational Sciences Unit and Laboratories.

All assignments are treated totally confidentially. As we do not market or sell any equipment, products or chemicals, our advice is wholly independent.

Our service is fast, our fees competitive. We pride ourselves on giving excellent value and on the speedy delivery of results and reports. Our recommendations are always objective and practical.

Located in London and Reading, we provide our services throughout the UK and overseas.

**wq**





**CASE HISTORY:**  
**MAKING AN OFFICE**  
**WATER SUPPLY SAFE**

A CONTRACTOR PERFORMED QUARTERLY LEGIONELLA TESTING ON SELECTED TAP OUTLETS. LEGIONELLAE WERE OFTEN FOUND AND THE WATER SYSTEMS WERE DISINFECTED AND RE-SAMPLED. THIS WAS DISRUPTIVE, EXPENSIVE AND CAUSED CONCERN AMONGST STAFF. THE BUILDING MANAGER FELT THAT THE CONTRACTOR WAS TREATING THE SYMPTOMS AND NOT THE CAUSE OF THE PROBLEM. HE COMMISSIONED A SURVEY FROM THE WATER QUALITY CENTRE.

OUR INVESTIGATION REVEALED:

▲ EXCESSIVE COLD WATER STORAGE WHICH WAS PRONE TO WARMING AND STAGNATION.

▲ SEVERAL OUTLETS WERE HARDLY USED.

▲ THE CALORIFIER WAS UNDERSIZED AND COULD NOT PROVIDE ENOUGH HOT WATER AT THE CORRECT TEMPERATURE.

ARMED WITH OUR RECOMMENDATIONS, THE BUILDING MANAGER REDUCED STORAGE CAPACITY (SOME CISTERNS WERE DISCONNECTED AND PIPEWORK MODIFIED TO IMPROVE CIRCULATION).

SEVERAL OUTLETS WERE REMOVED AND INSTANTANEOUS WATER HEATERS INSTALLED TO BOOST THE SUPPLY OF HOT WATER. SINCE IMPLEMENTATION

OUR RECOMMENDATIONS, NO LEGIONELLAE HAVE BEEN FOUND. SIGNIFICANT COST SAVINGS HAVE BEEN MADE AND STAFF ARE CONFIDENT THAT THE BUILDING IS SAFE.



## Water quality

is always

someone's

responsibility

Often building engineers or services managers are ultimately responsible for ensuring the quality of water systems within buildings. By commissioning the Water Quality Centre's trained and experienced consultants to carry out an independent survey those responsible can be assured peace of mind.

Our surveys are commissioned by a wide range of organisations, including government departments, hospitals, hotels, schools, offices, retail outlets, industrial and manufacturing companies.

We can survey all and every kind of water supply and system, for example:

*Drinking water* Vending machines, fountains and chillers

*Domestic hot and cold water systems* Cisterns, calorifiers, localised water heaters, heat reclaim systems, water softeners, chemical conditioners, showers and taps

*Process and industrial water systems* Water curtains, spray booths, cooling systems and heat exchangers

*Air conditioning systems* Wet evaporative cooling towers, condensers and humidifiers

*Fire systems* Hose and sprinkler systems

*Recreational water features* Fish and ornamental ponds, water flumes, swimming pools, spa baths and hydrotherapy pools

*Private water supplies* Boreholes and well waters

*Emergency eye washes and deluge shower systems*

*Water spray, misting and fogging systems.*

### Three types of survey

Surveys are tailored to individual client requirements, but they generally fall into one of these categories:

*Water system surveys* Water systems are examined and samples may be taken from strategic points. Our reports describe our findings and provide recommendations.

### *Legionellosis risk assessments*

Assessments are performed in accordance with the 1991 Health and Safety Commission Approved Code of Practice (ACOP) on the control of Legionellosis.

*Food hygiene surveys* Surveys are undertaken which include advice on cleaning and prevention of cross-contamination.

Surveys are complemented by laboratory tests for foodstuffs. Our survey reports contain scientific information laid out in clear non-technical terms. Emphasis is placed on providing guidance and practical solutions.

### The benefits

Many positive results can arise from a survey:

- ▲ Highlighting specific water quality problems, either actual or potential
- ▲ Cost effective and practical solutions, wherever problems have been identified
- ▲ Peace of mind, by ensuring the health and safety of employees and employers, and by establishing that the water systems comply with current legislation, standards and codes of practice. COSHH implications relating to the use, storage and handling of treatment chemicals will also be considered
- ▲ Independent assessment of the operation and management of water systems, including reviewing the performance of sub-contractors, maintenance companies and water treatment companies
- ▲ Advice on the safe and efficient operation of systems
- ▲ Recommendations for reducing energy, water consumption, chemical usage and effluent costs
- ▲ Advice on suitable maintenance and water quality

## Surveys





**CASE HISTORY:  
TESTING COOLING  
TOWER SYSTEMS**

THE WATER QUALITY CENTRAL WAS COMMISSIONED BY A MANUFACTURER IN THE STEEL INDUSTRY TO UNDERTAKE MONTHLY MONITORING OF TWO COOLING TOWER SYSTEMS.

ALTHOUGH THE TOWERS WERE SUBJECT TO CHEMICAL TREATMENT AND MAINTENANCE THE CLIENT WAS CONCERNED ABOUT WATER QUALITY IN THE TOWERS WHICH WERE OLD AND DIFFICULT TO DISMANTLE AND CLEAN. THE CLIENT WAS

SYSTEMS BUT WAS FACED WITH A LIMITED BUDGET.

MONITORING INDICATED THAT ALTHOUGH THE MICROBIOLOGICAL RESULTS WERE GENERALLY SATISFACTORY, BLEED RATES WERE SET TOO HIGH. FOLLOWING DISCUSSIONS WITH THE CHEMICAL TREATMENT COMPANY THESE WERE REDUCED AND THE CLIENT HAS OBSERVED APPRECIABLE SAVINGS ON CHEMICAL AND WATER BILLS.

HE MAY RETAIN THE TOWERS FOR ANOTHER TWO YEARS THUS POSTPONING MAJOR CAPITAL EXPENDITURE. MEANWHILE HE

REPORTS AND IS CONTACTED IMMEDIATELY WHEN OUT OF RANGE RESULTS ARE OBTAINED.





## Regular

## testing pays

## dividends

Many authoritative bodies consider that regular water quality assurance testing (monitoring) is an essential element in water management.

Monitoring involves the regular collection of water samples, physical examination of system components and review of maintenance procedures and management records.

Water quality monitoring can be highly cost effective. The collection of samples from strategic points within water systems and subjecting them to a few relatively simple and inexpensive tests is generally all that is required. This approach provides far more useful and reliable information than a series of complex, elaborate and expensive tests performed less frequently.

Once baseline data has been established for a water system, any out of range results can be rapidly identified and dealt with.

Monitoring undertaken by an agency independent of on-site staff, maintenance contractors and water treatment companies provides the building manager with an accurate and objective picture of what is going on.

The frequency, type and extent of monitoring varies from system to system. Factors such as age, method of operation, use and purpose of the building must be considered when planning a monitoring programme. Monitoring is tailored to the client's requirements and circumstances. For example, some clients collect and send in samples for analysis to reduce costs, but only after they have undergone a suitable training programme.

We issue regular reports which detail the analysis results obtained and describe our observations on site. Full interpretation is included along with recommendations to improve water quality. Additionally, any out of range results are reported immediately.

Water systems which can be monitored in this way include:

*Air conditioning plant* Wet evaporative cooling towers, spray condensers and humidifiers

*Domestic hot and cold water systems* Water softeners, deionisation plants, water filters, storage cisterns, calorifiers, heat reclaim systems, taps and showers

*Drinking water systems* Vending machines, chillers and drinking water fountains

*Industrial water systems* Process waters used in manufacturing materials and products etc

*Emergency showers and eyewash systems*

*Hydro-therapy, swimming pools and spa baths*

*Vehicle washing plants*

*Boreholes and private water supplies*

*Natural recreational waters*

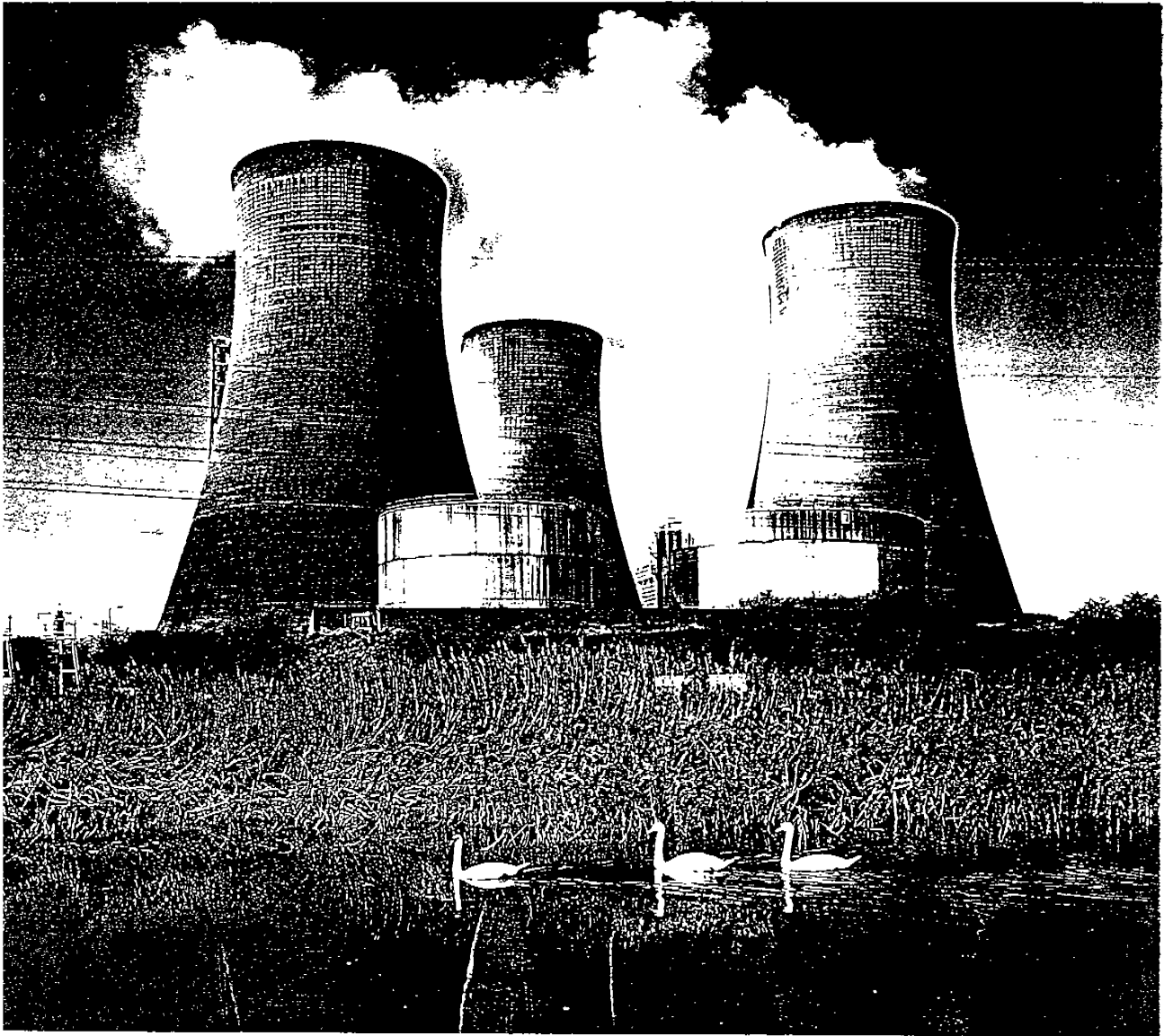
*Fogging, misting and spraying systems.*

### The benefits

Monitoring can provide many benefits:

- ▲ Reporting regularly on plant operation confirms that the system is running properly
- ▲ Ensures routine maintenance procedures such as cleaning and disinfection have been completed satisfactorily
- ▲ Confirms water treatment effectiveness where systems have been subject to regular chemical treatment or other treatment technologies, eg ultraviolet light, filtration or thermal disinfection
- ▲ Provides proof of quality assurance to third parties, eg enforcement bodies
- ▲ Audits the performance of other contractors, eg water treatment companies and maintenance contractors.

## Monitoring



**CASE HISTORY:**  
DECONTAMINATING A  
VENDING MACHINE

STAFF COMPLAINED ABOUT UNPLEASANT TASTING DRINKS DISPENSED FROM A VENDING MACHINE IN THEIR OFFICE. WE EXAMINED AND SAMPLED THE MACHINE AND ITS ASSOCIATED WATER SUPPLY AND TALKED TO THE MAINTENANCE STAFF.

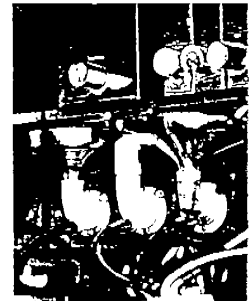
THE PROBLEM WAS ATTRIBUTED TO A SMALL PIECE OF PLASTIC TUBING INSIDE THE MACHINE WHICH HAD BEEN INSTALLED WHEN THE ORIGINAL HAD SPILT AND SPRUNG A LEAK. THE REPLACEMENT TUBE WAS

PURCHASED FROM A LOCAL HARDWARE STORE BY MAINTENANCE STAFF.

UNFORTUNATELY THE REPLACEMENT TUBE WAS CONSTRUCTED OF A BIODEGRADABLE MATERIAL WHICH HAD BECOME COLONISED BY MICRO ORGANISMS AND THESE IN TURN IMPARTED A FOUL TASTE TO THE WATER.

WE RECOMMENDED TAKING THE MACHINE OUT OF SERVICE AND REPLACING THE TUBING WITH A MORE SUITABLE MATERIAL.

COMPLETE DISINFECTION AND RE-SAMPLING OF THE MACHINE WAS ALSO ADVISED BEFORE RECOMMISSIONING.



## Tackling

tricky

problems

and finding

solutions

The Water Quality Centre is regularly asked to resolve sudden water quality problems. Problems can occur in all types of water systems. Even the best maintained and operated system can be subject to occasional operational failure and breakdown.

The Water Quality Centre can usually provide immediate advice and assistance. We are used to dealing with problems fast. We can also draw on the additional knowledge and expertise of our colleagues in Thames Water. Our experience of running one of the world's largest water systems means we can resolve virtually any type of water quality problem that we may encounter.

Typically, one of our consultants will visit the site, discuss the issues with staff, thoroughly examine the plant and collect water samples where appropriate. Our subsequent report will fully describe our findings and provide practical recommendations to resolve the problem and prevent a recurrence.



### CASE HISTORY: ELIMINATING CHEMICAL ODOUR

FACTORY STAFF COMPLAINED OF A STRONG CHEMICAL ODOUR WITHIN THEIR DOMESTIC WATER SERVICES. THIS WAS ATTRIBUTED TO INADEQUATE CURING OF A PAINT USED TO RE-LINE A STORAGE CISTERN. INVESTIGATIONS SHOWED THAT THE CISTERN HAD BEEN DRAINED, CLEANED AND PAINTED DURING A SHUT-DOWN PERIOD, BUT THE PAINT HAD NOT BEEN PROPERLY CURED (THE MINIMUM CURING TIME SPECIFIED BY THE PAINT

MANUFACTURER WAS 14 DAYS). WHEN THE CISTERN WAS BROUGHT BACK ON-LINE (3 DAYS AFTER PAINTING) SOLVENTS LEACHED OUT OF THE PAINT.

WE ADVISED ISOLATING, DRAINING, COMPLETE REMOVAL OF THE LINING AND REPAINTING.

PRECAUTIONARY FLUSHING OF THE ASSOCIATED WATER SERVICES WAS RECOMMENDED TO REMOVE

ALL TRACES OF THE SOLVENT. WE ALSO SUGGESTED THAT SAMPLES WERE COLLECTED AND ANALYSED FOR SOLVENT CONTENT.

THE COMPANY HAS NOW INSTIGATED A PROGRAMME OF ALTERNATING CISTERN PAINTING TO ENSURE THAT THE CISTERNS ARE NOT RECOMMISSIONED BEFORE THE PAINT HAS BEEN FULLY CURED

## Trouble shooting

### CASE HISTORY: REFRESHING A SWIMMING POOL

THE CAUSE OF BROWN STAINING ON TILES IN A SWIMMING POOL WAS ATTRIBUTED BY STAFF TO THE WATER TREATMENT SYSTEM, BUT THEIR INVESTIGATIONS FAILED TO PROVIDE A SOLUTION. WE EXAMINED THE POOL, WATER

TREATMENT PLANT AND HEATING SYSTEMS. WATER SAMPLES WERE TAKEN FROM SELECTED POINTS AND DISCUSSIONS WERE HELD WITH STAFF TO DETERMINE OPERATIONAL PROCEDURES.

THE WATER TREATMENT SYSTEM WAS IN GOOD ORDER. ANALYSIS RESULTS IMPLICATED THE HEATING SYSTEM AND RECOMMENDATIONS WERE MADE TO CHECK IT.

INVESTIGATIONS REVEALED LEAKS IN A CALORIFIER, AND THE CALORIFIER TUBES WERE REPLACED. ON THE ASSUMPTION THAT THERE WOULD BE NO FURTHER

TILES WERE METICULOUSLY SCRUBBED CLEAN WITH A CHEMICAL CLEANSER. TO DATE, NO STAINING HAS RECURRED



## Building

## a skilled

## team

The Water Quality Centre offers training programmes on water quality issues. We regularly run one-day training seminars in London and throughout the UK. The seminars are centrally located in conference centres and hotels. We also offer courses at client sites which are designed to meet clients' specific requirements.

### Training objectives

We aim to promote awareness and understanding of water quality issues amongst building services managers and engineers who are responsible for the day-to-day operation and maintenance of water systems.

Many of the talks are given by the Water Quality Centre's own consultants, but guest speakers are also invited to talk on specialist subjects.

To encourage delegate participation, the size of groups is usually restricted to a maximum of sixteen delegates.

Topics typically covered in our seminars include:

- ▲ Introduction to water microbiology and chemistry for building services managers and engineers, with particular emphasis on Legionella bacteria
- ▲ Review of current legislation relating to water quality with particular emphasis on the HSE Approved Code of Practice

- ▲ Chemical treatment of water systems and a review of alternative water treatment technologies
- ▲ Water sampling, analysis and interpretation of results
- ▲ Managerial responsibilities in setting up and operating water management systems
- ▲ Maintaining water quality in hydrotherapy, swimming and spa pools
- ▲ Water conservation and re-use
- ▲ Effluent treatment.

A seminar pack is issued to each delegate which contains summaries of each of the talks and a Certificate of Attendance.

## Training





THE WATER QUALITY CENTRE

Building Hygiene Air Quality Services

NADCA Test

Swabs Air Strips

Contact Plates

Fungi and  
Bacteria

The Water Quality Centre, through its NAMAS accredited laboratories, is able to provide a reliable and quality assured service

For further information and a quotation contact :

The Water Quality Centre  
Spencer House, Manor Farm Road, Reading, RG2 0JN.

Tel : 0118 9236222 Fax : 0118 9236311



Main Heading: 01 Customer Handbook  
Title: 01 The Water Quality Centre

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The Water Quality Centre provides to Thames Water an analytical service encompassing the entire water cycle and also to external organisations on a commercial basis. The Wqc will give advice on result interpretation and will help select appropriate tests and equipment for "on-site" testing.

The Water Quality Centre Laboratories based at Millharbour in Docklands - London and Spencer House- Reading are accredited by the United Kingdom Accreditation Service (UKAS). UKAS accreditation is formal certification that the laboratories are technically competent and are operating quality systems that comply with rigorous international standards. Each laboratory is issued with a schedule of accreditation which details the scope of accredited tests each of which must be fully validated before inclusion. Annual audits of the laboratories are carried out by a team assessors appointed by UKAS.

As well as these checks the laboratory is also audited by representatives of the Drinking Water Inspectorate who examine the Company's reporting and analytical arrangements that apply to the analysis of statutory samples.

Additional checks on performance are monitored through the participation in external proficiency test schemes which are in force for the analysis of raw and potable waters, domestic and industrial waste waters, soils, sludges and contaminated land.

The Laboratory Quality Section are responsible for the management of the quality system and carry out independent checks on the laboratories activities and also investigate formal complaints from internal and external customers recommending corrective actions.



Main Heading: 01 Customer Handbook  
Title: 07 Incidents and Events

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From time to time Thames Water is faced with unexpected incidents, which can crop up at any time and at any location where the company operates.

Wq<sup>c</sup> laboratories may be required to undertake analysis on associated samples. Analysts are available 24 hours a day to deal with urgent requests. Where the exact analytical requirements are not known at the outset, the wide expertise and experience of Wq<sup>c</sup> scientists, particularly in the area of public health, may be drawn on to assist in a resolution of the problem.

All incident samples arriving at Wq<sup>c</sup> will be marked with a yellow label, this will clearly identify the sample as an incident sample to Wq<sup>c</sup> staff and will ensure the sample is not disposed of after analysis.

The Event Support Centre in Reading is the co-ordinating centre for all incidents and events within Thames Water, both for clean and waste water. Staff at the centre continually monitor the company's computer systems and speak to the various control centres, looking for unusual incidents. When incidents affect customers, the centre ensures that information is passed consistently and accurately to all parties.

When an incident is declared by the Event Support Centre, Wq<sup>c</sup> will appoint an Incident Co-ordinator, who will be the focal point for all communication with the Event Centre, and in particular with the Event Controller who will normally be at the scene of the incident. Limiting the number of people communicating with the Event Centre in this way ensures a more efficient flow of information. Customers requiring up to date information about an incident should therefore contact the Event Support Centre Co-ordinator first on:

Tel 0118 925 1610 (external) 51610 (internal)



Main Heading: 01 Customer Handbook  
Title: 25 Wqc Sales

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Wqc Sales is based at Spencer House together with a dedicated support team. The Sales team service a wide range of organisations including: local authorities, government agencies, water companies, water treatment companies (cleaning and chemical disinfection), consulting engineers and land reclamation agencies.

The Materials Testing Team offer an unrivalled service for testing materials which come into contact with potable water in accordance with: BS6920 and the Drinking Water Inspectorate Regulation 25. In addition there is also a consultancy service offered to help clients understand why materials fail and to assist them with the development of new materials that come in contact with potable water.

Analysis offered by the Chemistry, Metals and Organic Chemistry teams is also available commercially to Wqc external customers.

Wqc Sales can also arrange building hygiene and risk assessments. They can provide advice and analytical services in air and water sample analysis.

Further information on the services offered by Wqc Sales can be obtained from:

Tel 0118 923 6222 (external) 36222(internal)

Fax 0118 923 6311(external) 36311(internal)

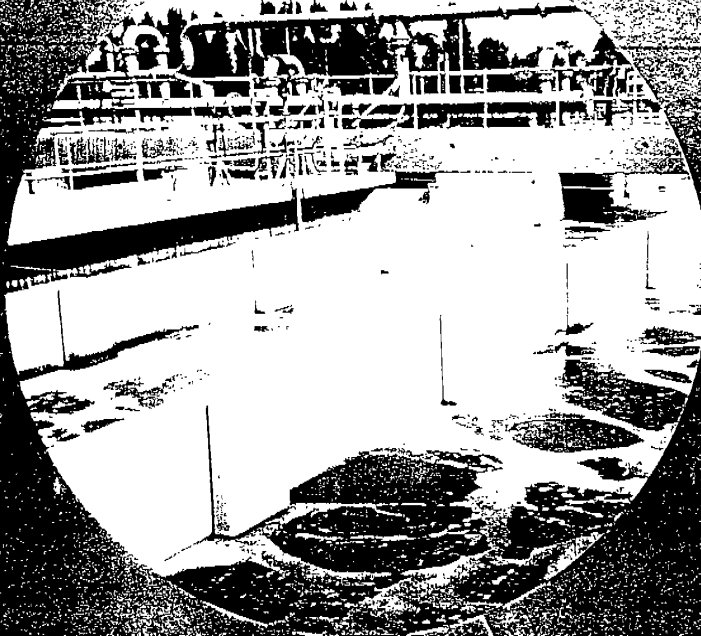
email: [wqc.sales@thameswater.co.uk](mailto:wqc.sales@thameswater.co.uk)

web site: <http://www.wqc.co.uk>





# Oxford Sewage Treatment Works



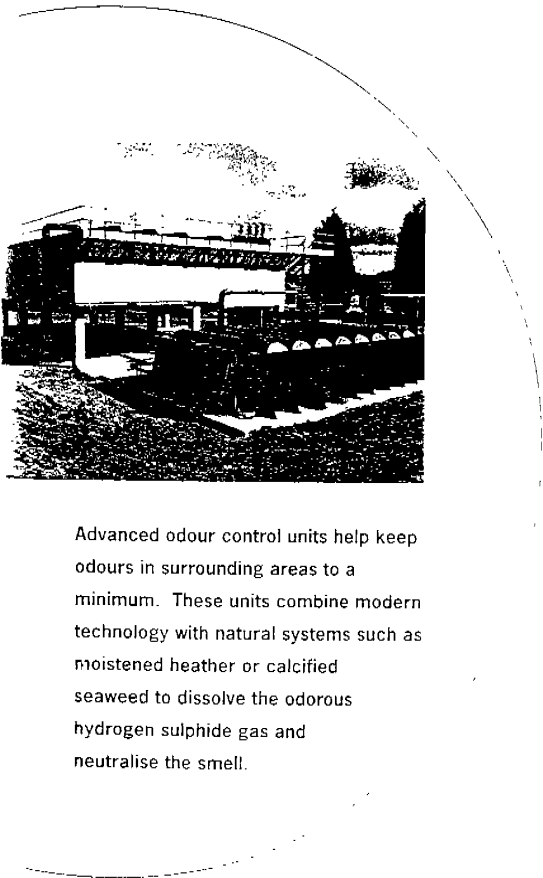
*Oxford Sewage Treatment Works treats wastewater, or sewage, for around 200,000 people living and working in Oxford and Didlington. The works was opened in 1956 and we recently invested £10 million to make sure that the wastewater continues to be treated to a very high standard.*

# Wastewater Treatment

Wastewater is a mixture of domestic waste, industrial waste and rain.

The raw water arrives at the works through sewers.

It is made up of 99.5% water, the rest is grit and organic matter and goes through the following process.



Advanced odour control units help keep odours in surrounding areas to a minimum. These units combine modern technology with natural systems such as moistened heather or calcified seaweed to dissolve the odorous hydrogen sulphide gas and neutralise the smell.

## 1 Screening

The wastewater is passed through screens to remove solid objects, such as rags, pieces of wood and plastics.

## 2 Grit removal

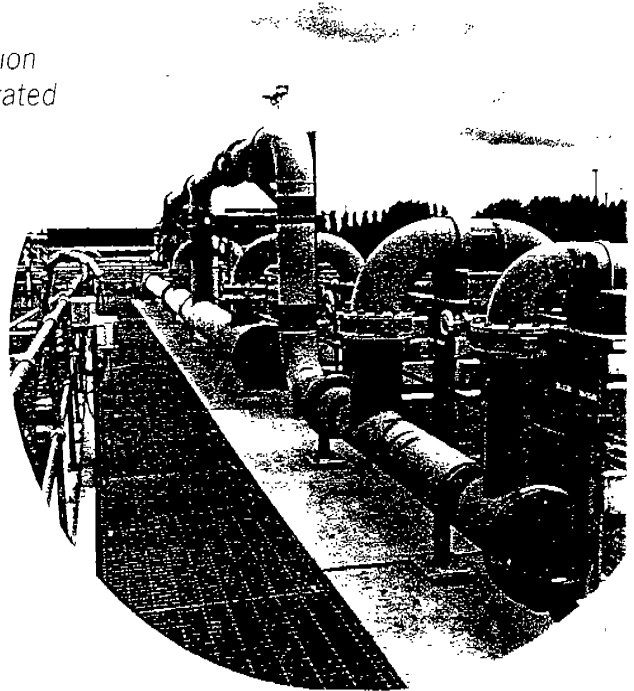
It then travels through specially designed structures that control the rate of flow, allowing any grit to settle. The grit is then removed and washed for disposal off-site to licensed tips.



The new  
Blower House

# Oxford Sewage Treatment Works

Air pipework distribution for Oxford's new activated sludge plant



## 1. Sedimentation

Raw wastewater is then passed through rough tanks which allow any large solids to settle. These solids are known as sludge. The sludge is then pumped to digesters and broken down by natural bacteria. This process produces methane gas which is used to generate electricity. The digested sludge is then dewatered prior to disposal to a landfill.

## 2. Aeration

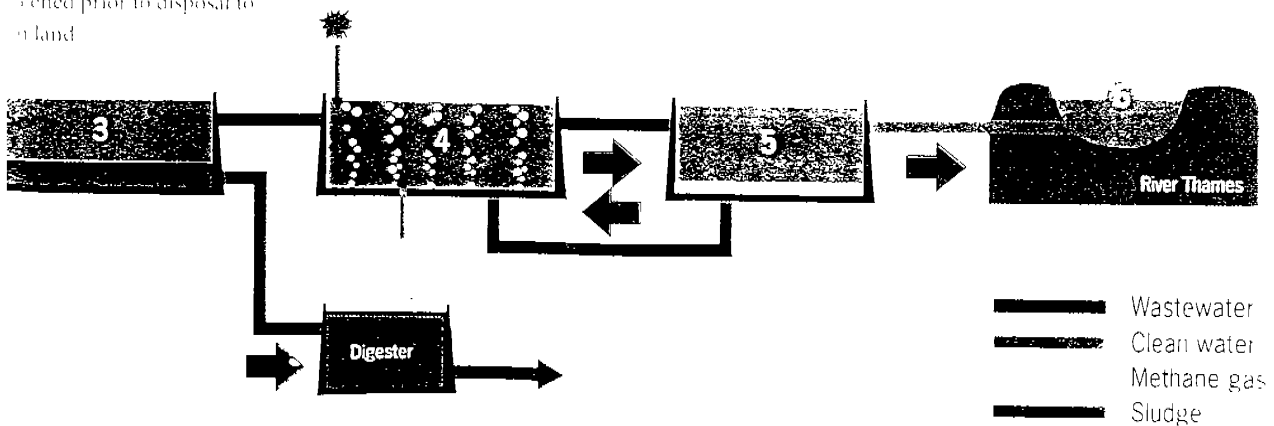
After sedimentation, the remaining liquid passes to aeration tanks where it is mixed with bacteria. Oxygen is bubbled through it to encourage the bacteria to 'eat' the organic material. This would happen in nature but much more slowly.

## 3. Clarification

The aerated mixture is then passed to more tanks to allow the remaining fine sediment to settle again. This is then pumped back to the aeration channels to repeat the process.

## 4. Disinfection

Finally the clean water, which is strictly monitored for quality, is passed into the Pottery stream, which flows into the River Thames.



# Protecting the Environment

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At Oxford we are helping to protect the environment by:

- using natural processes for treating wastewater
- maintaining the high quality of water in the River Thames
- using energy wisely - we generate power using the methane produced naturally by the water cleaning process
- protecting and enhancing the landscape and wildlife of the site wherever possible.

If you would like more information about water treatment or recreational activities, please contact our Customer Centre on **0645 200800**. The lines are open 24 hours a day, 365 days a year. All calls are charged at local rates. We record all our calls to ensure that we give you a quality service.

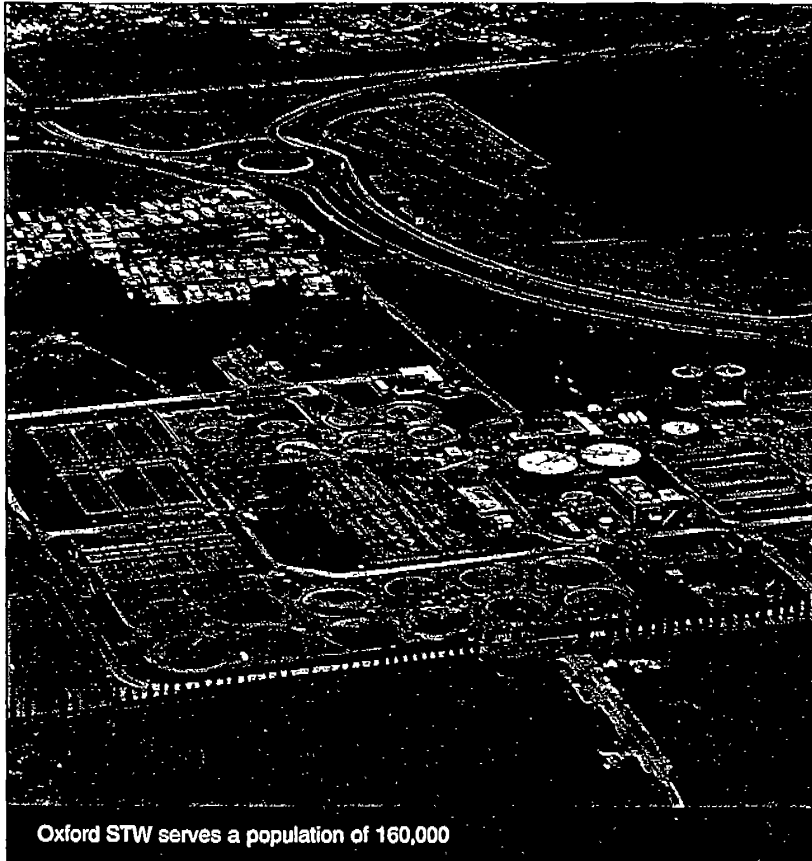
If you prefer, you can write to us at:

Thames Water  
PO Box 286  
Swindon  
SN38 2RA

[www.thames-water.com](http://www.thames-water.com)



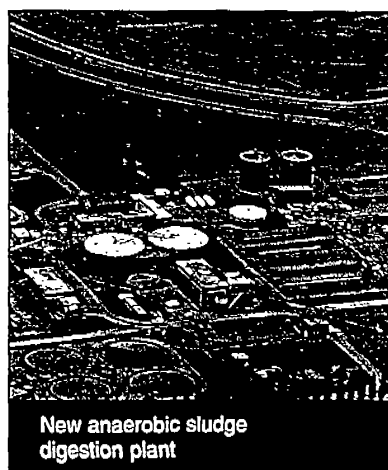
## Oxford sewage treatment works



Oxford STW serves a population equivalent of some 160,000 but is also a regional sludge centre for some 240,000 population. The works is a conventional dissolved air activated sludge plant in two streams. Sludge is digested and dewatered for land disposal. A contract was awarded in competition to construct new sludge dewatering plant, convert flat bottomed final tanks to conical tanks and provide a wide range of new mechanical, electrical and SCADA plant including standby generation and imported sludge reception plant. The scope of the contract works was extended by negotiation after award to include the redoming of one the aeration plants and provision of additional process air blower capacity. The total contract value was £4.3 million with completion achieved in March 1996.

The contract involved a number of complex constructional interfaces with live plant and was successfully completed, having achieved a very high level of operational satisfaction over the liaison achieved.

A further extension to the process plant consisting of a 25% increase in aeration plant, extended inlet works and associated infrastructure works is under way.



## **BRIEF DESCRIPTION OF OXFORD STW. (November 1999).**

Oxford STW was built in 1956. although there has been sewage treatment on the site throughout this century. It's current population is around 200,000. The flow is collected via the sewerage system from Oxford and surrounding areas.

The incoming sewage is all pumped to the works, which has a flow consent of 90,000 cubic meters a day to treatment. This equates to a thousand litres a second.

Approximately 2,300 litres a second can be pumped to Oxford sewage treatment works from three terminal pumping stations that have collected the sewage from the sewer network.

The sewage contains a mixture of domestic & industrial waste discharges. The incoming sewage has the following strengths - suspended solids of 340 mg/l, a biochemical oxygen demand (BOD) of 200 mg/l and ammonia of 40 mg/l.

New plant & equipment was installed as part of the five million pound scheme that was completed in January 1998 to allow Oxford to produce an effluent of 45 mg/l solids, 15 mg/l BOD & 5 mg/l ammonia. This is a new obligation set by the Environment Agency & is part of the requirement to improve the quality of the river Thames the receiving water course for the works final effluent.

### **Inlet & Screenings Handling**

Part of the flow is pumped into a balancing tank which "smoothes" the flow through the works. The average flow per day is around 40,000 meters cubed a day.

Because the sewage has travelled a long distance prior to reaching the works the balancing tank is sealed and an odour control system ensures there is no smell from the sewage.

The sewage is screened to remove large solids & other matter that would cause problems during the sewage treatment process. Rag and grit are disposed off site via the land fill route. If people did not put rag down the sewer it would not have to be dealt with - "Bag it & Bin it".

As with the screenings the grit is removed to protect plant & machinery in down stream processes.

### **Primary Settlement**

There are ten primary tanks that settle out the organic solid matter in the sewage. Part of the capital scheme gave better flow split control and confidence in giving correct flows to each of the three Activated Sludge. Tanks are automatically scraped & desludged.

It is important to keep the balance of micro organisms to sewage right to ensure optimum effluent treatment. Again this is all monitored and controlled automatically.

The final effluent then discharges into Pottery stream which feeds into the river Thames.

### **Primary Sludge Thickeners**

The raw sludge that has been settled in the primary sedimentation tanks is pumped into two tanks called picket fence thickeners which allow the sludge to settle by gravity whilst a slowly moving "picket fence" stirrer encourages water to pass through the thickening sludge to the surface where it discharges over a weir to be pumped back to the front end of the works to be processed with the incoming sewage.

The tanks are covered with an odour control system attached.

### **Imported Sludge Tanker Point**

Imported sludge which arrives on the site in tankers is pumped through two Rotamat sludge screens and fed into an odour controlled buffer tank. The sludge comes from the smaller rural sites in the Oxfordshire area.

Surplus activated sludge which has been dewatered using a Simon Hartley Aquabelt is mixed with the thickened primary sludge and the screened imported sludge prior to pumping to the anaerobic digesters.

### **Primary Digesters, CHP Odour Control Plant**

Four digesters are fed with the combined sludges and in an oxygen free environment. Anaerobic bacteria break down the organic matter and produce methane gas. The gas produced from this natural process is used to power the combined heat and power engine. The system produces heat to keep the digesters at around 35 degrees centigrade, This allows optimum bacterial activity. Enough gas is produced for the engine to produce electricity which is fed into the national grid and can truly be described as a "Green Energy" source. The system generates enough electricity to make about £800 a day revenue.

### **Press House plus The "Klam Presses" and Return Liquors Buffer Tank**

There are three Simon Hartley Klam presses which dewater the digested sludge from a liquid of about 3% dry solids to a "crumbly" cake of over 20% dry solids. A polymer is used which assists the water separation process. Each press can handle 25 cubic meters an hour of liquid sludge. The average dry biosolids production is 35 cubic meters a day.

### **Treated & De Watered Biosolids Area - " The Sludge Pad"**

Here the final product of the sludge stream. Digested Biosolids are stored on the pad prior to discharge to agricultural land. It is a natural source of essential plant minerals and other nutrients. It is also a good soil conditioner.

### **Rectangular Primary Settlement and Storm Tanks**

As already mentioned Oxford STW now has the capacity to treat 90,000 cubic meters a day of sewage, this is defined as three times the dry weather flow. Any flow in excess of this during a large storm overflows downstream of the inlet into three storm tanks where solids are allowed to settle. If the flow rises above the same amount again the settled storm sewage is mixed with the final effluent before being discharged to the water course. It will be so dilute by this time that it will have a very low impact on the river.

If a prolonged storm greater than two hours in duration takes place the storm sewage would be very dilute - even more of its content would be water - sewage is normally 99.9% water.

After a storm period the storm tanks which have at least two hours capacity at three times the dry weather flow, discharge back through the system for full treatment.

### **Phosphate Removal Plant**

The installation of the Phosphate Dosing system took place in November 1998. This reduced the level of phosphorus being discharged into the Thames by the final effluent - another quality enhancement. The dosing system pumps a flow related concentration of an iron salt into the settled sewage prior to the ASP.

### **Activated Sludge Plant Three plus Stand by Generation**

There are three activated sludge plants (ASP) at Oxford number three plant being the latest, put in under the latest capital scheme.

This secondary stage of the process is the biological stage. Here natural processes are used to give bacteria the right conditions to use the dissolved chemicals in the settled sewage as a food substrate. This then produces an effluent that is of a comparable quality (BOD and ammonia) to the receiving water course.

The ASP's are fully automated which allows optimisation of treatment process to produce a compliant effluent, at the same time making sure no air is wasted as the production of the diffused air from the blowers is the most expensive part of the sewage treatment process.

If there is a power cut from the mains electricity supply then two standby generators cut in automatically and guarantee an uninterrupted power supply.

### **Final Settlement Tanks**

Following the biological treatment the activated sludge flows into the final settlement tanks. These operate in the same way as the primary tanks allowing the solids which contain the bacteria from the activated sludge plant to settle in the bottom of the tank.

This activated sludge is drawn from the bottom where about half of the volume is returned to the front end of the ASP to continue the biological process. The other half is sent to be thickened up by Simon Hartley Aquabelts prior to digestion in the sludge process stream.



### **The Works Control Room - SCADA & SERCK System**

In the control room a Supervisory Control and Data Acquisition system monitors all parts of the processes operation.

Every stage of the process is constantly monitored by telemetry outstations that send information to the site control room. Charting, trending and recording takes place and alarms are generated if any part of the process move out side it's pre set parameters. The site technicians can control and make adjustments to the various on site programmed computer logic systems

All key alarms are also sent off - site via the SERCK system which constantly feeds status reports to our Wastewater Control Centre at Maple Lodge in Hertfordshire, which gives 24 hour a day 365 days a year. Out of hours local stand by technicians can be called on to give a instant response to any alarms.

The effluent quality is also monitored 24 hours a day by an ammonia monitor to ensure there is no drop in quality of discharge to the water course.