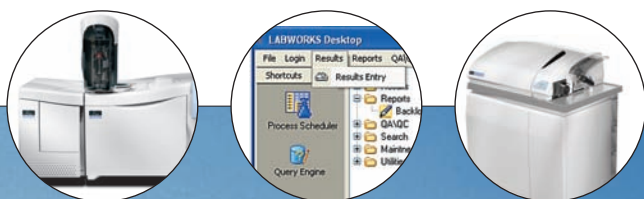


# environmental analysis



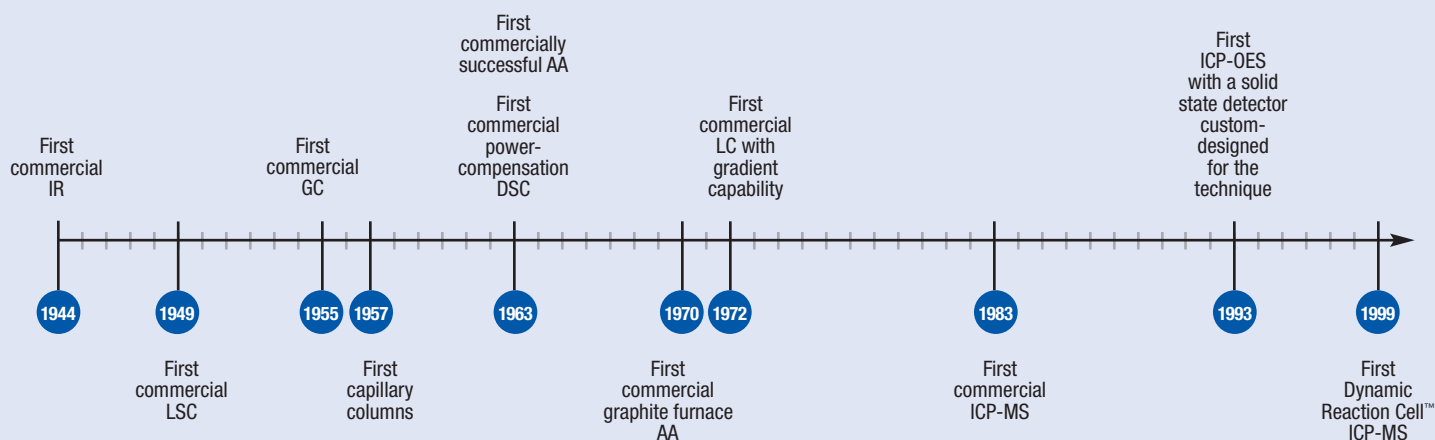
when **experience** counts

# your laboratory needs – our solutions

New contaminants, performance-based methods, endocrine disruptors, homeland security; even though environmental analysis has been around for a long time, new needs continue to develop. Whether your laboratory is in Europe, the U.S., China or anywhere in the world, we can help you keep up with a changing environment.

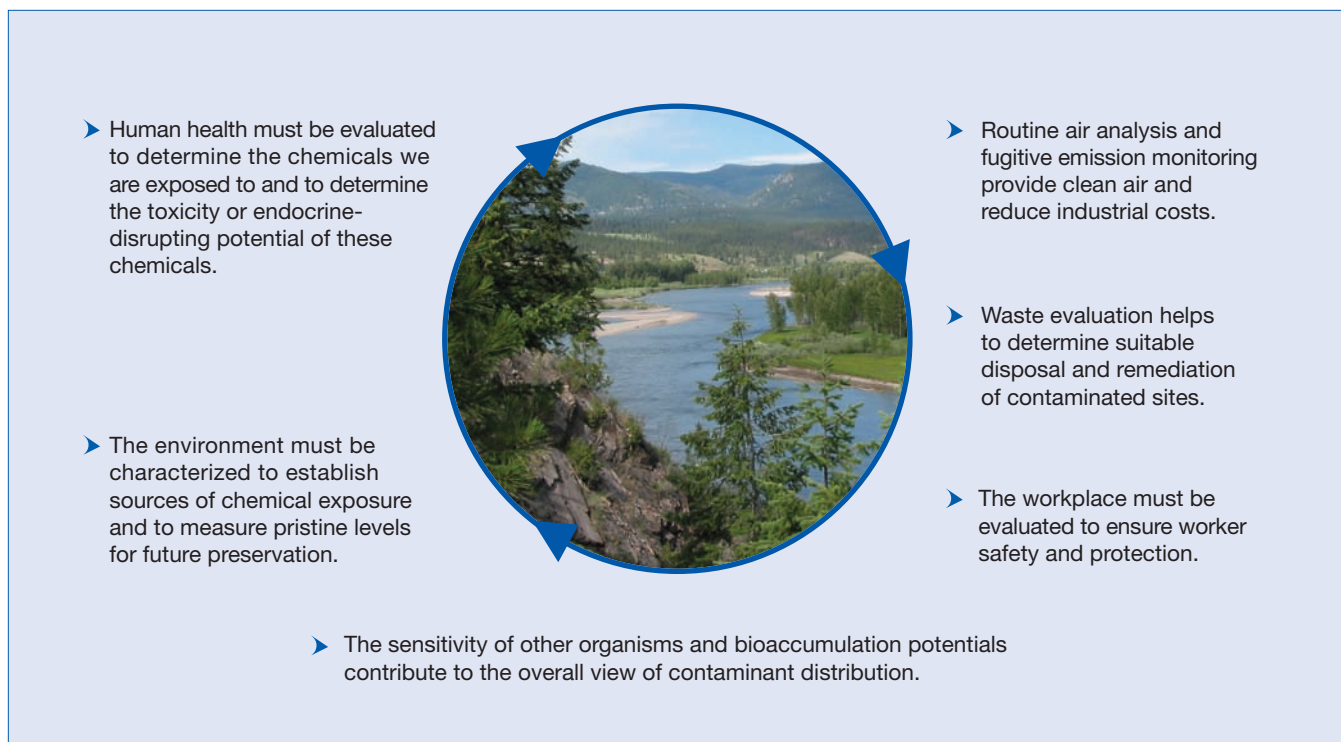
In developed nations, increased laboratory productivity will continue to be a driving force. Leveraging techniques developed for other industries, such as high-throughput screening techniques, can help meet these needs. Smaller, more compact instruments take up less laboratory space and provide the flexibility to respond to events requiring on-site analysis.

In developing nations, PerkinElmer's experience and knowledge of established regulations and methods can provide a quick start to new laboratories. Easy-to-use instruments with local-language capabilities simplify instrument set-up and training. Plus, global service and support are there to assist in any aspect of your analysis.



PerkinElmer has been a pioneer in the analytical measurements business for more than 60 years.

# knowledgeable support provides solutions



Analytical measurements permeate all aspects of the environment. They help ensure that our quality of life is preserved now and for future generations. Whether these measurements are performed on-site, on-line or in a laboratory, the quality of the data generated must match the needs of the project.

PerkinElmer® can provide all of the systems and support you need:

- High-quality, rugged instrumentation, supported by a global leader in analytical measurements, ensures high-quality data.
- Dedicated account managers can help you choose the correct application solution.
- Knowledgeable technical specialists can answer application questions before, during and after your purchase.
- PerkinElmer has the environmental expertise to act as a conduit of information between you, the regulatory agencies and our product development groups.

- Turnkey methods reduce the time before an instrument is qualified and can ensure data acceptable to regulatory programs.
- Our customer training programs maximize the value of your system in efficiency and range-of-use.
- PerkinElmer's factory-trained service representatives will help you minimize downtime with innovative customized contract programs and prompt service visits.
- A range of leasing options is available to keep your lab up-to-date with the latest technologies, while preserving cash flow.

A knowledgeable partner, such as PerkinElmer, can help you keep up with the changes facing environmental laboratories today and in the future. New instrumentation, software enhancements and turnkey methods from the knowledge leader in environmental analysis will ensure that you remain ahead in today's business climate.

# high quality systems for evolving application needs

PerkinElmer offers a wide variety of instrument systems, both laboratory and transportable, to fit the workload and analytical requirements of the environmental laboratory.

## Atomic spectroscopy solutions

Many environmental problems revolve around the determination of trace levels of elemental contaminants in water, soil, sludge, air and industrial hygiene samples. PerkinElmer offers a complete line of instrumentation designed to measure these elements precisely and accurately at the levels you need (see Table 1). Inorganic elemental analysis can be performed by graphite furnace atomic absorption spectroscopy (GFAAS) with Zeeman or continuum-source background correction, inductively coupled plasma-optical emission spectroscopy (ICP-OES), flame atomic absorption spectroscopy (FAAS), mercury cold vapor/hydride and inductively coupled plasma mass spectrometry (ICP-MS) systems.

## Atomic absorption

The AAnalyst™ series of atomic absorption instruments provides either stand-alone flame, graphite furnace capability or combined flame and graphite furnace capability with automated switchover between the two techniques. Utilizing stabilized temperature platform furnace (STPF) concepts, PerkinElmer graphite furnace systems ensure accurate results, freedom from interferences and high productivity. For laboratories determining contaminants at part-per-million concentration levels, flame atomic absorption systems are the perfect choice, providing the utmost in performance, reliability and safety. And, systems with easy-to-use touch-screen control can change between multiple languages at the touch of a button.



Flow Injection Mercury System.

## Mercury analysis

Cold vapor/hydride yields the lowest detection limits for mercury and can be used to determine arsenic, selenium and other hydride-forming elements. These determinations can be automated through the use of flow injection techniques. The Flow Injection Mercury System (FIMS) provides stand-alone automated mercury determinations. The capability of the system can be further extended, when coupled with amalgamation, to generate the ultimate detection limits for mercury. Table 2 shows the detection limits for mercury that can

Table 1. Detection Limits for Selected Elements by Various Inorganic Techniques (µg/L)

Element	FAAS	GFAAS	ICP-OES Radial	ICP-OES Axial	ICP-MS	DRC ICP-MS
Al	45	0.1	3	1	0.006	0.005
As	150	0.03	50	2	0.006	0.0006
Cd	0.8	0.008	1	0.1	0.003	0.00009
Cr	3	0.03	2	0.2	0.02	0.0002
Fe	5	0.1	2	0.1	0.005	0.0003
Mn	1.5	0.035	0.4	0.1	0.002	0.00007
Pb	15	0.06	10	1	0.001	0.00004
Se	100	0.3	50	4	0.06	0.0007
Tl	15	0.15	30	2	0.0005	0.0002

Source: *Guide to Atomic Spectroscopy Techniques and Applications*, PerkinElmer, Inc. 2000. Some DRC ICP-MS measurements were obtained under clean room conditions.

Table 2. Mercury Detection Limits by Various Techniques

Technique	Detection Limit ( $\mu\text{g/L}$ )
ICP-OES	1
ICP-MS	0.016
Flow Injection AAS	0.1
Flow Injection FIMS (dedicated analyzer)	0.004
Flow Injection FIMS with amalgamation	0.0002

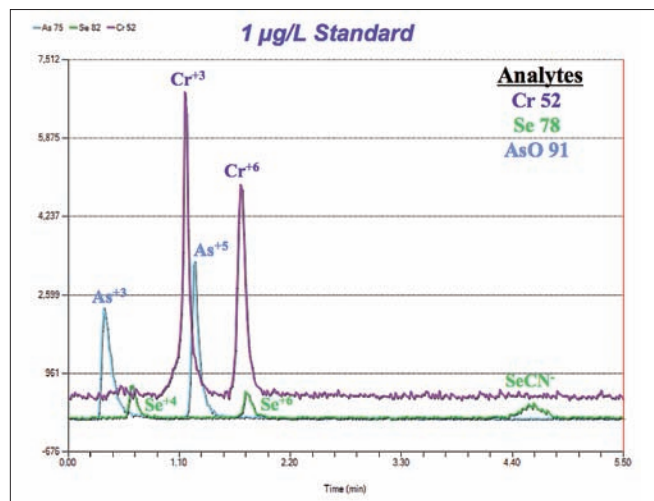


ELAN DRC-e ICP-MS.

be obtained using different techniques, combined with other elements as part of a multielemental analysis or measured separately in a dedicated analysis.

## ICP-OES

ICP-OES provides high sample throughput for many elements over a wide range of analyte concentrations. PerkinElmer ICP systems with axial viewing have significantly lower detection limits than traditional radial view systems – a critical achievement for environmental laboratories wishing to combine traditional graphite furnace and ICP-OES elements into a single determination. The Optima™ family of ICP-OES spectrometers takes ICP analysis even further – offering the only systems with a patented dual-view configuration for both axial and radial viewing in the same



Simultaneous As-Cr-Se Speciation.

analysis. This provides the full range of concentrations, from low ppb to high ppm levels, encountered in most environmental laboratories.

## ICP-MS

The ELAN® family of ICP-MS systems combines the speed of ICP with the ultimate detection limit capabilities for trace environmental contaminant analysis. ICP-MS has become the routine choice for demanding environmental laboratories. In addition, the ICP-MS can be used for isotopic analyses and the determination of long-lived radioisotopes such as thorium, uranium, plutonium and technetium, expanding your laboratory's capabilities. Couple the ICP-MS with a separation technology such as HPLC or ion chromatography and Chromera™ software for an integrated system to measure individual metal-containing compounds – a must for laboratories studying toxicology or environmental mobility.

## Sample preparation

Sample preparation is the critical step in any analysis, especially at trace levels. Contamination during the preparation step or loss of analytes can dramatically affect the accuracy of results. The ability to digest difficult samples reproducibly or digest in a closed environment can be especially important as detection limit requirements continue to be driven to lower levels. The Multiwave™ microwave digestion system offers compliance with U.S., European and other regulatory methods.

# organics analysis from sample handling to detection



PerkinElmer gas chromatography solutions include Clarus GC and GC/MS, TurboMatrix headspace and thermal desorption sampling accessories, and TotalChrom chromatography software.

## Gas chromatography (GC) and GC/MS

Many complex environmental materials must be analyzed for specific organic compounds. For instance, industrial wastewater must be analyzed for volatile and semivolatile priority pollutants. Agricultural products must be analyzed for pesticide residues and degradation products, and solid and hazardous waste must be analyzed for toxic materials before (and sometimes after) it is deposited in a landfill. PerkinElmer offers a complete family of gas chromatography products that can carry out these determinations and that have been optimized for regulatory methods. TurboMatrix™ automated headspace and thermal desorption sample-handling accessories provide integrated sampling options. The Clarus® family of GCs supports a variety of detectors, including mass spectrometry. Other detectors such as electrolytic conductivity, photoionization, electron capture, flame ionization, nitrogen phosphorus, flame photometry or thermal conductivity are also available to configure a system suited to virtually any environmental analysis.

Gas chromatography/mass spectrometry (GC/MS) is increasingly applied to difficult environmental

analyses. The Clarus GC/MS provides low detection limits for the measurement of semivolatile and volatile organic compounds in drinking water or wastewater. Increased sensitivity, further enhanced by large-volume injections, makes the determination of multicomponent pesticides in water or soil extracts feasible and extends the use of mass spectrometry. Figure 1 shows the simultaneous collection of data using selected ion and full ion (SIFI™) scanning mode to combine quantitative sensitivity with library searching capabilities, a new technique to enhance laboratory productivity. Advances in technology, such as a quadrupole prefilter and new detector technology, make the system more rugged for the analysis of dirty samples, minimizing downtime and cleanup frequency. Plus, TurboMass™ GC/MS software assures method compliance and increased productivity in the environmental laboratory with expanded resources for evaluation and reporting.

## Organic sample handling

Headspace samplers with a built-in preconcentration trap provide up to 100 times lower detection limits for completely automated determination of volatiles in drinking water, wastewater or soil. Automated thermal desorption, with Peltier cooling instead of liquid

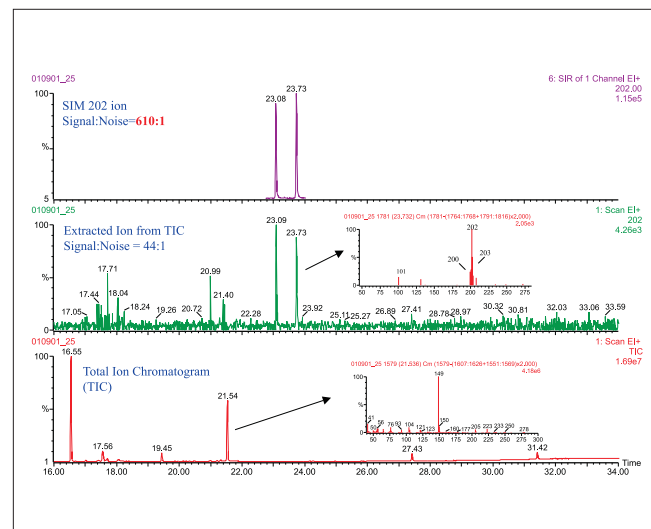
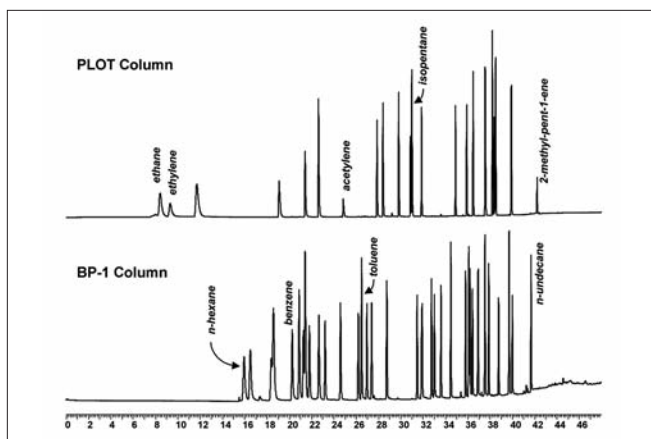


Figure 1. Simultaneous selected ion and full ion (SIFI) scanning on the Clarus GC/MS.



Chromatogram of ozone precursor components.

cryogen, provides the standard for air collection and automated analysis of ozone precursors and air toxics.

## High performance liquid chromatography (HPLC)

Many of the materials that have the potential to adversely affect the environment are thermally unstable at typical gas chromatographic temperatures. High performance liquid chromatography (HPLC) offers the means to measure these compounds. HPLC is used for the determination of polynuclear aromatic hydrocarbons (PAHs) in soil and water using procedures such as U.S. EPA Methods 610, 550 and 8310. Carbamate pesticides are an important contaminant and are determined using a post-column reaction system described in U.S. EPA Method 531.1. A Series 200 HPLC system from PerkinElmer, coupled with the appropriate accessories, provides an integrated system for this application. There is also growing interest in the use of HPLC for phenoxy acid herbicide analysis.

The Series 200 binary pump can be combined with the PerkinElmer Series 200 photo diode array detector coupled with IRIS™ spectral processing software and suitable columns for a versatile and highly sensitive environmental analysis system. The Series 200 autosampler, Series 200a fluorescence detector and

PerkinElmer chromatography data systems can expand the system for additional automation and applications. TotalChrom® chromatographic data-handling software uses an integrated approach to provide a PC-controlled system optimized for methods development and high sample throughput. Optional software is available to aid you in custom method development.

HPLC can also be coupled with inorganic detectors, such as ICP-MS, to provide separation and subsequent detection of metallic compounds important to determining mobility, toxicity and bioavailability. Speciation is a growing application area and is rapidly becoming more routine in many countries.

## Sample preparation

Sample preparation is often the time-limiting step in an analysis. Microwave-assisted solvent extraction can improve reproducibility and reduce the time required for this important step. The Multiwave microwave system provides the ultimate in safety and productivity.



Smoggy morning in Guangzhou, China.

# complete offerings for environmental testing

## Ultraviolet/visible (UV/Vis) and fluorescence spectroscopy

UV/Vis instruments may be used for any regulatory analyses requiring colorimetric or spectrophotometric detection, such as phenols and cyanides in wastewater. The PerkinElmer LAMBDA™ series of UV/Vis spectrophotometers can be configured with preprogrammed methods to perform many of the required U.S. and European chemistries. Fluorescence instruments, such as the LS-55, offer synchronous and emission scans for characterization and quantitation of polyaromatic hydrocarbons (PAHs). Fluorescence is useful in identifying organic materials in many matrices. Three-dimensional fluorescence scanning can aid in fingerprinting organic species, such as gasoline in soil.



LAMBDA UV/Vis.

## Elemental analysis

The PerkinElmer 2400 Series II Elemental Analyzer is capable of determining carbon, hydrogen, nitrogen and sulfur in a wide variety of environmental samples.

Organic particulate matter in water consists primarily of plankton, both phytoplankton (plant) and zooplankton (animal). Because organic particulate matter forms an important part of the aquatic food chain, an understanding of the level and distribution of this particulate matter is important to oceanographers and marine biologists. The PerkinElmer 2400 Series II CHNS/O



Alpine environment near Garmisch-Partenkirchen, Germany.

elemental analyzer measures the carbon and carbon-to-nitrogen mole ratios of material collected on filters and in sediments as a measure of the organic life cycle in water. These measurements can also be extended to include the analysis of periphyton. An important application for ecologists is the analysis of soil and tree samples. The effect of acid rain and fertilizer application are studied through the determination of the total content of carbon and nitrogen in soil, the organic-to-inorganic carbon ratio and the changes in carbon and nitrogen content in leaves and tree trunks.

Wherever Kjeldahl analysis can be used for agricultural materials such as feeds and fertilizers, the PerkinElmer 2410 Series II Elemental Analyzer offers an Association of Analytical Communities (AOAC® International) approved alternative.

PerkinElmer Elemental Analyzers feature microprocessor control for optimum performance in both quality and speed. Additionally, PerkinElmer microbalances offer automatic weight transfer to the analyzers, reducing transcription errors.

## Thermal analysis

Thermal analysis systems are also available for environmental research applications. Thermogravimetric analysis coupled with Fourier transform infrared (TGA/FT-IR) or mass spectrometry is used to identify and quantitate gases evolved from a sample under controlled heating. The Thermogravimetric Analyzer or the simultaneous Thermogravimetric/Differential Thermal Analyzer (TG/DTA) is used to measure the volatile organic content of solid and liquid pesticides. The volatility data may be used to assist in determining the human health risks associated with workplace exposure to volatile pesticides.

## Radioactivity

Determining radioactive contaminants in drinking water, wastewater and food is an important component of environmental protection. Our broad range of nuclear counter instrumentation offers solutions for many applications in this important field. The Tri-Carb® Liquid Scintillation Counter (LSC) family offers solutions from a low-sensitivity, low-cost alternative up to a high-sensitivity, low-radioactivity-level instrument with automatic sample changing mechanism. The unique PerkinElmer 1220 Quantulus or Tri-Carb 3170TR/SL instruments offer the highest possible sensitivity for detecting trace levels of radiation in environmental samples. Those who need to measure samples in a continuous-flow format can choose one of the Flow Scintillation Analyzers for on-line radioactivity monitoring.

For convenient sample preparation, the PerkinElmer Oxidizer 307 can be used to combust samples. The advantage of combustion over commonly used solubilization techniques is that we can physically separate  $^3\text{H}$  and  $^{14}\text{C}$  isotopes, providing full isotopic separation with virtually no cross-talk between isotopes.

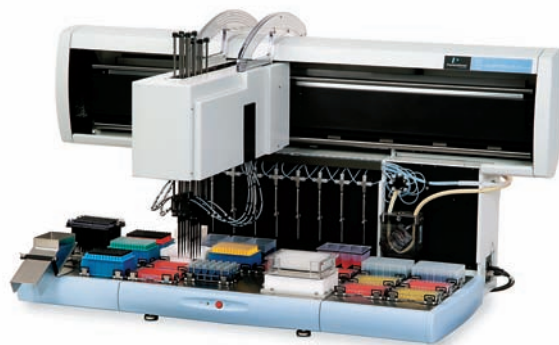
Our range of nuclear counter instrumentation can be used for many other environmental monitoring related fields as well – homeland security (dirty-bomb detection), ground water circulation studies, agricultural studies, radiocarbon dating and monitoring of materials at power plants.

## Microbiological measurements

Bacteria are a common contaminant in water and food and must be measured to ensure that the type and concentration is not sufficient to cause illness. We can help with assays to identify the most common bacteria regulated in drinking water with DELFIA® technology immunometric microplate assays as well as luminescence-based microbiological assays using the PerkinElmer VICTOR<sup>3</sup>™ multilabel plate reader or the VICTOR<sup>3</sup> Light microplate luminometer.

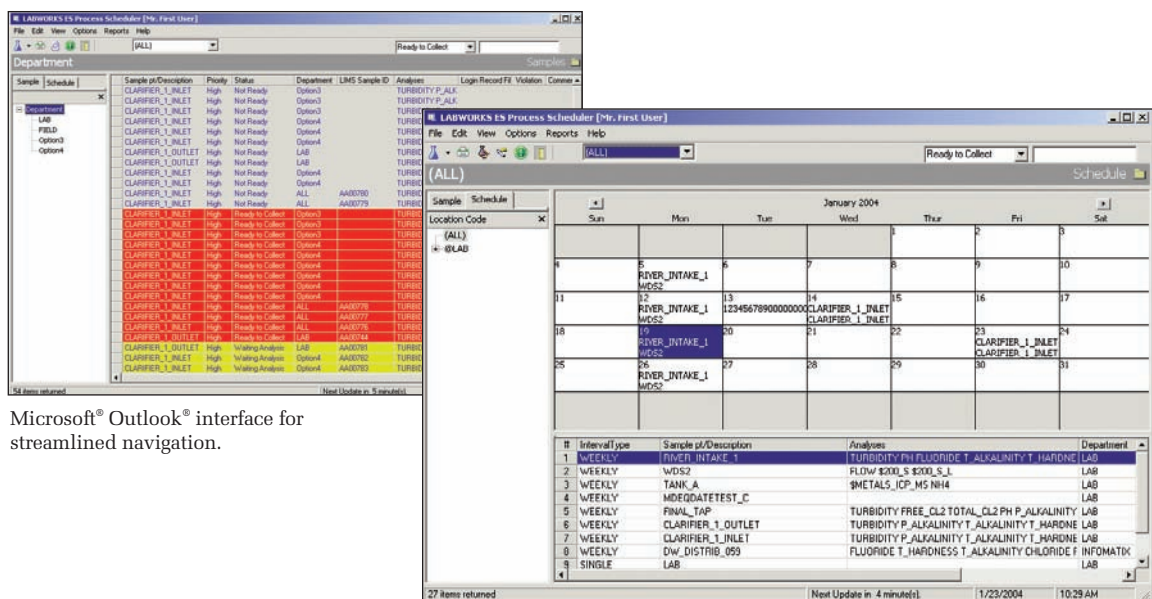
## High-throughput preparation and measurement

The ability to process large numbers of samples in a high-throughput mode is common in the pharmaceutical industry. Techniques which have been accepted for many years are moving into other industries that can benefit from more economical and rapid information generation. Flexible automation and liquid handling systems are key to successful implementation of high-throughput sample preparation. Flexible workstations like the MultiPROBE® II, capable of adapting to a variety of samples, labware types, capacity requirements and methodologies, are available from PerkinElmer. Integrated workstations can provide complete application solutions from sample preparation to results generation by combining core liquid handling technology with detection systems capable of measuring absorbance, luminescence, fluorescence and other methodologies.



MultiPROBE II Automated Liquid Handling System.

# bringing it all together with LIMS



Microsoft® Outlook® interface for streamlined navigation.

New calendar function shows a monthly display and daily listing of samples.

In today's environmental laboratory, the need to meet ever-changing regulations has increased dramatically since the mid-1990's. Laboratories across the world face the need to perform a higher volume of testing and improve data security in order to ensure the safety of their nation's water supply. Governmental organizations such as the National Environmental Laboratory Accreditation Conference (NELAC) in the United States are working to assure that the decisions made from analytical data have a sound technical, scientific and statistical basis.

LABWORKS™ Laboratory Information Management System (LIMS) provides a comprehensive solution for meeting new regulatory requirements. LABWORKS automates the process of ensuring data integrity by limiting data access to authorized users. Audit trails make it possible to trace the history of any particular piece of data.

LABWORKS LIMS is a leader in the environmental LIMS industry with a history of providing solutions to local, state, federal and commercial laboratories. One of the main benefits is its ability to meet the needs of the environmental industry, fully operational upon installation, without the need for customization. Add to that our commitment to the highest quality support – from

pre-implementation, to installation and training – and you've got a LIMS that leads the industry. In fact, over 90% of our current customers would recommend LABWORKS to other LIMS users. From our detailed discovery process that helps labs understand workflow to our knowledgeable implementation team and comprehensive support plans – LABWORKS is the LIMS of choice.

The Process Scheduler module allows labs to automatically schedule routine samples and provides a calendar view of samples and color-coded status. Bar-coded data entry saves time and eliminates manual data-entry errors. Virtually limitless reporting capabilities allow laboratories to create custom reports such as discharge monitoring reports (DMR) and regulatory reports for state and federal agencies. LABWORKS LIMS also includes capabilities for CLP reporting and electronic data deliverables.

LABWORKS understands the demands placed on environmental laboratories to meet increasing regulations with limited manpower. Our solutions help labs increase workflow, eliminate errors and provide secure, audit-trailed results. The combination of LABWORKS LIMS and PerkinElmer instruments creates a total solution for routine environmental laboratories, water supply or treatment facilities.

# comprehensive service and support for today's results-driven lab

With over 60 years of experience, and as a world leader in analytical instrumentation, PerkinElmer is the right partner for the environmental industry. In concert with global distribution of instruments, turnkey systems, and consumables, we provide factory-trained global service and support.

PerkinElmer's Laboratory Services provides you with a comprehensive worldwide service offering that allows you to take care of business and set your sights on what matters most – results. With over 1000 factory-trained professionals serving more than 125 countries worldwide, PerkinElmer is your single source for instrument care and repair, validation services, software and hardware upgrades, education and more.

worldwide applications support,  
coupled with  
factory-trained service  
keeps your lab productive

— *Chuck Schneider,  
Global Director,  
Environmental Analysis*



# PerkinElmer, Inc.

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## Whatever you're looking for, we've got it

PerkinElmer is a leading provider of scientific instruments, consumables and services to the environmental testing, pharmaceutical, biomedical, forensics and general industrial markets, providing integrated solutions, from sample handling and analysis to communication of test results.

If you are designing a new laboratory or updating an existing facility, look to partner with PerkinElmer to provide a full range of analytical solutions for your business – for the long term.



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