ENSPEC®
ENVIRONMENT AND RISK

arboricultural and environmental consultants

COMPANY OVERVIEW

ENSPEC is a privately owned and operated Australian Company that provides services in all aspects of the Arboricultural and Environmental Industries. Our primary focus is Risk Management and Consultancy to ensure the future preservation of the environment.

ENSPEC has a variety of organisations as clients, each with differing requirements and outcomes. This requires close working relationships to be established ensuring we meet the individual client's needs and exceed their expectations at all times.

ENSPEC knowledge, competencies and long affiliation with this unique professional industry has allowed the development of tailor-made systems and methodologies. This allows our many and varied clients to best manage their risks, ensuring their assets are managed in a pro-active manner to maximise the useful life expectancy without increasing any associated risks and costs.

ENSPEC believes that to ensure best practices in preservation and safety are achieved the focus must be on embracing new discoveries, and continually introducing new scientific equipment and innovative methodologies to the industry in practicable, administrative and technical ways. We have introduced many paperless methods of environmental management that allow ease of dissemination of acquired information to the client for the future management of their environmental asset.

ENSPEC believes science provides the answers to effective tree management.

ENSPEC provides the environmental and arboricultural industries the opportunity to work with industry leaders with the most advanced technology available in the world.

REGISTERED BUSINESS NAME

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Professional Indemnity	Ten Million Dollars ($10,000,000.00)
Public Liability	Twenty Million Dollars ($20,000,000.00)

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ISO 14001 mill accredited · TCF totally chlorine free · ECF elemental chlorine free · recycled · australian made · sustainable forest

OVERVIEW OF SERVICES

ENSPEC takes much pride in being one of only a very few specialist independent companies worldwide that focus on core practices. *ENSPEC* does not undertake any practical services such as tree pruning or removal, tree planting, pest management spraying or fertilising of plants. This ensures there is no conflict of interest when *ENSPEC* provides information to clients.

ENSPEC clients include:

- Local Government Authorities and Municipalities
- Government and Private Utilities
- State and Federal Regulatory Bodies
- Government Agencies (Federal and State)
- Research Institutes
- Commercial and Industrial Companies (by referral)
- Insurance Companies

ENSPEC offers a wide range of specific services; these include but are not limited to:

- Arboricultural, Environmental & Ecological Assessments, Consultancy & Management Plans
- Tree Health, Risk & Hazard Assessment and Management Reports
- Heritage, Significant & Cultural Tree Assessments and Management Reports
- Ecology, Flora, Fauna & Vegetation Net gain Assessments & Plans
- Strategic and Policy Management Plans
- Forensic Investigations and Expert Court Witness Statements
- Municipality & Utility Vegetation Project Management
- Bushfire Recovery Project Assessments & Management
- Contract Compliance Auditing
- Fungi Identification including DNA Laboratory Services
- Natural Antagonistic Laboratory Testing & Growth Services
- Soil & Plant Tissue Laboratory Testing Services
- GNSS - GIS Tree Surveys - all sized projects
- RADAR – Root Mapping, Archaeological, Soil Profiling, Utility Mapping
- Diagnostic Testing & Assessment
- Sonic Tomograph Testing
- Electric Impedance Testing
- Tree & Root Plate Dynamic and Static Stability Testing
- Wood Strength Testing Compression and Tension
- Chlorophyll Fluorescence Measurements (H-Pea)
- Soil, Bulk Density, Water Infiltration and Moisture Testing
- Natural Fertigation Batching Service
- Tree Propping and Stabilisation
- Silva Structural Cell, Design and Management

ENSPEC's head office facilities are located in Melbourne and incorporate our own scientific laboratory dedicated to the Urban Forest, and a warehouse area where semi-controlled trials are conducted and scientific equipment is stored.

Our laboratory offers a range of services including field and DNA fungi identification, and soil and plant tissue testing and analysis. *ENSPEC* is currently in partnership with several government authorities undertaking research on Dynamic Loading of trees, and natural antagonists to prevent tree diseases.

ENSPEC owns and operates the world's most diverse, innovative and up-to-date range of scientific diagnostic and quantitative measuring equipment and systems.

Our Ground Penetrating Radar (GPR), complete with GPS integration and the unique RADAN 3D software, has set a new standard in root analysis throughout the world; to date no other company using this system has achieved our standard of results in relation to tree root identification. Our GPR allows *ENSPEC* to undertake test scans and produce scaled digital 3D drawings while on site, allowing the client to evaluate their situation on site in real time and scale. With a range of antennas, our system has the ability to scan from the surface down to a depth of 5 meters in highly reactive clay soil and down to 10 meters in sand, identifying roots as small as 5mm in diameter.

The PiCUS Sonic Tomograph is a non-invasive method of measuring the structural integrity of trees and the extent of fungal invasion in all wooden structures. Through the sound waves created at each sensor, this system allows comprehensive 2D and 3D images of the internal structure of the tree to be mapped and produced.

Complementing the PiCUS Sonic Tomograph is the PiCUS (Treetronic) Electronic Impedance Tomograph. The Treetronic gathers chemical information about the wood, such as water and/or ion concentration, and provides a 2D computer printout. Point-like electrodes inserted into the cambium of the tree trunk create an electrical field that measures spatial difference, allowing accurate conclusions about the structure of the tree/wood/trunk to be made. The non-destructive nature of the Treetronic is an added advantage to using this particular piece of equipment.

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OVERVIEW OF SERVICES *(continued)*

The Tilt Sensor measures the Dynamic Loading of a tree and is used to gain a precise understanding of the structural situation of a tree's root plate. It is a small electronic instrument that is attached to the trunk base at the top of the root plate and continuously monitors root plate tilt. When the root anchorage is strong, as in stable trees, only low levels of tilt are recorded even under high wind conditions.

Data from the Tilt Sensor can be used by managers to assist in the evaluation of trees that are at risk of failure in high winds and to plan appropriate strategies to safeguard the trees.

In the case of dead trees, Static Loading can also be applied to the tree to complement the Dynamic Loading methodology. A series of controlled pulling loads are applied; the pulling force and tree strength are carefully measured using calibrated instruments so that the test is always kept within limits of structural safety. During the test electronic instruments monitor the loads and forces, and a trained *ENSPEC* operator constantly monitors the tree to ensure no damage occurs. Static Loading is only used on dead trees as they have no foliage to act as a windsail to load the tree using Dynamic measurement methodology.

A further enhancement to our scientific diagnostic service is the Electronic Fracture Meter. This diagnostic tool allows *ENSPEC* to conduct accurate wood strength testing on site, allowing verification of wood strength in trees and thereby giving our clients unprecedented confidence in our tree management decisions. These results can be graphed and included in our professionally written reports, providing the client with the most accurate and up-to-date information to present to the stakeholders.

The RADAR, PiCUS Sonic Tomograph, PiCUS Electronic Impedance, Tree Tilt sensors and the computerised Fracture Meter all complement *ENSPEC*'s comprehensive range of diagnostic equipment for assessing wooden structures.

For tree health assessment *ENSPEC* uses a Chlorophyll Fluorescence Meter, commonly known as a Handy-PEA or H-PEA. The H-PEA is a compact, highly portable continuous-excitation type chlorophyll fluorescence analyser. This unit is suitable for large scale screening of samples in the field providing quick analysis of tree health.

To complement our measuring equipment *ENSPEC* has an extensive range of Global Navigation Satellite Systems (GNSS) and GIS equipment and software. Our Trimble GNSS units with wireless reflective lasers allow *ENSPEC* to map assets to sub-150mm accuracy.

ENSPEC now has a complete range of computer software to back up our GNSS hardware; we can offer our clients a choice of software including Mapinfo, Geobasemap, Arcview, Arcpad and Pathfinder. *ENSPEC* has developed, and will continue developing, new mapping software that is compatible with all GIS programs for each individual client. By having this extensive range of software programs available for our clients, *ENSPEC* can supply a comprehensive level of service in data collection, data presentation and mapping. This enables *ENSPEC* to complete a mapping project from start to finish, including GIS overlays, ready to be integrated straight into the client's existing system.

ENSPEC has developed a unique 'lockable headstock and flotation base plate system' for propping trees. One prop can support branches up to 20 tonne in weight, and the tree prop can be continually adjusted to grow with the tree over many years. When using this system there is no requirement for digging foundation holes in the root plate of the tree, making it an excellent non-invasive system for tree preservation.

ENSPEC ENVIRONMENTAL SUSTAINABILITY STATEMENT

ENSPEC believes that economic growth and the well-being of society are inextricably tied to the health and preservation of the environment. Accordingly, *ENSPEC* embraces our responsibility for environmental stewardship and are committed to integrating leading environmental practices and sustainability principles into our core business.

Through collaboration with other researchers, federal, state and local government, arborists, ecologists, conservationists, mycologists and pathologists, we will actively work to reduce the environmental impact of our business activities and to continually improve and innovate on practices aimed at:

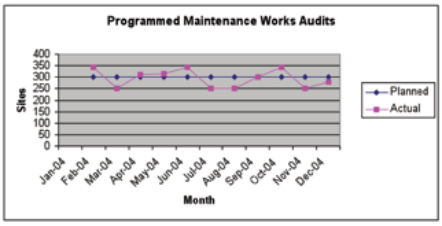
- researching natural antagonists
- developing new environmentally sustainable inoculation processes
- conserving natural resources
- minimizing waste and pollution
- enhancing indoor environmental quality
- raising environmental awareness among the public and continuing to educate all people of the benefits of trees in the environment.

ENSPEC acknowledges that in many ways we, like the trees we strive to preserve, are only in the early stages of developing and implementing the many changes that will be necessary to achieve these vital goals. Nonetheless, we strongly believe that our efforts to support a healthy environment serve the interests of future generations in environmental preservation.

PROJECT MANAGEMENT SERVICES

Project management is the application of knowledge, skills, tools and techniques to envisage activities that will meet a specific project's requirements. ENSPEC accomplishes this through the application and integration of a project management process of planning, organising, securing and managing resources to bring about the successful completion of project specific goals and objectives.

Skilful project management is critical to the successful delivery of any project, allowing the project to run smoothly and ensuring all parameters are met. The primary challenge of project management is to achieve all of the project goals and objectives within the client's predetermined project constraints including scope, time and budget. The secondary and more ambitious challenge is to optimise the allocation and integration of inputs necessary to meet pre-defined objectives. ENSPEC has the experience and expertise in project management to successfully meet these challenges.

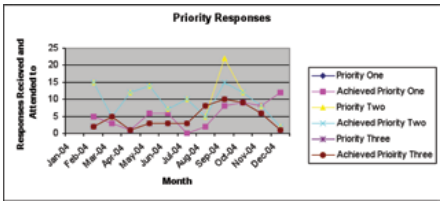


The arboricultural and environmental industries have unique project requirements and outcomes. ENSPEC has worked closely with a variety of clients from within these industries over many years and has a comprehensive knowledge and understanding of their needs, goals and constraints, and community expectations.

ENSPEC offers a fully integrated suite of project management services enabling us to manage your project from start to finish. ENSPEC's highly trained and experienced staff, and vast range of advanced scientific equipment and software ensure all client project needs are satisfied. ENSPEC can provide the following services:

- Data management, including asset audits, tree inspections and assessments, data collection, analysis, presentation and mapping, works recommendations, and data export and integration to client's own system
- Tender management, including tender document design, and tender letting, evaluation and awarding
- Works management, including monitoring the progress of programmed works and completion to timelines
- Project reporting, including expenditure against budget, budgetary seasonalisation, Occupational Health and Safety, and scope of work and contract requirement non-conformances
- Auditing for contract compliance, using random sampling methodology and providing comprehensive statistical analyses and detailed information on non-conformances
- Invoice management, including the processing and approval of invoices, and payment to the sub contractors

ENSPEC has a proven record of dedication and delivering projects to clients always ensuring the client key performance indicators are achieved.



QUALITY AUDITING, OH&S AND CONTRACT COMPLIANCE

Achieving high quality, cost effective, low risk outcomes relies on contractors and systems working to a high level of efficiency and quality. To achieve these high quality outcomes, strong, independent systems auditing and contract compliance monitoring is required.

ENSPEC is a highly dedicated and experienced specialist arboricultural and environmental consultancy company. *ENSPEC* does not have operational crews or affiliations with operational companies, which provides *ENSPEC* with an unmatched level of independence in the fields of arboricultural and environmental consultancy. Combined with *ENSPEC*'s extensive in-house experience in all aspects of tree management including local and State government, works supervision, contract management and power line management, *ENSPEC* has the unique ability to provide truly independent quality and compliance auditing services to clients.

ENSPEC can help the client to cost effectively achieve maximum quality by:

- Providing independent specialist advice on new or existing contracts and tenders
- Reviewing and improving existing work systems and contracts
- Reviewing, developing and implementing quality management systems
- Independent auditing for contract compliance

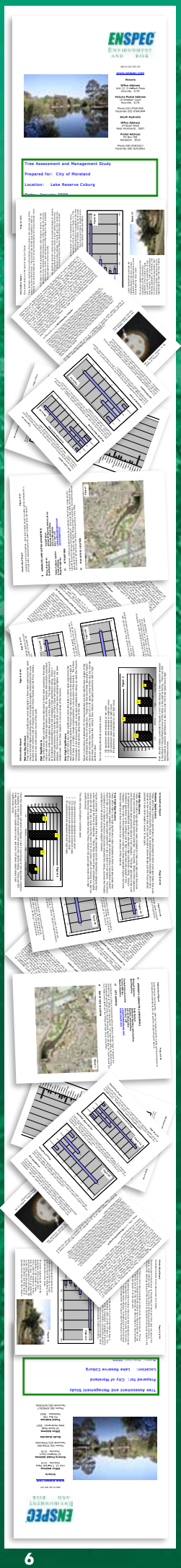
When conducting quality audits *ENSPEC* generally works to a random sampling methodology that is tailored to each client's specific project. There are four sampling methodologies that we use, all of which are in accordance with all standards.

- Simple random sampling
- Stratified random sampling
- Systematic random sampling
- Cluster random sampling

By using sampling methodologies the cost of audits is dramatically reduced, whilst still meeting the same outcome as completing a full audit. In simple terms the sampling rate can start at a percentage of inspections. If the contractor is meeting the specifications over a period of time the sampling rate could be reduced to less than 10%. If non-conformances are continually found then the sample rate will increase, as the contractor is continually not meeting specification.

ENSPEC auditing and contract compliance systems are based on comprehensive, verifiable data collected in the field and recorded electronically. Data is collected spatially so trends can be seen on GIS overlays. All reports to the client have comprehensive statistical analyses along with detailed information on the non-conformances.

These systems ensure that clients always have a strong and defendable position in negotiations with their contractors.



VISUAL TREE INSPECTIONS

ENSPEC conducts tree inspections using the Visual Tree Assessment (VTA) method that is used throughout the world by professional arborists.

Trained arborists use VTA's to inspect and assess trees in order to identify any defects or problems that may lead to structural instability or failure. VTA's are conducted on location because it is important that the tree is thoroughly checked on site, rather than remotely or from photos.

The VTA system is based on the theory of tree biology, physiology and tree architecture and structure, and is a method used by arborists to identify visible signs on trees that indicate good health or potential problems. Symptoms of decay, growth patterns and defects are identified and assessed as to their potential to cause whole tree, part tree or branch failure.

If internal or structural problems within a tree are suspected, *ENSPEC* has the scientific equipment to conduct higher level investigations and assessments; this is an area of expertise that *ENSPEC* is known for as the industry leader.

ENSPEC employs fully qualified arboriculturist with many years experience in conducting tree inspections using the VTA method. A comprehensive inspection (VTA) of the tree or trees is performed in the field by an *ENSPEC* arboriculturist and a comprehensive, professionally written report is provided to the client. The report gives details of tree health, condition, structural integrity, risk, value, useful life expectancy and recommended remedial works, with detailed advice for a practicing arborist to implement the remedial outcomes of the tree assessment.

ENSPEC employees have the required qualifications, hands-on experience, writing skills and unique ability to prepare documents from a basic layman's report through to detailed long term and strategic tree management plans, and scientifically validated reports.

ENSPEC has the credentials and experience to prepare expert witness statements, and the legal and technical knowledge to represent our clients in a court of law.

ENSPEC's fully professional Visual Tree Assessments and reports provide the client with the necessary information to make best practice decisions to manage trees to their full useful life expectancy while minimising risk to the tree owner.

GNSS AND GIS SYSTEMS

ENSPEC can map and assess thousands of trees over large areas to generate accurate up-to-date maps and databases using GPS (Global Positioning System) and GIS (Geographic Information System). *ENSPEC* is highly experienced, having mapped and assessed trees and other assets for a wide variety of clients in Australia and overseas. Managers can investigate the resulting databases to accurately assess their current inventory of tree species, condition, maintenance needs and costs.

ENSPEC innovatively uses the latest versions of hardware and software to provide the best mapping and GIS systems available in the world.

A satellite navigation system with global coverage is termed a Global Navigation Satellite System (GNSS) and sends signals to instruments that become part of a Global Positioning System (GPS). GPS-enabled devices use the satellite signals to locate their position on earth. A fully trained and experienced *ENSPEC* operator uses a GPS-enabled device to find the exact position of a tree. The location is then stored in memory and the operator moves on to the next tree and repeats the process. The combination of *ENSPEC*'s reflective lasers and GPS devices allow the accurate location of trees in the most difficult terrain.

ENSPEC post-processes all GNSS data to ensure a high level of accuracy is achieved in all situations. *ENSPEC* can provide co ordinates with 10 mm accuracy with our systems.

ENSPEC can also locate trees using existing GIS datasets including orthoimagery (aerial photography), property and street data. GIS-based methods are particularly effective in suburban and city areas. GIS accurately relates tree location to existing datasets and can automatically draw information from these datasets, efficiently providing comprehensive relational databases for clients.

As well as the precise location, a broad range of information such as tree species, health, height, canopy and trunk diameter, photographs, planting location or power line clearance can be captured during the survey. The resulting database is a powerful tool for managing trees and estimating works such as pruning and planting.

To rapidly and accurately record the locations of many trees over large areas *ENSPEC* operates quad bikes fitted with computers, GNSS units and reflective lasers. Due to their unique and safe setup all *ENSPEC* quad bikes are registered for road use.

ENSPEC systems are compatible with commercial programs such as MapInfo, Geobasemap (GBM Software), ESRI Arcview/Arcpad, Autocad and Pathfinder.

ENSPEC has the ability to establish and manage customized GIS-based tree management data systems to actively manage the client's tree maintenance and planting operations. Data can be collected by *ENSPEC* personnel or by the client's own staff, or by a combination of the two. *ENSPEC*'s remote data management capability means that the client's data is processed and returned quickly, keeping crews working and keeping the client in the project driver's seat. *ENSPEC* systems ensure the client has accurate and up-to-date data at all times, as well as archived and traceable data to manage risk. *ENSPEC* can provide experienced project oversight as well as hardware and software systems that can stand alone or be integrated into the client's existing management systems.

The GIS system allows for live transfer of data from the field that can be used to guide tree crews and contractors. *ENSPEC* can automate the processing of data, automate report writing and provide cost effective GIS programs for managing trees.

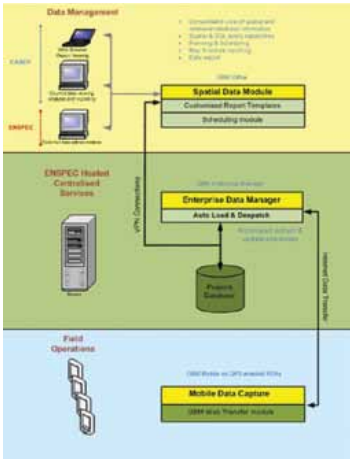
ENSPEC provides tree mapping and GIS services that use the most advanced technology available in the world. *ENSPEC* can provide a comprehensive service from start to finish, including field data collection, database development and final report generation. This integrated service includes GIS overlays that are compatible with existing systems used by clients. *ENSPEC* can complement this with onsite printing of hard copy maps and plans up to A0 size.

ENSPEC employs an Information Technology expert with a high level of experience in database and mapping software to cope with this rapidly developing technology and provide the most innovative and effective solutions to the client.

URBAN FORESTRY SYSTEM

ENSPEC's latest development, is a fully integrated spatial data base system. This will allow *ENSPEC* to fully centralise the client's data and store it securely and safely, and administer live spatialised data management on behalf of the client. This will provide *ENSPEC* with the ability to automate the processing of all data, automate reporting and work scheduling and importantly, to automate live reaction to Customer Requests from the field crews undertaking the works. By having access to systems councils have the opportunity of being able to update tree information and run full reports on any tree at anytime.

ENSPEC provides the environmental and arboricultural industries with the opportunity for clients to work with industry leaders with the most advanced technology available in the world.



I-TREE

ENSPEC has been one of the earliest proponents of incorporating i-Tree into Australia, and is the key research partner for converting and adapting i-Tree to an Australian context. This has involved the research, collation and formalisation of critical climatic, geographic and botanical data to be used for the program in Australia.

ENSPEC has undertaken numerous urban forest inventories for clients in Australia. More recently these inventories have included collecting the key attributes required for use with i-Tree Eco. These inventories have been conducted in conjunction with *ENSPEC*'s general urban forest inventory programs, which include GIS/GPS mapping of tree locations, full Visual Tree Assessments (VTA), and recommendations and prioritisation of remedial works.

i-Tree is a freely accessible peer-reviewed software program developed by the USDA Forest Service. The i-Tree suite of programs provides valuable information for the functional benefits of the urban forest. The i-Tree tools cater for municipalities, government agencies and the community to reinforce their urban forest management practices and advocacy by quantifying the structure, environmental services and economic benefits of their urban forests.

By understanding the local, tangible ecosystem services that trees provide, i-Tree users can link urban forest management activities with environmental quality and community liveability. Whether it is for a single tree or an entire forest, i-Tree can provide baseline data that can be used to demonstrate value and set priorities for more effective decision-making.

Developed by USDA Forest Service and numerous co-operators, i-Tree is in the public domain and available by request through the i-Tree website (www.i-Treetools.org). The Forest Service, Davey Tree Expert Company, National Arbor Day Foundation, Society of Municipal Arborists, International Society of Arboriculture, Arboriculture Australia, Casey Trees and ENSPEC have entered into a cooperative partnership to further develop, disseminate and provide technical support for the suite.

The i-Tree suite includes the following urban forest analysis tools and utility programs:

- i-Tree Eco provides a broad picture of the entire urban forest. It is designed to use field data from complete inventories or randomly located plots throughout a community along with local hourly air pollution and meteorological data to quantify urban forest structure, environmental effects, and value to communities.
- i-Tree Hydro (beta) is a new application designed to simulate the effects of changes in tree and impervious cover characteristics within a watershed on stream flow and water quality.
- i-Tree Vue allows you to make use of freely available national land cover data maps to assess your community's land cover, including tree canopy, and some of the ecosystem services provided by your current urban forest. The effects of planting scenarios on future benefits can also be modelled.
- i-Tree Design (beta) is a simple online tool that provides a platform for assessments of individual trees at the parcel level. This tool links to Google Maps and allows you to see how tree selection, tree size and placement around your home effects energy use and other benefits. This beta tool is the first stage in the development of more sophisticated options that will be available in future versions.
- i-Tree Canopy offers a quick and easy way to produce a statistically valid estimate of land cover types (e.g., tree cover) using aerial images available in Google Maps. The data can be used by urban forest managers to estimate tree canopy cover, set canopy goals, and track success; and to estimate inputs for use in i-Tree Hydro and elsewhere where land cover data are needed.
- i-Tree Species is a free-standing utility designed to help urban foresters select the most appropriate tree species based on environmental function and geographic area.
- I-PED Pest and Evaluation Detection Module is a portable, accessible and standardized protocol for observing a tree for possible insect or disease problems. I-PED is currently available within the i-Tree Streets program and can be adapted to other external tree inventory programs.

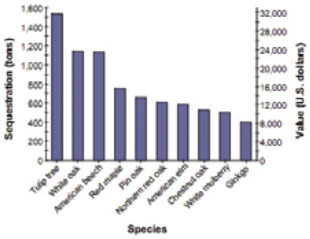


Figure 7. Carbon sequestration and value for species with greatest overall carbon sequestration in Beulah

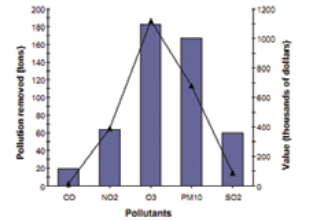


Figure 6. Pollution removal and associated value for trees in Beulah (line graph is value)

Structural values:

- Structural value: $3.99 billion
- Carbon storage: $12.3 million

Annual functional values:

- Carbon sequestration: $393 thousand
- Pollution removal: $2.30 million
- Lower energy costs and carbon emission reductions: $3.58 million (Note: negative value indicates increased energy cost and carbon emission value)

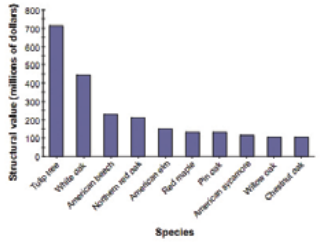


Figure 8. Structural value of the 10 most valuable tree species in Beulah

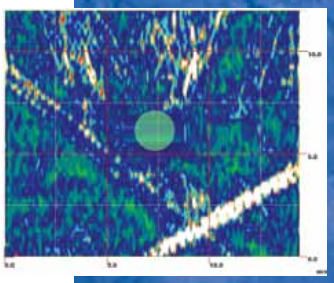
GROUND PENETRATING RADAR (GPR)

ENSPEC uses Ground Penetrating Radar (GPR) to locate tree roots and underground objects to generate scaled 3-dimensional images that allow clients to manage and mitigate damage to assets and tree root systems. *ENSPEC* is a world leader in this technology, achieving superior results in locating and identifying tree roots.

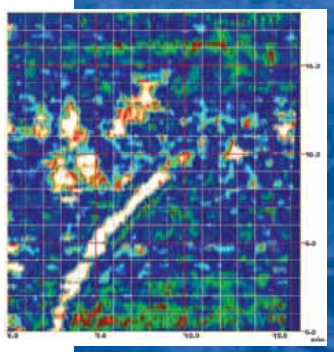
ENSPEC services with the GPR include:

- Root architecture mapping
- Soil profiling
- Water table mapping
- Forensic investigations
- Archaeological surveys
- Civil Engineering Structural investigations
- Research (root health and moisture measurements)
- Service location including fibre optic cables

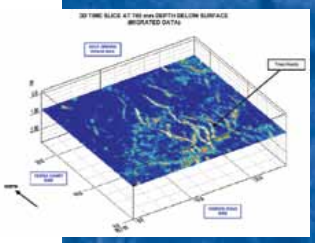
ENSPEC's GPR is an impulse type RADAR that uses a wide spectrum frequency emitted in rapid pulses (approx. 100,000 pulses per second). The GPR is slowly moved over the test area, and the radar pulses (radio waves) are transmitted from the antenna through the ground. The pulses transmit harmlessly through the soil and are reflected by subsurface objects or variances back to the surface where they are received by the antenna. The RADAR detects the depth, conductivity, permittivity, density and location of subsurface objects. The data is collected and stored within the field computer for later analysis. Basic field analysis and interpretation can be conducted onsite using the field computer display. The quality of the results is influenced by the site conditions; it is preferable that the test area is relatively flat and clear of debris. The GPR testing can be conducted through almost any surface type e.g. bitumen, concrete, grass, mulch, bare earth or wood.

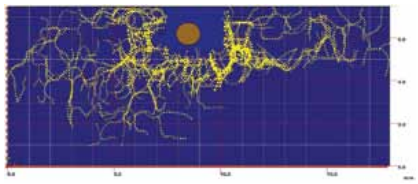


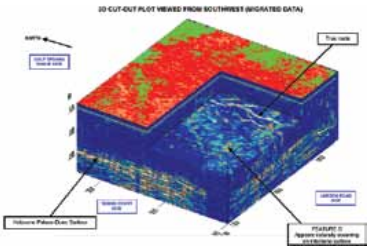
ENSPEC has a range of antennae that allow the GPR to penetrate variable depths and detect variable sized features dependent on client outcomes. The 900 MHz antenna is used for shallow detection (<1 meter) of small subsurface features (10 mm diameter); this is generally used for archaeological detection services and research. The 400 MHz antenna is used for detection of features greater than 20 mm diameter, and to depths of up to 3 meters in clay and 5 meters in sand; the 400 MHz antenna is generally used for tree root and subsurface utility detection. The 270 MHz antenna is generally used for deeper detection services (i.e. < 10 meters in sand and 5 meters in clay), and facilitates detection of broad soil profiles, water tables and the location of large rocks for civil works. The 270 MHz antenna is also used for detecting moisture in large hay stacks.

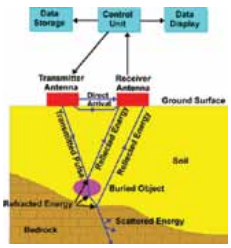


Distinguishing between roots, subsurface utilities (i.e. pipes) and other subsurface features requires familiarity and experience with the equipment and data collected. ENSPEC provides clear and concise GPR data and information to its clients by utilising the latest software tools once the data is exported from the field computer. The software allows for scaled 3-dimensional images (maps) to be created in a variety of formats. Features within these images are then interpreted, classified and collated into a concise report format by *ENSPEC*'s highly trained staff. The images within the reports can then be utilized by the client to prevent damage to tree roots and infrastructure when conducting excavations.

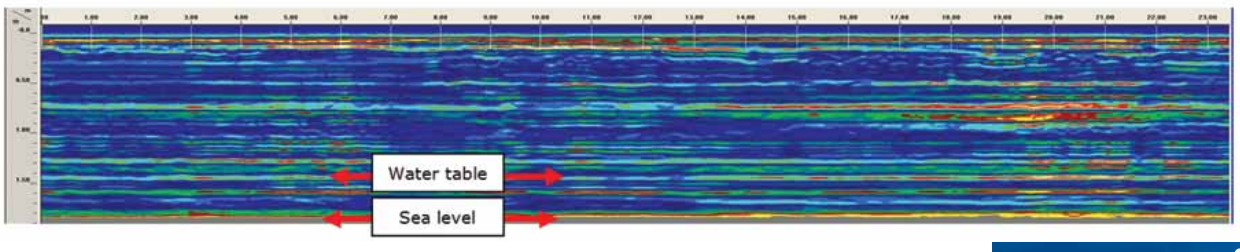








Soil Profile 1 and GPR Profile 3



ROOT PLATE STABILITY ASSESSMENT DYNAMIC LOADING

The roots and soil anchorage are the foundation of tree structure and any excessive movement indicates a reduction in stability, and the tree may be at risk of failure in high winds.

ENSPEC assess tree stability using tilt sensors that accurately measure root plate movement under natural wind conditions to identify trees at risk of failing. The tilt sensor is a small electronic instrument that records dynamic root plate movement to accurately measure the tree's response to winds. This is the only method currently available that accurately measures wind loading and directional information on root plate movement.

ENSPEC can identify trees that are at risk of failure and trees that are stable. Trees that are at risk of failure move excessively in winds due to poor root anchorage or root plate instability, whereas stable trees have little movement of the root plate even in strong winds because the root and soil anchorage is sound.

Root damage to trees is common in urban areas when digging trenches to install gutters or underground services. The stability of a tree can be affected if structural roots are cut, or if fungus or disease enters the tissue through root wounds. If this happens the root anchorage in the soil will be compromised and the tree root plate will move more in windy conditions.

Wind direction is important when assessing tree stability because wind comes from many directions and often the most destructive wind comes from the unexpected direction. Data from tilt sensor tests is valuable in urban areas where nearby buildings can affect wind direction and cause unexpected tree failures.

Fully trained and experienced *ENSPEC* staff attach the tilt sensor to the base of the tree trunk at the top of the root plate where it continuously monitors root plate tilt during natural wind conditions.

If low levels of tilt are recorded the tree can be identified as stable and unlikely to fail in high winds. If high levels of tilt or excessive movement are recorded the tree can be identified as unstable and at risk of failure in high winds.

ENSPEC personnel analyse the data from the tilt sensors and provide a detailed, professionally written report to the client. The information in the report can assist managers in evaluating trees that are at risk of failure in high winds and to plan appropriate pre-emptive strategies to mitigate the risk of tree failure.

Accurate data on root plate movement can be used to assess likelihood of failure and risks associated with different management strategies for trees, especially in public spaces, and provide evidence to support tree management decisions.

ENSPEC can use the tilt sensor to evaluate the effects of digging or trenching on tree stability by measuring and recording tree tilt before and after the construction works have been undertaken.

The tilt sensor enables the early detection of trees at risk of falling thus allowing managers to plan and implement remedial works that can prevent failure and damage occurring and safely retain the tree.

Although a tree may be moving at the root plate, it can be supported until roots regenerate and so may not need to be removed. *ENSPEC* offers tree stability assessment and preservation systems for trees at risk of failure, enabling time for the roots to recover and eventually support the tree. Tree stability can be verified using the tilt sensor to monitor the root plate movement over time to show that the tree anchorage is improving and the tree is becoming more stable.

Data obtained from tilt sensor tests may also be useful in proving that a tree is actually stable and therefore not in immediate danger of falling. This information allows managers to concentrate resources on high risk trees whilst preventing the unnecessary pruning or removal of stable trees.

Figure 1, shows an Electronic tilt sensor secured to the tree to continuously monitor dynamic root plate movement. During winds the root plate tilt is measured to assess wind loading and tree stability.

Figure 2, shows a graph of two adjacent trees in high winds. Stable tree has little root plate movement; other tree shows excessive root plate tilt in the same wind and is at a higher risk of failure.

Figure 3, shows a graph of dynamic root plate tilt for a *Eucalyptus rubida* (31.5 m high) during a wind storm on 21 July 2011 with a maximum tilt of 0.85 degrees. The circle indicates the tilt limit that is expected from a stable tree under the same wind loading. Wind was from the northerly direction, which caused the tree to tilt in a southerly direction. Failure of a neighbouring tree indicates that this wind was strong and that this tree is moving more than a stable tree and is therefore considered at high risk of failure.

Figure 1

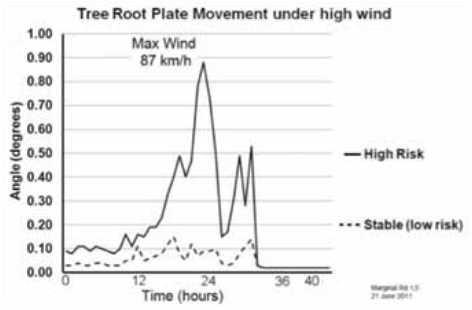


Figure 2

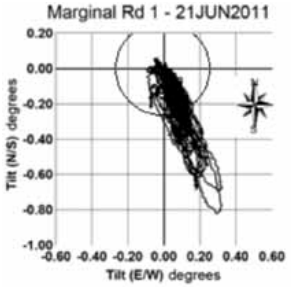


Figure 3

STRUCTURAL ASSESSMENT OF TREES - STATIC LOAD TESTING

ENSPEC can assess tree structure and stability using a static test that loads the tree and accurately measures the trunk strength and assesses root plate anchorage in the ground. This method of measurement is predominately used for dead trees.

The static test can provide evidence that confirms whether or not a tree or stump is stable so that informed decisions can be made as to whether it can be safely retained or should be removed. When conducted by a highly competent operator the test is non-destructive and no damage is caused to the tree or root system.

The level of operator competence is crucial to the successful application of the static test. *ENSPEC* only employs fully trained and experienced operators so that safety is always maintained at a high level and the test carefully controlled and monitored so that loads are kept within safe limits.

Dead stumps and trees that are pruned and kept as habitat trees require testing to confirm that the supporting roots are still sound and the tree stable. As dead roots gradually decay in the ground and the root anchorage becomes less secure, the tree or stump can become unsafe and at risk of falling over. This is a gradual process that occurs over several years.

The *ENSPEC* operator applies the static pull to the tree using a rope that is attached at one end to the tree, approximately half way up a trunk, and the other end to a winch on the ground. A series of controlled pulling loads are applied by the winch and the pulling force and tree strength are carefully measured using calibrated instruments so that the test is always kept within limits of structural safety. During the test, electronic instruments monitor the loads and forces, and the operator constantly monitors the tree to make sure that no damage occurs. At the conclusion of the test the load is removed and the tree returns to its original position.

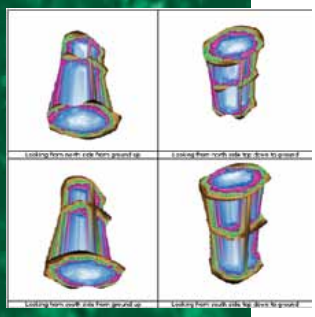
ENSPEC staff record and analyse the structural data from the test to confirm the stability of the tree or stump and an expert assessment is made about the risk of failure. A professional report is then prepared and provided to the client. The report assists managers to make informed decisions regarding the safe retention or necessary removal of the tree or stump.

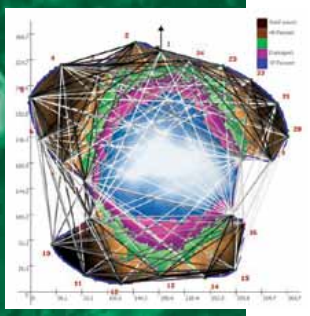
Annual static testing and reporting allows managers to monitor tree or stump stability over a period time so that any decline in stability is detected early, and risk management decisions can be made and actioned prior to a possible tree or stump failure.

ENSPEC appreciates the ecological benefits of retaining trees for habitat and believes static testing will allow more trees to be safely retained for this purpose.

Picture of a static pull test on a Brisbane tree to assess stability and root plate strength. The test was carefully monitored with electronic load cell and kept within safe limits. The test is non-destructive and does not damage the tree.

SONIC TOMOGRAPHY (ST)





ENSPEC uses the technologically advanced and highly sophisticated PiCUS Sonic Tomograph (ST) to accurately measure and assess the internal wood structure and strength in trees or other wooden structures. The PiCUS ST is a non-invasive instrument that works by passing sound waves through wood. Because the speed at which sound travels through wood is determined by the quality of the wood it is passing through, it is possible to detect areas of solid wood, areas of decay or cavities in a tree.

Fungi, pathogens and insects can attack and destroy the internal wood of a tree and compromise its structural integrity. Because internal damage to a tree is often not visible from the outside, it can be difficult to detect and assess; most tree failures are associated with fungal, insect or pathogen attacks.

The presence and extent of fungal, insect or pathogen invasion in trees can be quickly detected and accurately measured with the PiCUS ST. The early detection of decay and cavities in trees means that tree risk and health can be assessed and addressed in a timely manner.

The PiCUS ST uses a set of sensors (up to 30) that are placed around the trunk at the height being tested. The sensors are evenly spaced around the trunk and are connected by wires to record the sound transmitted through the trunk. Each sensor has a corresponding metal pin that is inserted into the trunk and then tapped with a hammer to create sound waves that travel from the tapped pin to all the sensors. Each pin around the trunk is tapped in turn and the test continues until all pins have been tapped with the hammer. The number of pins used is dependent on the size and shape of the tree at the test point.

The sensors around the trunk quickly measure the velocity of the sound waves that pass through the wood. Any variations in sound velocity are detected and can be linked to wood quality because sound velocity is different in solid wood, decayed wood or cavities.

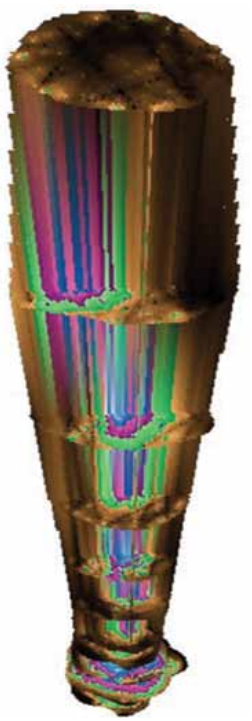
All sensor data recorded during the test is transmitted via Bluetooth to a computer for analysis. The sophisticated PiCUS professional software converts the sound data to wood quality values and the internal properties of the tree cross section are mapped on a colour image called a tomogram. The colours indicate solid wood, decayed wood and cavities and clearly show the location and extent of any damage.

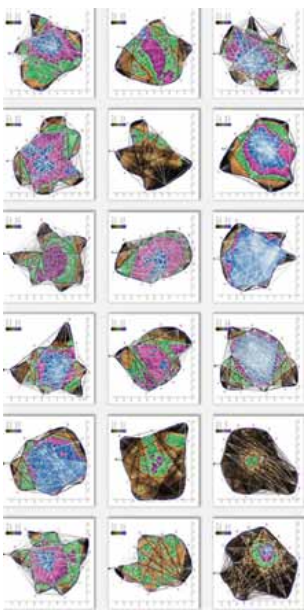
Skilled *ENSPEC* staff interpret the tomogram image, assess the structural integrity of the tree and identify the pathogens attacking the wood. The comprehensive and professional report that is provided to the client may be used by managers to identify and risk manage a tree that has internal defects that could lead to tree failure causing injury or damage to people or property. Alternatively, the evidence in the report may save a tree with suspected internal defects from unnecessary remedial works or removal.

Due to the sophisticated and complex nature of the PiCUS ST, the level of operator competence is crucial to its successful application. *ENSPEC* only employs highly trained and fully experienced operators to guarantee the integrity of the field tests and data interpretation and analysis. Clients can have full confidence in the veracity of *ENSPEC*'s PiCUS ST testing and reporting.

The PiCUS Sonic Tomograph offers an excellent non-invasive diagnostic instrument to evaluate and assess the internal structure of trees, and complements *ENSPEC*'s comprehensive range of diagnostic equipment for assessing trees and all wooden structures.

ENSPEC continues to utilise innovative equipment and methods that assist in creating safe environments and preserving trees.





ELECTRONIC IMPEDANCE (EI)

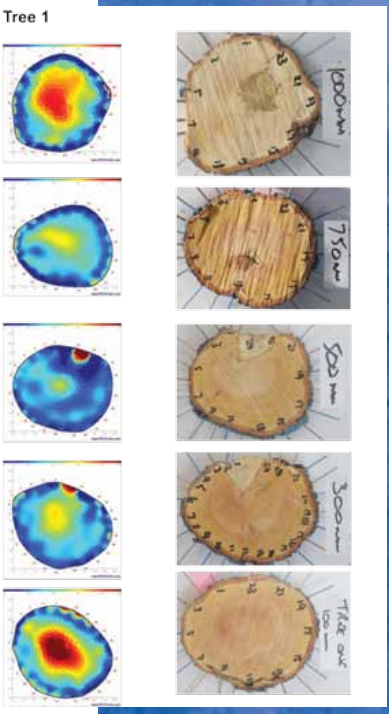
ENSPEC uses the PiCUS Treetronic instrument to assess the internal structure of a tree and to detect the presence of decay or defects such as cracks or cavities. The PiCUS Treetronic is one of the most up-to-date instruments designed for this purpose available in the world today. It is a non-destructive instrument that uses the latest technology and software to rapidly and accurately map the extent of decay and defects in trees.

The PiCUS Treetronic measures the internal wood properties of standing trees using the electrical characteristics of wood. The PiCUS Treetronic passes an electric current through the tree and measures the electrical properties (impedance) of the wood. Information on the moisture content and chemical properties of the wood (such as ion concentration) that affect the flow of electricity is measured.

The fully qualified and experienced *ENSPEC* operator mounts the PiCUS Treetronic onto a tree and attaches a portable power supply to the instrument. The operator inserts the metal electrodes into the tree trunk ensuring they are evenly spaced around the trunk.

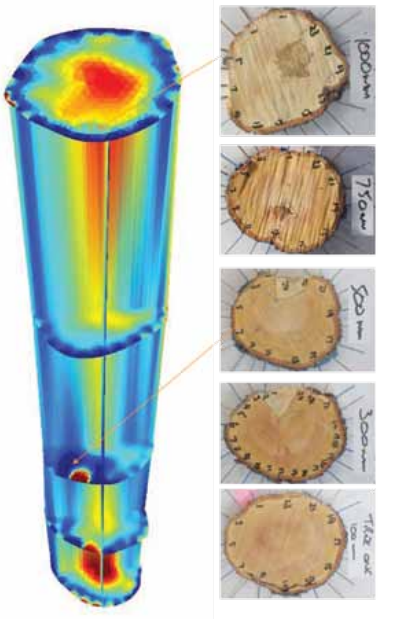
An electrical current is then passed through the trunk cross section, which detects changes in the electrical properties between the electrodes. Solid wood has different electrical properties to decayed wood or cavities and the flow of electricity is dependent on the quality of the wood. It is possible to distinguish between different types of damage such as 'wet' diseased wood and cavities because the electrical resistance is dependent on water content, cell structure and cell chemistry; these properties change if a pathogen has caused decay or rot.

The data from the test is collated by sophisticated PiCUS professional software that produces a tomogram, or colored map of the tree cross section. The *ENSPEC* operator is highly skilled in interpreting the tomogram and is able to accurately assess the tree's structural condition. The operator can also use the test results to obtain information about the tree above and below the cross section that has been tested, which is useful for analyzing decay pathways from roots or branches.



ENSPEC provides the client with a detailed, professionally written report that may assist managers to identify and risk manage a tree that has internal defects that could lead to tree failure causing injury or damage to people or property. Alternatively, the evidence in the report may indicate that a tree with suspected internal defects is in fact structurally sound, saving it from unnecessary remedial works or removal.

The PiCUS Treetronic complements *ENSPEC*'s PiCUS Sonic Tomograph enabling the comprehensive, scientific measurement of internal tree structure and allowing the early detection of cavities and defects in trees.



ELECTRONIC AND MANUAL CALIPERS

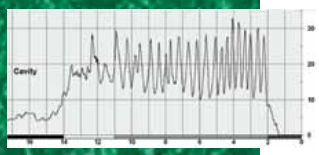
ENSPEC uses the PiCUS electronic caliper to measure tree trunk and branch diameters and to accurately map the exact shape of the area being measured. It is designed to operate with the PiCUS Sonic Tomograph and the Electrical Impedance Tomograph to give rapid, highly accurate measurements via Bluetooth to the PiCUS professional range of software. The PiCUS caliper is especially useful when the trunk shape is irregular and difficult to accurately measure using traditional tools or techniques.

The caliper is quick and easy to use in the field and the experienced *ENSPEC* operator simply opens the caliper and positions the tips of the two arms on either side of the trunk. If the trunk is irregularly shaped, the caliper arms are repositioned a number of times to obtain an accurate trunk diameter and map of the trunk shape.

In many cases trees that *ENSPEC* is requested to investigate are too large for the Electronic calipers. To accommodate Australia's large trees *ENSPEC* has had manual calipers engineered that can measure diameters up to 4000mm. When using the manual calipers, the measurements are manually recorded and entered into the PiCUS computer program to create the exact shape of the tree at the measurement point.

By using these calipers *ENSPEC* is able to provide the client with highly accurate data regarding trunk diameter and shape. Due to its ease and speed of use the caliper is extremely cost effective, saving the client time and money.

DIAGNOSTIC DRILL (IML-RESI F500)



ENSPEC uses the Diagnostic Drill (IML-RESI F500) to measure internal wood properties in trees or wooden poles. This is an invasive method of measurement and *ENSPEC* only uses this device as a last resort in specific circumstances. The Diagnostic Drill uses an extremely thin and long drill needle bit to make a small hole in the tree and as the drill needle rotates, the resistance to drilling is measured.

Highly trained and experienced *ENSPEC* staff use the drill to make a small hole in a tree or wooden pole. As the drill needle progresses through the wood the resistance and depth is recorded on a strip chart to show how strongly the drill must operate in order to pass through the wood. The depth of the drill is carefully measured so the chart curve is a record of the wood quality along the line of the drill path. The graph maps the wood profile giving a clear picture of the internal properties and wood quality of the tree or pole.

The Diagnostic Drill is able to accurately identify specific layers of wood. Solid wood has a high resistance to drilling and a corresponding high value on the strip chart. The softer decayed or fungi affected wood has a lower resistance to drilling and a corresponding lower value on the strip chart. Cavities offer no resistance to drilling and consequently have the lowest values on the chart.

Because the Diagnostic Drill is an invasive tool it must be used with caution; *ENSPEC* employs operators highly trained and experienced in its use to ensure any damage caused to the tree is kept to a minimum.

ENSPEC only uses this instrument as a last resort to gather evidence on the internal properties of trees. Such evidence may be used to identify and manage a tree that has internal defects that could lead to tree failure causing injury or damage to people or property.

PEOPLE COUNTERS

ENSPEC uses a people counter to record the number of people passing a specific point, and the time and date they passed, so that accurate information can be collected on the frequency of use of an area by pedestrians.

People counters are small infra-red instruments housed in weather-proof bollards that are strategically installed along tracks, walkways and open space areas. The system is robust, safe and blends into the surroundings.

With increasing concerns of risk management, facility managers need accurate information on how people use and access their resources. When managing the risks associated with people using parks, reserves, public toilets, walking tracks, pathways and nature tracks, information on how and when people use these resources can be a valuable guide to planning strategies that optimise time and costs.

A fully trained and experienced *ENSPEC* staff member installs the bollards containing the people counters along the designated tracks, walkways or open space areas. An infra-red beam is emitted and when the beam is interrupted by a passing pedestrian a count record is created and stored in the instrument's memory. After a set period of monitoring the data is downloaded and the records collated by *ENSPEC* staff.

ENSPEC uses people counters to provide clients with accurate information on the frequency of use of an area so that how patrons access and use the facility and how often they use it can be clearly established and understood.

The information can provide valuable data for the risk management of facilities and resources to ensure the area is a safe environment for patrons. The information is also useful for managers as a guide when implementing changes in layout or infrastructure design in parks, nature walks and paths.

ENSPEC believes that data obtained from people counters can be used by managers to optimise patron usage and enjoyment of their facilities.

ELECTRONIC FRACTURE METER 3 (EFM3)

ENSPEC operates an IML Electronic Fracture Meter 3; traditionally these units have only been used in laboratories for testing wood strengths for scientific research.

ENSPEC uses the Electronic Fracture Meter 3 (EFM3) to measure the quality and strength of tree wood by testing core samples taken from a tree's trunk or branch. The EFM3 electronically breaks an increment core of wood and directly records the kN strength into the computer, which then provides a digital printout of the wood's radial, tangential and compression strength against the various stages of wood degradation; this system eliminates any chance of human error.

Where there is concern about wood strength loss in a tree or branch the EFM3 can be used to determine the structural integrity of incipient and decayed wood.

A fully trained *ENSPEC* operator uses the EFM3 to extract a 5 mm diameter core sample from the tree using a specially designed increment borer. This core is carefully placed in the Fracture Meter so that the wood grain is aligned in the instrument ensuring it is tested in a manner that simulates the actual loading in a tree. The instrument then automatically applies a bending load to the core and the resisting forces are measured until failure of the core occurs.

The bending strength can be measured in both the radial and tangential directions and is expressed in Newtons or MPa. Typical values range from 8 to 34 MPa (radial) and 6 to 14 MPa (tangential). The compression strength can also be measured with typical values being in the range of 15 to 45 MPa.

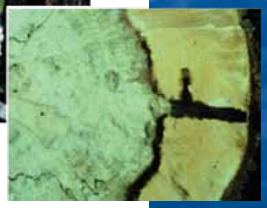
From this test the bending strength and compression strength of the wood is measured and the values cross referenced to tables for green wood samples. The trained *ENSPEC* operator interprets the results and provides the client with a professionally written detailed report. This can assist managers to make informed decisions regarding the appropriate management of the tree.

Because the EFM3 allows for the early detection of internal decay managers are able to plan and implement pre-emptive strategies to risk manage a tree. This may assist in reducing the incidence of unexpected tree failure that could cause injury or damage to people or property, and may allow the tree to be safely retained for many years.

Wood samples can be taken from a tree over a period of time to measure the progressive effects of decay and fungus on the structural integrity of the tree. These tests can assist managers in planning long-term strategies to risk manage the tree, which may allow the tree to be safely retained to fulfill its life expectancy.

ENSPEC can use the EFM3 as a research tool to measure wood quality and strength in various species of trees to screen or select for strong wood properties. The information can be then used to identify tree species that would be well suited for planting in urban environments and areas prone to high wind conditions.

The Electronic Fracture Meter 3 is an excellent example of *ENSPEC*'s ongoing dedication to saving trees and creating a safe environment through the use of equipment and techniques that are the most up-to-date and advanced in the world.



RHIZOSPHERE INVESTIGATION AND ANALYSIS

ENSPEC provides a range of soil testing services to measure the soils and sub-surface environment around tree roots and under roadways and pavements. Using a range of soil measuring instruments and technology, the soil can be kept in an optimum growing environment to ensure that conditions meet the needs of the client and the trees.

ENSPEC provides the following Rhizosphere services:

- Electronic penetrometer – Resistance soil compaction
- Undisturbed core sampler – Bulk density soil compaction
- Dutch Soil Auger – Soil profiling
- Soil Moisture meter - Soil Moisture Testing
- Infiltrometer – Water infiltration rate into the soil
- Electrical conductivity – Soil water quality
- Soil Acidity – pH levels

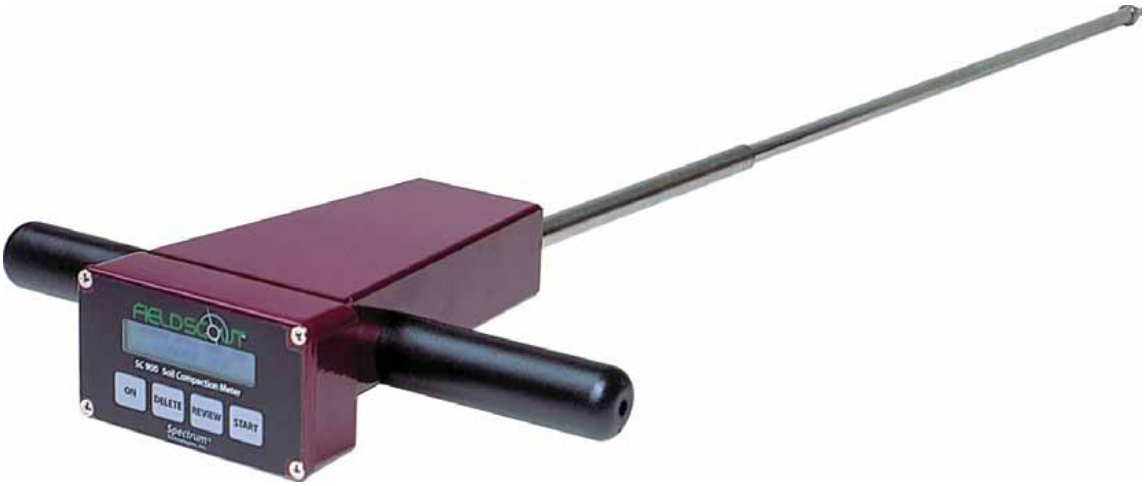
Often soil needs to be compacted for roadways or paths, yet must be de-compacted around tree roots to maintain good growing conditions. The optimum soil and sub-surface conditions can be monitored with the correct instruments to provide a sound understanding of soil moisture and water movement on site. Problems of soil moisture and drought, irrigation, drainage and water logging can affect trees and roots, and *ENSPEC*'s soil testing instruments and analysing services can help in the successful management of these problems.

Soils can be tested with a variety of instruments to check if the sub-surface conditions are at optimum or sub-optimum levels.

The following details describe *ENSPEC*'s soil testing instruments and their applications.

1. Electronic penetrometer – Resistance soil compaction

The electronic penetrometer measures soil compaction and is hand operated by pushing a stainless steel rod into the soil and electronically recording the resistance to the rod. At the end of the rod is a stainless steel conical tip that is precisely designed to calculate and record the resistance. The level of compaction is recorded in PSI or kPa units. This instrument is quick to use, robust and accurately measures soil compaction at different depths in the earth. By taking readings around a site or location the areas of soil compaction can be quickly located and recorded.



2. Undisturbed core sampler – Bulk density soil compaction

An undisturbed core of soil is taken in the field by hammering the hollow core into the soil and carefully extracting the sample. This ensures that the soil volume can be accurately measured and, together with the soil weight, can be used to calculate the bulk density. This is a simple, relatively quick (24 hours) and reliable method to obtain accurate measurements of soil compaction.

3. Dutch Soil Auger – Soil profiling

Also commonly known as the Edelman auger, this is designed for taking undisturbed soil samples and profiles from a variety of soil types and conditions. Separate attachments specifically suited to particular soils are available.

The auger is made from stainless steel so that it does not contaminate or interfere with the soil sample tests. The auger tip drills into the ground as the handle is turned in a clockwise rotation. Soil is forced into and retained in the auger to be brought to the surface and emptied; the auger is then carefully replaced into the hole and the process is repeated until the desired depth is reached. Soil augers are simple in design, but considerable skill is required to use them efficiently and safely. The extracted samples can be laid onto a clean surface in order of their extraction to develop a clear profile of the sampled area.

4. Soil Moisture meter - Soil Moisture Testing

The Fieldscout is the latest soil moisture probe that accurately measures volumetric soil moisture in a wide variety of soils. The hand held instrument is inserted into the soil and an electronic pulse is sent along probes called waveguides. The high energy electronic pulses pass through the soil and are then read by the instrument to determine moisture content.

This instrument uses a principle called Time Domain Reflectometry (TDR), which is suitable for all soils from sand to clay. TDR uses a dielectric principle to distinguish water from soil to give the most accurate soil moisture readings possible.

Trained *ENSPEC* operators can accurately measure soil moisture in root zones to determine irrigation needs or drought stress in trees, and to check if the moisture levels are within optimum levels. The instrument has applications for locating water logged areas as well as drought stressed areas.

5. Infiltrometer – Water infiltration rate into the soil

The infiltrometer consists of two metal cylinders that are pushed into the soil and filled with water. The inner cylinder water level is measured and as the water infiltrates into the soil, the drop in water level is recorded and the infiltration is calculated. The outer cylinder contains water to stabilize the readings and make sure no water from the central cylinder leaks sideways, which would introduce errors into the measurement.

Ring infiltrometers of different sizes are available (300mm, 600mm) to test different soil types (from sand to clay) and different rates of infiltration. Applications include determining irrigation requirements, water logging, leaching, drainage problems or seepage from underground tanks (e.g. septic tanks).

6. Electrical conductivity – Soil water quality

Electrical conductivity (EC) meters are used to assess the quality of soil water. An accurately calibrated electrical conductivity meter has an electronic probe that is inserted into a sample of water taken from a site. High EC readings mean a high level of salts or ions are present in the water, which may be harmful to plants. Water with low EC readings may indicate low levels of nutrients so plants have insufficient food to grow.

7. Soil Acidity – pH levels.

Accurately calibrated soil pH meters are used to measure the acidity levels in soil samples. Knowledge of the pH level helps maintain the soil at the correct acidity levels for good nutrient uptake by plants. If the soil acidity is not at the correct level, remedial treatments are specified to bring the conditions back the optimum growing levels.

LABORATORY SERVICES

ENSPEC's scientific laboratory, located in Melbourne, is dedicated to providing analytical services, and conducting and facilitating research for the urban forest industry and related sectors.

ENSPEC's laboratory is equipped to facilitate a range of services including, but not limited to:

Fungi:

- Fungi identification
- Preparation and submission of fungi samples for DNA sequencing
- Investigation and application of natural antagonists and fungal growth stimulants

Soil:

- Cation Balance
- Soil Nutrients
- Biological Activity

Plant tissue:

- Plant analysis (tissue and sap testing)
- Pathology and disease diagnosis
- Herbicide & pesticide analysis
- Pathology & disease diagnostics

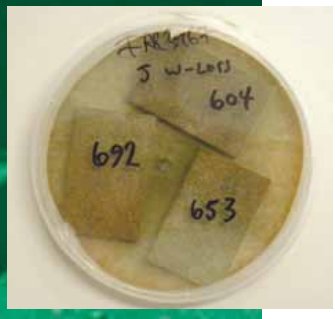
Fungi

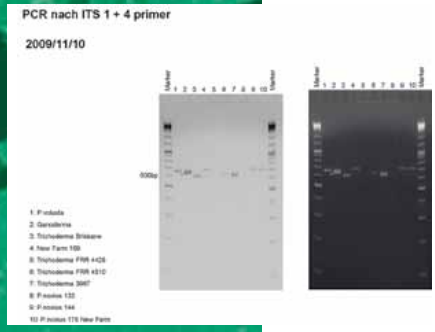
ENSPEC's primary utilisation of the laboratory is for in vitro screening of antagonistic *Trichoderma* strains against various wood decay fungi; primarily *Phellinus noxius*. This study, in collaboration with Prof Dr. Francis Schwarze and Swiss Federal Laboratories for Materials Testing and Research (EMPA), has led to the discovery and isolation of several highly antagonistic *Trichoderma* strains that can be used as plant growth stimulants and bio-control agents for lethal effect or suppression of wood decay fungi in tropical environments. *Trichoderma* are opportunistic avirulent plant symbionts that are typically fast growing, and can have mycoparasitic effects on other fungi. Further research is now being conducted to discover and isolate antagonistic *Trichoderma* strains for use in other areas of Australia, New Zealand and South East Asia.

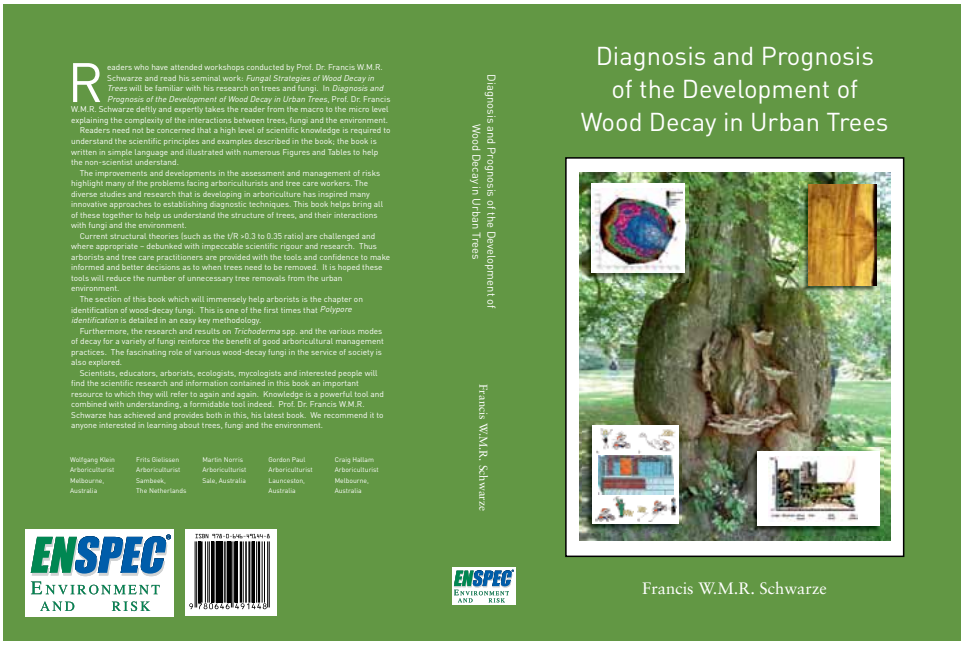
In association with the above research, *ENSPEC* now offers a full fungi identification service. *ENSPEC*'s fully trained staff can conduct the field collection on behalf of the client, provided that adequate site details are provided. Alternatively, clients can collect samples of their fungi for submission to the *ENSPEC* laboratory, provided that some basic field collection procedures are followed.

Clients can then choose to have their samples identified by their spores and morphological features, and/or sequenced for their DNA, depending on the level of accuracy required for the client's needs.

Once the wood decaying fungus has been identified, *ENSPEC* can provide a *Trichoderma* species to treat it. *ENSPEC* has a growing *Trichoderma* specimen collection; all specimens have been laboratory tested and proven to have a lethal or suppressive effect on various wood decay fungi species.







Plant Tissue

Plant tissue testing is the preferred method for diagnosing toxicities, deficiencies and imbalances for plants. Plant tissue tests determine the chemical constituents present in plant material (macro and micro nutrients), and any foreign chemicals, elements and compounds that are present. The outcomes and interpretation of the plant tissue tests will assist *ENSPEC* clients to make more informed and cost-effective decisions.

Soils

Soil biological, physical and chemical processes are interconnected and contribute to and affect plant health, productivity and disease susceptibility. The biological, physical and chemical properties of the soil are dependent on the management practices used, site history, and particularly the management of organic matter i.e. carbon. Changes that are made to the chemical and physical environment in soils will influence the biological processes and subsequently the contribution they make to soil fertility.

ENSPEC can facilitate complete soil analysis, from on-site testing and laboratory testing to post test analysis of soil conditioning.

ENSPEC's range of soil testing equipment allows for instant on-site soil assessments of pH, electrical conductivity, moisture, structure, infiltration and compaction. These tests can provide immediate results on-site, however to improve the accuracy of the testing, *ENSPEC*'s laboratory can facilitate a comprehensive analysis of soil chemistry, biology and its physical properties.

Cation Balance – Appropriate cation exchange capacity (cation balance) is essential to the development of good soil structure, biology and nutrient availability. Knowing this information facilitates the management of healthy soils.

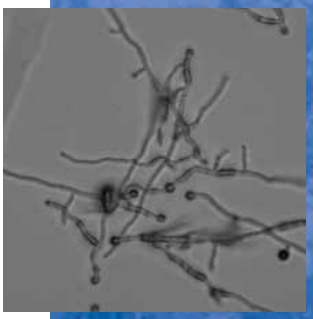
Soil Nutrients – All plants have their own particular nutrient requirements for optimum growth, production and longevity. These nutrients are obtained from the soil, and the condition of the soil and the quantities of certain elements, compounds and biological matter determine what nutrients are actively available for plant utilisation.

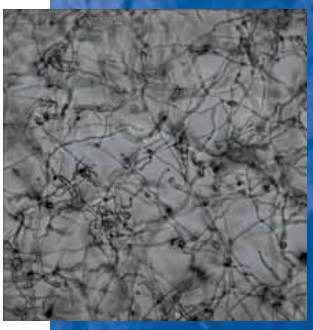
Biological Activity – Soil comprises a diversity of organisms that assist critical soil and plant functions. Soil organisms reconstitute organic matter making nutrients available for plant uptake and to other organisms. The reconstitution of organic matter facilitates soil permeability and its ability to retain and make nutrients available. Having the right diversity and balance of soil organisms is critical to maintaining healthy plants, thus knowing the biological constituents of a soil and the levels of biological activity will facilitate better plant management.

The complete soil analysis provides comprehensive information pertaining to the structure, nutrients and biology present within a site. Using the results obtained from the above tests, *ENSPEC* can provide recommendations for soil and site improvements. Such recommendations may include modifying land management practices, organic fertigation, mechanical decompaction, aeration, infiltration and where appropriate, the use of compost teas.

Natural Fertigation

For the application of specific soil constituents (i.e. biological matter, nutrients) *ENSPEC* has a mobile fertigation batching plant that can be easily set up near to or on site, so that soil improvers can be brewed close to site for easy delivery and quick application.





CHLOROPHYLL FLUORESCENCE OJIP TEST.

Trees in an urban landscape environment may undergo varying levels of stress during their lifetime. Stressors may include site specific factors such as anaerobic conditions, salinity and soil compaction, or climatic factors such as drought. Induced stress from herbicides or various pollutants is also common. In the urban environment nutritional disorders such as a lack of nitrogen or iron can also cause stress in trees, especially newly planted trees in streets and parks. Trees may be affected by a number of different stressors at any one time; compounding stress factors can lead to misdiagnosis or complications in treatment.

Photosynthesis is the primary process by which plants synthesize food and maintain energy. As part of that process some energy is released as light or fluorescence, commonly in the chlorophyll pigment areas in the leaf. This chlorophyll fluorescence can be measured using the Chlorophyll Fluorescence OJIP test to provide an inside look at the efficiency of the photosynthetic process or its disruption due to stress related factors.

The Chlorophyll Fluorescence OJIP test is a non-invasive and rapid method of testing stress levels and tree vitality in the field. Leaf samples can also be taken and tested up to 24 hours later without compromising the accuracy of the test results.

ENSPEC uses the Chlorophyll Fluorescence OJIP test to detect the early signs of stress in trees. The test is also used to identify and confirm the predominant stress factors in trees, and can assist in evaluating the degree of stress and the probability of tree recovery.

Tree decline in urban environments can potentially be reduced and managed by assessing tree species and identifying those that are adaptive to the site conditions. *ENSPEC* can use Chlorophyll Fluorescence OJIP tests to monitor stress levels in trees over time and identify species or phenotypes that are the most adaptable to specific site conditions. This information allows managers to select the most site-adaptable species or phenotypes for propagation and planting.

ENSPEC uses the Chlorophyll Fluorescence meter (commonly referred to as a Handy-PEA or H-PEA) to measure the fluorescence transient rise when a leaf is brought from a dark induced state to a fully active photosynthetic state. When graphed the florescence transient rise shows set stages in the biochemical processes of photosynthesis and energy transfer. These stages are designated as O, J, I and P.

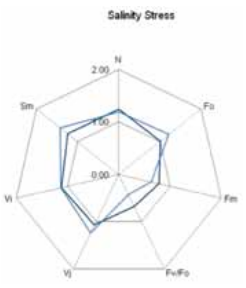
The data obtained from the Chlorophyll Fluorescence OJIP test provides various indicators that can be used to assess the level of stress and the probability of recovery. Two of these indicators are the CF value of the Fv/Fm ratio and the performance index or PI.

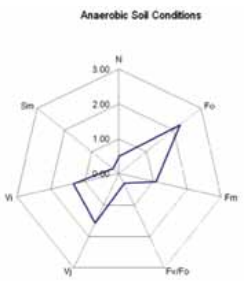
By evaluating other parameters in the data (Fo, Fm, Fv/Fo, Vi, Vj, Sm and N) it is possible to determine current stress in a plant such as drought, nitrogen deficiency, salinity or herbicide damage. If a known stressor is alleviated or is modified within the tree over time (as in the case with some herbicides), then the Chlorophyll Fluorescence OJIP test can confirm if the tree is recovering or will go into decline and die.

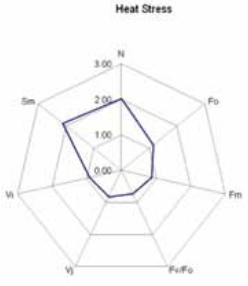
Transportation of trees from a nursery to a planting site can involve induced stress such as desiccation and heat. *ENSPEC* can use the Chlorophyll Fluorescence meter to test the vitality of the stock to ensure that the newly planted trees have an optimum chance of survival.

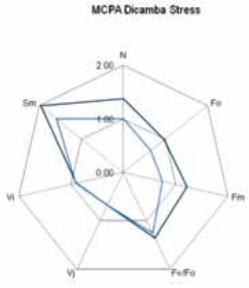
ENSPEC only employs fully trained and experienced operators to conduct Chlorophyll Fluorescence OJIP tests, interpret and analyse the results and to prepare the detailed professional report for the client.

Managers can use the report to make informed decisions regarding the retention or removal of the stressed tree. If the tree is able to be retained the report will assist managers to plan and implement strategies to alleviate the stressors and manage the tree back to health.









TREE PROPPING

ENSPEC uses tree props to provide structural support for valuable trees that may be leaning or have heavy side branches. Tree props can be used to preserve trees that are in danger of failing, and to reduce risk by stabilising trees in public places thereby providing a safe environment.

ENSPEC is a leader in tree propping systems that help to safely preserve trees in parks and public areas. *ENSPEC* has designed its own unique locking headstock and floating base plate system that gently supports the tree or branch so that the tree can withstand any structural loads. The propping system is designed to work with all trees; it is tamper proof, unobtrusive and guaranteed to last many years.

The headstock is designed to adapt to any size trunk or limb and is fitted to the tree with secure connections that gently provide support without damaging the bark. The props are adjustable in height to allow for changes in the tree's structure over time, and can be adjusted for all trees and branches.

The floating base plate is designed to support up to 20 tonnes of weight on the soil and to distribute the load over a wide area so there are no high pressure points and no need to dig holes.

The *ENSPEC* propping system can safely support leaning trees that are at risk of falling over and heavy branches at risk of breaking. Trees at risk of injuring people or damaging buildings and assets (e.g. park benches, BBQs) can be made safe using the propping system, eliminating the need to prune or remove the tree and thereby maintaining the tree's aesthetic integrity. This system can provide a safe environment around trees in public areas and is an unobtrusive and cost effective alternative to fencing off these areas.

Highly skilled and experienced *ENSPEC* staff assess the tree and calculate the structural loads. Each prop is designed for a specific tree or branch to ensure the prop and base can support the tree loads on the ground. *ENSPEC*'s unique propping system is simply and quickly installed without the need for any major earth works or digging.

ENSPEC has successfully propped many trees in parks and public areas ensuring the trees are structurally supported and made safe. These trees have survived for many years and they continue to provide beauty and shade into old age.

ENSPEC is proud to have developed a non invasive propping system that saves trees for the enjoyment of current and future generations.

STRUCTURAL CELLS

The Silva Cell is a specialised tool to help you meet your project's sustainability goals and improve the ecological function of your site. It enables you to enhance your site designs through the use of green infrastructure making it easy to integrate large tree growth and on site storm water management.

The Structural Cell supports traffic loads while providing non-compacted soil volumes for large tree growth and on-site storm water management. The modular framework provides unlimited access to the healthy soil, a critical component of tree growth in urban environments, allowing this system to manage storm water, reduce heat island effect, improve air quality and increase carbon dioxide sequestration.

Each Silva Cell is composed of a frame and a deck. Frames can be stacked one, two or three units high before they are topped with a deck to create a maximum amount of soil volume for tree root growth and stormwater treatment. Silva Cells can be spread laterally as wide as required to meet design requirements. Each unit is approximately 92% void space making it easy to accommodate surrounding utilities.

Six rigid vertical posts protrude from the bottom of the frame to support hardscapes along with the weight of any load they carry. The posts have a cross-sectional shape that maximises axial rigidity while also preventing the posts from telescoping together when the Cells are stacked upon each other. Their rounded edges prevent significant stress concentrations. This means that hardscapes supported by the Silva Cell are in no danger of sinking due to compressive forces.

The deck is a rigid platform with six recesses that are positioned to rest securely on the six posts of the frame. There is also a snapping mechanism on the deck to fasten it to the frame. Openings on the deck allow ample room for air and water to penetrate and nourish the enclosed soil. There are two diagonal channels on the upper portion of the deck that house two galvanized steel tubes; these tubes prevent deformation of the posts and help eliminate plastic creep.

MATERIAL SPECIFICATIONS

PARKING LOTS

- Grow large, healthy and functional trees while maximising the number of available parking spaces
- Recharge groundwater while providing soil bioremediation

COMMERCIAL / CIVIC PLAZAS

- Reduce urban heat island effect by growing larger trees
- Treat stormwater as a resource and maintain it on-site.

SIDEWALKS & DRIVEWAYS

- Create 'Break-out Zones' for street trees to access larger soil volumes

DESIGN FEATURES

- The modular design enables complete flexibility
- Highly efficient - 92% void space

MATERIAL SPECIFICATIONS

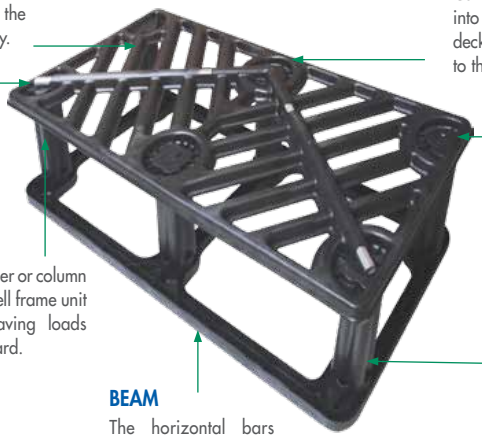
30% Fibreglass reinforced, chemically-coupled homopolymer polypropylene.
Meets AASHTO H-20 loading standards.

FRAME DIMENSIONS

Length: 48" (1200 mm)
Width: 24" (600 mm)
Height: 16" (400 mm)

DECK DIMENSIONS

Length: 48" (1200 mm)
Width: 24" (600 mm)
Height: 2 (51.5 mm)



IDEALS AND BELIEF

ENSPEC is a Risk Management and Consultancy company with superior expertise in managing risks posed by vegetation within all facets of the Arboricultural industry.

ENSPEC specialises in tree assessments and inventories, ecology evaluations, contractual and legislative compliance audits, GNNS/GIS, data acquisition, data base development, and industry training and project management, consistently delivering the world's best practice for our clients.

ENSPEC is committed to exceeding our client's expectations through the delivery of quality customer service and superior products and services.

ENSPEC's quality management system is established to meet ISO9001:2008, ISO14001:2004 and AS4801:2001

ENSPEC is a founder in vegetation management and fosters the principle of continuous improvement as part of our everyday business operations; our belief in this principle will ensure we maintain our reputation as the industry leader.

ENSPEC liaises with clients and special interest groups to cultivate vegetation management outcomes that improve the environment and provide a sustainable Eco System for future generations to enjoy.

HEALTH AND SAFETY POLICY STATEMENT

ENSPEC is committed to providing a healthy and safe workplace for all employees completing day-to-day company activities.

PERSONAL SAFETY MUST NOT BE COMPROMISED in the mistaken belief that other requirements are more important.

EFFECTIVE MANAGEMENT with commitment and personal involvement at all levels is necessary to maintain a safe working organisation.

WORK SHOULD BE CONTROLLED in such a way that hazardous situations are eliminated, avoided or managed.

THE EQUIPMENT, EDUCATION AND TRAINING necessary to preserve health and prevent accidents shall be provided as an integral part of every work task.

PERSONAL HEALTH AND SAFETY is the responsibility of ALL employees and is an integral part of every activity we perform. No task is satisfactorily completed unless it is achieved without accident or risk to personal health.

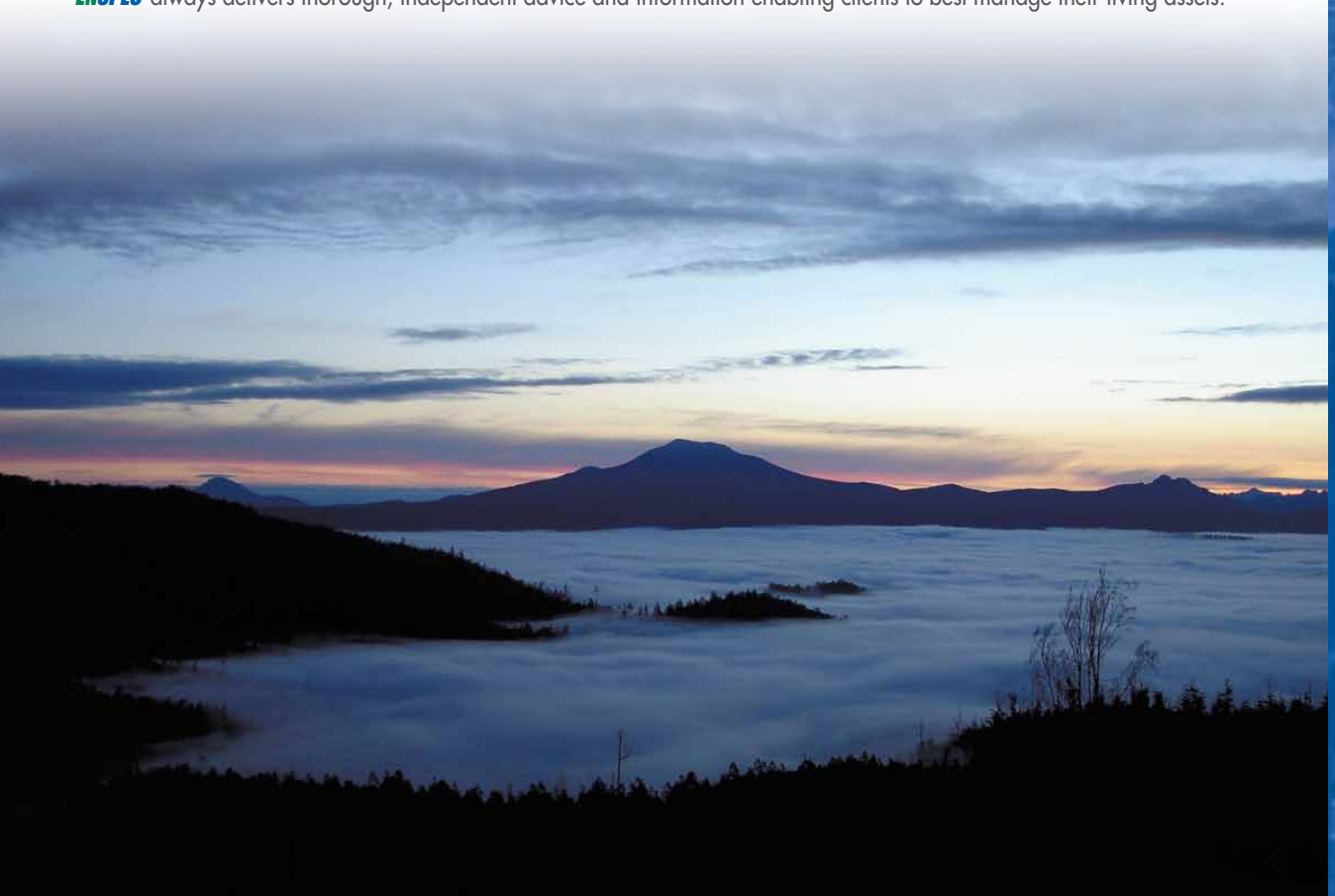
ETHICAL STATEMENT

ENSPEC is a wholly Australian owned and operated company that has no alliance with any other companies or organisations.

ENSPEC impartiality ensures unbiased advice and recommendations are offered at all times.

ENSPEC does not consult to developers or the private domestic sector unless referred by an industry person or client to provide independent advice on a specific matter.

ENSPEC always delivers thorough, independent advice and information enabling clients to best manage their living assets.

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