



Horizon - Business Profile

1 Expertise & scope of services

We offer clients the following services through our own and allied partners:

- Mine closure planning
- Final landform and cover design
- Mine site rehabilitation
- Contaminated soil survey & remediation
- EPBC Referrals, state and territory environmental approvals and environment management plans
- Sediment & erosion control planning
- Soil survey for agricultural land capability and strategic cropping land assessment
- Acid sulfate soil risk assessment and management
- Groundwater monitoring and remediation
- Due diligence biodiversity and archaeological surveys
- Project management

2 Best Practice Skills

Mine Landscape Restoration

Context: *Outcomes from open cast mine rehabilitation are unreliable where there is significant relief. The problem relates to:*

- detailed but unsupported botanical objectives for mine rehabilitation
- 75% of active mining & exploration in areas of high conservation value & watershed stress
- 30% in intact ecosystems of high conservation value
- concerns about the impact of mining on global biodiversity and critical ecosystems

Solutions: *Horizon has developed ecological landform design methods linking ecological studies to landscape design and providing assurance of ecological outcomes prior to construction.*

Ecological design refers to:

- *the ecological grain size and extent of analogue landforms*
- *design of constructed covers/soils for ecosystem support and erosion resistance*
- *predictable species distributions in the reconstructed landscape*
- *predictable surface water-groundwater interaction*



Hydrochemical Assessment of Caustic Impact to Groundwater

Context: Assessing caustic groundwater impact from alumina refining in coastal environments requires site specific groundwater trigger levels. The problem relates to:

- unreliable generic guidelines
- hydro-chemical variability in coastal groundwater systems
- plume boundaries that vary with operational issues and passive remediation processes
- regular optimization of groundwater recovery systems is needed to maintain their efficacy

Solutions: Horizon has developed a major ion characterisation method to classify background variation, set caustic impact trigger levels for recovery systems, define plume extents and monitor remediation using control charts.

The characterisation method refers to:

- *fingerprint diagrams to classify impacted and non-impacted groundwaters*
- *mixing model composition diagrams to identify and classify background variation*
- *control charts to track groundwater remediation to background conditions*

Digital Soil Mapping (DSM)

Context: Soil maps are unreliable at project scales and digital soil mapping methods using statistical inference are replacing thematic mapping. Opportunities relate to applying high resolution digital soil mapping methods to:

- *land resources assessment*
- *ecosystem survey*
- *environmental impact assessment*

Solutions: Horizon applied Digital Soil Mapping (DSM) to extensive land resources assessment in northern Australia (Tiwi Islands, Christmas Island) and detailed ecosystem survey for mine rehabilitation (ERA Ranger Mine in Kakadu).

The DSM method refers to:

- *robust database and survey design*
- *statistical modeling of soil property and soil type variation*
- *a data-based mapping approach with an estimate of uncertainty that can be updated with new survey information*



HORIZON SOIL SURVEY

Soil Carbon Farming Initiative (CFI)

Context: Soil carbon baseline and change measurement are the basis of the national carbon farming initiative (CFI). Opportunities relate to quantitative land evaluation to assess soil carbon status and measure change at the paddock scale efficiently using a phased survey approach:

- Phase 1: spatially nested sampling design for soil carbon to establish spatial variance, the optimal grid survey design for a particular site and the correlation between laboratory determination and field determination using a hand-held Near Infrared Spectrometer (NIR)
- Phase 2: optimised grid survey to establish soil carbon status in the field using NIR.

Solutions: Horizon applied Near Infrared Spectrometer (NIR) to paddock scale soil carbon assessment.

3 Project Experience

Client: ERA Ranger Mine

- Conceptual final landform and cover design
- Ecological surveys to identify natural analog landform properties
- Trial final landform and cover hydrological monitoring and drainage modeling
- Progressive mine rehabilitation
- Contaminated soil surveys
- Ecological modeling of final landform vegetation pattern.

Client: Rio Tinto Alcan Gove

- Groundwater impact monitoring and reporting
- Groundwater recovery system optimization
- Mineral waste management plan
- Environmental approvals for residue area expansion projects
- 2010 Water Management Plan
- Environmental approvals for the sewage treatment plant upgrade
- 2011 Waste discharge license report

CSIRO Land & Water

- Warren Reservoir Catchment soil mapping and water quality risk assessment GIS

CONSULMET

- Merlin Diamond Mine, Stage 3 environmental gaps analysis

Yates Pty Ltd

- Styx River Project, Strategic Cropping Land and Good Quality Cropping Land Assessment



GSS Environmental Pty Ltd

- Peer reviewed Strategic Cropping Land and Good Quality Cropping Land assessment reports for coal mining clients.

Department of Agriculture and Fisheries, Carbon Farming Initiative (CFI)

- Community assessor of on ground projects for CFI

4 Employees

Ian Hollingsworth (Principal)

Dr Hollingsworth has 33 years professional experience as a soil and landscape scientist in agriculture and the mining industry. In 2009 Dr Hollingsworth established HORIZON Environmental Soil Survey & Evaluation with the objective of providing specialist, accredited services in soil assessment, mine rehabilitation, sustainable land development and management.

Dr Hollingsworth has worked for established environmental consultants including URS (Manager and Principal Environmental Scientist, Environment Group); and EWL Sciences (Senior Environmental Scientist, Life Sciences Group) leading strategic mine rehabilitation planning at ERA Ranger mine. This followed a career with CSIRO Land & Water undertaking studies of land use interaction with non-point source contamination of reservoirs, soil formation following mining and soil shrink-swell risks to optic fibre cable performance. Earlier in his career Dr Hollingsworth consulted to the Murray Darling Basin Commission on River Murray floodplain mapping and vegetation health management, was District Soil Conservationist (Cooma) for the NSW Soil Conservation Service, completed a crop zoning map for the Malaysian State of Sabah and undertook food crops development work in the Ok Tedi Development Area, Western Province, Papua New Guinea.

5 Quality Management

Horizon has a quality management system that uses the principles of ISO 9001:2000 to implement sound business practices which focus on quality management. We aim to become 3rd party certified in the future as the business expands. The quality management system aims to ensure:

- work assignments are carried out competently and with integrity (do it well and get it right)
- costs are accrued on a time and materials basis irrespective of contact conditions and we can account in detail for expenses incurred on client invoicing if this is required
- qualifications and training are appropriate for each assignment i.e., we are working well within our area of competence
- we obtain feedback from customers on how well design services are being delivered and are
- proactive in improving the quality management system.



We have six documented procedures consistent with ISO9001:2000 requirements:

1. Control of Documents
2. Control of Records
3. Internal Audit
4. Control of Nonconforming Product- internal peer review, client review
5. Corrective Action – in response to non-conformance, corrective actions are made to document and record controls
6. Preventive Action – near misses are recorded and preventative actions identified

We have a digital document management system that uses proprietary bibliographic and reference software (Endnote V2, Thompson Scientific) to store, access and report all controlled documents. This includes business system forms, copies of receipts and invoices, business system procedures and client reports.

System changes are backed up incrementally each day to an external hard drive which is stored securely.

The quality management system incorporates:

1. Contract review procedure
2. Proposal review procedure
3. Project setup and management procedure
4. Peer review procedure
5. Documenting and responding to client feedback
6. A report style manual
7. Time sheeting and invoicing procedure

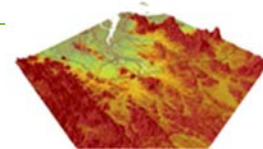
We do not undertake engineering design work. Our risk management program considers each job based on:

- Professional Indemnity/Liability, commercial/Legal Liability/Public Liability
- Occupational Health and Safety

Landscape Science & Environmental Evaluation

October 2013

Resilient and sustainable development by design



Overview

We offer clients the following services through our own and allied partners:

- ◆ Detailed soil survey for irrigation development
- ◆ Soil and land resources survey for agricultural capability, strategic cropping, land suitability assessment, soil carbon baseline assessment
- ◆ Acid sulfate soil risk assessment and management
- ◆ Contaminated soil survey & remediation
- ◆ Groundwater contamination monitoring and remediation
- ◆ Environmental approvals and management plans, EPBC Referrals
- ◆ Visual impact assessment
- ◆ Environmental offsets
- ◆ Due diligence biodiversity and archaeological surveys
- ◆ Final landform and cover design
- ◆ Mine closure planning
- ◆ Mine site rehabilitation
- ◆ Sediment & erosion control planning
- ◆ Project management

Best Practice Skills & expertise

Detailed soil survey

Context: Good quality agricultural land is protected from development on the Liverpool Plains, NSW:

- ◆ Grid survey designed to identify highly productive soils
- ◆ Proposed modelling approach to extrapolate soil information to new areas.

Solutions: Horizon working with McKenzie Soil Management to define land capability constraints to development.

Erosion management

Context: Erosion risks are heightened during development of TFS sandalwood plantations in the Douglas-Daly, NT:

- ◆ Undertake digital terrain analysis to resolve erosion risks at irrigation planning scale.
- ◆ Recommend erosion controls most appropriate to development constrains and local conditions.

Solutions: Horizon developed and analysed terrain data to map erosion

risk, liaised with operations personnel to implement a management plan during plantation development.

Mine Landscape Restoration

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- ◆ 75% of active mining & exploration in areas of high conservation value & watershed stress
- ◆ 30% in intact ecosystems of high conservation value
- ◆ concerns about the impact of mining on global biodiversity and critical ecosystems

Solutions: Horizon developed ecological landform design methods to link ecological studies with landform design — providing some assurance of ecological outcomes prior to construction.

Ecological design refers to:

- ◆ identifying the relevant ecological grain size and extent of analogue landforms
- ◆ designing ecological surveys to statistically support landform design
- ◆ predicting species distributions in the reconstructed landscape
- ◆ predicting environmental processes, such as surface water-groundwater interaction, that support ecosystem diversity
- ◆ design and evaluation of constructed covers/soils for ecosystem support

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- ◆ regular optimization of

groundwater recovery systems is needed to maintain their efficacy

Solutions: Horizon developed a major ion characterisation method to classify background variation, set caustic impact trigger levels for recovery systems, define plume extents and monitor remediation using control charts.

Hydrochemical characterisation relies on:

- ◆ fingerprint diagrams to classify impacted and non-impacted groundwaters
- ◆ mixing model composition diagrams to identify and classify background variation
- ◆ control charts to track groundwater remediation to background conditions

Digital Soil Mapping (DSM)

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Solutions: Horizon applied Digital Soil Mapping (DSM) to extensive land resources assessment in northern Australia (Tiwi Islands, Christmas Island) and detailed ecosystem survey for mine rehabilitation (ERA Ranger Mine in Kakadu).

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Soil Carbon Farming Initiative (CFI)

Context: Soil carbon baseline and change measurement are the basis of the national carbon farming initiative (CFI). There are opportunities in

quantitative land evaluation to assess soil carbon status and measure change at the paddock scale using a phased survey approach:

- ◆ Phase 1: spatially nested sampling design for soil carbon to establish spatial variance to optimise detailed survey design and correlate laboratory determination with field determination using a hand-held Near Infrared Spectrometer (NIR) and a recording cone penetrometer
- ◆ Phase 2: optimised detailed grid survey to establish soil carbon status in the field using NIR.

Solutions: Application of Near Infrared Spectrometer (NIR) and recording cone penetrometer measurements to paddock scale soil carbon assessment.

Environmental Impact Assessment

INPEX Blaydin LNG Plant

- ◆ Visual Impact Assessment
- ◆ Topography, soils, catchment impact

Project Experience

Blacktip & Trans-Territory LNG Pipeline

- ◆ Surface and groundwater Impact

Maud Creek Gold Mine EIS

Christmas Island Phosphate EIS

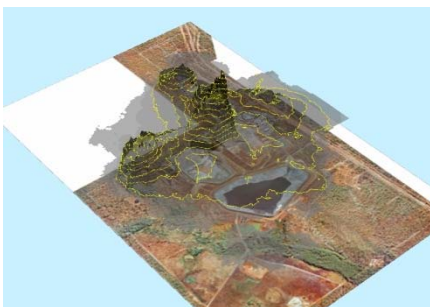
- ◆ Soil and landform impact
- ◆ Visual impact
- ◆ Mine rehabilitation plan

Jabiluka EIS

- ◆ Soil and landform impact

Woodcutters Base Metal Mine

- ◆ Contaminated site assessment

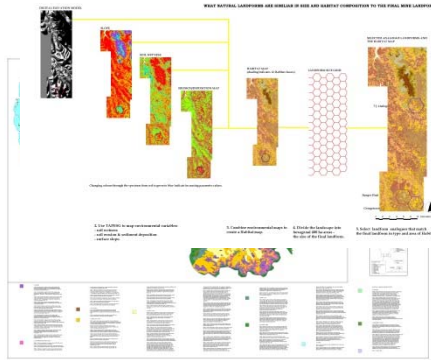


Client: NT Government & Tiwi Land Council

- ◆ Tiwi Islands digital soil mapping, land capability and suitability mapping

Client: ERA Ranger Mine

- ◆ Target natural analog landform properties and ecological surveys
- ◆ Conceptual final landform and cover design



- ◆ Ecological modeling of final landform vegetation pattern.
- ◆ Trial final landform revegetation, hydrological monitoring and modeling
- ◆ Stakeholder consultation with Traditional owners and regulators
- ◆ Progressive mine rehabilitation – revegetation
- ◆ Sediment and erosion control plans
- ◆ Stage 1 and Stage 2 Contaminated land surveys
- ◆ Stage 3 and Stage 4 contaminated land remediation and validation for independent audit
- ◆ Erosion mapping
- ◆ Irrigated waste water disposal system optimisation



Client: Department of Defence

- ◆ Bradshaw training area land resources mapping for training area management
- ◆ Bradshaw training area land condition monitoring

Client: Sylvatech

- ◆ Site quality assessments for *Acacia mangium* plantations on Melville Island

Client: Rio Tinto Alcan Gove/Pacific Aluminium

- ◆ Groundwater impact monitoring and reporting
- ◆ Groundwater recovery system optimization
- ◆ Mineral waste management plan
- ◆ Environmental approvals for residue area expansion projects
- ◆ Due diligence biodiversity surveys



200 0 200 400 600 800 1000 Meters

- ◆ Waterbodies
- ◆ Lot numbers
- ◆ Subcatchments

- ◆ 2010 Water Management Plan
- ◆ 2011 Mine Management Plan reporting
- ◆ Environmental approvals for the sewage treatment plant upgrade
- ◆ 2011 Waste discharge license report
- ◆ Waste water neutralization plant prefeasibility study, discharge options analysis

Client: CSIRO Land & Water

- ◆ Warren Reservoir Catchment soil mapping and water quality risk assessment GIS
- ◆ Non-point source dissolved organic carbon contamination and herbicide mobilization risk
- ◆ Site quality assessment for forestry
- ◆ Shrink-swell soil risk assessment to buried cables
- ◆ Soil formation from spoil

Client: CONSULMET

- ◆ Merlin Diamond Mine, Stage 3 environmental gaps analysis

Client: Cardno

- ◆ Girraween Lagoon estate subdivision impact assessment on surface water

Client: Sedgman Yates Pty Ltd

- ◆ Styx River Project, Central Queensland Strategic Cropping Land and Good Quality Cropping Land Assessment

Client: GSS Environmental Pty Ltd

- ◆ Peer reviewed Strategic Cropping Land and Good Quality Cropping Land assessment reports for coal mining clients.

Client: Department of Agriculture and Fisheries, Carbon Farming Initiative (CFI)

- ◆ Community assessor of on ground projects for CFI
- ◆ National Soil RD&E Strategy reference group member

Equipment

Field measurement of:

- ◆ soil bulk density, saturated hydraulic conductivity, soil water content, soil infiltration rate, soil carbon, pH and EC
- ◆ groundwater level, pH, temperature, DO, redox using low flow micropurge sampling systems.
- ◆ Automated climate, catchment and soil profile hydrological monitoring systems
- ◆ Pore water samplers and lysimetry

We use:

- ◆ NatSoil soils database (national soils database compliant)
- ◆ ArcGIS and SAGA for geographic spatial analysis and modeling
- ◆ Minitab & R statistical tools
- ◆ SADA spatial analysis and decision assistance system for contaminated site management
- ◆ ProUCL software for statistical evaluation of contaminated site data
- ◆ CMSS catchment management support system
- ◆ TIME/CLASS Spatial Analysis catchment analysis and terrain modeling software
- ◆ Concept tool for creating dynamic conceptual designs
- ◆ Terragen virtual landscape visualization
- ◆ APSIM cropping systems simulation
- ◆ EndNote bibliographic database

We contract NATA registered laboratories that support advanced organic and inorganic chemistry and soil physical analysis (water retention, saturated and unsaturated hydraulic conductivity).

Research Contributions

Digital soil mapping

- ◆ Developed and applied DSM methods to large area land resources mapping in northern savanna landscapes
- ◆ Developed quantitative site quality assessment tools for plantation forestry

Mine rehabilitation

- ◆ Developed and applied a range of statistical ecological modeling methods to mine landform design for biodiversity objectives.

Groundwater impact assessment

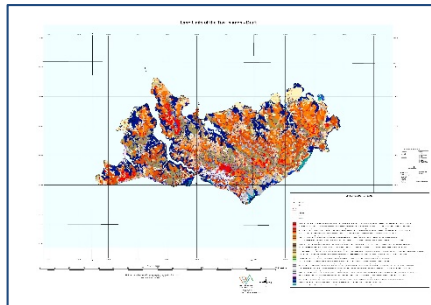
- ◆ Applied major ion characterization methods to assess caustic groundwater impact from alumina refining and setting site-based trigger and remediation objectives.

Non-point source contamination

- ◆ Soil assessment to evaluate herbicide mobility risk in water supply catchments.

Site quality assessment for forestry

- ◆ Statistical forest site quality modeling from soil, terrain and remote sensing data.



Quality & Risk Management

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