National Inventory of Soil Science Teaching on behalf of the Australian Soil Network (WG6)

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Contents

1 Executive Summary

Soil Science Australia has developed a National Inventory of Soil Science Teaching (the 'Inventory') to satisfy two primary drivers of the project, firstly to support the on-going development of soil science educators, and secondly to facilitate the need for professional development in soil science.

This report has:

- Described the methodology by which the Inventory has been developed.
- Provided an Inventory of soil science teaching across tertiary, VET and in-service sectors.
- Analysed the results of Inventory against the CPSS Fundamentals Exam Performance Objectives.
- Developed an initial soil science course mapping instrument for standardisation of evaluation

The methodology is assessed as robust, particularly for the tertiary and VET sectors. Whilst other approaches could have been taken, the methodology is student focused. The results are thus indicative of the information that a potential soil scientist may find when deciding what institutions to attend and courses to enrol in. Developing a robust methodology for the in-service training is by its haphazard nature a more difficult task.

The Inventory itself provides an extensive resource of soil science teaching in Australia across the three sectors. Whilst there may be some courses or training activities that have not been identified it is assessed that these would be 'on the margins' and not have a major impact upon the overall results.

The Inventory has not been validated with the education and training delivery institutions. This is a significant body of work and well beyond the resources currently available. Validating the results is however important for the accuracy and ongoing usefulness of the Inventory. The report includes a method and supporting mapping instrument in the form of a rubric, which with further development (to automate data collection and analysis) could be used both by universities to self-assess their soil science related courses and SSA to validate the results.

The development of the Inventory provides an interesting snapshot of the state of soil science education in Australia across the university, VET and in-service training sectors. Arguably the results indicate that soil science education is not well positioned to meet both the current and future demand for soil scientists. There are however a range of actions that could be implemented to improve the current situation. These have been detailed in Section 9.3 Bridging the gap: Towards a course of action.

Maintenance of the Inventory over time will be a crucial element of any plan to improve the current situation. Achieving this will require engagement with relevant stakeholders so that the value of the Inventory is maximised and ongoing funding to support its maintenance can be justified.

The recognition of degrees and institutions that provide the foundation knowledge expected of a CPSS should be a priority. This will encourage buy-in from the tertiary sector as well as being of great benefit to encouraging future soil scientists to enrol in relevant degrees. Recognition could initially be an informal process where universities, based on a self-assessment of their own soil science courses against the CPSS Fundamentals Exam POs, advertise relevant courses as contributing to meeting CPSS entry requirements. In the medium term, the Inventory can be used to encourage universities to establish majors or minors in soil science that waive the requirement for a student to complete the CPSS Fundamentals Exam. In the long term a more formal approach could be developed where soil science majors/minors/courses are officially recognised nationally for the purposes of CPSS

accreditation. This would be a marked improvement from the current situation where it is very difficult for a student to identify what path they should select with the aim of becoming a soil scientist.

The Inventory has identified a range of gaps in soil science education across Australia. This provides a national opportunity for the ASN, SSA and educational institutions to develop courses or packages that address these gaps. For the tertiary sector there is an opportunity for universities to develop new or enhance existing courses that support the recognition of excellence by a university in a specific field. SSA could develop training packages that address identified in-service training deficiencies as well as being financially beneficial.

It is difficult to draw conclusions on the training and education for the RSP qualification as it has not as yet been defined. However given the large gaps in content covered by VET and in-service training against the CPSS Fundamentals Exam POs, there does not currently appear to be a clear or obvious pathway to attain this qualification. This is an opportunity for SSA develop training that would support RSP recognition.

From the in depth analysis of the information sourced in this report, there are nine recommendations arising, which either compliment, or build upon the seven recommendations made in the National Soil Research, Development and Extension Strategy (2014) as detailed in Wardrop et al. (2013). The recommendations arising from this report are:

Recommendation A: Sustaining the inventory
Validation and maintenance of the Inventory is an imperative to tracking and building the required soil science capability and capacity for Australia. This must be resourced in a manner that is ongoing — in recognition of the multiple beneficiaries of such information — and with multiple benefactors. Initial Government dedicated funding is recommended, with a shared stakeholder investment the eventual and sustainable model. This will require stakeholder empowerment through a community of practice, or similar.

Recommendation B: Stakeholder Community of Practice
A stakeholder Community of Practice (COP) be developed to ascertain, in relatively real time, the industry requirement for graduates and their skill sets, as well as shape the graduate benchmarks of the future. It is recommended that this COP include tertiary, VET and in-service education provider representatives, as well as key stakeholders to ensure direct linkage from education to professional standards.

Recommendation C: Development of graduate knowledge benchmarks
The current mapping instrument for the mapping of soil science course to CPSS Competency Areas is based upon what is considered the bare minimum for soil science graduates. This benchmark places too much onus on industry to supply on-the-job-training. It is recommended that a stakeholder COP define new graduate knowledge benchmarks consistent with the ”applying”, “analysing” and “evaluating” learning levels of Bloom’s Taxonomy consistent with industry requirement and professional standards.

Recommendation D: Adoption and refinement of mapping instrument
There is clear requirement for standardisation in the soil science course evaluation process to allow evaluation between courses, institutions and through time for the purpose of improving Australia’s soil science capability. A mapping instrument based upon the learning levels of Bloom’s Taxonomy and the CPSS Competency Areas has been produced. It is recommended that this instrument be

refined and formalised as a capability mapping tool for ongoing application. It is further recommended that the application of this be expanded to support both VET and in-service training.

Recommendation E: Course accreditation
A soil science degree no longer exists, and creating the critical mass of CPSS personnel is a national strategic priority. It is also known that the CPSS assessment process is highly rigorous and respected within industry. Therefore, it is recommended that soil science courses are accredited against CPSS Competency Areas, and that Competency Area coverage is sufficient to mitigate any robustness risk. It is recommended that this commences as a recognition system as to whether a particular course is acceptable for the CPSS accreditation process, which should be determined by a stakeholder Community of Practice.

Recommendation F: Development of soil science degree majors & higher degrees
It is recommended that soil science majors are developed at a range of universities spanning the nation. Government support in creating the business case for this will be needed, as the student demand will not match the national capacity demand.

Cross institutional sharing of courses is recommended to support a greater number of institutional degrees addressing soil science. While it is tempting to consolidate and support a small number of universities to produce soil science graduates, a greater level of resilience is provided in diversifying offerings. Furthermore, a diverse network of soil science graduate producing universities also facilitates the ability to provide soil science majors and higher degrees that have a specialisation focus aligned to university research strengths. This a greater range of graduate specialisations to address the diverse demands of contextualised industry on the modern day soil science graduate.

Recommendation G: Engagement with VET sector
Engagement of VET education providers to develop rounded soil science based courses that deliver against industry requirements and professional standards is recommended. Coupled to this, the proposed Recognised Soil Practitioner (RSP) with SSA should be developed in coordination with the VET sector. An ideal outcome would be that a prospective RSP candidate would be able to readily identify the pathway to RSP recognition via a VET pathway.

Recommendation H: Development of a quality assured in-service training continuum
In-service training provides both a great challenge and a great opportunity to enhancing Australia's soil science capability. Quality assurance of content provides the biggest challenge. It is recommended that an in-service training continuum mapped to the CPSS Competency Areas is developed. Further, that resourcing is provided for the SSA Training Committee to produce quality assured training courses. Training providers could then work with SSA to provide this training, and/or SSA could implement it directly. This training is required at multiple levels of learning from recent graduate, to current accredited Certified Professional Soil Scientists.

Recommendation I: Career pathways from primary school to profession
While mapping tertiary education to professional standards proves an objective evaluation and means to map learning level and apply this to pathways from tertiary level to professional requirements, it does not create the students that will follow these pathways. It is recommended that soil science is facilitated for inclusion in existing curricula through a series of teaching information resources. These should extend from primary school through secondary school, building on the importance of soils to numerous and varied industry sectors. An initial attempt at this has been undertaken by SSA as the Soils in Schools Initiative (https://www.soilsinschools.com.au/); this should be revisited.

2 Version information

Version	Description	Date
0.1	Draft Report	24 January 2020
1.0	Final Report	21 February 2020

3 Abbreviations

AQF	Australian Qualifications Framework
PO	Performance Objective
CA	Competency Area
CE	Competency Element
CPSS	Certified Professional Soil Scientist
RSP	Recognised Soils Practitioner
SSA	Soil Science Australia
UoC	Unit of Competency
VET	Vocational and Educational Training

4 Introduction

This report arises 10 years after an initial report of similar nature investigating the tertiary education capacity for Australian soil science requirements, with the initial work also conducted by Soil Science Australia (SSA). The National Soil Research, Development and Extension (RD&E) Strategy was the catalyst to the initial investigation (Australian Government, 2014). On the 1 August 2012, the Reference Group of the National Soil RD&E Strategy agreed to six goals, with a direct goal relating to education and training in soil science:

"To build the skills, core competencies, capabilities and capacity of those working in soil RD&E to serve current and future RD&E needs."

Subsequently, a discussion paper was prepared, examining the state of soil (and more broadly agricultural) education and training opportunities (Wardrop et al., 2013). Within this report seven recommendations were made with the first specifying a need to:

"Continue to develop a national soil science curriculum that provides the skills and knowledge required to meet the ongoing needs of employers, clients and students."

This, and the other 6 recommendations, were included in the national soil RD&E strategy in Goal 4.3.4 as actions for implementation, providing a set of criteria with which to consider progress in developing the identified needed education pathways. Furthermore, the National Soil RD&E Strategy explicitly details a requirement for industry accreditation with the SSA Certified Professional Soil Scientist (CPSS) accreditation referred to for soil science expertise. This provides a means by which to assess the internal requirements of soil education courses against a standard. Indeed, one of the identified measure of success for Goal 4.3.4 of the National Soil RD&E Strategy is:

"Integrated and accredited soil science curriculum available nationally at different levels—for example, degree, award, vocational and refresher—and by different modes of study."

This suggests a national requirement for soil education to have a level of accreditation against a set of standards, not unlike the process for career-specific degrees such as engineering, law, and medicine. Hence, soil science should be thought of as a career-specific degree, or an accredited part thereof, with a requirement for pathways to professional accreditation governed by professional standards.

In 2014 it was well identified that there existed a requirement to put effort into determining the potential and probable demand for undergraduate and postgraduate education in soil science, including the adequacy of courses, resources and facilities to meet the demand (Australian Government, 2014). While no explicit information pertaining to this demand as a quantifiable figure has been found in response to the National Soil RD&E Strategy, the fact there is a current Australian Government initiative to develop a broader National Soil Strategy suggests that the demand has been assessed as of national importance. To add further weight to this speculation, Costanza et al. (1997) estimate that ecosystem services provide $33 trillion annually to the world economy, with soil underpinning the majority of these services, while Bennett et al. (2019) discuss that Australia's soil as having a conservative natural asset value of $3,860 billion. Weigh this up against the finding that "the demographics of Australian soil science suggest many scientists are likely to retire in the next decade and new appointments will be required" (Australian Government, 2014, p33), and the fact it is now six years into that stated decade (current year 2020), there is a clear requirement to assess the current day capability to provide soil science education, as well as progress towards integrated and accredited soil teaching with coordinated professional standards.

Arising from the National Soil RD&E Strategy (2014) was the Australian Soil Network, the implementation network, and a series of working groups within this. The Soil Science Education Working Group (WG6) identified the need to revisit and update the 2010 data-base that collated soil science teaching nationally. Firstly, it was deemed clear that there existed a need to provide resource that can support soil science educators with their own ongoing professional development. A specific need to assist in the development of contextually sensitive, robust and innovative learning and teaching opportunities was identified. However, this is complicated by the continued diversification of soil science teaching across agricultural, environmental, and urban and industry sectors. Soil science course examiners may need to rethink and renew their teaching to support the learning objectives demanded by the learning programs supporting the diversified acknowledgement of sectors requiring soil expertise. Furthermore, in response to ever changing curriculums the maintenance of a strong cohort of soil science staff is always being challenged, and in some cases, there are institutions where only one staff member would be identified as an expert in soil science. Therefore, there needs to be a resource where staff can identify not only the soil science courses, but make contact with those elsewhere to develop their own community of practice (COP).

Secondly, The Australian Government (2014) identified that there was a broader need for coordinated extension of soil related information to become knowledge through change in values concerning the role of soils in our ecosystems, in much the same way that water is evidently valued (Jenkins et al., 2013). In 2019, WG6 acknowledged that there still remains a need for providing information on learning opportunities and resources for on-going in-service training. Wardrop et al. (2013) stated that there was a paucity of professional development in existence, while Galea et al. (2013) recommended the creation of coordinated group of recognised specialists in the soils science discipline, with a range of soils information users from the following contexts: communication, extension, agricultural, built environment, civil construction, mining and engineering sectors. A grounded soils extension program was further recommended. Evidence gathered by Soil Science Australia (SSA) and previous work (Brevik et al., 2018, Field et al., 2017) report the need for a database where clients can explore and identify what soil science teaching and learning activities are available, as a 'one-stop shop'. Linked to this is the ability of a student at any level to identify pathways from education to a career either in soil science, or one where soil science is a major stakeholder. At current there is very little clarity for the student concerning which universities teach courses that could lead towards a Certified Professional Soil Science (CPSS) accreditation, which degree to select, which courses within these degrees and how this maps to the CPSS pathway. The latter was an expressed measure of success for the National Soil RD&E Strategy (Australian Government, 2014).

There are three primary drivers for developing this renewed data-base of soil science teaching:

1) This will be a resource that will support soil science educators to:
    a. explore and share teaching practices (COP),
    b. understand how the material and teaching is delivered across different sectors, and
    c. provide evidence to support curriculum renewal or opportunities for funding;
2) Provide a data-base that will contribute to SSA's efforts to establish a Training Board, where clients can explore their needs for professional development in soil science be it ad-hoc or formal; and,
3) Provide the means to allow identified soils related courses to be mapped to industry standards in a manner that could be used to standardise and (in the future) accredit soil science teaching against CPSS requirements.

The University of Southern Queensland (USQ), in collaboration with the University of Sydney, was contracted by Soil Science Australia (SSA) to develop a National Inventory of Soil Science Teaching. A draft report was submitted on 21 January 2020. This final report incorporates feedback received from SSA as well as providing synthesis of the report findings against the National Soil RD&E Strategy Goals and Measures of Success.

5 Objectives and scope

5.1 Objectives

The objectives for the overall project are detailed in Schedule 1 of the *National Inventory of Soil Science Teaching on behalf of the Australian Soil Network (WG6)* contract dated 11 November 2019. The objectives are:

1. Develop a protocol to capture relevant soil teaching and learning information to satisfy the two primary drivers identified for this project, summarized as:

    A) To support the on-going development of soil science educators, and

    B) To facilitate the need for professional development in soil science.

2. Review and update the existing soil science learning & teaching units/courses offered nationally, focusing on tertiary-VET-TEQSA recognized units/courses.

3. Work with the Soil Science Australia Training Committee to collate tertiary-VET-TEQSA units/course with the industry specific professional development training (the latter being the SSA Training Committee mandate)

4. Explore options for collating this information into an exportable database that can be housed by Soil Science Australia.

USQs outputs and deliverables are:

1. Provision of information in an excel spreadsheet database, fully populated (as is reasonable within resource and sphere of influence constraints) and in suitable format and detail to be integrated in an online searchable database containing details of higher education soil science courses
2. Report on the methodology used to develop and validate the draft database in sufficient detail to enable ongoing revision of the content.

Arising from the outputs in Points 1 and 2, immediately above, was the requirement for a mapping instrument to standardise evaluation of soil science education course content against industry standards; identified as the CPSS Fundamentals Exam as a bare minimum standard. A preliminary mapping instrument has been developed and is included as a first step in the ongoing maintenance of the database.

5.2 Scope

The primary focus of the report is identifying and mapping education and training relevant to the Certified Practicing Soil Scientist (CPSS). The secondary focus is identifying and mapping training that could be of relevance to a Recognised Soil Practitioner (RSP). The responsibilities of the RSP are yet to be defined. The findings from this report will assist in developing RSP responsibilities and requirements.

In the collation and analysis of the information this project addressed, consideration of the outputs against the recommendations of Wardrop et al. (2013) — subsequently recorded as actions within the National Soil RD&E Strategy (Australian Government, 2014) Goal 4.3.4 — is provided in the form of project based recommendations and identification of potential action.

6 Inventory

6.1 Methodology

In the initial 2010 SSA evaluation of soil science (reported in Wardrop et al. 2013), education providers were asked to self-assess whether or not they taught courses directly, or sufficiently, related to soil science. A total of 108 soil science courses were identified. However, a caveat to the results was provided where the evaluation explicitly stated the list was incomplete; e.g. ANU report no courses directly or indirectly relating to soil science in the 2010 evaluation, where courses are known to have existed at that time. While this methodology provided a useful first assessment with which to capture sufficient data to inform the discussion around capability requirement, it does not reflect the process a student goes through to identify soils related courses.

The methodology philosophy employed in this report uses the resources a student would have had at hand; i.e. manual exploration of the publically available information of university websites and, where insufficient information was found, use of the telephone to contact student support. Individual course examiners were not contacted, as this is not generally university policy, and is thus beyond the reality of the majority of student investigations into degrees. It is noted that the use of the Google search engine was often more powerful than individual university search engines, but this approach was disregarded as it is *ad hoc* and not representative of how institutions want students to identify degrees/courses within their institutions. Of course, this means that data recorded in this database will also be initially incomplete. However, it was assessed that it was more powerful for universities to have reported data on what could be reasonably found, to subsequently weigh against what they know exists. This provides means to highlight and improve how degree majors/courses might be offered. Courses were included where the learning objectives/outputs could be mapped against the CPSS Fundamentals Exam competency areas because if a student were challenged to find a soils related course, then it is fair to expect the learning objectives/outputs to identify soil related outcomes. Where learning objectives/outcomes did not specifically mention soils, but the context of the subject was related to soil science graduate requirements, the course was recorded as indirectly or partially related to soil science. This provides universities with a means to assess how their related courses align to external perspective of alignment (where the CPSS Fundamental Exam is the tool of alignment). Having used this methodological philosophy, the inventory, Australian education [providers, and key stakeholders are well poised to implement a living inventory with strong and empowered validation of career pathways.

6.1.1 Overview

The development of the National Inventory of Soil Science Teaching ('the Inventory') examined three types of soil education; tertiary, Vocational Education and Training (VET) and in-service training. The following broad methodology was applied to developing the Inventory:

1. Identifying soil science teaching courses using defined search terms
2. Capturing associated meta-data
3. Categorising identified training.
4. Mapping each identified course to the CPSS Fundamentals Exam Performance Objectives and Competency Areas

5. Analysing the results.

The application of this methodology varied, by necessity, for each of the three types of soils education. The specific methodology applied for each type of soils education is described in the following sections.

6.1.2 Tertiary education

The tertiary education sector provides education and training from Australian Qualification Framework Level 6 (Associate Degree) to Level 10 (Doctoral Degree). Currently individuals applying for CPSS recognition require a Bachelor Degree (AQF Level 7). The AQF describes graduates at AQF Level 7 as having a 'broad and coherent knowledge and skills for professional work and/or further learning' with the Bachelor Degree 'qualifying individuals who apply a broad and coherent body of knowledge in a range of contexts to undertake professional work and as a pathway for further learning.' More detail on the AQF can be found here: https://www.aqf.edu.au/sites/aqf/files/aqf-2nd-edition-january-2013.pdf.

A comprehensive list of Australian universities was obtained from https://www.australianuniversities.com.au/directory/universities-in-australia/. This was used as the starting point for identifying soil science related courses. A methodical search, by State and university was completed using the search function on each university's website individual for soil science subjects/units. It is noted that the efficacy of university search functions varied, and some university courses were only identified by prior knowledge of report authors, rather than through the search function. This presents a limitation that will be discussed later in the report. Search terms are listed in Table 1.

Table 1 Soil science education search terms

Soil	Soil chemistry
Soil science	Soil biology
Agriculture	Land management
Environment	Land degradation
Engineering	Pedology
Soil mechanics *Note: Alternate search terms were used including geo-mechanics and geotechnical engineering due to soil mechanics searches not identifying all relevant courses.*	Forestry
Soil physics	Irrigation

Courses identified as having soil science related content were added to a Microsoft Excel spreadsheet. The meta-data detailed in Table 2 was captured for each course.

Table 2 Meta-data collected for each soil science course

Tertiary institution	Year	Contact email
Location (state)	Unit name	Learning outcomes
Unit faculty/school	Contact/coordinator	LO/OBJ weightings (website reported)
Degree	Contact number	Comments

Each course was categorized by its relevance to soil science in accordance with the definitions provided in Table 3.

Table 3 Classification of soil science related content

Soil science related content	**Classification**	**Numerical value**
> 80 %	Direct	1
30 - 80 %	Indirect	0.66
< 30 %	Partially related	0.33

The classification of the courses by relationship to soil science was used to prioritise the mapping of courses with 'Direct' courses being the first priority. The classification was also used to provide a weighted score of soil science related courses for each university calculated from Equation 1. 'Partially related' courses were omitted as external input was required to map them accurately.

$$Weighted\ score = (Number\ of\ Direct\ Courses \times 1) + (Number\ of\ Indirect\ Courses \times 0.66) \quad \text{Equation 1}$$

Each 'Direct' and 'Indirect' course was subsequently mapped against the Performance Objectives (PO) and Competency Areas (CA) of the CPSS Fundamentals Exam. To assist with mapping, each of the CAs was allocated a two digit code that identified the relevant PO and CA (see Table 4); for example, Physical Properties was coded as 3.1.

Mapping of each course to the CPSS Fundamentals Exam PO and CAs was completed by:

- Reading through information gathered in the original university soil science subject spreadsheet [in particular Aspects of soil science covered, Learning Outcomes, LO/OBJ Weightings (Website reported)]
- Re-reading the subject outlines on the university web pages to see if there was any additional information such as more detailed information on the "learning activities" or lecture/assessment breakdowns etc.
- Then cross referencing the subject content keywords with the CPSS Fundamentals exam using the "find" function.

When a course was considered to have covered a CA, the corresponding CA code was inserted into the spreadsheet. Where required explanatory comments were added for each course.

Table 4. CPSS Fundamentals Exam Performance Objectives and Competency Areas

PO	**1 - SOIL CHEMISTRY AND MINERALOGY**	**2 - SOIL FERTILITY AND NUTRIENT MANAGEMENT**	**3- SOIL PHYSICS**
CA 1	Basic Concepts of Soil Chemistry	Roles of Nutrients in Plants and Their Availability in Soils	Physical Properties
CA 2	Solid Phase	pH	Soil-Water Relationships
CA 3	Mineral Weathering	Acidifying and Liming of Soils	Water Movement and Transport Processes
CA 4	Solid/Solution Equilibria	Nutrient Sources	Soil Temperature
CA 5	Ion Exchange	Soil Fertility Sampling	Soil Gases
CA 6	Sorption and Precipitation Reactions	Soil and Plant Analyses and Interpretations	Soil Mechanical Properties
CA 7	Acidity	Nutrient Management	—
CA 8	Oxidation-Reduction Reactions	—	—
CA 9	Alkaline and Salt Affected Soils	—	—
PO	**4 - SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION**	**5 - SOIL BIOLOGY AND SOIL ECOLOGY**	**6 - SOIL AND LAND USE MANAGEMENT**
CA 1	Soil Forming Factors	Living Soil Constituents	Erosion and Sediment Control
CA 2	Horizon Forming Processes	Soil Ecology	Wetlands and Hydromorphic Soils
CA 3	Soil Descriptions	Biological and Biochemical Activities	Soil Quality and Management
CA 4	Soil Interpretations and Land Use Management	Soil Organic Matter	Waste Management
CA 5	Soil Classification Concepts	Environmental and Agricultural Applications	Cropland and Field Management
CA 6	Soil Mapping	—	Water Quality and Management
CA 7	Geomorphology	—	Regulatory and Resource Agencies
CA 8	Soil Forming Environments	—	Urban Soils
CA 9	—	—	Forest Soils
CA 10	—	—	Geospatial Interpretation

As building the Inventory has been conducted as a desktop review, there are a number of uncertainties that should be considered. These include:

- Terminology used by universities differs. There are also variations between terminology used in the CPSS Fundamentals Exam Performance Objectives and by universities.
- The amount of information varies significantly between universities. Some universities provide a significant amount of detail whilst others provide limited information/cannot be accessed from the public internet.
- As a result of these factors, determining the classification of the soil science content in a course is not objective; it's a judgement based on the available information.

To limit these uncertainties and obtain an objective outcome, there is a requirement for a university self-assessment against a standardised instrument (e.g. competency assessment rubric) administered by an independent body such as SSA.

6.1.3 VET

The TAFE sector provides Vocational Education and Training (VET) typically encompassing Australian Qualification Framework (AQF) Level 1 (Certificate I) to Level 5 (Diploma). More detail on the AQF can be found here: https://www.aqf.edu.au/sites/aqf/files/aqf-2nd-edition-january-2013.pdf. Table 5 provides an overview of AQF Levels One to Five.

With the VET sector, the smallest training activity that can be assessed and recognised is known as a Unit of Competency (UoC). Each qualification consists of one or more UoC. A single UoC may also form part of multiple qualifications. To identify VET training that may contribute towards preparing an individual to undertake the CPSS Fundamentals exam or recognition as a Recognised Soil Practitioner, the UoC was used as the target training activity.

As VET training organisations deliver Nationally Recognised Training (NRT), the national register for training in Australia (https://training.gov.au/Home/Tga) was used to identify current soil science related UoC. The search terms used for the University sector identified very few soil science related UoC. As a result the following search terms were used within the national register for training:

- Soil
- Erosion
- Irrigation
- Plant
- Salinity

Table 5 Summary of AQF Levels One to Five

Level	Qualification	Summary	Purpose
1	Certificate 1	Graduates will have knowledge and skills for **initial work**, community involvement and/or further learning	The Certificate I qualifies individuals with **basic functional knowledge and skills** to undertake work, further learning and community involvement
2	Certificate II	Graduates will have knowledge and skills for **work in a defined context** and/or further learning	The Certificate II qualifies individuals to undertake **mainly routine work** and as a pathway to further learning
3	Certificate III	Graduates at this level will have **theoretical and practical knowledge and skills for work** and/or further learning	Certificate III qualifies individuals who apply a **broad range of knowledge and skills in varied contexts to undertake skilled work** and as a pathway for further learning
4	Certificate IV	Graduates will have **theoretical and practical knowledge and skills for specialised and/or skilled work** and/or further learning	The Certificate IV qualifies individuals who apply a **broad range of specialised knowledge and skills in varied contexts to undertake skilled work** and as a pathway for further learning
5	Diploma	Graduates will have **specialised knowledge and skills for skilled/paraprofessional work** and/or further learning	The Diploma qualifies individuals who apply **integrated technical and theoretical concepts in a broad range of contexts to undertake advanced skilled or paraprofessional work** and as a pathway for further learning

For each identified UoC the following meta-data was recorded from the National Register for Training:

- Unit of Competency Code and Title
- Usage Recommendation (only Current UoCs were recorded)
- AQF Level
- Application
- Elements
- Performance Evidence
- Knowledge Evidence

The training was classified for its relevance to soil science as described in the Tertiary methodology section.

Mapping was completed for each UoC by reviewing the Elements, Performance Criteria, Performance Evidence and Knowledge against the CA within the CPSS Fundamentals exam. Where the UoC explicitly stated that a CA was covered, or it could be reasonably inferred that it was covered, the UoC was marked as including content potentially relevant to the CPSS Fundamentals Exam using the same method as described in the Tertiary methodology section above.

With the requirements for the RSP yet to be defined, the initial mapping was not further considered for its relevance to RSP accreditation. A second and more critical review of the UoC mapping was completed to identify any UoC that maybe at the applicable level to support preparation for the CPSS Fundamentals Exam. This review only focused on AQF Level 4 and 5 UoC which equip graduates with the skills and knowledge required for skilled work.

Upon completion of the mapping the number of CA covered by an individual UoC was calculated. In addition a meta-analysis of the UoCs covered by VET training was also completed.

The mapping of VET soil science education only involved a desktop review of information obtained from the national register. This has resulted in some uncertainty in the results. This uncertainty is as a result of:

- Terminology used in the UoC differs from/does not necessarily align with the terminology used in the CPSS Fundamentals exam.
- The description of content within UoCs varied from general coverage to quite specific detail. As a result assumptions were made, based on the reading of the entire UoC as to whether it covered a particular Competency Area or not.
- The UoC does not describe how much detail or time is included on individual components. Judgement was required to determine whether the coverage was sufficient for each CA.

6.1.4 In-service training

In-service training was defined as any training activity outside of the formal AQF based training and education, which could provide an individual with the skills and knowledge necessary to attempt the CPSS Fundamentals Exam or RSP recognition. This included a wide range of activities from un-accredited training courses, to workshops, field trips and seminars.

Web searches were completed using the University sector search terms and a number of additional search terms were used to identify soil science related training activities. Additional search terms were required as it was apparent that the University sector search terms did not identify all of the known soil science related training activities.

For each identified training activity the meta-data listed in Table 6 was recorded:

Table 6. In-service training meta-data

Title	Target audience	Phone
Description	Organisation	Email
Length	Address	URL

Due to the disparate nature of the identified training activities, they were categorised by the type of training activity (see Table 7) in addition to its relevance to soil science.

Mapping of the content for each of the identified training activities was then compared against the CPSS Fundamentals Exam CAs. The initial review identified whether the training activity included content on the CA within the CPSS Fundamentals Exam. A second more critical review was completed to identify training that was suitable for CPSS Fundamentals Exam preparation.

Upon completion of the mapping the number of CA covered by a training activity was calculated. In addition a meta-analysis of the UoCs covered by In-service training was also completed.

There was greater uncertainty associated with the review of the in-service training compared with the tertiary and TAFE training for several reasons including:

- As this training is not part of a formal training system, the information available on each training activity varied greatly, from extremely limited to significant detail
- The purpose and type of training activities varied greatly
- There is no consistent quality control system in place for these training activities.

Table 7. Types and definitions for in-service training activities

Type	Description
Webinar	A seminar that is conducted over the Internet
Formal course	a series of lessons to teach the skills and knowledge for a particular job or activity that is assessed and either leads to, or prepares the trainee for a qualification
Informal course	a series of lessons to teach the skills and knowledge for a particular job or activity that is assessed but does not lead to a qualification
Seminar	an occasion when a teacher or expert and a group of people meet to study and discuss something:
Workshop	a form of training where participants are involved in the creation of knowledge
Field day	Learning/training activities predominantly conducted at a field site

6.2 Results

6.2.1 Tertiary

A total of 43 universities were examined, 38 of which yielded positive results for soil science relevant subjects. Course information from the University of Notre Dame was not available due to this information not being available on their public website, and information from Queensland University of Technology was very limited. Direct communication with these universities will be required to obtain course information.

The number of soil science related subjects by university are detailed in

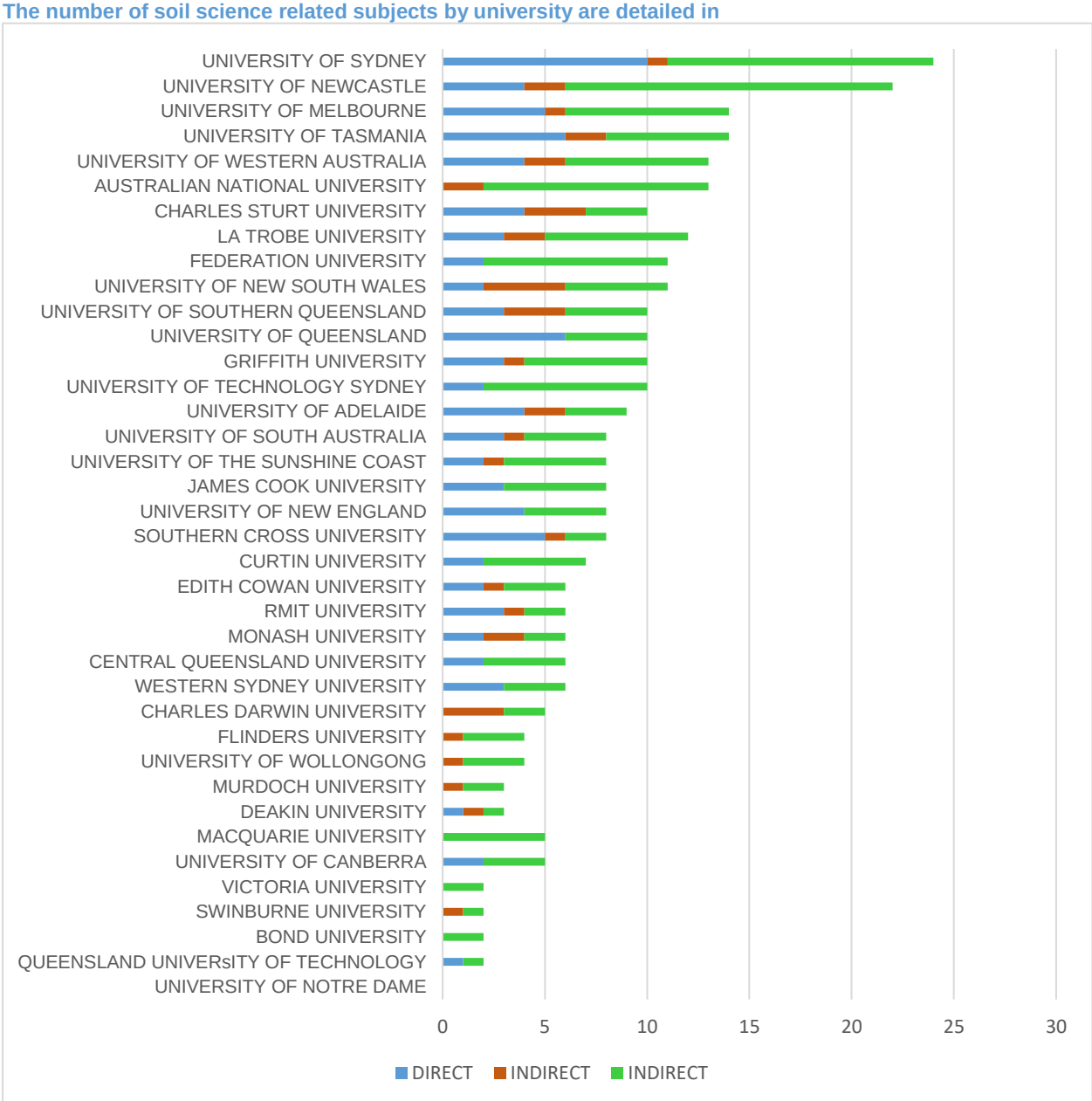

Figure 1. The universities which deliver the most soil science related courses (including courses classified as Direct, Indirect and Partially related) are:

- University of Sydney (24),
- University of Newcastle (22),

- University of Melbourne (15),
- University of Tasmania with (14), and
- Australian National University and the University of Western Australia (13 each).

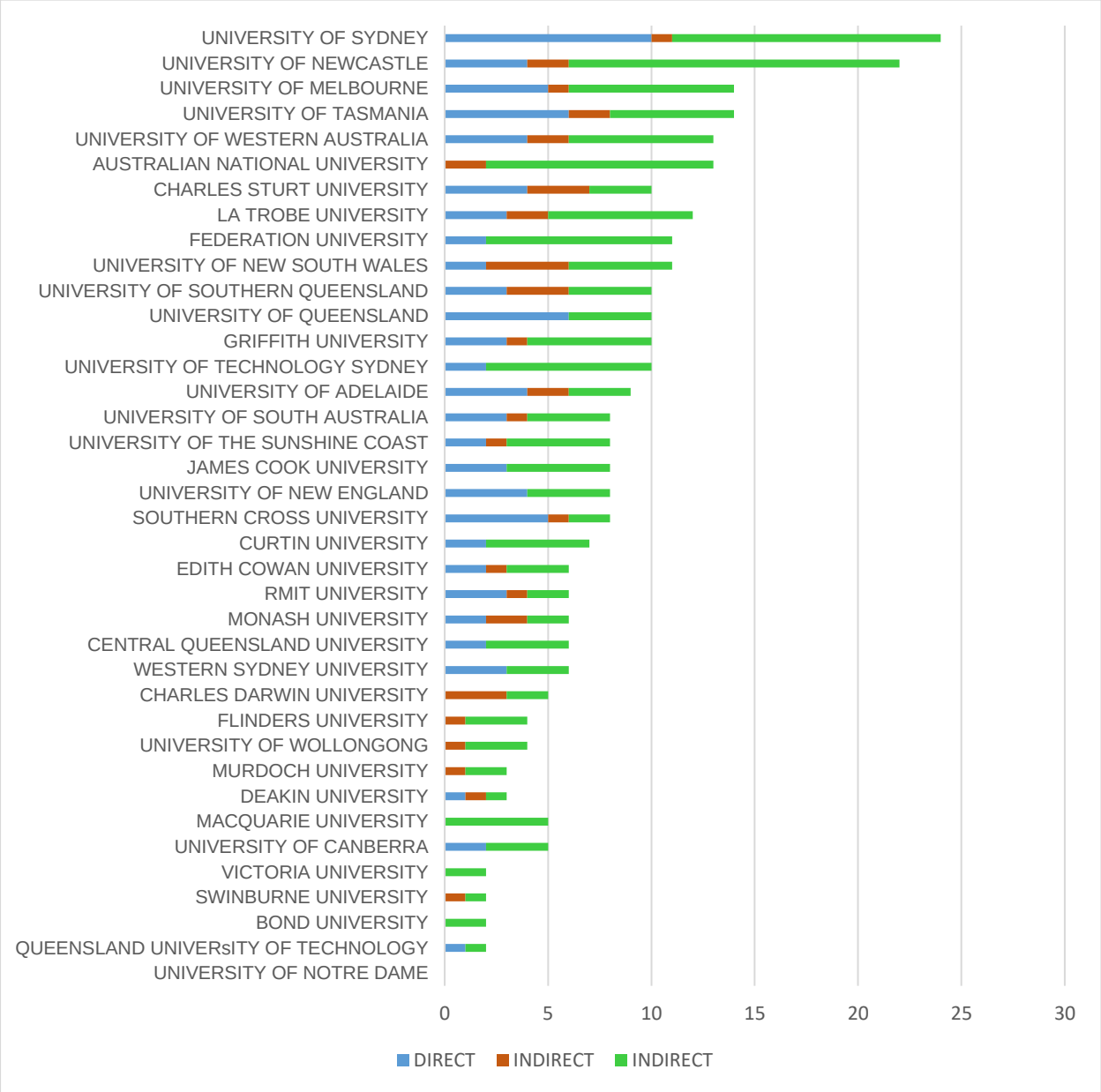

Figure 1 Number of soil science related university courses. Colour codes represent course relationship to soil science

Table 8 details the number of courses categorised by their relationship to soil science.

Table 8 Number of courses by relationship to soil science

Relationship to Soil Science	Number of Courses
Direct (>80%)	93
Indirect (30–80%)	40
Partial (<30%)	174
Unable To Be Rated	7

A meta-analysis of the Direct and Indirect soil science courses indicates that:

- All 45 CAs are covered by tertiary soil science courses delivered in Australia (see Figure 2 Number of courses covering CPSS Fundamentals Exam Competency Areas (Direct Courses)).
- On average each CA is covered by 26 'Direct' and 33 'Direct and Indirect' soil science courses with a range from 1 to 80. Nine CAs are covered by 10 or less 'Direct' soil science courses. Eight CAs are covered by 40 or more 'Direct' courses and 15 CAs are covered by 40 or more 'Direct and Indirect' courses.
- Courses cover on average 12.4 CAs with a range from 1 to 31. 26 courses cover 15 or more CA, whilst nine courses cover 5 or less CA indicating that some courses provide a general soil science overview whilst others are more specifically focused.

This meta-analysis indicates that potential CPSS candidates can gain the prerequisite knowledge from the existing tertiary soil science related courses currently delivered by Australian universities (i.e. all 45 CA in the CPSS Fundamentals Exam). However, this could only occur if courses at universities outside the student's enrolled university can be taken (many universities do allow this).

The number of CA delivered by each university was analysed by examining all of the soil science courses classified as being directly or indirectly relevant. The results are detailed in Figure 3. On average each university delivers content on 20 CA with a range of zero to 38. When the four universities that don't deliver Direct or Indirect soil science related courses are excluded the average is 23 CA with a range of 6 to 38. With the CPSS Fundamentals exam including 45 CA, this indicates that Australian universities deliver between 13 and 84 per cent of the expected base knowledge of a CPSS.

These results do not consider different programs, recommended enrolment patterns, or electives which may reduce the number of CA a student can complete within their degree/program.

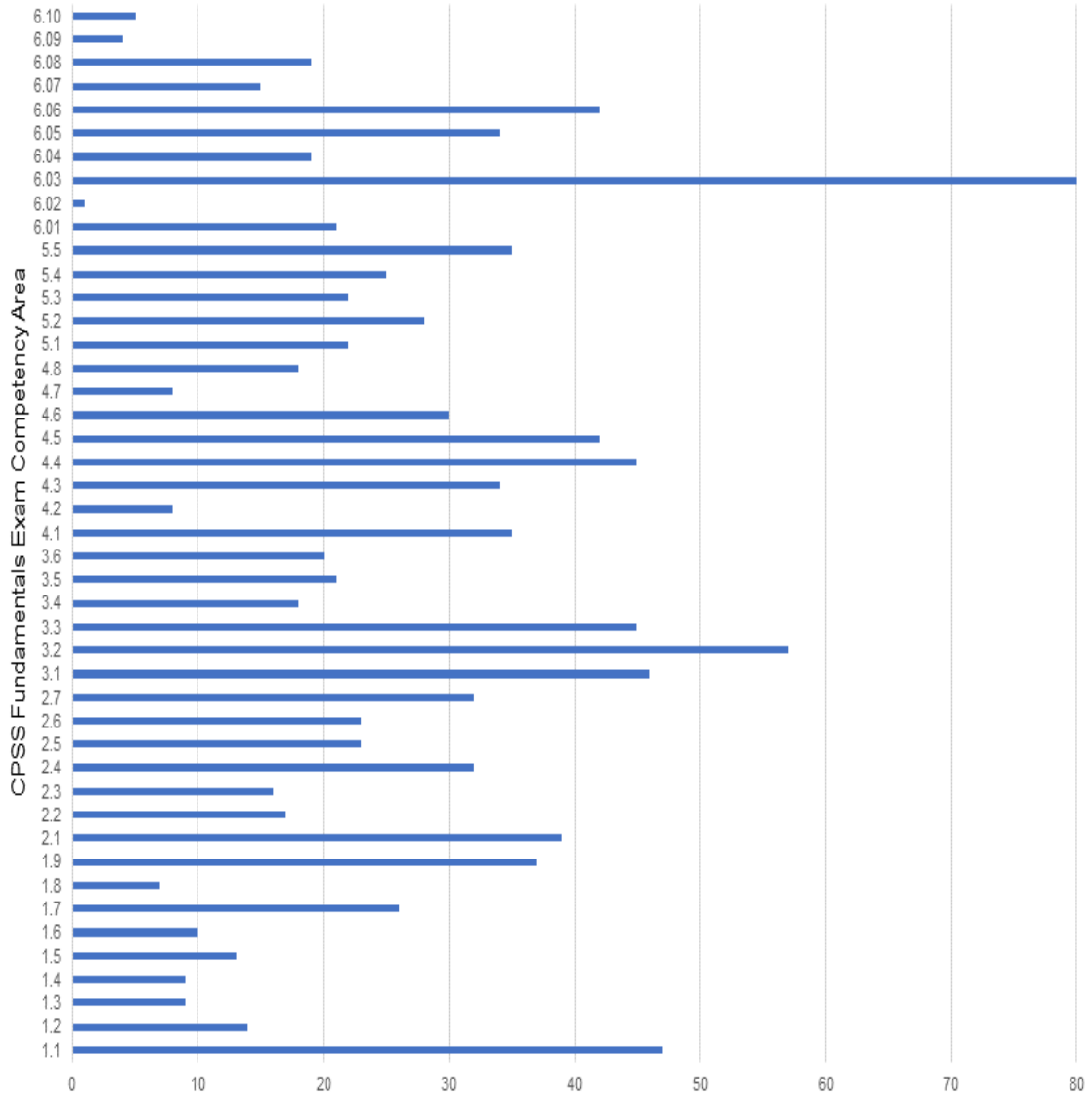

Figure 2 Number of courses covering CPSS Fundamentals Exam Competency Areas (Direct Courses)

Figure 3 Competency Areas covered by soil science related courses (Direct and Indirect only)

Four soil science courses are the minimum entry requirement for CPSS (without completing the CPSS Fundamentals exam). Using the course weightings and Equation 1 an overall course weighting for each university has been developed (Table 9**Error! Reference source not found.**). This indicates that there are currently 12 universities that equip graduates with the minimum CPSS entry requirements.

Table 9 CPSS Entry Requirements by university

UNIVERSITY	DIRECT SUBJECTS	INDIRECT SUBJECTS	PARTIALLY RELATED SUBJECTS	COURSE WEIGHTING	CPSS ENTRY REQ
CHARLES STURT UNIVERSITY	4	0	3	4.0	YES
LA TROBE UNIVERSITY	3	2	7	4.3	YES
SOUTHERN CROSS UNIVERSITY	5	1	2	5.7	YES
UNIVERSITY OF ADELAIDE	4	2	3	5.3	YES
UNIVERSITY OF MELBOURNE	5	1	8	5.7	YES
UNIVERSITY OF NEW ENGLAND	4	0	0	4.0	YES
UNIVERSITY OF NEW SOUTH WALES	2	4	5	4.6	YES
UNIVERSITY OF NEWCASTLE	4	2	16	5.3	YES
UNIVERSITY OF QUEENSLAND	6	0	4	6.0	YES
UNIVERSITY OF SYDNEY	10	1	13	10.7	YES
UNIVERSITY OF TASMANIA	6	2	6	7.3	YES
UNIVERSITY OF WESTERN AUSTRALIA	4	2	7	5.3	YES
AUSTRALIAN NATIONAL UNIVERSITY	0	2	11	1.3	NO
BOND UNIVERSITY	0	0	2	0.0	NO
CENTRAL QUEENSLAND UNIVERSITY	2	0	4	2.0	NO
CHARLES DARWIN UNIVERSITY	0	3	2	2.0	NO
CURTIN UNIVERSITY	2	0	5	2.0	NO
DEAKIN UNIVERSITY	1	1	1	1.7	NO
EDITH COWAN UNIVERSITY	2	1	3	2.7	NO
FEDERATION UNIVERSITY	2	0	9	2.0	NO
FLINDERS UNIVERSITY	0	1	3	0.7	NO
GRIFFITH UNIVERSITY	2	1	5	2.7	NO
JAMES COOK UNIVERSITY	3	0	5	3.0	NO
MACQUARIE UNIVERSITY	0	0	5	0.0	NO
MONASH UNIVERSITY	2	2	2	3.3	NO
MURDOCH UNIVERSITY	0	1	2	0.7	NO
QUEENSLAND UNIVERITY OF TECHNOLOGY	1	0	1	1.0	NO
RMIT UNIVERSITY	3	1	2	3.7	NO
SWINBURNE UNIVERSITY	0	1	1	0.7	NO
UNIVERSITY OF CANBERRA	2	0	3	2.0	NO
UNIVERSITY OF NOTRE DAME	0	0	0	0.0	NO
UNIVERSITY OF SOUTH AUSTRALIA	2	1	4	2.7	NO
UNIVERSITY OF SOUTHERN QUEENSLAND	3	3	3	3.9	NO
UNIVERSITY OF TECHNOLOGY SYDNEY	2	0	8	2.0	NO
UNIVERSITY OF THE SUNSHINE COAST	2	1	5	2.7	NO
UNIVERSITY OF WOLLONGONG	0	1	4	0.7	NO
VICTORIA UNIVERSITY	0	0	1	0.0	NO
WESTERN SYDNEY UNIVERSITY	3	0	3	3.0	NO

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Both the breadth and depth of soil science education across universities, for their coverage of the CPSS CA, has been analysed from the mapping results and is detailed in Table 10. Scores range from 0 (red cells) to 8 (green cells of increasing darkness have been used for values from 1 to 8) with a larger value indicating a greater depth of coverage and a score of 0 indicates no coverage. The results highlight significant limitations in both the breadth and depth of tertiary soil science education.

Table 10 Breadth and depth of soil science by university

University	PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS						PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION							
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8
AUST NATIONAL UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	1	2	0	0	1	0
UNIVERSITY OF CANBERRA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	2	0	0	2	1	1	0	0
CHARLES STURT UNIVERSITY	5	1	1	1	1	1	2	0	6	1	3	1	3	0	3	4	5	4	4	1	4	1	2	1	1	2	2	2	2	1
MACQUARIE UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTHERN CROSS UNIVERSITY	3	4	2	4	2	2	2	2	2	4	2	2	2	0	0	0	6	6	6	0	0	4	2	2	4	0	4	0	0	4
UNIVERSITY OF NEW ENGLAND	3	0	2	1	0	0	0	1	3	2	1	1	2	1	1	4	1	2	1	0	0	0	0	0	0	2	3	0	0	2
UNIVERSITY OF NSW	2	1	0	0	1	0	1	0	1	0	1	1	0	1	0	1	3	5	4	3	3	2	3	2	3	1	2	2	2	3
UNIVERSITY OF NEWCASTLE	0	1	2	1	2	2	2	2	2	2	2	1	1	3	0	1	3	5	5	1	1	3	3	2	1	3	3	3	0	1
UNIVERSITY OF NOTRE DAME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNIVERSITY OF SYDNEY	3	2	0	1	0	0	2	0	1	2	0	0	0	2	2	4	2	5	5	2	2	2	2	1	3	5	6	4	1	1
UNIVERSITY OF TECH SYDNEY	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	1	0	1	0	0	2	0	1	1	1	0	0	0
WESTERN SYDNEY UNIVERSITY	1	0	0	0	0	1	1	0	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0
UNIVERSITY OF WOLLONGONG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	1	0	0
CHARLES DARWIN UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	0	1	0	0	1	1	2	0
QLD UNIVERITY OF TECHNOLOGY	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	0
BOND UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CENTRAL QLD UNIVERSITY	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	1	0	0	0
GRIFFITH UNIVERSITY	2	1	1	0	0	0	1	1	1	3	1	1	2	0	0	2	3	1	1	1	1	2	2	1	3	2	1	2	1	1
JAMES COOK UNIVERSITY	3	0	0	0	0	0	0	0	0	3	0	3	3	0	0	3	3	3	3	0	3	0	3	0	0	0	3	3	0	0
UNIVERSITY OF QUEENSLAND	5	1	0	0	2	3	3	0	4	3	2	0	3	3	3	2	5	5	5	2	2	1	1	1	2	3	2	1	0	0
UNIVERSITY OF SOUTHERN QLD	5	1	0	0	0	0	0	0	2	2	0	0	2	1	1	2	5	4	5	2	3	2	1	0	3	2	3	2	0	0
UNIVERSITY OF SUNSHINE COAST	2	1	0	0	1	0	2	0	2	2	1	1	2	1	1	2	3	3	2	1	1	2	2	2	2	2	2	1	0	1
FLINDERS UNIVERSITY	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0
UNIVERSITY OF ADELAIDE	4	1	0	0	1	0	2	0	2	3	2	2	3	1	1	2	3	3	2	0	0	0	2	0	1	2	2	1	0	1
UNIVERSITY OF SOUTH AUST	4	1	0	0	0	0	0	0	2	1	0	0	1	0	0	1	4	2	2	1	2	1	1	0	2	0	2	1	0	0
UNIVERSITY OF TASMANIA	4	0	0	0	0	0	1	0	5	5	1	1	3	3	5	0	5	5	2	0	1	2	2	0	5	5	5	2	0	2
DEAKIN UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	1	2	0	0	1	0	1	0	0	0
MONASH UNIVERSITY	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	2	2	2	1	1	2	3	2	1	1	2	0	0	1
RMIT UNIVERSITY	1	1	0	0	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0
SWINBURNE UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	1	0	1	1	0	0
FEDERATION UNIVERSITY	1	0	1	0	1	1	1	1	2	1	0	0	1	1	0	0	0	1	0	0	0	0	1	1	0	1	1	1	1	0
UNIVERSITY OF MELBOURNE	0	1	0	0	0	0	3	0	2	3	0	1	3	3	3	2	0	2	1	0	0	0	0	0	2	4	0	1	0	1
LA TROBE UNIVERSITY	1	0	0	0	0	0	1	0	1	3	0	0	3	2	1	2	2	3	1	0	0	1	1	0	0	4	1	0	0	1
VICTORIA UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CURTIN UNIVERSITY	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
EDITH COWAN UNIVERSITY	1	0	0	0	1	0	1	0	2	1	0	0	1	1	0	2	1	3	3	1	1	1	1	0	0	2	2	0	2	1
MURDOCH UNIVERSITY	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	1	0	0	1	1
UNIVERSITY OF WESTERN AUST	2	0	1	1	1	0	2	0	2	3	1	0	2	1	1	3	4	5	5	0	0	1	3	1	3	3	1	4	2	2

University	PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT										Total CA Covered	Total CA Covered (%)
	5.1	5.2	5.3	5.4	5.5	6.01	6.02	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.10		
AUST NATIONAL UNIVERSITY	0	2	0	0	1	0	0	2	0	2	0	0	0	1	1	11	24
UNIVERSITY OF CANBERRA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	13
CHARLES STURT UNIVERSITY	0	3	1	0	1	2	0	4	3	2	5	3	0	0	1	38	84
MACQUARIE UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTHERN CROSS UNIVERSITY	2	2	2	2	0	2	0	6	0	0	0	0	0	0	0	28	62
UNIVERSITY OF NEW ENGLAND	2	2	2	2	2	0	0	4	2	3	3	3	2	1	0	30	67
UNIVERSITY OF NSW	0	0	1	0	0	3	0	3	3	0	2	0	1	0	1	30	67
UNIVERSITY OF NEWCASTLE	2	1	2	2	0	0	0	4	0	0	2	0	0	0	0	33	73
UNIVERSITY OF NOTRE DAME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNIVERSITY OF SYDNEY	1	4	0	2	4	3	0	8	3	6	8	3	3	0	1	35	78
UNIVERSITY OF TECH SYDNEY	1	1	1	1	1	1	0	2	1	0	1	1	1	0	0	22	49
WESTERN SYDNEY UNIVERSITY	2	2	2	2	2	1	0	3	1	2	1	0	2	0	0	28	62
UNIVERSITY OF WOLLONGONG	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	8	18
CHARLES DARWIN UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	20
QLD UNIVERITY OF TECHNOLOGY	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	12	27
BOND UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CENTRAL QLD UNIVERSITY	1	1	0	0	1	1	0	1	1	2	2	0	0	0	0	14	31
GRIFFITH UNIVERSITY	1	1	2	3	2	1	0	3	0	0	2	0	1	1	0	35	78
JAMES COOK UNIVERSITY	3	3	0	0	3	0	0	3	0	3	3	0	0	0	0	18	40
UNIVERSITY OF QUEENSLAND	2	2	2	4	4	0	0	4	1	3	1	2	1	0	1	36	80
UNIVERSITY OF SOUTHERN QLD	0	1	0	0	1	0	0	2	2	1	2	0	1	0	0	26	58
UNIVERSITY OF SUNSHINE COAST	1	1	2	1	1	0	0	3	1	0	1	0	1	0	0	34	76
FLINDERS UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	13
UNIVERSITY OF ADELAIDE	2	2	2	4	2	2	0	4	1	1	2	1	0	0	1	33	73
UNIVERSITY OF SOUTH AUST	0	0	1	0	1	0	0	2	2	0	2	0	1	0	0	22	49
UNIVERSITY OF TASMANIA	0	0	2	0	1	3	0	8	0	3	1	0	0	1	0	27	60
DEAKIN UNIVERSITY	0	0	0	0	0	0	0	2	0	0	0	1	1	0	0	11	24
MONASH UNIVERSITY	1	1	1	1	1	0	0	3	1	1	3	0	1	0	0	25	56
RMIT UNIVERSITY	0	0	1	1	1	0	1	4	3	0	3	1	1	0	0	30	67
SWINBURNE UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	16
FEDERATION UNIVERSITY	0	0	0	1	0	1	0	2	1	1	1	0	0	0	0	23	51
UNIVERSITY OF MELBOURNE	0	1	0	0	3	1	1	5	1	2	4	0	1	0	0	24	53
LA TROBE UNIVERSITY	0	0	0	0	4	0	0	5	0	3	1	0	0	0	0	20	44
VICTORIA UNIVERSITY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CURTIN UNIVERSITY	0	0	0	0	1	0	0	2	0	1	0	0	0	0	0	7	16
EDITH COWAN UNIVERSITY	2	2	1	0	2	2	0	3	1	0	2	0	1	0	0	28	62
MURDOCH UNIVERSITY	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	12	27
UNIVERSITY OF WESTERN AUST	2	2	4	3	3	4	0	5	1	2	4	1	1	1	0	37	82

An interesting finding from the soil science course search is that only four of the 314 units/subjects identified specifically mentioned CPSS. This included three units/subjects from James Cook University which stated that "The subject can be used towards accreditation as a Certified Practising (sp) Soil Scientist (CPSS)" (Practising should read Professional) and one unit/subject from the University of Melbourne which stated that "Build knowledge appropriate to Certified Professional Soil Scientist performance objectives" in the learning outcomes.

For the majority of courses, course information did not provide weightings against the course learning outcomes/objectives. Weightings were instead applied to the individual assessment items. A small number of courses did however provide an extensive amount of information on the learning outcomes assessed. For example University of Technology Sydney course 49119 - Problematic Soils and Ground Improvement Techniques (http://handbook.uts.edu.au/subjects/details/49119.html) provided both the subject learning objectives and associated course intended learning outcomes for each individual assessment item, as well as the weightings for that assessment item. This facilitated objective mapping of the course, as opposed to judgment based mapping.

The search identified that there is inconsistency across universities in the naming of soil science related courses. It was found that courses with similar content often had different titles. For example courses with titles such as soil mechanics, geo-mechanics and geotechnical engineering had the same or similar content. This content may have had contextual differences (e.g. tillage for soil-mechanics and foundations for geo-mechanics), but were based upon the same fundamental concepts. This makes tallying of the courses per university harder to interpret as not all courses will provide new learning (some may not even be available in a particular degree stream), and reinforces the need for a standardised instrument of content assessment, rather than recommending that courses standardise naming conventions.

Some university search functions and organisation of course information, including learning objectives/outcomes, did not function well. The University of New England's website was an example of where informal discussions with soil science teaching staff revealed more courses than were initially found that would certainly fit the partially related category (N.B. in being consistent with the methodological philosophy these were not subsequently included). On the other hand, some were exemplary (University of Technology Sydney course 49119 - Problematic Soils and Ground Improvement Techniques). This further supports the requirement for a mapping instrument that standardises organisational self-assessment against a given set of industry professional standards. While it might be recommended that universities could improve their search functions, this is much less reliable of an approach than seeking to work with university course examiners as empowered stakeholders in maintaining the inventory into the future in an objective and standardised manner.

6.3 VET

A total of 30 soil related UoC were identified (Table 11).

Table 11 Soil Related UoC

Unit of Competency - Code	Unit of Competency - Title	AQF Level	Rating description
AHCSOL504 - Develop and manage a plan to reclaim land affected by salinity	Develop and manage a plan to reclaim land affected by salinity	5	Direct
AHCSOL505 - Monitor and manage soils for production projects	Monitor and manage soils for production projects	5	Direct
AHCSOL502 - Manage soils to enhance sustainability	Manage soils to enhance sustainability	5	Direct
AHCIRG509 - Develop an irrigation and drainage management plan	Develop an irrigation and drainage management plan	5	Indirect
AHCPCM505 - Conduct environment and food safety risk assessment of plant nutrition and soil fertility programs	Conduct environment and food safety risk assessment of plant nutrition and soil fertility programs	5	Indirect
AHCSAW502 - Plan erosion and sediment control measures	Plan erosion and sediment control measures	5	Indirect
AHCSOL503 - Manage erosion and sediment control	Manage erosion and sediment control	5	Indirect
AHCORG503 - Design and document an organic farm landscape	Design and document an organic farm landscape	5	Partial
AHCORG507 - Develop an organic or biodynamic management plan	Develop an organic or biodynamic management plan	5	Partial
AHCCFP401 - Increase soil organic carbon using land management practices	Increase soil organic carbon using land management practices	4	Direct
AHCORG403 - Manage organic soil improvement	Manage organic soil improvement	4	Direct
AHCSOL402 - Develop a soil use map for a property	Develop a soil use map for a property	4	Direct
AHCSOL401 - Sample soils and interpret results	Sample soils and interpret results	4	Direct
AHCIRG441 - Evaluate water supply for irrigation	Evaluate water supply for irrigation	4	Indirect
AHCMER406 - Provide information on fertilisers and soil ameliorants	Provide information on fertilisers and soil ameliorants	4	Indirect
AHCPCM402 - Develop a soil health and plant nutrition program	Develop a soil health and plant nutrition program	4	Indirect
AHCSOL403 - Prepare acid sulphate soil management plans	Prepare acid sulphate soil management plans	4	Indirect
AHCSOL404 - Supervise acid sulphate soil remediation and management projects	Supervise acid sulphate soil remediation and management projects	4	Indirect
AHCIRG339 - Monitor soils under irrigation	Monitor soils under irrigation	3	Direct
AHCPER319 - Test, improve and maintain healthy soil in a permaculture system	Test, improve and maintain healthy soil in a permaculture system	3	Direct
AHCSOL304 - Implement soil improvements for garden and turf areas	Implement soil improvements for garden and turf areas	3	Direct
AHCPCM301 - Implement a plant nutrition program	Implement a plant nutrition program	3	Indirect
AHCWRK307 - Develop and apply fertiliser and soil ameliorant product knowledge	Develop and apply fertiliser and soil ameliorant product knowledge	3	Indirect
FBPVIT3010 - Implement a soil management program	Implement a soil management program	3	Indirect
FWPCOT3258 - Comply with soil and water protection	Comply with soil and water protection	3	Indirect
AHCMOM306 - Ground spread fertiliser and soil ameliorant	Ground spread fertiliser and soil ameliorant	3	Partial

AHCSAW302 - Implement erosion and sediment control measures	Implement erosion and sediment control measures	3	Partial
AHCPER215 - Assist with garden soil health and plant nutrition	Assist with garden soil health and plant nutrition	2	Direct
AHCSOL202 - Assist with soil or growing media sampling and testing	Assist with soil or growing media sampling and testing	2	Direct
AHCSAW201 - Conduct erosion and sediment control activities	Conduct erosion and sediment control activities	2	Indirect

The breakdown by AQF Level and relationship to soil science are detailed in Table 12 and Table 13 respectively.

Table 12. Number of UoC by AQF Level

AQF Level	Number of Units of Competency
Level 2	3
Level 3	9
Level 4	9
Level 5	9

Table 13. Number of UoC by relationship to soil science

Relationship to Soil Science	Number of Units of Competency
Direct (> 80 %)	12
Indirect (30 – 80 %)	14
Partial (< 30 %)	4

There are 45 Competency Area's in the CPSS Fundamentals Exam. Figure 4 details how many are covered by each UoC. Four UoC, initially identified as having soil science related content, did not align with any of the Competency Areas upon detailed examination. Of the remaining UoC, 21 included content on five or fewer competency areas with only six UoC including content on 10 or more Competency Areas. This indicates that the individual UoC provide only partial coverage of the CPSS Fundamental Exam Competency Area's. Even when combined in a qualification, such as the Diploma of Agriculture (AHC50116), which includes five soil related UoC (all of which are electives), only 24 of the 45 Competency Areas are covered.

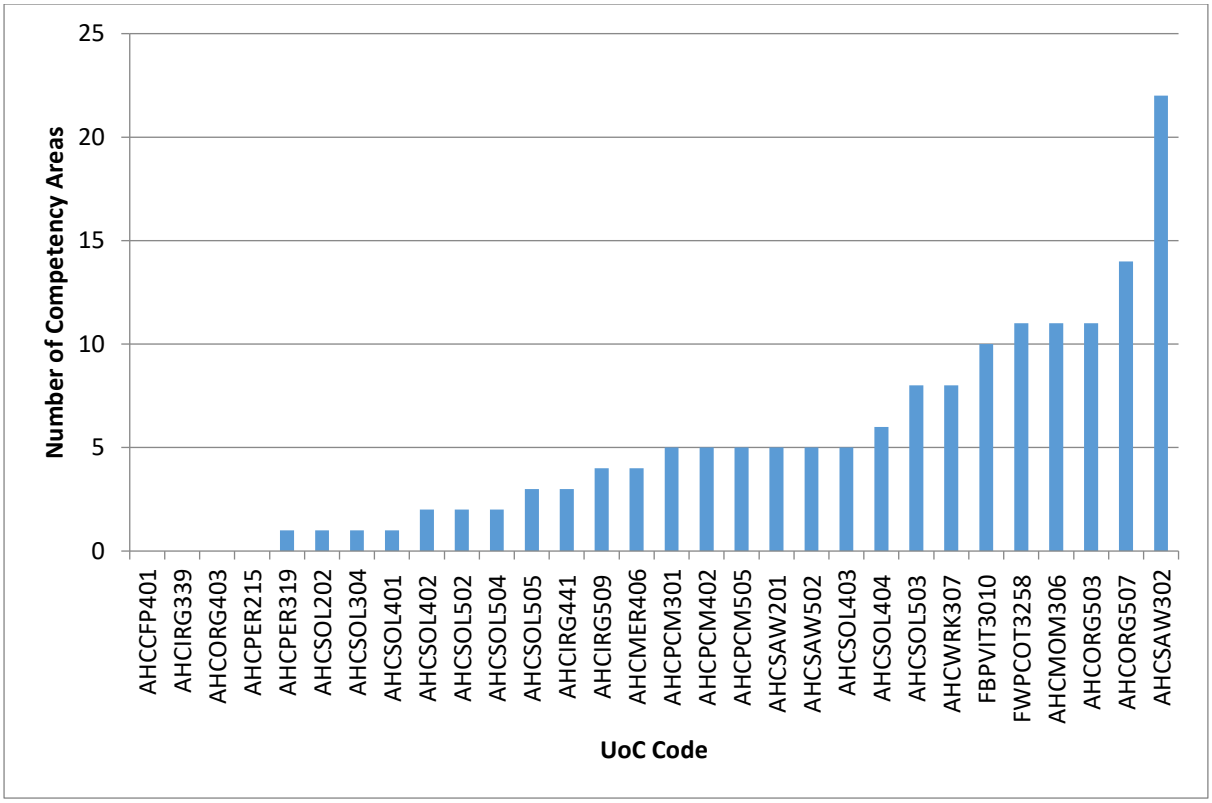

Figure 4 Competency Areas covered by UoC

Figure 5 indicates how many UoC include content for each of the 45 CAs. 15 Competency Areas (33 %) are not covered by any UoCs with an additional eight being included content in only one or two UoC. This indicates that there are only a narrow range of options available to gain knowledge across a range of CAs in the VET sector.

Table 14 breaks down the coverage of CA by CPSS PO. There are substantial gaps in coverage for four of the six POs.

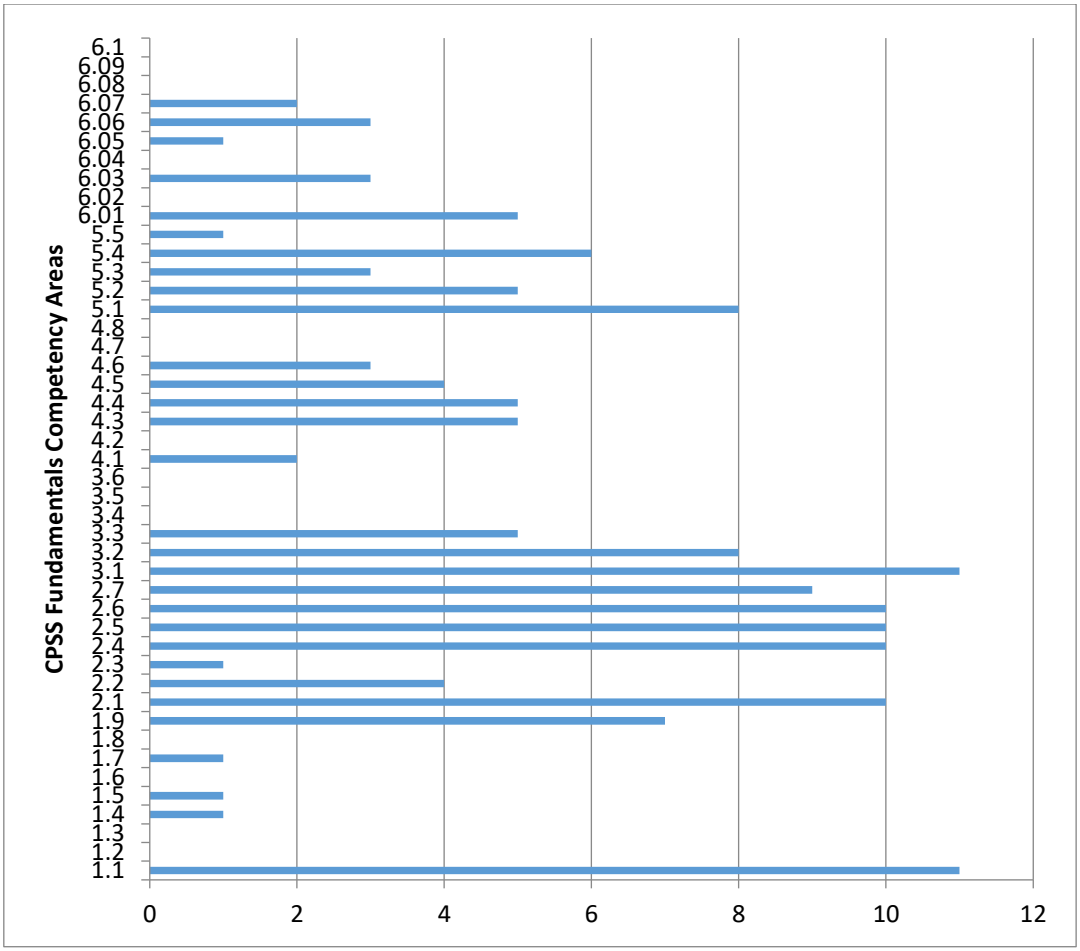

Figure 5 Comparison of number of UoCs versus CPSS Fundamentals Exam Competency Areas

Table 14 Breakdown of Competency Areas covered and not covered by UoCs

Performance Objective	Covered	Not Covered
1 Soil chemistry and mineralogy	5	4
2 Soil fertility and nutrient management	7	0
3 Soil physics	3	3
4 Soil genesis, morphology, and classification	5	3
5 Soil biology and soil ecology	5	0
6 Soil and land use management	5	5

The breadth and depth of VET soil science related training by qualification is presented in Table 15. Qualifications cover from 31 to 60 % of the CPSS PO with the Diploma of Agriculture, Certificate IV in Agriculture and Certificate IV in Production Horticulture providing the most extensive coverage.

Table 15 Breadth and Depth of VET soil science education by qualification

QUALIFICATION	PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS						PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION							
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8
AHC50116 - Diploma of Agriculture	2	0	0	1	1	0	1	0	2	4	2	1	4	4	4	4	3	1	0	0	0	0	1	0	2	3	2	1	0	0
AHC40116- Certificate IV in Agriculture	3	0	0	0	0	0	0	0	3	3	1	0	4	4	4	4	4	4	2	0	0	0	0	0	2	1	1	1	0	0
AHC40316- Certificate IV in Production Horticulture	2	0	0	0	0	0	0	0	2	2	1	0	2	2	2	2	3	4	2	0	0	0	0	0	2	1	1	1	0	0
AHC52116- Diploma of Permaculture	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	0	0	1	0	1	0	0
AHC50316 - Diploma of Production Horticulture	1	0	0	0	0	0	0	0	1	2	0	0	2	2	2	2	1	1	1	0	0	0	0	0	1	1	1	0	0	0
AHC41616- Certificate IV in Organic Farming	2	0	0	0	0	0	0	0	1	2	1	0	2	2	2	2	3	3	1	0	0	0	0	0	2	1	1	1	0	0
AHC41416- Certificate IV in Seed Production	2	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	2	3	2	0	0	0	0	0	1	1	1	0	0	0
AHC40916- Certificate IV in Conservation and Land Management	1	0	0	0	0	0	0	0	1	2	1	0	3	3	3	3	2	2	0	0	0	0	0	0	1	1	1	0	0	0
AHC31716- Certificate III in Natural Area Restoration	1	0	0	0	0	0	0	0	2	1	1	0	2	2	2	2	2	3	1	0	0	0	0	0	1	1	1	0	0	0
AHC31616- Certificate III in Lands, Parks and Wildlife	2	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	2	1	0	0	0	0	0	0	1	1	1	0	0	0
AHC31319- Certificate III in Sports Turf Management	2	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	2	1	0	0	0	0	0	0	1	1	1	0	0	0
AHC31116- Certificate III in Production Nursery	2	0	0	0	0	0	0	0	1	1	1	0	3	2	2	2	2	2	1	0	0	0	0	0	1	1	1	0	0	0
AHC30116- Certificate III in Agriculture	2	0	0	0	0	0	0	0	1	2	1	0	2	1	1	1	2	1	0	0	0	0	0	0	1	1	1	0	0	0

QUALIFICATION	PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS						PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION							
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8
AHC50116 - Diploma of Agriculture	2	0	0	1	1	0	1	0	2	4	2	1	4	4	4	4	3	1	0	0	0	0	1	0	2	3	2	1	0	0
AHC40116- Certificate IV in Agriculture	3	0	0	0	0	0	0	0	3	3	1	0	4	4	4	4	4	4	2	0	0	0	0	0	2	1	1	1	0	0
AHC40316- Certificate IV in Production Horticulture	2	0	0	0	0	0	0	0	2	2	1	0	2	2	2	2	3	4	2	0	0	0	0	0	2	1	1	1	0	0
AHC52116- Diploma of Permaculture	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	0	0	1	0	1	0	0
AHC50316 - Diploma of Production Horticulture	1	0	0	0	0	0	0	0	1	2	0	0	2	2	2	2	1	1	1	0	0	0	0	0	1	1	1	0	0	0
AHC41616- Certificate IV in Organic Farming	2	0	0	0	0	0	0	0	1	2	1	0	2	2	2	2	3	3	1	0	0	0	0	0	2	1	1	1	0	0
AHC41416- Certificate IV in Seed Production	2	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	2	3	2	0	0	0	0	0	1	1	1	0	0	0
AHC40916- Certificate IV in Conservation and Land Management	1	0	0	0	0	0	0	0	1	2	1	0	3	3	3	3	2	2	0	0	0	0	0	0	1	1	1	0	0	0
AHC31716- Certificate III in Natural Area Restoration	1	0	0	0	0	0	0	0	2	1	1	0	2	2	2	2	2	3	1	0	0	0	0	0	1	1	1	0	0	0
AHC31616- Certificate III in Lands, Parks and Wildlife	2	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	2	1	0	0	0	0	0	0	1	1	1	0	0	0
AHC31319- Certificate III in Sports Turf Management	2	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	2	1	0	0	0	0	0	0	1	1	1	0	0	0
AHC31116- Certificate III in Production Nursery	2	0	0	0	0	0	0	0	1	1	1	0	3	2	2	2	2	2	1	0	0	0	0	0	1	1	1	0	0	0
AHC30116- Certificate III in Agriculture	2	0	0	0	0	0	0	0	1	2	1	0	2	1	1	1	2	1	0	0	0	0	0	0	1	1	1	0	0	0

Next the identified UoC were reviewed for their potential relevance for CPSS accreditation. This involved comparing the information contained in the UoC to the detail provided for each Competency Area in the CPSS Fundamentals Exam Performance Objectives. Only Level 4 (Certificate IV) and Level 5 (Diploma) level UoC were reviewed as it was deemed that lower level UoC would not include a sufficient depth of knowledge. As a result of this review a number of CAs were found to not be covered in sufficient depth within the VET sector. The number of UoC by AQF Level and relationship to soil science are detailed in Table 16 and Table 17 respectively.

Table 16 Number of UoC by AQF Level

AQF Level	Number of Units of Competency
Level 4	9
Level 5	9

Table 17 Number of UoC by relationship to soil science

Relationship to Soil Science	Number of Units of Competency
Direct (> 80 %)	7
Indirect (30 – 80 %)	9
Partial (< 30 %)	2

Figure 6 details the number of Competency Areas covered by each UoC. The majority of UoC cover five or fewer Competency Areas with only two covering 10 or more. AHCSOL505 *Monitor and manage soil for production projects* covers 11 Competency Areas and AHCSOL502 *Manage soils to enhance sustainability* covers 22. Qualifications that include these two UoC are detailed in Table 18.

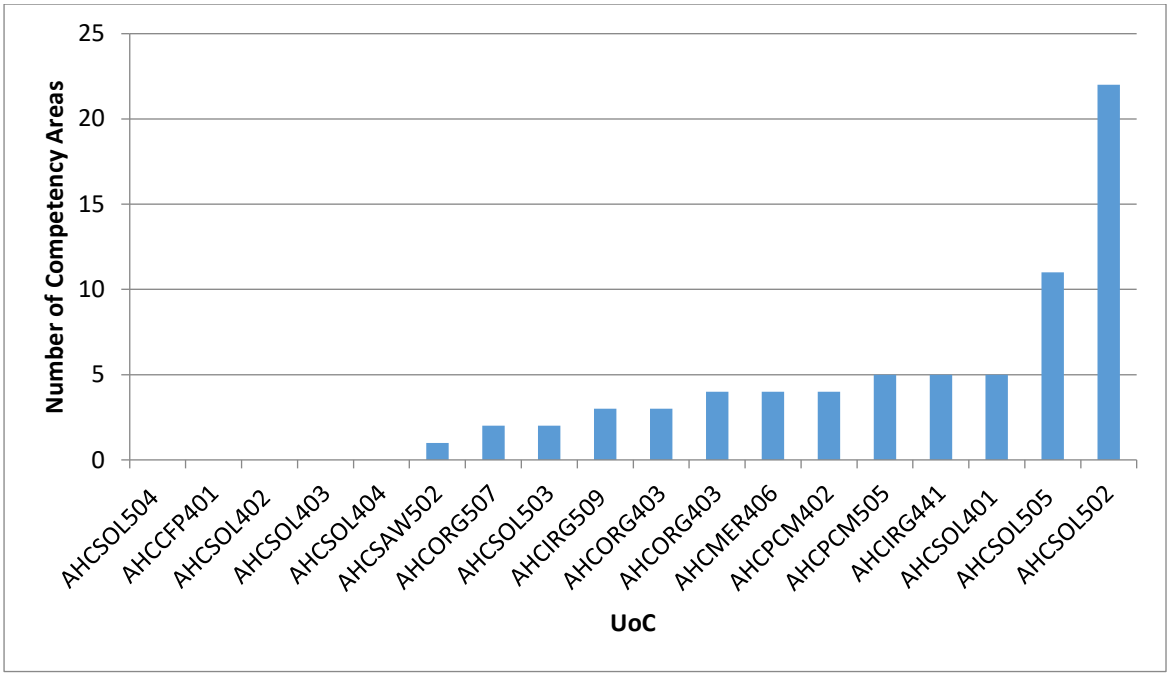

Figure 6 Number of CPSS Fundamentals Competency Areas covered by UoC (CPSS Level)

Table 18 Qualifications that include selected soil related UoC

AHCSOL502	**AHCSOL505**
Diploma of Agriculture	Diploma of Organic Farming Diploma of Viticulture Diploma of Agribusiness Management Diploma of Production Horticulture Diploma of Agriculture

Figure 7 details the number of UoC that cover the CPSS Fundamentals CAs. 16 CAs are not covered by any UoC, 20 are covered by one or two UoC and only nine are covered by more than two UoC. This indicates that there are a narrow range of options available to obtain some of the skills and knowledge required for a CPSS within the VET sector.

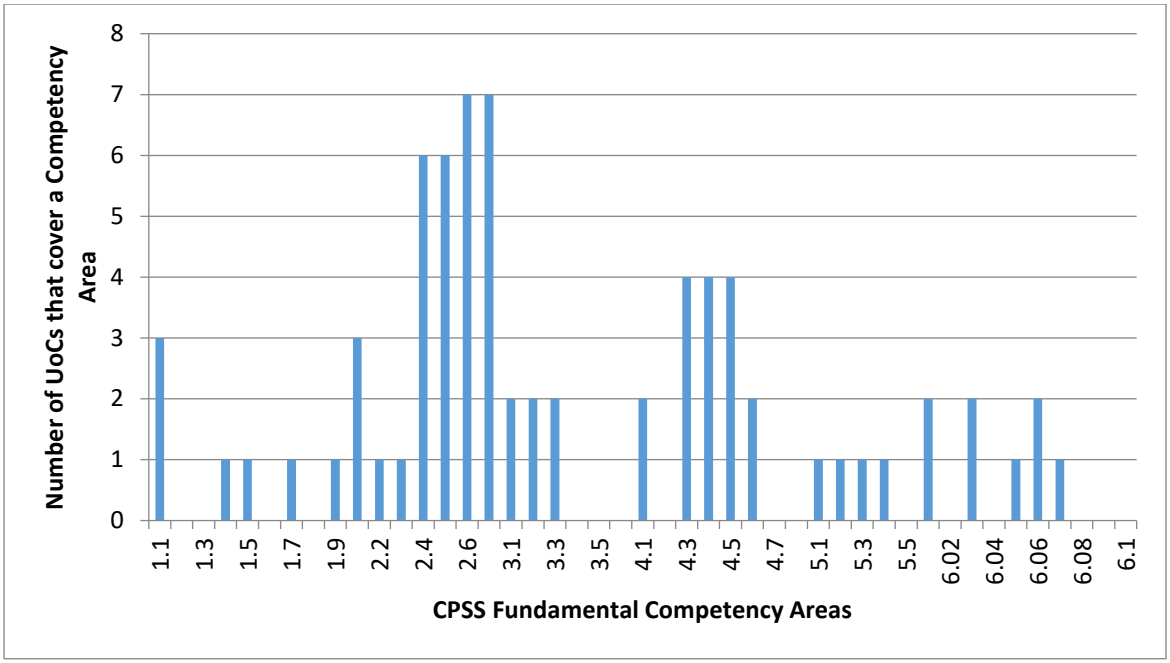

Figure 7 Number of UoCs covering each CPSS Fundamentals Competency Area

The VET sector does not have the capacity to equip an individual with the full range of skills and knowledge required for CPSS accreditation. It does however, in a small number of UoC, cover a significant component of the CPSS knowledge requirements. It should be noted however that this assessment has been made from a desktop review of the UoC; further investigation may indicate that the depth and breadth of content included in these UoC may not be sufficient for CPSS accreditation.

6.4 In-service

A total of 47 in-service soil science related training activities were identified from Internet searches. It is likely that not all training activities have been identified as in some cases access to training information requires membership of professional bodies (e.g. Australian Land and Groundwater Association). A summary of in-service training is provided in Table 19.

Table 19 Summary of in-service training

Ser	Title	Length	Training type	Organisation
43	Soil Science Australia Soil Judging Competitions	1 - 3 days	Field day	Soil Science Australia
14	Agronomy In Practice	3 days	Formal course	Nutrient Advantage
15	Soil Logging Workshop	4 hours	Formal course	Australian Contaminated Land Consultants Association (ACLCA)
10	Better Soils Management		Informal course	Back Paddock
11	Professional Soils/Nutrition Management: Irrigated Cropping		Informal course	Back Paddock
12	Understanding Soil Testing		Informal course	Back Paddock
13	Managing Soil Health		Informal course	Back Paddock
37	Land Degradation Restoration and Management	Self paced	Informal course	Gardening Training Academy
38	Landscape Restoration (Revegetation) Online Course	100 hours (self paced)	Informal course	Careerline Courses

39	Soil Management (Crops) BHT103 Online Course	100 hours (self paced)	Informal course	Careerline Courses
44	Soil Erodibilty Course	1 day	Informal course	Forest Practices Authority
45	Soil Management (Agriculture)	100 hours (self paced)	Informal course	learningcloud. Also offered by : ACS Distance Education
1	Acid Sulfate Soils Management for Construction Sites	1 day	Seminar	cet (Centre for Enironmental Training)
2	Erosion and Sediment Control (preparation for IECA CPESC examination) NSW (Blue Book)	4 days	Seminar	cet (Centre for Enironmental Training)
3	Erosion and Sediment Control (preparation for IECA CPESC examination) QLD	4 days	Seminar	cet (Centre for Enironmental Training)
4	Practical Erosion and Sediment Control for the Workforce	1 day	Seminar	cet (Centre for Enironmental Training)
5	Selecting and Installing Erosion and Sediment Control Measures	0.5 day	Seminar	cet (Centre for Enironmental Training)
6	ESC 1 - Awareness Training	4 hours	Seminar	Topo
7	ESC 2 - Intermediate Training	1 day	Seminar	Topo
8	ESC 3 - Advanced Training	3 days	Seminar	Topo
9	Type A, B & D Sediment Basin Design Course	1 day	Seminar	Topo
16	Unsaturated Soil Mechanics	05, 1 & 2 days	Seminar	3rd Rock Consulting
17	Introduction to classical soil mechanics	1 day	Seminar	3rd Rock Consulting
18	Soil Food Web Course	12 weeks	Seminar	Soil Learning Centre
19	Introduction to soil science	3.5 hours	Seminar	Queensland Arboricultural Association
20	SOIL HEALTH	?	Seminar	Glen Orton
21	Soil chemistry short courses	1 & 2 days	Seminar	Effective Soil Chemistry
22	Soil	0.5 day	Seminar	Simmonds & Bristow
23	Acid Sulfate Soils	0.5 day	Seminar	Simmonds & Bristow
24	Soil Tests 101	4 hours	Seminar	AgriStrategies
25	Sustainable Soil Management Workshop	5 days	Seminar	GroundGrocer
26	Applying SFI Methodology to Create Compost, Compost Tea and Analysing the Tea Created	3 days	Seminar	GroundGrocer
27	Soil Courses	1 day	Seminar	Western Port Catchment Landcare Network
28	Compost Soil Biology Natural Fertilizer Course	5 days	Seminar	Trust Nature Pty Ltd
29	Erosion and Sediment Control Training	3 days	Seminar	Landloch
30	Dispersive and Tunnel Prone Soils	1 day	Seminar	Landloch
31	Soil Fundamentals for Rehabilitation	1 day	Seminar	Landloch
34	Basic Soils Refresher Course	1 day	Seminar	Soil Science Australia
35	Soil Survey Course	1 day	Seminar	Soil Science Australia
36	Digital Soil Mapping	3 days	Seminar	Digital Soil Mapping
42	Soil Science Australia Branch Meetings	Approx 1 hour	Seminar	Soil Science Australia
46	Soil and Pasture Management Course	1 day	Seminar	West Gippsland Catchment Management Authority
47	Fundamentals of Solute Transport in Groundwater	4 hours	Seminar	Australasian Land & Groundwater Association (ALGA) Ltd.
41	Soils Network of Knowledge webinars	Approx 1 hour per month	Webinar	NSW DPI
32	Tarwyn Park Training	4 days	Workshop	Tarwyn Park
33	Digging Deeper Plus - Soil Management Program	6 days over 6 months	Workshop	Terrain NRM
40	Soil Knowledge Network Training Workshop	2 days	Workshop	Soil Knowledge Network

The breakdown of training activities by type is detailed in Table 20. The vast majority of training activities have been classified as seminars, which are generally delivered in the form of a course (e.g. structured lessons) but are not assessed. The target audience for these activities also varied greatly. A small number of the training activities prepared participants for industry qualifications but most did not.

Table 20 Breakdown of training activities

Type of training activity	Activity description	Number of training activities
Formal Course	A series of lessons to teach the skills and knowledge for a particular job or activity that is assessed and either leads to, or prepares the trainee for a qualification	2
Informal Course	A series of lessons to teach the skills and knowledge for a particular job or activity that is assessed but does not lead to a qualification	9
Seminar	An occasion when a teacher or expert and a group of people meet to study and discuss something	31
Workshop	A form of training where participants are involved in the creation of knowledge	3
Field Day	Learning/training activities predominantly conducted at a field site	1
Webinar	A seminar that is conducted over the Internet	1

A comparison of training activities versus each CA is detailed in Figure 8. Collectively, the training activities covered 34 of the 45 CA. It should be noted that some of the training activities, such as Soil Science Australia Branch meetings and NSW DPIs Soils Knowledge of Network webinars, have changing content and thus no CAs were assigned to these activities.

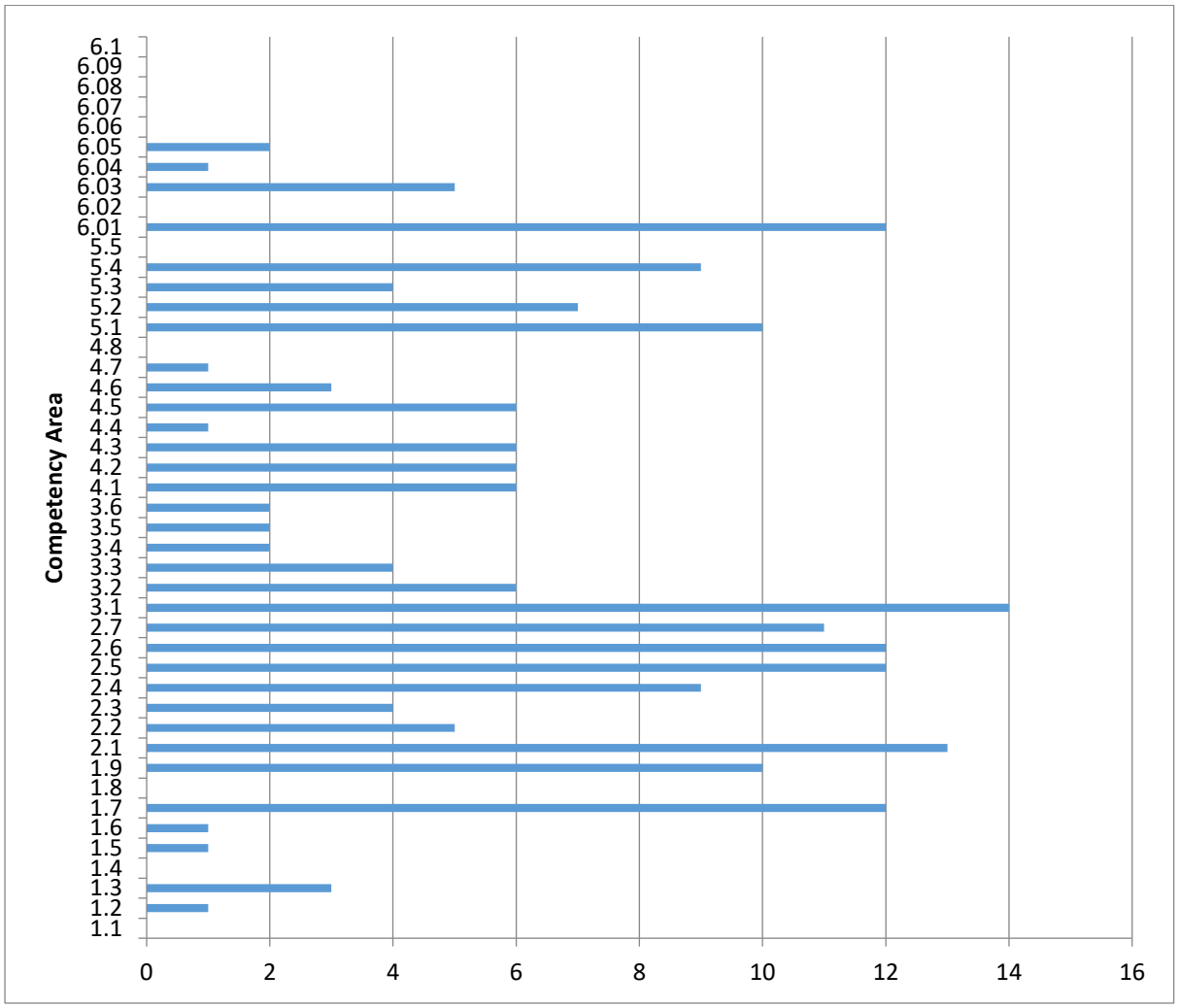

Figure 8 Number of training activities that cover each Competency Area

A breakdown of training activities by Performance Objective is provided in Table 21. The largest deficiencies are in soil chemistry and soil and land use management.

Table 21 Breakdown of Competency Areas covered and not covered by in-service training activities

Performance Objective	Competency Areas Covered	Competency Areas Not Covered
1 Soil chemistry and mineralogy	6	3
2 Soil fertility and nutrient management	7	0
3 Soil physics	6	0
4 Soil genesis, morphology, and classification	7	1
5 Soil biology and soil ecology	4	1
6 Soil and land use management	4	6

6.5 Discussion

6.5.1 Tertiary

A number of interesting findings have been identified through developing the Inventory of soil science related courses taught at Australian universities and subsequent mapping against the CPSS Fundamentals Exam Performance Objectives.

The first finding is that no Australian university offers a program which delivers content against all of the CPSS Fundamentals Exam Competency Areas. Even those universities with extensive soil science programs only cover up to a maximum of 84 percent of the Competency Areas. This leaves a significant knowledge gap.

The application process for CPSS (https://www.soilscienceaustralia.org.au/cpss/apply/) requires applicants to have either completed four university courses in soil science, or complete the Soil Science Australia CPSS Fundamentals Exam. The results indicate that applicants taking the first option may not have been taught nor assessed on significant components of what is expected knowledge of a CPSS. Whilst the five year professional experience requirement mitigates the knowledge gap, there is a potential risk to the robustness of the CPSS qualification in that individuals already CPSS qualified may have unidentified knowledge deficiencies. However, this of course depends upon the intent of the CPSS accreditation, the creation of future CPSS Specialisations, the weight placed upon the university learning portion of CPSS eligibility, and the weight placed upon the professional experience.

The passing mark of the fundamentals exam was also unknown to the authors of the report, as well as if there is a weighted passing mark, or specialist passing mark (pass assessed by lower benchmark over all sections, or much higher benchmark in a number of the sections). There is also the issue that a soil science degree no longer exists, and creating the critical mass of CPSS personnel the initial priority. It is also known that the CPSS assessment process is highly rigorous and respected within industry. Therefore, it is recommended that as CPSS critical mass is developed, that SSA work with universities to ensure that the CAs coverage is sufficient to mitigate any robustness risk.

The Apply for CPSS website (https://www.soilscienceaustralia.org.au/cpss/apply/) lists types of courses that may contribute to the four soil science courses required in lieu of completing the CPSS Fundamentals exam. These titles are: soil physics, soil chemistry, pedology and soil biology. A review of the courses titles from the Inventory identifies:

- 12 courses that include the phrase 'soil science' in the title. These are generally the first soil science course that a student will complete.
- No 'soil physics' courses but three titles that include 'physics'
- No 'soil chemistry' courses but 24 titles that include chemistry, most as an environmental chemistry course.
- No 'pedology' courses
- No 'soil biology' courses, but four titles that include 'microbiology.'

Taken from the perspective of an aspiring soil scientist, there is a large degree of uncertainty as to whether the courses they are planning to enroll in will be acceptable for CPSS accreditation. This suggests the requirements for a recognition system as to whether a particular course is acceptable for the CPSS accreditation process. This recognition should ideally be included as a field within the Inventory.

For those applicants who are required to attempt the exam there does not appear to be a structured preparatory pathway from university graduate to CPSS. This represents an opportunity for a training provider, whether that is a university, Soil Science Australia or a commercial organisation, to develop and deliver a CPSS Fundamentals Exam preparatory package.

For individuals interested in a soil science career, the results indicate that there is currently no structured pathway and limited information available to achieve that ambition. From the professions perspective this appears to be an impediment to generating interest in soil related programs and consequently building the capacity of the profession within Australia. The Inventory offers an opportunity to at least partially address this. Initially the Inventory can be used to identify those universities, programs, courses and enrolment patterns that best equip students for progression towards CPSS. In the longer term, a more formalised approach could be implemented where Soil Science Australia endorses soil science course/programs that contribute to the attainment of CPSS. In turn this would encourage universities to include the relevance of each course to CPSS accreditation in the respective course specifications/unit descriptions. Engineers Australia has a formal process where engineering courses delivered by universities are accredited on a regular basis. A similar approach could eventually be implemented by Soil Science Australia to provide a measure of quality assurance and consistency for soil science courses/programs. Overall these initiatives would benefit the profession, Soil Science Australia and participating universities.

Some of the soil science courses, particularly the introductory courses cover a large number of CA (for example 13 courses cover 20 or more CA). Most university courses have a workload expectation of around 150 hours per course inclusive of lectures, laboratory work, assignments, exams and private

study. This indicates that the depth of coverage on CAs may not be sufficient to gain the knowledge expected of a CPSS. This also reinforces the importance of a program of soil science courses to ensure that students obtain a good grounding in the theoretical aspects of soil science prior to commencing their career. Whilst the analysis has identified that no universities currently cover all CPSS CAs, it is also clear that there are a number of universities that deliver enough soil science courses that it appears possible to build either Major's or Minor's within degree programs. This is an opportunity for both Soil Science Australia and interested universities that would greatly assist in articulating programs that would lead to CPSS accreditation.

The Inventory has been developed through a desktop review process, which as previously explained has required judgements based on limited and varying amounts of information to be made during the course mapping. To improve the accuracy of the mapping it would be useful to engage with the universities and seek additional information; Appendices 1 and 2 provide the course mapping categorised by university to facilitate this process. This would however require additional time and resources to complete, as well as buy in from universities. The latter point is important, as university course examiners are often already overloaded with administrative tasks. Therefore, the process must be made as easy as possible for these staff, who will ultimately be the ones required to liaise with the organisation compiling the inventory. It is suggested that a CPSS Fundamentals Exam CA rubric is created whereby it becomes a quick process for course examiners to map their courses, or adjust the preliminary mapping done in this inventory. Additionally, to minimse the inventory work, PDF rubrics with *form fields* could be used to automatically collate the numerical mark/weighting against the rubric for systematic (potentially automated) entry into an updated inventory. In this case, a living document would become a reality because external parties would only have access to their course PDFs rather than the full inventory. This will require an initial investment and ongoing maintenance, which should be underwritten by the government and subsequently fulfilled by core stakeholders.

An additional consideration is that the Inventory does not include any quality assurance of the soil science being taught at universities. Whilst each course will be accredited by TEQSA this does not of itself guarantee the quality, accuracy and relevance of soil science related content. If a rubric for the CPSS Fundamentals Exam CAs were to be used, this would improve the standardisation of expectations. Engineers Australia use a similar approach, but also actively engage with universities on a regular basis to quality assure degrees for industry impact. There is no reason that CPSS should not consider this a reality given that governments are beginning to require CPSS qualifications for particular applications via policy.

6.5.2 VET

A number of conclusions can be drawn from the analysis of the soil science related training provided by the VET sector. Firstly the UoC delivered by TAFE only cover half of the Competency Areas within the CPSS Fundamentals Exam. This highlights a significant gap in knowledge for both prospective CPSS candidates and potentially RSP candidates as well. For those areas which are covered, there is uncertainty as to whether the depth and breadth of content aligns with the CPSS Fundamentals Exam. Because of the nature of the gaps in the coverage consideration should be given to creating RSP streams, for example RSP (Fertility Management) or RSP (Soil Degradation). This would make it clear what aspects of soil science an RSP has knowledge of. Consideration could be given for an alternate pathway to CPSS that includes selected VET qualifications in combination with other University or In-service training in addition to industry experience.

As the concept of the RSP qualification develops, SSA should consider engaging with the VET sector. This engagement should focus on:

- Validation of the content included in VET soil science related UoC and qualifications
- Potentially influencing changes in soil science related VET to ensure that training outcomes align with RSP requirements.

An ideal outcome would be that a prospective RSP candidate would be able to readily identify the pathway to RSP recognition via a VET pathway. For example the baseline education requirement to obtain RSP recognition is the completion of a Diploma of Agriculture that includes a number of specified UoC.

6.5.3 In-service training

The identified training activities vary significantly in their length, target audience, methods of delivery and assessment. From the RSP perspective, the following conclusions can be drawn:

- There is a wide variety of training activities that provide participants with a range of soil related knowledge, noting there are still gaps, particularly in the Soil Chemistry and Mineralogy and Soil and Land Use Management CPSS Performance Objectives.
- Most of the training activities are of short duration (i.e a couple of days or less). This indicates that the depth of content is likely to be limited and thus not cover the content to a depth expected of a CPSS, or are highly specific, meaning that only a small number of CA will be covered.
- The vast majority of training is unassessed, unlike VET and University courses. Consideration of whether unassessed training activities are suitable for RSP recognition is required.
- There is no guarantee of quality or accuracy in the provision of training. This suggests the requirement for a recognition program to be instituted to enable SSA to exercise quality control over in-service training activities as they relate to RSP recognition.
- Further investigation with industry bodies may be warranted to identify additional training activities that have not been identified.

For prospective CPSS candidates in-service training does not appear to offer either the breadth or depth of training required to obtain the knowledge required to pass the CPSS Fundamentals Exam. The target audience for the vast majority of training activities is for non-scientists and where the training maybe suitable for a scientist, the scope is narrow (i.e covers only a small number of Competency Areas). The major value of many of these training activities for CPSS maybe as Continuing Professional Development.

6.5.4 General comments

During the several months taken to complete the course search and subsequent mapping it was found that a number of courses became obsolete or are no longer offered. This indicates the importance of regular maintenance of the Inventory to ensure its ongoing accuracy and usefulness. To ensure the ongoing accuracy and usefulness of the Inventory a number of points are evident:

- Ownership. The Inventory needs an owner with assigned responsibilities. The Training Committee of Soil Science Australia appears to be logical owner of the Inventory.

- Maintaining the Inventory requires resources. Collecting, analysing and validating information in the Inventory is a time consuming task. It is assessed that regular ongoing maintenance will be more effective over the long term, both from a cost and usefulness perspective, than irregular and uncertain funding.
- The effort and resources required to maintain the Inventory can best be justified by making the Inventory a living and useful resource for students, industry, government, the education sector and the profession. This can be achieved through a number of methods:
    - Developing a SSA recognition process for soil science education provided in Australia
    - Providing readily accessible information on preferred degrees, courses and enrolment patterns for individuals interested in a soil science career.
    - Engagement with universities to improve the accuracy of information in the Inventory. Universities have a self-interest in participating as the Inventory/recognition can be used as a marketing tool to encourage enrolments

7 Mapping instrument development

Analysis of the publicly available course information suggests that a mapping instrument is required to standardise soil science related course mapping to CPSS requirements, and to assist in the future enhancement of soil education capacity. The outcomes of initial course mapping by degree and university reflect the publicly available information currently available to prospective students seeking to study soil science, or degrees associated with soil science professions. These were determined as directly related, indirectly related and partially related to soil science base upon their publicly available course objectives/ learning outcomes. The direct and indirect courses were subsequently mapped to the CPSS Fundamentals Exam Performance Objectives (PO) and Competency Areas (CA) based upon this information. It must be assumed that this information does not accurately reflect a course's relation to soil science — for a number of following reasons — but is the only and best publicly available information to prospective students:

A. Publicly available information is used without institution consultation, whereby consultation would enhance accuracy (N.B. prospective students do not have ready access to this level of consultation, so it was ruled out of the initial investigation);
B. Course objectives/ learning outcomes detail information at the CA level, not the competency element level (CE; subunit of CA) and CAs consist of multiple CEs that may need to be satisfied to appropriately address a CA;
C. Course objectives/ learning outcomes are often contextual, so specified objectives/ learning outcomes will be tailored to the context. For example, "irrigation science" as a context is very clearly related to soil hydraulic properties and land management attributes that meet CAs throughout a number of POs, but specified objectives may be "Analyse irrigation data to calculate irrigation efficiency, determine constraints to this and management options to improve it". In this instance irrigation efficiency is the subject, and soil science learning is implied, but not specified; and,
D. Partially related courses were not mapped, as the finest level of detail at the course objective/ learning outcome level addressed CAs, but not CEs. Due to contextualisation issues, described above, partially related courses were not able to be usefully mapped from public information at the CA level.

Considering that there are 270 CEs, it is not feasible to manually map and validate all direct, indirect and partially related courses (314 identified) with course examiners within the allocated budget of $50,000. The cost to undertake this manually, as a project team, would be more than four times greater (see Section 8). The provision of a mapping instrument for standardisation of course self-assessment is a feasible approach to overcome this.

This section of the report details the initial development of a mapping instrument for use in standardised course self-assessment at the CE resolution. This is a preliminary mapping instrument and no assertion is made that it is a final or perfect product. Such a mapping instrument simply provides a template from which improvement can be made—starting from a vacuum is often a barrier to useful outcomes (Bennett et al., 2019).

The mapping instrument is provided as an objective basis on which to make judgements concerning individual courses and the extent they align to CPSS performance objectives, competency areas, and their competency elements. The mapping tool allows courses, institutions and soil science stakeholders to identify areas for enhancement of graduate attributes, as well as specialisations within the soil science domain. Gribble et al. (2003) observe that the use of a well-designed (clear definition and structure) mapping instrument provides constructive means to evaluation, in that it greatly

resolves uncertainty and differences of opinion. Hence, the instrument is intended to remove debate over how results were obtained (standardisation), allowing focus on the task at hand: Improving Australia's soil science capacity.

7.1 Approach

7.1.1 Mapping basis and CPSS minimum standard

The POs, CAs, and CEs from the CPSS Fundamental exam were used to construct the mapping instrument. The Australian Examinations and Procedures Committee (AEPC), under the auspices of SSA's Accreditation Board for the CPSS, had used Bloom's Taxonomy (Bloom, 1956) in the writing of the CEs within the CPSS Fundamentals exam. Each CE contained a Bloom Taxonomy *key word* that was subsequently used to determine the CPSS minimum requirement within the mapping instrument.

However, it is noted that this minimum requirement is intended for the fundamentals exam, where the intention of the exam is to demonstrate the bare minimum of knowledge we would expect an undergraduate to have. Those taking the fundamentals exam have not completed a degree considered to have sufficient qualifying units of soil science. As such, the CPSS Fundamentals Exam is strongly skewed towards "Remembering" and "Understanding", which are the lowest levels of learning complexity (Figure 9). This may appear in conflict with the CPSS Standards for Professionals in Soil Science that demonstrate a requirement for the higher and more complex levels of learning, but it must be noted that these higher levels of learning are assessed through the CPSS application narrative process, and quality assured with references. Hence, it is appropriate for the Fundamentals Exam to assess basic knowledge. But, many undergraduates will not need to attain the level of CPSS in the future and will still function in roles with impact on, or stake in, the soil resource — candidates for the recognised soil practitioner (RSP). Additionally, industry employers would be reasonably warranted to expect a higher level of learning that Levels 1 and 2; on-the-job-training will always be required, but should be expected for highly specified tasks, rather than for the fundamental and general knowledge of soil science. The level of learning attained by undergraduates above Bloom levels 1 and 2 is therefore a subject for consideration.

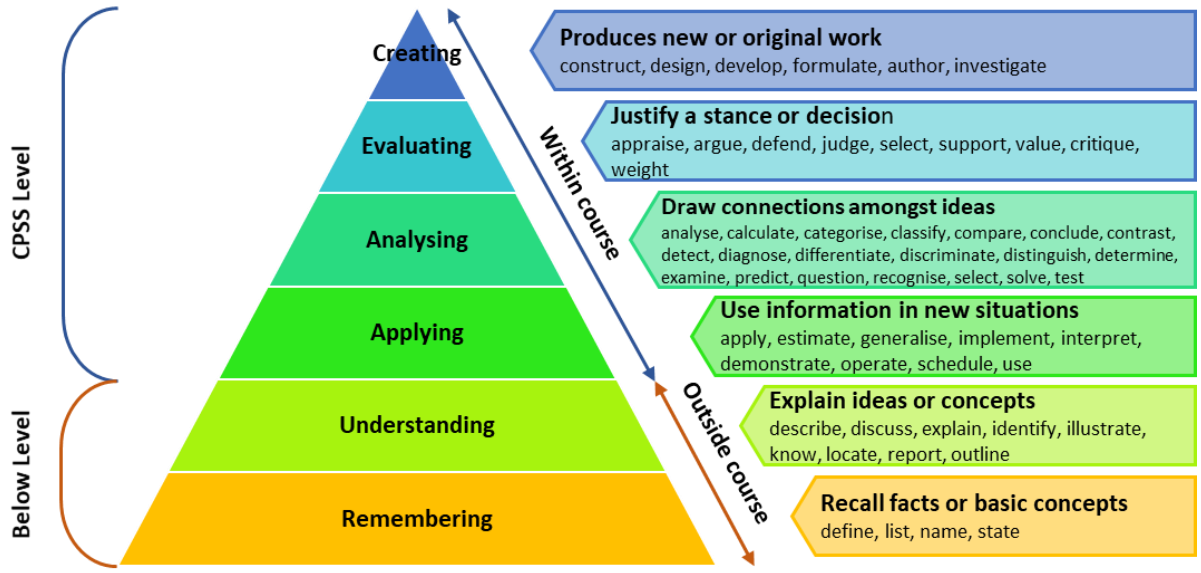

Figure 9. Modified version of Bloom's Taxonomy with key words defined for evaluation of soil science and related course level of learning.

In terms of university courses related to soil science, and in line with the CPSS Standards for Professionals in Soil Science, it is suggested that learning objectives should aim to produce graduates with knowledge applicable to "Applying", "Analysing" and "Evaluating". The highest level of learning in Figure 9 is "Creating". This reflects a change in Bloom's Taxonomy, whereby "Evaluating" and "Synthesis" were argued to be equally complex, while "Creating" transcended these. The "Creating" level would reflect honours, masters and doctoral research dissertations. The identified CPSS Level in Figure 9 is also in line with the notion that soil science courses aiming for higher level learning could focus on in-class application, analysis and evaluation of content as specified tasks, while remembering and understanding of the fundamental/ basic information required to complete in-class learning becomes out-of-class learning (implied tasks). This is mentioned here as a point of consideration, rather than to be prescriptive. Revisiting the desired level of learning of soil science graduates so as to minimise the differential between graduate knowledge, industry requirement, and CPSS accreditation requirement should be explored, but is beyond the scope of this report. The mapping instrument retains the CPSS Fundamentals Exam minimum requirement within it as a guide only.

7.1.2 Model approach

Rather than seek to reinvent the wheel, a literature search was conducted for an approach to evaluating learning levels of tertiary courses that were aligned to industry standards. Particular importance was placed on the ability to quantify the evaluation, given that this is a national level learning evaluation and mapping instrument. In terms of quantification, the intention was to allow tracking through time, rather than placing any value on absolute scores/values. A means of relative comparison was required. The approach of Engineers Australia was considered, but did not fit the CE approach that has been used by CPSS. Subsequently, the work of Gribble et al. (2003) provided a model approach, and was largely employed, with some modification. Their mapping instrument was designed for evaluation of actuarial tertiary studies through time and within degree with capability to quantify and assess the variance of learning aims and objectives to industry standards. In the current circumstance, aims and objectives were modified to CAs and CEs, allowing the remainder of the Gribble et al. (2003) approach to be applied.

7.1.3 Key definitions

To ensure a standardised approach to course evaluation — rather than define terminology for the many and varying national soil science course learning objectives — we took the approach of employing and defining the CPSS Fundamentals Exam terminology and allowing course examiners to relate this back to their own course terminology.

Performance Objective*:* A group of one or more Competency Areas. Performance objectives are in essence administrative groupings of Competency Areas. These are equivalent to "Units" in Gribble et al. (2003).

Competency Areas: Comprise of a number of Competency Elements, and are the broad areas of knowledge. These are equivalent to course "Aims" in Gribble et al. (2003).

Competency Elements: These are the basic requirements of knowledge at the finest scale taken directly from the CPSS Fundamentals exam, but reworded as generalities, rather than specified learning levels. These are equivalent to course "Objectives" in Gribble et al. (2003).

The Competency Element list is not considered to be all inclusive, but reflects the considerable work of the AEPC. The AEPC reviews and revises the POs regularly with input from end users to ensure the most pertinent soils knowledge is tested. However, new discoveries and approaches in Soil Science occur continuously, so the AEPC welcomes comments and suggestions for possible modifications to

the next edition of the POs. Comments should be sent to the Executive Officer, Soil Science Australia, PO Box 737, Prospect East, South Australia 5082. N.B. This also means that the mapping instrument will need to change with any approved AEPC change to the POs, which is raised here not as a deterrent, but for administrative note.

The specified list of *key words* for mapping and evaluation are supplied in Figure 9 and are exclusively applied to a level of learning. Words in general use may have different meaning to the specified level of learning in this mapping instrument, but these words are generally consistent with Bloom (1956) and Gribble et al. (2003), amended to reflect some specific usage in the CPSS Fundamentals Exam and to remove soil contextual words (e.g. "profile" was removed).

7.1.4 Quantifying the approach

The learning levels were given a numeric score from 0 through 6, as follows:

- 0, Not Examined within the course
- 1, Remembering
- 2, Understanding
- 3, Applying
- 4, Analysing
- 5, Evaluating
- 6, Creating

The learning levels in Figure 9 are also colour coded for rapid interpretation once courses are eventually collated within degrees, universities and nationally.

Within the mapping instrument there is a column for placing a weighting on both CAs and CEs. These weightings could be used by SSA to differentiate between fundamental knowledge and more important vocational attributes. However, as a default, all CAs and CEs have been assumed to be of equal weight.

As per Gribble et al. (2003), quantification of the average learning level and variance around this can be calculated at the Competency Area, Competency Element combined level and Competency Element levels:

$$(CE, CE)_L = \frac{CA_l \times CA_w + \sum(CE_{l_i} \times CE_{w_i})}{w_{total}}$$

$$CE_L = \frac{\sum(CE_{l_i} \times CE_{w_i})}{\sum CE_{w_i}}$$

Here, *L* refers to the summary level of investigation, *l* referes to the appropriate Bloom's Taxonomy level, *w* refers to the associated weight, and *i* is the ith level, or weight applied to this attribute level.

In general, the equations above describe the summary level of investigation as a weighted average of learning levels:

$$L = \sum l_i w_i$$

Thus, a measure of spread can be calculated to aid in understanding of the given summary level of investigation:

$$\sigma = \sqrt{\sum w_i(l_i - L)}$$

where, σ is a measure of spread analogous to a standard deviation that can be used as a standardised measure of spread where different weightings are used.

7.1.5 Allocation of levels of learning

There are two allocations for every CA and CE. These being the level of learning that may be expected by CPSS (reflects industry and professional requirements) for students on the CPSS pathway, and the intended level of learning of the individual course; this keeps in mind that courses have not necessarily been written for a CPSS pathway, and serves to highlight that a number of courses at an institution can be used to meet the CPSS level of learning over time (i.e. throughout the degree).

The expected level of learning as it pertains to the CPSS pathway is the allocation of concern for the mapping instrument. Without this, there is no standardisation benchmark in order to make assessment of the Australian soil science graduate capability. As discussed in the introduction to the mapping instrument, the bare minimum standard for the CPSS Fundamentals Exam has been used as a preliminary benchmark. However, a community of practice consisting of soil science course examiners and other key stakeholders could set an agreed level of learning at each CA and CE. This is strongly suggested.

Evaluation of course learning levels against the standarisation benchmark is then a matter for the individual course examiner and their institution.

7.1.6 Weightings

The weightings might be used to place more value on higher impact CAs and CEs, although the simplest approach would be to weight all CAs and CEs equally. It is suggested that an equal weighting approach be used to set the standarisation benchmark.

The best use of weightings occurs at the individual course level. In this case, the weighting might reflect the time allocated to learning about a particular CE. For this to work, the total weighting for CEs within a given CA would need to total to the standardisation benchmark CA. However, this complicates the process substantially, and may only serve to deter course examiners from using the mapping instrument. On the other hand, it means that for two different course where one supplies more time dedicated to CE “x” than the other, but where both address it, that both receive the same numeric score. Some assessment of the importance of this depth of learning needs to made by the community of practice. In the current version of the mapping instrument, the philosophy has been to keep the tool as simple as possible, thus the weightings are not employed, but included as a column for others’ consideration.

7.1.7 Assessment of results

The following comments are made when considering assessment from the context of the current mapping instrument being based on the CPSS Fundamentals Exam, and from the publication of Gribbele et al. (2003) that the instrument is based upon.

First, and foremost, the assessment of learning objectives/outcomes as a numeric value, based upon the level of learning defined by Bloom’s Taxonomy, provides no indication of the quality of teaching. There may be the temptation to reduce the assessment of a course down to a single value from CEs through CAs and POs to provide a measure of the overall learning level of that course for comparison to other courses. It is stressed that the comparison of courses in this manner, to suggest one may be better than another, is not appropriate. The actual level of information that could be gained by doing

this is simply whether the course met an overall learning level it might have been aimed at achieveing; for example, if on average a particular course was intended to provide learning outcomes and assessment at the “applying” level and a course average at the “understanding” level is obtained, this allows an examiner to restructure some of the learning focus.

The example above also highlights that as the level of summary investigation decreases in resolution, from CE (highest resolution) to course level, then information is lost. Within the CA there will be CEs with equal weighting, but different learning levels. The arithmetic mean of these pertaining to the CA learning level should not be used to replace the CE learning assessments. For example, two CEs, one with a learning level of 2 and the other 4 provides an arithmetic mean of 3. This mean should not be used to replace the actual CE assessments.

The use of CAs as the level at which multiple universities are compared would be considered appropriate as it can be used to quickly demonstrate depth and breadth of learning; this is useful to highlight specific niches, or teaching foci that might interest a prospective student.

Within universities, the use of CEs is very useful in assessing content over multiple courses to ensure a rounded education is provided for a soil science major. It may also help examiners as a collective to focus on teaching strengths. For many universities, teaching strengths reflect research strengths. Which is to say, within universities the mapping instrument could be used to ensure that the level of desired learning within teaching is obtained for niche research strengths. This may provide useful information for building future course business cases, or in developing a higher degree research student pipeline strategy that is demonstrable to university administrative structures.

If using the measure of spread, then the distribution may be expected to be uni-modal, typically around the average, *L*. However, if a bi-modal distribution is received, then this might provide important information about less desirable course structure to individual course examiners. This will not always be the case, so course examiners should be involved in interpretation of distributions at the course level.

The instrument does take into account other important criteria that affect learning. For example, the order of learning, the level at which new knowledge is introduced relative to how much this extends the presumed knowledge/skills, nor how appropriately the subject matter is covered. These criteria cannot be assessed using this mapping instrument and are not intended to be. The mapping instrument is a management tool. It has capability to measure the impact of changes to course structure that is reflected in learning objectives and therefore within CAs and CEs, providing a mechanism of standardised evaluation of the learning objectives/outcomes.

7.2 Discussion

7.2.1 Quality of teaching

It is important to note that even though the mapping instrument provides an objective and standardised means of evaluation, it does not address how the course is delivered. This would involve a quality assurance approach. Universities undertake such quality assurance for career-specifc degrees (e.g. Bachelor of Engineering via Engineers Australia) in association with accreditation of courses. Whilst there is possibly a case for future accreditation of courses with the CPSS Board via SSA, this is not the topic of the current work. The mapping instrument is presented here to assist universities and their stakeholders demonstrate soil science teaching capability and areas for enhancement/ investment to ensure the Australian requirement for soil science capability and capacity is met.

7.2.2 Next steps

The current instrument is Microsoft Excel based, which does not lend itself well to automated collation of information by university, or nationally. It is highly recommend that a form fill approach is used that would facilitate recognition of a unique course signifier for meta-collation. A simple program could be developed to automate this meta-collation and provide summary graphs and tables (potentially written in a simple coding language like R or Python). This would enhance the user experience alos, which results in better buy in by all stakeholders.

As has been indicated throughout the mapping instrument section, there is a requirement for buy in from university course examiners to aid in the mapping process and enhance our knowledge of Australia's soil science education opportunities. A community of practice is suggested. Both the SSA Training Committee and ASN Soil Science Education Working Group 6 provide useful groups for facilitation. The mapping instrument should be used as a preliminary version, with full expectation of improvement to it as an outcome of a living process. Even within the life of this project, there were two changes to courses that affected the inventory. Therefore, something such as a community of practice is suggested vital to its ongoing success.

8 Sustaining the Inventory

It has been identified in the previous sections that there is an ongoing requirement to maintain the Inventory to maintain its ongoing accuracy and usefulness. Four elements are considered as being necessary to sustaining the Inventory. The first element is the validation of the current Inventory. The second is demonstrating the value provided to a range of stakeholders by the Inventory. The third is the regular updating and maintenance of the Inventory. The fourth element is the resource required to maintain the inventory.

Due to the resource constraints and assessed priorities within the project, the Inventory has not been validated. A methodology and rubric to support standardised validation, for the tertiary sector, has however been developed. A systematic and objective (as possible) approach is deemed necessary, due to the potential labour costs and time required to manually validate the Inventory.

8.1 Why manual validation and maintenance is not sensible

Manual preparation of Australian soil science teaching capability was undertaken in 2010, this was manually updated a number of years after this, and has been conducted again in this project. While the cost of the initial efforts is not known to the project team, it is known that initial efforts were also not able to be validated manually, presumably due to the prohibitive cost (time and investment) associated with this. It is also known that the government periodically requires this information (e.g. current National Soil Strategy and to report on previous strategy measures of success). Therefore, in order to understand why manual validation and continued maintenance of the Inventory is not sensible, a planning cost for this activity has been constructed. An estimated planning cost scenario would require over $215,000 to fully validate all the courses in the Inventory (see Table 22 and

Table 23).

Table 22 Planning cost for continued manual maintenance of a validated Inventory

Item	Unit	Explanation
CE per course to validate	270	Competency elements per course.
Average time taken to validate each CE	3 minutes	Time to take interview course coordinator for each CE, as well as record information. Assumption made that for some CE that seconds may be required (i.e. not taught, move on), or up ten minutes for more detailed CE discussions. 3 min was considered reasonable and realistic for discussion and collation that would likely occur over the phone, or using video software, without a standardisation tool.
Time to validate each course (270 x 5min)	1350 minutes	Overall time taken to interview course coordinator for each CE across the course.
Number of courses	314	Number of courses in the current database.
Analysis and synthesis per course	0.25 days	Equates to 1.8 hours where a day is considered 7.2 hours with allocated breaks accounted for. Assumes 2.125 days' work per course.
Working time	223.75 days	The average number of working days per annum (averaged from the next 4 years) excluding public holidays, weekends and leave.
Number of course 1.0 FTE can assess, collate and synthesise	105	Assumes 1 person working on this task constantly without any burnout.
Total time taken to validate database	2.99 years	The total time taken to interview course coordinators for every course in the current database.
Number of personnel required to complete the task in 1 year	3	The number of personnel required to validate the database in 1 year. The assumption is made that 3 people working together would create sufficient efficiency to also report on national results within the 3.0 FTE.
Cost to complete	$215,900.16	Total cost of salaries of 3 FTE personnel completing the validation plus an additional 12% for overhead costs using APS Level 4.1, which is equivalent to university pay-scale Professional Level 5.1 (current project pay level for the Project Officer position undertaking assessment, collation and synthesis).

Table 23 Cost model assumptions

1. An assumed interview time of 3 minutes per interview question pertaining to each CE was used
2. The number of working days each year was taken from https://excelnotes.com/working-days-in-australia-in-2020/, over the next 4 years and averaged.
3. The average number of days sick/personal leave taken in Australia was 9.7 days taken from https://www.busyatwork.com.au/news/chucking-top-industries-sickies-australia/
4. The number of days annual leave was assumed to be 4 weeks X 5 days.
5. The salary of the 3 personnel was assumed to be APS Level 4, which was equivalent to the person currently compiling the database: $64,256 annually. https://www.abs.gov.au/websitedbs/Corporate.nsf/Home/abs+salary+rates
6. Other associated costs on top of salaries were assumed to be 12%, which is substantially less than university direct staff overheads ≈24%. The major difference between these two figures is the UniSuper contribution scheme.
7. The calculation of FTE assumes that staff do not burnout undertaking highly repetitive tasks. This is certainly not true, but is also not reliably estimated as a time effect.

Use of the manual approach to validation and maintenance (Table 22) is inefficient and expensive. Importantly, it increases the risk that the Inventory will not be maintained overtime, due to funding availability. To reduce this risk it is recommended that the rubric approach, the basis of which has been presented in this report, be further developed to significantly reduce the time required to maintain the Inventory. The major piece of work required to achieve this is the coding of the rubric into an electronic form and subsequent development of a code in a software package (such as R or python) to automate the importation of data, Inventory updating and reporting. A costing for this has not been developed at this time, but is broadly estimated that it could be created by university software development staff for approximately $25,000. This is a broad planning figure only, but serves to provide the order of magnitude of potential expense; private industry may be able to develop at a lower cost.

8.2 A stakeholder driven approach to sustaining Australia's soil science capability

In having undertaken the initial assessment and collation of the Inventory, as well as considering why a manual approach to validation and maintenance is not sensible, we reflect that the current project completes the initial phase of a four phase process, prior to mobilisation. Mobilisation would mean that an ongoing, living inventory has been validated and is actively maintained by a set of empowered stakeholders, with the inventory publically accessible via SSA (access as contracted). Phase one being the Initial Investigation, the remaining Phases are: 2) Community of Practice; 3) Securing resources; and 4) Development (Figure 10).

The Inventory has multiple beneficiaries all of whom have slightly different requirements from soil science education and in-service training. Bringing representatives together to develop a community of practice responsible for setting minimum standards for the level of learning graduates should be expected to attain, and to enhance the mapping instrument that standardises evaluation, is vital. The community of practice can be used for many important outcomes, including supporting of teaching staff, but would be well situated to finalise the business case for investment in an ongoing living Inventory. Central to this is identifying roles and responsibilities, as well as the tools required, to maintain the Inventory as a community of practice valued output.

Once a business case has been constructed, this should be used to continue to work as a community of practice and ensure the security of ongoing funding resource. As there are multiple beneficiaries, there should also be multiple benefactors. Assuming we consider soil science capability to be vital to

Australian prosperity (reasonable and established in the current National Soil RD&E Strategy), then there is an onus on all beneficiaries to some extent. The current educational approach develops graduates with very general skill sets, relying strongly on industry to provide on-the-job-training beyond highly specified and contextualises skills, and including the fundamentals and generalities of soil science that might be expected from a tertiary education. *Ipso facto*, the reason this investigation has been undertaken. A strong and empowered community of practice should be able to amicably and efficiently identify funding requirement and responsibilities between key partners.

Given empowered stakeholders and sufficient resource, then the development of the mapping tool as a streamlined and future-proofed instrument becomes the priority. The initial approach provided in Section 7 gives a strong basis to continued development. Any development needs to consider that courses, evaluation benchmarks, as well as CAs and CEs will change through time. Some resource will be required to maintain the tool, and its development must consider adaptation to change.

Figure 10. A phased timeline to a stakeholder driven approach

8.2.1 Initial considerations for implementation

A summary of the key partners, activities, value proposition and impact of the Inventory is provided in Figure 11 as a blueprint for continued discussion and development. The Inventory clearly offers value to a range of stakeholders and offers SSA a range of opportunities to maximise its impact whilst also provide a funding justification to external organisations. SSA and the ASN will, however, have to invest some effort in achieving the potential of the Inventory.

Major tasks involved in the physical maintenance of the Inventory, focusing upon the tertiary sector, would include:

- Establishing/confirming appropriate points of contact at each university.
- Confirmation that courses are still being offered.
- Removal of any discontinued courses.
- Cataloguing any recently developed soil courses and adding this information to the Inventory.
- Discussions with course staff to identify whether course content has changed.
- Updating course information changes to the Inventory, e.g. Aspects of soil science covered, Learning Outcomes, LO/OBJ Weightings (Website reported).

- Mapping any changes to the course content or depth of coverage of Performance Objectives and Competency Areas.
- Mapping recently developed soil courses for content or depth of coverage of Performance Objectives and Competency Areas.

Once this updating of individual courses was complete, there is also a requirement for analysis of the results and reporting. This could involve identifying changes over time both by institution and nationwide, identifying courses as being recognised for CPSS purposes and identifying institutions that offer soil science majors or minors. It is envisaged that a two year cycle would be the appropriate timeframe for the maintenance of the Inventory.

An estimated timeframe to complete a maintenance cycle is 12 weeks for one person. Based on the same salary as used for the casual employee in the current project this would result in an estimate cost of $20,000. The efficiency here comes from the fact that the initial groundwork has been done and assumes that the use of the mapping instrument (even in its current preliminary form) has been used.

As detailed in Figure 11 there are a range of organisations that could potentially fund/part fund the maintenance of the Inventory, and these may appropriately be included in a community of practice; it is suggested that the community of practice not only assists educators in enhancing their teaching approaches and consistency, but also in creating the market and pathways for new students, which is why the community should extend beyond educators. In the first instance it is likely that government agencies will be the most likely funding agency, however, SSA and the ASN should aim to establish a model where the organisations that benefit from the Inventory contribute to its funding. This could include the RDCs, major consultancies, industry groups and universities. This may mean that phased timeline in Figure 10 undergoes a number of iterations before effecting sustained implementation.

Key Partners	Key Activities	Value Propositions	Impact	Customer Segments
Universities ASN SSA Schools Soil CRC DAW NCTS National Committee for Soils and Terrain Landcare TAFE Local Government Regenerative Ag Carbon Farmers State Agencies	Ensuring on going funding to support growth and development of SSA through: (1) Ensuring Soil Science Courses are at of a suitable quality and standard to meet the requirements of SSA – Standardised, validated and compliant. (2) Ensuring individuals are appropriately professionally accredited. • Education and training for soil scientists and other professionals • Enhancing pathways for achieving CPSS accreditation	**Training Categories** 1. Members achieve CPSS 2. Members achieve Recognised Soils Practitioner (RSP) – specialist categories 3. Members achieve specialist CPSS 4. Accreditation of Providers **Specialist Services** Digital Soil Mapping and Assessment GIS Train the trainer **Access to Networks and Information**	**University Outcomes:** Promotion of accredited courses Linkages to other universities to broaden access to courses / expertise Improved collaboration **Student Outcomes:** • Becoming part of an accredited Industry • Improved and consistent training • Obvious career paths • Opportunity to build their own degree	**Universities** **Students** **Soil Scientists** **Prospective students** **Schools**
Consultancies Landscapers Organic Recyclers (composters) Development Infrastructure Organisations EAINZ, AIAS ICEA Agronomy Society Ecological Society of Australia Regional Australian Institute.	• Developing a digital platform to deliver online training courses and material • Working with education providers to enhance students access to tertiary soil science training • Developing resources and investigating mechanisms to embed the Soils in School Program in national curriculum • Searchable database (2) Promotion and adoption of specialist services Auditing of courses to ensure compliance???	Industry best practice information Conference promotion Professional Development	**Industry/ Soil Scientist Outcomes:** Engaged base of members Improved Environmental Outcomes Improved Soil Management Access to expertise networks Larger group – larger voice for lobbying government etc. Shared learning – new advances – increased levels of innovation **Prospective Students/Schools:** Soil Science seen as a potential career path Highlighting the importance of the Industry	

Figure 11 Inventory Value Proposition

9 Recommendations and course of action

This sections considers the report information in full against the initial National Soil RD&E Strategy (2014) recommendations from Wardrop et al. (2013), as well as the measures of success for Strategy Goal 4.3.4 (Figure 12). Subsequent recommendations arising from the current project are made, and a section on bridging the gap helps to outline the current problem, consequences and proposed solutions in brief. The intention of the latter is to facilitate discussion around how to proceed, enhancing and making best use of the ASN investment in this project.

9.1 Evaluation of National Soil RD&E Strategy recommendations

The National Soil RD&E Strategy (2014) sets out a series of recommendations that were adopted from Wardrop et al. (2013) and these are presented verbatim from the Wardrop et al. (2013) discussion paper. The evaluation of each recommendation is conducted given the information arising from the investigation detailed in this report. This evaluation discussion is used to augment the recommendations arising from the current project, as well as formulate a course of action to address the remaining issues.

9.1.1 Recommendation 1

"Continue to develop a national soil science curriculum that provides the skills and knowledge required to meet the ongoing needs of employers, clients and students."

Evaluation: Soil science has continued to have been taught throughout the period in which the National Soil RD&E Strategy was published to now. However, it is arguable that there has been little positive change in this period in terms of increased graduates. While the 2010 soil science course audit identified 108 soils related courses, and this current investigation identified 314, we assess this to be an artefact of methodology, rather than evidence for increased soil science teaching. The primary difference being that the current project had a dedicated, paid employee searching specifically for soils courses, while the initial 2010 method relied on voluntary self-assessment from already busy course examiners. To our knowledge, there is no publicly available information identifying the "ongoing needs of employers, clients and students". It would be valuable to obtain this information to some extent.

9.1.2 Recommendation 2

"Explore opportunities to establish knowledge hubs within educational institutions and develop courses, potentially at professional Masters level, so that students from all universities have access to world and Australian leading expertise."

Evaluation: Working Group 6 within the ASN provides the beginning of this, while the SSA Training Committee supports this recommendation to some extent also. However, a formalised process of recognising any existing knowledge hubs within/between education institutions does not appear to exist. Additionally, there is no existing professional masters in soil science, nor existence of pathways to complete degrees across institutions. Only one formal major in soil science across all universities was identified.

9.1.3 Recommendation 3

"Encourage research and development corporations to invest in future soil capability and capacity by funding industry specific PhDs and other scholarships in soil science."

Evaluation: No comment on increase or decrease in of these opportunities is made here, as it is beyond the scope of collected information. However, it is noted that while it would be pleasing to see such

opportunities increase, the students to service these opportunities still need to be created, and current pathways to this point remain unclear.

9.1.4 Recommendation 4

"Explore opportunities to improve soil knowledge and training through vocational education packages. Investigate undertaking an Agriculture, Horticulture and Conservation Training Package Continuous Improvement Project to develop and inform future training packages."

Evaluation: Vocational education was considered in the current project, and while courses exist there is opportunity for better coordination. Additionally, these were difficult to align to industry standards. Vocational training will be important, and the RSP pathway might provide opportunity to standardise course outputs against industry requirements — although these are currently unclear — and professional standards.

9.1.5 Recommendation 5

"Encourage the uptake of professional accreditation, either specific to soil or more broadly, to ensure soil knowledge exchange is delivered by suitably qualified personnel, with recommendations and information underpinned by good science and/or economics; articulate the benefits for accreditation to support this; and explore opportunities for linkages across accreditation bodies."

Evaluation: The CPSS accreditation has progressed since the Strategy was published, with significant advances in the incorporation of CPSS specialist competency into State regulatory, specifically to do with contaminated land. Given that the CPSS accreditation provides an industry professional standard with which to standardise soil science education (indeed it has been employed in this investigation), it would appear that this recommendation is key to driving sustained implementation of the Inventory and in the generation of Australia's future soil science capacity.

9.1.6 Recommendation 6

"Recognise the training and education opportunities offered outside of formal education systems and arrangements; and better coordinate, quality assess and assure, and promote these opportunities."

Evaluation: In-service training was considered *ad hoc* in the current investigation, which suggests that this recommendation still requires addressing. It is possible that the Recognised Soil Practitioner proposal through SSA would provide added value in meeting this recommendation, as well as providing a means for quality assurance. There is a clear requirement for an in-service training continuum and provider.

9.1.7 Recommendation 7

"Explore opportunities to incorporate soil education and training into new and evolving delivery pathways, including examining the market and need for this material, and how it may connect with current and future tertiary and vocational education and training opportunities."

Evaluation: Given the evaluation of Recommendation 1, it is apparent that the need for graduates still requires some level of quantification. The market and need for evolving pathways for soil education could be investigated simultaneously. Some educational institutions have been conducting their own innovative means of enhancing soil science teaching (see Field et al. 2017), which still requires formalisation within a community of practice.

9.1.8 Discussion

It is evident, especially when considering the timeline proposed by the National Soil RD&E Strategy (Figure 12), that implementation of the recommendations to achieve Goal 4.3.4 has largely not

occurred to the identified desired level, if at all in some aspects. We are aware that this is largely due to the required reinvestment resource not existing. This identifies the biggest risk to achieving these recommendations, and any others provided in the current report. Positively, there is vast opportunity to move these recommendations forward and a current national narrative concerning the importance of soils that should provide the required momentum. The current ASN investment into this project has provided much of the preliminary information and evidence required to achieve these recommendations, and those presented hereafter.

TABLE 8 Implementation of National Soil Research, Development and Extension Strategy, 2014 and 2015 Continued

Goals and reporting requirements	Implementation actions	Organisations responsible	Dates	Measures of success
Adopt a national approach to building future skills and capacity (Goal 4.3.4)	Conduct national skills audit to map existing expertise and capacity against what is needed	National Implementation Committee Skills and Capacity Working Group Australian Council of Deans of Agriculture/Environment, agribusiness, other organisations	October 2014	Audit published, results considered by tertiary education and other training bodies, commitments to additional training courses and places made public
	Develop professional masters program in soil science	National Implementation Committee Skills and Capacity Working Group, education and training organisations RD&E and providers agribusinesses	January 2015	Program under development
	Develop plan to improve employment opportunities, career pathways and funding sources for soil RD&E staff	National Implementation Committee Skills and Capacity Working Group RD&E funders and providers agribusiness	June 2015	RD&E funders and providers and other employers have considered age profile of soil RD&E staff and need for succession planning Improved career pathways established
	Complete national soil science curriculum that meets employer and land manager needs	National Implementation Committee Skills and Capacity Working Group education and training organisations RD&E funders and providers agribusiness	June 2015	Integrated and accredited soil science curriculum available nationally at different levels—for example, degree, award, vocational and refresher—and by different modes of study
	Review vocational education and training programs relevant to soil science and soil management and expand if required	National Implementation Committee Skills and Capacity Working Group, education and training organisations RD&E funders and providers agribusiness	June 2015	Up-to-date and expanded vocational education and training programs of study available

Figure 12. National Soil Research, Development and Extension Strategy (2014) implementation goals, achievement dates and measures of success.

9.2 Recommendations arising from this report

The following recommendations arise from the current project. It is acknowledged that the recommendations made in Wardrop et al. (2013) for the National Soil RD&E Strategy remain relevant. Recommendations arising from the report are labelled as A through I in order to facilitate discussion against Recommendations 1 through 7 of Wardrop et al. (2013); where National Soil RD&E Strategy recommendations are mentioned, it is these Recommendations 1 through 7 being referred to.

9.2.1 Recommendation A: Sustaining the inventory

Validation and maintenance of the Inventory is an imperative to tracking and building the required soil science capability and capacity for Australia. This must be resourced in a manner that is ongoing — in recognition of the multiple beneficiaries of such information — and with multiple benefactors. Initial Government dedicated funding is recommended, with a shared stakeholder investment the eventual and sustainable model. This will require stakeholder empowerment through a community of practice, or similar.

9.2.2 Recommendation B: Stakeholder Community of Practice

A stakeholder Community of Practice (COP) be developed to ascertain, in relatively real time, the industry requirement for graduates and their skill sets, as well as shape the graduate benchmarks of the future. It is recommended that this COP include tertiary, VET and in-service education provider representatives, as well as key stakeholders to ensure direct linkage from education to professional standards.

The COP provides the means to meeting the National Soil RD&E Strategy Recommendations 1 through 7, in the section above.

9.2.3 Recommendation C: Development of graduate knowledge benchmarks

The current mapping instrument for the mapping of soil science course to CPSS Competency Areas is based upon what is considered the bare minimum for soil science graduates. This benchmark places too much onus on industry to supply on-the-job-training. It is recommended that a stakeholder COP define new graduate knowledge benchmarks consistent with the ”applying”, “analysing” and “evaluating” learning levels of Bloom’s Taxonomy consistent with industry requirement and professional standards.

9.2.4 Recommendation D: Adoption and refinement of mapping instrument

There is clear requirement for standardisation in the soil science course evaluation process to allow evaluation between courses, institutions and through time for the purpose of improving Australia’s soil science capability. A mapping instrument based upon the learning levels of Bloom’s Taxonomy and the CPSS Competency Areas has been produced. It is recommended that this instrument be refined and formalised as a capability mapping tool for ongoing application. It is further recommended that the application of this be expanded to support both VET and in-service training.

9.2.5 Recommendation E: Course accreditation

A soil science degree no longer exists, and creating the critical mass of CPSS personnel is a national strategic priority. It is also known that the CPSS assessment process is highly rigorous and respected within industry. Therefore, it is recommended that soil science courses are accredited against CPSS Competency Areas, and that Competency Area coverage is sufficient to mitigate any robustness risk. It is recommended that this commences as a recognition system as to whether a particular course is acceptable for the CPSS accreditation process, which should be determined by a stakeholder Community of Practice.

This addresses Recommendation 5 in the National Soil RD&E Strategy. Soil has been acknowledged as vital to Australian prosperity. Therefore, Recommendation 5 needs to be thought of as an imperative on which to frame soil science education, capability and capacity discussions. Professional accreditation (CPSS) and practice quality assurance (RPS) must be considered here.

9.2.6 Recommendation F: Development of soil science degree majors & higher degrees

It is recommended that soil science majors are developed at a range of universities spanning the nation. Government support in creating the business case for this will be needed, as the student demand will not match the national capacity demand.

Cross institutional sharing of courses is recommended to support a greater number of institutional degrees addressing soil science. While it is tempting to consolidate and support a small number of universities to produce soil science graduates, a greater level of resilience is provided in diversifying offerings. Furthermore, a diverse network of soil science graduate producing universities also facilitates the ability to provide soil science majors and higher degrees that have a specialisation focus aligned to university research strengths. This a greater range of graduate specialisations to address the diverse demands of contextualised industry on the modern day soil science graduate.

9.2.7 Recommendation G: Engagement with VET sector

Engagement of VET education providers to develop rounded soil science based courses that deliver against industry requirements and professional standards is recommended. Coupled to this, the proposed Recognised Soil Practitioner (RSP) with SSA should be developed in coordination with the VET sector. An ideal outcome would be that a prospective RSP candidate would be able to readily identify the pathway to RSP recognition via a VET pathway.

This further supports Recommendation 4 of the National Soil RD&E Strategy, and is vital to the proposed RSP, which would have potential to formalise Recommendation 6 in the Strategy.

9.2.8 Recommendation H: Development of a quality assured in-service training continuum

In-service training provides both a great challenge and a great opportunity to enhancing Australia's soil science capability. Quality assurance of content provides the biggest challenge. It is recommended that an in-service training continuum mapped to the CPSS Competency Areas is developed. Further, that resourcing is provided for the SSA Training Committee to produce quality assured training courses. Training providers could then work with SSA to provide this training, and/or SSA could implement it directly. This training is required at multiple levels of learning from recent graduate, to current accredited Certified Professional Soil Scientists.

This also addresses Recommendation 6 of the National Soil RD&E Strategy.

9.2.9 Recommendation I: Career pathways from primary school to profession

While mapping tertiary education to professional standards proves an objective evaluation and means to map learning level and apply this to pathways from tertiary level to professional requirements, it does not create the students that will follow these pathways. It is recommended that soil science is facilitated for inclusion in existing curricula through a series of teaching information resources. These should extend from primary school through secondary school, building on the importance of soils to numerous and varied industry sectors. An initial attempt at this has been undertaken by SSA as the Soils in Schools Initiative (https://www.soilsinschools.com.au/); this should be revisited.

9.3 Bridging the Gap: Towards a course of action

The following is derived from the extensive investigation within this report. Having undertaken the search of publicly available information, assessment of this against CPSS requirements, collation of

the results and subsequent synthesis, the problem is now better defined. From this there are some apparent consequences that need to be considered. An achievable course of action is subsequently presented with the purpose of this action, the method, and the intended outcome identified. This should help facilitate the formulation of planning and priorities.

9.3.1 The problem

- No soil science degrees in Australia
- A range of soil courses delivered across different universities however no one university or suite of courses at a university covers all of the expected knowledge requirements of CPSS.
- For industry, the skills and knowledge of graduates varies/is uncertain due to the haphazard nature of soils education being delivered at universities
- Graduates do not have the requisite skills and knowledge required by industry.
- In-service training is ad hoc.
- Minimum CPSS requirement of four soil science courses is not easily mapped to existing courses. No clear pathway to attaining this requirement.
- CPSS accreditation is increasingly being required by Government, however the 'system' to grow CPSS qualified individuals struggles to meet this requirement
- Difficult to encourage students to become soil scientists when there is no clear path to becoming a soil scientist.
- Soil science is not included in primary and secondary curricula, meaning formal consideration to the importance of soils is largely not considered until tertiary education has commenced.

9.3.2 The consequences

- Additional training burden placed on industry. This has time, cost and risk implications.
- Reputational risk. If soil science as a profession cannot meet expectations of government/regulators and industry, the profession can be potentially marginalised.
- Environmental risk. Insufficient/underqualified soil scientists result in consequential impacts for soil health, water quality, mine site rehabilitation, contaminated land, agricultural productivity etc. Financial and potentially legal consequences for remedial works etc.
- Human resource risk: If graduates are not produced to replace the identified ageing critical mass of soil science expertise then industry demand cannot be met and the three consequential risks identified above are magnified.

9.3.3 Addressing the problem

1. Inventory of soil science teaching:
    1.1. Purpose: Provide a central repository of readily available information for all on soil science education stakeholders.
    1.2. Method: (1) Creation of the Inventory. (2) Validation of the Inventory. (3) Hosting of the Inventory on a readily accessible platform. (4) Advertising of the Inventory to relevant stakeholders. (5) Ongoing maintenance of the inventory.
    1.3. Endstate: The breadth and depth of soil science education in Australia is readily accessible whilst being maintained overtime. The Inventory is used by respective stakeholders to inform decisions on soil science education.

2. A clear path to CPSS accreditation (and RSP once determined):
    2.1. Short/mid term: recognition of courses that contribute to meet minimum requirements for CPSS Accreditation (i.e 4 soil science courses).

2.1.1. Purpose: Provide a clear pathway to CPSS accreditation.

2.1.2. Method: (1) Universities identify soil science/soil science related courses that contribute to meeting CPSS minimum requirements. (2) SSA provides a central repository of institutions/degrees/courses that meet CPSS prerequisite requirements.

2.1.3. Endstate: (1) For students, clear path to CPSS accreditation provided. (2) For SSA, enhanced ability to generate interest in soil science amongst prospective students. (3) For CPSS, programs/courses that meet CPSS minimum requirements (four soil science units) clearly articulated. (4) For industry/government, clear understanding and easy access to the skills and knowledge of graduates.

2.2. Mid/long term: Creation of soil science majors within degree streams.

2.2.1. Purpose: Improve the standards of soil science education and expand the pool of prospective soil scientists to meet future demand.

2.2.2. Method: (1) Build a business case to justify the requirement for a soil science Major – Role and responsibility of a stakeholder Community of Practice, which is suggested could be formed by combining the ASN Working Group 6 and SSA Training Committee, with expanded membership (2) Sponsorship (government) for a diverse, but limited, number of universities to create a Major is sourced [Assumptions. (a) Too expensive for all universities to be provided grants, and (b) not all universities will be interested]. (3) Selected universities create and implement soil science majors. (4) CPSS reviews the accreditation process for students with a major in soil science (professional experience requirements potentially reduced). (5) Over time the requirement for additional funding is reduced/eliminated as this becomes self-sustaining.

2.2.3. Endstate: A number of tertiary institutions across Australia provide degree level majors in soil science with sustainable student numbers. Over time both the number and quality of soil science graduates improves.

3. Alignment between tertiary education, government and industry.

3.1. Purpose: Align key stakeholders interests in support of a national soil strategy

3.2. Method: (1) national soil strategy addresses workforce requirements and initiatives. (2) Government (Federal and State) continues to emphasise the importance of soil science/CPSS through requirements detailed in legislation and regulation, where appropriate. (3) Industry and government engagement with tertiary sector, and potentially other training and education institutions to identify and rectify skills and knowledge deficiencies in soil science education.

3.3. Endstate: (1) For Government, national soil science capacity enhanced and sufficient to meet demand as created by a national soil strategy and to meet legislative and regulatory requirements. (2) For industry, sufficient and suitably qualified workforce to meet legislative, regulatory requirements and policy objectives. (3) For tertiary sector, sufficient demand for soil science graduates to justify soil science majors.

10 Attachments

- Master list of university courses as an excel spreadsheet
- Master list of VET and in-service training
- Mapping instrument

11 Appendices

- Appendix 1: University course considered directly related to soil science and mapped against the CPSS Fundamentals Exam competency areas, sorted by University
- Appendix 2: University course considered indirectly related to soil science and mapped against the CPSS Fundamentals Exam competency areas, sorted by University
- Appendix 3: University course considered partially related to soil science, sorted by University.

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Appendix 1. Directly related courses:

DIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of Canberra	10224	Integrated Catchment Science	1.1	1.2	1.3	1.4	1.5	1.6	1.7		1.9	2.1	2.2	2.3	2.4		2.6	2.7	3.1	3.2	3.3	3.4	3.5	
University of Canberra	10225	Landscape Processes	1.1								1.9		2.2		2.4		2.6	2.7						

DIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of Canberra	10224	Integrated Catchment Science	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8		5.2	5.3			6.01		6.03			6.06	6.07			
University of Canberra	10225	Landscape Processes														6.01		6.03		6.05	6.06	6.07			6.10

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	CODE	NAME	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4	3.5	3.6
Charles Sturt University	PSC104	Soil Science	1.1								1.9		2.2		2.4		2.6	2.7						
Charles Sturt University	PSC415	Soil Management							1.7										3.1					
Charles Sturt University	PSC350	Advanced Soil Management	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8		2.1	2.2		2.4				3.1	3.2	3.3			3.6
Charles Sturt University	GEO204	Ecological and Envrionmental Soil Science				1.4					1.9	2.1		2.3					3.1	3.2	3.3			

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	CODE	NAME	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	5.1	5.2	5.3	5.4	5.5	6.01	6.02	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.10
Charles Sturt University	PSC104	Soil Science						4.6				5.2										6.07			
Charles Sturt University	PSC415	Soil Management	4.1			4.4	4.5		4.7			5.2			5.5			6.03							
Charles Sturt University	PSC350	Advanced Soil Management	4.1	4.2	4.3		4.5			4.8	5.1	5.2	5.3	5.4		6.01		6.03							
Charles Sturt University	GEO204	Ecological and Envrionmental Soil Science								4.8						6.01		6.03							

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Southern Cross University	AGR00214	Soil Processes				1.4					1.9	2.1		2.3					3.1	3.2	3.3			
Southern Cross University	AGR03072	Soil Processes				1.4					1.9	2.1		2.3					3.1	3.2	3.3			
Southern Cross University	AGT00217	Land Degradation and Rehabilitation	1.1	1.2															3.1	3.2	3.3			3.6
Southern Cross University	AGT03090	Land Degradation and Rehabilitation	1.1		1.3					1.8		2.1						2.7		3.2	3.3			
Southern Cross University	ENG30002	Soil Mechanics and Geology			1.3	1.4					1.9							2.7	3.1					

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Southern Cross University	AGR00214	Soil Processes								4.8								6.03							
Southern Cross University	AGR03072	Soil Processes								4.8								6.03							
Southern Cross University	AGT00217	Land Degradation and Rehabilitation			4.3		4.5											6.03				6.07	6.08		
Southern Cross University	AGT03090	Land Degradation and Rehabilitation				4.4	4.5			4.8	5.1	5.2	5.3	5.4	5.5			6.03	6.04	6.05	6.06	6.07			
Southern Cross University	ENG30002	Soil Mechanics and Geology								4.8	5.1	5.2		5.4	5.5			6.03		6.05	6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of New England	SOIL222	Soil Science	1.1								1.9	2.1	2.2	2.3	2.4	2.5	2.6	2.7		3.2				
University of New England	SOIL310	Soils, Pollution and the Environment	1.1								1.9				2.4			2.7						
University of New England	SOIL311	Productive Soil Systems	1.1				1.5		1.7		1.9		2.2	2.3		2.5		2.7	3.1	3.2	3.3	3.4	3.5	
University of New England	SOIL431	Soils in Practice	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of New England	SOIL222	Soil Science					4.5											6.03	6.04	6.05	6.06	6.07	6.08	6.09	
University of New England	SOIL310	Soils, Pollution and the Environment				4.4	4.5						5.3					6.03	6.04						6.10
University of New England	SOIL311	Productive Soil Systems	4.1		4.3		4.5	4.6		4.8								6.03					6.08		
University of New England	SOIL431	Soils in Practice			4.3			4.6										6.03			6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of New South Wales	GEOS3721	Australian Soil Use and Management		1.2	1.3		1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5		2.7	3.1	3.2	3.3	3.4	3.5	3.6
The University of New South Wales	CVEN3202	Soil Mechanics				1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2											

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of New South Wales	GEOS3721	Australian Soil Use and Management	4.1		4.3	4.4	4.5	4.6		4.8	5.1	5.2	5.3	5.4				6.03			6.06				
The University of New South Wales	CVEN3202	Soil Mechanics									5.1		5.3	5.4											

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of Newcastle	GEOS2060	Soil Properties and Processes														2.5				3.2	3.3			
The University of Newcastle	ERAR6002	Chemodynamics of Environmental Contaminants														2.5				3.2	3.3			
The University of Newcastle	CIVL3431	Land Surface Process and Management														2.5	2.6							
The University of Newcastle	CIVL3432	Land Surface Process and Management							1.7		1.9					2.5								
The University of Newcastle	CIVL6431	Land Surface Process and Management							1.7		1.9					2.5								

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of Newcastle	GEOS2060	Soil Properties and Processes	4.1			4.4																			
The University of Newcastle	ERAR6002	Chemodynamics of Environmental Contaminants	4.1			4.4												6.03		6.05	6.06	6.07	6.08		
The University of Newcastle	CIVL3431	Land Surface Process and Management				4.4		4.6				5.2									6.06				
The University of Newcastle	CIVL3432	Land Surface Process and Management					4.5											6.03	6.04	6.05	6.06	6.07			
The University of Newcastle	CIVL6431	Land Surface Process and Management					4.5											6.03	6.04	6.05	6.06	6.07			

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of Sydney	SOIL3888	Protecting the Soil Resource																2.7						
The University of Sydney	SOIL3010/AFNR5510	The Soil at Work																2.7		3.2	3.3			
The University of Sydney	SOIL3009	Contemporary Field and Lab Soil Science	1.1			1.4						2.1								3.2	3.3			
The University of Sydney	SOIL2005	Soil and Water: Earth's Life Support Systems	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6
The University of Sydney	CIVL9410	Soil Mechanics	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6
The University of Sydney	CIVL5351	Geoenvironmental Engineering							1.7			2.1					2.6	2.7						
The University of Sydney	CIVL2410	Soil Mechanics	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6
The University of Sydney	AFNR5511	Soil Processes, Assessment and Management																2.7		3.2	3.3			
The University of Sydney	AFNR5502	Remote Sensing, GIS and Land Management	1.1									2.1			2.4		2.6	2.7		3.2		3.4		
The University of Sydney	SOIL2004	The Soil Resource																						

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	CODE	NAME	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	5.1	5.2	5.3	5.4	5.5	6.01	6.02	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.10
The University of Sydney	SOIL3888	Protecting the Soil Resource				4.4												6.03		6.05	6.06				
The University of Sydney	SOIL3010/AFNR5510	The Soil at Work				4.4	4.5					5.2		5.4	5.5				6.04		6.06				
The University of Sydney	SOIL3009	Contemporary Field and Lab Soil Science	4.1												5.5			6.03					6.08		
The University of Sydney	SOIL2005	Soil and Water: Earth's Life Support Systems			4.3			4.6								6.01		6.03	6.04	6.05	6.06	6.07			
The University of Sydney	CIVL9410	Soil Mechanics			4.3		4.5											6.03					6.08		
The University of Sydney	CIVL5351	Geoenvironmental Engineering				4.4		4.6			5.1	5.2			5.5	6.01		6.03		6.05	6.06				6.10
The University of Sydney	CIVL2410	Soil Mechanics			4.3		4.5											6.03					6.08		
The University of Sydney	AFNR5511	Soil Processes, Assessment and Management				4.4	4.5	4.6				5.2		5.4	5.5			6.03	6.04		6.06	6.07			
The University of Sydney	AFNR5502	Remote Sensing, GIS and Land Management	4.1		4.3	4.4					5.1	5.2	5.3	5.4	5.5	6.01		6.03					6.08		
The University of Sydney	SOIL2004	The Soil Resource	4.1				4.5									6.01		6.03		6.05					

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of Technology Sydney	41006	Principles of Soil Science															2.6							
University of Technology Sydney	49119	Problematic Soils and Ground Improvement Techniques																	3.1	3.2	3.3	3.4	3.5	3.6

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of Technology Sydney	41006	Principles of Soil Science	4.1			4.4	4.5	4.6			5.1	5.2	5.3	5.4	5.5			6.03					6.08		
University of Technology Sydney	49119	Problematic Soils and Ground Improvement Techniques																6.03	6.04	6.05	6.06		6.08		

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Western Sydney University	300823	Soils	1.1					1.6	1.7		1.9			2.3				2.7						
Western Sydney University	300985	Soil Mechanics	1.1																3.1	3.2				
Western Sydney University	301273	Land Degradation and Contamination	1.1																					

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Western Sydney University	300823	Soils									5.1	5.2	5.3	5.4	5.5			6.03		6.05					
Western Sydney University	300985	Soil Mechanics	4.1	4.2	4.3	4.4	4.5	4.6	4.8							6.01		6.03	6.04	6.05	6.06				
Western Sydney University	301273	Land Degradation and Contamination	4.1				4.5				5.1	5.2								6.05	6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Queensland University of Technology	EVB312	Soils and the Environment																		3.2				

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Queensland University of Technology	EVB312	Soils and the Environment			4.3	4.4									5.5	6.01		6.03			6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Central Queensland University	ENVR12001	Soil Science and Conservation	1.1						1.7	1.8	1.9	2.1	2.2	2.3	2.4			2.7	3.1					3.6
Central Queensland University	AGRI11001	Soil and Irregation Management	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Central Queensland University	ENVR12001	Soil Science and Conservation	4.1		4.3	4.4							5.3	5.4	5.5			6.03					6.08		
Central Queensland University	AGRI11001	Soil and Irregation Management			4.3			4.6										6.03		6.05	6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Griffith University	3441ENV	Land Degradation and Catchment Management	1.1									2.1		2.3	2.4			2.7	3.1	3.2	3.3		3.5	
Griffith University	2102ENG	Soil Mechanics	1.1									2.1		2.3	2.4			2.7	3.1	3.2	3.3		3.5	

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Griffith University	3441ENV	Land Degradation and Catchment Management	4.1				4.5	4.6			5.1	5.2			5.5			6.03		6.05	6.06				
Griffith University	2102ENG	Soil Mechanics	4.1				4.5	4.6			5.1	5.2			5.5			6.03		6.05	6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
James Cook University	EA3207	Soil Properties and Processes for Science	1.1									2.1		2.3	2.4			2.7	3.1	3.2	3.3		3.5	
James Cook University	EA2007	Soil Properties and Processes for Management	1.1								1.9		2.2						3.1	3.2	3.3	3.4	3.5	
James Cook University	EA5017	Soil Properties and Processes	1.1					1.6	1.7		1.9	2.1	2.2		2.4	2.5	2.6		3.1	3.2	3.3			

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
James Cook University	EA3207	Soil Properties and Processes for Science	4.1				4.5	4.6			5.1	5.2			5.5			6.03		6.05					6.10
James Cook University	EA2007	Soil Properties and Processes for Management		4.2	4.3	4.4	4.5				5.2	5.2	5.3	5.4	5.5			6.03	6.04		6.06				
James Cook University	EA5017	Soil Properties and Processes				4.4					5.1	5.2	5.3	5.4	5.5					6.05		6.07			

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of Queensland	LAND2003	The Soil Environment	1.1				1.5	1.6	1.7		1.9	2.1			2.4	2.5	2.6	2.7	3.1	3.2	3.3			
The University of Queensland	LAND3005	Soil Plant Relationships	1.1				1.5	1.6	1.7		1.9	2.1			2.4	2.5	2.6	2.7	3.1	3.2	3.3			
The University of Queensland	LAND7009	Soil and Growth Media Management	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6
The University of Queensland	LAND7000	Water & Land Resource Management																						
The University of Queensland	CIVL2210	Soil Mechanics										2.1			2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4		
The University of Queensland	LAND3006	Soils, Landscapes & Environments	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of Queensland	LAND2003	The Soil Environment												5.4	5.5					6.05		6.07			
The University of Queensland	LAND3005	Soil Plant Relationships												5.4	5.5			6.03					6.08		
The University of Queensland	LAND7009	Soil and Growth Media Management			4.3			4.6										6.03							
The University of Queensland	LAND7000	Water & Land Resource Management	4.1			4.4	4.5											6.03							
The University of Queensland	CIVL2210	Soil Mechanics			4.3	4.4	4.5	4.6										6.03					6.08		
The University of Queensland	LAND3006	Soils, Landscapes & Environments			4.3			4.6										6.03					6.08		

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of Southern Queensland	AGR3304	Soil Science	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6
University of Southern Queensland	AGR3903	Soil and Water Engineering Practice 2	1.1																3.1	3.2	3.3			3.6
University of Southern Queensland	AGR4305	Agricultural Soil Mechanics	1.1				1.5		1.7		1.9	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3			3.6

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of Southern Queensland	AGR3304	Soil Science			4.3		4.5	4.6										6.03	6.04		6.06				
University of Southern Queensland	AGR3903	Soil and Water Engineering Practice 2	4.1		4.3		4.5																		
University of Southern Queensland	AGR4305	Agricultural Soil Mechanics	4.1	4.2	4.3	4.4					5.1	5.2	5.3	5.4	5.5	6.01		6.03	6.04	6.05					6.10

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of the Sunshine Coast	ENG312	Soil Mechanics	1.1				1.5		1.7		1.9		2.2	2.3				2.7	3.1					
University of the Sunshine Coast	ENS224	Soil Properties, Processes and Rehabilitation	1.1									2.1			2.4				3.1	3.2				

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of the Sunshine Coast	ENG312	Soil Mechanics	4.1		4.3	4.4	4.5	4.6						5.4	5.5			6.03			6.06				
University of the Sunshine Coast	ENS224	Soil Properties, Processes and Rehabilitation				4.4								5.4		6.01		6.03			6.06	6.07			

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of Adelaide	SOIL&WAT 1000WT	Soils and Landscapes I	1.1						1.7		1.9			2.3						3.2	3.3			
The University of Adelaide	SOIL&WAT 2500WT	Soil and Water Resources II										2.1	2.2		2.4									
The University of Adelaide	SOIL&WAT 3017WT	Soil & Water: Management & Conservation III	1.1	1.2															3.1	3.2	3.3	3.4	3.5	3.6
The University of Adelaide	SOIL&WAT 3016WT	Soil Ecology and Nutrient Cycling III	1.1																3.1					

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of Adelaide	SOIL&WAT 1000WT	Soils and Landscapes I																6.03							
The University of Adelaide	SOIL&WAT 2500WT	Soil and Water Resources II									5.1	5.2	5.3	5.4	5.5			6.03					6.08		
The University of Adelaide	SOIL&WAT 3017WT	Soil & Water: Management & Conservation III			4.3		4.5	4.6										6.03							
The University of Adelaide	SOIL&WAT 3016WT	Soil Ecology and Nutrient Cycling III	4.1		4.3		4.5									6.01		6.03		6.05					

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of South Australia	CIVE 3008	Soil Mechanics	1.1								1.9	2.1					2.6		3.1	3.2				
University of South Australia	EART 1011	Soils in the Australian Landscape	1.1								1.9	2.1					2.6		3.1	3.2				
University of South Australia	CIVE 5075	Sustainable Irrigation Management	1.1								1.9								3.1	3.2	3.3		3.5	

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of South Australia	CIVE 3008	Soil Mechanics				4.4										6.01		6.03		6.05					
University of South Australia	EART 1011	Soils in the Australian Landscape				4.4		4.6								6.01		6.03			6.06				
University of South Australia	CIVE 5075	Sustainable Irrigation Management																	6.04		6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of Tasmania	KLA613	Soil Science							1.7		1.9	2.1	2.2	2.3	2.4	2.5	2.6		3.1	3.2			3.5	
University of Tasmania	KLA397	Soil Science	1.1								1.9	2.1			2.4	2.5	2.6							
University of Tasmania	ZAB224	Principles of Soil Management	1.1								1.9	2.1			2.4	2.5	2.6							
University of Tasmania	KLA213	Soil Formation, Function and Fertility																						
University of Tasmania	KLA440	Soil Formation, Function and Fertility																	3.1	3.2	3.3	3.4	3.5	3.6
University of Tasmania	KLA534	Agricultural Landscape systems									1.9													

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of Tasmania	KLA613	Soil Science																6.03							
University of Tasmania	KLA397	Soil Science	4.1		4.3	4.4	4.5			4.8			5.3					6.03							
University of Tasmania	ZAB224	Principles of Soil Management	4.1		4.3	4.4	4.5			4.8			5.3					6.03		6.05				6.09	
University of Tasmania	KLA213	Soil Formation, Function and Fertility			4.3	4.4	4.5	4.6							5.5			6.03					6.08		
University of Tasmania	KLA440	Soil Formation, Function and Fertility																6.03		6.05	6.06				
University of Tasmania	KLA534	Agricultural Landscape systems	4.1		4.3	4.4	4.5								5.5			6.03	6.04		6.06		6.08		

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Deakin University	SEV252	Geomechanics 1																	3.1	3.2	3.3	3.4	3.5	3.6

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Deakin University	SEV252	Geomechanics 1																6.03				6.07			

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Monash	EAE3321	Soils and land management																						
Monash	CIV3248	Groundwater and environmental geomechanics																						

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Monash	EAE3321	Soils and land management	4.1		4.3	4.4	4.5										6.02	6.03	6.04		6.06				
Monash	CIV3248	Groundwater and environmental geomechanics																6.03	6.04		6.06		6.08		

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
RMIT Univeristy	ENVI1012	The Soil Environment																	3.1	3.2	3.3	3.4	3.5	3.6
RMIT Univeristy	OENG1039	Land Contamination and Remediation	1.1				1.5	1.6	1.7	1.8	1.9	2.1			2.4	2.5								
RMIT Univeristy	CIVE1178	Geotechnical Engineering 1			1.3						1.9									3.2				

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
RMIT Univeristy	ENVI1012	The Soil Environment														6.01		6.03	6.04	6.05	6.06				
RMIT Univeristy	OENG1039	Land Contamination and Remediation	4.1				4.5							5.4				6.03							
RMIT Univeristy	CIVE1178	Geotechnical Engineering 1		4.2		4.4		4.6	4.7									6.03		6.05					

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Federation University Australia	ENVGC2747	SOIL SCIENCE										2.1					2.6							
Federation University Australia	SCGEO3112	SOILS AND WEATHERING: REGOLITH SCIENCE																		3.2				

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Federation University Australia	ENVGC2747	SOIL SCIENCE				4.4									5.5			6.03			6.06		6.08		
Federation University Australia	SCGEO3112	SOILS AND WEATHERING: REGOLITH SCIENCE			4.3	4.4				4.8						6.01		6.03	6.04		6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of Melbourne	AGRI90066	Soil Science and Management							1.7		1.9	2.1			2.4	2.5	2.6	2.7						
The University of Melbourne	ERTH90028	Urban Soils, Substrates and Water		1.2					1.7		1.9				2.4	2.5								
The University of Melbourne	AGRI30037	Soil Management							1.7			2.1		2.3	2.4	2.5	2.6	2.7						
The University of Melbourne	AGRI20038	Principles of Soil Science																	3.1	3.2	3.3			3.6
The University of Melbourne	AGRI30047	Soil Fertility and Nutrient Management									1.9	2.1			2.4					3.2				

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of Melbourne	AGRI90066	Soil Science and Management				4.4						5.2			5.5			6.03			6.06				
The University of Melbourne	ERTH90028	Urban Soils, Substrates and Water			4.3	4.4		4.6							5.5			6.03		6.05					
The University of Melbourne	AGRI30037	Soil Management																6.03							
The University of Melbourne	AGRI20038	Principles of Soil Science					4.5											6.03		6.05					
The University of Melbourne	AGRI30047	Soil Fertility and Nutrient Management	4.1			4.4				4.8					5.5			6.03		6.05					

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
La Trobe University	CIV3SOM	SOIL MECHANICS							1.7			2.1			2.4	2.5		2.7						
La Trobe University	AGR2ILS	INTRODUCTION TO LAND AND SOIL MANAGEMENT	1.1													2.5	2.6							
La Trobe University	AGR3LS	LAND AND SOIL MANAGEMENT																						

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
La Trobe University	CIV3SOM	SOIL MECHANICS				4.4									5.5			6.03		6.05					
La Trobe University	AGR2ILS	INTRODUCTION TO LAND AND SOIL MANAGEMENT													5.5			6.03							
La Trobe University	AGR3LS	LAND AND SOIL MANAGEMENT								4.8						6.01		6.03	6.04		6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Curtin University	AGRI5002	Advanced Soil Systems							1.7		1.9	2.1			2.4	2.5		2.7		3.2	3.3			
Curtin University	AGRI2006	Soil Systems	1.1				1.5				1.9							2.7		3.2	3.3			

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Curtin University	AGRI5002	Advanced Soil Systems	4.1			4.4	4.5		4.7	4.8	5.1	5.2	5.3		5.5	6.01		6.03			6.06				
Curtin University	AGRI2006	Soil Systems				4.4	4.5		4.7		5.1	5.2			5.5	6.01		6.03			6.06				

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Edith Cowan University	SCM2201	Soil and Land Processes					1.5		1.7		1.9	2.1			2.4			2.7	3.1	3.2	3.3			
Edith Cowan University	SCI5124	Land Degradation and Management	1.1						1.7		1.9	2.1			2.4			2.7	3.1	3.2	3.3			

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Edith Cowan University	SCM2201	Soil and Land Processes	4.1		4.3	4.4	4.5	4.6	4.7	4.8			5.3		5.5			6.03		6.05		6.07	6.08		
Edith Cowan University	SCI5124	Land Degradation and Management	4.1		4.3	4.4		4.6		4.8	5.1	5.2	5.3	5.4	5.5			6.03		6.05	6.06			6.09	

DIRECT COURSES			PO1 SOIL CHEMISTRY & MINERALOGY									PO 2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO 3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of Western Australia	ENVT3338	Land Capability Assessment										2.1				2.5	2.6	2.7						
The University of Western Australia	ENVT2236	Soil Science	1.1		1.3	1.4							2.2						3.1	3.2	3.3			
The University of Western Australia	ENVT3060	Soil–Plant Interactions										2.1				2.5	2.6	2.7						
The University of Western Australia	ENVT5510	Soil Dynamics	1.1		1.3	1.4							2.2						3.1	3.2	3.3			

DIRECT COURSES			PO 4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO 5 SOIL BIOLOGY AND SOIL ECOLOGY					PO 6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of Western Australia	ENVT3338	Land Capability Assessment											5.3	5.4		6.01		6.03			6.06				
The University of Western Australia	ENVT2236	Soil Science						4.6			5.1	5.2	5.3	5.4	5.5										
The University of Western Australia	ENVT3060	Soil–Plant Interactions											5.3	5.4				6.03		6.05	6.06			6.09	
The University of Western Australia	ENVT5510	Soil Dynamics						4.6			5.1	5.2	5.3	5.4	5.5	6.01		6.03			6.06				

Appendix 2. Indirectly related courses:

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Charles Darwin University	ENG311	Geomechanics																	3.1	3.2	3.3			3.6
Charles Darwin University	ENV316	Ecosystem Function: Field Studies in North Australia														2.5								
Charles Darwin University	ENV516	Ecosystem Function: Field Studies in North Australia														2.5								

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Charles Darwin University	PSC415	Soil Management		4.2			4.5	4.6																	
Charles Darwin University	PSC350	Advanced Soil Management							4.7																
Charles Darwin University	GEO204	Ecological and Envrionmental Soil Science							4.7																

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Griffith University	7309NSC	Bioavailability and Pollutant Management in Agriculture										2.1			2.4			2.7						

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Griffith University	7309NSC	Bioavailability and Pollutant Management in Agriculture									5.1	5.2	5.3	5.4	5.5			6.03			6.06				

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of Southern Queensland	CIV2403	Geology and Geomechanics	1.1																3.1		3.3			
University of Southern Queensland	ENV4106	Irrigation Science	1.1								1.9								3.1	3.2	3.3		3.5	
University of Southern Queensland	AGR2303	Agronomy	1.1								1.9	2.1			2.4			2.7					3.5	

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of Southern Queensland	CIV2403	Geology and Geomechanics					4.5																		
University of Southern Queensland	ENV4106	Irrigation Science				4.4													6.04		6.06				
University of Southern Queensland	AGR2303	Agronomy										5.2			5.5				6.04	6.05	6.06				

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of the Sunshine Coast	ENS103	Earth's Surface Processes							1.7		1.9	2.1			2.4			2.7	3.1	3.2				

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of the Sunshine Coast	ENS103	Earth's Surface Processes	4.1	4.2		4.4	4.5			4.8			5.3					6.03							

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Flinders University	ENGR2832	Engineering Geology and Geomechanics	1.1																3.1	3.2	3.3			3.6

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Flinders University	ENGR2832	Engineering Geology and Geomechanics					4.5																		

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of Adelaide	C&ENVENG 2069	Geotechnical Engineering II		1.2															3.1	3.2	3.3			
The University of Adelaide	PLANT SC 3505WT	Soil and Plant Nutrition III	1.1									2.1			2.4	2.5	2.6	2.7						

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of Adelaide	C&ENVENG 2069	Geotechnical Engineering II	4.1				4.5			4.8															
The University of Adelaide	PLANT SC 3505WT	Soil and Plant Nutrition III									5.1	5.2	5.3	5.4											

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of South Australia	NASC 2009	Materials Science for Environmental Sustainability	1.1								1.9	2.1			2.4			2.7	3.1					

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of South Australia	NASC 2009	Materials Science for Environmental Sustainability											5.3		5.5				6.04		6.06				

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
University of Tasmania	KNE273	Engineering Geology and Soil Mechanics																	3.1	3.2	3.3			3.6
University of Tasmania	ENG221	Engineering Geology and Soil Mechanics																	3.1	3.2	3.3			3.6

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
University of Tasmania	KNE273	Engineering Geology and Soil Mechanics			4.3		4.5											6.03							
University of Tasmania	ENG221	Engineering Geology and Soil Mechanics			4.3		4.5											6.03							

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Deakin University	SEV200	Geotechnical Investigation and Design																	3.1	3.2	3.3			3.6

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Deakin University	SEV200	Geotechnical Investigation and Design			4.3		4.5											6.03				6.07			

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Monash University	EAE2322	Environmental earth science														2.5	2.6							
Monash University	CIV2242	Geomechanics 1																	3.1	3.2	3.3			3.6

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Monash University	EAE2322	Environmental earth science	4.1	4.2						4.8	5.1	5.2	5.3	5.4				6.03			6.06				
Monash University	CIV2242	Geomechanics 1	4.1	4.2			4.5																		

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
RMIT Univeristy	CHEM1085	Environmental Chemistry 3A	1.1	1.2			1.5	1.6	1.7	1.8	1.9	2.1	2.2		2.4			2.7						

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
RMIT Univeristy	CHEM1085	Environmental Chemistry 3A											5.3	5.4	5.5			6.03	6.04		6.06				

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Swineburne University	CVE20004	Geomechanics																	3.1	3.2	3.3			3.6
The University of Melbourne	FRST90022	Ecosystem Processes of Water and Soil																		3.2	3.3			

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Swineburne University	CVE20004	Geomechanics			4.3		4.5	4.6																	
The University of Melbourne	FRST90022	Ecosystem Processes of Water and Soil															6.02				6.06				

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
La Trobe University	SCI2ECO	ECOLOGICAL SYSTEMS	1.1									2.1			2.4			2.7	3.1	3.2				
La Trobe University	AGR2LMT	LAND MANAGEMENT														2.5	2.6							

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
La Trobe University	SCI2ECO	ECOLOGICAL SYSTEMS				4.4									5.5			6.03			6.06				
La Trobe University	AGR2LMT	LAND MANAGEMENT				4.4									5.5			6.03		6.05					

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Edith Cowan University	ENS3242	Soil Mechanics and Foundation Engineering									1.9						2.6			3.2	3.3			

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Edith Cowan University	ENV243	Soil Mechanics and Foundation Engineering	4.1			4.4			4.7	4.8								6.03	6.04	6.05	6.06				

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
Murdoch University	ENS3242	Water and Earth Science									1.9						2.6			3.2	3.3			

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
Murdoch University	ENS3242	Water and Earth Science	4.1			4.4			4.7	4.8								6.03	6.04	6.05	6.06				

INDIRECT COURSES			PO1 SOIL CHEMISTRY AND MINERALOGY									PO2 SOIL FERTILITY AND NUTRIENT MANAGEMENT							PO3 SOIL PHYSICS					
UNIVERSITY	**CODE**	**NAME**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
The University of WA	ENVT4401	Advanced Land Use and Management																		3.2	3.3			
The University of WA	ENSC3009	Geomechanics																	3.1	3.2	3.3			3.6

INDIRECT COURSES			PO4 SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION								PO5 SOIL BIOLOGY AND SOIL ECOLOGY					PO6 SOIL AND LAND USE MANAGEMENT									
UNIVERSITY	**CODE**	**NAME**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**6.01**	**6.02**	**6.03**	**6.04**	**6.05**	**6.06**	**6.07**	**6.08**	**6.09**	**6.10**
The University of WA	ENVT4401	Advanced Land Use and Management				4.4		4.6	4.7							6.01		6.03	6.04		6.06				
The University of WA	ENSC3009	Geomechanics	4.1	4.2	4.3											6.01									

Appendix 3. Partially related courses:

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Australian National University	Australian Capitol Territory	ENVS3004	Land and Catchment Management
Australian National University	Australian Capitol Territory	ENVS3014	Ecological Assessment and Management
Australian National University	Australian Capitol Territory	ENVS3019	Advanced Remote Sensing and GIS
Australian National University	Australian Capitol Territory	ENVS1004	Australia's Environment
Australian National University	Australian Capitol Territory	ENVS2001	Biodiversity Science: Wildlife, Vegetation and Landscape Ecology
Australian National University	Australian Capitol Territory	ENVS2002	Environmental Measurement, Modelling and Monitoring
Australian National University	Australian Capitol Territory	ENVS2015	GIS and Spatial Analysis
Australian National University	Australian Capitol Territory	ENVS2020	Water Science
Australian National University	Australian Capitol Territory	ENVS2025	Indigenous Cultural and Natural Resource Management
Australian National University	Australian Capitol Territory	ENVS3008	Fire in the Environment
Australian National University	Australian Capitol Territory	ENVS3040	Complex Environmental Problems in Action

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
University of Canberra	ACT	6915	Ecochemistry
University of Canberra	ACT	8101	Earth System Science
University of Canberra	ACT	10002	Environmental and Forensic Geochemistry

PARTIALLY RELATED COURSES

UNIVERSITY	STATE	CODE	NAME
Charles Sturt University	New South Wales	AGS107	Precision Agriculture and Data Handling
Charles Sturt University	New South Wales	PSC270	Annual Crop Management
Charles Sturt University	New South Wales	PSC236	Pasture Production and Utilisation

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Macquarie University	New South Wales	ENVS266	Earth Surface Processes
Macquarie University	New South Wales	GEOS112	The Planet Earth
Macquarie University	New South Wales	ENVS362	Environmental Management
Macquarie University	New South Wales	ENVS338	Environmental Quality and Assessment
Macquarie University	New South Wales	GEOS375	Environmental Geology

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Southern Cross University	New South Wales	AGR00215	Water and Catchment Management
Southern Cross University	New South Wales	CHE00073	Environmental Chemistry

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
The University of New South Wales	New South Wales	GEOS2181	Earth Materials
The University of New South Wales	New South Wales	GEOS1211	Earth and Environmental Science
The University of New South Wales	New South Wales	CHEM3901	Environmental Toxicology
The University of New South Wales	New South Wales	GEOS3281	Applied Geochemistry
The University of New South Wales	New South Wales	GEOS3733 / GEOS6733	Environmental Geophysics

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
The University of Newcastle	New South Wales	CIVL4250	Geotechnical Site Characterisation
The University of Newcastle	New South Wales	GEOS2050	River Basin Processes
The University of Newcastle	New South Wales	ENVS6555	Applied natural resource management
The University of Newcastle	New South Wales	GEOS1050	Earth Processes and products
The University of Newcastle	New South Wales	ENVS1001	Environmental Science concepts and methods
The University of Newcastle	New South Wales	CHEM2610	Environmental Chemistry I
The University of Newcastle	New South Wales	ENVS3007	Environmental remediation
The University of Newcastle	New South Wales	ERAR6007	Contamination of terrestrial environments
The University of Newcastle	New South Wales	ERAR6010	Applied environmental microbiology and biotechnology
The University of Newcastle	New South Wales	ERAR6009	Measurements, sensors and instrumentation for environmental contaminants
The University of Newcastle	New South Wales	CIVL6280	Geomechanics 2
The University of Newcastle	New South Wales	CIVL2282	Introduction to Geomechanics
The University of Newcastle	New South Wales	ENVS2710	Environmental Control Practice
The University of Newcastle	New South Wales	CIVL4201	Geotechnical and Geoenvironmental Engineering
The University of Newcastle	New South Wales	CIVL1200	Earth Systems
The University of Newcastle	New South Wales	CIVL4240	Geotechnical Risk Analysis

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Univeristy of New England	New South Wales	AGSY300	Grazing Systems
Univeristy of New England	New South Wales	COTT300	Applied Cotton Production
Univeristy of New England	New South Wales	COTT400	Applied Cotton Production
Univeristy of New England	New South Wales	COTT500	Applied Cotton Production

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
The University of Sydney	New South Wales	MICR2031	Microbiology
The University of Sydney	New South Wales	ENVX3001	Environmental GIS
The University of Sydney	New South Wales	ENVI1003	Global Challenges: Food, Water, Climate
The University of Sydney	New South Wales	CIVL6455	Engineering Behaviour of Soils
The University of Sydney	New South Wales	CIVL5460	Particle Mechanics for Geotechnics
The University of Sydney	New South Wales	CIVL5453	Geotechnical Hazards
The University of Sydney	New South Wales	CIVL3411	Geotechnical Engineering
The University of Sydney	New South Wales	CHEM2404	Forensic and Environmental Chemistry
The University of Sydney	New South Wales	AGRO4005	Livestock Production Systems
The University of Sydney	New South Wales	AGRO4004	Sustainable Farming Systems
The University of Sydney	New South Wales	AGRO4003	Crop and Pasture Agronomy
The University of Sydney	New South Wales	AGRO3004	Managing Agro-Ecosystems
The University of Sydney	New South Wales	AGRI3888	Sustainable Plant Production

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
University of Technology Sydney	New South Wales	49254	Advanced Soil Mechanics and Foundation Design
University of Technology Sydney	New South Wales	48330	Soil Behaviour
University of Technology Sydney	New South Wales	48821	Principles of Environmental Engineering
University of Technology Sydney	New South Wales	48860	Pollution Control and Waste Management
University of Technology Sydney	New South Wales	48881	Water and Environmental Design
University of Technology Sydney	New South Wales	41011	Environmental Chemical Processes
University of Technology Sydney	New South Wales	65621	Environmental Chemistry
University of Technology Sydney	New South Wales	91149	Geological Processes

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Western Sydney University	New South Wales	300614	Environmental Geochemistry
Western Sydney University	New South Wales	301001	Engineering Geomechanics
Western Sydney University	New South Wales	300604	Advanced Geotechnical Engineering

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
University of Wollongong	New South Wales	PHYS233	Introduction to Environmental Physics
University of Wollongong	New South Wales	EESC202	Shaping Earth's Surface
University of Wollongong	New South Wales	CHEM337	Environmental Chemistry

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Charles Darwin University	Northern Territory	ENG464	Geotechnical Engineering
Charles Darwin University	Northern Territory	ENG267	Hydraulics and Soil Mechanics

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Queensland University of Technology	Queensland	EGB270	Civil Engineering Materials

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Bond University	Queensland	SSUD13-311	Introduction to Structures
Bond University	Queensland	SDCM71-316	Structures and Materials

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME

Central Queensland University	Queensland	ENEC12008	Geotechnical Engineering
Central Queensland University	Queensland	BLAR12052	Geotechnical Studies
Central Queensland University	Queensland	CHEM19085	Environmental Chemistry
Central Queensland University	Queensland	GEOG12021	Remote Sensing of Environment

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Griffith University	Queensland	1044SCG	Earth Systems
Griffith University	Queensland	3115ENG	Geotechnical Engineering Practice
Griffith University	Queensland	7308ENG	Advanced Geotechnical Engineering
Griffith University	Queensland	7313NSC	Advanced NMR and Analytical Chemistry: Food Security
Griffith University	Queensland	2203ENV	Environmental Chemistry and Monitoring
Griffith University	Queensland	7960ESC	Water, Agricultural Landscapes AND Food Security

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
James Cook University	Queensland	CS3002	Soil Mechanics and Geology
James Cook University	Queensland	EV2401	Australian Landscape Processes and Evolution
James Cook University	Queensland	EA3007	Field Studies in Tropical Land and Water Science
James Cook University	Queensland	CH3041	Environmental Chemistry
James Cook University	Queensland	CS2005	Introduction to Geotechnical Engineering

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
The University of Queensland	Queensland	CIVL4230	Advanced Soil Mechanics
The University of Queensland	Queensland	LAND3007	Land Use & Management
The University of Queensland	Queensland	ERTH1501	Earth Processes & Geological Materials for Engineers
The University of Queensland	Queensland	ENVM3405	Managing Post-Mining Landscapes: Land Rehabilitation in the Mining Industry

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
University of Southern Queensland	Queensland	CIV2901	Geology and Geomechanics Practice
University of Southern Queensland	Queensland	CIV3403	Geotechnical Engineering
University of Southern Queensland	Queensland	AGR3905	Agricultural Engineering Practice
University of Southern Queensland	QLD	ENV2201	Land Studies

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
University of the Sunshine Coast	Queensland	ENG432	Advanced Soil Mechanics(construction major only)
University of the Sunshine Coast	Queensland	PUB262	Environmental Health Risk Management
University of the Sunshine Coast	Queensland	ENS305	Environmental Chemistry
University of the Sunshine Coast	Queensland	GEO201	Hydrology and Geomorphology
University of the Sunshine Coast	Queensland	ENS330	K'gari-Fraser Island Field Studies

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Flinders University	South Australia	ENVS3731	Ecohydrology
Flinders University	South Australia	EASC1101	Earth and Environmental Sciences
Flinders University	South Australia	GEOG2711	Australian Environmental Change
The University of Adelaide	South Australia	C&ENVENG 4112	Advanced Civil Geotechnical Engineering
The University of Adelaide	South Australia	SOIL&WAT 3004WT	Environmental Toxicology and Remediation III
The University of Adelaide	South Australia	SOIL&WAT 3005WT	Research Project: Soil and Land Systems III

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
University of South Australia	South Australia	CIVE 5083	Advanced Soil Mechanics
University of South Australia	South Australia	EART 3012	Engineering and Environmental Geology
University of South Australia	South Australia	ENVT 2015	Environmental Microbiology
University of South Australia	South Australia	EART 3020	Earth and Landscape Evolution

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
University of Tasmania	Tasmania	KNE373	Geotechnical Engineering
University of Tasmania	Tasmania	ENG706	Foundation Engineering and Design
University of Tasmania	Tasmania	ENG421	Foundation Engineering and Design
University of Tasmania	Tasmania	KRA211	Environmental Chemistry
University of Tasmania	Tasmania	KGA334	Agroforestry
University of Tasmania	Tasmania	KNE787	Rock Mechanics and Rock Engineering

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Deakin University	Victoria	SEV362	Geotechnical Engineering

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Monash	Victoria	EAE3000	Earth, atmosphere and environment research project
Monash	Victoria	CHM3960	Environmental chemistry

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
RMIT University	Victoria	CHEM1014	Environmental Chemistry 1B
RMIT University	Victoria	CHEM 1058	Environmental Chemistry 2A

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Swineburne University	Victoria	ENV30003	Environmental Management

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Federation University Australia	Victoria	ENCIV3050	GEOMECHANICS
Federation University Australia	Victoria	ENGGC2206	INTRODUCTION TO GEOENGINEERING
Federation University Australia	Victoria	ENGGC3202	GEOENGINEERING
Federation University Australia	Victoria	ENGGC3203	ENVIRONMENTAL GEOENGINEERING
Federation University Australia	Victoria	ENGIN2204	INTRODUCTION TO GEOTECHNICAL ENGINEERING
Federation University Australia	Victoria	ENGIN3202	GEOTECHNICAL ENGINEERING
Federation University Australia	Victoria	ENGIN5204	ENVIRONMENTAL GEOTECHNICS
Federation University Australia	Victoria	SCCHM2002	ENVIRONMENTAL CHEMISTRY
Federation University Australia	Victoria	MGGGC6204	GEOHYDROLOGY

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME

The University of Melbourne	Victoria	CHEM90007	Environmental Chemistry
The University of Melbourne	Victoria	AGRI10046	Foundations of Agricultural Sciences 2
The University of Melbourne	Victoria	AGRI20044	Microbiology in Agriculture
The University of Melbourne	Victoria	AGRI20026	Plant Growth Processes
The University of Melbourne	Victoria	AGRI30016	Irrigation and Water Management
The University of Melbourne	Victoria	ENVS10001	Natural Environments
The University of Melbourne	Victoria	ENEN20002	Earth Processes for Engineering
The University of Melbourne	Victoria	CVEN90050	Geotechnical Engineering

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
La Trobe University	Victoria	CIV5GI	GROUND IMPROVEMENT & GEOSYNTHETICS ENGINEERING
La Trobe University	Victoria	AGR1TM2	TURF MANAGEMENT 2
La Trobe University	Victoria	AGR1TM1	TURF MANAGEMENT 1
La Trobe University	Victoria	AGR1VM	VINEYARD MANAGEMENT
La Trobe University	Victoria	AGR2FFT	FUTURE FARMING TECHNOLOGIES
La Trobe University	Victoria	AGR3FTE	FUTURE TECHNOLOGIES
La Trobe University	Victoria	ENV3GPL	GEOLOGY AND PLANT LIFE

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Victoria University	VIC	NEC3201	Hydraulic Engineering
Victoria University	Victoria	NEC2202	Geomechanics

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Curtin University	Western Australia	AGRI1000	Land and Water Resources
Curtin University	Western Australia	CHEM3001	Environmental Chemistry
Curtin University	Western Australia	GEOP3005	Environmental Geophysics
Curtin University	Western Australia	GEOL3008	Environmental Geoscience
Curtin University	Western Australia	GEOT6001	Geotechnical Engineering for Foundations

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Edith Cowan University	Western Australia	SCI1184	Australia's Physical Environment
Edith Cowan University	Western Australia	GEO3125	Western Landscapes: Land Use, Environment and Sustainability
Edith Cowan University	Western Australia	SCC3202	Environmental Chemistry and Analysis

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME
Murdoch University	Western Australia	ENV554	Land and Water Management
Murdoch University	Western Australia	ANS312	Advanced Crop and Pasture Science

PARTIALLY RELATED COURSES			
UNIVERSITY	STATE	CODE	NAME

The University of Western Australia	Western Australia	CIVL4401	Applied Geomechanics
The University of Western Australia	Western Australia	ENVT3361	Environmental Assessment
The University of Western Australia	Western Australia	ENVT2251	Hydrology and Water Resource Management
The University of Western Australia	Western Australia	ENVT3339	Land Rehabilitation
The University of Western Australia	Western Australia	ENVT5503	Remediation of Soils and Groundwater
The University of Western Australia	Western Australia	AGRI5548	International Agriculture: Research and Development (Soil Science and Plant Nutrition)
The University of Western Australia	Western Australia	AGRI4407	Plant and Human Nutrition