Professional Services
Specifications (PSS)

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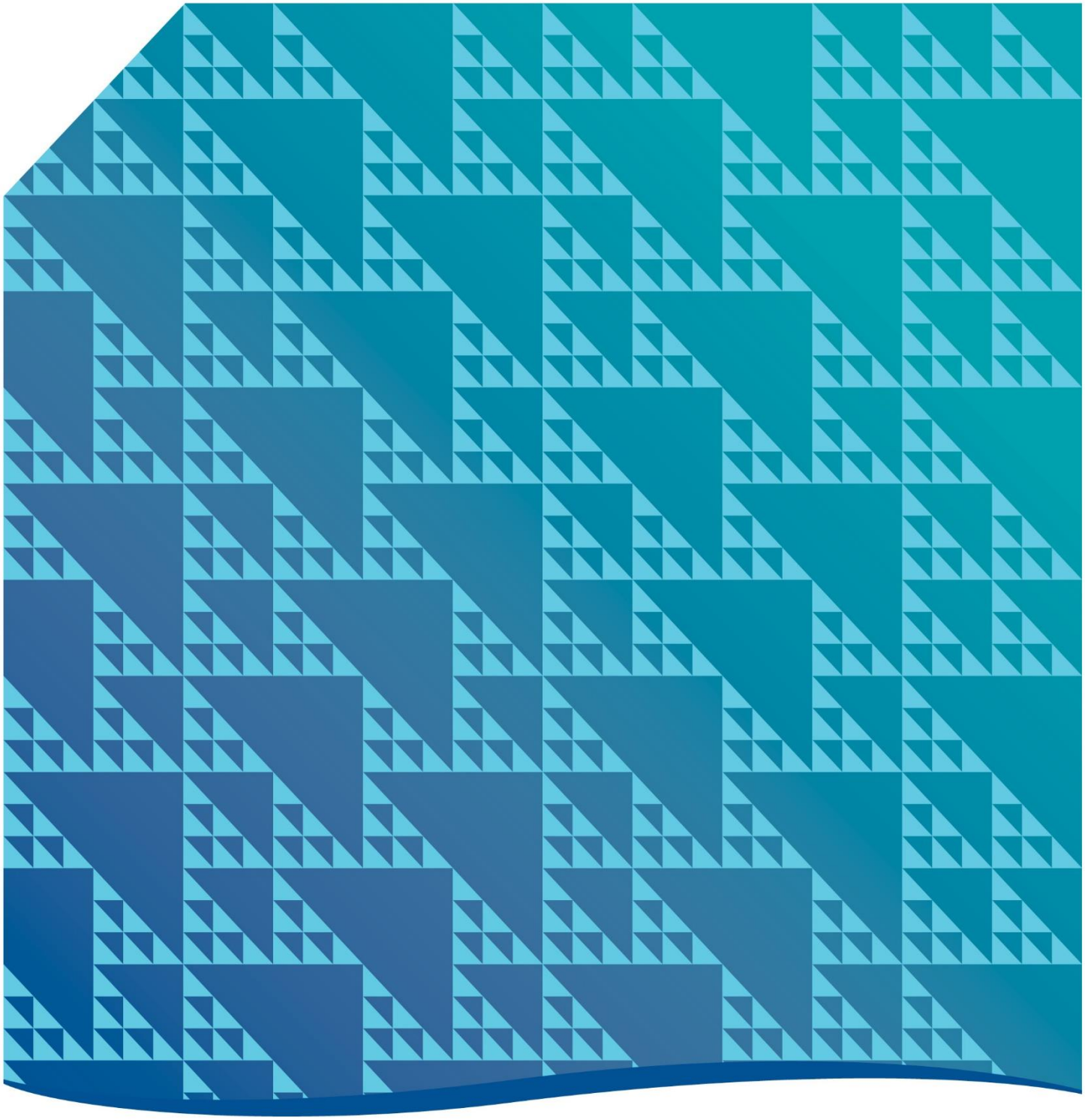
T6 – Geotechnical and Site Investigations & Reporting



Department of State Growth

Tasmanian Government

Contents

Revision History

Version No.	Date	Description of changes
1.1	17 August 2020	Template updated and old references to superseded documents/entities updated Minor updates to content
1.0	7 July 2014	*'Department of State Growth'* replaces *'DIER'* T6.1 reworded New Clauses (T6.2-T6.5) added, previous Clauses T6.3 & T6.4 removed T6.6 replaces previous Clause T6.2, Clause reworded New Clauses (T6.7-T6.10) added T6.11 replaces previous Clause T6.5, Clause reworded T6.12 replaces previous Clause T6.6 and previous Appendix T6.A, Clause reworded New Appendix (T6.A) added

T6.1 Scope

This Standard Specification sets out the minimum requirements for undertaking geotechnical and other site investigations, and the development of associated reports, relating to:

- Earthworks design
- Land stability assessment
- Existing and new pavement design
- Bituminous surfacings treatment selection
- Foundation design for structures
- Drainage including existing ground water conditions, particularly with respect to pavements and land stability, but excluding hydrological studies.

It incorporates the following tasks:

- Research
- Description, measurement, testing and monitoring
- Data collation and analysis
- Reporting and presentation of data.

This specification does not apply to survey (refer *Specification T4 Planning and Design* Survey, environmental investigations (refer *Specification T5 Environmental Investigations and Reporting*), hydrological studies (refer *Specification T8 Drainage Design Standards*) or structural assessment of existing structures (refer *Specification T1 Structural Assessment).*

T6.2 Objective

The objective of this Specification is to provide a guideline for the geotechnical and site investigations and reporting required for Department of State Growth projects.

This Specification encompasses a wide range of investigations, and as such it relates to the process required, rather than the specific detail of every possible type of investigation.

The objectives of the geotechnical and site investigations are to:

- Develop an understanding and appreciation of the site conditions and issues;
- To provide information that assists designers to develop solutions that take into account the site conditions;
- Identify risks and hazards associated with the site conditions, and where applicable provide advice on managing those risks; and
- Support informed decision-making throughout all stages of the project design and delivery.

Individual Project Brief's may contain specific information relating to the preferred scope of site investigations or the required reports.

Note: Specifications are not stand alone documents, and may trigger clauses in a related specification. The outcomes from site investigations will impact on a number of other Standard Specifications.

T6.3 References and Standards

The site and materials investigations shall be compatible with the provisions of all Department of State Growth's Standard Specifications for Design, Construction and Maintenance, Austroads Guides and Test Methods and Australian Standards in particular:

Department of State Growth Standard Specifications and Codes of Practice

- https://www.transport.tas.gov.au/roads_and_traffic_management/contractor_and_industry_information/specification_listings_-_standard_sections
- https://www.transport.tas.gov.au/roads_and_traffic_management/contractor_and_industry_information/codes_of_practices

Austroads

- AP-C87/10 Glossary of Austroads Terms

Austroads Guide to Road Design

- Part 2 –Design Considerations

Austroads Guide to Pavement Technology

Austroads Guide to Bridge Technology

This specification takes precedence over the *Austroads* documents if and where they differ.

Other contemporary guides or practices may also be utilised.

Where testing is required, the relevant *Australian Standards* shall be used.

T6.4 Intellectual Property

Information, data and outputs that are the direct and/or indirect result of works conducted for and on behalf of Department of State Growth, is the Intellectual Property (IP) of Department of State Growth. All project information that is sourced, collated, generated and/or produced by virtue of a Department of State Growth contract, is owned by Department of State Growth.

T6.5 Investigation Plan

Further to the requirements of *Specification PM2 Project Management Plan*, the Consultant shall develop an Investigation Plan for all projects. The Investigation Plan shall detail the scope of works and reasons for it, the amount of sampling and testing envisaged and the expected cost of these works, along with the expected costs of traffic control measures, service location etc.

The extent of sampling and testing shall be determined after the analysis of Department of State Growth's network data and any previous investigations.

An outline of this Investigation Plan including estimated costs, time frames and potential risks and issues is to be provided to the Principal's Representative for approval prior to undertaking any investigations.

The Investigation Plan shall be based on:

- Considerations of factors that are likely to control future performance of the project, ensuring that these factors are appropriately covered in the plan;
- An examination of available and relevant background material, including past reports, maps, air photos etc.;
- Access and safety considerations;
- Time frames, including the need or otherwise of monitoring.

Departures from standard practice or terminology shall be clearly documented.

T6.6 Client Supplied Product

The Department of State Growth will provide copies of, or access to, relevant information in its possession. This information (where applicable) may include, but is not limited to:

1. Prior or related geotechnical investigation reports;
2. Road Information Management System data e.g. road condition, asset inventory;
3. Traffic data.

Note: The information generally available from Department of State Growth for pavement investigations includes;

- *Construction and surfacing history, including previous investigations, reports and test data;*
- *Rutting depth as measured with a multi-laser profilometer across lane widths averaged over a 100m section;*
- *Cracking as measured with a multi-laser profilometer;*
- *Roughness in terms of IRI Lane (quarter car);*
- *Skid resistance as measured by SCRIM. It is normally available as a characteristic value for 100m lengths. Differential frictions between wheel paths are also available;*
- *Texture depth in terms of the Sensor Measured Texture Depth (SMTD). The SMTD is not the same as the Sand Patch Texture Depth. The available data includes average values over 100m lengths and also as percentile values within each 100m length; <10mm, 10 to 20mm and >20mm;*
- *Traffic information. This might include AADT, heavy vehicle content and its breakdown into classes. Weigh in motion data may be available. This can provide information on the distribution of axle loads, ESAs etc.*

T6.7 Permits

Subject to the agreement of the Principal's Representative, the Consultant shall provide notifications and obtain all the necessary approvals to enter property.

The Consultant shall establish the location of any services prior to undertaking destructive testing and notify the appropriate Service Authority.

Should any Aboriginal artefacts be uncovered by works, all works affecting the site shall stop immediately and the Principal's Representative informed.

T6.8 Investigations

The principal stages of a geotechnical investigation are:

- preliminary investigation which involves generally non-intrusive and largely desktop investigations
- preparation and approval of an Investigation Plan
- detailed geotechnical investigation
- analysis and reporting.

Note: For larger or more complex projects, the investigation may be undertaken in several phases, particularly for projects in the planning stage or where preliminary investigations are required to ascertain the scope of more detailed investigations.

T6.9 Reporting

Available information should be referenced in the Report if not included. Where not included, the reasons should be stated. In preparing the Report it should be recognised that the report has uses beyond the design and project specification functions. It may be used by the Principal to assess priorities and risks, by the Contractor to determine methodology and costs and by the Superintendent to make decisions throughout construction.

The report, in addition to full disclosure, should include:

- A description of the proposed project or site;
- The objectives of the investigation;
- Description of the site or materials under investigation;
- Assessment of the potential for use of in situ materials from any proposed cuttings as subgrade or fill and/ or pavement materials;
- A description of the methods of investigation used;
- All factual information collected or used;
- Recommendations;
- Statements concerning reliability of the data and interpretations and opinions where expressed, deficiencies or inconsistencies in the data, residual uncertainties and risks to the Principal;
- Descriptions of nomenclature and standards used.

The Report shall include definitive locations of test locations, by co-ordinates and either in terms of design chainage with offset or in terms of the Department of State Growth's road link system with offset. The elevation, to the nearest 0.1m, of the ground surface shall be provided for drill holes.

Data presentation shall be clear and unambiguous. Where data is voluminous it should be summarised by utilising pictorial, graphical and tabulation techniques.

The Report shall clearly distinguish between fact, interpretation and opinion. Opinion should be avoided unless it is necessary to fulfil the objectives of the investigation.

T6.10 Samples

The Consultant on completion of the investigation report should seek advice from the Principal's Representative regarding the need for an inspection during the tendering process of any drill cores or samples collected.

In the event that a construction contract pretender inspection of drill cores or samples is required, the core or samples shall be stored in a secure manner.

When there is no further need to hold the drill cores, it shall be delivered to the State Government drill core depository.

Samples shall not be disposed of until approved by the Principal's Representative.

T6.11 Hold Points

Hold Points for this Specification are listed in *Table T6.11.1 – Schedule of Hold Points.*

T6.11.1 Table – Schedule of Hold Points

Description of Hold Point	**Nominated Work Not to Proceed**	**Evidence of Compliance**
Provision of the Investigation Plan	All investigation work.	Approval from Principal's Representative

Note: For larger or more complex projects, the Investigation Plan may be undertaken in several parts, or updated, particularly where preliminary investigations are required to ascertain the scope of more detailed investigations. In this instance, the updated Investigation Plan must be submitted and approved prior to undertaking the nominated investigations.

Appendix T6.A – Management of Sulphate Soils in In situ Materials

T6.A.1 Introduction

This appendix sets out the minimum requirements for the management of Acid Sulphate Soils ASS) in the design, construction and maintenance of infrastructure projects. It aims to provide a framework to inform those involved on how best to identify and manage acid sulphate soils. It has been included in this specification as it is expected that identification of acid sulphate soils and the development of management proposals is part of the investigation process.

T6.A.2 Objectives

The objective of this appendix is to provide information and provide a step-by-step process that can be followed by designers to ensure that appropriate measures are undertaken to manage the risks to infrastructure from acid generating soils.

T6.A.3 Occurrence of Acid Sulphate Soils in Tasmania

T6.A.3.1 What are acid sulphate soils?

Acid sulphate soils (ASS) are naturally occurring Holocene sediments that are rich in iron sulphides (mainly pyrite). ASS is typically found in low-lying coastal and estuarine environments, and originates from the anaerobic decomposition of organic material often within tidal marine muds.

Iron sulphide particles are relatively small and react quickly with oxygen; therefore if ASS is exposed to air, the iron sulphide within the soil will oxidise to produce sulphuric acid. If ASS remains in a saturated state, the iron sulphate will not oxidise because it has no access to oxygen and the soil is considered harmless.

There are two types of ASS present in the environment and they are defined as follows:

- Actual acid sulphate soils (AASS) are sediments that contain iron sulphides, which have already undergone oxidation. These soils are acidic in nature and unless the sulphuric acid is neutralised, they will acidify soil water, ground water and even surface water.
- Potential acid sulphate soils (PASS) are sediments that contain iron sulphate, which has not yet oxidised and is therefore not acidic. PASS is found beneath the water table in a saturated state and is thus harmless until exposed to air through activities such as excavation or lowering of the water table. When exposed, PASS can create extensive amounts of very strong sulphuric acid, which can be a major environmental issue.

If works are planned in an area where AASS or PASS has been discovered or is probable, a geo-environmental consultant should be sought for clarification.

T6.A.3.2 Where are acid sulphate soils found?

ASS is more prevalent in specific states but can be found throughout Australia in low-lying coastal areas generally less than 5 m below the Australian Height Datum (AHD).

In Tasmania, Holocene sediments with the potential to contain iron sulphate are located mostly along the northern coastlines and on Flinders Island and King Island.

It should be noted that although Holocene sediments in Queensland and New South Wales are usually hosted below 5 m AHD, they can be found up to 30 m AHD in Tasmania. The location of PASS in Tasmania occur mostly in the Smithton and Woolnorth areas, usually in back swamps such as Mowbray, Montagu and Brittons swamps which have been drained for dairy purposes and have therefore oxidised.

T6.A.4 Procedure for Identification of Acid Sulphate Materials in Soil and Water

T6.A.4.1 How are they identified?

The following is a procedure for identifying elements within soils and water that may cause harm to infrastructure and the environment. Both visual and laboratory testing can be used to identify ASS.

Identification of ASS & PASS in Soil:

1. Complete desktop investigation from geology maps (refer to Mineral Resources Tasmania's, (MRT) map database.
2. Undertake field investigations in suspected areas.
3. Geotechnical Engineer/Geologist to review all investigation logs and select samples requiring testing.
4. Samples to be sent together with element list to NATA accredited testing facility.
5. Analyses and report on results.
6. Action if necessary.
7. Complete QA during construction (periodic checks of critical materials).

The principle elements of influence include:

- PH.
- Electrical Conductivity.
- Soluble salts (Chlorides and sulphates).

Note: Analysis of logs will consist of determination of iron sulphide (pyrite) within rock faults and soil logs.

Reactivity of sulphur is not always dependant on the level of sulphur but more on the combination of ph, EC and sulphur.

Identification of ASS & PASS in Water:

1. Complete desktop investigation including evaluation of catchment type and prominent natural features or man made infrastructure that may lead to variations within the readings.
2. Field investigations to be undertaken in all waterways, however if many waterways present just complete on suspected/ critical ones (decision undertaken by suitably qualified person).
3. Analyse and report on results.
4. Action if necessary.
5. Set up water monitoring program should a change in water quality be critical.

The principle elements of influence include:

- PH.
- Electrical Conductivity.
- Turbidity (environmental influence).
- Chloride.
- Sulphate.
- Heavy metals.

T6.A.5 Effects of Acid Sulphate Soils on Infrastructure

T6.A.5.1 What are the risks to infrastructure?

AASS and PASS (when exposed) create sulphuric acid, which can be detrimental to engineering works and the environment if it becomes concentrated in surrounding water. Sulphuric acid corrodes metals such as iron, steel and aluminium and also attacks concrete.

In Tasmania there are records of very low pH levels (<3.5) found in excavated drains and drained swamps which have leached this acidity from AASS. Examples of this are Mella, Smithton; and coastal sand flats in the Harcus River, Woolnorth. Acid at this concentration has the ability to weaken the concrete and metal structures of bridgeworks, slabs, roads, metal and concrete culverts, drainage structures and underground concrete water and sewerage pipes. The acid often dissolves salts when reacting with surrounding soil, which can be deposited at the surface of the pavement and break the asphalt pavement bond which would lead to many problems such as blistering or cracking.

PASS muds are also very poor load bearers due to their gel-like consistency. For engineering works such as heavy structures where subsoil characteristics are very important, investigations in areas where there may be PASS should be carried out.

Heavy metals are dissolved in the sulphuric acid which results in the breakdown of clays, which reduces the shear strength of the sediment and can lead to subsidence.

The products of ASS also affect the natural environment, the sulphuric acid and dissolved metals are toxic to fish, native animals, stock and aquatic and terrestrial vegetation. The sulphuric acid can also lead to loss of productivity of agricultural lands.

T6.A.6 Management of Acid Sulphate Soils

When ASS has been identified an Acid Sulphate Soil Management Plan must be prepared. This plan should outline the steps that are being carried out to address the removal or treatment and ongoing monitoring of the ASS. The main priorities when dealing with an acid sulphate soil on a site is to minimise the impact that it can have on the surrounding environment and also on the engineering works. There are five main management techniques for dealing with sediments rich in iron sulphides.

These include:

- Avoidance.

- Prevention of oxidation.
- Neutralisation.
- Oxidation and leaching.
- Removal of pyrite material.

Avoidance:
The most obvious and effective way to manage PASS and ASS is to avoid disturbance of the ground in areas where it has been identified. PASS is harmless covered below the water table, and if it is not exposed to air through excavation or lowering of the water table through drainage then it will not be an issue. But for most applications this will not be a feasible option.

Prevention of oxidation:
When avoidance of the ASS is not an option, then prevention of oxidation of the PASS is another management method that can be applied. This can be done in multiple ways, such as limiting the amount of time the pyritic material is exposed to the air; disposal of pyritic material below the water table; capping of the pyritic material with non-porous clay soils; raising of the water table or flooding the soils to create a surface saturated layer. All of these options have been successfully used to prevent the oxidation of ASS.

Neutralisation:
Another popular option is the neutralisation of the sulphuric acid over time with a basic substance (usually lime). A method that has worked in the past is liming the walls of drains so the sulphuric acid is neutralised as it runs through. This is not an instant solution but instead reacts with the sulphuric acid as it is created from the sediment. The amount of lime that is used can be estimated from the volume of ASS, but a multiplication factor should be applied to account for the slow reaction and uncertainty.

Oxidation and Leaching:
A permanent management solution for dealing with ASS is deliberately oxidising the iron sulphates and collecting and disposing of the leachate. Oxidising and leaching is useful because after all the iron sulphate has oxidised and the products have been collected then the soil should not pose any more acid problems. This method is not ideal for all soil types though, especially surrounding clays because of the structural breakdown, which ensues. When the acid moves through the clay it dissolves the metals within and changes the shear strength and compression characteristics of the clay. It can also be quite an expensive method when dealing with a large quantity of affected sediment, especially when ongoing monitoring and management is often required.

Removal of Pyrite Material:
Another group of management methods relate to the removal of pyrite material, but these solutions usually prove too expensive for the majority of projects. Pyrite removal involves the excavation of the acid sulphate soils, and the extraction of the acid sulphate fines through a process of hydro cloning or sluicing.

T6.A.7 Summary & Conclusions

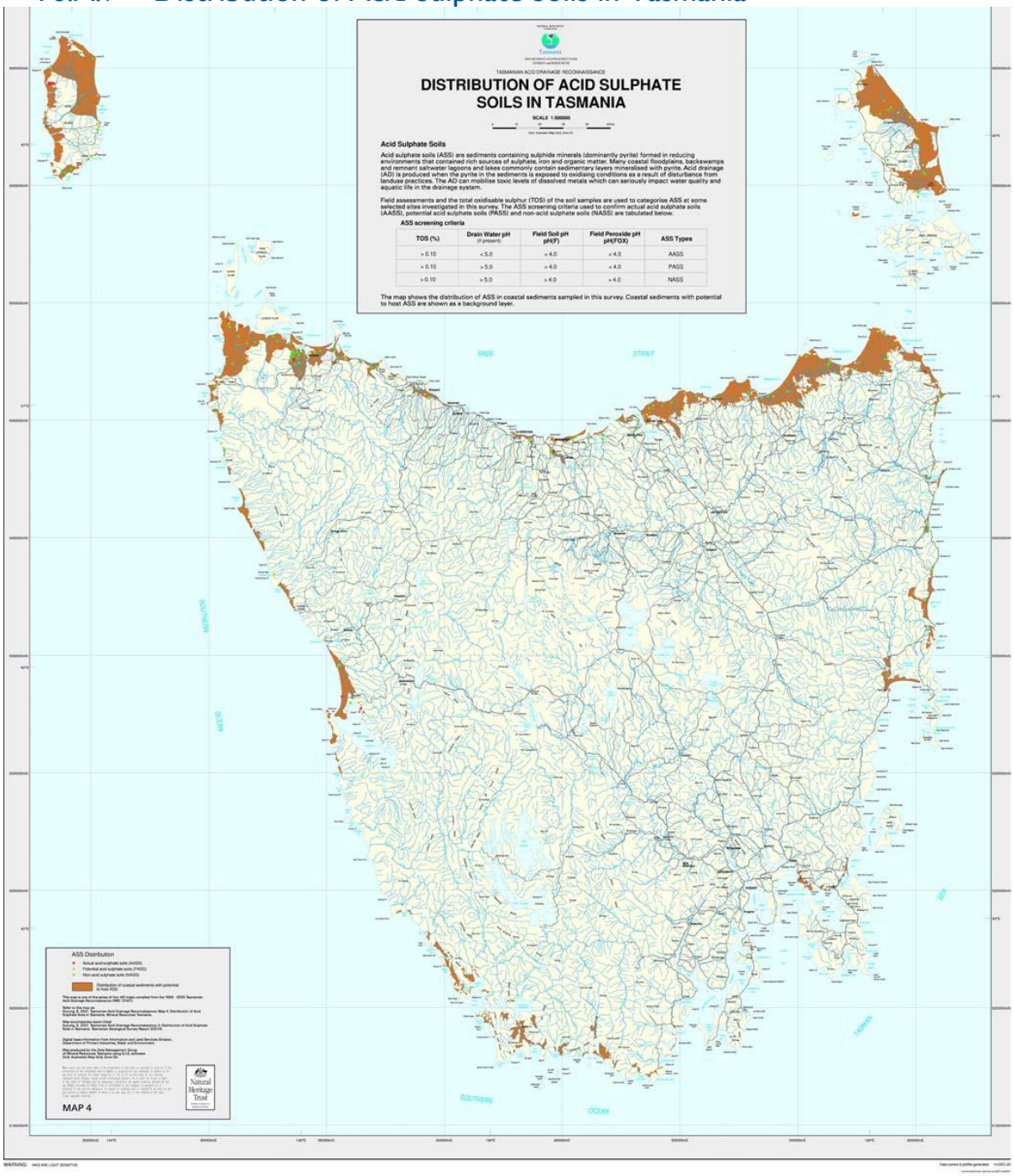
Acid sulphate soil can create some serious problems for infrastructure and the environment if it is not managed correctly. If works are planned in an area where ASS or PASS has been discovered or is probable, a geo-environmental consultant should be sought for tests and clarification. Maps are available from the Department of State Growth that outline areas where Holocene sediments and acid sulphate soils have been discovered. In particular the map included in T6.A.9 - *"Map - Distribution of Acid Sulphate Soils in Tasmania"* is a useful reference for Tasmania projects.

Once acid sulphate soil has been identified there are five common management options that can be considered. The choice of management techniques should be determined by whether the environmental and project outcome of the treatment is satisfactory.

T6.A.8 References

1. N. Fok - Acid Sulphate Soils, Technical Note 22, June 2006, GeoPave, VIC.
2. G. Bannerman – Acid Sulfate Soils, Technical Note 24, Transport Technology Division, Herston, QLD.
3. S. Gurung – Distribution of acid sulphate soils in Tasmania, 2006, Department of Infrastructure, Energy and Resources, Rosny Park, TAS.

T6.A.9 Distribution of Acid Sulphate Soils in Tasmania



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