Australian Government

Department of Infrastructure and Regional Development

Guidance Note 1

Project Scope

March 2017

ISBN 978-1-925531-32-9
March 2017 / INFRASTRUCTURE 3190

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Director - Publishing and Communications
Communications Branch
Department of Infrastructure and Regional Development
GPO Box 594
Canberra ACT 2601
Australia

Email: publishing@infrastructure.gov.au
Website: www.infrastructure.gov.au

Document information

Document Name	Project Scope
Version and Date	1.0 March: 2017
Prepared by	Ben du Bois

Approvals

Approval and Authorisation	Name	Position	Date
Prepared by	Ben du Bois	Civil Engineer Change and Project Review Major Infrastructure Projects Office (MIPO)	March 2017
Reviewed by	Warren Fletcher	Director Change and Project Review MIPO	March 2017
Approved by	Andrew Danks	General Manager MIPO	March 2017

Revision history

Issue	Date	Revision Description
1.0	March 2017	Initial release

Before using any downloaded PDF version, or printed copy of the PDF version of this Guidance Note, readers should check the Department's website at the below URL to ensure that the version they are reading is current. Note that the current version of the Department's Cost Estimation Guidance supersedes and replaces all previous cost estimation guidance published by the Department, other than that already included in current versions of the NOA and NPA (refer to Section 1.1).

http://investment.infrastructure.gov.au/funding/projects/index/cost-estimation-guidance.aspx

Table of Contents

1: Introduction

1.1: Context and Authority

This Guidance Note – *Project Scope* is one component of the suite of documents that in aggregate, constitute the Department of Infrastructure and Regional Development's (the Department's) Cost Estimation Guidance.

The Cost Estimation Guidance (the Guidance) is referred to in Appendix B to the "Notes on Administration for Land Transport Infrastructure Projects 2014-15 to 2018-19" (the NOA). The Guidance outlines the principles that must be followed by proponents in preparing cost estimates accompanying Project Proposal Reports which seek Australian Government funding for road and rail infrastructure projects. The NOA and the associated National Partnership Agreement is available at the following link: http://investment.infrastructure.gov.au/funding/projects/

The Cost Estimation Guidance comprises the following key components:

- Overview;
- Guidance Note 1 (Project Scope);
- Guidance Note 2 (Base Cost Estimation);
- Guidance Note 3A and 3B (Probabilistic and Deterministic Contingency Estimation); and
- Guidance Note 4 Outturn (Escalation) Cost Estimation.

In particular, this Guidance Note aims to explain to the user the importance that a well-defined project scope plays in the development of a realistic project cost estimate. Applying the principles herein will assist in achieving consistent, realistic, traceable, and appropriate project cost estimates at each phase of the project life cycle. This Guidance Note should be read in the context of the Overview component of the Guidance and the specific requirements of the NOA.

1.2: Related Guidance

Additional guidance on cost estimation practices, to the extent that they do not contradict the guidance provided by the Department's Cost Estimation Guidance, may be found in individual agency cost estimation guidance or manuals, and in the guidance provided by professional associations, for example, the Project Management Institute or AACE International, or in applicable textbooks.

1.3: Availability and Version Control

The Cost Estimation guidance is subject to periodic update, and is not available from the Department as a printed bound document. Rather it is being published on the Department's website in PDF form, both as individual components, as well as a single consolidated document, that can either be read online or downloaded for subsequent use. A number of Excel spreadsheets and presentations accompany the various components of the guidance to illustrate various aspects.

The PDF components of the Guidance, and the accompanying spreadsheets and presentations are available from the Department's website at: http://investment.infrastructure.gov.au/funding/projects/index/cost-estimation-guidance.aspx, and are the current versions of the guidance. The version date of each component of the "Cost Estimation Guidance" will be listed on the above webpage and will also appear as Appendix A "Current Component Version Status – Cost Estimation Guidance" to the "Cost Estimation Guidance Overview document".

1.4: Objective and Scope of Guidance Note 1

The objective of this Guidance Note is to provide guidance on the preparation of the project scope as it applies to the development of realistic capital cost estimates, as well as describing some of the inefficiencies that may arise as a result of inadequate scoping. This guidance aims not to be prescriptive, but rather seeks to be a reference and a resource document leading to greater awareness of approaches which will facilitate successful scoping.

The guidance covers the following topics:

- **Project scope definition** – defining and improving project scope;
- **Constraints and Assumptions** – the importance of clearly identifying and documenting what is, and what is not included in a cost estimate;
- **Design considerations** – a broad overview of factors that typically influence project scope on road and rail transportation projects is presented at Appendix GN1-1; and
- **Road Standards across Australian states** – a list of web links to Australian state and territory technical publications is provided at Appendix GN1-2.

This Guidance Note is premised mainly towards project scoping approaches expected to be utilised in major or high risk projects. However, the principles apply generally to projects of all sizes.

It is expected that the primary users of this document will be jurisdiction (i.e. Australian State and Territory) public sector organisations (Agencies), including Local Government Authorities and their contractors/consultants that have responsibility for delivering infrastructure projects. However, the guidance may also be relevant to contractors and members of the public with an interest in major infrastructure projects.

1.5: Definitions and Abbreviations

Table 1: Definitions and Abbreviations

Term	Definition
Agency	A state or territory government body that generally will deliver an infrastructure project.
Assumption	A documented, cost-related factor that, for the purpose of developing a base cost estimate is considered to be true, real or certain.
Constraint	A restriction or limitation, either internal or external to the project that will affect the performance of a project.
Exclusion	An item specifically excluded from the project estimate.
Interface	A common boundary or point of connection between two or more items or systems.
Jurisdiction	An Australian state or territory.
NOA	The Notes on Administration for Land Transport Infrastructure Projects 2014-15 to 2018-19 provide administrative guidance for managing projects to be funded under the National Partnership Agreement.
NPA	National Partnership Agreement on Lan Transport Infrastructure Projects.
Project Scope	The work that must be performed to deliver a product, service or result with the specified features and functions.
Project Scope Statement	States what work is to be accomplished and what deliverables need to be produced.
Scope creep	The increase in project scope not anticipated at the start of a project. These changes are often uncontrolled and/or unapproved.
Triple Constraint	The combination of the three most significant restrictions on any project: scope, time and cost.
Work Breakdown Structure (WBS)	A hierarchical decomposition of the work to be executed to accomplish the project objectives and create the required deliverables. The WBS organizes and defines the total scope of the project.

2: Project Scope Definition

A key issue underlying the accuracy of any cost estimate is the ability to define the project scope. A cost estimate relies heavily on project scope definition as it defines the work to be performed in a project, or stage of the project, and thus identifies the elements for which a cost must be estimated. Vague scope has two implications for cost control:

- It decreases the accuracy of an estimate due to the large number of assumptions that will need to be made. Additionally, what has been initially estimated may not be representative of the final product; and
- If a clear functional and physical description of the project is not adequately prepared in the first instance it will be difficult to monitor and control any changes impacting the cost as the project progresses through subsequent pre-construction phases.

Unfortunately, early estimates must often be developed based on limited scope definition. Although this lack of definition can lead to an inaccurate estimate, early estimates (accurate or not) often become ‘cast-in-stone’, and future estimates may then be unrealistically expected to align with the early estimate. These future estimates may even be ‘corrected’ to be consistent with early estimates[1].

A well-defined project scope allows for the creation of a Work Breakdown Structure (WBS) – the subdivision of the major project deliverables and project work into smaller, more manageable components. Guidance Note 2 – Base Cost Estimation provides further detail of the creation and importance to the project estimate of a WBS. In practice, this process may at times work in the reverse, with scope definition being achieved through development of the WBS which acts as a visual representation and provides a framework for identifying the required project elements. However, the amount of information available, and hence the degree of scope definition achievable, depends on the stage of the project[2].

It should also be noted at this point that there is a difference between project scope and the scope of the estimate (or “estimate scope”). At times an estimate may only be prepared for a portion of a project, particularly if it is to be staged or different parts of the project are seeking funding from different sources.

2.1: The Importance of Scoping

Scoping work is a critical and highly technical task requiring experience, discipline and clarity of purpose[3]. Project scoping typically involves:

- Identification of the project objectives;
- Identification or development of the performance outcomes/criteria and functionality requirements to achieve those objectives;

[1] Creedy G (2006), *Risk Factors Leading to Cost Overrun in the Delivery of Highway Construction Projects*
[2] RTA (2008), *RTA estimating manual*
[3]Australian National Engineering Taskforce (2010), *Scoping Our Future*

- Identification of the context in which the project is to be delivered, and the key constraints and assumptions; and
- The translation of the project requirements into contractual scope documents (construction drawings and specifications, etc.) for the project.

The consequences of poor scoping can be significant and are likely to lead to cost overruns, delayed completion, and disputes, many of which can drag on for several months or more. The scope of a project is the contractual expression of a client's requirements[4] and poor specifications can cause construction rework and delays.

Inadequacies in scope documents tend to manifest themselves more often during project delivery than any other phase[5]. This becomes a problem as parties will generally have entered into contracts by that stage. Unless there is a significant level of goodwill, parties may fall back on their contracts rather than seek to negotiate and compromise in making changes. Changes at this stage are highly likely to have an impact on the cost, quality, or timeliness of delivery of the project, or potentially, a combination of all three.

If deficiencies in scope are not detected until work has begun, the client is likely to be required to pay the contractor for variations, which means that neither the budget nor the original contract price reflects the actual cost, and the work may not be completed by the original due date.

Utilising a procurement approach such as a design and construct (D&C) arrangement is a legitimate method where the client may not wish to assume all of the design risk and/or wishes to encourage innovation. However, this should not be seen as a way of circumventing the need to undertake project scoping activities. The outcomes of a project will reflect the Client's Project Performance Requirements, so it is critical that these are well-defined at the time of going to tender and carefully specified in the Project Brief to ensure high-quality outcomes are delivered[6].

2.2: Defining the scope

There is a hierarchy in the way the project scope definition should be structured, as shown in figure 1 below and described in the following sections. In principle, the **objectives** must be set first, from which **performance criteria** and **functionality requirements** can be established. **Definition, context, constraints and program** list out the characteristics of the project which together with the **physical scope, and estimate scope,** are the key items to be considered in the cost estimate.

[4] Blake Dawson (now Ashurst 2008), *Scope for Improvement 2008 – A report on scoping practices in Australian construction and infrastructure projects*
[5] Ibid
[6] Austroads (2014), *Building and Construction Procurement Guide – Principles and Options*, Austroads, Sydney

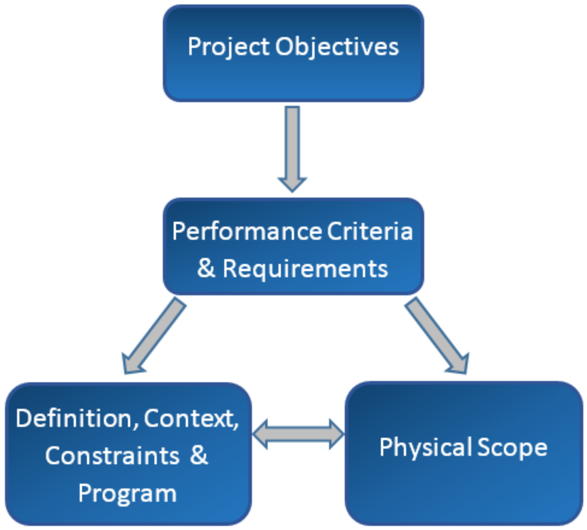

Figure 1: Project Scope Definition

A clearly documented scope is an invaluable tool to manage project development and enable cost changes within the project phases to be better explained.

2.3: Project Objectives

A project should have defined objectives. Figure 2 below provides some examples of what project objectives might cover and that they could have specific exclusions as well.

Project Objectives

Should be expressed as:

- An operational target date;
- A link between corridors;
- A corridor capacity improvement;
- A community linking facility;
- A safety target; or
- Another reasonable objective,

With any exclusion noted.

Figure 2: Project Objectives

The objectives of new and existing road and rail projects should be carefully considered to achieve the desired balance between factors such as the level of traffic service provided, safety, whole of life costs, flexibility for future upgrading or rehabilitation, and environmental impact. Balancing these factors while achieving project objectives at an acceptable cost requires consideration of a broad range of design characteristics related to planning, site conditions, construction, maintenance and operational matters.

Appendix GN1-1 provides an overview of the design considerations that may have a bearing on the scope of road and rail projects and how they might impact on the design, and hence assist in determining the optimal solution to achieve the project objectives.

2.4: Project Performance Requirements

Project performance requirements may alternatively be described or expressed as functional requirements. However they are expressed, they should be capable of measurement such that any subsequent design can be assessed against those requirements. Examples of Project Performance Requirements are shown in Figure 3 below.

Project Performance Requirements

Should be stated as:

- Vehicle carrying capacity / train path capacity;
- Functionality of an intersection/junction or section of highway/rail track;
- Design and posted speed limits;
- Pavement or track life/axle load capacity;
- Sustainability criteria;
- Maintenance and operational requirements for structures and track/pavements; and/or
- Any other reasonable performance requirements,

With any exclusions noted.

Figure 3: Project Performance Requirements

By not specifying measurable performance and criteria before undertaking concept and preliminary engineering design and drawings, the reliability of cost estimates will suffer. The result is that additional features may be included that were not originally contemplated or budgeted for and may not be recognized as being out of scope.

2.5: Project Definition, Context, Constraints and Program

This part of a project cost estimate is not immediately apparent from the list of items making up the costs because the definition and context, as well as the constraints and program, of a project is what affects construction productivity. A good project definition and context will set out the key parameters and constraints under which the project will be delivered such as impact on community and users, working restrictions etc. That in turn, affects the direct costs of the work, the indirect costs, and the contractor's risk and margin allowances to be included in the cost estimate. For example in some projects the requirements for temporary works and staging may have a significant impact on the project's constructability and its cost.

A project plan is required to determine when construction will commence and its planned duration. The start date may depend on many factors, including the availability of funding from any other funding parties (e.g. jurisdiction governments), approvals, site access and the like. The program (schedule) duration may increase cost, particularly if it is not optimised, and is a tight or constrained program.

Some examples of definition, context, constraints and program are shown in figure 4 below.

Project Definition, Context, Constraints and Program

Should include and define:

- Likely project program/schedule (both pre-construction & construction phases);
- Type of project to establish level of risk & complexity (is it 'greenfield' or 'brownfield');
- What constraints exist (on access/possessions, staging, continuity of traffic/train flow, etc.);
- Key interfaces so extent of project is known and conditions applying at those interfaces;
- Method of delivery such as Construct only, Design & Construct, Alliance, Early Contractor Involvement or Public Private Partnership; and
- Exclusions to the project as defined (for avoidance of doubt, for example refits or upgrades often require existing items to be brought up to current standards, etc.).

Figure 4: Definition, Context, Constraints and Program

2.6: Physical Scope

Following on from the performance criteria and functionality requirements and taking into account the definition and context of the project, an engineering design should be created that will document the physical scope of works, both permanent and temporary. The extent of the design and its accuracy will depend on the stage of the project, the level of planning and investigation and the experience of the designer.

The most important aspect for a reliable cost estimate is to ensure that the part of a project that accounts for the greatest cost and/or the greatest risk is where design resources should be focused. The lesser or straightforward items can be estimated from the performance criteria with limited design, or allowances can be made based on past experience and benchmarking standards.

The physical scope should not just be drawings. A design report should be prepared that gives textual comment and lists the various constraints e.g. required property acquisitions and regulatory approvals. Future development of the project should be assessed against this report. Figure 5 below gives some guidance as to what physical scope includes:

Physical Scope

Should be properly documented and consistent with concept/preliminary design drawings to identify:

- Nature of work (interchange/junction, stretch of new highway or track, widening existing highway/track duplication, large bridgeworks, change to signaling etc.);
- Extent and limits of work (so there is less uncertainty as to extent of work costed);
- Assumptions made in design of key features (for pavements/track, the soil tests, for earthworks extent of rock, for signalling and communications the ability to add to existing systems, etc.);
- Interfaces such as property, grade separations and existing infrastructure;
- Services (utilities) relocations as these are regularly vastly underestimated; and
- Specific exclusions to physical scope, so that scope creep can be measured.

Figure 5: Physical Scope

2.7: Improving Scope Definition

The main factors leading to poor scoping on infrastructure projects are[7]:

- Lack of experienced and competent personnel;
- Insufficient time to prepare the scope document;
- Inadequate definition by the principal of project objectives resulting in subsequent changes to the scope;
- Incomplete, uncoordinated and inaccurate scope document;
- Failure to properly consult with end users; and
- Insufficient site information.

There are a number of steps that can be taken to overcome these factors including:

- Bringing together all relevant stakeholders at the start of a project to identify project objectives and allocate sufficient time and resources to do so;
- Considering the delivery of the project in context with any related upcoming projects and with existing infrastructure;

[7] Blake Dawson (now Ashurst 2008), *Scope for Improvement 2008 – A report on scoping practices in Australian construction and infrastructure projects*

- Establishing a core project team with a project leader who has clear authority and accountability to drive the scoping process;
- Preparing and sharing site related information such as underground services and geotechnical data;
- Considering early contractor involvement which may assist in identifying scoping issues; and
- Preparing a contract that includes effective means for managing and resolving scoping issues, should they arise.

2.8: Management of Scope Creep

Scope creep is the tendency for the accumulation of many minor scope changes which, although individually may have only minimal cost effects, in aggregate, result in a significant increase in project cost over time[8]. These alterations can often be uncontrolled or unapproved and will undermine the original estimate which will not have taken them into account. An example of the way in which scope creep can occur is when the community or stakeholders request that additional or changed elements be made to the defined project, such as a pedestrian overbridge or a set of traffic lights. At this point a conscious decision must be made regarding such changes which may then have an impact on the time, cost or quality of the project[9].

Scope creep should not be confused with the later inclusion of items that may have been omitted from the original scope due to oversight and should have formed part of the original estimate.

Design refinements and associated adjustments to the Base Cost Estimate throughout each of the project phases is a normal part of the project management process and is one reason why contingency is expected to reduce as the project moves through its phases. This should not be confused with major scope changes which are changes to basic project premises such as those defined by the project objectives and project performance criteria and functionality requirements (design life, capacity, etc).

A change control process can be a useful mechanism to document and manage the actual changes when they occur. Note that in the instance of a major scope change, the Base Cost Estimate should be revised and reissued to reflect the change.

Scope control ensures that the project changes are identified, evaluated, coordinated, controlled, reviewed, approved, and documented. Scope control requires that the proposed scope of a project, as well as any proposed scope changes, be continually evaluated against the essential functions necessary to accomplish its intended purpose.

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[8] Transportation Research Board (2007), *Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming and Preconstruction*, NCHRP Report 574
[9] Austroads (2014), *Austroads Guide to Project Delivery Part 2 – Planning and Control,* Austroads, Sydney

2.9: The Triple Constraint

Scope should always be considered in the context of the classic project management issue of addressing the competing project requirements or "triple constraint" of project scope, time and cost[10]. Project quality is affected by these three factors.

The relationship among these factors is such that if any of the three changes, at least one other factor is likely to be affected. For example, if there is a threat that a project will be delayed due to wet weather, the project may well be held to schedule by increasing the resource intensity, which is likely to increase unit costs (due to factors such as overtime penalty rates), or alternatively by reducing the scope which may affect the quality of the final product. If on the other hand, the priority is for the project to remain within budget while delivering the proposed scope, there may be no option other than to allow the project to be delivered late.

A project delivery plan may assist the project team to balance the competing demands for scope, time and cost. Such a plan sets the priorities for the project and identifies the boundaries of each of the three competing factors and whether there is room for any to move in the event of project changes:

- Time constraints – examples may include when the project is to be opened to traffic or key milestones to be achieved to meet government requirements;
- Cost constraints – are further funding sources available or is the budget fixed?; and
- Scope constraints – can the physical aspects such as number of carriageways and lanes, and pavement widths and type, be altered to meet time or cost constraints?

Whether changes are planned, (for example project staging is intentionally accelerated), or unplanned, (for example, the project is delayed due to wet weather), understanding which constraints are fixed and which are flexible will serve to assist in balancing each of the three factors.

2.10: Assumptions

Cost estimates are typically based on limited information and therefore the estimator is responsible for making assumptions, in consultation with the project manager, that allow the estimate to proceed. Because of the many unknowns, these assumptions serve as constraints that bind the estimate's scope, which establishes the baseline conditions that the estimate will be built from.

Assumptions represent a set of judgments about past, present, or future conditions postulated as true in the absence of proof. Assumptions must be realistic, based on expert judgment and backed up by historical data where possible. Many assumptions, such as those relating to underlying

[10] Project Management Institute (2004), *A Guide to the Project Management Body of Knowledge, 3rd Edition,* Project Management Institute Inc., Newton Square, PA

ground conditions, enormously influence cost and the rejection of even one assumption by decision makers could invalidate many aspects of the estimate. Therefore, assumptions must be well-documented so that decision makers fully understand the conditions the estimate was structured on. Assumptions serve to[11]:

- Answer questions from management and stakeholders;
- Help make the estimate complete and professional;
- Provide useful estimating data and techniques to other cost estimators;
- Provide for reconstruction of the estimate when the original estimators are no longer available; and
- Document areas of potential risk to be resolved.

The following are examples of factors on road and rail projects about which limited information may be available and upon which an estimator may need to make an assumption. The list is not meant to be exhaustive, nor will each assumption need to be applied to every project but is presented as a list of general factors only.

- The nature of ground/geotechnical conditions;
- Requirements for dewatering;
- Disposal of waste material and assumptions around contaminated material;
- Whether excavated material can be reused such as for embankment construction;
- Availability of water for construction;
- Environmental and heritage constraints such as threatened species, archaeological and Indigenous sites, and offsets and/or compensatory planting;
- Working hours, labour resources and rates including penalty rates;
- Plant productivity rates;
- Contractors, subcontractors and their roles;
- Assumptions around long lead time items;
- The contracting/procurement method;
- Whether specialised design or technologies would likely be employed;
- Material wastage factors;
- Distances from proposed edge of shoulder for clearing and grubbing;
- Availability and distances to stockpile locations;
- Assumed quantities of solid rock excavation required;
- Traffic control requirements;
- Requirements for utility relocations;
- Wet weather allowances;
- Tunneling method to be employed (if applicable);

[11] US Government Accountability Office (2009) GAO Cost Estimating and Assessment Guide (downloadable from http://www.gao.gov/new.items/d093sp.pdf)

- Site running and maintenance costs; and
- Impacts if work is to be staged.

Qualifications and assumptions should be described and documented at the most detailed level practical, and they should be clearly described so an individual not intimately involved with the project can understand the estimate's basis.

2.11: Exclusions

Similar to assumptions, any items not included in the cost estimate, but which may form part of the final cost under certain circumstances should be documented and justified. Exclusions are often corollary to assumptions and are usually related to construction activities particularly if there is no reasonable expectation of them occurring but where occurrence cannot be discounted. Some examples of exclusions may include:

- Excavation in rock;
- Hazardous materials investigations and abatement;
- Stream stabilization; and/or,
- Any other potential items for which no costs have been included in the estimate.

Assumptions and exclusions are sometimes referred to, or known as, contract modifiers[12] in that they may be depended upon by contractors to change the arrangements of a contract at a later date by seeking variations. However, they may assist decision makers in determining which risks should be managed or financed by the sub-contractor, the partner, the alliance, joint venture, public private partnership or insurance. Therefore, careful attention should be paid to these factors.

3: Conclusion

This Guidance Note – Project Scope:

- Defines Project Scope and provided an overview of the link between a well-defined scope and a robust and reliable cost estimate;
- Provides an outline of defining and improving project scope definition; and
- Discusses the importance of documenting assumptions and exclusions.

Application of the principles outlined in this Guidance Note will lead to greater awareness of the need to spend sufficient time and resources on scoping in order to ensure that any cost estimate is based on a true reflection of what is to be delivered under the project.

[12] Transport for NSW (2015), *Transport for NSW Investment Cost and Risk Management Guidelines*

Appendix GN1-1: Factors Influencing Project Scope on Road and Rail Projects

Factors influencing scope on road projects

A range of factors influence design choices, and hence project scope, for road projects. A road solution must provide satisfactory service to road users within financial, topographical and environmental constraints[13].

There are many aspects to be considered in the planning and design of road projects. The following tables[14] provide a broad overview of the engineering design considerations that will have a bearing on the overall project scope for a road project. The factors presented in these tables below are a guide only and should not be considered an exhaustive list.

Table AGN1-1-1: Engineering Design Considerations – Planning

Design consideration - Planning	Impact on design/scope
Land use / zoning	• Alignment & grade line controls • Clearance / screening / landscaping requirements
Right of way boundaries	• Alignment & grade line controls • Intersection treatments
Other Authorities • Local Government • Service Authorities • Public Transport • Airports	• Drainage design • Relocation and protection of public utilities • Provision for future public utilities

[13] Austroads (2015), *Austroads Guide to Road Design Part 2 – Design Considerations,* Austroads, Sydney
[14] Adapted from Austraods (2015) *Austroads Guide to Road Design Part 2 – Design Considerations*, Austroads, Sydney

Table AGN1-1-2: Engineering Design Considerations – Geographical

Design consideration - Geographical	Impact on design
Topography / terrain	• Horizontal and vertical alignment
Ground conditions • Ability to re-use material • Groundwater levels • Slope stability • Soft ground • Ability to excavate	• Alignment • Drainage design • Batter slopes & benches • Ground improvement design • Pavement design
Rainfall, runoff and drainage	• Number and size of pits, pipes and channels • Number and size of culverts and bridges • Road level to achieve flood immunity
Urban or Rural	• Geometry • Cross section • Intersection and interchange layout
Seasonal temperature variation	• Pavement design • Treatments for icy conditions

Table AGN1-1-3: Engineering Design Considerations – Construction Factors

Design consideration – Construction Factors	Impact on design
Whole of Life Cost	• Design life • Cost of replacement • Pavement design – concrete vs asphalt vs granular
Constructability	• Alignment • Bridge form
Material availability	• Pavement design

Table AGN1-1-4: Engineering Design Considerations – Environmental Factors

Design consideration – Environmental Factors	Impact on design
Flora and Fauna	• Alignment • Fauna crossings • Waterway crossings
Noise and Vibration	• Noise attenuation measures
Air Quality	• Alignment
Water Quality	• Location of drainage outfalls • Water quality treatment measures
Contaminated soil	• Alignment • Treatment measures – removal, minimum cover, etc.
Cultural / heritage factors	• Land preservation requirements • Alignment • Approvals from heritage authorities

Table AGN1-1-5: Engineering Design Considerations – Built Environment

Design consideration – Built Environment	Impact on design
Utility Services	• Alignment to avoid clashes • Relocation design • Design to protect existing utilities
Aesthetics	• Alignment • Landscaping • Road Art • Consideration of existing scenic values

Table AGN1-1-6: Engineering Design Considerations – Traffic

Design consideration - Traffic	Impact on design
Traffic volumes / growth & design year	• Alignment • Number of lanes • Pavement design • Type and layout of intersections and interchanges
Traffic type	• Lane widths • Gradients • Pavement design
Design vehicle	• Intersection layouts
Special users	• High Occupancy lanes • Public transport • Bicycles and pedestrians • Vehicle breakdowns
Speed	• Alignment • Layout of intersections and interchanges
Level of service	• Intersections
Intelligent Transport Systems	• Gantries • Cross section • Communications and power

Factors influencing scope on rail projects

Rail projects, unless they are large greenfield projects, tend to be major upgrades, duplications, or enlargements to existing rail infrastructure. The requirement to identify and manage the various interfaces on typical rail projects can result in design and planning being arguably more complex than for road projects.

In general, interfaces can be described as common boundaries or points of connection between two or more items or systems. In the context of rail networks, interfaces, defined as a system to be modified or for which a design task is required, may be categorised as follows[15]:

- Physical and functional interfaces within the same system such as hardware, software, electrical, and data;
- Physical and functional interfaces with external suppliers such as electrical and telecommunications;
- Physical Interfaces with installations on the railway network owned by others such as pipelines, roads, and private crossings;
- Management systems interfaces such as RAMSYS and Geographical Information Systems;
- Interfaces with regulatory authorities;
- Physical and functional interfaces with other network systems such as track signals, communications, drainage;
- Operational conditions of use such as axle speed, loading vehicle configuration and traffic density; and
- Operational management and safeworking procedures.

Concept Level Design Considerations

As well as the need to consider the various interfaces as described above, the following table highlights the basic content that should be addressed at a concept level design[16]. It also serves to assist in creating an understanding of the context through which hazards or risks may arise, noting that the considerations listed are a guide only and should not be interpreted as an exhaustive list.

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[15] Railcorp (2009), *Railcorp Engineering Procedure ED0007 – Interface Definition and Management*

[16] Adapted from Queensland Department of Transport and Main Roads, (June 2015) *Guide to Development in a Transport Environment: Rail*

Table AGN1-1-7: Concept design level considerations – rail projects

Type of Design Detail	Consideration
Site Details	• Site condition, cutting, embankment • Soil type and geology • Topography • Prevailing drainage patterns over the site • Proximity to a railway and railway infrastructure/utilities
Railway Details	• Track geometry, formation and alignment • Track speed • Type of rolling stock • Derailment history • Current and future estimated usage and growth in patronage • Future planned upgrades/works • Potential for the carrying of freight and dangerous goods
Development Details	• Structural integrity/collision protection in the event of significant incident (derailment, explosion) • Proximity of development to the railway corridor, railway infrastructure and railway station access points • Potential traffic generation which may impact on the railway • Clearances and setbacks from railway infrastructure • Demolition design of existing buildings • Ventilation system design and smoke modelling • Potential impacts on nearby railway tunnels
Construction Details	• Method of construction and use of pre-fabricated or pre-cast materials • Timing of construction and impact of disruption to scheduled services • Impact of construction for public transport routes and people accessing railway stations and associated interchange facilities • Railway encroachment • Requirements to de-energise overhead line equipment • Details of how the security of the railway will be maintained during construction • Services and utilities interference or relocation • Stormwater, drainage, sediment and erosion control

Work adjacent to a railway

The following table[17] provides an overview of the technical considerations that may need to be taken into account when planning work adjacent to (but not on) a railway, including roadworks.

Table AGN1-1-8: Technical considerations when planning work adjacent to a railway

Technical consideration	Impact on design
Noise and Amenity Impacts	• Requirement for acoustic treatment
Railway Crossing Safety	• Preference for grade separation • Design of level crossing to minimize traffic impacts • Clearances and setbacks
Structures, Setbacks, Utilities and Maintenance	• Maintenance of existing railway access points • Provision of setbacks from infrastructure including overhead line equipment and bridges • Setbacks from adjacent property boundaries
Preventing unauthorised access	• Throw protection screens • Electrification screens • Rail interface barriers • Fencing
Development within close proximity of an existing tunnel	• Foundation design including footings, piles and columns • Use of retention structures such as rock anchors, bolts, soil nails, shoring, piles, piers, beams
Dangerous Goods and Fire Safety	• Fire protection and alarm systems • Emergency access and egress

[17] Adapted from Queensland Department of Transport and Main Roads, (June 2015) *Guide to Development in a Transport Environment: Rail*

Technical consideration	Impact on design
	• Preventing fire arcing to overhead line equipment
Filling, Excavation and Ground Disturbance	• Requirement for retaining structures • Design for lateral and surcharge loads
Stormwater and Drainage	• Flood impact assessment • Location of pits, culverts, channels and drains • Water quality treatment measures
Collision Protection	• Geometry and formation of the railway • Physical barriers • Location of supporting elements to avoid domino effects

Appendix GN1-2: Road Standards Across Australian States

Standards and specifications for road works are largely state based. This arguably reflects the autonomy of the state road authorities in their responsibility for establishing a network of main roads within their relevant state.

Pre Second World War, and in the immediate boom in road construction activity, road authorities at both state and local government level maintained substantial direct labour forces for the construction and maintenance of roads. Road authorities were particularly innovative in developing road construction techniques and quality control measures and in the establishment of specifications and test methods that were largely peculiar to each individual authority.

Since that period public authorities have divested the majority of such direct labour activities to the private sector. State road authorities still, however, remain closely involved in the setting of materials standards and framing of road construction specifications although there is a greater recognition of uniform national standards for materials and test methods, as well as the need to avoid unnecessary duplication, through the influence of Austroads, Standards Australia, and various industry groups.

Links to technical guidance for state and territory agencies, particularly in relation to pavement design, are listed below:

NSW - http://www.rms.nsw.gov.au/business-industry/partners-suppliers/aus-roads-guides/road-design.html

Queensland - http://www.tmr.qld.gov.au/business-industry/Technical-standards-publications.aspx

Western Australia - https://www.mainroads.wa.gov.au/BuildingRoads/StandardsTechnical/RoadandTrafficEngineering/GuidetoRoadDesign/Pages/home.aspx

Victoria - https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/road-design

South Australia - http://www.dpti.sa.gov.au/standards

Tasmania - http://www.transport.tas.gov.au/road/contractor

Northern Territory - http://www.nt.gov.au/infrastructure/techspecs/

Australian Capital Territory - http://www.tccs.act.gov.au/roads-paths/Road_Infrastucture_and_Maintenance/trunk-road-infrastructure-standards-tris

Appendix GN1-3: Glossary of Technical Terms

Table AGN1-3-1: Glossary of Terms[18, 19]

Term	Definition
Aggregate	A material composed of discrete mineral particles of specified size or size distribution, produced from sand, gravel, rock or metallurgical slag, using one or more of the following processes: selective extraction, screening, blasting, or crushing.
Alignment	The geometric form of the centreline (or other reference line) of a carriageway in both the horizontal and vertical directions.
Asphalt	A mixture of bituminous binder and aggregate with or without mineral filler, produced hot in a mixing plant, which is delivered, spread and compacted while hot.
Axle load	That portion of the total vehicle load transmitted to the road through a single axle.
Base (roadbase)	The layer underlying the surface which supports and distributes loads such as traffic. May also refer to the unbound pavement material intended for use as base.
Batter	The uniform side slope of walls, banks, cuttings, etc. Usually expressed as a ratio of horizontal to vertical.
Brownfield sites	Existing developed areas that are undergoing change as business needs change. Due to the constraints of the existing road and rail networks, and land ownership patterns, these areas present challenges to jurisdictions and developers trying to make them relevant to current business or transport needs.
Clearing and grubbing	The removal of vegetation, roots or other obstacles at or above ground level, prior to the commencement of earthwork, drainage, etc.
Deep lift asphalt	A paving technique whereby asphalt is placed in a lift of at least 75mm compacted thickness.
Dewatering	Removal or draining of groundwater or surface water from a construction site, usually by pumping.
Earthworks	All operations involved in loosening, removing, depositing, shaping and compacting soil or rock.

[18] Austroads (2015), *Austroads Glossary of Terms*, Austroads, Sydney
[19] Queensland Department of Transport and Main Roads (2015), *Guide to Development in a Transport Environment: Rail* See also *Glossary of Railway Terminology – Guideline*, Rail Industry Safety & Standards Board, 2010

Term	Definition
Embankment	A construction (usually of earth or stone) to raise the ground (or formation) level above the natural surface.
Flexible pavement	A pavement which obtains its load spreading properties mainly by intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material. Generally, any pavement in which high strength Portland cement concrete is not used as a construction layer.
Gantry	A bridging structure such as a signal gantry that carried signaling equipment above the railway tracks.
Grade separation	The separation of road, rail or other traffic so that crossing movements, which would otherwise conflict, are at different elevations.
Granular pavement	A pavement which obtains its load spreading properties mainly by intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material, which is gravel or crushed rock graded so as to be mechanically stable, workable and able to be compacted.
Greenfield sites	Undeveloped land, typically on the outer areas of cities.
Heavily bound base	A bound pavement having a minimum compressive strength value of 4 MPa.
Lateral load	The horizontal pressure or force usually referred to in the context of a horizontal pressure load on a retaining structure.
Pavement	That portion of a road designed for the support of, and to form the running surface for, vehicular traffic.
Possession (track possession)	The temporary closure of a section of railway corridor for the purpose of carrying out construction or maintenance work.
Railway corridor	(In general) the land which contains a railway track or tracks, measured from property line to property line.
RAMSYS	A proprietary software platform used to manage railway assets.
Rock anchor	A steel rod or cable placed in a hole drilled in rock, held in position by grout, mechanical means, or both.
Select fill	Fill complying with specified requirements.
Setback (rail)	The separation distance between a rail corridor and a sensitive land use, such as a residence.
Setback (road)	The distance of (say) a pole from the edge of the roadway.

Term	Definition
Spray seal (chip seal)	A thin layer of binder sprayed onto a pavement surface layer with a layer of aggregate incorporated and which is impervious to water.
Stockpile	A heap or stack of aggregate held in stock for future use.
Subbase	The material laid on the subgrade below the base either for the purpose of making up additional pavement thickness required, to prevent intrusion of the subgrade into the base, or to provide a working platform.
Subgrade	The trimmed or prepared portion of the formation on which the pavement is constructed. Generally taken to relate to the upper line of the formation.
Surcharge load	The vertical applied pressure behind a retaining structure.
Track (Plain)	Track comprising of rails, sleepers, fastenings and ballast.