What is the Impact of Poor Definition of Boundaries and Interfaces on Projects, and What, if Anything, Should be Done? - 11471

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ABSTRACT

There is much guidance and many standards that identify the key requirement of a project scope as being one of the most important elements of successful project delivery. However, there is less guidance as to what should actually be included within a scope. In particular, much less attention is given to the issue of the boundaries between, and interfaces with, other projects and the environment in which the project is to be delivered. This issue is of particular relevance to Waste Management because of the timescales involved. In many cases, the teams currently operating the facility and planning decommissioning works are not likely to be around when facilities are finally decommissioned, possibly many decades in the future.

While it is possible to address the interface and boundary issues as projects come to fruition, early identification and definition is extremely important. Without clarity and agreement of these boundaries and interfaces, it is not possible to ensure that all scope has been properly captured, handshakes have been agreed, and that project scope has been properly bounded. The result of this is that either scope is missed, key handshakes and interdependencies are inadequately defined or that scope is duplicated.

Where scope is simply missed or neglected, this will lead to additional scope and cost escalation later in the project. At the very least, this is embarrassing and damaging to relationships because responsible entities such as U.S. Department of Energy (DOE) and UK Nuclear Decommissioning Authority (NDA) will have to return to government to sanction additional funds. This can also be commercially damaging as liability funding turns out to be inadequate to cover final decommissioning costs. Alternatively, duplication of scope means that costs are exaggerated which could cause cost control problems during execution or potentially get the project cancelled before it is even started. Furthermore, while it is always nice to be able to identify cost savings later in the day, if these savings are due to poor estimation in the first place it simply makes the project team and responsible bodies look unprofessional. Where the money has been allocated from public funds, over-allocation also ties up funds that could be used elsewhere; this is particularly relevant when demands on government(s) to spend wisely are extremely high priority.

INTRODUCTION

One of the most fundamental steps in achieving successful delivery of a project is proper scope definition. It lies at the heart of the Total Cost Management (TCM ®) framework and, together with the Work Breakdown Structure (WBS), is pivotal to generating the Cost Estimate, the Schedule, and for managing risk and project delivery. Much emphasis is often given to defining the core requirements of scope. However, while this is undoubtedly important, the author raises the challenge that it is often not in this area that problems lie. The suggestion is that more consideration should be given to the edges of the scope, the boundaries and interfaces, as it is in these areas, rather than the achievement of the core deliverables, where problems can lurk to bite us when our backs are turned.

To this end, the author presents first a simple discussion of what boundaries and interfaces mean in the context of scope definition and then a review of project management standards, guidance and best practice with regards to scope definition to determine how the issues of boundary and interface definition and management are addressed. This is then followed by a review of a sample of reports available in the public domain, primarily those carried out by the U.S. Government Accountability Office (GAO) and the U.S. DOE on government funded projects in the United States.

All this is prefaced by illustrative examples to establish the basis of the challenge. It is completed with the results of the research, as to whether the hypothesis that boundaries and interfaces should be areas of more attention and concern is valid or should be rejected.

BACKGROUND

‘Fly me to the moon’ – an example of the impact of poor consideration of boundaries and interfaces

On 25th May 1961, President J.F. Kennedy famously said,

> “I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth” [1]

As project scope statements go, it was a pretty good one. The objective was clearly stated, and the timescale, endstate, and the quality measure all clearly defined. This was a very early stage of the project, at the concept stage, but it included a perfectly appropriate level of detail. Nine years later, after two successful moon landings, there was an explosion during the Apollo 13 mission which nearly caused a disaster. The explosion damaged the oxygen supplies and caused the mission to be aborted. Despite the explosion, the astronauts had enough oxygen to survive. However, to conserve power the astronauts had to move into the Lunar Module (LM) and use it as a ‘life boat’ until they returned to earth orbit. Unfortunately, incompatibility between the Lithium Hydroxide (LiOH) canisters on the LM carbon dioxide scrubber system and the ones on the Command Module (CM) was nearly enough to scupper their chances. It was only some truly imaginative work by the ground crew, and creative use of available material on the spacecraft that allowed the astronauts to return safely to earth. The core requirements of the scope of each module had been successfully met. However, the lack of commonality of the systems across the LM/CM interface meant that the equipment wasn’t readily interchangeable to help the crew recover from the problem.

There were undoubtedly some really good reasons why the carbon dioxide scrubber systems on the LM and CM were fundamentally different (the LM used cylindrical LiOH canisters while those on the CM were cubic). However – and with apologies to those engineers who delivered one of the most fantastic engineering projects that the world has ever seen – as an example of how cross-boundary scope issues can cause project problems, it makes a compelling example of what can go wrong.

Most of the projects that we will be involved with as cost engineers will not be quite as 'life or death' as the Apollo missions. Nonetheless, getting the scope right, especially at the boundaries, and across inter project interfaces, is vital if we are going to achieve our goal of successfully delivering projects on time, to cost and to quality.

An example from personal experience

In one particular example, taken from the author's experience of carrying out External Independent Reviews (EIR) with Project Time & Cost UK, Ltd, it was clear that the project team knew what needed to be done. The project team had defined their core scope; the demolition of a turbine hall on a nuclear reactor site. They had determined how they were going to demolish the key structures and had identified the types and quantities of waste that were going to be generated. They knew the final destination for the waste; uncontaminated material would be sent to landfill and Low Level Waste (LLW) and Intermediate Level Waste (ILW) would be consigned to the off-site repository and on-site store respectively by the site's radioactive waste management group. However, the team had not fully considered the project boundaries and interfaces and it was clear that the detail practicalities of how the waste was going to be handled had not been completely addressed. For example:

- Was transportation of the waste across the site the responsibility of the demolition project or the waste group?
- Would the waste be size reduced by the demolition project or by the waste group?
- Who would segregate the waste, for example the rebar from the concrete, the free release material from the contaminated material?

These were not complicated issues to resolve, and, in fact, were addressed very promptly. All it took was to establish a formal handshake between the two groups to agree their respective areas of responsibility. Once determined, and agreement reached, this was recoded formally and the handshake incorporated into the project scope. This formal record provided the key benefit of allowing the project scope to be defined independent of the knowledge of the project team members. In other words, the scope was no longer dependent on the fallible memories of project team members who might not actually still be involved when the project is finally delivered.

Furthermore, this confirmed boundary allowed a more accurate and precise project cost estimate and schedule to be developed. If the issues had not been resolved, then scope could have been duplicated in both projects (as in Figure 1, below), resulting in over-estimated costs. Alternatively, scope could have fallen between the two projects (as in Figure 2, below) potentially resulting in costly project delays, requests for additional funding, and in contractual disputes which are never conducive to project success.

Figure 1.Project overlaps result in duplication of work

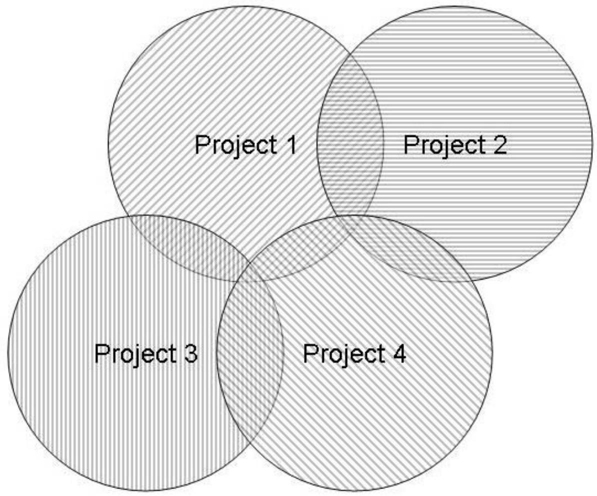
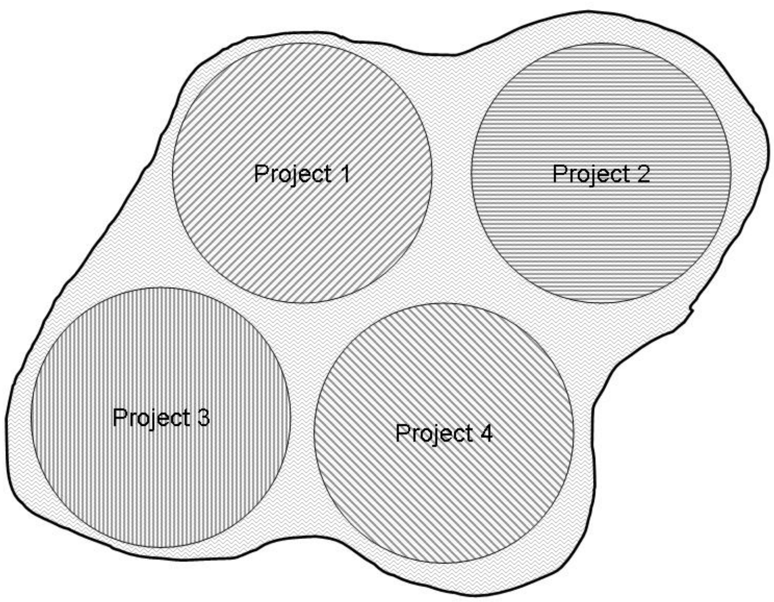


Figure 2.Project gaps result in missed scope

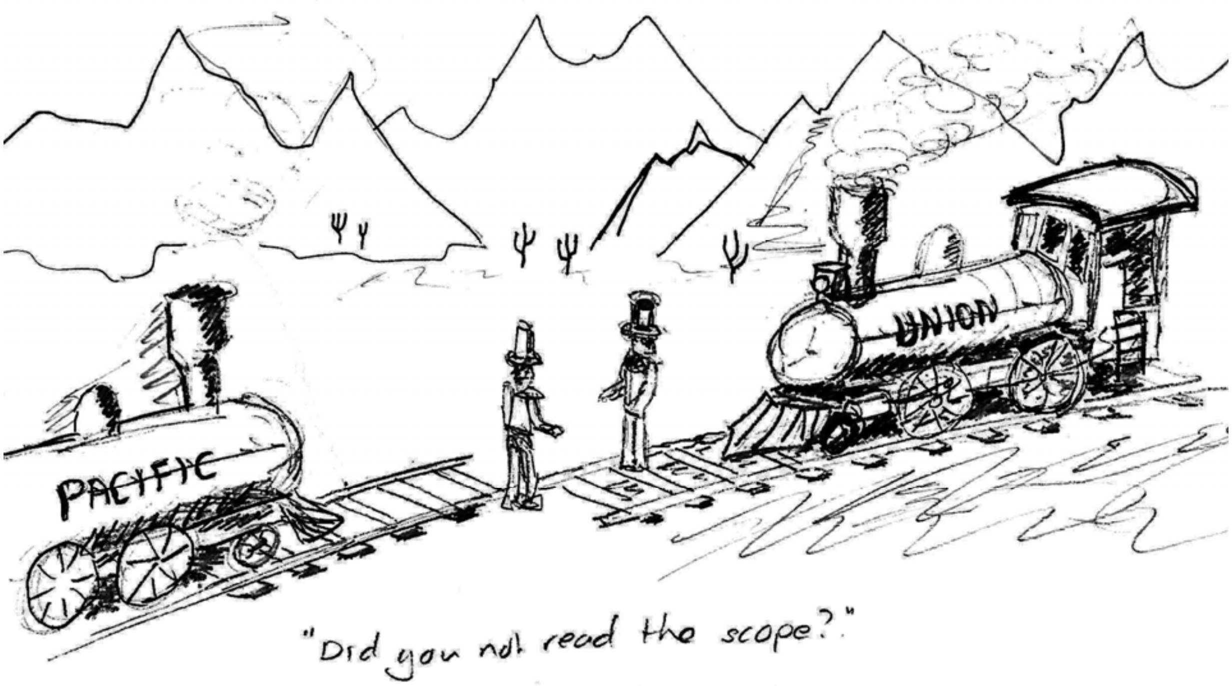


CORE PROJECT REQUIREMENTS VS. BOUNDARIES AND INTERFACES

Core project requirements

In the author's experience of reviewing projects at various stages of delivery, from concept through to execution and close-out, project team members often know very well what they're trying to achieve. They have a clear understanding of the project objectives and deliverables, the 'what needs to be done'. Project core scope requirements are (relatively) easy to identify, such as 'build railroad from the Atlantic to the Pacific'. This project core or 'kernel' is the part that is clear and well clarified. However, further away from this core it can all go wrong (see Figure 3, below).

Figure 3. What could have happened at Promontory Summit, Utah, 1869, when the Union and Pacific railroads met, if the interface had been poorly defined.



Constraints, boundaries and interfaces

Projects very rarely sit it complete isolation. They are carried out in context, and have to be delivered within a frame of reference and with consideration to constraints, boundaries and interfaces, both internal and external. Of particular importance is how the project in question interacts with the environment around it. These interactions define the bounds of the project and comprise both static and dynamic elements. It can be useful to think of the static elements as typically being the project boundaries and constraints, while the dynamic elements typically are the project interfaces.

The following sections expand on the definitions of these three elements. While the issue of constraints is not part of the core discussion, it is important that these be discussed, in order to clarify their relationship with the other two elements of boundaries and interfaces.

Constraints

Constraints can be physical, such as a limited plot size or access limitations; they can be operational, such as having to fit in around other projects and manufacturing processes; and they can be stakeholder driven, such as minimizing noise and nuisance. Constraints are those things that restrict and limit the ability of a project team to deliver a project in line with the client's expectations, and of meeting the requirements of time, cost and quality, the three fundamental tenets of project delivery. Constraints can often form part of the client specification.

Boundaries

Project boundaries can often be similar to project constraints. However, in this case, there is often more to be considered than simple limitations or caps to what can and cannot be done. A typical boundary would be the connections to utility supplies and drainage. Certain specifications and requirements need to be met. They can be simple, for example, matching pipe sizes, thread types and electrical termination specifications. Or they can be the more complex issues of load limits, flow rates, volumes and pressures. Where projects are delivering modifications or extensions to existing plant or equipment, the boundary definition often becomes part of the functional specification of the scope of work. This is particularly relevant when, for example, connecting new control and instrumentation equipment to existing systems. Due to the pace of development of Information Technology (IT) systems, there may be many generations of development between existing and proposed equipment that need to be bridged.

Interfaces

Project interfaces are the items of interaction with other elements of the project environment that must be clarified in a similar way to the project boundaries but which then must be actively managed. This management can take many forms, but it typically requires some active engagement with the party on the other side of the boundary. The key here is a proper ongoing dialogue and handshaking with the other side. It is not acceptable for this to be one sided. This does not demonstrate acceptance or understanding. In the same way that good personal communication benefits from echoing thoughts back to the speaker, a full handshake ideally requires an acceptance and re-declaration of requirements by the recipient party. Referring back to the example of the utility boundary, this can be perfectly simple if both the requirements and capacity are known and simply defined. However if, for example, significant utility supplies of electricity or compressed air, or an operational resource such as maintenance is required, then the issue very much becomes one of ongoing interface management and allocation. It is no use expecting that the electrical sub-station you were planning to use is going to be there over the operational lifetime of the plant you are constructing. What is needed is a full exchange of requirements with, in this case, the owner of the sub-station. This should include an appreciation of what demands are expected (such as power, current, voltage, phases, impedance matching) so that the supplier can confirm, or otherwise, that they can meet the project’s needs both during the project delivery phase and after handover to the client.

SCOPE DEFINITION GUIDANCE AND GOOD PRACTICE

The scope is something that the Project Management Institute (PMI), via the Project Management Body of Knowledge (PMBOK ®), identifies as a fundamental building block of a project and as being an essential pre-requisite step to creating a project cost estimate and schedule. The Project Management Body of Knowledge (Fourth Edition) [2] identifies a project scope as:

> "The work that needs to be accomplished to deliver a product, service, or result with the specified features and functions."

Furthermore, it also identifies product scope as:

> "The features and functions that characterize a product, service, or result."

Both of these definitions of scope have to be fulfilled. Project scope needs to be comprehensive and properly bounded if the work is to be completely identified with no gaps (or duplications) and product scope needs to be comprehensive and properly bounded if features are going to be complete and the product is going to perform as required in the context of the systems around it. It is noted that neither of these definitions raise the issue of the environment in which the project is to be delivered and that neither definition explicitly considers the issues relating to boundaries and interfaces.

If scope is not properly defined then the work packages necessary to deliver the scope cannot be properly defined. Consequently, it will not be possible to estimate work element resource requirements, costs, or schedule durations. Poor estimates will lead to cost errors, loss of stakeholder confidence, and potentially result in damaging contractual disputes. None of these are conducive to successful project delivery.

The Association for the Advancement of Cost Engineering International (AACEI) makes only limited references to the issue of scope definition. In the Skills and Knowledge of Cost Engineering [3], Scope Development is identified as being a pivotal element in the TCM ® Project Control Process. Elsewhere in this document, in the section on project planning, there is reference to a ‘Project Co-ordination Procedure’ (PCP) as part of the ‘Internal Project Charter Program’. While this does address some of the issues of co-ordination, working together to a common goal, and cross boundary communication, it is still primarily focussed internally, rather than being outward looking.

Further guidance can be found in U.S. DOE guidance G413.3 – 15 [4]. (Note, the reference to CD-4, below, is the DOE gated process stage gate ‘Critical Decision 4 - Approve Start of Operations or Project Completion’.)

> “Technical performance parameters and deliverables should define key features of the asset and how the asset will perform when completed at CD-4 including characteristics (quantity, size, etc.), functions, requirements, or the design basis that, if changed, would have a major impact on system or facility performance.”

Some of the key elements identified within this DOE guidance include the requirement to define the key feature, functions and requirements, making it closely aligned to the PMI definition. An example project scope definition is provided:

> “The high-level waste vitrification system shall be capable of 100 liters per hour of qualified chemical makeup; containing 40 weight percent high-level waste; loaded into Department of Energy approved canisters for shipment to the storage facility; with a plant availability of 66% or greater.”

This is a clear and unambiguous statement. However, once again, it describes the system in isolation. It therefore misses out on identification of some of the crucial interfaces, such as:

- From where the raw waste is coming– local plant, other plant in the U.S., or from overseas suppliers?
- How it is delivered to the system – is the waste delivered in transport containers, by pipeline; is it to be collected?
- What support systems are required for the plant to operate – is steam, compressed air, electricity required; if so, at what demand?

- How the vitirified product is transferred to the storage facility – is it to be delivered, or will it be collected?

This list is by no means exhaustive.

It is recognised that such a simple example is exactly that, an example, but it does emphasise the concentration on core requirements, to the detriment of context. It is noted that this particular DOE guidance document does suggest elsewhere that key project interfaces are identified and managed. However, it suggests that this should happen separately from the scope definition and includes provision for them to instead be managed within the Project Execution Plan (PEP). While it is good to see that interfaces are being addressed and managed somewhere, the author suggests that they first need to be identified and defined, and that the scope is the place that this should be done.

One more example comes also from the Association of Project Managers (APM) Body of Knowledge Definitions [5],

> "Identification and definition of the scope must describe what the project will include and what it will not include, i.e. what is in and out of scope."

Again, while this does imply the use of inclusions and exclusions, no explicit reference to boundaries, interfaces or environment is stated.

However, there is guidance around which does take into account the importance of project boundaries. For example, the Washington State Department of Information Services Project Management Framework [6] includes the following as part of the definition of project scope:

> "Scope provides a common understanding of the project for all stakeholders by defining the project's overall boundaries"

In summary, therefore, while there is a significant level of focus on scope, scope development, and the importance of scope management to the project delivery process, it is considered that very little of what is written addresses the issues of boundaries and interfaces, and the relationship of the project to the environment in which it is being delivered.

LITERATURE REVIEW

There are many documented examples showing where poor scope management, poor scope definition and scope creep have contributed to projects being delivered in a sub-optimal manner. For example a report by the Construction Industry Institute carried out in 1983 concluded that,

> ". . . Poor scope definition and loss of control of the project scope rank as the most frequent contributing factors to cost overruns." [7]

And examples continue to be reported; this taken from a recent National Audit Office (NAO) report of an upgrade to the British Broadcasting Corporation (BBC) studios in the UK,

> "The scope of the project was not sufficiently defined when the project was approved and there were over 42 contract variations individually over £50,000 in value and with a total value of £13.9 million, which contributed to significant delays and ultimately to a dispute with the developer" [8]

Furthermore, a recent review of scope carried out by the U.S. DOE on the Hanford site clean-up project in Washington State determined that poor scope definition accounted for some 20% of the increase in project costs:

> "Environmental Management (EM) now estimates that the life-cycle cost for the program could increase by $50 billion. Of this increase, approximately $10 billion is attributable to new scope not in EM's previous baseline." [9]

However, while poor scope definition is often cited as the root cause of the problem of cost growth and schedule overrun, there is rarely any discussion as to why this should be the case. Although a report by the U.S. GAO [10] in 1993 identified that:

> "project definition [at the completion of design] accounts for 50 percent of the cost growth variance [in environmental remediation projects]"

However, these examples have mainly focussed on the generic nature of poor scope definition as being the root cause of the problem and none of them have identified either boundary issues or interface issues as being key drivers for the scope related problems.

SUMMARY

While the author's perception is that the definition and resolution of boundaries and interfaces within scope documents is important, this is not backed up by the requirements of best practice guidance. Neither is it backed up by research carried out internationally on poor cost and schedule performance, which identifies poor scope definition and poor scope management as issues but does not identify boundaries and interfaces explicitly as a root cause.

CONCLUSION

There is the potential, in all projects, to concentrate on the core deliverables and to ignore the boundaries and interfaces to the potential detriment of successful project delivery. The way a project interfaces with its environment and with other project elements can have a significant impact on the success of project delivery. A great deal of the current guidance and best practice identifies proper scope definition as something that is essential to successful project delivery, yet there is little information as to how this should be achieved, especially at the edges of projects, where poor definition of boundaries and interfaces can have a significant impact on project delivery.

Although this review was initiated by the author's concerns, it is clear that there is little documented evidence available to support the theory that boundaries and interfaces are being neglected. This would suggest either that there is no weakness in these areas or that they do not impact significantly on project delivery. One other alternative, however, is that these areas have simply not been subject to detailed examination and they do contribute to the problems that are identified in relation to such issues as poor initial scope definition and management.

Therefore, despite the lack of significant documented evidence to specifically support the hypothesis, the author suggests that the risk posed by poor management of boundaries and interfaces is still one that should be properly managed. A relatively simple process of stakeholder management and proper two-way communications or handshaking is the key. By examining the edges of the project, and clarifying the boundaries by discussion and dialogue, any potential problems and issues can by identified and successfully defused.

However, it is not enough to simply identify these issues on a one-off basis. They must be incorporated explicitly into the project scope and then they must be managed, as scope should be, to ensure that no surprises occur. Once defined and agreed, boundaries and interfaces must continue to be controlled through a proper process of management and configuration control. By ensuring that they are captured and kept clearly visible, the significant threat of the unknown and unexpected can be kept at bay.

RECOMMENDATIONS

Despite the lack of documented evidence, it is still recommended that a change of approach from one that is inward looking, and focussed on the internal issues of project delivery, to one that is outward looking and aims to allow the project to co-exist with its environment, would be beneficial. One approach is the use of a fully populated ‘stakeholder management plan’. Such plans are typically used to engage stakeholders and manage stakeholder expectations where potentially controversial decisions are to be made. However, they can have great use and be applied whatever level of potential conflict and sensitivity the project is likely to encounter. Another tool is the project/site/facility wiring diagram, which considers the projects, plant, facilities and services that rely upon the project and upon which the project is dependent. These diagrams, which are simple in concept but which can turn out to be extremely complex, are a very powerful tool to help determine the environment in which a project is sited.

Whatever documents are made available, they should be used to look to the edges of the project, and be used to systematically review the boundaries and interfaces both internal (for example between disciplines such as safety, engineering, finance and purchasing) and external (for example between the owners of adjacent buildings, utility suppliers, support services, and upstream and downstream plant, etc). Once this list has been generated, the project team can systematically address each interface in turn. A simple table of key areas, interfaces and boundaries can be drawn up and included in the project scope. Each key interface can have its own interface document, if complexity and technical requirements demand such a level of definition. Otherwise, a simple statement of agreement may be adequate, with an exchange of e-mails or memos recorded in the project supporting documentation and referenced in the scope text. An example interface document is shown in Table , below. In this way, any potential problems can be identified at an early stage and can continue to be managed in a way that supports project delivery.

Table I. Example Boundary/Interface Definition Table

Boundary/interface	Key requirement/interface	Agreement/reference
Utilities		
Electricity	Electrical requirements identified and communicated during meeting, 15/5/09	Agreement for 11kV substation from May 2011 to end 2030. See memo – attached to scope as attachment 1

Water	Peak requirement of 15000l/day, potable.	To be supplied from potable water main. Identified in site infrastructure requirements document
Compressed Air	No requirement yet defined	To be supplied from compressor house. Included explicitly in scope, section 5, 'ancillary plant'
Support services		
Engineering	No requirement – outside project scope. However, discussions have been held with manufacturing manager. See minutes of stakeholder meetings, 12th March 2008, 19th October 2008.	Requirement for engineering support to be defined during final stage design and through commissioning phase. Finalised plan to be provided to manufacturing manager no later than 12 months prior to hand-over. Engineering support specifically excluded from project scope. See scope document, section 8 – 'Exclusions', item 5.
Asset care	No requirement during construction phase. However, discussions have been held with manufacturing manager. Also, lifecycle costs to be analysed during phase 1 concept design as part of construction optioneering process. See also comments in 'Engineering', above.	Asset care requirements to be defined following detailed design assessment. Finalised requirements to be provided to manufacturing manager no later than 12 months prior to hand-over.
And so on…		

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