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PERSPECTIVES

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# PROJECT INFRASTRUCTURE REQUIREMENTS

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When considering a prospective mining operation, much of the focus is naturally on the resource itself and the ability to extract and process the material into a commercial product. However the ability to achieve this is dependent on the infrastructure that is available, or needs to be constructed for the project.

## Boring but Important

a commercial product. However the ability to achieve this is dependent on the infrastructure that is available, or needs to be constructed for the project. Infrastructure is that boring, but important stuff that a project requires to support the operation. To give an idea of the scale of infrastructure in a project, consider the capital cost breakdown for a planned 10 Mtpa mine in the Hunter Valley of New South Wales, Australia.

Even in an area that is well supported with regional facilities, 19% of the capital spend is required for project based infrastructure. This is almost as much as the mine development, and is more than the cost of the coal handling and process plant. If the project overheads are distributed across the various physical elements, the split grows to some 28%. All of this for a project that has well established rail and road access, water and power

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running past the front door. What is also interesting is that in this project of approximately $2B, 5% of the capital cost is required for offsite infrastructure. In a more remote area such as the Galilee Basin, the need to construct rail and port infrastructure drives the infrastructure costs to some 45% of the total capital costs. Applying the same on cost distributions that occur for the Hunter Valley project, the total infrastructure cost reaches 60% of the capital spend.

## Infrastructure Considerations

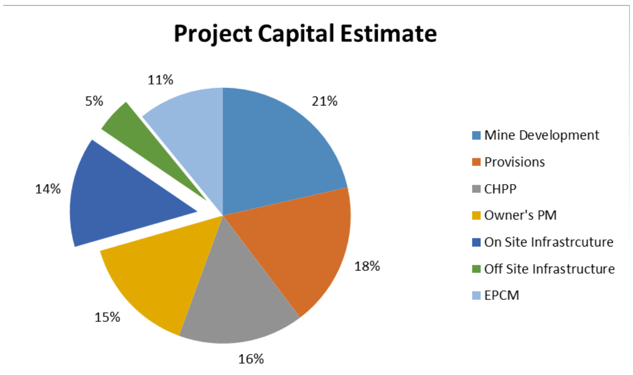
Infrastructure for a project covers a wide range of facilities. These can include;

### Roads

Roads need to be built to allow access to the site for people, materials, equipment and possibly to allow for the movement of product or waste material off site. Roads need to be built around the site to allow for the movement of all the same things between parts of an operation. These roads need to be properly engineered to allow for both the load and the frequency of traffic.

### Rail

Rail access is often required for the transport of the finished product for the mine. This is a necessity for bulk commodities as there is often no other economically viable method that can handle the volumes involved. Rail transport is a classic area of trade off for metals mine where the volumes can be handled by either road or rail. Generally it's a case of the high initial capital and low operating costs of the rail competing with the reverse situation for road transport. The higher the volume and the longer the distance the greater the analysis tips in favour of rail.




### Power

Mining operations are large users of electric power. In ideal circumstances, the mine is located in an area with an established electricity grid, sufficient generating capacity to meet the demand and major distribution line running next to, but not across the lease. If the mining operation impinges on existing power infrastructure then a choice needs to be made between sterilizing parts of the orebody or undertaking an expensive diversion. Reliability of supply is often critical, particularly where there are complex metallurgical processing operations on site, or underground mines that need pumping and ventilation. In the event that all of these factors not being present, then a decision will need to be made to upgrade the existing infrastructure, or generate power on site. Location and past history have a great influence on the availability, and hence cost, of supplying power to the site. There are times when the distances are so great that local generation is the only option.

### Water

Water is a necessary part of almost every mining and processing operation. The reliable supply of water is a necessity for the personnel working on site, a critical part of the site safety systems and will often require the construction of dams and weirs some distance from the operation in addition to pipelines and treatment plants. The presence of excess water is equally an issue. Ground water from the mine and waste water from the process plant requires recycling or disposal. To complicate matters, often one is incompatible with the other. Rainwater falling on site must be collected and drained. Local water courses may need to be diverted. Weather cycles and variability play havoc on the planning and operation of water infrastructure.

### Communications

Modern mining operations require a variety of communication systems to operate. These include data and voice radio networks, telephone both fixed and mobile, and computer networks both internally and externally. Mining operations now require rapid, reliable internet access for many mining functions, and this is a key necessity of all sites. In remote areas this now drives the use of satellite based communications on the site.

### Non-Process Buildings

Apart from the buildings that house the process plant, the site will require a range of other buildings. These include things such as workshops, warehouses, car parks, emergency response facilities and explosive storage each of which have their own unique requirements.

### Airstrip

Remote operations are great users of air transport to support the FIFO workforce that is now being commonly engaged. But these are not the only requirements for air access. Even with residential based operations, air access is required for fast emergency response and patient transport. Almost every mine in NSW has either an airstrip or a helipad on site for just this reason. However the design standards and regulations for aviation can be an order of magnitude more difficult than that required for mining infrastructure.

### Accommodation

Often providing accommodation for mine workers is part of the setup of the mine. Historically this was achieved through the construction of a dedicated town where both the will require a range of other buildings. These include things such as workshops, warehouses, car parks, emergency response facilities and explosive storage each of which have their own unique requirements. mine employees and their families resided. This then generated the needs for facilities for medical, educational, retail and recreational services. Many operations are now turning to temporary accommodation of the workforce during their rostered time on site. Even though this is their temporary home, the quality of the accommodation needs to be of a high standard to avoid problems. While savings can be made in the number of accommodation units required, there is now a requirement for messing facilities, and often an even greater requirement for recreational facilities.

### Ancillary Equipment

While the key mining equipment is the focus of a very detailed selection process, and the construction of the multi-storey process plant is generally well thought out, there is a vast range of smaller equipment that is required to keep the place running. Cranes, forklifts, specialized trailers and other equipment all need to be included in the plan. Once this equipment has been identified, it then needs facilities to store and maintain it.

### Hydrocarbon Storage

The storage and handling of hydrocarbons on site is a necessity for the operation, but imposes some strict requirements on the design of the facilities. This material is some of the most demanding to create storage facilities for. It can be flammable, poisonous, carcinogenetic, a pollutant and the most common target for theft. As a result, the design requirements for these facilities are stringent. It is unfortunate, but true, that many storage tanks and pipework will leak at some stage of their lives. If pipe is buried underground, then the leak may not be detected until sometime later when the fluid eventually seeps to the surface.

### Security

Mining is a process that has many hazards, and as a result it is necessary to control access to the mining and processing areas. Mining also requires a large amount of both capital equipment, and operating supplies that are an attractive target for thieves. Control of access is required not just for humans, but also for domestic and native wildlife. Theft in the developed world is often associated with issues such as fuel and power theft, removal of copper conductors, and the theft of equipment. Added to this, in the developing world, theft may also include such basic necessities as food, clothing and building materials. While security services are part of the deterrent and response to these issues, careful design plays a more important role. In designing the site for security it must be remembered that the majority of theft is undertaken by personnel who have legitimate access to the site.

## Infrastructure Requirements

Once the scope of the infrastructure requirements is known the sizing and construction timing can be considered. Unlike the mine, the infrastructure is designed at built at the start of the project, and very little opportunity redesign later. In particular, fundamental choices such as on site or off site power supply, and rail or road transportation are almost impossible to change. This is because once the capital has been spent on one option, it will be very difficult to get the economically justify the other option, even if the operating costs are lower.

### Production Rate

There is always a trade off in estimating the infrastructure required to meet planned production and that which will allow for production increases in the future. To keep initial capital costs low, infrastructure should be sized for the current planned levels of production. However this may limit the future ability to increase production should circumstances change. While site buildings and fixed facilities can be extended at reasonable cost, long distance supply of services such as power, water and rail are much more difficult to expand.

### Production Ramp Up

Infrastructure needs to be designed to meet the maximum demand that will be placed on it, even if it sees this demand only sporadically, or later in the mine life. It is during the construction phase that all of the required services are available and mobilized to undertake the building of the infrastructure. Bringing these services back at a later stage will be an expensive exercise. Temporary facilities may be used to facilitate construction. As a result in the early years of the mine life, the infrastructure may be considerably over sized for the operation.

### Equipment Size

Similarly, the size of workshops, cranage and clearances on site need to accommodate the largest equipment planned for the site and any reasonably foreseeable increase in the future. While buying new cranes and building bigger buildings is relatively easy, lifting pipes and power lines for increased clearance, or strengthening roads is much more costly.

### Climatic Change

Countries such as Australia have a climate that allows for year round working conditions without substantial infrastructure to deal with climatic variations. Areas that experience very cold weather will have increased infrastructure requirements. Almost all work must be done indoors, and outdoor work scheduled for the summer months. This results in both stricter building standards and a larger variation in the peak work load. Additional services such as site wide heat distribution systems may also be required.

### Community Involvement

The introduction of a mining operation to many areas is a great boon to the local community from an economic, social and educational viewpoint. Community support for the project is now vital to gaining, and keeping, regulatory approval. As a result, some compromise may be required in the infrastructure design. This typically affects infrastructure in two ways. Firstly the range of infrastructure required increases to provide community facilities, and secondly the design and construction method may need to be modified to allow local suppliers of goods and services to participate in the construction and maintenance of the infrastructure.

### Estimation Accuracy

The feasibility study will progress through a number of stages to reach the final design that is approved and constructed. It is important to match the level of effort and detail to the stage of the study to avoid additional work that is not adding value. Figure 2 below outlines the detail required at each stage.

| Phase | Concept | Scoping | Pre - Feasibility | Feasibility | Construction |
|---|---|---|---|---|---|
| Basis of Costs | Comparable Project | Database of costs | Budget Quotations | Firm Quotations | Contracts |
| Design Detail | Outline description | Sources & volumes | Single Line Diagrams | P&IDs | Engineering Drawings |
| Risk & Mitigation | Fatal Flaws & Red Flags | Control Measures Identified | High Level Risk Assessment | Detail Risk Assessment | Active Control Measures |

### Concept

At the concept stage the key question is whether this project is worth considering. The level of information on the orebody is low, and broad estimations are being made on the deposit characteristics. From an infrastructure perspective, much of the data will be drawn from similar projects. Detail is limited to an outline description of the facilities that are required. The major risks are identified as either fatal flaws that will stop the project, or major issues that pose an engineering or economic challenge.

### Scoping

In the scoping stage, there is genuine interest in undertaking the project. Major functional issues are addressed and an operational philosophy is developed. This will now guide the development of an infrastructure plan. Costs are drawn from similar projects and internal cost databases, in a greater level of detail than in the concept phase. The design of infrastructure is now focused on identifying the sources of supply of services to the mine for both construction and operation. Many options are considered and evaluated on a qualitative basis. Control measures are identified for the key risks, and these will have a key role in the design of much of the infrastructure.

### Pre-Feasibility

This is where the design process becomes more detailed. Infrastructure parameters are being calculated and options evaluated on a quantitative basis. A key part of this process is the detailed trade off studies between the viable alternatives. Costs are now developed on the basis of budget quotations from suppliers that give an indication of price and timing of supply. Design detail shows the functional factors of each system and structure, but not details. The risk assessment now broadens to consider the full range of issues. The outcome of the Pre-Feasibility study is the preferred design concept for the project infrastructure and a detailed explanation in both technical and economic terms as why it was chosen over the alternatives.

### Feasibility

The feasibility study is all about optimisation. A difficult issue here is that the decision to make the investment in the project is yet to be made, so there is a need to limit expenditure. The level of engineering needs to be set in line with this fact. Costs are now sourced from tenders or firm quotations. The design detail is now at the drawing stage and shows the overall configuration of the infrastructure, but the finer details for construction are generally not present. A detailed risk assessment is undertaken to ensure that all risks are identified and control measures have been included in the designs.

### Construction

This is stage where physical construction of the mine starts. For infrastructure this incudes finalizing costs through contracts and producing detailed engineering drawings for construction. Risks are now controlled by active measures through a well-developed Site Safety and Health Management Plan.

## Infrastructure Issues

There are a number of factors that can impact the design of the infrastructure through the feasibility process and have proven to be a trap for the unwary.

### Varying Legislative Environment

Generally in undertaking infrastructure design, reference is made to the legislation and standards that exist. Given the lead time between the various phases of the study and the point at which the infrastructure goes into use, there is a possibility that these requirements will change. In almost all cases, the infrastructure needs to meet the standards present when it is introduced into service, not those that exist when it was designed. In some cases, it will also be necessary for infrastructure to be upgraded to meet new standards when they are introduced. This retrospective enforcement of standards is rare in most engineering design processes, but not uncommon in the mining industry. The NSW Mine Design Guidelines are a good case where updates require modification of equipment on site within a specified timeframe.

### National / International Standards

While it is reasonably obvious that infrastructure meds to meet the standards of the country where it is in use, many countries do not specify standards for all engineering designs.

An interesting example is structural steelwork where there are a number of different national and international standards. From a functional viewpoint there is little difference between them in that the goal is make sure that the structure does not collapse. There is great variation in detail though in the dimensions of the various steel sections. Selection of a particular standard may then exclude suppliers from other countries from bidding on the work. This has been a major factor in limiting the uptake of equipment manufactured in emerging markets that operate to different standards. In particular Chinese steel sections are dimensionally different from AS / BS / ISO steel sections.

Even when the dimensions are the same, quality issues can remain, as seen by the current issues with some foreign sourced building materials containing asbestos being used in Australia.

### Political & Community Expectations

In some projects, more distant political influences may be in contrast to these local expectations. While the issue appears to be resolved, the recent free trade agreement with China brought these issues to the fore in Australia. We still face the prospect that work undertaken by overseas tradesmen is subject to approval by local inspectors, potentially creating some delays to projects.

### Battery Limits

It is critically important to understand where the limits of the project are. Overlap causes a waste in resources, but gaps can cause major issues. This needs to be controlled on both the external limits of the mine infrastructure to the regional infrastructure, for example external supply points being defined, and internally on the site between the various design teams and contractors.

A major issue here is compatibility. While issues within a design team / single supplier are rare, it is more common where the different parts of the infrastructure come together. Electrical and communication networks are typical areas where compatibility checks are vital at the design stage to avoid costly rework.