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Queensland Sugar Limited

Conference Paper

Report

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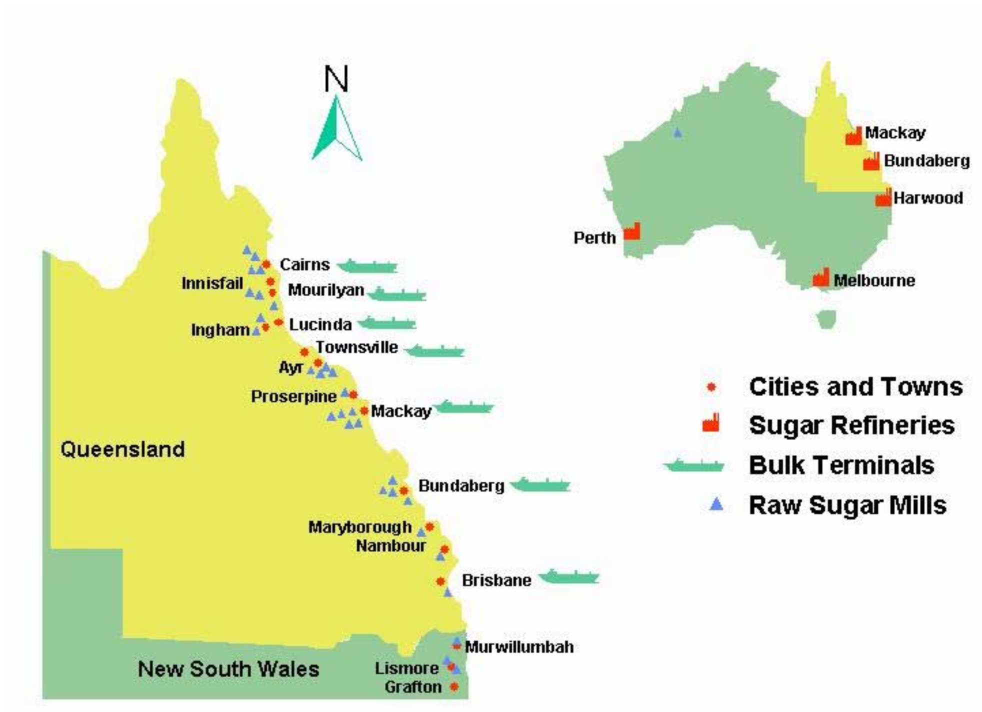
1. INTRODUCTION



Raw sugar in Queensland is produced from sugar cane grown on farms which stretch along 2,100 kilometres of Australia's eastern coastline. The cane harvest on the approximate 6,500 cane farms (approximately) begins in June of each year and normally finishes in November, depending on seasonal conditions.

The harvested cane is transported by road or a network of cane railways to where it is crushed by one of Queensland's 25 sugar mills. The raw sugar is then transported by road or rail to one of seven Bulk Sugar Terminals to await shipment or directly to Australian customers for refining.

Queensland Sugar Limited (QSL) with its head office located in Brisbane is the exclusive marketer of the State of Queensland's annual raw sugar production. Each year, the company sells the state's entire raw sugar production on behalf of Queensland's cane growers and mill owners to customers in Australia and around the world. QSL is a company limited by guarantee, owned by the growers and millers of Queensland.

The bulk sugar terminal network plays a key role in the high level of service provided to customers. Queensland is a leader in the bulk handling of raw sugar with some of the largest, most advanced bulk storage and handling facilities in the world.

The seven terminals are located at Cairns, Mourilyan, Lucinda, Townsville, Mackay, Bundaberg and Brisbane and are specifically designed to receive, store and out-load raw sugar to domestic and export markets. Given the limited harvesting period, the 2.4 million tonnes storage capacity of the seven bulk sugar terminals enables Queensland Sugar to schedule customer deliveries year round.

Sugar Terminals Limited (STL) owns the seven bulk sugar terminals which have been constructed and financed by the sugar industry. STL represents the owners who are either Queensland cane growers or Queensland mill owners. Trading in STL shares is restricted to industry participants. QSL manages the terminals under a leasing arrangement with STL.

2. DEVELOPMENT OF PROJECT

There had been no increase in storage in Queensland in line with the production growth that occurred in the 1990s, and as a result the proportion of the total raw sugar production which could be supplied outside of the crushing season had been reduced. This reduced supply flexibility had constrained the industry’s approach to marketing and had changed the nature of the marketing package offered to many customers.

This led to change in the marketing strategy to respond to logistical considerations (i.e., the need to move sugar early), rather than in response to customer requirements.

Without additional supply flexibility, Queensland was constrained to selling a larger proportion of production as it was produced and not at a time of the industry’s choosing. The change in structure of the world market over the past 13 years has seen the production of almost 70% of world sugar for export in the second half of the year. The major proportion of Queensland production was entering the market place at a time when competition for destinations was at its height. In this environment the Queensland industry risked securing insufficient outlets to move the required volume of sugar by the end of the crushing season.

There was a wide range of alternative storage possibilities available to the industry to achieve a more flexible supply regime. The possibilities included permanent storage solutions such as traditional facilities, temporary storage such as storage “under canvas”, storage at mills and storage at regional hubs or at customers.

A review team was established by QSL in February 1999 to examine alternative storage solutions in Queensland. The team identified and evaluated 47 options before producing a short list of five which met all evaluation criteria and had the lowest comparative cost rankings compared with the traditional design and cost structure.

Of the options considered, increased port storage was found to provide the most cost-effective means of providing additional storage capacity. Construction of additional capacity at mills was found to have relatively higher cost structures than would port-based storage to achieve the same storage capacity.

Additional storage capacity to enable delivery in the non-crushing season would enable the industry to maximise the benefits flowing from the co-ordinated sale of Queensland’s raw sugar.

Townsville was chosen because of all the terminals in Queensland, Townsville had the greatest strategic requirement for more storage capacity. Townsville had significant scope for further expansion in its supplying districts and the terminal had the highest stock turnover ratio of 4.5:1 (1,300,000 t production: 290,000 t storage). The development of an additional 400,000 tonnes of storage at Townsville provides increased supply flexibility at this terminal as well as to the network as a whole.

In December 1999 expressions of interest were called for the design and construction of a 400,000 t storage facility situated on available land within the original terminal’s lease. After assessing the expressions of interest, concerns were raised with respect to the impact of such a large building given the urban development adjacent to the port and the city's urban renewal project.

It became obvious that it would be impractical to build the new facility on the available land. With the assistance of the Townsville Port Authority and agencies of the Queensland Government an alternate site was identified. This site required the amalgamation and modification of five different properties having four separate owners. Given the obvious complications, it was decided that the quickest way to deliver the project would be for QSL to progress the design phase whilst land tenure was secured. STL appointed QSL as its agent to deliver the additional storage. QSL appointed GHD as its Engineer.

3. CONTROLLED RISK APPROACH TO DESIGN

QSL went to pains to develop a relationship with their project consultants (particularly the designer) which enabled a culture of complete openness to pervade the design environment. At every step of the design process, GHD gave feedback to QSL, QSL digested and understood the issues surrounding the design, and in an informed manner provided direction back to GHD on the basis of a balanced risk assessment.

Some of the design solutions arrived at would not have been possible in an environment of total reliance on the designer's judgement. By assuming ownership of the technical risk (rather than assuming it was transferred on appointment of the designer) as well as making strategic project decisions, "best for project" solutions came to the fore. This is the desired outcome within an Alliance project framework, however was facilitated in a "traditional" consultant-owner relationship through QSL's careful but wholehearted involvement in the decision making process.

Following is a description of a number of the technical solutions achieved through this relationship process. It is demonstrative of the outcomes possible when clients understand and embrace their ultimate ownership of project risk.

3.1 DESIRE FOR CHANGE

QSL approached this project, looking for quantum improvements in the unit cost of handling bulk sugar.

Utilising the project team's combined experience in handling a wide range of materials, available technologies that could be adopted from other industries were identified and assessed. This work centred around the use of automated mechanical reclamation machines for the outloading of sugar.

Based on this comprehensive review, it was demonstrated that the current material handling techniques employed by QSL were the most cost efficient, and possessed a more attractive risk profile. It was found that:

- Initial capital cost would be in the order of $10-15M more than a traditional retrieval system (including building costs).
- There was a risk of product degradation.
- The ability of automated machines to move "hard" sugar was unknown.

The subsequent design was developed with the current means of sugar reclamation as a basis, although subject to continued improvement.

3.2 PROJECT OBJECTIVES

QSL's major design objectives for the project were as follows:

- Create 400,000 tonnes additional raw sugar storage;

- Create storage for at least 5 separate stockpiles of sugar of different “brands”;
- Facilitate the blending of sugars from any of the independent stockpiles;
- Increase the terminals in-loading rate to 1,800 tph;
- Increase the terminals out-loading rate to 2,800 tph .

Other important requirements of the project included:

- Ensuring the new storage facility be no higher than the existing storage buildings within the Townsville Bulk Sugar Terminal;
- Creating physical linkage between the new storage and the existing storages, both for materials handling and for vehicular and pedestrian movement;
- Improving efficiency in sugar handling, particularly in out-loading,
- Control of mechanical equipment through the existing Terminal Control Room.
- Minimising impacts to the community and environment.

3.3 GEOMETRY AND LAYOUT

The geometry and layout of the TBST had to achieve each of the client’s objectives, with the primary challenge being the creation of a design that satisfied community and town planning concerns.

The Townsville CBD and tourism precinct is immediately to the west of the current terminal and the original QSL site for the expansion project. QSL and other stakeholders examined the potential of alternative sites to provide a more socially acceptable location for such a massive development. The chosen site is nestled within the industrial port precinct, on otherwise under-utilised land, but still within appropriate proximity to the existing facilities.

Numerous geometric parameters were analysed to arrive at a cost effective solution that achieved these objectives. QSL was involved at every decision point in the process to ensure the success of the final geometry.

The result was an innovative building layout allowing the TBST to house two adjacent stockpiles under one large over-arching roof. The key advantages of this were:

- Significant reduction in cladding area.
- Blending and recirculation of sugar was facilitated.
- Improved operational efficiencies as layout enabled both stockpiles to be viewed at once and made movement between them easy.
- Roof able to be profiled and aesthetics improved.
- No central drainage required between two roofs (would be needed if stockpiles housed separately).
- Provision for emergency storage in the void between the two longitudinal stockpiles.
- Reduced wind loads at the ends of the building enabled reductions in structural steel quantity.

The appearance of the TBST also played a significant role in securing project acceptance from authorities and community. It was difficult to hide a building 30m tall and covering an area the equivalent of 5 rugby football fields. The single faceted roof design reduced the visual “bulk” of the building. The alternative site allowed GHD to orient the building façade sympathetically to the prevailing vistas available from the CBD and tourism areas.

3.4 FOUNDATION IMPROVEMENT

The economic viability of this project was threatened in early stages when it was found that almost the entire site was overlain with a layer of inconsistent fill over marine sediments. In its natural state this foundation would present problems with settlement and stability beneath the stockpile and walls and would be prone to liquefaction in a seismic event. The conventional treatment for foundations of this nature involves piling the floor yet this is both costly and brings time penalties. To overcome this problem, QSL and their designers went through a process of risk-based evaluation of alternative treatments to identify cost and time effective solutions.

This evaluation revealed that a ground improvement technique known as Dynamic Compaction/Dynamic Replacement (DC/DR) could be used in lieu of piling to provide structural support for the TBST. This technique combines the dynamic compaction of landfill with the reinforcement of foundations (alluvium and fill) by dynamic columns of either sand or stone. Although DC/DR had been used internationally, this project represented its first application in an Australian building construction.

The adoption of the DC/DR technique:

- Saved QSL approximately $8M over the cost of piling.
- Allowed the progressive handover of the site for building works.
- Overcame the problem of preloading whereby the site is inactive for substantial periods of time.

3.5 FLOOR SLAB

The use of a non-piled foundation had a flow on impact on the rest of the structural design:

- Elastic (reversible) settlement will be a feature of the facility each time the shed floor is loaded with sugar and unloaded;
- Plastic (permanent) settlement during the first loading.

GHD looked at a range of solutions for the storage facility floor, including provision of temporary floor surfacing, conventional concrete, and prestressed concrete. Taking into account the significant settlement movement that the floor would have to endure over its life, a prestressed concrete solution was favoured by QSL. The additional strength, and low thickness of such a slab system, provided the flexibility to move with the foundations without cracking.

3.6 ROOF DESIGN

The roof always represented a substantial portion of the project’s total capital cost. QSL recognised that incremental improvements in design efficiency would prove lucrative in terms of total savings.

Wind tunnel testing could be used to predict the wind loads that would be imparted by a cyclone. This would do away with the need to rely on the standardised Wind Code loads, ensuring that the roof structure was not conservatively designed. It was demonstrated that around 10% lower wind loads than specified by the Wind Code would actually occur, and led to savings of nearly $1M (for an outlay of around $30k to do the testing).

Durability concerns were overcome by the use of RHS closed truss sections. This eliminated the need for corners and crevices that encourage the collection of sugar dust from structurally important joints.

Mechanical equipment access problems were overcome via an approach that is unique to Queensland’s sugar terminals. The space in-between the trusses in conventional “A” frame roof structures used at other terminals for conveyors, was not available in the TBST due to structural limitations of the over-arching roof. Conveyor systems were housed within the truss section to minimise building height and building access ways and maintenance points were also built into the geometry of the trusses. The very long length of the roof also necessitated special detailing of conveyor/structure interfaces to ensure the expansion and contraction of each element was compatible.

3.7 CONVEYOR SYSTEMS

GHD had to design original in-loading and out-loading systems for the TBST as nominal building size limitations and performance improvement objectives meant traditional methods could not be used. The configuration and system control permits ready “blending” of sugar within the storage, that is, the simultaneous removal of sugar from two or more separate stockpiles, and placement as a blended mix in another.

The in-loading system features reversible travelling shuttle conveyors, so as to eliminate conventional “trippers” which would have increased the overall shed hight by another 3 1m. The shuttles are 130m long and consist of eleven modules, and are too long for conventional belt take-up technology. GHD designed a special take-up using helical coal springs.

Another innovation that reduced building height involved conventional flip-flop gates being replaced by pivoting chutes at transfer points where variable feed direction was required. Replacement of the flip-flop gates necessitated the incorporation of a moving head on one of the conveyors and this was achieved via a large pneumatic cylinder.

Traditional methods of sugar reclaim are associated with significant spillage and feed rate difficulties. GHD’s innovative out-loading system solves these problems by choke feeding sugar, which virtually eliminates spillage. The system features six mobile hoppers that are positioned under reclaim gates in the floor. Hopper outlets are tapered in the direction of belt travel and each hopper is slightly higher than the previous unit. This results in the sugar being fed uniformly onto the belt, with almost no spillage or dust generation.

The hopper train is also able to be split to enable recovery of sugar from multiple stockpiles. This gives QSL almost infinite control over the blending operations they might wish to implement to meet their markets.

Each of these innovations was made possible by the close involvement of QSL staff during the design process.

3.8 FIRE PROTECTIVE SERVICES

Sprinkler based fire protective systems that are traditionally used in industrial buildings are expensive due to TBST's building size and layout. The unique fire protection solution provided QSL with an efficient and cost effective solution to fire protection, saving some $2M from the project budget. The system also provides benefits to the Fire Brigade by enabling fires to be fought from a safe distance, external to the building.

The system features closed circuit cameras and remote operated articulated monitors (water cannons). The strategically placed articulated monitors enable fires to be fought from a safe location while a system of well positioned cameras gives visual feed back to those fighting the fire.

QSL's drive for a cost effective project, and high level of involvement and proactivity, facilitated this innovation. A number of external stakeholders had to be brought into the decision making team, and convinced of the merits of the system, to ensure approval.

3.9 STORM WATER DRAINAGE

Townsville is subject to tropical downpours and local flooding throughout the wet season. An effective stormwater system for the facility needed to address the following issues:

- Absolutely prevent stormwater from entering the building.
- Pollution control within runoff.
- Greatly increased runoff given the huge expanse of impermeable roof area, compared to the pre-existing condition of the site which was undeveloped (runoff from the roof alone would fill an Olympic swimming pool in around 15 minutes).
- Low elevation of the site, giving limited natural assistance to the removal of runoff.

The stormwater design featured the following innovations:

- The TBST's roof water was kept separate from other site run-off. As the water was essentially clean it could be removed from the site without further treatment and directed into the Ross River with no environmental impact.
- The roof water drainage system was designed as a sealed "pressure" pipe system, so that under normal operating conditions, roof water would back-up the downpipes, providing much

greater “driving pressure” within the pipes. This led to a very substantial decrease in pipe sizes to get the water to Ross River.

- All other stormwater from ground level was directed through a detention pond between the building and the street. This pond effectively controlled the rate of the water’s release and did not overload the Council’s existing drainage system. It also allowed polishing of water quality, and screening of gross pollutants.
- The building floor level was established taking account of potential ponding of water on the site, influence of tides on standing water level, and the expected long term settlement of the building.

Lateral thinking in respect of the stormwater drainage identified up to $300,000 in savings over the cost of a conventional solution.

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