



# CONSTRUCTION MANAGEMENT

During the development of the  
Gautrain Rapid Rail System



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## LEARNING OUTCOME

While meticulous plans were made to carry out the civil contract site management of the Gautrain project, the playing field changed regularly. This case study illustrates how staff and employers needed to be agile, resilient and adaptable in order to meet the project's continually shifting challenges.

## BUSINESS OBJECTIVE

To overcome the challenges that may occur with changing civil works and construction sites through effective and thorough site management that is done in a cost effective way.

## 1. BACKGROUND

### 1.1 Landscape

The Gautrain Rapid Rail Network, a Public Private Partnership (PPP) project, was initiated to construct a modern rapid rail system in South Africa's Gauteng Province. The first and largest project of its kind in Africa, the Gautrain rail system today links three metropolitan areas (Johannesburg, Tshwane and Ekurhuleni) and the OR Tambo International Airport (ORTIA).

The Gautrain network consists of 10 stations, 80 kilometres of railway lines, a train depot and a bus depot, constructed for the Dedicated Feeder and Distribution Services at all stations except for ORTIA.

The first phase of this greenfield project – the first Public Private Partnership rail project in South Africa – was completed shortly before the 2010 FIFA World Cup, and involved linking Sandton to the ORTIA as well as constructing the train depot. The second phase, completed in June 2012, expanded the rail network to include Hatfield and Park stations.

The Gautrain project involved several key public and private partner role players.

The key public partner is the Gauteng Provincial Government, administered via the Gautrain Management Agency (GMA). Other key public partner role players include the Gauteng Provincial Treasury and the

National Treasury through its PPP Unit.

The project's private partner is Bombela Concession Company (Pty) Ltd. (known as the Concessionaire), which is made up of both local and international companies. Bombela holds a 19,5 year concession for the construction, operation and maintenance of the Gautrain system.

The novelty and scale of the Gautrain project created many challenges that had to be overcome. This case study discusses the project's civil construction up to formation level, taking into account the complex project management and integration processes that were involved. These processes were needed in order to meet the completion dates so that the work of other parties (for example electrical, mechanical construction and operational testing) could be carried out.

### 1.2 Task Objective

Before the PPP contract was signed between the Concessionaire and Gauteng Province in September 2006, it had become clear that the organisational structure of the Concessionaire's construction arm, Bombela Civil Joint Venture (BCJV), needed to be taken into account in setting up the Provincial Construction Assurance Management (CAM). The CAM team needed to manage the Bombela BCJV, and was responsible for overseeing the team that would manage the PPP project. This required

setting up the staff plan, the CAM structure and outlining the responsibilities and work procedures of the Provincial Support Team (PST).

Development of the team organisational structure started in May 2006 and was completed in February 2007. This process included:

- developing job descriptions
- drawing up a Site Monitoring Handbook to guide CAM staff
- planning office accommodation for the four construction sections (see section 2.1 below)
- procuring equipment such as safety gear and cameras
- initialising a CAM Procedures document in order to formalise execution procedures for the CAM team

The final approved organisational structure for the project consisted of 92 personnel in construction assurance, with a maximum total of 77 employees during the development phase (see annexure). Because works were phased, staff appointments also were made in a phased approach.

## 2. SOLUTION STATEMENT

### 2.1 Civil Construction Sections

The construction phase of the Gautrain project was divided into four main sections:

- ① Tunnel Link Park Station via Sandton to Marlboro Portal (15 km)
- ② Airport Link from Marlboro Portal to OR Tambo International Airport (ORTIA) (19 km)
- ③ Midrand Link from the turnout on the ORTIA link at Marlboro to Nelmapius Overpass (20.6 km)
- ④ Hatfield Link from Nelmapius Overpass to Hatfield via Pretoria Station (18 km)

### 2.2. Obtaining Suitable and Qualified Staff

Obtaining suitably qualified candidates to interview for appointments was a difficult task. Ahead of the 2010 FIFA World Cup, construction including roads and soccer stadiums were being carried out at the same time, which meant that qualified staff members were in short supply. Advertisements were sent out internationally, which resulted in applications and

appointments of people of different nationalities, languages, education and experience.

### 2.3. Effective Administration

Because this was a PPP project, the Concessionaire was responsible for the design, construction and any associated risks. Because of this, the functions of the CAM staff differed from those of a standard site supervisor in a conventional construction project. Most notably, CAM staff did not have to approve all aspects of the construction.

In terms of the contract, the Concessionaire was solely responsible for the quality and progress of the work and for compliance with the relevant specifications. This meant that:

- Engineers monitored the Concessionaire's procedures and materials and advised on any non-compliance. It's important to note that the engineer is not the contractor's foreman and so was not responsible for any non-conformance issues. Their primary role was to act as the agent to protect the interests of the employer, which in this case was Gauteng Province.
- The engineer had to know the expected outcome or product in order to ensure the quality of work.
- The engineer needed to be fair but firm and make it clear that the specifications had to be complied with.



Because of this, the engineer needed to know and understand the design and specifications and the way these should be applied.

- The engineer had to balance time spent in the office with time spent on site.
- The engineers had to attend the weekly, monthly site and project meetings.
- Good and comprehensive record keeping by the engineer was of utmost importance. The engineer had to ensure that their supervisor and the PST were aware of progress, problems and any other matters concerning the project.

Although CAM staff could not enforce compliance, the role of the engineer as outlined above helped encourage the Concessionaire's staff to comply with specifications.

### 3. WORK METHODOLOGY

#### 3.1. Staff Deployment

Given the scope of the construction management required and the various civil engineering and building disciplines involved, monitoring responsibilities were separated into several teams. Each team had its own resident engineer and technical support specialist who reported to a section manager. Teams were split as follows:

- Tunnelling
- Viaducts, Bridges and U-Shapes
- Earthworks, Lateral Support and Drainage

- Stations and Depots & Yards
- Off-Site Works (Utilities, Road Works and Fencing)

#### THE FOLLOWING STAFF SUPPORTED THESE TEAMS:

Commercial and Contractual staff (Programme, Milestone Payments, Claims and Disputes)

Administration and Document Control staff



#### 3.2. Training and Skills Transfer

The PST aimed to cultivate a sense of common purpose within the team. To achieve this, they held regular combined staff meetings that were attended by team members from all the various disciplines.

During these meetings, the resident engineers, commercial managers and office managers updated the four section managers on the activities of each discipline. Because all team members were in attendance, everyone became familiar with the activities of the team as a whole, and were encouraged to alert the other disciplines about issues or events that could concern them.

These meetings also helped to identify areas of increased activity so that one team would be able to provide temporary

assistance to another – and so broaden individual skills in the process.

### 3.3. BCJV Staffing/Team

BCJV, along with its network of consulting and contracting companies, consisted of a multi-national, multi-cultural and multi-language group of people. This meant that various cultural and language differences had to be dealt with on site and in meeting rooms. In addition, although various groups had the same interests, different agendas had to be understood and managed. When the project started, partnering sessions were held where all parties could meet and interact on a social level in order to understand one another and build sound working relationships.

In addition to the internal team and individual challenges, various works and designs were produced internationally, which meant that there was the potential for delayed decision-making and misalignments with South African requirements and standards. These challenges impacted on the quality of work and project progress, and had to be dealt with on an ongoing basis in order to avoid possible claims.

### 3.4. CAM Site Staff Duties

Site staff duties included:



Carrying out site inspections and attending site meetings.



Attending to correspondence and ensuring that the required correspondence files were on site. This included general administration documents, site investigations and surveys, programmes and progress, contract matters, materials and accident reports.



Ensuring that the contractor was using the latest drawings from a set of as-built drawings (a drawing register) that was kept on site.



Managing the testing requirements as laid down in the standards and project specifications as well as the control results. This included aspects such as density results, concrete cube results, material tests and approvals, density and thickness tests and compaction densities.



Monitoring adherence to occupational health and safety requirements, including the required appointments in terms of the Occupational Health and Safety Act.



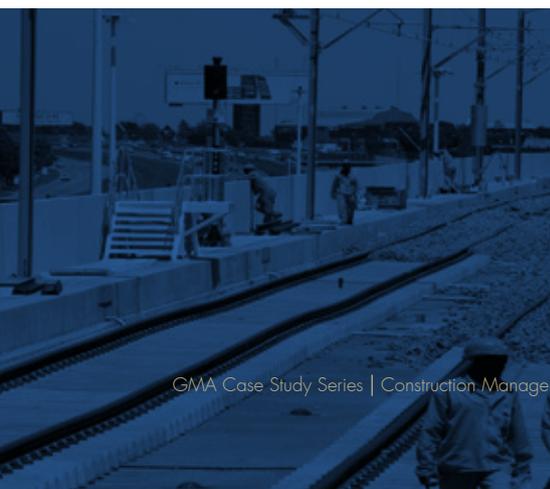
Knowing whom the main contractors and sub-contractors were.



Knowing the working hours of the contractors and compliance staff.



Evaluating the site in terms of what claims could potentially arise and what needed to be done to prevent or limit them.





### 3.5. Records

Records relating to activities in the Concessionaire Construction Programme were kept, including detailed records of all events relating to the contractor's performance. Records included construction management procedures and quality plans that needed to be considered and/or developed.

Records needed to be collated in one place, and past records also needed to be considered taking into account other sources. These were then uploaded to the PST's ProjectWise database in Linbro Park to ensure their safekeeping.

Because commercial imperatives need to be regularly reinforced, people with commercial expertise were required to examine the records and advise site staff accordingly:

- Section managers were the link between the programme and actual progress, and so needed to record critical activities. Section managers also had to decide on the 80/20 focus based on knowledge of where the main predicted claim areas could be.
- The Bombela-approved three week rolling project programme needed to be compared with the contractor's actual working programme, as well as actual work progress. Site staff needed to provide detailed comments on the contractor's progress and relate them back to the approved project plan.

### 3.6. Inspection and Monitoring

It was essential that the contractor's progress was monitored at each stage of the project before further work began. To do this, the CAM

technical team carried out inspections of works on a daily basis. These inspections served three main purposes:

- ① To monitor BCJV's adherence to their Quality Management Plan (QMP) and, where necessary, to prompt BCJV's construction supervisors to raise deviation reports. If these weren't completed, the CAM team raised quality advisory notices requiring remedial action and formal closeouts before payment milestones could be approved.
- ② To monitor and record construction activities in active work areas, including the types of activities underway and the nature of the resources allocated to the work. Because of the wide variety of construction activities, records were primarily written and supported photographic materials.

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- ③ To confirm the material properties needed by BCJV, whether samples or tests were required and, if so, when and where these needed to be taken.

Daily site progress was recorded in daily site diaries that technical teams compiled digitally before uploading them to the ProjectWise database.

#### EXAMPLES OF ITEMS RECORDED IN THESE DIARIES INCLUDED:

the number of skilled, semi-skilled and unskilled people employed on each section of the contract

operations carried out

weather conditions including maximum and minimum temperatures when casting concrete

time lost

quantities of different materials excavated

land handovers (when and where)

consents

design-related matters

compliance issues

notices of delay, along with reasons and plans of action

These diaries were scrutinised by the site's commercial team each day, and all data relevant to programming, claims and disputes were extracted. The technical team also regularly consolidated daily site reports into detailed weekly and monthly progress reports. Data in these reports was extracted by the section manager for inclusion in monthly reports that were submitted to the project construction assurance manager. Monthly reports also covered all other construction, quality, safety, resources and commercial matters relating to the project.

Where BCJV contracted work out to other private contractors, BCJV contract managers on site kept proper site diaries that were also made available to CAM site staff. However, where BCJV did the work internally, no site diaries were kept on the site. In these cases, Gauteng Province was unable to gain access to these diaries.

On Bill of Quantity contracts, the normal process involves site instructions written in the site diaries that are then available to all the contracting parties. The Province's CAM team had no access to, or could not access, the site diaries of BCJV.

### 3.7 Construction Challenges

The Gautrain project faced several challenges along the way:

	<p>There were poor ground conditions at Marlboro Portal as well as in the twin tunnel from Mushroom Farm to Sandton Station. The Tunnel Link starts at Marlboro Portal where the line submerges underground toward Sandton, Rosebank and on to the Johannesburg CBD at Park Station.</p>		<p>Pumping out underground or site water into various storm water and sewerage networks needed to be approved by the various authorities concerned.</p>
	<p>The Tunnel Boring Machine (TBM) tunnel face collapsed and Oxford Street had to be closed off for a period of time.</p>		<p>Required water use licences had to be obtained from the relevant authorities.</p>
	<p>Noise caused by underground blasting in residential areas meant that ongoing noise and vibration level readings had to be taken to ensure that there was compliance with the required sections of the Environmental Act.</p>		<p>Construction designs and plans had to be approved by the relevant stakeholders including metropolitan, governmental and provincial authorities.</p>
	<p>Dust caused by above ground blasting and construction works in residential areas meant that dust level readings had to be taken so that they complied with the required sections of the Environmental Act.</p>		<p>Designs for compliance submitted by Bombela needed to be checked, reviewed and comments provided.</p>
	<p>Several buildings had to be demolished in the Park Station area, and getting the necessary certificates to do this was time consuming and problematic at times.</p>		<p>The rare site fatality and resultant labour law matters had to be resolved, and unnamed graves found within the rail reserve needed to be removed.</p>
	<p>In some cases, there was water in the tunnel where excavations took place, and sealing off rock face cavities where the water was entering posed a major challenge. This was worse in places where there wasn't a proper concrete tunnel lining.</p>		<p>Traffic management needed to be done where construction works impacted on various road networks.</p>
	<p>Contaminated water and soil had to be treated, or alternatively spoiled at municipal-approved spoil sites.</p>		<p>Dolomite conditions in the Centurion area needed to be dealt with in terms of design, construction and drainage.</p>
			<p>Parallel processes had to be dealt with throughout the project as they impacted each other, for example decision-making and authorisation, EIA processes, and stakeholder involvement.</p>

#### 4. ANALYSIS OF ISSUES

Initially, the primary task objective of the PST and on-site CAM teams was quality assurance, with regular site inspections to monitor and verify the frequency and effectiveness of BCJV's Quality Assurance Plan implementation.

This process included the following tasks:

- evaluating BCJV's method statements
- evaluating BCJV's inspection and test plans
- monitoring the construction teams' adherence to these plans
- ensuring that the works were constructed in accordance with the latest signed and approved Issued for Construction (IFC) drawings

Where work was not compliant, CAM staff would ensure that BCJV raised an appropriate deviation report, either in the form of a Non-Conformance Report or a Corrective Action Report. Where the construction detailed on an IFC drawing was inappropriate or a better solution was advisable, the PST would ensure that the construction engineer generated a Field Change Request that had to be approved by the design engineer before proceeding.

All these procedures were monitored by a CAM quality assurance manager, who

conducted quality assurance audits on BCJV's processes as well as their survey and laboratory testing records.

At a fairly early stage of construction, findings from a high-level risk analysis concluded that Gauteng Province was more likely to be exposed to claims relating to time delays and disruptions rather than to poor construction quality. This made sense, considering that the Concessionaire was required to manage the project and monitor all levels of quality assurance, from design through to construction, taking into account the required risks and the fact that the project contract value was fixed upfront before contract works started.

Acting on these findings, PST management reviewed the role of the CAM site staff and redirected the primary monitoring function towards monitoring and maintaining accurate records of the sequence, duration, delays and progress of BCJV's

construction activities. This was done together with monitoring the mobilisation and deployment of resources such as major equipment and staff.

In order to do this, the on-site CAM team reduced the amount of time and effort spent in assuring adherence of the construction teams to the Quality Assurance Plan. At the same time, they continued to closely follow the actual construction compliance, as well as issuing and closing deviation reports.

#### 5. LESSONS LEARNT

##### 5.1. Successes

- A single project head office was established in Marlboro for employees of Gauteng Province and BCJV, Independent Certifiers (IC) and the Independent Socio-Economic Monitor (ISEM). One single office meant better communication between different groups of people involved on the project, as they were all within walking distance.



- **Independent certifiers** helped streamline the compliance process in terms of the various specifications.
- The **partnering initiative** at the start of the project made for a better working relationship at site level in the context of the many different nationalities, cultures and languages of staff involved.
- **Public participation** through monthly meetings created an understanding of the works in terms of what would happen when and why, as well as helping to streamline the communication process between Gauteng Province and members of the public. As part of this, a website was also used to inform citizens of expected disruptions during construction.
- **SED** as well as **Employment Equity commitment requirements** were clearly written in the Concession Agreement as part of the contract, making it easier for Gauteng Province to ensure that the Concessionaire complied with these requirements.
- Proper and clear **transfer of project construction risks** was identified before contract signature. This assisted the work and compliance process between Gauteng Province and the Concessionaire.
- Staff were set aside or appointed to deal with and expedite at the local authorities/stakeholders **project submissions for approval**

during the design and construction phase of the project. In certain cases, funding was provided by Gauteng Province for this purpose where the stakeholder could not afford it.

- The **Gautrain Political Committee** was set up to streamline governmental approvals and to prevent project delays.
- A mega multi-faceted project of this nature requires **intricate project management** including planning, organising, leading and controlling, and appropriate resources were mobilised in order to integrate these elements.
- **Good working relationships** were established with landowners whose land was being expropriated.
- A team of fulltime staff was set up to **deal with the media regarding publicity**, as well as to arrange presentations and site visits.
- **Parallel processes** had to be dealt with including consultation, decision making, legal processes, authorisations, project and

external pressures, land requirement as well as adhering to any relevant Acts involved.

- After construction (e.g. earthworks, embankments or cuttings) was completed, **certain elements such as earthworks, embankments and cuttings** needed to be maintained until they settled and stabilised, and until vegetation had grown.

## 5.2. Room for improvement

- **Various staff and site condition problems**, as well as a **lack of sufficient design detail** with the required method statements, caused on-site decision making to be delayed.
- **Lack of approved detailed drawings** on site caused delays, as these had to be referred to decision makers and designers who were located off site.
- **Integrating designs and work methods with progress on site was difficult**, as these were prepared by consultants who were situated in different locations across South Africa and internationally.



- The **varying agendas** (e.g. providing poorer quality products) of individuals and companies involved in the works created tensions throughout the project's construction period.
- **Attention to detail was lacking in daily record keeping**, specifically in terms of keeping daily site diaries and completing monthly correspondence. Because of slow progress on site, some staff members tended to copy and paste information

instead of capturing specific details that applied to that day, or they simply fell behind in record keeping.

- All parties on site should have used **one site diary** or progress report system instead of each party creating their own. These different diaries and reports resulted in different reporting and disagreements about the project's actual progress.
- Certain processes and procedures around site and document management that should have been made available to the PST management team at the start of the project were **only finalised towards the end of the project's construction period.**
- Where BCJV brought in external contractors and/or sub-contractors, proper site instruction and progress records were kept and any site irregularities and contract problems could be identified. **Where BCJV did the work themselves, no records were kept nor was information shared with the on-site PST staff.** In retrospect, this record keeping and sharing should have happened regardless of whether internal or external contractors were used.

## 5. CONCLUSION

A megaproject like the development of the Gautrain requires detailed planning, taking into account all the different aspects that need to be dealt with in parallel.

Proper planning also helps integrate different role players, which in turn reduces the amount of organisation and frustration involved.

In planning the Gautrain's construction, it was vital to fully understand the nature of the project, who the stakeholders were, what the main deliverables were and when they needed to be completed. Control and quality procedures also needed to be put in place, along with consensus on what the acceptance criteria were for each stage.

With any project, the reality is that things can and do go wrong. As part of this awareness, Gautrain project staff and planners needed to be able to predict where and at what stage problems could occur. This meant implementing measures such as daily inspections and comprehensive record keeping while the project was in progress.

According to Gautrain CEO Jack van der Merwe, "Large projects involve seven key stages: enthusiasm, promises and programmes, disillusionment, panic, hunt for the guilty, punishment of the innocent and reward for those who had nothing to do with it."

A project like the Gautrain is a team effort rather than the work of one individual, and proper planning and cooperation were essential so that every team member could reap the rewards for the work they put in.





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SMS "Alert" to 32693 for service updates

44 Grand Central Boulevard Grand Central ext. 1 Midrand 1 682 |  
 PO Box 1266, Kelvin, Johannesburg, 2054 | Telephone: +27 (0) 11 086 3500 |  
 Email: info@gautrain.co.za | www.gma.gautrain.co.za

FRAUD HOTLINE:

Toll free: 0800 637 283 (0800 6 FRAUD) | SMS "FRAUD" to 33 000 |

Email: fraudhotline@nkonki.com