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New Lynn Rail Trench –transformation through collaboration

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Abstract

The New Lynn Rail Trench is KiwiRail's single largest construction project to date. Its outcomes included fundamentally improving the rail function, improving multimodal public transport and encouraging urban township renewal in New Lynn.

The project demonstrates the innovation and opportunities for added value that a collaborative contract form offers. It was procured via an Early Contractor Involvement (ECI) contract in 2007, and was completed in late September 2010, ahead of schedule and under budget. This is a project that will stand the test of time, not only through leaving a legacy of its transformational transport infrastructure but as a blue print for future project delivery.

This paper specifically focuses on the successful delivery of the New Lynn Rail Trench contract. Among other benefits, the procurement model of Early Contractor Involvement (ECI) allowed the project team to achieve:

- an optimised and constructible design,
- a parallel consenting process,
- significant enabling works,
- the inclusion of the third parties' "Enhanced Station" scope which was developed at a later stage of the project
- the inclusion of additional scope to improve sequencing between adjacent DART projects.

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Introduction

Project DART (Developing Auckland's Rail Transport) is a series of improvement projects to Auckland's rail network by KiwiRail. The North Auckland Line (NAL) provides passenger transport services to West Auckland and has been double tracked from its previous single track configuration between Newmarket and Waitakere. By introducing the New Lynn Rail Trench (DART 6) project on the NAL, a more frequent and reliable rail passenger service at 10 minute intervals each way, in addition to the current four freight services per day, was achieved. DART 6 is KiwiRail's single largest construction project to date. It was more than just a "rail" improvement project; its legacy includes fundamentally improving the rail function, improving multimodal public transport and encouraging urban township renewal in New Lynn.

Throughout the project development, the two key aspects to address were:

- Improve the efficiency of the train system with minimal rail delays as a result of the installation of dual railway train tracks and

- dropping the rail alignment below ground level to reduce road traffic congestion.

In addition the project scope was expanded to include additional works on the NAL (DART 4 and DART 5), and works to construct an "Enhanced Station" transport hub that was consistent with New Lynn's urban renewal plans.

Project Outline

The DART 6 project is located within the existing rail corridor which bisects the New Lynn residential community and adjacent commercial town centre. The existing rail line was at ground level and intersected with a heavily trafficked roundabout at the intersection of Clark Street, Rankin Avenue and Totara Avenue close to the Lynn Mall shopping centre, refer Figure 1.

The works involved lowering and double tracking a 1.5 km long section of the NAL between Whau Creek and Titirangi Road, and constructing a new below ground central "island" platform.

Construction on the project commenced in December 2007 with the enabling works, followed by the main rail trench construction from August 2008 until practical completion in September 2010. A simplified construction programme is included in Figure 5.

New Lynn is the third busiest rail station on the Auckland network and KiwiRail's Principal's Requirement was that the design and scheduling of construction were to ensure minimal disruption to existing rail freight and passenger rail services that were expected to remain operational throughout the construction period.

Figure 1: New Lynn Rail Trench under construction

(New Lynn Mall to the left, Clark St on right)

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Primary Trench Structure

The primary structure that provided the built solution included:

- A large trench structure- approximately 900m length, maximum retained height 8m, varying width 11-18.5m,
- Large retaining walls,
- Tension piles – hold down system, resisting significant buoyancy effects and supporting vertical loadings from above.

The trench structure has limited permeability in order to maintain existing groundwater levels and cross trench groundwater flows, to ensure that there were no detrimental settlement effects on the adjacent properties, buildings and utilities, especially those located immediately on the rail designation boundary. Refer Figures 4 and 5 for an illustration of the constructed structure.

Improved road user and pedestrian connections

The rail trench achieves grade separation between the rail tracks and five local road crossings plus safety improvements at an existing level crossing. The most notable outcome was the removal of the busy at grade roundabout at the intersection of Clark Street, Rankin Avenue and Totara Avenue that was previously bisected by the rail. Previously traffic would regularly back up in either direction as it waited for the train to pass at the level crossing. With the dual rail lines below ground level this has eliminated the issue and has significantly enhanced safety and neighbourhood connectivity. Additionally there are pending plans for even more beneficial gains to the for traffic flow with the Clarke Street bypass project expected to start in early 2011.

DART 6 has also improved the movement of pedestrian traffic, through an increase in designated safe crossing areas at regular distances and improved connectivity via two more crossing points over the rail corridor.

The visual and physical barrier that bisected the community has been significantly reduced by these grade separations. This has provided the catalyst for Waitakere City Council's (now Auckland Council) vision of urban renewal with enhanced road and pedestrian traffic connections and multi-modal Transport Interchange. This is discussed below.

Enhanced Station – a Multi-Modal Transport Hub

The nature of the contract and the collaborative relationships that had been developed during the Contract meant that significant additional scope was able to be included. The package, which became known as "TOC 2", included an Enhanced Station package that incorporates a signature station building with a wrap around road transport interchange. The timing of the additional works was such that construction of the diaphragm walling had started before the form of the station was confirmed so the design was continually pushed to deliver ahead of contract works. Not only was this a challenge from a time perspective but was further complicated by the fact that the Enhanced Station Architecture and interfacing streetscape design was undertaken by Architectus, employed separately by the former Waitakere City Council/ARTA. This meant that a third party client and designer had to be integrated into the project, not only from a design and construction perspective, but also in a contractual sense. This is a key project success story, as without the "best for project" collaborative team behaviour the Enhanced Station could not have been included into the project and would have, most likely, been added at a later time with substantial rework and additional costs.

The Enhanced Station scope involved four inverted pyramidal canopies, an extensive glass enclosure for waiting and ticketing areas, bicycle storage and escalator, lift and stair access to the platform and plant rooms. The style of the canopy adds to the modern character of the regenerated New Lynn, with the functionality of providing shelter from the weather for daily commuters, which was extremely limited in the past. Being creative to maintain the right balance of mixing history with modern features, the station was transformed into a practical, visually appealing transit area supported with effective design and management principles. This was accomplished through the colours and décor. The station generates a community ambience with added historical touches, from the swan detailing reflecting Crown Lynn Potteries and the colours around the station that resemble the clay bricks of the past. The Glass Fibre Reinforced Concrete (GRC) panelled walls (refer Figure 2) within the station have been designed to reflect the New Lynn landscape. Besides the aesthetics of the panels they also act as an acoustic buffer to help reduce the noise created by the trains. Overall the New Lynn station provides a safer feel to pedestrians and daily commuters that will encourage more of the public to take up this mode of travel.

Figure 2: New Lynn train station and GRC panels

Urban Regeneration

By structuring a revitalised New Lynn around the transportation hub, radiating out through to the business and residential community, an orderly flow of commuters, cyclist and vehicle movement is achieved. This design approach helps reduce road congestion and contributes to New Lynn's Transit Oriented Development (TOD) which will significantly improve past perceptions of New Lynn.

Repositioning of the bus station from the original Totara Street location encourages the integration between the commuters moving from the train onto the buses. The concourse station facilities integrated with the bus canopies adjacent to the station and the northern canopies, on Totara Avenue East, help to create the bus-rail interchange.

Figure 3: Constructed "Enhanced Station" with wrap around bus facilities

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Scope Changes to interface with adjacent DART projects

Due to sequencing requirements between adjacent DART projects, the interfacing projects to the east, DART 4 and the DART 5 East/West, were also varied into the project.

The ECI based cost reimbursable TOC contract model, which is explained below, enabled a fast response to the DART 5 East/West project when clashes in methodology between the adjacent projects were identified. DART 5 required the construction of a duplicate Whau Creek Bridge to accommodate the NAL double tracking. The DART 5 East/ West package was developed and included within the contract in order to transition temporary rail alignments into the DART 5 works, which assisted in alleviating delay risk and cost in DART 6.

The ECI model also allowed “intervention” in the stalled DART 4, the project name for the 1.8 km of NAL double tracking section in Avondale, including a new Avondale Station. An example of a success story was that the significant risky “construct only” Christmas works package was conceived, planned, and delivered with only 5 month lead in time from start to finish.

Outline of Contract Model

Kiwi Rail, being the owner of rail assets, took the lead in procuring the base rail trench structure which compromised the largest financial portion ($145 million) of the project. Using the Early Contractor Involvement (ECI) procurement model, KiwiRail secured funding from Central Government for the rail trench structure and double tracking. The DART 6 contract used a heavily modified NZS3910 based on collaborative NEC3 principles. These NEC3 principles are based on the latest version of NEC family of standard contracts used extensively in the UK. NEC contracts promote effective management of the relationship between the two parties to the contract and, use clear language and a document structure which is straightforward and easily understood.

The nature of the Contract meant that Resolve Group, with the role of Engineer to Contract, needed to balance between a project environment which incorporates a quasi-Alliance-type collaborative design-construct culture, with the contractual requirements of a conventional NZS3910 Contract between KiwiRail and the Fletcher Construction Company.

The contract utilised a Cost Reimbursable Target Outturn Cost (TOC) structure with a Pain/Gain share mechanism for incentivised construction performance. This is a form with similarities to a lot of New Zealand Alliances contracts. A key part for the success of the project is the form for payment mechanism, coupled with the strong collaborative “best for project “behaviours displayed by all parties involved. The nature of the cost reimbursable contract, led to an open-book policy focused on common goals, which in turn enhanced the collaborative behaviours.

Key areas of success were evident in construction. This resulted in:

- Productivity gains for diaphragm wall work
- Productivity gains for tension piling
- Productivity gains for base slab construction
- Joint mitigation of project risks
- Enabling early completion of the primary civil trench works.

The net outcome was a substantial saving from the TOC with the actual completion costs almost 10% under the expected out turn cost, thereby returning funds under a pain/gain mechanism to the Government for reinvestment. This is a demonstration of tangible positive benefits of the ECI Contract model and collaborative environment it created between all parties.

The contract procurement process involved a three stage approach:

Stage One – Registration of Interest (ROI)

Stage Two – Concept Design development and Target Outturn Cost (TOC) development

Stage Three - Detailed design and construction.

This process is discussed in detail below.

Initial TOC

After the initial Stage One attribute-based ROI Procurement in mid 2007, two shortlisted progressed to separate half day interview workshops with KiwiRail in early September 2007. The project was awarded two weeks later, which enabled the Fletcher / Beca / Synergine consortium to proceed to the cost reimbursable “Stage Two” contract, to develop and evaluate options and partially design works for the rail trench. This involved undertaking sufficient preliminary design work and construction planning in order to initiate early enabling works in December 2007.

Enabling works

Site investigation works were accelerated and rolled up into a $10 million enabling works package, including existing services investigation and relocation, with operational rail track slews and site access provisions. This facilitated a seamless start to main construction works upon execution of the Stage Three Contract. Early procurement of specialised plant, equipment, and materials plant and materials for the main construction works packages were able to be achieved, prior to execution of the stage 3 contract, because design decisions were locked down.

Prior to commencement of the project in the centre of the corridor’s 20m width, the existing at grade track required relocation. During the Enabling Works phase, a temporary at-grade alignment and associated passenger platform was constructed against the southern boundary of the corridor, leaving a maximum 14m width of corridor available for construction activities. This included a lateral shift of three existing level road crossings.

Team focus

Early team formation showed its advantages right from the start. An open collaborative environment from one co-located team focused on project objectives and imperatives, reinforced by open book and cost reimbursable remuneration was one major benefit. Other benefits derived during this all-inclusive process were an early establishment of collaborative relationships between key players, like the Client as the owner and asset operators, Contractor, Designers, Consent Planners, and Key Stakeholders (ARTA and WCC). This also assisted the consortium focus to understand KiwiRail's business operation, operational constraints, take collective ownership and be involved in mitigation of all risks.

The TOC phase design had no guiding specimen design which could have created pre-conceived concepts. This allowed vigorous optioneering from a "blank page". The benefit of this was that more options were tested leading to a more robust final design solution.

Stage 2 of the contract was to generate and evaluate several options for the trench structure. This process involved the design options being priced and programmed prior to selection. The preferred options were then subject to a detailed constructability review with a high level of detail to construction planning and logistics. This meant that the design was well tested, and challenged prior to selection of the final option, and prior to Contract signing and agreeing on an optimised TOC for the project by August 2008.

The Principal's Requirements, which formed the basis of design, went through an interactive development. This meant that the documentation reflects outcomes aligned with TOC rather than providing standards to design to. In some cases the lack of standards available for rail design in New Zealand meant that a jointly agreed standard was discussed and approved.

Sufficient detail was developed to enable pricing and agreement of a TOC for the design and construction of the primary rail trench enabling works. At that point there was no guarantee of being awarded the main design and construction stage, the Stage Three Contract.

In summary, advantages to the project outcome from the Stage 2 TOC phase included;

- Thorough understanding of the various Client parties' objectives and desires
- Thorough optioneering of alternative design concepts
- Pricing of alternatives to assist in decision making processes
- Thorough constructability review and inputs to the design, before final selections made
- Construction Work Plans well advanced (many complete) ahead of Contract signing and Main Works start.

Stakeholders

Key successes with regard to stakeholder involvement were evident through this project, notably:

- Early engagement with other third party Key Stakeholders (WCC and ARTA) ensured their pending additional Enhanced Stations scope was able to be understood, futureproofed for, and ultimately seamlessly incorporated into the Design and Construct Contract.

- Early engagement of regulatory authorities i.e. WCC Building Consents etc, resulting in setting up protocols for staged submission and approval, and appointment of a project Champion at WCC to facilitate streamlined processes
- Early engagement with neighbourhood Stakeholders, enabling concerns to be addressed before final form of design was locked down

Despite the potential for significant community upheaval there was large public support for the project. The nature of the cost reimbursable ECI contract form provided framework for proactive management with the employment of a key role of stakeholder manager who was empowered to influence outcomes. This resulted in the public being generally prepared to tolerate short term disruption for longer term better good. This was due in part to the early proactive work from WCC on public relations, which provided a sound base from which to build from.

Consents

As there were no consents gained at the start of the process, there were no consent conditions providing unnecessary constraints to inhibit the design or construction methods, during optioneering, and the design selection phase. This resulted in draft consent conditions being developed around and in sympathy with the design. The parallel submission of Outline Plan of Works (OPW) and Resource Consent applications to territorial authorities was in complete alignment with the design and construction methodologies to be utilised. Proactive engagement by the design and construct team with ARC during Consent application process meant that the draft consent conditions were included in the contract documentation, on which the TOC was based.

The outcome of this was:

- Little change between draft and final ARC Groundwater Resource Consent conditions thus minimising risk and cost to Client
- Early termination of monitoring achieved

Value engineering

The Preliminary design in accordance with the Principal's Requirements was completed in March 2008. However, it required significant Value Engineering (VE) to achieve the funding criteria set by Treasury for KiwiRail. This VE phase included a full assessment of the Principal's Requirements (PRs). Had this project been delivered in a "traditional sense" then there was the potential for the project to be shelved due to the lack of available funds. However with a joint, focused approach the paradigm for the project was thoroughly challenged, with some real scrutiny on the PRs. As a consequence the project was totally redesigned and the cost was substantially reduced.

Key outcomes from the VE were:

- Removal of the initial requirement for "future proofing for trench over-build" due to added technical complications and costs. This proposal was originally to allow for construction of two-storey high diaphragm wall over the rail trench to allow future commercial development above it.

- Construction methodology / design solution developed to keep works within existing designation, rather than raising local roads over at-grade rail
- Relaxation of rail alignment for the western trench grade, permitted further reductions in the extent of diaphragm walling by some 100m and consequential reduction in wall depth and base slab thickness
- Improved natural ventilation criteria to be met for diesel locomotives through geometry changes allowing better positioning with regard to trench roof voids.
- Detailed design able to be advanced from 50 % to 90% during Value Engineering phase, ahead of main Contract signing, thereby also enabling a reduction in the risk provision with the increased certainty of outcome.

This VE exercise resulted in a Target Outturn Cost reduction of $25m, allowing the budget to be confirmed and the project to proceed, without compromising project delivery timelines.

Lessons

The ECI contract was very effective and is recommended where:

- The design solution is largely driven by construction method
- Where there is a highly constrained site
- Where Client (rail) operations are a major constraint
- Where significant programme imperatives require early start, and timely delivery.

- ECI = good ideas, early

Construction

One key advantage of the ECI delivery model was that the early effort by the Contractor and the Designer enhanced the understanding of KiwiRail's rail operational imperatives and constraints. Therefore, this led to the ability to test or challenge those requirements during construction planning, pricing, and delivery phases.

As discussed above, the main challenge of constructing the rail trench in a narrow corridor while maintaining safe rail operations demanded careful planning. The 900m long site was only 20m wide, with either buildings or public roads immediately adjacent to the boundaries. Of the 20m width, 6m were to be maintained for the existing single operating rail track, leaving only a 14m width for construction activities. To complete the diaphragm wall and piling works within the required project timeframes required up to nine 70 to 120 tonne crawler cranes and drill rigs occupying the 14m wide construction zone at any one time. These clearly posed significant lateral and overhead risks to safe rail operations.

To maximise the separation between live rail services and construction activities, and also maximise the remaining width of corridor available for construction activities, a sequence of track slews was planned. Figure 5 illustrates the construction sequence.

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With working space maximised by the initial southern slew of the existing track during the enabling works, construction of the northern diaphragm wall commenced in October 2008, along with the bored tension piles immediately inboard of the wall. Once topped with a capping beam, underpinned with driven piles to accommodate the train loads, and fitted out with another temporary platform, the operative train track was “slewed” onto this newly constructed north wall, some seven months later in April 2009. The three existing level crossings were again shifted laterally.

This maximised the space available to construct the south diaphragm wall, its capping beam, and the second row of tension piles, during the following six months. In June 2009 the bulk excavation of the trench began ahead of schedule, along with both permanent and temporary propping of the trench walls, and concrete base slab construction.

By reducing the number of construction joints in the base slab, and therefore doubling the size of each slab pour, the completion of base slab works, and notionally the structure of the trench, was completed by Christmas 2009, some six weeks earlier than programmed.

All this was achieved with the normal passenger and freight train operations continuing to run atop the northern trench wall.

With rail track fixed to fibre-reinforced concrete plinths subsequently formed on the base slab, and the new permanent platform completed within the trench, the train operations were finally “slewed” onto the new “upmain” in the bottom of the trench, on 1 March 2010, also some six weeks ahead of schedule. This then enabled the completion of street works and architectural trench linings, on the northern wall.

Other notable aspects of the construction are detailed below.

Refinement processes

The learning curve on diaphragm wall operations, sequencing of activities, and synchronizing with rail operations and rail protection measures lead to some initial delays and when combined with delays in Resource Consent approval, meant that the project fell some five weeks behind original programme. Once processes had been optimised, better-than-bid productivities were achieved.

Interim slew

A good example of “Best for project” decision making enabled all parties to agree on an “interim slew” of the operational rail onto the partially-completed northern wall, and hence allowed an early start on a portion of the southern diaphragm wall. This coupled with the improved productivities had diaphragm wall works complete ahead of time, and an early commencement to bulk excavation and base slab construction. Also the reduced cost of the plant standing time led to further cost savings.

The installation of 35 tonne precast permanent top props was undertaken at night so as to not disrupt rail operations. A “signals lock out” control, enabled the lifts to be undertaken “foul” of the track, in the knowledge that the nightly freight train service would be held until the lift was clear and no longer posed a threat to rail operations.

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Rail safety

KiwiRail operated a Permit to Enter system, and had developed a hierarchy of rail safety controls and protection supervision, based on the constraints of the preceding DART projects. The ECI model allowed for the alignment of Client and Contractors proposals, through a number of workshops where both KiwiRail and contractor staff were able to reach a common understanding of rail constraints, alongside the construction challenges yet to be faced. Thus detailed protocols were established before design, construction sequencing, programme and price were enshrined in the main Construction Contract. This allowed both the Client and Contractor, to enter into the Construction Contract confident in the knowledge that proposed work methods would not compromise rail safety, or the traditional project objectives of time and cost.

To undertake these works safely in conjunction with rail operations:

- Wall excavation was undertaken during the day, using slew limiters on the cranes to prohibit overhead risk to the train services;
- Reinforcing cage erection and pitching was undertaken in the early evening, when the frequency of passenger train services had diminished sufficiently to allow the heavy lifts to occur “between” train arrivals at the site;
- Concrete pouring of the walls was undertaken at night, when there were minimal train services, and concrete trucks were not inhibited by daily commercial road traffic.

This schedule of activities enabled up to four sections of wall to be constructed by the three spreads during a 24 hour cycle.

With three diaphragm wall spreads, one bored piling spread and one driven piling spread all operating within the narrow confines of the available construction zone and with limited site access points for muck removal and materials deliveries, the project works required detailed logistical sequencing.

Bulk excavation was carried out during normal daily train movements by applying normal rail protection controls to each excavation spread, until such time as the excavation had progressed below the level that it could pose any threat to rail services atop the northern wall.

In total some 50,000m^3 of concrete trench pour involving 7,500 tonnes of reinforcement and 100,000m^3 of bulk excavation was completed in the period from October 2008 to December 2009.

Road / Rail Crossing - Construction Sequence

The existing level crossing at Portage Road required the lowering of the levels by some 1.5m, which was achieved with full road closures for each of the interim slews, and the final double tracking.

Grade separation at the Veronica Street level crossing was achieved by replacement with a new bridge. A simple sequence of road closures was required; firstly to construct the northern diaphragm wall and abutment beam, allowing the northern slew of rail traffic, after which the road crossing was reopened. Two months later the road was closed for a second and final time; to allow construction of the southern diaphragm wall and abutment beam, along with sufficient excavation between the walls to accommodate the bridge deck and pavement construction prior to re-opening to road traffic. Edge barriers were completed prior to rail trench excavation beneath the bridge deck, later in the programme.

The additional trench crossings, bridging at Hetana Street, and Memorial Drive, were constructed as part of the permanent trench propping sequence, and excavation carried out beneath.

Much more challenging was the construction sequencing for the replacement of the Clark / Rankin / Totara Street level crossing, being a convergence of four arterial roads at a roundabout "straddling" the operational rail track. These works also required 84 service relocations. Here road closures were not permitted, nor any interruption to rail traffic.

By careful longitudinal scheduling, the diaphragm wall and piling spreads were completed, firstly with the north wall construction, then the south wall construction. By integrating this with a 60m longitudinal displacement of the road traffic roundabout and level crossing, both trench walls and the new bridge deck spanning between them were able to be constructed without interruption to either road nor rail traffic. Each shift required reconfiguration of the signal bells and barrier arms. Associated pedestrian crossings were also maintained throughout the duration linking the residential areas, with the commercial /retail precinct.

Conclusion

The successful use of the ECI contract form has enabled the delivery of a challenging project seamlessly, without major disruption, to the satisfaction of all stakeholders and the community at large. Among other benefits, the ECI procurement model of allowed the project team to achieve:

- an optimised and constructible design,
- a parallel consenting process,
- significant enabling works,
- the inclusion of the third parties' "Enhanced Station" scope which was developed at a later stage of the project,
- the inclusion of additional scope to improve sequencing between adjacent DART projects.

The New Lynn Rail Trench project has successfully:

- improved rail efficiency and timetabling,
- reduced traffic delays through removal of at grade rail crossings and construction of improved intersections,
- enhanced the pedestrian and road user connectivity in New Lynn town centre,
- improved the integration of rail/bus/cycle/pedestrian travel modes,
- provided the catalyst for urban regeneration in the New Lynn town centre.

This is a project that will stand the test of time, not only through leaving a legacy of its transformational transport infrastructure but as a blue print for future project delivery.

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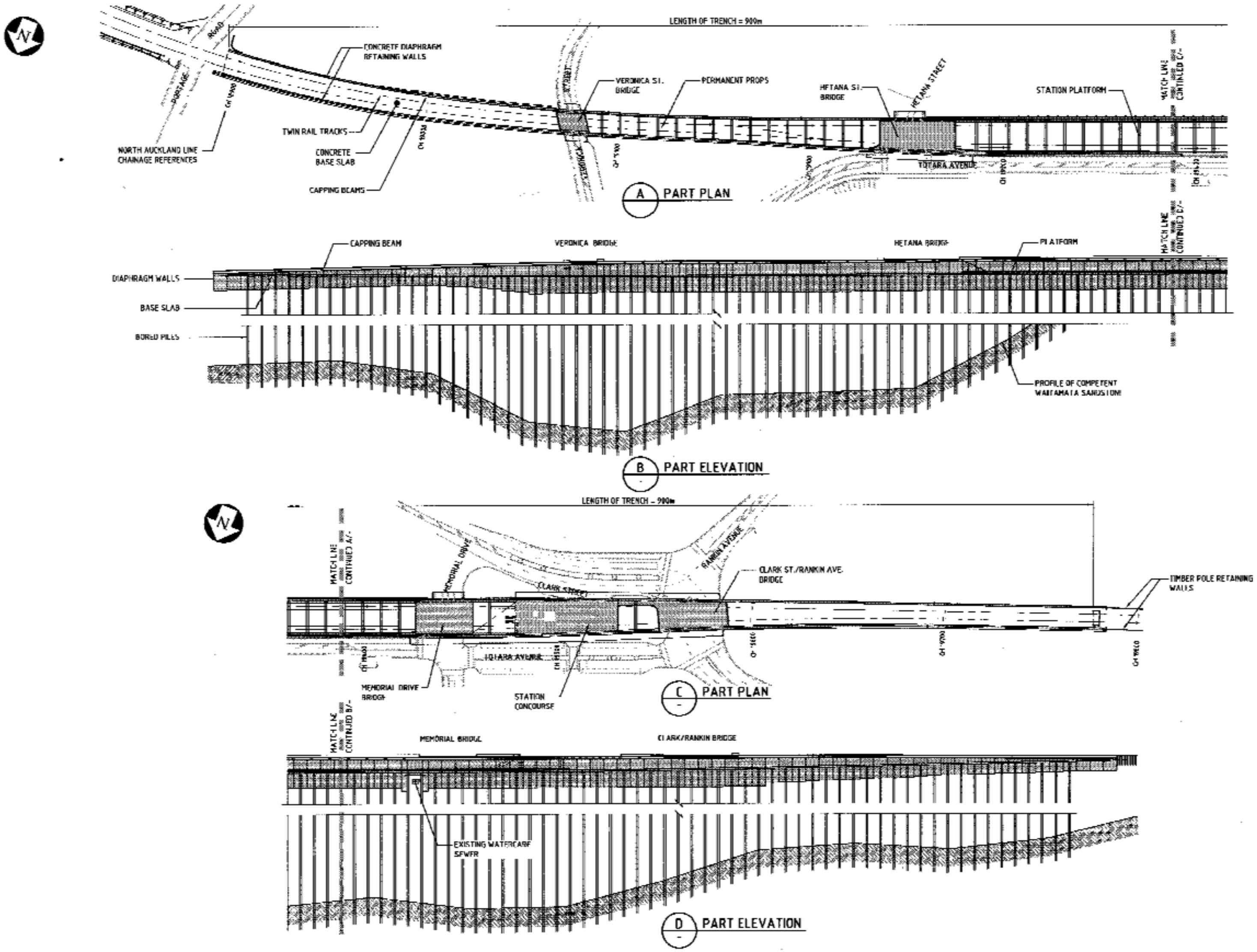

FIGURE 4: GENERAL ARRANGEMENT PLANS

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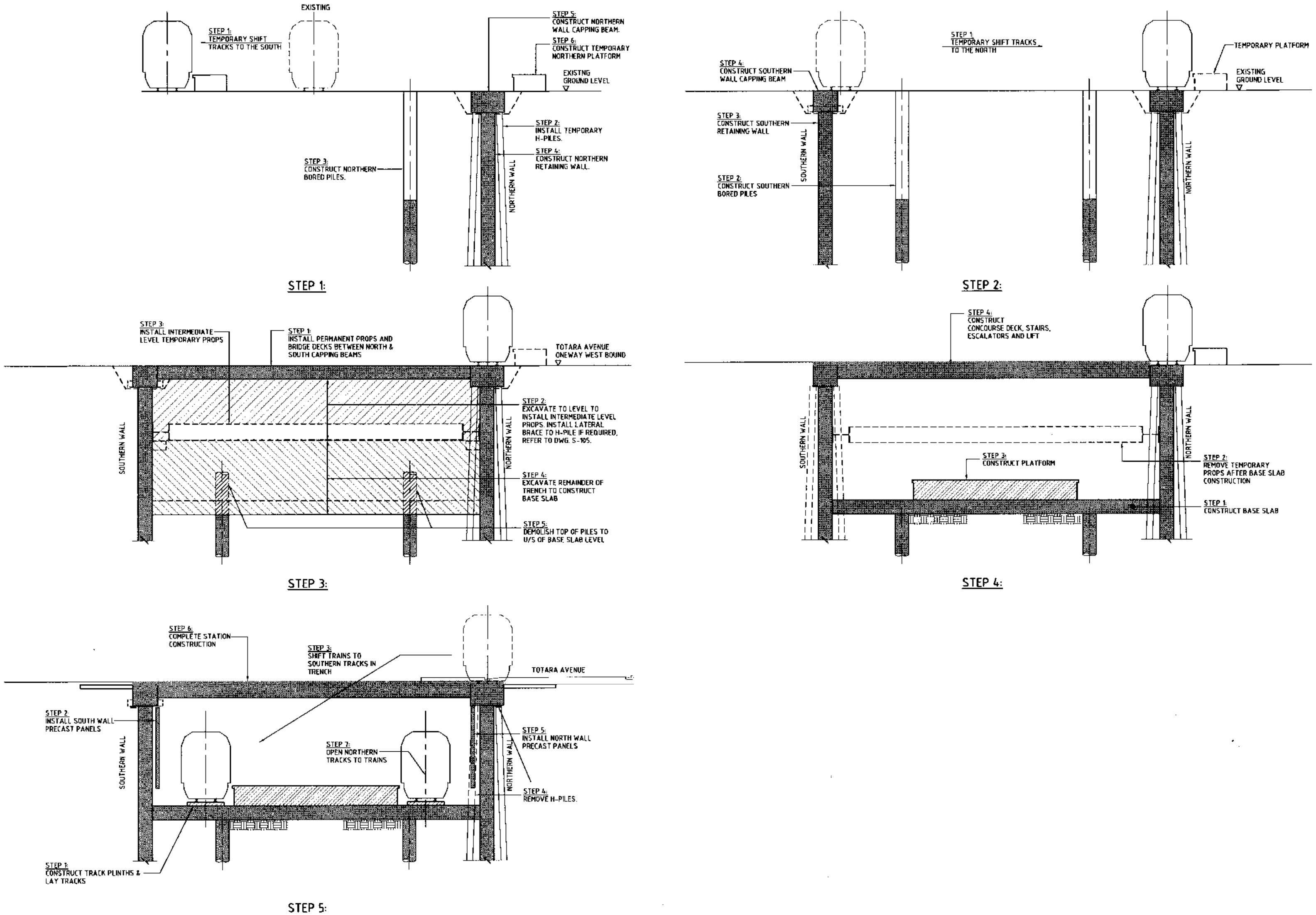

FIGURE 5: GENERAL CONSTRUCTION SEQUENCE

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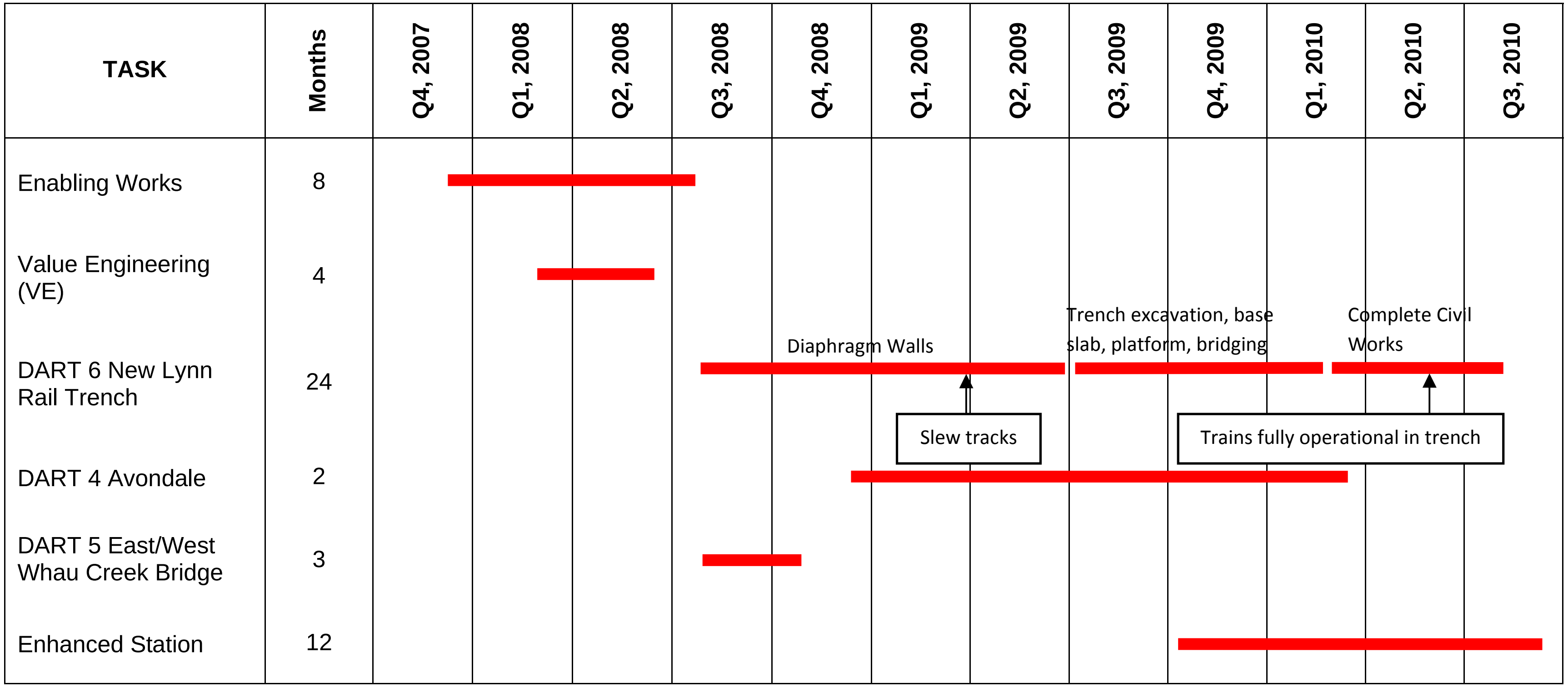

FIGURE 6: SIMPLIFIED CONSTRUCTION PROGRAMME