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1.1 Introduction

The project brief requires a commercial development to be constructed on a green field site without any adjacent buildings. The development itself requires the construction of a basement area for car parking, plant and storage, with a 2 above ground levels with retail outlets. This report will provide suitable options for the construction of the basement and foundation of the development.

The Methods of construction to be looked at will be Tradition Masonry Construction, Soldier Pile Wall Systems, Contiguous/Secant Pile Wall Systems and Diaphragm Wall Systems alongside suitable methods of Excavation for the basement area.

1.2 Traditional Masonry/Concrete Construction

The traditional method of constructing a basement is to have an open cut excavation to the level grade of the basement. In this excavation the beams, floor slab and basement walls are put into place. The area outside the walls is then backfilled to retain the original ground level.

The advantage of this method would be that access for the installation of a waterproof membrane and suitable foundation walls would be easier. The cost of this method however would be fairly high as the soil would have to be removed, stored and returned for the backfilling process and a lot of money would have to be spent on a soil support and water exclusion system to allow construction to take place.

1.3 Diaphragm Wall System

Construction of a diaphragm starts with digging a vertical trench with either specialized plant equipment or a simple cable hung clam bucket. This trench is filled with an engineered liquid slurry with provides the hydraulic pressure against the trench walls to prevent collapse. A steel reinforcement cage is placed in the trench and then the concrete is poured into the trench in alternating positions replacing the slurry to create a primary panel. A secondary trench is then cut into the earth between each primary panel and then the secondary panel is poured to create a continuous wall.

Advantages of the Diaphragm Wall system is that it can be specified to fulfill a large number of design criteria including soil support, water exclusion and foundations. This allows the Diaphragm wall to be designed to any site conditions and site requirements. The disadvantage of this system is that extensive bracing systems would have to be used before the interior of the basement was built to hold the walls in place after excavation. This would reduce the workable area inside the excavation considerably on such a large site.

1.4 Secant Pile Wall System

Secant Pile are primarily concrete piles bored and set in a continuous line and then in the gaps between each pile another pile is bored and set to provide a continuous wall. The individual piles are each carrying any load to the ground and the finished wall also provides a reliable soil support.

The main advantage that the Secant Pile Wall has over the other types of construction researched is that the system is easily adapted to changing soil conditions like on the Venture Park
site with each pile able to have a different length. The construction of the Secant Piles, when compared to other construction methods, has less ground vibration and less noise during the process. The system can also be easily adapted into a waterproof barrier for the basement area. The major disadvantage of a Secant Pile Wall would be that the verticality of the piles can be hard to maintain which can lead to problems in terms of loading capacity and shear strength. Also the system requires that for sufficient soil support the pile must be sunk below the design depth of the basement to provide enough passive resistance, increasing the amount of volume needed for this system.

1.5 Soldier Pile Wall System

This system uses steel I-beams spaced at 1 to 3 meters apart with a concrete or timber infill or lagging. The space behind the lagging is then backfilled and compacted or vibrated. The moment resistance is carried solely by the soldier piles. Passive soil resistance is achieved by placing the bottom of the pile below the excavation grade and the lateral load of the soil is carried by the lagging to the soldier piles.

The Soldier Pile system is extremely adaptable as it can use almost any local products in its construction. It can also be used in any type of soil condition as each system reacts to its site. This combined with the fact that the construction of the retaining wall and foundation can continue alongside the excavation process make it a lot cheaper relative to other walling systems. However as this type of system is primarily a temporary retaining wall system, adapting it to a basement foundation could be troublesome and costly. Also unless the backfilling is done properly problems can arise in terms of nearby roadways and future adjacent buildings due to settlement.
### 2.1 Cost Analysis

<table>
<thead>
<tr>
<th>Method</th>
<th>Base Monetary Cost</th>
<th>Temporary Works</th>
<th>Excavation</th>
<th>Foundation</th>
</tr>
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<tbody>
<tr>
<td>Traditional Masonry/Concrete</td>
<td>Moderate</td>
<td>Highest</td>
<td>Highest</td>
<td>Moderate</td>
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<tr>
<td>Construction</td>
<td>Due to practices</td>
<td>Temporary soil support</td>
<td>The soil must be excavated in a fairly standard practice but it must then be stored for the backfilling process during the removal of any temporary soil support systems</td>
<td>Due to the retaining wall and the building foundation can be easily accessed for installation before the site gets backfilled</td>
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<tr>
<td>Diaphragm Wall System</td>
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<td></td>
<td>Due to highly</td>
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<td>Due to the large amount of bracing required during the excavation process to prevent the wall from collapsing</td>
<td>Once set in place and the basement area is excavated the wall requires very little extra work to provide a suitable foundation to the building</td>
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<td>High</td>
<td>Low</td>
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<td>High</td>
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<td></td>
<td>Due to specialized</td>
<td></td>
<td>The excavation must be careful not to break the wall with any unnecessary vibration or settlement during the process</td>
<td>The piles have to be of sufficient depth to provide the necessary strength to act as both soil support and building foundation</td>
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<tr>
<td>Soldier Pile Wall System</td>
<td>Low</td>
<td>High</td>
<td>Moderate</td>
<td>Highest</td>
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<td></td>
<td>Installation of</td>
<td>Water exclusion</td>
<td>As excavation occurs alongside the construction process the costs of the entire process are relatively cheaper than any other type of construction</td>
<td>The wall must be sufficiently anchored and stressed to act as a building foundation or a completely different system must be put into place to act as the building foundation</td>
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<td>piles using</td>
<td>during the construction process is a major concern for this type of construction</td>
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### 3.1 Chosen Construction Method
I have chosen to use a Secant Pile Wall System to construct the basement for this development project. The following section will be a step by step run through of the construction process.

3.2 Installation of Guide Wall for CFA System

A guide wall is installed on site to guide the Continuous Flight Augur System during its use in the construction of the piles. The guide wall is a temporary way of ensuring that the Secant pile wall matches the design plans and maintains its integrity throughout the construction process.
3.3 Installation of Casing for CFA System and Concreting

A steel casing is driven through the guide wall into place in the soil to guide the CFA and to maintain the verticality of the pile during concreting. The site will need enough head room for the vibro-hammer equipment. The steel casing is driven in until about 1 meter of the casing is protruding from the ground.
3.4 Auguring of Primary Borehole

An augur then drills and removes the soil from the casing which prevents the borehole from collapsing. If the required depth of the pile is greater than the depth of the casing, bentonite slurry is used to prevent collapse.
3.5 Concreting of Primary Borehole

The primary borehole is then concreted using a tremie pipe. As the concrete is poured the tremie pipe is retracted so that it is always immersed in the concrete until concreting is finished to avoid any air pockets forming. The concrete is then vibrated to maintain the mixture for the curing process.
3.6 Auguring of Secondary Borehole

After the concrete has sufficiently set for the next stage of the process the casing is removed and the augur then drills and removes the soil between two primary piles while also cutting into the original piles to create an overlap that forms a mechanical bond between the primary and secondary piles.
3.7 Installation of Reinforcement Cage

A crane then lifts a steel rebar reinforcement cage into the secondary borehole. Verticality is maintained with plastic spacers on the reinforcement cage. The end of the cage is left to protrude from the top of the pile for tying the capping beam to the secant pile wall.
3.8 Concreting Secondary Borehole

The secondary borehole is then concreted using a tremie pipe. As the concrete is poured the tremie pipe is retracted so that it is always immersed in the concrete until concreting is finished to avoid any air pockets forming. The concrete is then vibrated to maintain the mixture for the curing process.
3.9 Repetition of Process to complete Secant Wall

The process of boring and concreting primary and secondary pile is repeated until the design specified wall is completed.
3.10 Installation of Reinforcement and Formwork for Capping Beam

The guide wall for the piles is now removed and the formwork and reinforcement for the capping beam is put into place. This capping beam will form the platform on which the superstructure for the remaining development will be placed.
3.11 Concreting of Capping Beam

The capping beam is then concreted either as one whole beam for in sections, always adhering to the engineering standards for this structural element.
3.12 Excavation of Basement Area

The soil is then excavated and the secant pile wall exposed to form the walls of the new basement area. Care should be taken not to damage the secant pile wall or the capping beam during the excavation process. The excavation should continue until the excavation reaches the design grade of the basement floor.
3.13 Laying Reinforcement for Floor Slab

The basement area is then leveled and fitted with the reinforcement for the floor slab. Each cage should be lifted in by crane so care should be taken that each cage has enough room to maneuver both above and inside the basement excavation.

![3.13 Plan](image1)

![3.13 Section AA](image2)
3.14 Concreting of Floor Slab

Concrete should then be piped into the excavation and the floor slab should be formed.

3.14 Plan

3.14 Section AA
3.15 Fit out of Basement Area

All mechanical services and access should be constructed after the structural elements are fully formed. These would include car parking access and any equipment areas that need to be built for the development.
3.16 Axonometric Progression Diagram

This axonometric progression shows the step by step production method detailed in sections 3.2 through to 3.15 on pages 4 to 17.
4.1 Reflective Statement

This report contains a discussion on Traditional Masonry, Diaphragm Wall, Secant Pile, and Soldier Pile Basement Construction. The advantages and disadvantages of each type of construction are located in Section 1 on Pages 1 and 2. An estimated Cost Analysis is located in Section 2 on Page 3 which enabled me to advise the construction of Secant Pile Wall System for the basement construction on the Venture Park Site, as it is the most economical way of dealing with the site and design issues presented by this project. A step by step explanation of the construction of a Secant Pile Wall System, contained in Section 3 on Pages 4 to 18, will help to advise Cook Retailers of the needs of the process to provide a frame for more accurate cost estimation.
4.2 Resources

- [http://www.deepexcavation.com](http://www.deepexcavation.com), 2006, Deep Excavation LLC, United States
- Piling and Deep Foundations, Volume 1, John Burland & John Mitchell et al., 1989, A. A. Balkema, Netherlands
- Land Transit Authority Project Brochures, 2003, Land Transit Authority, Singapore
- An Introduction to Geotechnical Processes, John Howard, 2005, Spon Press, United States
- Geotechnical Engineering Handbook, Volume 3, Ernst & Sohn, 2003, Ernst & Sohn Gmbh, Germany
- Sefi-Infrator Soldier Pile Walls Brochure, 2000, Sefi-Infrator Fayat Group, France