

Facilities Plan for a Centralised Timber Depot for BedRock
Mining Support (Pty) Ltd

by

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Executive Summary

BedRock Mining Support (Pty) Ltd is a fully integrated timber-based mine support company that supplies timber support to the gold and platinum mines. BedRock runs a J.I.T process and therefore has a challenge to consistently produce and provide quality products to the platinum mines. This is due to the fact that timber has a limited shelf life and timber extraction from plantations is rendered during the wet months. Currently a buffer has been implemented, but can only serve mines within its region, therefore mines that fall outside this region will struggle obtain timber during the wet months. A proposed centralised site located back in the chain is seen to be a solution to the current concerns and the bigger picture. A facilities plan needs to be generated for management purposes of understanding the size of the depot that is required and layout to use as a benchmark when a physical site is determined. Research was done to determine the best methodology to apply to the project problem. Systematic planning procedures became the viable option and were then used to develop a design. The design involved defining the project environment, using quantitative and qualitative measurements to determine the degree of closeness for each department relative to each other. These measurements were then used to produce various charts and diagrams that assisted in the development of alternative facility layouts known as block layouts. These block layouts were then evaluated by means of three integrated techniques to finally reveal the most feasible layout design that BedRock would use in their New Centralised Depot. The size of the depot was calculated to be 20262 square meters and block layout 2 was deemed the most feasible layout design.

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1. Introduction and Background

BedRock Mining Support (Pty) Ltd is a fully integrated timber-based mine support company, that currently employees 2000 people, produces 400 000 tons of timber per annum and operates in six different provinces. BedRock is in the business of providing mine support cost effectively, consistently, reliably and lives by the philosophy of Quality, on-Time and in Full delivery every time (www.bedrockms.co.za).

BedRock currently supplies timber support products to the Gold and Platinum mines where the products used for the respective markets differ by nature. The main difference between the two markets is a function of mining depth which determines what products are designed for and used. The Platinum mines are fairly shallow when compared to Gold mines where mining takes place 2-3 kilometres below the surface. Products used in the Gold market are essentially a combination of support products clustered together to form one product or support block.

This support block has been designed to provide the necessary support resistance that is required to keep the roof intact while mining at such depths. Platinum products on the other hand are single products like mine poles that are installed on a grid system to perform the same function. The integrity of individual mine pole is far more onerous than a cluster product and therefore a greater emphasis is placed on mine pole quality to guarantee support performance.

❖ *The figures below were provided by BedRock Mining Support (Pty) Ltd.*



Figure 1: Gold Mine (Left) & Platinum Mine (Right) Products

It is with this in mind that BedRock has a challenge to consistently produce and provide quality mine poles to the Platinum industry. The shelf-life of a mine pole is the main cause of concern due cracking that progressively takes place shortly after timber is harvested. Numerous other factors also affect the cracking process and because of this fact, BedRock decided to run a just-in-time (J.I.T) delivery service to prevent products from being supplied out of specification and product write-offs

BedRock currently produces two types of products for their Platinum market, namely mine poles and pencils. Harvested trees that are cut into standard unit lengths are called mine poles and mine poles that are tapered at the one end are called pencils. Both products are similar in nature and perform the same functions, but follow different process paths.

Mine poles and pencils both begin at the plantations, where trees are harvested and cut into standard lengths, which are called mine poles. These mine poles then follow two separate paths, where mine poles are either distributed directly to the mines in form of units or bundles or to a production mill. The production mill then converts these mine poles into pencils, which are then bundled and distributed to a service centre then to the mines (see figures below).

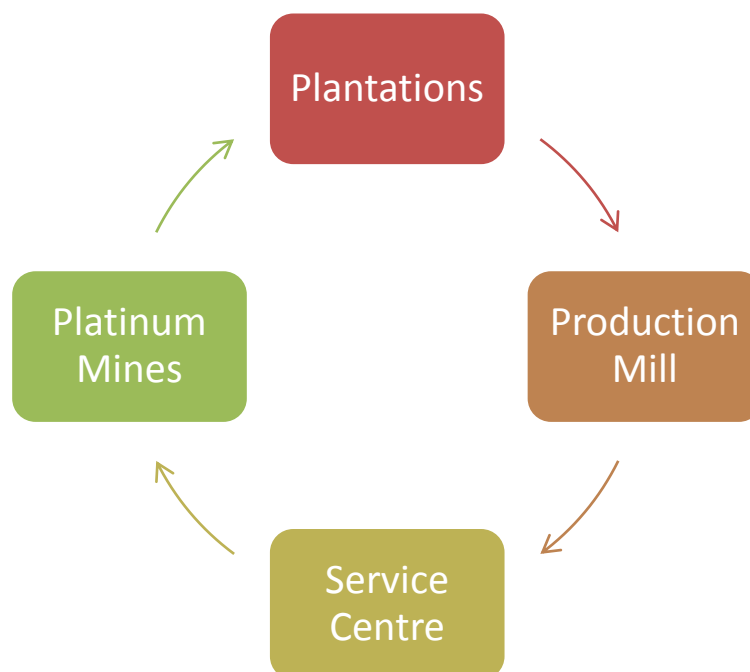


Figure 2: Pencil Prop Process Cycle

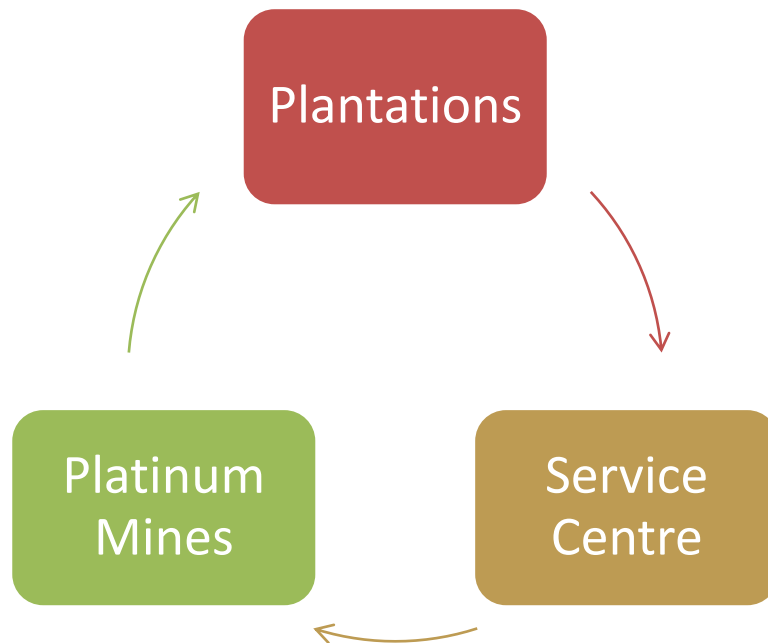


Figure 3: Mine Pole Process Cycle

BedRock has also learnt that operating a J.I.T service has fundamental flaws especially during the rainy season that prevails for a period of five months from October to March each year. During the rainy period heavy downpours can be experienced, where timber cannot be removed from the plantations resulting in the mines being short supplied. Mine production areas where face support is used cannot afford to stand without safety consequences and hence the importance of supply.

Currently a buffer has been implemented at Bleskop Service Centre in Rustenburg to address the above problem. At this present time the buffer can support all mines situated in the North West Province, but the problem arises when mines like Bekoni, Twickenham and Modikwa that are situated in the Mpumalanga Province need to be supplied with timber. This is a problem because BedRock will have to pay additional transport cost to transport timber back to the region from where timber was originally sourced (*See Figure 4 below*). Therefore during the rainy seasons these mines fall at the bottom of the priority list.

❖ Figures 4 & 5 were based on a sketmatic drawn up by the project sponsor from BedRock Mining Support (Pty) Ltd.

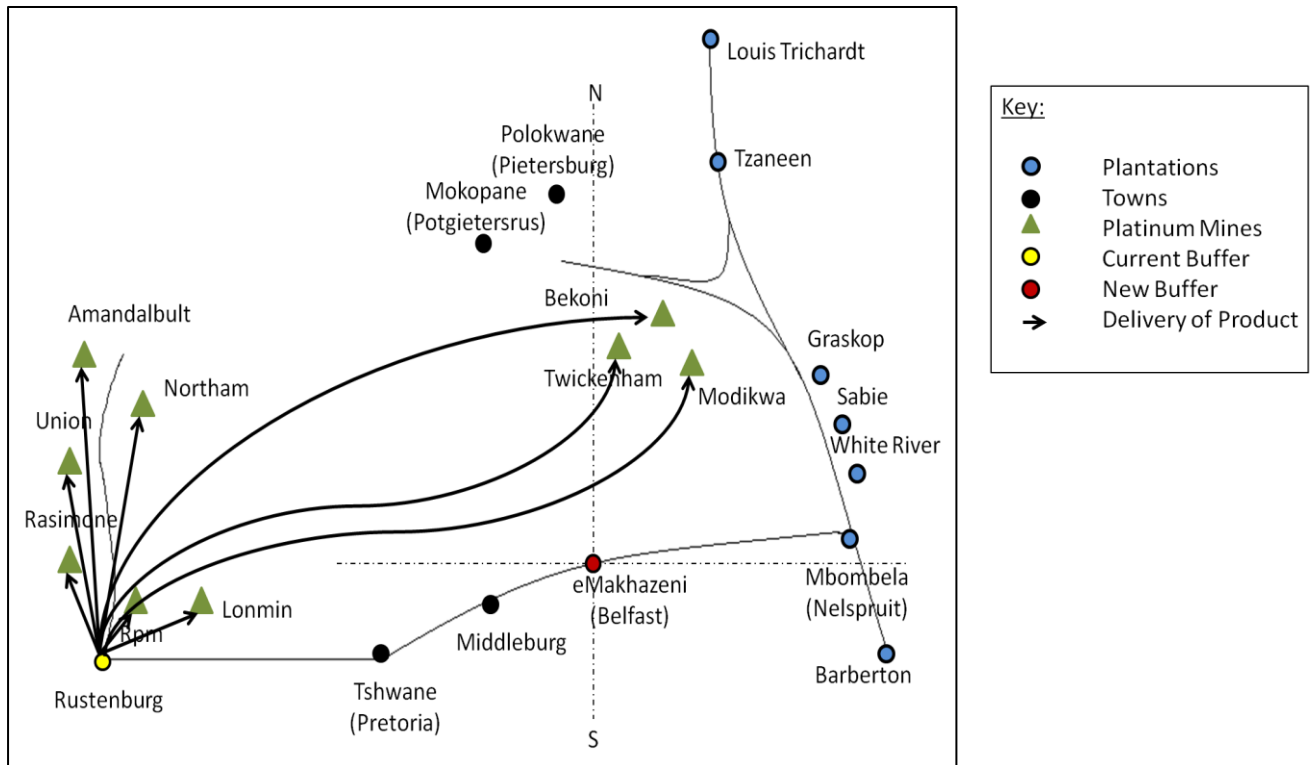


Figure 4: Delivery of Timber from Current Buffer Location

BedRock is experiencing a problem with the consistent delivery of quality products to their service centres, which is due the fact that quality procedures are not being adequately carried out at the plantations and mills. Bedrock is paying unnecessary costs to transport these out of specification products to the end of the chain and added labour costs to remove or rework these products back into the market. The problems arise where the responsibility for quality management is distributed among too many areas throughout the value chain and therefore becomes difficult to co-ordinate and manage.

Through careful consideration, management decided that the only practical solution to overcome their current concerns in the Platinum market is to place a centralised depot back in the chain. All timber for the platinum market will then be delivered directly to the depot from the plantations, where products will be produced and distributed. Therefore the quality of timber coming into the depot and products leaving the depot can be monitored.

eMakhazeni (Belfast), Mpumalanga was chosen to be the ideal location to house a centralised depot for the following reasons to name a few;

- eMakhazeni is situated on the main access route to the timber plantations situated in the Lowveld namely, Barberton, Mbombela (Nelspruit) and White River.
- A high percentage of timber sourced for the mining industry is transported through eMakhazeni.
- eMakhazeni is also situated in close proximity to the Lothair and Piet Retief area, another important sourcing area for the platinum market.
- Piet Retief area produces high density specie of timber, due to the high altitude and exposure to cold winters. Harvesting of these plantations is within close proximity to eMakhazeni.
- eMakhazeni is also suited for short haul transportation economics from a Lothair and Piet Retief point of view
- eMakhazeni can house a buffer that can supply all platinum mines during the rainy seasons without paying additional transport costs (See figure below).

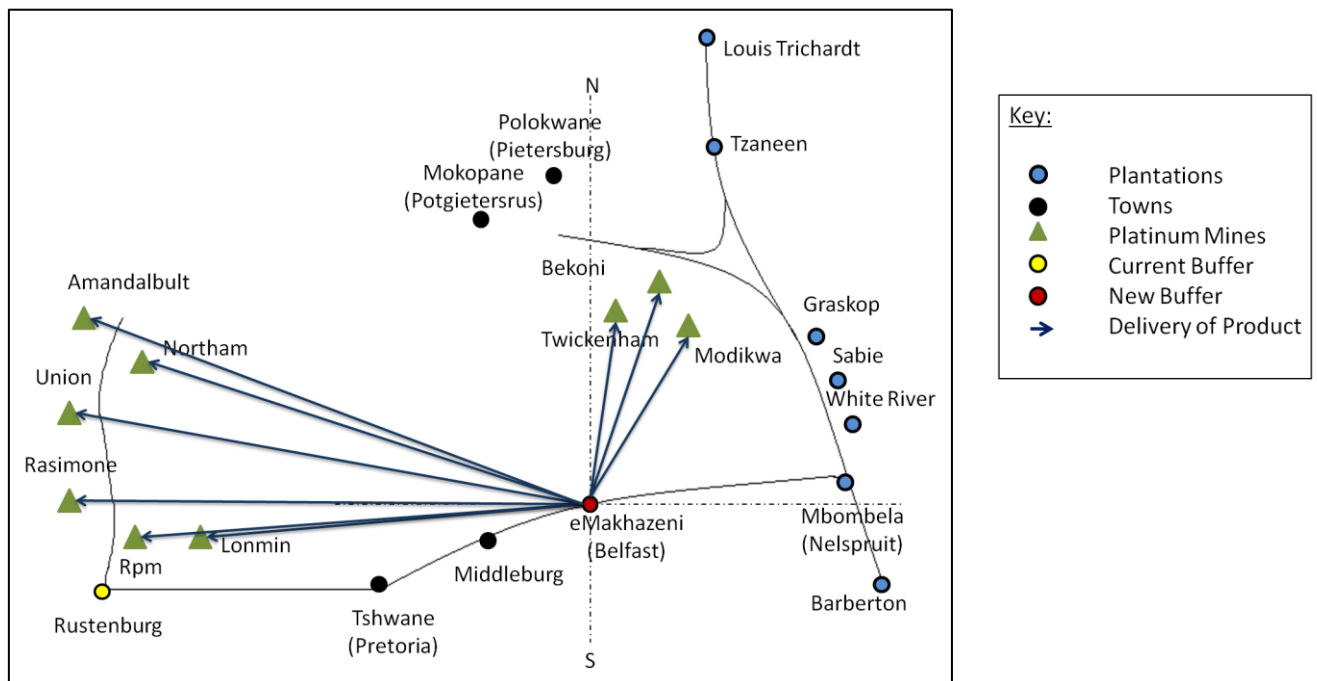


Figure 5: Delivery of Timber from New Proposed Buffer Location

2. Project Aim

The aim of this project is to develop a facilities plan for a centralised depot to serve the platinum market, which will include space requirements and a proposed facility layout. This will provide management with an understanding of the size of the depot that is required and the layout that can be followed when a physical site in the Belfast area has been determined. This depot must accommodate a *Buffer*, *Scanner*, *Pencilling* and a *Chipper Operation* with the necessary supporting facilities.

Objectives to be addressed:

1. Determine the total space requirements for the centralised depot, which will include the following;
 - Buffer size that will be used to ensure continuity of supply during the rainy season and to act as a contingency for any other disruption that may occur.
 - Scanner, pencilling and chipper operations that will be used to sort and produce products.
 - Bundling areas that will be used for the bundling of pencils and mine poles.
 - Supporting facilities, which will include Offices, Parking, Change Rooms and a Guard House.

2. Design a facility layout, which will address the following;
 - Problems identified in other timber depot environments.
 - Efficient and practical process flows, with regard to the flow of timber and employees through the depot as well as incoming and out-going of delivery trucks.
 - Efficient relationships between departments/operations which will compliment the production process.
 - Effective material handling functions/responsibilities with efficient distances travelled where possible.

3. Determine equipment availability;
 - Make use of redundant process and handling equipment in the New Centralised Depot

3. Project Scope

Phase 1

Step 1: Acquire an understanding of BedRock's current environment with regard to their supply chain, the various processes and procedures that are followed to ensure quality on time and in full delivery to customers. This step is important to ensure understanding of the project environment and to be capable in asking questions.

Step 2: To obtain knowledge of the project environment through the following;

- i. Arrange and attend meetings with project sponsor.
- ii. Consult employees.
- iii. Plan visits to the mills and service centres.

Step 3: Observations and data gathering of the various depots will be done during planned visits. This will be in terms of layout design, highlighting departments/facilities, material handling equipment, process equipment, interrelationships amongst various departments/facilities and flow plan.

Step 4: This data will then be analyzed for any possible problems and will then be used as a prevention cause in the design of the new facilities plan.

Step 5: Research will be done to determine the best methodologies to adopt when determining a facilities plan for a centralised depot. This will be done via books, journals, internet and observations.

Phase 2

Step 1: Through research the best methodology(s) will be selected in determining a facilities plan. Data that is required to perform the necessary calculations and support the chosen methodology(s) will be then be gathered from project environment.

Step 2: These methodology(s) will then be used to develop a facilities plan and a possible solution to the proposed problem. The new facilities plan will then checked and validated by project sponsor to ensure that calculations are correct and facilities design is feasible.

Step 3: Stating recommendations and conclusions gained from the project problem.

4. Literature Review

The positioning of facilities in a demarcated area is often referred to as a facility layout problem. The positioning of facilities is known to have an impact on a number of factors, namely; manufacturing costs, work in process, lead times and productivity. If the placement of facilities within a facility is done correctly it can improve operation efficiency as a whole and the total operating expenses of a firm can be reduced by half (Drira, Pierreval & Hajri-Gabouj, 2007:255).

Facility planning is all about how a process or activity's fixed assets can best support and achieve the process or activity's objectives. Facilities planning can be subdivided into two main categories, facilities location and facilities design. The figure below shows the facilities planning hierarchy approach, which can be applied to a number of different types of facilities (Tompkins, White, Bozer & Tanchoco, 2010:7-9).

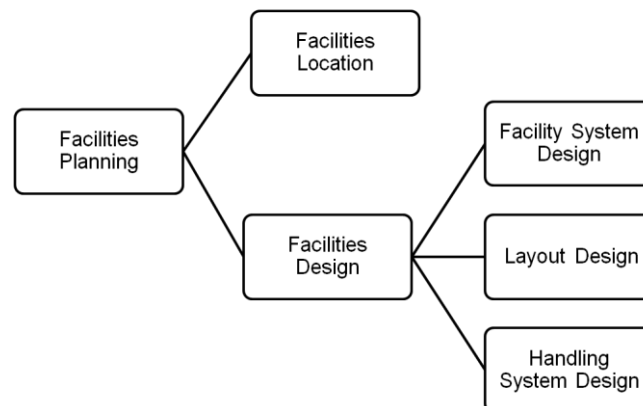


Figure 6: Facilities Planning Hierarchy

According to Tompkins *et al.* (2010:14), facilities planning can be approached systematically by applying the traditional engineering design process. This systematic approach involves numerous steps in developing facility plans, selecting the preferred plan and implementation. Importantly this approach can be used whether planning a new facility or improving an existing facility.

Facility location involves determining the ideal location of a single facility or multiple facilities, with respect to customers, suppliers or other facilities. The solving of single or multiple facility location problems can be done by using Rectilinear-Distance or Euclidean-Distance location models (Tompkins *et al.*, 2010:518-519).

Tompkins *et al.* (2010:520) had the following to say about these models:

“The models we present are “quick and dirty”. They are “quick” because they are simple formulations that can be solved quickly; they are “dirty” because these models can be abstract or overly simplified representations of a real facility location problem.”

Facility design involves three parts that need to be addressed separately; mainly facility systems design, layout design and handling system design (Tompkins *et al.*, 2010:6).

According to Drira *et al.* (2007:256), layout design consists of four types of layouts, namely

- i. Fixed product layout.
- ii. Process layout.
- iii. Product layout.
- iv. Cellular layout.

- i. Fixed product layout is the phenomenon where the product is too large to move, therefore facilities and movement are based around the product.
- ii. Process layout is the grouping of facilities (e.g. Machines) with similar functions to form workstations. Therefore a product will move from workstation to workstation in a sequence of operations that a product must follow to be produced.
- iii. Product layout is where facilities are set up in order of the various operations that a product must follow to be produced.
- iv. Cellular layout is the grouping of machines into cells or workstations to produce families of similar parts.

Through observation the timber industry follow a Process type layout, where timber is moved from one area to another by means of specialized material handling equipment.

Layout problems can be solved by numerous different methods by using software packages, genetic algorithms, models and formulations. These approaches are mostly based on minimizing material handling cost, employee travelling distance and optimization of an existing facility. These methods don't address a procedure on how to develop a facilities plan or analysing and using concepts from separate existing facilities to produce a facilities plan.

According to Tompkins *et al.* (2010:296), there are a number of layout procedures that have been developed in order to assist a facilities planner in generating layout alternatives. Construction type and improvement type are the two main categories for procedures. The Construction type involves developing a layout from scratch, where as an improvement type generates layout alternatives in an attempt to improve the existing layout.

Muther (Muther, 1973) developed a layout procedure called systematic layout planning procedure (SLP). This procedure uses charts and diagrams that are dependent on each other in order to generate alternative block layouts, which are then evaluated to select the best alternative. These charts and diagrams involve the following;

- From –to charts.
- Activity relationship chart.
- Relationship diagram.
- Space relationship diagram.

When considering a material handling system, it's important to remember that the type of material-handling device determines the type of layout pattern (Devise & Pierreval, 2000; Heragu & Kusiak, 1988). There are four types of layout patterns namely;

- i. Single row layout
- ii. Multi-rows layout
- iii. Loop layout
- iv. Open-field layout

According to Yang, Peters, & Tu (2005), an open-field layout is basically the placement of facilities within a specified area without any restrictions. In the timber industry it was observed that layouts within the service centres and production mills make use of an open-field type layout. The material handling equipment used within these facilities are mainly Renosters (Cat It14) and Tele-loggers (Cat 225).

Through observation material handling equipment must be able to perform grabbing, lifting and lowering functions within the timber depots. Renosters and Tele-loggers perform these functions with relative ease; they have great manoeuvrability and are best suited for rough terrains that are experienced in the depots (*See figure 7 below*).

❖ The figures below were provided by BedRock Mining Support (Pty) Ltd.



Figure 7: Renoster (Left) & Tele-logger (Right)

In calculating space requirements for a department, it is important to take in account additional space for material handling that could take place. As this additional space cannot be determined exactly it can be approximated, provided that the handling of load sizes is known (Tompkins *et al.*, 2010:123-124).

Table 1: Aisle Allowance Estimates (Tompkins *et al.*, 2010:124)

If the Largest Load is	Aisle Allowance Percentage (%) is
Less than 6ft squared	5-10
Between 6 & 12 ft squared	10-20
Between 12 & 18 ft squared	20-30
Greater than 18ft squared	30-40

According to Tompkins *et al.* (2010:145-146), **6ft²** should be allocated to every employee that will make use of a locker room and between **12.5 ft²** and **15ft²** for every toilet in a restroom for planning purposes. The ratio of workers to toilets in the industry is **1:20**, therefore one toilet for every twenty workers employed (Boshoff, 2010).

When considering area requirements for particular offices, the following can be used as a guideline (“Tenants’ Rule of thumb,” 2008);

- *Executive office:* **100 – 150 ft²**
- *Partitioned open space- supervisor:* **80 – 110ft²**
- *Open space- secretary:* **60 – 110ft²**
- *Receptionist area (Receptionist and 2-4 people):* **125 – 200 ft²**

5. Design

5.1 Part 1: Define Problem

5.1.1 Problem Objectives

The objectives of the new centralised depot have already been mentioned under the *Project Aim*, but the main role that the new depot will play will be within its supply chain. BedRock has a vision of timber being transported directly from the plantations to the depot, where the bundling of pencils and mine poles will be done. From the depot the bundled pencils will then be distributed to service centres and then to the mines, where as bundled mine poles and units will go directly to the mines. The main purpose for this depot is to control the quality of incoming timber and outgoing products (See figure 8).

❖ The figures below were provided by BedRock Mining Support (Pty) Ltd.



Figure 8: Role of the New Centralised Depot

5.1.2 Primary and Support Activities

As mentioned in the *Project Aim*, the Centralised Depot must accommodate a *Buffer*, *Scanner*, *Pencilling* and a *Chipper Operation* with the necessary supporting facilities. Currently Bleskop Service Centre has a *Buffer* and *Bundling Operation* and Glenthorpe Production Mill has a *Scanner*, *Pencilling* and a *Chipper Operation*. These primary activities as well as their supporting activities will be analysed in both depots and will consist of the following;

The primary activities;

I. Scanner Operation

This operation involves sorting timber into their various diameter classes and contains three main components, namely;

- Off-Loading Stock Pile
- Scanner
- Sorted Stock pile

The process begins where timber is moved from an Off-loading stock pile and is fed through a scanner, where the timber is then scanned, sorted and stacked onto a sorted stock pile in their various diameter classes.

How does the Scanner work? Timber is stacked on a rack, where a mechanism feeds timber poles through a laser. The laser determines the diameter of the pole and then allocates it to a bin. Once the pole has been scanned, it is then transported by means of a conveyor belt to its allocated bin, where a worker then removes the pole and places it in the bin (See figure 9 below).

❖ *The figures 9, 10 & 11 below were provided by BedRock Mining Support (Pty) Ltd.*



Figure 9: Scanner at Glenthorpe Production Mill

II. Pencilling Operation

This operation involves transforming mine poles into pencils and contains two main components, namely;

- Pencilling Machine
- Pencil Prop Bundling Area

The process begins where mine poles are cut into their required lengths; from there they are then tapered on one end by a pencilling machine and then moved directly to the bundling area, where they are then bundled by workers.

How does the Pencilling machine work? Mine poles are loaded by workers into the machine mechanism, where they are held firmly in place by means of a vice grip. The mechanism then turns the pole, whilst an angled blade cuts a taper on the one end of the pole.

III. Chipper Operation

This operation transforms timber off-cuts into chips, which removes waste in the depot, minimizes losses and produces a product that is sold to a market.

IV. Bundling Operation

This operation involves bundling of mine poles and pencils for the Rustenburg region, by means of strapping and labour. For the Centralised Depot the Bundling Operation will only include the bundling of mine poles as the Pencilling Operation will do the bundling of pencils.



Figure 10: Bundling at Bleskop Service Centre

V. Buffer Operation

This operation involves the storage of timber that will be used for emergency purposes during the wet months. Timber is preserved by means of water, where its main function is to keep the timber moist and slow down the cracking process. Using this technique, timber can be kept for a couple of months, before timber begins to perish.



Figure 11: Buffer at Bleskop Service Centre

The support activities;

I. Guard House

The guard house controls the incoming and outgoing of delivery trucks as well as the employees. The guard house checks the delivery notes as well as ensures that nothing additional has been taken out of the yard.

II. Parking

This area provides space for employees to park their vehicles as well as for visitors. Parking spaces are reserved for the Mill manager, Stores clerk and Administrative clerk.

III. Offices

This is where employees deal with all of the depots administrative issues and where meetings take place. Offices are provided for the Mill manager and Administrative clerk.

IV. Workshop

This is where equipment, spare and tools are stored as well as a place where maintenance and repairs are done on material handling equipment. This area also provides an office for the Stores clerk.

V. Change Rooms

This is an area where workers can get changed into their overalls and store their personal belongings. This area also provides toilets for the workers to use.

5.1.3 Identified Problems

Through speaking to Managers and spending time in Bleskop Service Centre and Glenthorpe Production Mill a few problems were identified. These identified problems will be considered and avoided when designing the new Centralised Depot and consist of the following;

Bleskop Service Centre;

- Trucks entering the depot to off-load products are forced to reverse and make u-turns in order to turn the truck around before exiting the yard. This is because there is no fixed path for the trucks to follow and this poses a problem because a truck reversing in a yard places employees at danger (*See figure 12*).
- The material handling equipment used to move timber throughout the depot is experiencing random movement and therefore seemingly travelling larger distances than expected. This is because handling equipment has not been assigned to fixed areas in which they must operate in or to perform certain functions. The figure below illustrates the movement observed by a Tele-Logger during one day of operation at Bleskop Service Centre (*See figure 12*).

Glenthorpe Production Mill;

- The Pencilling Operation receives its timber directly from the scanner, which is a fair distance away. Therefore this results to handling equipment making longer trips than what is expected, in order to move timber from the Scanner to the Pencilling Operation.
- The chipper receives its off-cuts from the Pencilling Operation, which is also a fair distance away. Therefore this results to unnecessary trips made by handling equipment, where if the chipper was for instance close in proximity to the pencilling Operation a worker could do the job at no additional cost.

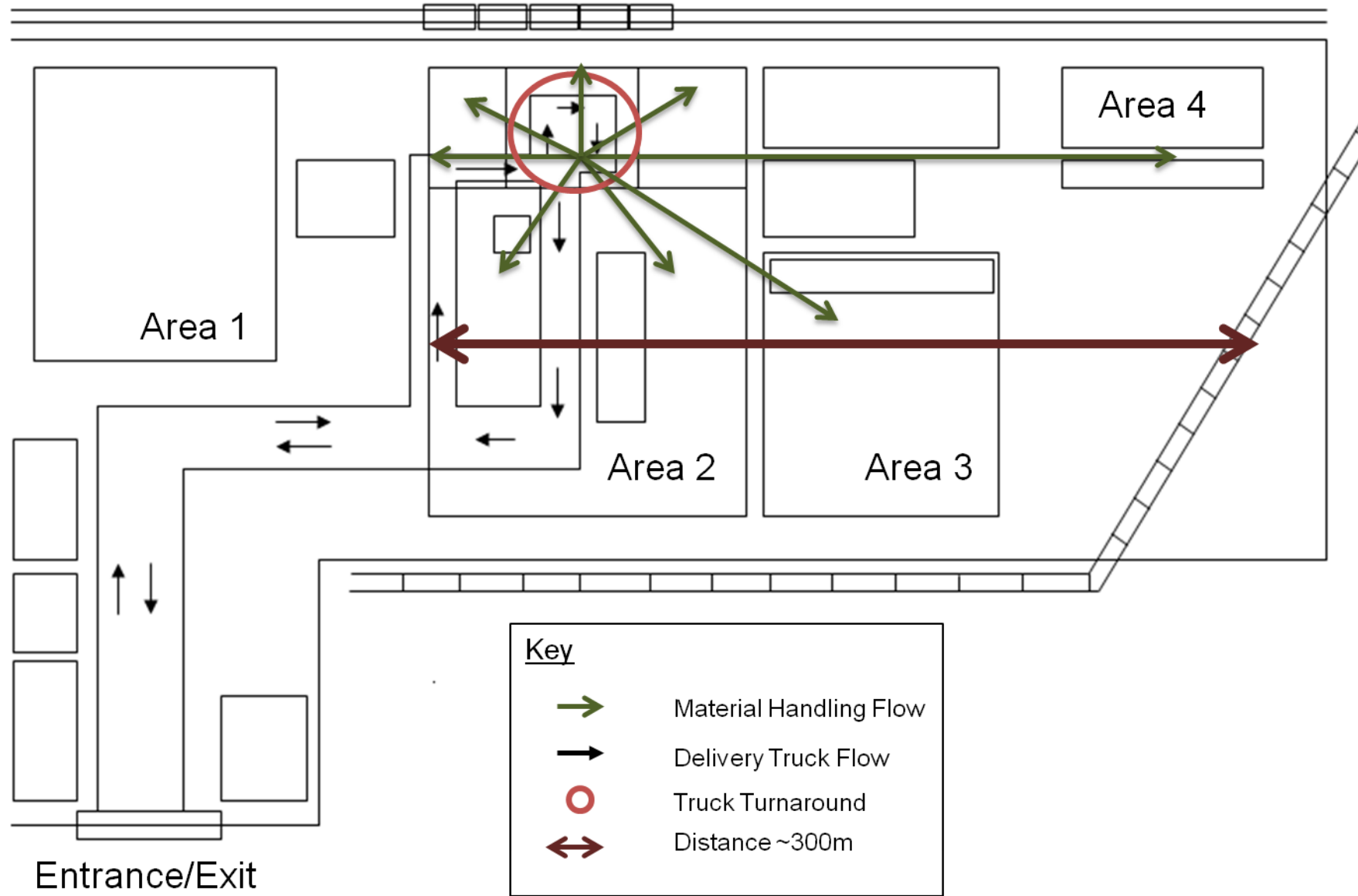


Figure 12: Bleskop Service Centre Current Layout (Not to Scale)

5.1.4 Material Handling Research

Research was done to investigate the current material handling and process equipment being used at the various service centres and production mills. This investigation was an attempt to discover redundant equipment that could possibly be used in the new centralised depot (See Table below).

Table 2: Service Centre & Production Mill Equipment

Depot Name	Service centre (S) or Mill(M)	Scanner Machine	Pencilling Machine	Chipper	Tele-logger	Renoster
Lonmin	S					
Bleskop	S		X1		X2	X1
Union	S				X2	
Amandalbult	S				X1	
Atok	S					
Modikwa	S			X1		
Makhado	M		X1			
Rutlands	M		X2			
Glenthorpe	M	X1	X1	X1		
Piet Retief	M	X1	X1			
Rocklands	M		X1			
Paul Piet	M		X1			
Eazi mine	M		X2			
Venus	M	X1				
Zungwini	M			X1	X2	X1

It was through further research it was discovered that Venus mill was closed and Zungwini mill is scheduled to be closed. Therefore a chipper machine, Renoster and two Tele-loggers will be available from Zungwini mill and a scanner machine from Venus mill.

At this present time Bleskop service centre is holding an unused pencilling machine and therefore will also be available. This handling equipment and process equipment can now be used in the new centralised depot, therefore reducing redundancy and saving costs.

6. Part 2: Analyze the Problem

6.1 Flow Planning

Flow planning is determining the activity relationships between various departments and is therefore important when designing a new facility layout. Activity relationships can be determined by using a quantitative and qualitative flow measurement approach. A quantitative approach will be used when there is a high flow of material, information or people between departments and a qualitative approach when the flow is low (Tompkins *et al.*, 2010:113).

The quantitative approach will include developing *from-to charts* and qualitative approach, *Activity Relationship charts*. These techniques will be used to determine the closeness of each department relative to each other, which contribute to the strategic placement of departments in a new facility layout plan (Tompkins *et al.*, 2010:113-119).

6.1.1 From-to Chart

A from-to chart was developed for Glenthorpe Production Mill for the reason being that the departments under analysis correlate and have sufficient movement between departments for a quantitative measurement approach. Currently Glenthorpe accommodates a scanner, pencilling and chipper operation. These above mentioned operations will form the basis of the new centralised depot and therefore hence the reason for analyses.

The quantitative measure that will be analyzed between departments will be the number of *trips per day* and measurements will be taken over a week. A Trip is defined in two ways namely,

- I. The movement of timber from one department to another and
- II. The empty back haul to the original department.

Trips between departments were made possible either by a Renoster or a Tele-Logger, but for calculation purposes,

- I. Timber moved will be done in *cubic meters (Cubes)*, eliminating units,&
- II. A Renoster will be assumed to do all the material handling, as it can carry approximately **2.2** cubes of timber, where as a Tele-logger can only carry approximately **0.7** cubes of timber.

Therefore ensuring that the number of trips between departments were determined using the same variables when compiling the from-to chart.

Glenthorpe From-to chart:

The from-to chart that was compiled below, shows the quantitative measure between the following departments (*Dep*);

- I. Dep A: Off loading stock pile & Dep B: Scanner.
- II. Dep B: Scanner & Dep C: sorted stock pile.
- III. Dep B: Scanner & Dep D: Pencilling machine.
- IV. Dep D: Pencilling Machine & Dep E: Chipper

From/To	Off loading Stock Pile	Scanner	Sorted Stock Pile	Pencilling Machine	Chipper
Off loading Stock Pile		569	0	0	
Scanner	569		542	62	
Sorted Stock Pile	0	542		0	
Pencilling Machine	0	62	0		28
Chipper	0	0	0	28	

Figure 13: Glenthorpe From-to Chart (Tompkins et al., 2010: 114-115).

❖ *The data that was used to determine the amount of trips between departments was provided by BedRock Mining Support (Pty) Ltd which was obtained from Glenthorpe’s scanner operation (See figure 14).*

The data reflects the amount of timber processed through a typical day in units and cubic meters with impressive accuracy. By using this data the number of trips could be determined between departments as the process is consistent and the amount of timber processed is directly proportional to the amount of timber moved in a particular day.

The figure below shows the amount of timber processed for a particular week as well as the amount of timber moved for Pencilling (Bins 6&7). Therefore these totals were divided by 2.2 (Renoster carry load in cubes) to give the total trips (to and fro) between departments. The quantitative measure was done over a period of a *week* as this would provide a good estimate of the amount of movement between departments.

Note:

- ❖ The number of trips between Dep A&B differs to Dep B&C, because timber rejects were not included in the calculations for Dep B&C.
- ❖ The number of trips between Dep D&E was calculated by dividing 60 cubes by 2.2, as this was the total amount of timber scrap delivered to the chipper on a weekly basis.

			Count (Units)					Volume (Cubic Meters)				
	Min Dia (cm)	Max Dia (cm)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5
Bin 1	9.5	10.5	1367	1579	1079	976	1149	30.84	35.71	24.47	22.25	26.01
Bin 2	10.5	11.5	1399	1648	1125	1078	1193	36.15	42.87	29.13	28.19	30.86
Bin 3	11.5	13.3	2503	2568	1881	1915	2306	79.96	81.45	60.37	61.00	73.02
Bin 4	13.3	14.5	1145	1281	914	1034	1139	45.33	50.05	36.16	40.86	45.01
Bin 5	14.5	16.0	786	647	529	803	981	37.16	29.71	24.67	37.87	45.97
Bin 6	16.0	18.0	322	101	204	440	599	18.80	5.64	11.52	25.41	34.27
Bin 7	18.0	21.0	91	24	72	153	233	6.57	1.71	5.21	11.01	16.26
Bin 8	21.0	21.0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Rejects			629	728	555	508	502	12.60	14.50	11.00	10.20	10.20
			8242	8576	6359	6907	8102	267.41	261.64	202.53	236.79	281.60
Total: Bin 6&7							2239					136.40
Total: Week							38186					1249.97

Figure 14: Glenthorpe Scanner Data

6.1.2 Activity Relationship Charts

A separate relationship Chart was developed for both the *Primary and Supporting Activities* of the Centralised Depot. The Primary Activity Relationship chart was compiled using the following:

- I. Glenthorpe from-to chart.
- II. Observations made in Bleskop Service Centre and Glenthorpe Production Mill, &
- III. Discussions with BedRock (Project Sponsor).

Whereas the Supporting Activity Relationship chart was compiled using just the last two above mentioned points. These two separate relationship charts were then analysed and used to produce a final relationship chart that shows the following;

- I. The integration of the primary and supporting activities in the centralised depot, &
- II. The closeness and reason for closeness for each department relative to each other.

The closeness between Departments was determined using the *Closeness Relationship Values* developed by Muther and defined reasons for closeness (*See Tables below*).

Table 3: Closeness Relationship Values (Muther, 1973).

Value	Closeness
A	Absolutely necessary
E	Especially important
I	Important
O	Ordinary closeness okay
U	Unimportant
X	Undesirable

Table 4: Reasons for Closeness (Tompkins et al., 2010:300).

Code	Reason
1	Employee flow high
2	Employee flow medium
3	Employee flow low
4	Little or no flow of employees
5	Timber flow high
6	Timber flow medium
7	Timber flow low
8	Little or no flow of timber
9	Little or no flow of timber or employees

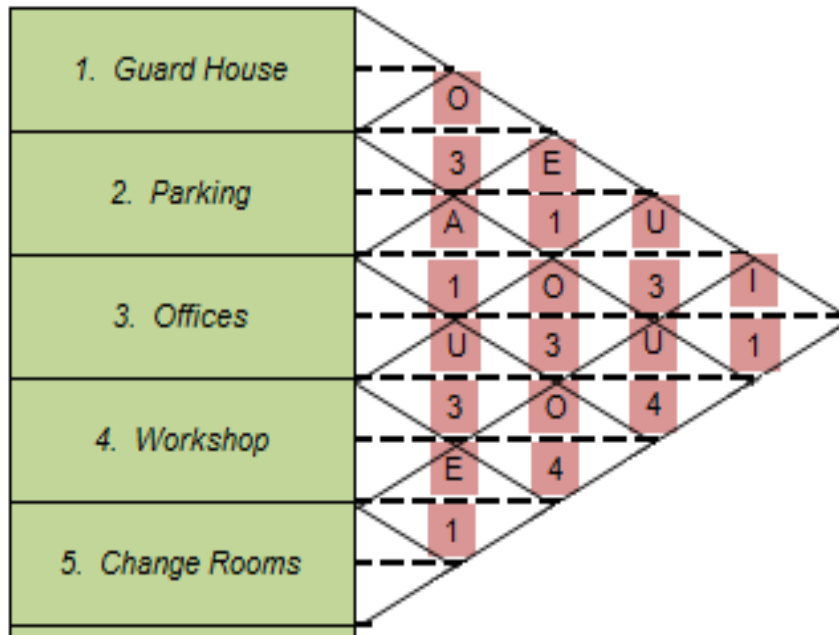


Figure 15: Supporting Activities Relationship Chart (Tompkins et al., 2010:300).

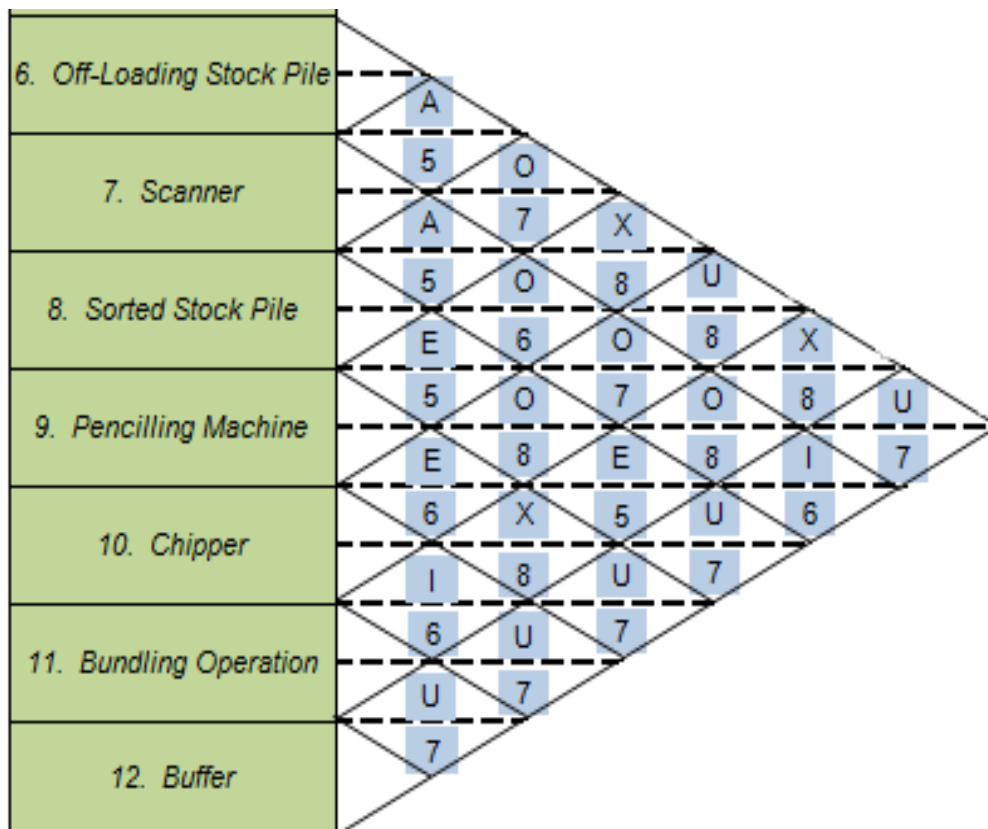


Figure 16: Primary Activities Relationship Chart (Tompkins et al., 2010:300).

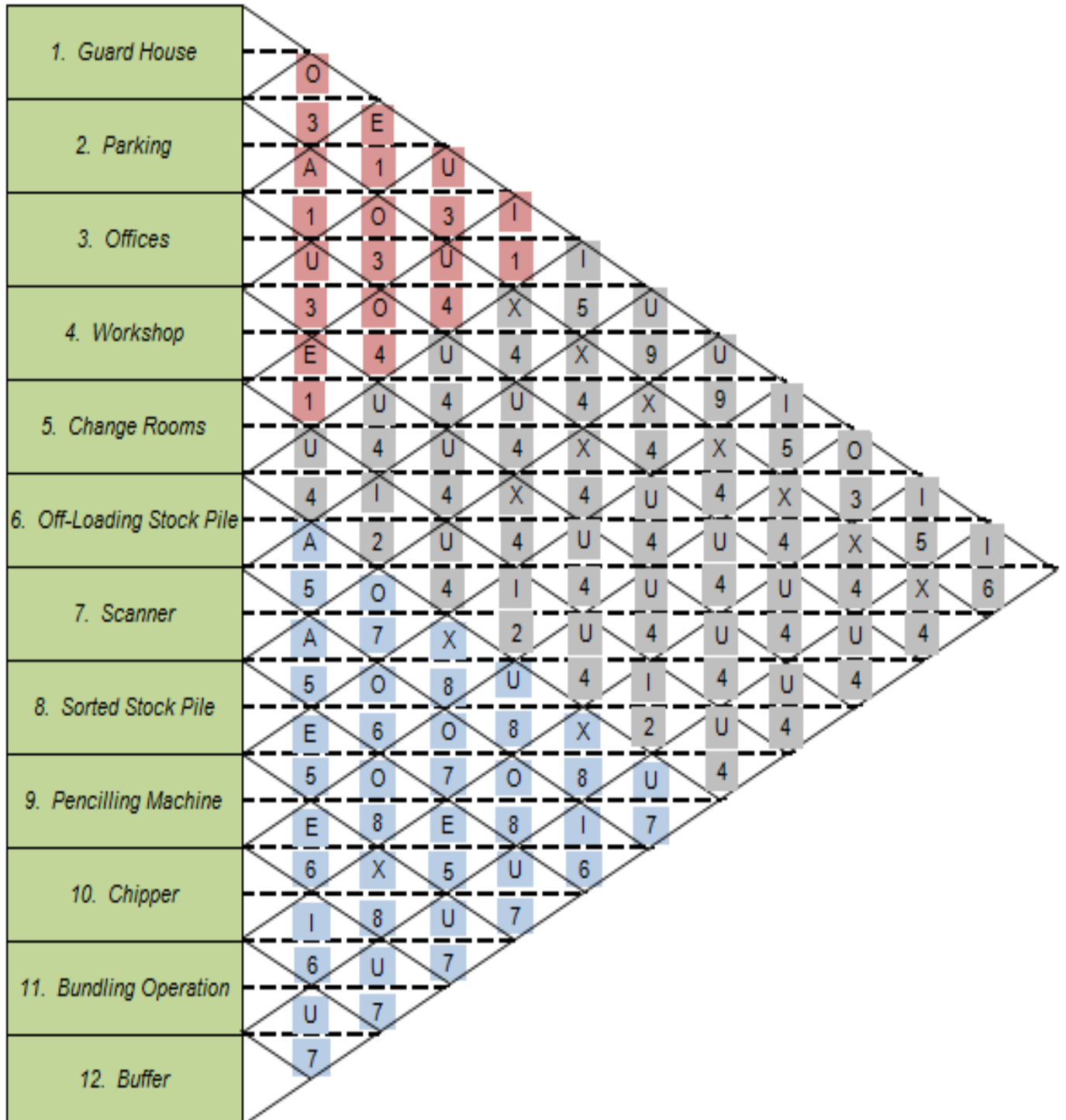


Figure 17: Final Relationship Chart (Tompkins et al., 2010:300).

7. Part 3: Space Requirements

Space requirements involve determining the total amount of floor space (M^2) required for activities, machinery and movement that can be expected to take place within a facility. From a manufacturing point of view, the best methodology to adopt when determining space requirements is;

- I. Firstly, determine the space requirements for each individual workstation within the department.
- II. Secondly, determine the space requirements for the department.

The department's space requirement is determined by combining each workstations requirement, then making space provision for *aisle space* for material handling and movement (Tompkins *et al.*, 2010:119-124).

The following factors will be taking in consideration when determining the space requirements for each department, namely;

- I. The requirements for each department, ie toilets, equipment and machines etc.
- II. Aisle space required for material handling and employee movement.
- III. Unidirectional and Bidirectional flow.

The amount of aisle space to make provision for within the various departments will be determined by analysing the type of load that will be moved through that department. The table below explains the type of load and respective aisle allowance percentages that will be used during calculations.

❖ *The conversion ratio of 1ft = 0.3048m was used to convert feet into meters*
(www.google.co.za).

If the Largest Load is	Aisle Allowance Percentage (%) is
Less than 6ft squared	5-10
Between 6 & 12 ft squared	10-20
Between 12 & 18 ft squared	20-30
Greater than 18ft squared	30-40

The space requirements for following Departments will be calculated, just to recap;

1. *Guard House*
2. *Parking*
3. *Offices*
4. *Workshop*
5. *Change Rooms*
6. *Off-Loading Stock Pile*
7. *Scanner*
8. *Sorted Stock Pile*
9. *Pencilling Operation*
10. *Chipper*
11. *Bundling Operation*
12. *Buffer*
13. *Centralised Depot*

7.1 Guard House

The size of the guard house will be compared to the size as *secretary office (open spaced)* which will accommodate a *desk, two chairs, a computer* and a *notice board*. The guard house will also include a toilet, which will allow employees to return to guard duties in good time. The type of movement that will take place in the guard house will be bio-directional, as employees will be moving in and out of the guard house on a regular basis. The type of load that will be experienced will be less than 6ft^2 , which will represent the movement of paperwork, boxes etc.

Space requirements;

- ❖ *Secretary open space office* (110ft^2) = 10.22M^2
- ❖ *Toilet* (15ft^2) = 1.4M^2
- ❖ *Aisle space allowance* = 10% bio-directional(x2)
- ❖ *Total space requirements* = **13.944M^2**

7.2 Parking

Parking bays will be provided for the *Mill Manager*, *Stores Clerk* and *Administrative Clerk*, but another *three* bays will be provided for people paying visits to the centralised depot. Through observation the size on a single parking bay was determined, which also includes the space required for employee movement in accessing his vehicle.

Space requirements;

- ❖ *Parking bays* = $6 \times (4\text{m} \times 3\text{m}) = 72 \text{ M}^2$
- ❖ *Total space requirements* = 72 M^2

7.3 Offices

The office department will accommodate two offices (*Executive office & Secretary office*), a *receptionist area*, a *kitchen* and a *toilet*. In each office there will be a *desk*, three *chairs*, *computer*, *shelves* and a *file cabinet*. The Executive office will be provided for the Mill Manager and Secretary office for the Administrative clerk.

The size of the kitchen will be based on the size currently used in Glenthorpe Production Mill that accommodates a fridge, microwave and a sink with cupboards. The type of movement that will be experienced in the office will be *bio-directional*, as employees will move back and forth between offices, the kitchen and toilet. The type of load that will be experienced will be *greater than 6ft²*, which will represent the movement of paperwork, boxes etc.

Space requirements;

- ❖ *Executive office* (150 ft²) = 13.94 M²
- ❖ *Secretary open space office* (110 ft²) = 10.22 M²
- ❖ *Receptionist area* (125 ft²) = 11.61 M²
- ❖ *Kitchen* = 4.5 M²
- ❖ *Toilet* (15 ft²) = 1.4 M²
- ❖ *Aisle space allowance* = 10% bio-directional(x2)
- ❖ *Total space requirements* = 50 M^2

7.4 Workshop

The workshop will accommodate a *supervisor's office*, a store room, a *toilet* and *parking bays* that can accommodate a Tele-logger or Renoster during maintenance and repairs. The supervisor's office will include a *desk*, three *chairs*, *computer*, *shelves* and a *file cabinet*. The size of the store room will be based on the size currently used in Glenthorpe Production Mill that can hold various tools, supplies and equipment.

The type of movement that will be experienced in the office will be *bio-directional*, as employees will move back and forth between the office, store room and toilet. The type of load that will be experienced will be *greater than 18ft²*, because during maintenance of handling equipment, tyres can be re-moved and replaced. Therefore taking in account the largest load that could be experienced in the Workshop.

Space requirements;

- ❖ *Supervisor's office* (110 ft²) = 10.22 M²
- ❖ *Store room* = 14.85 M²
- ❖ *Parking bays* = 2*(6m*2.5m) = 30 M²
- ❖ *Toilet* (15 ft²) = 1.4 M²
- ❖ *Aisle space allowance* = 40% bio-directional(x2)
- ❖ *Total space requirements* = **101,65M²**

7.5 Change Rooms

The change room will have two separate areas for *locker rooms* and *toilets*. There will be male and female locker rooms and toilets, which must accommodate approximately 100 workers (30 female, 70 male). Just to recap, 6ft² will be provided for each worker using the locker room and one toilet for every 20 workers.

Space requirements;

- ❖ *Locker room* (6ft²per worker) = 100*6 = 55.74 M²
- ❖ *Toilet* (15 ft²) = 5*15 = 6.97 M²
- ❖ *Total space requirements* = **62.71M²**

7.6 Off-Loading Stock Pile & Sorted Stock Pile

These areas for planning purposes will accommodate a *week's* stock pile of raw material that can produce *mine poles* and *pencils*. This value was calculated by using monthly customer consumption rates in *cubes* for *mine poles* and *pencils* over a period of a year. Using these monthly rates, the monthly averages were calculated and divided by *four* to give the approximated weekly consumption rate for each customer. These weekly quantities were combined to produce a total weekly consumption rate for all the customers in the Platinum market (See Appendix). Aisle space was ignored in both departments and a **5%** reject value was taking in consideration.

- ❖ *The monthly consumption rates of customers were provided by BedRock Mining Support (Pty) Ltd (See Appendix).*

Space requirements:

- ❖ *Weekly Mine Pole rate = 1101.12 M²*
- ❖ *Weekly Pencil Prop rate = 756.72 M²*
- ❖ *Total space requirements = 1857.84M²*
- ❖ *5% Reject Value = 92.89 M²*
- ❖ *Final Space Requirements = 1950,73M²*

Calculation:

- ❖ All the above mentioned M³ values were converted to M² by using the following calculation;

$$M^2 = M^3 / (2m * 0.67)$$

- ❖ (Where **0.67** is a determined air ratio that is used by Bedrock & **2m** is the height that timber can be stacked).

7.7 Scanner

The scanner will include a *scanner mechanism*, *scanner feeding rack* and *scanner bins*. For the platinum market, there are four different diameter classes for incoming timber which each class will be represented by a separate bin as well as an additional bin for *rejects*. Through physical measurements the space requirements for the scanner mechanism, scanner feeding rack and a single scanner bin was determined. The size of a single scanner bin includes the space required for a worker to manage that particular bin. Aisle space was ignored in this department.

Space requirements:

- ❖ *Scanner mechanism* = 15M^2
- ❖ *Scanner feeding rack* = 60M^2
- ❖ *Scanner bins* = $5 \times (4\text{m} \times 2\text{m}) = 40\text{M}^2$
- ❖ *Total space requirements* = 115M^2

7.8 Pencilling Operation

This department will include a *pencilling machine* and *pencil prop bundling operation*. As there is a pencilling machine available in Bleskop Service Centre, these dimensions were physically taken and the space requirements determined. For planning purposes the pencil prop bundling operation will accommodate a *week's* stock pile of pencil props.

This value was calculated by using monthly customer consumption rates in *cubes* for *pencils* over a period of a year. Using these monthly rates, the monthly averages were calculated and divided by *four* to give the approximated weekly consumption rate for each customer. These weekly quantities were combined to produce a total weekly consumption rate for all the customers in the Platinum market (See Appendix).

The type of movement that will be experienced in this department will be *bio-directional*, as workers will move back and forth between bundles checking the quality. The type of load that will be experienced will be *less than 6ft²*, which will represent the movement of bundles, tools and strapping used for bundling.

- ❖ *The monthly consumption rates of customers were provided by BedRock Mining Support (Pty) Ltd (See Appendix).*

Space requirements;

- ❖ *Pencil Machine* = 150 M²
- ❖ *Pencil prop bundling* = 756.71 M²
- ❖ *Aisle space allowance* = 10% bio-directional(x2)
- ❖ *Total space requirements* = **1088.05M²**

7.9 Chipper

The chipper will include a *chipper machine* and a *chip bin*. The dimensions for a chipper machine and chip bin were physically measured out from Glenthorpe Production Mill and the space requirements determined. Aisle space was ignored in this department.

Space requirements;

- ❖ *Chipper Machine* = 7.5 M²
- ❖ *Chip Bin* = 64M²
- ❖ *Total space requirements* = **71.5M²**

7.10 Bundling Operation

For planning purposes the *mine pole bundling operation* will accommodate a *week's* stock pile of mine poles. This value was calculated by using monthly customer consumption rates in *cubes* for *pencils* over a period of a year. Using these monthly rates, the monthly averages were calculated and divided by four to give the approximated weekly consumption rate for each customer. These weekly quantities were combined to produce a total weekly consumption rate for all the customers in the Platinum market (See Appendix).

The type of movement that will be experienced in this department will be *bio-directional*, as workers will move back and forth between bundles checking the quality. The type of load that will be experienced will be less *than 6ft²*, which will represent the movement of bundles, tools and strapping used for bundling.

- ❖ *The monthly consumption rates of customers were provided by BedRock Mining Support (Pty) Ltd (See Appendix).*

Space requirements;

- ❖ *Mine pole bundling* = 1101.12M²
- ❖ *Aisle space allowance* = 10% bio-directional(x2)
- ❖ *Total space requirements* = 1321.34M²

7.11 Buffer

For planning purposes the *buffer* will accommodate a two week stock pile of raw material that can produce *mine poles* and *pencils*. This value was calculated by using monthly customer consumption rates in *cubes* for *pencils* and *mine poles* over a period of a year. Using these monthly rates, the monthly averages were calculated and divided by *two* to give the approximated weekly consumption rate for each customer. These weekly quantities were combined to produce a total weekly consumption rate for all the customers in the Platinum market (See Appendix).

The type of movement that will be experienced in this department will be *unidirectional*, as handling equipment will move in and out of the stock pile. The type of load that will be experienced will be between 6 & 12ft², which will represent the movement of timber by a Tele-logger.

- ❖ *The monthly consumption rates of customers were provided by BedRock Mining Support (Pty) Ltd (See Appendix).*

Space requirements;

- ❖ *Two week mine pole rate* = 2202.24M²
- ❖ *Two week pencil prop rate* = 1513.43M²
- ❖ *Aisle space allowance* = 20% unidirectional
- ❖ *Total space requirements* = 4458,80M²

7.12 Total Space Requirements for the Centralised Depot

This will be the summation of all the departments space requirements combined with consideration for aisle space. The type of movement that will be experienced in the Centralised Depot will be *bi-directional*, as handling equipment will move back and forth between departments. The type of load that will be experienced will be greater $18ft^2$, which will represent the movement of timber by either a Renoster. Therefore taking in account the largest load that could be experienced in the Depot.

Table 5: Total Space Requirements for Centralised Depot

Department	Space Requirements
Guard House	13.944
Parking	72
Offices	50
Workshop	101.65
Change Rooms	62.71
Off-Loading Stock Pile	1950.73
Scanner	115
Sorted Stock Pile	1950.73
Pencilling Operation	1088.05
Chipper	71.5
Bundling Operation	1321.34
Buffer	4458.80
Total	11 256.45
Aisle Space allowance: 40% bio-directional	9005.16
Final Total	20262 M²

8. Relationship Diagram

The Relationship Diagram (See figure 19) shows the degree of closeness of each department relative to each other. This diagram was developed based on the results obtained in the final relationship chart and only the top three important relationships between departments were considered. This diagram is important as it creates a set of rules that are used when developing alternative block layouts (Tompkins *et al.*, 2010: 297-301).

Each circle represents a department (See Key 1) and each individual line between departments represents the type of closeness (See Key 2). By analyzing the figure below, Departments 2&3, 6&7 and 7&8 should be *Absolutely Necessary* in closeness, which should be taken in account when designing alternative block layouts. Therefore these are the type of rules that need to be considered as they drive block layout designs and determine their feasibility.

9. Space Relationship Diagram

The Space Relationship Diagram (See Figure 20) is similar in nature to the Relationship Diagram with only one difference, that it now shows the total space required for each department in square meters. This is important as it will affect “how” block layouts are designed and “where” the departments will be placed within the available space. Figure 20 was developed using the final relationship chart as well as the departmental space requirements (Tompkins *et al.*, 2010: 297-301).

Through analysing *figure 20*, departments 6, 8, 9, 11 and 12 will require the largest available space between departments. These space requirements will need to be considered as it will determine where they are placed within the depot; e.g. Department 12 should be ideally placed near the entrance of the depot. For the reason being that it contains the largest amount of timber, which will therefore require the most amounts of trips to off-load or to move the timber within the depot. These are the type of rules that need to be considered as they drive block layout designs and determine their feasibility.

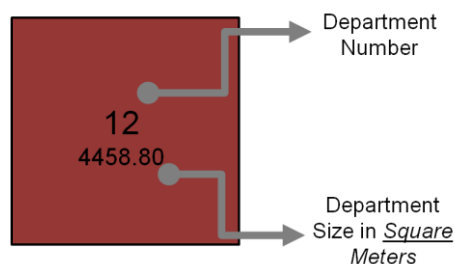


Figure 18: Space Relationship Diagram Explanation

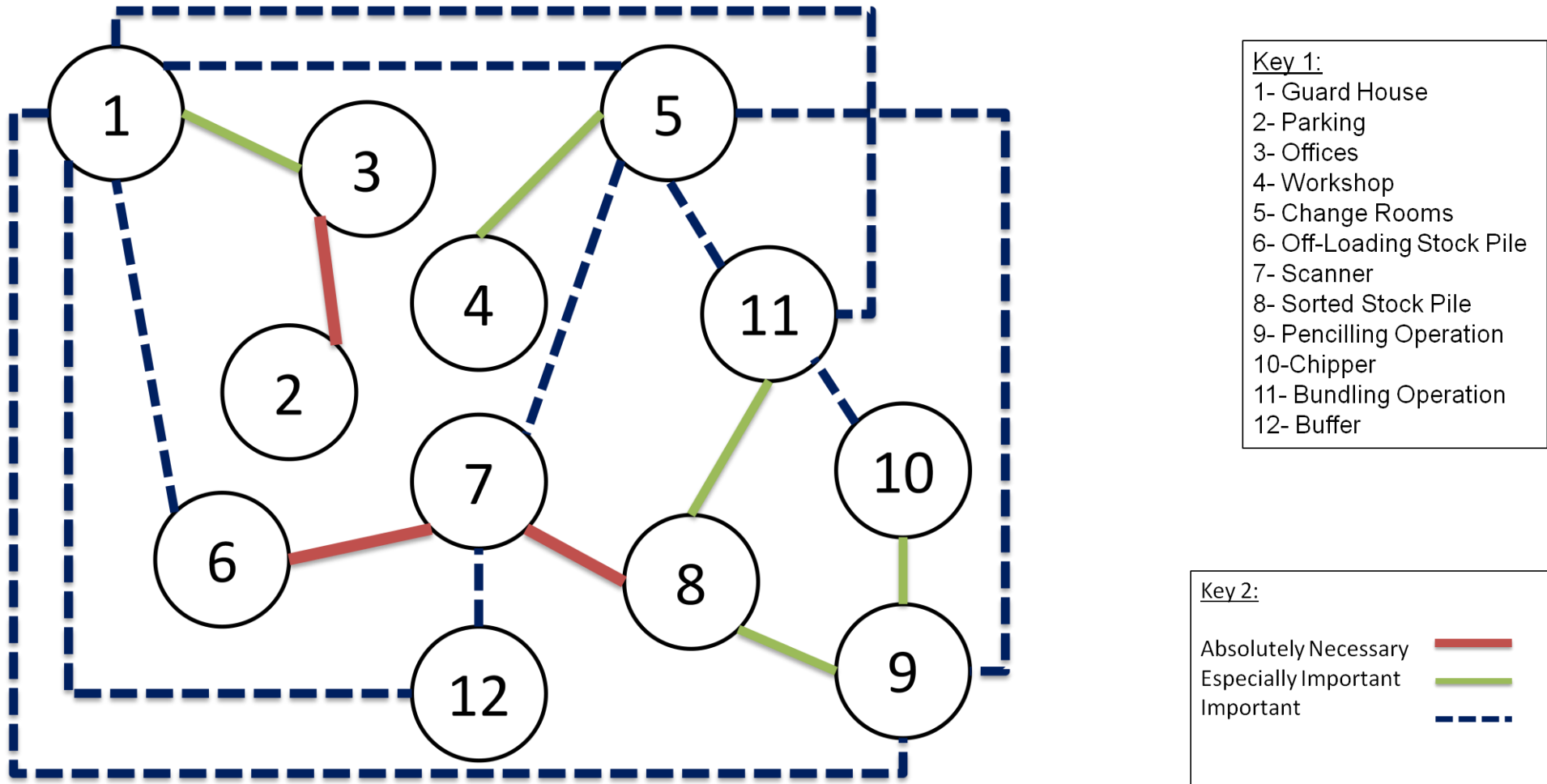


Figure 19: Relationship Diagram (Tompkins *et al.*, 2010: 301).

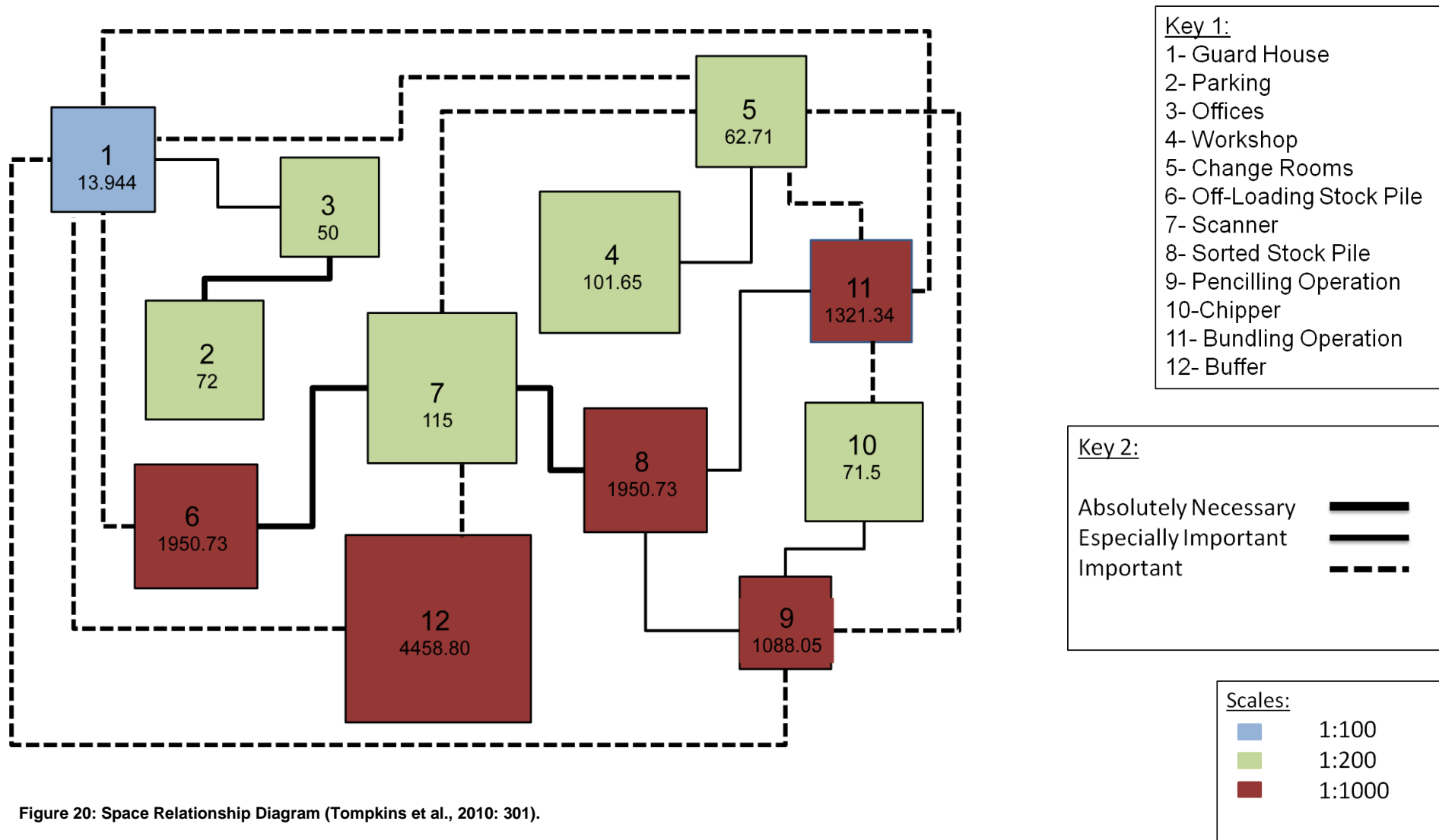


Figure 20: Space Relationship Diagram (Tompkins et al., 2010: 301).

10. Alternative Block Layouts

The Relationship Diagram and Space Relationship Diagram were both used as a guidance tool to produce three alternative block layouts. The Block layouts were developed using a scale of **1:500** and the Guard house a scale of **1:250** as this department was small in comparison to the rest. The various departments were arranged in an available space of **20262 M²** determined by space requirements in order to address the following;

- Efficient and practical process flows, with regard to the flow of timber and employees through the depot as well as incoming and out-going of delivery trucks.
- Efficient relationships between departments/operations which will compliment the production process.
- Effective material handling functions/responsibilities with efficient distances travelled where possible.

The development of the various block layouts also took in account the identified problems observed in Bleskop Service Centre and Glenthorpe Production Mill which were the following just to recap;

Bleskop Service Centre;

- Trucks entering the depot to off-load products are forced to reverse and make u-turns in order to turn the truck around before exiting the yard. This is because there is no fixed path for the trucks to follow and this poses a problem because a truck reversing in a yard places employees at danger.
- The material handling equipment used to move timber throughout the depot is experiencing random movement and therefore seemly travelling larger distances than expected. This is because handling equipment has not been assigned to fixed areas in which they must operate in or to perform certain functions.

Glenthorpe Production Mill;

- The Pencilling Operation receives its timber directly from the scanner, which is a fair distance away. Therefore this result's to handling equipment making longer trips than what is expected, in order to move timber from the Scanner to the Pencilling Operation.

- The chipper receives its off-cuts from the Pencilling Operation, which is also a fair distance away. Therefore this results to unnecessary trips made by handling equipment, where if the chipper was for instance close in proximity to the pencilling Operation a worker could do the job at no additional cost.

Each block layout will be discussed in terms of *Departmental Strategic Placement* within the depot, *Process Flows* and *Material Handling* in order to provide some insight which will be used during the selection process.

10.1 Departmental Strategic Placement

10.1.1 Block Layout 1

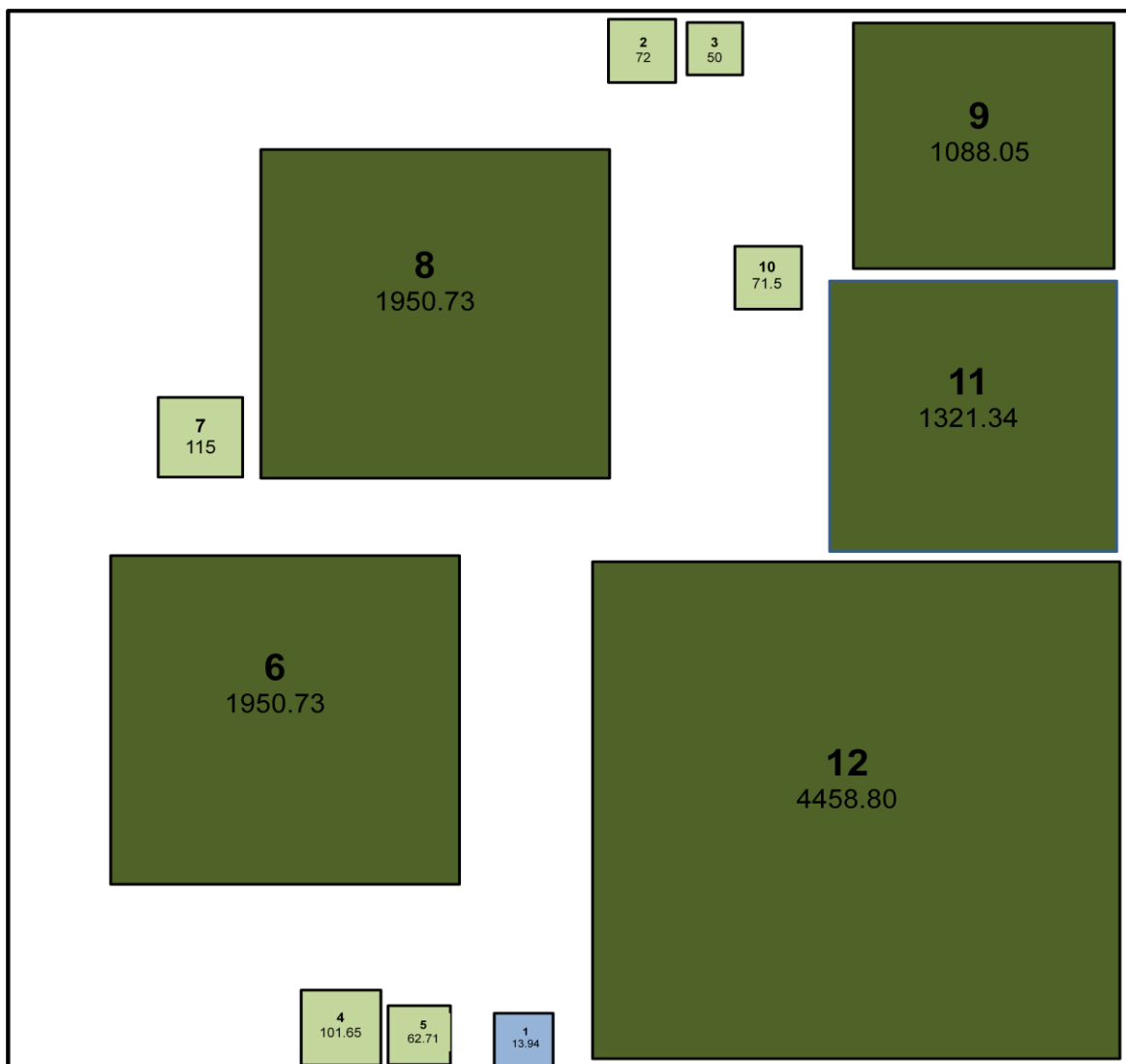


Figure 21: Block Layout 1 (Tompkins et al., 2010: 302).

Department 1:

The *Guard House* was strategically placed near the entrance of the depot, as this was the logical choice in ensuring the control of incoming and outgoing of delivery trucks, workers and day to day security functions.

Department 2&3:

The *Office* and *Parking* facilities were strategically placed next to each other as they adhere to the *Absolutely Necessary* closeness factor determined by the *Relationship Charts*. The placement was also at the back of the yard near the Bundling and Pencilling operations, for the reason being that managers have visual of employee productivity and the loading of outgoing delivery trucks.

Department 4&5:

The *Change Rooms* and *Workshop* were strategically placed next to each other as they adhere to the *Especially Important* closeness factor determined by the *Relationship Charts*. The placement was also near the Guard House to ensure that incoming of workers can change quickly and commence work immediately as well as monitor worker activity through these departments.

Department 6, 7&8:

The *Off-Loading Stock Pile*, *Scanner* and *Sorted Stock Pile* were strategically placed in close proximity to one another as they adhere to the *Absolutely Necessary* closeness factor determined by the *Relationship Charts*. The Off-Loading Stock Pile was placed near the entrance/Guard House to allow quick off-loading and decreased contractor turn-around times.

Department 9&11:

The *Pencilling* and *Bundling Operations* were strategically placed near to the Sorted Stock Pile as to adhere to the *Especially Important* closeness factor determined by the *Relationship Charts*. These departments were also placed next to each other to ensure the loading of final products will be done in a common area.

Department 10:

The *Chipper* was strategically placed near to the Pencilling and Bundling Operations as to adhere to the *Especially Important* and *Important* closeness factor determined by the *Relationship Charts*. This also ensures that loading of final products will still share a common area.

Department 12:

The Buffer Operation was strategically placed near to the Guard house/entrance as to adhere to the *Important* closeness factor determined by the *Relationship charts*. This also allows quick off-loading times and improved contractor turn-around times.

10.1.2 Block Layout 2

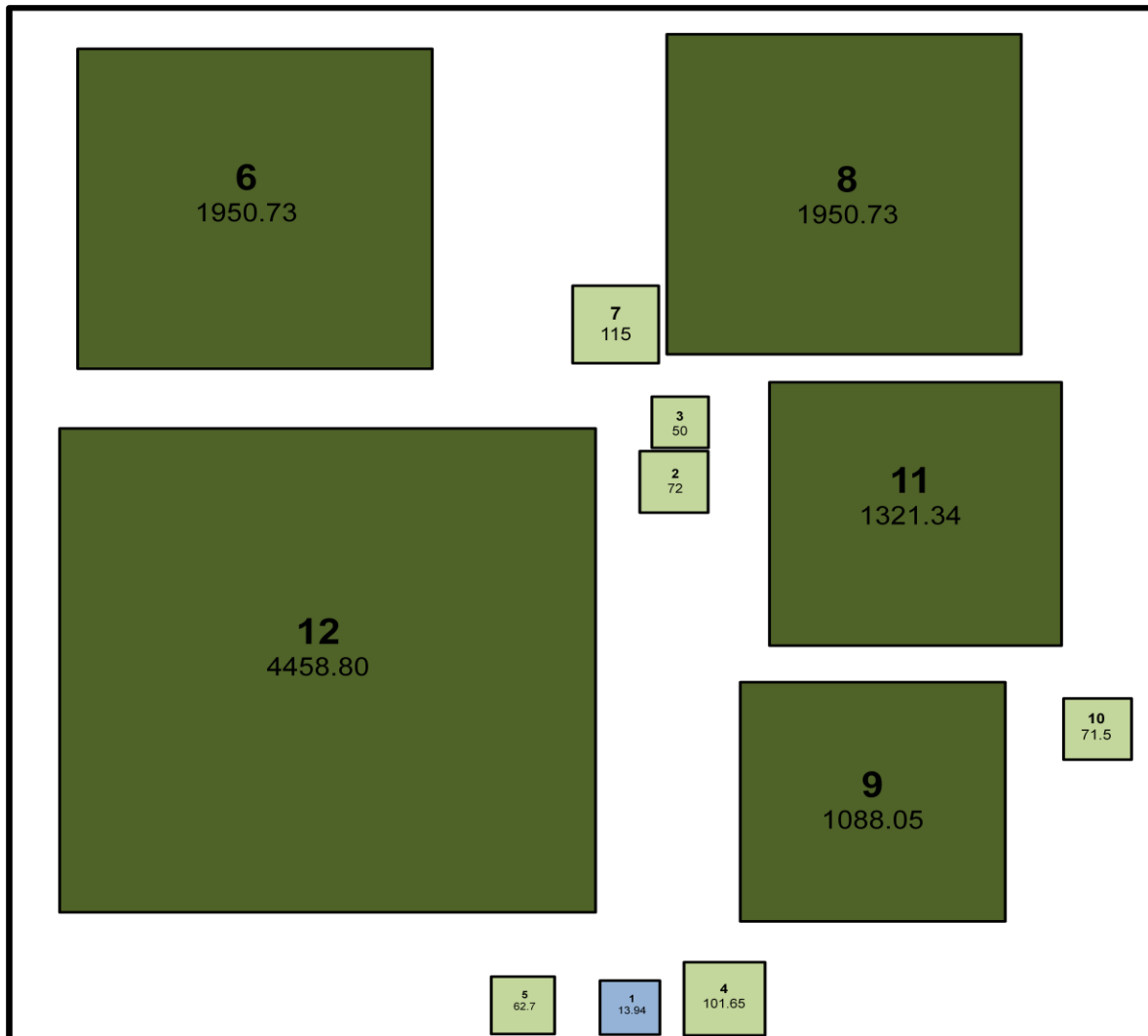


Figure 22: Block Layout 2 (Tompkins et al., 2010: 302).

Department 1:

The *Guard House* was strategically placed near the entrance of the depot, as this was the logical choice in ensuring the control of incoming and outgoing of delivery trucks, workers and day to day security functions.

Department 2&3:

The *Office* and *Parking* facilities were strategically placed next to each other as they adhere to the *Absolutely Necessary* closeness factor determined by the *Relationship Charts*. The placements of these departments were situated in the middle of the depot to ensure that managers have full visual of all activities taking place within the depot.

Department 4&5:

The *Change Rooms* and *Workshop* were placed in close proximity to one another and to the *Guard House* to allow workers to change and commence work in good time once entered into the depot, therefore increasing the productivity. This placement also ensures that the *Guard House* can monitor worker activity taking place at these departments.

Department 6, 7&8:

The *Off-Loading Stock Pile*, *Scanner* and *Sorted Stock Pile* were strategically placed in close proximity to one another as they adhere to the *Absolutely Necessary* closeness factor determined by the *Relationship Charts*. These departments were situated at the back of the yard in order to ensure the movement of timber flows from the back of the yard to the front.

Department 9&11:

The *Bundling Operation* was strategically placed next to the *Sorted Stock Pile* as to adhere to the *Especially Important* closeness factor determined by the *Relationship Charts*. This department was also placed near the *Pencilling Operation* to ensure that the loading of final products will be done in a common area. The placement of these departments were also situated in close proximity to the *Guard House/entrance* to ensure decreased turn-around times for outgoing delivery trucks.

Department 10:

The *Chipper* was strategically placed near to the Pencilling and Bundling Operations as to adhere to the *Especially Important* and *Important* closeness factor determined by the *Relationship Charts*. This also ensures that loading of final products will still share a common area.

Department 12:

The Buffer Operation was strategically placed near to the Guard house/entrance as to adhere to the *Important* closeness factor determined by the *Relationship charts*. This also allows quick off-loading times and decreased contractor turn-around times.

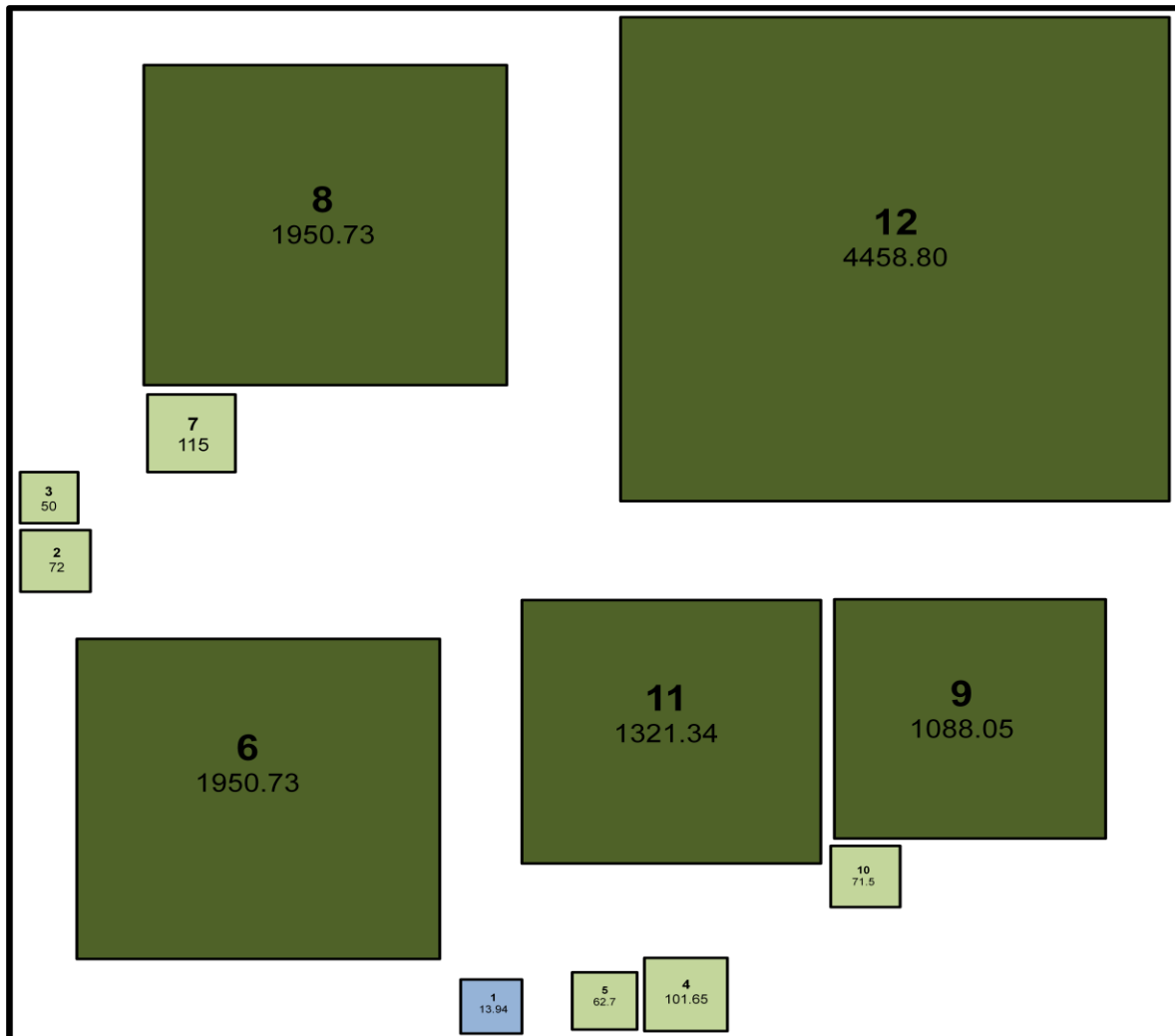
10.1.3 Block Layout 3

Figure 23: Block Layout 3 (Tompkins et al., 2010: 302).

Department 1:

The *Guard House* was strategically placed near the entrance of the depot, as this was the logical choice in ensuring the control of incoming and outgoing of delivery trucks, workers and day to day security functions.

Department 2&3:

The *Office* and *Parking* facilities were strategically placed next to each other as they adhere to the *Absolutely Necessary* closeness factor determined by the *Relationship Charts*. The placements were also middle left of the yard for the reason being that managers can monitor the Scanner and Off-Loading stock pile that drives the production process as well as still have visual of the remaining depot activities.

Department 4&5:

The *Change Rooms* and *Workshop* were strategically placed next to each other as they adhere to the *Especially Important* closeness factor determined by the *Relationship Charts*. The placements were also near the Guard House to ensure that the incoming of workers can change quickly and commence work immediately, therefore increasing the productivity.

Department 6, 7&8:

The *Scanner* and *Sorted Stock Pile* were strategically placed in close proximity to one another as they adhere to the *Absolutely Necessary* closeness factor determined by the *Relationship Charts*. The Off-Loading Stock Pile was placed near the entrance/Guard House to allow quick off-loading and decreased contractor turn-around times.

Department 9&11:

These departments were placed next to one another to ensure that the loading of final products will be done in a common area as well as in close proximity to the Guard House/entrance to ensure decreased turn-around times for outgoing delivery trucks.

Department 10:

The *Chipper* was strategically placed near to the Pencilling and Bundling Operations as to adhere to the *Especially Important* and *Important* closeness factor determined by the *Relationship Charts*. This also ensures that loading of final products will still share a common area.

Department 12:

The Buffer was strategically placed in the back right hand corner of the depot in order to create more space and remain out of the way of day to day depot activities.

10.2 Process Flows

There will be three types of process flows looked at in the block layout alternatives namely the *Flow of Employees*, the *Flow of Timber* and the *Flow of Trucks* through the depot. In each block layout the separate flows will be explained and illustrated in order to provide some insight which will be used during the *evaluation process*.

10.2.1 Flow of Employees

There are two types of employees that will be employed in the depot namely, employees that will manage the day to day activities of the depot and employees (workers) that will perform the physical activities of the depot. *Employee Type 1* will be assigned mainly to the offices and *Employee type 2* to the yard.

Employee Type 1 will move directly to the Parking/ Office facilities once entered into the depot. These employees will mainly be arriving in their own vehicles and work clothes therefore can commence work soon after entering into the depot.

Employee Type 2 will move directly from the Guard house to the Change Rooms, where majority of workers will make an outfit change. Once changed, workers that have been assigned to the Pencilling or Bundling Departments will move via the workshop before heading off to these departments (See *figure 24*). The movement via the Workshop is with regard to workers collecting their daily tools required for them to perform bundling on a day to day basis.



Figure 24: Employee Type 2 Process Flow

The above mentioned flow of *Employee Type 2* will be focussed on for the reason being that the majority of workers assigned to the yard will be performing bundling. The flows of the previously mentioned *Employee Types* will be illustrated and shown in the block layouts below (See *Figure 26*).

10.2.2 Flow of Timber

The flow of timber in the depot will be uniform for all block layout alternatives, but the layout of these departments differ for each alternative and will be analysed during the *evaluation process*. Timber is off-loaded at the Off-Loading Stock Pile and Buffer, where it is then fed into the scanner and sorted. The sorted timber is then transported to either the Pencilling or Bundling operation determined by diameter class, where products are produced and loaded onto outgoing delivery trucks. Off-cuts from the Pencilling and Bundling operation are then recycled through the chipper and stored in a chip bin ready for collection (See *figure 25*).



Figure 25: Timber Process Flow

All the timber flows in the block layout alternatives move in a clockwise fashion, where products are produced and stored in the *back right* and *front right* hand corner of the depot for block layout 1 and block layouts 2&3. In Block layout 1&2 the timber flows from *front to back* and *back to front* of the depot, where as block layout 3 flows from *front to back to front* (See *figure 27*).

10.2.3 Flow of Trucks

There will be two types of truck flow paths that will be illustrated in the block layout alternatives namely, the *Flow of Incoming trucks* and the *Flow of Out-going Trucks*. Incoming trucks are responsible for the delivery of timber to the depot and Out-going trucks the delivery of products to customers.

The incoming trucks will be primarily off-loading timber at the Off-Loading Stock Pile and Buffer where as out-going trucks will be loading products from the Pencilling and Bundling Operations. These various flow paths have been illustrated in the block layout alternatives which will be analysed to provide some insight during the *evaluation process* (See *figure 28*).

Block Layout 1

Block Layout 2

Block Layout 3

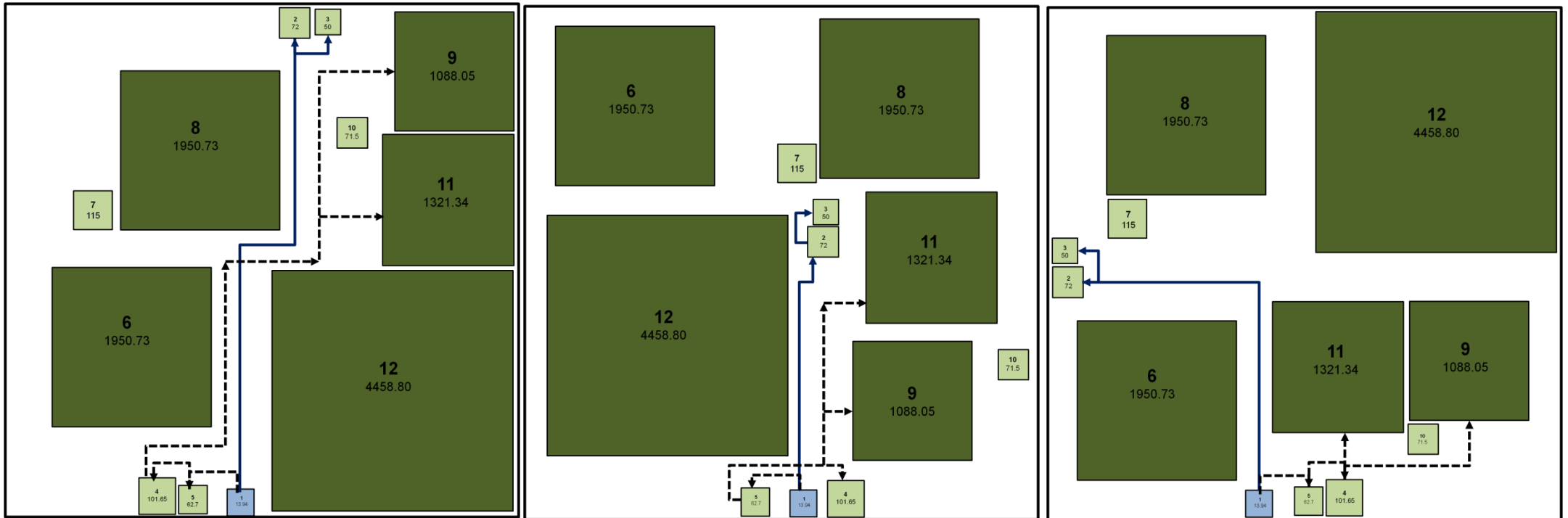
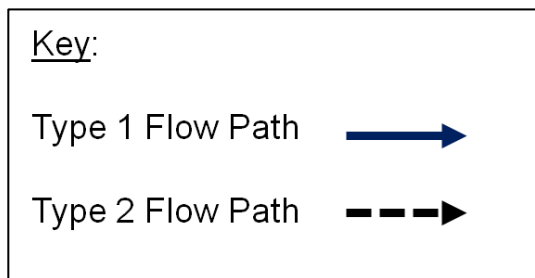


Figure 26: Employee Type 1&2 Flow Paths



Block Layout 1

Block Layout 2

Block Layout 3

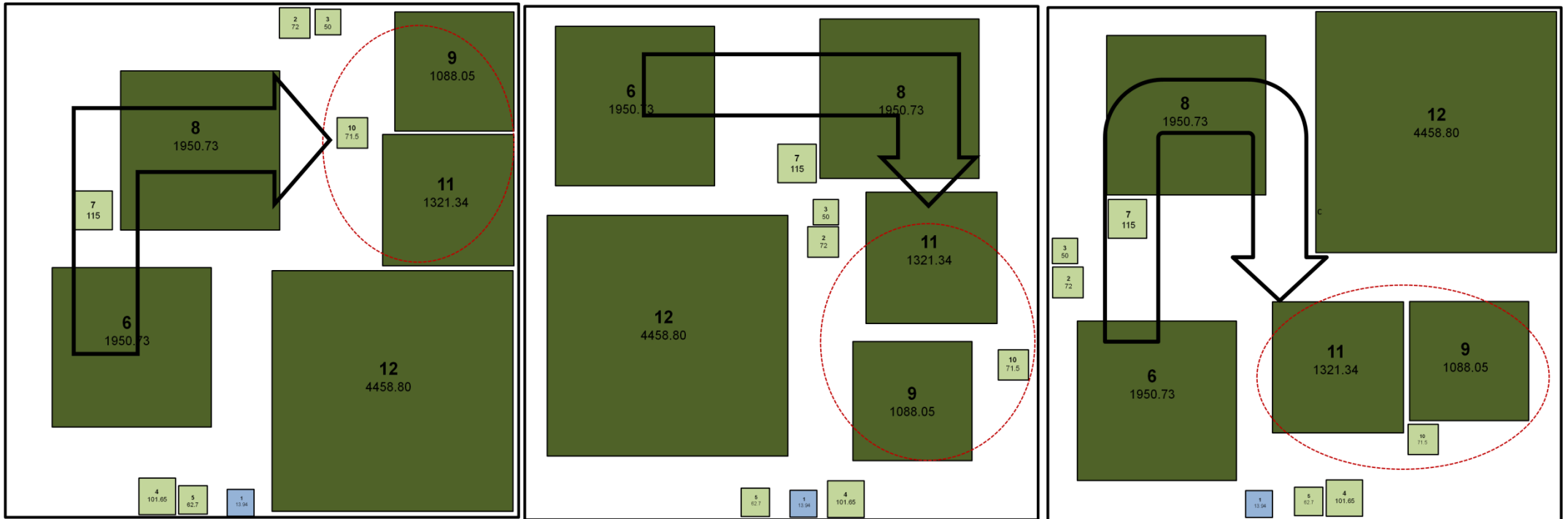
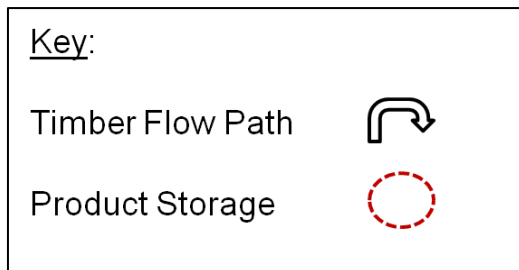


Figure 27: Timber Flow Paths



Block Layout 1

Block Layout 2

Block Layout 3

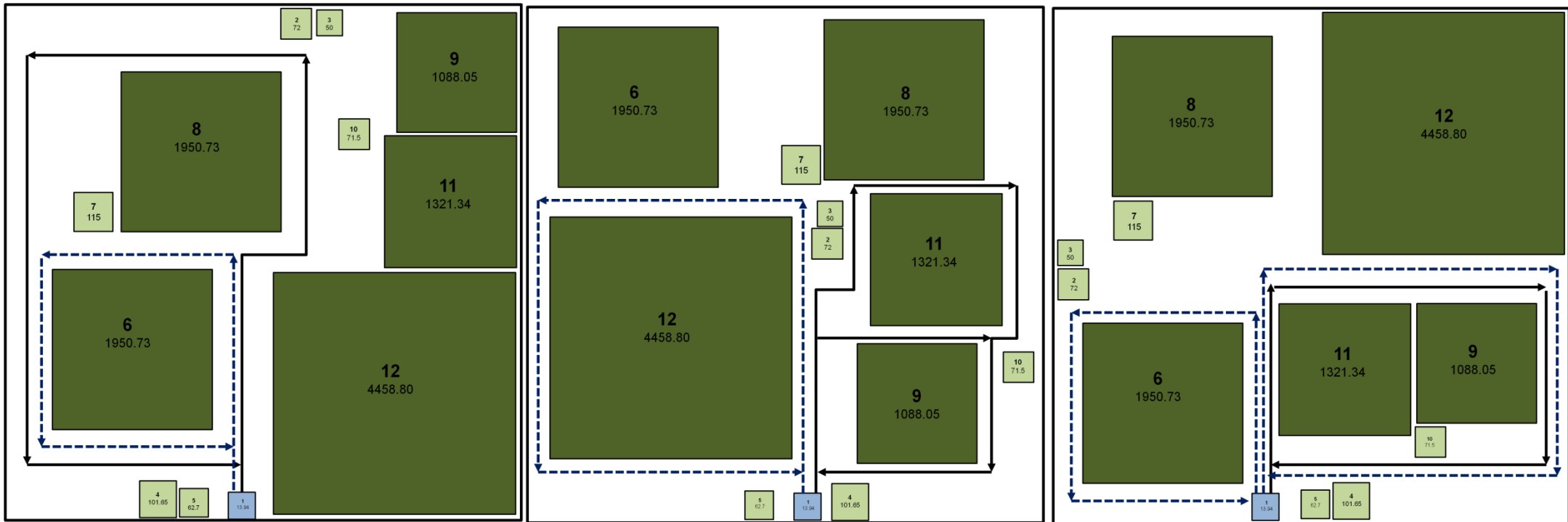
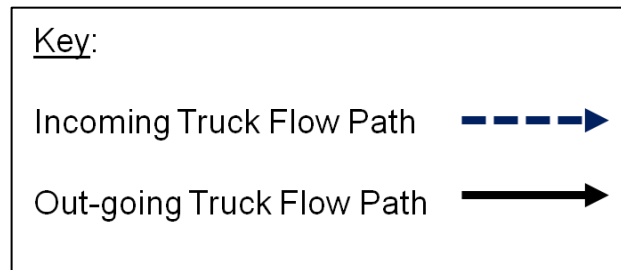


Figure 28: Delivery Truck Flow Paths



10.3 Material Handling

The material handling equipment currently used in the depots are mainly Renosters and Tele-Loggers for the following reasons;

- Excellent manoeuvrability
- Performs lifting, grabbing and lowering functions
- Excellent in rough terrains

Bleskop Service Centre is currently experiencing a problem with their material handling equipment where the movement is at random and the distances covered seemly larger than expected. This is because handling equipment has not been assigned to fixed areas in which they must operate in or to perform certain functions.

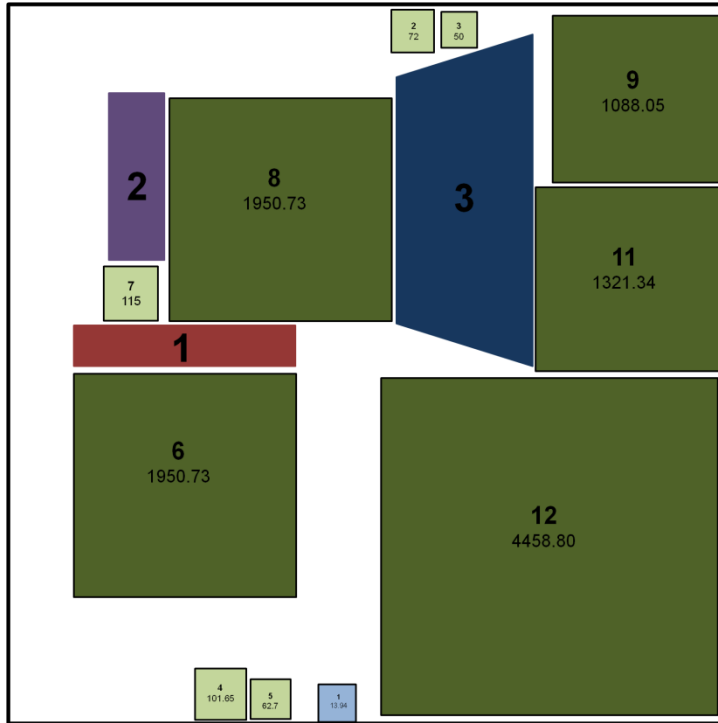
In the block layouts three areas have been demarcated for material handling, where they will be performing certain functions and those functions alone. The demarcated areas will mainly cover the areas that will experience the most frequent movement by handling equipment on a day to day basis. The distances covered by handling equipment within these demarcated areas will be analysed and taking in consideration during the *evaluation process*.

Demarcated area 1: The functions/responsibilities assigned to handling equipment will be primarily to load timber from the Off-Loading Stock Pile to be fed to the Scanner as well as responsible for the off-loading of incoming delivery trucks. This demarcated area will be occupied by a single Renoster or Tele-logger (*See figure 29*).

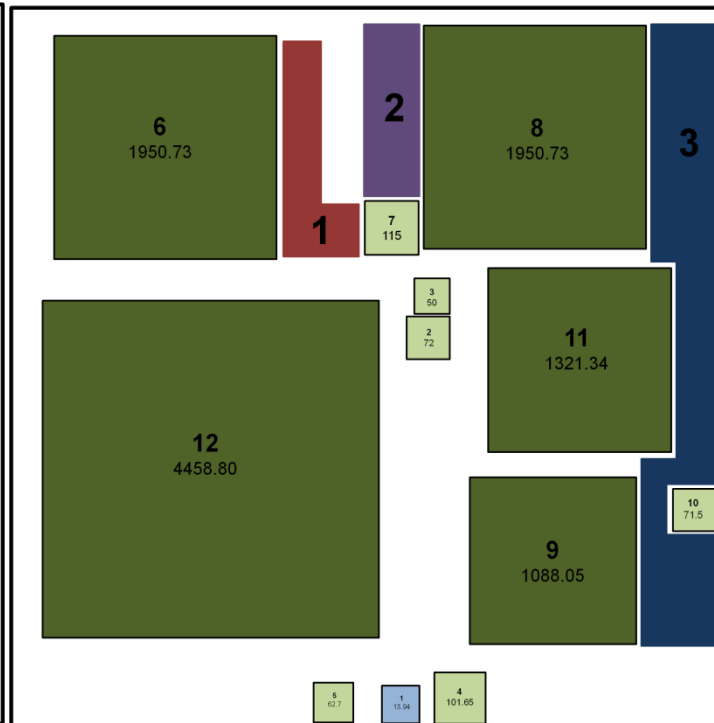
Demarcated area 2: The functions/responsibilities assigned to handling equipment will be primarily to off-load timber from the scanner and stack it in the Sorted Stock Pile. This demarcated area will be occupied by a single Renoster or Tele-logger (*See figure 29*).

Demarcated area 3: The functions/responsibilities assigned to handling equipment will be primarily to off-load timber from the Sorted Stock Pile to both the Pencilling and Bundling Operations as well as responsible for the loading of out-going delivery trucks. This demarcated area will be occupied by a single Renoster or Tele-logger (*See figure 29*).

Block Layout 1



Block Layout 2



Block Layout 3



Figure 29: Material Handling Demarcated Areas



11. Part 4: Evaluation of Alternatives

The evaluation process will involve three steps in order to determine the most feasible layout design to be selected for BedRock to implement or use as a benchmark for the centralised depot. These steps involve the following (Tompkins *et al.*, 2010: 748-762):

- I. Listing the *Positive and Negative Aspects* of each block layout alternative.
- II. *Ranking* the performance of each layout according to the determined criteria set out for all block layout alternatives
- III. Using the *Weighted Factor Comparison Method* to determine the most feasible layout design to be selected.

11.1 Positive and Negative Aspects

11.1.1 Block Layout 1

Positives:

- Incoming delivery trucks can off-load timber quicker at the necessary stock piles situated in the front of the depot rather than at the back, therefore optimizing truck turnaround times.
- Office clerks i.e. Managers are forced to drive through the depot, therefore allowing them to have a good look at the depot i.e. Stock levels during entering and exiting.
- Optimized material handling movement.
- Efficient timber process flow through the depot.
- Office Department is situated in close proximity to the Pencilling and Bundling Operations where office clerk can monitor worker productivity.

Negatives:

- Final products are stored in the back of the depot rather in the front, therefore increasing truck turnaround times of out-going delivery trucks.
- Office clerks don't have full visual of all the depot operations, therefore forcing clerks to enter into the yard and walk large distances to reach these departments.
- Accessibility of trucks to the Buffer, Bundling and Pencilling Operations is limited, therefore can cause material handling equipment to travel longer distances in certain circumstances.

- There will be a crossing of Employee type 2 and Material Handling process paths during the day when workers leave the bundling sections to go to the toilet which is not ideal from a safety point of view.
- Workers assigned to the bundling sections are forced to walk a fair distance before resuming work, therefore can reduce their productivity.
- Bundling sections containing the majority of workers in the yard are separated by a fair distance from access to toilets.

11.1.2 Block Layout 2

Positives:

- Office clerk have full visual of all depot operations, therefore reducing the time/distance for clerks in reaching these operations.
- Office Department is situated in close proximity to the Pencilling and Bundling Operations where office clerk can monitor worker productivity.
- Final products are stored in the front of the depot rather than in the back, therefore reducing truck turnaround times of out-going delivery trucks.
- Delivery trucks have full accessibility to all timber stacks, therefore optimizing distances travelled by material handling equipment.
- Workers are in close proximity to bundling sections as well as access to toilets, therefore can increase their productivity.
- Efficient timber process flow through the depot.

Negatives:

- Material handling equipment assigned to demarcated area 3 will involve travelling large distances.
- It's not practical having the Offices and Parking facilities situated right in the middle of the depot.

11.1.3 Block Layout 3

Positives:

- Incoming delivery trucks can off-load timber quicker at the necessary stock piles situated in the front of the depot rather than at the back, therefore optimizing truck turnaround times.

- Final products are stored in the front of the depot rather in the back, therefore reducing truck turnaround times of out-going delivery trucks.
- The Office and Parking facilities are situated out of the way from depot activities and still where office clerk have reasonable visibility of all depot operations.

Negatives:

- The timber process flow is not ideal as it is moved from *front to back* then *back to front* of the depot.
- Material handling equipment assigned to demarcated area 3 will involve travelling large distances.
- Accessibility of trucks to the Buffer is limited, therefore can cause material handling equipment to travel longer distances in certain circumstances.
- Office Department is not situated in close proximity to the Pencilling and Bundling Operations therefore office clerk cannot monitor worker productivity.

11.2 Ranking

According to Tompkins *et al.* (2010:749), block layout alternatives will be ranked according to a fixed set of criteria for each layout design to address. The ranking system will use a scale of 1-10 (*10= Best; 0= Worst*) for each separate criteria factor. The set of criteria will be ranked by the *Project Sponsor* and the *Student* to obtain two different views (*See figure 30*).

11.2.1 Criteria

The following criterion listed below explains what will be evaluated when ranking the block layout alternatives;

1. Employee Flow Paths

The flow of employees through the depot should be practical, involving optimal distances travelled and reasonable proximity to toilets. Greater emphasis must be placed on Employee type 2 flow path for the reason being that workers will be travelling by foot and office clerk by vehicle.

2. Timber Flow Paths

The movement of timber must flow in a logical and practical pattern as not to affect other depot activities i.e. Material handling and loading of final products.

3. Delivery Truck Flow Paths

The flow path of incoming and out-going of delivery trucks through the depot must follow a fixed route as to avoid trucks from reversing from a safety point of view. The flow paths must also be optimal in order to reduce inbound or turn-around times of trucks.

4. Material Handling

Material handling equipment must follow a fixed pattern in assisting the production process as well as assigned to demarcated areas with optimal distances travelled.

5. Office Location

The offices should be situated in an area where there is good visibility of the depot operations as to reduce walking distances/times to these various operations. The offices should also be situated in close proximity to the bundling and Pencilling Operations as to monitor worker productivity.

6. Accessibility

Incoming and outgoing trucks should have reasonable accessibility to the related timber stacks as to prevent handling equipment from travelling unnecessary distances from a cost point of view.

7. Safety

Safety is a priority, therefore the crossing of flow paths of machinery and employees must be minimal or avoided. Greater emphasis must be placed on Material Handling and Employee Type 2 flow paths.

8. Pros and Cons

The positives of each layout design must outweigh the negatives.

9. Identified Problems

All or majority of identified problems in Bleskop Service Centre and Glenthorpe Production Mill have been addressed.

Criterion	Sponsor Ranking			Students Ranking		
	BL 1	BL 2	BL 3	BL 1	BL 2	BL 3
1	6	7	9	5	7	9
2	6	8	6	7	8	6
3	7	8	9	7	8	9
4	8	6	6	8	6	6
5	5	9	7	6	9	7
6	5	9	7	6	9	8
7	6	8	8	5	8	8
8	6	8	7	6	8	6
9	6	8	6	7	9	7

*BL=Block Layout

Figure 30: Ranking Criterion (Tompkins *et al.*, 2010: 760-761).

11.3 Weighted Factor Comparison Method

This method involves assigning a weight to each separate criterion that will represent its degree of importance when evaluating block layout alternatives (See *table 6*). The rankings of each criterion will be multiplied by its correlating weight and their products summed to reveal a total for each block layout alternatives (See figure 31). The alternative with the highest total will be selected as the most feasible design to be implemented or to serve as a benchmark for the New Centralised Depot (Tompkins *et al.*, 2010:753-761).

Table 6: Weighted Criterion

Criterion	Weight
1	5
2	15
3	5
4	30
5	10
6	10
7	20
8	2.5
9	2.5
Total	100

The total weighted values were calculated for each block layout alternative and are illustrated in the Weighted Factor Comparison Chart. According to the rules of the weighted factor comparison method, **block layout 2** had the highest weighted value in both instances and therefore is the most feasible layout to be selected. The 2nd and 3rd choice for selection would be block layout 3 and then block layout 1, but because of their large differences in weighted values between them and the 1st choice these layouts will not be re-evaluated for selection.

Criterion	Weight	Sponsor Ranking						Students Ranking					
		BL 1	WV	BL 2	WV	BL 3	WV	BL 1	WV	BL 2	WV	BL 3	WV
1	5	6	30	7	35	9	45	5	25	7	35	9	45
2	15	6	90	8	120	6	90	7	105	8	120	6	90
3	5	7	35	8	40	9	45	7	35	8	40	9	45
4	30	8	240	6	180	6	180	8	240	6	180	6	180
5	10	5	50	9	90	7	70	6	60	9	90	7	70
6	10	5	50	9	90	7	70	6	60	9	90	8	80
7	20	6	120	8	160	8	160	5	100	8	160	8	160
8	2.5	6	15	8	20	7	17.5	6	15	8	20	6	15
9	2.5	6	15	8	20	6	15	7	17.5	9	22.5	7	17.5
Total	100		645		755		692.5		657.5		757.5		702.5

*WV= Weighted Value, BL = Block Layout

Figure 31: Weighted Factor Comparison Form (Tompkins et al., 2010: 762).

12. Recommendations and Conclusions

Through space requirements the physical site that is required to house a Centralised Depot in the eMakhazeni area will be of the size of **20262 M²**. This proposed facility size will be able to accommodate a Buffer, Scanner, Pencilling and chipper operation with the necessary supporting facilities that are required by the centralised depot.

The proposed facility layout that is recommended to be implemented or used as a benchmark will be **block layout 2** as this was determined the most feasible design by the weighted factor comparison method. The main problem associated with this layout design was the material handling movement in demarcated area 3. This problem can easily be resolved by implementing a unit load principle which will therefore reduce the number of trips and in so doing reducing the distances travelled by handling equipment on a day to day basis.

Through research a scanner, a chipper, a pencilling machine, a Renoster and two Tele-loggers were identified as redundant equipment. Therefore it is recommended that the Centralised Depot make use of this equipment as it will result in huge savings in process and handling equipment required by the depot. Also it is recommended that BedRock allocate an additional Renoster or Tele-Logger to the depot that will be solely used as a back-up.

The determination of the Centralised Depot size and possible facility layout is a step forward in the right direction for BedRock's continual goal of Quality, on-Time and in Full delivery every time philosophy (www.bedrockms.co.za).

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Appendix

Mine Poles 2012																								Ave Amounts/ Month		Ave Amounts/2 Weeks					
Customer A		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Units	Ave M ³	Ave Units	M ³		
Count	InvtID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³				
20.83	MPT24015	483	23	483	23	435	21	435	21	483	23	580	28	411	20	435	21	604	29	483	23	459	22	580	28	489.31	23.49	244.65	11.75		
16.17	MPT30015	51	3	51	3	46	3	46	3	51	3	61	4	43	3	46	3	63	4	51	3	48	3	61	4	51.24	3.17	25.62	1.58		
13.09	MPT36015	47	4	47	4	42	3	42	3	47	4	56	4	40	3	42	3	59	4	47	4	45	3	56	4	47.53	3.63	23.76	1.82		
10.90	MPT42015	26	2	26	2	23	2	23	2	26	2	31	3	22	2	23	2	32	3	26	2	24	2	31	3	25.93	2.38	12.97	1.19		
																								Total		307		16			
Customer B		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Units	Ave M ³	Ave Units	M ³		
28.62	MPT1801416	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	1.98	0.07	0.99	0.03
57.74	MPT2250810	347	6	347	6	312	5	312	5	347	6	416	7	295	5	312	5	434	8	347	6	330	6	416	7	351.28	6.08	175.64	3.04		
21.12	MPT3601013	27	1	27	1	24	1	24	1	27	1	33	2	23	1	24	1	34	2	27	1	26	1	33	2	27.48	1.30	13.74	0.65		
																								Total		190		4			
Customer C		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Units	Ave M ³	Ave Units	M ³		
75.55	MPU15010	166	2	174	2	143	2	136	2	166	2	151	2	136	2	151	2	159	2	151	2	166	2	166	2	155.43	2.06	77.71	1.03		
22.38	MPU22515	4	0	4	0	3	0	3	0	4	0	3	0	3	0	3	0	3	0	3	0	4	0	4	0	3.33	0.15	1.66	0.07		
16.17	MPU30015	38	2	40	2	33	2	31	2	38	2	35	2	31	2	35	2	36	2	35	2	38	2	38	2	35.71	2.21	17.85	1.10		
10.90	MPU42015	13	1	13	1	11	1	10	1	13	1	11	1	10	1	11	1	12	1	11	1	13	1	13	1	11.76	1.08	5.88	0.54		
																								Total		103		3			
Customer D		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Units	Ave M ³	Ave Units	M ³		
22.38	MPU22515	128	6	133	6	110	5	104	5	128	6	116	5	104	5	116	5	122	5	116	5	128	6	128	6	119.30	5.33	59.65	2.67		
13.09	MPU36015	43	3	45	3	37	3	35	3	43	3	39	3	35	3	39	3	41	3	39	3	43	3	43	3	40.33	3.08	20.16	1.54		
																								Total		80		4			
Customer E		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Units	Ave M ³	Ave Units	M ³		
36.80	MPU1201518	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0.83	0.02	0.41	0.01		
27.96	MPU1201820	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0.83	0.03	0.41	0.01		
22.10	MPU1501820	3 045	138	3 045	138	2 740	124	2 740	124	3 045	138	3 654	165	2 588	117	2 740	124	3 806	172	3 045	138	2 893	131	3 654	165	3082.96	139.50	1541.48	69.75		
18.19	MPU1801820	475	26	475	26	428	24	428	24	475	26	570	31	404	22	428	24	594	33	475	26	451	25	570	31	481.04	26.45	240.52	13.22		
43.54	MPU2250813	3 164	73	3 164	73	2 847	65	2 847	65	3 164	73	3 796	87	2 689	62	2 847	65	3 955	91	3 164	73	3 005	69	3 796	87	3203.22	73.57	1601.61	36.78		
34.17	MPU2401013	257	8	257	8	231	7	231	7	257	8	309	9	219	6	231	7	321	9	257	8	244	7	309	9	260.36	7.62	130.18	3.81		
17.40	MPU2401518	6	0	6	0	5	0	5	0	6	0	7	0	5	0	5	0	7	0	6	0	5	0	7	0	5.79	0.33	2.89	0.17		
13.32	MPU2401820	171	13	171	13	154	12	154	12	171	13	206	15	146	11	154	12	214	16	171	13	163	12	206	15	173.57	13.03	86.79	6.52		
26.31	MPU3001013	278	11	278	11	250	10	250	10	278	11	334	13	236	9	250	10	347	13	278	11	264	10	334	13	281.43	10.70	140.72	5.35		
13.55	MPU3001518	249	18	249	18	224	17	224	17	249	18	299	22	212	16	224	17	311	23	249	18	237	17	299	22	252.17	18.61	126.09	9.31		
10.40	MPU3001820	94	9	94	9	85	8	85	8	94	9	113	11	80	8	85	8	118	11	94	9	90	9	113	11	95.46	9.18	47.73	4.59		
8.47	MPU3601523	105	12	105	12	95	11	95	11	105	12	126	15	89	11	95	11	131	16	105	12	100	12	126	15	106.37	12.56	53.19	6.28		
																								Total		3972		156			

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Customer F		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
34.73	MPU1201618	9 820	283	9 820	283	8 838	254	8 838	254	9 820	283	11 784	339	8 347	240	8 838	254	12 276	353	9 820	283	9 329	269	11 784	339	9943.16	286.30	4971.58	143.15
29.49	MPU1401618	6 606	224	6 606	224	5 946	202	5 946	202	6 606	224	7 927	269	5 615	190	5 946	202	8 258	280	6 606	224	6 276	213	7 927	269	6688.75	226.81	3344.38	113.41
22.53	MPU1801618	6 712	298	6 712	298	6 041	268	6 041	268	6 712	298	8 055	358	5 705	253	6 041	268	8 390	372	6 712	298	6 377	283	8 055	358	6796.15	301.65	3398.07	150.82
43.54	MPU2250813	44	1	44	1	40	1	40	1	44	1	53	1	37	1	40	1	55	1	44	1	42	1	53	1	44.63	1.03	22.32	0.51
53.48	MPU2408010	101	2	101	2	91	2	91	2	101	2	121	2	86	2	91	2	127	2	101	2	96	2	121	2	102.49	1.92	51.24	0.96
12.81	MPU3001618	443	35	443	35	399	31	399	31	443	35	531	41	376	29	399	31	554	43	443	35	421	33	531	41	448.39	35.00	224.20	17.50
Total																										12012	426		
Customer G		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
156.64	MPU1800575	41	0	41	0	37	0	37	0	41	0	49	0	35	0	37	0	51	0	41	0	39	0	49	0	41.33	0.26	20.66	0.13
8.47	MPU3601523	40	5	40	5	36	4	36	4	40	5	48	6	34	4	36	4	50	6	40	5	38	4	48	6	40.22	4.75	20.11	2.37
Total																										41	3		
Customer H		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
18.19	MPU1801820	4 639	255	4 639	255	4 175	230	4 175	230	4 639	255	5 567	306	3 943	217	4 175	230	5 798	319	4 639	255	4 407	242	5 567	306	4696.76	258.21	2348.38	129.10
13.32	MPU2401820	439	33	439	33	395	30	395	30	439	33	527	40	373	28	395	30	548	41	439	33	417	31	527	40	444.26	33.35	222.13	16.68
53.48	MPU2408010	4 434	83	4 434	83	3 990	75	3 990	75	4 434	83	5 320	99	3 769	70	3 990	75	5 542	104	4 434	83	4 212	79	5 320	99	4489.14	83.94	2244.57	41.97
Total																										4815	188		
Customer I		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
44.28	MPU1201416CTE	4 074	92	4 074	92	3 667	83	3 667	83	4 074	92	4 889	110	3 463	78	3 667	83	5 092	115	4 074	92	3 870	87	4 889	110	4124.88	93.15	2062.44	46.58
37.56	MPU1401416CTE	4 058	108	4 058	108	3 652	97	3 652	97	4 058	108	4 870	130	3 449	92	3 652	97	5 073	135	4 058	108	3 855	103	4 870	130	4108.85	109.39	2054.42	54.70
34.88	MPU1501416CTE	4 207	121	4 207	121	3 786	109	3 786	109	4 207	121	5 048	145	3 576	103	3 786	109	5 258	151	4 207	121	3 996	115	5 048	145	4259.36	122.11	2129.68	61.06
28.62	MPU1801416CTE	766	27	766	27	690	24	690	24	766	27	919	32	651	23	690	24	958	33	766	27	728	25	919	32	775.78	27.11	387.89	13.55
13.32	MPU2401820	3	0	3	0	3	0	3	0	3	0	4	0	3	0	3	0	4	0	3	0	3	0	4	0	3.50	0.26	1.75	0.13
10.40	MPU3001820	142	14	142	14	128	12	128	12	142	14	171	16	121	12	128	12	178	17	142	14	135	13	171	16	143.98	13.84	71.99	6.92
9.62	MPU42015	5	1	5	1	4	0	4	0	5	1	6	1	4	0	4	0	6	1	5	1	5	0	6	1	4.96	0.52	2.48	0.26
Total																										6711	183		

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Customer J		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	Inv#ID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
36.80	MPU1201518cte	10 601	288	10 601	288	9 540	259	9 540	259	10 601	288	12 721	346	9 010	245	9 540	259	13 251	360	10 601	288	10 071	274	12 721	346	10733.04	291.66	5366.52	145.83
29.03	MPU1501518cte	10 445	360	10 445	360	9 401	324	9 401	324	10 445	360	12 534	432	8 878	306	9 401	324	13 056	450	10 445	360	9 923	342	12 534	432	10575.71	364.30	5287.85	182.15
21.27	MPU2001518cte	833	39	833	39	749	35	749	35	833	39	999	47	708	33	749	35	1 041	49	833	39	791	37	999	47	842.98	39.63	421.49	19.82
17.40	MPU2401518	21	1	21	1	19	1	19	1	21	1	25	1	18	1	19	1	26	2	21	1	20	1	25	1	21.24	1.22	10.62	0.61
13.55	MPU3001518cte	499	37	499	37	449	33	449	33	499	37	599	44	424	31	449	33	624	46	499	37	474	35	599	44	505.12	37.28	252.56	18.64
9.72	MPU4001518cte	75	8	75	8	68	7	68	7	75	8	90	9	64	7	68	7	94	10	75	8	71	7	90	9	75.94	7.82	37.97	3.91
7.44	MPU5001518cte	26	3	26	3	23	3	23	3	26	3	31	4	22	3	23	3	32	4	26	3	25	3	31	4	26.14	3.51	13.07	1.76
																										Total		11390	373
Customer K		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	Inv#ID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
16.45	MPU2401618	205	12	205	12	185	11	185	11	205	12	246	15	175	11	185	11	257	16	205	12	195	12	246	15	207.96	12.64	103.98	6.32
22.53	MPUJP1801618JP220NT	55	2	55	2	50	2	50	2	55	2	66	3	47	2	50	2	69	3	55	2	53	2	66	3	56.04	2.49	28.02	1.24
																										Total		132	8
Customer L		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	Inv#ID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
39.06	MPU1201517	82	2	82	2	74	2	74	2	82	2	99	3	70	2	74	2	103	3	82	2	78	2	99	3	83.48	2.14	41.74	1.07
34.73	MPU1201618	42	1	42	1	38	1	38	1	42	1	51	1	36	1	38	1	53	2	42	1	40	1	51	1	42.65	1.23	21.32	0.61
27.96	MPU1201820	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0.50	0.02	0.25	0.01
33.16	MPU1401517	156	5	156	5	141	4	141	4	156	5	188	6	133	4	141	4	195	6	156	5	149	4	188	6	158.28	4.77	79.14	2.39
29.49	MPU1401618	61	2	61	2	55	2	55	2	61	2	73	2	52	2	55	2	76	3	61	2	58	2	73	2	61.91	2.10	30.95	1.05
30.80	MPU1501517	44 624	1 449	44 624	1 449	40 161	1 304	40 161	1 304	44 624	1 449	53 548	1 738	37 930	1 231	40 161	1 304	55 779	1 811	44 624	1 449	42 392	1 376	53 548	1 738	45181.39	1466.77	22590.69	733.38
27.40	MPU1501618	34	1	34	1	30	1	30	1	34	1	40	1	29	1	30	1	42	2	34	1	32	1	40	1	34.14	1.25	17.07	0.62
22.10	MPU1501820	56	3	56	3	50	2	50	2	56	3	67	3	48	2	50	2	70	3	56	3	53	2	67	3	56.78	2.57	28.39	1.28
25.30	MPU1801517	29 603	1 170	29 603	1 170	26 643	1 053	26 643	1 053	29 603	1 170	35 524	1 404	25 163	994	26 643	1 053	37 004	1 462	29 603	1 170	28 123	1 111	35 524	1 404	29973.43	1184.61	14986.71	592.30
22.53	MPU1801618	192	9	192	9	173	8	173	8	192	9	231	10	163	7	173	8	240	11	192	9	183	8	231	10	194.73	8.64	97.37	4.32
18.19	MPU1801820	47	3	47	3	43	2	43	2	47	3	57	3	40	2	43	2	59	3	47	3	45	2	57	3	47.86	2.63	23.93	1.32
18.44	MPU2401517	283	15	283	15	254	14	254	14	283	15	339	18	240	13	254	14	353	19	283	15	268	15	339	18	286.10	15.51	143.05	7.76
4.10	MPU2403040	1 586	387	1 586	387	1 428	348	1 428	348	1 586	387	1 903	464	1 348	329	1 428	348	1 983	483	1 586	387	1 507	367	1 903	464	1605.95	391.45	802.97	195.72
25.00	MPU3001517	2 233	89	2 233	89	2 009	80	2 009	80	2 233	89	2 679	107	1 898	76	2 009	80	2 791	112	2 233	89	2 121	85	2 679	107	2260.59	90.42	1130.30	45.21
12.81	MPU3001618	11	1	11	1	10	1	10	1	11	1	14	1	10	1	10	1	14	1	11	1	11	1	14	1	11.57	0.90	5.79	0.45
10.28	MPU4001517	11	1	11	1	10	1	10	1	11	1	13	1	9	1	10	1	13	1	11	1	10	1	13	1	10.91	1.06	5.46	0.53
																										Total		40005	1588
Final Total/2 Weeks																													
Ave Units													Cubes																
79758													2951																

Pencil Props 2012																													
Customer C		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvntID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Ave Units	M ³
31.25	PPU1401518	40	1	42	1	35	1	33	1	40	1	37	1	33	1	37	1	39	1	37	1	40	1	40	1	37.89	1.21	18.95	0.61
27.09	PPU1601518	49	2	52	2	43	2	40	1	49	2	45	2	40	1	45	2	47	2	45	2	49	2	49	2	46.21	1.71	23.10	0.85
27.09	PPU160151810	274	10	287	11	237	9	224	8	274	10	249	9	224	8	249	9	262	10	249	9	274	10	274	10	256.51	9.47	128.26	4.73
18.19	PPU1801820	602	33	629	35	520	29	492	27	602	33	547	30	492	27	547	30	574	32	547	30	602	33	602	33	562.89	30.95	281.45	15.47
16.24	PPU2001820	148	9	155	10	128	8	121	7	148	9	135	8	121	7	135	8	141	9	135	8	148	9	148	9	138.62	8.54	69.31	4.27
14.64	PPU2201820	137	9	143	10	118	8	112	8	137	9	124	9	112	8	124	9	131	9	124	9	137	9	137	9	128.12	8.75	64.06	4.38
																									Total	585	30		
Customer E		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvntID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Ave Units	M ³
40.34	PPU1101518	6 230	154	6 230	154	5 607	139	5 607	139	6 230	154	7 476	185	5 296	131	5 607	139	7 788	193	6 230	154	5 919	147	7 476	185	6308.08	156.37	3154.04	78.19
30.63	PPU1101820	6 232	203	6 232	203	5 609	183	5 609	183	6 232	203	7 478	244	5 297	173	5 609	183	7 790	254	6 232	203	5 920	193	7 478	244	6309.73	206.00	3154.87	103.00
27.96	PPU1201820	6 233	223	6 233	223	5 610	201	5 610	201	6 233	223	7 480	268	5 298	189	5 610	201	7 791	279	6 233	223	5 921	212	7 480	268	6311.06	225.72	3155.53	112.86
23.77	PPU1401820	15 700	660	15 700	660	14 130	594	14 130	594	15 700	660	18 840	793	13 345	561	14 130	594	19 625	826	15 700	660	14 915	627	18 840	793	15896.25	668.75	7948.13	334.38
22.10	PPU1501820	11 439	518	11 439	518	10 295	466	10 295	466	11 439	518	13 727	621	9 723	440	10 295	466	14 298	647	11 439	518	10 867	492	13 727	621	11581.76	524.06	5790.88	262.03
20.63	PPU1601820	1 641	80	1 641	80	1 477	72	1 477	72	1 641	80	1 969	95	1 395	68	1 477	72	2 051	99	1 641	80	1 559	76	1 969	95	1661.33	80.53	830.66	40.26
18.19	PPU1801820	4 339	239	4 339	239	3 905	215	3 905	215	4 339	239	5 207	286	3 688	203	3 905	215	5 423	298	4 339	239	4 122	227	5 207	286	4393.01	241.51	2196.51	120.75
13.32	PPU2401820	407	31	407	31	366	27	366	27	407	31	488	37	346	26	366	27	509	38	407	31	387	29	488	37	412.03	30.93	206.01	15.47
																									Total	26437	1067		
Customer G		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvntID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Units	M ³
22.53	PPU1801618	10347	459	10347	459	9312	413	9312	413	10347	459	12416	551	8795	390	9312	413	12933	574	10347	459	9829	436	12416	551	10476	465	5238	232
18.19	PPU1801820	3716	204	3716	204	3344	184	3344	184	3716	204	4459	245	3158	174	3344	184	4644	255	3716	204	3530	194	4459	245	3762	207	1881	103
13.32	PPU2401820	1198	90	1198	90	1078	81	1078	81	1198	90	1437	108	1018	76	1078	81	1497	112	1198	90	1138	85	1437	108	1212.60	91.04	606	46
																									Total	2487	149		
Customer H		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Ave Amounts/ Month		Ave Amounts/2 Weeks	
Count	InvntID	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Units	M ³	Ave Units	Ave M ³	Ave Units	M ³
18.19	PPU1801820	18 451	1 014	18 451	1 014	16 606	913	16 606	913	18 451	1 014	22 141	1 217	15 683	862	16 606	913	23 064	1 268	18 451	1 014	17 528	964	22 141	1 217	18682	1027	9341	514
13.32	PPU2401820	7 053	530	7 053	530	6 348	477	6 348	477	7 053	530	8 464	635	5 995	450	6 348	477	8 816	662	7 053	530	6 700	503	8 464	635	7141	536	3571	268
																									Total	12911	782		
																									Final Total/ 2 Weeks				
																									Units	42421			
																									Cubes	2028			