ARCHITECTURE OF MATERNITY

IN MALAWI HEALTH FACILITIES

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FRAMING THE PROBLEM

There is a deficiency of adequate maternity wards for expecting mothers in Malawi that lack privacy, patient dignity, infection control practices, and efficiency.

THESIS

Architectural solutions that focus on improving quality of care, infection control, and staff efficiency will improve experiences in maternity facilities and ultimately aid in lowering Malawi's maternal mortality rate.

ABSTRACT

While medical studies show that maternal mortality is best addressed through improved clinical practice, very little research exists regarding maternal mortality improvement through architecture. The aim of this study was to comparatively access existing maternity wards in health centres, district hospitals, and central hospitals with regards to quality of care, staff efficiency and infection control. In addition, we reviewed medical research, evaluated exemplary case studies, analyzed large and small scale ward typologies, and performed interviews with health professionals and students. These methods revealed that 20% of maternal mortality is due to nosocomial infections which can be preventable through the availability and use of wash stations. With Malawi's growing population, which is said to increase to 42 million by 2050, maternal mortality needs to be addressed to accommodate for the growing population of mothers and children in the hospital scale. Furthermore, interviews revealed that the larger percentage of mortality was due to c-sections that could've been avoided if bed turnover rate wasn't such a problem. The main problem being framed in this study is the deficiency of adequate maternity wards for expecting mothers in both rural and urban contexts. The closer study of current ward conditions in all healthcare infastructures will serve as doors to new opportunities for design solutions that address quality of care, staff efficiency, and infection control. Resulting design solutions will not address cost, materials, delivery, construction, and expansion.

MATERNITY IN MALAWI

MATERNAL MORTALITY

Malawi is one of the many countries currently suffering from very high maternal and neonatal death due to various instances from complications at birth to infant sickness such as malaria, diarrhea, and pneumonia. Over the past 5 years, rates have decreased but as of 2015, according to UNICEF, there were 634 deaths per 100,000 live births and the under-five mortality was at 64 every 1,000. Over 35% of deaths under-five are newborn

MATERNITY CARE

Maternity care is provided in all levels of Malawi's Health System from Primary (Health Centres) to Tertiary (Central Hospitals). However, care in each of the levels differ which could be a result of understaffing, poor infrastructure, and lack of resources and transportation. Malawi's health system works in a referral system in which, especially for maternity, a woman may be referred to another hospital dependent on whether they're a high or low risk patient. Health centres provide basic low-risk care for expecting mothers including a delivery ward and potentially a surgery theater and Maternity Waiting Homes according to the Malawi Ministry of Health. District hospitals offer services for both low and high risk, and is the direct referral for higher-risk patients that come into health centres. Central hospitals offer low and high risk maternity care as well, but mainly targets only high-risk. During the process of referral, there are many circumstances that block/prevent women from reaching and receiving the care that they need ranging from lack of transportation to these facilities as well as negative cultural assumptions about health infrastructure and staff.

CHALLENGES

Maternity facilities in all levels face similar challenges. All hospitals and health centres for instance face overcrowding such that the facilities aren't designed to provide for as many people that come in. The population of Malawi has increased from 16 million to 19 million between 2015 and 2020 (3) which is a critical indication that maternal facilities need to be designed with resilience to ever-growing population. Many women who attend these health facilities will often base their circumstances on the quality of care they receive as well as their rate of satisfaction. This can vary by facility, oftentimes, but there are ways that we as designers may be able to contribute a way that facilities can balance low patient to staff ratio and an increasing number of women coming into these wards

"The death of a woman while pregnant within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes." -WHO

CHALLENGES IN HEALTH CENTRES

Challenges for women in health centres are mainly transportation and lack of resources. Given that health centres are mainly in rural areas, most people walk several kilometers just to reach care. This is a factor in maternal mortality given that it acts as a delay for women to want to recieve help giving birth at a facility versus giving birth at home. Giving birth at home, however, increases the potential for complications that would otherwise be too late to be taken care of.

CHALLENGES IN HOSPITALS

In the hospital levels, the main challenges related to maternal mortality has to do with the rate of c-sections. Hospitals are referrals for health centres which puts all high-risk pregnancies here. Therefore, beds in hospitals are usually filled. The facility addresses the overcrowding by increasing c-sections and giving c-sections to women who might not necessarily need them. This increases the rate for mortality and infection rates because women who could be giving a normal birth have to go through the surgery process that is evidently avoidable. Furthermore, another challenge related to maternal mortality is that since there is so little room in the hospital for the amount of women coming in everyday, forced c-sections also mean full recovery spaces. Bed turnover rates have to be higher in order to treat as many women as possible. Therefore, many women who recently give birth are forced to go home earlier than they should. WHO defines maternal health as any death that occurs 42 hours after a termination of a pregnancy. A percentage of those deaths occur at home because some women are released too early.

This project will seek to understand the relevance of maternal mortality on architectural strategies that can encourage women to attend facilities but also lower potential and avoidable maternal death by redesigning spaces that are more efficient for staff and more comfortable for expecting mothers.

HEALTH FACILITIES IN MALAWI

PRIMARY

This tier of the Malawi health system incorporates the health centres. There are about 413 health centres so far. There is an MOH goal to construct 250 more health centres in order to reach more Malawians with little access to health care due to far distances. The goal requires an 8km radius distance of a walk from a residence to a health facility. Health centres are mainly found in rural areas and are also mainly low risk. There are rarely any doctors in health centres but rather HSA's and nurses. There are no surgery theaters and maternity waiting homes; although the goal is to eventually expand health centres into community hospitals that can provide inpatient services.

SECONDARY

The secondary tier is the middle ground of the Malawi Health System, which acts as a referral hospital for high risk expecting mothers coming from health centres. They provide both surgery services and maternity waiting homes. They are large enough to house outpatients and in patients. The difference between health centres and district hospitals is that they are able to house at least 1-3 doctors.

TERTIARY

The third tier of the Malawi Health system is the Central Hospital. There is one in each region of Malawi (northern, central, southern). Located in urban areas, Central Hospitals mainly take care of high-risk situations that can't be handled in district hospitals, acting as a referral for the district hospitals. Central Hospitals requires the most staff and most resources, which lends itself to most clinical research occurring in this tier.

BREAKDOWN OF HEALTH FACILITY TIERS

FACILITY PERFORMANCE CONSIDERATIONS

WHAT CAN BE ADDRESSED ARCHITECTURALLY IN EACH TIER?

Being aware that we can't solve every single problem related to maternity and maternal mortality in all tiers of the Malawi Health System, we chose to study three main criteria influenced by our literature review to address. All three categories have elements that spatial organization can address in order to produce the outcome we hope to achieve. These three categories are Quality of Care, Staff Efficiency, and Infection Control.

QUALITY OF CARE

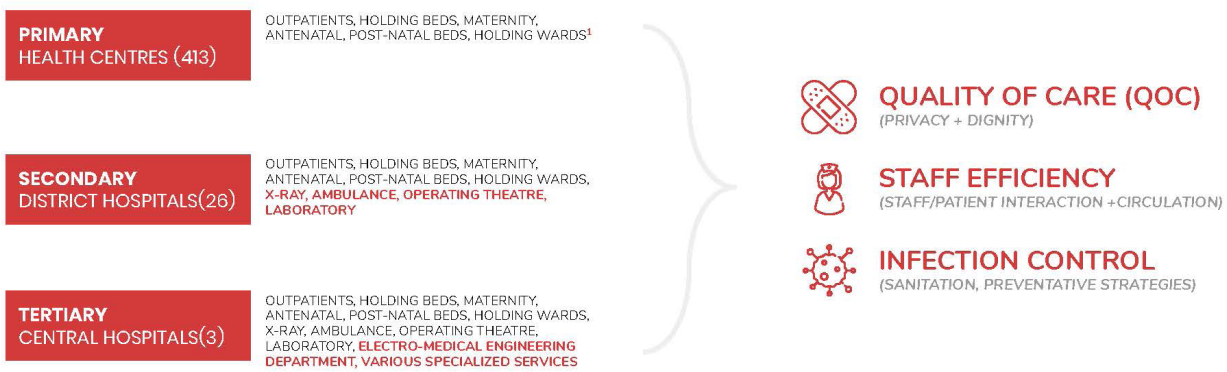
Quality of Care is the study of privacy and dignity for women in maternity wards. Preserving the dignity of women in these facilities could be ways to ensure that attendance is encouraged and healing is actively being observed. Architecturally, quality of care can be addressed through elements such as bed spacing, privacy levels between beds and within different wards.

STAFF EFFICIENCY

Given that the main vessels for infection in health facilities are the health workers themselves, there is a great need for analyzing how often patients and staff interact as well as the circulation patterns for both patient and staff. By addressing staff efficiency, we hope to use architectural strategies to create spaces that control circulation to effectively improve burnout in staff and decrease patient waiting times.

INFECTION CONTROL

Infection control covers sanitation, water, and preventative strategies. Architecturally, ventilation, indoor air quality, daylighting strategies, and location of wash stations can improve health outcomes. Infection is difficult to prevent given that most of it is on-site challenges across all tiers, but by taking on infection control from the perspective of educating the use of wash stations, and providing access to clean water can impact maternal mortality.



ARCHITECTURAL RELATION

GOALS + INTENTIONS

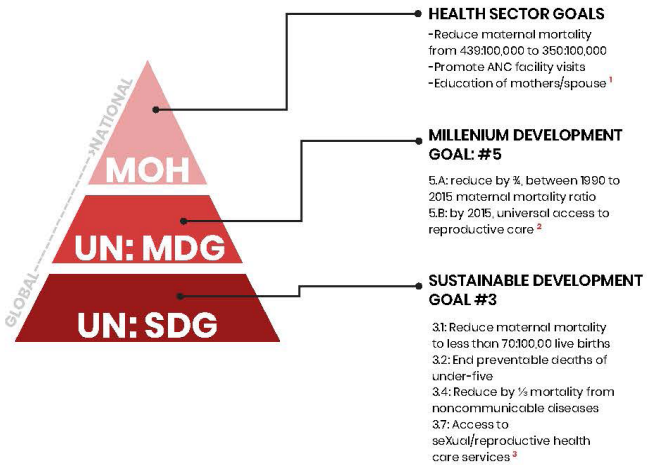
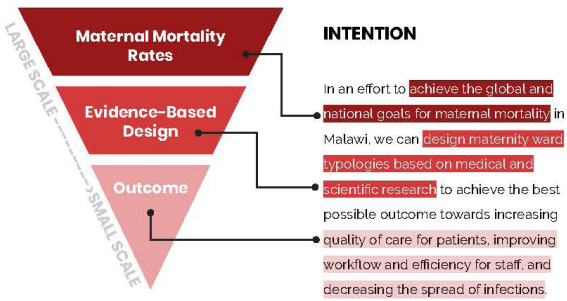


FIGURE 5: GLOBAL AND NATIONAL GOALS FOR MATERNTIY

GLOBAL AND NATIONAL GOALS FOR MATERNIITY

Our purpose for this research began in the study of the global and national goals for maternity. We looked through a bottom up approach, seeing the goals of the UN in maternity and into the goals of the Malawi Ministry of Health (1). Under the UN Sustainable Development Goals, #3 speaks on reducing maternal mortality to less than 70:100,00 live births, ending preventable deaths of under-five, reducing mortality from noncommunicable diseases and increasing access to sexual/reproductive health care services (family planning/info, education). (3).The Millenium Development Goal #5 speaks on reducing by ¾, maternal mortality ratio by and providing universal access to reproductive care(2). In the health sector goals for the MOH, the main goals were to reduce maternal mortality from 439:100,000 to 350:100,000, promote ANC facility visits, and educate mothers and spouses on the healthy practices to follow.



PURPOSE FOR RESEARCH

OUR GOALS

Our goal for this project is to be able to address the issue of maternal mortality through the lens of quality of care, efficiency, and infection control at all levels of health facilities in Malawi. We want to do so by ensuring we are able to

1) Develop a comparative analysis of existing conditions of maternity wards through the examination of the three main criterias

2)Create a series of design explorations that best expresses our design goals and strategies according to our research

3)Encourage the effectiveness of evidence-based design relative to the three criterias in any future hospital/facility design for maternity.

PURPOSE OF RESEARCH

"In an effort to achieve the global and national goals for maternal mortality in malawi, we can design maternity ward typologies based on medical and scientific research to achieve the best possible outcome towards increasing quality of care for patients, improving workflow and efficiency for staff, and decreasing the spread of infections."

METHODOLOGY

LITERATURE REVIEW
Past medical research will help inform how maternity wards function and inform how to analyze staff efficiency, infection control, and patient satisfaction/dignity. Future plans on various levels from the WHO to the Malawi government will guide what sections of maternity wards should be prioritized.

INTERVIEWS WITH PROFESSIONALS
Guidance from medical professionals will provide guidance on how medical staff utilize the different programs and help define the different stages of maternity. Professionals who have experience in Malawi will provide perspective on what it is like to work and experience Malawi healthcare facilities and can provide an empathetic and cultural view of Malawi healthcare that literature may not include.

ANALYZING MEDICAL RESEARCH FROM KAYLA INTO DESIGN STRATEGIES
Medical field research will help assist in highlighting areas of interest which can be improved upon in the future design process

CASE STUDY ANALYSIS
A comparative analysis between existing maternity wards and designs that challenge existing wards to better understand what responses may be effective or ineffective

SPACE PLANNING + CIRCULATION FLOW STUDIES
Analysis of how existing maternity wards are organized can help highlight areas of high circulation or population density which can inform where spaces need to be improved

TYPOLOGY ANALYSIS (IN DIFFERENT SCALES)
Small Scale: Bed area/workstations: understanding small scale typologies may provide solutions that directly affect personal interaction. Improvements at this scale can directly affect the patients comfort, quality of care and dignity. Solutions at this scale include bed dividers, guardian placement in respect to the patient's bed, and the organization of a staff workstation.

Large Scale: Maternity Ward: The large scale view of the complete maternity ward will focus on circulation flows between the different stages of maternity. From the waiting area to post-natal, where are patients at risk of infection, what are their travel distances between stages, and are they waiting in between the stages? These questions will help seek improvement in the planning of future wards.

FINDINGS

KEY TAKEAWAYS

Large Scale Typologies
- Ward typologies can be utilized to resolve areas of low efficiency,quality of care, or infection control.
- Well planned facility typologies include direct circulation paths and access to outdoor spaces which benefit a health facility's operation.

Small Scale Typologies
- A 3.6 by 3.7 meter space should be provided for each patient.
- A patient's bed should have 1 meter of free space around it on three sides for staff to work.

Quality of Care
- Quality of care means that healthcare must be safe, effective, timely, efficient, equitable and people-centred.
- A lack of beds and staff members leads rooms to be open and no privacy for patients.
- The physical comfort, privacy and confidentiality of a patient influences the dignified care they receive.

Infection Control
- 20% of maternal mortality in Malawi is caused by infections which are avoidable
- Of all infection prevention strategies, the most effective in addressing infection at health facilities is hand hygiene
- Of all ventilation types, double-loaded corridors are not recommended for infection control and natural ventilation is preferred over mechanical in climates like Malawi

Staff Efficiency
- Factors of staff efficiency include circulation, access to nurse stations, technical efficiencies such as bed turnover rates, and staff satisfaction.
- All health facilities should strive for a Pabon Lasso Zone III rating, achieving high turnover and high occupancy rates.
- Facilities designed to enhance staff performance without a focus on staff comfort levels can show cases of fatigue for staff, decreasing their efficiency in the field.

Interviews
- Unnecessary surgeries in larger facilities cause larger mortality rates
- Rather than patient-focused design, most hospital design only caters to staff efficiency
- Infection control can also be addressed through plumbing system, water access, and waste management

Case Study Synthesis
- Anchor Farms Health Centre: A centralized nurse's station in the double-loaded corridor design allows for a more efficient staff circulation path by decreasing the distance staff need to travel to care for patients.
- Domasi District Hospital: L-shaped design works in favor of staff efficiency and patient privacy by allowing two separate wings guided by two separate nurse's station
- Queen Elizabeth Central Hospital:

FACILITY-SCALES

OVERVIEW

The research of macro-scale typologies looks to gain perspective on varying large-scale planning and circulation between different divisions of healthcare facilities. At the health centre scale this looks at how different wards relate to each other in a singular building. At higher levels like district and central hospitals take on varying expansions. Typology analysis at a macro scale will help better an understanding of how maternity wards best work with circulation and spatially. This research includes the programmatic and spatial relationship between different buildings. The analysis of the typologies can further evaluate the efficiency and quality of care through a spatial perspective. In Malawi, most health facilities derive from a European or American typology. However, those typologies may not best be suited for the societal and medical needs of Malawi. In regards to maternity, some medical typologies that work in other health divisions may not work the same way with the processes of maternity.

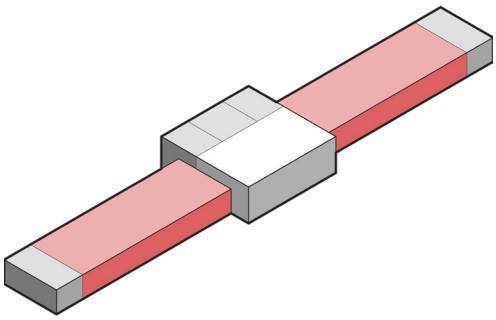
WARD TYPOLOGIES

The design of ward typologies is typically gauged toward the efficiency of the staff considering a certain population or programmatic requirements. Common ward typologies try to conquer these varying issues to better the healthcare process. The nightingale configuration is one of the most common designs for Malawian wards, including maternity. The focus of open wards allows for a small staff to oversee a large population of patients. The corridor design promotes the use of a centrally located double loaded corridor for circulation outward treatment rooms direct patients outward. A courtyard typology attempts to utilize outdoor spaces to better the patients experience. While all the examples intent is well, due to conditions in Malawi, they may not perform as expected. Open wards in nightingales have high risk of infections, corridors do not work as efficient without proper staff, and courtyards create congested circulation corridors.

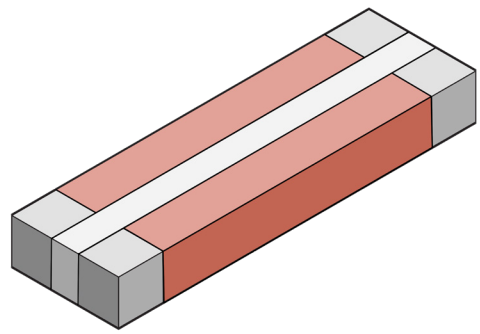
FACILITY TYPOLOGIES

When individual wards are combined into overall facilities, the relationship between the individual wards becomes very important, especially if patients are expected to see professionals in multiple buildings. Malawian facilities tend to be organized in three manners: a village, a branching corridor, or a cluster. A village organization is usually the result of unplanned expansion. Village facilities consist of scattered wards occasionally arranged in a courtyard setting or along vehicle circulation paths. Branching corridors work efficiently and are easy to navigate due to a centrally located exterior corridor which commonly moves in only two directions. Finally, clustered typologies arrange individual wards closer together to allow for easy circulation through smaller connecting corridors but they reduce outdoor space and can create daylighting issues.

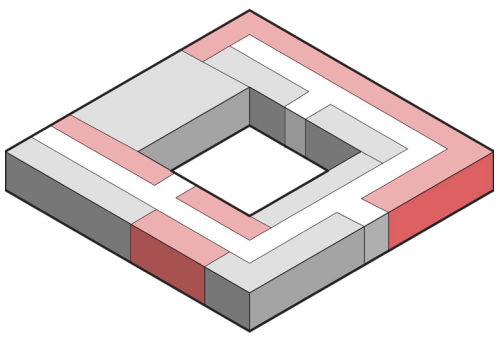
WARD TYPOLOGY



NIGHTINGALE WARD

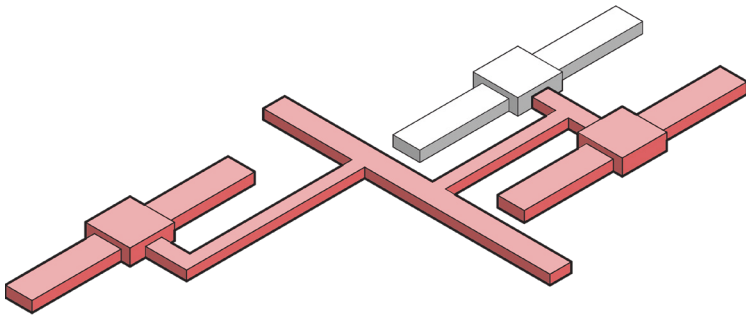


CORRIDOR WARD

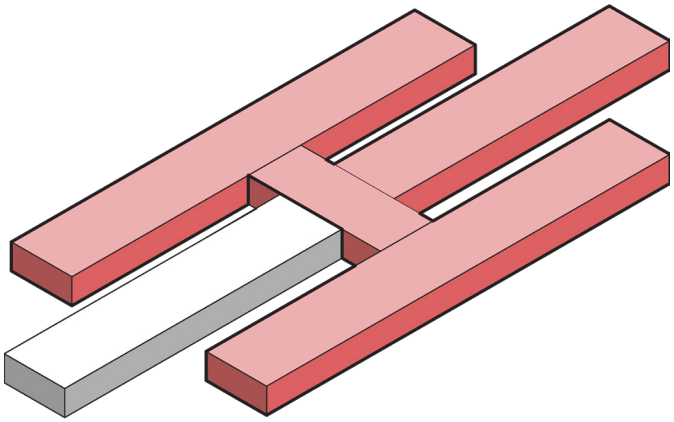


COURTYARD WARD

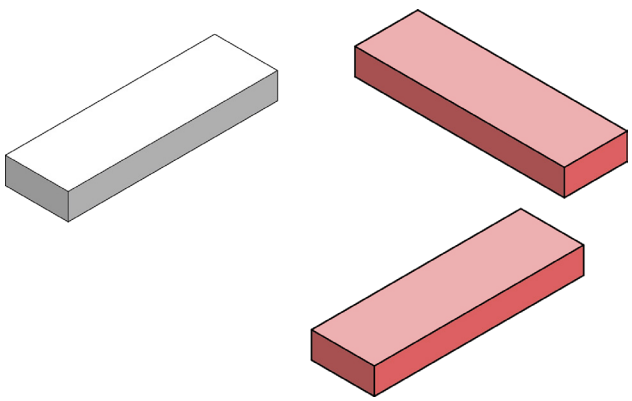
COMMON FACILITY TYPOLOGY



BRANCHING TYPOLOGY



CLUSTERED TYPOLOGY

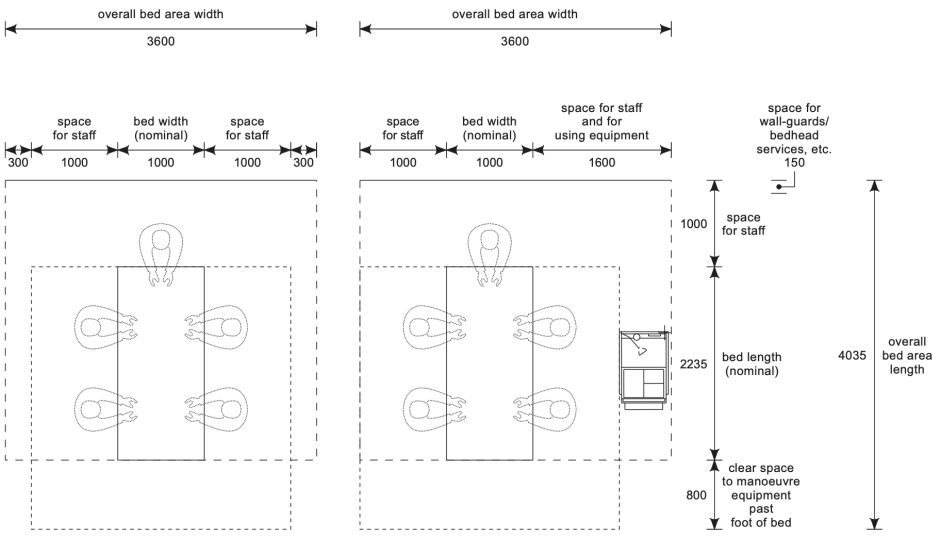


VILLAGE TYPOLOGY

MICRO-SCALES

CLEARANCES

As shown below in figure ##, the overall bed area width that is being shown is 3600 mm, or 3.6 meters. That is the minimum space that a single patient's bed should be placed within so that there is adequate space for the various things that need to happen around the bed. A typical nominal bed dimension is 1 meter wide (1000 mm) and 2.235 meters (2235 mm) long. That being said, on the left side of figure ##, if the bed is centered within the 3.6 meters, there is a clearance on either side of the bed, along with at the foot of the bed, that is a designated space for staff to provide care for the patient. On either side of the bed, there is an extra 300 mm allotted for extra space for either the staff to work, circulation for people to move around, etc. Staff might be positioned at each side of the bed and at the head and foot of the bed. The bed has to be moved to allow access to the patient's head. It is imperative that staff should be able to bring in and set up their equipment quickly with minimum disruption and maximum safety, not having to spend precious time moving furniture and equipment in order to get to their positions. There should be space for staff to stand at their positions, park the equipment in the most appropriate place and carry out the tasks, safely and efficiently.[1] The diagram on the right shows a different arrangement of uses for the space requirements and clearances that should be used around the bed, while still maintaining the 3600 mm by 4035 mm overall bed area. This diagram shows the bed off to the side, in order to make extra room on the right side for the staff member and for the use of various types of equipment that might be needed to care for the patient.



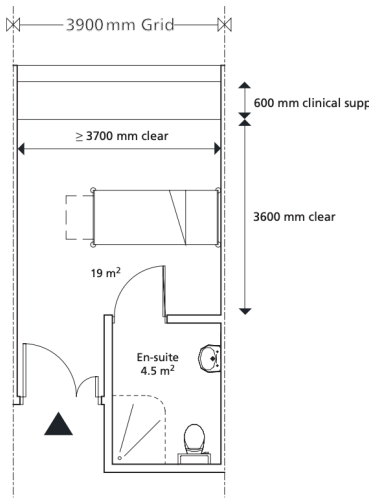
BED CLEARANCES

SINGLE-BED ROOM

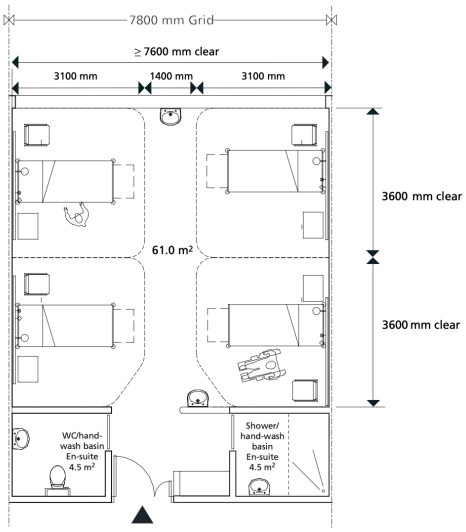
The single-bed configuration shown below in figure ## represents the spacing that should be required, however this configuration shows the addition of an in-suite bathroom as well, which would not be the case in Malawian health facilities. These digrams represent a theoretical, and useful arrangement, that would be utopian in a sense, but would most likely not be built in Malawi. However, even if the exact configuration will not be built, mayn of the clearances and distances that should be left are still relevant, and are numbers that we can base our designs off of moving forward. Figure ## shows a room, with a single bed that would fit within a 3900 mm grid. The room itself is 12 square meters, and leaves a square space, with the bed centered along one wall, of 3600 mm by 3700 mm. This spaces allows for a proper area for staff to provide care to the patient on all sides of the bed, and leaves enough room for the bed to be rolled out of the room.

MULTI-BED ROOM

In this diagram however, it is compromised of a multiple bed layout within the same room. Like the previous diagram, it still follows the 3900 mm grid, but doubles it so the total width is 7900 mm. This figure shows a layout with four beds together, where each of the beds still maintain the 3600 mm width, but the length shortens a little to 3100 mm. These areas represent what would be considered a single patients' space, but because there are four beds in a single room, there is a 1400 mm aisle down the center, acconuting for the lost length per person, which acts as common space. It allows for wash stations to be placed at the end of the common space, and also allows for a proper amount of space for several staff members to circulation and treat various patients that are located within the same room. The overall room is 61 square meters, and has two hand washing stations at either end. This configuration has the option to add on in-suite restrooms as well.



SINGLE-BED ROOM DIAGRAM



MULTI-BED ROOM DIAGRAM

QUALITY OF CARE

WHAT IS QUALITY OF CARE?

Quality of care can be defined in many ways however, the World Health Organization (WHO) defines it as the extent to which health care services provided to individuals and patient populations to improve desired health outcomes. In order to achieve this, health care must be safe, effective, timely, efficient, equitable and people-centred. Together, these six elements make up the pieces of quality of care, and are carried throughout every element of health care provided to patients. Through research, the quality of care can be broken down into two major categories; privacy and dignity. The National Health Service (NHS) believes that the design of facilites should have a focus on the dignity of patients and their families while also aiming to allow sufficient space for both aural and visual privacy during. Hospital stays are often very stressful on the patient, so being able to provide both adequate dignity and privacy will allow for a more comfortable and less worryful experience.

SAFE — Delivering health care that minimizes risks and harm to service users, including avoiding preventable injuries and reducing medical errors

EFFECTIVE — Providing services based on scientific knowledge and evidence-based guidelines

TIMELY — Reducing delays in providing and receiving health care

EFFICIENT — Delivering health care in a manner that maximizes resource use and avoids waste

EQUITABLE — Delivering health care that does not differ in quality according to personal characteristics such as gender, race, ethnicity, geographical location or socioeconomic status

PEOPLE - CENTRED — Providing care that takes into account the preferences and aspirations of individual service users and the culture of their community

PRIVACY

32% of mothers felt their **privacy** was not maintained

Lack of partitions
No separate rooms
Lack of beds
Lack of space for everyone
Ward Layout / Design

DIGNITY

Dignity of Place
Inadequate spaces

Dignity of People
Initial interactions upon arrival

Dignity of Processes
Management shortcomings

PRIVACY

PRIVACY IN MALAWI HEALTH FACILITIES

Within the health care facilities in Malawi, specifically regarding maternity patients, there have been several studies conducted in order to find out more about the issues of patient privacy within the health care system. Some studies found that both women and healthcare providers tend to value the importance of privacy during childbirth. Both the staff members and the patients are generally unhappy with the condition of most labor rooms, which tend to lack patient privacy due to the poor design. Most of the time, there are no separate room or partitions to separate the women, which often leads women to be exposed to other women, their families and care providers. Most of the delivery rooms contain several beds and if curtains are available, they are often tattered, not closed properly and sometimes left open to allow for the only midwife to be able to observe all the women in labor at the same time. Becuase there tends to be a lot of staff shortages, especially in health centres, a midwife can only be in one place at once so in order to help the overcrowded facility, curtains are left open to she can go back and forth between patients. In some studies however, patients felt that it is the healthcare provider's duty to preserve their confidentiality, a word brought up a lot when dealing with patient privacy. But, on the other hand, some care providers feel like it is justifiable to breach that confidentiality in certain circumstances, regardless of whether or not it damanged the patient-healthcare provider relationship that most patients strive for. When patient's confidentiality of breached, they said they feel embarassed, especially when exposed to other patients, gaurdians, staff members, and others. Overall, most women preferred health care providers that were respectful, welcoming, caring, freindly, helpful and sympathetic.

IMPORTANT PATIENT VIEWS ON PRIVACY

A VALUED PATIENT-PROVIDER ***RELATIONSHIP***

NEED FOR ***MORE EDUCATION*** OF WOMEN REGARDING THE STAGES OF PREGNANCY AND LABOR

WOMAN'S INVOLVEMENT IN DECISION-MAKING

THE NEED TO MAINTAIN ***CONFIDENTIALITY*** WHEN REQUIRED

INSUFFICIENT HUMAN RESOURCES

PROMPT AND ***TIMELY SERVICE*** CONSIDERED AS A ***PRIORITY***

PRIVACY_PATERNAL INVOLVEMENT

BACKGROUND

Paternal involvement within maternal health care is very low in Malawi and it's rooted in cultural ties. Most obstetric complications occur unexpectedly around the time of delivery in women with no risk factors, which means removing any potential obstacles that communities and individuals may experience in accessing health facilities is key. There is widespread recognition that involving men in maternal and child health services offers positive benefits. However, Malawian society is largely male-dominated, even with regard to female reproductive health. In Malawi, pregnancy and childbirth traditionally have been a woman's domain and maternal health care services have focused on women, with very little attention paid to male involvement... the notion of male involvement during labour and birth is perceived as a foreign culture not commonly practiced in Malawi. The main obstacles to male involvement mostly center on the traditional constructions on masculinity and power and the stigma about being involved. A number of studies have highlighted the important role played by men in making decisions pertaining to maternal health issues and called for male involvement. However, the men lack knowledge on maternal health issues that limits women's access to life saving treatment. Most studies that revolve around the involvement of males within the maternal process shows that an increase in education for both men and women is crucial. Maternal health education interventinos targeting both men and women have proved to increase knowledge in both men and women; increase health seeking behavior among pregnant women; raise awareness and use of family planning in the postpartum period, and also increase awareness of dual protection of STIs. In some places, like at the Mwanza District Hospital, they are using incentives, like a competition among villages to encourage male involvement in maternal health care. UNICEF organized the competition in 2008 and since then, there have been an increased number if males becoming involved. The health care providers were of the view that male peer approach should be emphasized, as men would want to identify with fellow men. So the men that are influential among their peers should be targeted with male involvement information in order for them to be role models for their peers. This enables them to disseminate male involvement information in a socio-culturally acceptable manner.

"Overall, what is critical to catalysing social change are approaches that view men as partners or view men as agents of positive change."

PRIVACY IN PATERNAL INVOLVEMENT

In a study done where husbands were involved, the husbands participated in all ANC and postnatal consultations but not in labour and delivery care due to privacy issues. Generally the labour and delivery rooms are large and open with mulitple beds that are demarcated by curtains, leaving women fairly exposed to their surroundings. Most often than not, women labour naked, as the hospital did not have hospital gowns and women had to spare their home clothes to be put on after delivery. The lack of privacy in the labour room hindered birthing women to have a spouse or family member present in labour ward for emotional support. support.

The labour and delivery period is crucial because potentially woman having a baby may lose her sense of dignity. There are many circumstances during labor and childbirth where staff can fail to treat women with the respect and dignity they have the right to expect. These include the maintenance of her privacy and dignity during physical examinations, late-stage labor and childbirth. In a survey done, women were asked about if their labor and delivery beds were partly screened (12%) or not screened at all (20%). These women were exposed to other women and guardians, other health workers and students who were also in the labor ward. Studies that have looked at dignity and place also highlighted concerns about being exposed. Therefore, the 32% of women that were either not screened at all, or only partially screened would be exposed to anyone else present in the room, including husbands, which would compromise the patient's dignity and privacy.

PRIVACY_GRIEVING

BACKGROUND

The death of a child around the time of birth is highly contradictory to the 'natural order' of life, and has profound effects on parents and families. Shock, anger, emptiness, helplessness and loneliness are common responses for mothers and fathers. In regions of the world where most deaths occur, maternal grief may be compounded by social stigma, blame and marginalisation. Practices of isolating women and their newborns and a perception that the newborn is not a person contribute to suboptimal care for parents when a baby dies. Even in high income settings, where support services are more likely to be available, approximately one in five parents whose baby dies at or soon after birth will display intense and enduring grief following the loss. Many facilities are overcrowded and lack the proper space for a woman in labor, let alone a woman that is in the grieving process after the loss of a child. Proper privacy needs to be met to comfort these mothers and families in the grieving process. A failure to recognise the value of these lost lives leads to disenfranchised grief and diminished preventive efforts to reduce stillbirth and neonatal deaths. Acknowledging these deaths to bring them 'out of the shadows'17 and compassionate, respectful care for parents suffering perinatal loss, irrespective of country or resources, are critical to addressing the totality of the burden of this public health problem.[7]

PARENTAL NEEDS FOLLOWING A LOSS

High levels of distress are part of the normal grieving process following a baby's death and although some parents develop mental health problems, most do not. What helps to protect and sustain parents and families in the aftermath of such an unambiguously tragic loss? High quality evidence on specific support interventions following stillbirth or neonatal death is lacking and different interventions will be required for different settings and cultural groups, but essential ingredients of quality care include a deep respect for the individuality and diversity of parents' grief and respect for the deceased child. Parents whose baby has died face many difficult decisions in the context of overwhelming grief and frequently have a diminished capacity to absorb and retain information. Maternity staff who are calm and supportive and who provide objective information while balancing guidance with parental autonomy, can assist parents to make informed decisions while minimising regret.

In many settings, reproduction is central to women's perceived purpose in society. In this survey, one in five women responded that women experiencing the loss of a baby to stillbirth are marginalised as a failure, both as a mother and as a spouse, and considered impure or taboo.

HEALTHCARE PROVIDERS

There are several key components that are recommendations for maternity care providers. These components include; respect, information, creating memories and professional development and support. Upon the loss of a child, it demands a deep respect for the individuality and diversity of the parents' grief. Recognition and valuing of the deceased baby is critical. Maternity staff should also provide objective information in a calm, supportive manner to the parents. All maternity are providers need to receive training to ensure that they are equipped to provide appropriate care following a perinatal death. The staff that are confronted with such losses need ready access to debriefing and support.

Many facilities are overcrowded and lack the **proper space** for all the women in labor, let alone a woman that is in the grieving process following the **loss of a child**.

DIGNITY

BACKGROUND

Quality of care is largely determined by the preserved dignity of a patient. The WHO states that the provision of a safe clinical environment is one way of people's dignity and respect. The environment that a patient is in has the ability to make them feel either valued or devalued, or even worth or worthless. The physical comfort, privacy and confidentiality influence dignified care therefore, the sharing of spaces without any division of space can affect a patient's dignity. Beside the physical space that a patient is placed in, the healthcare team members also have the potential to humiliate, degrade and devalue patients through their actions and interactions. These actions from the staff members are common issues that are brought up in health care facilites, and also can be caused due to the shortage of staff members, causing staff to become irritable, overworked, and exhausted. Especially in maternity wards, women accord total trust to their physicians, and vey rarely question the usefulness of many routine procedures they receive. The patients generally value good interaction and communication with their health care providers but that is something that is not always the cawe in healthcare facilities within Malawi.

DIGNITY & PLACE

Dignity and place tends to deal a majority with inadequate spaces that patients are placed in. Infrasturctures are too small to handle the number of women that they have to serve. Having too small of space leads to compromising dignity when there are floor beds or women being discharged too early to make room for more. Typically, a woman can stay for a minimum of 8 hours after delivery before discharge but midwives feel like they are sending women away prematurely due to the inadequate space and would be happier if women were monitored 48 hours after delivery, since most maternal deaths are within the first two days after delivey. Monitoring and caring for them in a facility might avert some maternal deaths.[8]

DIGNITY & PEOPLE

In terms of dignity and people, several factors are involved including the reception, the midwives' behavior, patient behavior and communication. 36% of postnatal mother expressed a need to be welcomed warmly upon arrival at the maternity unit, and 26% expressed the need to be welcomed with respect. However, for the midwives' behavior, 52% of women indicated that the midwives' behavior is one factor that affects the provision of care with dignity to the women and 16% of women expressed that they lose dignity during labor and devliery because of how the the midwives talk to them. 77% of women even felt that the women themselves also contribute to them not being treated with dignity during labor and delivery.

DIGNITY & PROCESSES

Women's experiences of maternity care showed that women accord total trust to their physicians, and very rarely question the usefulness of many routinely applied procedures, even those which the literature shows are unnecessary. Standardized protocols and routines are usually written with the intent to promote dignity but the manner in which they are implemented may promote or compromise dignity.

"It's very important to keep the results confidential, because if the doctors tell others ... that will not be respectful to us."
– Woman

FACTOR	PROMOTES DIGNITY	COMPROMISES DIGNITY
DIGNITY & PLACE	MINIMAL PATIENTS IN LABOR LESS OVERCROWDING AMPLE SPACE FOR BELONGINGS AND LAUNDRY	ASKING PERSONAL QUESTIONS IN FRONT OF OTHERS LACK OF SPACE FOR PATIENTS AND THEIR BELONGINGS CROWDED WARD WITH FLOOR BEDS
DIGNITY & PEOPLE	DIRECTING WOMEN WHERE TO GO GOOD COMMUNICATION PROVIDING ADEQUATE PRIVACY, NOT EXPOSING WOMEN, USE OF SCREENS, USE OF LOW TONE FOR AUDIO PRIVACY POSITIVE STAFF BEHAVIOR / ATTITUDES ASSISTANCE AS SOON AS IT'S NEEDED, PROPER CARE FOR WOMEN'S NEEDS	POOR RECEPTION GIVEN TO WOMEN NON-CARING BEHAVIORS OF STAFF: ABANDONING WOMEN, ASKING WOMEN TO CLEAN DELIVERY BEDS OR MOP THE FLOOR, RUSHING WOMEN, ETC. NEGATIVE STAFF ATTITUDES: RUDE, SHOUTING, EASILY IRRITATED, ETC.
DIGNITY & PROCESSES	INNOVATION IMPROVISING ADEQUATE RESOURCES (MATERIAL AND HUMAN)	FLOOR BEDS / BEDS WITHOUT PROPER LINENS DISCHARGING WOMEN TOO EARLY HIGH WORKLOAD / OVEREXHAUSTED STAFF MEMBERS

INFECTION CONTROL

MATERNAL MORTALITY: INFECTIONS

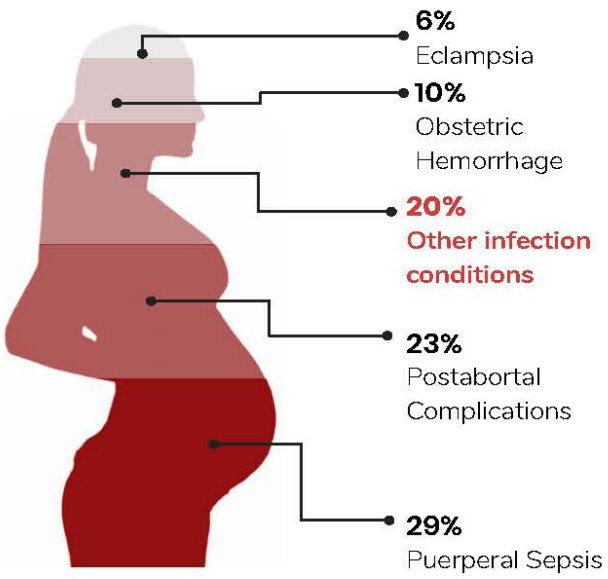
Infection control is an important aspect to consider in the design of maternity wards because it is one of the main leading causes of maternal mortality in Malawian women. What is striking is the fact that most of the infections women get during pregnancy, labour, and recovery are preventable. However, there are several reasons/delays why mothers are still very much vulnerable. These reasons can range from bed turnover rates which increase c-sections that aren't needed to simple acts of infection prevention methods that aren't being met due to lack of resources and access to clean water supply. The following research will identify types of infections, causes of the infections, guidelines to prevent infection in health facilities and will conclude with how to manage infections architecturally.

Maternal Mortality is typically multi-casual. Our findings reveal that a retrospective descriptive study in Queen Elizabeth Central Hospitals Research shows that the top five causes of death were puerperal sepsis, (29.4%); postabortal complications, (23.5%); other infectious conditions, (20.1%); obstetric haemorrhage, (10.6%), and eclampsia, (6.4%). The research concludes that most of the causes and operational factors for maternal deaths are easily avoidable. Of these factors, infectious conditions. which make up 20% of maternal deaths is a matter of infection control that can be dealt with architecturally and spatially.

The key issue with infections is that although a substantial amount of it can be reduced through simple infection control measures, under-resourced countries still suffer from mortality rates in the hospital and health center settings. A research study in Nigeria investigated the nature and pattern of existing policies and practices relating to infection control in maternity care centres. The findings showed that caesarean sections are the most important risk factor of postpartum infection. Compared to regular vaginal delivery, chances of infection with c-sections are associated with a 5-to-20-fold increased risk ratio. During labor, blood and body fluids are easily uncontrollable and transmission rates of bloodborne pathogens are high when preventative infection control measures are neglected, hence amplifying the importance of infection prevention methods. The study concludes that infection control in maternity units should be a priority and a major strategy into reducing maternal mortality. There should be protocols for hand washing, sterilization and decontamination of surgical equipment, reuse of materials and environmental cleanliness.

Infection control is not only directly related to nosocomial infections during labour and recovery, and cesarean section, but also HIV. A study done in Malawi back in 2012 described the three delays related to social, economic, and behavioral factors that affect maternal mortality and its relationship to HIV . Research shows that there are three delays are attributed to the decision to seek care, the delay in reaching the appropriate care, and the delay in receiving adequate care at the facility. Furthermore, the research concludes that some of these infections, maybe due to relevance to HIV. Studies showed that of 61 maternal deaths in central region hospital during 2007-2011 revealed that 20% were HIV positive and died of non-pregnancy related infection such as meningitis and pneumonia, This concludes that HIV infections can also affect pregnant women and affect the severity of maternal mortality, which is why infection prevention methods should be applied to maternity wards wholly.

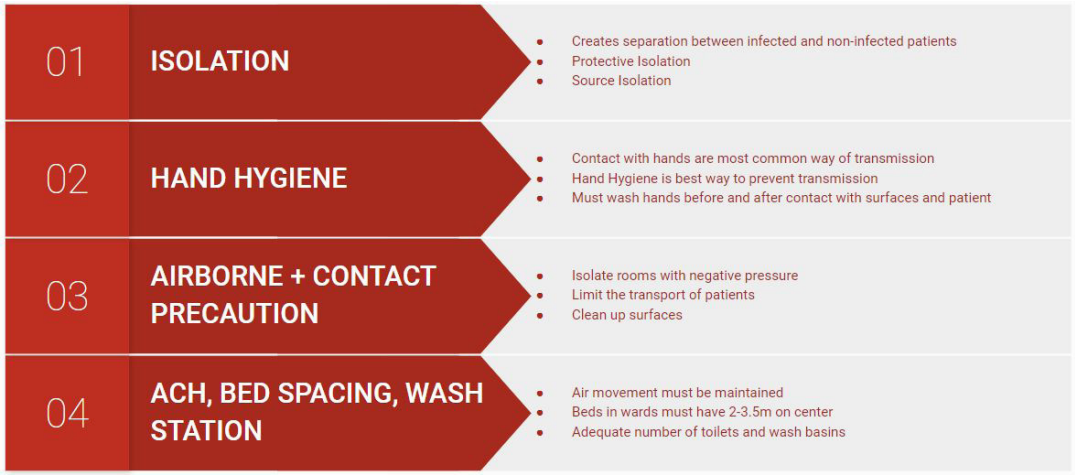
"some improvement will be seen if basic conditions such as the availability of sufficient space, isolation capacity, and facilities for handwashing are met(4)"



chances of infection with c-sections are associated with a 5-to-20-fold increased risk ratio

GUIDELINES TO PREVENTION

INFECTION PREVENTION
When discussing infection control, HAI's,also known as hospital acquired infections play a major safety concern for patients and staff. In our findings, we found guidelines for health care personnel involved in patient care and areas responsible for control of infections within the hospital (5). Within the guidlines, the measures used to access and develop these protocols are all based on existing scientific data, rationale, applicability, and economic impact.



1

ISOLATION

Isolation rooms are recommended in order to create separation from patient with and without infections to prevent the spread of it. There are two types of isolation: Protective and Source Isolation. Protective prevents infection prone women from recieivng other infections whereas Source Isolation is isolating women with infections to prevent others from getting it.

2

HAND HYGIENE

Hands are the most common way of transmitting infection and hand hygiene is the most effective way to prevent transmission. In low-resource settings such as Malawi, hand hygeine has been attempted. However, due to lack of adequate clean water and access to enough wash basins, this still poses as a challenge. The WHO places 5 moments for hand hygiene. Step 1 is (IB) before touching a patient. Step 2 is (IB) before any procedures. Step 3 (IA) is after exposure to body fluids. Step 4 (IB) is after touching any patient. Step 5 (IB) is after touching patient's surroundings.

3

AIRBORNE AND CONTACT PRECAUTIONS

Microorganism in the air can infect areas and spread over time and distance. A recommended precuation to take is to isolate room with negative-pressure ventilation. At the same time, infections can be spread with direct and indirect contact with an infected person whether through surfaces or items in the room. Therefore, ways to address this would be the inclusion of isolation rooms and limiting the transport of patients as much as possible. In addition, environmental factors must be considered in infection control which require theneed for surface cleaning before and after contact with patients.

4

ACH, BED SPACING, WASH STATIONS

Air must be filtered to 99% efficiency and safe air quality must be maintained by ensuring that air movement always going from clean to dirty areas. It is recommended to have a minimum of 6 total air changes per room oer hour. Air change per hour for a positive pressure room is the ratio of the volume of outdoor air flowing into a space in an hour divided by the volume. Isolation rooms must have negative an dposstivie pressure ventilation. Beds in ward space need adequate space around it, ideally 2-3.5m. When it comes to washing hands, there must be an adequate number of washbasins (one in each ward). Adequate toilet faciltiies must also be provided.

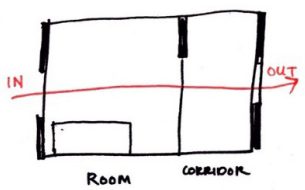
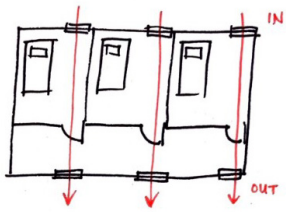
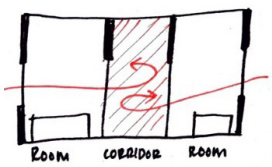
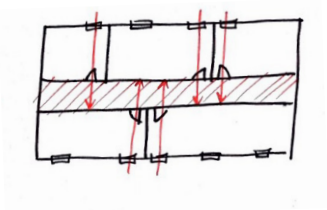
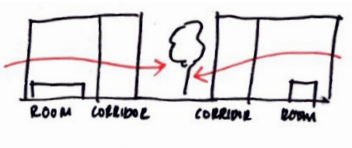
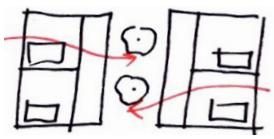
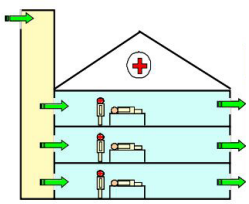
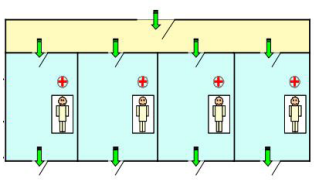
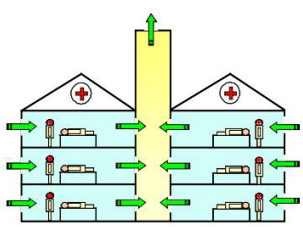
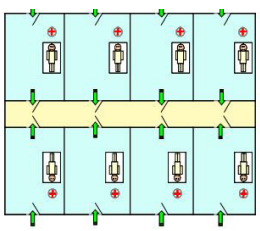
TYPES OF VENTILATION

TYPES OF VENTILATION

MECHANICAL:
According to WHO, mechanical ventilation is when mechanical fans drive ventilation which can be installed directly in windows or wall or air ducts(6). In warm and humid climates, infiltration is needed to prevent condensation. Mechanical can be un-reliable in areas where electrCicity isn't readily available and may not often work as expected affecting maintenance costs and availability.

NATURAL VENTLIATION:
Advantages of natural ventilation is that its more desireable economicaaly due to use of natural forces and large openings. It is efficient especially when heating isn't necessarily needed. Well-designed ventilation can also be used to access higher levels of daylight. Overall, it provides high air exchange rates at low cost, with a very simple system. Disadvantages of natural ventilation is that in can be difficuly yo control airflow direction (especially in negative pressure rooms), climate, security, and cultural criteria may impact how open the building can beand may only when when natural forces available. Our findings conclude that natural and mechanical venilation systems can be effective for infection control. However, natural ventilation only works when forces are available (winds or breezes). In existing faciltiies with natural ventulation, it should be maximized as much as possible before considering the addtition of mechanical systems. the decision to use either or for infection control should be based on needs, availability of resources, and the cost of the system to provide control.

CORRIDOR TYPES

TYPE	SECTION	PLAN
SINGLE-SIDE CORRIDOR *This is when a corridor is on one side of the ward. Airflow is a single directional flow from the ward to the corridor or corridor to ward depending on wind direction. WIndow design for this layout is crucial. It is better to place windows in line with the door to create path for cross ventilation. CLIMATE PREFERENCE: HOT AND DRY*		
CENTRAL CORRIDOR TYPE *This is when a single-side corridor type is added another series of wards on the other side. The possible airflow path would be from one ward to the corridor, to the ward on the other side. This could result in contaminated air moving from the upstream ward to the downstream ward. This isn't recommended.*		
COURTYARD TYPE *This is when enclosed zones help to channel and direct airflow to ceate microclimates around buildings. This system provides more ventilation than others so long as courtyard is large. An outer corridor type as more advantage over the inner type because it can avoid cross-infection with connected corridors. CLIMATE PREFERENCE: HOT AND DRY*		
WIND TOWER TYPE *This is when wind is captured at rood level and directed down into the rest of the building. CLIMATE PREFERENCE: HOT AND DRY + MODERATE*		
ATRIUM AND CHIMNEY TYPE *This is what is used to increase the natural ventilation potential. Outdoor air is sucked into wards through windows by the staff effect. Air that is now contamination wil be pulled up the hot atrium.chimney and discharges it through the top openings. CLIMATE PREFERENCE: MODERATE AND COLD*		

STAFF EFFICIENCY

OVERVIEW

The efficiency of a medical staff results from multiple influences, some are architectural like the efficiency of the spaces the staff work in and others are outside of the realm of architecture like the miseducation of staff, poor communication, or the impact of social/cultural traditions. The research in the following section focuses on the architectural effects on the maternity staff. Three criteria will be discussed which will evaluate case studies and guide designs in later sections.

The first criteria, user circulation looks at the relationships between staff stations and patients through calculations and user flow analysis. Technical efficiency which considers multiple calculations such as bed turnover rates, occupancy rates, and average length of stay. The last criterion is an uncommon consideration when looking at staff efficiency and that is staff accommodations. In high stress environments, it is important to allow for spaces where staff can take a break from the hectic maternity atmosphere. Increasing staff efficiency can increase the patient's quality of care and result in better health outcomes.

USER CIRCULATION

There are many user flows that can affect the efficiency from the circulation of patients and staff to how information and supplies move throughout a facility. There is a clear correlation between the time taken to collect supplies and the time spent with a patient. In the context of Malawi, low staffing increases the need for efficient circulation.

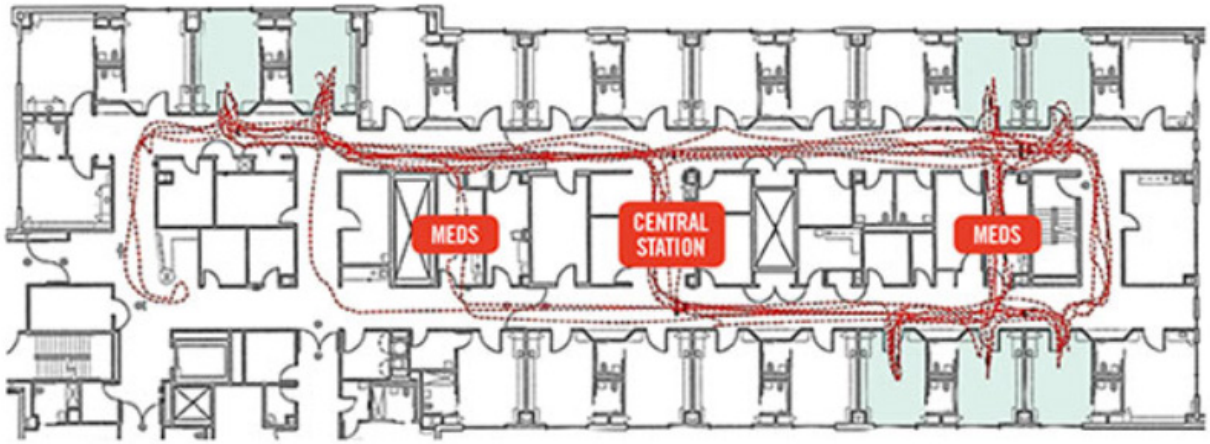
Long circulation paths tire staff overtime, reducing their effectiveness with patients. There is a strong relationship with the ward and facility typologies and the circulation of staff. Open wards typically have a shorter distance of travel than individual rooms. When evaluating user circulation paths, it is essential to understand the perspective of the of all users including the staff, patients, and visitors. By identifying inefficiencies and distractions in user flows, spaces can begin to be reevaluated and redesigned. Patient flow charts and staging diagrams will work as the tools to identify irregularities.

PATIENT ACCESS TO STAFF HUBS

The organization of patients in relation to nursing stations and other staff hubs is a main factor that impacts the flow and care of a health professional. Variations in centralized versus decentralized hubs have their own benefits to the design of a healthcare facility. Centralized stations showed medical staff accomplishing more administrative work than patient contact while decentralized nursing hubs show shorter interactions with health professionals. The distance traveled between patients and nursing stations will help create an understanding of how wards and nursing stations can be reorganized to shorten the distances across the whole facility. The incorporation of more staff hubs or the redesign of wards to increase views of patients are two potential solutions but further investigation at all levels should inform those decisions.

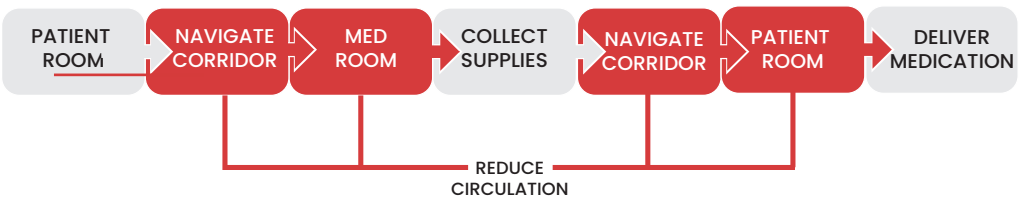
STEPS TO NEAREST NURSE STATION = DISTANCE BETWEEN PATIENT AND NURSE STATION (M) / .76 M

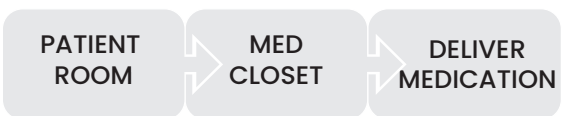
PATIENT TO STAFF RATIO = NUMBER OF STAFF / NUMBER OF PATIENTS



Circluation of a Nurse's eight hour shift.

CURRENT STATE





TARGET STATE

TECHNICAL EFFICIENCY

RATIOS & CALCULATIONS

Technical Efficiency is a measure of inputs and outputs to analyze the efficiency of a system. In healthcare settings, technical efficiencies primarily evaluate the number of patients coming in versus the number of patients leaving and how long their stay is. Technical efficiencies are important to the testing of a healthcare facility's proficiency, utilizing these methods will help draw conclusions of how architectural interventions can begin to increase technical efficiencies. There are four common calculations which gauge a healthcare facility's efficiency: average length of stay (ALS), bed occupancy rate (OOC), bed turnover rate (CRT), and the turnover interval (TL).

A study conducted in 2005 and 2006 evaluated Malawi's district hospitals both private and public to create a synthesis of the efficiency of the two different types of facilities. The private hospitals resulted with: ALS of 4.3 days, 34 BTR, and a 40 percent OCC. The Public Hospital results show: ALS of 3.8 days, 62 BTR, and 56.9 percent OCC. The numbers show similar results other than the bed turnover rate. One important factor to consider is the technical efficiency of a healthcare facility does not account for the quality of care a patient receives. For the public district hospitals, they have a higher bed turnover rate but that could be a result of low staffing and a higher need for space due to high patient populations.

Average Length of Stay (ALS) =

$$\frac{\text{Total Length of Stay for a Month}}{\text{No. of Admissions for the Month}}$$

Bed Occupancy Rate (OCC) =

$$\frac{\text{Admissions of } x \text{ Time X Avg Length of Stay}}{\text{Number of Beds X } x \text{ Time}}$$

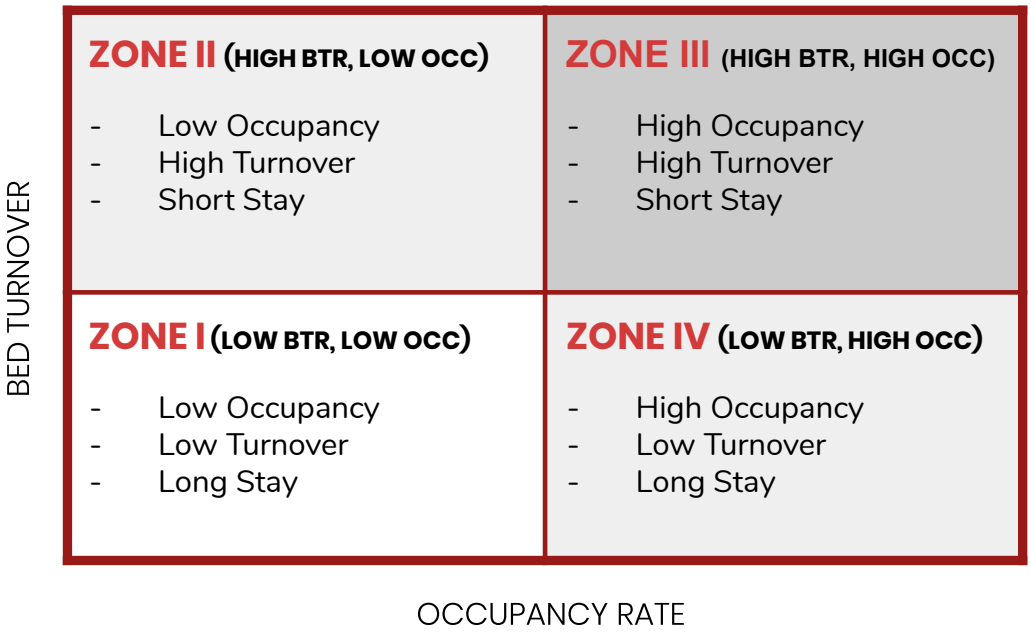
Bed Turnover Rate (BTR) =

$$\frac{\text{Total Patients Admissions}}{\text{Number of Beds}}$$

Turnover Interval (TI) =

$$\frac{365}{\text{BTR}} - \text{Average Length of Stay}$$

PABÓN LASSO (PL) TECHNIQUE



PABÓN LASSO (PL) TECHNIQUE

The Pabón Lasso Technique is a tool to synthesis the information collected through technical efficiency calculations by comparing the bed turnover rate and the occupancy rate. The method organizes the data collected into four different zones which categorize the facility to identify problem areas. The information is represented in a chart similar to the Punnett square for genetics. Zone I indicates a facility receiving the most inefficient facility with low occupancy and low turnover rates suggesting the scale of the facility may be too large. Zone II is an average efficiency rating showing short stays with low occupancy. Zone III is the most efficient showing high occupancy rates and high turnover rates showing high quantitative performance. Zone IV is similar yet opposite to Zone II, as an average ranking, Zone IV represents facilities with high occupancy with low turnover suggesting longer stays for more intensive care. The cross dividing the four zones is representative of the average occupancy and bed turnover rates of all the subjects evauluated.

The results from the District Hospital study showed most Malawian district hospitals ranking primarily in zone I, some in zone II, and a few in zone III. The high zone I ratings advises a need for change in how district hospitals are functioning. The Pabón Lasso technique is a useful device for the evaluation of case studies exemplary and existing along with future design proposals.

STAFF ACCOMODATIONS

STAFF FATIGUE

One criterion that is commonly overlooked in determining staff efficiency is staff accommodations and well-being. While the interactions between patients and staff is vital, those interactions are stressful situations which can negatively impact a professional's performance. Health professionals take on a considerable amount of physical, mental, and ethical strain. In Malawi, low staff populations result in overwhelming fatigue which has shown major declines in the efficiency of a professional's abilities overtime. Research shows slowed reaction times, diminished attention, compromised problem solving, reduced motivation, and decreased completion of tasks. The design and location of staff areas such as nurse stations, break rooms, and sleeping quarters impact the strain on the staff and how they regenerate.

REST AREAS

Areas for staff to rest vary on different programs but collectively have an impact on the well-being of the performance of the staff. Nurse stations are temporary rest areas between patients. While nurse station primarily serves as a workstation for administrative work, they also serve as the first location to escape the stress of patient contact. Break areas can include a variety of amenities for staff such as lockers, dining, kitchen, and lounge spaces. Even in western models, staff break rooms lack in comfort levels with low natural daylighting or access to natural views Well designed break room spaces are necessary to ensure staff a regenerative space where they can refocus from space like maternity wards where deaths are likely. The location of break room spaces should have various considerations in terms of location to patient spaces. Break areas need to be available enough that staff could respond to patient needs but separate enough to allow for a barrier. Most maternity wards in Malawi also include sleeping quarters for alternating staff, these spaces should be considerably more separate from the patient areas to allow for privacy and decreased noise levels.

INTERVIEWS

NAME: LINDA ROBINSON
Linda Robinson is a certified nurse midwife who taught at the Kamuzu College of Nursing in Malawi and is part of the Global Health Service Partnership, which is a partnership between SEED Global Health and Peace Corps

NAME: KAYLA HOLSTON
Kayla Holsten is pursuing an MD at Thomas Jefferson University and is particularly interested in improving patient and staff flow in understaffed health systems.

NAME: MEGHAN GANNON
Meghan Gannon is an assistant professor and research project manager at Thomas Jefferson University within the department of obstetrics and gynecology. She is working and advising Kayla Holston with her research.

NAME: DR. ZAYITHWA FABIANO
Dr. Fabiano a medical doctor by profession working in digital health innovation and health promotion. She was a Mandela Eisenhower Fellow at Drexel, and currently a research at Johns Hopkins research center in Blantyre Malawi.

NAME: STAFF AT QUEEN ELIZABETH HOSPITAL
Staff at QECH talk about the Midwives in the hospital. They are trained and safe practicioners to care for woman and family to ensure that woman can experience normal pregnancy. This interview was held by Chris Harnish

INTERVIEW: LINDA ROBINSON

ANTENATAL

Antenatal care appointments in Malawi happen once a month, and are more frequent towards the end of the pregnancy. There are no appointments, and all of the women come to the clinic on the specific day that the antenatal clinic is being held. Regardless of how many mothers show up, all of them are seen by noon, which means that women don't always get a very effective visit. In the health centres, antenatal care is terrible and women have little to no privacy. In District Hospitals, antenatal is typically not attached but often has more windows for light, more airflow, and doesn't smell as bad as health centres but rooms are still overcrowded.

LABOUR AND DELIVERY

Labour and delivery in health centres are simple and usually only have a single midwife who works all day and night, causing over working and exhaustion. Health centres have between 30-50 births in a month, depending on the density of the area it's in. However, in district hospitals, which Linda think function the best, they typically have 30-40 births a day and are decently staffed but all of the beds are typically full and women are left to sit on the floor or on a stretcher in the hall. Central hospitals have a lot of staff because they are often teaching hospitals but also have a lack of dignity; women aren't asked permission for things, and the daily rounds for staff and students often consist of surrounding a woman and talking over the woman to each other, not even addressing her presence. In some ways they are similar to district hospitals, where the patients have been referred to go there, but is often more efficient because they should already know why the patient is coming, making it easier to address the patients needs faster.

RECOVERY

In post-partum, women can hardly walk, don't sleep much, and are also trying be with their baby as much as possible. In this stage, the staff members give a health talk, to educate the new mothers. This means, however, that women have to cram together into a confined space and it is not helpful for infection control. Women also need to get examined, but the way in which they do this is inefficient. Women are to line up in the hall and sit on the floor to wait to be examined, whether they gave birth naturally or had a c-section. The layouts of the buildings are designed for the convenience of the practitioner, not the patients. The hallways are confusing and disorienting for patients to find their way back to their beds, and the facilities are just not designed for the number of women that go there today.

+

In addition to the maternity processes, Linda mentioned that the best way to prevent infections is washing and stressed the importance of the location and access to sinks. Another major issue brought up was the unnecessary amount of surgeries that take place. These unnecessary surgeries increase the risk of problems and infections, but are often done due to the quickness compared to a natural birth so that beds can be flipped for the next patient.

INTERVIEW: KAYLA HOLSTON + MEGHAN GANNON

QUALITY OF CARE

Dignity / privacy in maternity wards is a topic of concern to patients and staff, but is also hardly addressed due to other issues, like staff shortages and a lack of resources. There were two major questions that were raised in the interview around the topic of privacy / dignity. The first question was: Is paternal participation a dignity / privacy issue and how might we test for these issues? However, if paternal participation in the process is going to happen, there has to be an increase in square meters so that there is space for the additional guests. The second question was: Anticipating that the current conditions in the facilities is that is there no privacy, how do we go about by improving the problem? In order to understand the problem, Kayla suggested to address these issues by starting with patient satisfaction surveys about confidentiality and privacy.

INFECTION CONTROL

As for infection control, Kayla and Meghan both mentioned that there are many spatial things things that we as designers could consider in order to keep the number of infections as low as possible. Some things to consider spatially include; hand washing stations locations and access, the placement of latex gloves and hand sanitizer stations, the lighting in the various types of spaces, where personal belongings of the patients are kept. However, with things like hand washing stations, some things to consider are infections that can happen through the sharing of the same plumbing system and a lack of upkeep for the plumbing. Another major issue brought to our attentions was the waste that is created and how to deal with it in an architectural way like where it's placed, how it's contained, and the distance people have to travel to it.

STAFF EFFICIENCY

Staff efficiency is a big issue in health care facilities in Malawi since they patient to staff ratio is relatively poor, and there are staff shortages frequently. In order to improve the efficiency of the staff that are there, things to consider moving forward are the flow of the mothers and nurses, the staff member's routes, what they need to accomplish, and how many patients an average nurse sees in a day. Architecturally, interventions can be done in order to improve the efficiency of staff and their routes by making every step of the process that the staff needs to complete be virtually impossible to mess up. For instance, the placement of charts, hand washing stations, and chart drop off locations so that they are within the staff's route so it is not out of the way and they need to walk past it to get to where they are going.

INTERVIEW: STAFF AT QUEEN ELIZABETH HOSPITAL

POLICIES

- *Malawian midwives belong to a midwife association and they get their definition from the international affiliation of midwives and they prescribe appropriate competences that they need to acquire in order to be called midwives as practitioners*
- *ICM prescribes who is a midwife, training, and competencies they need, what skills students should have, what a delivery suite should look like, etc.*

DELIVERY WARD

- *Promotling infection prevention and hand washing is very important*
- *Hand washing basins are there so that after any procedure you need to wash your hands. Going from one patient to another you need to wash hands*
- *Important to keep the environment clean so they need cleaning resources for the room and regular cleaning*
- *Waste management - another important area*
- *How can we manage the waste in the delivery suite after delivery and how to dispose of the waste being produced*
- *Some needs incinerated*
- *Infection prevention buckets are needed for wet waste, dry waste, etc.*

MIDWIVES

- *Antenatal - need a triage area where the assess patients to see if they need immediate attention*
- *After assessment, if the woman is in labour she will go to the prenatal room, where there are 1-2 midwives monitoring the patients*
- *After assessing the woman in the prenatal room, if she is in active labour the woman gets moved to the delivery suite*
- *Delivery unit needs 1-2 midwives (there's 2 beds)*
- *Normal ratio is 1:4 (patient to staff ratio) but they might need 1:1 ratio*
- *Teaching area*

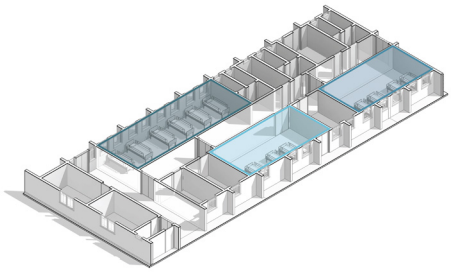
SLUICE

- *Could use more facilities / money to buy things, they don't know where to place things like waste management*
- *Desperately needs storage*
- *Have ropes hanging from windows to bars above your head in order to put linens to dry (if it's raining outside)*

PRENATAL

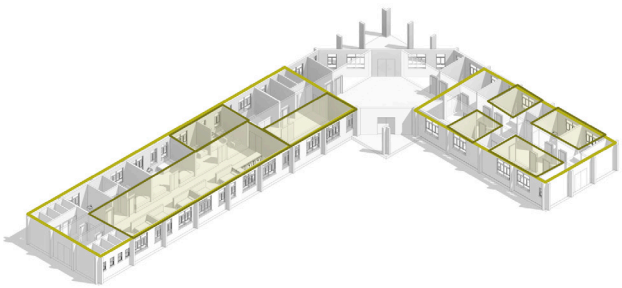
- *Low-risk area, high risk Is separated into a different side of the hospital*
- *No surgery space in the future for the low-risk side*
- *90% of women deliver normally, 10% have complications*
- *Try to promote the normal course of delivery otherwise they will start depending more on the medicalization of medicines and that should not be the case*
- *Promote the natural birth process in the low risk unit*
- *Rate of c-sections is climbing; Results in many complications Is expensive*
- *Space consuming / time consuming*
- *It is a teaching hospital - lots of schools send students there so they need to provide students with a variety of types of care, even natural birth*
- *Typically have about 30 deliveries in a single day*

SYNTHESIZED CASE STUDIES



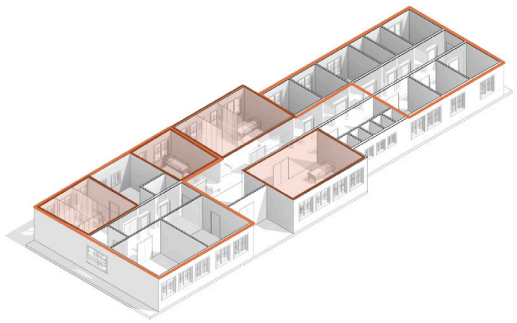
LEVEL: HEALTH CENTRE

Anchor Farms
Location: Santhe - Central Region
Built: 2016
Catchment Population: 29,210
Maternity Bed Capacity: 6
Average Length of Maternal Stay: 1-2 Days
(see page ## for full case study analysis)



LEVEL: DISTRICT HOSPITAL

Domasi District Hospital
Location: Domasi - Southern Region
Built: 2018
Catchment Population: 105,000
Maternity Bed Capacity: 12
Average Length of Maternal Stay: 2-4 Days
(see page ## for full case study analysis)



LEVEL: CENTRAL HOSPITAL - LOW RISK

Queens Elizabeth Central Hospital
Location: Blantyre - Southern Region
Built: ---
Catchment Population: + 6 million
Maternity Bed Capacity: 8
Average Length of Maternal Stay: 7-16 Days
(see page ## for full case study analysis)

CASE STUDY: ANALYSIS

QUALITY OF CARE	INFECTION CONTROL	STAFF EFFICIENCY
Privacy: There is very little privacy in this scheme, since most rooms are open with several beds, leaving women very exposed. *Dignity: There is a lack of dignity that is preserved when there are no boundaries between patients, resulting in unnecessary exposure and a breach of confidentiality.* *Paternal/Guardian Involvement (Do they have space): The design does allow for much space for family members or guardians, creating crowded rooms with no separation of space.*	*Wash Stations: There are 14 hand washing stations and 15 beds in the maternity ward leaving almost a 1:1 ratio which is desirable.* *Infection Hotspots: Most infection hotspots are located within public areas where various patients would cross paths, like restrooms and the waiting area, but also in the delivery suite and postnatal room where patients are fairly close together and most vulnerable.* *Ventilation/Daylighting: The double loaded corridor layout allows for natural light within rooms on exterior walls, however there is little to no natural light in the corridor itself. This also prevents effective airflow throughout the spaces, when every room is isolated.*	*User Circulation/Access to Nurse Station: The nurse's station is fairly centralized within the maternity ward. The scheme is designed for staff efficiency rather than patient efficiency.* *Pablo Lasso Zones (Turnover Rate/Bed Availability): Zone 2 due to relatively low occupancy compared to district / central hospitals, but patients stay for very short periods of time resulting in a high turnover rate.* *Staff Satisfaction: As seen through walking distance and efficiency, staff are able to get to where they need to be in a short amount of steps, but patients are not able to receive the desired amount of privacy.*
Privacy: privacy is handled well in each ward. Privacy is more seen in delivery and recovery as opposed to prenatal ward which makes sense. *Dignity: is preserved and is evident in the programmatic division of spaces and beds to allow room for staff and patients* *Paternal/Guardian Involvement (Do they have space): isn't any designated space for guardians in prenatal and recovery. There is however more room in delivery because its individualized rooms.*	*Wash Stations: There are 18 washstations and 22 beds. This is keeping in mind that recovery wards have one sink per 4 beds. Every room has at least one sink which is desirable.* *Infection Hotspots: In this scheme, there is almost one sink in every location where there are hotspots which works. It would be convenient to have washstations in the waiting if possible.* *Ventilation/Daylighting: double loaded corridors make it difficult for lighting to access corridors except for the recovery room. Ventilation works better in this scheme than the health centre because doors are directly parallel to windows.*	*User Circulation/Access to Nurse Station: The ability to have two nurse's stations work well in the L typology ward because one strip can be handled by one station and the other end can be handled separately.* *Pablo Lasso Zones (Turnover Rate/Bed Availability): Zone 3 due to very high occupancy rates and ample amount of delivery spaces and availability of surgery theater that helps turnover rates.* *Staff Satisfaction: As seen through walking distance and efficiency, staff are able to get to where they need to be in a short amount of steps while maintaining privacy for patients and separation of selected program which is beneficial.*
Privacy: There is very little privacy in this scheme, since most rooms are open with several beds, leaving women very exposed. *Dignity: There is a lack of dignity that is preserved when there are no boundaries between patients, resulting in unnecessary exposure and a breach of confidentiality.* *Paternal/Guardian Involvement (Do they have space): The design does allow for much space for family members or guardians, creating crowded rooms with no separation of space.*	*Wash Stations: There are 14 hand washing stations and 15 beds in the maternity ward leaving almost a 1:1 ratio which is desirable.* *Infection Hotspots: Most infection hotspots are located within public areas where various patients would cross paths, like restrooms and the waiting area, but also in the delivery suite and postnatal room where patients are fairly close together and most vulnerable.* *Ventilation/Daylighting: The double loaded corridor layout allows for natural light within rooms on exterior walls, however there is little to no natural light in the corridor itself. This also prevents effective airflow throughout the spaces, when every room is isolated.*	*User Circulation/Access to Nurse Station: The nurse's station is fairly centralized within the maternity ward. The scheme is designed for staff efficiency rather than patient efficiency.* *Pablo Lasso Zones (Turnover Rate/Bed Availability): Zone 2 due to relatively low occupancy compared to district / central hospitals, but patients stay for very short periods of time resulting in a high turnover rate.* *Staff Satisfaction: As seen through walking distance and efficiency, staff are able to get to where they need to be in a short amount of steps, but patients are not able to receive the desired amount of privacy.*

RESEARCH CONCLUSIONS

QUALITY OF CARE (QOC)
(PRIVACY + DIGNITY)

- Quality of care means that healthcare must be safe, effective, timely, efficient, equitable and people-centred.
- A lack of beds and staff members leads rooms to be open and no privacy for patients.
- The physical comfort, privacy and confidentiality of a patient influences the dignified care they receive.

INFECTION CONTROL
(SANITATION, PREVENTATIVE STRATEGIES)

- 20% of maternal mortality in Malawi is caused by infections which are avoidable
- Of all infection prevention strategies, the most effective in addressing infection at health facilities is hand hygiene
- Of all ventilation types, double-loaded corridors are not recommended for infection control and natural ventilation is preferred over mechanical in climates like Malawi

STAFF EFFICIENCY
(STAFF/PATIENT INTERACTION +CIRCULATION)

- Factors of staff efficiency include circulation, access to nurse stations, technical efficiencies such as bed turnover rates, and staff satisfaction.
- All health facilities should strive for a Pabon Lasso Zone III rating, achieving high turnover and high occupancy rates.
- Facilities designed to enhance staff performance without a focus on staff comfort levels can show cases of fatigue for staff, decreasing their efficiency in the field.

CASE STUDY CONCLUSIONS

Health Centre
Anchor Farms Case Study Conclusion:

The double loaded corridor layout is efficient for staff in the programmatic distribution of space because it allows for a fairly centralized nurse's station with quick access to all areas of the maternity ward. This scheme could improve through better ventilation strategies and daylighting strategies to prevent hospital acquired infections.

District Hospital
Domasi Hospital Case Study Conclusion :

The L shape scheme for this maternity ward is efficient in the programmatic distribution of space because it allows delivery to be separate from prenatal and recovery but still provides nurse's station access points on both wings. This scheme could improve through better ventilation strategies which can be applied in the roof design.

Central Hospital
Queen Elizabeth Hospital Case Study Conclusion :

The double loaded corridor is efficient in terms of programmatic distribution and circulation between wards. The scheme could improve with better accessibility to the patients through a centrally located nursing station and increased sanitation stations in general.

GENERAL DESIGN GUIDELINES

QUALITY OF CARE (QOC)
(PRIVACY + DIGNITY)

- Provide a type of partition between patients to increase their privacy and confidentiality.
- Provide the proper amount of space for patients, family members and staff to be in
- Avoid open room layouts in labour and delivery wards to increase paternal involvement

INFECTION CONTROL
(SANITATION, PREVENTATIVE STRATEGIES)

- Have at least 1 sink/washbasin for every 4 beds in one bay, ward, or room
- Provide separate wash stations for hand washing and for everything else such as cleaning, laundry, etc.
- Avoid double loaded corridors; instead opt for roof designs that allow for improved natural ventilation
- Minimize travel distance for critical patients to avoid spread of infection

STAFF EFFICIENCY
(STAFF/PATIENT INTERACTION +CIRCULATION)

- Evaluate the needs of the staff and patients based off of patient to staff ratios
- Accommodate facility populations with properly scaled spaces to increase bed turnover and bed occupancy rates, striving for a Zone III Pabon Lasso rating.
- Staff accommodations should incorporate natural lighting and natural views to reduce stress levels

PROGRAM DESIGN GUIDELINES

ANTENATAL

- Must have access to sink and toilet
- Provide more private space for patients to provide more personal information
- Space should be flexible when not utilized
- Must be allow for education programs to occur to large audiences

PRENATAL

- Privacy isn't too critical in this phase; can allow for more open ward typologies
- Access to sink (recommended) and bathroom (if possible)

DELIVERY

- Privacy is very critical at this phase; accommodate ways to shield patients from view of other patients
- Must be very accessible from nurse's station
- Must have access to sink and toilet
- Must meet minimum requirements for bed spacing

RECOVERY

- Privacy isn't so critical; half-walls can be used to provide some level of privacy
- Must have space for guardians (recommended), family members (if possible), and students/researches (spec. for Central Hospitals)
- Availability of Isolation Rooms/wards for any women recovering who finds out they have an infection
- Must have access to sink and toilet
- Must have view of all patients from nurse station since it is the most critical phase
- Spaces should be ordered to allow for examination without the patient moving multiple times

SURGERY

- Surgery should not be separate from maternity ward as much as possible
- Must have recovery room for post-op patients separate from maternity recovery ward

NURSE STATION

- Must have easy access and views to all stages of maternity (multiple stations can relieve a singular station)
- Centralized or Decentralized organizations should be determined on a case to case basis.

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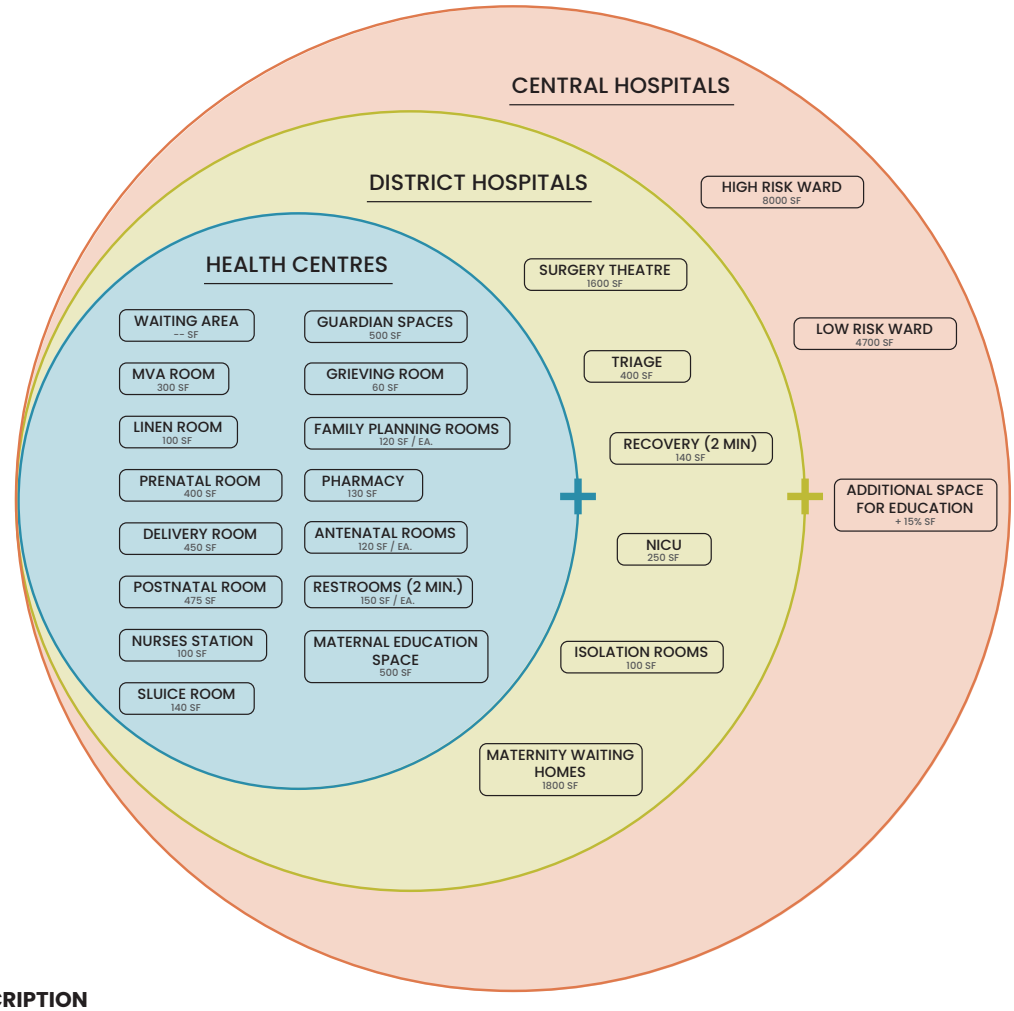
SCHEMATIC DESIGN

- This portion of this book discuss the program needs for maternity facilities in health centres, district hospitals, and central hospitals. We categorized the programs into adjacencies in order to see which spaces need to be close or far from each other.
- We developed a kit of parts where we designed each program space, from wards to support spaces. These individual components will be used as we design our proposed maternity facilities.

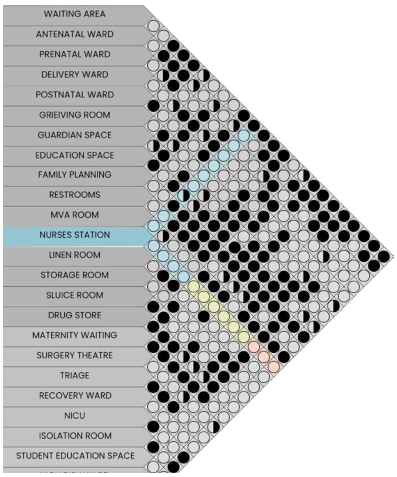
MATERNITY PROGRAM



DESCRIPTION

The diagram above shows the spatial differences between the three tiers of healthcare facilities. While moving from low risk, to higher risk patients, from the health centre tier up to a central hospital, each facility increases in size with the added programmatic elements. The blue represents all of the components found within a maternity ward at a health center level. The blue plus the green show the programmatic elements that make up a district hospital, and the blue, green and orange together represent the components that make up a central hospital.

PROGRAM ADJACENCIES



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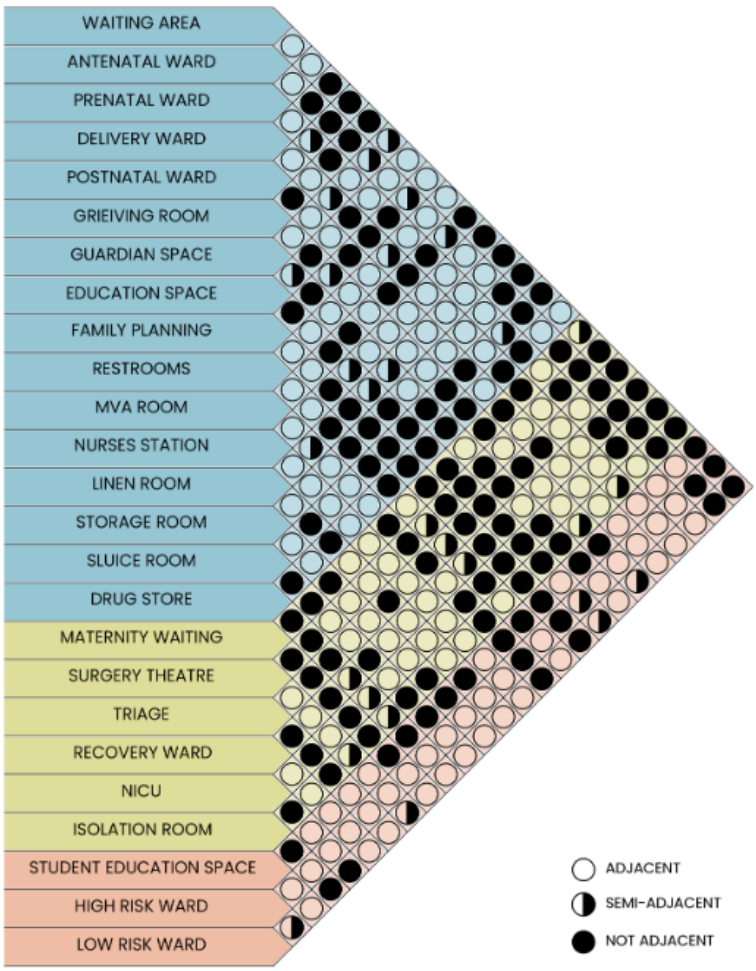
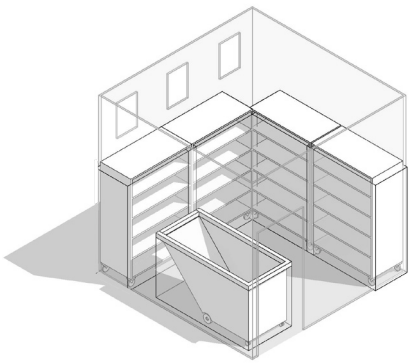


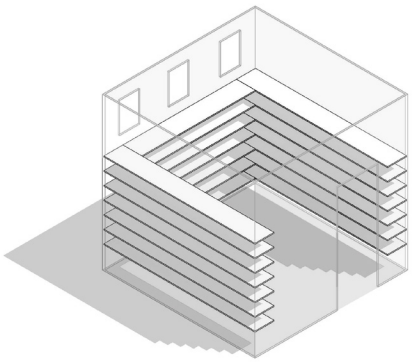
DESCRIPTION

We identified program adjacencies across the three levels of care. Some programs were applicable across all levels while some components only related to one or two. We found that the high levels included all programs of lower levels with an increase in scale and complexity at each level.

SUPPORT SPACES



LINEN ROOM TYPE 1
100 SF
9 SQ M



STORAGE ROOM TYPE 1
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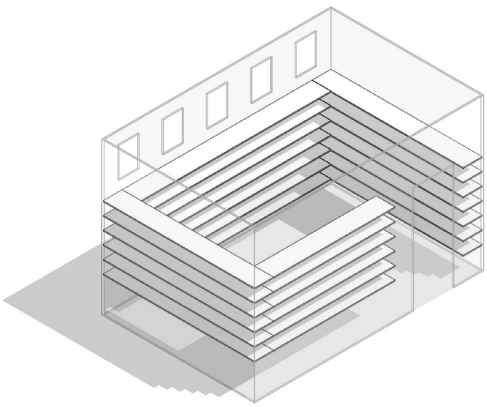
9 SQ M



STORAGE ROOM TYPE 2
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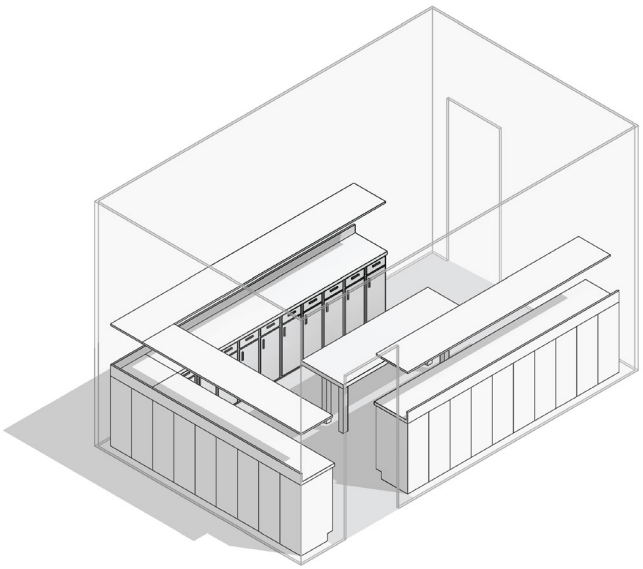
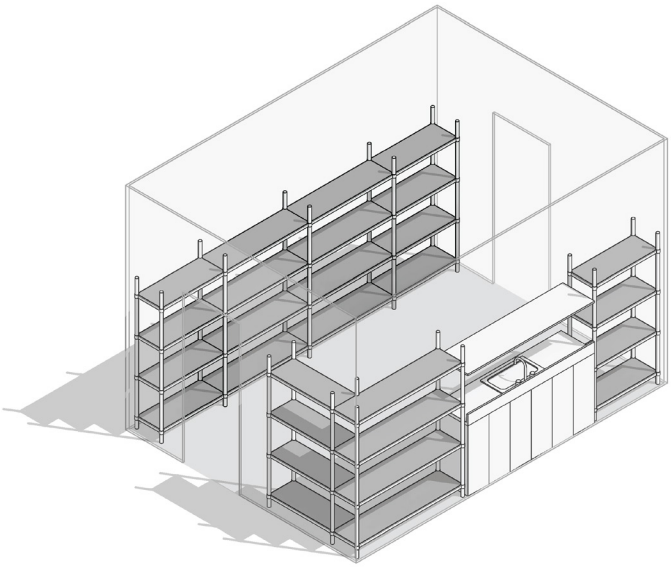
14 SQ M



PHARMACY
135 SF
13 SQ M



SLUICE ROOM
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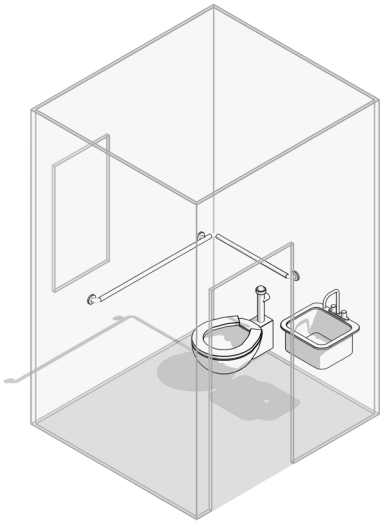
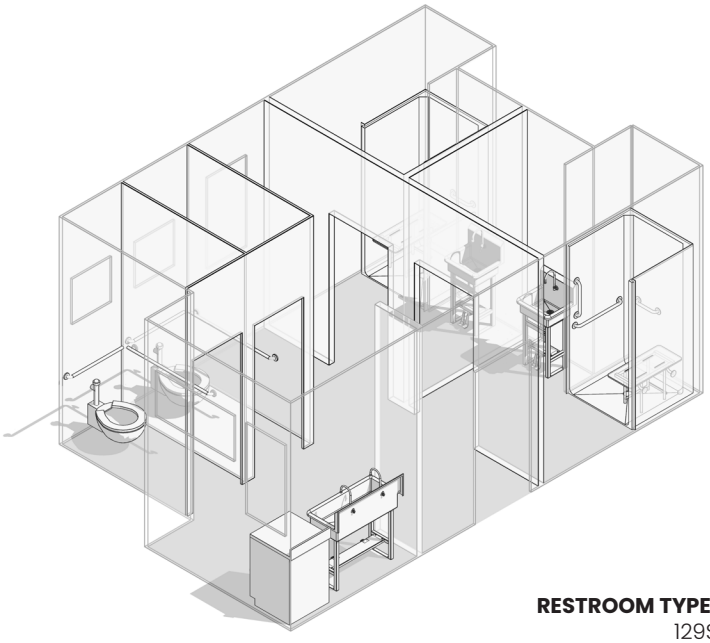
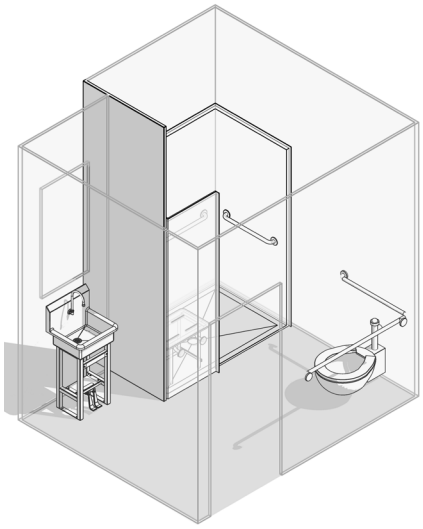
13 SQ M



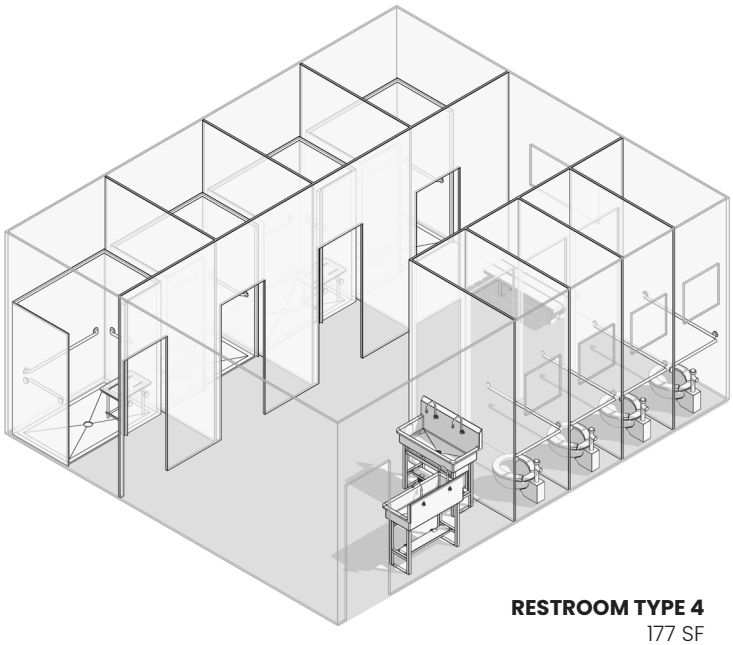
RESTROOM TYPE 1
40 SF
4 SQ M



RESTROOM TYPE 3
129SF
12SQ M



RESTROOM TYPE 2
68 SF
6 SQ M



RESTROOM TYPE 4
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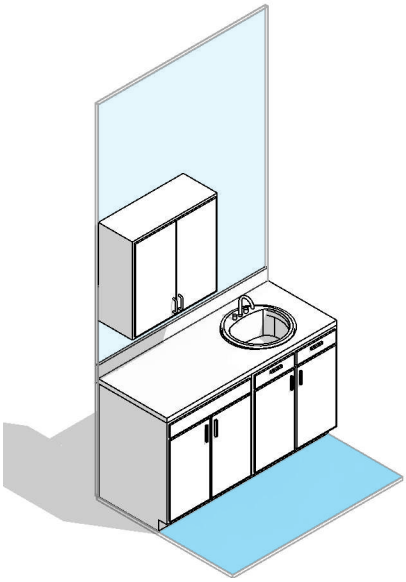
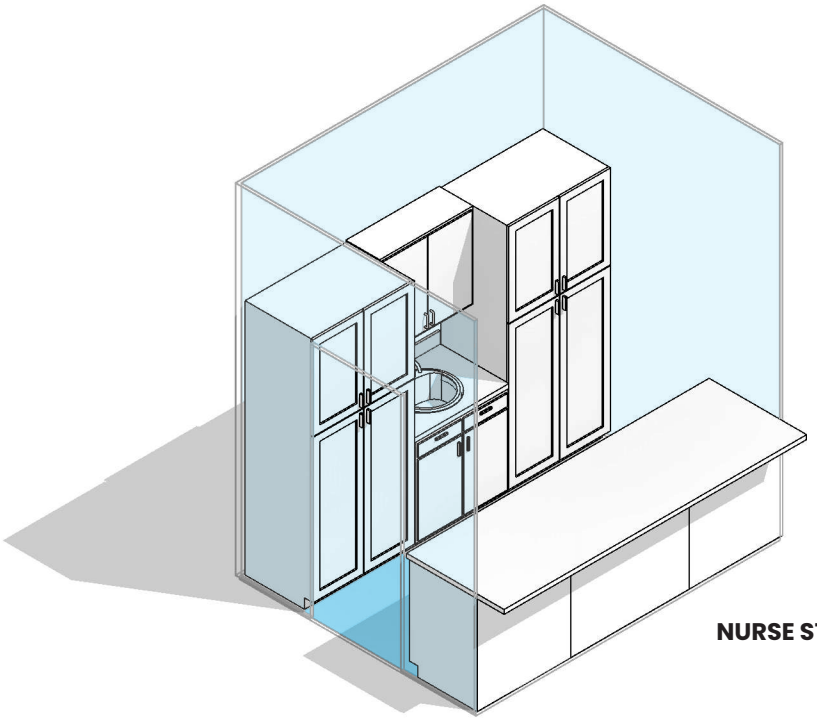
16 SQ M

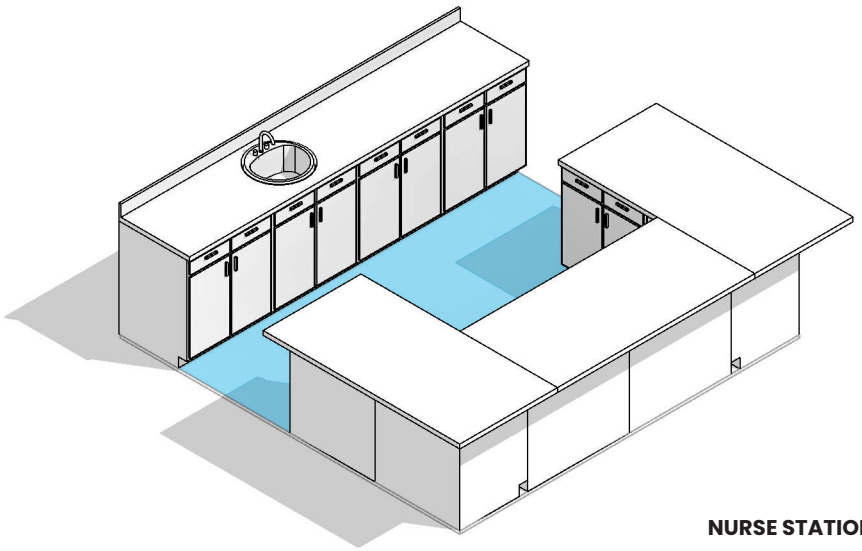
NURSE STATIONS



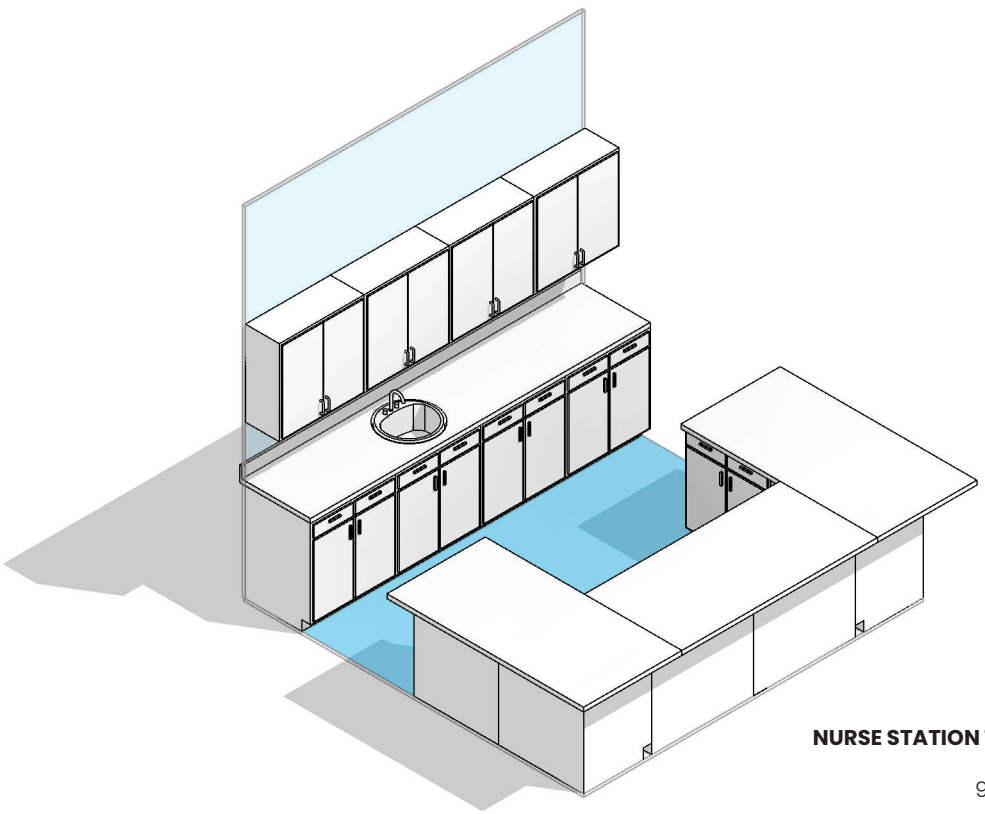
NURSE STATION TYPE 3
20 SF
1.8 SQ M



NURSE STATION TYPE 4
60 SF
5.5 SQ M

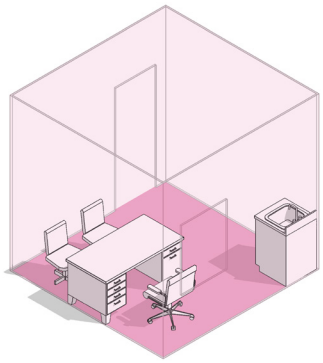


NURSE STATION TYPE 1
100 SF
9 SQ M

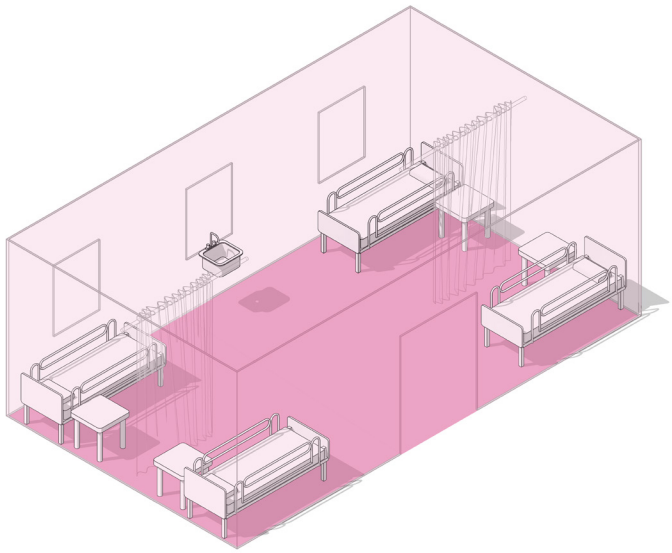


NURSE STATION TYPE 2
100 SF
9 SQ M

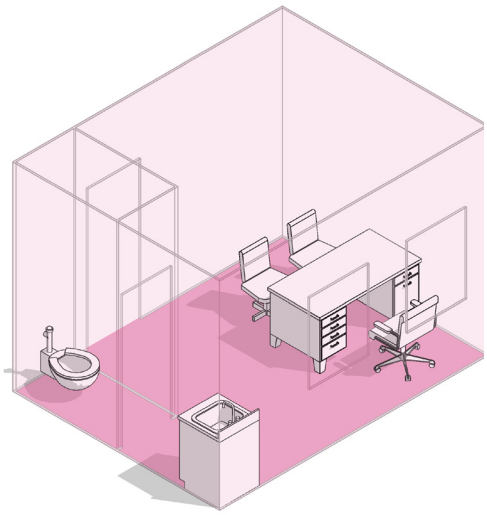
ANTENATAL TYPES



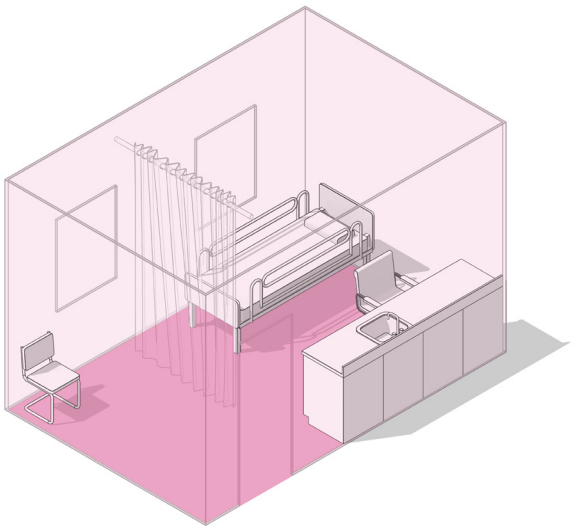
FAMILY PLANNING
100 SF
9 SQ M



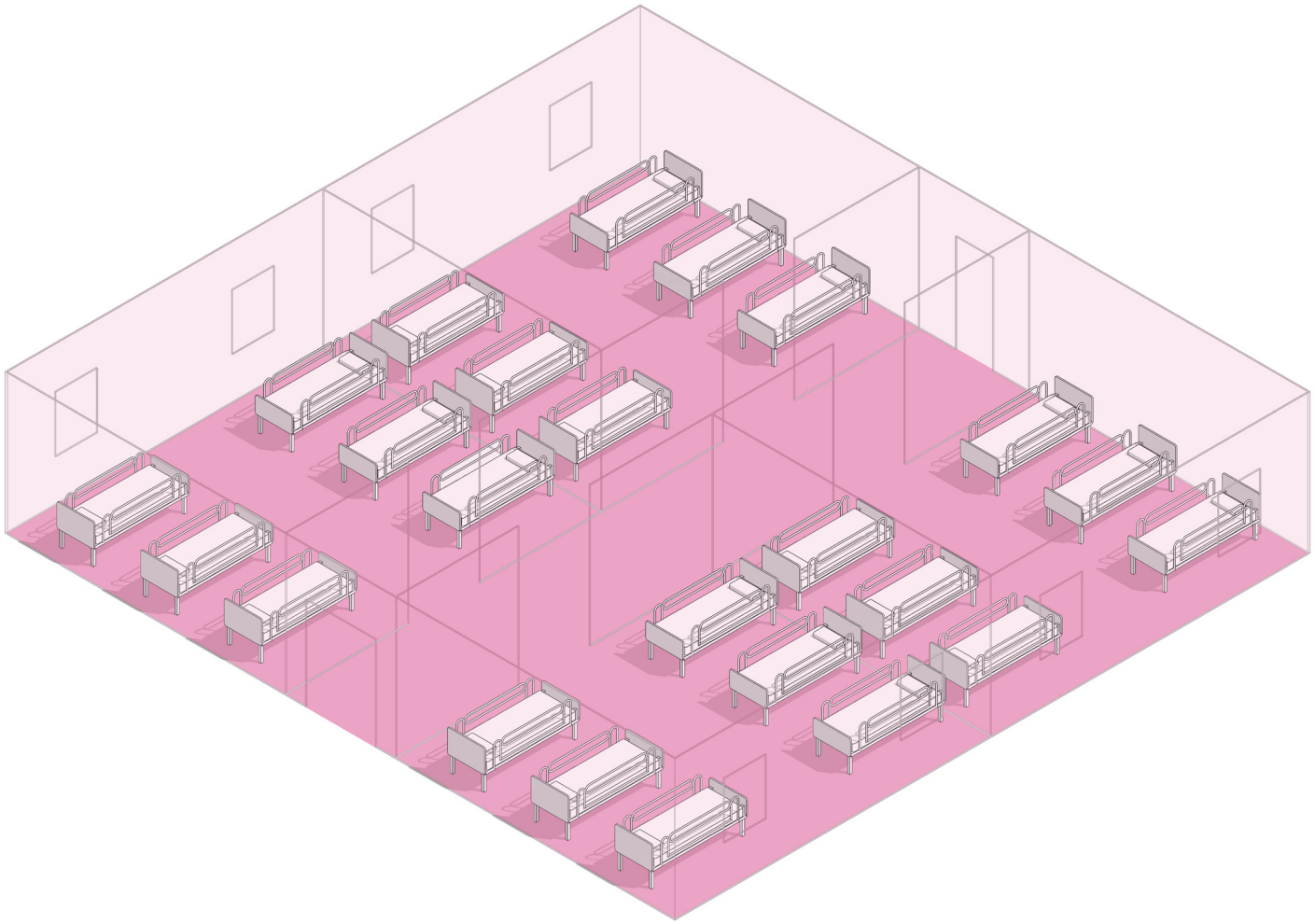
TRIAGE
400 SF
371 SQ M



MVA ROOM
150 SF
14 SQ M

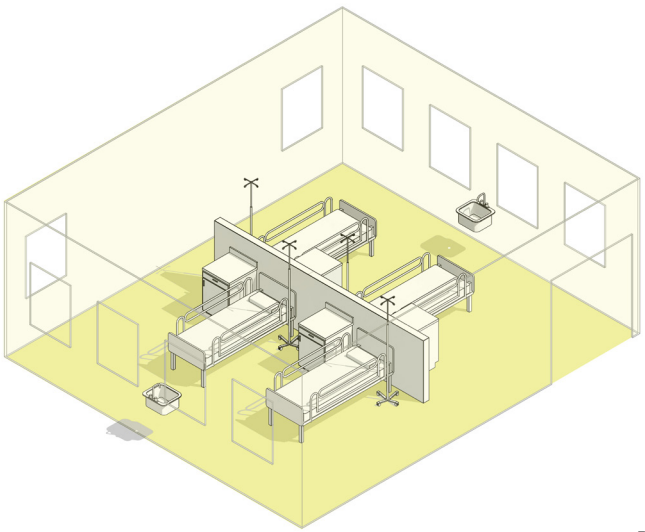


TRIAGE
122 SF
11 SQ M

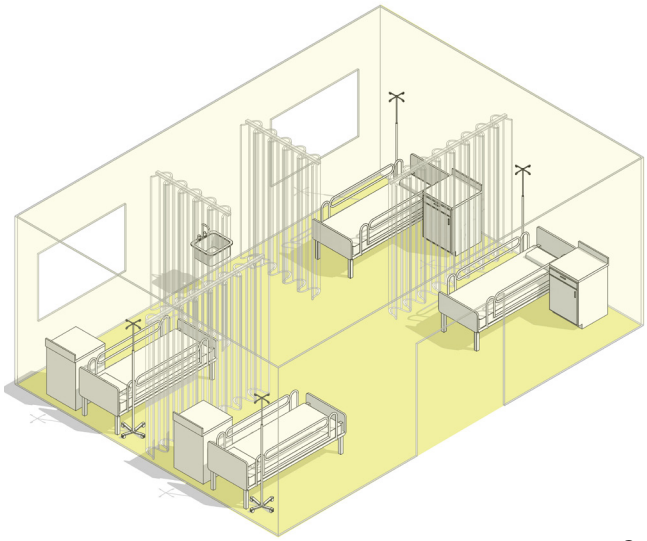


MATERNITY WAITING HOMES
1800 SF
167 SQ M

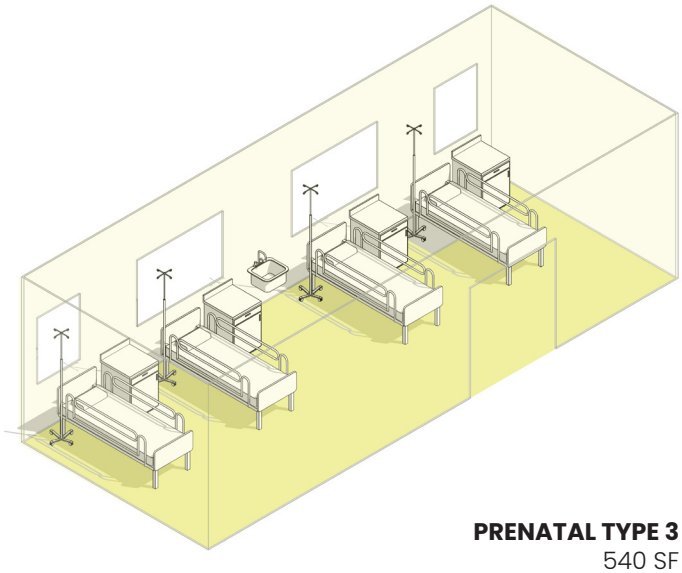
PRENATAL TYPES



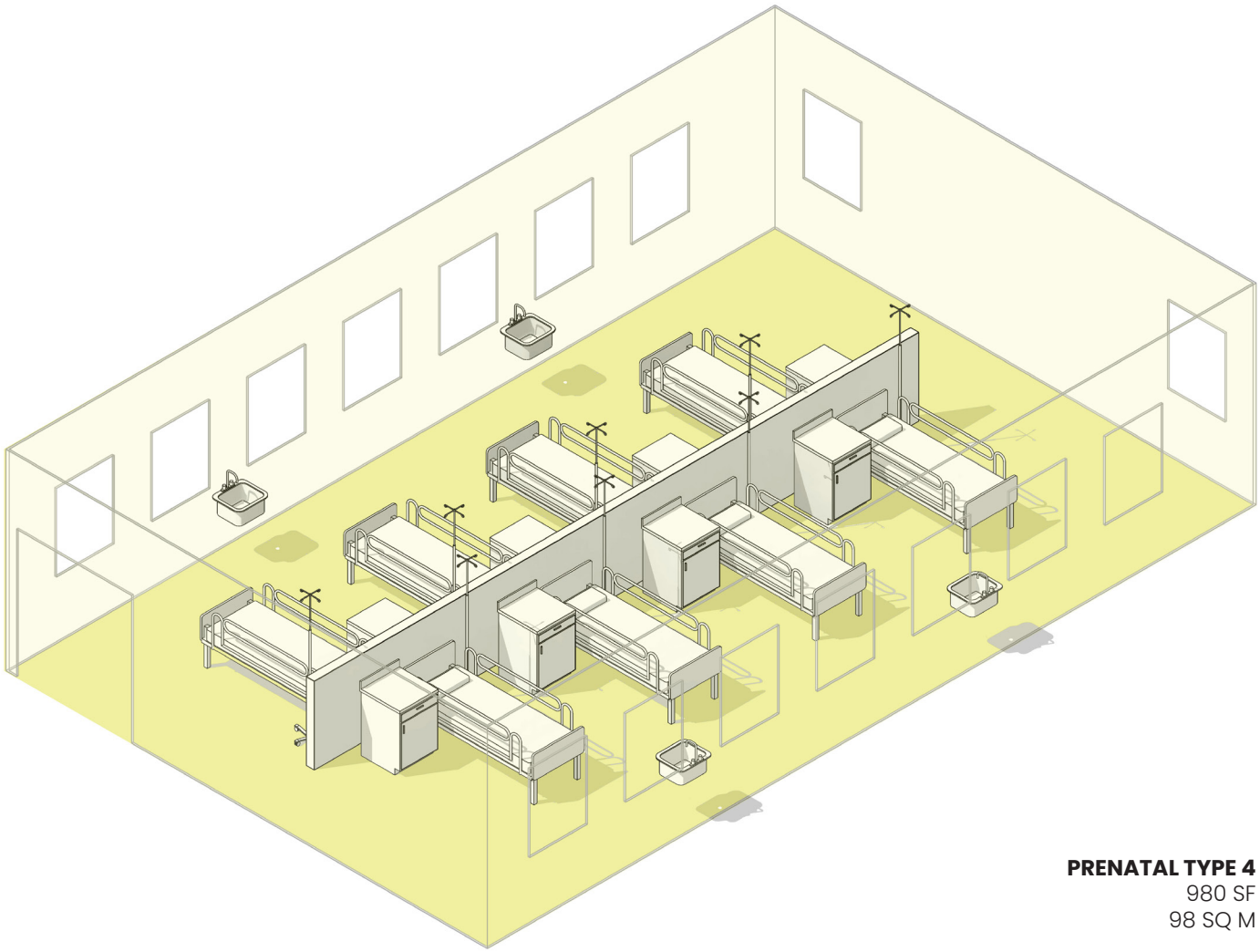
PRENATAL TYPE 1
423 SF
42 SQ M



PRENATAL TYPE 2
446 SF
44 SQ M

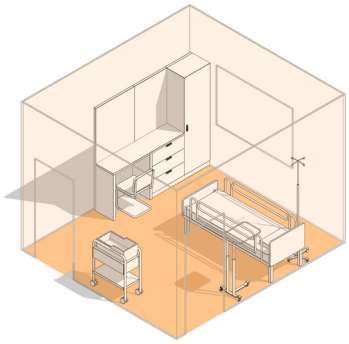


PRENATAL TYPE 3
540 SF
54 SQ M

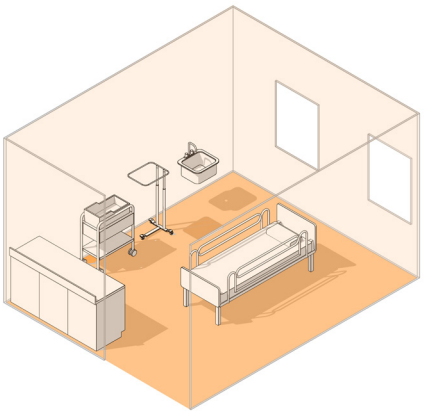


PRENATAL TYPE 4
980 SF
98 SQ M

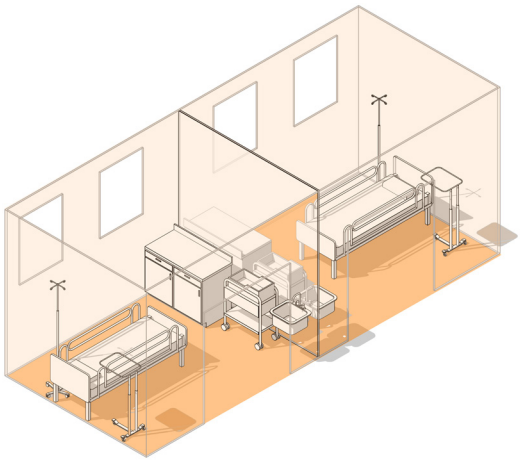
DELIVERY + SURGERY TYPES



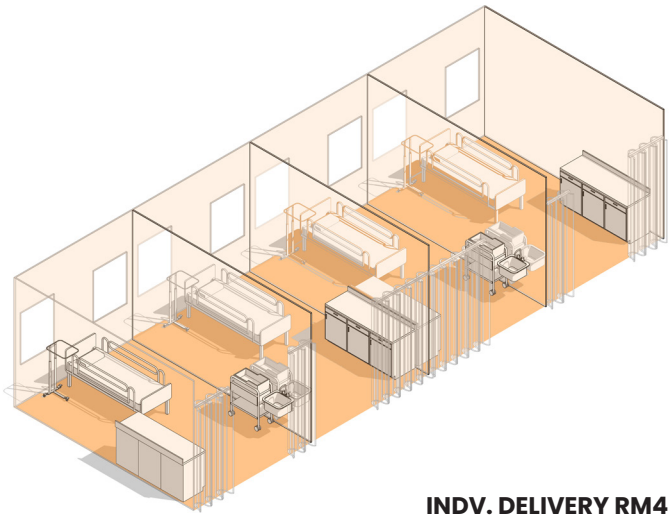
INDV. DELIVERY RM 1
150 SF
15 SQ M



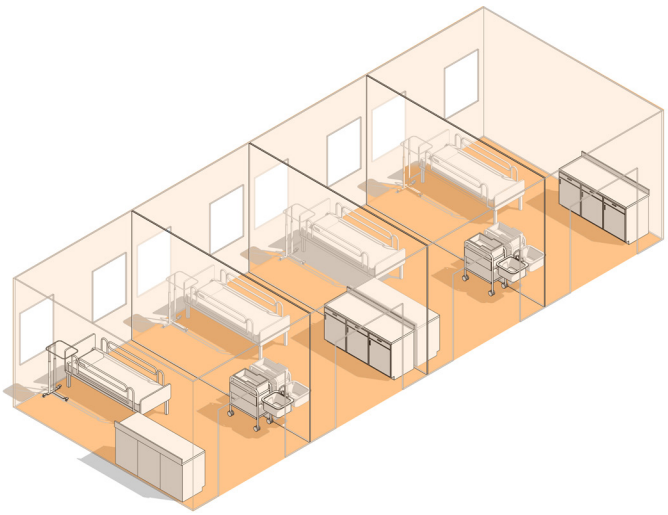
INDV. DELIVERY RM 2
205 SF
20 SQ M



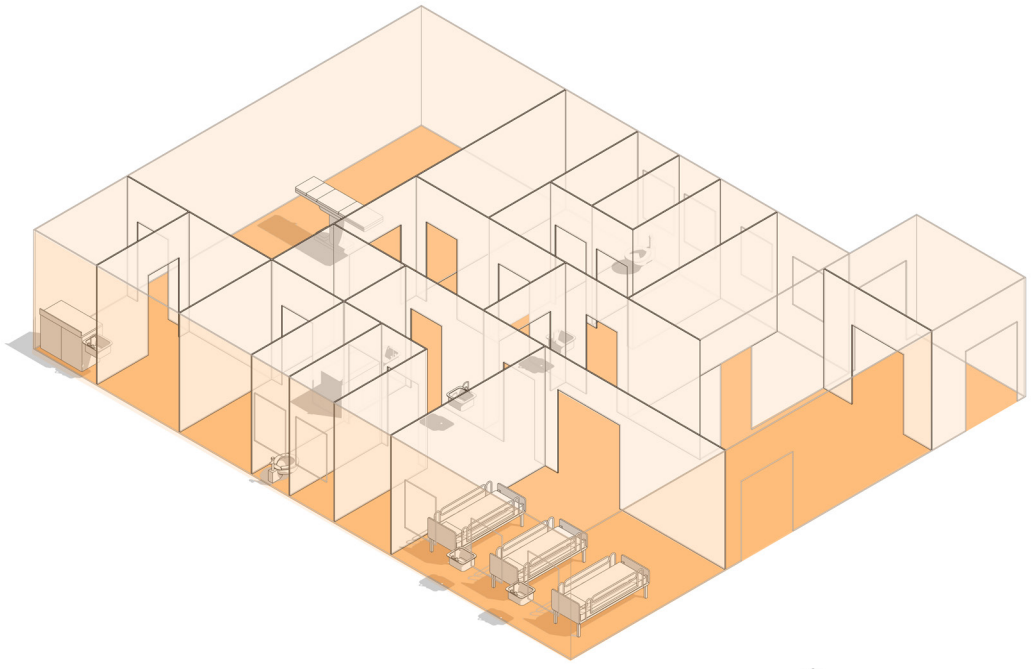
INDV. DELIVERY RM 3
120 SF
12 SQ M



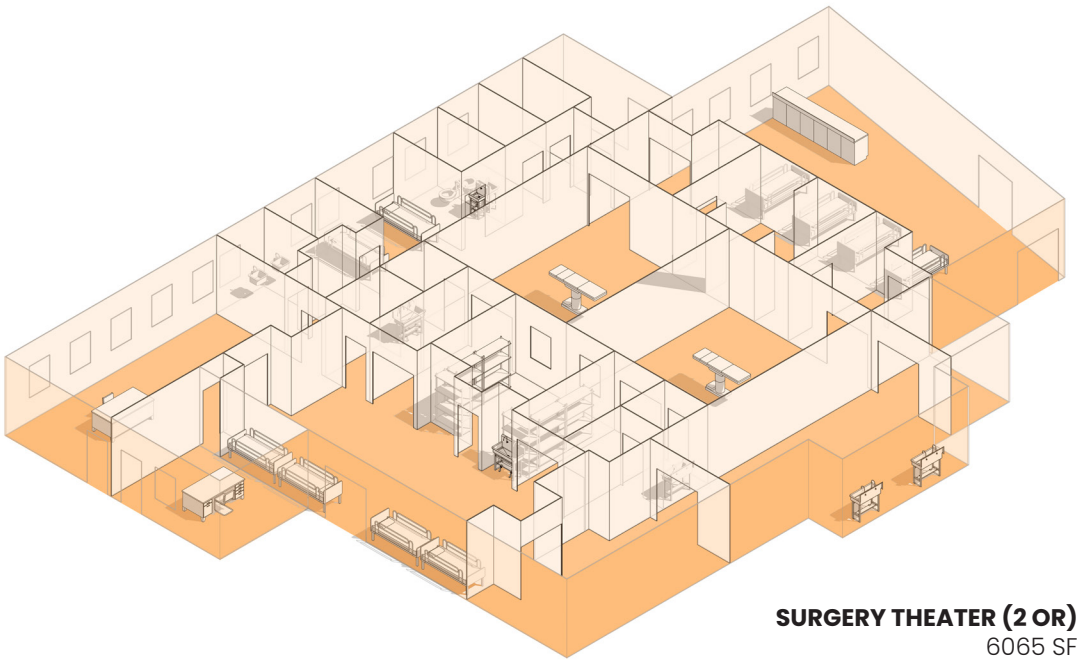
INDV. DELIVERY RM4
165 SF
16 SQ M



INDV. DELIVERY RM 5
165 SF
16 SQ M

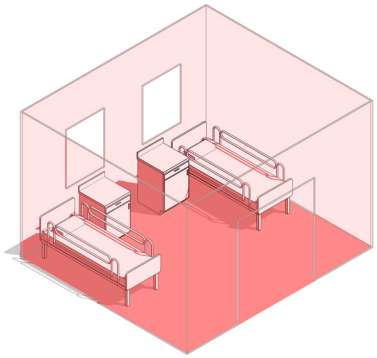


SURGERY THEATER (1 OR)
2018 SF
201 SQ M

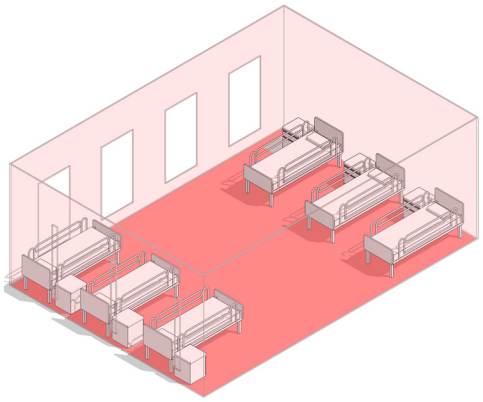


SURGERY THEATER (2 OR)
6065 SF
605 SQ M

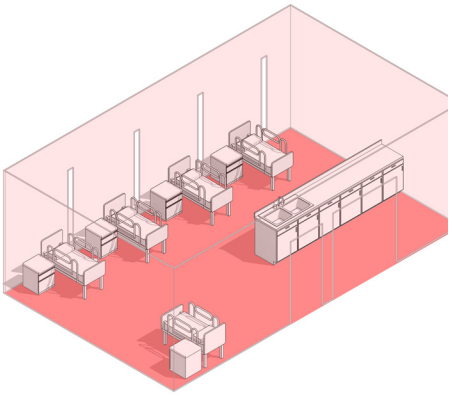
RECOVERY + POSTNATAL TYPES



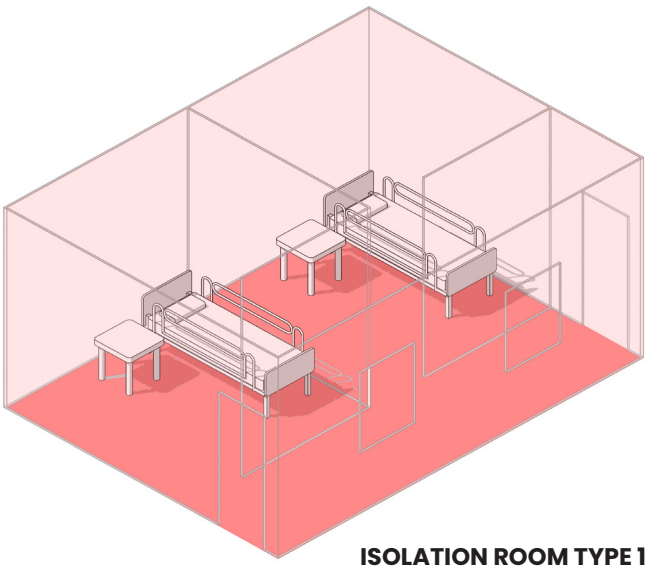
RECOVERY ROOM
186 SF
18 SQ M



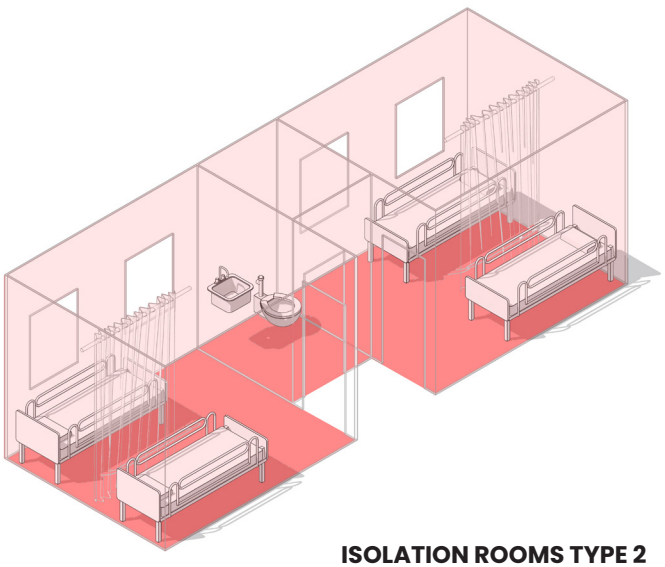
KANGAROO CARE
476 SF
47 SQ M



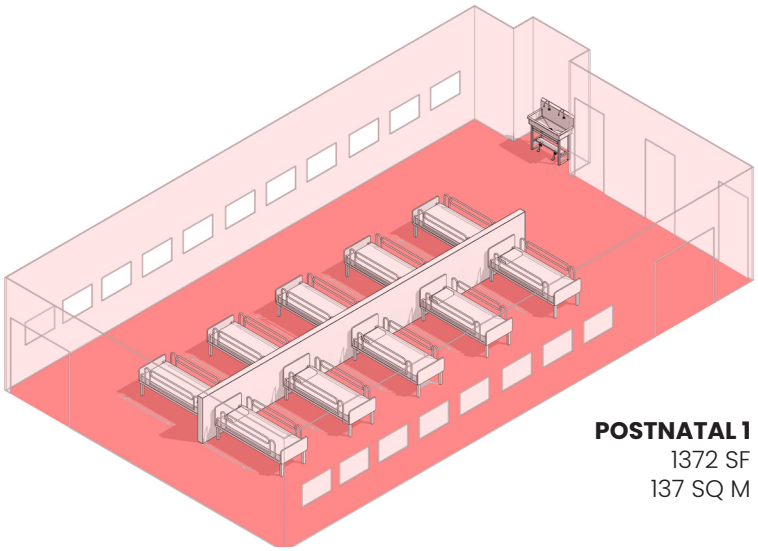
NURSERY
428 SF
43 SQ M



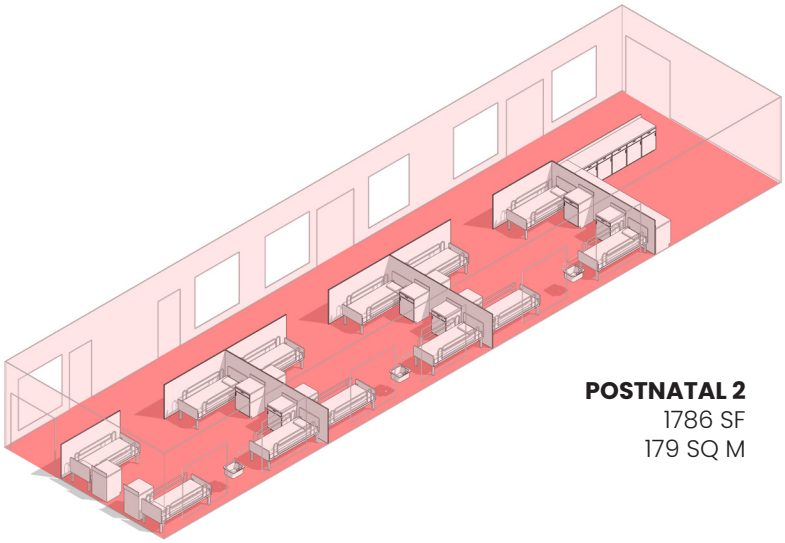
ISOLATION ROOM TYPE 1
476 SF
47 SQ M



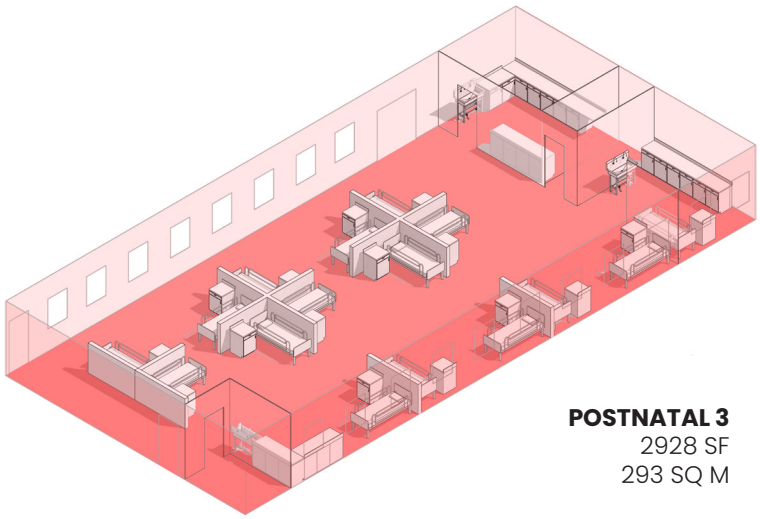
ISOLATION ROOMS TYPE 2
300 SF
30 SQ M



POSTNATAL 1
1372 SF
137 SQ M

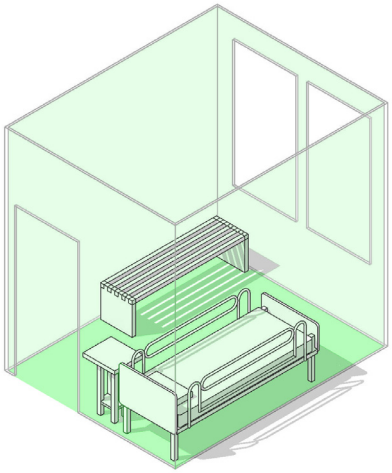


POSTNATAL 2
1786 SF
179 SQ M

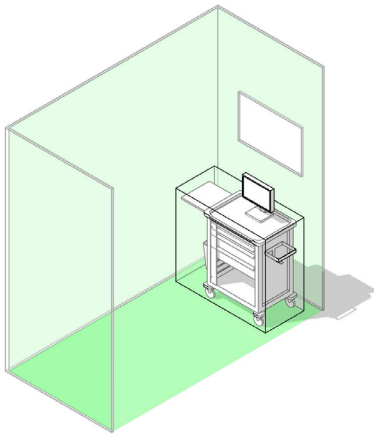


POSTNATAL 3
2928 SF
293 SQ M

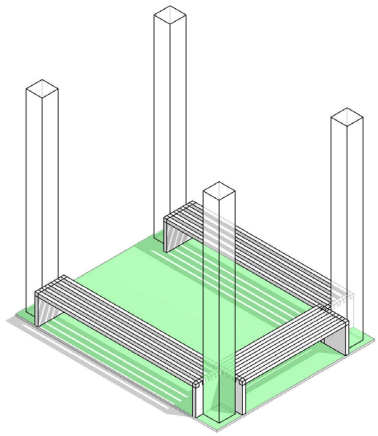
COMMUNITY / GATHERING TYPES



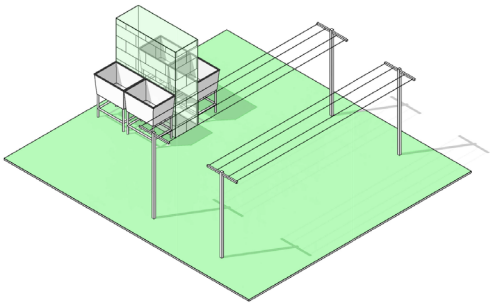
BEREAVEMENT ROOM
60 SF
6 SQ M



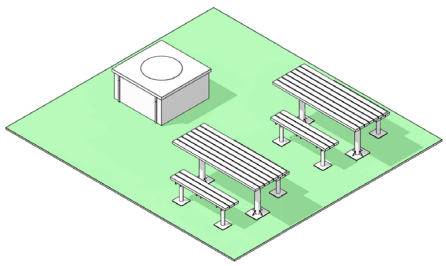
STUDENT EDUCATION
15% SF
15% SQ M



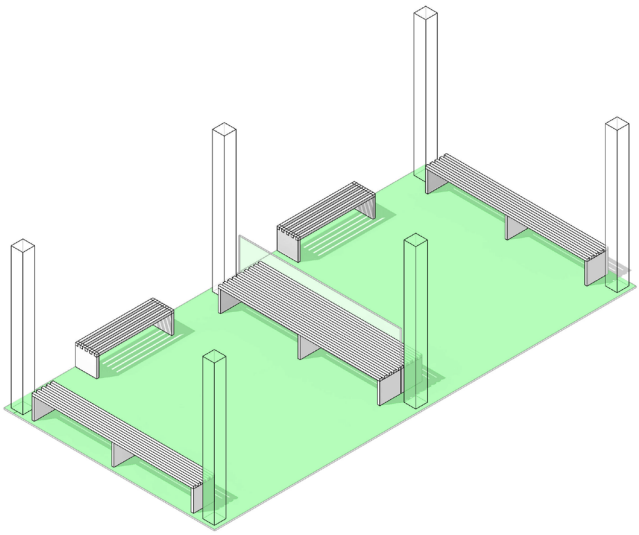
EXT BEREAVEMENT AREA
60 SF
6 SQ M



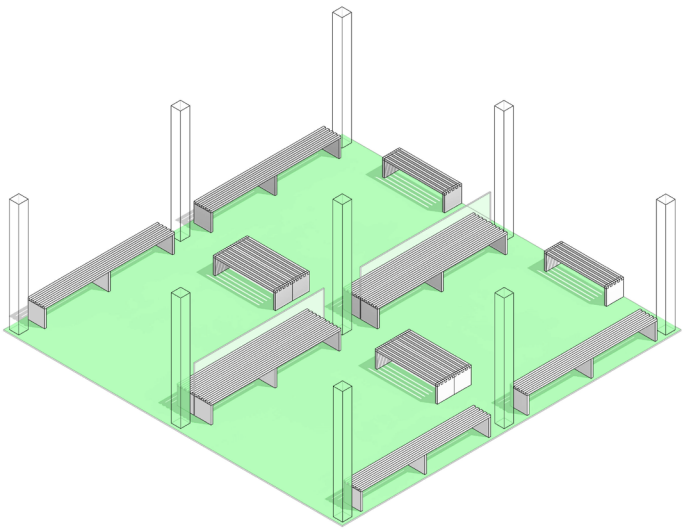
GUARDIAN LAUNDRY AREA
60 SF
6 SQ M



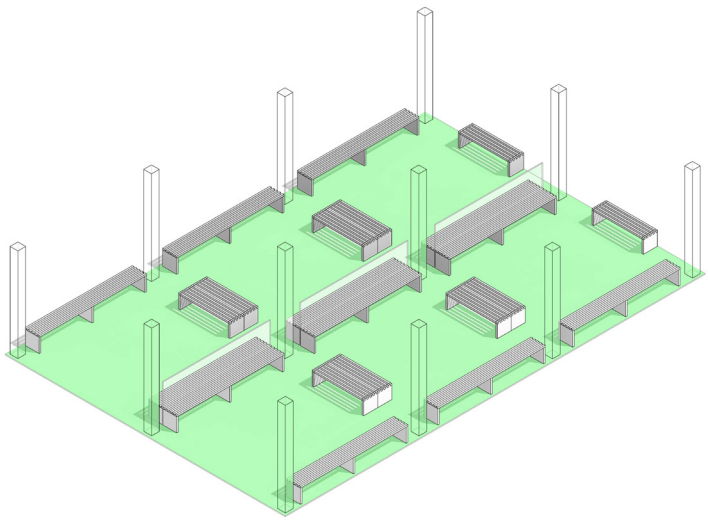
GUARDIAN COOKING AREA
250 SF
25 SQ M



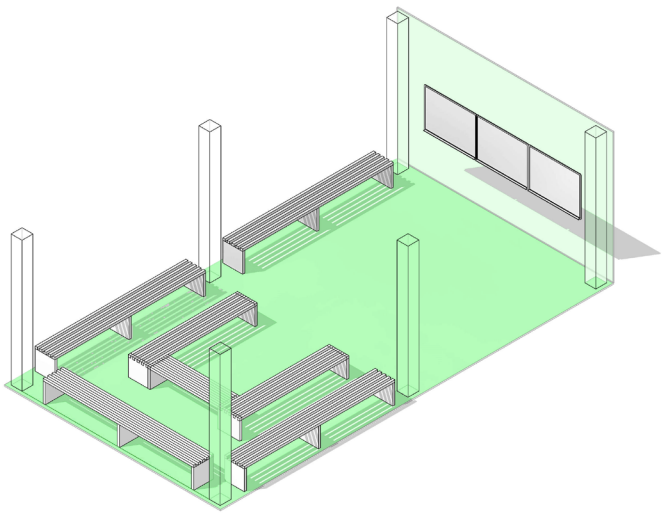
WAITING AREA 1
500 SF
46 SQ M



WAITING AREA 2
1000 SF
100 SQ M



WAITING AREA 3
1500 SF
150 SQ M



MATERNAL EDUCATION SPACE
500 SF
50 SQ M

HEALTH CENTRE EVALAUTION

KATELYN HIGH

HEALTH CENTRE

BACKGROUND OF HEALTH CENTRES IN MALAWI

Within the four-tiered healthcare system that Malawi has, health centres fall within the second tier and act as primary level of care facility where, "their services are free and they are often the only medical facility that many village people will see in their lifetimes."[1] Although health centres are the most readily available and accessible to those living in rural areas, they have many issues within the facilities that make them inefficient and lacking in the quality of care that is provided to the patients. "There are almost no doctors and few nurses at any of the rural hospitals, and supplies to them are often not available." [1] The health centres are staffed by nurses and medical assistants or clinical officers (mid-level practitioners). Nurses deal largely with primary maternal and child health services.[2] Every district hospital in Malawi has approximately 11 to 40 different health centres in its drainage area, where the patients at district hospitals get referred from. "Health centres offer ambulatory and maternity services and are meant to serve and average population of 10,000 people however, some urban facilities serve up to 237,000 people." [2]

RESEARCH QUESTION

How can you increase privacy for patients within health centres without compromising the efficiency of the staff?

RESEARCH QUESTION

"How can different maternity ward typologies increase privacy for patients within health centres without compromising the efficiency of the staff?"

CASE STUDY: ANCHOR FARMS HEALTH CENTRE

BACKGROUND

The Anchor Farms Health Centre is located in the central region of Malawi towards the western side as shown in figure 1. It is about 1.5 kilometers in the outskirts of the town of Santhe within the Kasungu district. The Anshor Farm Health Centre was funded by the Clinton Foundation in 2016. The foundation focuses on several global issues that they address in each of their projects including, but not limited to; childhood education, poverty, and climate change. However, the two that are implemented on the Anchor Famrs site are economic growth in Africa and the improvement of global health and well-being. [3]

Previously, the original site originally housed the Anchor Farms project which was funded under the Clinton Development Initiative (CDI) to help sustanace farmers become more food secure. The health centre was built on the same site as the project in order to support these farming communities and their families receive more accessible healthcare. In turn, this helps improve productivity through improved health. [4]

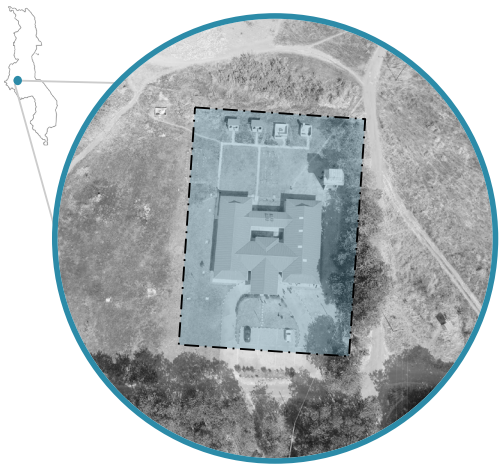
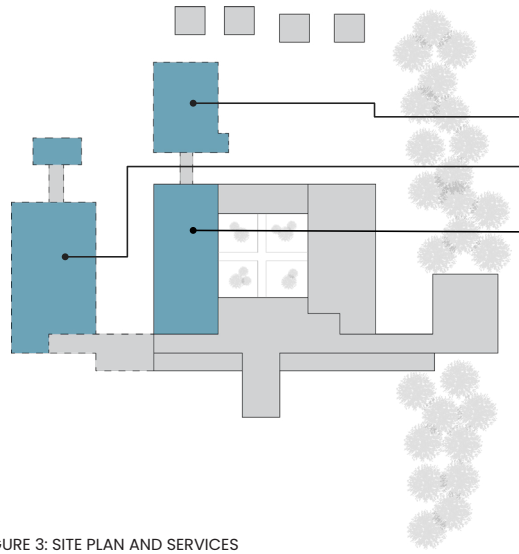


FIGURE 1: REGION IN MALAWI AND SITE IMAGE

FIGURE 2: ANCHOR FARMS FRONT ENTRANCE



MATERNITY SERVICES

FUTURE SURGICAL SUITE

FUTURE MATERNITY WAITING HOMES (MWH'S)

MATERNITY WARD
Delivery Suite
Prenatal
Postnatal
Sluice Room
Linen Room
Nurses Station
Drug Store
MVA Room
Family Planning Rooms (2)

Other Services Provided:

Administration
Consultation Rooms
EPI Room
Dispensary
Staff Room
VCT/STD
Screening
Future TB Ward

FIGURE 3: SITE PLAN AND SERVICES

FIGURE 4: FLOOR PLAN OF ANCHOR FARMS HEALTH CENTRE

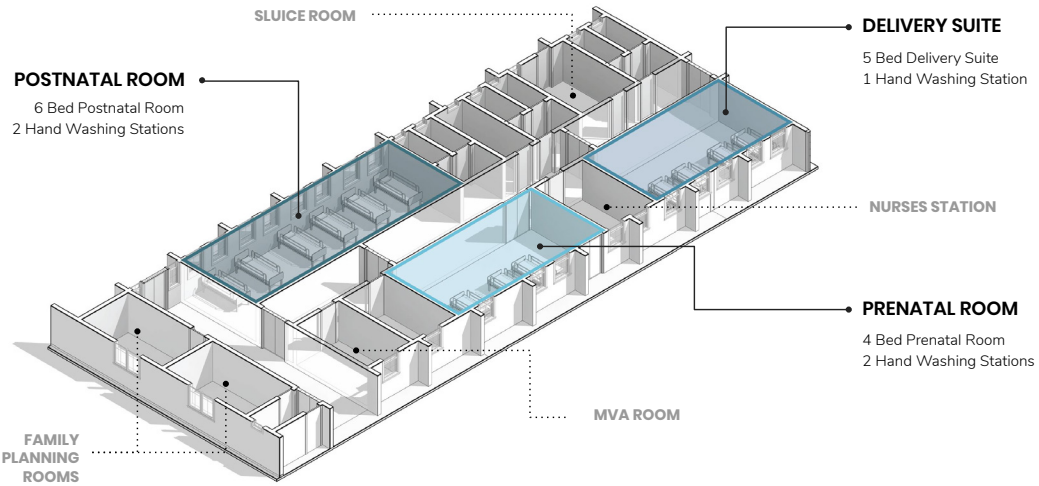


FIGURE 5: PROGRAMMATIC DISTRIBUTION

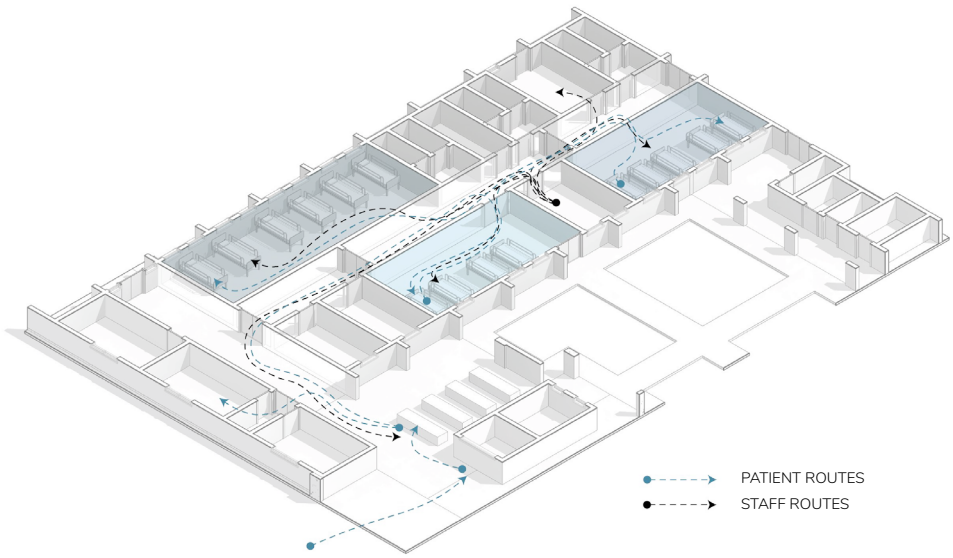


FIGURE 6: CIRCULATION FLOW

STEPS TO TRAVEL

DRUG STORE	7
PRENATAL (CLOSEST)	12
POSTNATAL (CLOSEST)	13
RESTROOMS	14
SLUICE	15
DELIVERY (CLOSEST)	16
PRENATAL (FARTHEST)	20
DELIVERY (FARTHEST)	20
POSTNATAL (FARTHEST)	27
WAITING AREA	41

PROGRAM + CIRCULATION ANALYSIS

PROGRAM

Within the maternity ward, there is a 4-bed prenatal room, a 5-bed delivery suite and a 6-bed postnatal room. For all of the patients in the maternity ward, there is a single nurses station, 3 restrooms, a sluice room, 2 family planning rooms, an MVA room and some smaller programmatic elements like a linen room and drug store. All of these rooms are laid out along the length of a double-loaded corridor, as shown in figure 5.

PATIENT CIRCULATION

The patient circulation within the maternity ward is relatively simple, however the distances from room to room could be closer than they are designed. The main ciruclation flow for a patient invovles first going into the reception area and the waiting area, then through the various stages of the maternity wing. The most common route that a patient would take from the waiting room would be to prenatal room, then to the delivery suite, and finally the postnatal room before leaving.

STAFF CIRCULATION

Staff circulation in the materntiy ward of this health centre is primarily focused around the nurses station, which is located between the prenatal room and the delivery suite, as shown in figure 5. The staff primarily spend their routes going to and from this station to the patients. The circulation flow is established in order to minimize the distance it takes for a staff member to get to their destination. Not only does the nurses station have windows on either side to see into the delivery suite and the prenatal room, but the increased visibility the staff has to the patients and the shortest distance to travel to them means that they are able to get patients their care more efficiently.

DISTANCES

The distances that staff memebers have to travel are represented in the chart within figure 6. Each area that a staff member would need to go is represented on the left-hand side, while the number of steps it takes for them to get there from the nurses station, is shown on the right hand side. The nurses station, as mentioned before, is fairly centralized so that the staff members can quickly get to each location in the maternity ward relatively quickly. The closest places that the staff would need to travel to are the drug store, which is only 7 steps away. The farthest distance, taking a staff member an average of 41 steps, would be to the waiting room. In health care, the number of steps that a staff member takes to get to where they are going directly affects the amount of time it takes. Making sure that the staff members have short distances to travel between the different places they would need to go is essential to cut down time it takes to help a patient in need.

INFECTION CONTROL ANALYSIS

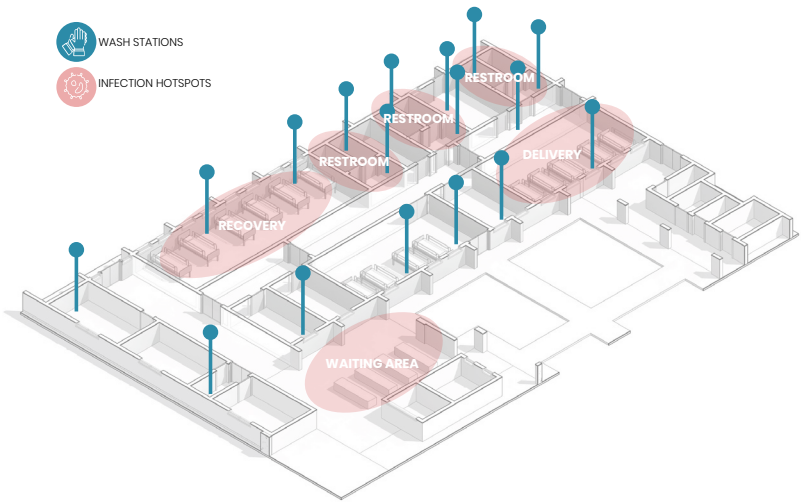


FIGURE 7: WASH STATIONS AND HOT SPOTS

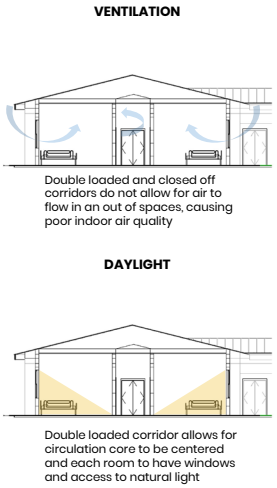


FIGURE 8: VENTILATION + DAYLIGHTING

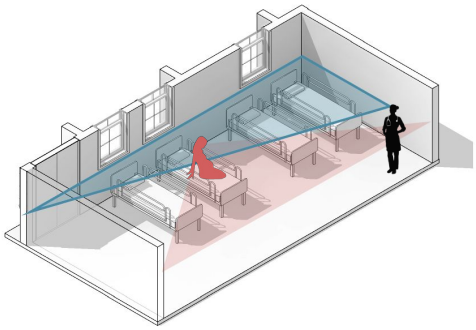
HOT SPOTS FOR INFECTION

The hot spots for infection are outlined in figure 7 above. The major areas where most infections would occur in this health centre would be in the waiting area, the restrooms, the delivery suite and the recovery or postntal room. The figure also shows where each of the hand washing stations are located. It is important that there are an abundance of these stations around, in order to help cut down on how many hospital aquired infections, also known as nosocomial infections, would take place. Hand washing has proven to be the best method for sanitation in these facilities, so making sure they are placed frequently around the building is essential.

VENTILATION + DAYLIGHTING

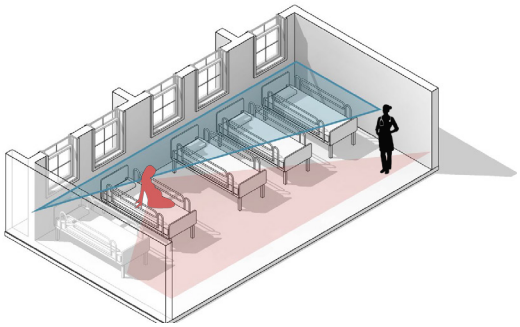
Besides the location of hand washing stations comparative to the infection hot spots, ventilation and daylighting within health facilties are two of the most common ways to measure for infection control. When cut in section, the maternity ward inside Anchor Farms, represented in figure 8, is relatively simple. The ventilation diagram shows the double loaded corridor layout of the maternity ward. By having a double loaded corridor, the circulation within the corridor is closed off and does not allow for air to circulate throughout the building effectively. The air within the spaces cannot flow back and forth, which causes poor indoor air quality, and conditions that allow for infections to happen more frequently. However, as for the natural daylighting within the health centre, the double loaded corridor allows for the circulation core to be pushed to the center of the ward. By centralizing the circulation core, the rooms then have the ability to be along the exterior walls, allowing for each room inside the ward to have the maximum amount of windows within then and in turn, the maximum amount of natural light to come into the spaces.

WARD ANALYSIS



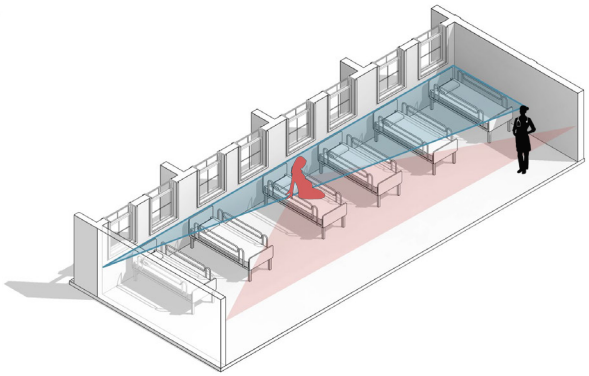
PRENATAL WARD

Area: 36 sq. meters
Beds: 4
Bed Spacing: .5-1m
Privacy: Low
Staff Vision: Facing Patient and Windows
Patient Vision: Facing Wall
Nurse Station: 7 steps from door
Privacy Level: ****



DELIVERY SUITE

Area: 33 sq. meters
Beds: 5
Bed Spacing: .5m
Privacy: Low
Staff Vision: Facing Patient and Windows
Patient Vision: Facing Wall
Nurse Station: 12 steps from door
Privacy Level: ****



POSTNATAL WARD

Area: 51 sq. meters
Beds: 6
Bed Spacing: 1m
Privacy: Low
Staff Vision: Facing Patient and Windows
Patient Vision: Facing Wall
Nurse Station: 10 steps from door
Privacy Level: ****

CASE STUDY: RUGERERO HEALTH CENTER

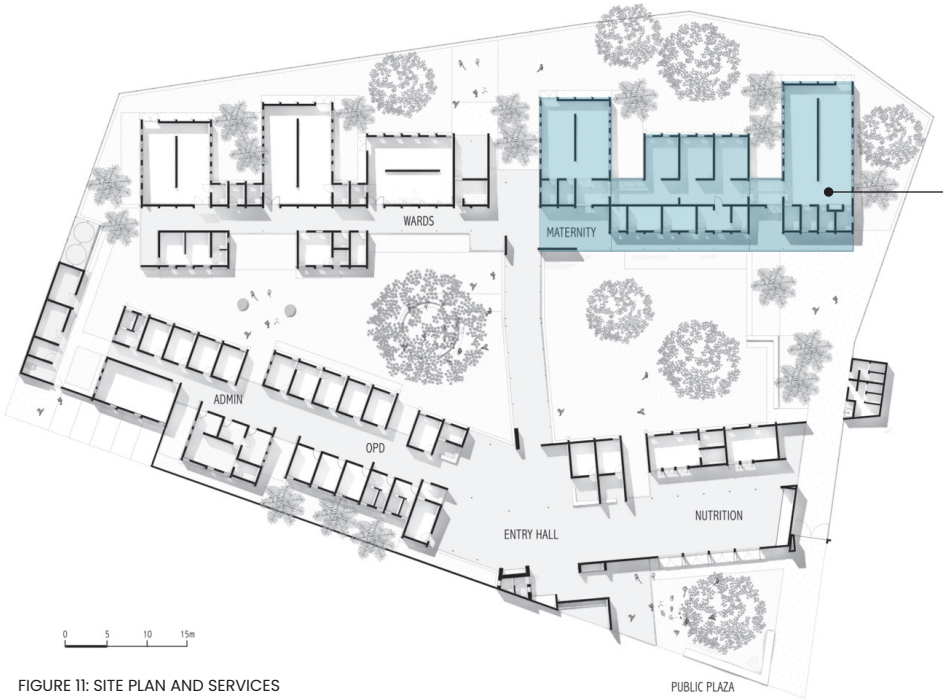
BACKGROUND

The Rugerero Health Center was built in 2018, deigned by Active Social Architecure and is located in the Rubavu District in Rwanda. The health centre was designed to be the first health center in Rugerero, and was designed in order to swerve 45,000 people. "The design concept rests on the idea to offer a long lasting improved health facility involving the community through design and construction while adopting locally sourced materials and traditional techniques."Upon completion, the health centre was created in order to contribute to the infants mortality reduction, the mothers wellbeing, the spread of education in nutrition, and the reduction of infections and diseases transmission.

Overall, the building is a single level, that was built using locally sourced fired bricks, stone foundations, metal roofing and wood ceilings. "The design is based on simple considerations of accessibility and strategic flows separation to avoid cross contamination between outpatients, inpatients, mothers and visitors.

FIGURE 9: RUGERERO MATERNITY WARD

FIGURE 10: RUGERERO EXTERIOR AREA



MATERNITY SERVICES

MATERNITY WARD
Delivery Suite
Pre-Delivery
Post-Delivery
Family Planning Rooms (2)
Antenatal
Nurses' Station

Other Services Provided:

Administration
Consultation Rooms
Vaccination Area
Pharmacy
Laundry
Library / Class
Incineration
Labs
Restrooms
Storage Rooms
Offices
Guard Area

FIGURE 11: SITE PLAN AND SERVICES

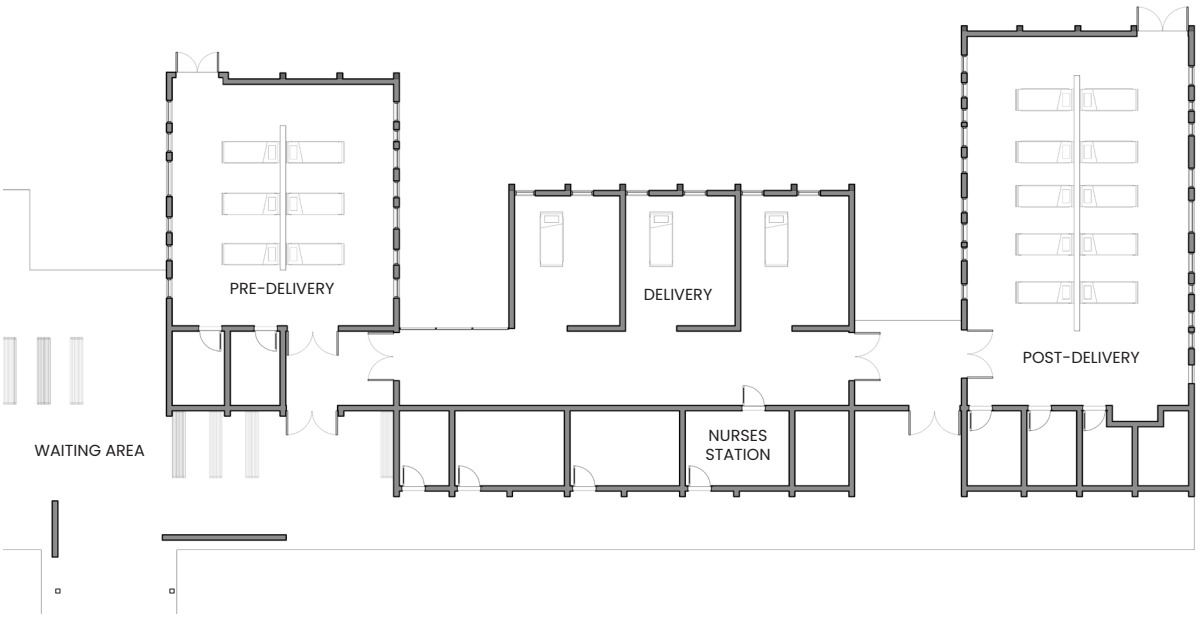


FIGURE 12: FLOOR PLAN OF RUGERERO MATERNITY WARD

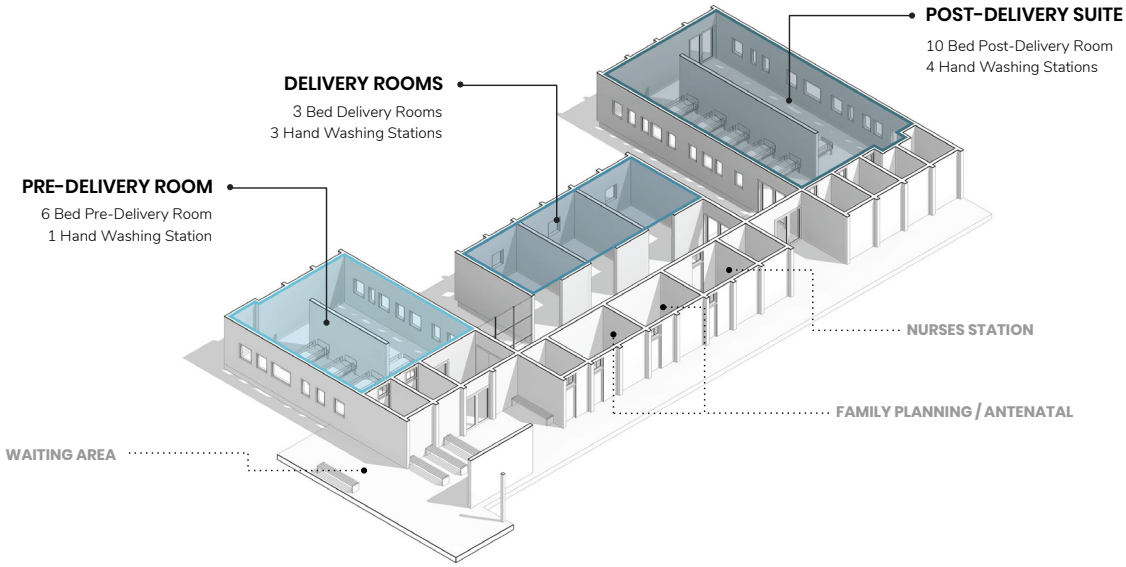


FIGURE 13: PROGRAMMATIC DISTRIBUTION

STEPS TO TRAVEL

DELIVERY (CLOSEST)	8
ANTENATAL	16.8
DELIVERY (FARTHEST)	17.6
PRE-DELIVERY (CLOSEST)	19.6
POST-DELIVERY (CLOSEST)	29.2
POST-DELIVERY (FARTHEST)	36.8
WAITING AREA	39.2
PRE-DELIVERY (FARTHEST)	40.8

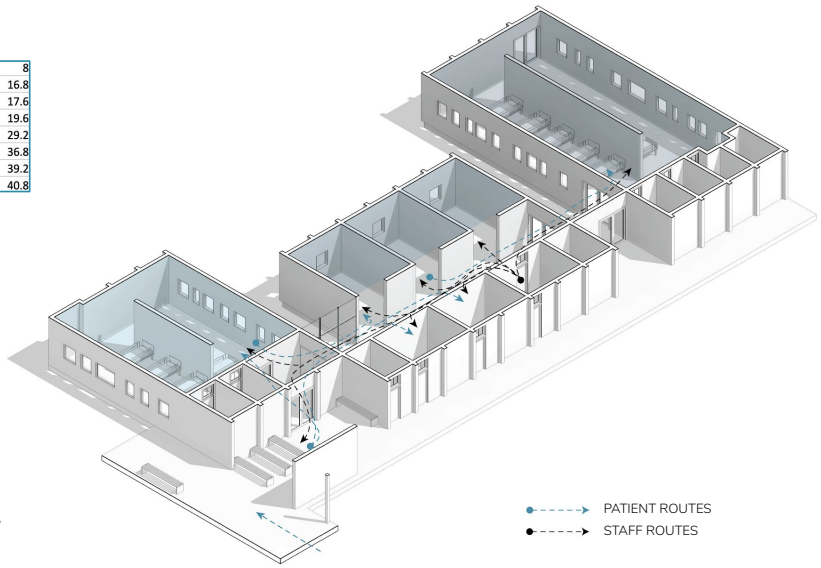


FIGURE 14: CIRCULATION FLOW

PROGRAM + CIRCULATION ANALYSIS

PROGRAM

Within the maternity ward at Rugerero, there is a 6 bed pre-delivery room, 3 single-bed private delivery rooms, and a 10 bed post-delivery room. There is a centralized nurses station, to accomodate all of the patients, along with multiple restrooms, two family planning/antenatal rooms, and storage rooms in the hall, and the pre-delivery and post-delivery rooms for things like linens. Within the part of the hearlth centre where the maternity ward is located, the laundry area is also located, allowing for easy access, and separate area to do laundry.

PATIENT CIRCULATION

The patient circulation path is laid out along a main central corridor, that allows for patients to move sequentially down the hall, depending on what stage of the labor process they are in. By having the rooms in the hallway laid out sequentially, the patients just keep moving down the hall, and never have to cross paths with other patients in other areas, in order to minimize cross contamination and address infection control within the maternity ward.

STAFF CIRCULATION

The staff circulation path, however, is much different than the patient circulation. The maternity ward is laid out so that there is a centralized nurses station, as shown in figure 13. By having a centralized nurses station, this allows for the staff circulation paths to be as short as possible, decreasing the wait time a patient experiences before being seen by a staff member. The centrazlized nurses station allows for staff members to see more patients at one time, and be as close to the women in delivery, who are the most critical and the most in need of their assistance.

DISTANCES

By having staff circulation and patient circulation carefully thought through, Rugerero is an exemplary case study of how a centralized nurses station works. The goal of the layout of the ward was to decrease the distance staff need to travel to and from the patients and the nurses station, which in turn, decreases the amount of time it takes for them to get from one place to another. By creating shorter distances, not only does travel time decrease, but things like infection control and quality of care can also be addressed so that patients are receiving the best care, that is efficient and timely.

INFECTION CONTROL ANALYSIS

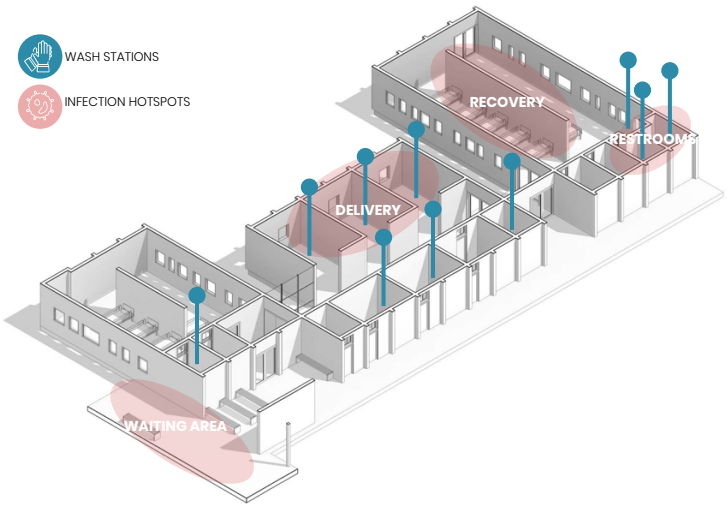


FIGURE 15: WASH STATIONS AND HOT SPOTS

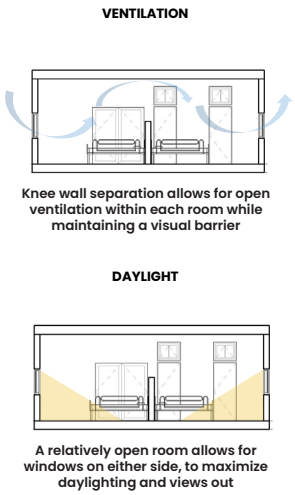


FIGURE 16: VENTILATION + DAYLIGHTING

HOT SPOTS FOR INFECTION

The layout of the maternity ward within Rugerero is spaced out so that each room is separated, and laid out sequentially so patients travel in one direction down the main circulation corridor. While this layout reduces hot spots for infection efficiently, there are possible areas like the waiting area, the delivery rooms, and the recovery room / restrooms inside it that would be the biggest hot spots for infections. While these are the spaces that have the relative highest probability of a patient acquiring an infection, figure 15 above shows that in these spaces, with the exception of the waiting area, there are plenty of wash stations to further reduce the possiblity of a patient acquiring a nosocomial infection.

VENTILATION + DAYLIGHTING

As for the ventilation and daylighting, figure 16 above shows the sectional diagrams through the pre-delivery and post-delivery rooms. These rooms are relatively open, but have a knee wall in the center to create a visual barrier between patients on either side to increase privacy. By implementing a knee wall, the natural ventilation that can take place in these spaces is much better than that of a double loaded corridor. The windows on either side allow not only for double the natural daylighting and more views to the exterior for the patients, but allow for air to flow in the room and out the other side. The rooms also have more ventilation strategies than just the windows, as shown in figure 17 below. These openening in the walls allow for even more ventilation to happen.

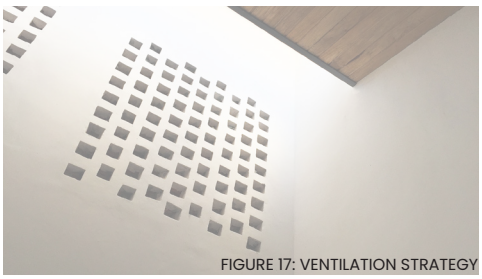
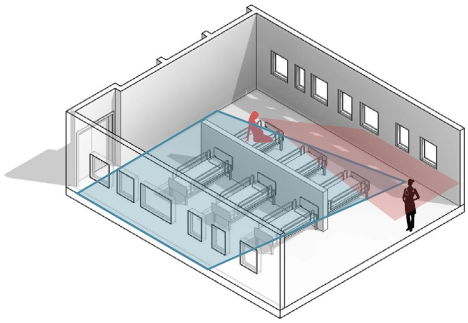


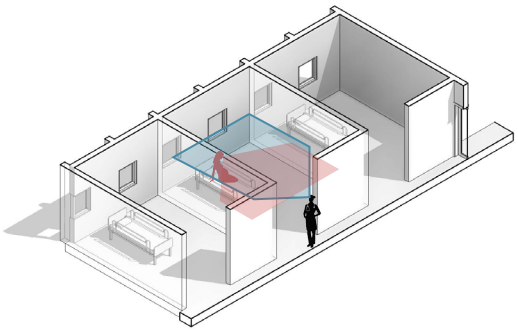
FIGURE 17: VENTILATION STRATEGY

WARD ANALYSIS



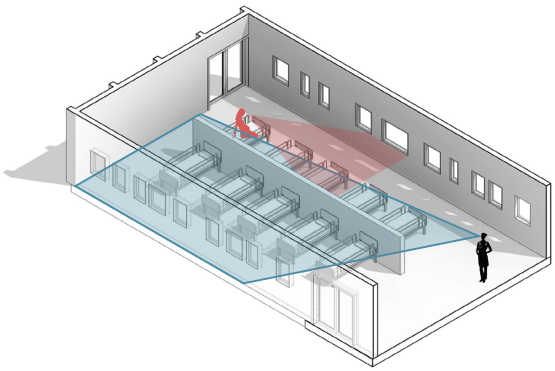
PRE-DELIVERY ROOM

Area: 72 sq. meters
Beds: 6
Bed Spacing: 1 m
Privacy: Medium
Staff Vision: Facing patients and windows
Patient Vision: Facing out towards windows
Nurse Station: 16 steps from door
Privacy Level: *****



DELIVERY ROOMS

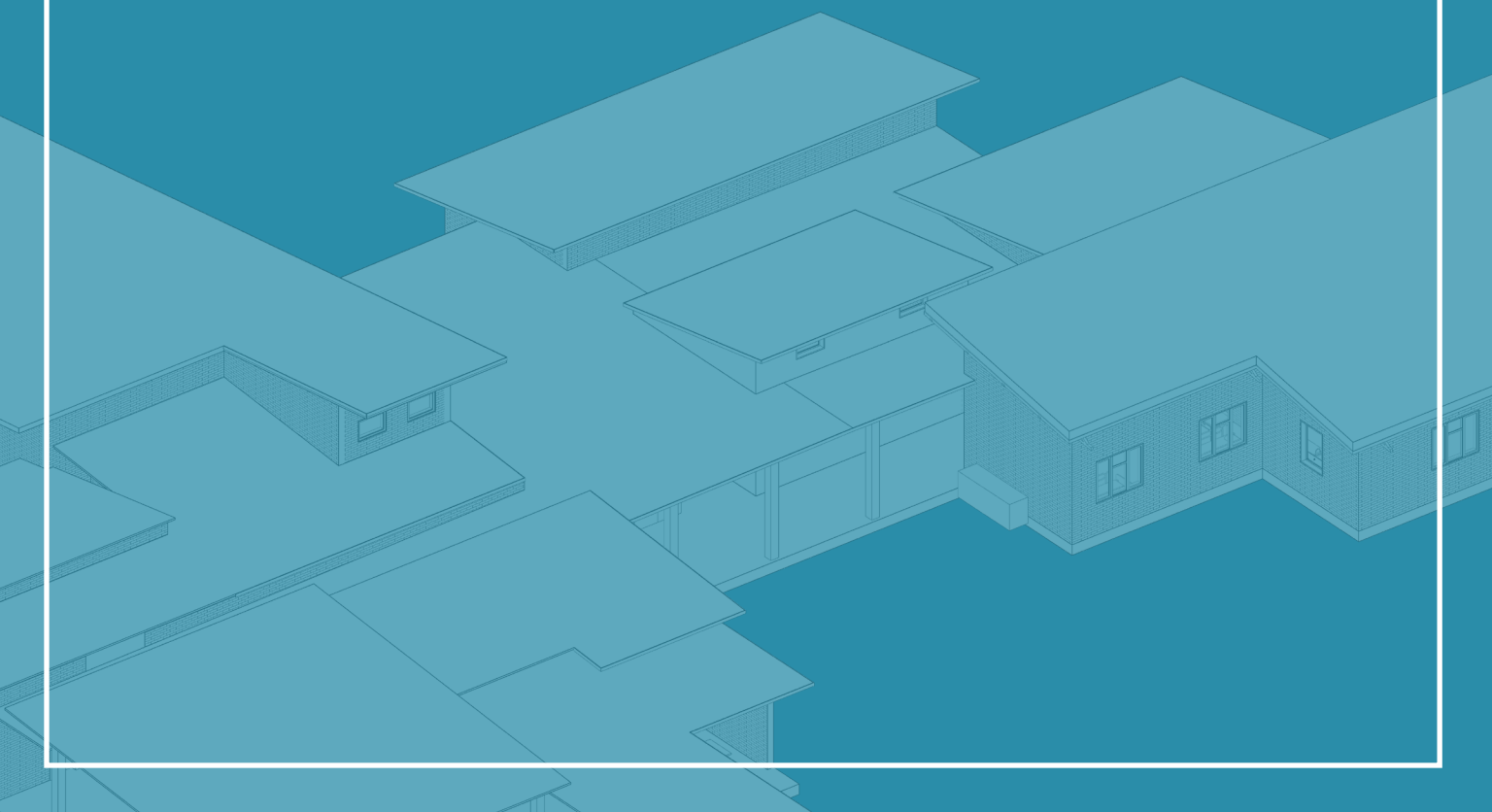
Area: 18.5 sq. meters / each
Beds: 3 single-bed rooms
Bed Spacing: n/a - separated by walls
Privacy: High
Staff Vision: Facing patients
Patient Vision: Facing out towards nurses
Nurse Station: 6-10 steps to the doors
Privacy Level: *****



POST-DELIVERY ROOM

Area: 110 sq. meters
Beds: 10
Bed Spacing: 1m
Privacy: Medium
Staff Vision: Facing patients and windows
Patient Vision: Facing out towards windows
Nurse Station: 26 steps to the door
Privacy Level: *****

HEALTH CENTRE SCALE DESIGN PROPOSAL



DESIGN SKETCHES

PROGRAM

The initial idea for the design proposal revolved around the program sketch below. The program would promote a centralized nurse station, for ease of efficiency, and a centralized circulation 'spine' that runs down the middle with program staggering either side of it, in sequential order. Although the final design has changed, the initial concept and design goals have remained the same.

CIRCULATION

After various iterations of the initlal program layout, and finally settling on the program sketch below, the next big design goal of this maternity ward revolves around the circulation flows of patients, staff and visitors. The circulation sketch below emphasizes the various circulation paths within the maternity ward, and shoes the separation of the visitors compared to the patients and staff.

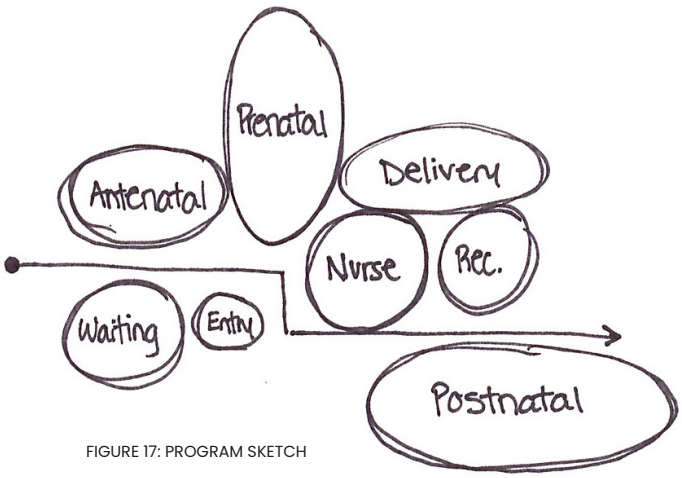


FIGURE 17: PROGRAM SKETCH

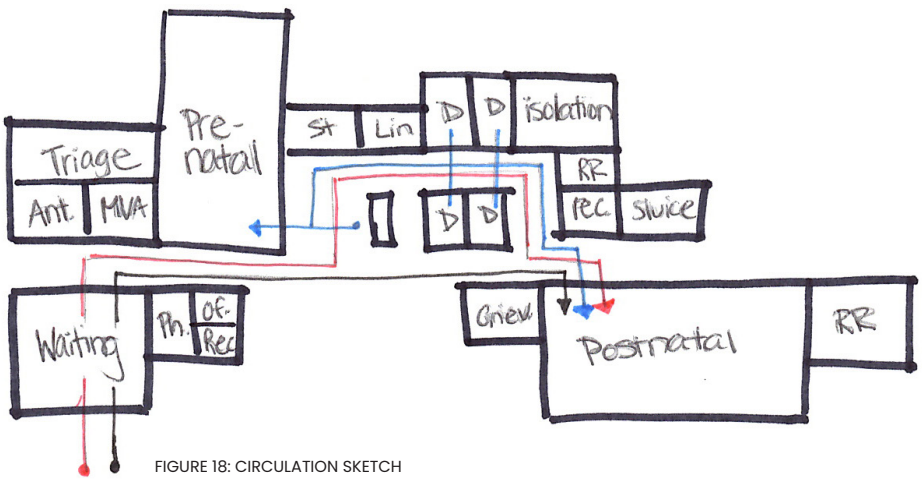


FIGURE 18: CIRCULATION SKETCH

DESIGN PROPOSAL

DESIGN GOALS

1. Improving spatial layout by keeping programmatic elements in a sequential order in relation to the maternity process so patients only have to move in a single
2. Improving circulation patterns for staff, patients and visitors to reduce spatial confusion and reducing the risk of acquiring infections
3. Separating the three main areas of the maternity ward (pre-delivery, delivery and post-delivery)
4. Central circulation 'spine' to keep all spaces easily accessible

BACKGROUND

Health facilities within Malawi are continually adjusting to take in the increasing number of people that are going to them. With Malawi's estimated exponential population growth in the coming years and limited resources to handle it, health centres are constantly becoming overcrowded, which in turn, severely affects the quality of care provided to the patients, the efficiency of the staff members and the risk of patients acquiring nosocomial infections during their time at the facility.

This design proposal takes into consideration the needs of a growing population in an achievable way that not only provides the adequate space needed for staff and patients, provides spaces that are not typically found within health centres that research has proven to be necessary, and addresses the three major design criteria previously outlined; quality of care, staff efficiency and infection control.

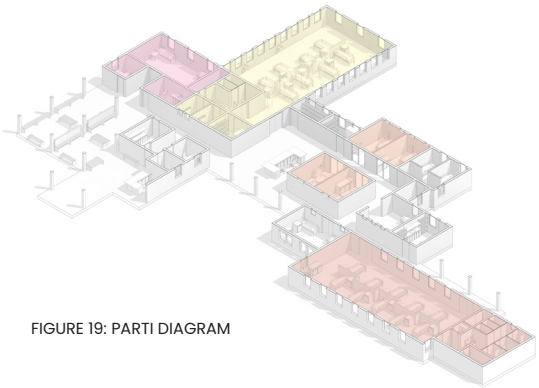


FIGURE 19: PARTI DIAGRAM

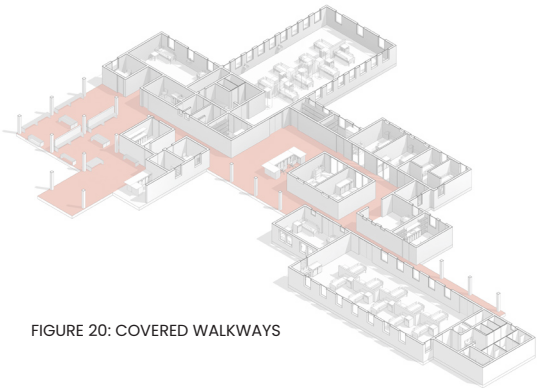


FIGURE 20: COVERED WALKWAYS

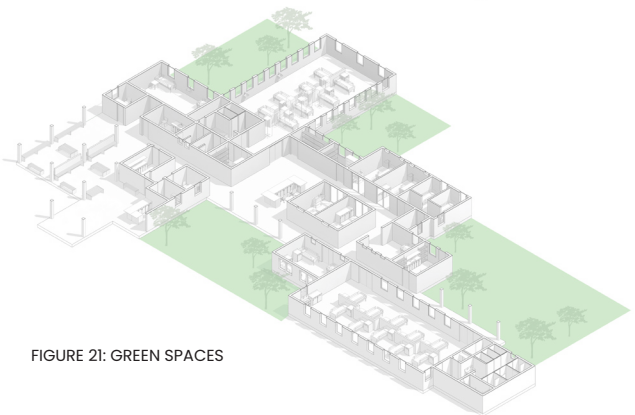


FIGURE 21: GREEN SPACES

PARTI DIAGRAM

The parti diagram in figure 19 shows the main components that make up a maternity ward with pink being antenatal, yellow being prenatal, orange being delivery, and red being postnatal. These spaces are spread out amongst the main circulation corridor, keeping the nurse station centralized.

COVERED WALKWAYS

This diagram, figure 20, shows the main circulation areas highlighted in red. All of the main circulation is outdoor and covered, to allow for natural ventilation while providing protection from the sun and inclement weather conditions.

GREEN SPACES

The green space diagram, shown in figure 21, shows the main green areas that are found around the maternity ward, These areas have direct access to the ward, to allow for patients, staff members, or visitors to travel to and from the building with ease.

FLOOR PLAN

The floor plan below (figure 22) shows the proposed maternity ward for a health centre scale facility. It encompasses all necessary components of a maternity ward, and includes some spaces not typically found within a health centre, that our research has shown to be important to include.

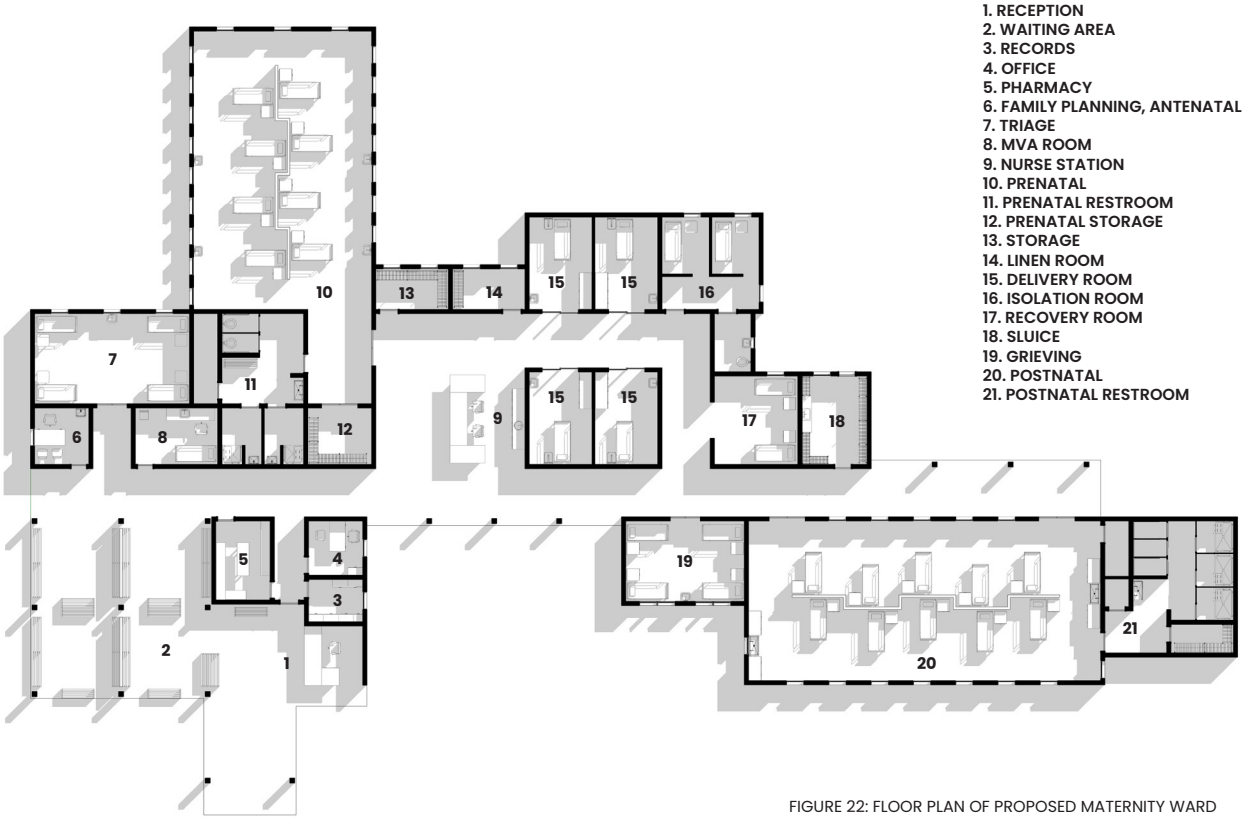


FIGURE 22: FLOOR PLAN OF PROPOSED MATERNITY WARD

DESIGN ANALYSIS

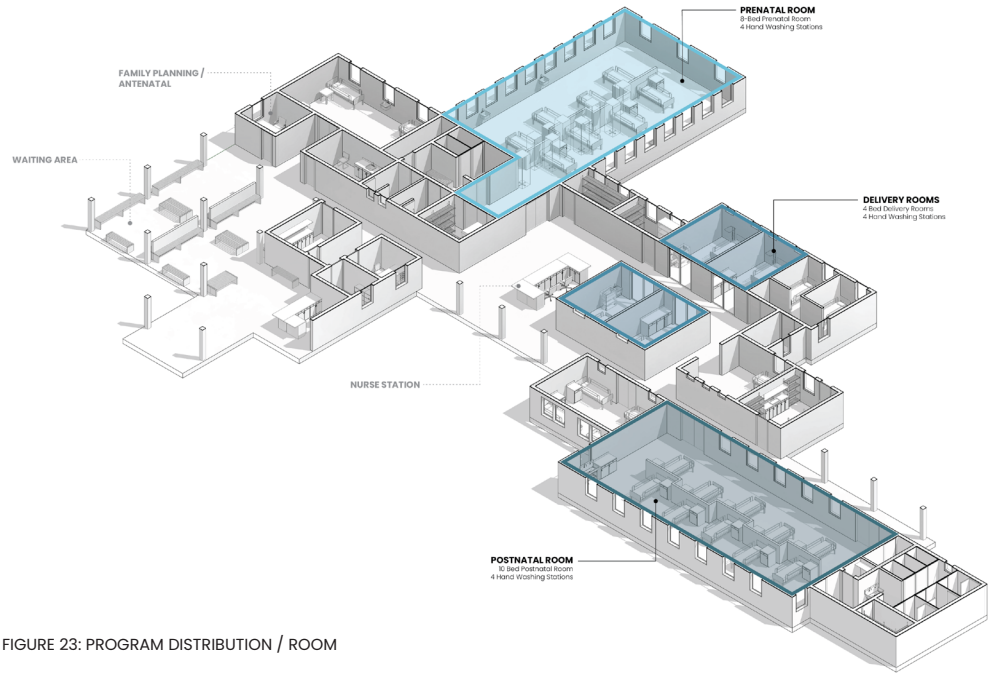


FIGURE 23: PROGRAM DISTRIBUTION / ROOM

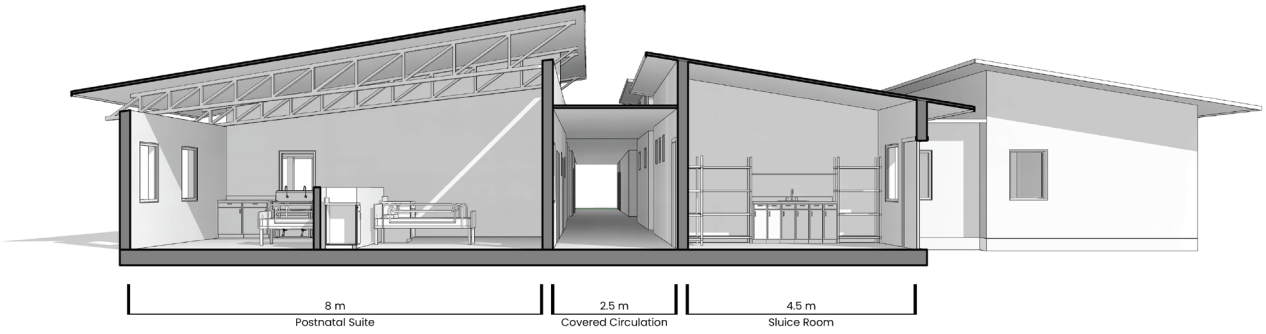


FIGURE 24: SECTION THROUGH POSTNATAL

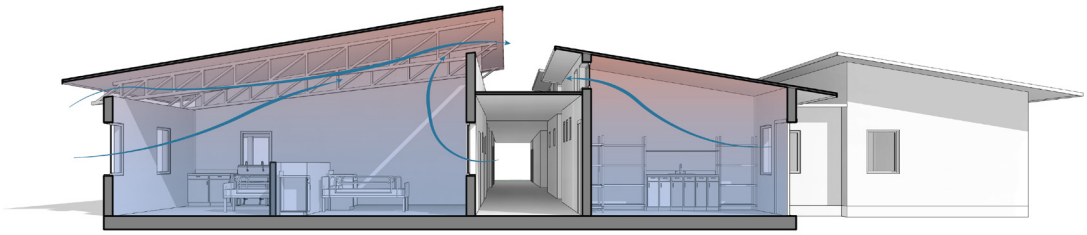


FIGURE 25: VENTILATION SECTION DIAGRAM

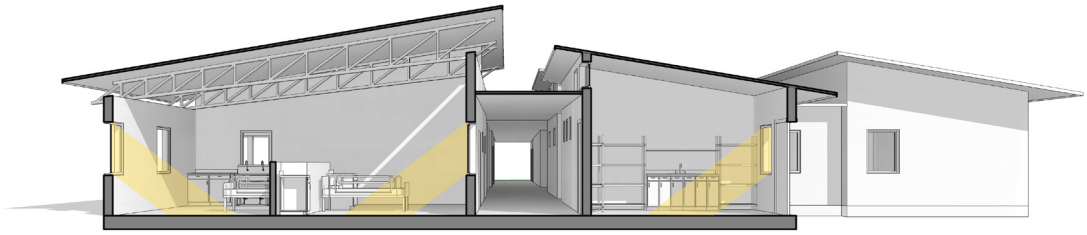


FIGURE 26: DAYLIGHTING SECTION DIAGRAM

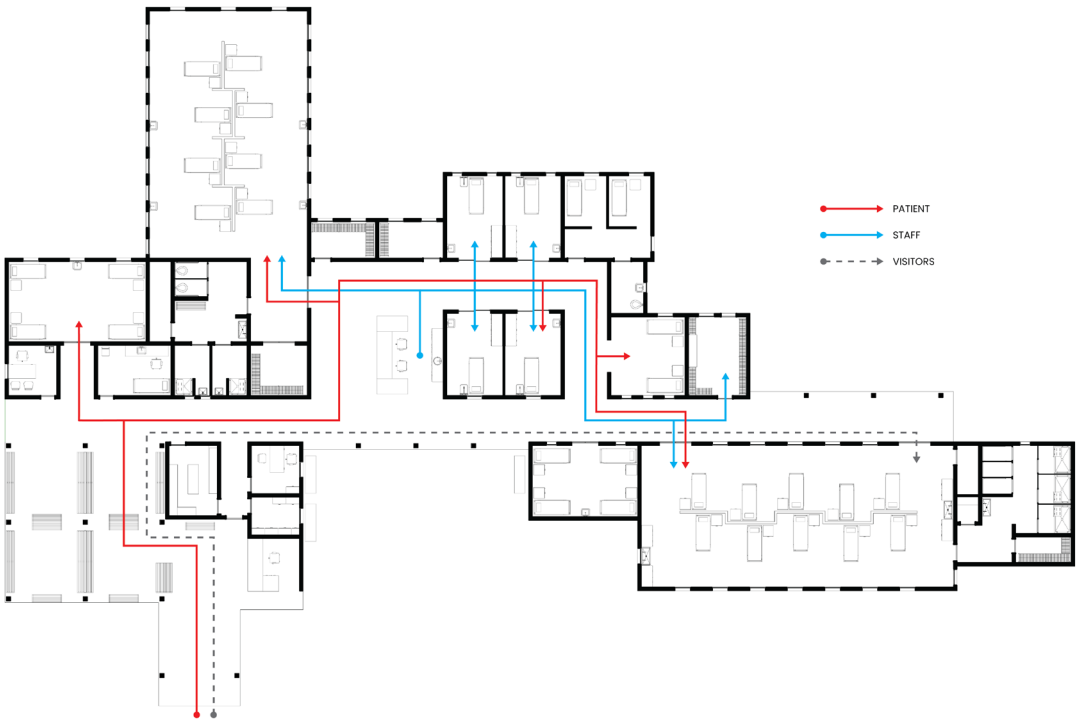
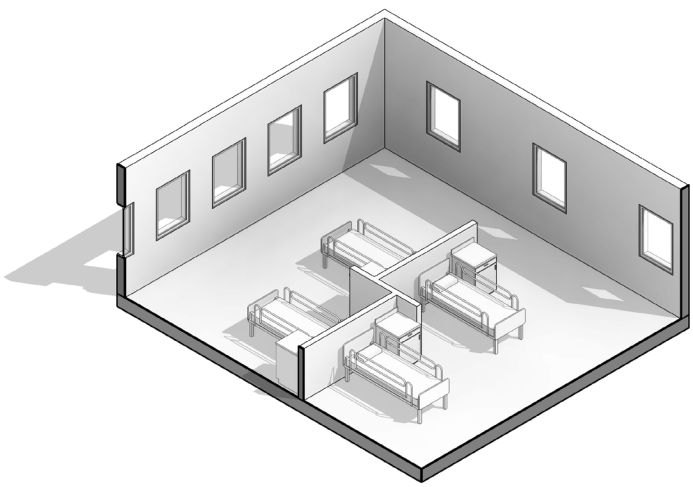


FIGURE 27: CIRCULATION PLAN

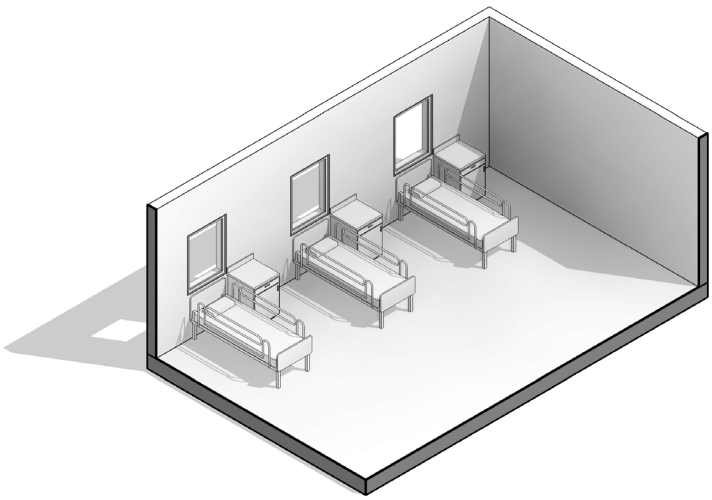
WARD ANALYSIS



DESIGN WARD LAYOUT

Bed Spacing: 2 m
Patient Area: 7.5 m^2
Privacy: Medium/High
Staff Vision: Facing patients, high
Patient Vision: Facing out towards windows
Privacy Level: ****

This type of ward layout addresses visual patient privacy, while maintaining staff efficiency. Each patient bed has an area for staff on one side, and guardians on the other while leaving enough space and privacy between the patients.



MOH WARD LAYOUT

Bed Spacing: .5 m
Patient Area: 5.5 m^2
Privacy: Low
Staff Vision: Facing all patients
Patient Vision: Facing in away from windows
Privacy Level: *****

The standard MOH ward layout does not take into consideration the reality of maternity wards within Malawi. It does not anticipate the spatial needs of patients, guardians or staff and does not address privacy issues due to the overcrowding of health centres from an increasing population.

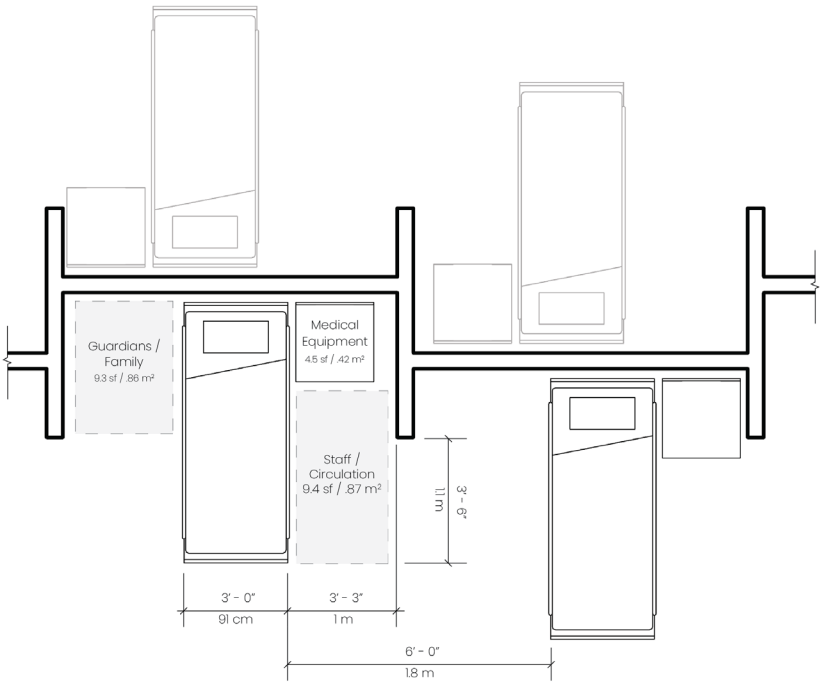


FIGURE 28: WARD DIMENSIONS AND BED SPACING

WARD LAYOUTS

The two layouts on the left page, show the differences between my design proposal on the top, and the standard MOH design on the bottom. Although the MOH ward layout is simplistic and easy for staff to navigate, it does not take into consideration the reality of maternity wards within Malawi. It doesn't not anticipate the spatial needs to patients, guardians or staff, and does not address the necessary privacy issues due to the overcrowding of health centres.

However, in my proposed ward layout, as shown both on the top of the left page and the top of this page, the layout addresses visual patient privacy (that our research shows is a key to maintaining patient dignity as well) while maintaining staff efficiency, that the standard MOH layout does well. Each patient's bed has an area for staff on one side of it, and an area for guardians or family members on the other side. This layout reduces the bottleneck effect that happens when health centres become overcrowded, and leaves the staff with the proper amount of space to care for the patient, without compromising bed-side space for guardians or family members.

The diagram above shows the dimensions and bed spacing that my proposed ward layout would provide. The knee walls between the patients provide visual privacy, while the 1.8 meter bed spacing would also provide better audio privacy than the .5 meter bed spacing in the MOH layout.

WARD ANALYSIS

COMPARISON

Below is the size comparison between this design proposal maternity ward, and the maternity ward found within the standard MOH design. Not all of the elements in the design proposal are found in the standard MOH design, but have been included as they have been found through research to not only promote positive maternal health outcomes, but also be able to serve mothers in any way that they might need. Some of the rooms however, have significantly more space in them. While this design proposal does not outline a specific site or location, the design was created in order to serve a larger catchment population than that of the standard design, in hopes to help address the issue of Malawi's significant projected population increase in the coming years.

ROOM AREAS (SQ. M)	DESIGN	MOH
WAITING AREA	84	66
PHARMACY	11	7
OFFICE	7.5	12
RECORDS	6	7
REGISTRATION	13	5
TRIAGE	35	N/A
MVA	12	11
FAM. PL. / ANTENATAL	8	13 (2)
PRENATAL	120	46
PRENATAL RR	13	N/A
PRENATAL ST. / LINEN	9	N/A
STORAGE	7	N/A
LINEN	7	11
DELIVERY ROOMS (4)	15 ea.	33
ISOLATION ROOM	22	N/A
ISOLATION RR	5	N/A
RECOVERY	19	N/A
SLUICE	15	13
POSTNATAL	135	54
POSTNATAL RR	30	N/A
POSTNATAL ST. / LINEN	5	N/A
GRIEVING	24	N/A
TOTAL SQ. M	**734**	**289**

62% LARGER PRENATAL SUITE

60% LARGER POSTNATAL SUITE

4 PRIVATE DELIVERY ROOMS

BEDSIDE AREAS FOR GUARDIANS

INCLUSION OF TRIAGE, RECOVERY, ISOLATION AND GRIEVING AREAS

(COMPARED TO STANDARD MOH DESIGN)

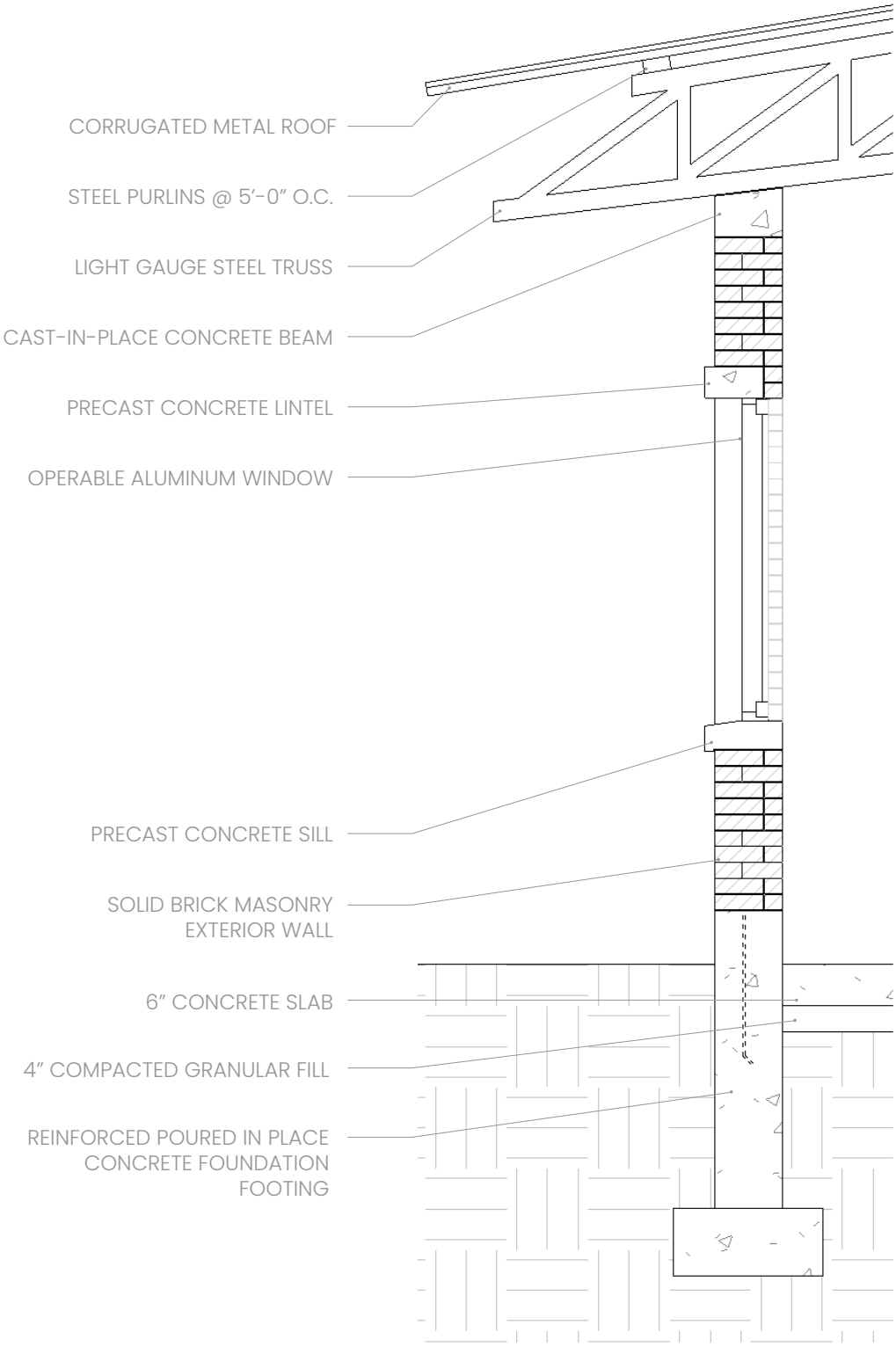


FIGURE 29: TYPICAL WARD WALL SECTION

COMPARATIVE ANALYSIS

ARCHITECTURAL COMPONENTS

While there are many elements of the standard MOH design for Malawian maternity wards in a health centre facility that are advantageous, there are others that can be further improved. By further improving these conditions, the quality of care that patients receive will be better, staff efficiency will be enhanced, and infection control can be improved.

The diagrams on the right show a comparison between standard MOH design elements and those same elements found within my design proposal. Through research and analysis, I have found that some of these conditions are not sufficient enough to address the reality of health centre maternity wards in Malawi. I used the existing conditions, and found ways to further imprive them in order to more effectively promote quality of care, staff efficiency and infection control. The ventilation diagrams show that the existing conditions are mostly double loaded corridors, which tend to promote staff efficiency, but compromise natural ventilation which is necessary for infection control. The second set of diagrams show the daylighting conditions within the wards. The existing conditions only get daylighting on one side of every room, due to the double loaded corridor. However, in my design, I have kept the centralized corridor, but allowed it to become exterior space to stagger rooms on either side of it, allowing every room to have daylighting from both sides, further more increasing views to the exterior. Lastly, the bottom set of diagrams show the views that patients have from their beds. The existing conditions have beds backed up against windows, with the patients view being directed towards a blank wall. In my proposal, every bed backs up to a knee wall in the center of the room, allowing for every bed to face a large window to the exterior, promoting privacy between beds, and an increased quality of care for the patients.

1

QUALITY OF CARE

As previously mentioned through our research, quality of care should be addressed in various ways; like patient privacy, dignity, grieving and paternal involvement. Through the analysis of the standard MOH design of a health centre maternity ward, I found that these topics should be further addressed in any design proposal, not only spatially, but architecturally as well.

2

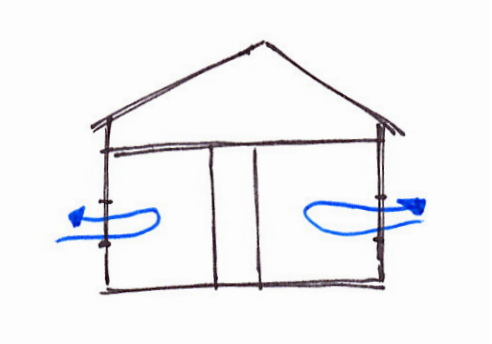
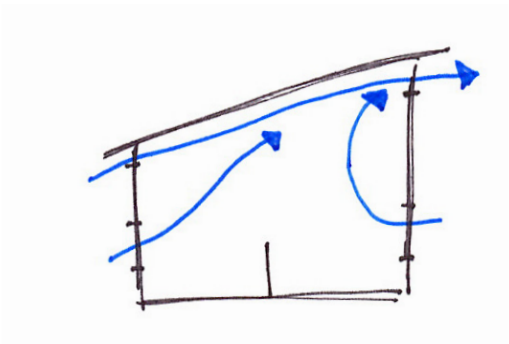
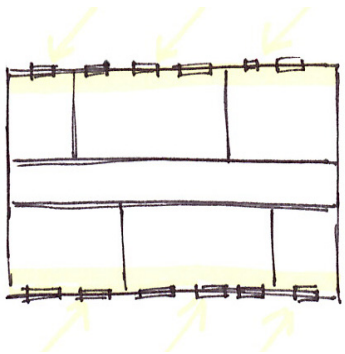
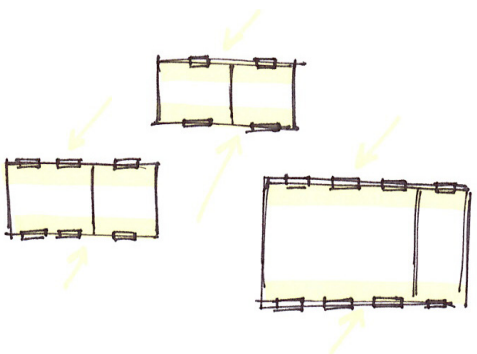
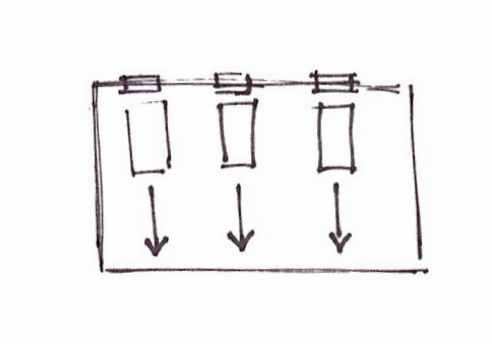
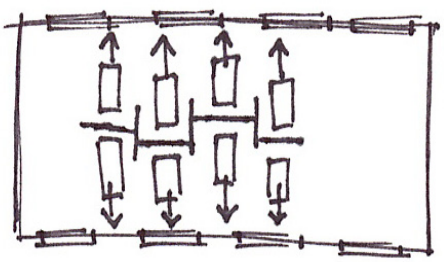
STAFF EFFICIENCY

Staff efficiency plays a big role in also providing a higher quality of care for patients. While the standard MOH design did a relatively good job at utilizing a centralized nurses station in order to minimize the distances that staff need to travel to patients, the efficiency could be addressed even further, to not only help minimize overcrowding, but also minimize the risk of acquiring infections.

3

INFECTION CONTROL

Nosocomial infections, also known as hospital-acquired infections (HAI) are a big concern for maternity wards within Malawi. Minimizing the risk of acquiring an infection is not only a cultural component, but an architectural one as well. In order to minimize the risk of acquiring an infection, good ventilation within wards is key, while also utilizing hand washing stations.

	STANDARD MOH DESIGN	DESIGN PROPOSAL
VENTILATION		
DAYLIGHTING		
PATIENT VIEWS		

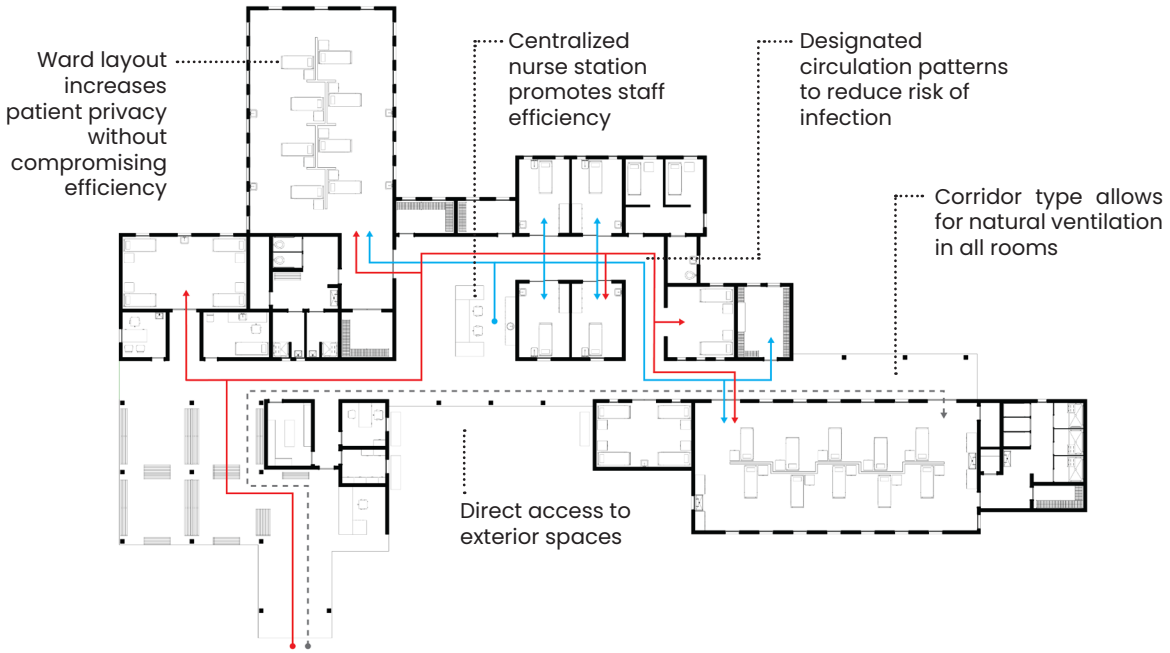
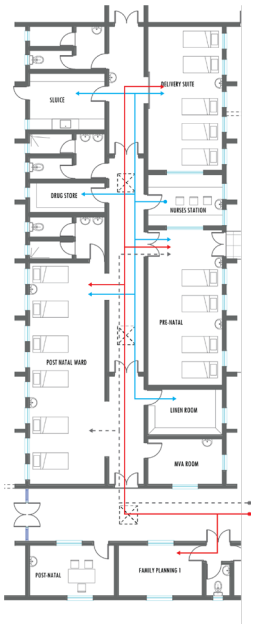


FIGURE 30: PROPOSED MATERNITY WARD AND KEY COMPONENTS

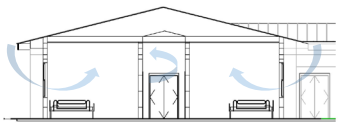
Through analysis of the standard MOH design, various design issues were presented. Below are a few of these concerns along with how I've addressed them in order to propose solutions to better the standard of design for maternity wards in Malawi.

	QUALITY OF CARE	STAFF EFFICIENCY	INFECTION CONTROL
ISSUE	A lack of privacy, and in turn dignity, for the patients due to open ward layouts	Travel distances for staff members become too long due to spatial arrangements	Double loaded corridors leads to a lack of proper ventilation, increasing risk of infections
SOLUTION	Using staggared knee walls provides visual barriers which increase privacy and provide designated areas for the staff to properly provide care for patients while maintaining the necessary space for guardians and family members. An increase in visitor space would promote paternal involvement	Implementing a centralized nurse station in a maternity ward in a health center level is key to improving staff efficiency in terms of travel distances and times. Allowing the program to 'pin-wheel' around it further shortens the distance needed for staff to travel to reach patients in need of their care	Outdoor covered circulation corridors allow for natural air to flow to and from each room, without limiting necessary air flow to the wards. With outdoor circulation, there is able to be windows on either side of the main wards, allowing proper cross ventilation to take place without the use of equipment

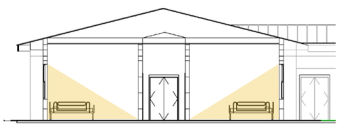
STANDARD MOH DESIGN FOR COMPARISON



CIRCULATION PLAN



VENTILATION



DAYLIGHTING

For more detailed infortmation regarding the analysis of the standard MOH design, refer to pages 68-73

36% MORE HANDWASHING STATIONS AVAILABLE

1 SINK FOR EVERY **4** BEDS

SEPARATE CIRCULATION FLOWS TO **REDUCE RISK** OF **INFECTION**

AN **INCREASE** IN NATURAL **VENTILATION** AND **DAYLIGHTING**

(COMPARED TO STANDARD MOH DESIGN)

DESIGN CRITERIA RATINGS

STANDARD MOH DESIGN	DESIGN PROPOSAL
Quality of Care **	Quality of Care ****
Privacy Level *	Privacy Level ****
Staff Efficiency ***	Staff Efficiency ****
Infection Control **	Infection Control ***
Zone Rating II	Zone Rating III

ZONE II (HIGH BTR, LOW OCC) - Low Occupancy - High Turnover - Short Stay	**ZONE III** (HIGH BTR, HIGH OCC) - High Occupancy - High Turnover - Short Stay
ZONE I (LOW BTR, LOW OCC) - Low Occupancy - Low Turnover - Long Stay	**ZONE IV** (LOW BTR, HIGH OCC) - High Occupancy - Low Turnover - Long Stay

DESIGN CONCLUSIONS

CONCLUSION

Malawi made significant strides in meeting the millennium development goals for literacy, childhood mortality, HIV and malaria. Other areas, for example, maternal health, still require innovation and further effort.[1] In an attempt to pursue innovation in maternal health through architectural interventions, this design proposal aimed at finding solutions to better maternity services within Malawi, and in turn, enhancing maternal health.

While this design proposal is attempting to enhance maternal health through the maternal health infrastructure at a health centre level, in practice, the health system is marked by lack of resources, maldistribution of staff and funding between rural and urban settings across tiers of care.[1] Due to these ongoing concerns, this proposal creates a framework to compensate these issues, and mitigate the negative effects of them. For instance, through one of the main architectural interventions proposed in this design, a centralized nurse station, the ongoing problem of a shortage of staff members can be compensated with and easier __ for the staff members. By cutting down on travel distances, travel time, and promoting a sequential spacial organization, the shortage of staff members becomes unobtrusive to the care being provided to the patients.

1. Makwero, Martha T. "Delivery of Primary Health Care in Malawi." African Journal of Primary Health Care & Family Medicine 10, no. 1 (2018). https://doi.org/10.4102/phcfm.v10i1.1799.

FIGURE 31: EXTERIOR PUBLIC AREA

FIGURE 32: VIEW OF NURSE STATION AND COVERED WALKWAY

FIGURE 33: INTERIOR VIEW OF PRENATAL WARD

DISTRICT HOSPITAL EVALAUTION

ENYA BARQUIA

DISTRICT HOSPITAL

BACKGROUND OF DISTRICT HOSPITALS IN MALAWI

District Hospitals are in the Secondary Tier of the Malawi Health System. They act as referral hospitals for health centres and house both inpatient and outpatient services. District Hospitals are mainly located in rural Malawi whereas Central Hospitals are mainly found in urban cities. Under the Malawi Ministry of Health, there are about 26 government district hospitals. Other district AND OR community hospitals are under CHAM (Christian Health Associaton of Malawi). Most of the clinical work done in District Hospitals are spread out between doctors, nurses, and medical assistants. Typically, there is 1 minimum doctor per district hospital and 3 maximum. There is a range of 30-75 nurses available in District Hospitals and a range of 10-30 medical assistants. As per beds, district hospitals will typically house 150-300 inpatient beds.

MATERNITY IN DISTRICT HOSPITALS

Unlike Health Centres, District Hospitals cater to a catchment population of about 150,000. District Hospitals provide ante-natal clinic services, as well as L&D services (labor and delivery), surgery, and maternity waiting areas. On average, there are 30-40 deliverys per day in district hospitals. All beds are usually full which forced some women to take up floor and corridor space. Since this is a referral hospital, women who usually come here are reffered from a health centre due to possible complication and the needs for surgery.

RESEARCH QUESTION

"Research Question To Come During Schematic Design"

RESEARCH QUESTION

"How can maternity wards designed to address infection control strategies through spatial organization and ventilation improve maternal outcomes in district hospitals?

CASE STUDY: DOMASI DISTRICT HOSPITAL

BACKGROUND

Domasi Hospital is located in the Southern region of Malawi. It is a fully funded government project in an effort to decongest the amount of people attending the Zomba Central Hospital, located East of Domasi.

The construction of the facility began in 2012 and was completed in 2018. The fairly new facility is now able to provide services such as maternity and PEDs which aren't available in the nearby Domasi Rural Hospital.

This scheme works well in the use of adjacencies. Labour and Delivery for instance are right across the Surgery Theater and to the right of the antenatal clincs. Just behind the Surgery Theater but still separate is the Maternity Waiting Home.

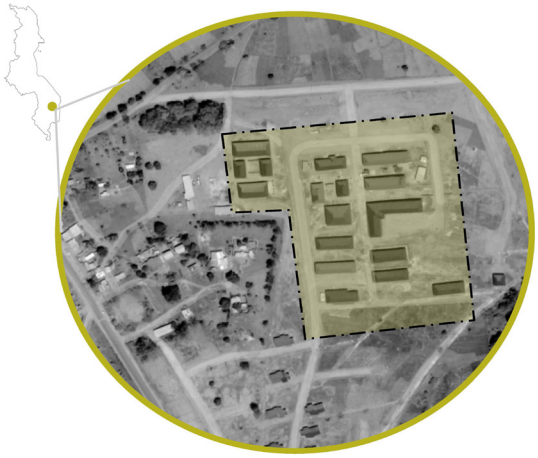


FIGURE 1: REGION IN MALAWI AND SITE IMAGE

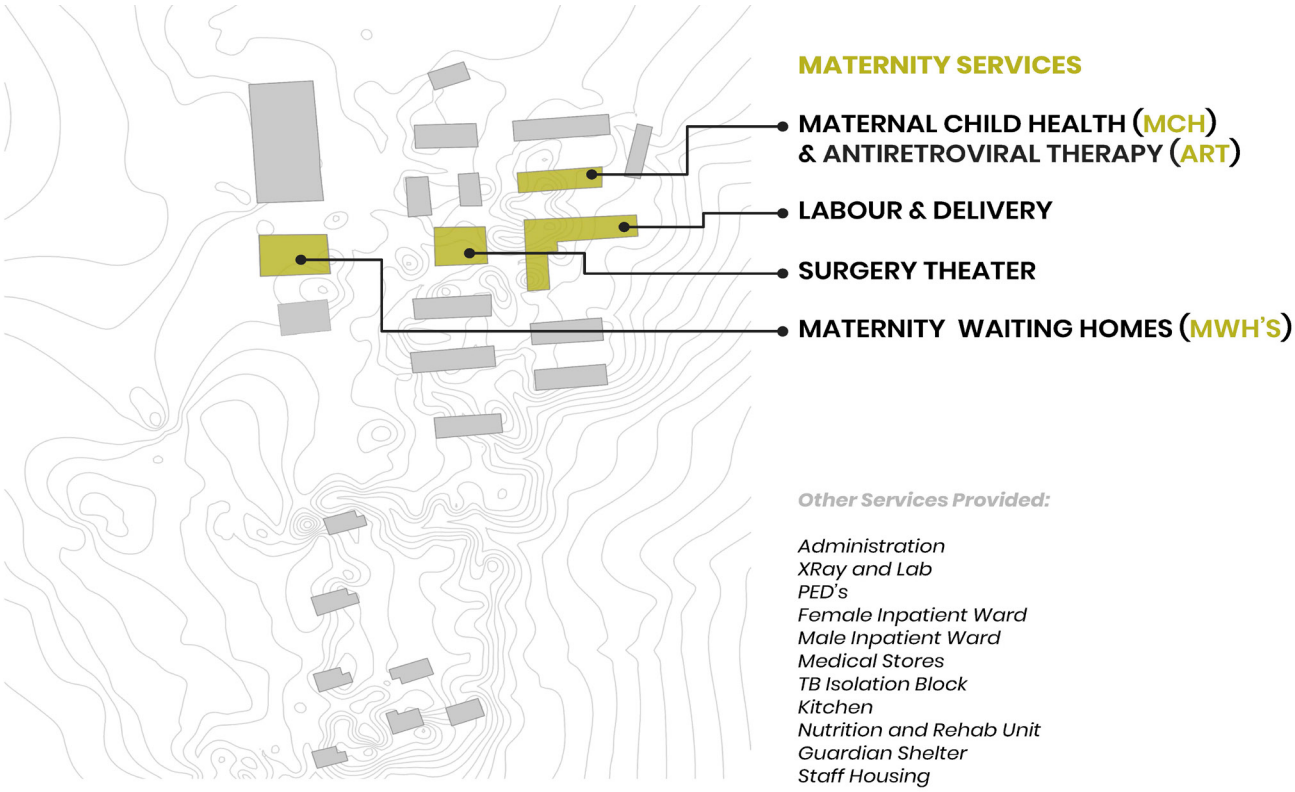


FIGURE 3: SITE PLAN AND SERVICES

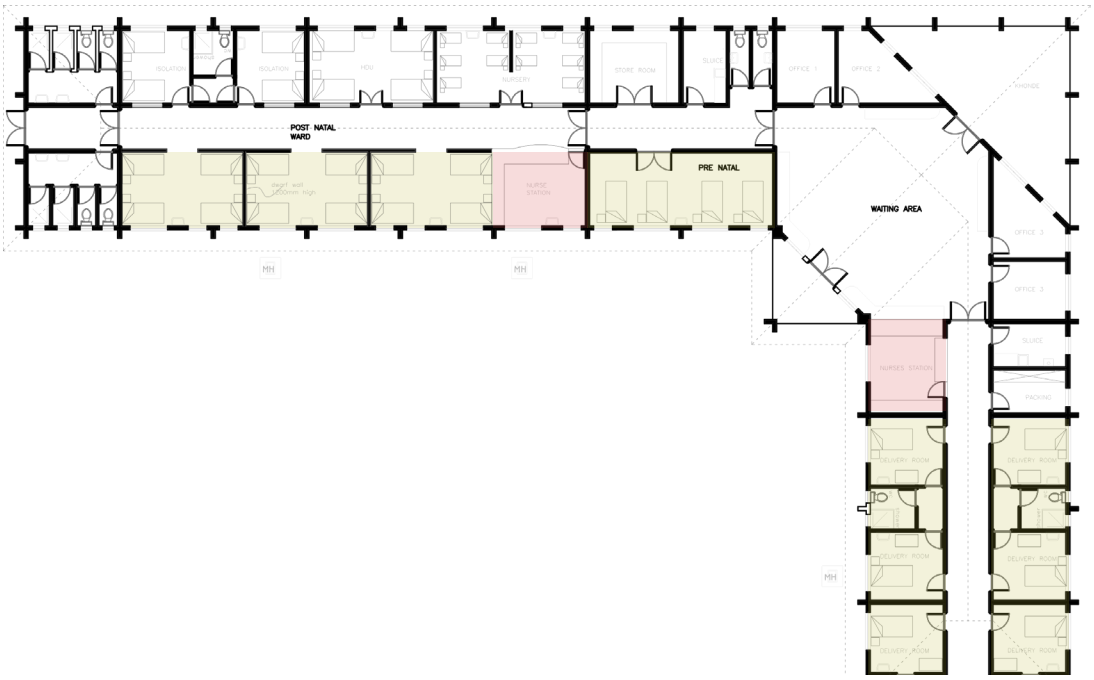


FIGURE 4: FLOOR PLAN OF MATERNITY BLOCK

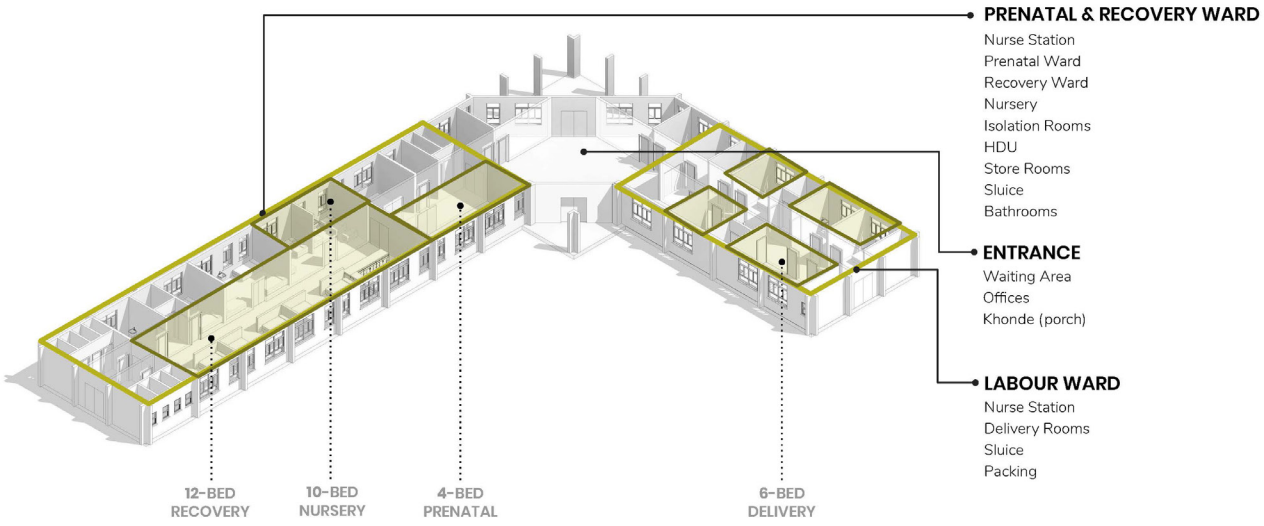


FIGURE 5: PROGRAMMATIC DISTRIBUTION

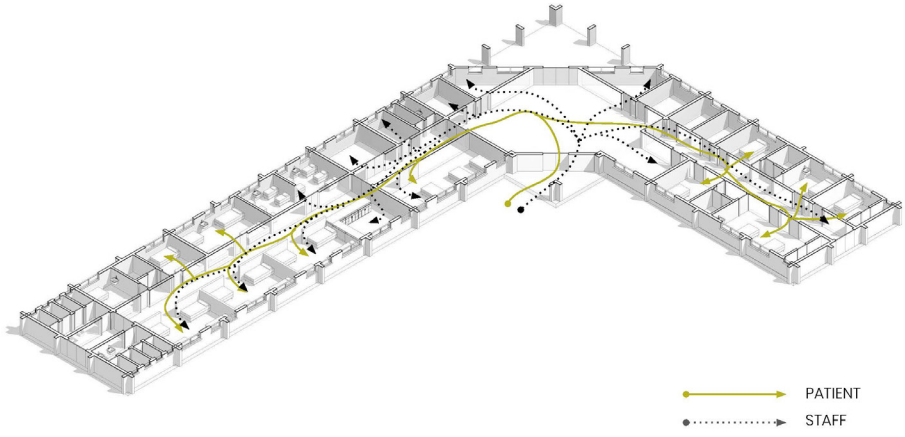


FIGURE 6: CIRCULATION

SLUICE	4
NURSERY	5
DELIVERY (CLOSEST)	6
PRENETAL	9
OFFICE	10
RECOVERY (CLOSEST)	12
WAITING AREA	14
DELIVERY (FURTHEST)	17
ISOLATION ROOMS	23
RECOVERY (FURTHEST)	28
RESTROOMS	30

FIGURE 7: NUMBER OF STEPS TO FROM NURSE STATION

PROGRAM + CIRCULATION ANALYSIS

PROGRAM

The L shape scheme lays out the program in such a way that separates maternity into two wings. One wing takes care of prenatal and recovery while the other wing strictly ofcuses on delivery and labour. Other programmatic spaces that are also important to this scheme is the entrance which holds the interior space for waiting, offices, as well as a khonde, which is another word for porch in Malawi.

PATIENT CIRCULATION

From a patient perspective, a woman enters into the ward through the middle of the L scheme where the waiting room is. They are then taken to the prenatal room where there are 4 beds. Once they are ready to deliver, they are taken to the other wing into their own delivery room. There are 6 available rooms. One the women is done delivering, they are ready to recover in the other wing where there is direct views to the nurse station.

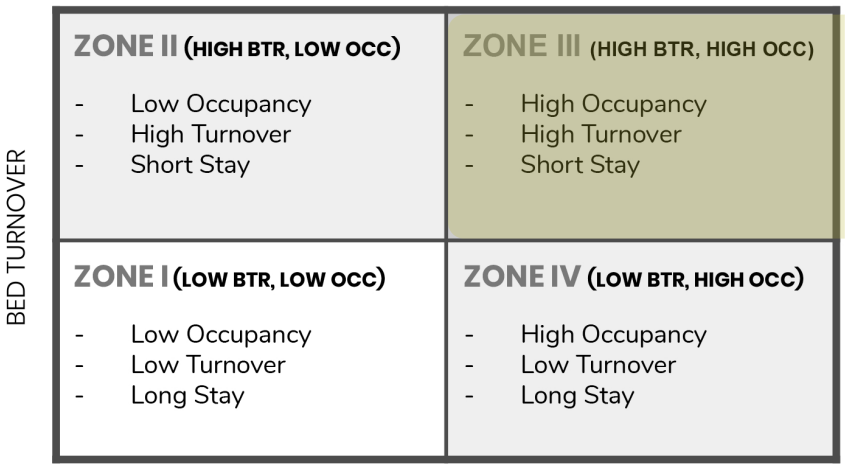
STAFF CIRCULATION

Staff are able to enter the same place where patients do. Their offices are located right by waiting area which make them very accessible. Staff have access to all spaces and one main take away from this design scheme is the decision to have two nurse stations instead of one central station in order to accomodate both wings.

DISTANCES

The closets rooms to the nurses station are sluice, nursey and delivery. The furthest travel are the restrooms which makes sense in the context of Malawi given the way restrooms are misued and can create noise and smell. The main take away from this study is that having 2 nurses station increases efficiency in terms of a more direct focus on delivery separately from recovery and prenatal.

Zone Rating: 3 because district hospitals have high occupancy but this scheme allows women to have higher turnoever rates due to an increased amount of space



INFECTION CONTROL ANALYSIS

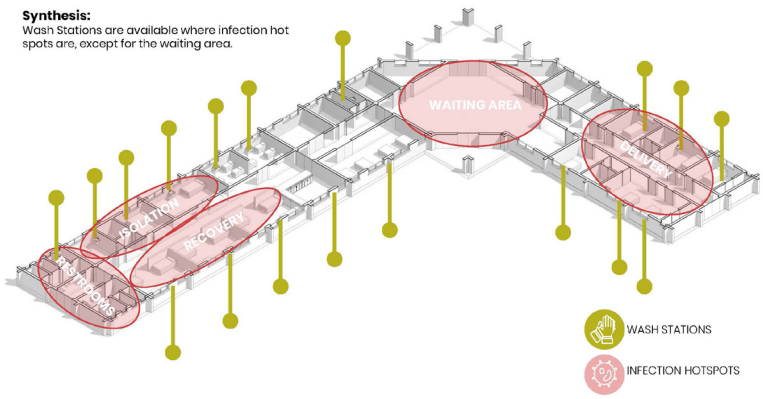


FIGURE 7: WASH SHATIONS AND HOTSPOTS

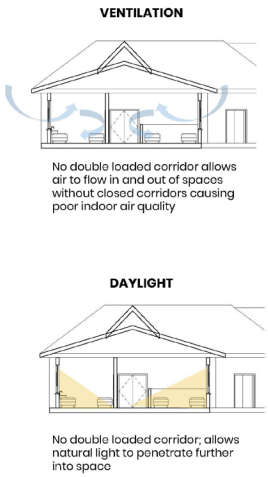


FIGURE 8: VENTILATION + DAYLIGHTING

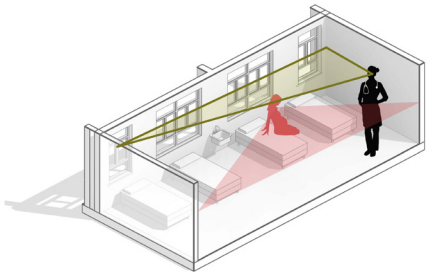
HOT SPOTS FOR INFECTION

The main hotspots for an infection is highlighted in the diagram. However, they key hotspots are recovery, isolation rooms, restrooms, and delivery. This is because this is where most bodily fluids are present and there is more contact with nearby women who may or may not be infected after delivery. However, due to the L shaped scheme, restrooms are able to be at the furthest end of the wing. The availability of sinks allows the practice of hand hygiene in this scheme.

VENTILATION + DAYLIGHTING

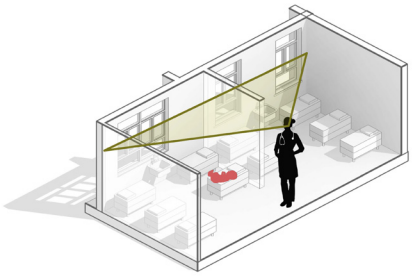
The way this scheme addresses daylighting is very different in each ward. In prenatal, light enters the space but doesn't reach the corridor, whereas the design of the recovery ward sharing the corridor floor allows light to filter all the way through. The way daylight enters the delivery room is different because of the need for privacy. Each individual room has its own window which is beneficial for ventilation. Ventilation works well in this scheme such that most doors and windows line up with one another to allow cross-ventilation. However, the scheme still uses a double-loaded corridor type which is problmeatic for air that may not be ventilated properly. Therefore, this design can be improved by incorporating strategies that allow light into the corridor and simultaneously allowing hot and dirty air to filter out from the building.

WARD ANALYSIS



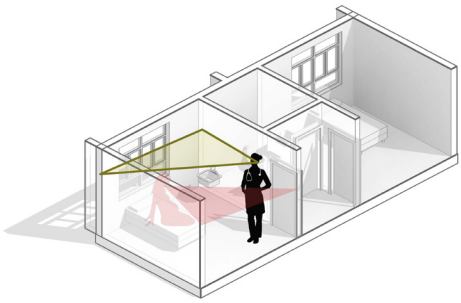
PRENATAL WARD

Area: 30.8 sq. meters
Beds: 4
Bed Spacing: 1m
Privacy: Low
Staff Vision: Facing Beds and Windows
Patient Vision: Facing Wall
Nurse Station: 9 steps from door
Privacy Level: ****



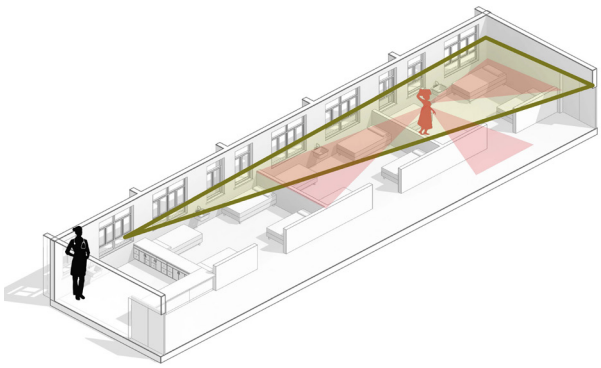
NURSERY

Area: 25 sq. meters
Beds: 10
Bed Spacing: .5m
Privacy: Low
Staff Vision: Divided by Wall
Patient Vision: N/A
Nurse Station: 5 steps from door
Privacy Level: N/A



DELIVERY WARD

Area: 11.5 sq. meters
Beds: 1 per room (6 total)
Bed Spacing: Indv. Rooms
Privacy: Very High
Staff Vision: Facing Patient and Windows
Patient Vision: Facing Wall
Nurse Station: 6-17 steps from door
Privacy Level: ****



RECOVERY WARD

Area: 62 sq. meters
Beds: 12 (4 per bay)
Bed Spacing: 1m
Privacy: Medium
Staff Vision: Facing All
Patient Vision: Bay View
Nurse Station: 12-28 steps from door
Privacy Level: ****

EXEMPLARY CASE STUDY: RWINKWAVU MATERNITY BLOCK

BACKGROUND

Located in Kayonza DIstrict of Rwanda, this exemplary case study showcases a NICU ward, a branch of maternity in the larger scale facilities. Rwuinkwavu Hospital was finished in 2014 by Mass Design Group. What is notable about this design is the Surgery and NICU Block.

The overall area of this hospital is 1,294 sq. m. Clients for this project are the Rwanda Ministry of Health and Partners In Health. The hospital closed back in 1994 during a genocide in which Mass took on the project to redesign and build Surgery and NICU. The concept for the design allows an array of steps going from Maternity, to Surgery, and to NICU. The NICU in this study consists of a kangaroo ward, a mum's ward, and a NICU for babies connected by a central Nurse Station.

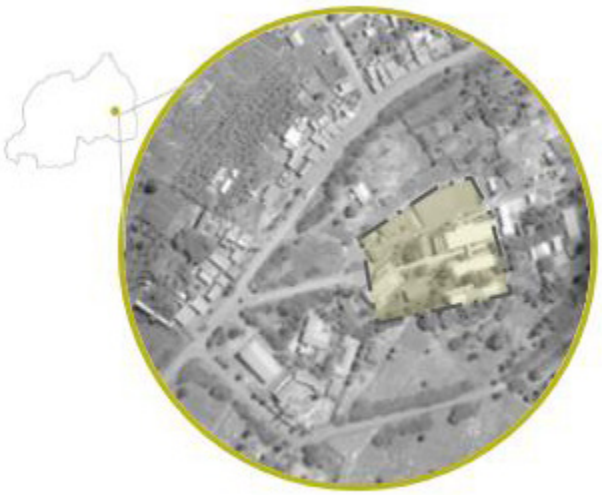


FIGURE 9: REGION IN RWANDA AND SITE IMAGE

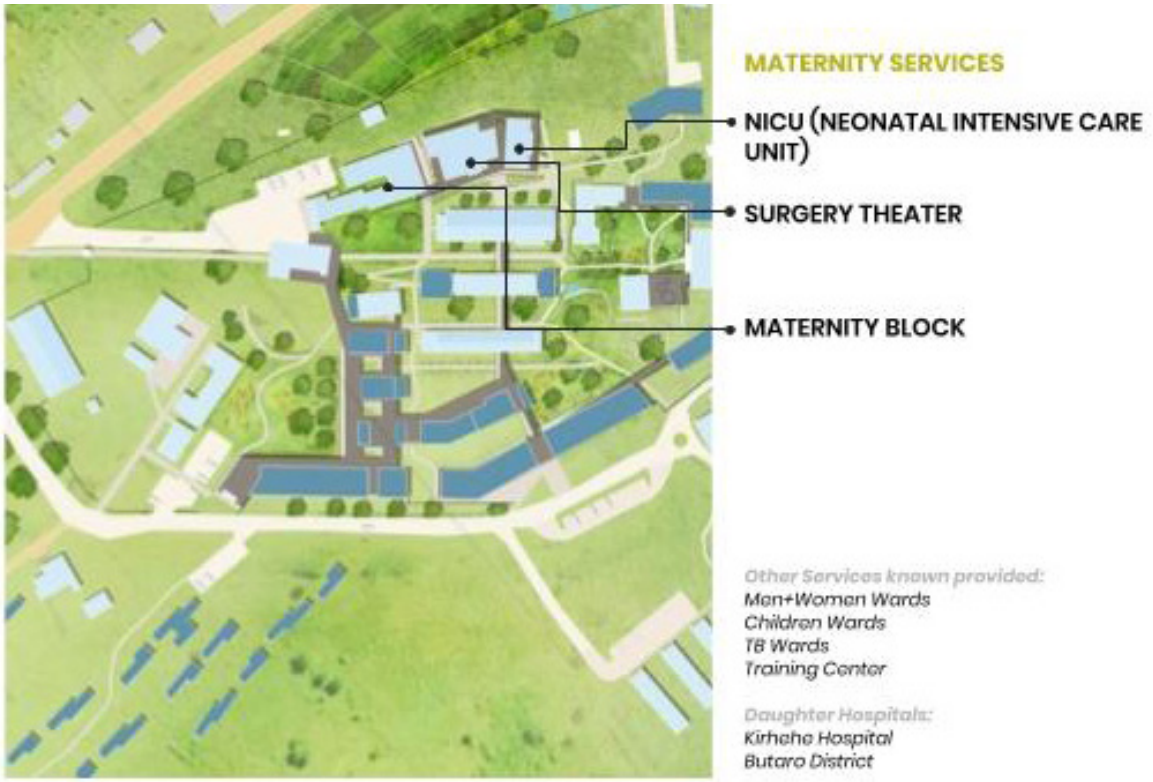


FIGURE 10: SITE PLAN AND SERVICES

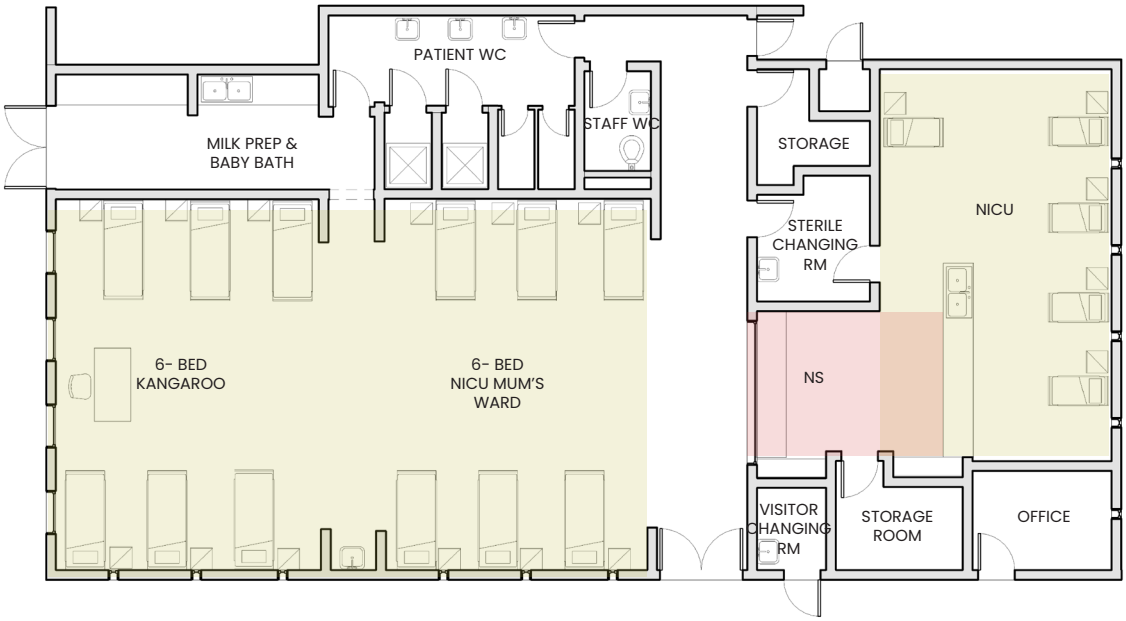


FIGURE 11: FLOOR PLAN OF MATERNITY BLOCK

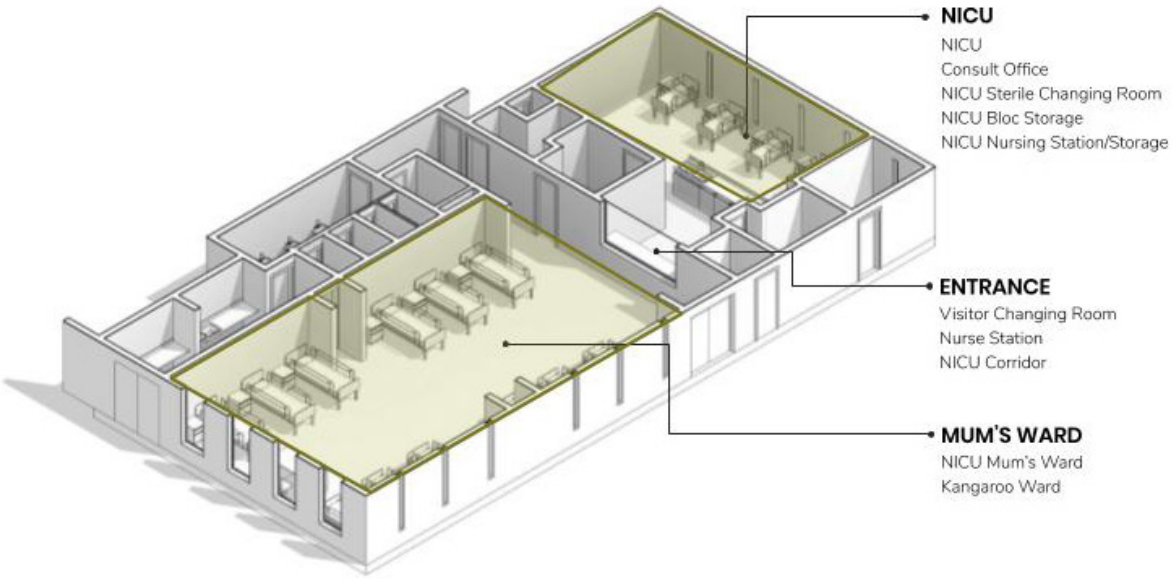


FIGURE 12: PROGRAMMATIC DISTRIBUTION

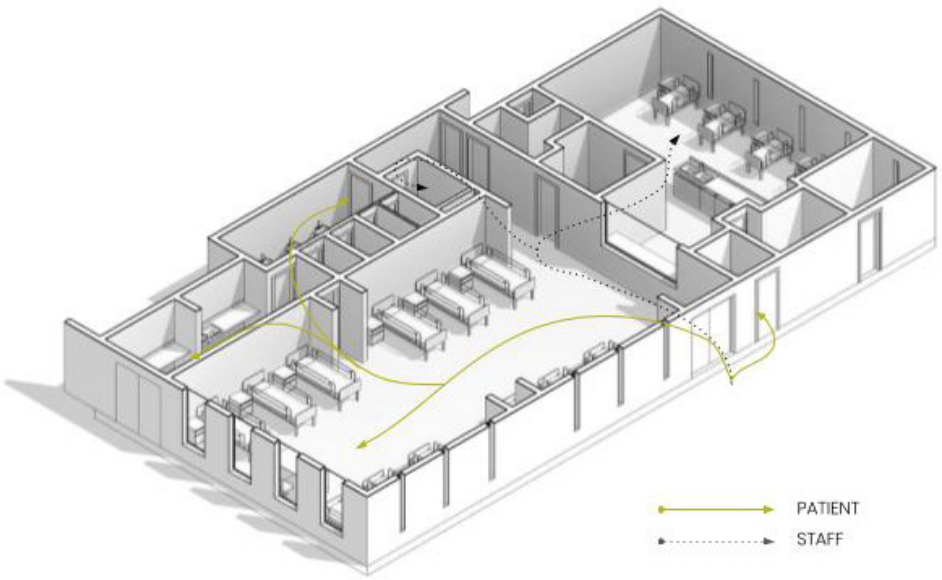


FIGURE 13: CIRCULATION

STERILE CHANGING RM	5
NICU MUM'S WARD	7
NICU	10
STAFF WC	10
NICU CONSULT OFFICE	14
KANGAROO CARE	15
MILK PREP	18
PATIENT WC	20
BABY BATH	22

FIGURE 7: NUMBER OF STEPS TO FROM NURSE STATION

PROGRAM + CIRCULATION ANALYSIS

PROGRAM

This case study sets up a good example for understanding the programatic needs of NICU. In this case, we see the baby NICU and the Mum's NICU separated by the central Nurse's Station. The Mum's NICU and Kangaroo Wards are in open ward layouts. Connected to it are Baby Prep and Milk Prep Stations as well as a WC.

PATIENT CIRCULATION

From a patient perspective, a woman enters into the ward through the main entrance. There is also a room to the right for visitor's who need to change. In the open wards, women are able to rest and spend time with their babies. This one on one time and skin to skin contact is referred to as the kangaroo strategy, which is very common in Rwanda and in most of Mass' Designs for maternity.

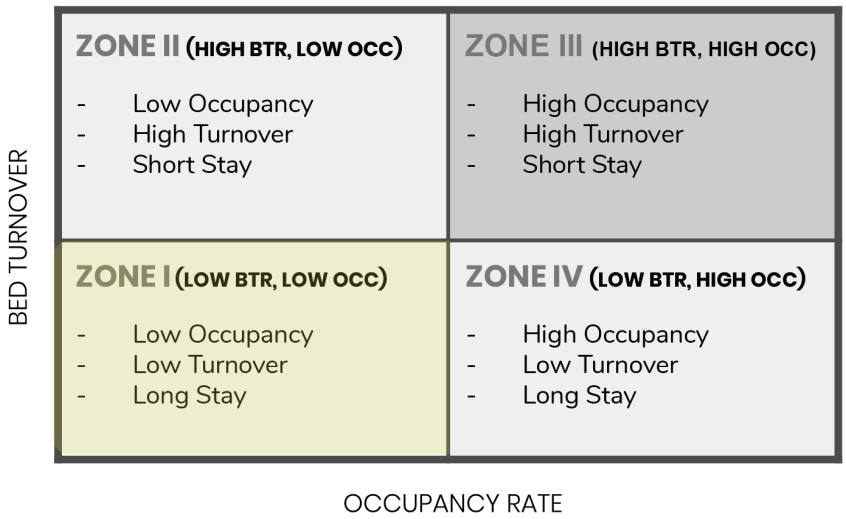
STAFF CIRCULATION

Staff have separate entrances. When they enter, they have their own staff WC. In order to enter the NICU, nurses have to go through the sterile changing room. This ensures that anyone going to the NICU was clean and safe for the babies in intensive care.

DISTANCES

The closets rooms to the nurses station are the sterile changing rooms, the mum's ward as wellas the main ward. Distances are pretty short in this scenario which is good for both the nurse and the mothers because nurses are able to have direct views of the babies and the mom's at the same time. Mothers are also able to have clear views of the babies through the glass from the main ward. This can help make mothers feel like their child is being taken care of while still ensuring a level of distance.

This particular study, we believe is Zone Rating: 1 because due to it being a NICU, there is a much longer time span for mothers in the beds. Given examples in images, turnover rates arepretty low and occupany in low as well.



INFECTION CONTROL ANALYSIS

HOT SPOTS FOR INFECTION

The main hotspots for an infection is highlighted in the diagram: Mum's Open Wards and the WC. The reasoning for this is that there is little privacy between women and infection can easily be shared between the women sharing the space if precautions aren't considered. There are three sinks in the WC and on in the Baby Prep Area. However, we don't think that one sink is sufficient enough for the two open wards. As seen in other example, a ratio of 1 sink to 4 bed seems reasonable. Since there is a total of 12 beds, there has to be a minimum of 3 in the open ward to project the importance of hand hygiene.

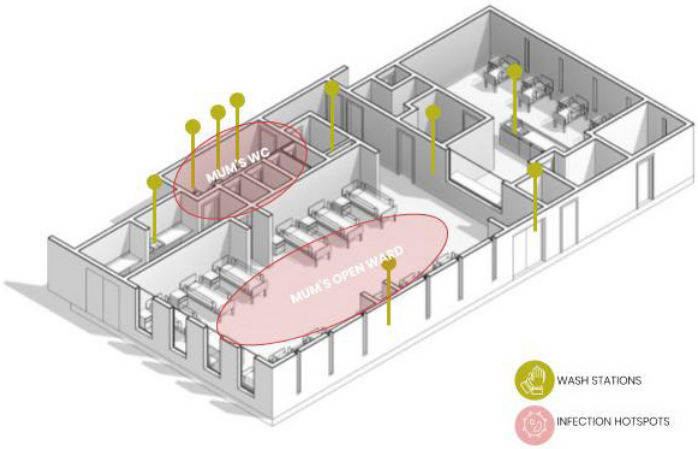


FIGURE 14: WASH SHATIONS AND HOTSPOTS

VENTILATION + DAYLIGHTING

The way this scheme addresses daylighting and ventilation is very different in most of the case studies we've looked at so far. In this case, they used stacked ventilation throughout the whole scheme. By doing so, cool air that comes into the building that is then polluted by airborne particles as well heat in the building can rise up and be naturally vent out. This scheme does two things at once where not only does it allow air to ventilate out but it also creates a sunroof, allowing a lot of light to enter into the center of the ward.

This can be a potential future design inspiration for maternity ward designs in order to bring light into really tight and dark corridors as well as open wards such as these.

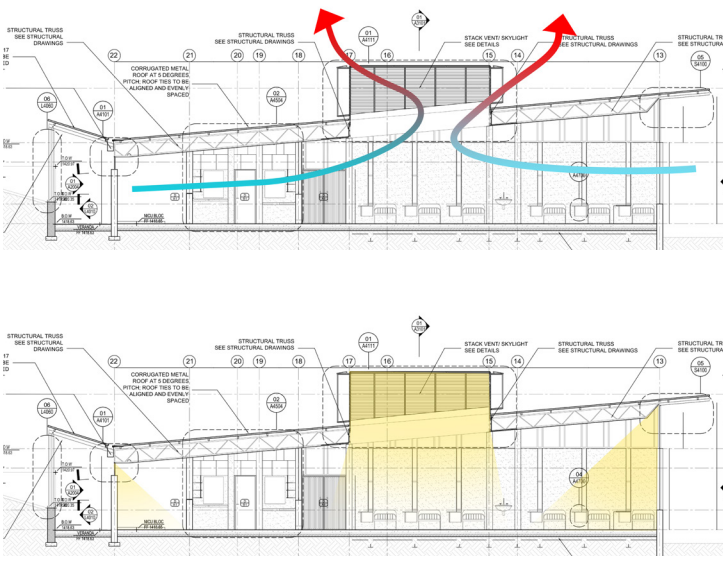
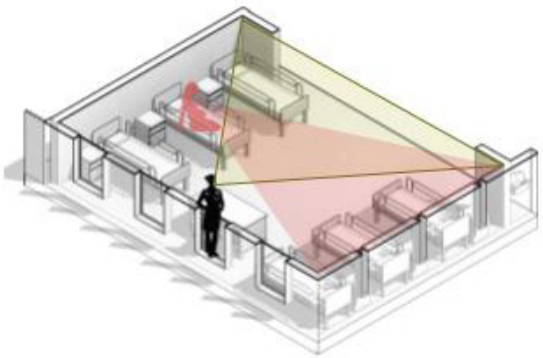


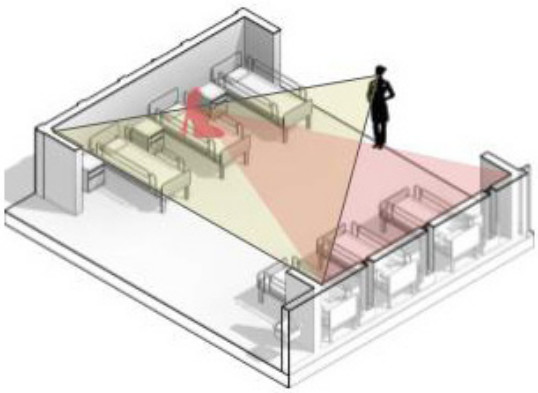
FIGURE 15: VENTILATION + DAYLIGHTING

NICU WARD ANALYSIS



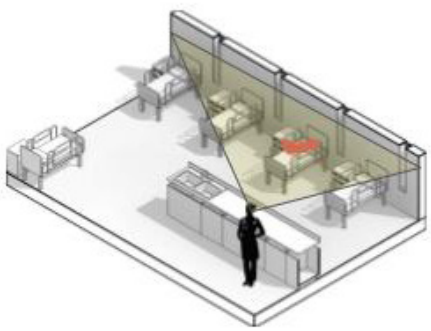
KANGAROO CARE WARD

Beds: 6
Bed Spacing:
Privacy: Low
Staff Vision: Facing Patient and NS
Patient Vision: Other beds
Nurse Station: 15 steps
Privacy Level: *****



NICU MUM'S WARD

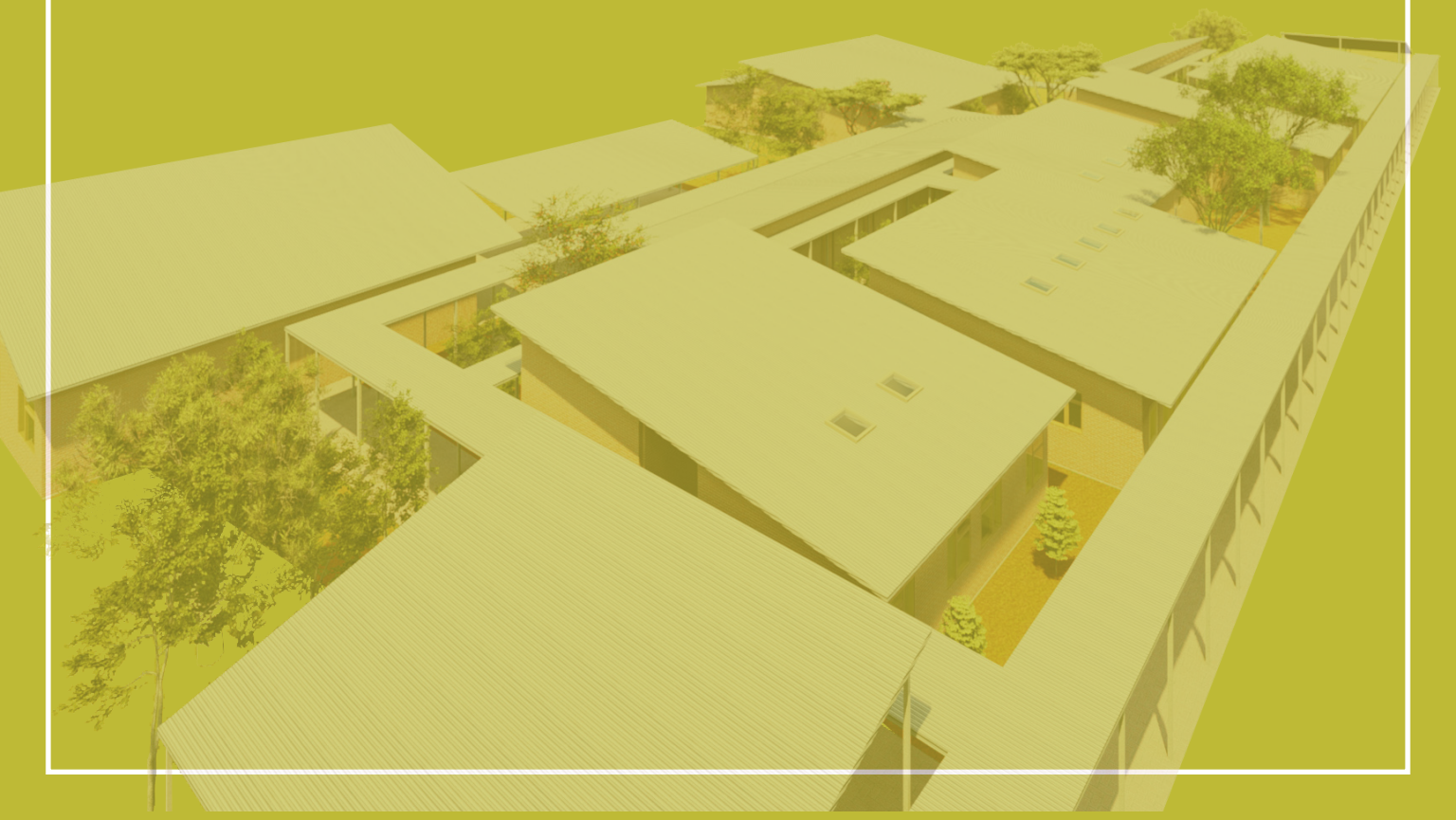
Beds: 6
Bed Spacing:
Privacy: Low
Staff Vision: Facing Patient and Windows
Patient Vision: Facing Other Beds
Nurse Station: 7 steps
Privacy Level: *****



NICU

Beds: 5
Bed Spacing:
Privacy: N/A
Staff Vision: Facing Patient and Windows
Nurse Station: 10 steps from door

DISTRICT HOSPITAL SCALE DESIGN PROPOSAL



DESIGN SKETCHES

TYPOLOGY

For this district hospital scheme, the straight typology was preferred rather than an L or U shape scheme. This is because typical maternity blocks in district hospitals are laid out this way. By applying this typology, we are able to compare how a revised linear typology compares to the typical linear typology commonly found. The bubble diagram below shows the three different delivery paths through the program spaces left to right. The linear typology is beneficial because paths of patients do not cross and everything happens one way.

INTENTIONS

The intention for the linear typology is to replicate the process of delivery from a step by step process into a step by step programmatic set up. This considers key adjacencies for the main wards and allows three circulation paths: one for visitors and family, one for staff, and one for patients. This linear typology differs from the typical maternity typology because where there is one main circulation path in the typical ward, this revised ward has multiple circulation paths and limits the use of double loaded corridors.

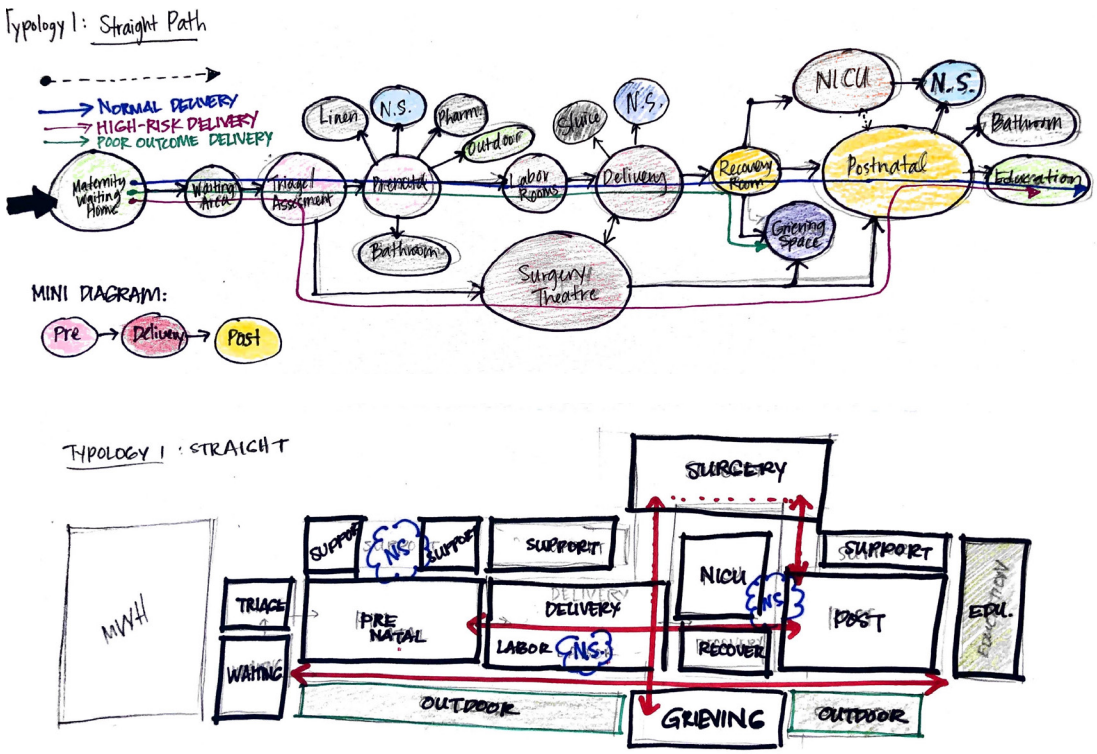
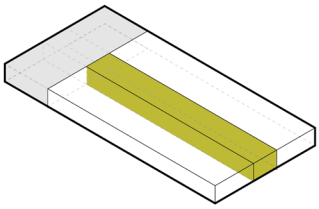
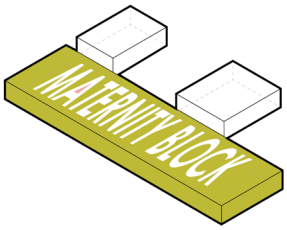


FIGURE 16: DESIGN SKETCHES

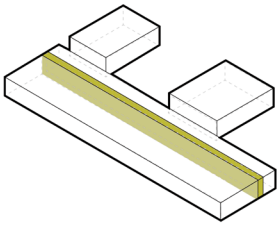
DESIGN CONCEPT



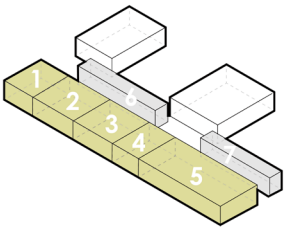
TYPICAL MATERNITY BLOCK
Typical maternity blocks have a central double loaded corridors with support spaces at the end. This is problematic for wards because only one side gets views out and corridors become poorly ventilated and very dark.



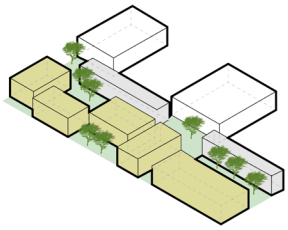
DESIGN STEP 1: ADJACENCY TO MWH AND SURGERY
First step in re-designing the typical maternity block is by ensuring that it is accessible from Maternity Waiting Homes and the Surgery Theater. By placing them strategically, we are able to decrease walking distances for staff and patients.



DESIGN STEP 2: OUTDOOR CIRCULATION
This small separation in the maternity block that isn't central compared to the typical ward will separate support spaces from wards. By doing so we separate server and served.



DESIGN STEP 3: DIVIDING BLOCKS
The maternity block is divided into 5 sections, each with different program use. Support spaces are also divided into 2 sections in order to create better access to Surgery and open space for staff accomodations.



DESIGN STEP 4: SHIFTING BLOCKS AND COURTYARDS
Each block in maternity gets shifted up or down in order to create openings for outdoor courtyard spaces. Each block is also separated in between in order to be accessed by staff.

FLOOR PLAN

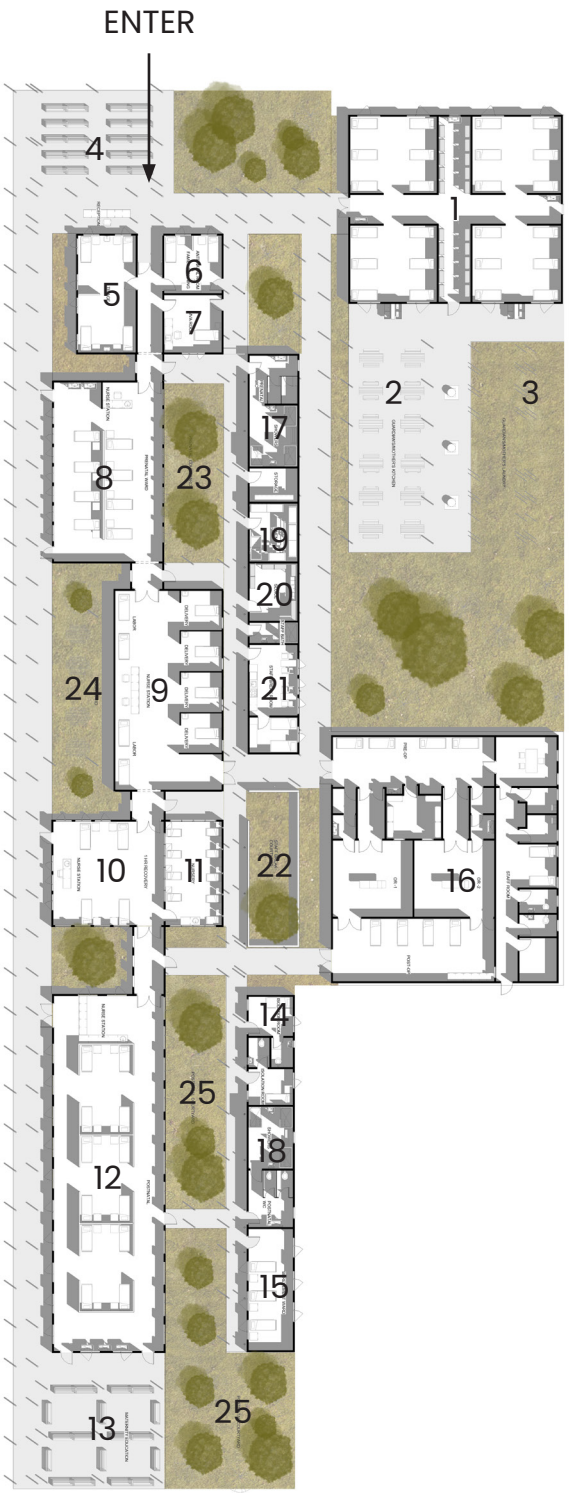
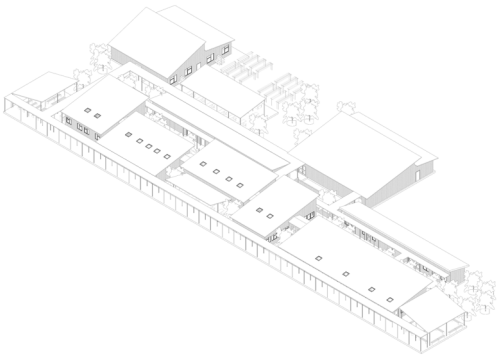


FIGURE 17: FLOOR PLAN

Given the limitations of this project, there is no assigned site location. However, the plan is oriented North. This orientation allows efficient use of eastern winds to cool down the buildings, as well as plenty of light in the wards.

The waiting area is located at the top left near the MWH. This waiting area has a direct access to reception and triage for monthly examinations. When a woman is checked-in and given a bed, they are directed into the prenatal ward, the next block over. There is access to an outdoor bathroom as well for patients. The next block over is delivery which follows recovery and postnatal.

What is notable about this floor plan is the use of outdoor circulation which will improve patient and staff satisfaction as well as address infection control.



PLAN KEY

MATERNITY WAITING HOME
1- SLEEPING QUARTERS
2-OUTDOOR KITCHEN/DINING
3-LAUNDRY

MATERNITY BLOCK
4-MATERNITY WAITING
5-TRIAGE
6-FAMILY PLANNING
7-MVA ROOM
8-PRENATAL WARD
9-DELIVERY WARD
10-RECOVERY
11-NURSERY
12-POSTNATAL
13-EDUCATION AREA
14-ISOLATION ROOMS
15-BEREAVEMENT ROOM

SURGERY THEATER
16-SURGERY

SUPPORT
17-PRENATAL BATHROOMS
18-POSTNATAL BATHROOMS
19-LINEN
20-SLUICE
21- STAFF BREAK ROOM

COURTYARDS
22- STAFF OUTDOOR SPACE
23- PRENATAL COURTYARD
24-DELIVERY COURTYARD
25-POSTNATAL COURTYARD

PROGRAM DIAGRAMS

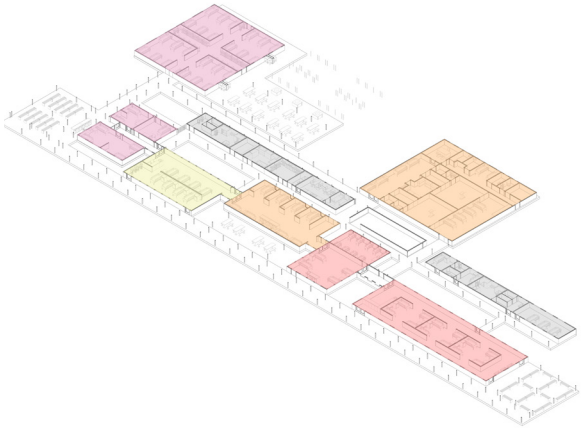
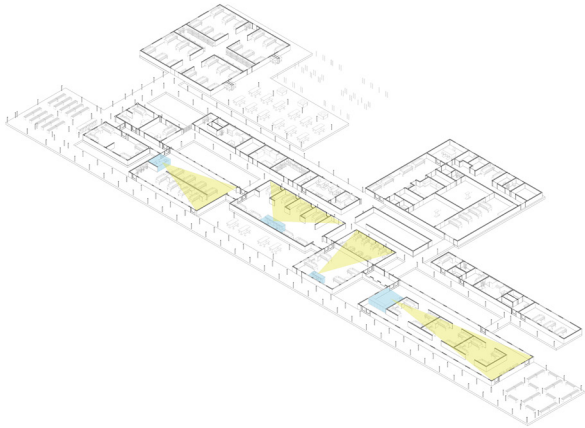


FIGURE 18: PROGRAM SPACES



FIGUER 19: NURSE STATION AND NURSE VIEWS

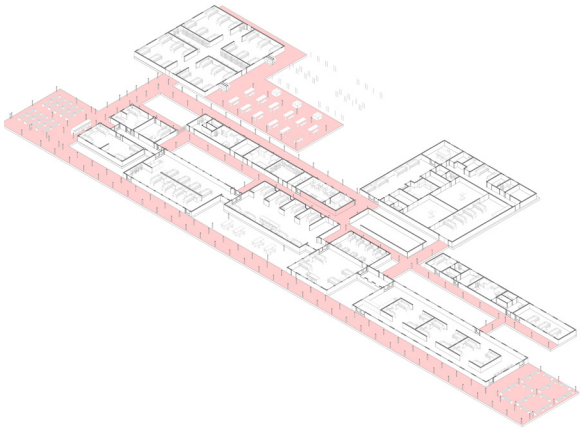


FIGURE 20: COVERED WALKWAYS

FIGURE 21: GREEN SPACES

CIRCULATION

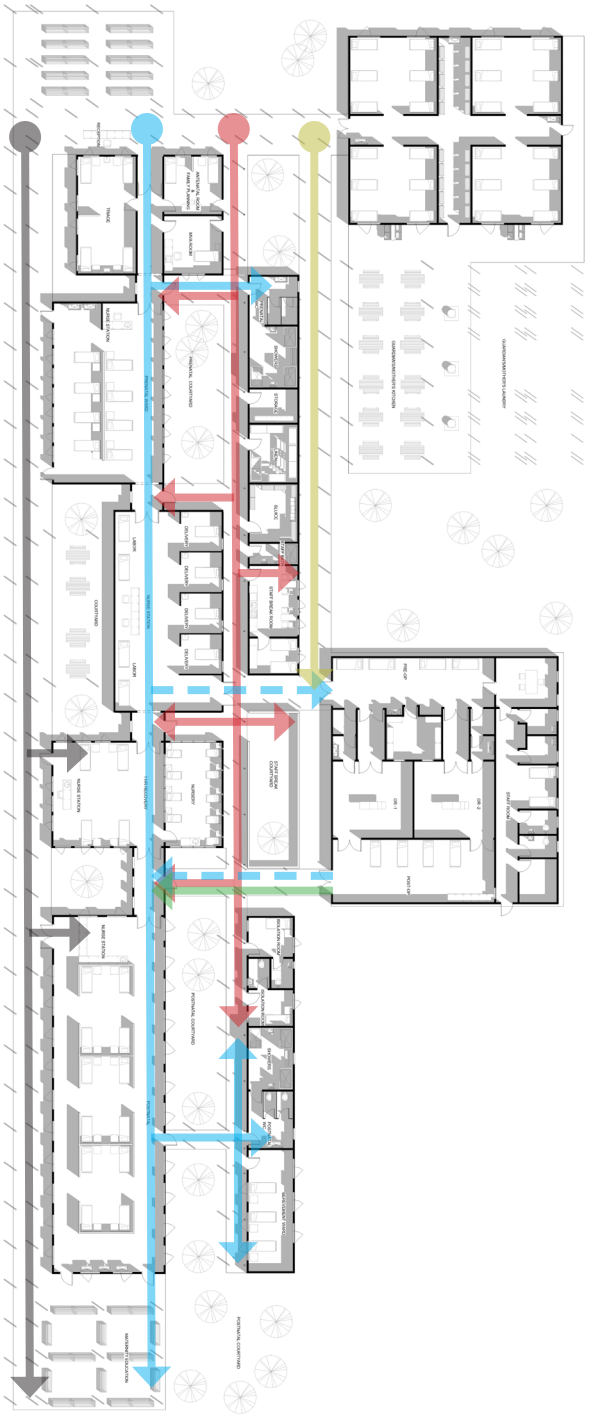
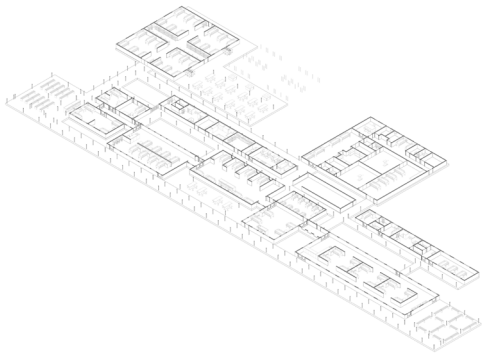


FIGURE 22: CIRCULATION DIAGRAM

There are four main circulation paths in this design scheme, each catering to a patient need, a family need, and a staff need. The blue lines represent patient flow for both natural delivery and emergency c-sections. The dotted lines show the the idea proximity of a delivery ward to the Surgery Theater. Green line represents awoman's path who is having a planned c-section where they are taking through a back route straight to surgery without passing the inside of the maternity wards. The red lines represent the private staff circulation. There are a few moments where this circulation crosses paths with a patient but only for bathroom access and surgery access. The staff circulation leads down a middle covered walkway with small access ways to the wards to provide efficient circulation. Lastly, the blank line represents the path of visitors and family who are able to come in during recovery and postnatal periods.



CIRCULATION KEY

- NATURAL DELIVERY
- EMERGENCY C-SECTION
- PLANNED C-SECTION
- STAFF
- VISITORS AND FAMILY

PRENATAL WARD

1 Exterior Covered Circulation

2 Wash Station (Foot Lever)

3 Nurse Station

4 Exit to Prenatal Bathrooms

5 4' Wall Divider

6 Operable Windows to Courtyard

7 White Painted Walls to increase light

8 Staff Access to Wards

9 Ceiling Fans and Operable Skylights

10 High Vents

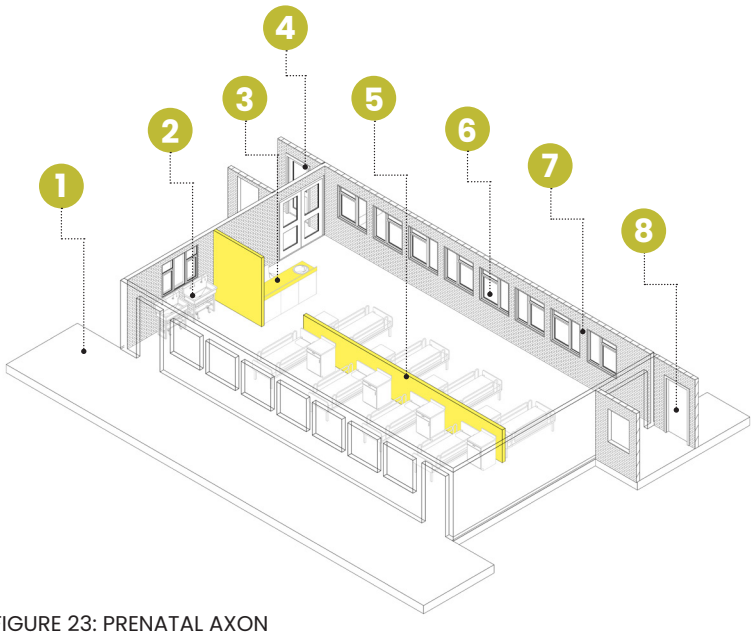


FIGURE 23: PRENATAL AXON

FIGURE 24: PRENATAL WARD

DELIVERY WARD

1 Staff Access to Wards

2 Labor Beds

3 Small Operable Windows for Privacy

4 Nurse Station

5 Sink in Indv. Rooms

6 High Vents

7 Exit to Surgery Theater

8 Staff Access to Wards

9 Ceiling Fans and Operable Skylights

10 Vents

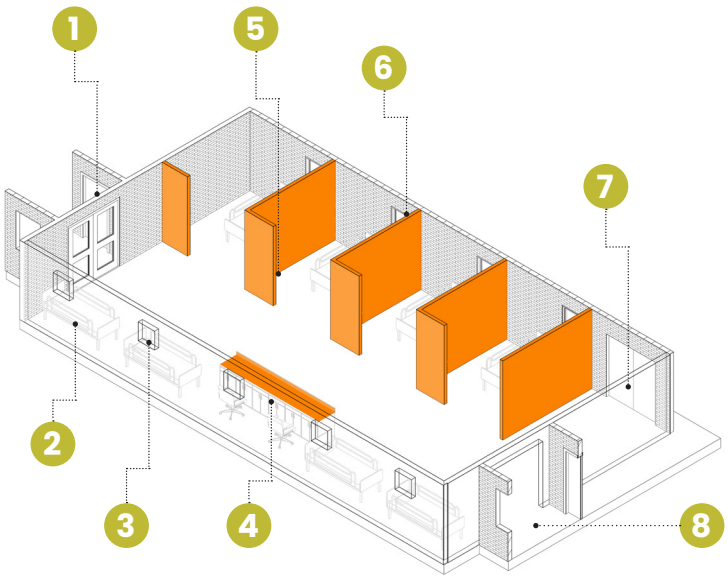


FIGURE 25: DELIVERY AXON

FIGURE 26: PRENATAL WARD

POSTNATAL WARD

1 Exterior Covered Circulation

2 Nurse Station

3 Staff Access to Wards

4 Operable Windows to Courtyard

5 White Painted Walls to Increase Light

6 4' Bay Walls

7 Exit to Outdoor Postnatal Bathrooms

8 Handwashing Stations (Foot Lever)

9 Exit to Outdoor Education Area

10 Ceiling Fans and Operable Skylights

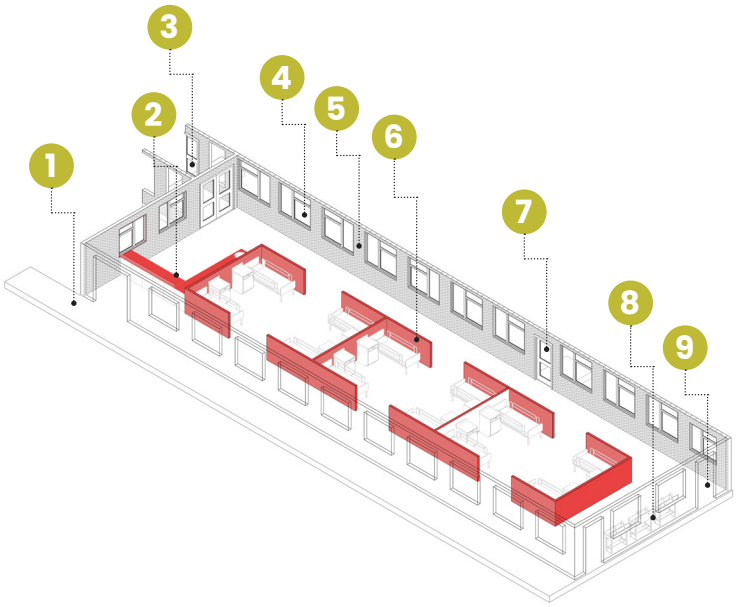


FIGURE 27: PRENATAL AXON

FIGURE 28: PRENATAL WARD

VENTILATION AND LIGHTING

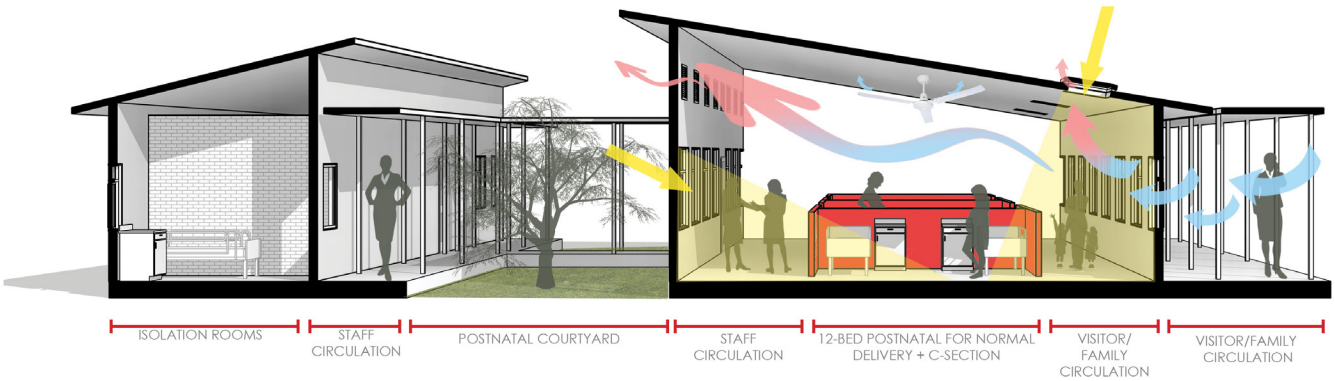


FIGURE 29: SECTION OF POSTNATAL WARD

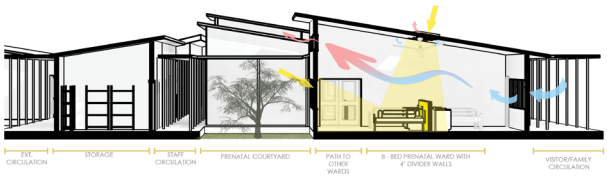


FIGURE 30: SECTION OF PRENATAL WARD

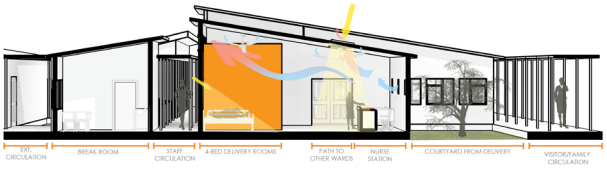


FIGURE 31: SECTION OF DELIVERY WARD

VENTILATION

Due to the angled roof, and the open courtyard and walkway on both sides, air is able to come across the building allowing for cross ventilation. Cool air comes into the building and keeps patients comfortable. The ceiling fan helps cool the air. As heat rises, it escapes through the vents and the operable skylights.

Compared to typical wards with no vents and no angled roofs, air that comes into wards are poorly ventilated and decreases comfort levels for patients, especially during high stress.

LIGHTING

Each ward is given an ample amount of windows, all operable in order to allow cool air in views out. At the same time, plenty of light can filter into the space in order to prevent dark spaces for patients to be in. When wards are dark, they become very unpleasant spaces for patients. By allowing windows on almost all sides of the building, we ensure that during the day, there is plenty of light to fill the space. The white painted walls also play a role in makin g the space feel brighter and cleaner to improve patient and staff satisdaction.

QUALITY OF CARE ANALYSIS

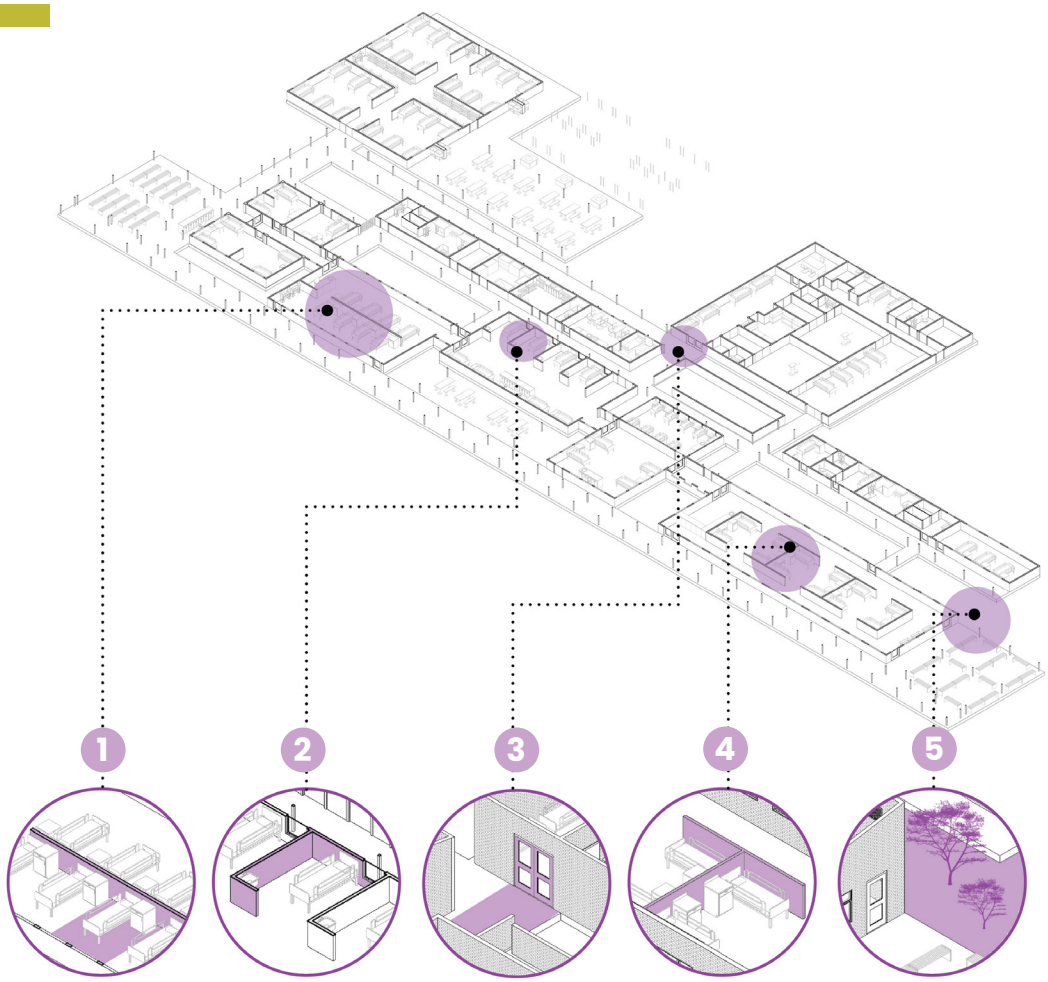


FIGURE 32: QUALITY OF CARE

1_PATIENT PERSONAL SPACE Prenatal wards don't require as much privacy but layout allows for enough personal space between patients

2_DELIVERY PRIVACY Delivery requires the most privacy. There are divider walls but no doors which allow for easy access from nurse

3_QUICK SURGERY ACCESS Travel from delivery to Surgery is a very critical time for a woman giving birth. Quick access helps reduce mortality and increase efficiency

4_SEPARATION IN POSTNATAL Women in postnatal need to be separated depending on whether you had a natural birth or had a c-section. Bays allow easy ways divide women.

5_CONNECTION TO OUTDOORS All wards have access and views to the outdoors. This embraces Malawian women's culture to walk around during the birthing process and spend more time outside than in as much as possible.

INFECTION CONTROL ANALYSIS

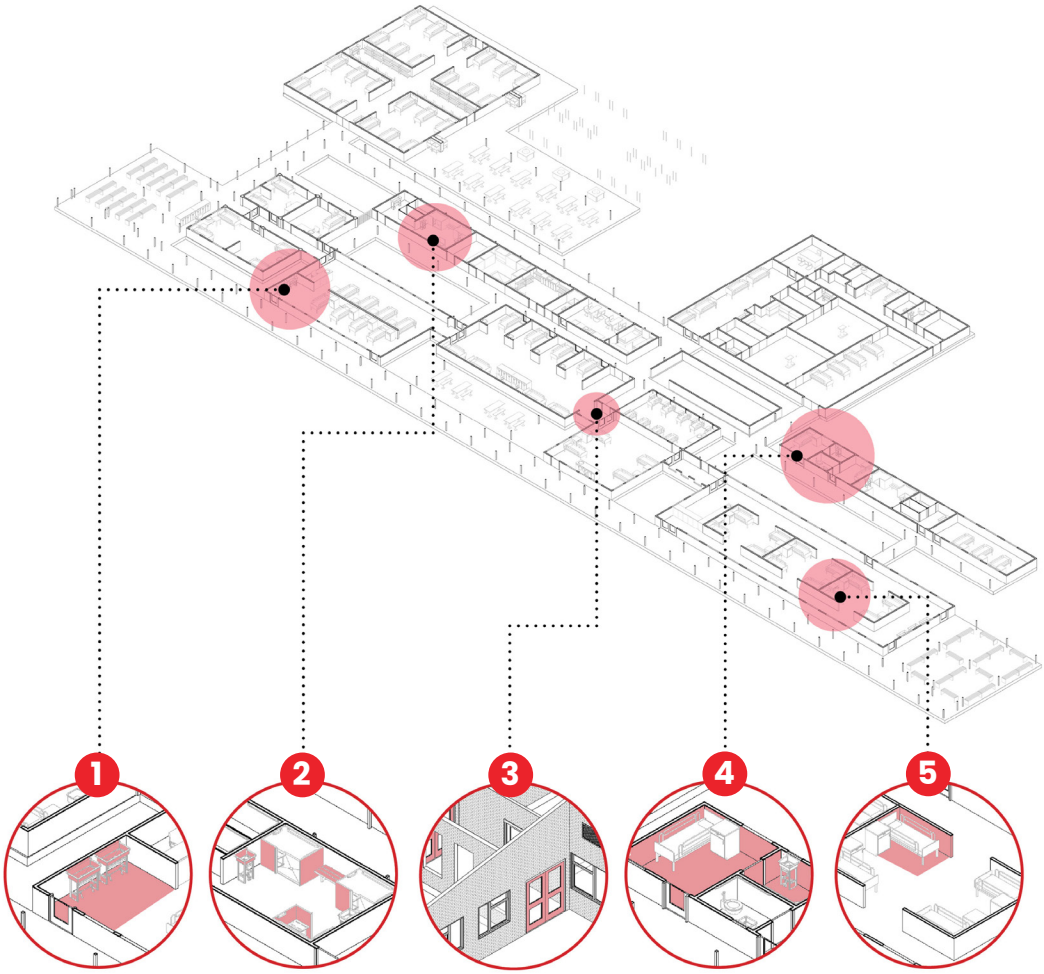


FIGURE 33: INFECTION CONTROL

1_HANDWASHING STATIONS For every 4 beds is 1 sink. These handwashing stations ensure that hand hygiene is practiced. Foot levers are used to operate sinks to address infection control.

2_ACCESSIBLE SHOWERS Women must shower before delivery and after delivery in order to prevent infections from spreading or worsening.

3_SWING DOORS Swing doors allow staff to get from one ward to another without having to use their hands; just their back.

4_ISOLATION ROOMS Women suffering form a serious infection or a spreadable disease coming into the maternity block are isolated from the rest in order to prevent any spread

5_BED SPACING Bed spacing is ensured to be greater than 1m on center in order to make sure there is room for a staff, a guardian, and a family member to surround the patient.

STAFF EFFICIENCY ANALYSIS

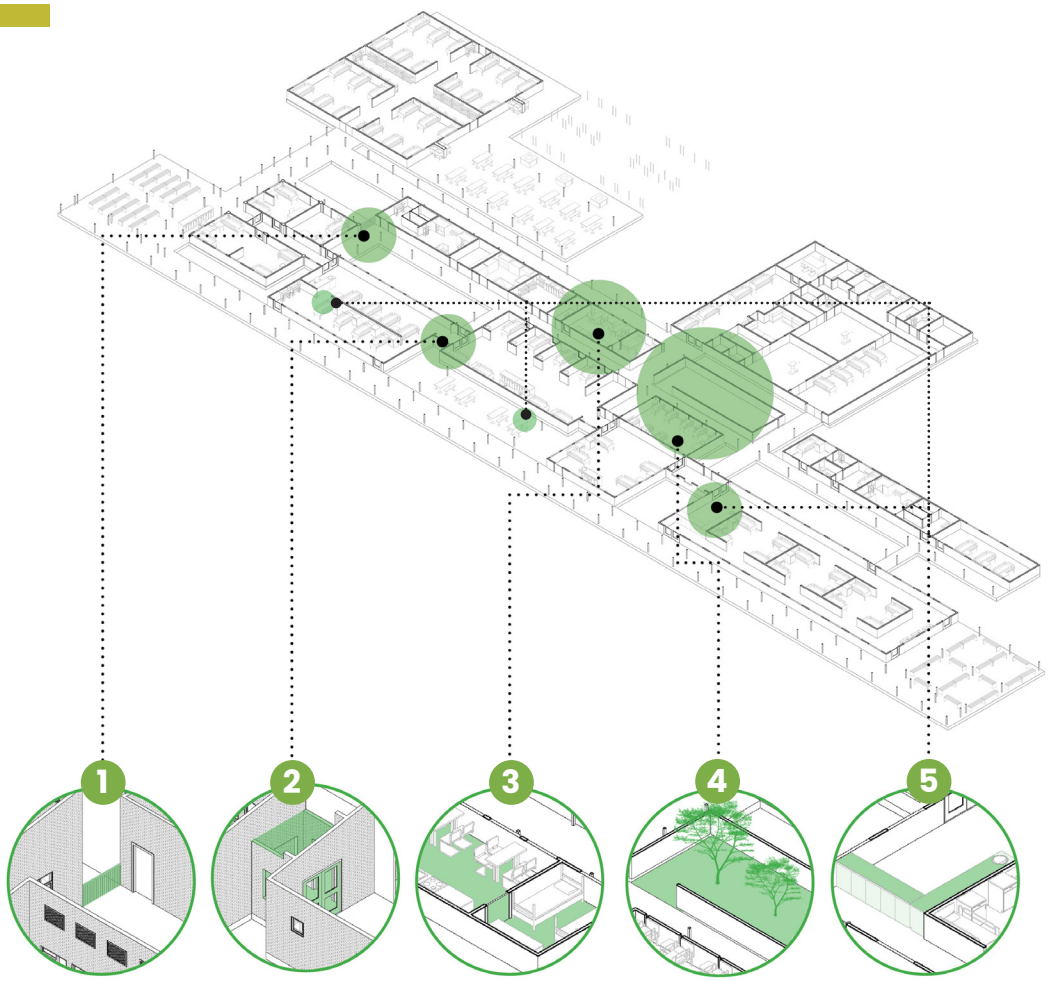


FIGURE 34: STAFF EFFICIENCY

1_STAFF PRIVATE ENTRANCE Gated private entrance for staff ensures that there is a deliberate separation of staff and patient circulation

2_STAFF ACCESS POINTS Along the staff covered walkway are points to access each ward without having to go through certain ones

3_STAFF BREAK ROOM In order to increase efficiency of staff, they are reuiqred to have a break room where they can rest, eat, and use their own restroom seprate from patients.

4_STAFF COURTYARD This courtyard allows space for staff to be relieved with their own courtyard surrounded by a 4' wall to prevent views of activity when sitting in

5_NURSE STATIONS Each ward has it's own nurse's station or nurse dock where nurses can keep watch of patients and keep files and or medicine in.

View of Entrance to Maternity Block from Waiting Area
(Mid) Reception Desk where patients are greeted (Right) Exterior Covered Walkway for Family and Visitors

View of Staff Covered Walkway and Access Point to Wards
(Left) Access Point to Nursery and Postnatal Wards (Mid) View looking towards entrance
(Right) Path from Surgery Theater

View of Postnatal Ward from Education Area
(Left) Path coming from Entrance for visitors and family (Mid) Covered area for maternity education

View of Entrance to Postnatal Ward from Staff Access Point
(Left) Entrance to Access Point for Staff and Patients from Surgery (Mid) Doors to Postnatal (Right) Courtyard with openings on brick wall

DESIGN CONCLUSIONS

THIS DESIGN SCHEME IS RATED OUT OF 5 FOR QUALITY OF CARE, INFECTION CONTROL AND STAFF EFFICIENCY

RATING FOR QUALITY OF CARE
4/5 - There could have been more ways to provide privacy for patients in pre and post natal between the individual beds

RATING FOR INFECTION CONTROL
3.5/5 - Opportunities for waste management weren't considered and could be problematic especially in delivery wards

RATING FOR STAFF EFFICIENCY
4/5 - The linear typology makes distances really far from the entrance to the back end of the maternity block.

IDEAS AND QUESTIONS MOVING FORWARD

After careful evaluation of district hospitals and the attempt at designing an ideal typology of one, there is an evident balance that needs to be met between quality of care and staff efficiency. This scheme attempts to find the balance between the two. A question moving forward is, "What would individualized maternity rooms look like in Malawi and how might it affect staff efficiency, quality of care, and infection control?" This question is to stress the idea that a nurse having to move each woman from ward to ward is less efficient than keeping them in one room. Moreover, women don't have to be put in a lot stress having to move from bed to bed and ward to ward. This also helps address infection control and preventing the spread between women sharing spaces in one ward.

Views of Separate Circulation Paths
(Left) Straight Path to Surgery Theater (Mid) Private Entrance for Staff (Right) Reception Desk and Maternity Block Entrance

CENTRAL HOSPITAL EVALAUTION

ADAM HOOVER

CENTRAL HOSPITAL

BACKGROUND OF DISTRICT HOSPITALS IN MALAWI

Central Hospitals are in the Tertiary Tier if the Malawi Health System. Central Hospitals primarily function as referral hospitals for more rural health centres. District Hospitals are mainly located in rural Malawi whereas Central Hospitals are mainly found in urban cities. Under the Malawi Ministry of Health, there are about 26 government district hospitals. Other district AND OR community hospitals are under CHAM (Christian Health Associaton of Malawi). Most of the clinical work done in District Hospitals are spread out between doctors, nurses, and medical assistants. Typically, there is 1 minimum doctor per district hospital and 3 maximum. There is a range of 30-75 nurses available in District Hospitals and a range of 10-30 medical assistants. As per beds, district hospitals will typically house 150-300 inpatient beds.

MATERNITY IN CENTRAL HOSPITALS

Matenrity at the Central Hospital level serves the same function as the district and health centre levels with additional services for high risk patients. Even in western models, staff break rooms lack in comfort levels with low natural daylighting or access to natural views Well designed break room spaces are necessary to ensure staff a regenerative space where they can refocus from space like maternity wards where deaths are likely. The location of break room spaces should have various considerations in terms of location to patient spaces.

RESEARCH QUESTION

"How can improved spatial planning and circulation to existing Central Hospital Maternity wards reduce travel distance to auxiliary departments (pediatrics, surgery, guardian housing) and enhance patient health outcomes?"

CASE STUDY: QUEEN ELIZABETH CENTRAL HOSPITAL

BACKGROUND

Queen Elizabeth Central Hospital is located in Malawi's second largest urban hub, Blantyre in the southern region. Queen Elizabeth Central Hospital (QECH) is the only publicly funded hospital of the four hospitals in Blantyre. QECH is adjacent to the University of Malawi and serves a facility for medical training and research. The hospital program includes a large range of low-high risk services from inpatient, outpatient, pediatrics, emergency care, and maternity. The maternity ward itself has several sectors. QECH is primarily a referral hospital for district level hospitals but the facility is still responsible for the population of Blantyre. The maternity section of the hospital is in the northeast section of the hospital complex. The maternity sector includes all necessary programs of the district hospital level with additional services for surgery and a high and low risk wards.

FIGURE 1: REGION IN MALAWI AND SITE IMAGE

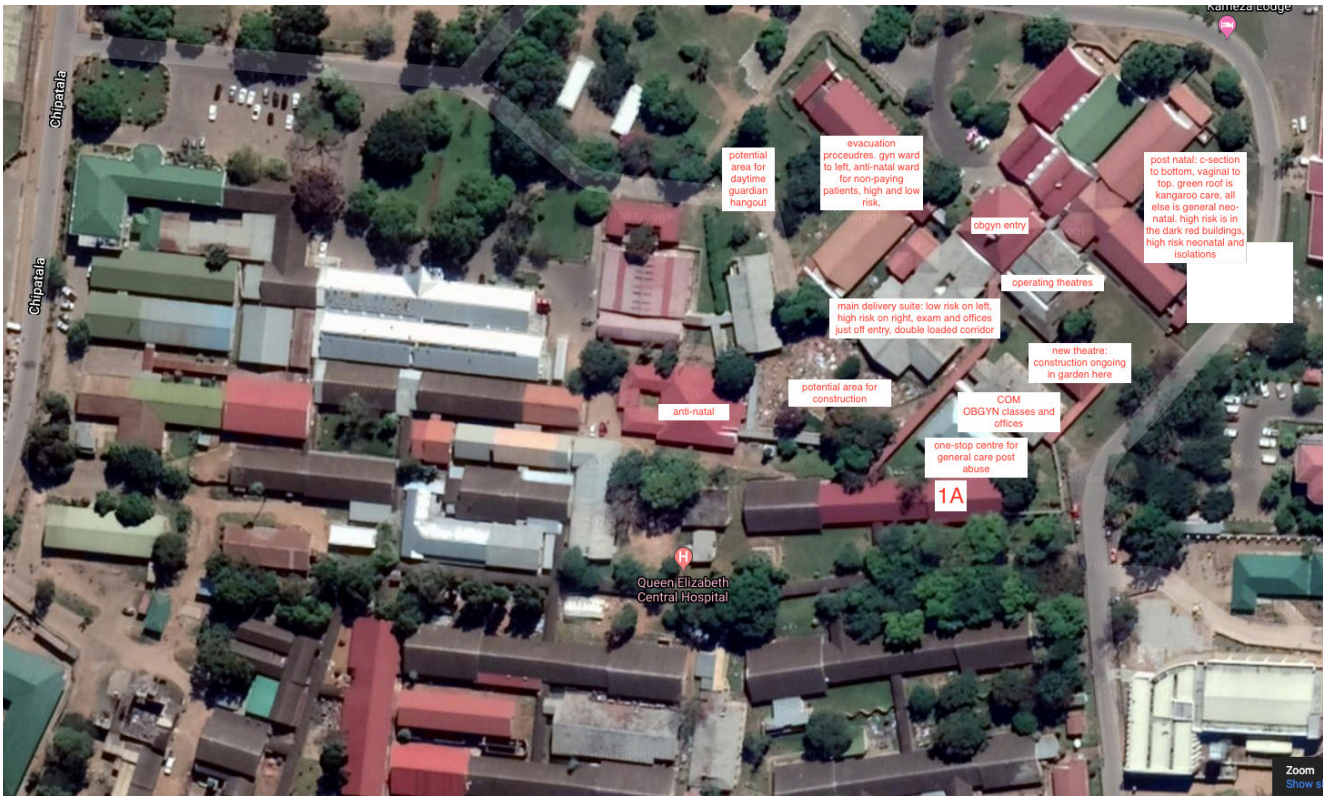


FIGURE 3: SITE PLAN AND SERVICES

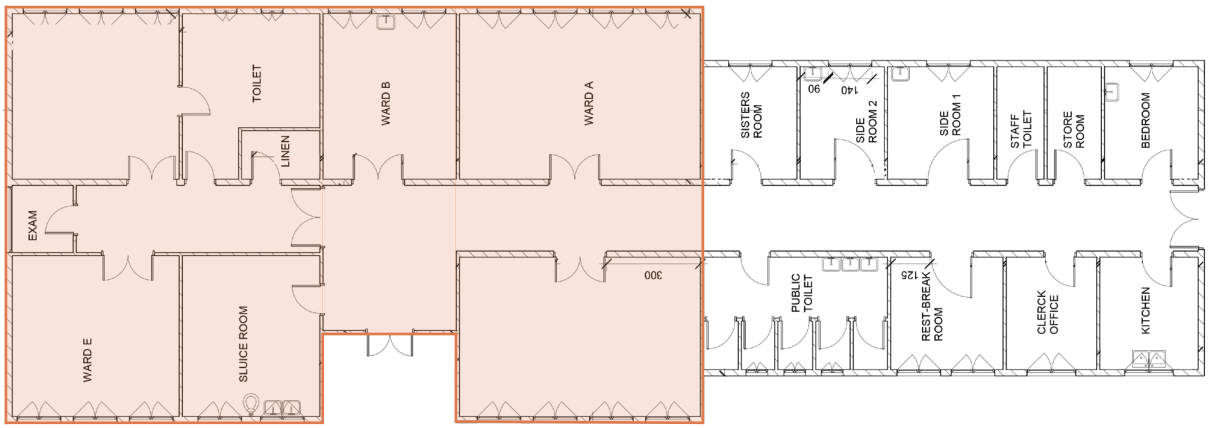


FIGURE 4: FLOOR PLAN OF MATERNITY BLOCK

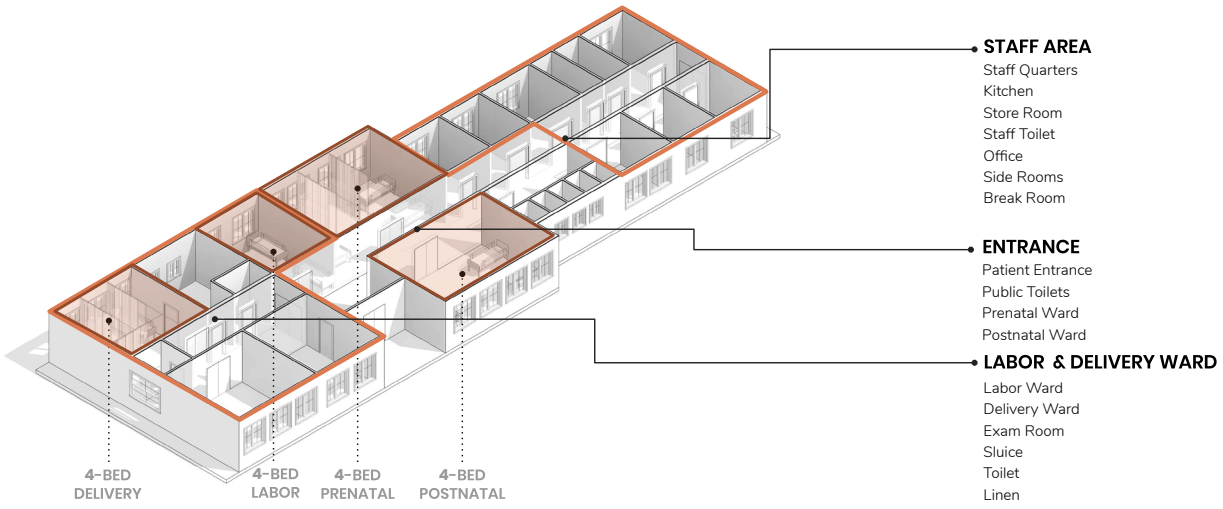


FIGURE 5: PROGRAMMATIC DISTRIBUTION

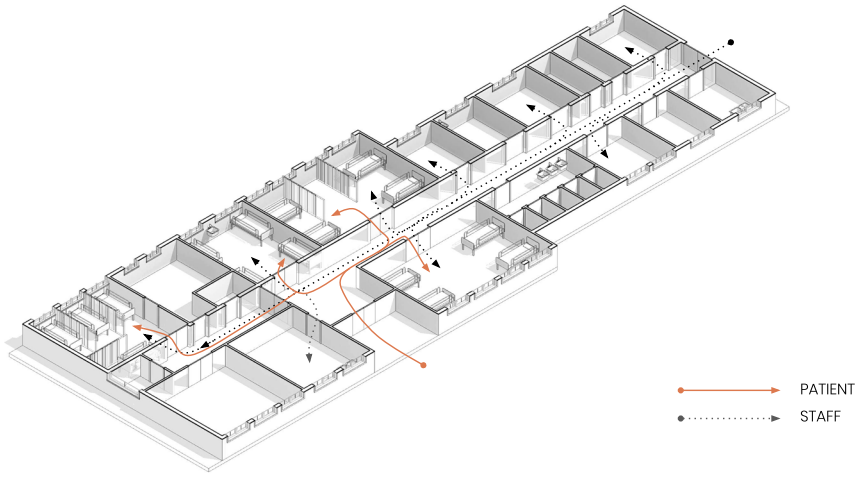


FIGURE 6: CIRCULATION

SLUICE	24
DELIVERY	17
LABOR	8
PRENETAL	12
POSTNATAL	12
OFFICE	17
SISTERS ROOM	24
PUBLIC RESTROOMS	4
STAFF QUARTERS	21
LINENS	12
SIDE ROOMS	12

FIGURE 7: NUMBER OF STEPS TO FROM NURSE STATION

PROGRAM + CIRCULATION ANALYSIS

PROGRAM

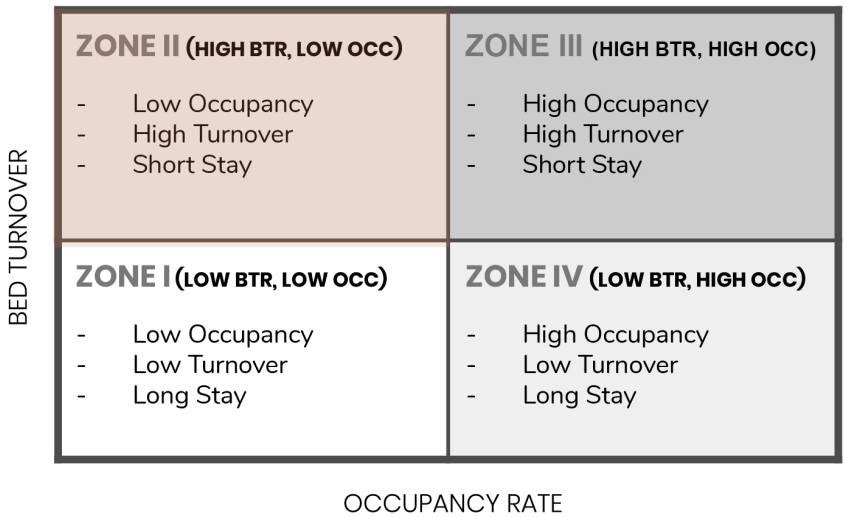
Ward 1A serves as Queen's low risk ward and is similar to that at the district and health centre level. The design of Ward 1A divides the staff and patients across the ward. The staff facilities include a kitchen, staff quarters, break room, and preparation rooms. The patient rooms include prenatal, labour/delivery, and postnatal all adjacent to a sluice room. The ward does not include any deliberate nurse stations.Collectively, the program of Ward 1A is very standard with open wards in all program areas.

PATIENT CIRCULATION

The entire ward utilizes a central corridor for circulation. The corridor allows for efficient circulation for both patients and staff across the ward. However, for staff, the lack of visual separation and a proper nurse station reduces the staff's ability to monitor patients.

DISTANCES

Patients have a short travel distance between stages of birth while staff distances can get very long due to the lack of access to a centralized or decentralized nurse station. The overall efficiency of Ward 1A is low for the number of incoming patients. The ward collectively has minimal space for patients with only four beds in each ward, creating an imbalance in necessary bed numbers in the prenatal and the postnatal wards. The visual and audial separation from patients and staff also suggests a low efficiency. The overall rating of Ward 1A is a zone two meaning there is a low occupancy, high turnover rate, and a short stay.



INFECTION CONTROL ANALYSIS

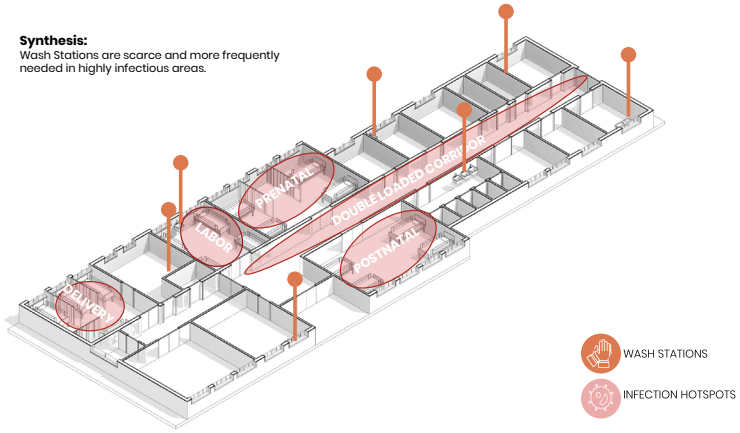


FIGURE 7: WASH SHATIONS AND HOTSPOTS

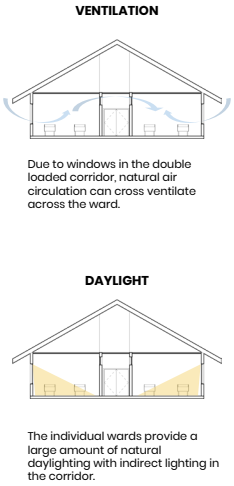


FIGURE 8: VENTILATION + DAYLIGHTING

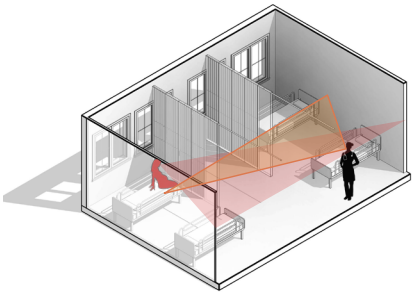
HOT SPOTS FOR INFECTION

From a design approach, Ward 1A has major issues with infection control. There is a lack of sanitation stations throughout the ward especially within the different wards. An increase in sanitation stations is necessary to ensure patient safety, even in a low risk setting. The wards are all open wards with room for four patients in each, some wards have curtains for privacy. While the curtains grant a reasonable amount of visual privacy, there is no privacy acoustically. Additionally, the curtains block views of patients when nurses are passing in the corridor. Therefore, if a patient needs attention they do not have a visual connection to staff. There are only windows on the doors of the wards so there is already a limited vision of patients for nurses. Detachment from a nurse station also limits the nurse's ability to monitor patients.

VENTILATION + DAYLIGHTING

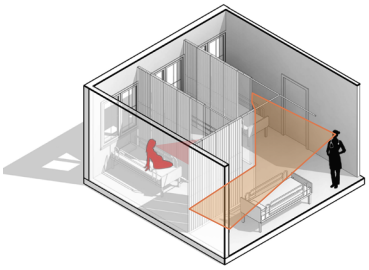
Ward 1A is pretty well ventilated and naturally lit. The exterior of the ward has a large amount of windows for ventilation and natural daylighting. All the open wards have views into an exterior garden space which allows for a nice view. However, most of the ward beds face inward and would require mothers to move to experience the view. In terms of ventilation. The exterior windows are operable and while the central corridor creates a barrier there are high positioned windows which create a path for cross ventilation. The individual wards are flooded with light which creates lots of natural light but could increase the temperature. Again, the corridor windows allow for natural light to enter into the hall, indirectly. The corridor could use better daylighting in dark spots and with the changes throughout the day.

WARD ANALYSIS



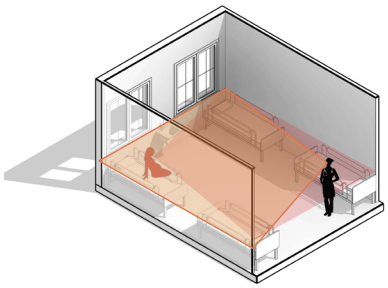
PRENATAL WARD

Area: 41 sq meters
Beds: 4
Bed Spacing: 2m
Privacy: Medium
Staff Vision: View of ward
Patient Vision:View of ward, distorted by curtains
Nurse Station: 12 steps from door



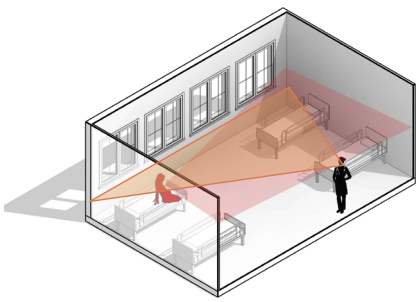
LABOR WARD

Area: 22.5 sq meters
Beds: 4
Bed Spacing: 1 m
Privacy: Low
Staff Vision: View of ward
Patient Vision: View of ward
Nurse Station: 8 steps from door



DELIVERY WARD

Area: 28 sq meters
Beds: 4
Bed Spacing: 1.8m
Privacy: Medium
Staff Vision: View of ward, distorted by curtains
Patient Vision: Distorted from curtains
Nurse Station: 17 steps from door.



POSTNATAL WARD

Area: 40 sq meters
Beds: 4
Bed Spacing: 2.5m
Privacy: Low
Staff Vision: View of ward
Patient Vision: View of ward
Nurse Station: 12 steps from door

CASE STUDY: NYARUGENGE DISTRICT HOSPITAL

BACKGROUND

The Nyarugenge District Hospital is located in Rwanda's capital of Kigali in the Nyarugenge District. The project is currently under construction and was designed by MASS Design Group. The hospital will have a catchment area population of about 255,000 people Upon completion of the two phases of construction, the hospital will consist of 300 beds for inpatient, outpatient, maternity, emergency care, pharmacy, and diagnostic imaging.x The hospital is designed with a series of indoor and outdoor spaces to connect with the landscape. Exterior waiting areas and garden spaces are used to create comfortable healing environments. The Nyarugenge district hospital consists of two buildings the first is two stories and the second is three stories. The maternity ward is located on the second floor of the second building.

FIGURE 1: REGION IN MALAWI AND SITE IMAGE

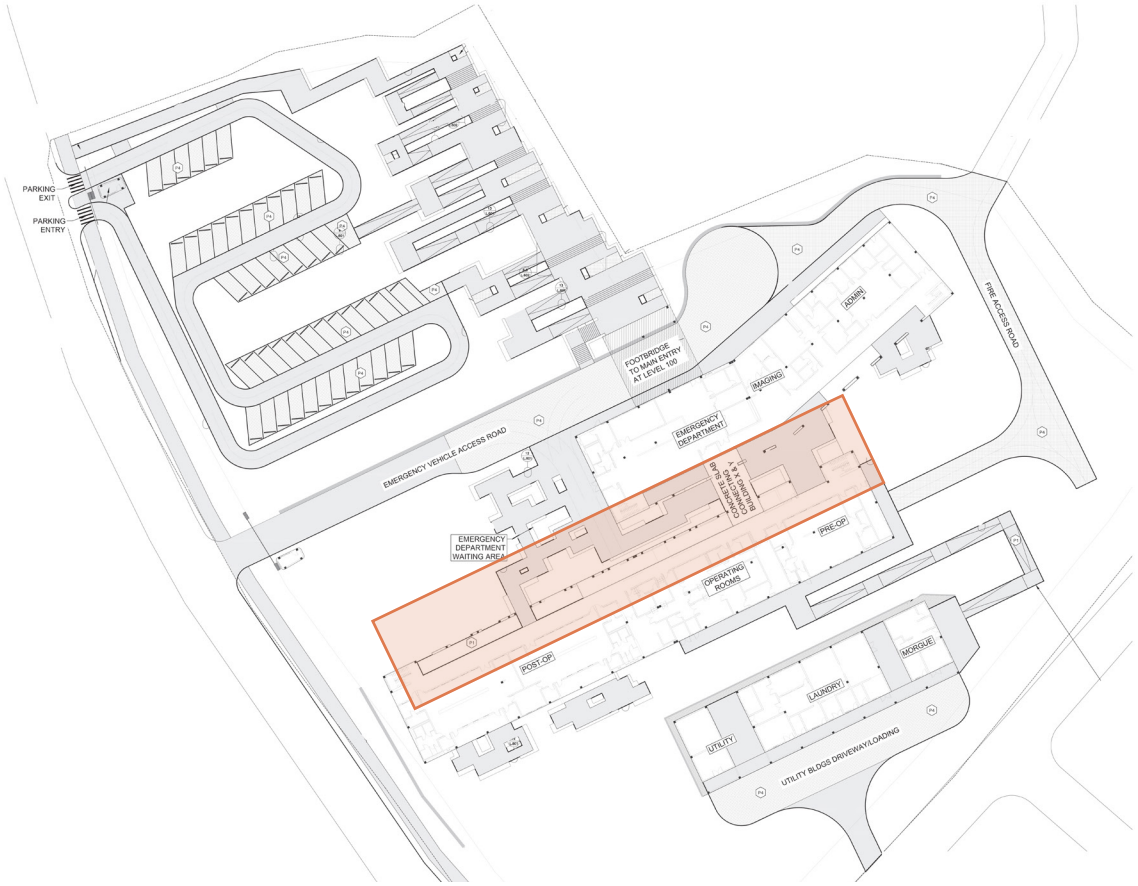


FIGURE 3: SITE PLAN AND SERVICES

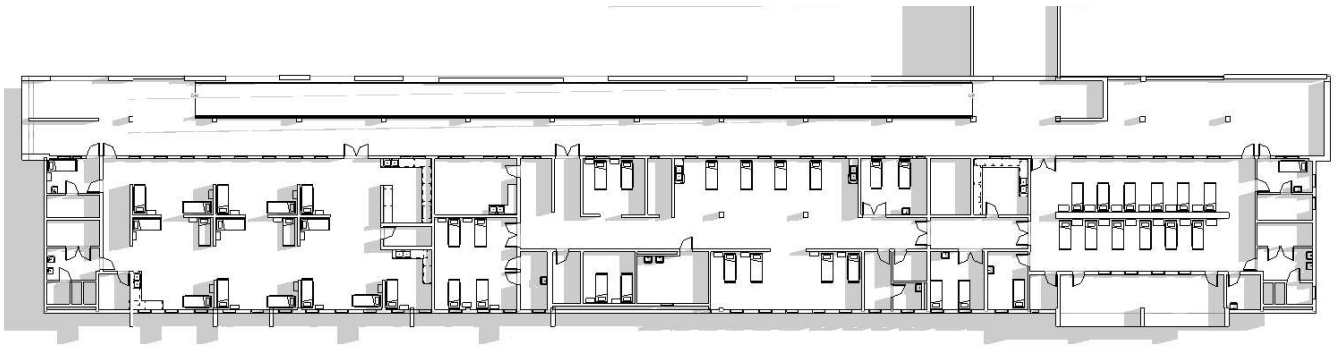


FIGURE 4: FLOOR PLAN OF MATERNITY BLOCK

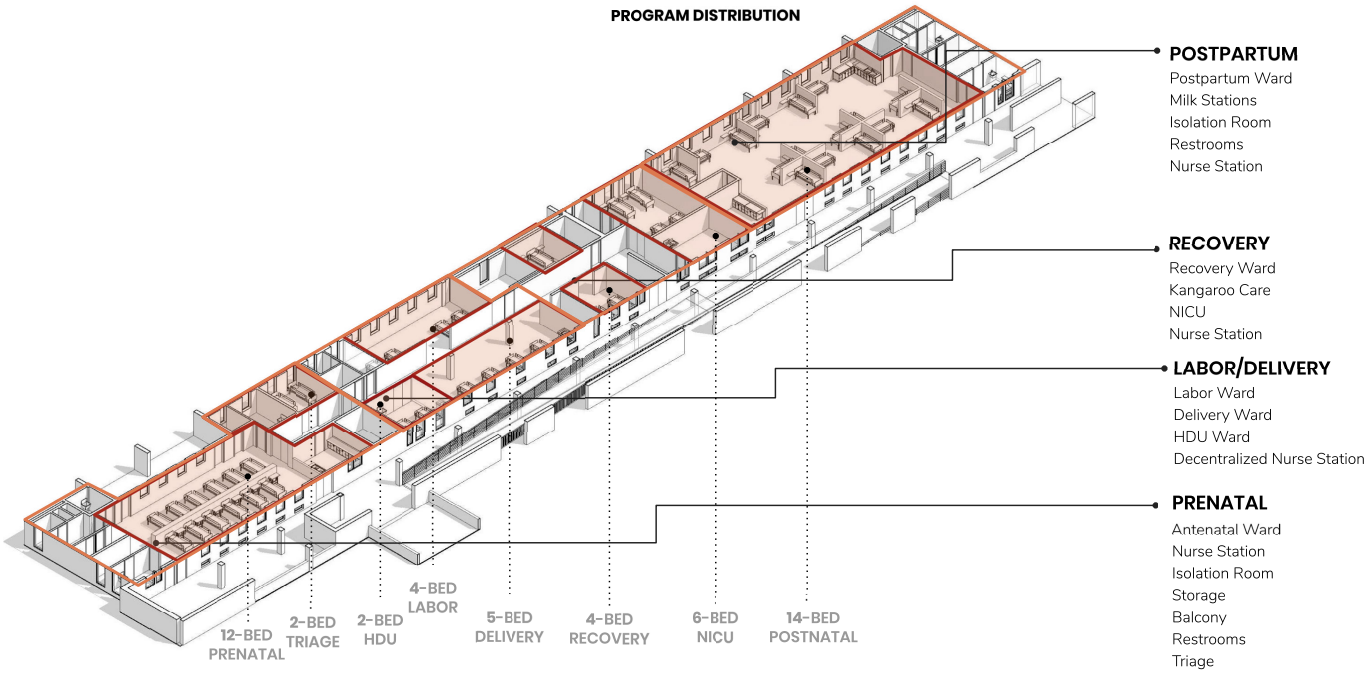


FIGURE 5: PROGRAMMATIC DISTRIBUTION

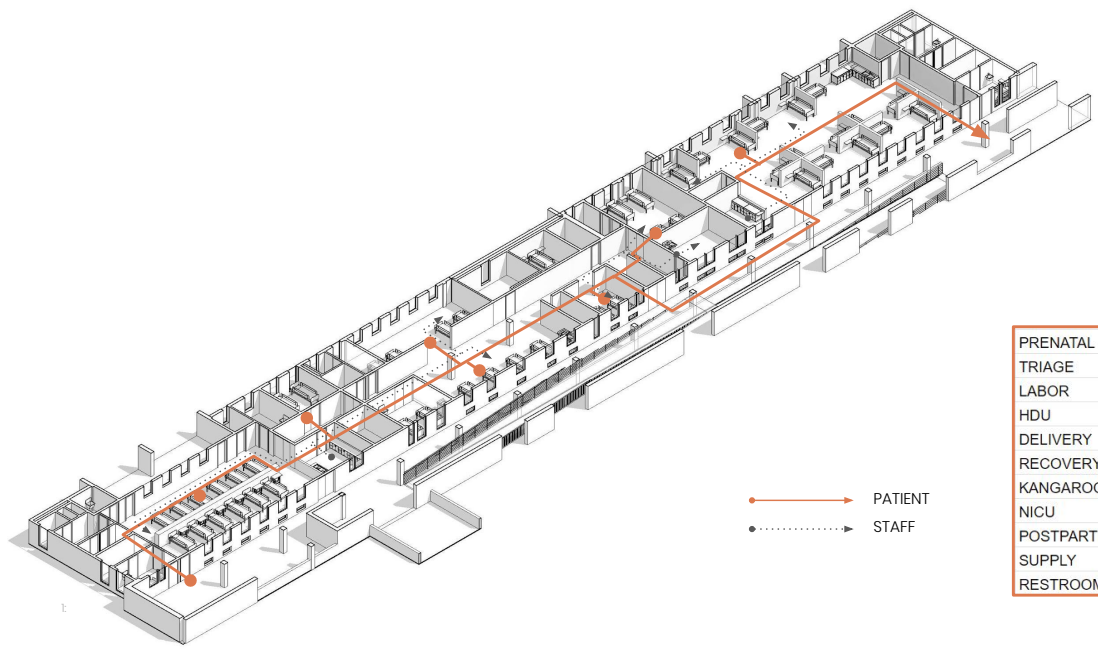


FIGURE 6: CIRCULATION

PRENATAL	8
TRIAGE	7
LABOR	13
HDU	10
DELIVERY	0
RECOVERY	11
KANGAROO CARE	6
NICU	0
POSTPARTUM	0
SUPPLY	8-15
RESTROOM	5-35

FIGURE 7: NUMBER OF STEPS TO FROM NURSE STATION

PROGRAM + CIRCULATION ANALYSIS

PROGRAM

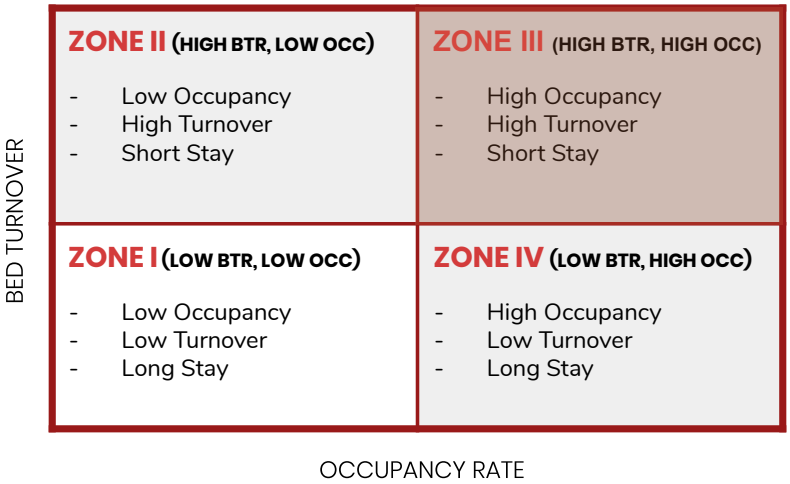
The Nyarugenge District Hospital has a extensive maternity program which is organized in a linear orientation from pre-operation to post-operation. The prenatal and postpartum wards are open wards suited for larger populations. An interior corridor connects prenatal to recovery with labor and delivery in between. Additional rooms are available for intensive care such as the High Dependency Unit (HDU) for complicate delivery. The program does not have direct access to a surgical suite. The recovery section includes a Neonatal Intensive Care Unit (NICU) and a Kangaroo Care room.

PATIENT CIRCULATION

A large open air corridor runs along the maternity ward to allow for regular hospital circulation from the entrance to the other floors. The transportation from prenatal to recovery is facilitated through an interior corridor which allows for staff to accompany mothers through the birthing process. After recovery, mothers will need to utliize the main corridor for a short period to enter into the postpartum ward. A combination of centralized and decentralized nurse stations assists in short distances throughout the ward. Centralized stations are placed in longer period areas like the prenatal, NICU, and postpartum wards while decentralized stations are situated into the operation stages like labor and delivery.

TECHNICAL EFFICIENCY

Nyarugenge's efficient organization suggests a Zone III rating in terms of the Tabon Lasso Technique. The ward cares for a reasonable population in an efficient and straight forward manner. The internal corridor will allow for a direct circulation path and help with increasing turnover rates.



INFECTION CONTROL ANALYSIS

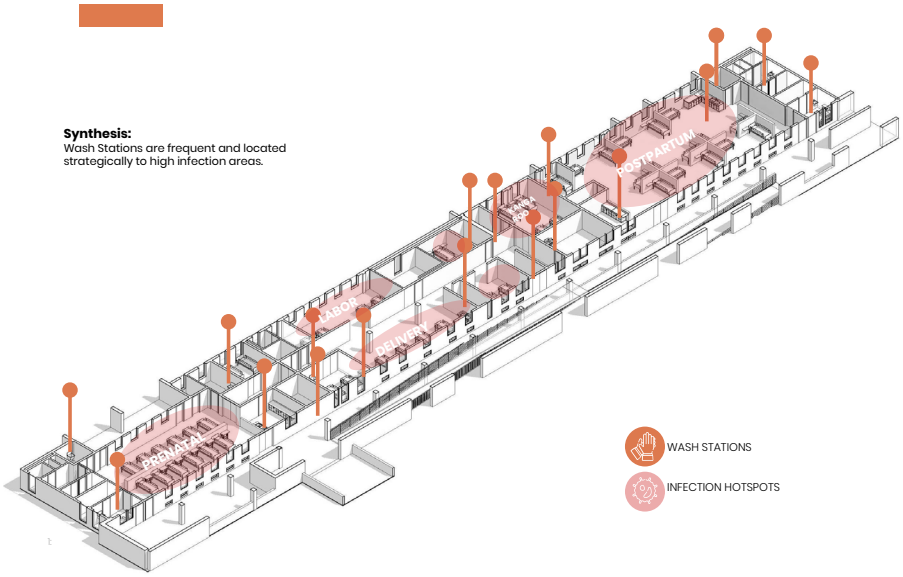


FIGURE 8: WASH SHATIONS AND HOTSPOTS

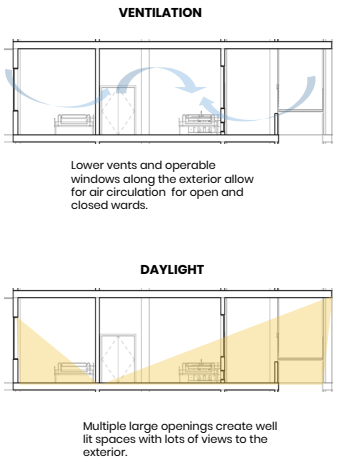


FIGURE 9: VENTILATION + DAYLIGHTING

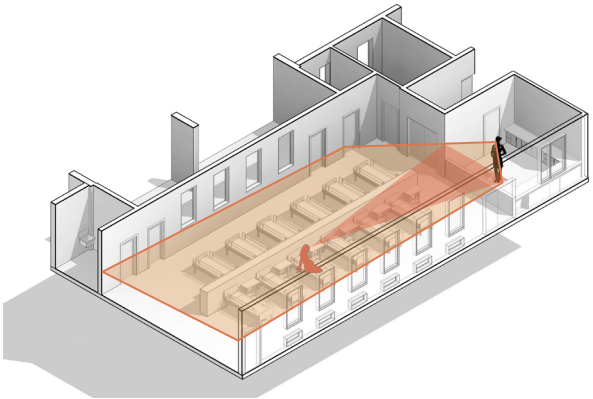
HOT SPOTS FOR INFECTION

Nyarugenge is also successful in its approach to infection control. The availability of sanitation stations allows for easy access to wash and decontamination rooms across the maternity ward. Highly risk infection areas such as prenatal, labor, delivery, recovery, and postpartum all have access directly to sanitation and nurse stations. Isolation rooms are also provided in the prenatal and postpartum wards to separate high risk cases from low risk cases. The separated circulation from the rest of the hospital is also a good stragtegy to reduce nomosocial disease spread. The only area in which the design is lacking in infection control is with the bed spacing. Each program has different bed spacings with postpartum having a large spacing of 3 meters. However, other wards like the delivery and prenatal are only spaced around 1-1.5 meters.

VENTILATION + DAYLIGHTING

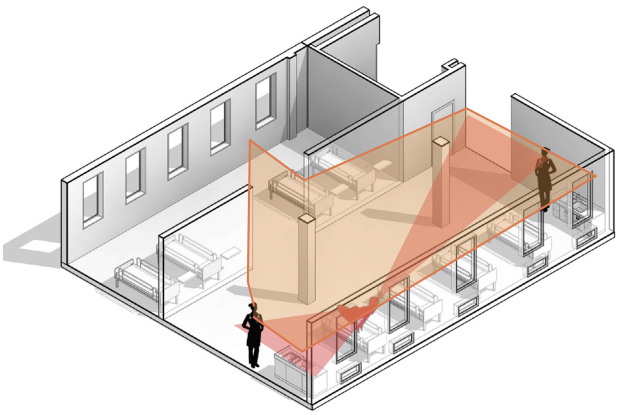
The maternity ward at Nyarugenge is filled with natural lighting and ventilation. Large openings for operable windows allow for cross ventilation and natural lighting. The main corridor is open air so even with large hospital populations, the air change per hour is high. The prenatal ward also accesses an exterior balcony to allow for expecting mothers to actually get fresh air in a safe exterior setting. Low positioned brick vents allow for constant air change and with operable windows on the opposing wall, cross ventilation is easily achievable. The large windows that open to exterior spaces also provides a pleasant view for mothers to see during their stay. This can increase the quality of care and comfort levels in the maternity ward.

WARD ANALYSIS



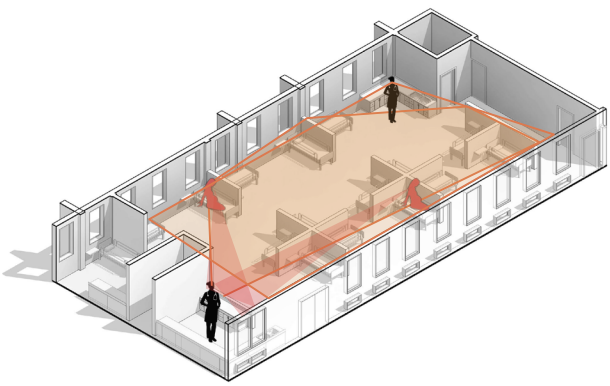
PRENATAL WARD

Area: 123 sq meters
Beds: 12
Bed Spacing: 1 m
Privacy: Low
Staff Vision: View of ward
Patient Vision: View of outside
Nurse Station: 8 steps



DELIVERY WARD

Area: 93 sq meters
Beds: 4 Labor, 5 Delivery
Bed Spacing: 1.5 m
Privacy: Low
Staff Vision: View of ward
Patient Vision: View of ward/outside
Nurse Station: 13 labor, 0 delivery



POSTPARTUM WARD

Area: 41 sq meters
Beds: 14
Bed Spacing: 3m
Privacy: Medium
Staff Vision: View of ward
Patient Vision:View of ward and outside, distorted by division walls
Nurse Station: 0 steps

CENTRAL HOSPITAL SCALE DESIGN PROPOSAL

SCHEMATIC DESIGN

DESIGN GOALS

Increase staff efficiency through an ordered circulation

Increase the staff and patient experience through greenspaces, natural lighting, and ventilation

Accommodate staff shortages with strategic placement of nurse stations for patient surveillance

PRE-DESIGN

Initiating my design process, I looked at the stages of maternity at the Central Hospital level. I analyzed the order and the time frames for each stage to understand where mothers spend the most time. Since Central Hospitals are primarily referral hospitals, patients are divided between high risk and low risk labor. While the two differ in risk level the process is the same. Low risk wards are similar to that at a health centre or district hospital level. The high-risk ward is where most patients are located at the central hospital level, requiring more space for patients and delivery stages. Through various interviews I found the central hospital level to commonly face issues of **overcrowding, rushed deliveries** due to lack of space, and a **high strain on the medical staff,** especially the midwives and nurses.

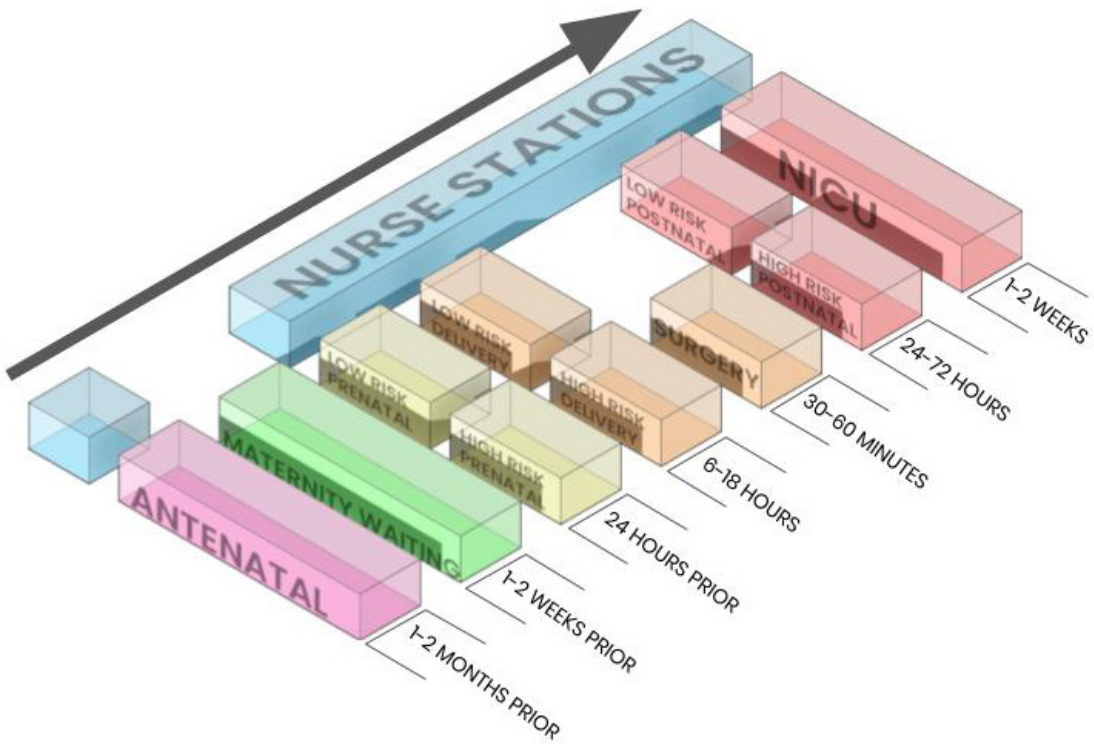


FIGURE 17: STAGES OF DELIVERY WITH TIME FRAMES

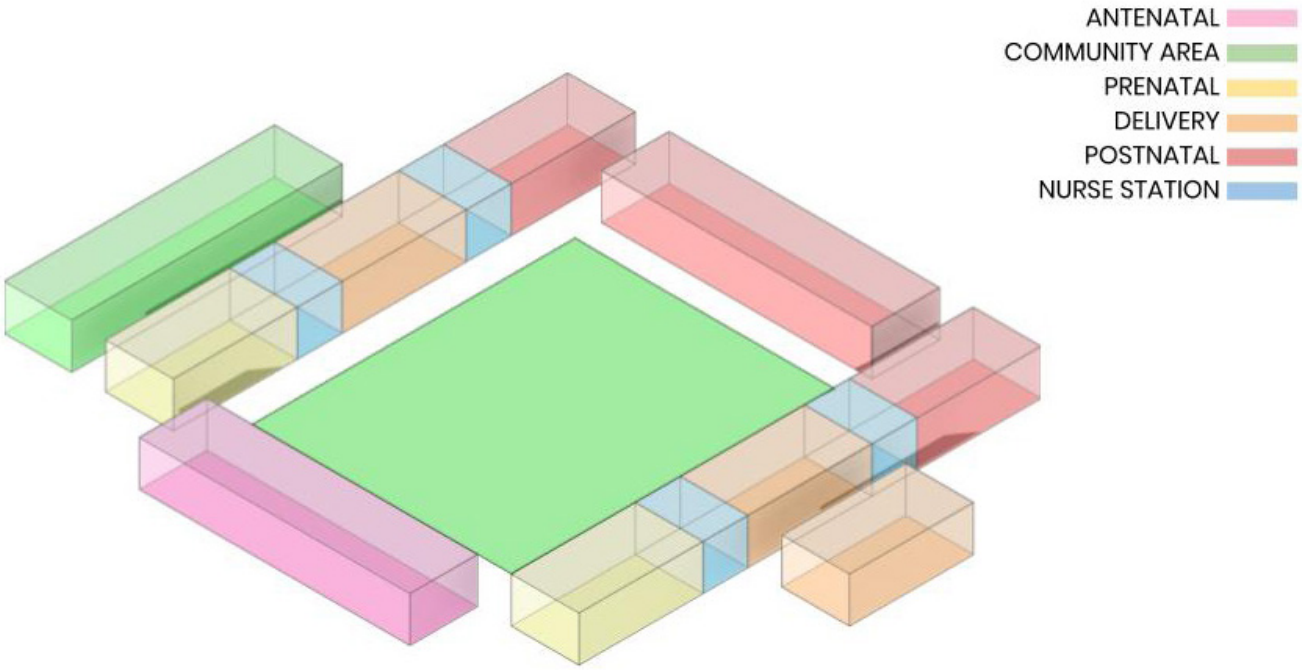


FIGURE 18: MASSING ORGNAIZATION

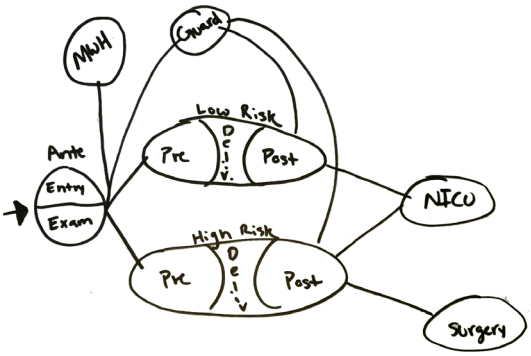


FIGURE 19: SPACE PLANNING

FIGURE 20: INITIAL MASTERPLAN

SPACE PLANNING

The organization of the central hospital maternity ward is preordered with the stages of maternity creating a clear linear bath for patients. To add outdoor space, the low and high-risk wards are divided, giving the complex a courtyard typology. The entrance of the facility is included in the antenatal ward which primary consists of waiting areas/public education spaces with some exam and triage rooms. From the entrance, the paths spilt for low and high-risk. High-risk is adjacent to the surgery theatre for any necessary cesarian section surgeries. While the low-risk ward does not require as many surgeries, newborn complications still occur with any birth so the neonatal intensive care unit or NICU is located between both delivery wards. Guardian and maternity waiting homes border the edge of the complex to provide privacy for waiting mothers and guardians. Also, these spaces require a considerable amount of outdoor space for laundry and cooking. Nurse stations are incorporated into all the individual medical wards where necessary, suiting the individual designs of each ward. The forms of each building are designed to increase natural lighting and ventilation. On all buildings, extended eaves allow for proper shading to the interiors. The buildings are spaced to provide privacy between each program. The one exception to this is the surgery theatre which is closely positioned near the high-risk ward.

MASTERPLAN PROPOSAL

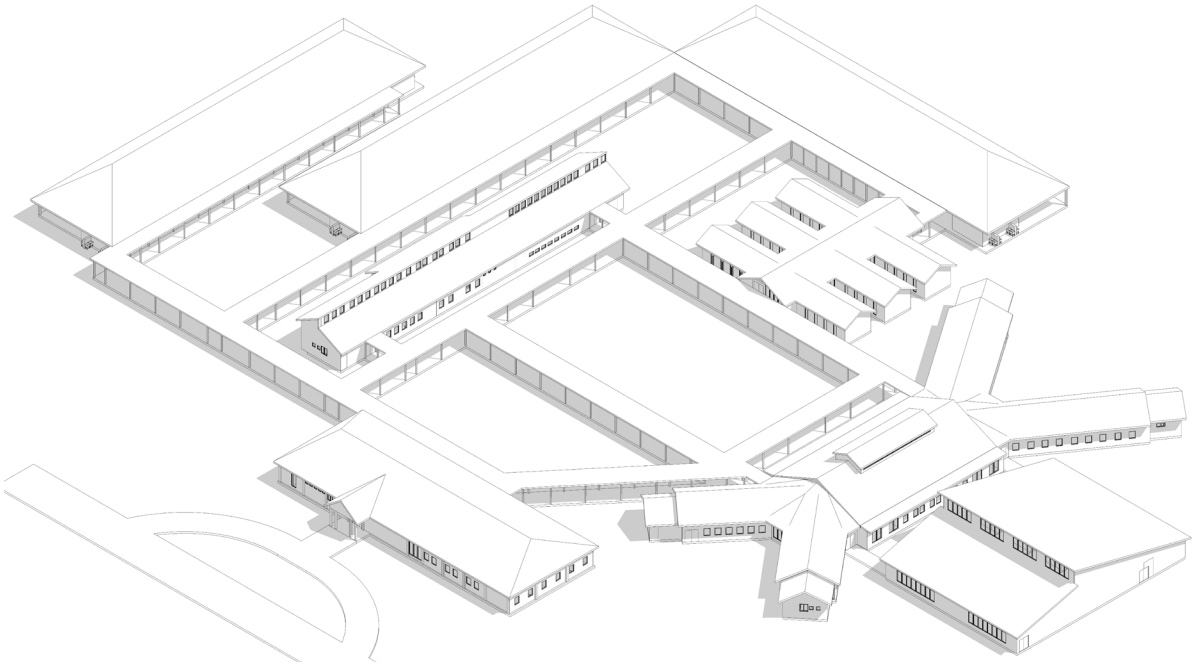


FIGURE 21: FINAL MASTERPLAN

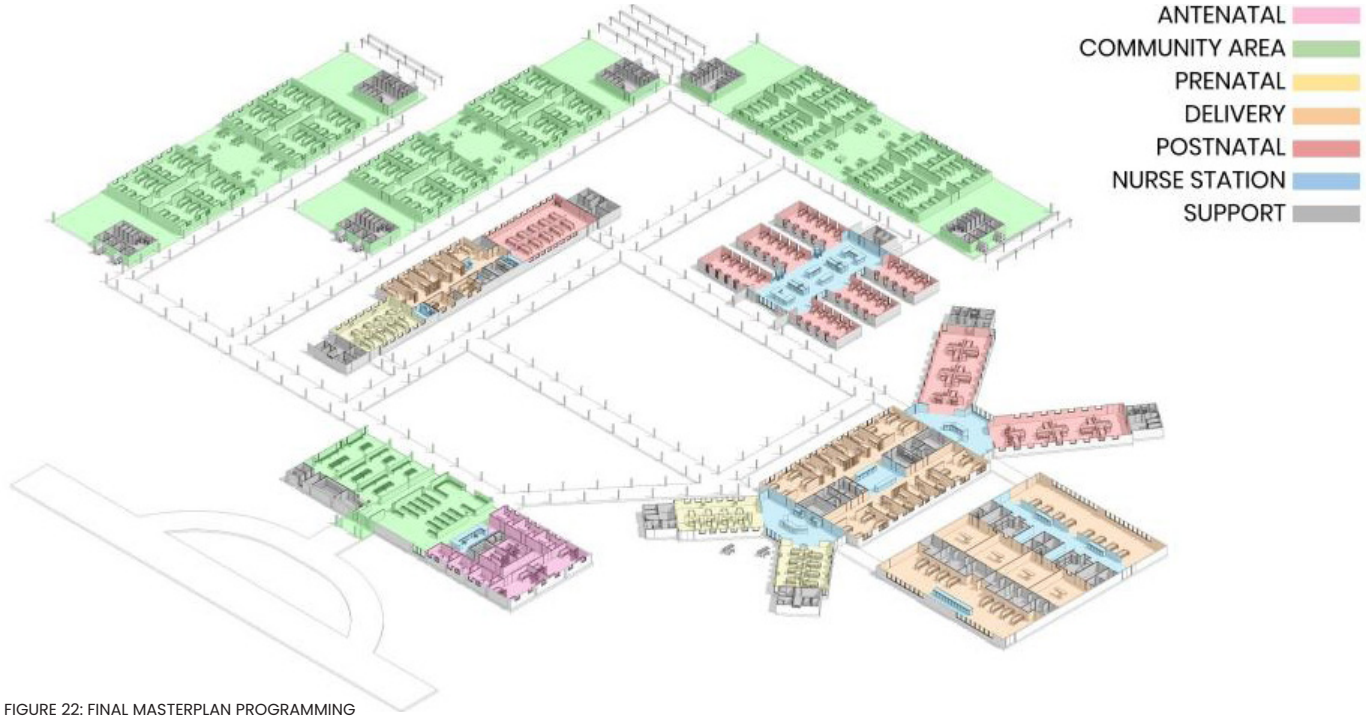


FIGURE 22: FINAL MASTERPLAN PROGRAMMING

GARDENS & CIRCULATION

MATERNITY GARDENS

The maternity gardens provide various advantages to increasing the user experience. Greenspaces are proven to act as stress relief to patients and staff. This is especially important in the maternity ward as there are high stress and emotional situations. These gardens provide space for exterior waiting and education spaces like the garden closest to the antenatal ward and entrance. The central corridor is a place for visitors to wait to see patients, staff to escape the stress of the delivery wards, and as a place for waiting mothers and guardians to gather. The exterior spaces near guardian and maternity waiting homes include space for laundry and cooking pits for group cooking. The high-risk has to additional gardens locate in prenatal and postnatal. These gardens can serve as areas for waiting mothers to walk and for recovering mothers to spend time with her child.

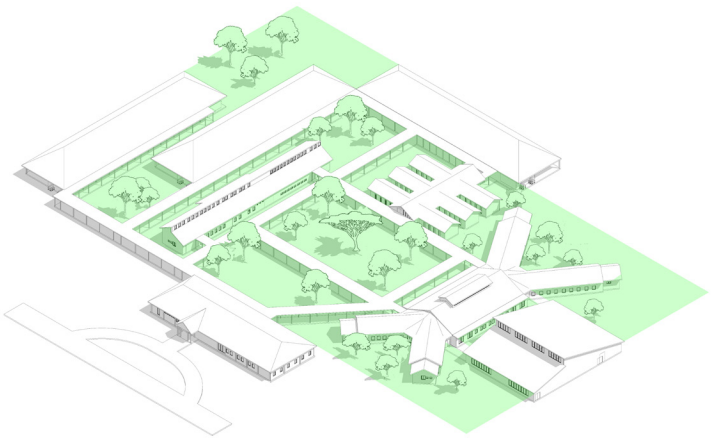


FIGURE 23: MASTERPLAN GREENSPACE

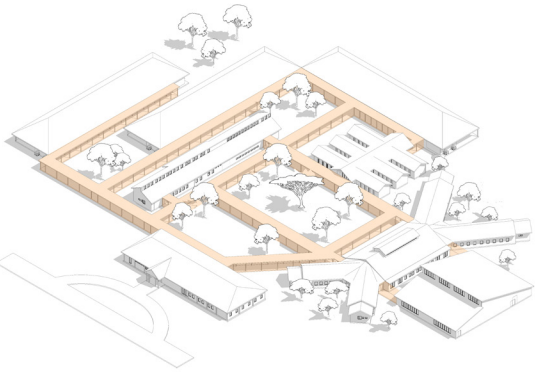


FIGURE 24: COVERED CIRCULATION

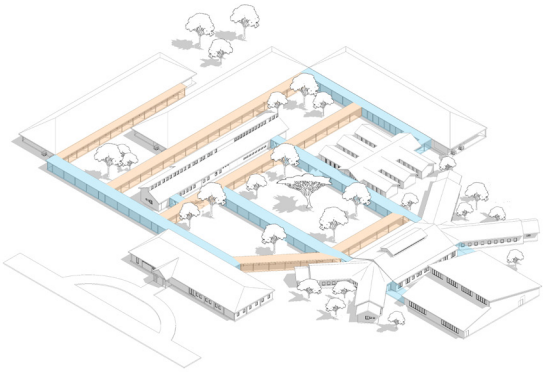


FIGURE 25: PRIMARY & SECONDARY CIRCULATION

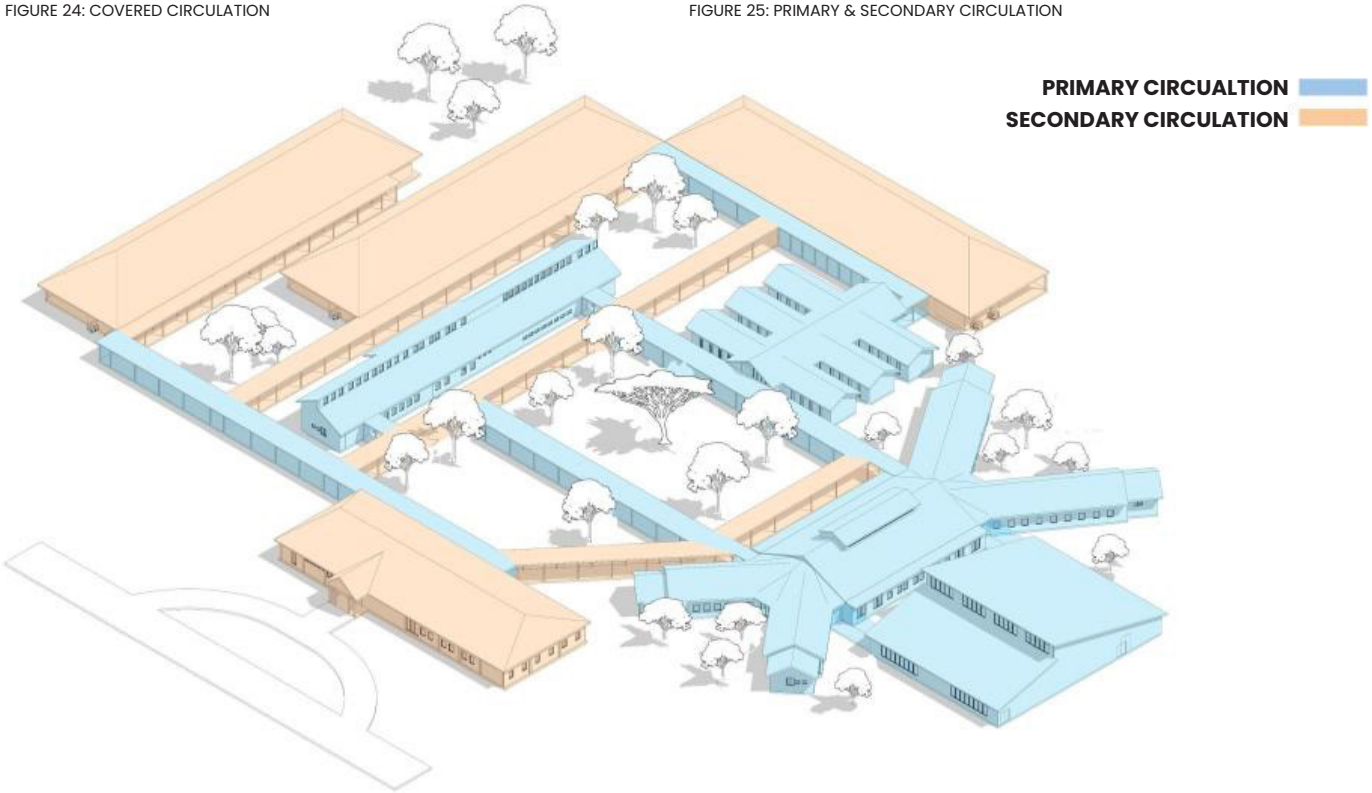


FIGURE 26: PRIMARY & SECONDARY CIRCULATION

CIRCULATION PATTERNS

All exterior corridors are covered and connect directly to the open courtyards. Arranged in a biaxial pattern, the corridors are organized to direct different users in different directions with little cross-over. Primary corridors provide efficient circulation between connected areas such as antenatal to the maternity waiting homes, or low-risk and high-risk to NICU, or high-risk to surgery. These corridors will primarily be occupied by staff and some patients. Secondary corridors allow for visitors, guardians, and waiting mothers to circulate without interrupting the function of the facility. Also, secondary spaces surround the primary spaces, while these corridors tend to be longer, they provide separation and privacy for the less mobile patients. Large waiting populations and guardian populations commonly cause crowding in existing central hospitals, by locating corridor next to courtyards, the crowds can congregate in the open space.

HIGH RISK WARD PROPOSAL

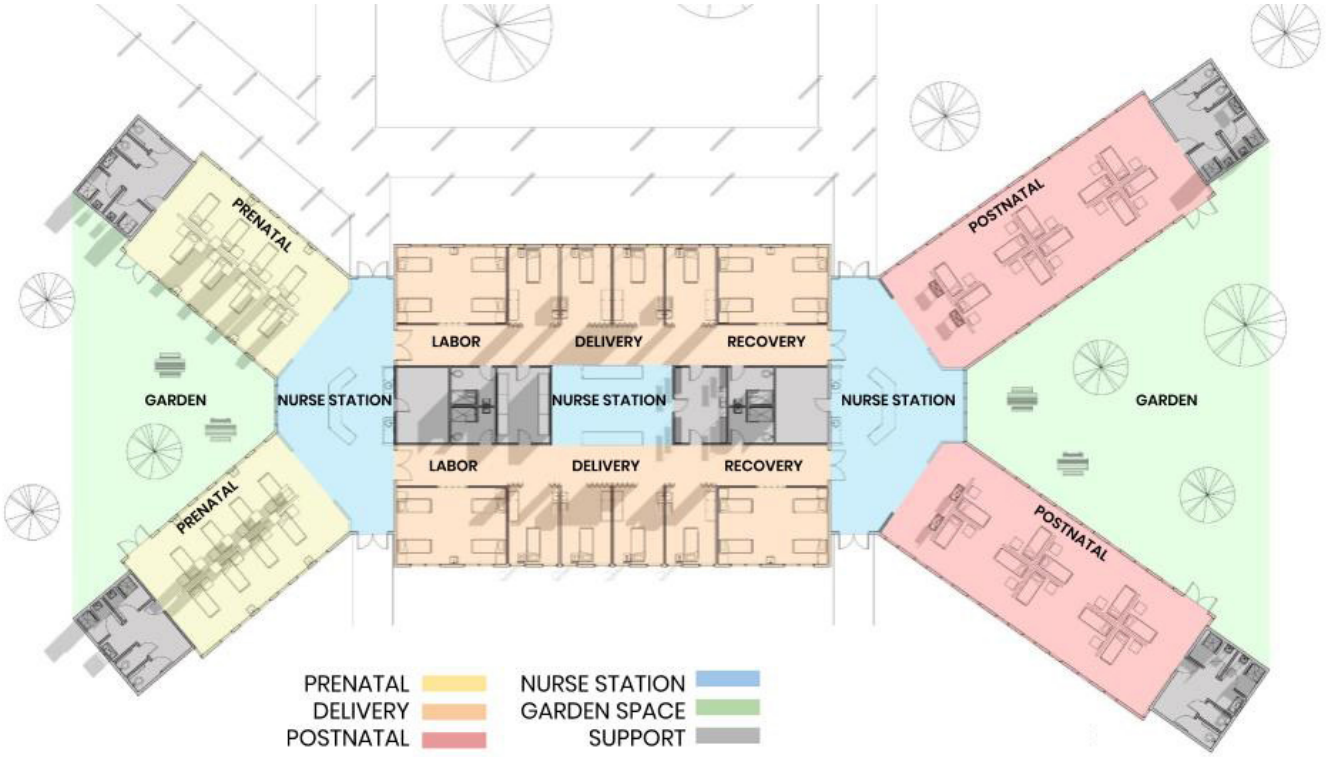


FIGURE 27: HIGH RISK PROGRAM

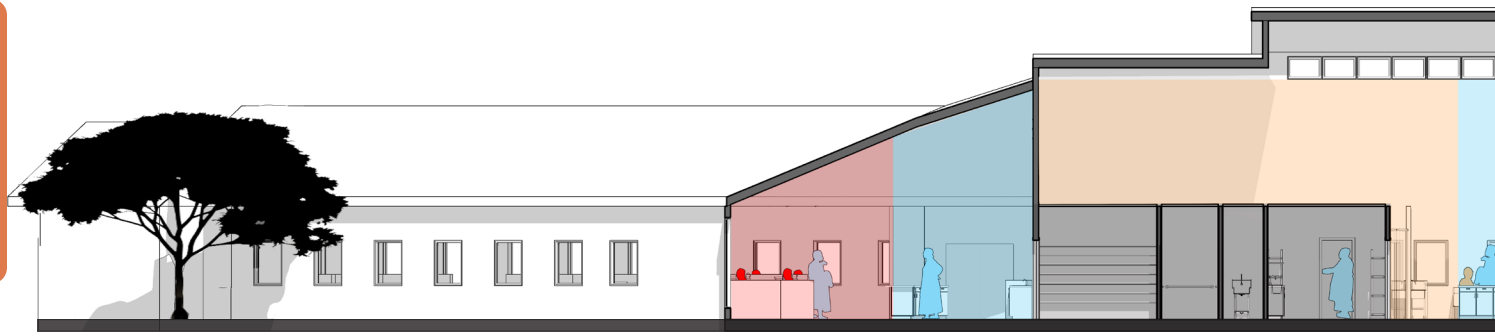


FIGURE 28: PROGRAMMED SECTION

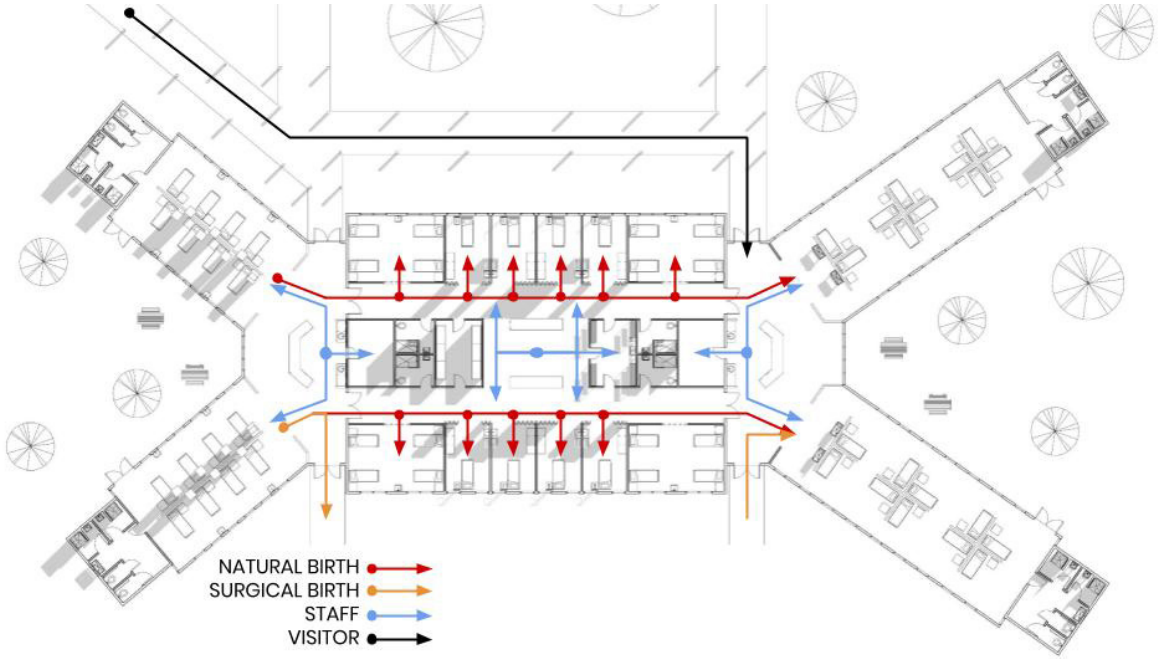
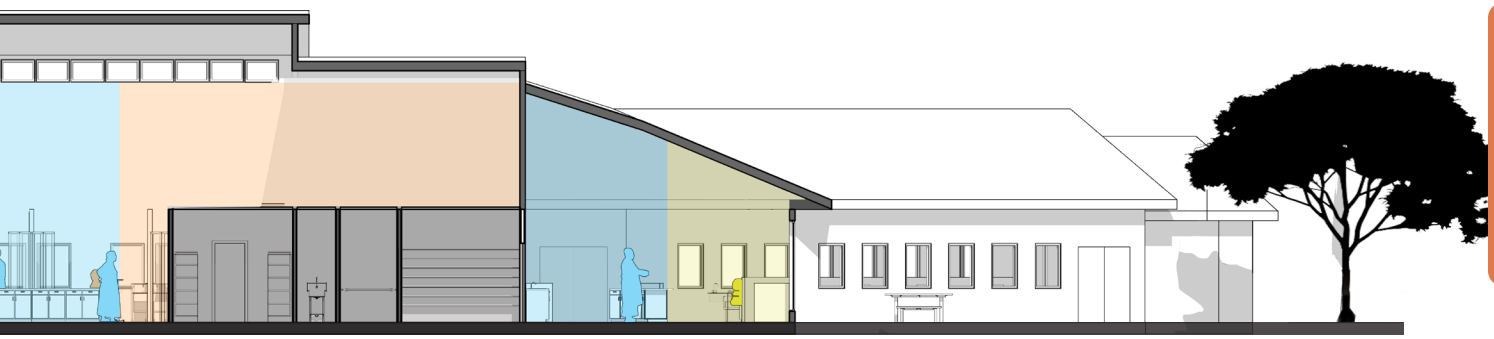


FIGURE 29: HIGH RISK CIRCULATION

ORGANIZATION & CIRCULATION

The high-risk ward is divided into three primary areas: prenatal, delivery, and postnatal. The ward holds a high population, to add privacy the ward is mirrored across a central staff and support area. The prenatal ward features two wards with eight beds each. Restrooms are at the end of the wards while the angling of the wards creates a garden space in the middle. In the middle of the two wards is a central nurse station. The angling of the form allows for a small nursing staff to look over the total sixteen beds. The central portion of the building is dedicated to the delivery area. Delivery consists of three separate stages, labor, delivery, and one-hour recovery. Two corridors border the central support and staff areas. The four-bed labor and recovery rooms are located at the ends. The middle portion is dedicated to delivery. The delivery rooms are individual semi-private rooms directly adjacent to the nurse station. The postnatal ward is last in the sequence with a similar design to the prenatal ward. The bed arrangement differs with a pinwheel organization providing more privacy to recovering mothers. Patients utilize the two corridors while staff circulate radially from their stations. Visitors can enter the postnatal ward through the exterior corridor without interrupting the prenatal and delivery stages. Patients requiring surgery will be separated at prenatal.



PATIENT SURVEILLANCE

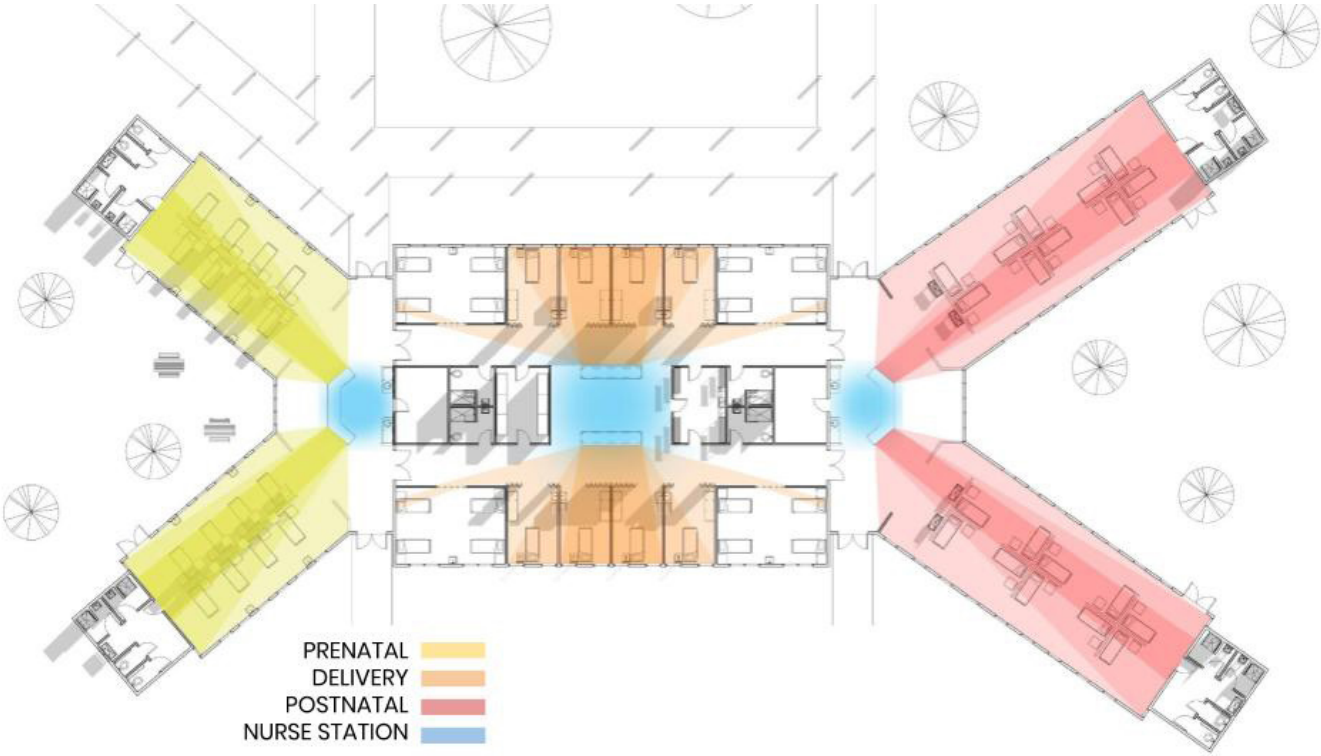


FIGURE 31: PATIENT SURVEILLANCE

PATIENT SURVEILLANCE

Patient surveillance is critical in the high-risk ward to identify any complications throughout the birthing process. Nurse stations are centrally located to efficiently monitor multiple patients at once. In the prenatal and postnatal wards, the radial design supports easy access to the wards and to any medical storage. In the delivery ward, nurses directly monitor the delivery rooms with close access to sluice and linen rooms.

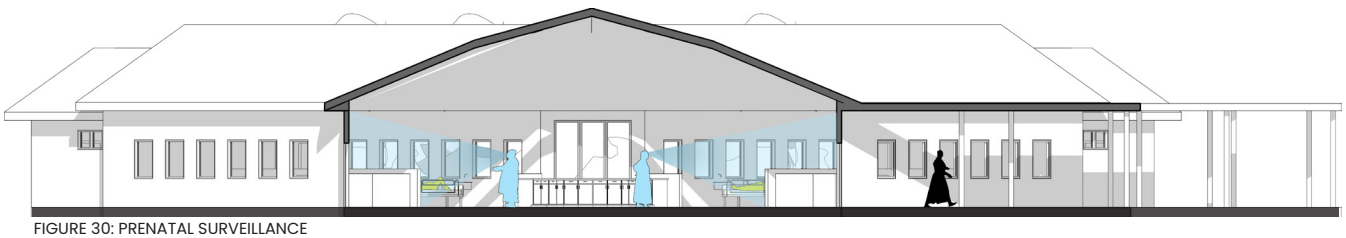


FIGURE 30: PRENATAL SURVEILLANCE

DAYLIGHTING & VENTILATION

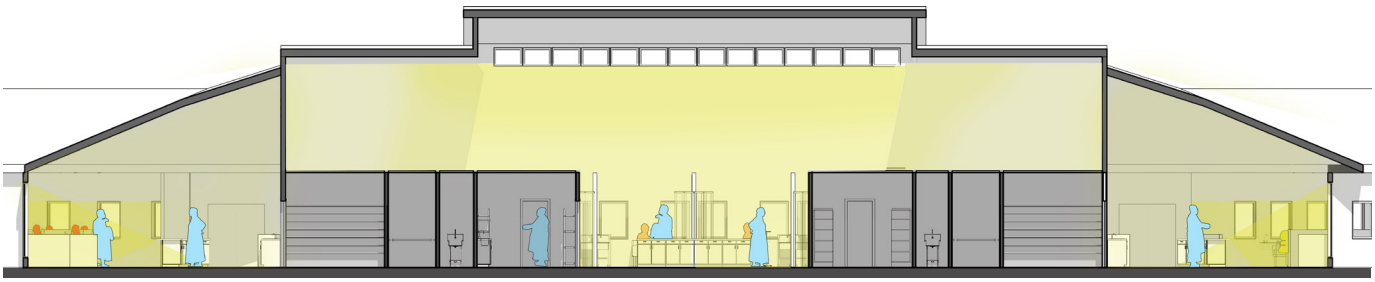


FIGURE 32: DAYLIGHTING DIAGRAM

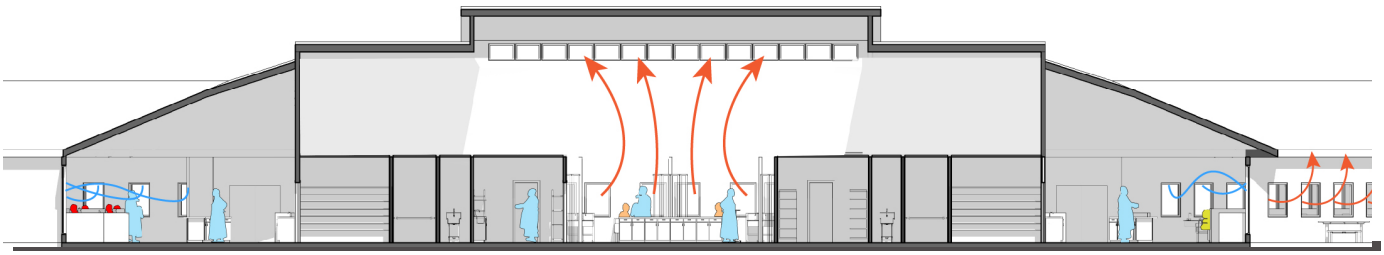
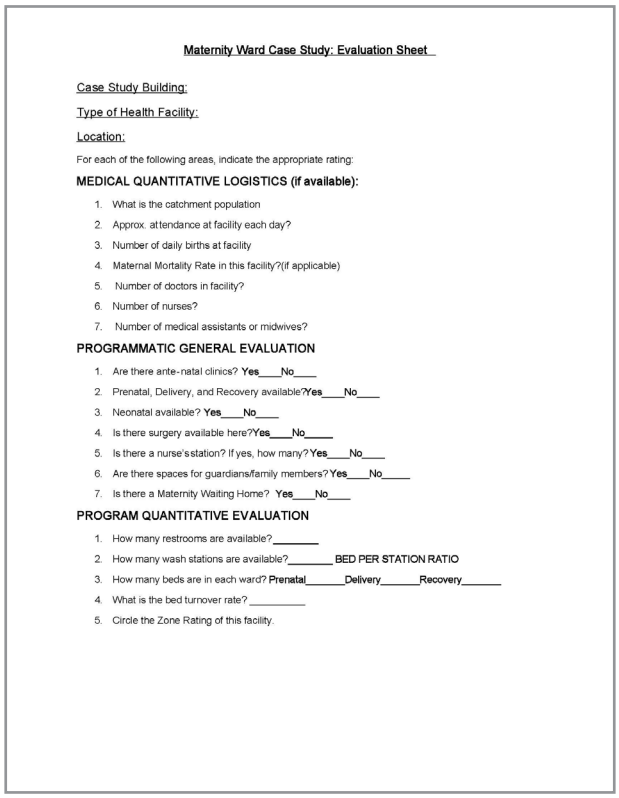


FIGURE 33: VENTILATION DIAGRAM

PATIENT SURVEILLANCE

Throughout the high-risk ward there is an abundance of openings connecting the interior and exterior for natural daylighting and ventilation. In the environment of Malawi this is particularly important due to the common power outages. In a high-risk ward, loss of light during delivery could increase the patients risk level. The prenatal and postnatal wards feature large opening facing the angular courtyard. Smaller openings on the wards edge provide privacy while allowing cross-ventilation. In the delivery windows allow air to circulate upward into the cupola. The cupola is positioned above the delivery rooms to provide more natural lighting where it is needed most during a power outages.

EVALUATION SHEET



Maternity Ward Case Study: Evaluation Sheet

Case Study Building:

Type of Health Facility:

Location:

For each of the following areas, indicate the appropriate rating:

MEDICAL QUANTITATIVE LOGISTICS (if available):

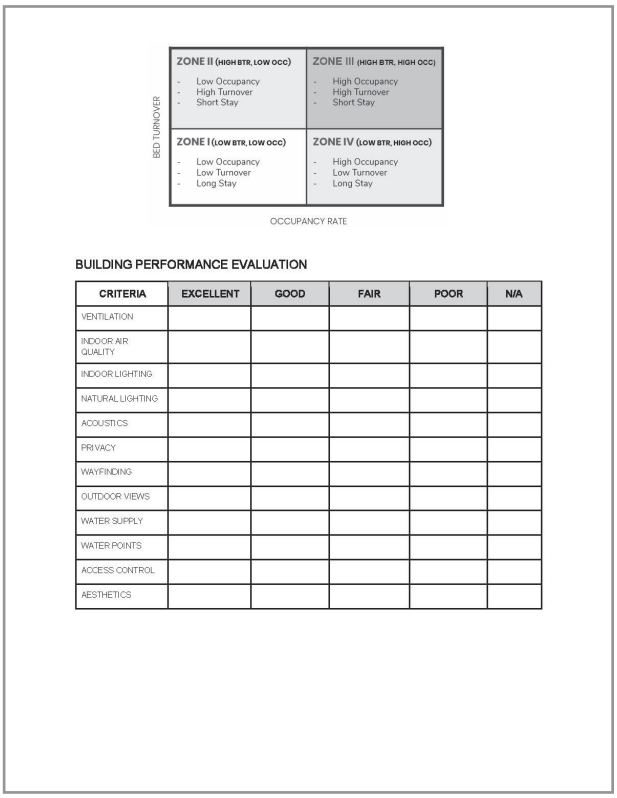
1. What is the catchment population
2. Approx. attendance at facility each day?
3. Number of daily births at facility
4. Maternal Mortality Rate in this facility?(if applicable)
5. Number of doctors in facility?
6. Number of nurses?
7. Number of medical assistants or midwives?

PROGRAMMATIC GENERAL EVALUATION

1. Are there ante-natal clinics? **Yes**____**No**____
2. Prenatal, Delivery, and Recovery available?**Yes**____**No**____
3. Neonatal available? **Yes**____**No**____
4. Is there surgery available here?**Yes**____**No**_____
5. Is there a nurse's station? If yes, how many?**Yes**____**No**____
6. Are there spaces for guardians/family members?**Yes**____**No**_____
7. Is there a Maternity Waiting Home? **Yes**____**No**____

PROGRAM QUANTITATIVE EVALUATION

1. How many restrooms are available?_____
2. How many wash stations are available?_____ **BED PER STATION RATIO**
3. How many beds are in each ward? **Prenatal**_____**Delivery**_____**Recovery**_____
4. What is the bed turnover rate? _____
5. Circle the Zone Rating of this facility.



BUILDING PERFORMANCE EVALUATION

CRITERIA	EXCELLENT	GOOD	FAIR	POOR	N/A
VENTILATION					
INDOOR AIR QUALITY					
INDOOR LIGHTING					
NATURAL LIGHTING					
ACOUSTICS					
PRIVACY					
WAYFINDING					
OUTDOOR VIEWS					
WATER SUPPLY					
WATER POINTS					
ACCESS CONTROL					
AESTHETICS					

EVALUATION SHEET 1

This is an evaluation sheet that each of us used in order to study both typical wards and exemplary case studies. This first sheet evaluates medical quantitative logistics, and program.

EVALUATION SHEET 2

This second sheet takes a look at Zone Ratings as well as a check list of building performance.

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