KILIMANJARO HOPE ORGANIZATION
MAJI MARWA PROJECT
DECEMBER 2017: A SPECIAL MISSION at MARWA VILLAGE
KIHO AND OHIO STATE UNIVERSITY CONDUCTED VILLAGE DISCUSSION ON SHARING FEEDBACK OF THE ACTIVITIES EXECUTED IN 2017:

DAY 1: EVALUATION AND FEEDBACK SHARING SESSION IN MARWA SUB VILLAGE 18/12/2017

Swali: Sisi Wananchi wa Marwa Tutachangia Nini? Question: We people of Marwa, what shall we contribute? Bellow are replies from the villagers:

1. **Kujitolea kwa nguvu zetu**
   Labor contribution – relatively depending on the nature of activity in the project
2. **Kuchangia Huduma ya maji kwa kununua**
   Water user fee contribution
3. **Kushiriki katika kuandaa mipango ya mradi**
   Involvement in project planning
4. **Ukusanyaji wa malighafi za ujenzi zipatikanazo kijijini mfano mchanga na mawe**
   Collection and mobilization of local materials e.g. sand and stones
5. **Kupakia na kupakua malighafi katika malori mfano saruji, nondo, bomba, mbao n.k**
   Loading and offloading of materials at project sites e.g. cement, iron bars timbers etc
6. **Ulinzi na Usalama wa Vifaa katika maeneo ya mradi**
   Involvement in Planning on project sustainability e.g. security of material in storages and various sites
7. **Kupokea mafunzo elekezi ya vitendo kwa mafundi wa mradi**
   Onsite training of Village Project Caretakers on technical issues of project
8. **Kuandaa Katiba na sheria ndogondogo za kulinda mradi**
   Prepare Constitution and Bylaws to safeguard the community project
9. **Kufungua Banki ya Akaunti ya Mradi wa kijiji. Opening of Village Project Bank Account**
10. **Kuchagua vijana mafundi na waangalizi wa mradi kijijini**
    To select/appoint young people as permanent project caretakers
11. **Kushiriki katika vikao mbalimbali vya kijiji vya kufanya maamuzi juu ya mradi**
    Involement in different community decision making meetings about the project
12. **Kushiriki katika mafunzo mbalimbali juu ya matumizi mbalimbali ya maji na usafi**
    Get engaged in different continuous training sessions on water use, multiple uses of water and hygiene
13. **Kuendelea kufundisha watoto wetu kuthamini na kuendeleza mradi wetu**
    Continuing teaching our children valuing and maintaining our project
14. **Kuunda mfumo wa kijiji juu ya usimamizi wa mradi**
    Setting our own (community) project management committees

15. **Kuandaa harambee na ushawishi wazee na wenye mapenzi mema wachangie katika mradi. Organizing local fundraising events to focusing on elders and other interested people to support the project**
16. **Kutoa ukarimu na mapokezi mazuri kwa marafiki na wafadhili wetu**
    Always providing hospitality to our friends and development partners

DAY 2: EVALUATION AND FEEDBACK SHARING SESSION IN LESIRWAI SUB VILLAGE 19/12/2017

<u>Swali:</u> Sisi Wananchi wa Lesirwai Tutachangia Nini? <u>Question:</u> We people of Lesirwai, what shall we contribute? Bellow are replies from the villagers:

1. **Kujitolea nguvu zetu; mfano kukusanya mawe, kupakia vifaa katika malori, kufukia mitaro, kujitolea ghala au vyumba vya kuhifadhia vifaa nk**
   Manual labor contribution – relatively depending on the nature of activity in the project; for example collection of stones in the bush, loading of construction materials on trucks, backfilling of trenches, offering some rooms/space for as storage of construction materials etc
2. **Wananchi, viongozi na kamati kuandaa na kushiriki vikao na mikutano ya wananchi ya mipango na mikakati ya kufanikisha mradi**
   Villagers, Village leaders and different committees will get engaged and participate in various village meetings to plan and make strategies to implement the water project.
3. **Wananchi tutasaidia kuchota maji na kusaidia mafundi wataalamu wajenzi katika maeneo ujenzi utakapokuwa ukifanyika**
   Villagers will assist in water collection in the neighborhood of construction sites and assist the Technical people during construction
4. **Kushiriki katika utendaji wa kazi, usimamizi na ufuatiliaji wa kazi zilizopangwa kufanyika**
   Villagers will get involved in all project planned activities, in monitoring and follow up on performance of their project activities
5. **Wananchi na viongozi wao watashiriki katika zoezi la kuandaa Katiba na Sheria ndogondogo za kulinda mradi**
   Villagers and their village leaders will participate in formulation and preparation of village water project constitution and bylaws to strengthen and guide the project
6. **Wananchi watashirikiana na viongozi wa Kijiji kufungua Akaunti ya benki kwa ajili ya mradi wa maji**
   Villagers and through the village government leadership will open a Village Bank Water Account
7. **Wananchi watashiriki katika kazi ya kufyeka vichaka na sorovea ya kupitishia mabomba**
   Villagers will participate in bush clearing and surveying of the water project piping system

8. **Wananchi watashirikiana na viongozi wao kuainisha maeneo yatakayohitajika kwa ajili ya mradi na pia kuyapitisha kwa ajili ya mradi unaolenga kusaidia jamii**
   Villagers and their village leaders will participate in project site identification and approval for the use of those sites/land for the public use and benefits
9. **Wananchi wameahidi watashiriki kuchangia katika kuhakikisha ulinzi na usalama wa vifaa vyote vya ujenzi wa mradi na usalama wa mradi wenyewe wakati wote wa maisha yake**
   Villagers promise to be fully involved in making sure that, all project materials that will be delivered to the village for construction of the project will under their good and assured security and the same; that, they will make sure that the project is secured throughout.
10. **Wananchi watashirikiana na uongozi wa kijiji kuunda kamati za kuendesha, kusimamia ujenzi na utunzaji wa mradi**
    Villagers will participate in collaboration with village leaders in formulation and election of different project committees during implementation of the project and even after the completion of the project execution
11. **Wananchi watachagua miongoni mwao vijana waaminifu na wachapakazi, ambao watashiriki katika kufundishwa ujuzi wa kujenga na kurekebisha miundo mbinu ya mradi wao hata baadaye mradi ukiwa umekamilika**
    Villagers are ready and willing to elect faithful and hard working young people from the community, who must be trained from the on-set of the project, and that these young trainees will remain their village water project caretakers
12. **Wananchi wako na utayari wa kupokea mafunzo elekezi ya kuchangia huduma endelevu ya mradi wao wa Maji**
    Villagers are ready and willing to participate in training and decision making on how they shall contribute to project as "water user fee"

DAY 3: EVALUATION AND FEEDBACK SHARING SESSION IN PATEL SUB VILLAGE 19/12/2017

<u>Swali:</u> Sisi Wananchi wa Patel Tutachangia Nini? <u>Question:</u> We people of Patel, what shall we contribute? Bellow are replies from the villagers:

1. **Kufyeka vichaka na kusafisha sorovea kwa ajili ya kuchimba mitaro ya bomba**
   Bush clearing and assisting physical survey for trenches digging laying pipes
2. **Kukusanya mawe kwa ajili ya ujenzi wa mradi**
   Collection of stones for construction of project
3. **Kupakia mizigo katika malori**
   Loading materials on trucks
4. Kuandaa Katiba na sheria ndogondogo za kulinda mradi
   Prepare village water project constitution and bylaws to safeguard the project
5. Kuhakikisha ulinzi na usalama wa vifaa vya mradi

Ensure provisioning of security of the project materials

6. Kushiriki vikao vya mipango ya utekelezaji wa mradi wa maji ngazi ya kijiji na kitongoji
   Participation in village and sub village planning meetings of the village water project
7. Kuchangia kutoa huduma ya chakula wakati wa kazi za mradi pale hitaji litakapobainishwa
   Contributing food items/meals during project working hours if need be
8. Kuunda kamati mbalimbali za kijamii za kusimamia mradi wa maji
   Formulation of different community committees to monitor implementation of water project
9. Kusaidia mafundi na wataalamu wa ujenzi wa maji wa maji pale hitaji litakapowekwa bayana.
   Assisting the technical people of the project during the execution of the project when needs identified
10. Kuendelea kushawishi wananchi na wadau wengi zaidi kuweka jitihada zao katika kufanikisha mradi huu wa maji
    Continue motivating and sensitizing as many villagers and other stakeholders in making success and realization of the project objectives
11. Kuchagua vijana watakaokuwa mafundi wa kufundishwa namna ya kutunza mradi wa maji kijijini
    Appointing young people who will be trained to be village water project and pipe line care takers
12. Kukusanya mchanga katika mto tayari kwa ajili ya malori kusomba kupeleka maeneo ya ujenzi
    Collection of sands at from the dry rivers (gorges) ready for loading the trucks to freight it to the construction sites
13. Kufyeka mapori kuandaa barabara za muda yatakapopita malori na magari madogo wakati wa ujenzi wa mradi
    Bush clearing to make temporary passable roads/path where the trucks and other cars will drive through during the execution of the project
14. Utayari wa kushiriki na kusaidia wataalamu na mainjinia katika kazi yoyote isiyo ya kiufundi ya kusavei maeneo ya mradi
    Ready to assist Technical people and Engineers for any surveying and or resurveying of the project sites in the village
15. Kutoa kipaumbele cha kwanza katika shughuli za ujenzi wa mradi wa maji katika kijiji cha Marwa
    Giving the first priority and commitment to the construction of water project amongst all other projects in Marwa village**END**

SRTC Community Consultation and Assessment September 2016

Thursday, 1 September 2016

- District Commissioner (Mm. Rosemary Staki Senyamule)
    - Newly appointed, been in Same for 1 month; has been a DC for different District before. Female with experience working with community-based NGOs – very acknowledging and appreciative of our idea and work
    - Understands water is major problem here; "how can we collect run-off from the mountains during the rainy season?"
    - "(our) model of approach is good because it's comprehensive and focused on water and the impact it will have across many areas", "make Same a model for all of Tanzania", "for Same to be a learning point"
    - Marwa should become the model in Tanzania for providing water to create development

- District Immigration Officer
    - Very welcoming and enthusiastic – we saw him several times also at the Elephant with his children playing
    - We may need to secure COSTECH clearance to do research in the District – he will check with his boss and let us know if we do it is not a problem
    - Marwa listed as most dire for water shortages in the District

- District Executive Director
    - Confirmed pledge of support for the project
    - Ms Anna-Claire Shija - Very new to the community (1 month), first time as DED. Young female, attorney from Dar Es Salaam.
    - Described Maji Marwa as "out of Marwa comes many things….focus is water in Marwa to create opportunity, diversity, freedom of choice." This can be a model for development, " through our achievement we also achieve"

- District Water Engineer
    - Has been trying to work closely with Kateri to transfer the information that has been requested but he's been delayed (said apologies several times).
    - *We got a scope of the requested items on blue flash drive*
    - There are ~20 rainwater harvesting systems in the District at primary schools, dispensaries, which are supported/installed by NGOs
    - Materials to build rain harvesting systems: bricks, sand, water, iron bars, gutters, plastic tanks…all are available in the District
    - Three types of rainwater storage, in order of preference:
        1. concrete blocks: last longest and cheaper, estimate a 28 day construction period for a 30,000L tank
        2. Ferro cement
        3. Plastic tank
    - The proposed Ruvu Project (proposed 10 years ago?) is funded at 60% by donors (Arab Development Bank and OPEC funds) and 40% by "government." – no sign of confirmation of funds and project still not moving
    - For the Ruvuu project the cost is very large:
        1. Phase 1 Intake and Treatment Tank = $41 million
        2. Phase 2 Distribution to Same and villages = $52 million

- Discussed importance of Water Quality Standards:
    1. Must comply to standards – we cannot pump "bad water and disease" into communities
    2. Approved water quality testing facilities in Arusha and Dar. Take ~6-8 hours to process the sample, so expect a 2-3 day process to test Pangani River water near Marwa.
    3. These are Ministry of Water facilities, which are preferred, although there are private providers.
    4. Shared example of Japanese project that developed the distribution but "departed" with inadequate treatment and filtration as the cost was very high.
- *Made hard copy of previous water project (Tony has the copy)*
- Following up direct with senior staff at Pangani Basin Authority – caught up in business of Freedom Flame this week and will follow back next week

- Initial meeting with KiHO Staff meeting
    - Mr. Jerry Umbugga specializes in social networking and computers
    - Mr. Orest specializes in math and technical support (looks after KiO finances and record keeping)
    - *In November 2015, the 3 KIHO staff decided "to believe in the dream (of KiHO) but must work the fields to pay for (survival)."*
    - *Background and introduce Dr. Joe*

- Initial meeting with Marwa Village Council
    - Mr. George is the paid government officer position
    - The meeting went very well…. Greetings and appreciation was extended to Professor Michael
    - Shared intent of the visit and agreed one day in each sub village with Mr. George and the Village Chairman to attend and participate each day

Friday, 2 September 2016

- Strategic Planning with KIHO
    - We overviewed SRTC, and what the plan is for Spring and May 2017 (all on board)
    - "From water comes many things…" 30 students are fine if spread across 4 sub-villages (they've hosted 20 volunteers from Columbia University before) *need to get contact info for "Ben Lanza?" at Columbia who KIHO worked with
    - Developed a Communication Protocol: KIHO and SRTC will communicate twice per week
        - KIHO-Kateri is first; Jerry is second
        - SRTC-Tony is first; Joe is second
        - A regular weekly / bi-weekly schedule will be agreed
        - Acknowledged need for improved communication and consistent communication times
    - Overall, excellent discussion on communication and the strengths and barriers that KIHO and SRTC face
    - Discussed Values - agreed
    - Discussed Expectations of one another leading to roles and responsibilities
    - *Brief meeting with DWE (Engineer) who we exchanged items with and we gave him one GPS device (his staff person said the GPS device would be major asset to their department). "Marwa people are desperate for water."*

- Discussed Methods for developing the community development plan/Maji Marwa

Saturday, 3 September 2016

- Attended the Freedom Torch ceremony. Met District Works Engineer (Mr. Vitus Kapinga) who was very professional and interested in Maji Marwa/working with OSU students and KIHO. His email address is: kapinga.vitus@gmail.com
- Drove up into the Pare Mountains to see the Daghageta Primary School's rain harvester.
  - Tony took lots of photos of the rain harvester, which was made in preferred method.
  - Feeds a 10,000 to 15,000 L concreate tank.
  - A large rain will maintain it for 4-5 months
  - Needs to be concrete, unless elevated then it can be plastic – District will not approve plastic tanks on ground.

Monday, 5 September 2016

- Confirmed and agreed methodology and process for data collection and collation
  - Maji Marwa at the center – a stone dropped into a pond with ripples of impact
  - Divide into four quadrants:
    - Food and livestock;
    - Housing and Infrastructure;
    - Education and Enterprise;
    - Health and Well-being
  - Acknowledge the male and female way the community works
- Njaktai Sub-Village Maji Marwa assessment
  - Leadership/ facilitation team: Njaktai Village Chairman ("Zakiah"?); Marwa Chairman (Elifuraha Masom); Nursery (pre-school) Teacher (Samuel Lilengivido); Same District Rep. to Same (George); KIHO (Kateri, Orest, Simon); SRTC (Tony, Joe)
  - 5 hour session very active participation – the framework of the ripples and Maji Marwa at the centred allowed us to keep focusing onto Maji Marwa
  - a separate sheet for "great idea but not now" captured other ideas and development needs not directly related to impact of bringing water
  - Approximately 60 adults and 20 children attended including a most Senior Masai cultural leader
  - Positive feedback from process – data collected in Swahili to be translated for bi-lingual reporting

Taarifa ya Mrejesho wa Ushiriki na Ushirikishwaji wa Wananchi kwa ajili ya Mradi wa Maji Kijiji cha Marwa

Maji Marwa Community Consultation Feedback Report from the Four Marwa Sub-Villages: Njakitai, Marwa town, Lesirwai, and Pateli

5 - 8 September, 2016

Njozi (Ndoto) Yetu / Vision Statement:

Maji Marwa: Uwepo na upatikanaji wa huduma ya maji safi na salama kwa karibu zaidi, ili kuboresha afya, uhai na maisha ya watu kwa ujumla

Maji Marwa: bringing safe, accessible and clean water to sustain and enrich our lives and livelihoods.

Wajibu (Jukumu) Letu / Mission Statement:

Kwa njia ya ushirikishwaji wa jamii na uhusishwaji wa wadau wengi zaidi, tutafikia malengo yetu, tukiheshimiana na kuenzi mila na desturi zetu, tukiyatunza mazingira yetu na pia, tukiwa na utayari wa kujifunza mambo mengi na mapya zaidi katika maisha yetu

Through participating and by partnering we will build a future that affirms our culture, respects the environment and values education and life long learning.

Mambo Mtambuka ya Kuheshimiwa / Our Shared Values:

Mila / Destori / Culture
Familia / Boma / Family
Asili / Asilia / Nature
Siasa / Politics
Malengo ya Baadae / Njozi / Future
Urithi / Heritage
Jamii / Jumuiya / Community
Mazingira / Environment
Endelevu / Uendelevu / Sustainablity

Taarifa hii imeandaliwa na kuhakikiwa na / This Report was Organized by:

Kateri Genes Daniel	Kilimanjaro Hope Organization
Gerry Joseph Mmbaga	Kilimanjaro Hope Organization
Orest Josephat Issae	Kilimanjaro Hope Organization
Simon William Msemo	Kilimanjaro Hope Organization
Elifuraha Masoni	Chairman of Marwa Village
George Maeda	Marwa Village Executive Officer
Upendo Ulomi	Ruvu Ward Community Development Officer
Tony Duke	The Ohio State University / consultant
Joe Campbell	The Ohio State University / University of Dodoma
Partimaya Olotumu	Lesirwai Sub-Village Chairman
Zakayo Paulo	Njakitai Sub-Village Chairman
Hassan Bakari	Marwa (town) Sub-Village Chairman
Betram M. Mtenga	Pateli Sub-Village Chairman

Disclaimer: THIS IS NOT A PLAN. The following pages are the working notes from the Maji Marwa consultation with Marwa Village from 5 - 8 September, 2016.

Yaliyomo/ Table of Contents

Vielelezo kwa Ufupi / Codes:

Vielelezo kwa Ufupi / Code	English	Swahili
WL	Water long	Maji Mda mrefu
WS	Water short	Maji Mda mfupi
F	Food	Chakula
L	Livestock	Mifugo
EN	Enterprise	Ujasiriamali
ED	Education	Elimu
HE	Health	Afya
WB	Well-being	Afya ya jamii
H	Housing	Makazi
I	Infrastructure	Ujenzi na miundo-mbinu

Vielelezo vilivyotumika hapo juu vitakuwa msaada kumfanya msomaji kuelewa maneno yaliyotumika katika taarifa hii. Ifahamike kuwa, haimaanishi kuwa vielelezo hivyo vinaashiria mtiririko kwa vipaumbele, ila tukitambua kuwa Njozi kubwa ni mradi wa Maji. Hivyo tumetumia vielelezo hivyo tukifuata mtiririko wa mawazo ya watu wakati wa mijadala mbalimbali tuliyoifanya katika kila Kitongoji.

These codes will assist in the analysis of data in this report. There is no priority in the listing or how the comments are listed in order. They are simply reported in the manner in which the comments were received.

Maji Marwa

Marwa Maji

Njakitai Sub-Village

Monday, 5 September 2016

Mifugo na chakula -- Food and livestock

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Kuotesha miti ya matunda mfano papai, machungwa na parachichi F	To plant fruit trees, for example papaya, orange and avocado	Uvunaji wa Maji ya mvua WS	Rainwater harvest
Tutatupa urahisi wa kunywesha mifugo karibu L	To simpflify the exercise of giving water to the livestock	Kujenga Josho L, I	Construction of cattle dips
Tutapata mda wa kuenda kuletea majani ya ngombe na ndama L	More time to bring fodder (grass) to big cows and calves	Kujenga Luresho L, I	Construction of water troughs
Ujenzi wa Josho, Bustani ndogo za mboga, Chainizi, Sukuma wiki, Mchicha, Kabechi na Mnavu F, L, I	Construct cattle dips, small gardening to grow green vegetables, for example: Chinese (bok choi/green leaves), salad, cabbage, and green vegetables	Kuvuna maji ya mvua kwa ajili ya kilimo WS, F	Rainwater harvest for farming
Kupata muda wa kusimamia bustani za mboga F	Extra time to monitor the vegetable gardens	Kupanda miti ya matunda F	To plant fruit trees
Muda wa ziada wa Shughuli za nyumbani WB, EN	Extra time for home activities	Kuvuna maji ya mvua kwa ajili ya nyumbani , Taasisi , Kutenga eneo la kulisha mifugo eneo lipandwe majani na kumwagiliwa WS, F, L	Rainwater harvest for domestic purposes, institutions, to sight areas for animal fodders, planting grass and watering them
Ubunifu wa miradi na Ufugaji wa mabata EN, F	New initatives of projects and duck keeping	Uvunaji wa maji ya mvua WS	Rainwater harvest
		Kupanda miti ya asili WB	Planting indigenous trees
		Kupata madawa ya mifugo kwa karibu L	To get livestock medicines nearby

		Kilimo cha mbogamboga F, EN	Vegetable gardening

Makazi na Ujenzi -- Housing and Infrastructure

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Kupanda miti ya vivuli, miti ya upepo, na maua WB	Planting shading trees, wind breakers, and flowers	Ujenzi wa nyumba bora za kudumu H, I	Construction of modern houses
Ujenzi wa shule za kulala, Kanisa na Ofisi za vikoba EN, I	Construction of boarding schools, church building, and VICOBA (microfinance) offices	Ujenzi wa Kanisa I	Construction of church
Kujenga nyumba za kuishi za kisasa H, I	Construction of living modern houses	Elimu ya mpango wa matumizi bora ya ardhi ED	Education on land use management

Elimu na Ujasiriamali -- Education and Enterprise

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Muda wa ziada wa kujadili vikundi pamoja na vikao vya vitongoji ED, EN	Extra time to discuss Saccos groups (small VICOBA group) within sub villages	Kuhimiza watoto kwenda shule ED	To encourage pupils to to go to school
Kuanzisha elimu ya kusimamia miradi ED, EN	To give education on micro-project management	Kuwa na shule za msingi Njakitai ED, I	To have primary schools at Njakitai
Muda wa ziada wa kupata ellimu kwa ajili ya vikundi vya ujasiriamali ED, EN	Extra time to get education for entrepreneurship in groups	Kutoa elimu juu ya ardhi, Ndoa za utotoni, Watoto wasikatizwe masomo ED	To provide education for land use and management, education on prohibition of early ('child') marriages
		Kutoa elimu kwa jamii kujua thamani ya miradi na kuipokea ED	To provide education to the community on values of projects and ownership
		Kujenga eneo la makumbusho kwa ajili ya ujasiriamali EN, I	To build a museum for entrepreneurship

Afya na afya ya jamii kwa jumla -- Health and Wellness

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Maradhi yatokanayo na maji: Kupindupondu, Kuumwa na tumbo, Kutapika, na homa ya matumbo HE	Waterborne diseases: Cholera, stomach ache, vomiting, diarrhea, and typhoid fever	Kuwa na soko la mnada wa mifugo L, I	To have livestock market
Magonjwa mengine wakati wa mvua: Upele, Uchafu wa mkojo (UTI) HE	Other disease during rain season : Scabbies, and Urinary Tract Infection (UTI)	Kutengeneza barabara I	Road construction
Maji yakishaletwa yawekwe dawa ili yawe safi na salama HE	Water treated to be safe and clean	Kutibu maji ili kupata maji safi na salama HE	Water treated so as to make it clean and safe
		Kuwa na Dispensary eneo la Njakitai I, HE	To have Dispensary at Njakitai
		Kuwa wasafi na kuondoa magonjwa yatokanayo na uchafu HE, ED	To become clean and to eradicate waterborne diseases
		Kupata dawa ya kuua kunguni HE	To get medicine for eradicating bedbugs
		Kujenga vyoo bora kila Boma H, HE	To build good toilets in each and every boma (home)
		Kutibu maji yawe safi na salama HE	To treat water to make it safe and clean
		Kuimarisha ushuru kwa ajili ya mapato ya kijiji EN, ED	To maintain village revenue to promote the village income
		Elimu ya watu wazima ED	Education for adults

Miradi mikubwa ya baadae -- Great Ideas Not Now

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Wanawake kujenga sehemu za kuuzia	Women to build areas for selling farm and	Kujenga shule ya wamasai kuanzia	To build schools for Maasai from

mazao ya kilimo na mifugo; I, EN, F, L	animal products	chekechea hadi chuo ED, I	kindergarten up to College level
Kuwa na duka la kuuzia dawa za kuangamiza wadudu wa mazao na mifugo EN, L, F	To have shop for selling pesticides and animal medicines	Kujenga eneo la kumbukumbu za mila za wamasai (Manyata) I, EN	To build Maasi museum (“Manyata” Maasi word for museum)
Kuweka mashine za kusaga, kukoboa na kuuzia mahindi EN, F, I	To establish a center for milling, husking and selling of maize	Kujenga shule za kufundishia waalimu ED, I	To build a teacher’s training center
Ujenzi wa Madarasa, Ofisi, Chekechea, Primary na Elimu ya watu wazima ED, I	Construction of classrooms for offices, nursery (pre-school), primary school and adult education	Dawa za kunguni ili kupata usingizi vizuri HE, WB	To eradicate bedbugs for better sleep
Kuimarisha vituo vya afya kwa kuboresha vifaa I, HE	To promote health center by putting in place more facilities	Kujenga barabara I	Road construction
Kuimarisha barabara za masoko I	To improve market access roads	Ujenzi wa Hostel kwa ajili ya wageni kijijini I, EN	Construction of hostel for guests in the village

Marwa (Town) Sub-Village

Tuesday, 6 September 2016

Mifugo na chakula -- Food and livestock

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Kuwa na bustani za mbogamboga F, EN	Establish gardening for green vegetable	Kuhamasisha uanzishwaji wa biashara ndogondogo, ufugaji wa kuku, sungura, mabata na mbuzi na kondoo EN, F, L, I	Establishment of small scale business for livestock keeping, chicken, ducks, goat, sheep, and rabbit
Vifaa vya kunyweshea bustani za mbogamboga F, EN	Facilities for gardening irrigation	Vitalu vya miti ya matunda, mbao, vivuli, mbogamboga na miti kwa ajili ya chakula cha mifugo EN, L, F	Tree nursery centers for fruit trees, timbers, shading, vegetables, and trees for animal fodders
Ufugaji wa kuku za mayai na nyama F, EN	Poultry keeping for eggs and meat	Masoko ya mifugo na chakula, Maluresho na Majosho ya kuogeshea ngombe F, I, L	Livestock and food markets, cattle troughs and dips for washing of cows
Ufugaji wa ng'ombe wa maziwa L, F, EN	Keeping of hybrid milk cow	Umwagiliaji wa kutumia mirija kwa upandaji wa bustani na miti EN, F	Drip water irrigation for growing gardens and trees
Mashine za kusindika asali EN	Honey processing machine		
Viwanda vidogo vya kusindika nyanya I, EN	Small machine for tomato processing		
Ujenzi wa soko la mazao ya mifugo na shamba L, EN, I	Construction of market for farm and animal produce		

Makazi na Ujenzi -- Housing and Infrastructure

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Ujenzi wa nyumba bora H, I	Construction of modern house	Elimu ya usafi wa mazingira, Ujenzi wa shule, Zahanati na	Education for environmental hygiene schools construction,

		Vyoo ED, WB, HE, I	dispensaries and toilets
Kujenga luresho I, L	Construction of water trough	Uvunaji wa maji ya mvua and ujenzi wa matanki ya kukusanyia maji katika taasisi (shule, makanisa na misikiti) WS, I	Rainwater harvesting and construction of water tanks in institutions (schools, churches, and mosques)
Kuboresha barabara I	Maintenance of roads	Ufyatuaji matofali ya kujengea I, EN	Sand bricks making for construction
		Ujenzi wa nyumba bora. Vikundi vya ufundi kutengeneza milango, madirisha ya kuchomea (chuma) H, I, EN	Construction of modern houses. Techinal groups of people making doors, windows (welding)
		Uvunaji maji ya mvua na ujenzi wa matank ya kuhifadhia maji aina mbalimbali I, WS	Rainwater harvesting and construction of varieties of technology to construct water tanks
		Shule zote na Taasisi zipate maji ya bomba WS, WL, I	Schools and institutions to be supplied with water

Elimu na Ujasiriamali -- Education and Enterprise

Wanawake -- Females		**Wanaume -- Males**	
Swahili	**English**	**Swahili**	**English**
Elimu ya kutengeneza siagi EN, ED	Education on making butter	Mafunzo ya matumizi bora ya maji ED	Training on proper land use and management
Kupata mikopo midogo midogo katika vikundi EN, ED	Getting small loans for small groups (VICOBA)	Mpango wa Kupanda miti mashuleni ED, WB	Creating school program on tree planting
Vikundi vijengewe uwezo zaidi wa ubunifu na ujasiriamali EN, ED	Small groups to be empowered in knowledge		
Kuwa na soko la kuuzia vitu vya asili kama shanga na batiki EN, I	Having market for selling cultural products (such as bracelets, necklaces)		
Mashine za kupukuchulia mahindi na za kupandia mbegu	Machine for peeling maize and planting seeds		

ED, EN			
Kuwa na duka la pembejeo za kilimo na mifugo I, F, L	To have shop for buying and selling farm inputs and livestock medicines		
Ujenzi wa soko kuu la kijiji I	Construction of main market for village		

Afya na afya ya jamii kwa jumla -- Health and Wellness

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Kuboresha Zahanati kuwa kituo cha afya I, HE	To improve dispensary to become a health center		
Watoto watakuwa wasafi na afya zitaboreka HE, ED, WB	Children will be clean and health will be improved		
Kuanzisha vitalu cha miti WB, EN	To establish tree nurseries		
Kuboresha zahanati iwe na wodi za wagonjwa HE, I	Improving dispensary with modern wards		
Kuanzisha miradi ya vitalu vya miti EN, WB	To establish tree nursery projects		

Miradi mikubwa ya baadae -- Great Ideas Not Now

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Kuanzisha kiwanda cha maziwa I, EN, L	To establish milk factory	Uanzishwaji wa ufugaji nyuki sambamba na viwanda vidogovidogo kwa vijana na wakina mama EN, I	Establishment of bee keeping in line with small-scale industries for youth and women
Kuweka mashine za kuchapia EN, ED	Put in place printing machine for making photo copies	Uanzishaji wa viwanda vya kusindika vyakula, matunda na mbogamboga EN, I, F	To establish food processing factories for fruits and vegetables
Kuwa na umeme	Permanent/reliable	Ujenzi wa malambo ya	Construction of charco

I	electricity power	kunyweshea mifugo I, L	dams for livestock
Mashine za kufulia nguo EN, HE	Washing (clothes) machine	Kupanda miti kwa ajili ya msitu WB	Tree planting on selected tree lots
Kujenga shule ya sekondari I, ED	Construction of secondary schools	Kuandaa shamba kwa ajili ya mbegu EN, F, ED	Establishment of seed producing farm for variety seeds
Kuwezeshwa kuwa na trekta za kulimia EN	Be supported to have tractors for farming	Ujenzi wa vyuo vikuu, sekondari , Mabwawa ya kuogelea, Hosteli kwa ajili ya kulala wawekezaji na barabara nzuri kwa ajili ya kuvutia utalii ED, WB, I, EN	Construction of universities, secondary schools, swimming pools, hostels for investors in the village, and good roads to attract tourism
Kuhamasisha kuwa na shule za binafsi ED, EN	To sensitize on the importance of having private schools	Kuweka mazingira ya kupata marafiki na wahisani wa muda mrefu ndani nanje ya nchi ED, EN	Creating a good environment of getting friends and long-term development partners from outside the country

Lesirwai Sub-Village

Wednesday, 7 September 2016

Mifugo na chakula -- Food and livestock

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Ujenzi wa Josho la mifugo L ,I	Construction of cattle troughs	Kuvuna maji ya mvua kwa ajili ya Ndama,watoto wa mbuzi na Bustani za mbogamboga F, WL	Rainwater harvest for young cattle, goats and small-scale gardening
Ujenzi wa Luresho kunyweshea ngombe L, I	Consruction of water trough	Kuhamasisha upandaji wa miti ya matunda, Mbao, vivuli na makinga upepo F, EN	Promoting tree planting for fruits, timber and windbreaking forest
Kuanzishwa bustani za mbogamboga EN, F	Establishment of vegetable gardens		
Kupanda miti ya chakula cha mifugo na matunda F, EN	Planting trees for animal fodders and fruits		

Makazi na Ujenzi -- Housing and Infrastructure

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Ujenzi wa nyumba bora H, I	Modern house construction	Kujenga barabara za kudumu EN, I	Permanent road construction
		Umeme wa jua kwa ajili ya kusukuma maji mashuleni,zahanati na majumbani HE, WB	Using solar power to pump water to the schools, health centers and homes
		Ujenzi wa intake kwenye vyanzo vya maji na mifereji ya umwagiliaji mashambani WL, F	Construction of water source intake and canals for farming irrigation
		Ujenzi nyumba bora H, I	Construction of modern houses
		Ujenzi wa barabara za	Construction of

		kudumu I	permanent roads

Elimu na Ujasiriamali -- Education and Enterprise

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Ujenzi wa kiwanda cha maziwa EN, I	Construction of milk factories	Uanzishaji vikoba kwa Vijana, Wamama na Wazee EN, ED	Establishment of small community banking groups (VICOBA) for youth, women and elder men and women
Ujenzi wa Soko dogo la kuuzia vitu kwa ajili ya matumizi ya nyumbani EN, I	Construction of small market for domestic uses (home goods)	Usafi wa mazingira Mashuleni WB, HE	Hygiene and environmental cleanliness in schools
Watoto watapata muda wa kwenda shuleni badala ya kuchunga mifugo ED	Children will get time to go to school instead of taking care of livestock	Uongezwaji idadi na ujenzi wa madarasa I, ED	Construction of an increased number of classrooms
Elimu ya namna ya kutengeneza siagi EN, ED	Education for making butter	Elimu ya uvunaji maji ya mvua EN, I	Education on rainwater harvesting
Ujenzi wa mashine ya kusaga mahindi I, EN	Construction of maize milling machine	Ulimu ya ujasiriamali EN, ED	Education for entrepreneurship
Charahani kutengenezea nguo za shule WB, EN	Sewing machine for making school uniforms	Kubuni miradi ya maendeleo EN, ED	New initiatives of development projects
Mashine kwa ajili ya kushona sweta za watoto EN, ED	Sewing machine for making sweaters for children to wear during the cold season	Kuimarisha elimu ya kilimo na ufugaji bora F, L	Promoting education on agriculture and modern livestock keeping
Ujenzi wa Soko kitongojini I, EN	Construction of sub-village market		
Uanzishwaji wa eneo la utalii kwa ajili ya kuhifadhi na kuona vitu vya asili EN, I	To set aside the suitable area for cultural tourism		
Ujenzi kiwanda cha maziwa F, I	Construction of milk factory		

Afya na afya ya jamii kwa jumla -- Health and Wellness

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Usafi wa mazingira na majumbani HE, WB	Cleanliness of the general environment and home environment	Usafi wa mwili HE, WB	General body hygiene
Kujenga vyoo bora mashuleni na majumbani HE, WB	Construction of good toilets around the school and at home	Tunahitaji hospitali na maji safi ya bomba HE, WL	We need hospitals and clean pipeline water
Watoto watakuwa wasafi mwili pamoja na nguo HE, WB	Children will be clean in their bodies and clothes	Kijengwe kituo cha afya na zahanati HE, WB	Building health care center and dispensary
		Uchujaji wa maji na kuyatibu HE, WB	Filtration and treatment of water
		Kunywa maji ya bomba, na kuanziswa bustani za mbogamboga WL, F	Drinking tap water and establishment of vegetable gardens
		Usafi wa maji kuondoa magonjwa yatokanayo na maji WL, HE	Cleanliness of water to avoid water borne disease

Miradi mikubwa ya baadae -- Great Ideas Not Now

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Ujenzi wa zahanati HE, I	Construction of dispensaries	Usafiri kwa ajili ya kuharakisha biashara na huduma za jamii I, WB	Transport to make faster business and community services
Ukarabati wa barabara na madaraja I	Rehabilitation of roads and culverts	Kuhamasisha ujenzi wa shule za binafsi za kulala ili kuepuka kukatisha masomo watoto EN, ED	To sensitize on the establishment of private schools (boarding) to minimize school dropout
Kuboresha kiwanja cha ndege I	To improve the small airstrip	Uimarishwaji wa mfereji wa (Asili Lesirwai) ili kunufaisha wanajamii F, I, WB	To improve the canals (specifically the Asili Canal in Lesirwai) in order to help the community

Kuwa na Solor Power kubwa ya kusukuma maji toka mtoni na hadi katika maeneo wanapoishi watu I	To have big solar power to pump water from the source borehole up to the community where people live	Umwagiliaji eneo la mifugo I, L	Irrigating the livestock area for grasses (animal feed)
Mifereji ya umwagiliaji mashambani I, F	Canals for farm irrigation	Kuimarisha mfereji mkubwa wa maji I	Maintainance of bigger irrigation canals
		Mfereji kwa ajili ya umwagiliaji miti ya asili I, WB	Big canals for irrigation of indigenous tree lots
		Uthibiti wa maji mtiririko kuepusha korongo na mmomonyoko wa udongo I, ED	Maintain flowing water to minimize gullies and erosion
		Mfereji wa umwagiliaji kuimarisha kilimo cha chakula na matunda F, I	Irrigation to promote farming for food crops and fruit trees
		Ufugaji wa nyuki na utengenezaji mizinga ya kisasa F, EN, ED	Bee keeping and construction of modern bee hives
		Elimu ya kufundisha kilimo na mifugo F, L, ED	Get education on farming and livestock
		Kiwanda cha maziwa L, I	Milk factory

Pateli Sub-Village

Thursday, 8 September 2016

Mifugo na chakula -- Food and livestock

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Tutapata muda wa kulima mboga mboga (bustani) F, EN	Extra time for dry season gardening	Uchimabaji wa malambo kwa ajili ya kuvuna maji ya mifugo I, WS, L, WL	Digging of chacol dams for run off water harvesting to feed the animals
Kuwa na mabwawa ya ufugagi wa samaki EN, F, I	To put in place fish ponds	Elimu ya utaalamu wa ufugafi kuku ED, EN	Education on chicken rearing
Kuwa na jokofu za kuhifadhia maziwa EN, L	To put in place containers to preserve milk	Usindikaji wa mvinyo wa nyanya EN, ED	Processing of tomato wine
Tusadidiwe kupata madawa ya mifugo L	Access to veterinary medicine for the animals	Uanzishaji bustani za mboga mboga EN, F	Establishment of vegetable gardens
Kupatiwa elimu ya kuhifadhi chakula maana tutakua na muda wa ziada EN, ED, F	Getting trained on techniques of food preservation and storage	Uanzishaji vikundi vya kuotesha miti (matunda, vivuli,mbao na dawa) EN, WB, F	Introducing tree planting initiative groups (for fruits, shading timber and medicine)
Tupatiwe mbegu bora za mifugo za kuku, ngombe na mbuzi L, EN, ED	Getting accessibility to good variety species of chicken, cows and goats	Ujenzi wa nyumba bora na za kisasa H, I	Construction of modern housing
Tutaweza kunywesha mifugo yetu mbuzi na kondoo L	We will be able to give water our goats and sheep	Uanzishwaji wa kiwanda kidogo cha usindi kaji wa nyanya EN, I	To establish small scale industries for processing tomatoes
		Utafiti wa kilimo cha zabibu ED, F, EN	Research on how to grow grapes
		Utaalamu wa kuandaa mabwawa ya samaki ED, EN	Education on how to construct fish ponds
		Ufugaji wa sungura na bata EN, F, I	Rabbit and duck keeping
		Ujenzi wa luresho na majosho L, I	Construction of cattle troughs and dips
		Kiwanda cha kusindika	Industries to process

		maziwa F, EN, I	milk products
		Kuanzishwa mabwawa ya kufugia samaki EN, I	Fish pond establishment
		Ujenzi wa soko la biashara mchanganyiko I, EN	Market for different variety of goods
		Upandaji wa miti ya matunda, maua na vivuli WB, EN	Tree nursery established for fruit trees, flowers and shading trees
		Kuanzisha bustani za mbogamboga EN	Establish green vegetable gardens
		Viwanda vya maziwa kwa matumizi ya muda mrefu I, F, EN, L	Establishment of milk processing and storing for long-term use
		Ufugaji wa nyuki kwa mizinga ya kisasa katika vikundi EN	Modern bee-keeping by initiative groups
		Kujengwa luresho kwa ajili ya kunyweshea mifugo L, I	Constructing cattle troughs for animals' water
		Kuanzisha duka la kuuza zana za kilimo na mifugo I, L, F	To build a shop for selling farm and livestock inputs
		Kuanzisha miradu midogo midogo ya ufugaji wa kisasa EN, L	To start small-scale microbusiness of cattle keeping

Makazi na Ujenzi -- Housing and Infrastructure

Wanawake -- Females		Wanaume -- Males	
Swahili	**English**	**Swahili**	**English**
Tusaidiwe kupata – majiko sanifu yaku – pikia, yanayotumia kuni chache EN, I	To be assisted on construction of energy saving stoves that use fewer firewoods	Barabara ya vitongoji (mitaa) I, WB	Construct sub-village feeder roads
Tusaidiwe kupata	To be assisted with	Utunzaji wa mazingira	Improving our home

elimu ya ujenzi wa mitambo ya biogas EN, I	education on the construction of biogas technology	ya makazi yetu WB, H	environment
Tutapata muda wa kutafuta masoko ya bidhaa zetu EN	Getting time to find markets for our goods	Kuanzisha kiwanda cha kufyatua tofali kwa kundi la vijana ili kuboresha ajira kwa vijana EN	Establish bricks making industries so as to create employment for the youth
Ujenzi wa nyumba ya kuhifadhia mazao (ghala) I, F	Construction of warehouse for farm crops produce (store)	Ujenzi wa vivuko vya maji na mifereji katika mashamba I, F	Construction of controlling gates for irrigation canals
		Kugawanya viwanja Pateli kwa makazi mapya H	Allocation of plots for construction of new houses at Pateli
		Ujenzi wa nyumba bora za kuishi H, I	Cobnstruct new and modern houses for residential purposes
		Usafiri na usafirishaji wa watu na bidhaa za shambani vitakuwa kwa wepesi zaidi WB	Transport and transportation of people and farm products will be faster than before
		Ujenzi rahisi na wa haraka wa nyumba za ibada, makanisa na misikiti WB, I	Easy and cheaper construction of church and mosque buildings

Elimu na Ujasiriamali -- Education and Enterprise

Wanawake -- Females		**Wanaume -- Males**	
Swahili	**English**	**Swahili**	**English**
Tusaidiwe kupata elimu ya masoko ya mazuri ya bidhaa tunazozalisha mashambani EN, ED	To be trained on knowledge to get and access better markets for our products from the farming economy	Kuanzisha maeneo ya utalii wa asili kijijini EN, I	To put in place cultural traditional tourism center
Tupatiwe uwezo wa kutengeneza bidhaa za kusuka au kuchonga kwa mikono –waume na wanawake EN	Get knowledge on hand craft works for both men and women	Kuanzisha ufugaji bora na wa kisasa wa samaki EN	Introduce modern fish farming
Tujengewe uwezo wa	Capacitated on the	Uanzishwaji wa	To establish hides

vikundi katika kuweka na kukopa fedha kwa ajili ya biashara EN, ED	knowledge of saving and credits to manage small scale businesses	masoko ya ngozi EN, I	market
Uvunaji wa maji ya mvua mtiririko na katika mabati vitasaidia kuongezeka kwa uoteshaji wa miti na mbogamboga kijijini EN, WL, WS	Run off water harvesting and roof water harvesting will enable tree and vegetable growing in the village	Shule kwa ajili ya watoto chekechea I, ED	Have kindergarten school built
Tujengewe shule yachekechea kwa ajili ya watoto wetu kijijini ED, EN	To construct nursery school for our children in the village	Afya na elimu ya usafi kwa watoto HE, ED	Health and children's hygiene improved at school
Muda wa ziada utatumika vyema kuunda vikundi mbalimbali vya ujasiriamali EN	Extra time will be better used by women to create women development initiative groups	Elimu ya usafi wa mazingira na miundo mbinu mashuleni HE, ED	School environmental hygiene and other sanitatary infastructures improved
Kuwapo na mashine za kusindika mazao na bidhaa za mashambani EN, F	Establish small scale industries to process agro products	Ujenzi wa nyumba bora za kuishi ili kupandisha hadhi ya maisha H, WB	Construction of houses to improve well-being of the people
Tutaweza kutengeneza vitu vya asili kama shanga na tutasaidiwa kutafutiwa masoko EN	We will be in better position to engage ourselves in hand making products, for example necklace and get assisted in accessing better markets	Mashine ya kufulia EN	To have in place a clothes washing machine
Tupatiwe mashine za kushonea nguo kama masweta EN	To get assisted with a clothesmaking machine for clothes and sweaters	Uanzishaji wa ujasiriamali na uwekezaji kwa kuanzisha viwanda vya kusindika chakula, mbogamboga, mafuta na nafaka EN, I	Establishing small scale development initiatives by introducing food, vegetable and oil processing industries
Tusaidiwe kupata mashine ya kubangua vifaranga katika kikundi wavu EN, I	Get assisted with the incubators for hatching eggs and wire mesh for constructing chicken house	Viwanda vya kutengeneza matofali EN, I	Bricks making technology
Tupewe elimu ya	To be educated on	Ufugaji bora wa nyuki	Beekeeping initiatives

kutengeneza vifunguo EN	how to make buttons	na wa kisasa zaidi uanzishwe EN	developed and improved
Tusaidiwe mashine za kusindika matunda katika kikundi cha akina mama EN, I	Get assisted on technology to process fruits in women's groups	Ujenzi wa malambo ya kunyweshea mifugo L, I	Construction of water troughs for livestock
Tutafanya ufugaji wa kuku, mbuzi kwa sababu tutapata muda EN, F, L	To be in a position to make better rearing of chickens, goats because of the extra time available	Tusaidwe nishati ya umeme wa jua kwa ajili ya viwanda vidogovidogo I	To be assisted with the installation of solar power for managing small industries
		Kiwanda kidogo cha kutengenza ngozi EN, I	Industries for making hides
		Mpango wa kufundisha elimu ya ujasiriamali, ubunifu, uwezeshaji, uendeshaji na undeshaji wa biashara ndogondogo na kubwa EN	A program to train on entrepreneurship, new initiatives, investment and managing small-scale business

Afya na afya ya jamii kwa jumla -- Health and Wellness

Wanawake -- Females		**Wanaume -- Males**	
Swahili	**English**	**Swahili**	**English**
Tutaogesha watoto na tutasafisha nguo zao HE, WB	Improve the hygiene for our children and washing our clothes	Ujenzi wa kiliniki ya watoto, ili kupambana na magonjwa ya watoto HE, I	Construction of a children's clinic to eradicate children's diseases
Tusaidwe kupata kliniki ya macho, masikio na meno HE, I	Get clinic for eyes, ears and dental	Kujenga kituo cha afya HE, I	Construct health center
Ukarabati wa zahanati na tupewe huduma za afya kwa magonjwa sugu HE, I	Repairing the village dispensary and get other special services for crucial diseases	Kuanzisha mpango maalumu wa kuotesha miti: watoto mashuleni, wazazi katika makazi, na miti ya kuzuia upepo WB, H, ED	Introduce a program of tree planting, emphasizing children planting trees at schools and parents planting trees at their residences
Itasaidia kufuta	Assist in eradication of	Ujenzi wa vyoo bora	Construction of

magonjwa ya mlipuko HE	eruptional diseases	HE, I	improved sanitary systems
		Kuwe na tekinolojia ya kuchuja na kutibu maji inayoletwa kijijini na mashuleni HE, ED	To put in place a technology to filter and treat water brought to the school and villages
		Kina mama watakuwa wasafi na maradhi mengi yatapungua HE, WB	Women will remain cleaner and many women diseases will reduce and finish
		Kuanzisha ufugaji bora wa kisasa wa ngombe na mbuzi L, EN	Establish modern cow and goat rearing

Miradi mikubwa ya baadae -- Great Ideas Not Now

Wanawake -- Females		**Wanaume -- Males**	
Swahili	**English**	**Swahili**	**English**
Tujenge shule ya manesi na wakunga HE, I	Get construction of mid-wives school	Ujenzi wa barabara za mashambani kwenda sokoni I, F	Construction of village market access roads
Tujengewe shule ya sekondari ya kulala (jinsia zote) I, ED	Get assisted with construction of secondary schools with boarding facilities	Ujenzi wa zahanati nzuri ya kijiji na iwe na vifaa vya kutosha, pia umeme wa uhakika (solar power) I, HE	Construction of village dispensary, equipped with facilities including installation of solar power
Tujenge zahanati na tuongezewe madaktari I, HE	Have to construct dispensary and equip more doctors	Ujenzi wa shule bora na ya kisasa ya msingi I, ED	Construction of better primary school
Tujenge kituo cha watoto yatima I, WB	Have to construct an orphanage center	Kuwe na mpango maalumu wa wakulima na wafugaji kuwa na ziara za kwenda kujifunza ujasiriamali EN, ED	Study tour visits for farmers and livestock keepers to learn best practices elsewhere
Tusaidiwe kupata gari la wagonjwa HE	Put in place ambulance for village dispensary	Ujenzi wa chuo cha ufundi kijijini kwa ajili ya ajira ya vijana EN, I	To create employment for the youth by constructing a technical school
		Ujenzi wa sehemu ya makumbusho ya mila na desturi za kimasai (vifaa, nyimbo, nyumba, miti ya dawa	Construction of Masai cultural center (where we can see cultural items, dancing, traditional houses, and

		za asili na eneo la mikutano ya kimila) I, EN	growing traditional medicines and good hall for meetings)
		Ujenzi wa zahanati bora na ya kisasa Marwa HE, I	Construction of modern dispensary in Marwa
		Ujenzi wa shule bora ya chekechea ED, I	Construction of better nursery schools
		Ujenzi wa kituo kikubwa cha afya Marwa HE, I	Construction of village health center
		Ujenzi wa kiwanda cha kusindika nyama EN, F, I	Construction of meat products industries
		Uoteshaji wa mbegu za nafaka na mbogamboga EN, F	Establishment of seed growing farm for cereals and vegetable crops
		Ujenzi wa kiwanda cha kisasa cha kuhifadhi mbegu bora za nafaka na mbogamboga EN, I	The center to pack the seeds for distribution
		Ujenzi wa umeme utakaosaidia maendeleo na ujasiriamali kijijini I, EN	Installation of electricity which will aid for more village development investments and new initiatives
		Ujenzi wa kiwanda cha usindikaji wa ngozi na utengenezaji wa bidhaa za ngozi EN, I, L	Construction of hides and skins industry

Village Council Members

Thursday, 8 September 2016 - afternoon

Mifugo na chakula -- Food and livestock

Swahili	English
Viwanda vidogovidogo vya mazao ya matunda na mbogamboga EN, F	Small scale industries for processing fruits and vegetables
Viwanda vidogovidogo vya mazao ya mifugo (Maziwa, Ngozi na Mifupa) EN, F	Small scale industries for processing animal products (milk, skin and bones)
Kuanzisha masoko ya mazao ya kilimo na mifugo EN, F	Creation of village markets for livestock and farm products
Mpango wa uvunaji wa maji ya mvua katika zahanati ya kijiji na katika shule ya msingi WS, ED, I	The program of rain water harvesting at village dispensary and primary schools

Makazi na Ujenzi -- Housing and Infrastructure

Swahili	English
Mpango wa uvunaji maji ya mvua katika mapaa ya Zahanati ya kijiji na Shule ya msingi WS, ED, I	The program to build top roof water harvesting at village dispensary and primary school

Elimu na Ujasiriamali -- Education and Enterprise

Swahili	English
Uanzishaji elimu ya kujua mahitaji ya upatikanaji wa masoko kwa wakulima na wafugaji EN, ED	Introduction on training on demand chain approach marketing for the benefit of farmers and livestockeepers
Elimu ya watu wazima ED	Adult education promoted
Elimu ya namna ya kusimamia matumizi ya fedha ED	Micro finance education
Elimu ya uanzishaji Vikoba EN, ED	Training on VICOBA and micro finance education

Afya na afya ya jamii kwa jumla -- Health and Wellness

Swahili	English
Kampeni ya usafi wa mazingira na vyoo katika mazingira ya makazi ED, WB	Campaign on environmental hygiene and sanitary systems at the home environment

Kampeni ya upatikanaji vifaa katika Zahanati ya Marwa hata kabla ya kuwa kituo cha afya ED, I, HE	Campaign to ensure availability of village Dispensary facilities even before having the Dispensary promoted to a Health Centre
Uwezekano wa kupatiwa Jokofu kwa ajili ya kuhifadhia madawa I	The possibility of getting a refrigerator for the village dispensary to preserve some medicines

Miradi mikubwa ya baadae -- Great Ideas Not Now

Swahili	**English**
Utafiti wa kitaalamu wa madini yanayopatikana katika kijiji cha Marwa ED, I	The technical mineral deposits research at Marwa village
Upatikanaji Majiko sanifu EN, I	To have in place improved cooking stoves
Miundombinu ya ujenzi na ukarabati wa madarasa na uendelezaji madarasa mapya ED, I	Construction of school infastructures and possibility for new classrooms
Upanuzi wa Zahanati ya kijiji kuwa kuwa Kituo cha afya na kuongezewa wataalamu I, HE	Promotion of village dispensary to be a health centre with an additional number of doctors
Jamii za watu kijijini zipatiwe elimunya mapokezi ya miradi na mabadiliko ya kijamii pasipo kuathiri mila na desturi zao mfano: utafiti wa madini na mikataba isiyo na manufaa kwa jamii husika ED, EN	The community to be given education on how to accept changes without interruption or corruption of their values and cultural norms
Kuboresha masoko ya mazao ya mifugo na kilimo pamoja na barabara za kijijini EN, I	Improvement of village markets both for crops and animals products including village road construction
Upatikanaji wa umeme wa uhakika kijiji cha Marwa I	Availability of sustainable electricity supply in Marwa village
Kupatiwa elimu ya matumizi ya Gas ya kinyesi cha mifugo ED, I	Promotion and training of the use of Biogas from animal waste
Ujenzi wa josho na luresho I, L	Construction of cattle trough and cattle dip
Uanzishwaji duka la pembejeo za kilimo na mifugo	Establishment of village shop for animal and farm inputs

THE VILLAGE COUNCIL OF MARWA

VILLAGE CHAIRMAN

MARWA VILLAGE

P.O. BOX 223

SAME

15TH OF JANUARY, 2013

THE DIRECTOR FOR KIHO,

P. O. BOX 250,

SAME – KILIMANJARO.

RE: A REQUEST TO KIHO ORGANIZATION

Refer to the heading above.

On behalf of citizens of Marwa, I would like to send our request for a support on provision of clean and safe water in Marwa village. From the founding of the village, there has been a big problem of lack of clean and safe water. In recognition of KIHO organization contributions, I am sending this request on behalf of Marwa villagers. Whilst water is their first priority, there are also other projects as follows;

- Strengthening the dispensary
- Improvement of primary school buildings
- Construction and establishment of market and
- Availability of reliable electricity supply

With respect, we are sending this request so that you can help us

Thank you

_____

ELIFURAHA MASON
VILLAGE CHAIMAN
MARWA.

HALMASHAURI YA KIJIJI CHA MARWA

MWENYEKITI WA KIJIJI
KIJIJI CHA MARWA
S.L.P 223
SAME
15-01-2013.

MKURUGENZI WA KIHD.
S.L.P 250,
SAME- KILIMANJARO.

YAH: MAOMBI KUOA SHIRIKA LA IKIHO.

Kichwa cha barua juu chatusika Sana.

Kwa niaba ya wananchi wa Marwa napenda kutuma maombi ya kupatiwa maeneo wa kupatikana kwa Mzee Sofi na Selema Katika kijiji cha Marwa, toka kijiji kimeanzishwa kumekua na Tatizo kubwa la Upatikanaji wa Mzee Sofi na Selema, kwa kutambua mchango wa Shirika la kiho ninatuma maombi haya kwa niaba ya Wanakijiji wa Marwa ikiwa Mzee ndio kipaumbele chao cha kwanza pia kwa mindi mingine kama ifuatayo.

- Kuimarisha Dispensary
- Ubareshaji wa Mgengo ya s/m
- Ujenzi na Uwanzishwaji wa Soko
- Upatikanaji wa Umeme wa Uhakika.

Kwa heshima tunatuma maombi haya kwani ili mweze kutusaidia

Asante

Sm:

ELIFURAHA MASON
M/KITI WA KIJIJI
MARWA.

Instructions: The information gathered from this log will be beneficial in the continued progress and success of the MajiMarwa Project. Please record the information daily in the tables provided.

Date:

Recorded By:

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	**TOTAL**
# of buckets used								
# of patients seen								
# of patients utilizing water								

Date:

Recorded By:

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	**TOTAL**
# of buckets used								
# of patients seen								

Date:	Gauge Reading:

Date: _____

Summary of issue: _____

Solution: _____

Date: _____

Summary of issue: _____

Solution: _____

Block Making Process

1. **Observations**

   Materials were delivered to A to Z in Same. The block mixture was made and blocks were formed using a hand press block maker. They were removed and placed in a line and allowed to cure. Water was poured over top of the bricks to aid in the curing process.

2. **Recommendations**
   - **a.** Smaller aggregates should be used in the block mix. (3/8” or smaller)
   - **b.** Blocks should be tamped with a rod to consolidate before they are pressed

Foundation

1. **Observations**

   Proposed tank area was cleared of debris. A pit was dug for the slab, the depth of the pit was approximately twelve inches. The bottom of pit was layered with stones three to six inches in diameter. A layer of concrete was placed on top of this stone footer. A footer was dug around the slab to ¾ m deep. Large stones were broken and laid level along the entirety of the hole. A 1:4:4 ratio of sand, small stones and medium stones (combined), and bags of cement were measured and mixed in the center. Water was then added to areas of the mix to make the concrete mixture. The mixed concrete was pushed into the sides and compacted with a tamp until level. Multiple batches of concrete were made until the entire hole was filled. Each batch took approximately two hours to complete. The concrete placement process took two working days and some parts began to dry before other portions were added. The excavation took 1 day.

   Using a trowel, a block key was cut into the concrete where the bricks would be laid. Mortar was made using a 1:4:8 ratio of sand, bags of cement, and bags of granite powder, water was not measure but added on as needed basis. Mortar was applied in the key and bricks were laid level onto the mortar. This process continued around the circle, adding mortar between the bricks, until an entire row of bricks were laid. Wooden inserts were fitted inside the bricks. A concrete slab was poured utilizing the blocks around the outside as formwork. The wooden inserts were then removed creating a joint. That joint had wire placed into it and then covered with mortar mix. Square rebar mesh was added to the slab and covered in concrete. A small square indent was left to create a clean out.

2. **Recommendations**
    - **a.** Stone foundation not necessary
    - **b.** Concrete foundation is thicker than necessary
    - **c.** Remove stone foundation and reduce thickness of foundations and footer.

Masonry Block Wall

1. **Observations**

   Masonry blocks were laid on the previous block utilized as formwork. A pipe with a four inch diameter was placed into the first course in the mortar joint. The blocks were laid with thick mortar joints (approximately one inch). A small threaded pipe of diameter one ince was placed into the second course mortar joint to act as the outlet. The block was laid in layers of three courses. The workers would not lay more than three layers in one day as they believed this would compromise the integrity of the wall. Mortar was mixed little by little in the center of the tank. In each course wire was placed to add horizontal reinforcement. Towards the top of the wall a block was chiseled to allow the inlet pipe to fit. An overflow pipe was installed one course above inlet pipe.
2. **Recommendations**
    a. Blocks were too rough thus creating the issue of thick mortar joints
    b. Reduce size of mortar joints
    c. Lay more than three courses of block if time permits

Column

1. **Observations**

   The column was formed from rough lumber and the formwork was constructed to the top of the walls. The concrete column was poured in place with steel rebar reinforcement. The column was built up to be flush with the edges of the tank walls. The column was not tied into the floor slab.
2. **Recommendations**
    - **a.** Remove column

Exterior Finish

1. **Observations**

   Mortar mix was applied to the outside of the tank and flattened to make smooth appearance. The thickness of the finish was approx. ¾". Using a straight piece of wood and a piece of rebar, vertical and horizontal lines were cut into the plaster to add aesthetic appeal.

2. **Recommendations**

a. Lay blocks in a neat and uniform fashion and the exterior coating would not be needed.

Interior Finish

1. **Observations**
   The inside of the tank was coated with two layers of cement mixture. The floor was also coated and sloped downward towards the drain.
2. **Recommendations**
   a. The thickness of this layer can be reduced. Two thin layers can be utilized instead of the excessive layer technique utilized.

Roof Slab

1. **Observations**
   The formwork for the top slab was made from rough sawn lumber. The pieces were held in place by long rough cut logs. The top of the lumber was cover in a plastic sheeting. The slab was reinforced with rebar (12mm and 16mm bars space 15mm x 20mm on center). A thin piece of lumber was wrapped all the way around the tank to create the side formwork. Then concrete was poured by the bucket fill into the slab. The slab was four inches thick on the edges and five inches thick in the middle. The ratio was 2 sand: 4 aggregate: 6 bags of cement. In total 36 of sand: 70 buckets of aggregate: 6 bags of cement.
2. **Recommendations**
   a. Thicken the slab to adjust for the removal of the middle column.

Tap point

1. **Observations**
   The threaded pipe that was inserted during wall construction was connected with another piece with a valve, around the valve a box made of concrete and masonry block was created thus encasing the valve. On the top a cover with a lock was added. The pipe extended out of the box and the area beneath the tap was dug out to create an area large enough for a bucket to be placed.

2. **Recommendations**
   a. The tap valve box is excessive. A masonry block box would serve the same purpose
   b. The final tap has a lock on it making the entire valve box redundant.
   c. The bucket area should be lower to accommodate for larger buckets

Gutters and Piping

1. **Observations**

Gutter hooks were attached to a board and then spacers added to ensure all the water is captured. Then the board was hoisted into place and the downslope was found by utilizing a string level. The gutters were then placed into the hooks. On one side of the dispensary the building and roof had settled. The roof was raised on one end to bring it back to level. Once that was done the gutters were added and the water was able to flow into the pipe system that met at the midpoint of the tank and empty into the tank.

2. **Recommendations**
    - **a.** N/A

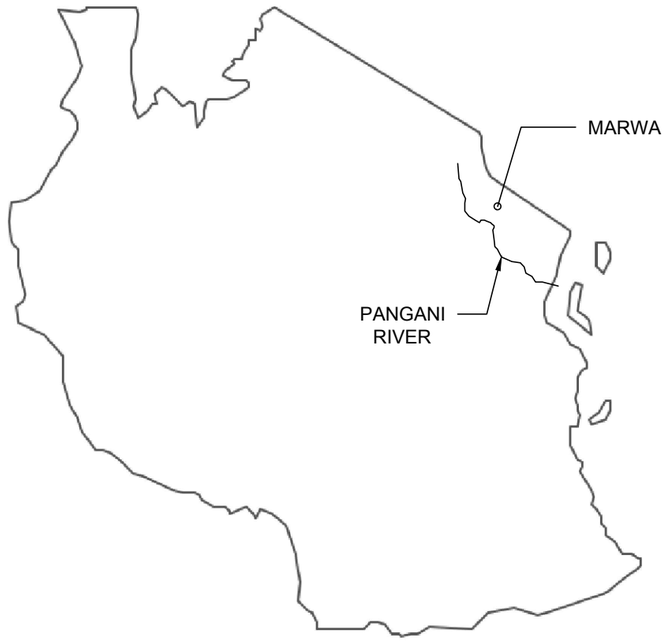
Overall Observations

1. **Observations**

   When the formwork was removed the tank was entered and inspected. Measurements were taken to determine an actual storage volume. The Inside tank was measured to have a radius of 70 Inches. The water inlet was measured to be 72” from the bottom of the tank. The outlet tap point was found to be 7 inches from the bottom of the tank. Utilizing these measurements and subtracting the volume of the column The volume capacity was calculated to be 19,300 L. When question about why the inlet pipe was put so low the answer received was “the water will settle out and the tank will fill up”.

2. **Recommendations**
    - **a.** This is quite a bit less than the 27,000 L volume stated by Mr. Kaki. The inlet pipe should be moved up higher and the out pipe should be moved lower.

MAJI MARWA:
SUSTAINABLE AND RESILIENT TANZANIAN COMMUNITY



RAINWATER HARVESTING

TRH4

LEGEND

FOR REVIEW
AND COMMENT

R.W. HARVESTING
SYSTEM PLAN

SCALE	SHEET NUMBER
N/A	T-000
PLOT DATE	
03/13/2017	

FILE NAME

RWH_2017-03-13.dwg

GENERAL NOTES:

1. ALL DETAILS, SECTIONS, AND NOTES SHOWN ARE TYPICAL AND SHALL APPLY TO SIMILAR SITUATIONS.

2. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS AT SITE PRIOR TO COMMENCEMENT OF CONSTRUCTION

3. ALL OMISSIONS OR CONFLICTS BETWEEN THE VARIOUS ELEMENTS OF THE WORKING DRAWINGS AND/OR THE SPECIFICATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER BEFORE PROCEEDING WITH ANY WORK INVOLVED

4. ALL WORK SHALL CONFORM TO THE BEST PRACTICES PREVAILING IN THE VARIOUS TRADES COMPRISING THE WORK

DESIGN CRITERIA:

1. DEAD LOAD: ACCUMULATIVE WEIGHT OF ALL STRUCTURAL MEMBERS, THE FIXTURES AND THE PERMANENTLY ATTACHED EQUIPMENT AND ITS FOUNDATION.

2. LIVE LOADS:
   ROOF: 20 PSF

CONCRETE:

MINIMUM COMPRESSIVE STRENGTH: 4000 PSI

MASONRY:

1. TYPE M OR S MORTAR

2. WYTHE WALLS ARE BONDED WITH WALL TIES AND THE COLLAR JOINT IS FILLED SOLID WITH GROUT

3. WALLS ARE CONSTRUCTED USING RUNNING BONDS

4. BOTH WYTHES ARE CONCRETE MASONRY UNITS WITH THE SAME MASONRY COMPRESSIVE STRENGTH

5. BLOCK SIZES ARE 100 MM X 200 MM X 300 MM (SEE DETAIL FIGURE 1)

6. MINIMUM GROUT COMPRESSIVE STRENGTH: 2000 PSI

7. MINIMUM MASONRY COMPRESSIVE STRENGTH: 1500 PSI

REINFORCEMENT:

1. MODULUS OF ELASTICITY FOR STEEL: 29,000 KPSI

2. YIELD STRESS: 60 KSI

3. MINIMUM DEVELOPMENT LENGTH: 500 MM

4. MINIMUM LAP LENGTH: 750 MM

ABBREVIATIONS:

CLR. = CLEAR

DIA. = DIAMETER

MSA = MAXIMUM SIZE AGGREGATE

MIN. = MINIMUM

MM = MILLIMETERS

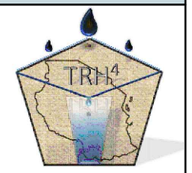
MSA = MAXIMUM SIZE AGGREGATE

RC = REINFORCED CONCRETE

T&B = TOP AND BOTTOM

TYP. = TYPICAL

TRH4



LEGEND

FOR REVIEW AND COMMENT

GENERAL NOTES

SCALE	SHEET NUMBER
N/A	S100
PLOT DATE	
03/13/2017	

FILE NAME

RWH_2017-03-13.dwg

NOTES: GUTTER AND PVC

1. MATERIAL:
   1.1. USE _____ 125MM OR 150MM HALF-ROUND GUTTERS (OR APPROVED EQUAL).
   1.2. USE _____ PVC PIPE AS PLANNED (OR APPROVED EQUAL).

2. _____ SEALANT (OR APPROVED EQUAL): USE ON ALL GUTTER JOINERS/CONNECTIONS, END STOPS, OUTLETS, AND OTHER SEEMS (AS REQUIRED) FOR WATERPROOFING.

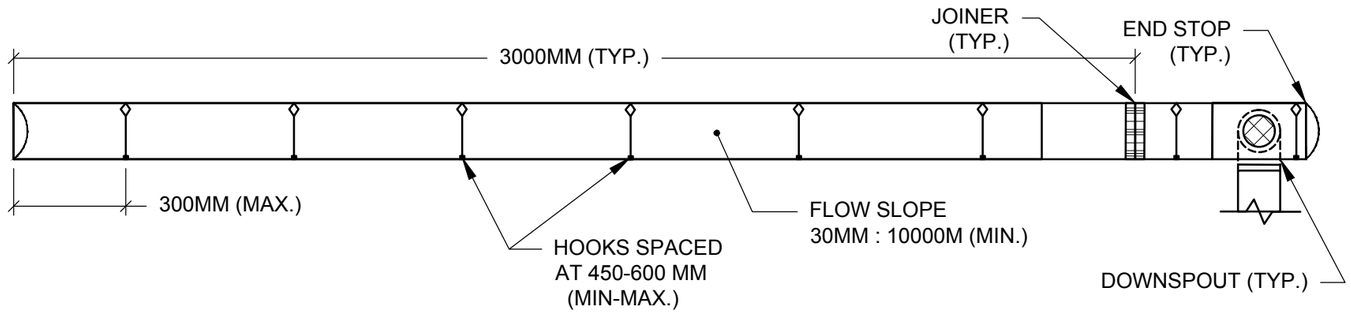
3. RAFTER BRACKETS: REQUIRED ON ALL PVC PIPE SPANS FOR SUPPORT (3000 MM MAX. SPACING).

4. FASCIA BRACKET/HANGERS:
   4.1. REQUIRED ON PLANNED GUTTER SPACED AT 450MM TO 600MM ON MIDSECTIONS AND 300MM (MAX.) FROM END CAPS.
   4.2. TO BE INSPECTED BY ENGINEER PRIOR TO INSTALLATION.
   4.3. SPECIAL REQUIREMENTS MAY BE ADDED, DEPENDING ON EXISTING FASCIA STRUCTURE (SEE DETAIL FIG. 2/S102)

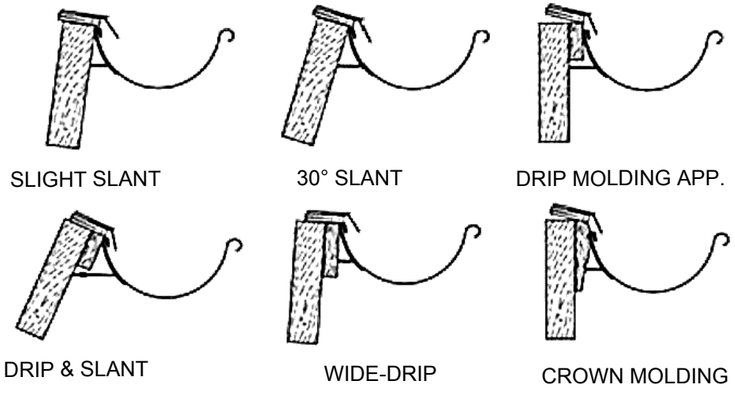
5. END STOPS: REQUIRED AT ALL GUTTER ENDS (AS PLANNED).

6. SCREEN GUARDS: REQUIRED AT ALL GUTTER AND PIPE OUTLETS/INLETS OR OTHER OPENINGS.

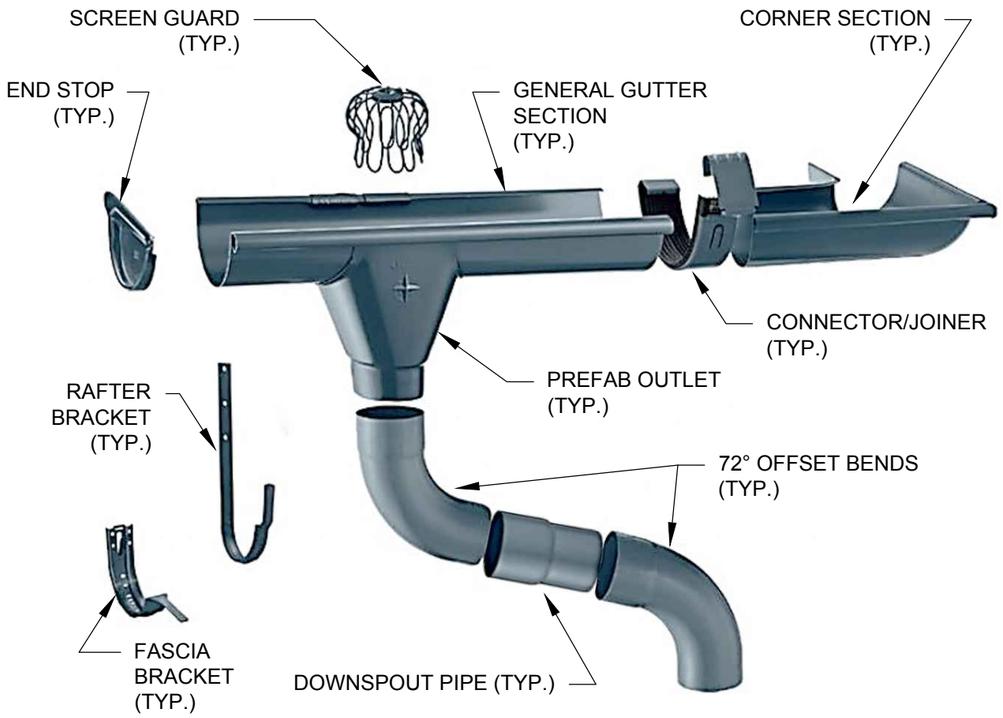
7. GENERAL INSTALLATION SHOULD BE FOLLOWED ACCORDING TO THE APPROVED MANUFACTURER'S SPECIFICATIONS AND INSTRUCTIONS.



1 TYP. HALF-ROUND GUTTER SECTION

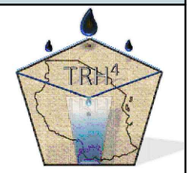


2 FASCIA ADJUSTMENT METHODS



3 TYP. GUTTER/PIPE BREAKDOWN

TRH4

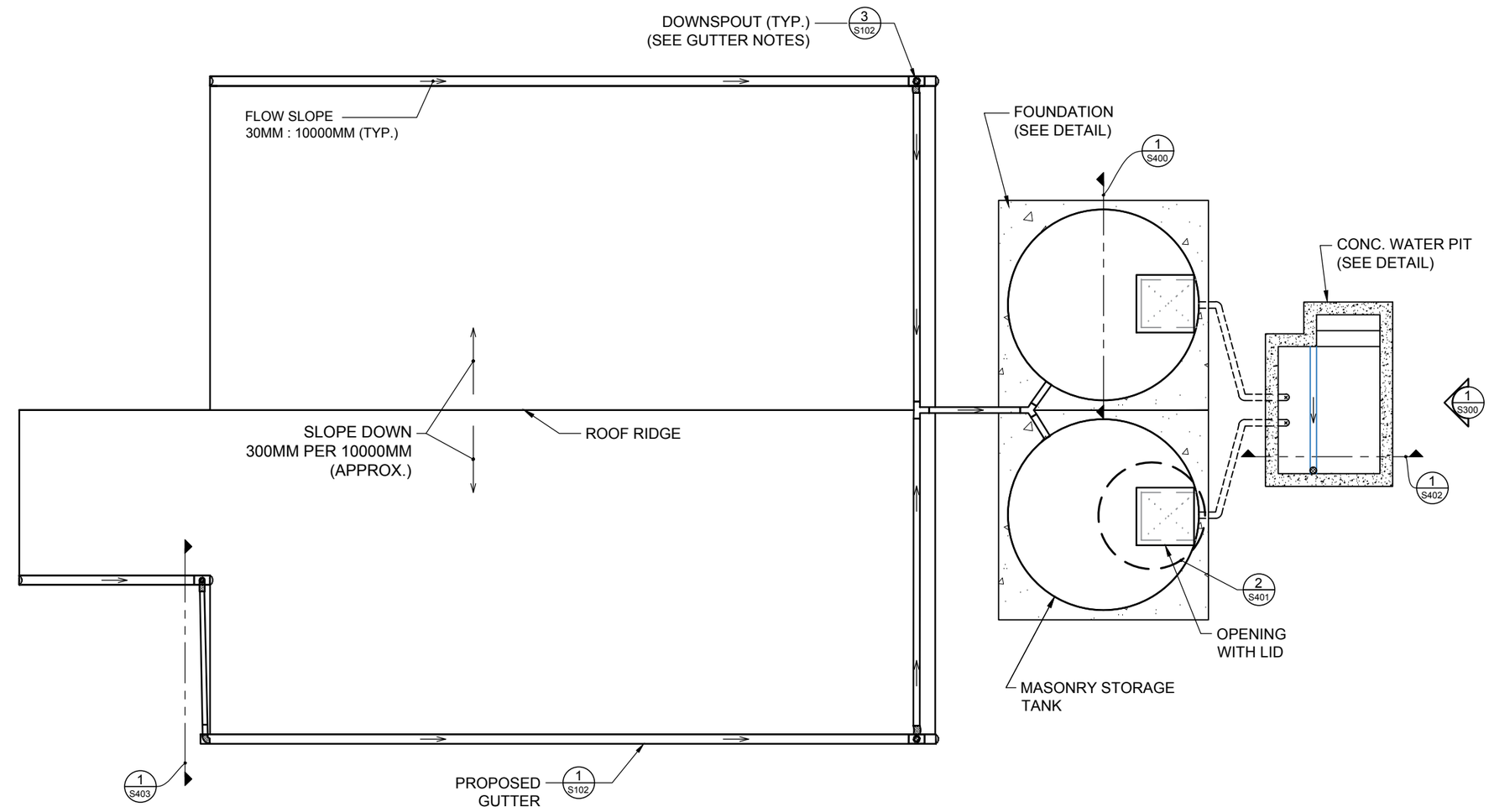


LEGEND

FOR REVIEW AND COMMENT

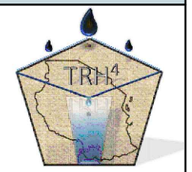
GENERAL NOTES: GUTTER AND PVC

SCALE	SHEET NUMBER
N/A	S102
PLOT DATE	
03/13/2017	
FILE NAME	
RWH_2017-03-13.dwg	



MARWA DISPENSARY RAINWATER SYSTEM
PLAN - A

TRH4

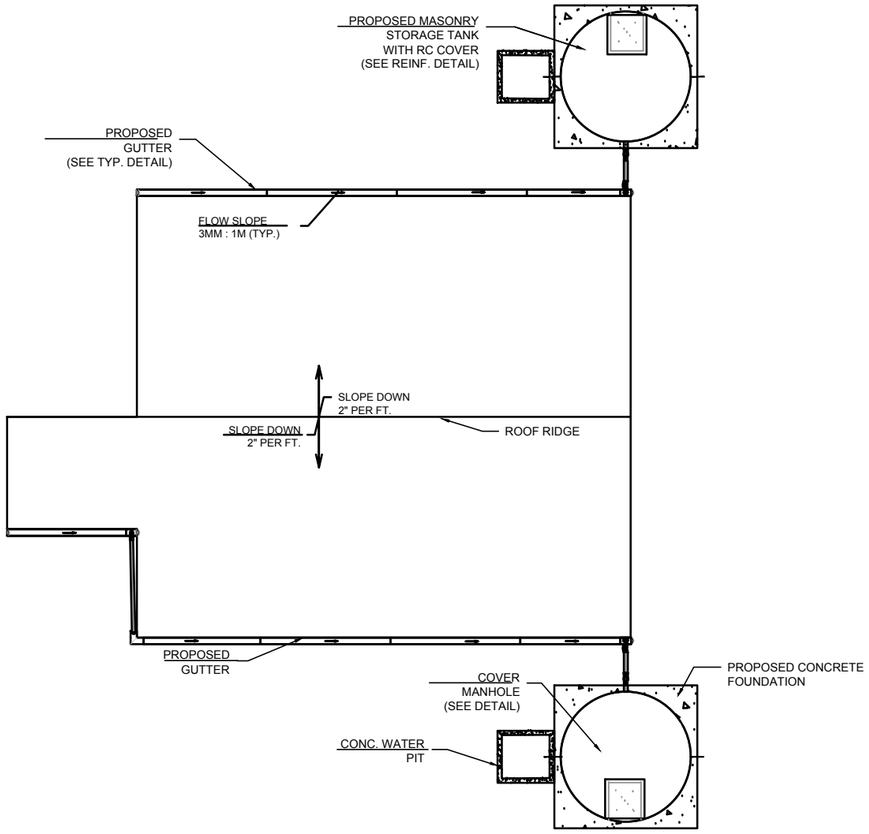


LEGEND

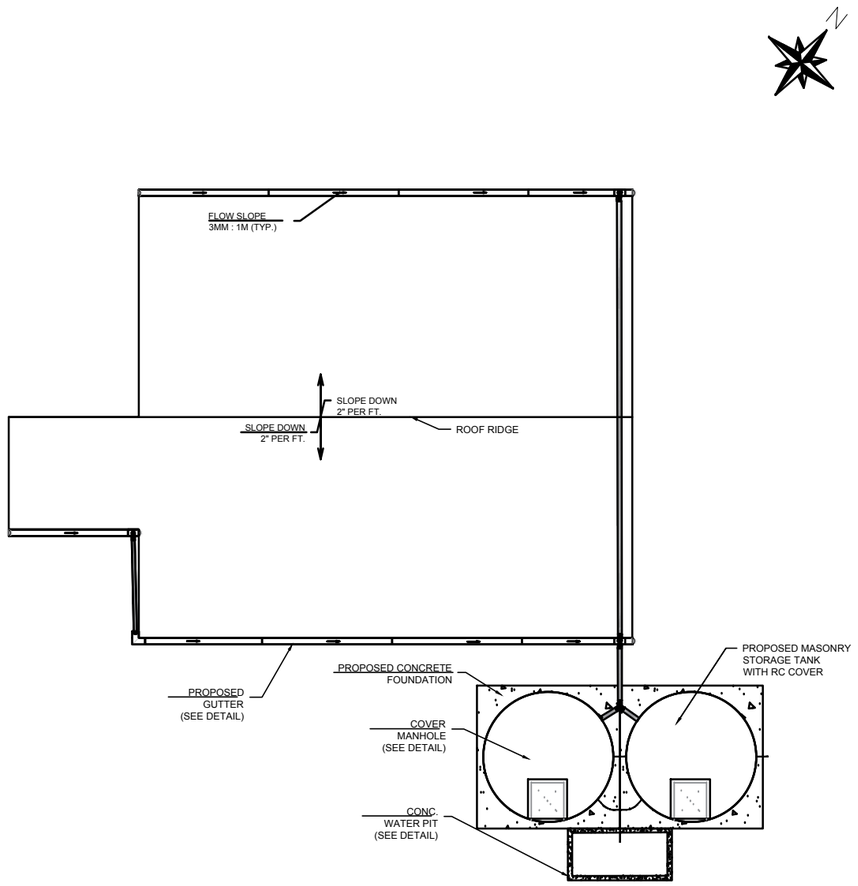
FOR REVIEW
AND COMMENT

R.W. HARVESTING
SYSTEM PLAN

SCALE	SHEET NUMBER
1:2	S201
PLOT DATE	
03/13/2017	
FILE NAME	
RWH_2017-03-13.dwg	

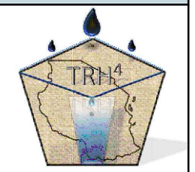


MARWA DISPENSARY RAINWATER SYSTEM
PLAN - B



MARWA DISPENSARY RAINWATER SYSTEM
PLAN - C

TRH4



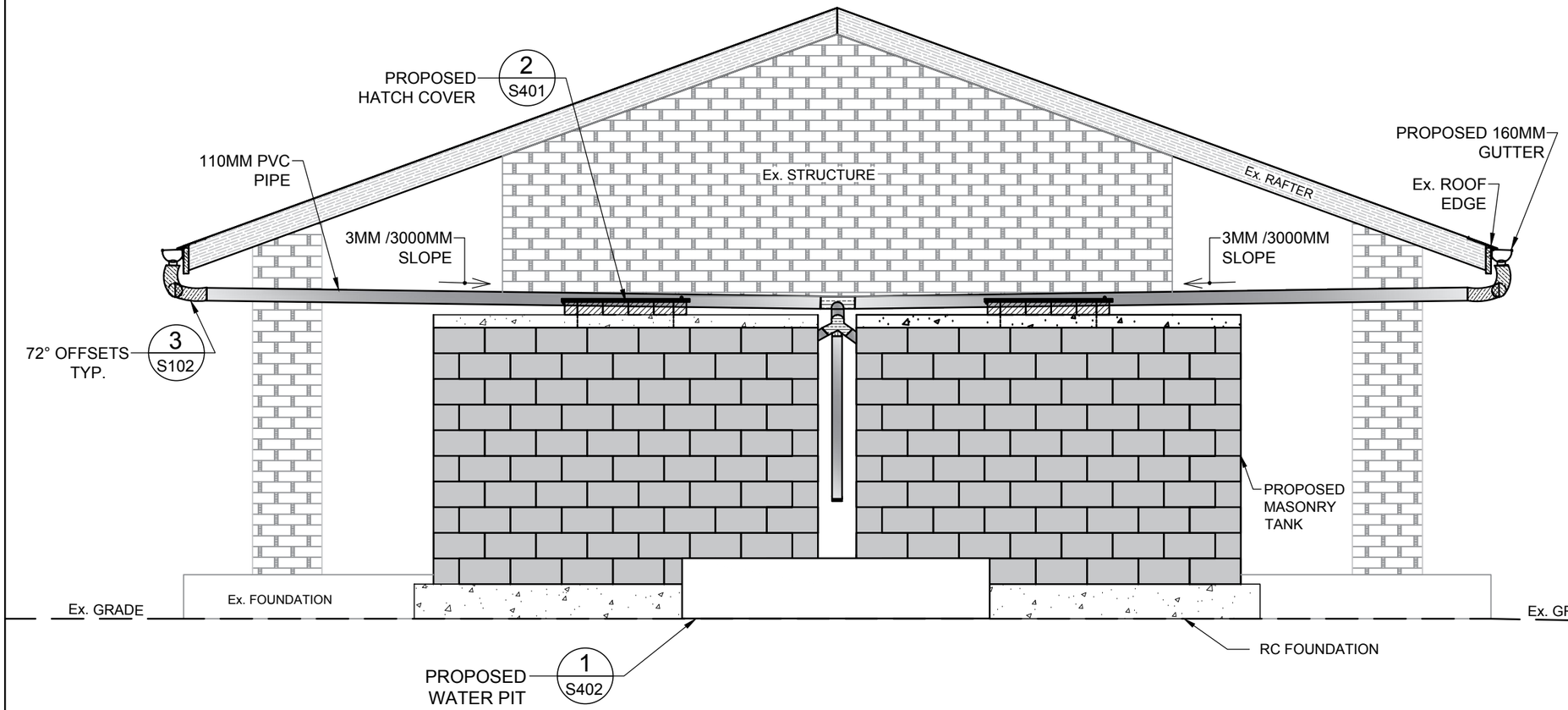
LEGEND

FOR REVIEW
AND COMMENT

TANK PLACEMENT
OPTIONS B AND C

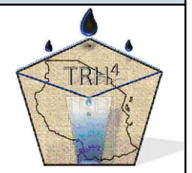
SCALE	SHEET NUMBER
AS NOTED	S202
PLOT DATE	
03/13/2017	

FILE NAME
RWH_2017-03-13.dwg



1 ELEVATION

TRH4

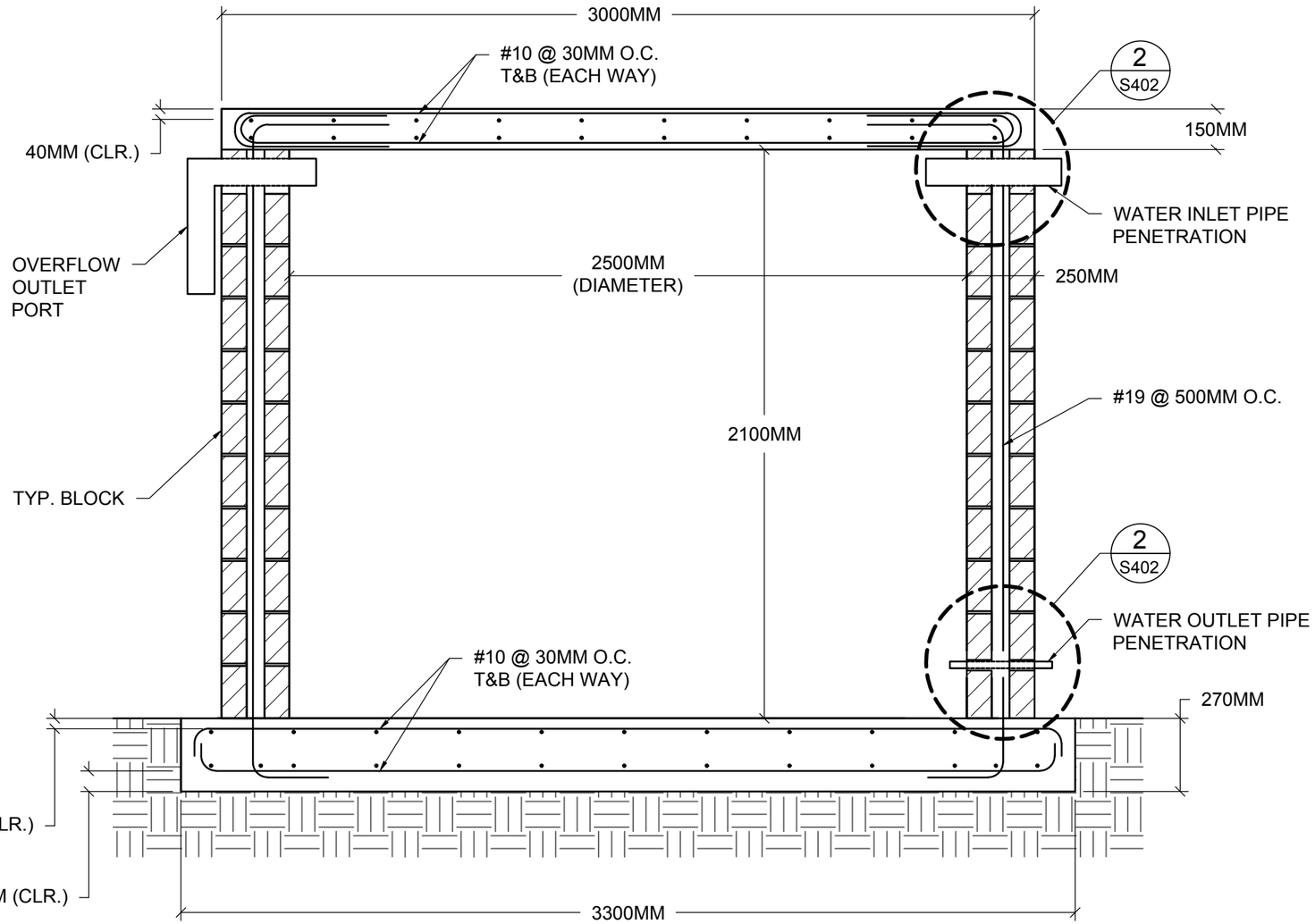


LEGEND

FOR REVIEW
AND COMMENT

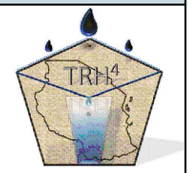
STRUCTURE
PROFILE (FRONT)

SCALE	SHEET NUMBER
1:1	S300
PLOT DATE	
03/13/2017	
FILE NAME	
RWH_2017-03-13.dwg	



1 STORAGE TANK REINFORCEMENT DETAIL

TRH4

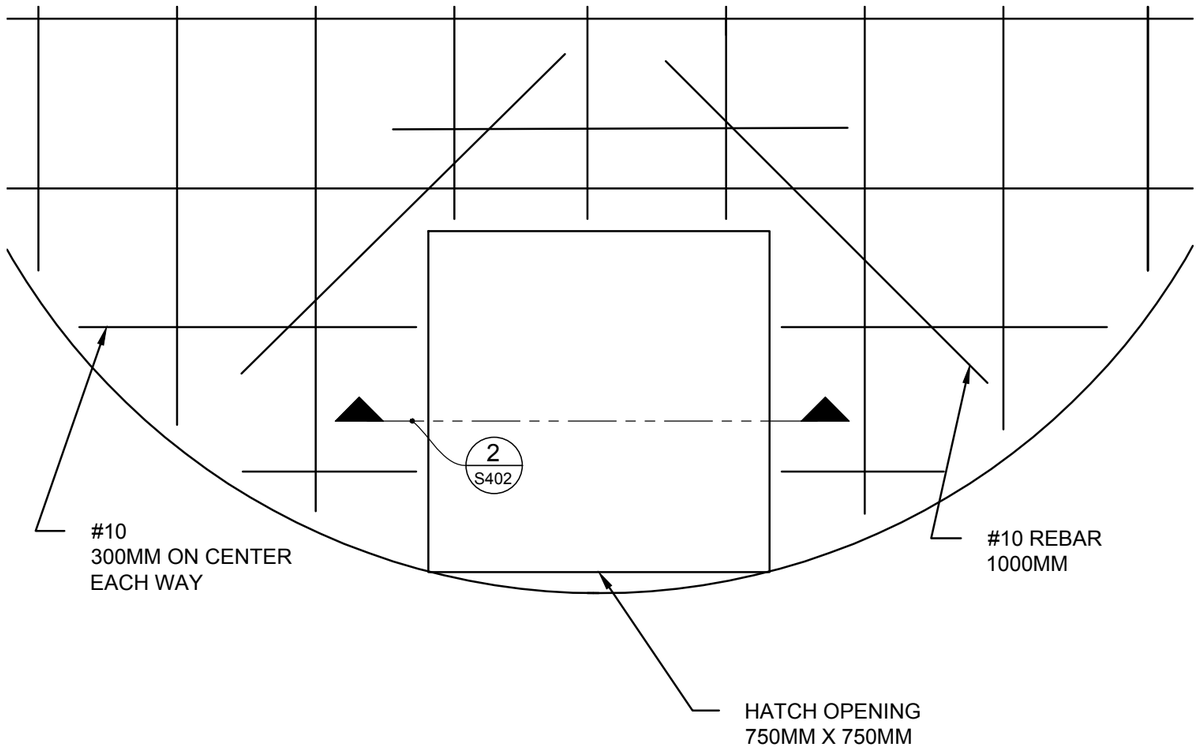


LEGEND

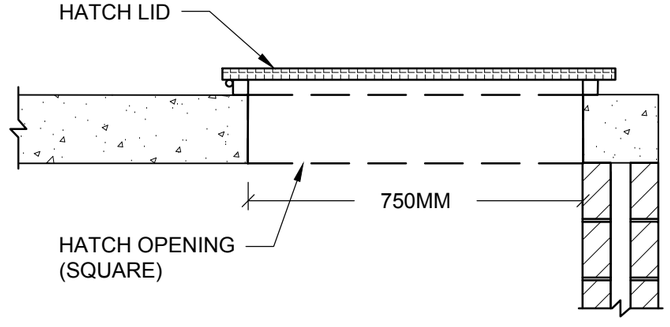
FOR REVIEW
AND COMMENT

DETAIL:
TANK CROSS SECTION

SCALE	SHEET NUMBER
2:1	S400
PLOT DATE	
03/13/2017	
FILE NAME	
RWH_2017-03-13.dwg	



1 TANK ROOF TYPICAL REINFORCEMENT



2 HATCH LID DETAIL (TYP.)

TRH4

LEGEND

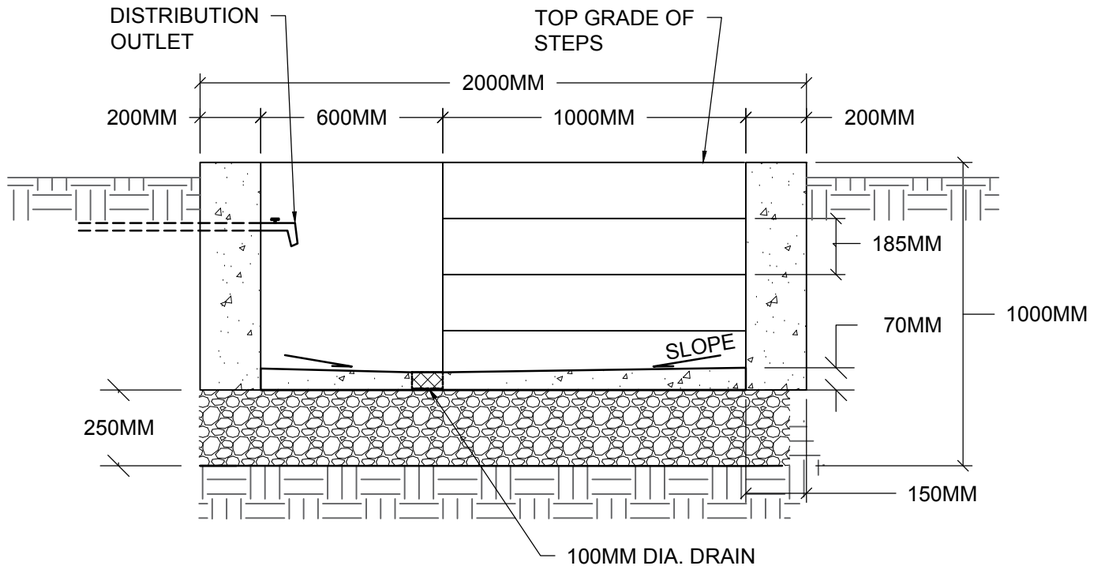
FOR REVIEW AND COMMENT

DETAIL: TANK ROOF

SCALE	SHEET NUMBER
AS NOTED	S401
PLOT DATE	
03/13/2017	

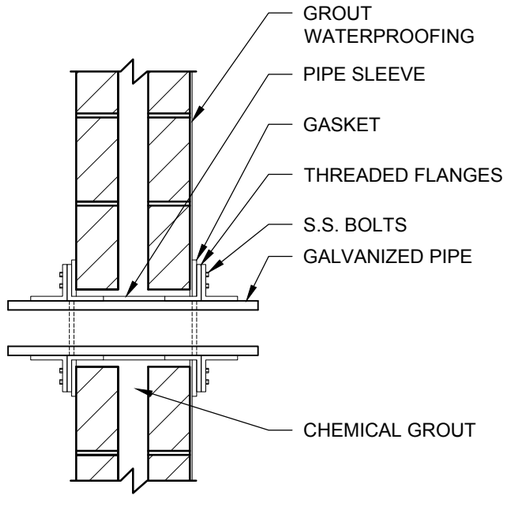
FILE NAME

MajiMarwa.dwg



1 WATER DISTRIBUTION PIT DETAIL

SCALE: 2:1



2 PIPE PENETRATION DETAIL

SCALE: 3:1

TRH4

LEGEND

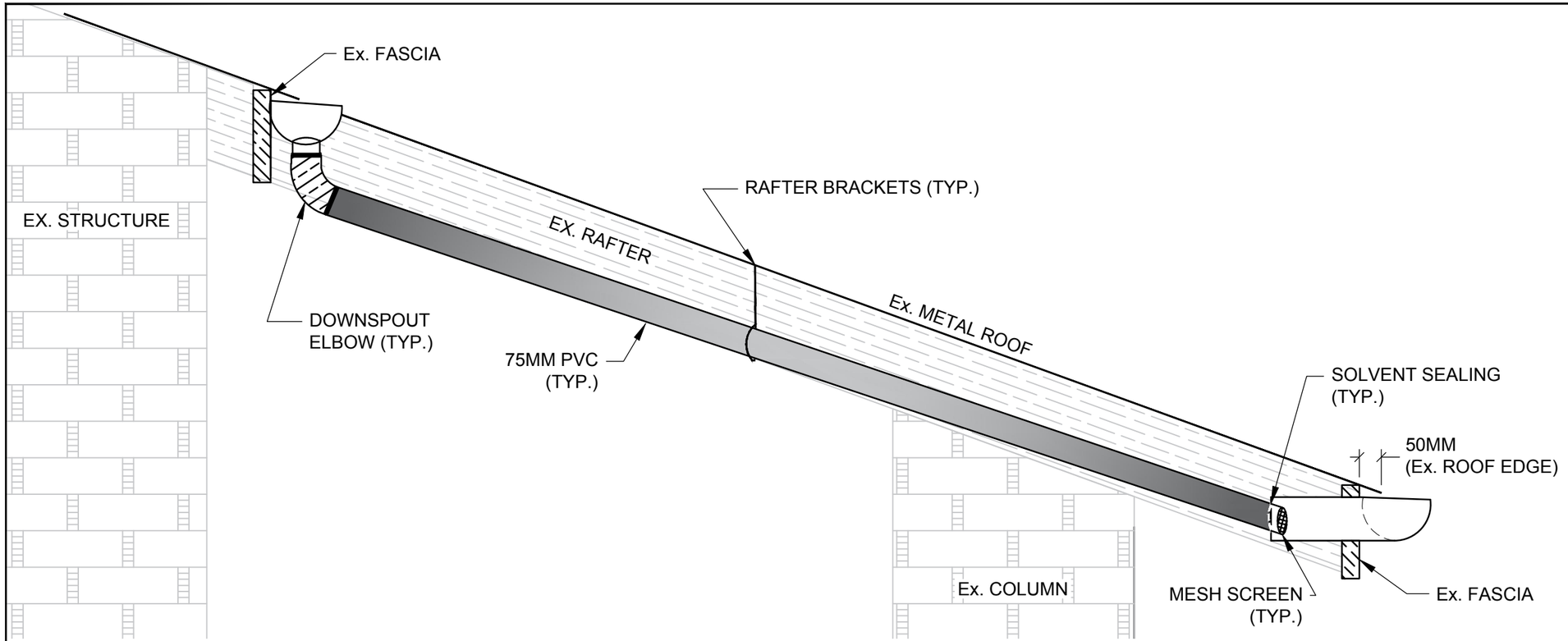
FOR REVIEW
AND COMMENT

DETAIL:
DISTRIBUTION PIT

SCALE	SHEET NUMBER
AS NOTED	S402
PLOT DATE	
03/13/2017	

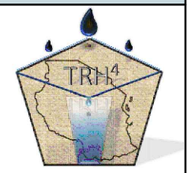
FILE NAME

RWH_2017-03-13.dwg



1 GUTTER PVC BRIDGE DETAIL

TRH4



LEGEND

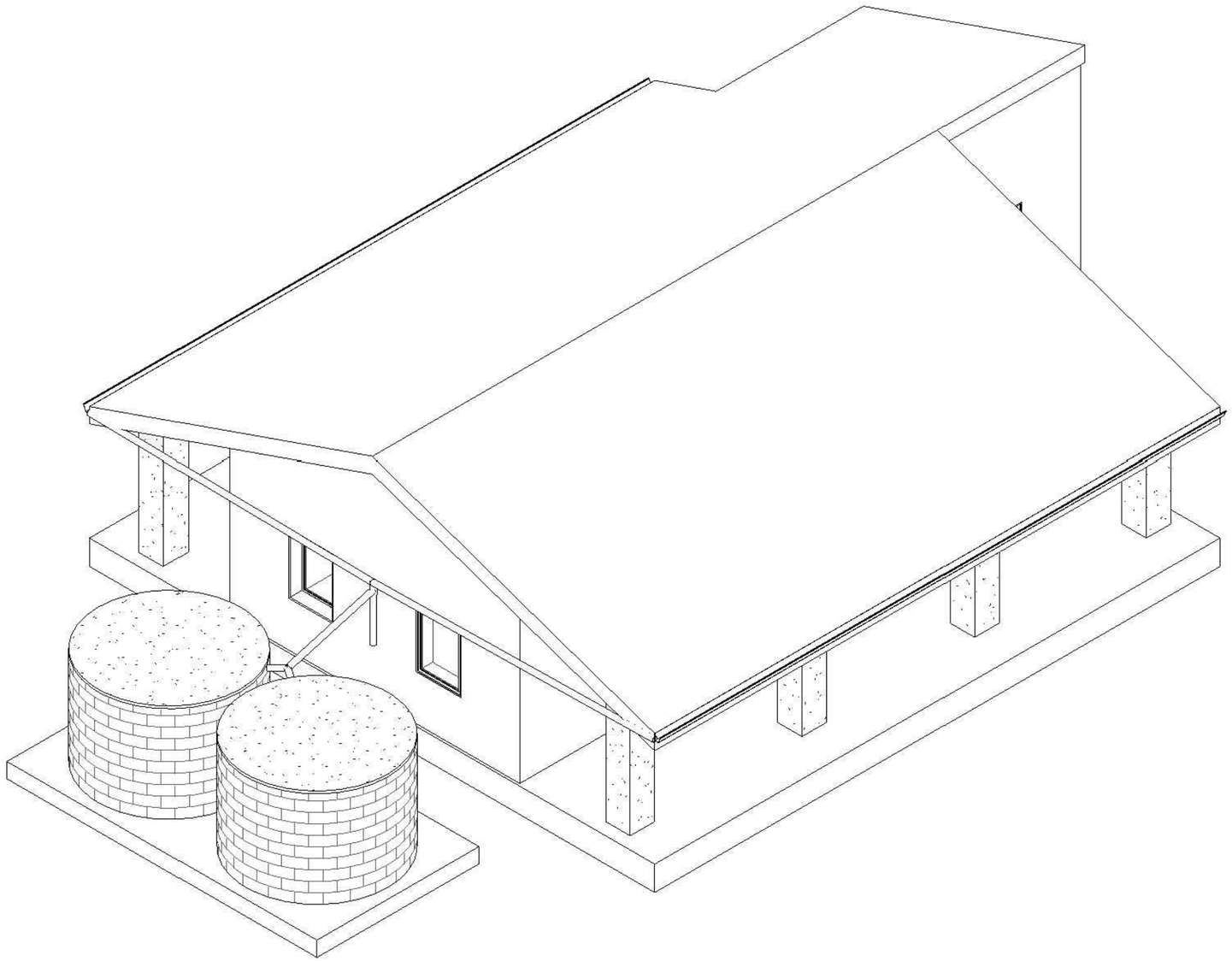
FOR REVIEW
AND COMMENT

DETAIL:
GUTTER SECTION

SCALE	SHEET NUMBER
N/A	S403
PLOT DATE	
03/13/2017	

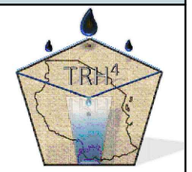
FILE NAME

RWH_2017-03-13.dwg



1 PERSPECTIVE: OPTION - A

TRH4



LEGEND

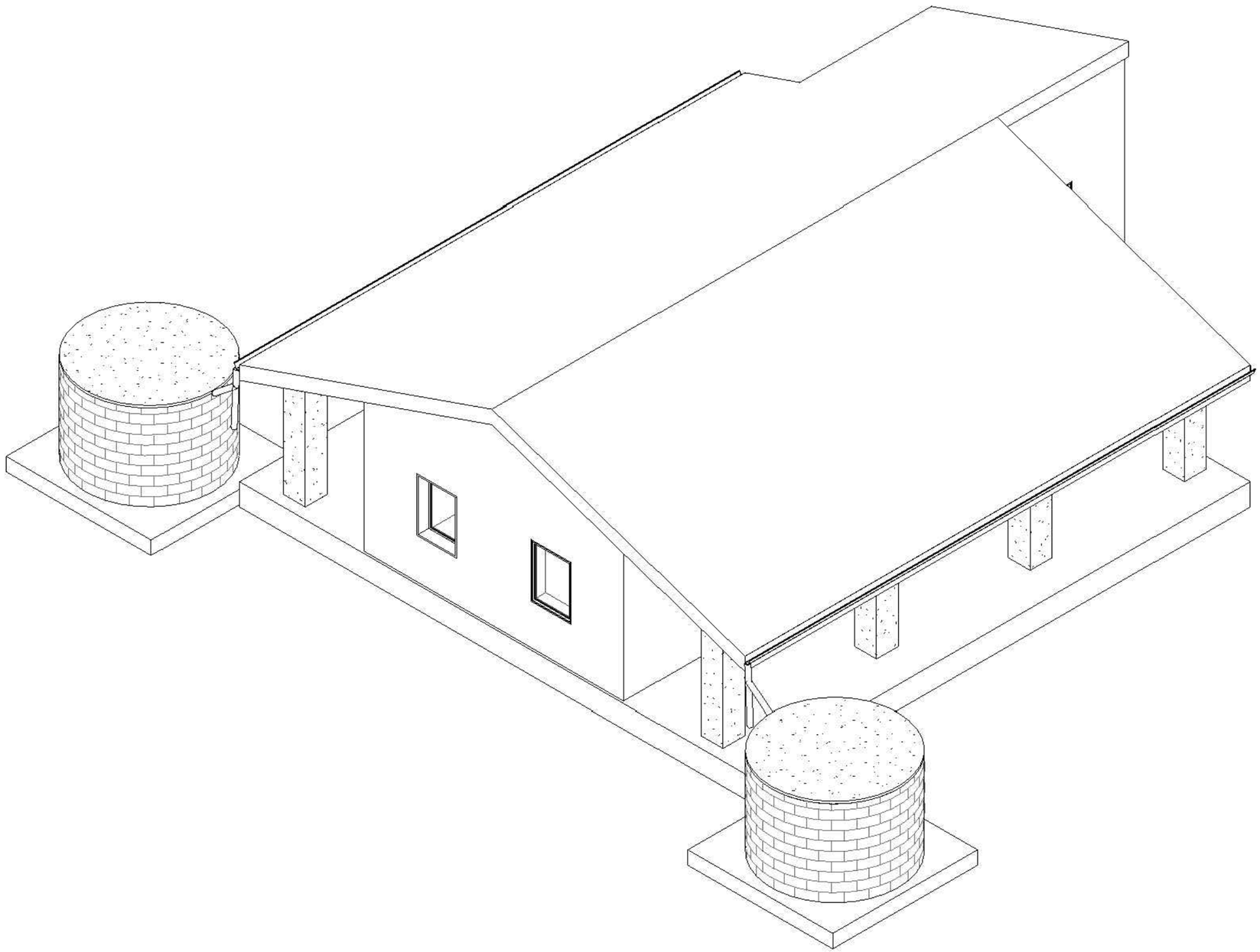
FOR REVIEW
AND COMMENT

PERSPECTIVE:
OPTION - A

SCALE	SHEET NUMBER
N/A	S404
PLOT DATE	
03/13/2017	

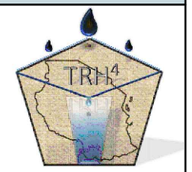
FILE NAME

RWH_2017-03-13.dwg



1 PERSPECTIVE: OPTION - B

TRH4



LEGEND

FOR REVIEW
AND COMMENT

PERSPECTIVE:
OPTION - B

SCALE	SHEET NUMBER
N/A	S405
PLOT DATE	
12/1/2016	
FILE NAME	
RWH_2017-03-13.dwg	

Process by Process Construction Photo Document

An initiative of

Maji Marwa

the Sustainable and Resilient
Tanzanian Community
Program

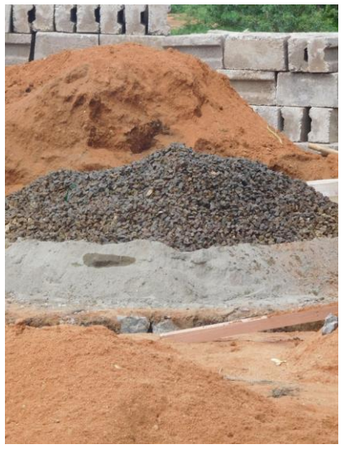
Lauren Hoffman
Patrick Sours

Block

Block-making

Foundation

Footer



Masonry Block Wall

Block Laying, Cement Base

Masonry Block Wall

Pipes, Outlets, Outside Treatment

Top Slab

Formwork, Concrete Slab

Center Column

Formwork, Concrete Pouring

Tap

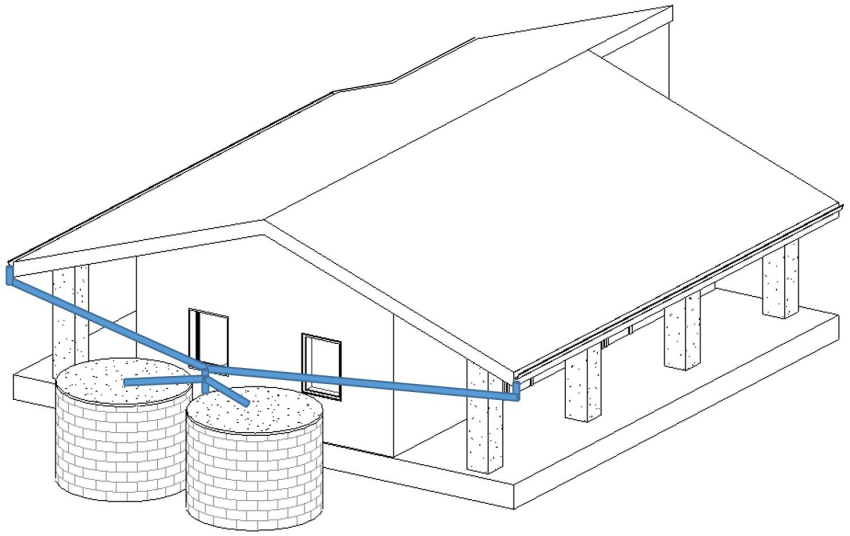
Spout, Access Point

Guttersand Piping

Hooks, Gutters, Connections, Piping

Tanzania Rainwater Harvesting

Draft Technical Report



Executive Summary

Water is a precious commodity that drives many of the daily social and economic activities of the residents of rural Marwa, Tanzania. This team has proposed and designed a rainwater harvesting system that will supplement ongoing water initiatives (i.e. residents traveling to the Pangani River and carrying water back on foot) and target public, communal buildings that are critical for the community. Rainwater will be obtained from building rooftops and it will travel through a gutter system. The water will undergo filtration and point of use bleaching. Currently, this team recommends that two storage tanks made out of masonry be constructed and placed behind a local dispensary. These two tanks will store up to 20,000 L of water. Resources allowing, more rainwater harvesting systems can be implemented at other public locations such as schools.

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Acknowledgements

TRH4 is grateful to all supporters of this project. We would like to give special thanks to Dr. Michael Hagenberger for providing us with the opportunity to work on this project and his consultation. Secondly, we would like to thank Chad Boyer as well as Professor John Krinks for their involvement and suggestions. This project is not possible without the help and guidance of outside collaborators.

Project Background:

In Marwa, Tanzania, there is only one reliable water source for the region. Residents of the community travel great distances regularly in order to obtain water. Potable water is not always guaranteed at the end of the trip. Even with the abundance of the Pangani river, human capacity limits the amount of water that can be carried home. The local residents are currently only able to obtain a few liters of water with each trip. Despite this constraint, the average resident requires an estimated 50 liters of water per day for basic activities--consumption, bathing, agriculture etc. The difficulty surrounding obtaining this fundamental resource limits the social effectiveness of the community. It is arguably the greatest factor hampering sustainable community and economic development.

Four groups of Autumn, 2016 Ohio State Civil Engineering Capstone students have set out to design and help implement a sustainable water system for Marwa, Tanzania. The implementation of major portions of this multiphase sustainable system is scheduled for a year from now. The immediate implementation of a smaller project, a rainwater collection system, will help to relieve strain on the community until a large scale sustainable system is fully delivered.

Key Elements:

The fundamental need for water and the demand for an efficacious, low cost water delivery system have determined the key elements of this rainwater harvesting system. The key elements for this system are: (1) the water collection system material type, (2) pipe material type, (3) water storage system material type, (4) a filtration and water quality assurance mechanism, (5) and the types of fittings and connections. It is important to note that all key elements are constrained by their ability to be sourced in country.

The water collection material type is a major factor in designing the system due to how material properties vary. For example, PVC might resist weathering better than metal but it may not be as easily modified. Pipe material type refers to the material options that transfer water from the collection system to the storage system. The water storage system is important because different types of materials meet different performance standards (i.e. stability, heat conduction etc). Aesthetics are relevant in the design of the water storage system. The pipe fittings and connections must be designed accurately so that no water leaks, potentially undermining the system. Finally, the filtration and water quality system design is important in ensuring that the water the residents receive is clean and does not carry any unwanted particles or pollutants. While these key elements are concerned with different issues, budget and technical aspects are important constraint for all of them.

Alternatives:

Engineering design work, working constraints, and community preferences have determined the design alternatives.

Water Collection System Material Type:

The main material types that will be considered for the water collection system are: PVC or metal preformed. In order to determine which alternative is optimal, analysis will be performed of each alternative's capacity, availability, impact to scheduling, and cost.

Pipe Material Type:

Similar to the collection system, the main material types that will be considered for leading pipes are: PVC or metal preformed. In order to determine which alternative is optimal, analysis will be performed of each alternative's capacity, availability, impact to scheduling, and cost.

Water Storage System Material Type:

The main and preferred material types for the storage system in descending order of preference to the community are: masonry, reinforced concrete, or poly-tank. The preference of the community is mainly due to their expertise. In order to determine which alternative is optimal, analysis will be performed of each alternative's capacity, availability, aesthetics, impact to scheduling, and cost.

Storage Tank Lid:

Several different options are available for the storage lid. The choice will depend highly on the storage tank used. Plastic tanks will not need an additional lid, while reinforced concrete and masonry tanks can have a variety of lids including: reinforced concrete, plastic, and metal. These options will be evaluated for their availability, aesthetics, impact to scheduling, and cost.

Pipe Fittings and Connections:

The fittings and connections for this system will dictate whether or not the system can easily be disassembled for maintenance. The types of fittings and connections used and the types of materials used for the gutters and piping both constrain each other. The fittings and connections can be in the form of: threaded PVC pieces, threaded metal pieces, glue bonded PVC pieces, glue bonded metal pieces, rubber stoppers, rubber washers, metal washers, plastic washers, waterproof caulking, and plumber's putty.

Filtration / Water Quality:

Potable and palatable water must be achieved. These two standards can be achieved by chemical or physical means or some combination of both. They include: a chlorination, a First Flush system, a bypass for accumulated particles (such as dust) on the track, a runoff valve, and a constrained and closed system. The team has evaluated using chlorine to purify the water and have come to the conclusion that it would be easier for the residents to separate out a portion of the water and then chlorinate that. This could be achieved using the ratio of one drop of household bleach to one liter of water. The storage system will also be designed to allow particles to settle to the bottom of the tank below the distribution valve. This will limit the amount of particles that leave the tank via the distribution valve and into the water transport containers.

Number of Storage Tanks:

Having one or two storage tanks will be evaluated. The cost savings of one large tank versus the flexibility of two smaller tanks will be compared. Analysis of each option's impact to scheduling, cost, and aesthetics will also be considered. After completion of the analysis the team has decided to recommend the construction of two tanks, if the communities deems this unfit then the team will support the wishes and construct one tank.

Schematic Design:

This rainwater harvesting system will make use of a five phase design: a collection system, a pipe network, quality control mechanism(s), storage, and an outlet interface. All phases are illustrated in basic Figure A1.

The collection system will make use of the existing roof surface area. Water from the roof will be diverted by the slope of the roof into a gutter system. After evaluating the possible alternatives, this team has decided to move forward using preformed PVC gutters. If this is not available in country metal gutters will be used.

PVC has been chosen for the pipe network. PVC can reliably transport water, is widely available, and is a common construction material.

The quality of the water will be controlled through as many as three mechanisms: a mesh filter, a first flush downpipe, and or a point of use chemical treatment. The mesh filter will filter out larger particles. The first flush downpipe will automatically trap the initial rainwater from the roof. This water will be especially contaminated with dust from the rooftop. A tennis ball or buoyant object will be placed in the downpipe. As the downpipe fills with dirty water, the object will rise in the water and eventually cut off the opening near the top of the downpipe--this will divert any and all remaining water into the tank. If the downpipe is not cleared and allowed to fill again then it will simply continue to divert rainwater. The chemical treatment will be applied by the resident that is making use of the tank. This system is superior to other alternatives because it will be difficult to gauge the amount of water in the tank at any given time. This option reduces the risk of under or over bleaching.

Evaluation Methodology:

A decision matrix will be used to compare the different alternatives by identifying multiple evaluation criteria, and then determining their relative importance. The relative

magnitude of importance will be determined through communication with our in-country contacts and consultant. A weight will then be calculated for each criteria depending on its relative magnitude of importance. The different alternatives will each be given a section and will be given a rating from 0-1 based on each criteria listed. That rating is multiplied by the criteria weight, yielding the weighted score. The summation of the weighted scores of a section will yield each alternative's total score to be compared. A sensitivity analysis will then be performed to eliminate uncertainty in our analysis. Upon completion the team will decide on an alternative based on the results of the analyses. The matrix has been created and coded for each key element (shown in the appendix). The layout of this matrix is shown below in Figure 1.

Key Element:			Alternatives			
			A		B	
Ranked Importance	Evaluation Criteria	Weight	Rating (1-3)	Score A	Rating B	Score B
1	Water Quality	0.x		W*R		W*R
2	Ease of Construction	0.x		W*R		W*R
3	Availability	0.x		W*R		W*R
4	Preference	0.x		W*R		W*R
5	Durablity/Duration	0.x		W*R		W*R
6	Cost	0.x		W*R		W*R
7	Aesthetics	0.x		W*R		W*R
Total Score		1.0		**0**		**0**

Figure 1: Layout of decision matrix used for each key element.

Evaluation Criteria:

1. Water quality / safety:

    Different systems could lead to different types of water quality.

2. Ease of construction (constructability):

    This category is used to represent how much labor would go into building a system by using a particular material. This includes items such as labor hours, if training is required, and the amount of material that would be required to complete construction.

3. Availability of Materials:

    The material will be rated based on availability and complexity of transport depending on the particular region.

4. Preference:

    What the preferences of the locals are.

5. Durability/Duration of Material:

    This criteria represents the material's quality and resistance to wear and tear (ability to last a reasonable amount of time before needing to be replaced or repaired).

6. Material Cost:

    The cost of the system will be determined by utilizing an engineering estimate for each material alternative.

7. Aesthetics:

    Consideration given to how the overall system presents itself and appeals to the eye. Cultural views and values will be taken into account when evaluating this category.

Cost Estimate:

Table 1: Project Cost Estimate

Item	Quantity	Cost
Tank (Masonry, Mortar, Rebar)	(2)	$ 1,755.79
Lid	(2)	$ 439.61
Foundation	(2)	$ 1,000.80
Plastic (Vinyl) Gutter	41.5 meters	$ 54.37
PVC Pipe	19.8 meters	$ 122.56
Pit	(2)	$ 205.71
Total		$ 3,578.84

The cost of this project was estimated using parametric logic. The design parameters and dimensions were determined using engineering design (such as the ACI 530 Masonry Design Code). The quantities of inputs were determined by concrete, masonry, and mortar mix design standards. For example, the ACI 530 determined that two rows of masonry with reinforcing steel was necessary for the amount of hydrostatic pressure the tank would endure at maximum capacity. Knowing the required width of the tank walls, the size and spacing of the rebar, and the dimensions of the masonry In-Country, mix design could then be used to determine the amount of each ingredient by volume in a designed structural component. The gutters and PVC pipe were estimated based on a linear foot (meter) price.

The cost above does not include the price of labor and the potential cost of renting equipment such as a concrete mixer.

Recommendations:

Since the rainwater harvesting system will serve the community of Marwa, the ultimate alternative decisions are up to them. However, the alternatives chosen will be evaluated and a suggestion will be provided. Currently, a masonry tank is the recommended storage mechanism based on the decision matrix. Metal gutters and PVC pipes are recommended for the collection and pipe apparati.

Appendix A:

Exhibits:

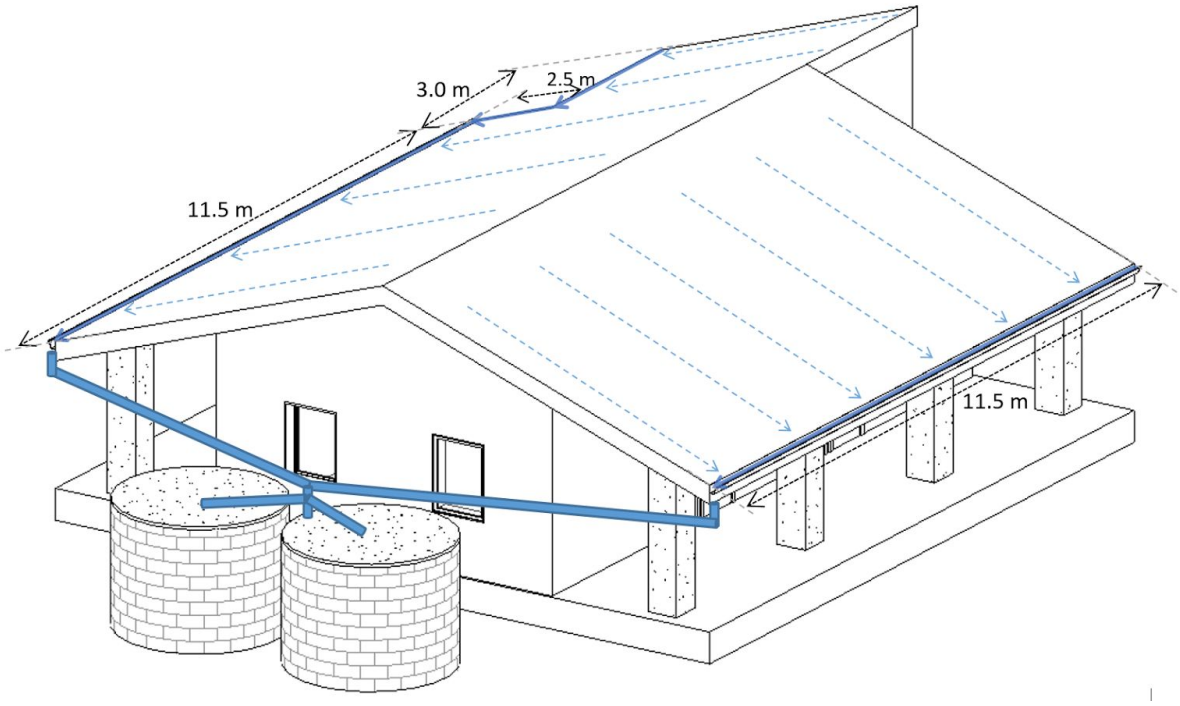


Figure A1: Preliminary System Design

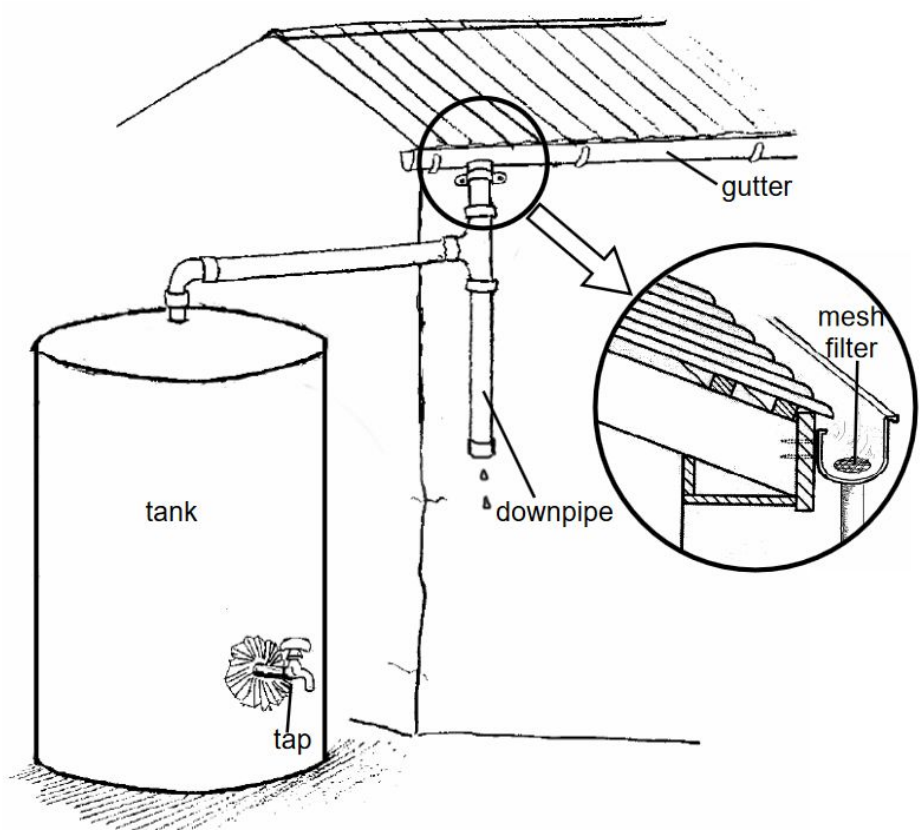


Figure A2: Example Rainwater Harvesting System Design

Table A1: Design storage capacity relative to number of tanks.

	Masonry and RC		Plastic	
Shape	Cylinder		Cylinder	
Number of Tanks	1	2	1	2
Height	2m	2m		
Diameter	3.5m	2.5m		
Volume	19,240L	19,630L	20,000L	20,000L

Table A2: Decision Matrix for Water Collection System type.

Water Collection System Material Type:			Alternatives			
			Metal Gutter		Plastic Gutter	
Criteria	Importance	Weight	Rating	Score	Rating2	Score3
Quality/Safety	1	0.2	1	0.2	3	0.6
Construction	2	0.18	2	0.36	2	0.36
Availability	3	0.18	2	0.36	2	0.36
Preference	4	0.15	1	0.15	3	0.45
Durablity/Longevi	5	0.12	2	0.24	2	0.24
Cost	6	0.1	3	0.3	1	0.1
Aesthetics	7	0.07	1	0.07	3	0.21
Total Score		1		1.68		2.32

Table A3: Decision Matrix for pipe material type.

Pipe Material Type:

				4" PVC		3" Metal Preformed	
Importance	Criteria	Weight	Rating A	Score A	Rating B	Score B
1	Water Quality	0.2	3	0.6	1	0.2
2	Construction	0.18	3	0.54	1	0.18
3	Availability	0.18	2	0.36	2	0.36
4	Preference	0.15	3	0.45	1	0.15
5	Durablity/Duration	0.12	3	0.36	1	0.12
6	Cost	0.1	3	0.3	1	0.1
7	Aesthetics	0.07	1	0.07	3	0.21
Total Score		1		2.68		1.32

Table A4: Decision Matrix for Water Storage System type.

Water Storage System Material Type:

			Masonry		Rein. Concrete		Polytank	
Importance	Criteria	Weight	Rating A	Score A	Rating B	Score B	Rating C	Score C
1	Water Quality	0.2	1	0.2	2	0.4	3	0.6
2	Construction	0.18	2	0.36	1	0.18	3	0.54
3	Availability	0.18	3	0.54	2	0.36	1	0.18
4	Preference	0.15	3	0.45	1	0.15	2	0.3
5	Durablity/Duration	0.12	2	0.24	2	0.24	2	0.24
6	Cost	0.1	3	0.3	2	0.2	1	0.1
7	Aesthetics	0.07	2	0.14	2	0.14	2	0.14
Total Score		1		2.23		1.67		2.1

Appendix B:

Photos

Dispensary:

Appendix C:

Calculations

All Volumes are in m^3 and all lengths are in m

Foundation					
Concrete of Concrete	2.60		Unit Cost		Cost
Cement Volume	0.4		$ 984.53		$ 393.81
Sand Volume	0.8		$ 10.20		$ 8.16
Water Volume	0.2		$ -		$ -
Aggergate Volume	1.2		$ 30.60		$ 36.72
No. 3 Steel Length	93.50		$ 0.66		$ 61.71
				Sum	$ 500.40
				2 Tanks	$ 1,000.80

Lid					
Volume Concrete	0.98		Unit Cost		Cost
Cement Volume	0.15		$ 984.53		$ 148.44
Sand Volume	0.30		$ 10.20		$ 3.08
Water Volume	0.08		$ -		$ -
Aggergate Volume	0.45		$ 30.60		$ 13.84
No. 3 Steel Length	82.50		$ 0.66		$ 54.45
				Sum	$ 219.80
				2 Tanks	$ 439.61

Pit					
Volume	0.61		Unit Cost		Cost
Cement Volume	0.09		$ 984.53		$ 92.33
Sand Volume	0.19		$ 10.20		$ 1.91
Water Volume	0.05		$ -		$ -
Aggergate Volume	0.28		$ 30.60		$ 8.61
				Sum	$ 102.86
				2 Tanks	$ 205.71

Masonry Cost					
Volume / Brick	0.00629				
Bricks / layer	58				
# of layers	10				
# of Bricks	580				
Total Volume	3.65		Unit Cost		Cost
Cement Volume	0.56		$ 984.53		$ 552.70
Sand Volume	1.12		$ 10.20		$ 11.45
Water Volume	1.12		$ -		$ -
Aggergate Volume	1.68		$ 30.60		$ 51.54
				Sum	$ 615.69
				2 Tanks	$ 1,231.37

PVC	
Gutter to Center	5.1
x2	10.2
First Flush /	
Center Piece	1.5
Juncture to Tank	1
x2	2
Total Linear Meter	19.8
Cost per Meter	$ 6.19
Total Cost	$ 122.56

Gutter	
Side of House	12
x2	24
Bump Out	3
Transition	2.5
Total (m)	41.5
Unit Cost	$ 1.31
Total Cost	$ 54.37

Steel					
Volume / Brick	0.00029				
# of Bricks	540				
First Layer Volume	0.02				
Volume for Bricks	0.18				
"Grout" Volume	1.37				
Total Volume	1.55		Unit Cost		Cost
Cement Volume	0.34		$ 984.53		$ 338.50
Sand Volume	1.03		$ 10.20		$ 10.52
Water Volume	0.17		$ -		$ -
Aggergate Volume	0		$ 30.60		$ -
No. 6 Steel Length	18		$ 2.30		$ 41.40
				2 Tanks	$ 390.42

Design of CMU Tank Walls

Constraints

$\gamma := 9810 \ \frac{N}{m^3}$ $\rho_{CMU} := \frac{50 \ psf}{6 \ in} = 100 \ pcf$ Solid units, divide by 6" to get density. Table 3 TEK 14-13A

$h := 2 \ m$ $b := 12 \ in$

Loading Calculation per 12" block

$P_{bot} := \gamma \cdot h = 409.772 \ psf$ $P(x) := \frac{P_{bot}}{h} \cdot x$

$F := \int_0^h P(x) \cdot b \, dx = 1.344 \ kip$

Assume Simply Supported at Foundation and Cap

$M_{max} := \frac{\left(P_{bot} \cdot b \cdot h^2\right)}{9 \cdot \sqrt{3}} = 1.132 \ kip \cdot ft$

$V_{max} := \frac{\left(P_{bot} \cdot b \cdot h\right)}{3} = 0.896 \ kip$

Assume #6 @40" in Double Wythe walls

$\frac{M_{max}}{b} = \left(1.358 \cdot 10^4\right) \ lbf \cdot \frac{in}{ft}$ $M_r := 13884 \ in \cdot \frac{lbf}{ft}$ TEK 16-3B Table 2

$\frac{V_{max}}{b} = 896.265 \ \frac{lbf}{ft}$ $V_r := 2237 \ \frac{lbf}{ft}$

$M_r > \frac{M_{max}}{b} = 1$ $V_r > \frac{V_{max}}{b} = 1$

#6 @40" in Wythe walls works (2 3 5/8" blocks with a 2 3/8" gap)

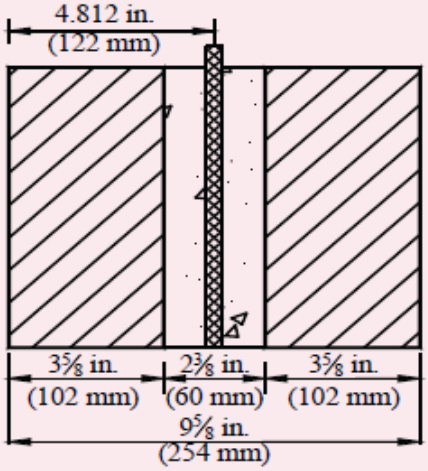


Table 2

Slab/Footing Design

$f_c := 4\ ksi$ $f_y := 60\ ksi$ $c_c := 3\ in$

Assume 6" Thick slab

$t := 12\ in$ $b_w := 12\ in$

$diam := 2.5\ m$ $w_{block} := 9.625\ in$ $h := 2\ m$ $t_{top} := 4\ in$

$d_{extra} := 6\ in$ Extra radius around outside of tank

$d_{slab} := diam + 2 \cdot w_{block} + 2\ d_{extra} = 3.294\ m$

Design

$A_g := t \cdot d_{slab} = (1.556 \cdot 10^3)\ in^2$

$A_{st.min} := .0018 \cdot A_g = 2.801\ in^2$

12" spacing results in 12 bars

$\frac{d_{slab}}{12\ in} = 10.806$ 12 bars $\frac{\frac{A_{st.min}}{2}}{12} = 0.117\ in^2$ $A_{\#4} := 0.2\ in^2$ min bar size, #3

$A_{st} := 12 \cdot 2\ A_{\#4} = 4.8\ in^2$ $A_{st} > A_{st.min} = 1$ Use 12 #3's @ 12" OC T&B, both directions

Development Length

$d_{\#4} := 0.5\ in$ $d_b := d_{\#4}$

$\psi_t := 1$ $\psi_e := 1$ $\lambda := 1$

$l_d := \left(\frac{f_y \cdot \psi_t \cdot \psi_e}{25 \cdot \lambda \cdot \sqrt{\frac{f_c}{psi}} \cdot psi} \right) d_b = 18.974\ in$ $l_d := 19\ in$

Cap/Roof Design

$w_c := 150\ pcf$ $f_c := 4\ ksi$

Young's Modulus $E := 33\ psi \cdot 150^{1.5} \cdot \sqrt{4000} = (2.644 \cdot 10^{10})\ \frac{N}{m^2}$

Slab thickness $t_s := 6\ in$
Poisson ratio $\nu := 0.1$
Slab diameter $d := 2\ m$
Masonry height $h := 2\ m$
Masonry wall thickness $t_m := 9.625\ in$
Live Load $q := 20\ psf$

$$D := \frac{E \cdot t_s^{\,3}}{12\ (1-\nu^2)} = (7.877 \cdot 10^6)\ J$$ plate constant

$$y_c := \frac{q \cdot \left(\frac{d}{2}\right)^4 \cdot (5+\nu)}{64 \cdot D \cdot (1+\nu)} = 0.009\ mm$$ center deflection

$$M_c := \frac{q \cdot \left(\frac{d}{2}\right)^2 \cdot (3+\nu)}{16} = 185.536\ N$$ moment at center

$$V_{max} := \frac{\pi \cdot \left(d - (2 \cdot t_m)\right)^2}{4} \cdot h = (3.587 \cdot 10^3)\ L$$ max internal volume

Steel Calculations

$A_g := t_s \cdot d = 0.305\ m^2$
$A_{st.min} := 0.0018 \cdot A_g = (5.486 \cdot 10^{-4})\ m^2$

12 inch spacing results in $\#bars := \frac{d}{12\ in} = 6.562$ $\#bars := 7$

$\frac{A_{st.min}}{\#bars} = (7.838 \cdot 10^{-5})\ m^2$ round up to 7 bars

$A_{\#3} := 0.2\ in^2$ min bar size, #3

$A_{st} := \#bars \cdot A_{\#3} = (9.032 \cdot 10^{-4})\ m^2$ $A_{st} > A_{st.min} = 1$

Use 7 #3's @ 12" OC
T&B, both directions

Dimensions and Information

Tank Dimensions

$d_{tank} := 2.5\ m$ $d_{out} := d_{tank} + 2 \cdot 9.625\ in$ $h := 2\ m$

Block and Mortar Dimensions

$w_{block} := 3.625\ in$ $l_{block} := 11.625\ in$ $w_{mortar} := 0.375\ in$ $h_{block} := 7.625\ in$

Distance to outer edge of each row of blocks and rebar

$w_{block1} := 3.625\ in$ $d_{block1} := d_{tank} + w_{block1} = 2.592\ m$

$w_{block2} := 6\ in$ $d_{block2} := d_{tank} + w_{block2} = 2.652\ m$

$$d_{bar\_tank} := \frac{\left(d_{block1} + d_{block2}\right)}{2} = 2.622\ m$$

Rebar Information

$s_{bar} := 40\ in$ $d_{\#6} := 0.75\ in$

Volume of Brick

Number of Bricks Required

$$Num_{B1} := \frac{\left(\pi \cdot d_{block1}\right)}{\left(l_{block} + w_{mortar}\right)} = 26.717 \qquad Num_{B2} := \frac{\left(\pi \cdot d_{block2}\right)}{\left(l_{block} + w_{mortar}\right)} = 27.338$$

$$Num_B := \text{floor}\left(Num_{B1} + Num_{B2}\right) = 54$$

$$Num_{Height} := \frac{h}{\left(h_{block} + w_{mortar}\right)} = 9.843 \qquad Num_H := \text{floor}\left(Num_{Height}\right) + 1 = 10$$

$$Num := Num_B \cdot Num_H = 540$$

$$V_{brick} := Num \cdot l_{block} \cdot w_{block} \cdot h_{block} = 2.843\ m^3$$

Volume of Mortar

$$V_{NotBrick} := \left(\frac{\pi}{4} \cdot \left(d_{out}{}^2 - d_{tank}{}^2\right) \cdot h\right) - V_{brick} = 1.372\ m^3$$

Volume of Bars for Tank Calculation

$$Num_{Bar\_tank} := \frac{\left(\pi \cdot d_{bar\_tank}\right)}{\left(s_{bar}\right)} = 8.108 \qquad Num_{Bar\_tank} := \text{floor}\left(Num_{Bar\_tank}\right) + 1 = 9$$

$$V_{bar} := h \cdot Num_{Bar\_tank} \cdot \left(\frac{\pi}{4} \cdot d_{\#6}{}^2\right) = 0.005\ m^3$$

Foundation Information

$d_{slab} := 129.675\ in$ $t_{slab} := 12\ in$ $d_{\#4} := 0.5\ in$ $t_{top} := 6\ in$ $s_{open} := 0.75\ m$

$$V_{slab} := t_{slab} \cdot \frac{\pi}{4} d_{slab}^{\ 2} = 2.597\ m^3$$

$$V_{opening} := s_{open}^{\ 2} \cdot t_{top} = 0.086\ m^3$$

$$V_{top} := t_{top} \cdot \frac{\pi}{4} d_{out}^{\ 2} - V_{opening} = 0.984\ m^3$$

Rainwater Harvesting Supply Calculation

$\text{Rain}_{\text{Monthly}} := \text{READEXCEL}(\text{“Z:\RWH Calc.xlsx”}, \text{“Climate Change Data!B16:B27”}) \cdot mm$

$$\text{Rain}_{\text{Monthly}} = \begin{bmatrix} 61.6 \\ 51.71 \\ 175.63 \\ 188.77 \\ 76.16 \\ 20.61 \\ 15.1 \\ 13.21 \\ 16.55 \\ 42.45 \\ 135.35 \\ 114.25 \end{bmatrix} mm$$

Found with location of dispensary
Rainfall for each month is presented chronologically by row.

$A_{Roof} := 132\ m^2$ Calculated Using Google Maps

$Efficiency_{Collection} := .9$ Corrugated GI Roof Efficiency >.9

$$Supply := \text{Rain}_{\text{Monthly}} \cdot A_{Roof} \cdot Efficiency_{Collection} = \begin{bmatrix} 7.318 \cdot 10^3 \\ 6.143 \cdot 10^3 \\ 2.086 \cdot 10^4 \\ 2.243 \cdot 10^4 \\ 9.048 \cdot 10^3 \\ 2.448 \cdot 10^3 \\ 1.794 \cdot 10^3 \\ 1.569 \cdot 10^3 \\ 1.966 \cdot 10^3 \\ 5.043 \cdot 10^3 \\ 1.608 \cdot 10^4 \\ 1.357 \cdot 10^4 \end{bmatrix} L$$

$Supply_{Yearly} := \sum Supply = (1.083 \cdot 10^5)\ L$

2018 May

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
30	01	02	03	04	05	06
07	08	09	10	11	12	13
14	15	16 Excavation of Foundation	17 Rebar Placement	18 Concrete Foundation Placement	19	20
21 Blocks +66	22 Finish foundation	23 Blocks +100, Facia, Gutters and Piping	24 Blocks +100, Facia, Gutters and Piping	25 Blocks +100, Facia, Gutters and Piping	26	27
28 Blocks +100, Facia, Gutters and Piping	29 Blocks Finish, Facia and Gutters	30 Finished with block making, facia, gutters and piping	31 Starting wall and water proofing, bitumen	01	02	03
04	05	Notes:				

2018 June

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
28	29	30	31	01 Walls +3,	02	03
04 Patrick in Dar,	05 Walls +4 (7)	06 Walls +4 (11)	07 Walls +1 (13), Finish Gutters,	08 Walls +4(17),	09 Plaster inside,	Plaster Drying
11 Plaster Outside	12	13 Formwork	14 Rebar	15 Place Slab	16	17
18	19 Remove Formwork	20	21	22	23	24
25	26	27	28	29	30	01
02	03	Notes:				

DESCRIPTION	Unit (m^3)	UNIT	QUANTITY	RATE (Tshs)	Amount (Tshs)	Amount (~$)	
BLOCKS (1:2:4) Total# Blocks: 520n							
Cement		50kg Bags	35	14000	490000	218	
Sand	5.3	$140ft^3$	1.34	0	0	0	
10mm Aggregate	6.97	$140ft^3$	1.56	85000	592544	263	
M4 rebar (6mm)	518m	(40ft)	51	7000	357000	159	
Sub Total:					1439544	640	
Mortar							
Cement		50kg Bags	25	14000	350000	156	
Sand	1.5	$140ft^3$	0.38	0	0	0	
Sub Total:					350000	156	
FOUNDATION (1:3:6)							
Cement		50kg Bags	20	13000	260000	116	
Sand	1.86	$140ft^3$	0.768	0	0	0	
3/4" Aggregate	8.65	$140ft^3$	1.75	85000	735427	327	
#10 Steel Rebar ($71mm^2$)	333	40ft	35	16000	560000	249	
Sub Total:					1555427	691	
ROOF (1:3:6)							
Cement		50kg Bags	15	13000	195000	87	
Sand	1.01	$140ft^3$	0.205	0	0	0	
large Aggregate	8.65	$140ft^3$	1.41	85000	735427	327	
#3 Steel Rebar ($71mm^2$)	283	40ft	23	16000	371422	165	
Sub Total:					1301848	579	
Internal Coating							
Cement		50 Bags	6	14000	84000	37	
Sand	1.00	$140ft^3$	0.25	0	0	0	
lyme					0	0	
Waterproof		1 kg bag	30	2000	60000	27	
Sub Total:					84000	64	
Gutters	51m	19' sections	10	28000	280000	124	
Pipe		20' pcs	2	28000	56000	25	
1" x 8" x 12' (Faciaboard + Sanding)		PCS	5	16800	84000	37	
Transition Pieces		PCS	4	9000	36000	16	
Handles (Supports)		PCS	25	6000	150000	67	
Gutter connection downsprout		PCS	4	9000	36000	16	
T-connection gutters		PCS	2	7000	14000	6	
Elbows		PCS	6	6000	36000	16	
PVC Cement		PCS	1	7000	7000	3	
End Caps		PCS	8	5000	40000	18	
Blue Paint		4 liters	1	35000	35000	16	
Screws		(500 pcs)	1	7000	7000	3	
Sub Total:					781000	347	
STEEL ITEMS							
Ladder 6" x 6"		PCS	1	125000	125000	56	
Pad Lock 2"		PCS	2	9000	18000	8	*
Nails Wire 2"		Kgs	25	3000	75000	33	*
Nails Wire 3"		Kgs	10	3000	30000	13	*
Nails Wire 4"		Kgs	2	3000	6000	3	*
Cover Manhole 18" x 18"		Pcs	2	55000	110000	49	
Pipes (overflow, inlet, outlet)	approx. 12" ea.	Pcs	4	35000	140000	62	*
Valve piece		pcs	1	30000	30000	13	
Spiggot		pcs	1	25000	25000	11	
Vent		pcs	1	51,000	51000	23	
Sub Total					610000	273	
SCARFFOLING							
1" x 8" x 13'		PCS	21	15600	327600	146	
Forest Poles 3" x ~14'		PCS	44	6500	286000	128	
Plywood (Formwork for top slab)		pcs	3	16000	48000	21	
Sub total					661600	296	
Total Material Cost					6783418	3045	
Labor							
Digging Foundation					200000	89	
Building Foundation					800000	356	
Build the wall					700000	311	
Top Slab & Rebar					500000	222	
Plaster inside wall					200000	89	
Gutters					300000	133	
Brick Making					500000	222	
Sub total					3200000	1422	
Transport Charge							
Block Making Agreggate Small			2	350000	700000	311	
Loading of Small Aggregate			1	15000	20000	9	
Foundation Slab Aggregate large			3	350000	1050000	467	
Loading of Large Aggregate			1	15000	20000	9	
Hardware store, forest poles, wood (Same to Leserewai)			1	200000	200000	89	
Loading of Hardware store, forest poles, wood			1	30000	30000	13	
unloading of Hardware store, forest poles, wood			1	30000	30000	13	
Sand transportation			4	25000	100000	44	
Sub total					2150000	961	
						5427	
Contingency (5% of Total)					107500	301	
Grand Total					12133418	5729	

MAJI MARWA – AN SRTC PROJECT

RAINWATER HARVESTING LEISERWEI TANK CONSTRUCTION

RAINWATER HARVESTING

a. Athumani
    i. Observations
    ii. Recommendations

b. Fascia Board
c. Gutters
d. Foundation
    i. Soil Testing
    ii. Excavation
    iii. Rebar
    iv. Concrete Slab
e. Concrete Masonry Blocks
f. Walls
g. Plastering
    i. Interior
    ii. Exterior
h. Roof
    i. Scaffolding
    ii. Rebar
    iii. Concrete slab
i. Tap point

Foundation

Soil testing

Observations:

Three 4.5” radius, 9” long steel rings were utilized. The potential tank was drawn out in the dirt and the center of the proposed tank located. Three locations equal distance from the center and each other were marked. The first hole (A) was dug to a depth of 24”. The width of the hole was 24”x24”. The second hole (B) was dug to a depth of 22” with a width of 18”x18”. The third hole was dug to a depth of 15” with a width of 16” X 16”. To note, there was a grade change between the first and third hole of ~9” The steel ring was then pounded into the earth to a depth of 3”. The rings were then filled with water to the top of the ring. The water infiltrated the soil at a rate faster than expected, 27 minutes, 21 minutes and 39 minutes. None of the tests resulted in a complete settlement of the soil but there were a few small sinkholes of < 1” diameter present. The team conducted a visual assessment of the soil and noted that around 18” roots and other organic matter was no longer present. The soil appeared sandy and crumbly.

Recommendations:

Conduct soil test were the ring of the foundation will be. Become familiar with the various soil tests prior to travel.

Digging

Observations: The tank outline was redrawn in the dirt with a radius of 2.5m. The inside of the foundation was then drawn in the dirt with a width of 18”. The ring was then excavated to a depth of 18” from the top of the school slab. The team determined that this might case issues with bringing in the water from the gutters, so the decision was made to excavate another 12”. The decision was then made to measure up 18” from the bottom of the ring instead of 12”. The “waffle” design was also reduced to one beam in each direction. The remaining soil was removed and then the bottom of the ring and the bottom were compacted. The cross sectional beams were dug all the way to 18” even though we instructed them to dig them to 12”. In order to avoid the tank being above the gutter line the foundation was excavated to 47” down from the top of the school building foundation, from the gutter line to the top of the foundation was 82”.

Recommendations:

Do not dig ring first. Excavate the depth required and compact and then dig the remaining depth required for the foundation ring. Ensure that grade is drawn on the drawings. Work in meters. Increase

the width of the tank and set a maximum height for the tank to ensure they the tank will be below the gutter line.

Notes:
Labor: Fundi A and three workers not all working at the same time. Teacher and other community members helped out as well. Work started around 11:30 and continued to around 4:30. Not everyone was continuously working.

Rebar
Observations:
Athumani did not realize how much rebar needed to go into the design. He did not understand the drawing. He did not understand the amount of rebar nor the spacing that it was to be placed. He only though there would be the cross sectional rebar. The stirrups were hard for him to understand. Thirty-two stirrups consisting of two pieces each were cut and bent. Athunamni did question why we did not just cut one piece and then bend them into the shape that we needed. The team had to demonstrate and talk through this process in detail utilizing KiHo and Udom partners to interpret. The team utilized a ladder to bend the rebar. The team attempted to explain and show the laborers the idea of batching rebar and assembly line processes. Example: showing the workers that one can be measuring, one cutting, one bending and one tying the slab foundation lattice. Five workers plus athunani. Stirruping cutting and bending took around 1 hour. Two men cut binding wire, A marked were it went and two workers placed the stirrups. The outter rings were accidental crossed and this was determined not to be an issue and they crossed between a stirrup. The temperature and shrinkage steel was a lot of work and having the approx. steel spacing was helpful to know how long to cut the different pieces.
Recommendations: Bending rebar was difficult. Rebar bending tools should be purchased. Having pictures or more clear drawings to communicate.

Notes:
This was a valuable day for the relationship building between the new fundi and the osu team. Working together on cutting and bending rebar. This was a huge change to what they are used to doing. Another thing to note is that the laborers seem to be quite in experienced

Place lower foundation
Observations:
The team had a goal to fill the whole foundation in one day. Brought extra OSU students to help. We thought the fundi said 5bags of cement, 10 wheelbarrows of sand, 15 wheelbarrows of aggregate, which we thought was 1:4.5:6.75 ratio. Decided to leave it, looked ok (we approximated 1:3:6, respected local fundi expertise). Actual first batch 5 bags cement, 10 wheelbarrows of sand, and 9 wheelbarrows aggregate, added three more wheelbarrows of aggregate at the end of the mix to finish up excess sand and cement.
Hard for students to actually participate in days work. When attempted to help, seemed to disrupt flow of work. Students observed.
Thought it would take 5 batches of initial mix 5:10:15 mix to finish foundation pour, this was incorrect.

Batching Process: At first Athumani tried to make one large batch of concrete by mixing all dry materials and then slowly adding water. The first large batch was 5 bags of cement, 10 wheelbarrows of sand, 12 wheelbarrows of aggregate. This mix was difficult to handle and far too much water was added. Approx. 15-20L buckets and 11-“10”L buckets. Counting the amount of water was extremely difficult as they sometimes would pour a full bucket, a half bucket, or just a splash. They added water until the concrete was easy for them to mix. The concrete was extremely wet.

After this first batch of concrete we discussed with Athumani to try and break the batch into smaller batches. He agreed. He made the same size batch but then separated it into piles. Which is essentially the same thing as he did before. The concrete was still too wet.

The next day when the top portion of the slab was to be placed, after discussion the team convinced Athumani to make small batches surrounding the foundation. The small batches consisted of 1 bag of cement, 1.5 of wheelbarrows of sand and 2 of wheelbarrows of aggregate. Athumani seemed to like this and the workers did as well as they did not need to transport the concrete from the big batch to the spot where it needed to be placed. The team attempted to limit the amount of water being added to approx. a 0.4 w/c ratio. The workers did not like this because it made the concrete harder to mix. The team conveyed to Athumani that even though it is harder to mix the concrete will be much stronger.

The foundation ended up being larger than proposed. There was confusion that the tank was supposed to be below grade so they just kept filling the foundation. The beams also caused confusion. They were supposed to only be 12” deep by 12” but they ended being 18” deep and 18” wide. The top slab was supposed to be 6” and it ended up being 10”.

The slab was waterproofed with a sloped finishing slab. The thickness was 2in on one side and 4in high on the other so that water will drain to the low end.

Recommendations:
Leveling techniques need to be taught to the end constructor. Changes from the plan resulted in confusion. Trying to save time by not excavating farther was not worth the effort of having to replace that volume with concrete. The foundation and area should be excavated and then the outside ring slab dug second and there was a lot of collapsing and that lead to excess volume needing to be filled with concrete. The design should be simplified. Make the tank wider instead of taller.

Crew:

Fundi A

Number of laborers: 7

Number of days: 3

Masonry Blocks making

Observations:

A local block maker was rented and taken to Leseriwei. The machine was spaced with three wooden spacers to form the desired block size. The concrete for the block was batched in one bag of cement batches. This consisted of 10 buckets of sand, 12 buckets of aggregate ("15L" bucket). An area was cleared and water poured onto the ground. The cement, sand and aggregate were mixed together and shoveled into another pile. Water was slowly added to the mix. Approximately two 20L buckets of water were added. The first batch of blocks yielded 17 blocks and took around 1.5 hours. The concrete was added to the machine using a small bucket and then compacted with a small hand tool, more mix was added then the block was compacted with the heavy lid.

For the second batch of blocks the team convinced Athumani to break his batch in half and only add water to one portion and then use up all of that concrete and then add water to the second portion. This was done because of how long the wet concrete mix was sitting, the team was worried that it was starting to set.

Later during the block making process after discussion with Athumani, he agreed to transition to a higher sand content for the batch mix. The photos of the blocks the team made at OSU were used to demonstrate this. This was a back and forth conversation and his opinions and concerns were taken into account. He agreed to do a mix of 1 bag of cement, 15 buckets of sand and 10 buckets of aggregate.

The color and quantity of the block were inconsistent. One side of the block is not as tall as the other due to the way that the block maker compacts them. As the workers continued the process they started to have some workers prep the next mix batch while others finished making the remaining blocks from the previous batch. This was a suggestion from the OSU team.

The workers averaged about 1 hour per batch throughout the process.

Recommendations:

Batch the making process, having some workers ready the next batch while others make the blocks. Don't break the block maker. Look into purchasing our own block maker. There was also an issue of the block maker being rented for twice as long as it was required. Continue to work towards a more consistent mix ratio for the blocks.

Fundi A

4 laborers

3 of days: Hard to say because some days they made more than 100 and other

Building Reinforced Masonry Block Wall

Observations:
Laid out all the blocks and kicked out the blocks as far as possible, ended up doing 30 blocks around evenly spaced. Concrete was made on the middle slab which was good because they realize that the extra dirt isn't good for the concrete. Every third block was leveled to one another and then the inside blocks leveled to the already leveled blocks. Chipped out part of a block in order to place the clean drain. Using a process. One worker laid mortar, one made mortar and refilled buckets, one laid the block and A gave the final check. A stated that it 3 bags of cement per two courses. It ended up being closer to 1 bag of cement per course. Using the plum bob to ensure that each block was lined up with other blocks below it (see photo) 3 workers and A took around 2 hours to do one complete course. The mortar mix utilized was 10 * 15L sand, 1 cement, 1 kilo waterproofing, 2.5 "20L" buckets, actual bucket size was ~22L

Fundi A

Number of laborers: 4

Courses per day: 3

Number of days: 5

Roof Slab

Observations:
Forest poles were used to create scaffolding to hold up the top slab. The poles were cute to size and then placed underneath rough cut lumber. This took an entire day to do. This was communicated to the team that all of the scaffolding would be completed before the team arrived to work on the rebar. This was not the case. The scaffolding was barely started and Athumani said they could complete that and the rebar in one day. The OSU team worked with two laborers to complete the rebar structure while the remaining workers completed the scaffolding. The rebar structure was made on the ground. Athumani wanted the spacing to be 8" but then we explained there was two layers of rebar and he agreed to the

11” spacing. The Z supports were done incorrectly. They put them a course lower than they were supposed to be and only the straight portion was sticking up into the slab.

A black layer of plastic was placed on top of the scaffolding and the rebar structure was lifted into place. The workers bent the rebar but we needed to bend it more to get the required length and to ensure the rebar was not sticking out past the edge of the tank. Rebar was cut in order to make room for the access hole. This was made immensely difficult because the hole was cut much larger than the manhole cover. The second layer of rebar was placed. The rebar was spaced the same on the top and bottom which made it easier to walk around but it was hard to space the rebar to the required distance.Plywood was used to cover the gaps that remained. Where the rebar was cut, replacement steel was added. The lengths of these pieces were 6’ 1” the bottom layer had three cuts and the second layer only required one cut because of the manhole port being smaller. One piece was placed on either side. The 6’1” was a splice length on either side plus the length of the gap. Additional pieces of 53” at minimum were placed diagonally. Plywood was cut in strips and then placed around the outside of the wall to create the side formwork for the slab. There was not enough wire to support the plywood edge formwork. They used forest poles to help support the edge. The mix ratio was 2 bags cement, 2 wheelbarrows sand, 2.5 small aggregate and four 22L buckets of water. At the start of concrete making, the OSU team insisted that the concrete batch be completely mixed before pouring (no tiny batches off the side of the big one).The concrete was mixed and then passed up to the top using small buckets. The vent was placed in the center and then 10in of concrete was placed around the vent. The concrete was then placed in a spiraling patterning. Placing wet concrete on wet concrete moving around the existing pile towards the outside. The sides were measured to 6in and a long piece of steel with a level on it was used to find the required slope. The concrete was compacted using a compaction tool made from wood. The rebar was spaced using stones and the stones were removed as the concrete was placed. The batches were not always continuously being made. At times there were gaps between when the concrete was being made and when it was being placed. There was an agreement that there would be 8 people there to work. There was only four. This made it extremely difficult to get the work done, and the pour took much longer. The slab was also set down 2 inches from the top of the wall in some places so the slab is thicker than required.

Recommendation:
If a certain material is going to be required, i.e. binding wire. The contractor should verify that the material is there and that there is enough of it for work to be completed the following day. Considering going back to a center column and widening the tank (setting a smaller height of tank). This could require a thinner top slab, resulting in an easier pour, and not having to move concrete as high. Continuously make concrete through the day. Do not cut the access hole too large. Workers need to have specific jobs. There was a lot of sitting around when there was a lot of work that needed done. Ensure that the formwork is flat and level. The small stone was much easier to mix than the large stone. The side formwork was not done well and needs to be improved. Workers could try mixing concrete in circular motion, for more consistent concrete. Top vent was very expensive, look for alternative.

Fundi A:

Number of men: 3 first day, 4 second day

Number of days: 2

Interior/ Exterior Finish

The inside of the slab was finished with a cemet, sand, waterproof mixture. The sand was screened

Materials:

Price:

Number of men: 2

Number of days: 2

Labor Price:

Exterior finish required 2 layers instead of the anticipated 1 layer. Potentially could have been done in one layer.

TAP POINT

Tap point was encased in a concrete structure. The area underneath was excavated. The water access pit was not install as design or as discussed.

Athumani:

Observations:

1. Not good at delegating tasks.
    a. Rarely tried to delegate tasks. Sometimes had too many people there and others too little
2. Seemed to have very little understanding of drawings.
3. Had no role in ensuring that there was enough materials present for task. Did not tell team about shortage of material until they ran out. (Conducting his own estimates could have potentially forced him to have a better understanding of drawings)
4. Did not stick to schedule.
    a. Did not step into role of head fundi as anticipated.
    b. His perspective of time was different. Mindset of things will get done when they get done.
    c. Difference in US perspective of prices per day (each day costs money), vs. Lesirwai payment per task, so as long as the task gets done it is ok.

Recommendations

1. Allow more buffer time in schedule. Knowing their perspective of task completion is different than our background.

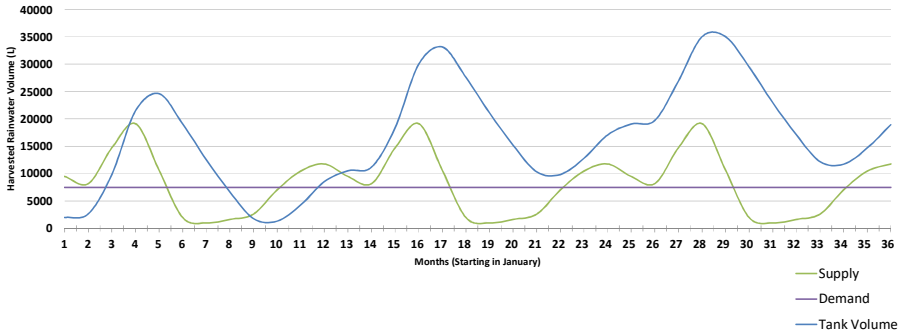
To use the calculator fill in all highlighted input values.

Tank Volume and Supplemental Water Needs for Three years

Input Values	
Catchment area (m^2):	172
Collection efficiency (%):	0.95
Initial tank volume (gal):	0
Tank size (L):	35000
Monthly demand (L):	7500

Avg. monthly rainfall (mm)		
January:	58	
February:	50	
March:	90	
April:	117	
May:	65	10621
June:	12	
July:	6	
August:	10	
September:	16	
October:	43	
November:	64	
December:	72	
Total:	603	98530.2

Yearly Percent Average Rainfall (%)	
Year 1:	90%
Year 2:	90%
Year 3:	90%



Calculations

		Supply	Demand	Tank Volume
Year 1	January	9477	7500	1977
	February	8170	7500	2647
	March	14706	7500	9853
	April	19118	7500	21471
	May	10621	7500	24592
	June	1961	7500	19053
	July	980	7500	12533
	August	1634	7500	6667
	September	2614	7500	1782
	October	7026	7500	1308
	November	10458	7500	4265
	December	11765	7500	8530
Year 2	January	9477	7500	10507
	February	8170	7500	11177
	March	14706	7500	18383
	April	19118	7500	30001
	May	10621	7500	33122
	June	1961	7500	27583
	July	980	7500	21063
	August	1634	7500	15197
	September	2614	7500	10312
	October	7026	7500	9838
	November	10458	7500	12796
	December	11765	7500	17060
Year 3	January	9477	7500	19038
	February	8170	7500	19708
	March	14706	7500	26914
	April	19118	7500	35000
	May	10621	7500	35000
	June	1961	7500	29461
	July	980	7500	22941
	August	1634	7500	17075
	September	2614	7500	12190
	October	7026	7500	11716
	November	10458	7500	14673
	December	11765	7500	18938

8211

Input Values

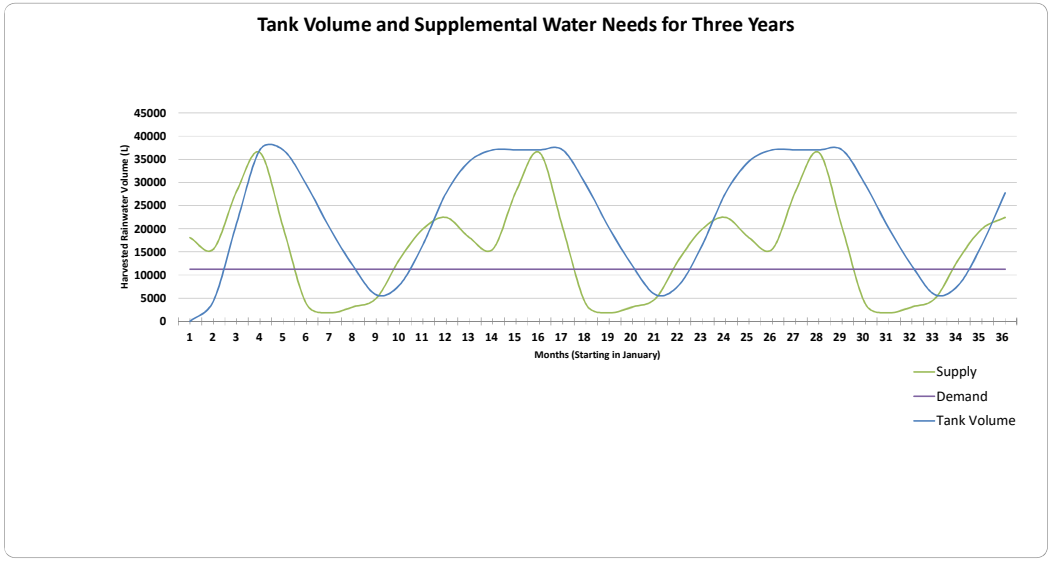
Catchment area (m^2):	346.2
Collection efficiency (%):	0.9
Initial tank volume (gal):	0
Tank size (L):	37000
Monthly indoor demand (L):	11250

Avg. monthly rainfall (mm)

January:	58	
February:	50	
March:	90	
April:	117	
May:	65	20253
June:	12	
July:	6	
August:	10	
September:	16	
October:	43	
November:	64	
December:	72	
Total:	603	187883

Yearly Percent Average Rainfall (%)

Year 1:	80%
Year 2:	80%
Year 3:	80%



Calculations

		Supply	Demand	Tank Volume
Year 1	January	18072	11250	0
	February	15579	11250	4329
	March	28042	11250	21121
	April	36455	11250	37000
	May	20253	11250	37000
	June	3739	11250	29489
	July	1869	11250	20108
	August	3116	11250	11974
	September	4985	11250	5710
	October	13398	11250	7857
	November	19941	11250	16549
	December	22434	11250	27732
Year 2	January	18072	11250	34554
	February	15579	11250	37000
	March	28042	11250	37000
	April	36455	11250	37000
	May	20253	11250	37000
	June	3739	11250	29489
	July	1869	11250	20108
	August	3116	11250	11974
	September	4985	11250	5710
	October	13398	11250	7857
	November	19941	11250	16549
	December	22434	11250	27732
Year 3	January	18072	11250	34554
	February	15579	11250	37000
	March	28042	11250	37000
	April	36455	11250	37000
	May	20253	11250	37000
	June	3739	11250	29489
	July	1869	11250	20108
	August	3116	11250	11974
	September	4985	11250	5710
	October	13398	11250	7857
	November	19941	11250	16549
	December	22434	11250	27732

15657

To use the calculator fill in all highlighted input values.

Marwa Primary	346
Leserwei	172
Marwa Dispensary	145

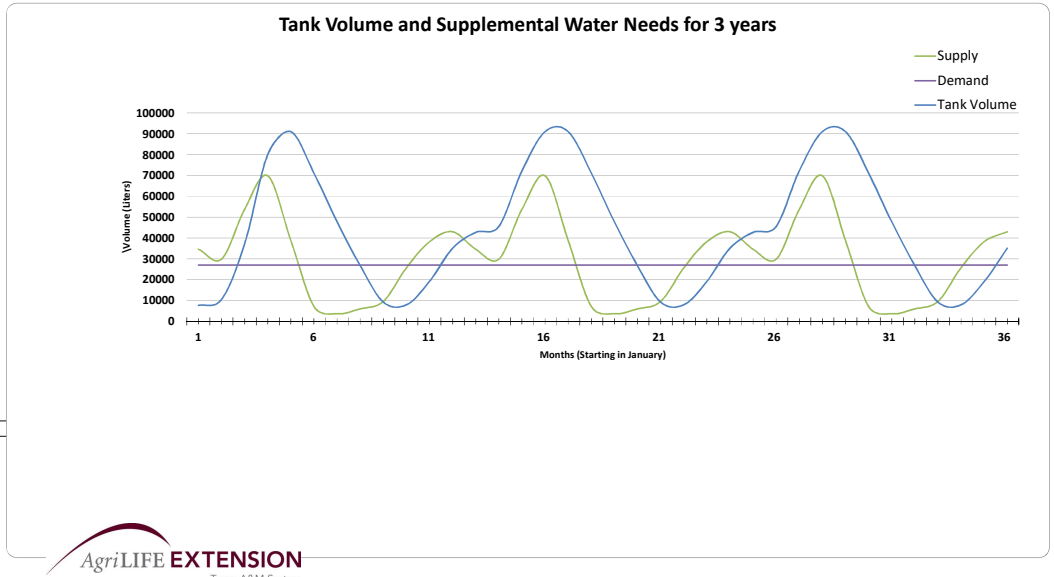
Input Values

Catchment area (m^2):	663
Collection efficiency (%):	0.9
Initial tank volume (gal):	0
Tank size (L):	91000
Monthly indoor demand (L):	27000

Avg. monthly rainfall (mm)			
January:	58		58
February:	50		50
March:	90		90
April:	117		117
May:	65	38785.5	65
June:	12		12
July:	6		6
August:	10		10
September:	16		16
October:	43		43
November:	64		64
December:	72		72
Total:	603	359810.1	603

Yearly Percent Average Rainfall (%)

Year 1:	80%
Year 2:	80%
Year 3:	80%



AgriLIFE EXTENSION
Texas A&M System

Calculations

		Supply	Demand	Tank Volume	
Year 1	January	34609	27000	7609	
	February	29835	27000	10444	
	March	53703	27000	37147	
	April	69814	27000	79961	
	May	38786	27000	91000	
	June	7160	27000	71160	
	July	3580	27000	47741	
	August	5967	27000	26708	
	September	9547	27000	9255	
	October	25658	27000	7913	
	November	38189	27000	19102	
	December	42962	27000	35064	359810
Year 2	January	34609	27000	42673	
	February	29835	27000	45508	
	March	53703	27000	72211	
	April	69814	27000	91000	
	May	38786	27000	91000	
	June	7160	27000	71160	
	July	3580	27000	47741	
	August	5967	27000	26708	
	September	9547	27000	9255	
	October	25658	27000	7913	
	November	38189	27000	19102	
	December	42962	27000	35064	
Year 3	January	34609	27000	42673	
	February	29835	27000	45508	
	March	53703	27000	72211	
	April	69814	27000	91000	
	May	38786	27000	91000	
	June	7160	27000	71160	
	July	3580	27000	47741	
	August	5967	27000	26708	
	September	9547	27000	9255	
	October	25658	27000	7913	
	November	38189	27000	19102	
	December	42962	27000	35064	

29984

Water Volume

Usage (L/day/person)	3
#people	100
Water Usage/year (L)	9000
Water Usage/month (L)	750

Site investigation for Leiserwei rainwater system

1. Building A (Smaller of the two school buildings):
    a. The building has a roof area of 127.5 m^2. The building has intact fascia boards. There is a potential issue with gutters as the roof is broken into two sections of different heights. The difference is approx. 20 cm. The section to the north is higher than the section to the South. The overhang of the roof would be sufficient for rain water harvesting. The roof appears to be built square and shows no signs of sufficient settling.
2. Building B (Larger of the two school buildings):
    a. The build has a roof area of 172 m^2. Building B does not have any intact fascia boards. Boards would need to be installed. From inspection this appears to be reasonable as the roof supports extend out but not past the roof overhang. This structure also has two separate roof sections. The separation of the section is approximately 20 cm. The section to the North is higher than the section to the south. The overhang would be sufficient for a rain water harvesting system. An attempt to verify if the roof was level was made. All four corners of the roof structure were measured and the difference in elevations were 6cm drop on one side and a 2 cm gain on the other (See attached diagram for further clarification). This is troublesome as this is accounting for the 20 cm drop to the next section.
3. Other potential tank sites / tank options
    a. Two teacher's homes were inspected. Both have fascia boards and usable overhangs. The area of Home A was approx. 62 m^2. The area of Home B was approx. 61 m^2. These options should be further discussed as there is worry that rainwater systems should only be built on public buildings but when discussed with the community they suggested the teacher's homes because they are farther from the approaching river which was of grave concern to the community.
    b. When the question was posed where the community thought the tank should go it was suggested that the tanks go on the teacher's houses as that was the farthest possible place from the flood plain. When the discussion continued it was expressed that the tank should on the North West side of the School. Again to keep the tanks away from the approaching flood plain. A discussion of putting the tank in between the two buildings and attempting to capture all of the water also took place. The community expressed this as their preference as it would allow for the most water captured.

Recommendation

The school buildings within Leiserwei should be utilized to collect rain water. The area of the roof structure present is sufficient. The community stressed that they want the tank to be on the North west side of the building to avoid the flooding river. The most convenient location for a tank would on the South east side of the buildings as the roof structure are offset with the lower section on that side. This issue will make collection difficult if a tank is place on the North West side. If the river issue is fixed then the tank should be constructed on the South west side half way between each of the school buildings. The placement of the tank half way between the buildings will allow for water to be collected on both buildings. This would allow for an estimated 260,000L of water to be collected a year. Cost estimate based of Price per liter calculated from Marwa Dispensary RWH System. From calculation, the teachers homes could be outfitted with one 10,000L Plastic tank slight elevated on each home.

i. Size of the tank for school buildings
    1. With no usage of the tank:
        a. 198 mm x 270 m^2 = 60,000 L
        b. Estimated cost: $11,250
    2. With minimal estimated usage:
        a. 198 mm x 270 m^2 = 60,000 L – 450 L/day * 30 days = 46,500 L
        b. Estimated cost: $8,700
    3. With maximum estimated usage:
        a. 198 mm x 270 m^2 = 60,000 L – 775 L/day * 30 days = 36,750 L
        b. Estimated cost: $6,500

1. Develop site layout – Suggested location of tanks, etc.

2. Develop preliminary budget based on dispensary system costs
    a. See Appendix for Excel estimate.

RAINWATER HARVESTING AT LEISERWEI PRIMARY SCHOOL

MAJI MARWA

SUSTAINABLE AND RESILIENT TANZANIAN COMMUNITY PROGRAM

Maji Marwa
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RAINWATER HARVESTING
MAJI MARWA

SCALE	N/A
DRAWN	CMV
CHECKED	--
DATE	03-08-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	T100

GENERAL NOTES

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS AT SITE PRIOR TO COMMENCEMENT OF CONSTRUCTION
2. ALL OMISSIONS OR CONFLICTS BETWEEN THE VARIOUS ELEMENTS OF THE WORKING DRAWINGS AND/OR THE SPECIFICATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER BEFORE PROCEEDING WITH ANY WORK INVOLVED
3. ALL WORK SHALL CONFORM TO THE BEST PRACTICES PREVAILING IN THE VARIOUS TRADES COMPRISING THE WORK

DESIGN CRITERIA

1. DEAD LOADS
   CUMULATIVE WEIGHT OF ALL STRUCTURAL MEMBERS, FIXTURES, PERMANENTLY ATTACHED EQUIPMENT AND ITS FOUNDATION.
2. LIVE LOADS
   WIND & SEISMIC: NEGLIGIBLE
   WEATHER (RAIN): 10 PSF
   ROOF LIVE: 20 PSF

CONCRETE

1. 28-DAY DESIGN COMPRESSIVE STRENGTH: 3000 PSI

MASONRY

1. TYPE M OR S MORTAR
2. ALL MASONRY WALLS SHALL BE CONSTRUCTED USING RUNNING BONDS
3. MINIMUM GROUT COMPRESSIVE STRENGTH: 2000 PSI
4. MINIMUM MASONRY COMPRESSIVE STRENGTH: 1500 PSI

REINFORCEMENT

1. MODULUS OF ELASTICITY FOR STEEL: 29,000 KPSI
2. YIELD STRESS: 60 KSI
3. MINIMUM DEVELOPMENT LENGTH: 500 MM
4. ALL SPLICES SHOWN SHALL BE TENSION LAP SPLICES. SEE DETAIL XX
5. ALL HOOKS SHOWN SHALL BE STANDARD HOOKS. SEE DETAIL XX
6. REINFORCEMENT SHALL BE A615 GRADE 60 OR APPROVED EQUIVALENT
7. REINFORCEMENT SHALL BE BENT COLD PRIOR TO PLACEMENT
8. FIELD BENDING OF REINFORCEMENT PARTIALLY EMBEDDED IN CONCRETE SHALL NOT BE PERMITTED

ABBREVIATIONS

CC ≡ CLEAR COVER
CLR ≡ CLEAR
DIA ≡ DIAMETER
M2 ≡ REBAR WITH 12 MM² CROSS-SECTIONAL AREA
MSA ≡ MAXIMUM SIZE AGGREGATE
MIN ≡ MINIMUM
MM ≡ MILLIMETERS
MSA ≡ MAXIMUM SIZE AGGREGATE
OC ≡ ON CENTER
RC ≡ REINFORCED CONCRETE
T&B ≡ TOP AND BOTTOM
TYP ≡ TYPICAL
VIF ≡ VERIFY IN FIELD

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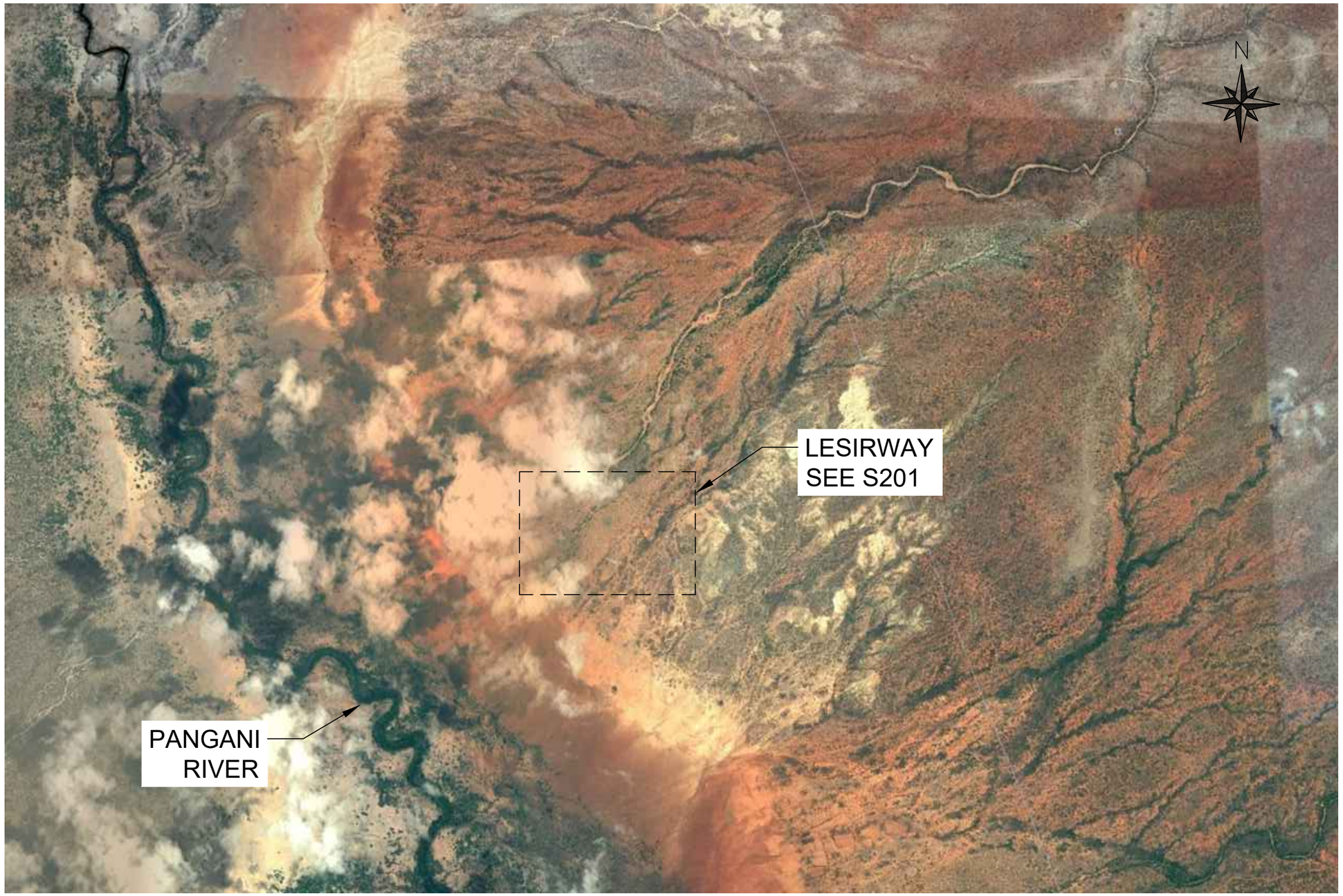
RAINWATER HARVESTING

GENERAL NOTES

SCALE	N/A
DRAWN	CMV
CHECKED	--
DATE	04-10-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	G100



1 AERIAL - VILLAGE OF MARWA, SAME DISTRICT

SCALE
4000M

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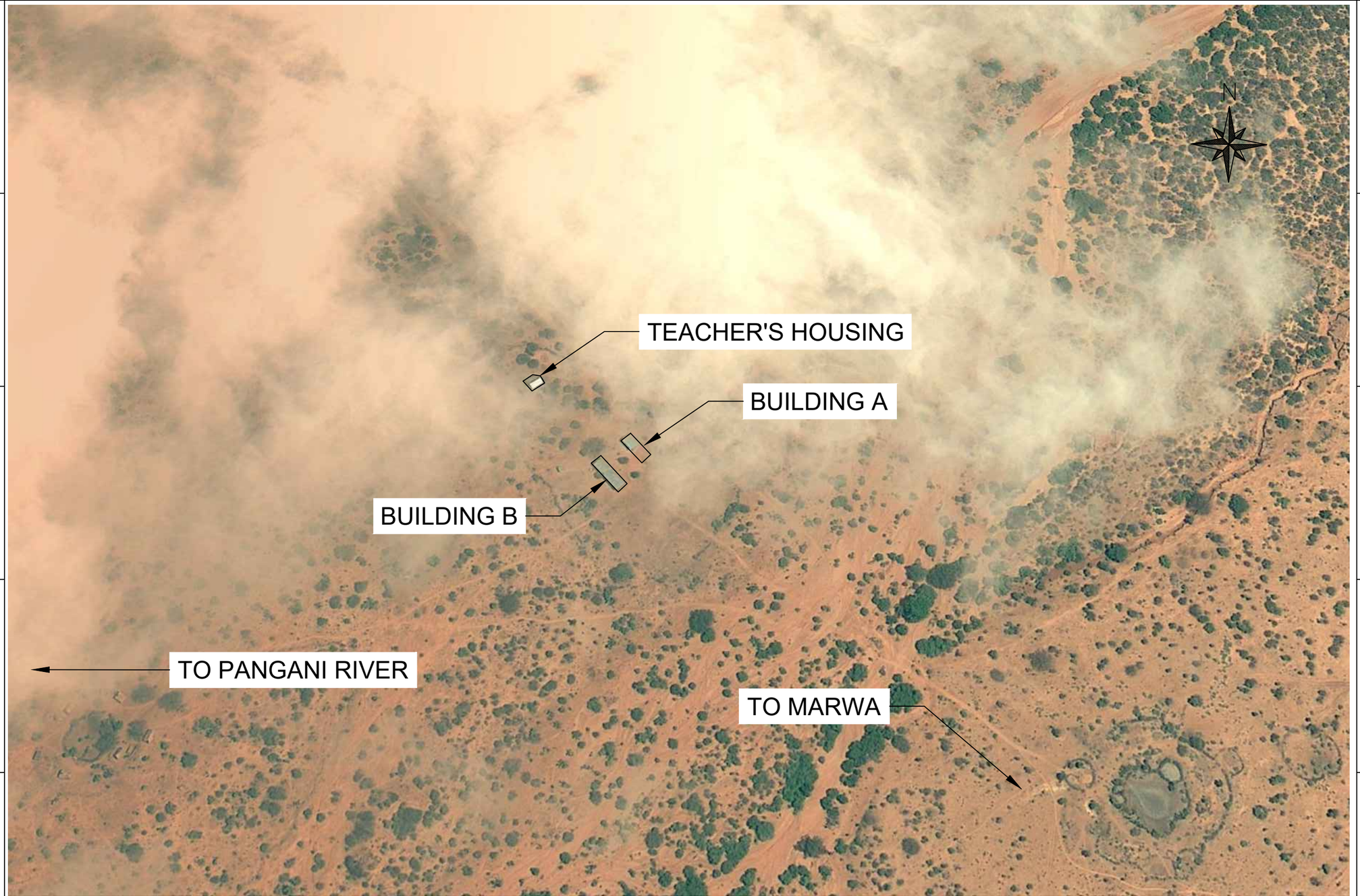
RAINWATER HARVESTING

SITE IMAGES

SCALE	AS NOTED
DRAWN	RCW
CHECKED	CMV
DATE	04-03-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	S200



1 AERIAL - SUB DISTRICT OF LESIRWAY

SCALE 500M

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RAINWATER HARVESTING

SITE IMAGES

SCALE	AS NOTED
DRAWN	RCW
CHECKED	CMV
DATE	04-03-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	S201

1 LESIRWAY SCHOOL BUILDINGS

2 EAST ELEVATION OF BUILDING A (EAST)

3 EAST ELEVATION OF BUILDING B (WEST)

4 WEST ELEVATION OF BUILDING A (EAST)

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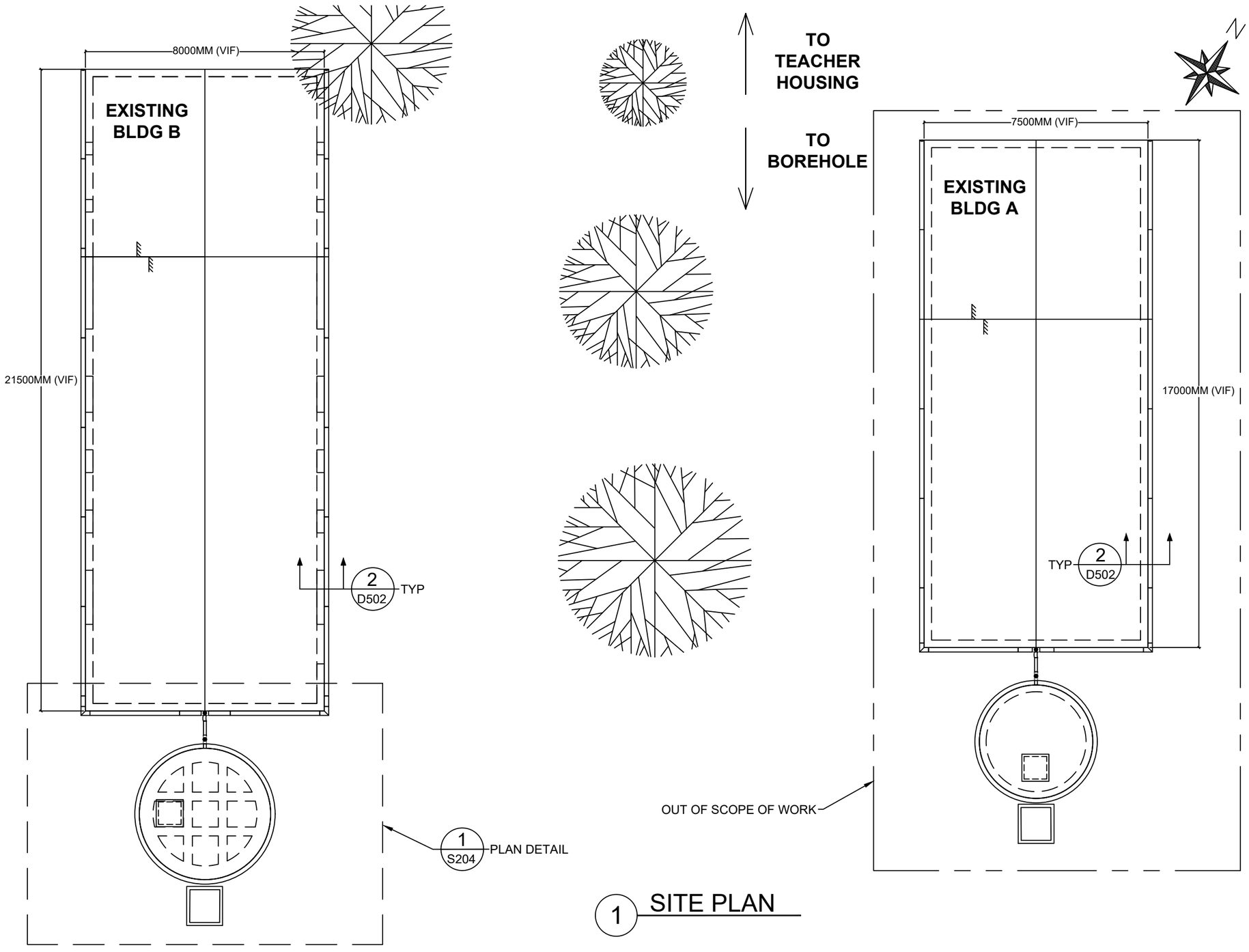
RAINWATER HARVESTING

SITE IMAGES

SCALE	N/A
DRAWN	RCW
CHECKED	CMV
DATE	03–08–2018
REVISION	--
PROJECT	MM–RWH–2018
DRAWING	S202



1 SITE PLAN

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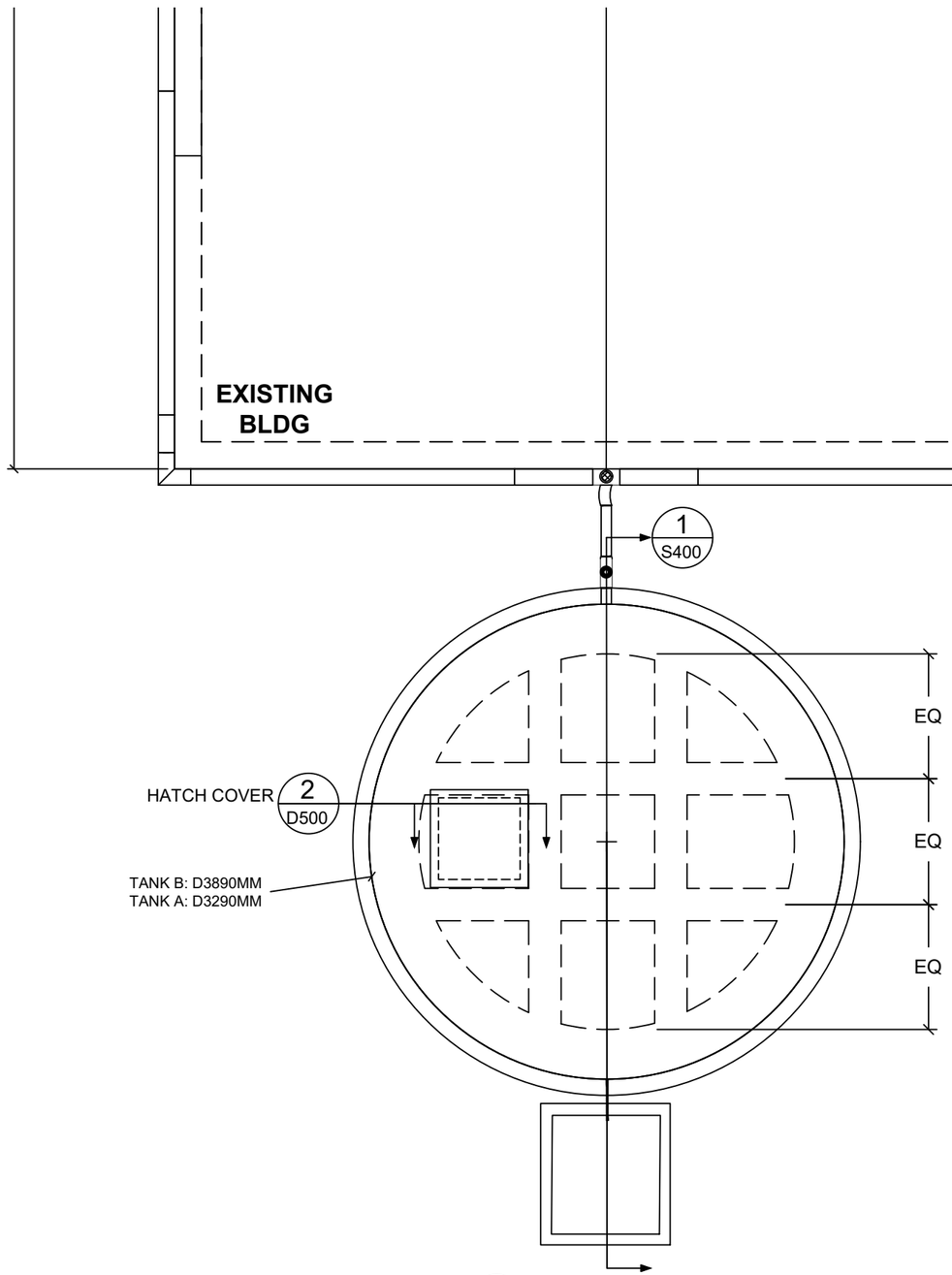
RAINWATER HARVESTING

PLAN VIEWS

SCALE	AS NOTED
DRAWN	RCW
CHECKED	CMV
DATE	05-03-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	S203



1 PLAN - TANK VIEW

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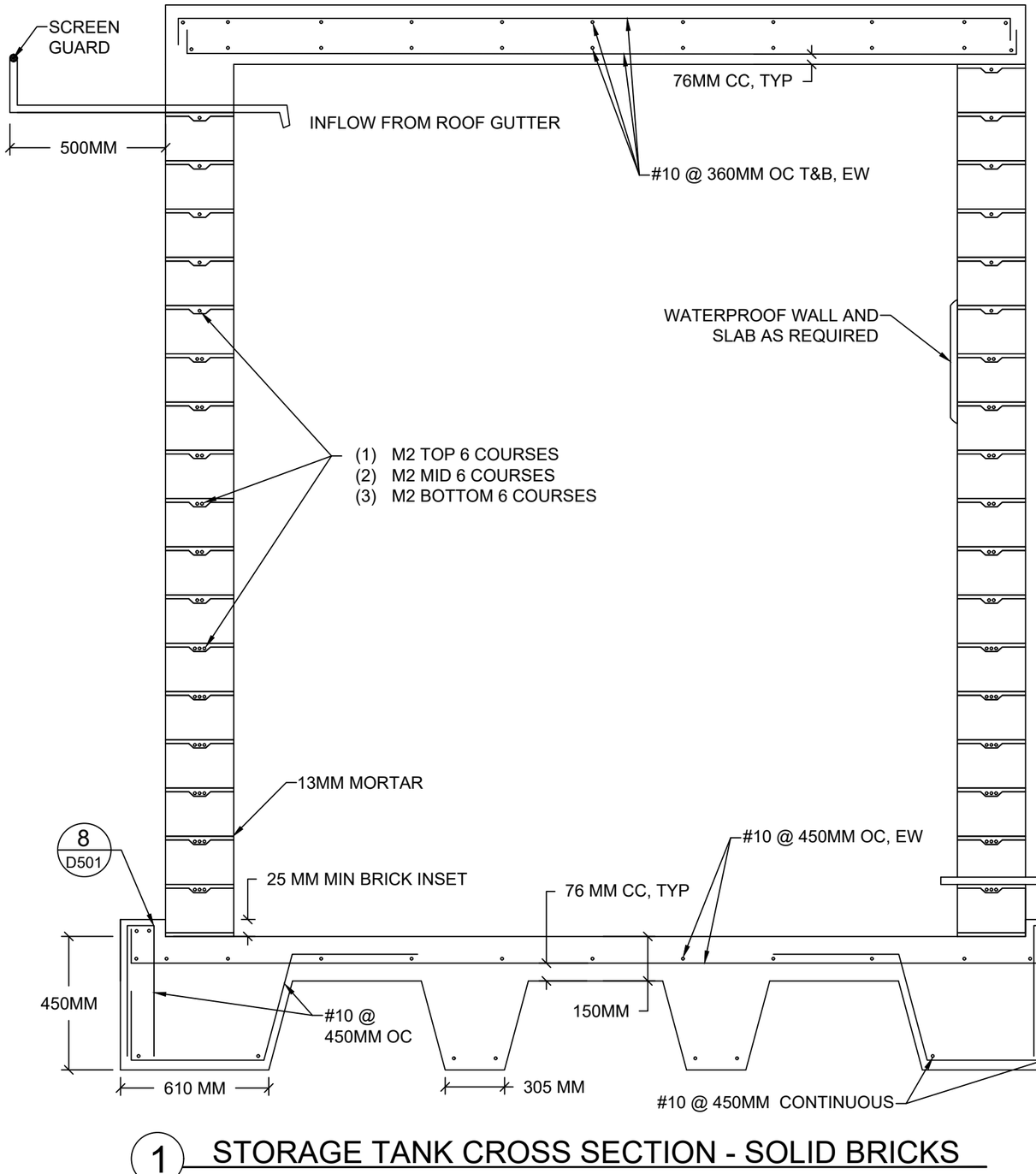
RAINWATER HARVESTING

PLAN VIEWS

SCALE	AS NOTED
DRAWN	RCW
CHECKED	CMV
DATE	04–10–2018
REVISION	--
PROJECT	MM–RWH–2018
DRAWING	S204



1 STORAGE TANK CROSS SECTION - SOLID BRICKS

SOLID BRICK USAGE (VIF)		
TANK	A	B
# COURSES	18	18
CIRCUMFERENCE (BRICKS)	26	30

REINFORCEMENT FOR TANK B		
COURSES	A_s per row (MM^2)	# M2
TOP BALANCE	12	1
MID 6	24	2
BOTTOM 6	36	3

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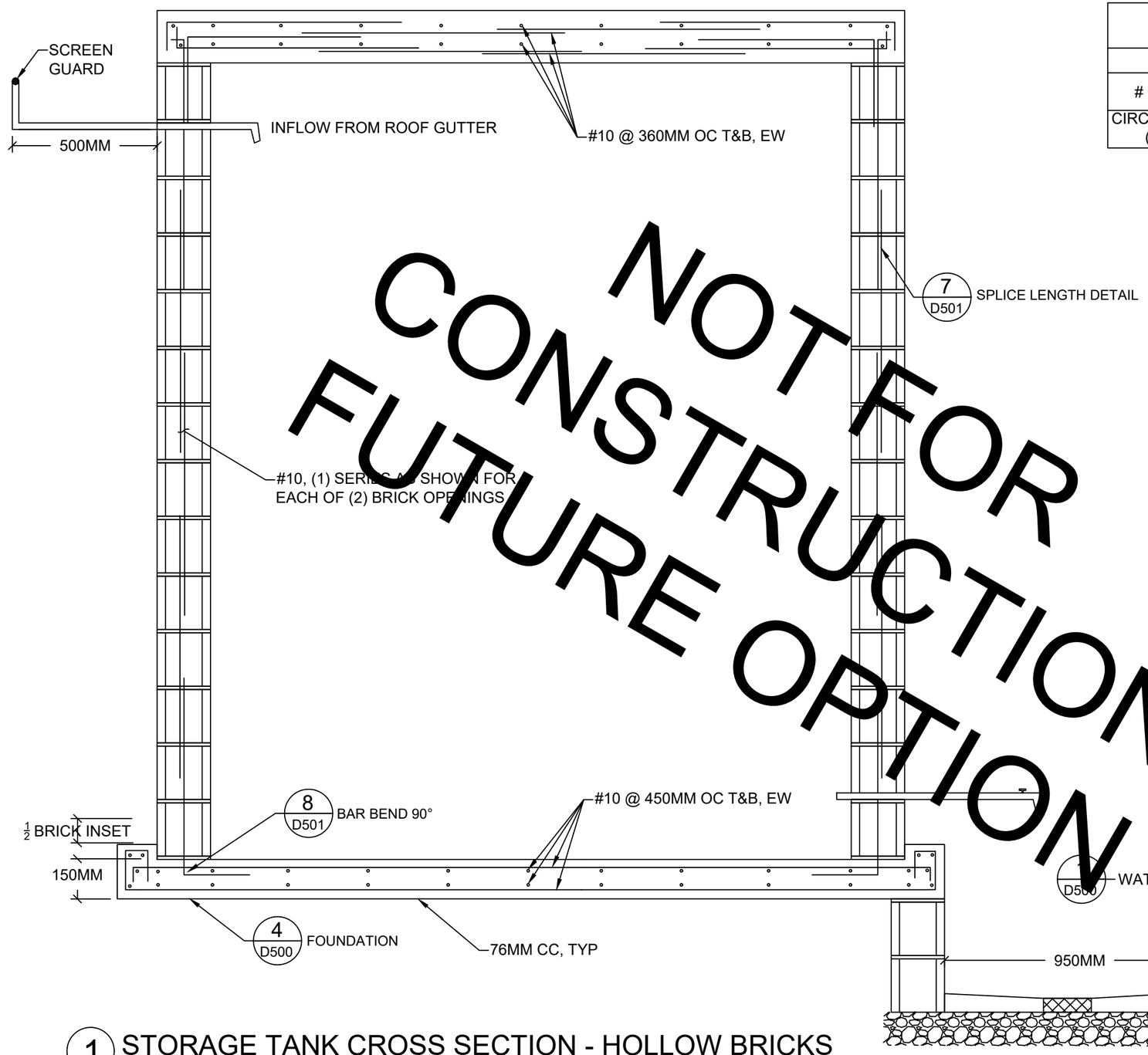
STORAGE TANK

CROSS SECTION

SCALE	AS NOTED
DRAWN	--
CHECKED	--
DATE	04-10-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	S400

HOLLOW BRICK USAGE		
TANK	A	B
# COURSES	14	14
CIRCUMFERENCE (BRICKS)	29	33



1 STORAGE TANK CROSS SECTION - HOLLOW BRICKS

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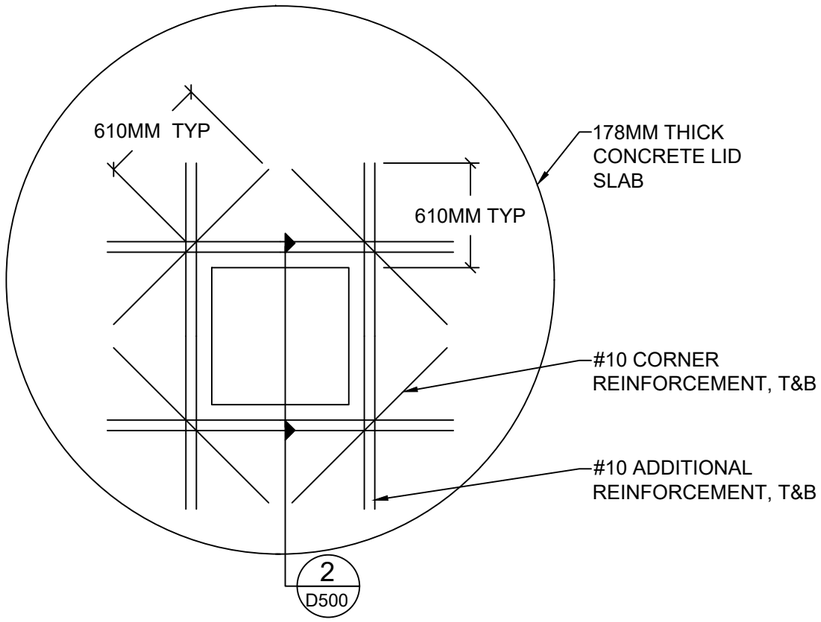
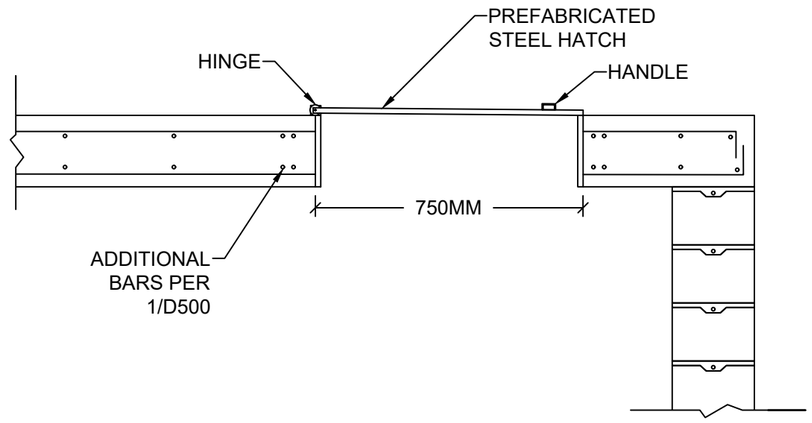
STORAGE TANK
CROSS SECTION

SCALE	AS NOTED
DRAWN	CMV
CHECKED	--
DATE	04-10-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	S400A



1 ADDITIONAL TANK ROOF REINFORCEMENT AT OPENING



2 HATCH COVER

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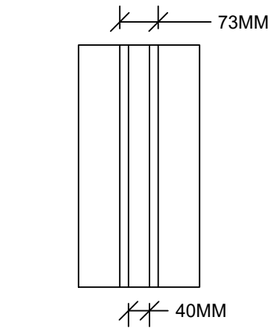
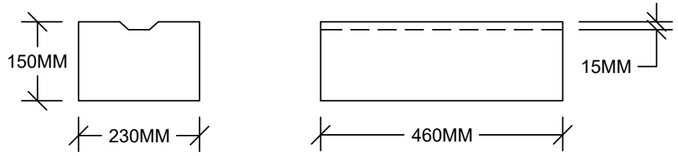
RAINWATER HARVESTING

DETAILS

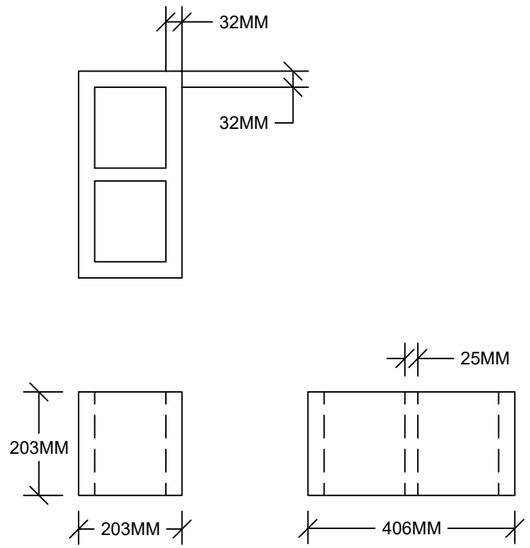
SCALE	AS NOTED
DRAWN	CMV
CHECKED	--
DATE	03-29-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	D500



CONCRETE MIX 1:3:6

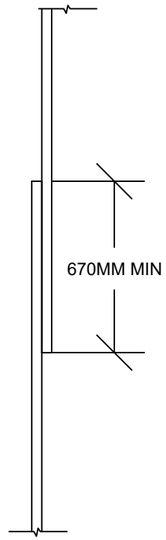


3 SOLID BRICK



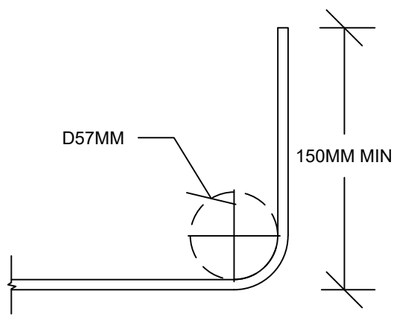
4 HOLLOW BRICK

NOTE: FOR ALTERNATIVE S400A



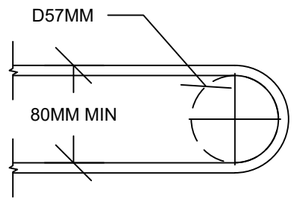
5 SPLICE LENGTH DETAIL

#10 BAR (11.7MM²)



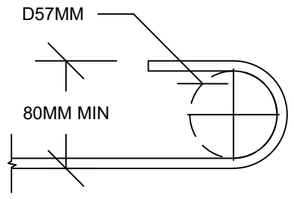
6 BAR BEND 90°

#10 BAR (11.7MM²)



7 BAR BEND 180°

#10 BAR (11.7MM²)



8 STANDARD HOOK

#10 BAR (11.7MM²)

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RAINWATER HARVESTING

DETAILS

SCALE	AS NOTED
DRAWN	CMV
CHECKED	--
DATE	04-10-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	D501

NOTES: GUTTER AND PVC

1. MATERIAL:
   1.1. USE 125MM OR 150MM HALF-ROUND GUTTERS OR APPROVED EQUAL.
   1.2. USE PVC PIPE AS PLANNED OR APPROVED EQUAL.

2. SEALANT: USE ON ALL GUTTER JOINERS/CONNECTIONS, END STOPS, OUTLETS, AND OTHER SEAMS AS REQUIRED FOR WATERPROOFING.

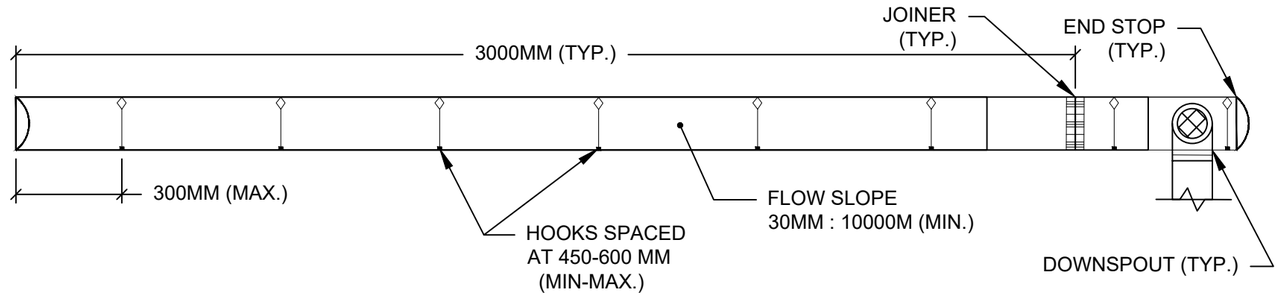
3. RAFTER BRACKETS: REQUIRED ON ALL PVC PIPE SPANS FOR SUPPORT (3000 MM MAX. SPACING).

4. FASCIA BRACKET/HANGERS:
   4.1. REQUIRED ON PLANNED GUTTER SPACED AT 450MM TO 600MM ON MIDSECTIONS AND 300MM (MAX) FROM END CAPS.
   4.2. TO BE INSPECTED BY ENGINEER PRIOR TO INSTALLATION.
   4.3. SPECIAL REQUIREMENTS MAY BE ADDED, DEPENDING ON EXISTING FASCIA STRUCTURE (SEE DETAIL FIG. 2/S102)

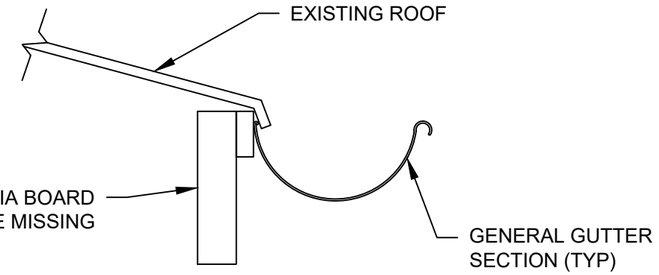
5. END STOPS: REQUIRED AT ALL GUTTER ENDS AS PLANNED.

6. SCREEN GUARDS: REQUIRED AT ALL GUTTER AND PIPE OUTLETS/INLETS OR OTHER OPENINGS.

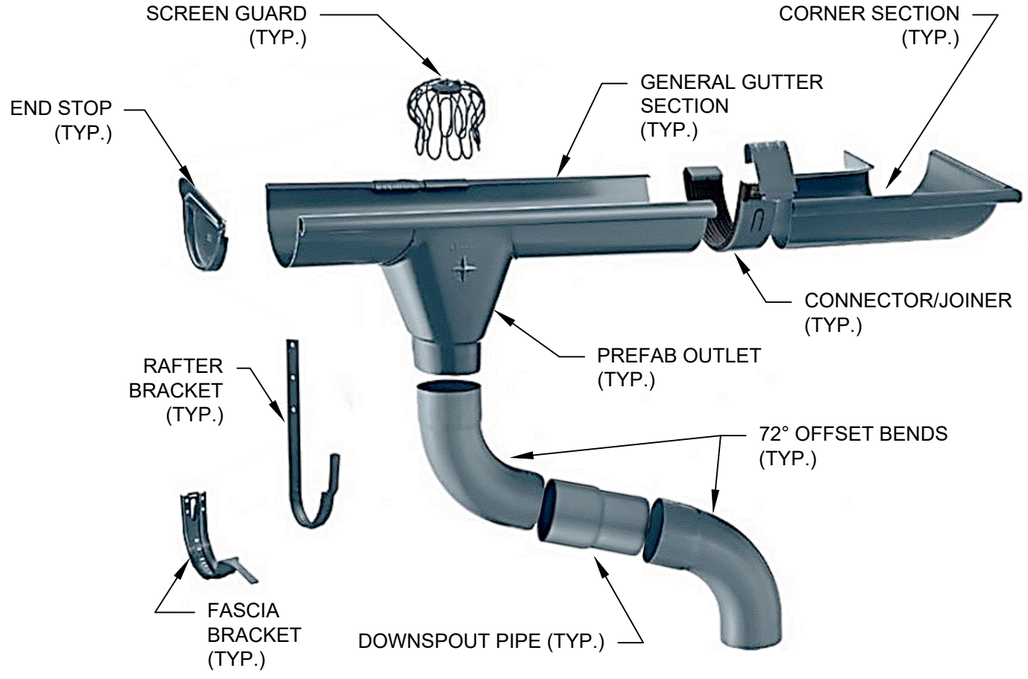
7. GENERAL INSTALLATION SHOULD BE FOLLOWED ACCORDING TO THE APPROVED MANUFACTURER'S SPECIFICATIONS AND INSTRUCTIONS.



1 TYP. HALF-ROUND GUTTER SECTION



2 FASCIA PLACEMENT



3 TYP. GUTTER/PIPE BREAKDOWN

Maji Marwa
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RAINWATER HARVESTING

GUTTER AND PVC DETAILS

SCALE	AS NOTED
DRAWN	PJS
CHECKED	--
DATE	1-30-2018
REVISION	--
PROJECT	MM-RWH-2018
DRAWING	D502

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Tests Conducted	Units	Lesirwei Borehole			Lesirwei RWH			Marwa RWH		
pH		8.86	-	-	8.71	-	-	-	-	-
Conductivity	µS	2.76	-	-	67.5	-	-	-	-	-
TDS		-	-	-	-	-	-	-	-	-
Salinity	%	0.16	-	-	-	-	-	-	-	-
Turbidity	NTU	0.61	0.73	0.62	2.43	3.1	2.95	-	-	-
Alkalinity	mg/L as CaCO3	35 drops			40	40	40	-	-	-
E. Coli	MPN/100 ml	-	-	-	-	-	-	-	-	-
Nitrate	mg/L as NO2	0.35	0.26	0.35	0.7	0.64	0.5	0.88	0.75	0.71
Total Hardness	mg/L as CaCO3	-	-	-	22.8	22.5	23.9	-	-	-
Calcium Hardness	mg/L as CaCO3	-	-	-	-	-	-	-	-	-
Manganese	mg/L as MnO_4	3	2.1	2	-	-	-	-	-	-
Phosphate	mg/L as PO_4	0.11	0.26	0.12	-	-	-	-	-	-
Sulfate	mg/L as SO_4	96.3	94.6	96.3	5.5	5.7	6.8	-	-	-
Iron	mg/L as Fe	0.12	0.09	0.08	-	-	-	-	-	-
Nitrite	mg/L as NO_2	0.0076	0.0078	0.0071	-	-	-	0.0025	0.0023	0.0028
Ammonia	mg/L as NH_3-N	0.08	0.1	0.05	-	-	-	0	0	0

TZ Standard
6.5-9.2
2000
2000
50
25
na
75
500
75
0.5
na
600
1
na
0.5

Rainwater Harvesting System for Marwa Primary School
Scope of Work MOU - Maji Marwa

The labor outlined below is for the Marwa Primary School rainwater harvesting system. Additions to the scope of work must be approved by all parties prior to starting additional services in order to receive compensation. Work performed without modification to this agreement and not included in the description of the scope of services are assumed to be included in the scope of work and additional compensation will not be provided.

Services to be delivered	Cost, TZ Shillings
Block Making Includes: Block making, block curing, block machine rental and transportation Number of blocks: _____ Days of block machine rental: _____	
Foundation Digging Includes: Excavation and removal of soil, leveling of subgrade	
Foundation Construction Includes: Placing steel reinforcement, mixing and placing of concrete, finishing of concrete, curing of concrete	
Building of Tank Walls Includes: Laying courses including mortar joints, leveling courses and placing steel reinforcement; construction of water access point, installation of clean out and overflows, waterproofing and curing of walls Number of courses of blocks:_____	
Roof Slab Construction Includes: Formwork including roof hatch, placement of steel reinforcement, mixing and placing of concrete, finishing of concrete, and curing of concrete, removal of scaffolding and cleaning of tank.	
Plastering Inside Tank Includes: Placing and finishing of waterproofing inside of tank	
Plastering Outside Tank Includes: Plastering and decorating outside of tank wall	
Gutter and Facia Installation Includes: Preparation of facia, repair of facia as required, painting of facia; Installation of gutter hooks, gutter, and piping to storage tank	
Total Cost:	

Rainwater Harvesting System for Marwa Primary School
Scope of Work MOU - Maji Marwa

Signatures

Contractor Name: _____

Signature: _____ **Date:** _____

Name of KiHO Representative: _____

Signature: _____ **Date:** _____

Name of OSU/SRC Representative: _____

Signature: _____ **Date:** _____

MAJI MARWA – AN SRC PROJECT

RAINWATER HARVESTING MARWA PRIMARY TANK CONSTRUCTION

Executive Summary

The Ohio State University (OSU) Rainwater Harvesting (RWH) team spent January 2019-April 2019 finalizing the design of the rainwater harvesting system for the Marwa Primary School and creating a Pre-Departure Plan for the project to be successfully completed when the OSU was in Tanzania during May 2019. This was done in conjunction with OSU faculty, the Kilimanjaro Hope Organization (KiHO), the local Tanzanian Government, the local Same Engineer, and the Marwa Community. The OSU team then traveled to the Marwa Community in Tanzania in early May 2019 to start work.

OSU team member Patrick Sours left a week earlier than the main OSU team in order to procure materials and discuss this years RWH system with the local stakeholders. This included going over the construction drawings created by the OSU team. Patrick used an estimated bill of materials created by the OSU team to efficiently procure the needed material.

Construction started on Tuesday, May 14th 2019. In attendance throughout construction was the OSU team, a UDOM student, a KiHO representative, and Athumani, the local builder who built the previous RWH systems. On the first day, all the stakeholders of the project went over a memorandum of understanding and negotiated the labor pricing and payment for construction of the system. This discussion was constructive and more like it will be the key to the successful completion of future systems.

First the workers made the required number of blocks while also working on the fascia and gutters for the system. Then, the foundation slab was dug and placed, followed by laying courses of blocks to build the tank walls. Throughout the construction process the OSU team documented daily logs and photos while also offering recommendations for improvement and working with the local builders to problem solve along the way.

Much of the material required to build the system was purchased and brought to the Marwa Primary School. However, the sand and water required to make the concrete was brought by local community members. Local leadership also tracked contributions from members of the local sub-villages. Isaac, the UDOM student on the team recommended that the project continue to involve community members when and wherever they can in order to foster a sense of community ownership in the project.

The OSU team's final day onsite was Saturday, May 25th 2019. At this time most of the gutter system, the tank foundation, and 7 courses of the tank walls had been completed.

RAINWATER HARVESTING

a. Pre-trip Planning
b. Athumani
    i. Observations
    ii. Discussion of MOU
    iii. Recommendations
c. Fascia Board
d. Gutters
e. Foundation
    i. Excavation
    ii. Rebar
    iii. Concrete Slab
f. Concrete Masonry Blocks
g. Walls
h. Conclusion

Pre-Trip Planning

Observations:

Before the trip several actions were taken to prepare for the in-country work. The RWH team condensed and printed a daily log to account for daily activities. The team had these in hand each day on the project. Having Patrick Sours order the materials a week prior to starting construction allowed for work to start immediately. A bill of materials was sent with him to be used as a shopping list to make material procurement go more smoothly. The bill of materials included quantities of materials in metric and U.S. customary units. The list also included the prices of each materials from the Lesirwei tank construction for reference. The schedule is more of a reference than a strict timeline.

Recommendations:

The RWH team recommends a person travel to Same a week prior to procure materials. Having the bill of materials was useful in the purchasing process. Drawing the parts for clean out, overflow, vent and outlet was useful for material procurement.

Athumani

Observations:

Fundi A still has trouble reading constructions drawings. However, he is open to suggestions from the OSU team. He started designating tasks to other workers instead of doing all the work, himself. This year he trained a team to make the blocks so he could begin hanging up the gutters. He also had laborers laying brick simultaneously. After discussion with last year's RWH team to save and safely store all formwork and forest poles, he only had half of the materials in possession (unsure if it was Athumani or KiHO).

Discussion of MOU:

The OSU team consisting of Patrick, Frank, Gabby sat with Kateri from KiHO, Athumani the local builder, and Isaac, the UDOM student, to discuss the MOU and settle on a price for labor. The discussion went smoothly. Kateri served as a middle-man and interpreter for this discussion. Fundi A seemed most concerned with the total price. After some back and forth, the final price was settled on and then the breakdown for each subtask was priced. Fundi A believed that as he improves his tank building skills he deserves to be paid more. He also mentioned it is getting harder for him to find laborers because want to work more in the city.

Recommendations:

The RWH team recommends utilizing the MOU to keep Athumani and KiHO accountable for storage of reusable materials. Looking ahead, the team recommends settling on a yearly acceptable labor price increase.

Patrick went over the drawings with Athumani and KiHO before the start of construction to make sure Athumani understood the drawings. During construction, some problems arose due to Athumani not understanding the drawings such as the cut section details. The OSU team recommends that a simple

field instruction guide containing the important dimensions and materials needed for construction be compiled while also still compiling a full engineering plan set for review purposes by various engineering authorities. Also recommend that Athumani have his crew multitask. This was somewhat present when some workers made blocks, some hung fascia, and some hung gutters on the same day. But other days workers would sit around when they could be moving material in preparation for the next construction process.

Notes:
Athumani understands inches and centimeters due to his tap measure being in those units. Do not use millimeters as units. Athumani also doesn't understand the English notes on the drawings. Need to translate those to Swahili in the future. Athumani also does not ask many questions.

Labor: Not all workers work at the same time. Work started around 6am daily and finished around 3pm. The labor team is beginning to multitask. Community members brought water and sand the first 2 days of project work for block making. Students collected stone to fill the foundation after Fundi A dub the foundation 6 inches deeper than required.

Fascia Board

Observations:
The OSU team observed the laborers started fascia while blocks were still being made. Hanging and painting of fascia took 2 days. The laborers had to spread the paint somewhat thin on one side of Building A so the OSU team did not have to buy another can of paint.

Recommendations: N/A

Gutters

Observations:
Laborers took 3 days to hang gutters. Gutters are installed section by sections. Workers then test each section at a time before moving onto the next by throwing water onto roof and seeing if it flows down. This led to adjusting the gutter at several points until the correct sloping was achieved. The OSU team decided on connection for building B to A in field.

Recommendations:
The OSU team should create a standardized way to slope the gutters for future RWH systems. Another recommendation would be to have the building connections exhibited more clearly on the drawings.

Foundation

Excavation

Observations:

The OSU team came back after the weekend to an excavation of 18 inches deep. Patrick had told Athumani to dig a 12 inch foundation before the OSU team left for the weekend. Athumani said that Orest told him to dig 18 inches. Orest says he told Athumani to dig 12 inches. When asked why Athmani did not refer to the drawings, he said he did not understand them. To fix this, the Marwa Primary School children collected rocks. The workers then spread the rocks over the entire foundation, filling in spaces with smaller rocks, and breaking up some of the bigger rocks into smaller filler pieces. This filled in roughly 2-3 inches. Next, the workers filled in another 1-2 inches with the small aggregate leftover from block making. This was then leveled. The concrete foundation slab would be going 12 inches up from this level. This took roughly half a day.

Recommendations:
Need to make sure critical dimensions such as the foundation depth are prominent in the drawing sets and know by all parties involved in the construction process in order to avoid confusion. Also, in the future if stone is needed for future tank foundations, getting the community involved to collect rocks would be a great way to involve the community in future tank construction. The laborers also can break the stones with hammers into smaller pieces.

Rebar

Observations:
The workers cut the rebar to the desired lengths as calculated by the OSU team. The OSU team did not account for waste at first, so after several pieces had been cut, the OSU team helped the workers figure out how to cut the remaining rebar in order to minimize the waste. The rebar was then laid out in a general lattice pattern on the ground. The lattice consisted of 31 bars going one way with another 31 bars laid on top at 90 degrees. The workers then spaced each bar 6 inches apart and tied them together. The rebar ends were then bent to roughly 90 degrees using the handles of the metal hammers as a lever of sorts. This was completed in half a day.

Recommendations:
The workers do not minimize waste when cutting rebar. Recommend to either purchase enough rebar where waste is not a factor or have a plan for cutting rebar in order to minimize waste. The workers also still struggle with tying the rebar. The workers need to start in the center, with the two most center bars that are orthogonal to each other, and space out from there. Athumani also needs to follow the spacing designated by the plans, and the plans need to specify an exact spacing dimension.

Concrete Slab

Observations:
The workers mixed concrete in roughly 3 small cone piles at the start. Last year's OSU RWH team recommended they mix in smaller piles to achieve a better mix, and this year's OSU RWH team was happy to see they stuck to the recommendation. They mixed 1 bag of cement with 12 small buckets of sand (~one small bucket is roughly 15L) at first. Then they mixed in 25 small buckets of larger aggregate.

After this was all mixed, they would pour small portions of water to the mix at a time. The total amount of water added per bag of cement was roughly 30L (1 large bucket of 20L + 1 small bucket of 10L). Since a majority of the gutters had been hung, the workers placed a 500L poly tank under one of the gutters that collected water during a recent rainstorm that the workers then used to mix the concrete.

The workers then laid a layer of 3 inch concrete to start. They monitored the level by placing four posts in the foundation with string that was tied and leveled 3 inches above the small aggregate course. The workers would fill up to 3 inch line in "clumps" of concrete that Athumani would then spread and tamp with a wooden post for compaction. After fully laying the 3 inch layer, the workers placed the completed rebar layer into the foundation hole. The workers then repeated what they did for the previous concrete layer, but instead filling up to 9 inches for the total thickness designed of 12 inches. The workers filled all the way up to the 9 inch level in thick "clumps" instead of filling the foundation in using multiple layers of smaller thickness. This was all completed in 1 day.

Recommendations:
Recommend the workers do not let the concrete slab sit before completing finishing it. Workers took a lunch break when roughly 2/3's of the 9 inch layer still needed completed. Also recommend the workers try to lay the concrete in smaller and less thick layers in order to achieve higher and more uniform compaction.

Masonry Block Making

Observations:

The block maker was rented for 5 days at 20,000 TSH per day. Using the mix composition from the Lesirwei construction. The water was brought to site by sub-village community members, likely a variety of different water sources. The village leaders kept track of how much each sub-village contributed. The sand used was moist and taken from a dried riverbed about 50 yards away.

The laborers used a thinner tamping rod when making the blocks upon suggestion by the OSU team. The number of blocks produced was limited to 109 each day because of the quantity of wooden pallets the blocks are made on. 105 blocks were made on the first day. 109 blocks were made on the second day. 105 blocks were made on the third day. The workers made blocks from 6am to about noon each day. The laborers used continuous batching to improve the block making process.

The blocks were removed from the wooden palettes after a day and lay on their side. During curing, only one side of the block was watered. Additionally, some of the blocks were cured in the sun and others in the shade. On day 3 of curing, the blocks were then stacked to make room for more. Shear cracks were seen in roughly 6 of the blocks.

The OSU team inquired about why the blocks were made several yards away from the tank site. Fundi said they wanted to make them close to the water source.

Recommendations:

Look into buying a block maker and having KiHo of Fundi A accountable for it. Have more wooden pallets available to make more blocks each day. A standardized procedure for watering and curing would be beneficial and lead to more consistency in the final product. It was also mentioned to tamp the half of the concrete in the block machine before filling it completely, however this recommendation was not followed.

It is also recommended to make the blocks near the site of the tank, instead of close to the water source on site because it is more work to carry the blocks over to the tank than to carry water to tank site.

Building Reinforced Masonry Block Wall

Observations:
When the team arrived on the day that the block wall construction was to start, Athumani had laid out a circumference of 31 blocks. Athumani followed the criteria of keeping the blocks 6 inches from the edge of the foundation slab and was able to lay 31 blocks in circumference without sacrificing any of the thickness of the mortar joints.

Athumani then laid the first course using the already made masonry blocks and mortar mixed by his crew. The workers used a mix ratio of 1 bag of cement to 9 small buckets of sand to roughly 30L of water for the mortar. After fully placing the first course of bricks, Athumani started the bitumen layer. The bitumen layer is inside the tank and on top of the foundation slab roughly 3 inches thick. The workers used wooden pallets as forms to separate the bitumen and the laid blocks. For the mix ratio for the bitumen, they used the same ratio as the mortar but adding 16 small buckets of aggregate. Athumani also chipped in a hole through a block in the first course for the clean out pipe, and he also chipped in a hole through blocks in the first and second course for the outlet pipe.

The workers then placed more courses over the following days. Before laying the next course, the workers laid the W2 reinforcing wire in the grooves of the blocks before mortar was placed to keep them in place and then, the next course was placed on top of the mortar and wire. There was slight design change in the W2 reinforcing wire design due to enlarging the tank. This changed the number of wire rows in the 11 course. The new wire reinforcement was 3 rows for the first 5 courses, 2 rows for the following 6 courses, and 1 rows for the top 3 courses. The workers stuck to the only laying three courses per day after having another conversation saying they could lay more. On the final day the OSU team was at the Marwa Primary School, the workers had seven of the fourteen total courses laid.

Recommendations:

It is recommended that more of an effort to convince Athumani to lay more than 3 courses be made. This would allow the tank walls to be built at a much faster rate. It is also recommended that the smooth layer poured on top of the foundation slab could be lessened to 1 or 2 inches. Lastly, be sure to included waste in the material quantity calculation.

Conclusion

The roof slab, plastering, and tap point was not completed by the last day on the project. Therefore, no observations or recommendations were recorded. Material costs were saved by using some of the materials like forest poles and scaffolding from the Lesirwei project. The transportation rates were less than last years rates. The increase in size of the tank added $ more to the estimate. The final cost of the rainwater harvest system was $, which was % more than the estimated cost.

Rainwater Harvesting System for Marwa Primary School
Scope of Work MOU - Maji Marwa

Ratiba iliyoandaliwa hap ani kwa ajili ya mfumo wa uvunaji maji ya mvua . Ratiba hiyo ya utendaji wa kazi lazima ikubaliwe na pande zote mbili na ongezeko lolote kiutendaji kinyume na makubaliano haitakubalika.

Huduma zitakazotolewa:	**Gharama TZShs:**
Utengenezaji wa Matofali: Utahusu: Utengenezaji Matofali, Unyweshaji wa Matofali, Ukodishaji wa Mashine ya kufyatulia Matofali. Idadi ya Matofali_____ Muda wa ukodishwaji wa Mashine_____	
Uchimbaji wa msingi: Unajumuisha: Kuchimba na kusogeza udongo, Kusawazisha eneo	
Kujenga Msingi: Inahusisha: Kupanga Nondo kwa ajili ya kuimarisha mfumo, Kuchanganya na kuweka zege, Kumalizia kuweka zege,Kusubiri zege kukomaa.	
Kujenga ukuta wa Tanki Inahusisha: Kuanza kujenga laini za matofali pamoja na kusiriba kwa zege,Kulinganisha laini za matofali na kupanga Nondo za kuimarisha kuta , Kujenga sehemu ya kuingizia maji, kuweka sehemu ya kuingiza maji safi na kupunguza maji yatakayozidi, kuweka sementi yak inga dhidi ya uvujaji na kunywesha ukuta kusudi ukomae. Idadi ya laini za matofali_____	
Ujenzi wa mfuniko wa Tanki juu: Inahusisha: Kuta za mabati, Kuweka Nondo kwa uimarishaji wa Tanki,Kuchanganya na kuweka zege, Kumaliza kazi ya zege, Kunyweshea zege ikusudi ikomae vizuri Kubandua mbao na kusafisha Tanki.	
Kupiga Ripu upande wa ndani ya Tanki Inahusisha: Kuweka na kumalizia uwekaji wa sementi ya kuzuia uvujaji wa maji ktika Tanki kwa ndani	
Kupiga Ripu Tanki upande wa nje Inahusisha: Kupiga Rip una Kuweka urembo / Mistari upande wan je wa Tanki	
Kuweka Gata pamoja na Ficha bodi Inahusisha: Kuziandaa Ficha bodi nakuzirekebisha pale inapohitajika, kupaka rangi Ficha bodi , Kuweka Gata vishikizo vya Gata Na Sehemu ya Kuingizia maji Kwenye Tanki.	
Total Cost: **Jumla ya Gharama**	

Rainwater Harvesting System for Marwa Primary School
Scope of Work MOU - Maji Marwa

Signatures

Sahihi:

Contractor Name:
Jina La Mkandarasi / Mjenzi _____

Signature: **Date:**
Sahihi _____ **Tarehe** _____

Name of KiHO Representative:
Jina la Mwakilishi wa KIHO _____

Signature: **Date:**
Sahihi _____ **Tarehe** _____

Name of OSU/SRC Representative:
Jina la Mwakilishi wa OSO/SRC _____

Signature: **Date:**
Sahihi _____ **Tarehe** _____

RAINWATER HARVESTING
MARWA PRIMARY SCHOOL

MAJI MARWA
SUSTAINABLE AND RESILIENT COMMUNITY PROGRAM

Maji Marwa
Sustainable Resilient Tanzanian Communities

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COLUMBUS, OH, 43210

RAINWATER HARVESTING
MAJI MARWA

SCALE	N/A
DRAWN	FRK
CHECKED	--
DATE	04-07-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	T100

SHEET LIST

G101 - GENERAL NOTES

S200 - AERIAL OF VILLAGE OF MARWA

S201 - AERIAL OF MARWA PRIMARY SCHOOL

S202 - BUILDING IMAGES

S203 - SITE PLAN

S204 - PLAN VIEW (TANK LAYOUT)

S204A - PLAN VIEW (TANK DIMENSIONS)

S205 - BUILDING A ELEVATIONS

S206 - BUILDING A & INLET

D500 - DETAILS (OUTLET AND CLEAN OUT)

D501 - DETAILS (WALL AND ROOF)

D502 - DETAILS (BLOCK AND REBAR)

D503 - DETAILS (GUTTER AND PVC)

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RAINWATER HARVESTING

SHEET LIST

SCALE	N/A
DRAWN	FRK
CHECKED	--
DATE	04-07-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	G100

GENERAL NOTES

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS AT SITE PRIOR TO COMMENCEMENT OF CONSTRUCTION
2. ALL OMISSIONS OR CONFLICTS BETWEEN THE VARIOUS ELEMENTS OF THE WORKING DRAWINGS AND/OR THE SPECIFICATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER BEFORE PROCEEDING WITH ANY WORK INVOLVED
3. ALL WORK SHALL CONFORM TO THE BEST PRACTICES PREVAILING IN THE VARIOUS TRADES COMPRISING THE WORK

DESIGN CRITERIA

1. DEAD LOADS
   CUMULATIVE WEIGHT OF ALL STRUCTURAL MEMBERS, FIXTURES, PERMANENTLY ATTACHED EQUIPMENT AND ITS FOUNDATION.
2. LIVE LOADS
   WIND & SEISMIC: NEGLIGIBLE
   WEATHER (RAIN): 10 PSF
   ROOF LIVE: 20 PSF

CONCRETE

1. 28-DAY DESIGN COMPRESSIVE STRENGTH: 3000 PSI

MASONRY

1. TYPE M OR S MORTAR
2. ALL MASONRY WALLS SHALL BE CONSTRUCTED USING RUNNING BONDS
3. MINIMUM GROUT COMPRESSIVE STRENGTH: 2000 PSI
4. MINIMUM MASONRY COMPRESSIVE STRENGTH: 1500 PSI

REINFORCEMENT

1. MODULUS OF ELASTICITY FOR STEEL: 29,000 KPSI
2. YIELD STRESS: 60 KSI
3. MINIMUM DEVELOPMENT LENGTH: 500 MM
4. ALL SPLICES SHOWN SHALL BE TENSION LAP SPLICES. SEE DETAIL XX
5. ALL HOOKS SHOWN SHALL BE STANDARD HOOKS. SEE DETAIL XX
6. REINFORCEMENT SHALL BE A615 GRADE 60 OR APPROVED EQUIVALENT
7. REINFORCEMENT SHALL BE BENT COLD PRIOR TO PLACEMENT
8. FIELD BENDING OF REINFORCEMENT PARTIALLY EMBEDDED IN CONCRETE SHALL NOT BE PERMITTED

ABBREVIATIONS

CC ≡ CLEAR COVER
CLR ≡ CLEAR
DIA ≡ DIAMETER
M2 ≡ REBAR WITH 12 MM² CROSS-SECTIONAL AREA
MSA ≡ MAXIMUM SIZE AGGREGATE
MIN ≡ MINIMUM
MM ≡ MILLIMETERS
MSA ≡ MAXIMUM SIZE AGGREGATE
OC ≡ ON CENTER
RC ≡ REINFORCED CONCRETE
T&B ≡ TOP AND BOTTOM
TYP ≡ TYPICAL
VIF ≡ VERIFY IN FIELD

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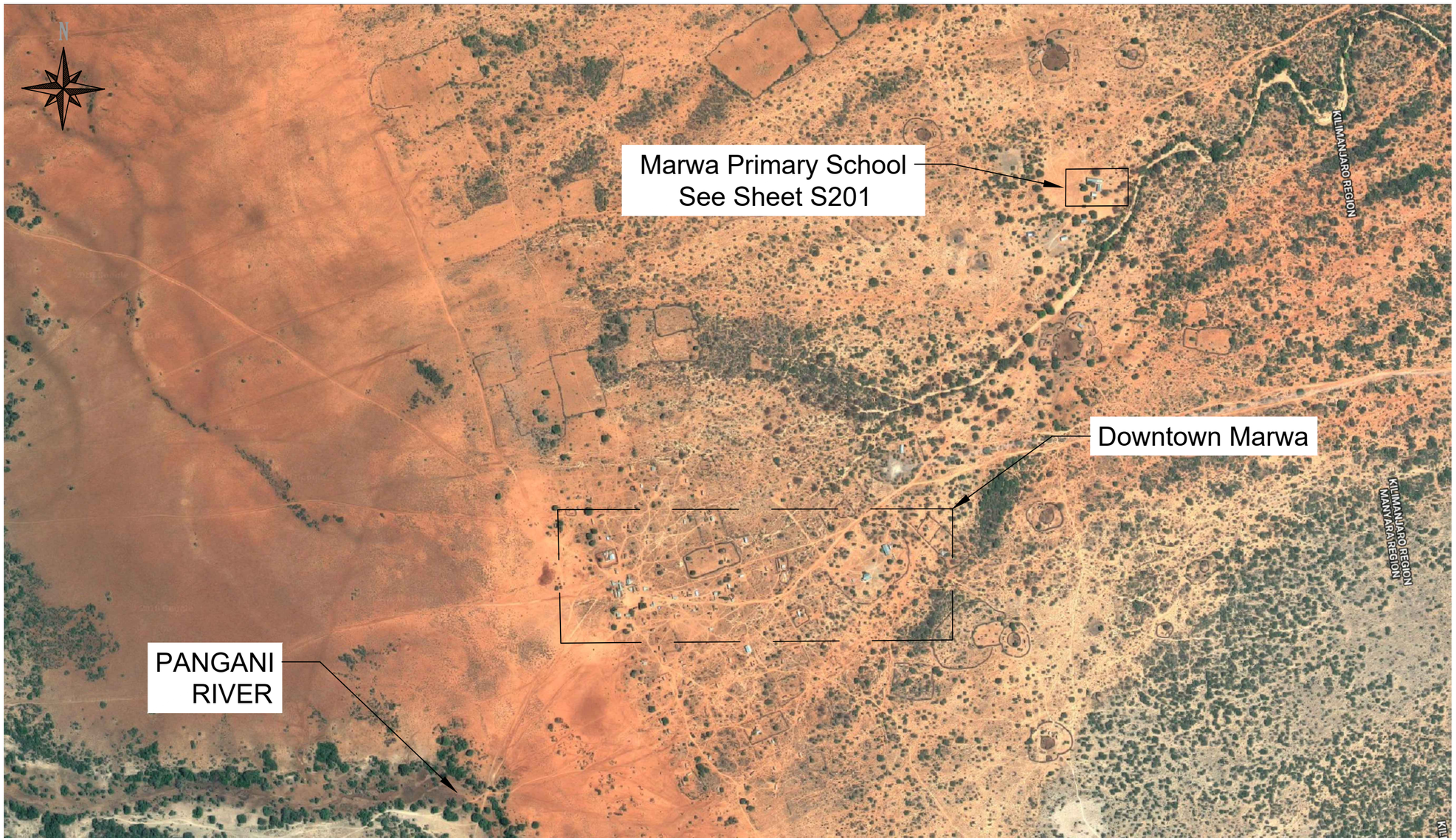
COLUMBUS, OH, 43210

RAINWATER HARVESTING

GENERAL NOTES

SCALE	N/A
DRAWN	FRK
CHECKED	--
DATE	04-07-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	G101



1 AERIAL - VILLAGE OF MARWA, SAME DISTRICT

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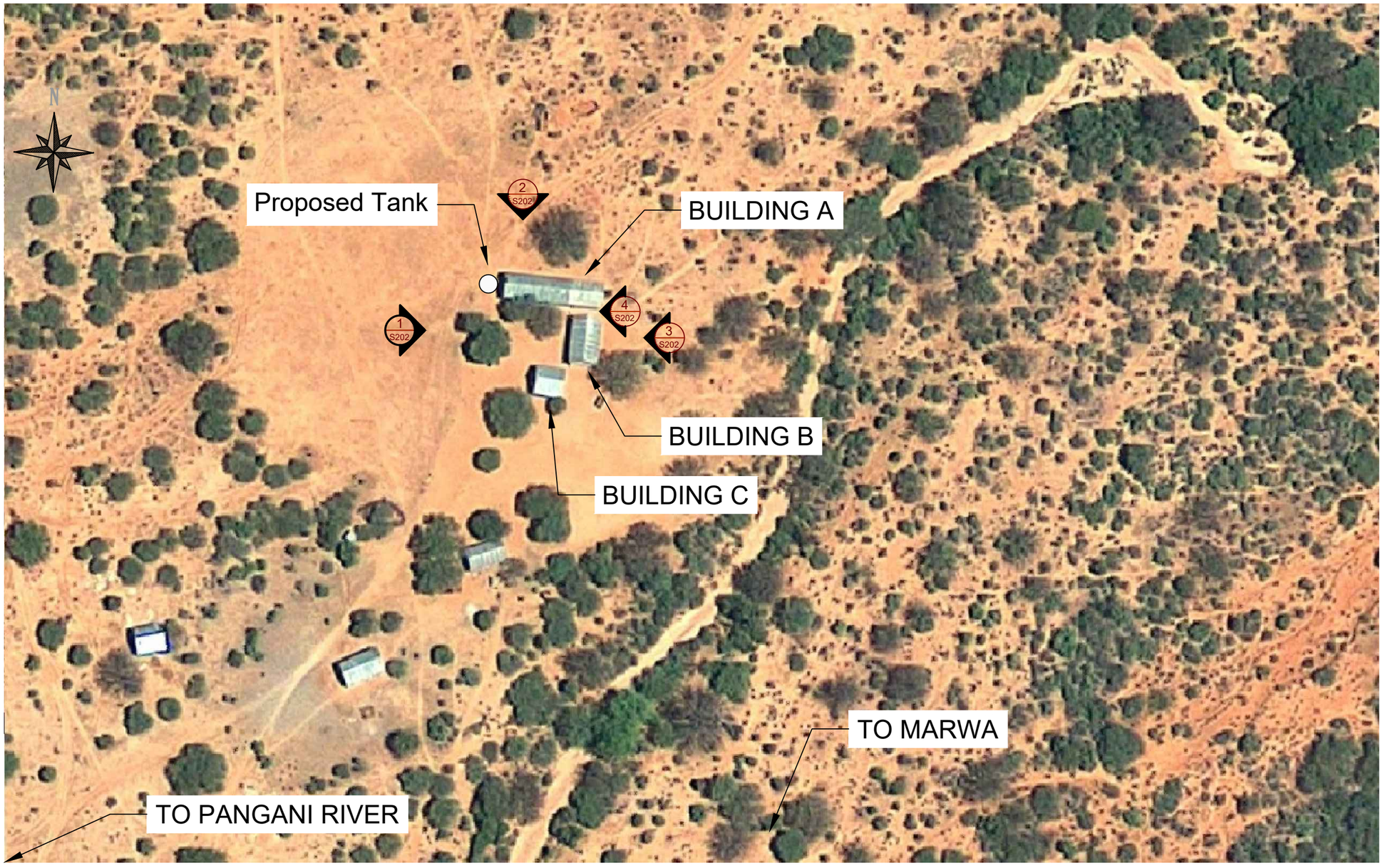
COLUMBUS, OH, 43210

RAINWATER HARVESTING

SITE IMAGES

SCALE	N/A
DRAWN	FRK
CHECKED	--
DATE	01-03-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	S200



1 AERIAL - MARWA PRIMARY SCHOOL

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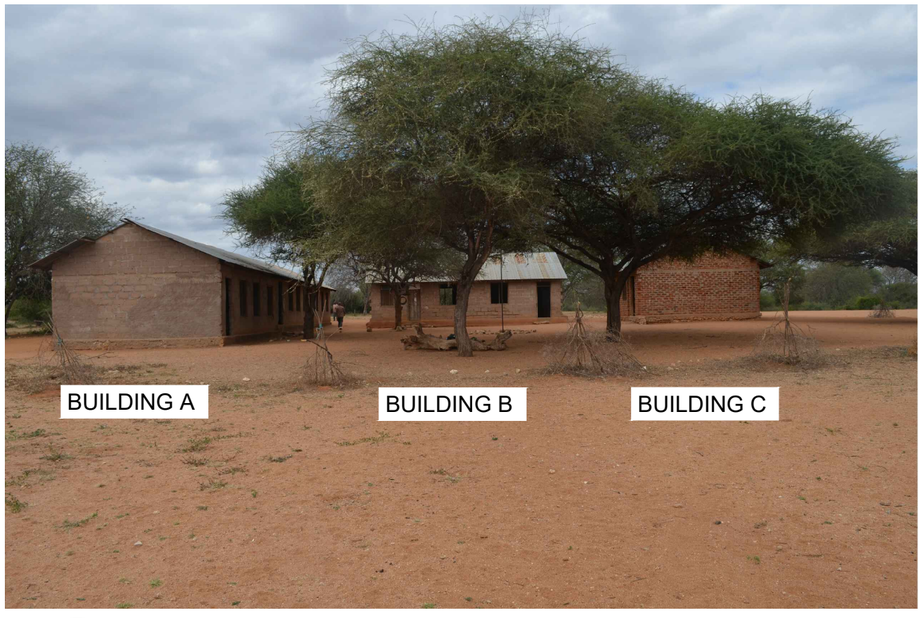
COLUMBUS, OH, 43210

RAINWATER HARVESTING

SITE IMAGES

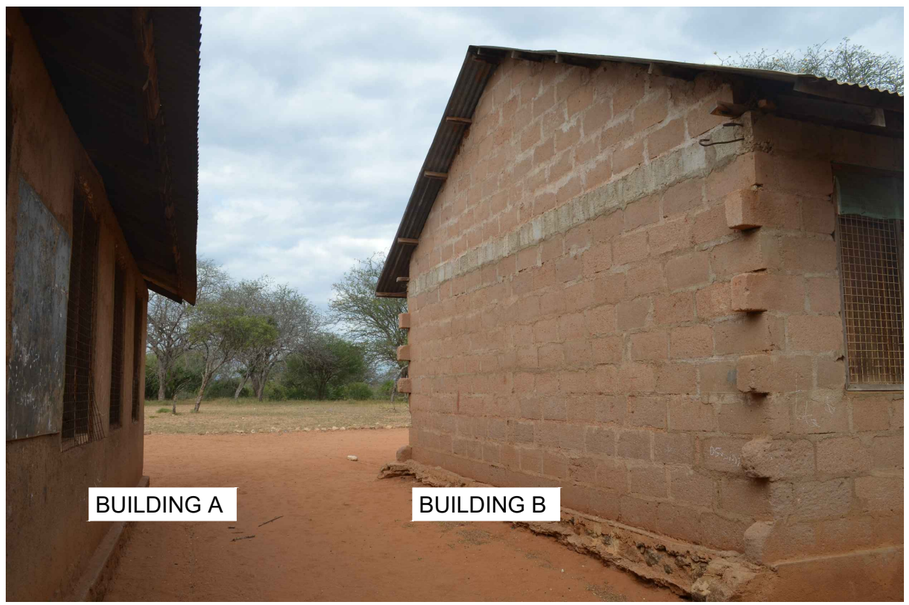
SCALE	N/A
DRAWN	FRK
CHECKED	--
DATE	01-03-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	S201



1 MARWA PRIMARY SCHOOL BUILDINGS

2 WEST ELEVATION OF BUILDING A (EAST)

3 NORTH ELEVATION OF BUILDING B (SOUTH)



4 GAP BETWEEN BUILDING A & B

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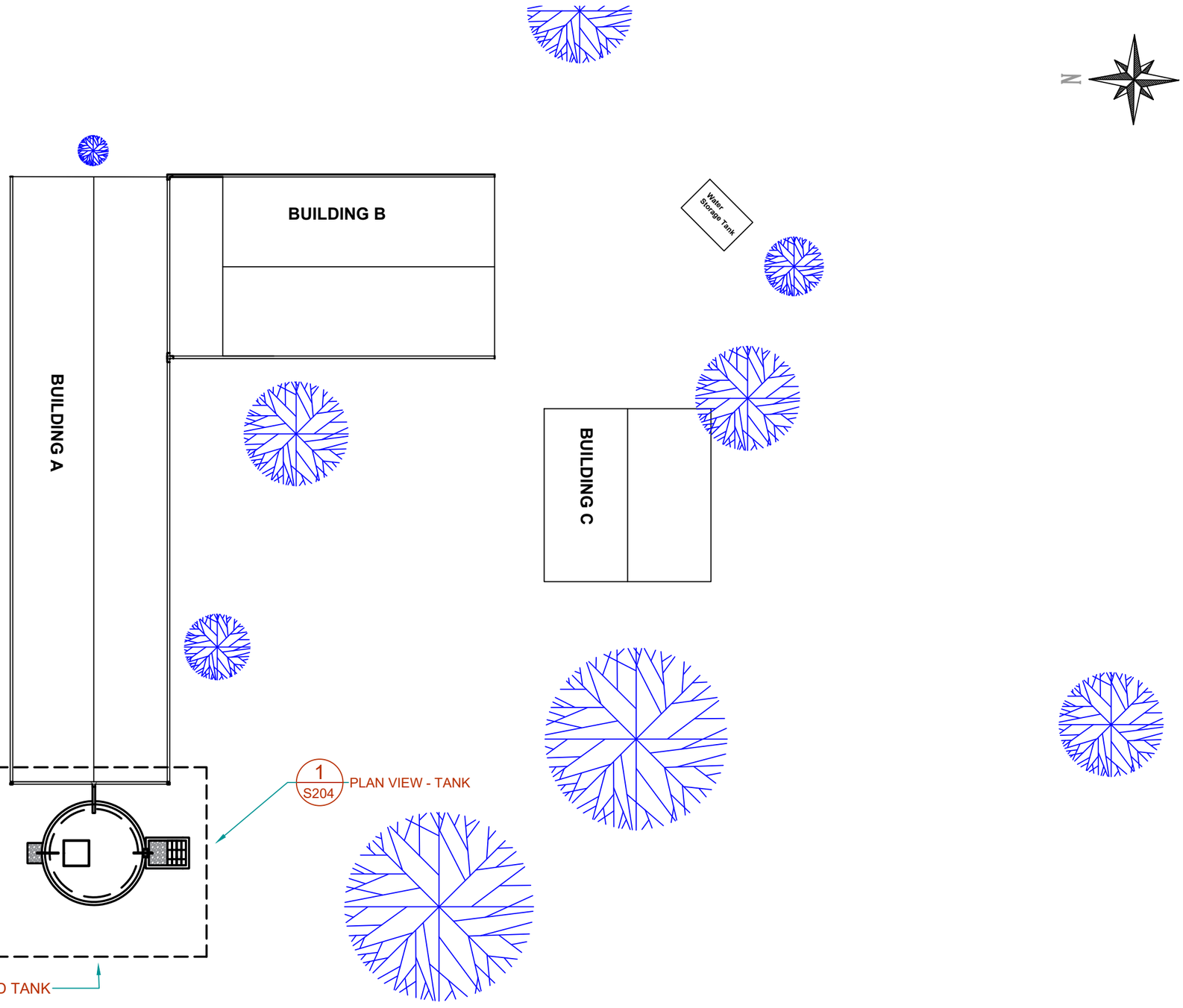
RAINWATER HARVESTING

SITE IMAGES

SCALE	N/A
DRAWN	FRK
CHECKED	--
DATE	01-03-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	S202



1 SITE PLAN

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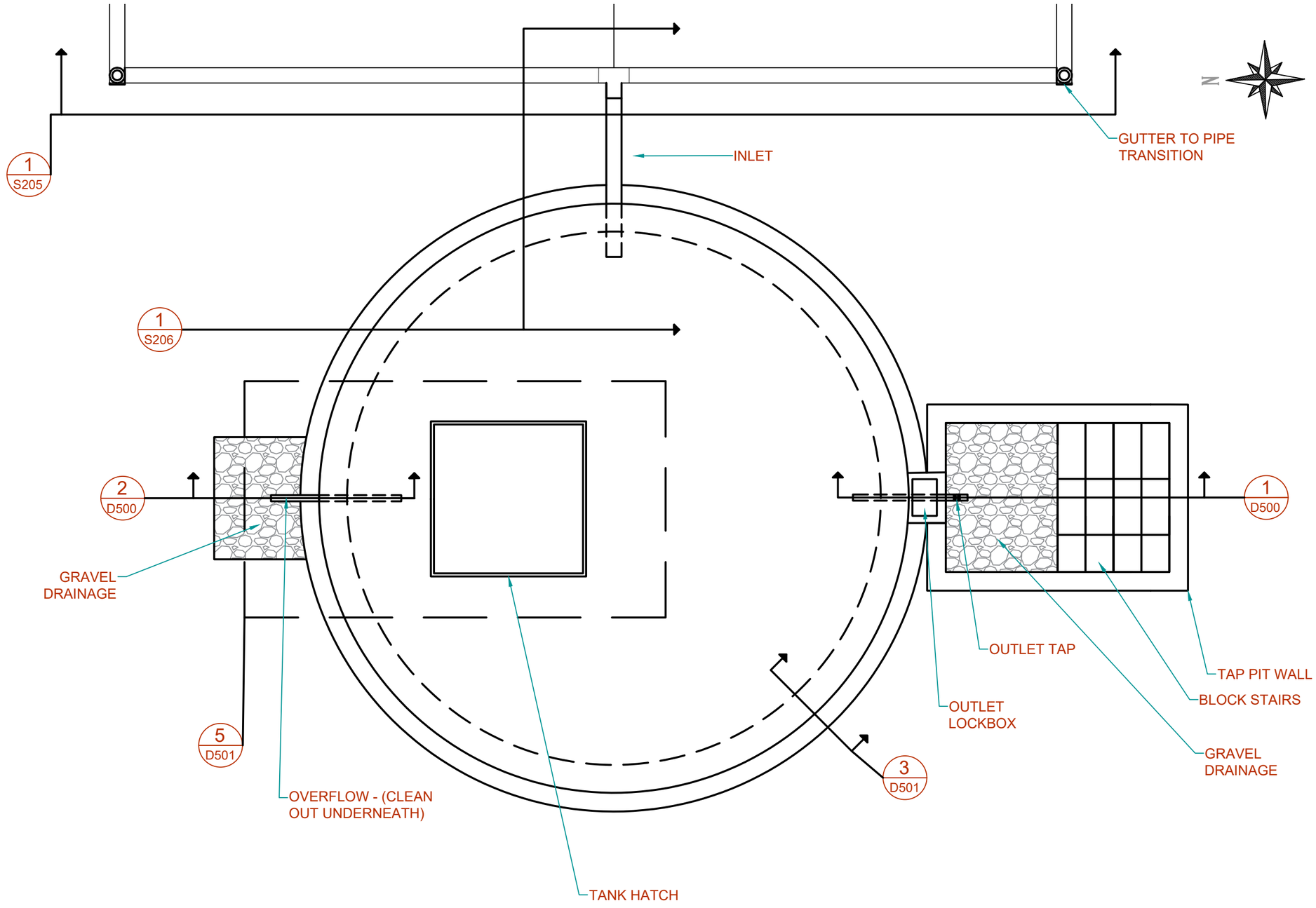
RAINWATER HARVESTING

SITE PLAN

SCALE	AS NOTED
DRAWN	FRK
CHECKED	--
DATE	04-07-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	S203



1 PLAN VIEW - TANK LAYOUT

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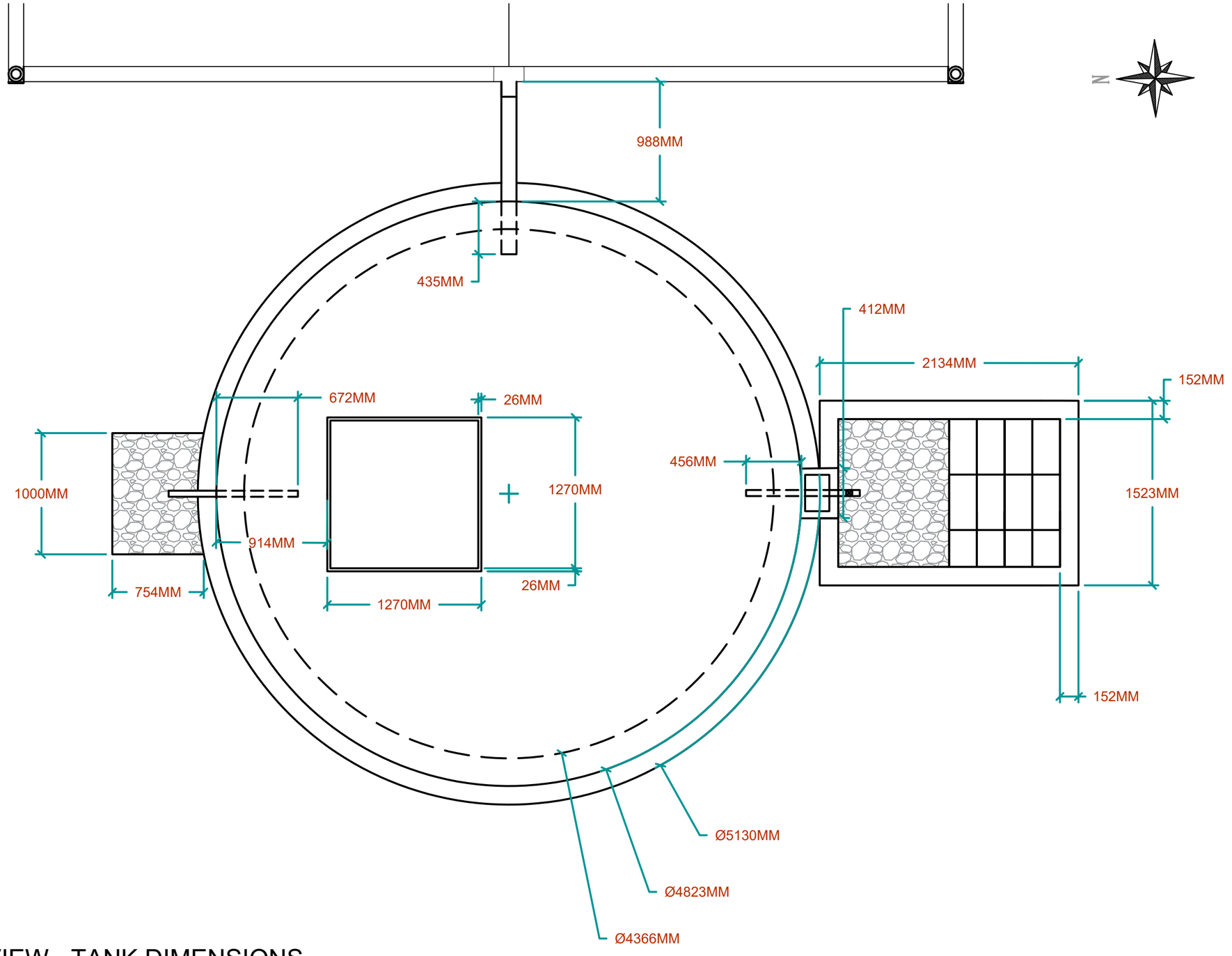
RAINWATER HARVESTING TANK LAYOUT
PLAN VIEW

SCALE	AS NOTED
DRAWN	FRK
CHECKED	
DATE	04–07–2019
REVISION	--
PROJECT	MPS–RWH–2018
DRAWING	S204



1 PLAN VIEW - TANK DIMENSIONS

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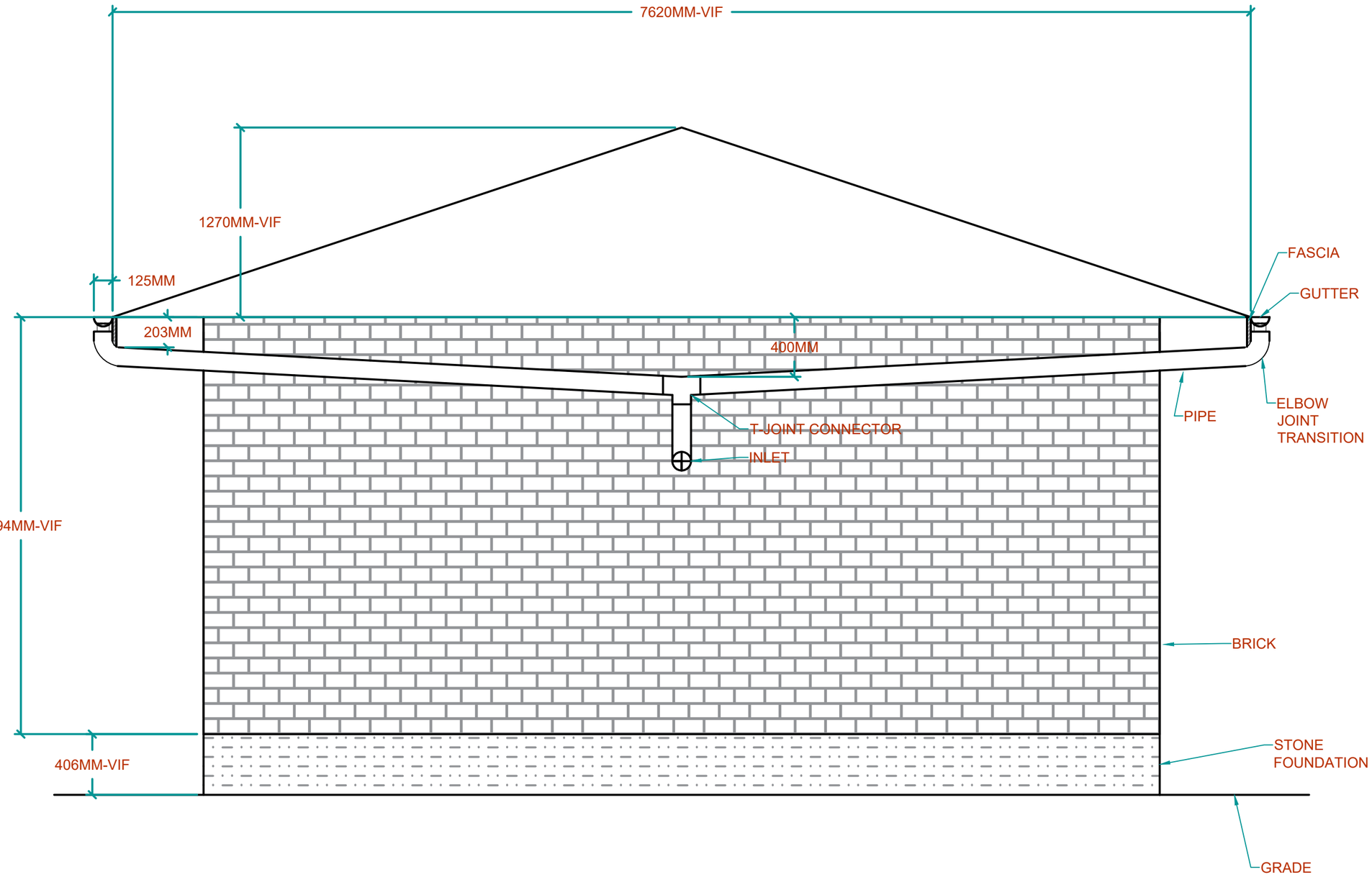
RAINWATER HARVESTING

TANK DIMENSIONS

PLAN VIEW

SCALE	AS NOTED
DRAWN	FRK
CHECKED	
DATE	04–07–2019
REVISION	--
PROJECT	MPS–RWH–2018
DRAWING	S204A



1 WEST SIDE OF BUILDING A ELEVATIONS

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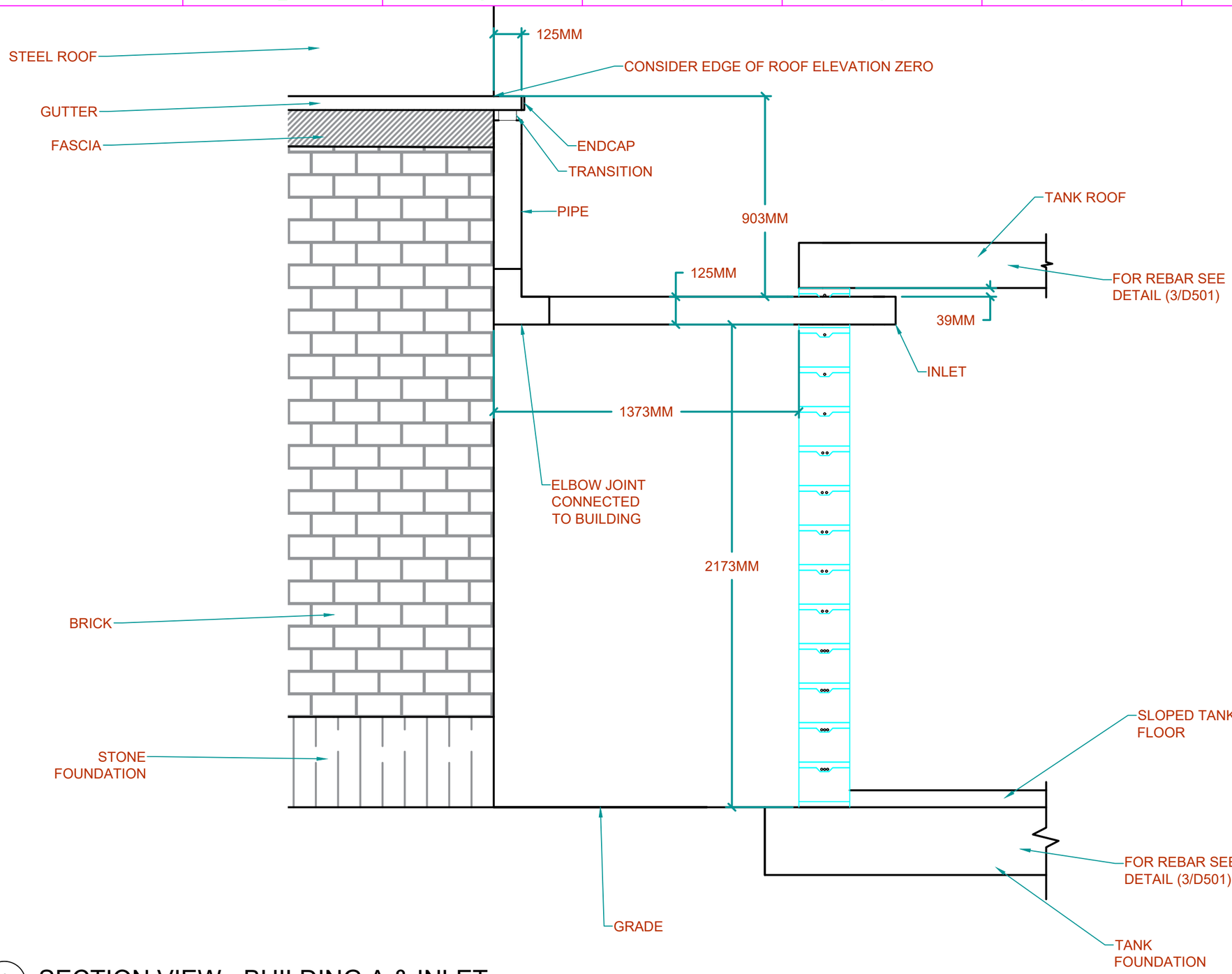
COLUMBUS, OH, 43210

RAINWATER HARVESTING

BUILDING A ELEVATIONS

SCALE: AS NOTED
DRAWN: FRK
CHECKED:
DATE: 04-07-2019
REVISION: --
PROJECT: MPS-RWH-2018
DRAWING: S205



1 SECTION VIEW - BUILDING A & INLET

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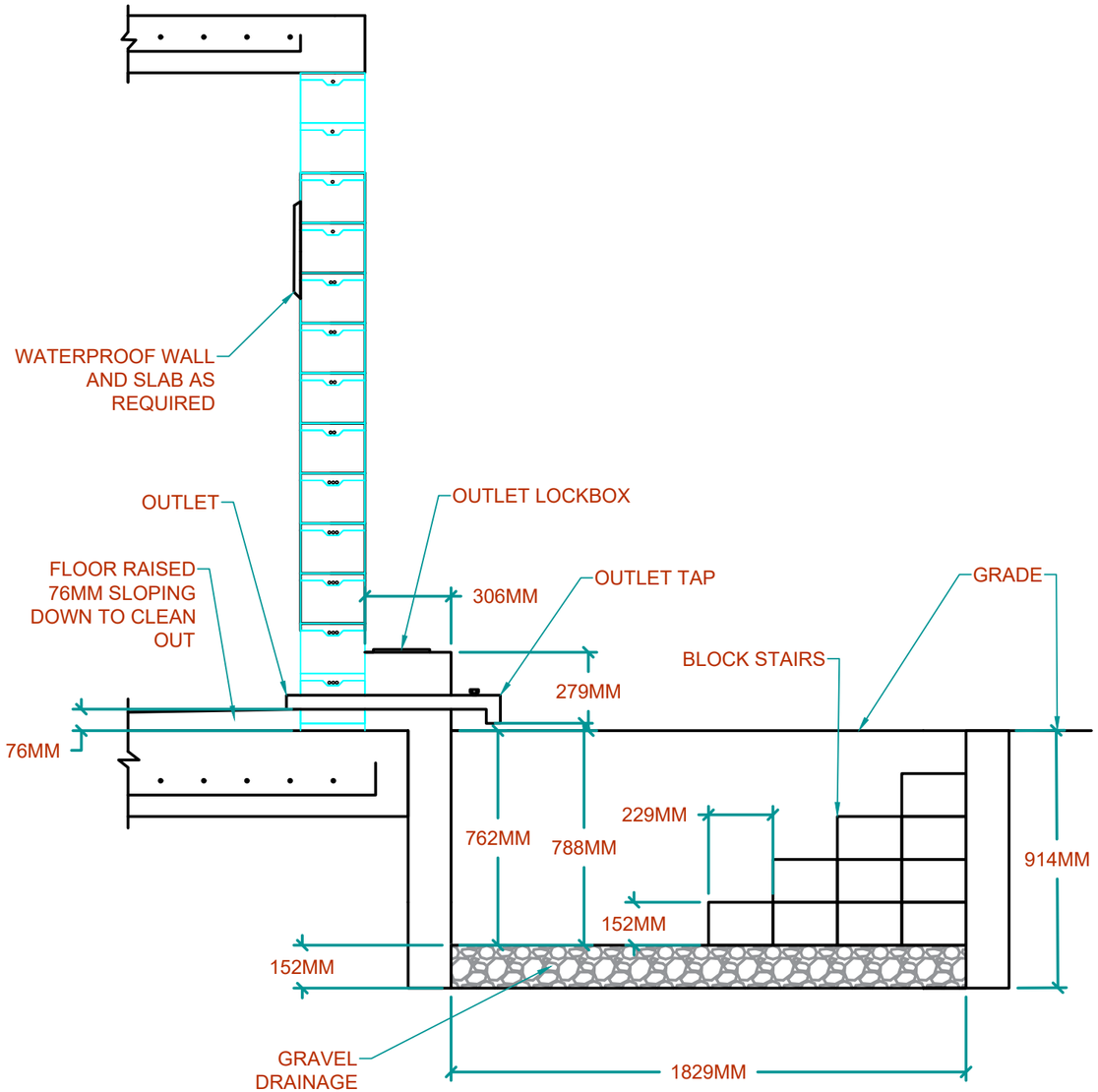
COLUMBUS, OH, 43210

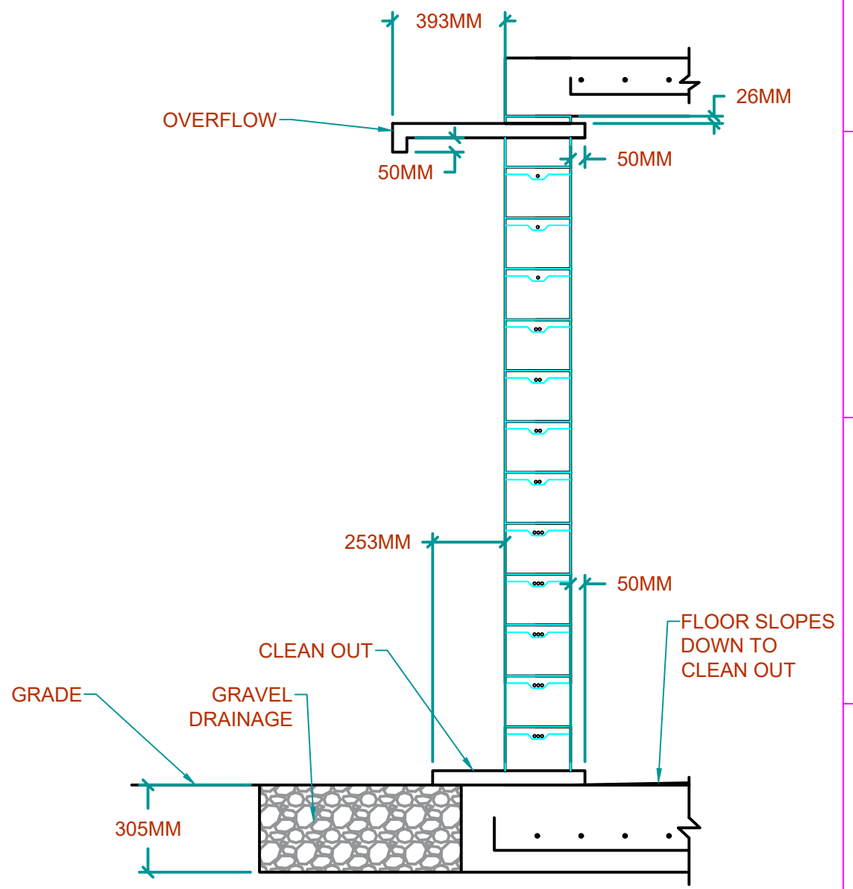
RAINWATER HARVESTING

BUILDING A & INLET

SCALE	AS NOTED
DRAWN	FRK
CHECKED	
DATE	04-07-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	S206



1 WALL SECTION - OUTLET & TAP PIT



2 WALL SECTION - CLEAN OUT & OVERFLOW

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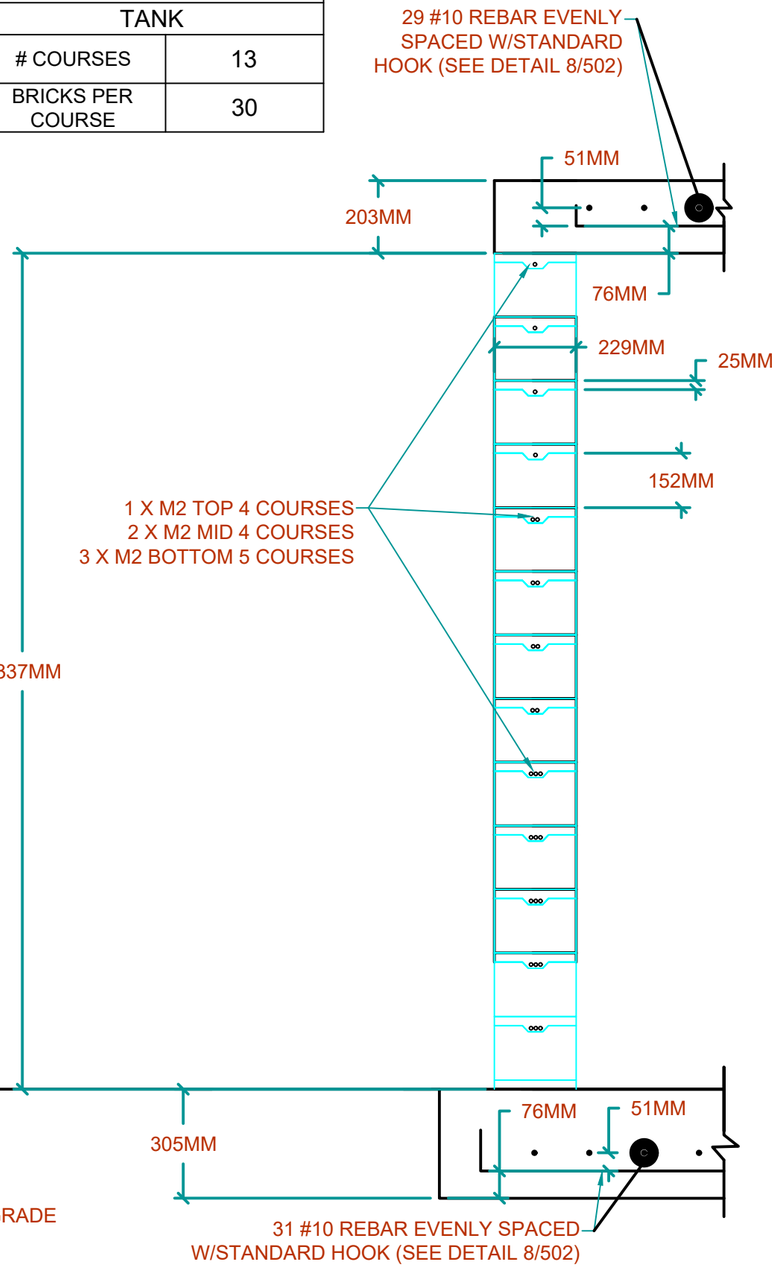
RAINWATER HARVESTING

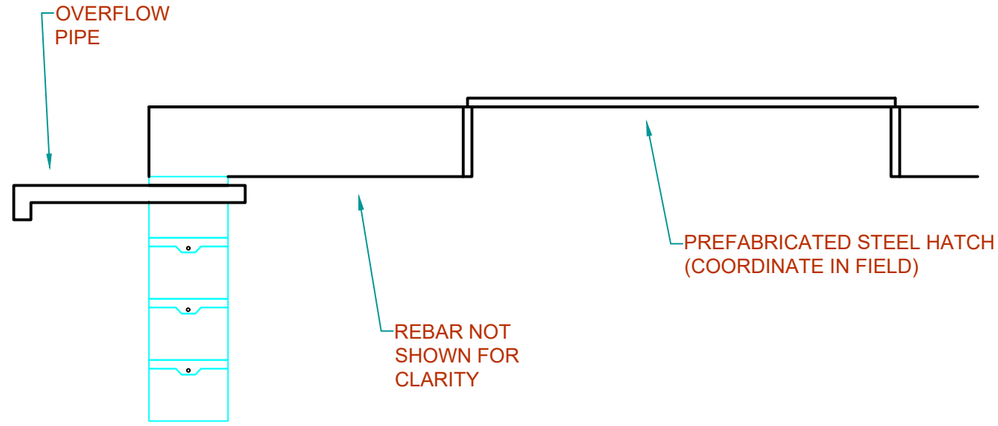
OUTLET AND CLEAN OUT DETAILS

SCALE	AS NOTED
DRAWN	FRK
CHECKED	--
DATE	04-07-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	D500

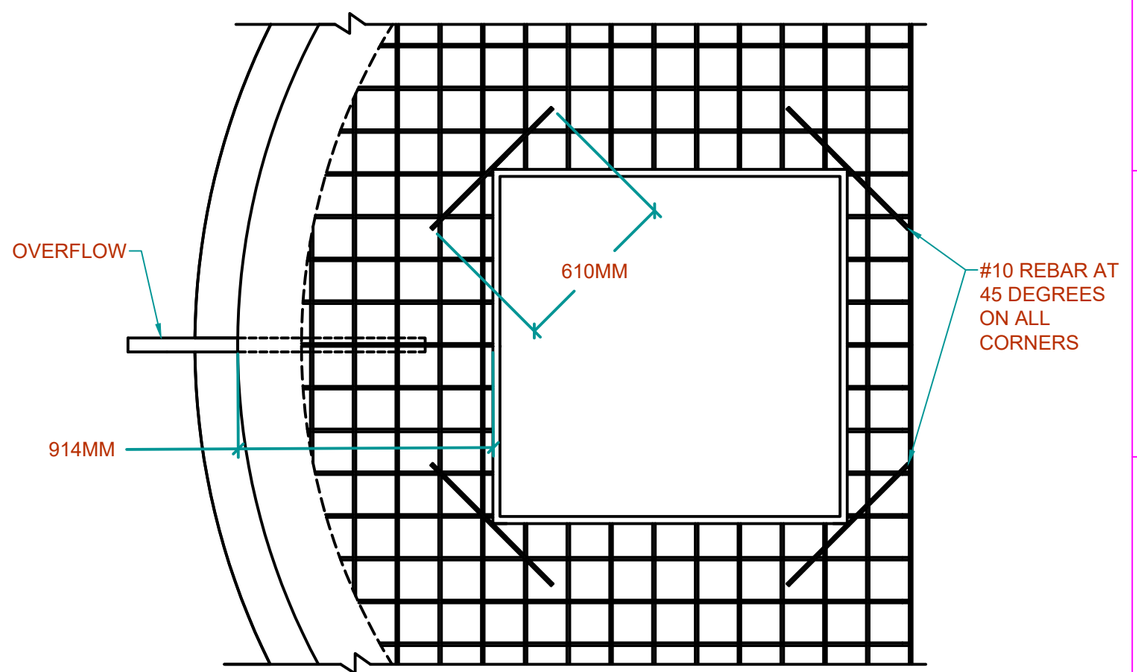
SOLID BRICK USAGE (VIF)	
TANK	
# COURSES	13
BRICKS PER COURSE	30



3 WALL SECTION - TYPICAL



4 ROOF HATCH



5 ROOF REINFORCEMENT AT OPENING

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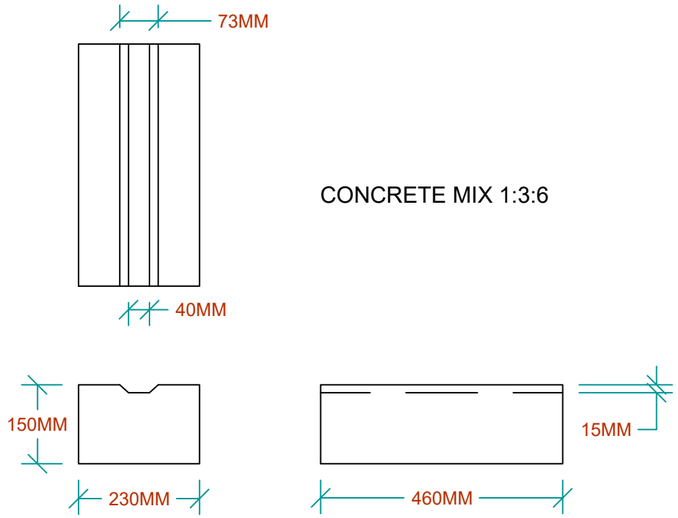
COLUMBUS, OH, 43210

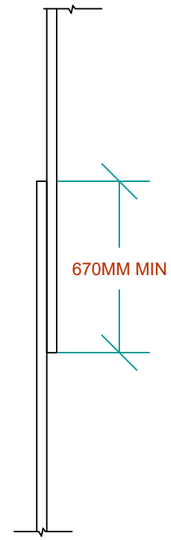
RAINWATER HARVESTING

WALL AND ROOF DETAILS

SCALE	AS NOTED
DRAWN	FRK
CHECKED	--
DATE	04-07-2019
REVISION	--
PROJECT	MPS-RWH-2018
DRAWING	D501

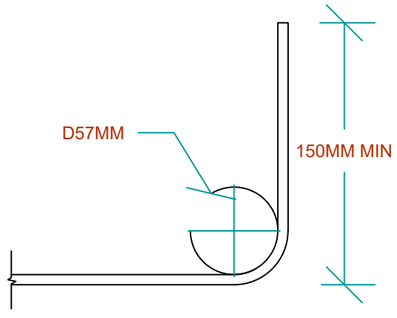


6 SOLID BRICK



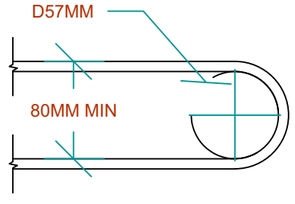
7 SPLICE LENGTH DETAIL

#10 BAR (11.7MM²)



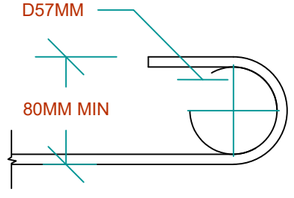
8 BAR BEND 90°

#10 BAR (11.7MM²)



9 BAR BEND 180°

#10 BAR (11.7MM²)



10 STANDARD HOOK

#10 BAR (11.7MM²)

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RAINWATER HARVESTING

BLOCK AND REBAR DETAILS

SCALE	AS NOTED
DRAWN	CMV
CHECKED	FRK
DATE	04–07–2019
REVISION	--
PROJECT	MPS–RWH–2018
DRAWING	D502

NOTES: GUTTER AND PVC

1. MATERIAL:
   1.1. USE 125MM OR 150MM HALF-ROUND GUTTERS OR APPROVED EQUAL.
   1.2. USE PVC PIPE AS PLANNED OR APPROVED EQUAL.

2. SEALANT: USE ON ALL GUTTER JOINERS/CONNECTIONS, END STOPS, OUTLETS, AND OTHER SEAMS AS REQUIRED FOR WATERPROOFING.

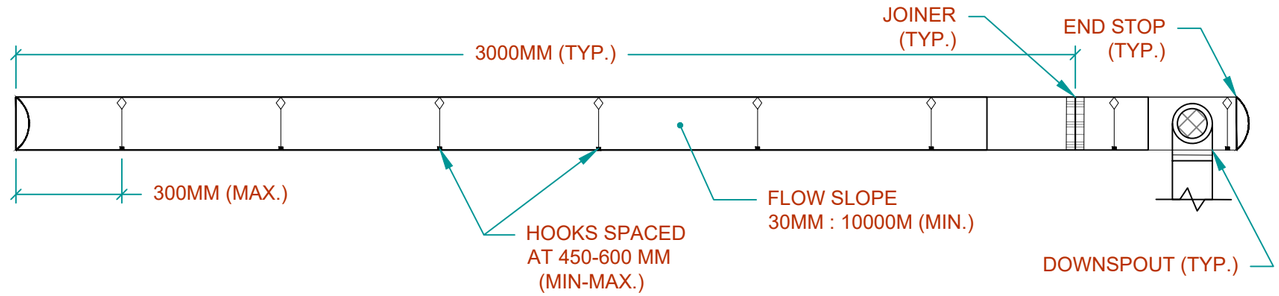
3. RAFTER BRACKETS: REQUIRED ON ALL PVC PIPE SPANS FOR SUPPORT (3000 MM MAX. SPACING).

4. FASCIA BRACKET/HANGERS:
   4.1. REQUIRED ON PLANNED GUTTER SPACED AT 450MM TO 600MM ON MIDSECTIONS AND 300MM (MAX) FROM END CAPS.
   4.2. TO BE INSPECTED BY ENGINEER PRIOR TO INSTALLATION.
   4.3. SPECIAL REQUIREMENTS MAY BE ADDED, DEPENDING ON EXISTING FASCIA STRUCTURE (SEE DETAIL FIG. 2/S102)

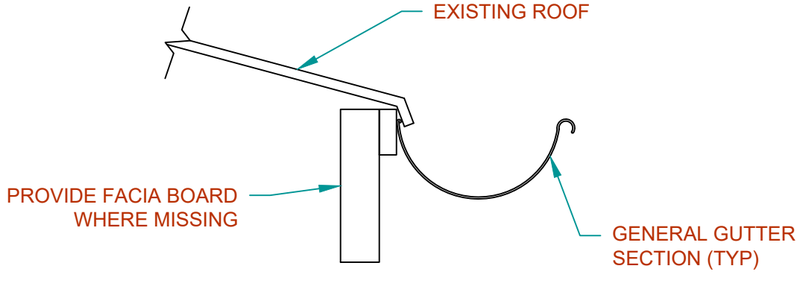
5. END STOPS: REQUIRED AT ALL GUTTER ENDS AS PLANNED.

6. SCREEN GUARDS: REQUIRED AT ALL GUTTER AND PIPE OUTLETS/INLETS OR OTHER OPENINGS.

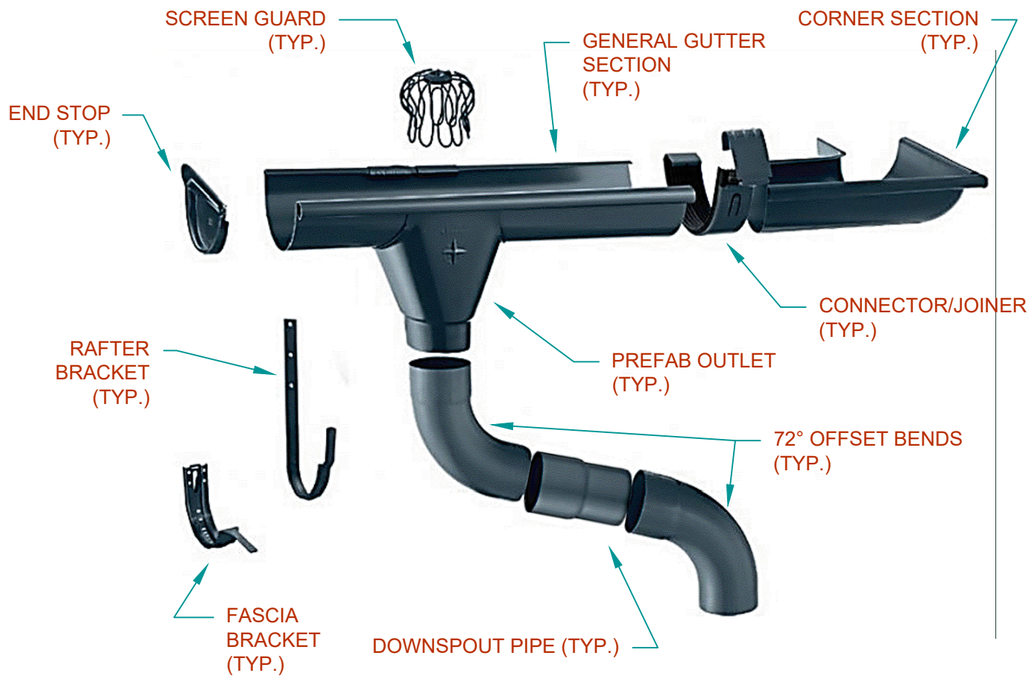
7. GENERAL INSTALLATION SHOULD BE FOLLOWED ACCORDING TO THE APPROVED MANUFACTURER'S SPECIFICATIONS AND INSTRUCTIONS.



11 TYP. HALF-ROUND GUTTER SECTION



12 FASCIA PLACEMENT



13 TYP. GUTTER/PIPE BREAKDOWN

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COLUMBUS, OH, 43210

RAINWATER HARVESTING

GUTTER AND PVC DETAILS

SCALE	AS NOTED
DRAWN	PJS
CHECKED	FRK
DATE	04–07–2019
REVISION	--
PROJECT	MPS–RWH–2018
DRAWING	D503