Columbia University – Engineers without Borders
Drawing Package

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Alternative Analysis

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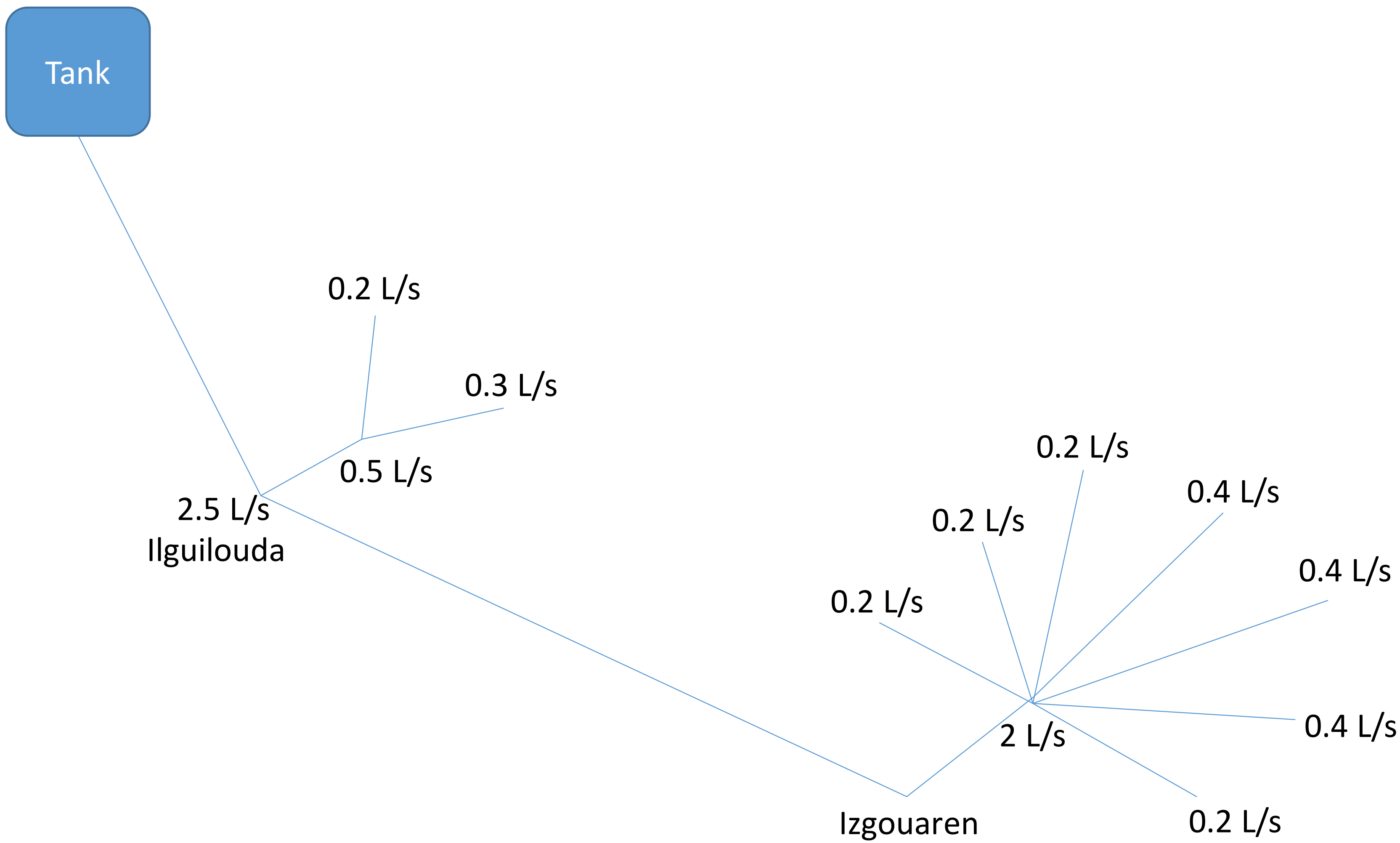
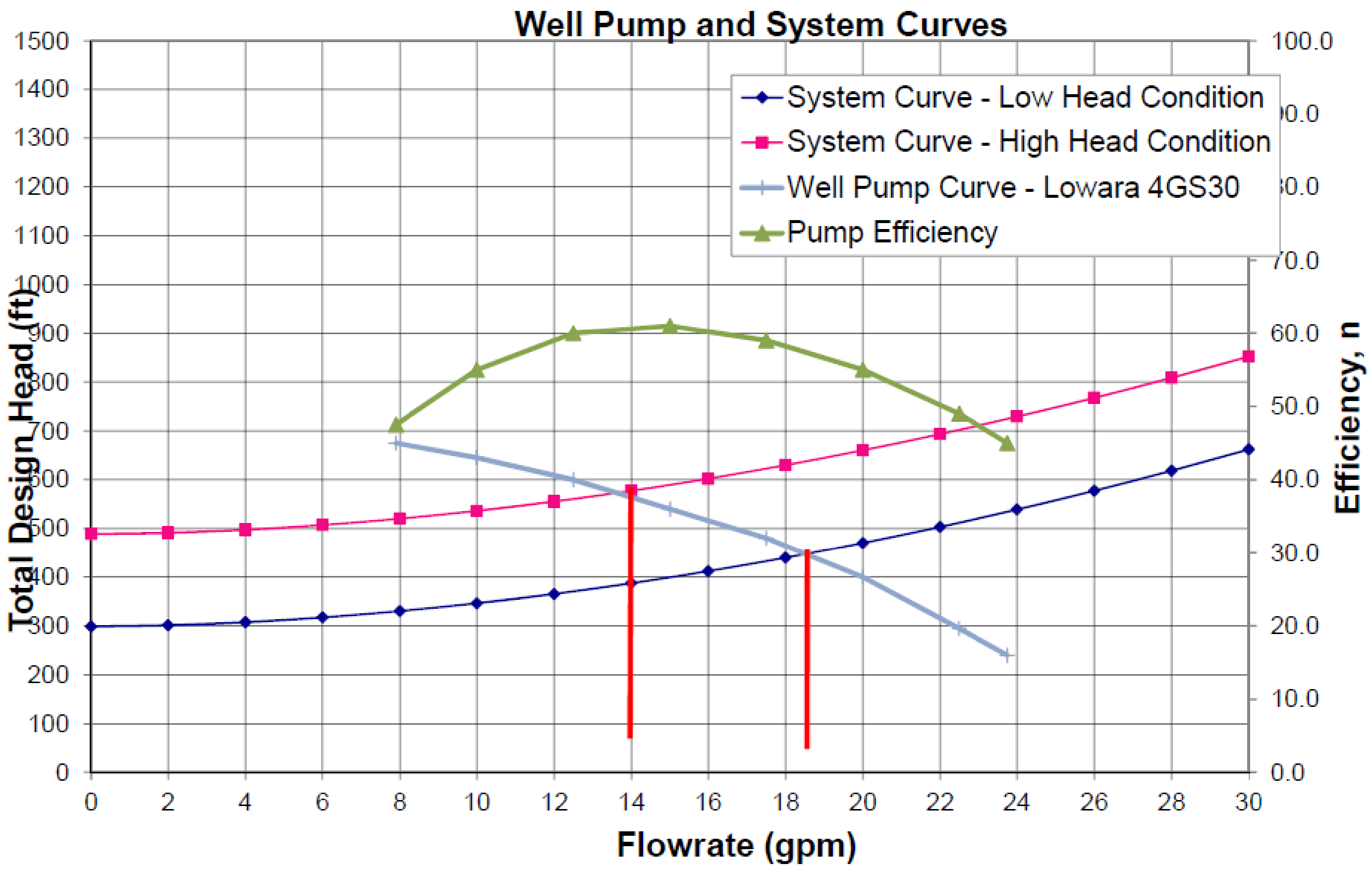
Starting with Daily Demands



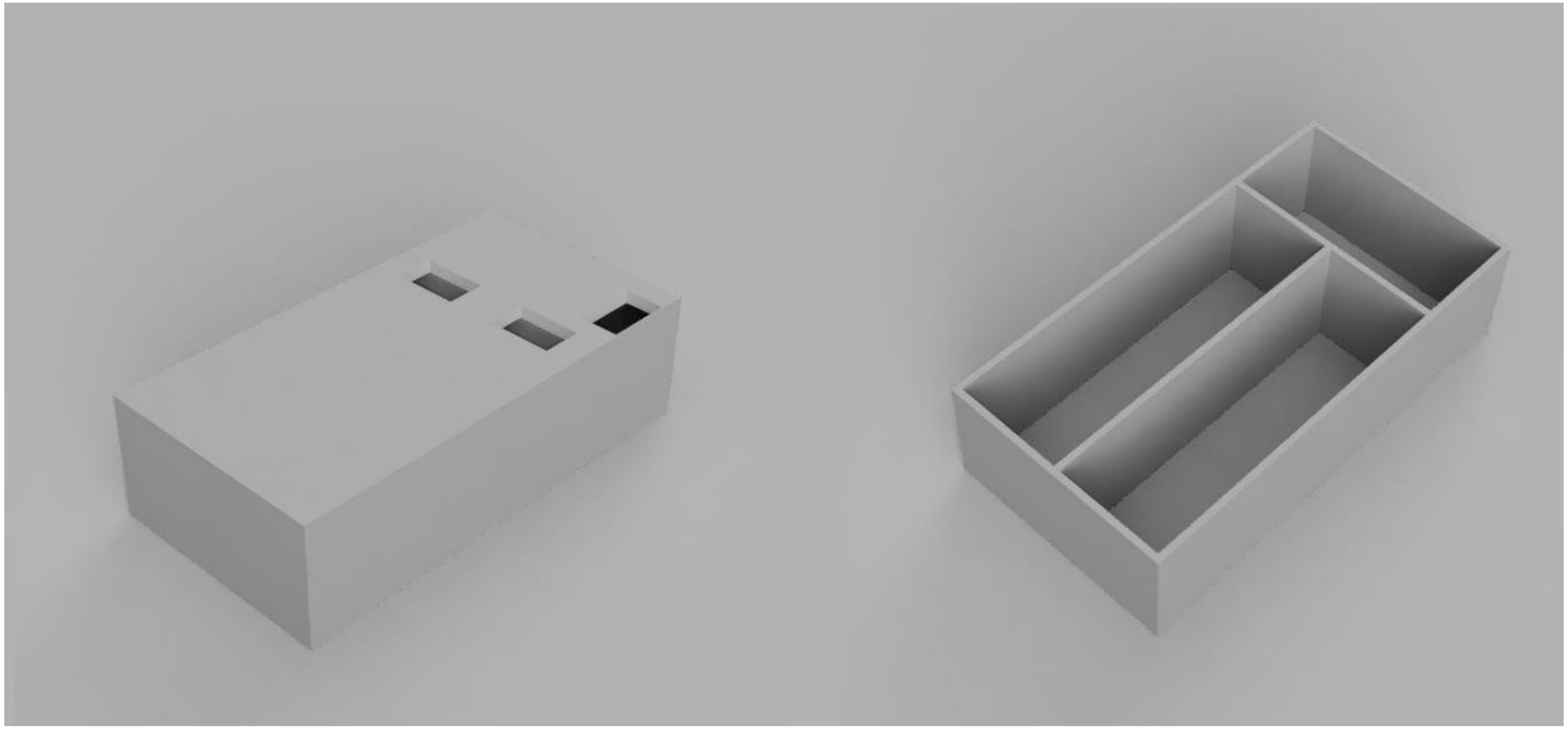
When designing this pipeline, we started with listening to the community. In 2015, working closely with a Peace Corp Volunteer, we took a community wide survey assessing daily demands and needs. The total daily demand for both villages (dwars) is 40,000 L. 10,000 L of which will be utilized by the 120 citizens of Iliguilouda. 30,000 L of which will be utilized by the 250 citizens of Izgouaren. Knowing this, we created a variety of taps at each community with varying flow rates. These taps could be run continuously for 4 to 5 hours a day in each community. Compression fittings produced in accordance with ISO 17885 : 2015 will be used for pipe networks within the village.

Next, we looked at the terrain of the region. After consulting the community and many iterations, a pipeline route was finalized. A well was drilled in January 2015 after consulting with a Professor of Hydrogeology at the University of Cadi Ayyad in Marrakech, Morocco. The following summer, a pump in the borehole was installed. The route imaged above is corresponding to a HDPE pipeline. HDPE was chosen due to its durability, cost, and its lack of joints. The total pipeline route is roughly 5.9 km long.

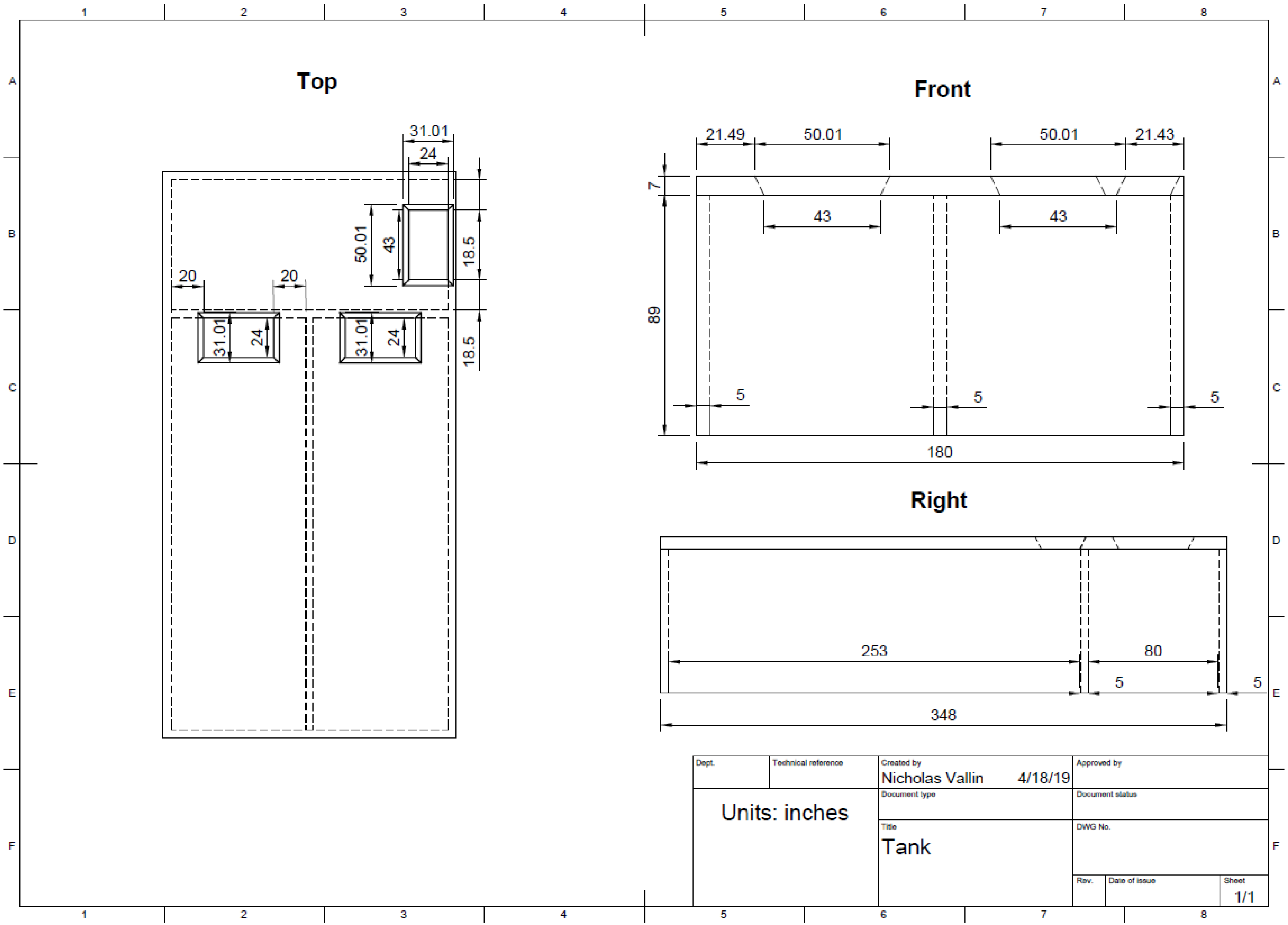
The pipeline is divided into two primary sections. A pumped and a gravity fed portion. The pumped system will bring water from the existing well up towards the highest point in the region which we labeled the Chateau site. A concrete foundation was laid in 2016 in anticipation for two 20,000 L tanks. SDR 11 pipe was chosen after applying a temperature derating factor 0.5 (1.3% for every C above 20 C) to satisfy a static lift of 48m and friction losses resulting from a pumped flow of 1.2 L/s. In 10 hours of pumping, 45 m^3 of water can be provided.



Our optimal operating range is between 15 to 21 GPM using a Lowara 4GS30 pump that has been installed. At the moment we are looking into a solar alternative as well.



A three-chambered monolithic reinforced concrete tank with a total capacity of 77,090L. Dimensions are 29 feet long, 15 feet wide, and 8 feet high. The first chamber (22,187 L) acts as a settling chamber with a detention time of 2.5 hours for particles to settle. When the water level rises, the second two chambers which serve as storage tanks will be filled. Each of these storage chambers will have 26,337 liters of water storage capacity. All three chambers can rise to a maximum height of 85 inches at which point a float will stop the flow. Walls are 5" thick, with ½″ rebar spaced vertically at 24" and horizontal ½″ rebar spaced at 16" in the walls. Please see Attachment I for complete structural calculations.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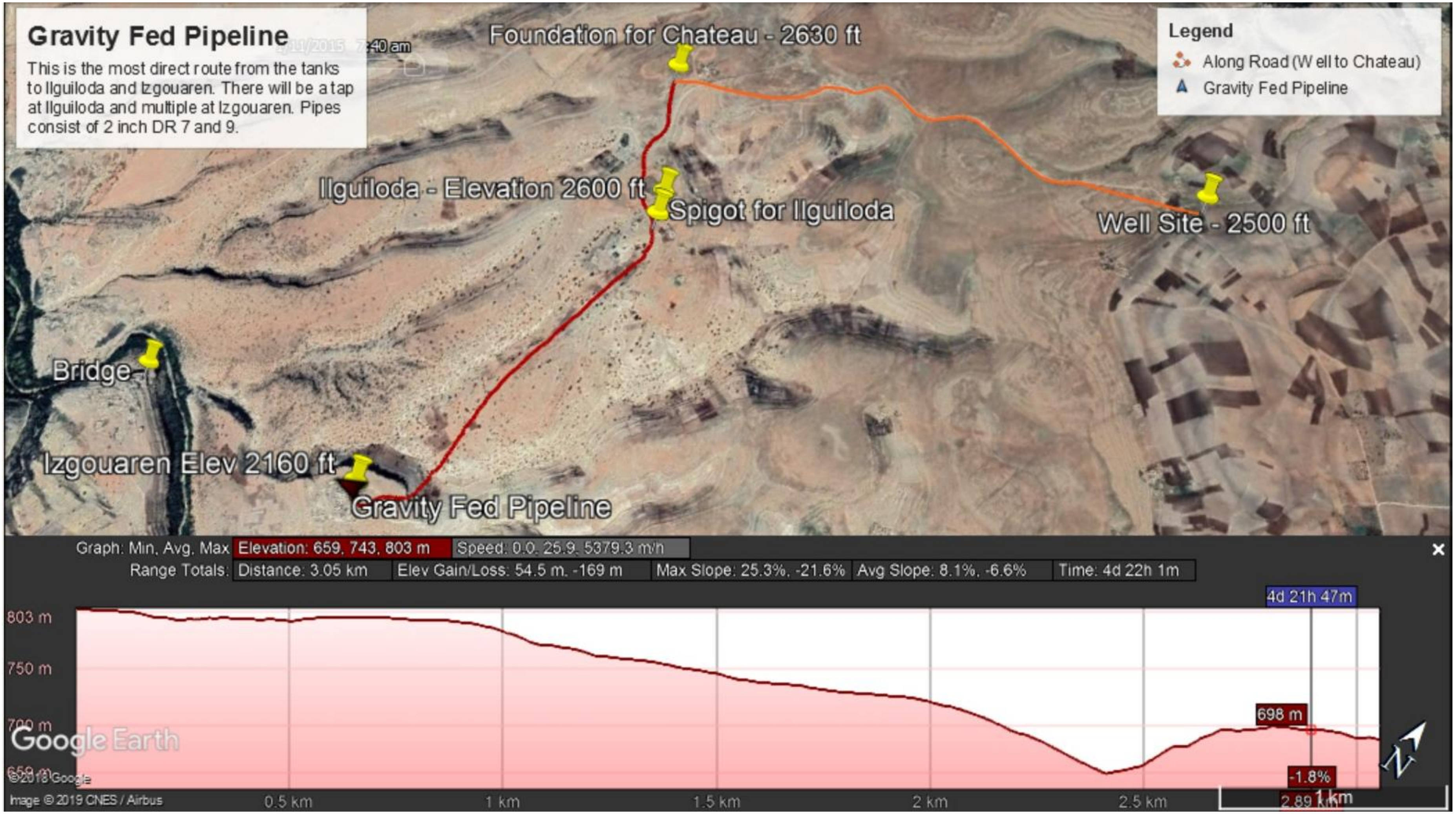
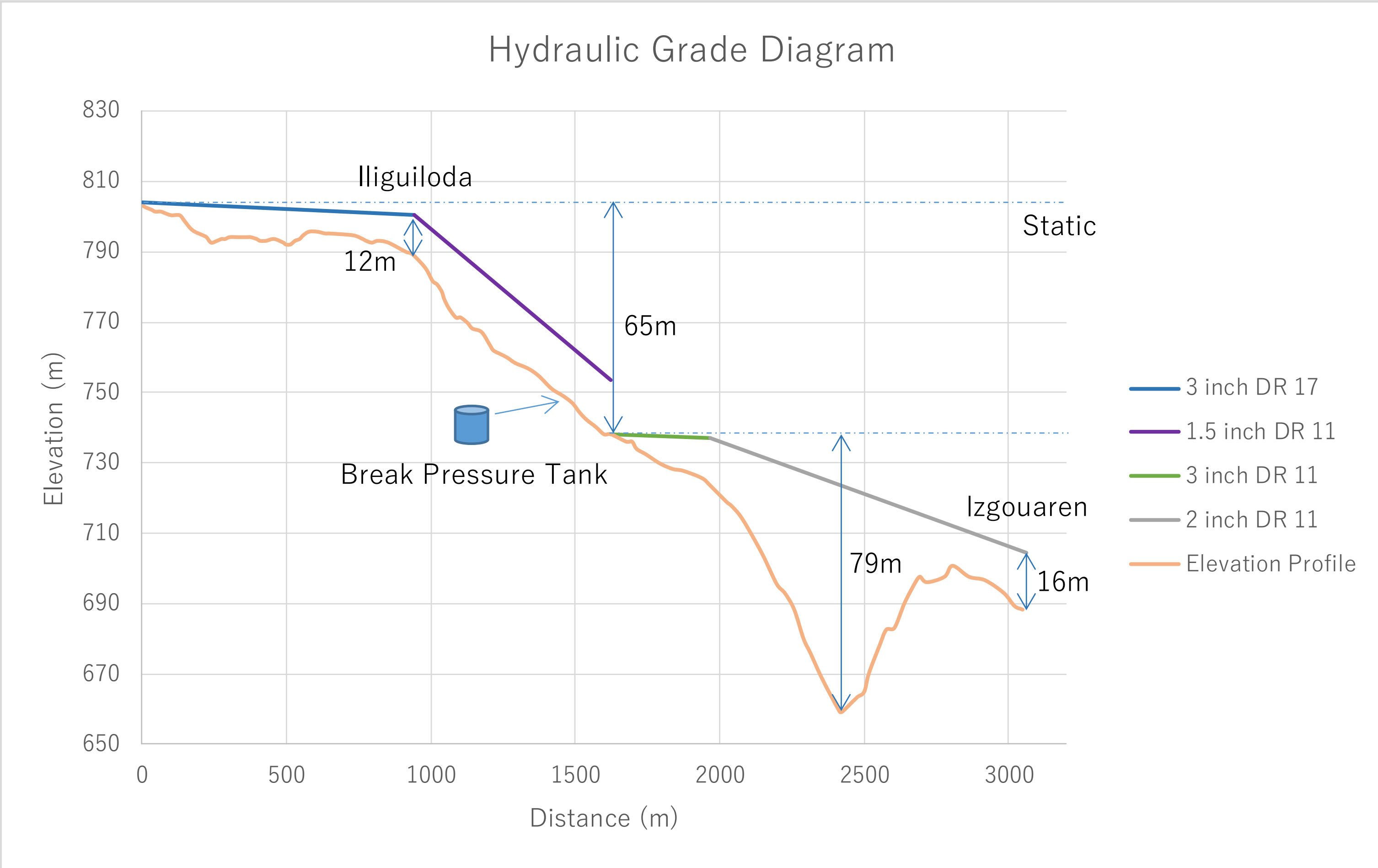
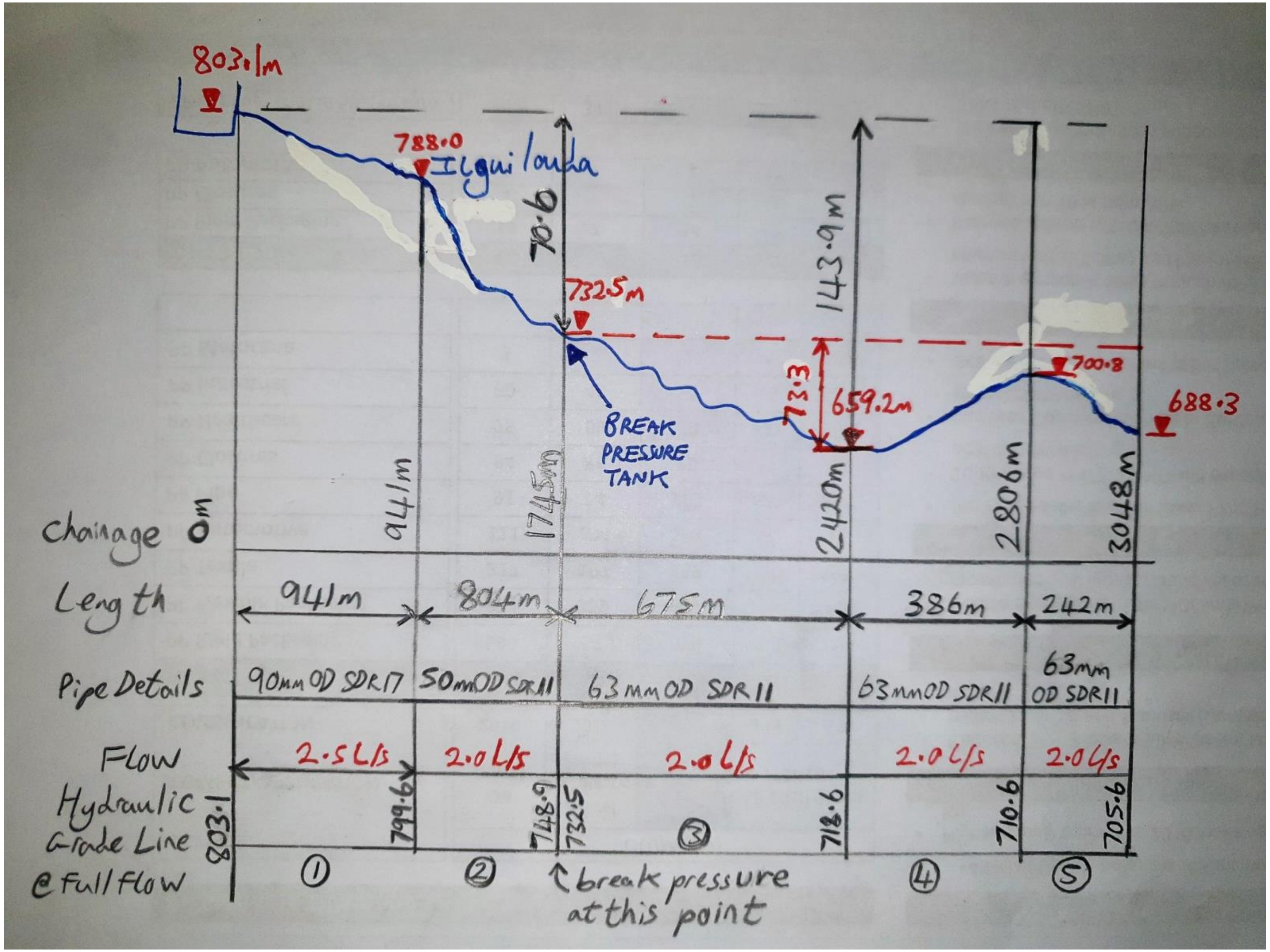


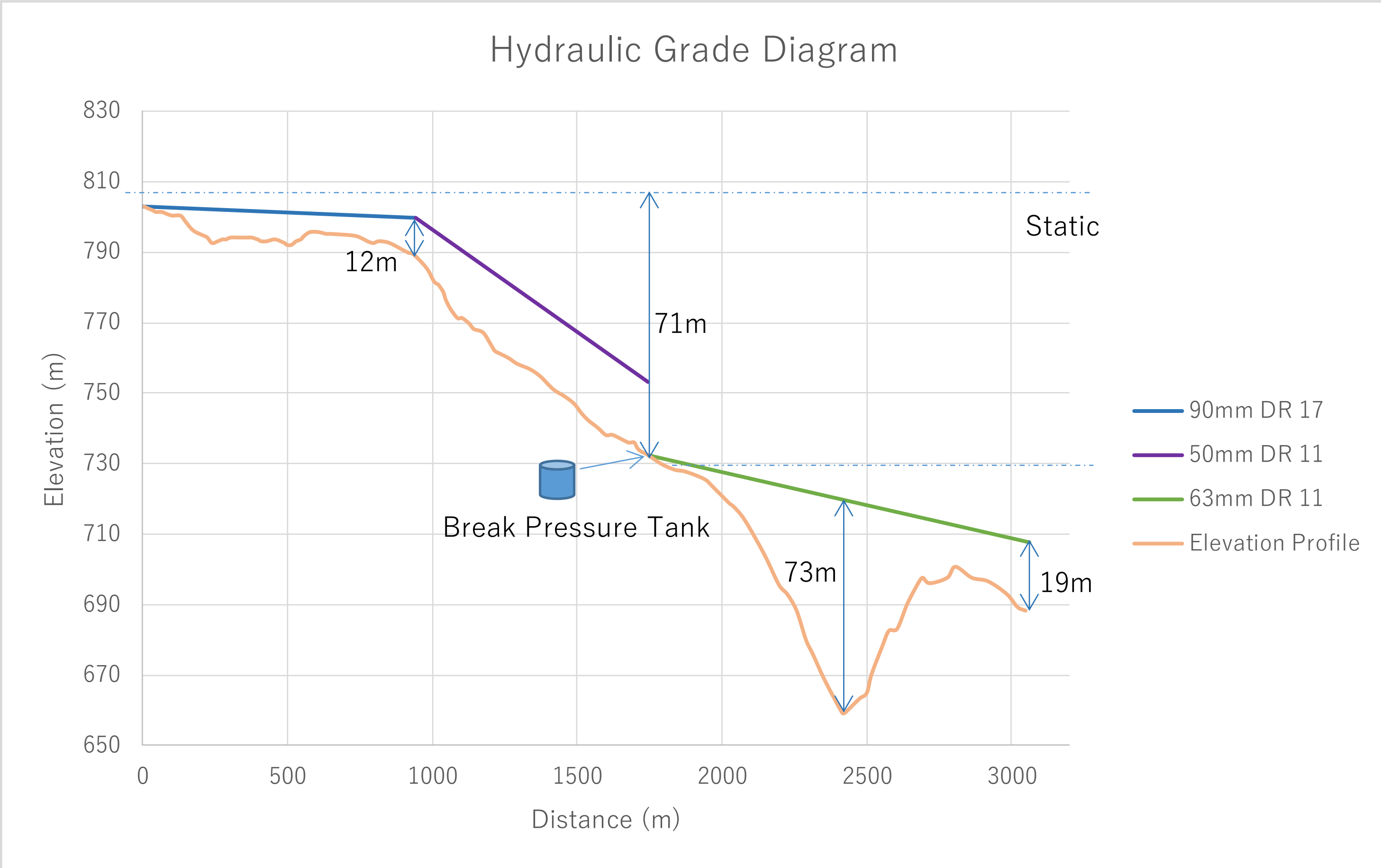
The gravity fed section starts from the highest point in the region named the Chateau site and flows into the two villages of Ilguilouda and Izgouaren. The accompanying elevation profile is provided above. A hybird of SDR 11 and 17 will be used for this section.



The elevation profile was extracted and a hydraulic grade diagram was calculated for the gravity fed portion of the pipeline. Referring to the water demands schematic on page 3, we design flows correspondingly and require at least 10m of head at each tap. The difference between the highest and lowest point (in the valley) requires a 1 m^3 break pressure tank to satisfy pressure requirements after de-rating. 3" SDR 17 is required to provide adequate head at Ilguilouda. The first reach is followed by 1.5" SDR 11. The third reach is an extendable 3" SDR 11 section, finished with 2" SDR 11.

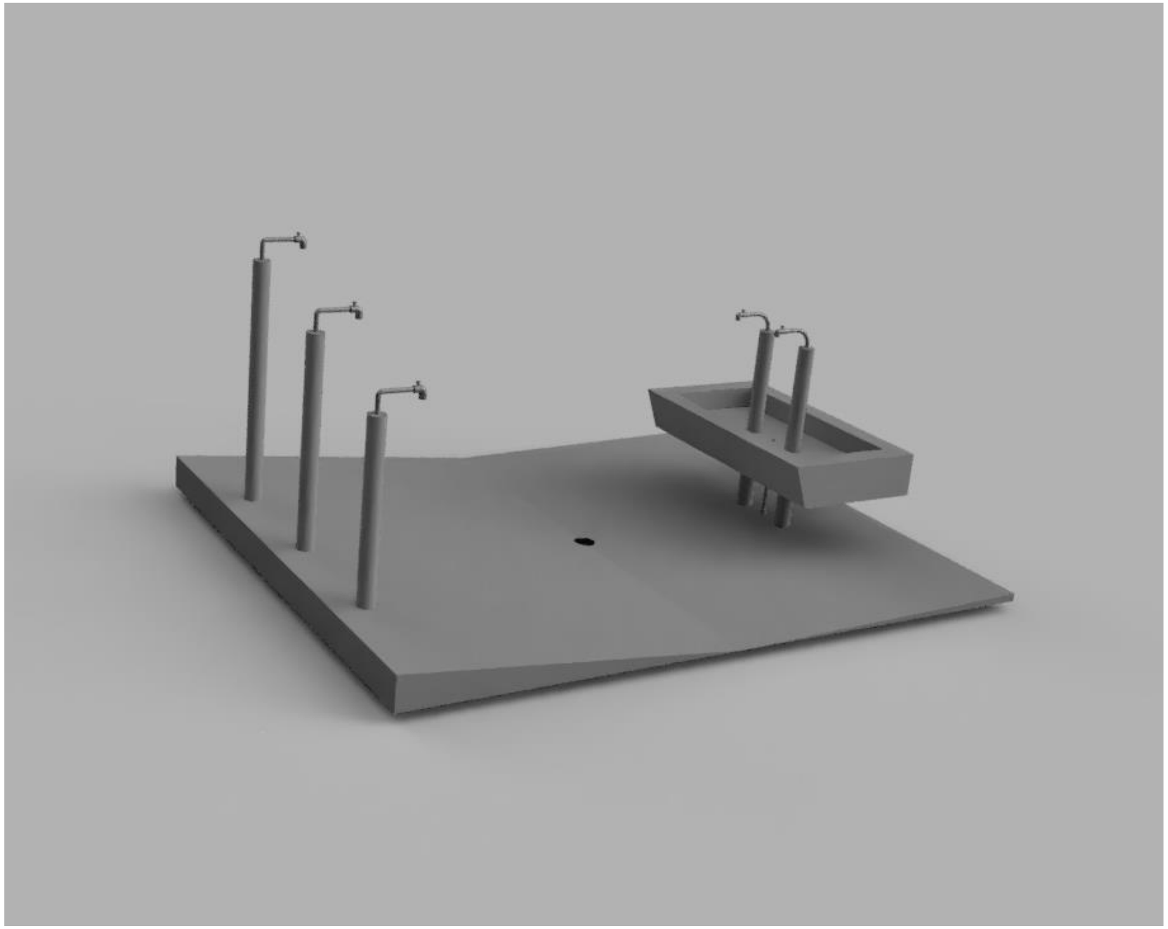


A sketch version of the hydraulic grade diagram for a metric pipeline if the material is PE100RC or PE100. Credit for this specific version goes to our mentor Mr. Andrew Wedgner of Lyondellbasell.

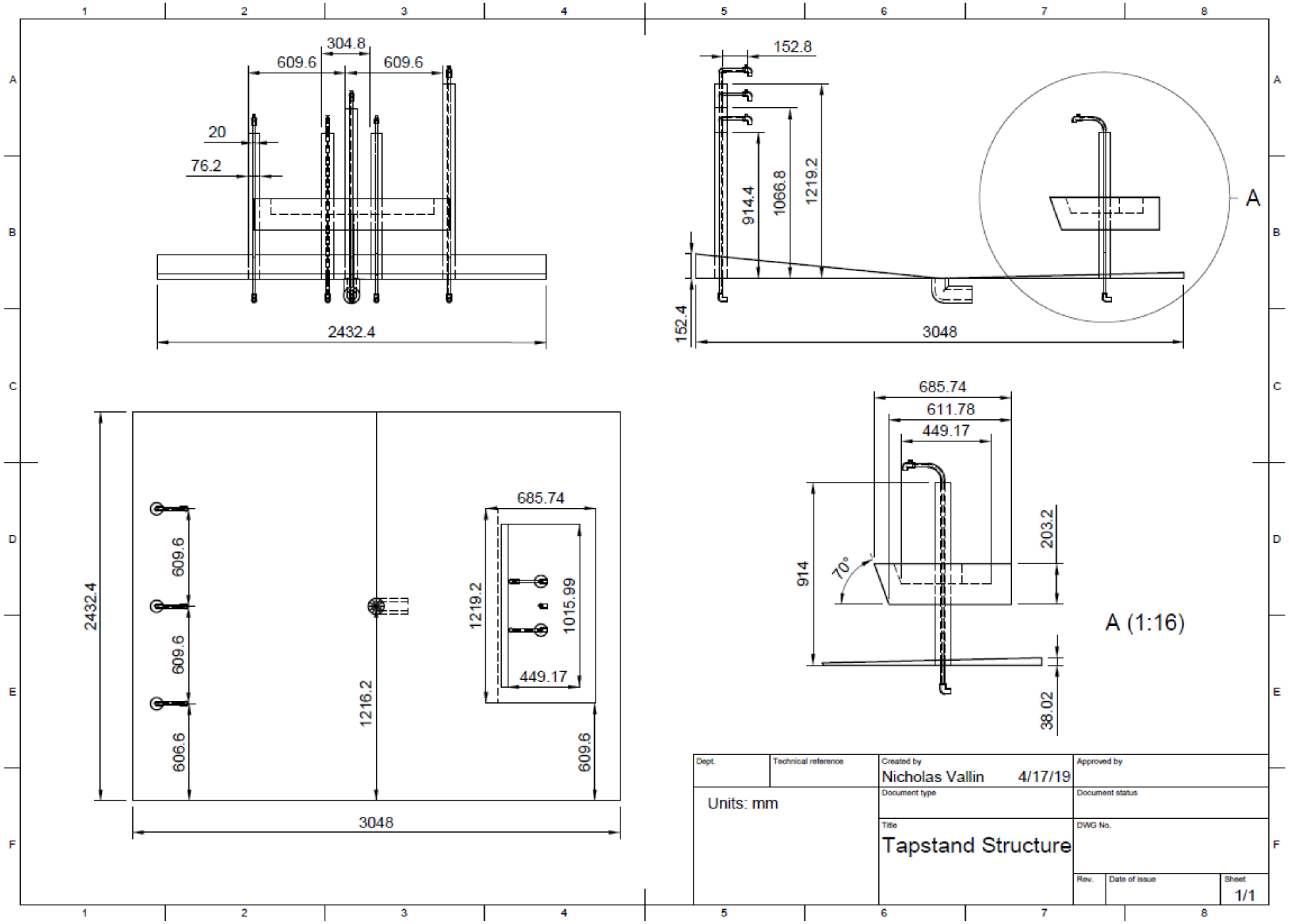


Similar to the PE4710 pipeline, here is a PE100RC or PE100 pipeline based on ISO standards whereas previously we used ASTM standards. This is simply a digitized version of the previous drawing.

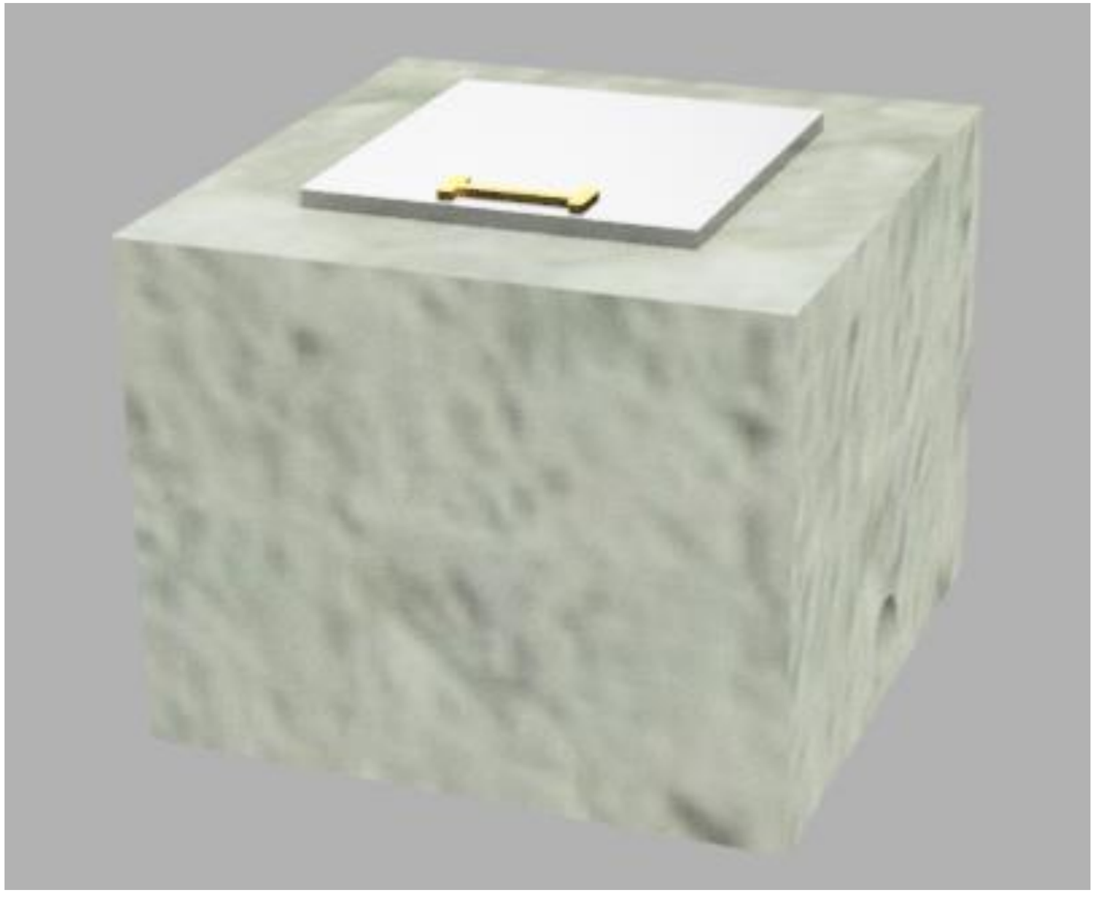
Communal tapstands (left) can have up to six spouts with controllable flow rates set by a globe valve secured in a locked valve box to prevent tampering. The base will be concrete and all fittings will be in metric and sourced locally. Just before the tapstands, we will fuse PE4710 with PE100 or use mechanical fittings such as MULTI/JOINT, iJOINT by Georg Fischer, or compatible flange adapters. Locations of the communal tapstand and individual tapstands will be consulted with the community.



Shown above is another iteration on the tapstand designs. The essence of this design is the simple tapstands. Tapstands will be constructed using larger diameter PVC molds. The piping would be placed inside, concrete poured into it, and a hot rebar would be used to slice the PVC off afterwards. Sinks or small basins could facilitate communal gathering and interactions, but will be done at a later trip. All water drains towards productive use such as irrigation for crops. The foundation would be concrete. We plan to have all tapstand materials be locally sourced. These tapstand designs allow us to be flexible while building these tapstands with community input and feedback.



Detailed dimensions of previous rendered design.



A break pressure tank will be installed roughly half way down the valley to renormalize pressure to atmosphere. The size is approximately 1 m^3 and will be made either of rock and mortar or reinforced concrete similar to the larger tanks at the Chateau. It will be locked on the top with a metal opening to provide entry. There will be a float valve, overflow pipe, inlet, outlet, and a gate valve to flush sediment. A gate valve will be installed before the inlet to allow for easy service. A detailed design will be shown in the upcoming implementation reports.