C2.04 – Horquetas Wastewater Treatment Plant

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FACT **Wastewater**

Problem Statement

The team will design a wastewater treatment plant for the town of Horquetas, Costa Rica. Some challenges for the project include the city's mountainous terrain, seasonal tourism, population growth, and affordability. The project will replace households' individual septic systems. The community needs a centralized system to stop septic tank effluents from being washed away by runoff.

Site Characteristics
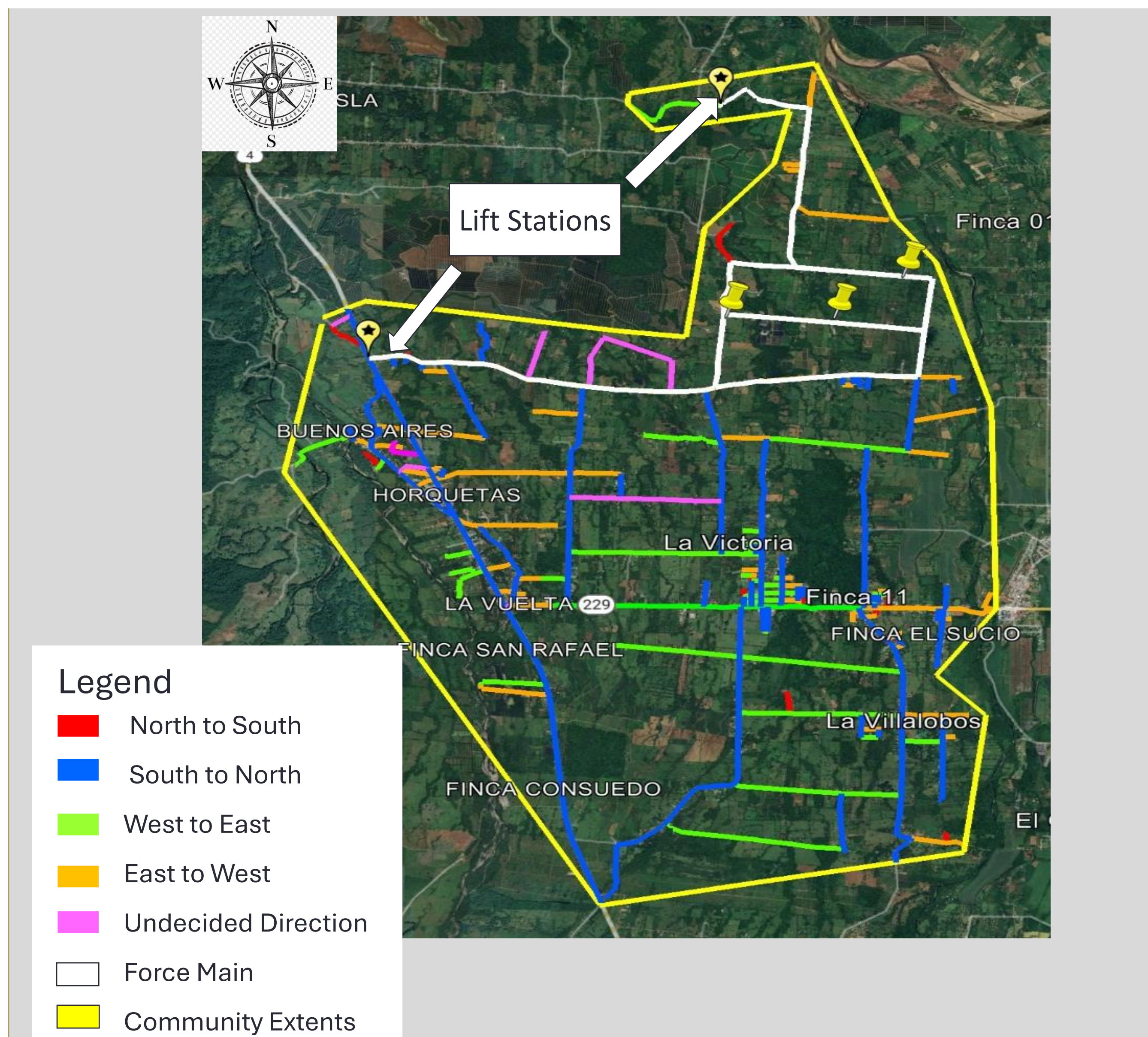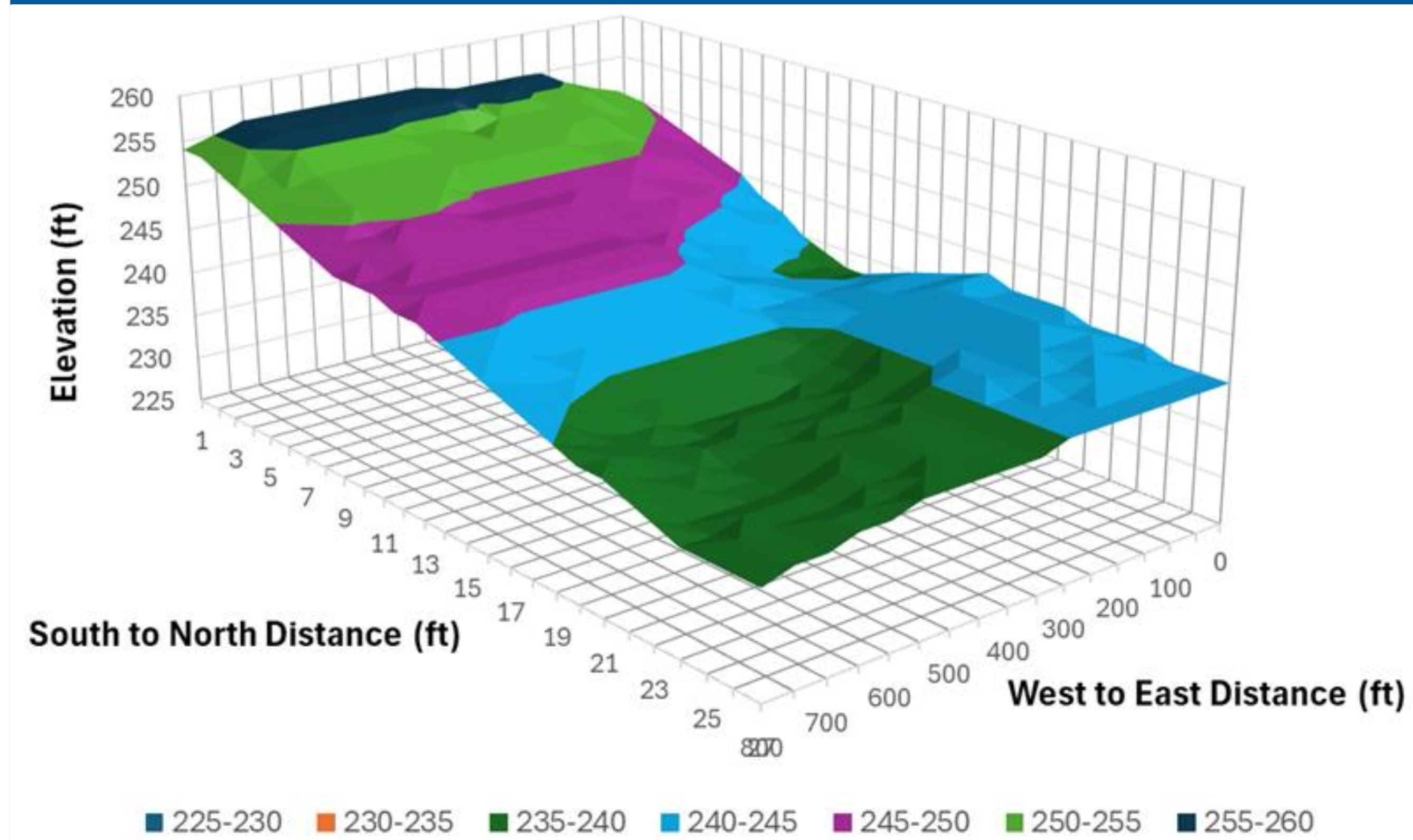
Hydraulic Element

Hydraulic Profile
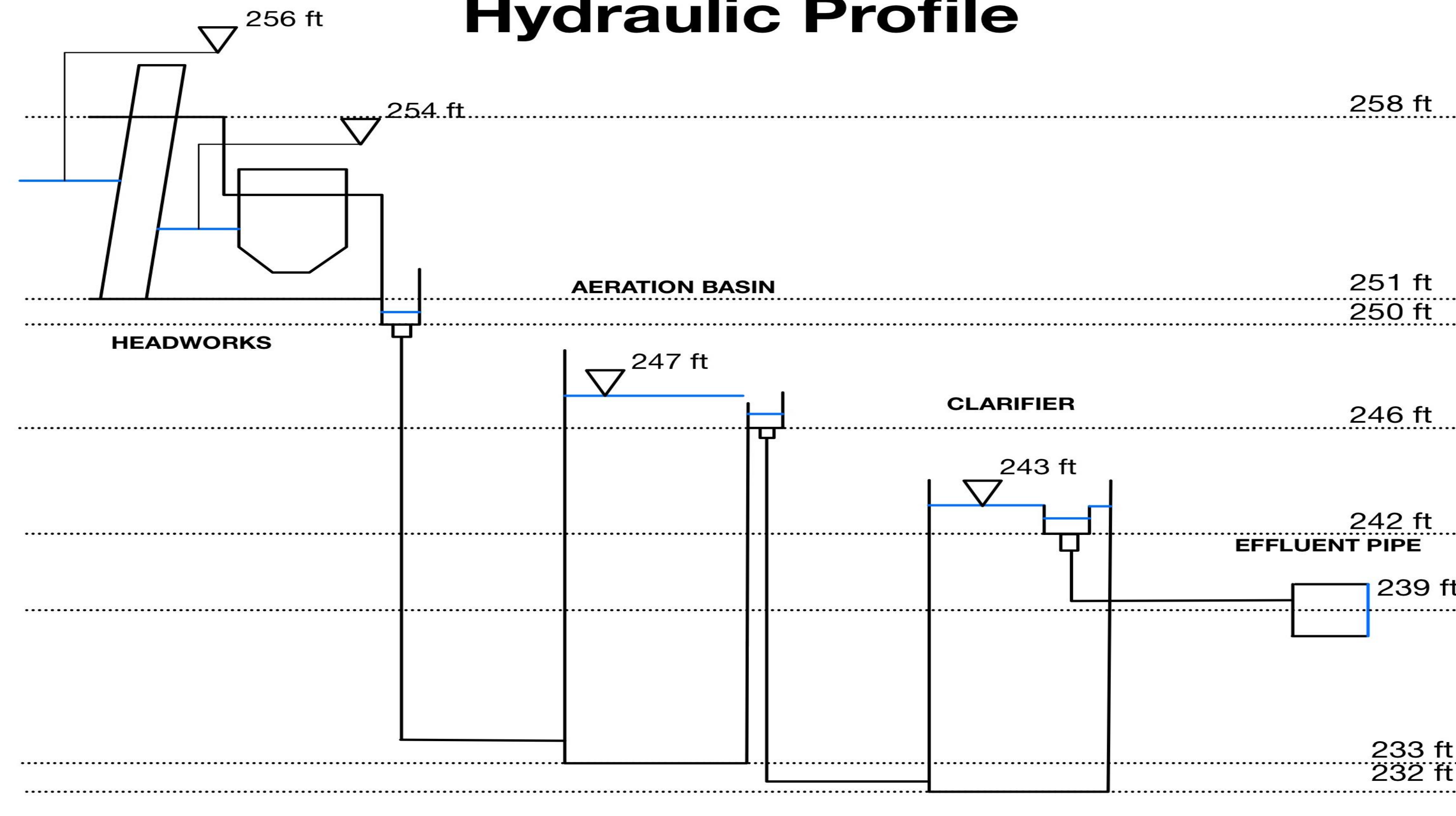
Bernoulli's Equation:

$$\frac{P_1}{\gamma_w} + z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma_w} + z_2 + \frac{V_2^2}{2g} + h_L \qquad z_1 = z_2 + h_L$$

P= pressure V= velocity g= gravity acceleration

z_1 = WSE at Point 1
z_2 = WSE at Point 2
h_L = Total Head Loss

Structural Element

Concrete Mix Design

Component	28-day f'c (psi)	Max Water-Cement Ratio	Maximum Size Aggregate (in)
Bar Screen	4000	0.40	3/4
Grit Removal	5000	0.38	3/4
Aeration Basin	4000	0.40	3/4
Clarifier	4000	0.40	3/4
Storage Tank	5000	0.38	3/4

Type ll and V Portland Cement were considered viable options for our component mix designs as they are sulfate resistant, mitigating possible sulfate attacks from wastewater and soil. Fly ash is also a recommended additive in our mix designs to reduce permeability. Additional admixtures such as corrosion inhibitors, chemical resisting inhibitors, and abrasion resistors were added in certain component mixes to help with their respective challenges.

Sustainability

ENVISION SILVER

Submitted Score Information

Credit Category	Applicable	Submitted	Percentage
Quality of Life	156	54	35%
Leadership	182	65	36%
Resource Allocation	196	67	34%
Natural World	170	68	40%
Climate and Resilience	170	56	33%
Total	874	314	36%

Life Cycle Cost Analysis

Using a design period of 50 years with 4% discount rate and referencing bids from contractors to build the similarly sized WWTP in Kyle, Texas, FACT estimates the following:

Collection System Construction = $18 million
Construction of Horquetas WWTP = $30 million
50-Year Operation & Maintenance = $75 Million
Rehabilitation = $1.4 million
Salvage Value = $4.7 million

Net Present Value, $NPV = 48 + 75 + 1.4 - 4.7 = \textbf{\$119.7 Million}$

Constraints & Standards

- 30 Texas Administrative Code (2020).
- ASCE Manuals and Reports on Engineering Practice No. 60
- ACI 318-19
- ACI 350-06-1
- Effluent Wastewater Requirements