Stormwater Utilization on NAU Campus

MADI MARCOLINA, DORSHANNA COOLIE, JIAYU ZHANG

CENE 476C

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Project Understanding

- Client: Jon Heitzinger (Associate Director of NAU Utility Services)
- Technical Advisor: Jeffery Heiderscheidt (CECMEE Lecturer)
- Location on Northern Arizona University (NAU): Science and Health Building (SHB)
- Purpose: To utilize the collected and stored stormwater from the three detention tanks near SHB to reuse for the heating & cooling plant and irrigation
- Rainwater harvesting: capture, storage, and reuse of stormwater

Figure 1. Project Location SHB [1]

Location of Detention Tanks

Table 1: Detention Tank Parameters

Tank Number	Volume (ft^3)	Volume (full) Gal.
1	7,917	59,222
2	7,917	59,222
3	1,005	7,520

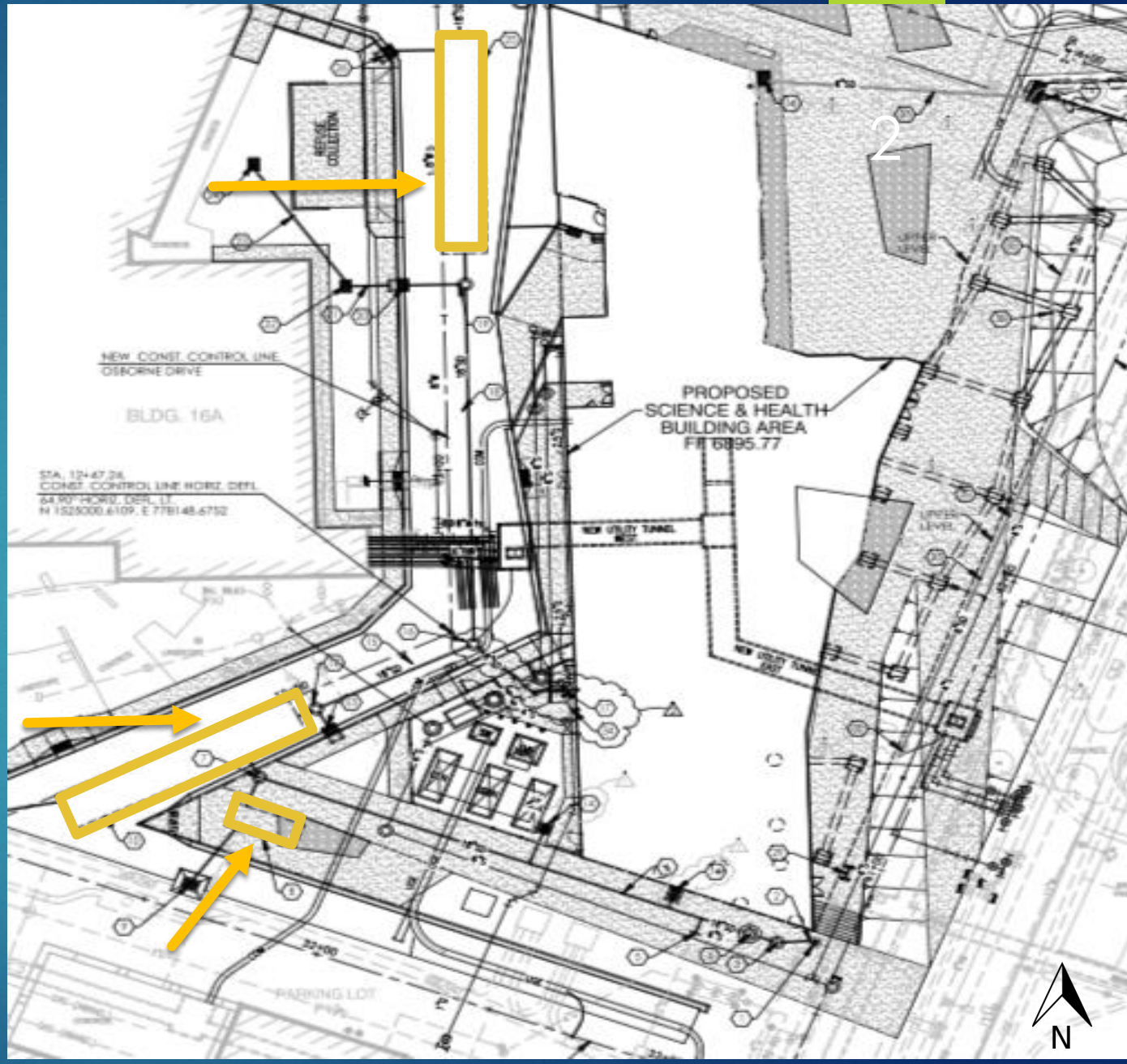


Figure 2. Detention Tank Location [2]

Project Background

- Heat and Cooling Towers
- Irrigation Location

Figure 3. Heating and Cooling Plant (West View)
Taken by: Dorshanna Coolie

Figure 4. East West View of SHB [3]

Challenges & Constraints

- Challenges
  - Coordination with multiple NAU facilities
  - Lack of data on seasonal variations in rainfall data
- Constraints
  - Criteria for pipes: C-900 (PVC-material), depth (3 ft.), length (based off manufacturer), and roughness coefficient
  - Codes and regulations

Stormwater Quality Requirements

Table 2. Water Testing Requirements

Water Testing	Requirement
pH	7-9
Corrosion Inhibitor	Required
Sulfides	< 10 ppm
Sulfate	< 100 ppm
Chloride	< 50 ppm
Bacteria	< 1000 CFU/mL
Total Hardness	< 200 ppm
Residue after Evaporation	< 50 ppm
Turbidity	< 20 NTU (nephelometric)

Table 3. Irrigation Water Testing Requirements

Water Testing	Requirement
Turbidity	< 5 NTU
Fecal Coliform Organisms	< 1000 CFU/mL

ppm: parts-per-million, equal to mg/L
CFU: Colony-Forming Unit
NTU: The units of turbidity from a calibrated nephelometer

Task 1: Surveying

- Surveying of key areas will be conducted using total stations
- Survey data will be used to create a three dimensional model of the site using AutoCAD
- Model will demonstrate the distances and changes in elevation needed to develop the conveyance system designs

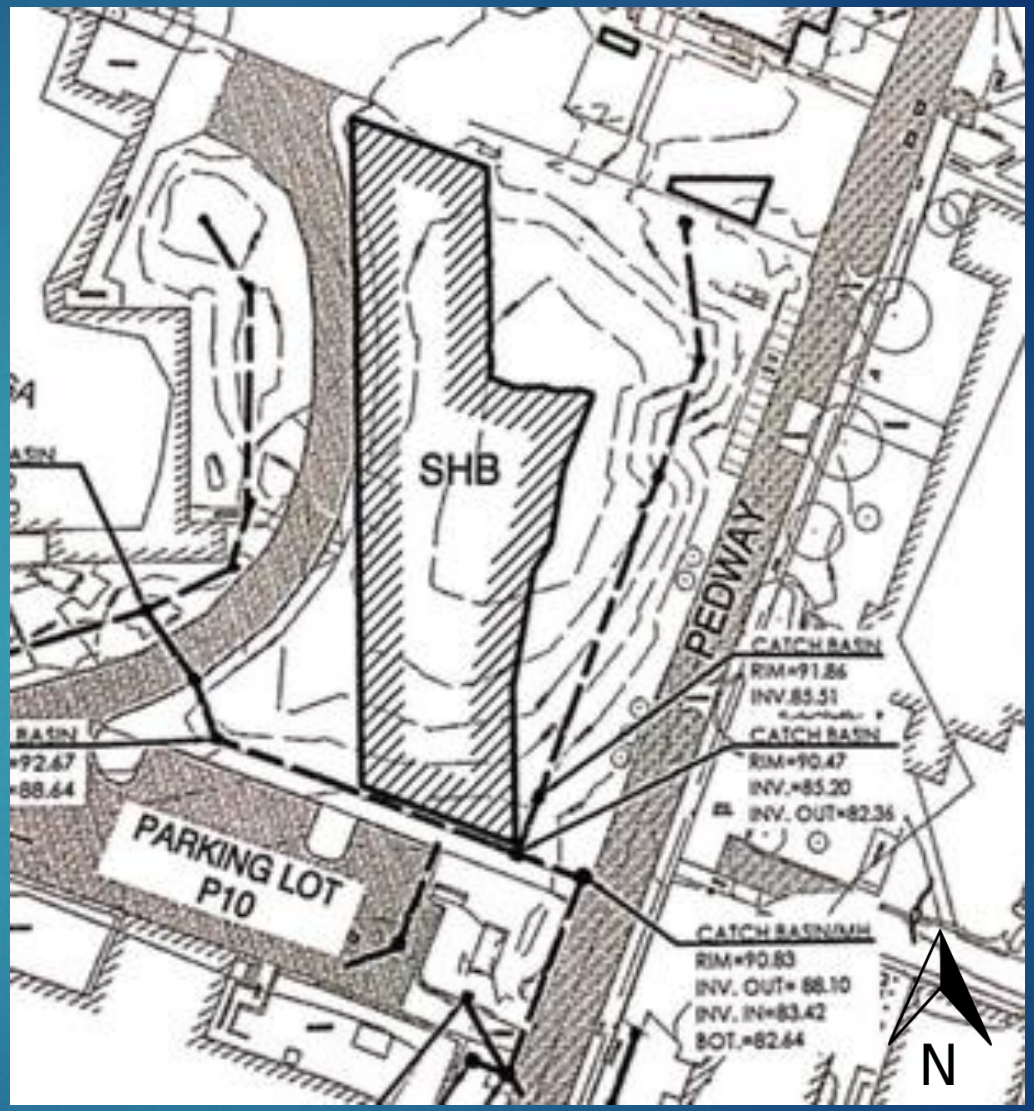


Figure 5. Topographic Map with Existing Storm Drains [2]

Task 2: Hydrology

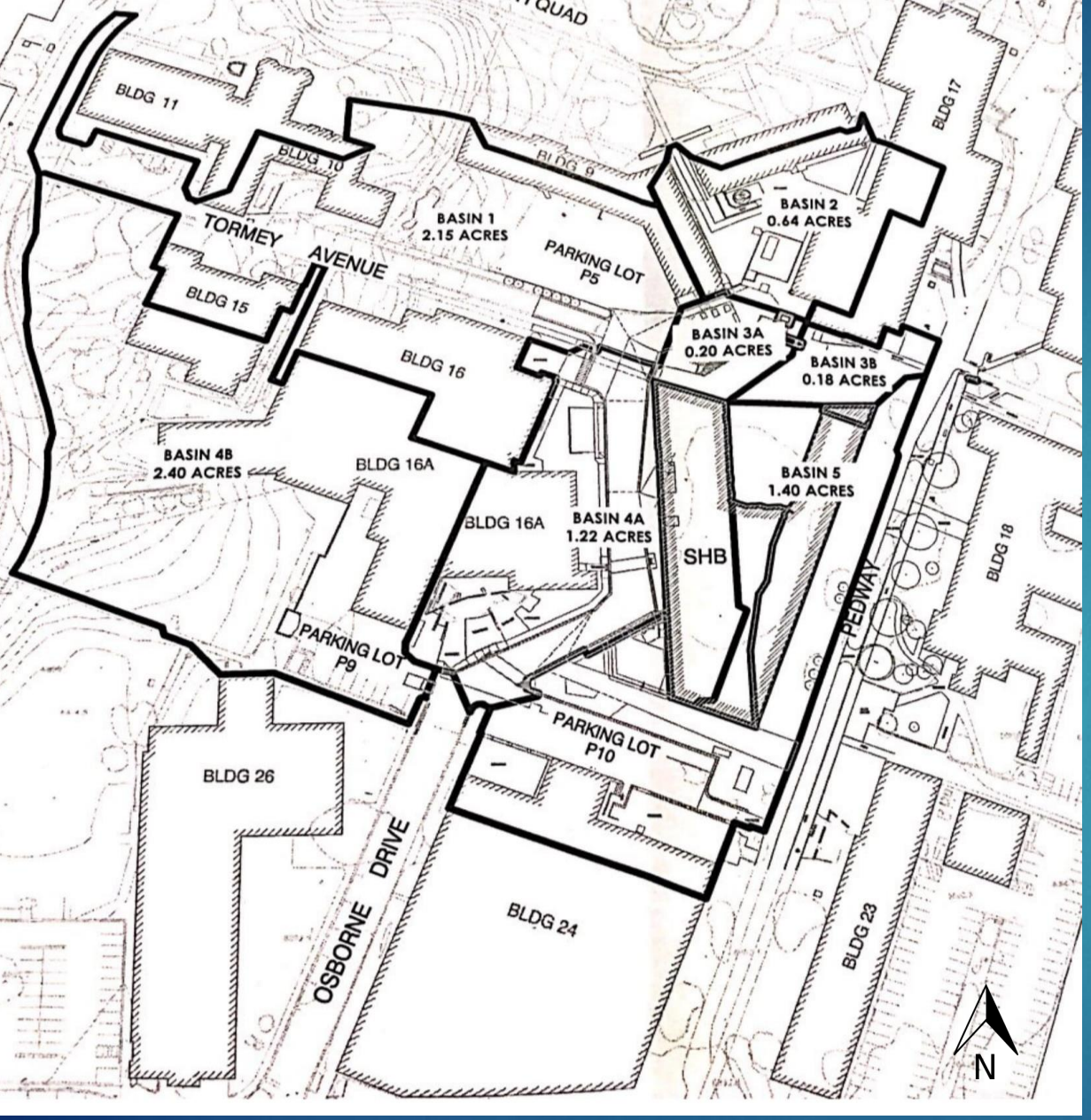


Figure 6. Drainage Basins of the Water Being Collected in the Detention Tanks [2]

Table 4. Site Hydrology Summary

Basin Number	Drainage Area (acres)	Flowrate-100 yr. (cfs)
1	2.15	14.29
2	0.64	4.01
3A	0.20	1.24
3B	0.18	1.22
4A	1.22	8.71
4B	2.40	9.75
5	1.40	9.32

Task 3: Stormwater Testing

Table 5. Stormwater Test Methods

Requirement	Test Method
pH	HACH Method #8156: pH
Sulfate	HACH Method #10248: Sulfate
Chloride	HACH Method #8113: Chloride
Bacteria	HACH Method #8074: Coliform
Total Hardness	HACH Method #8266: Total Hardness
Turbidity	Standard Method #2130B: Nephelometric Method
Total Suspended Solids	Standard Method #2540 C: Suspended Solids
Total Dissolved Solids	Standard Method #2540: Total Solids

Figure 7. Water Sample [4]

Task 4.1 Heating and Cooling Plant

4.1.1 Water Treatment System

- Client requested to implement the water treament system in Rm. 144
- After testing the initial inflow of the stormwater the steps for the treatment process will be determined

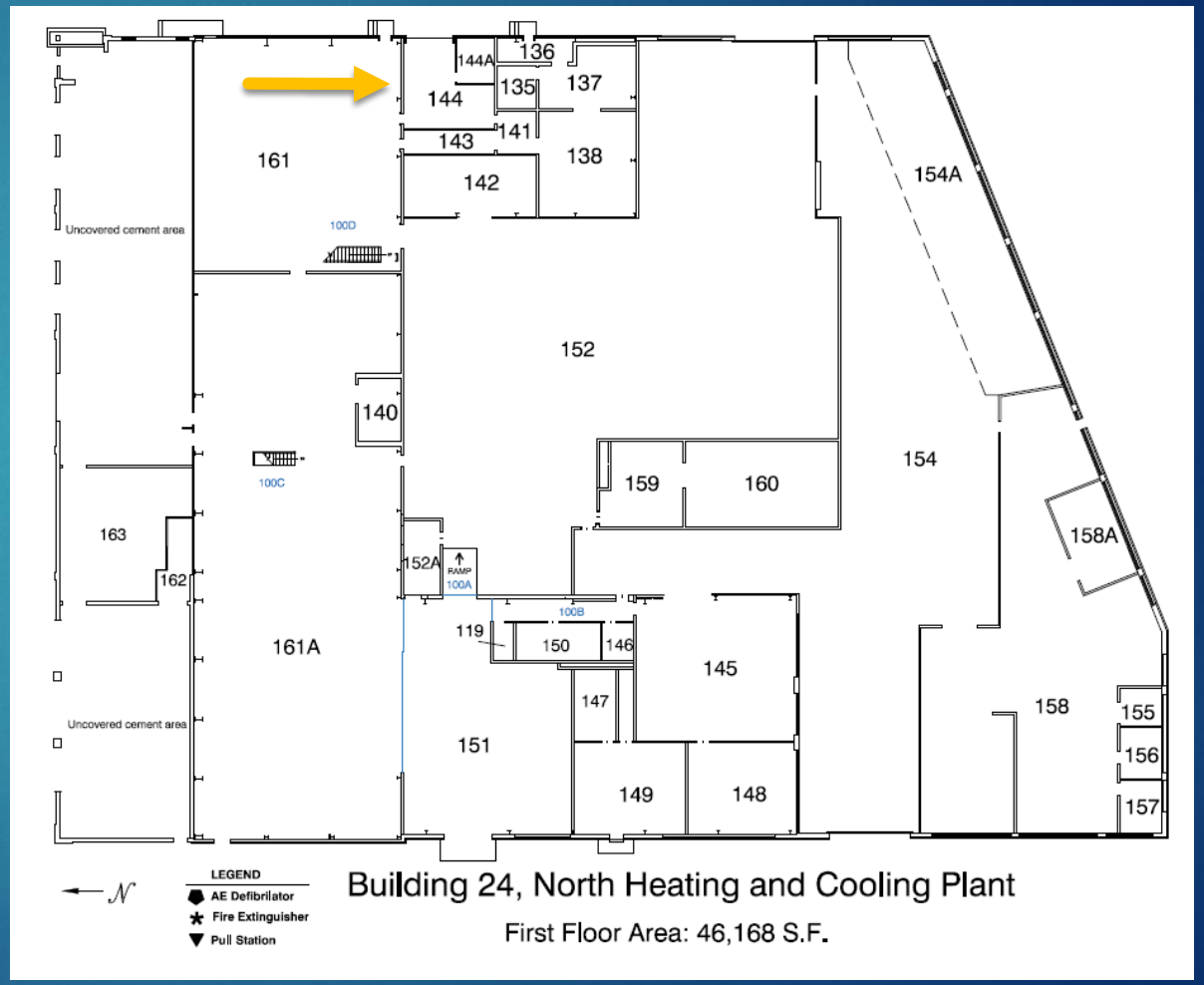


Figure 6: Storage and Treatment Location in Heating and Cooling Plant [2]

Water Treatment Process

The treatment process for the alternatives may include:

- Physical Treatment
  - Filtration: separate solids and oil from water
- Biological Treatment
  - Biological: remove organic matter to simple substances and additional biomass
- Chemical Treatment
  - Oxidation: eliminates the hydrogen sulfide and other chemicals
  - Disinfection: Used to remove, inactivate and killing pathogenic microorganisms (chlorination, ozonating)

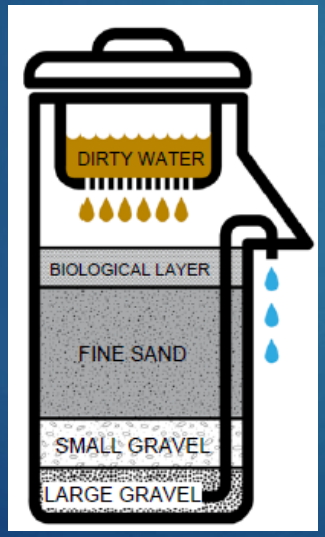


Figure. Example of Physical Treatment [5]

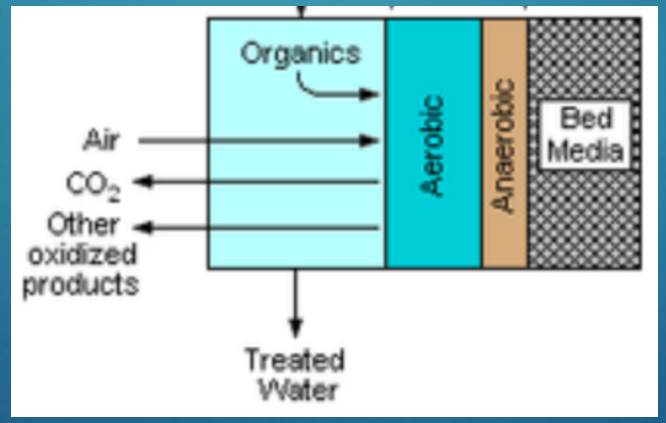


Figure. Example of Biological Treatment [6]

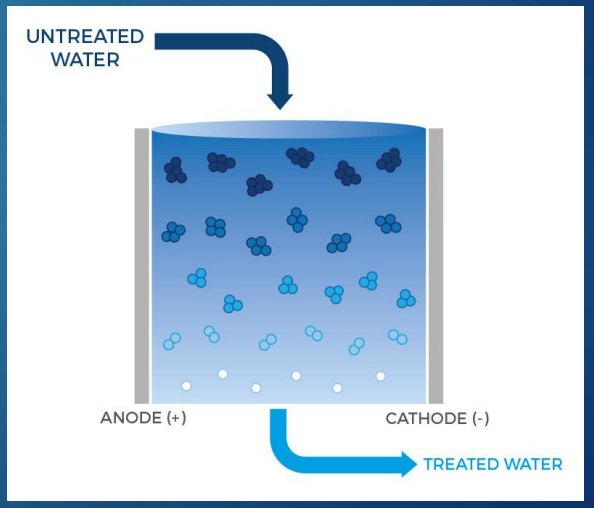


Figure. Example of Chemical Treatment [7]

4.1.2 Pipe Network

- Distance from the tanks to the heating and cooling plant
- Determine design flow in gallons per minute (gpm)
- Import existing infrastructures into WaterGems (for differential elevations; static head, valves and fittings)
- Design according to depth, diameter, roughness coefficient, and pressure of water

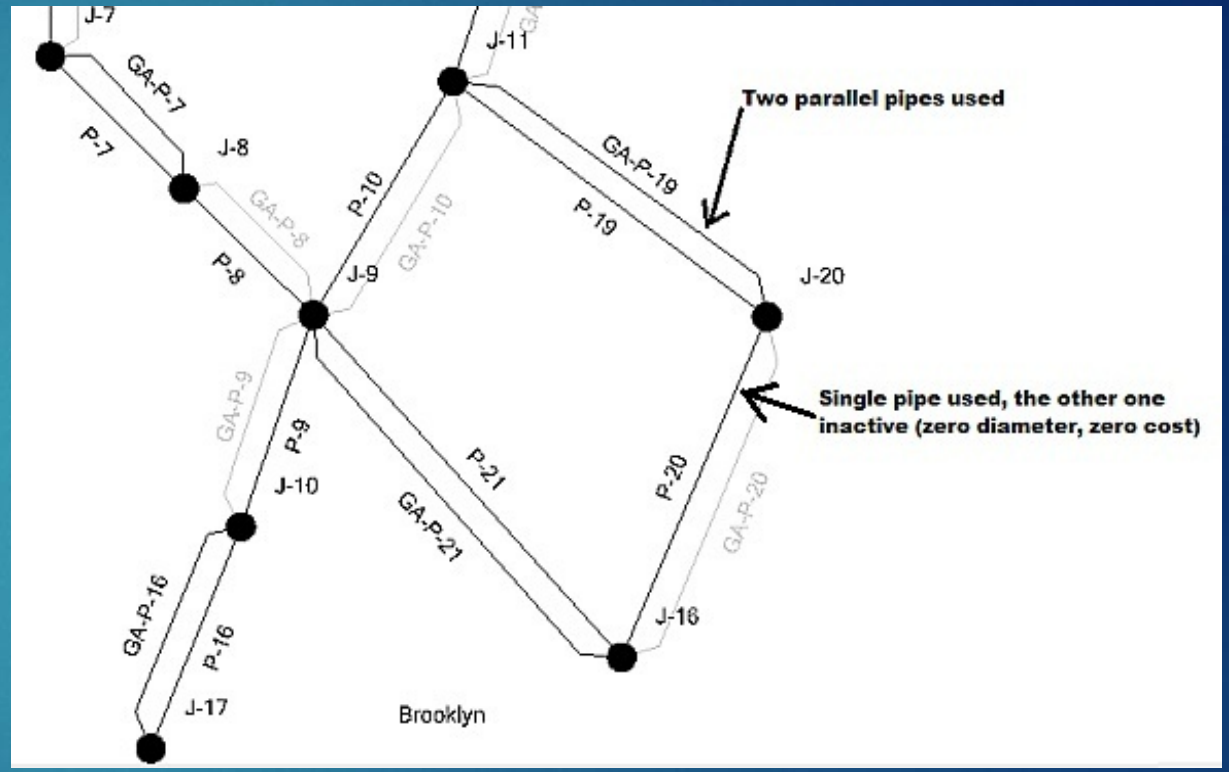


Figure 7. Example of a Pipe Network Design in WaterGEMS [8]

4.1.3 Pump Selection

- Flow rate (Q-max)
- Vertical elevation change
- Required horsepower
- Minor and major head losses
- Pump-Flo program

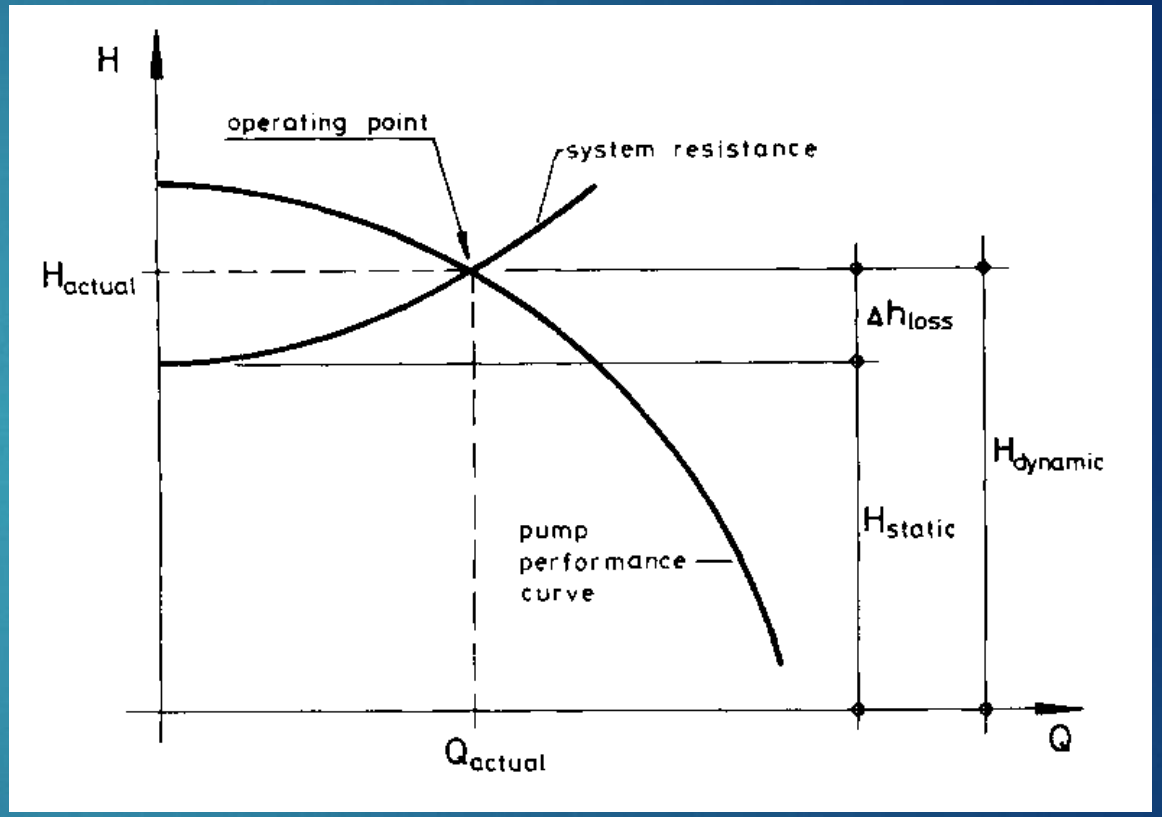


Figure 8: Example of an Operating Point of the Pump [9]

Task 4.2 Irrigation

4.2.1 Water Treatment Process

- Determined after intial stormwater testing

4.2.2 Pipe Network

- Tie into the existing pipe plans and existing sprinklers for irrigation

4.2.3 Pump Selection

- Chosen according to static, dynamic head, and pump effciency curve

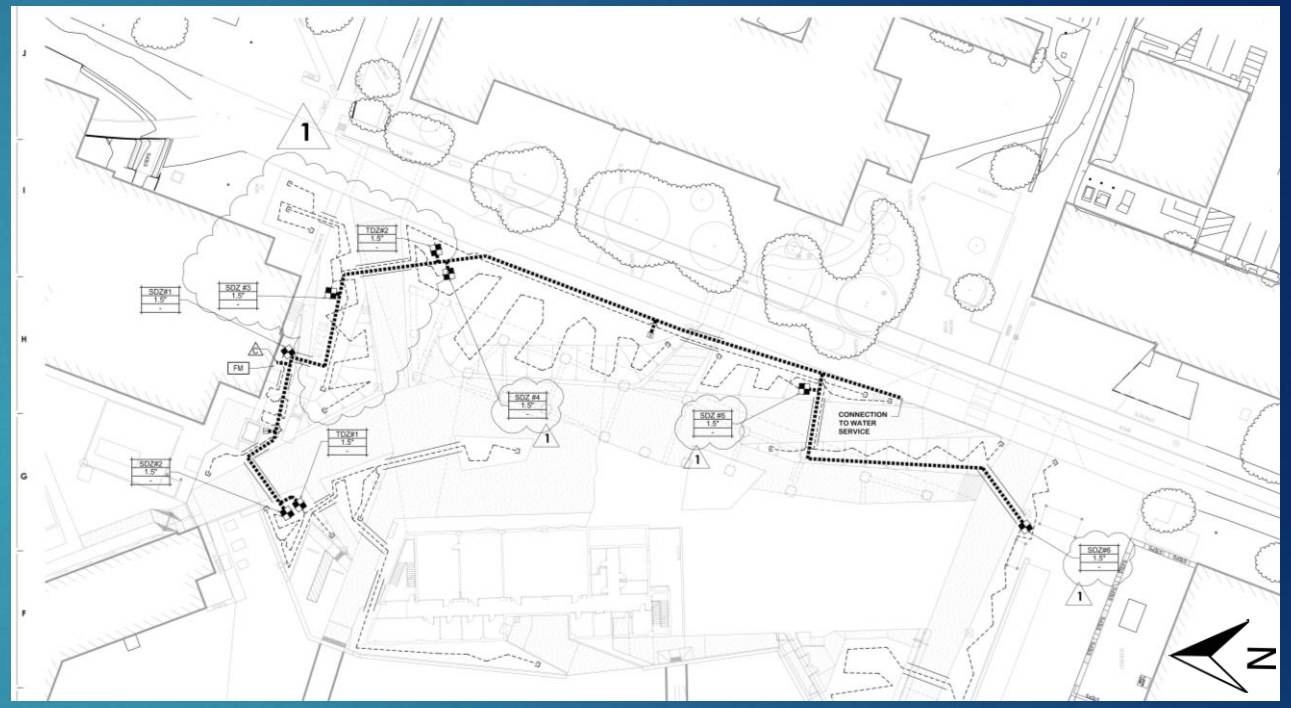


Figure 9. Possible Locations for Irrigation Purposes [2]

Task 5: Cost Analysis

Heating & Cooling Plant and Irrigation cost analysis will be based on:

5.1 Materials

- C-900
- Diameter
- Length

5.2 Operation

- Maintenance
- Power

5.3 Pumps

- Size
- Total amount of pumps

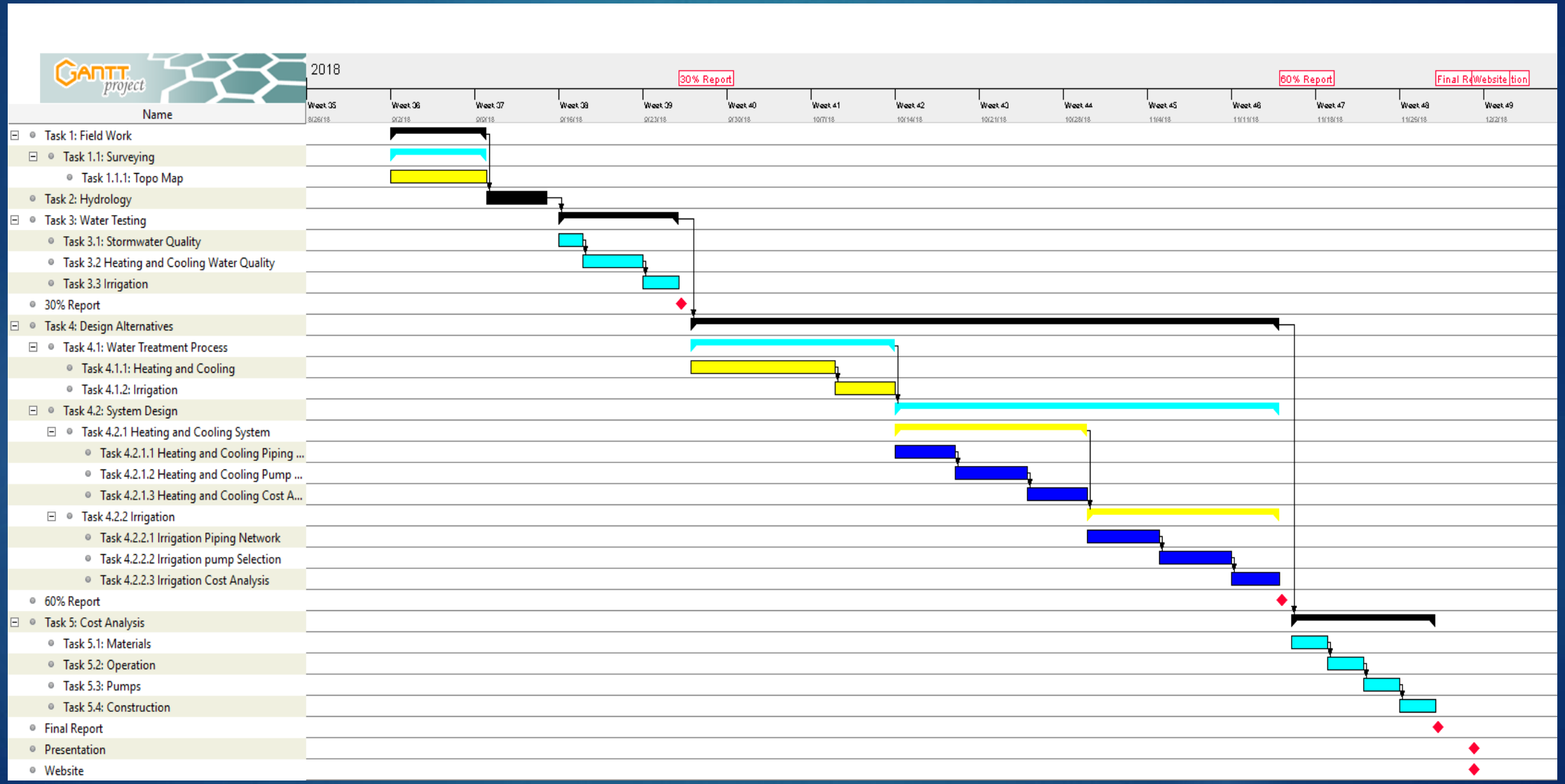
5.4 Construction

- Trenching for piping
- Installation
- Equipment
- Labor

Task 6: Project Management

- Meetings
  - Grading instructor meeting (biweekly meetings)
  - TA/Client meeting (monthly meetings)
  - Team meeting (weekly meetings)
  - Timing and tasks are logged through meeting agendas and minutes
- Deliverables
  - 30% and 60% Report
  - Presentation
  - Final Report
  - Website

Project Schedule



Project Staffing

Table 6. Equipment Fee

Equipment	Cost ($/hr.)	Hours	Cost
Total Station	100	12	1200
Water Testing	80	25	2000
Total	--	--	3200

Table 7. Position Rates

Staff Position	Cost ($/hr.)
Project Manager	80
Senior Engineer	120
Junior Engineer	90
EIT	40
Administration	25

Project Staffing Continued

Table 8. Descriptive title

Task	STAFF					Task Total (hr)	Cost ($)
	Project Manager	Senior Engineer	Junior Engineer	EIT	Administration		
1.0 Field Work	12	8	11	10	10	51	3560
2.0 Water Testing	0	8	0	0	10	18	1210
2.1 Initial Stormwater	12	0	11	10	0	33	2350
3.0 Design Solutions	0	8	0	0	10	18	1210
3.1 Heating and Cooling	12	0	10	10	0	32	2260
3.2 Irrigation	12	0	10	10	0	32	2260
4.0 Cost Analysis	10	8	11	10	10	49	3400
5.0 Project Management	20	8	29	10	15	82	5945
Staff Total (hr)	78	40	82	60	55	315	22195
						Equipment/ Facility Costs	3200
						Total Cost	25195

References

[1] Google. Northern Arizona University. (2018).

[2] Northern Arizona University Stormwater Drainage Report. (2013). Flagstaff: GLHN Architects & Engineers Inc.

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