Design of A Solar Operated Pump and Watering System

Andy Cheung, P.E., CPESC
Watershed Agricultural Council
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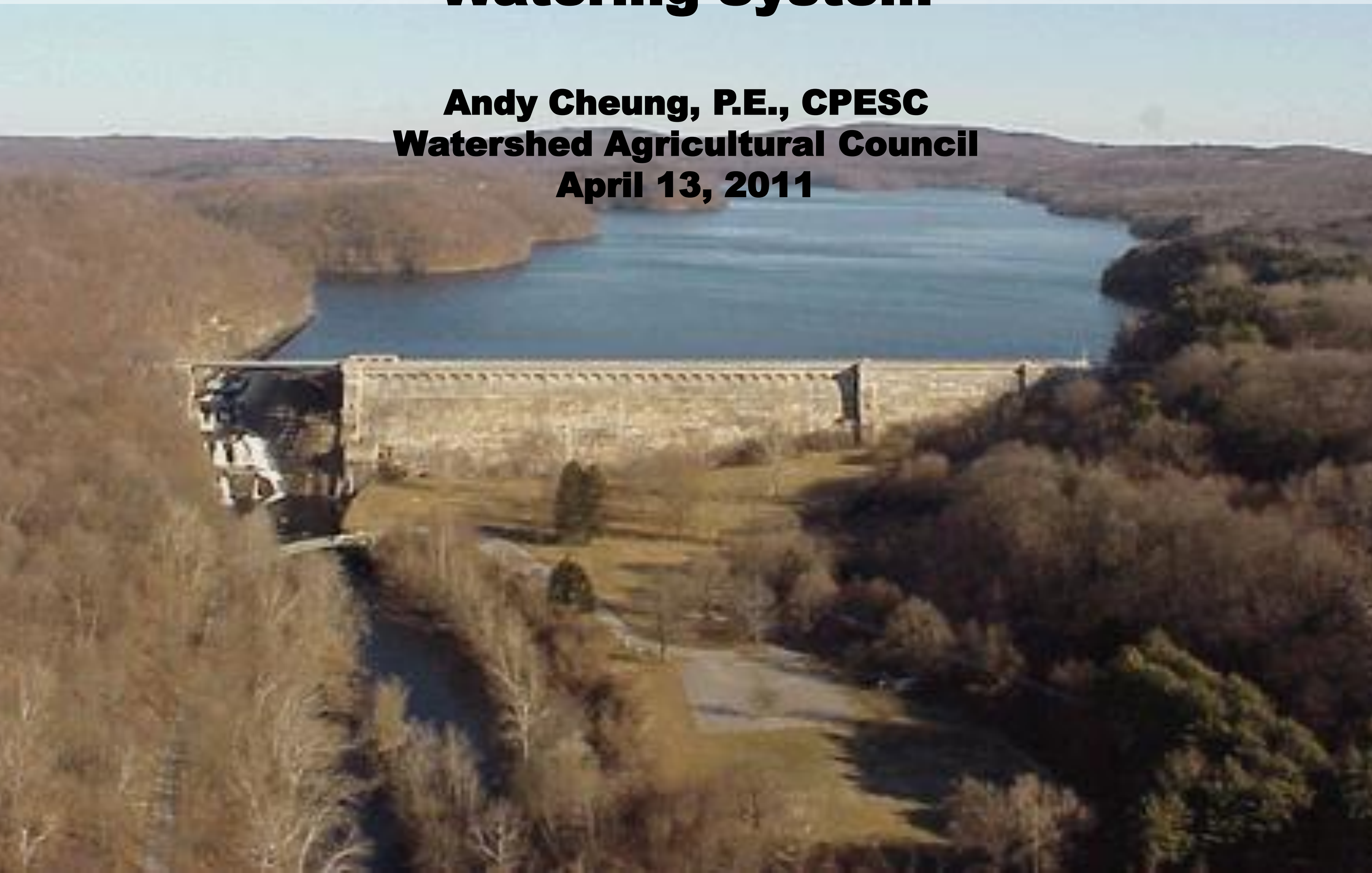

Housekeeping

-Thank you to Environmental Finance Center, Finger Lakes Lake Ontario Watershed Protection Alliance, NY Farm Viability Institute for this opportunity.

-Feel free to ask questions anytime.

-Please provide feedback, questions or comments to
acheung@nycwatershed.org

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NYC Environmental Protection

Forest Service U.S. Department of Agriculture

USDA

along with other federal, foundation and private sources.
The WAC is an equal opportunity employer and provider.

Watershed Agricultural Council
Who We Are and What We Do:

-Plan, design and implement BMPs on agricultural lands in the New York City Watershed Region

-Farms located in the Croton and Catskill/Delaware Watersheds

-Designs follow NRCS guidelines

Livestock Farm located in Westchester County, NY

Project Specifics

- No other water source in vicinity of pasture
- No electric service in vicinity of pasture
- Animals used to drink from a stream in lower pasture
- Stream was fenced out, WAC to provide alternative water source
- Existing 6” well approximately 230’ deep installed in the 1950’s

Project Questions

- Does the existing well have enough yield?
- How much water will we need?
- How many hydrants do we need to service 3 pastures?
- Can solar panels generate enough power?

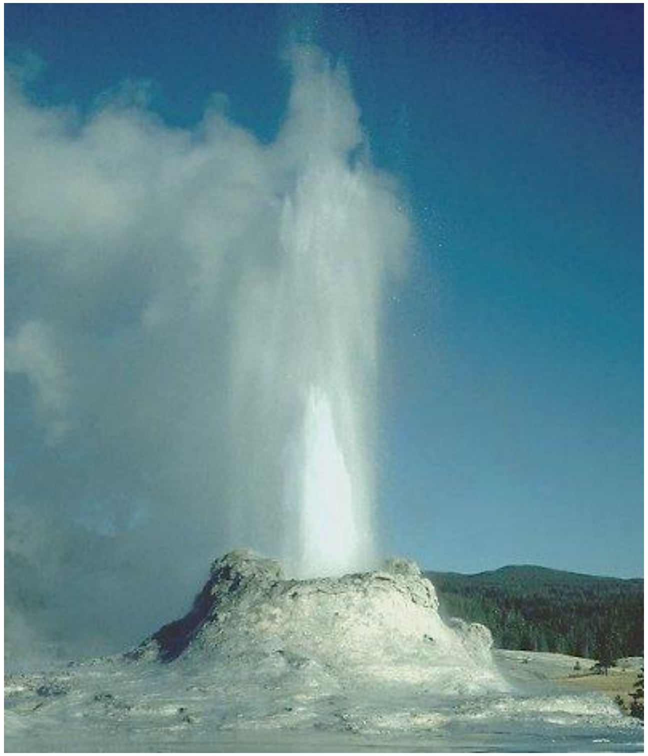
Well Yield

- Is there enough water in the well to be able to use as a permanent watering system?
- Pump test to determine well yield

Pump Test

Pump Test Results

- Pump test showed the well yielded 10 gpm with a recharge of 3 to 5 gpm



How much water do we need?

- At full capacity, farm has:
- 120 sheep

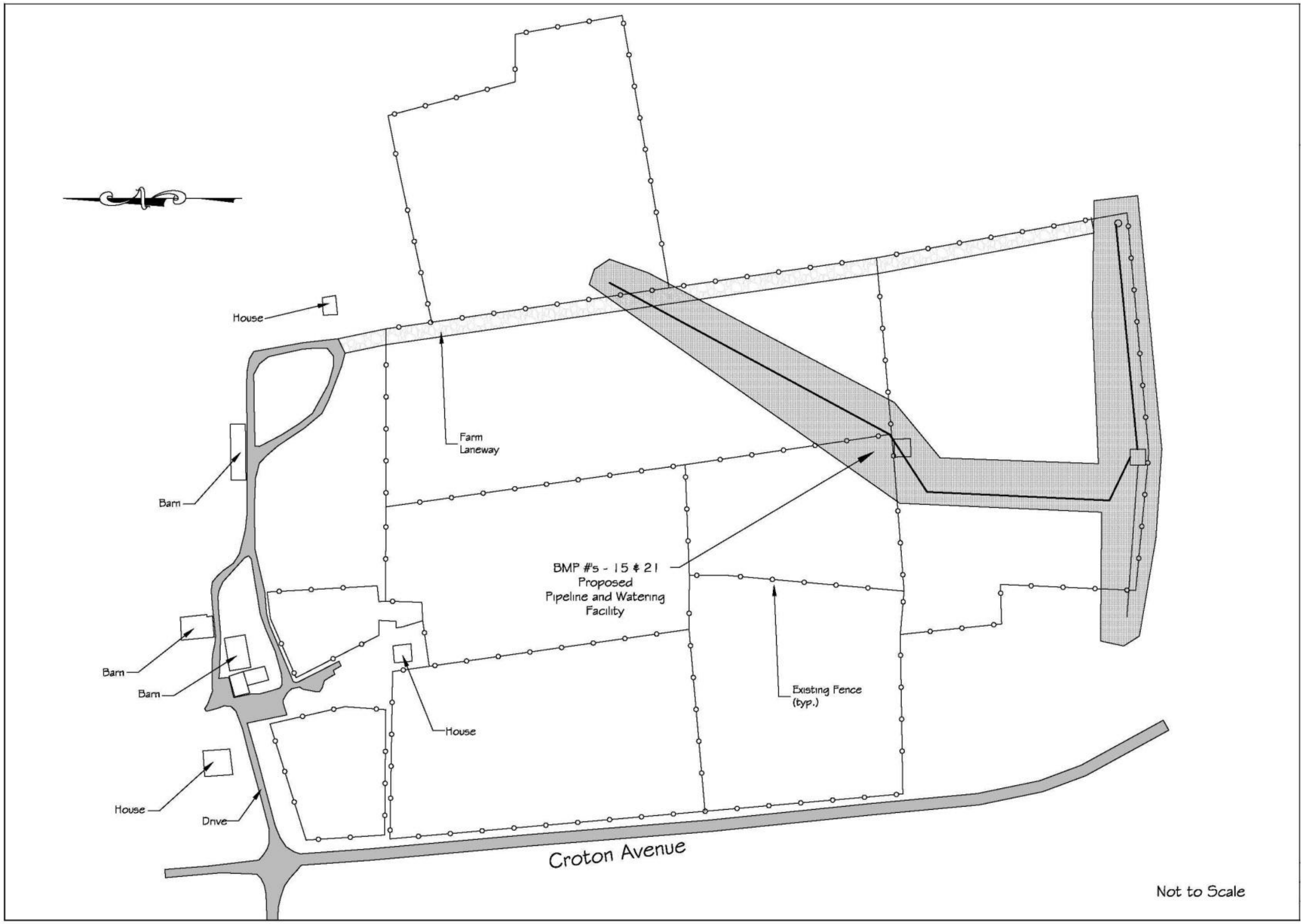
- 1 sheep uses 2 gallons of water per day (3 gallons per day for temperatures over 77 degrees) for a total of 360 gallons

How much water do we need?

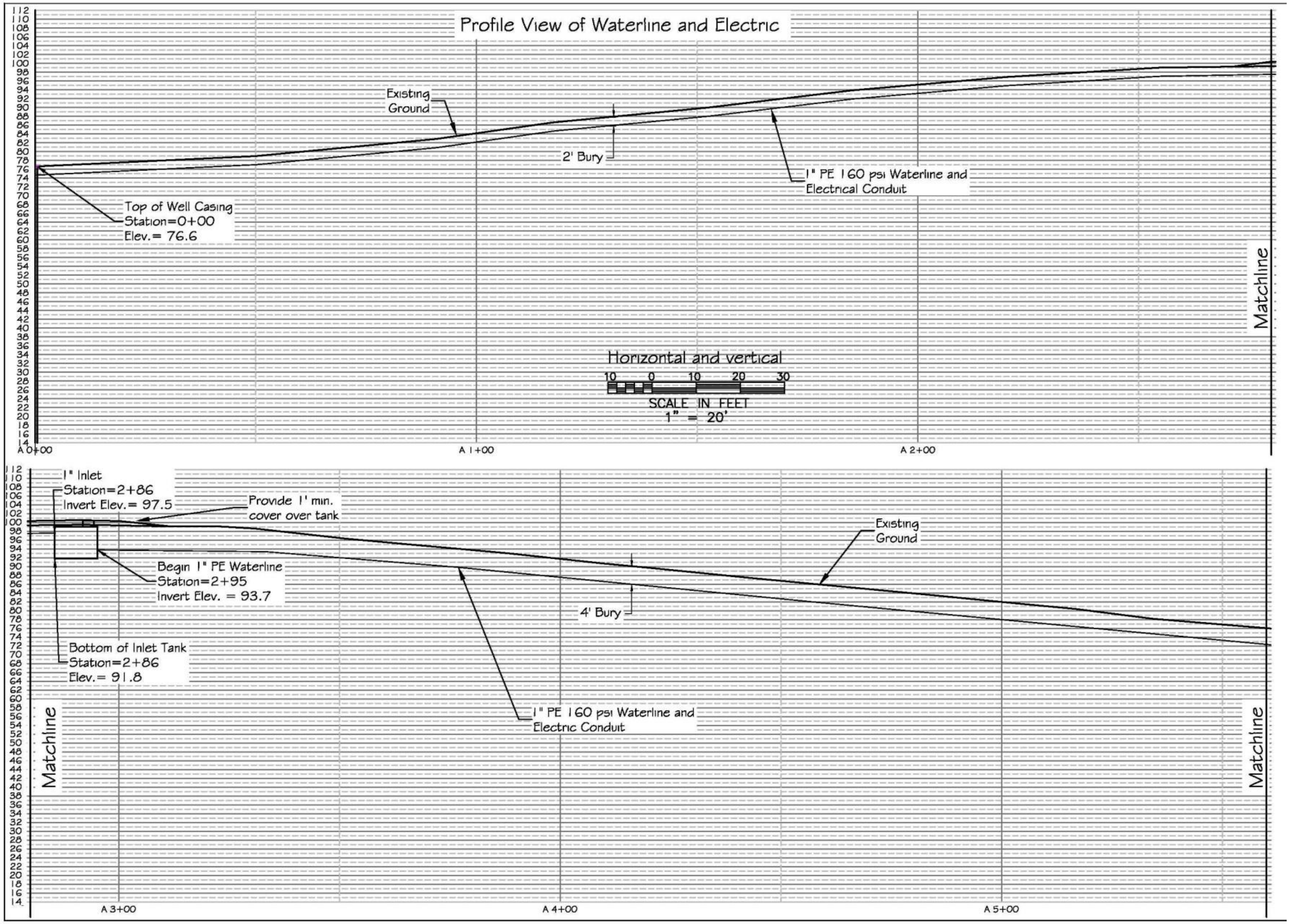
- At full capacity, farm also has:
- 35 cattle

- 1 cow uses 12 gallons of water per day (24 gallons per day for temperatures over 77 degrees) for a total of 840 gallons
- We need a total of 1,200 gallons per day

Layout of Water Reservoir and Hydrants



Pipeline Design



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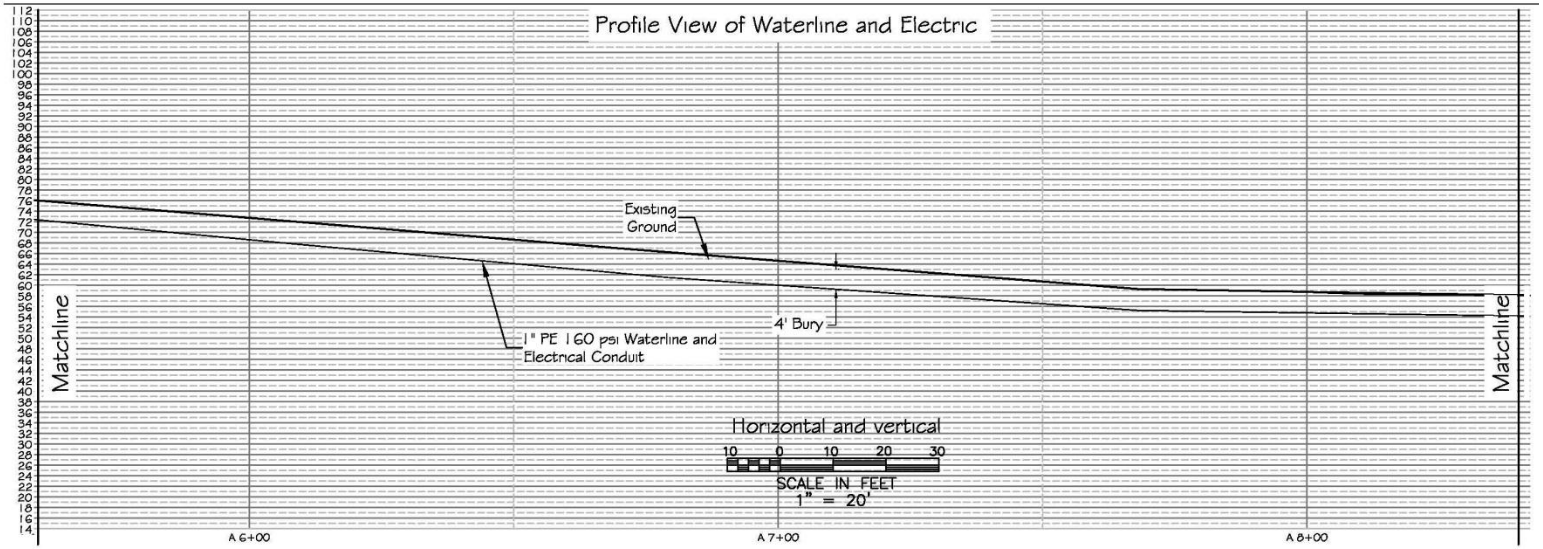

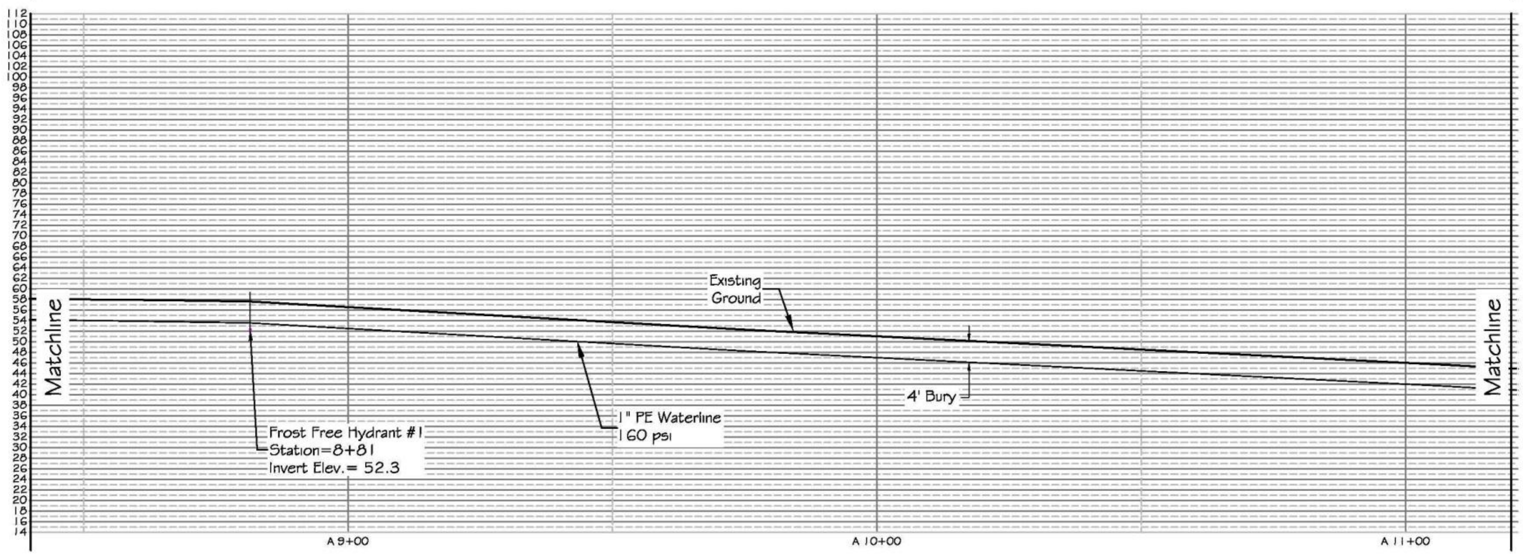

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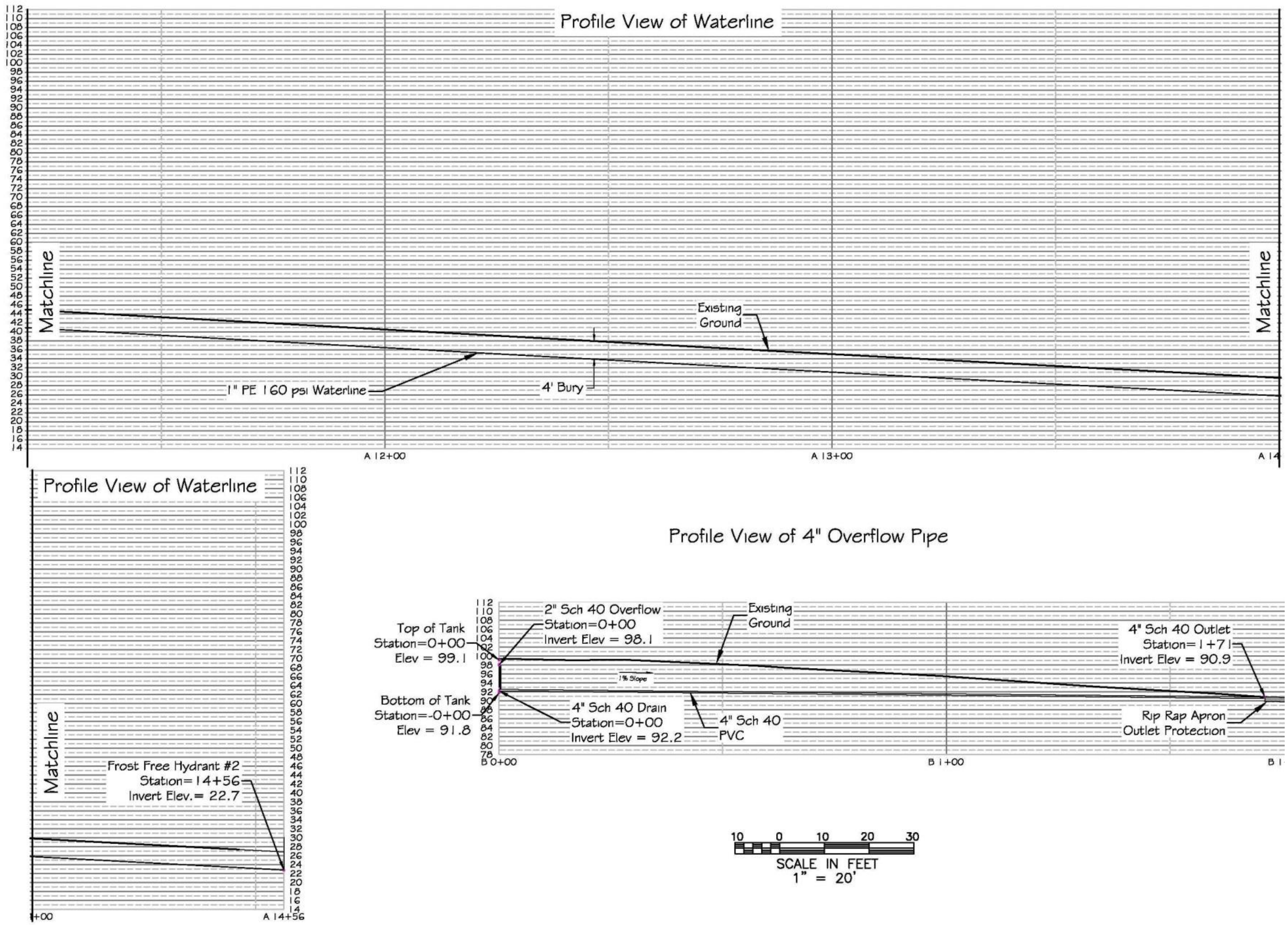

Pipeline Design – Hydrant Pressure

- Tank outlet at Elevation 93.7
- Hydrant #1 Elevation 52.3
- Hydrant #2 Elevation 22.7

- $P = \rho g h = 62.4 lb/ft^3 \times 32.2\ ft/s^2 \times \Delta h$
  - Or 2.3 feet per 1 psi

  - Pressure at hydrant #1 = 18 psi
  - Pressure at hydrant #2 = 31 psi

Pump Design

- Determine total dynamic head (velocity head + static head + friction head)
  - Velocity head: caused by motion of the fluid
  - Static head: caused by fluid’s weight
  - Friction head: caused by friction acting against the fluid by pipe

- For simple systems, velocity head and friction head are negligible so we primarily look at static head

Pump Design – Velocity Head

- Velocity Head = V^2 / 2g
  - V is calculated by

    V=Q/A (flow rate/cross sectional area of pipe)
  - g = 32.2 ft/s^2

- For flow rate of 10 gpm, V = 4.1 ft/s

- Velocity Head = 0.26 ft

Pump Design – Static Head

- Static Head = elevation distance from when the pump shuts off to the discharge point of the tank
- Top of well casing is at elevation 76
- Well is 230 feet deep = elevation -154
- Well pump will be installed approximately 10' from the bottom of the well = elevation -144
- Discharge point at the tank is at elevation 98
- Static head = 144' + 98' = 242 ft

Pump Design – Friction Head

- Friction Head = friction caused by the pipe acting against the fluid. Calculated by Hazen-Williams Equation

- Friction head = $V / (1.32\ C\ R^{0.63})^{1.852}\ L$
  - V = velocity
  - C = Hazen-Williams Coefficient = 150
  - R = hydraulic radius (pipe diameter/4)
  - L = Equivalent length of pipe plus fittings

- Friction head at 10 gpm = 22 ft

Pump Design – Total Dynamic Head

- Total Dynamic Head of the System = Velocity Head + Static Head + Friction Head

- TDH = 0.26 ft + 242 ft + 22 ft = 264.26 ft

Pump Curve

18.4 6 SQF-2

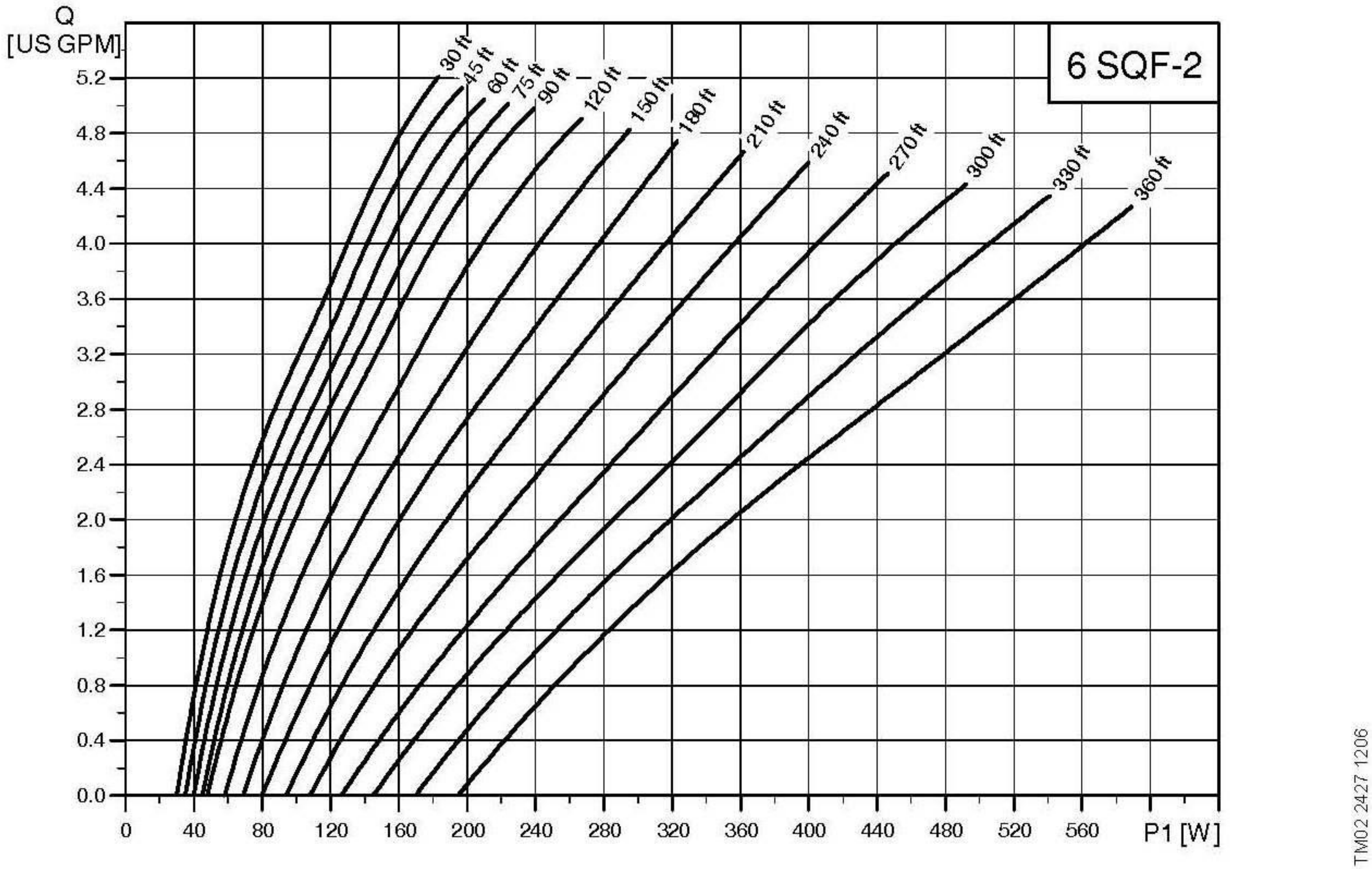

Fig. 29 Curve chart, 6 SQF-2

Pump and Solar Panel Selection

- Grundfos 6 SQFlex-2 pump
  - Runs on 30-300 VDC, 90-240 VAC
  - Pump rate from 2 gpm to 10 gpm
  - TDH from 30 ft to 360 ft
  - 1” NPT outlet
  - 3” diameter stainless steel with helical rotor

- Grundfos solar panels
  - GF-80 panels crystalline
  - 80W power output per panel

Pump and Solar Panel Selection

GRUNDFOS

Miscellaneous Components

IO-101 Switch Box – allows for manual start-stop and connection to generator for AC backup power. Automatic transfer switch disconnects solar array when AC power is present.

Miscellaneous Components

CU-200 Interface Box – communicates with the pump and monitors operating conditions. Indicate faults, dry run, displays operating status, power consumption and level switch.

Miscellaneous Components

Level Switch – interfaces with the CU-200 control unit to turn off when the tank is full

Construction Process

1,250 gallon pre-cast concrete tank was installed first

Construction Process

Trenching, pipeline and hydrants installed

Construction Process

Well extended, hydrofractured, pitless adapter and locking cap installed

Construction Process

Solar panels installed and wired

Construction Process

All electrical work installed

Construction Process

System test and monitor

Construction Process

Frame around solar panels, electrical, and hydrants

Construction Process

Install troughs and floats

Finished Product

Happy Cows

For more information:

Andy Cheung, P.E., CPESC
Project Engineer
East of Hudson Program
(914) 962-6335, ext. 11
acheung@nycwatershed.org