GEORGETOWN
Wet Weather Treatment Station

King County
Protecting Our Waters
Doing our part on rainy days

Reliability & Redundancy for CSO Facilities – Using GWWTS as a Case Study

By

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King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Presentation Content

- Purpose
- WTD CSO program and GWWTS project background
- Project hydrology
- GWWTS facilities overview
- Sizing of major design elements

Acknowledgements

Bruce Nairn – KCWTD

Butch Perry – KCWTD

Karl Zimmer - KCWTD

Tina Hastings – CH2M

Pat Burke – CH2M

Miaomiao Zhang– CH2M

Thanks!!

Purpose

To bring to light and discuss the thought process and decision making of the Owner and design team to optimize the facility and provide efficiency for the rate payer.

Emphasize the benefits of early decision making.

Acknowledge the collaborative effort used by the team.

Emphasize that early decisions on equipment make design effort more efficient

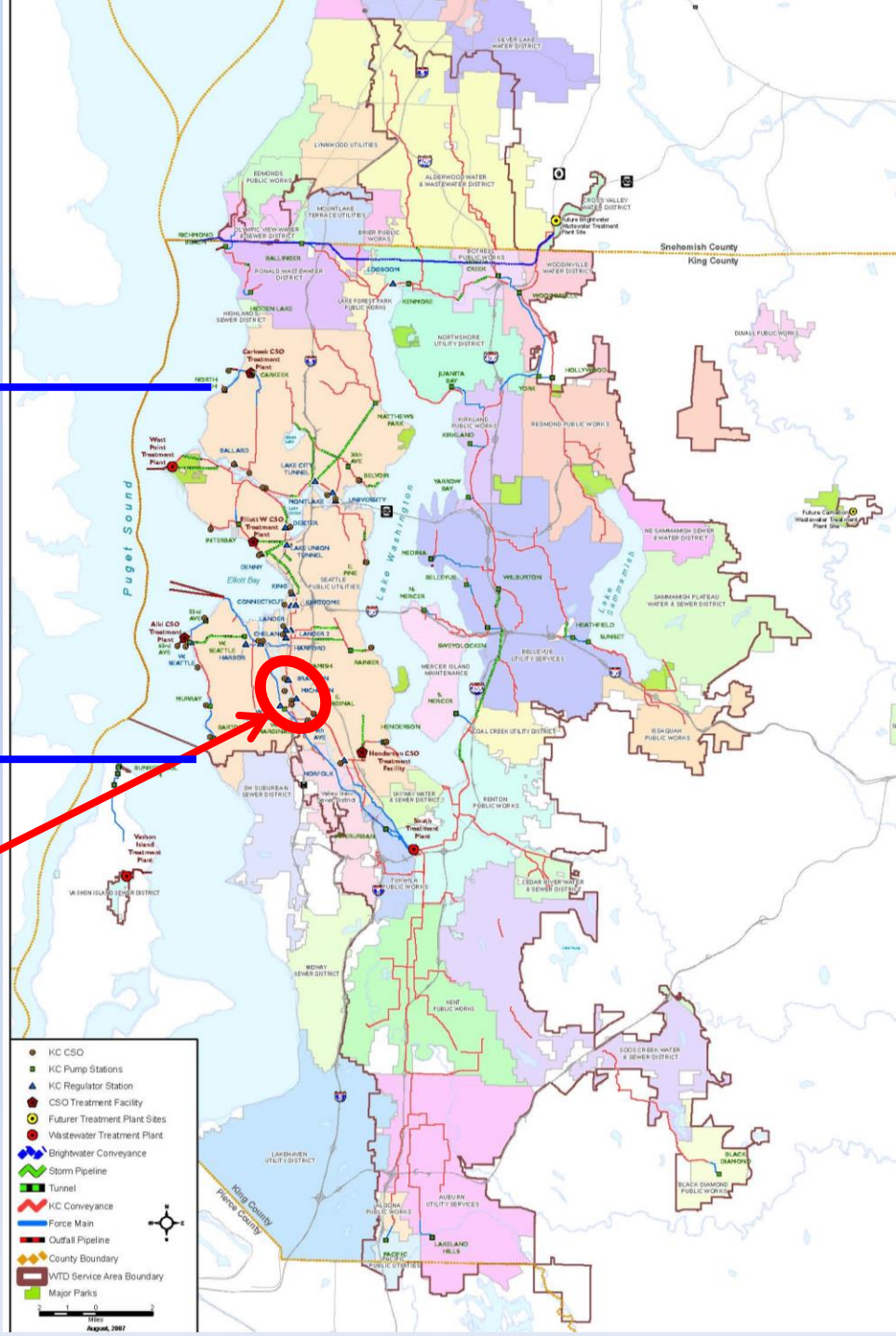
Considerations

- Requirements of DOE Orange book
- Consent decree
- Flow and duration of the event
- Experience with equipment reliability
- Total service hours for interim use equipment
- Consequences of reduced operation or non-operating state for each element
- Cost of redundant facilities
- Time to bring equipment back on line @ 100%
- Water quality varies widely

KCWTD Service Area

A large portion of the central part of service area west of Lake Washington is combined sewers

GWWTS – in the heart of the South Seattle Industrial District



WTD CSO Facilities

- 15 marine CSOs
- 11 Freshwater CSOs
- 9 River CSOs under saltwater influence
- 5 CSO storage or treatment facilities built

WTD CSO Program

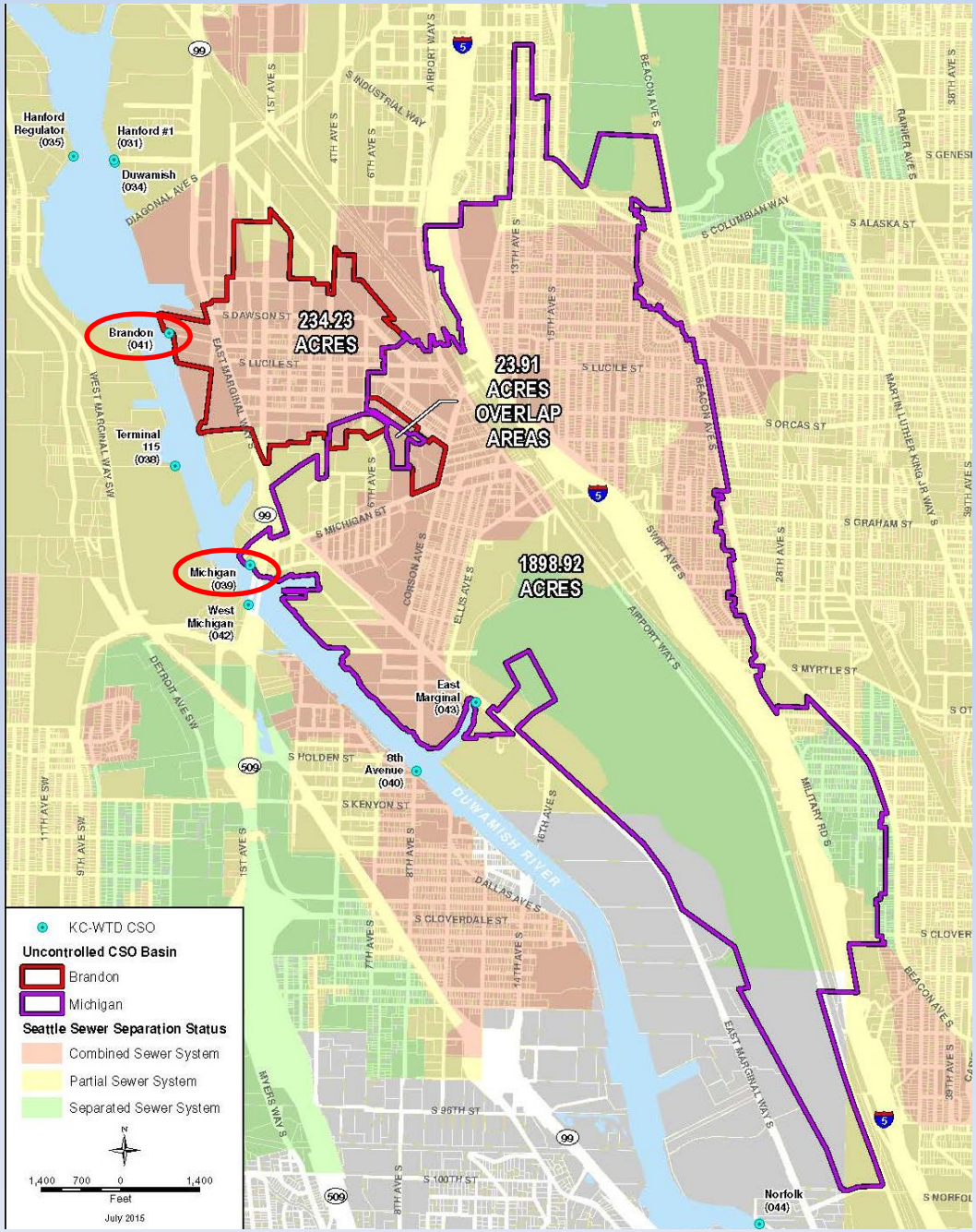
- Mandate to reduce untreated CSOs to 1 per year per location, long term average
- 3 storage projects under construction
- 1 Green Stormwater Infrastructure project completed
- Rainier Storage Tank
- Georgetown Wet Weather ***Treatment*** Station under design
- Other planned facilities:
  - Chelan
  - Hanford Lander King Kingdome

Why Treatment?

- Additional conveyance capacity would be prohibitively expensive, horribly disruptive
- Limited treatment capacity at existing WWTPs
- Frequent, short duration events of varying intensity
- Storage would be ~~large~~ HUGE
- Soils are troublesome

Basin Map

- Brandon – 234 acres
  - FLAT!
  - Mostly combined sewers
  - Primarily industrial
- Michigan – 1,899 acres
  - Mostly flat, some slope I-5 & east
  - Combined sewers, partially separated & fully separate
  - Primarily industrial, marine, airport & freeway
  - Residential east of I-5



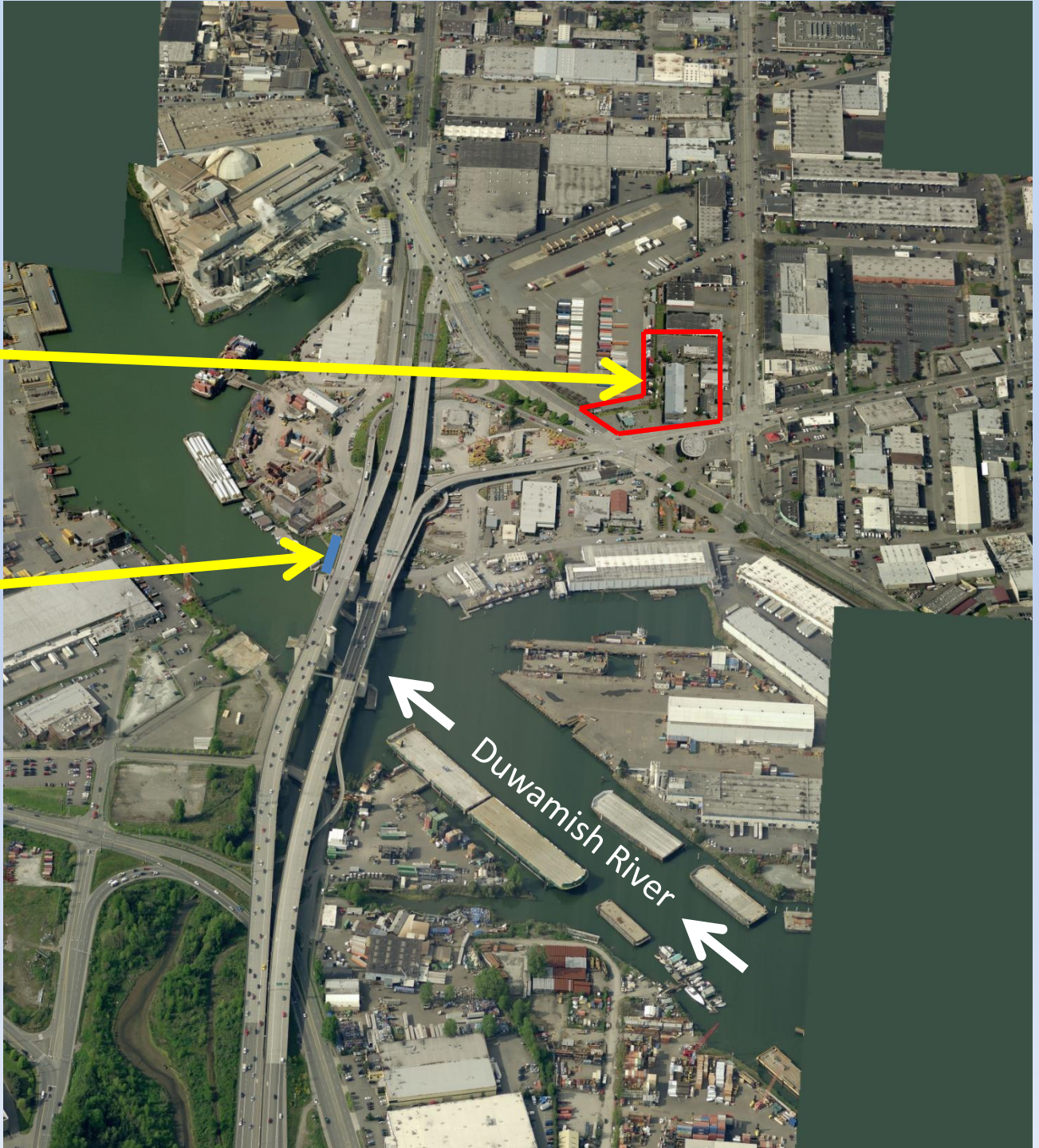
Configuration

- Two outfalls to control
- Approximately a mile apart
- Single treatment location
- Minimal conveyance
- “Unload” EBI at Michigan ST to make room for Brandon flow

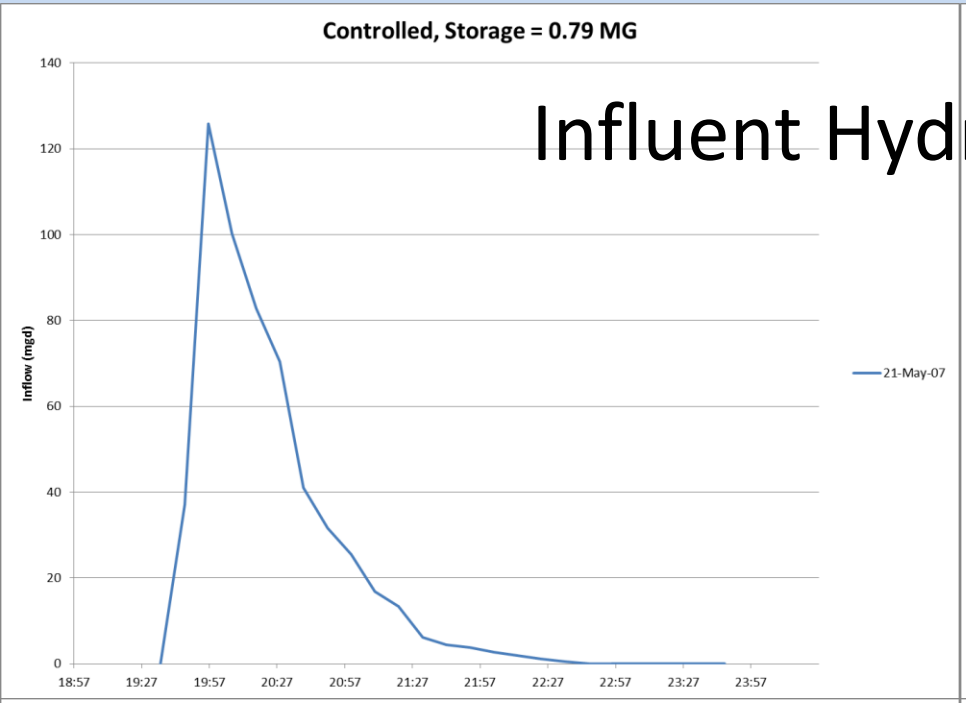
GWWTS Details

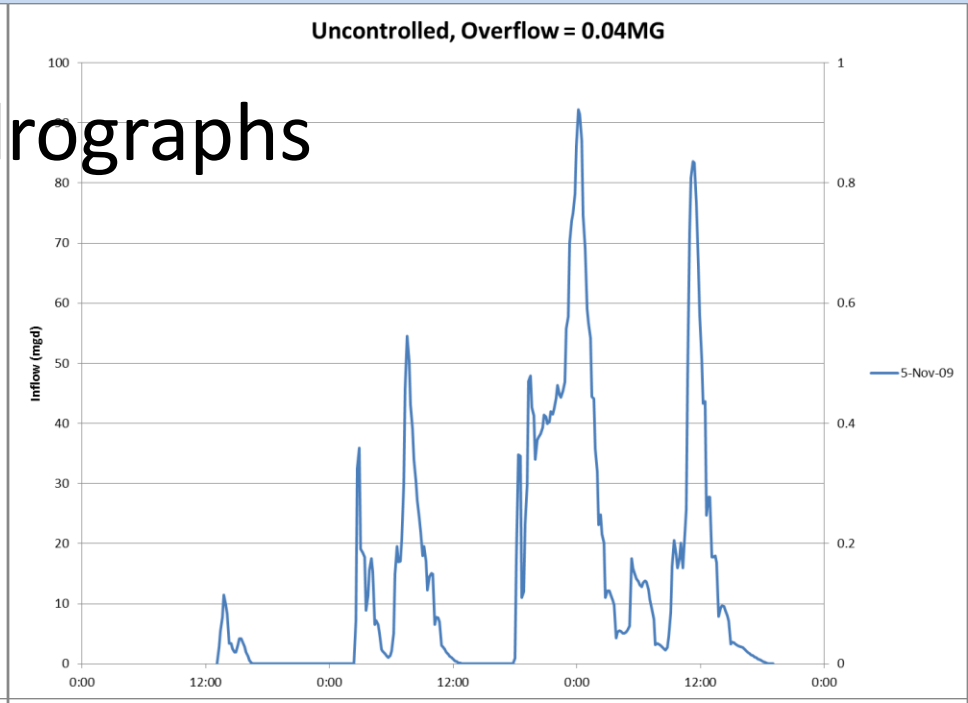
- 70 MGD treatment capacity
  - Screening – 115 MGD
  - Equalization – 1.1 MG
  - Conveyance storage counted in the model
  - Ballasted Sedimentation – 70 MGD
  - UV disinfection – 70 MGD
  - River outfall – 70 MGD
- Peak event volume – 85 MG
- Average annual treated volume – 67 MG/year
- Average number of events – 20+
- Events are a few hours to a few days long

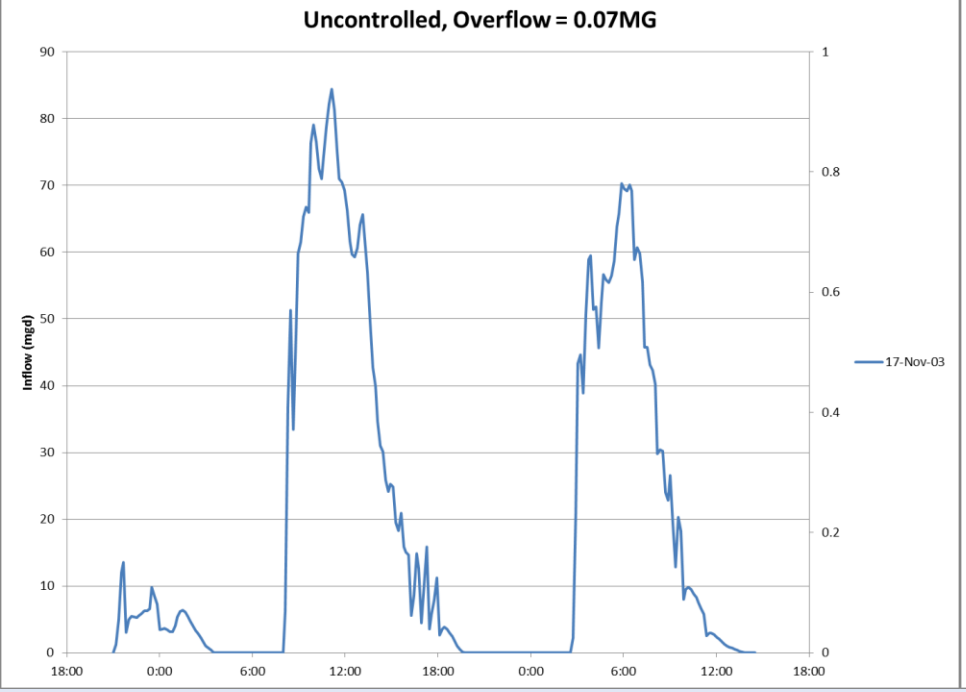
Site Aerial View

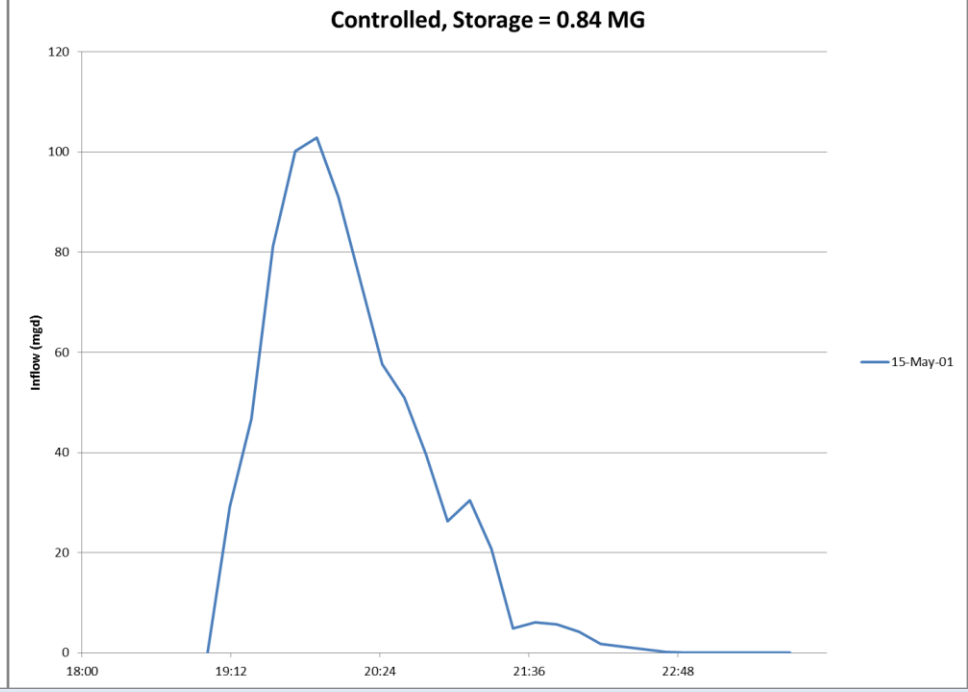


Influent Hydrographs

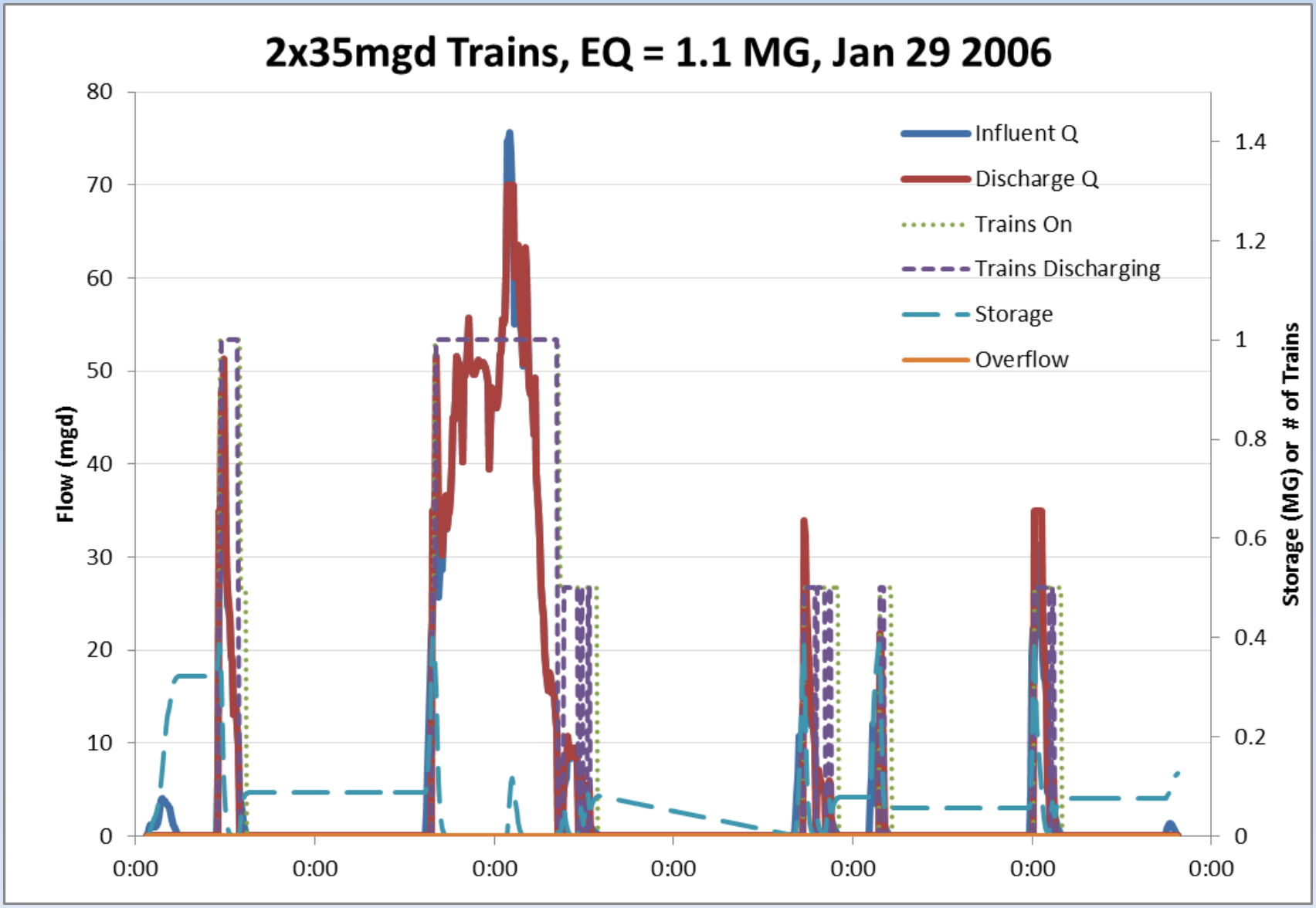








Operational Hydrographs



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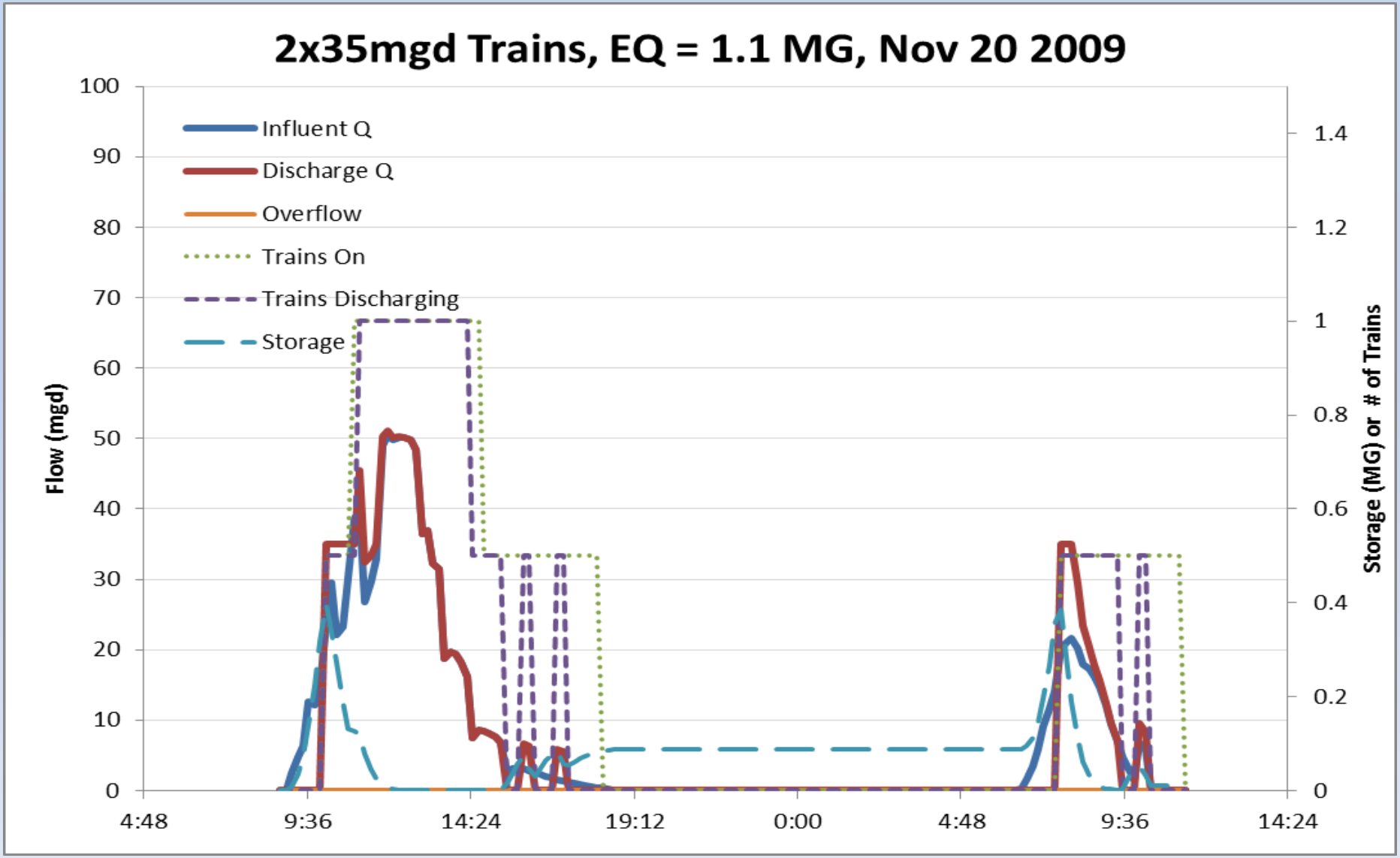

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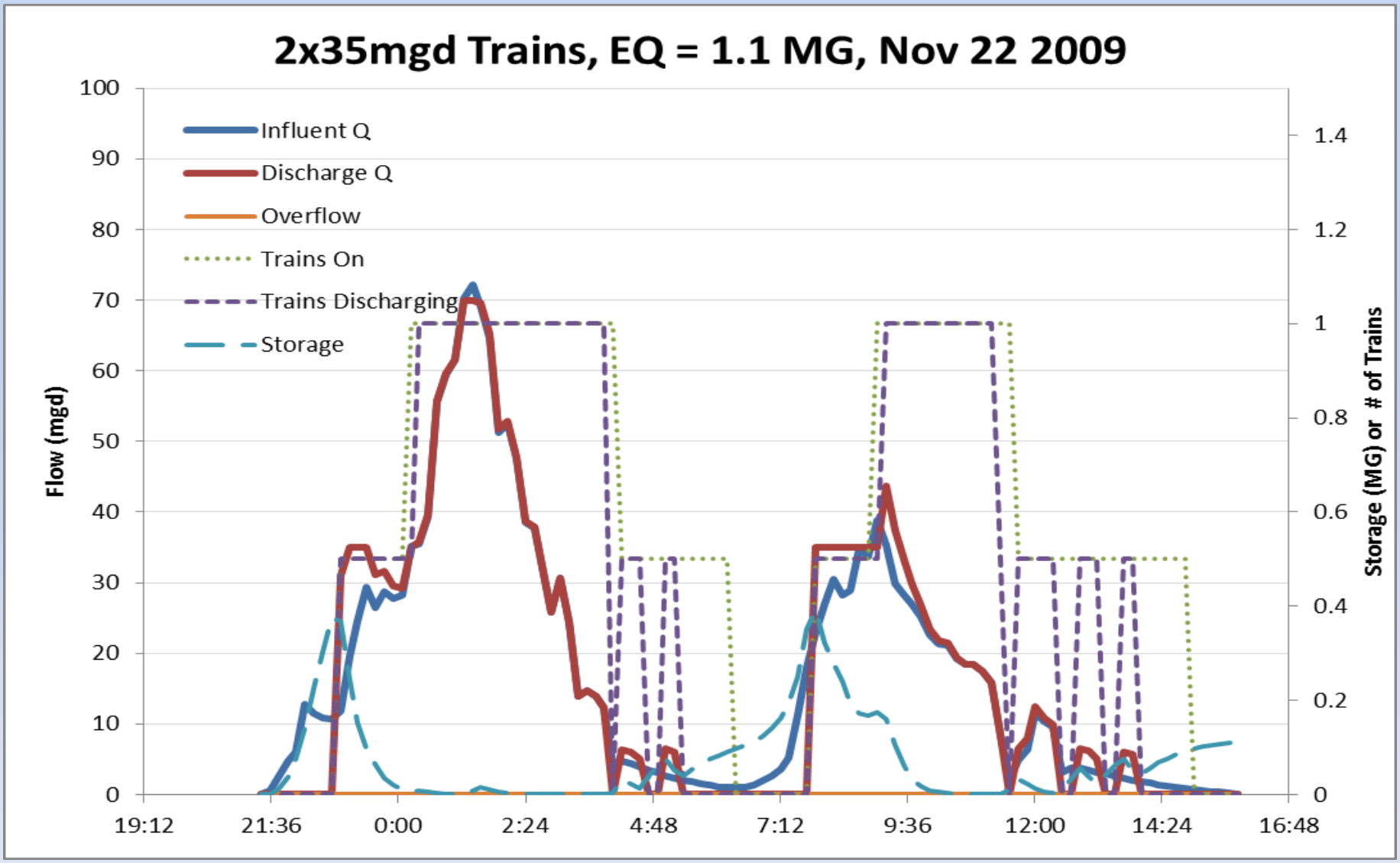

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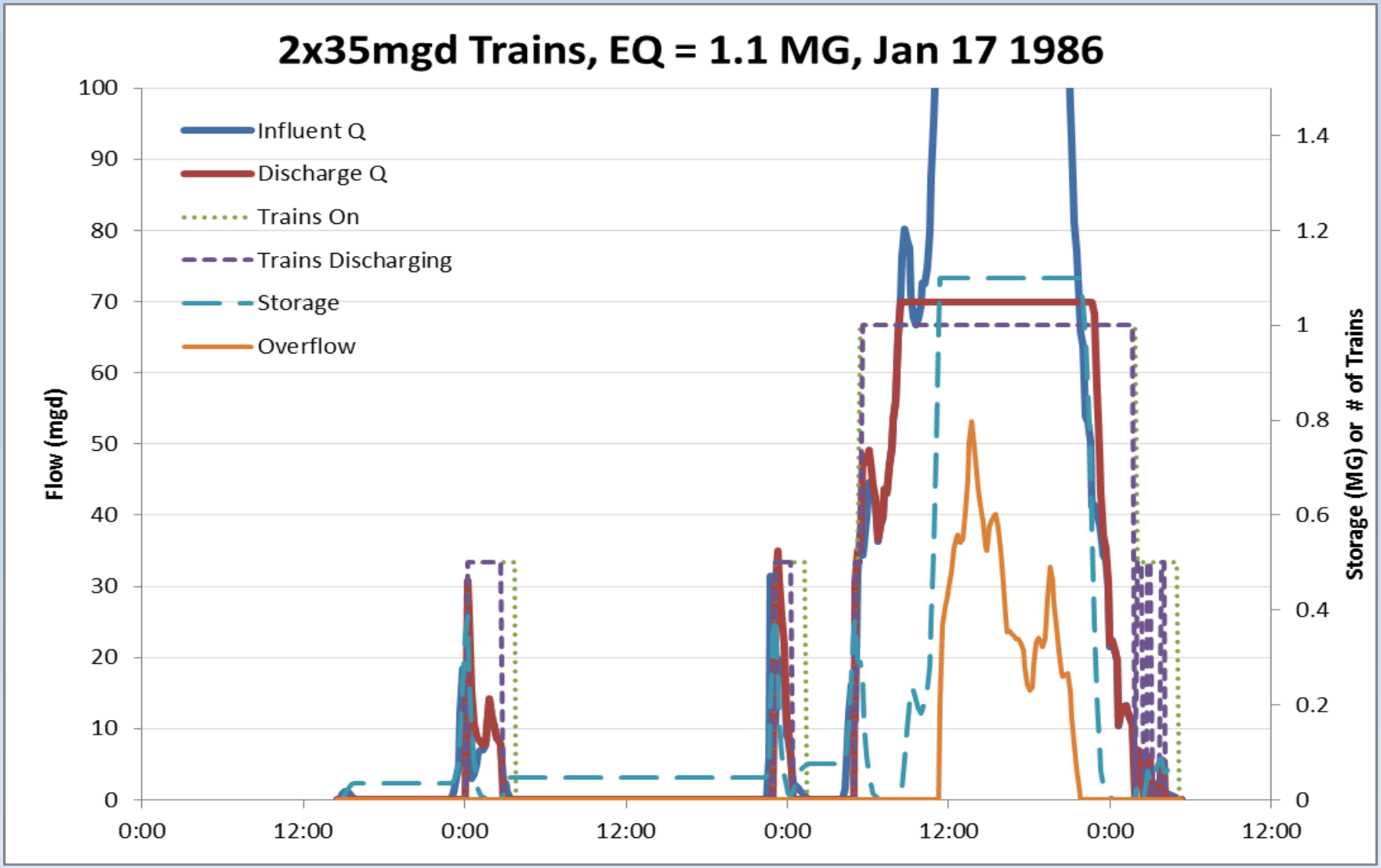
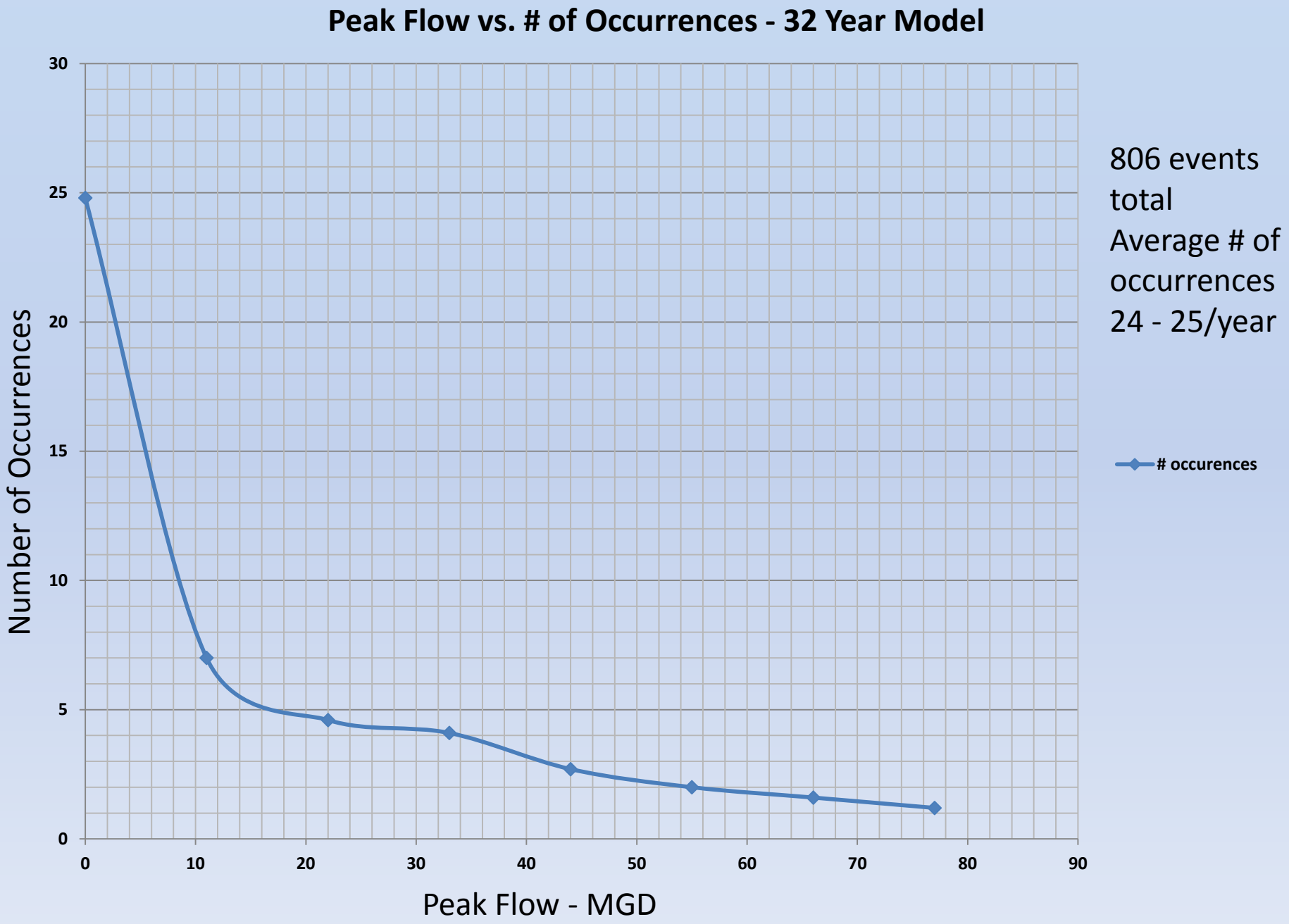
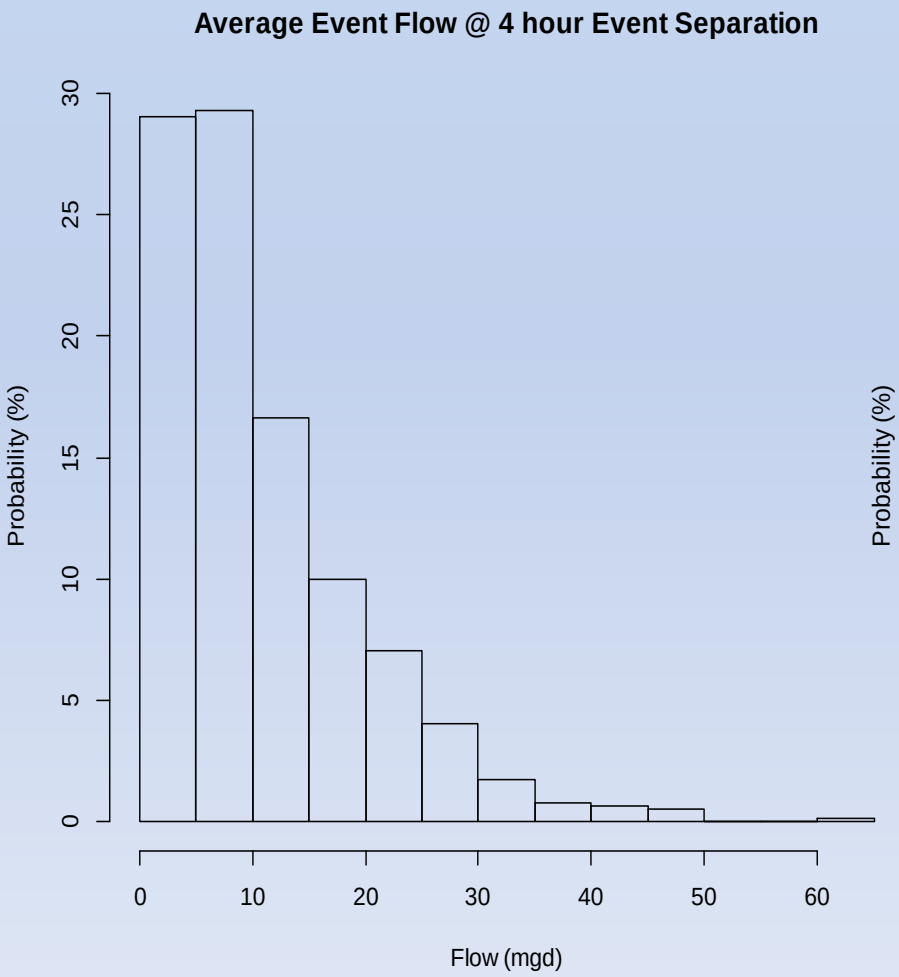


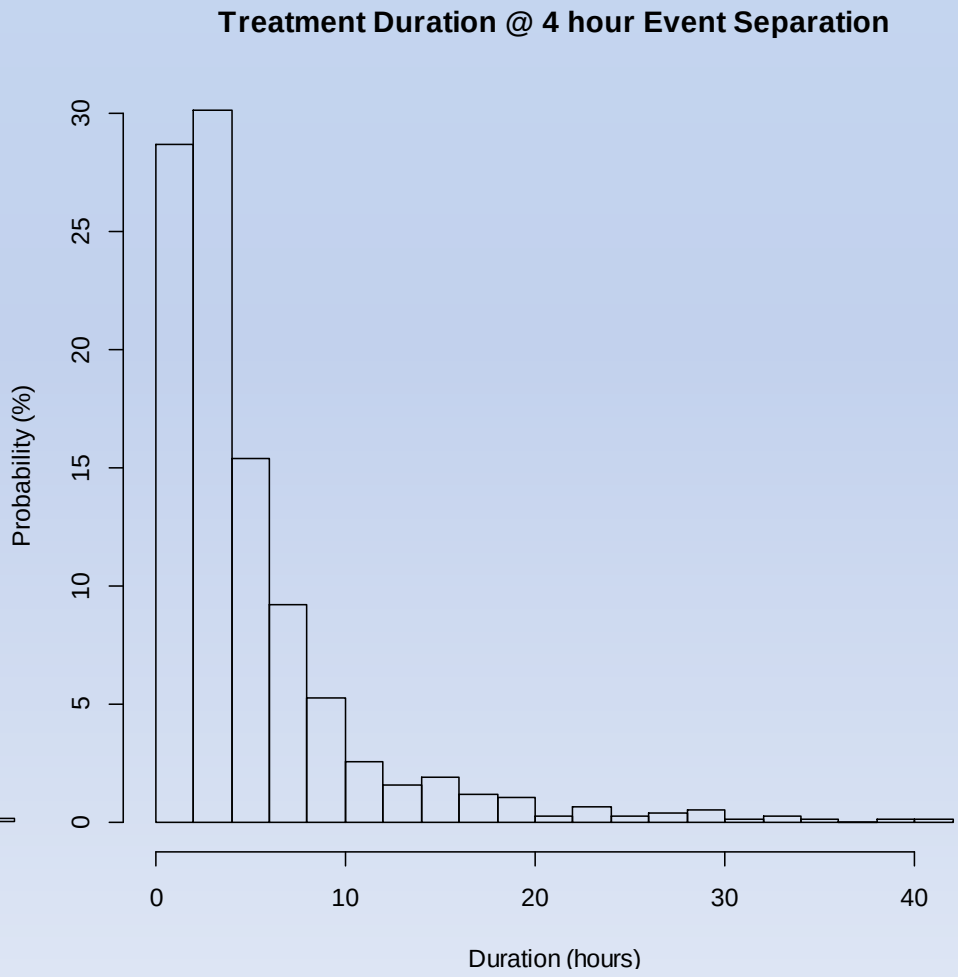


806 events total

Average # of occurrences 24 - 25/year

Storm Flow & Duration Probability

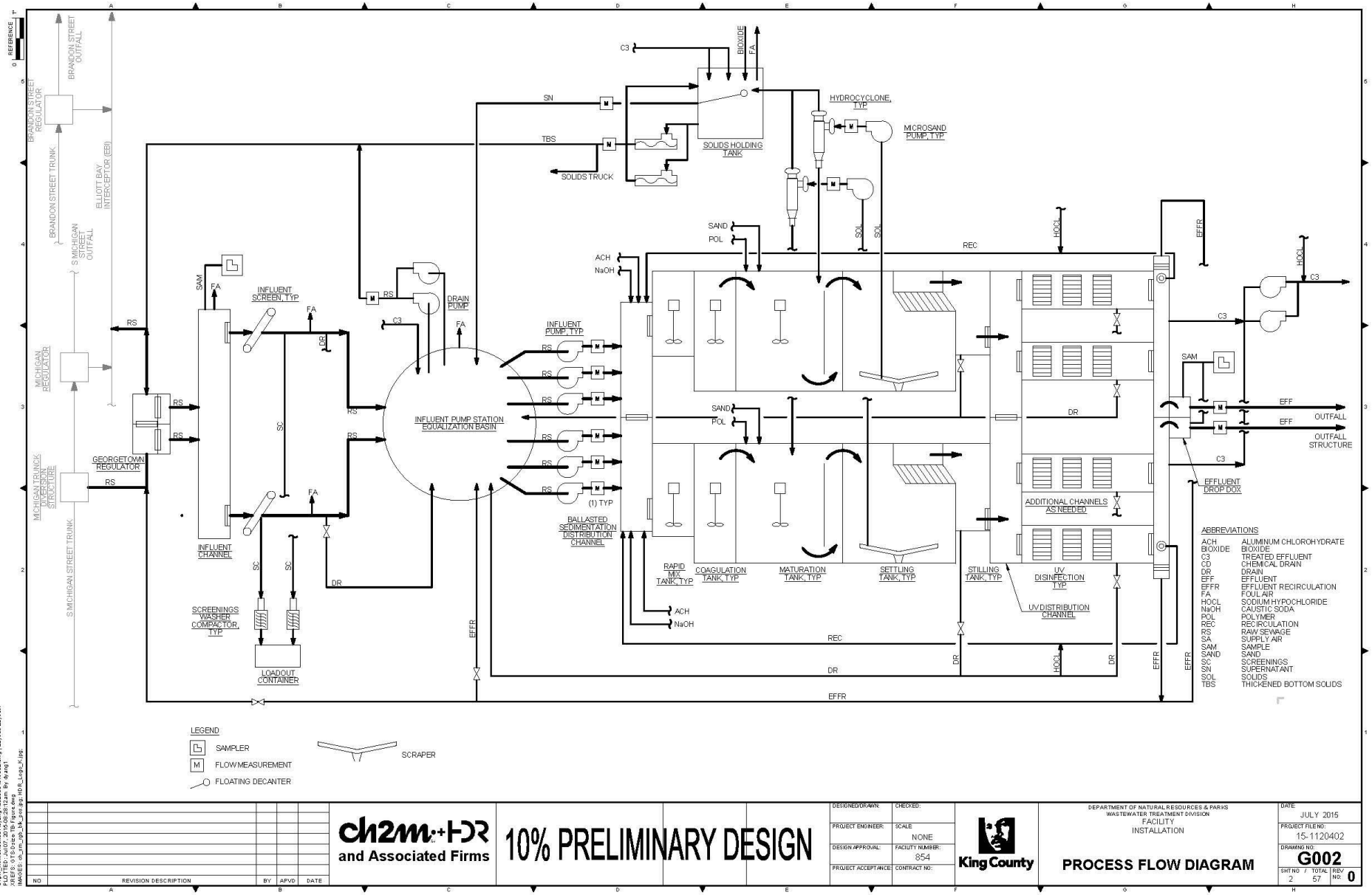




Design Criteria

- Meet the requirements of the Consent Decree
- 1 uncontrolled overflow per year per CSO based on a long term average
- Equal to 20 year return period storm
- Events of greater intensity are uncontrolled CSOs
- Treatment process will produce effluent that is above permit requirements

GWWTS Schematic



ch2m:+HDR and Associated Firms

10% PRELIMINARY DESIGN

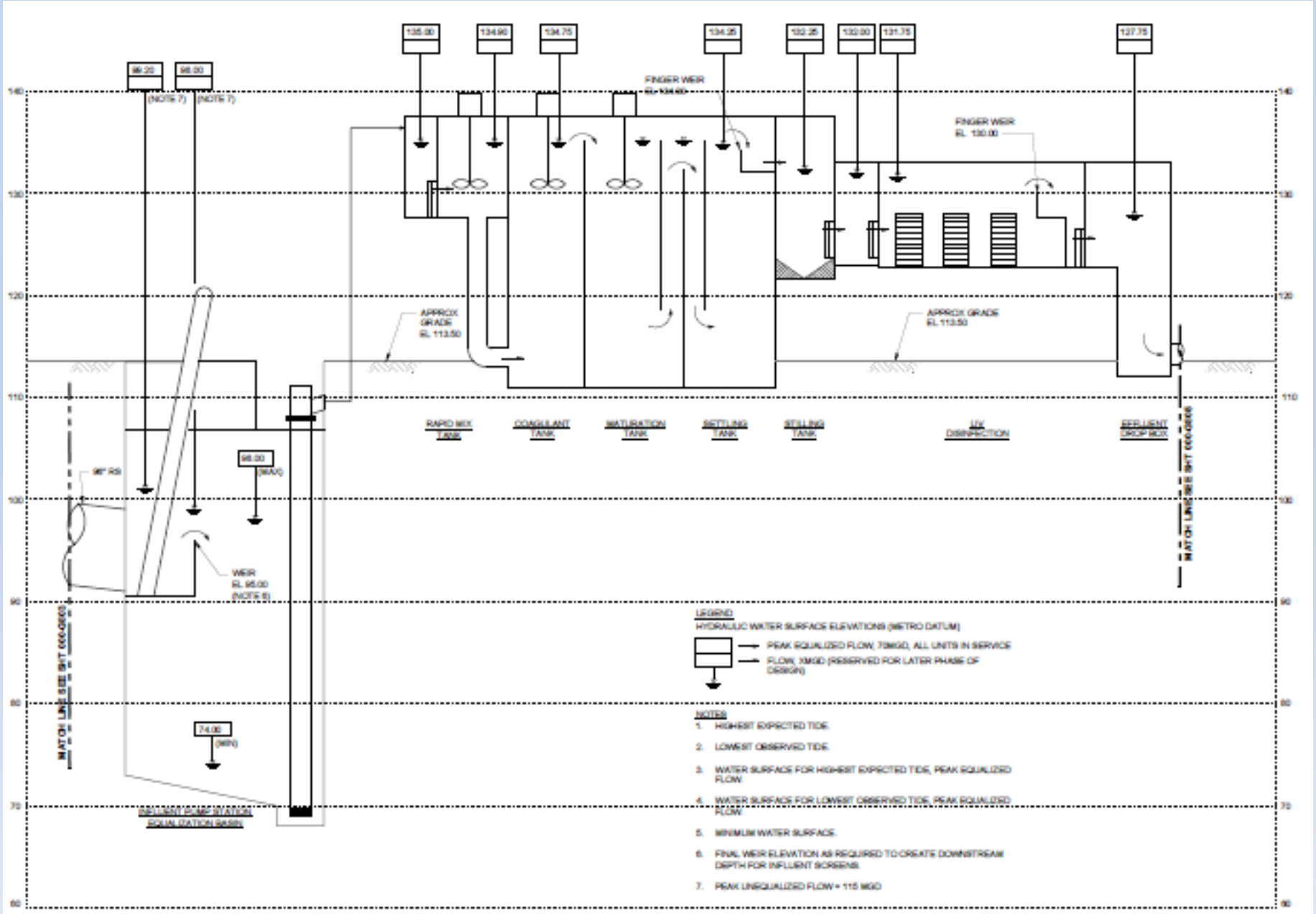
King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION
FACILITY INSTALLATION

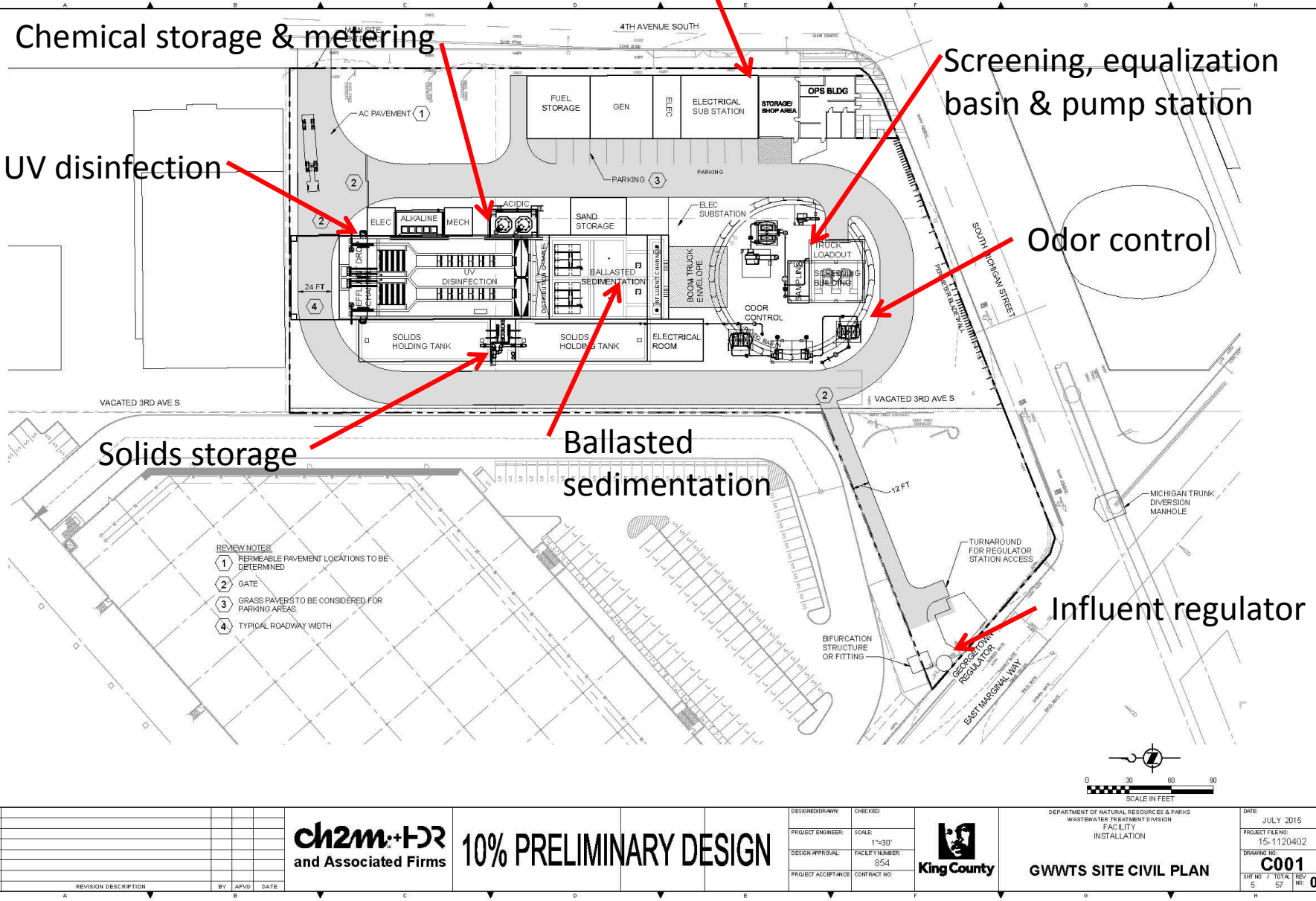
PROCESS FLOW DIAGRAM

DATE: JULY 2015
PROJECT FILE NO: 15-1120402
DRAWING NO: G002
SHT NO / TOTAL: 2 / 57
REV NO: 0

Hydraulic Profile



GWWTS Plan


Control room, electrical & maintenance
Chemical storage & metering
Screening, equalization basin & pump station
UV disinfection
Odor control
Solids storage
Ballasted sedimentation
Influent regulator
4TH AVENUE SOUTH
FUEL STORAGE
GEN
ELEC
ELECTRICAL SUB STATION
STORAGE/ SHOP AREA
OPS BLDG
AC PAVEMENT
PARKING
ELEC
ALKALINE
MECH
ACIDIC
SAND STORAGE
ELEC SUBSTATION
UV DISINFECTION
BALLASTED SEDIMENTATION
BOOM TRUCK ENVELOPE
TRUCK LOADOUT
SCREENING BUILDING
ODOR CONTROL
SOLIDS HOLDING TANK
SOLIDS HOLDING TANK
ELECTRICAL ROOM
24 FT
VACATED 3RD AVE S
VACATED 3RD AVE S
SOUTH MICHIGAN STREET
12 FT
MICHIGAN TRUNK DIVERSION MANHOLE
TURNAROUND FOR REGULATOR STATION ACCESS
BIFURCATION STRUCTURE OR FITTING
GEORGETOWN REGULATOR
EAST MARGINAL WAY
REVIEW NOTES:
1 PERMEABLE PAVEMENT LOCATIONS TO BE DETERMINED
2 GATE
3 GRASS PAVERS TO BE CONSIDERED FOR PARKING AREAS
4 TYPICAL ROADWAY WIDTH
SCALE IN FEET
ch2m:+HDR and Associated Firms
10% PRELIMINARY DESIGN
King County
DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION
FACILITY INSTALLATION
GWWTS SITE CIVIL PLAN
JULY 2015
15-1120402
C001

Areas to be discussed

- Influent conveyance
- Screening
- Equalization basin
- Pumps
- Treatment
- Disinfection
- Solids storage
- Solids pumping

Interim use ≠ 24/7/365

Different “rules” apply

There is time for repair and recovery

Flow varies with events

Water quality varies between & within events

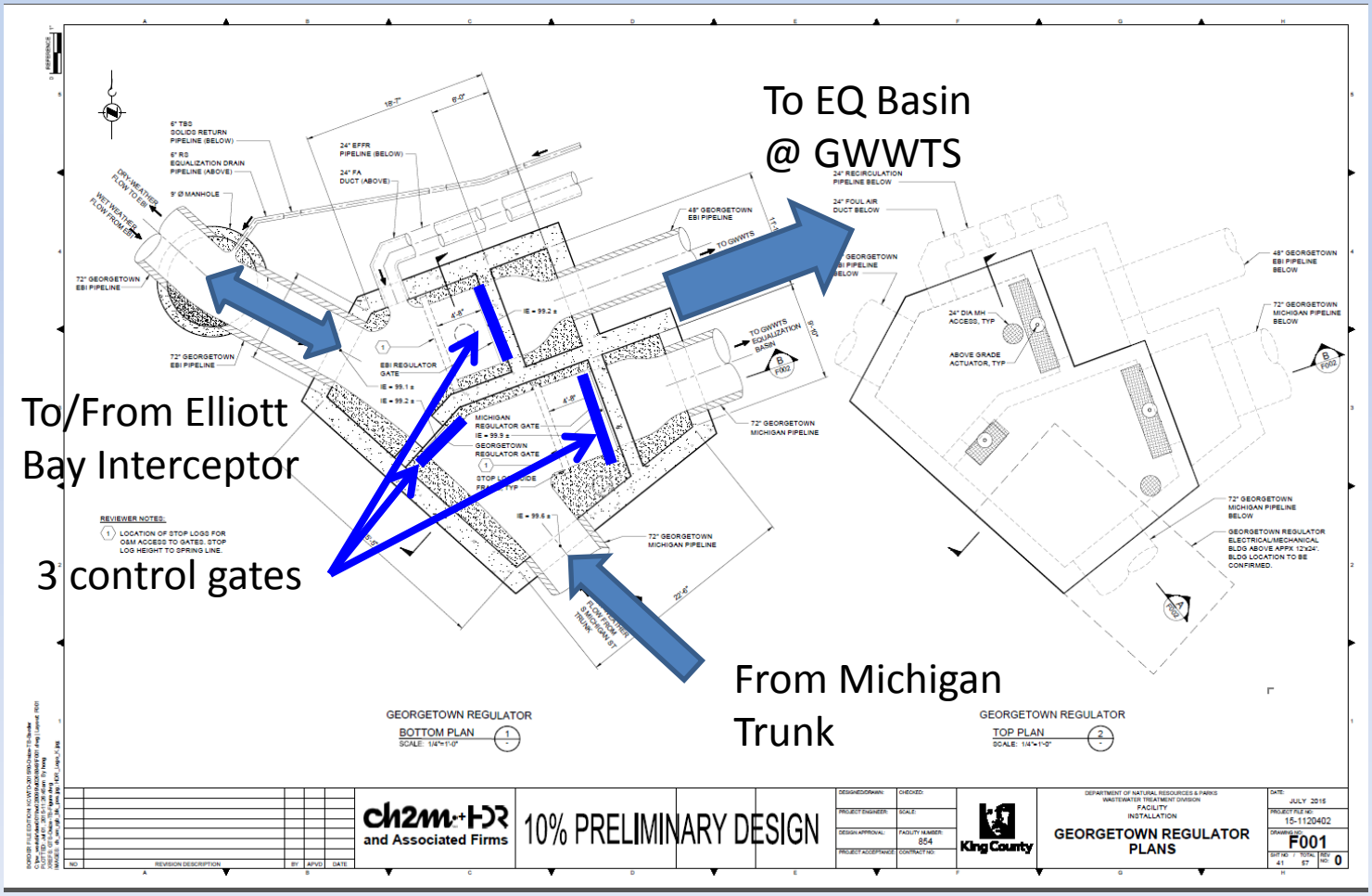
Event duration varies

Basin characteristics do not vary:

- Flashy basin with rapid flow changes
- Impact of upstream and downstream basins on the same interceptor

Influent - Regulator

- Two diversions
  - Michigan trunk
  - Elliott Bay Interceptor
- Regulator with three control gates
- Capacity of each trunk peak or combined peak

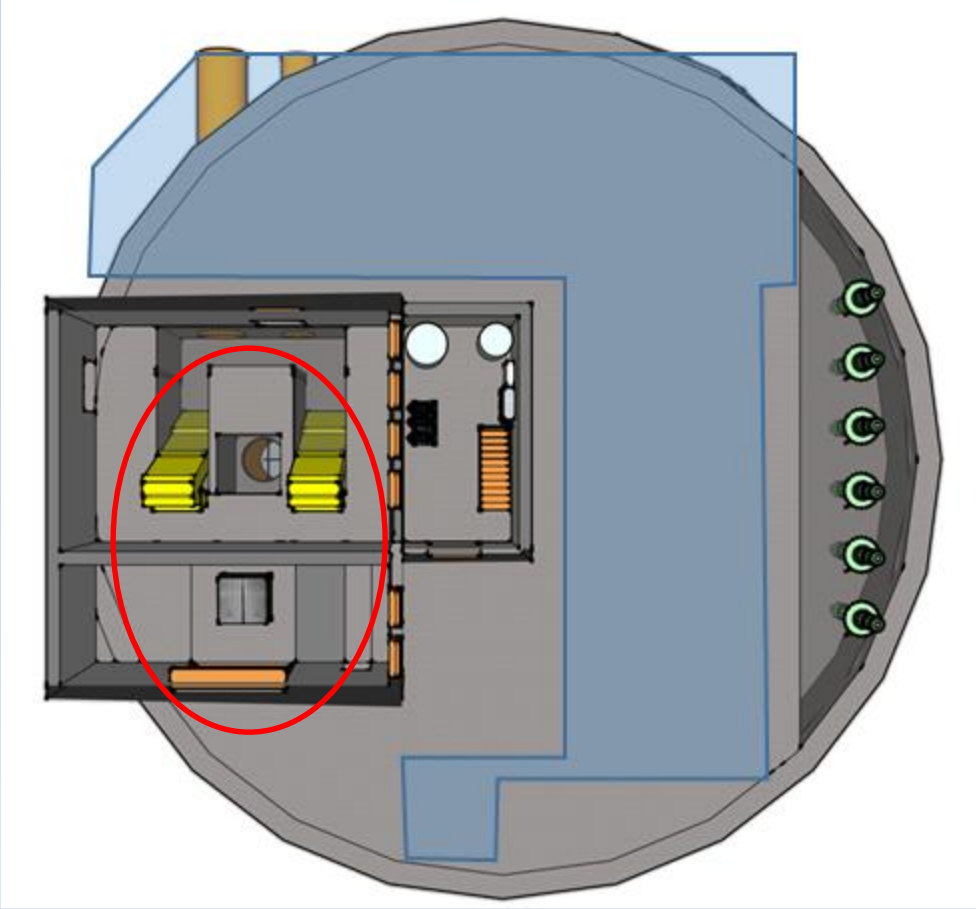


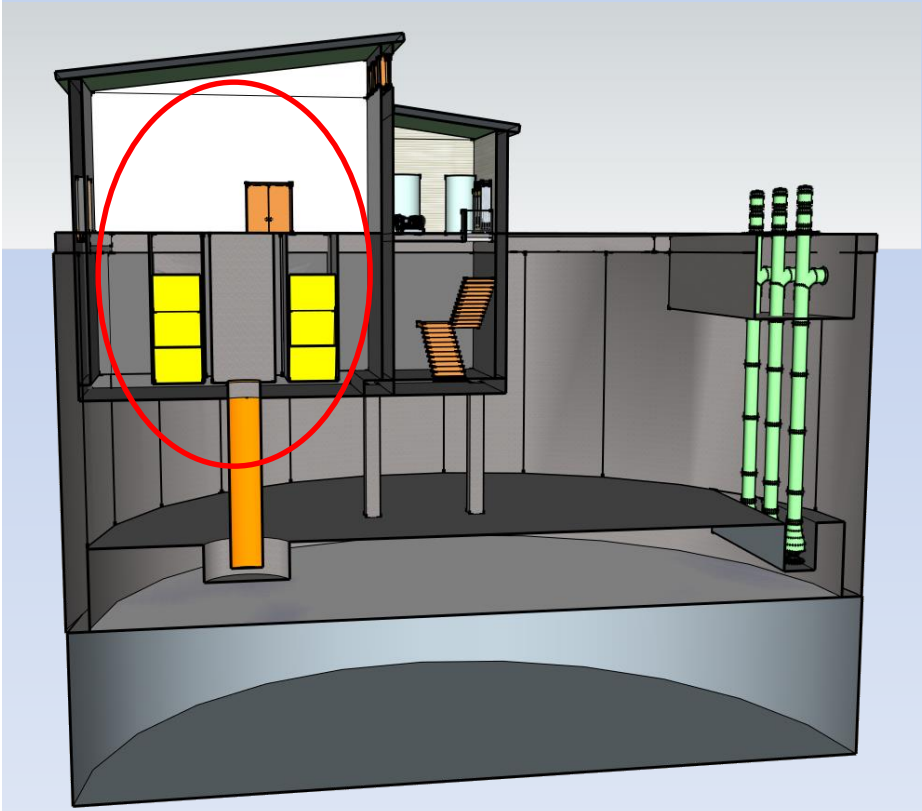
Influent - Sizing

- Regulators
  - Brandon – pull flow off EBI to make room for Brandon flow, peak rate: 35 MGD
  - Michigan – diversion on the trunk sewer, peak flow: 112 MGD
  - Combined peak flow: 115 MGD
- Influent piping, gates sized for this flow

Screening/ Equalization/Pumping

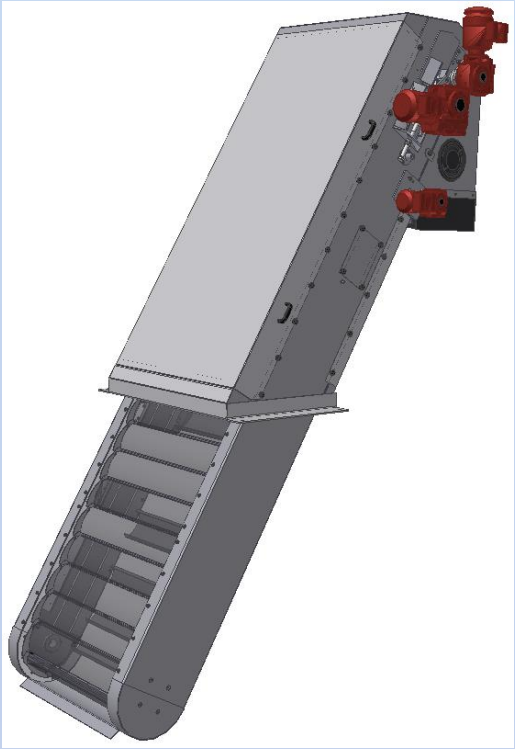
- All in one structure
- Screen capacity 115 MDG
- Overflow into EQ basin
- Possible overflow at Michigan CSO





Screening/ Equalization/Pumping

Graphic from Nordicwater.com

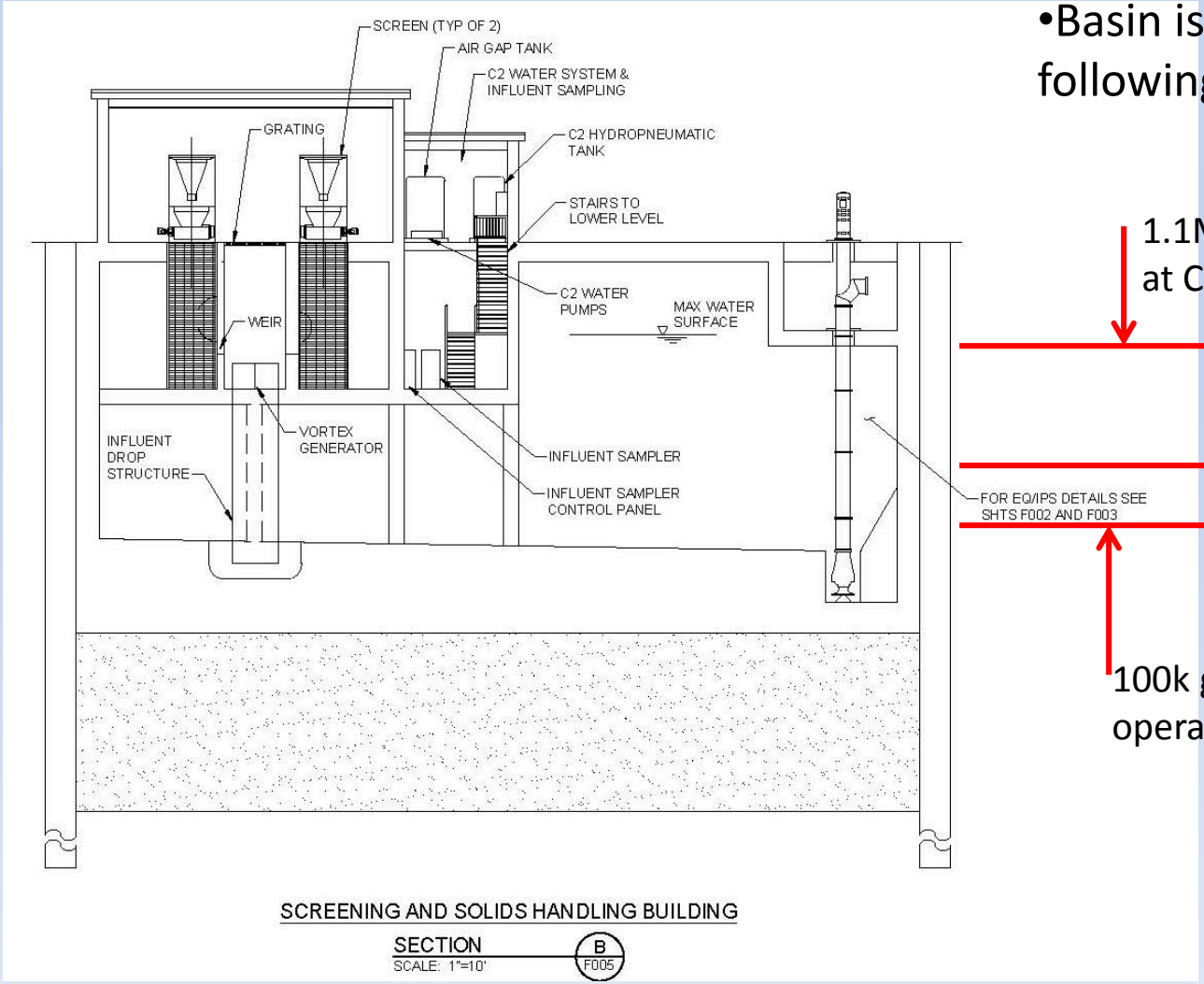


- Multi-rake bar screen
- Screenings washing and compacting
- Two trains, flow equally divided
- Both components sized for ½ peak influent
- No redundancy 2 + 0
- Need to clean washer/compactor between events – sawdust bin!

✓Installed at other plants
✓Good track record
✓Loss of cleaning doesn't mean 0 flow
✓ Increases head and drives flow through
✓High CSO flows = lower solids loading

Screening/ Equalization/Pumping

- 1.1 MG total usable volume in Equalization Basin
- Operate at 100k gallon level
- 1 MG "reserved" for storage
- Basin is flushed and drained following each event



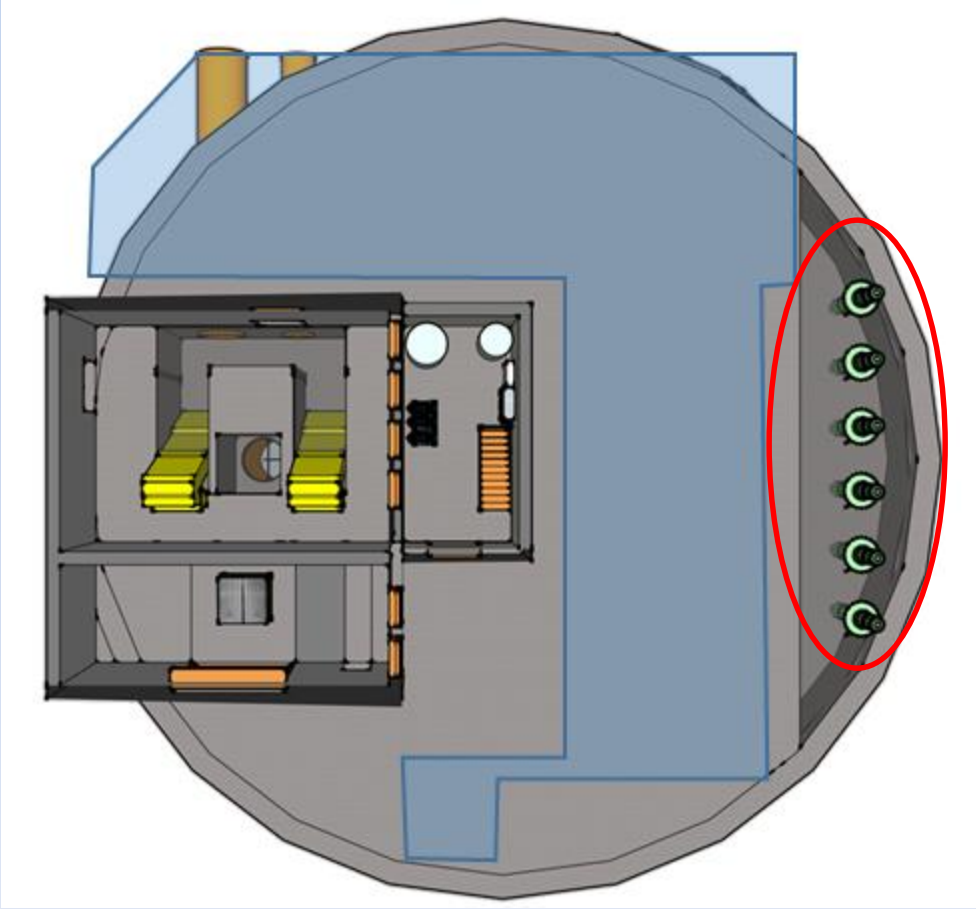
1.1MG – Max. WS, overflow at CSOs

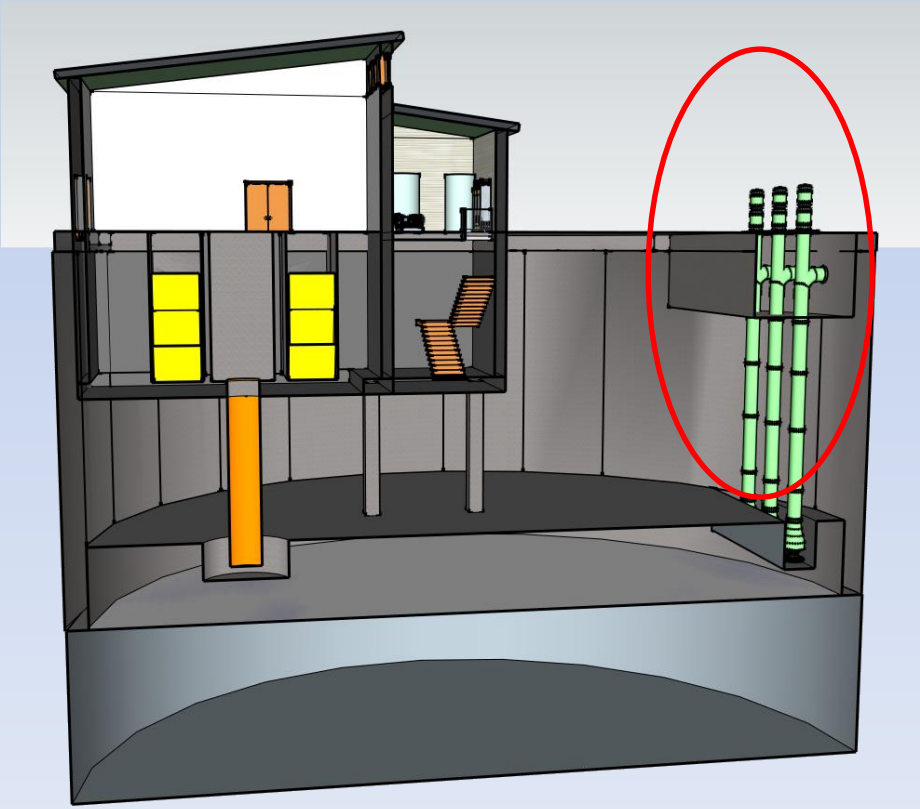
100 - 400k gallons – Volume for treatment "startup"

100k gallons – Min WS for pump operation

Screening/ Equalization/Pumping

- Pumps in wetwell
- Vertical Turbine Sewage Pumps
- 3 pumps/treatment train
- 35 MGD/train
- 2 @ 10x MGD & 1 @ 16 MGD





Screening/ Equalization/Pumping

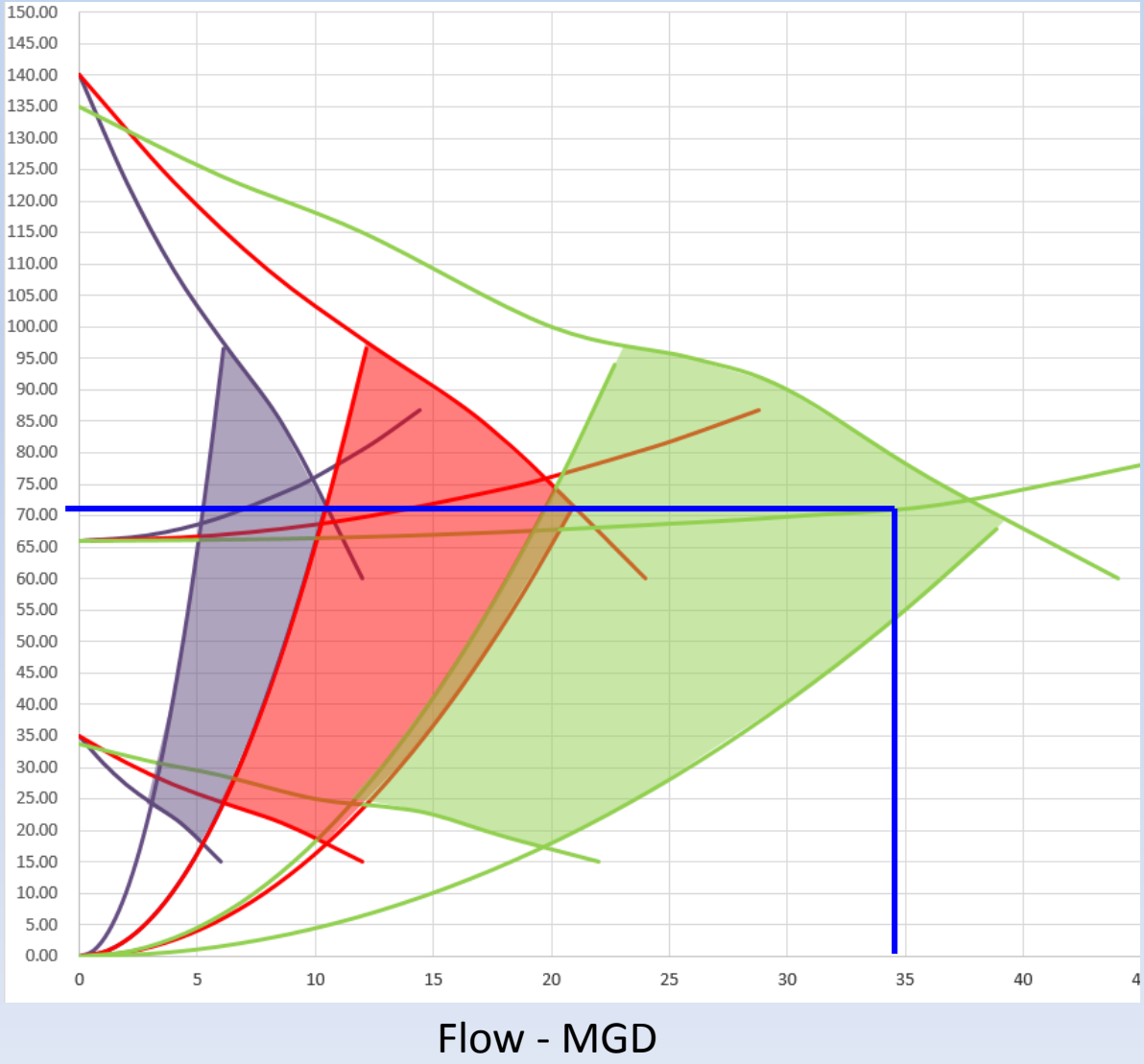
Graphic from Fairbanks Nijhuis

- Typical pump station standard
  - Dry pit submersible
  - Dry well pump w/ motor above flood elev.
  - Not comfortable with large submersibles
- Dry pit construction prohibitively expensive
- Vertical Turbine Sewage Pumps selected
- Installed screening upstream to minimize potential for clogging
- New pump style for WTD but used elsewhere

Screening/ Equalization/Pumping

- In the event of loss of a pump
  - Normal EQ basin operating WS is 100,000 gallon level
  - If inflow > pumping capacity water surface level rises
  - Static head & TDH decreases
  - Remaining pumps push further to the right on the curve and increase flow
  - Loss of equalization or storage volume

Screening/ Equalization/Pumping

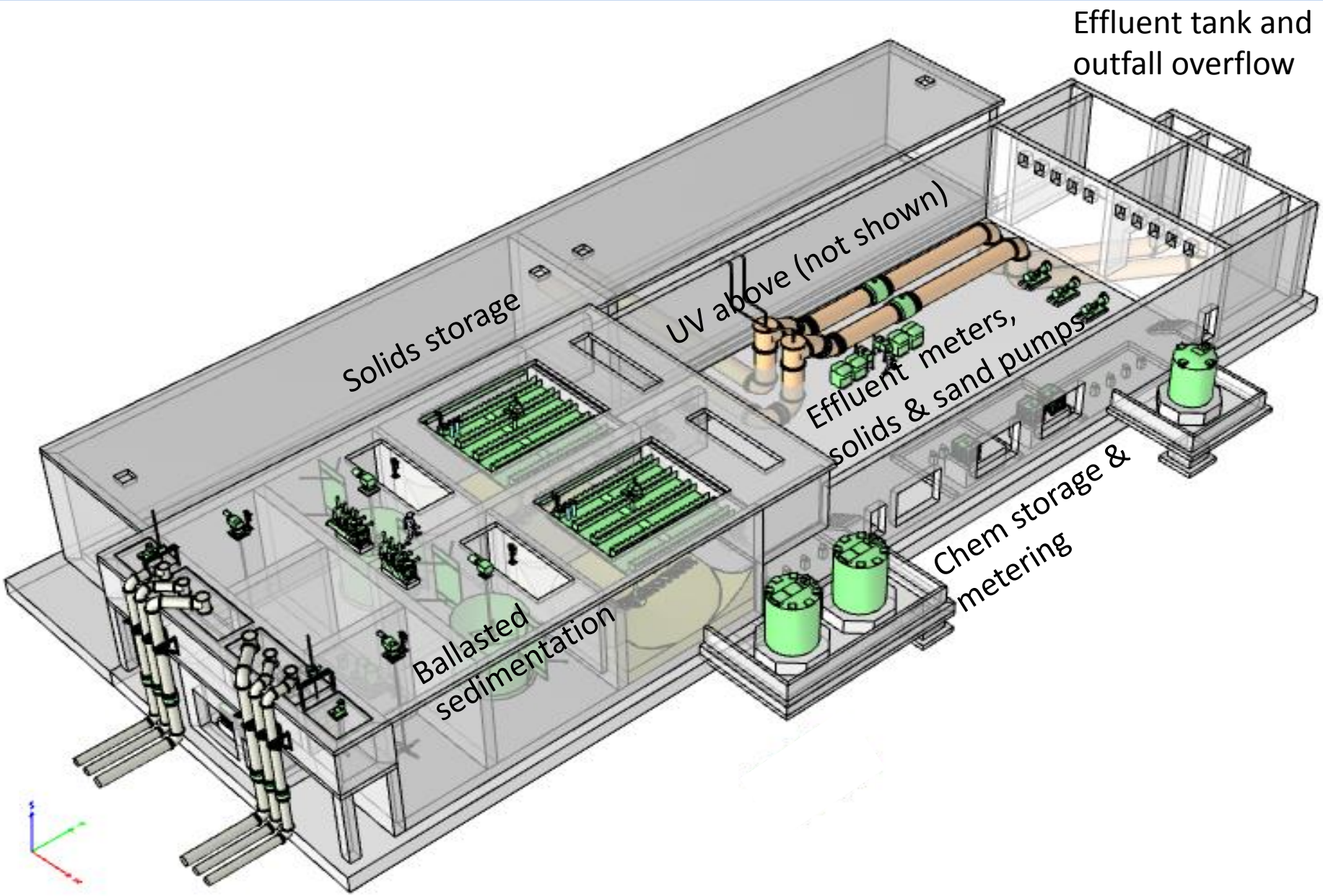


- Pumps dedicated to treatment train
- Each pump piped separately to treatment
- Staggered pump sizes
  - 2 @ 10 MGD each train
  - 1 @ 16 MGD each train
- VFD on all pumps
- Lowest flow 5.5 MGD
- Max capacity 38 MGD

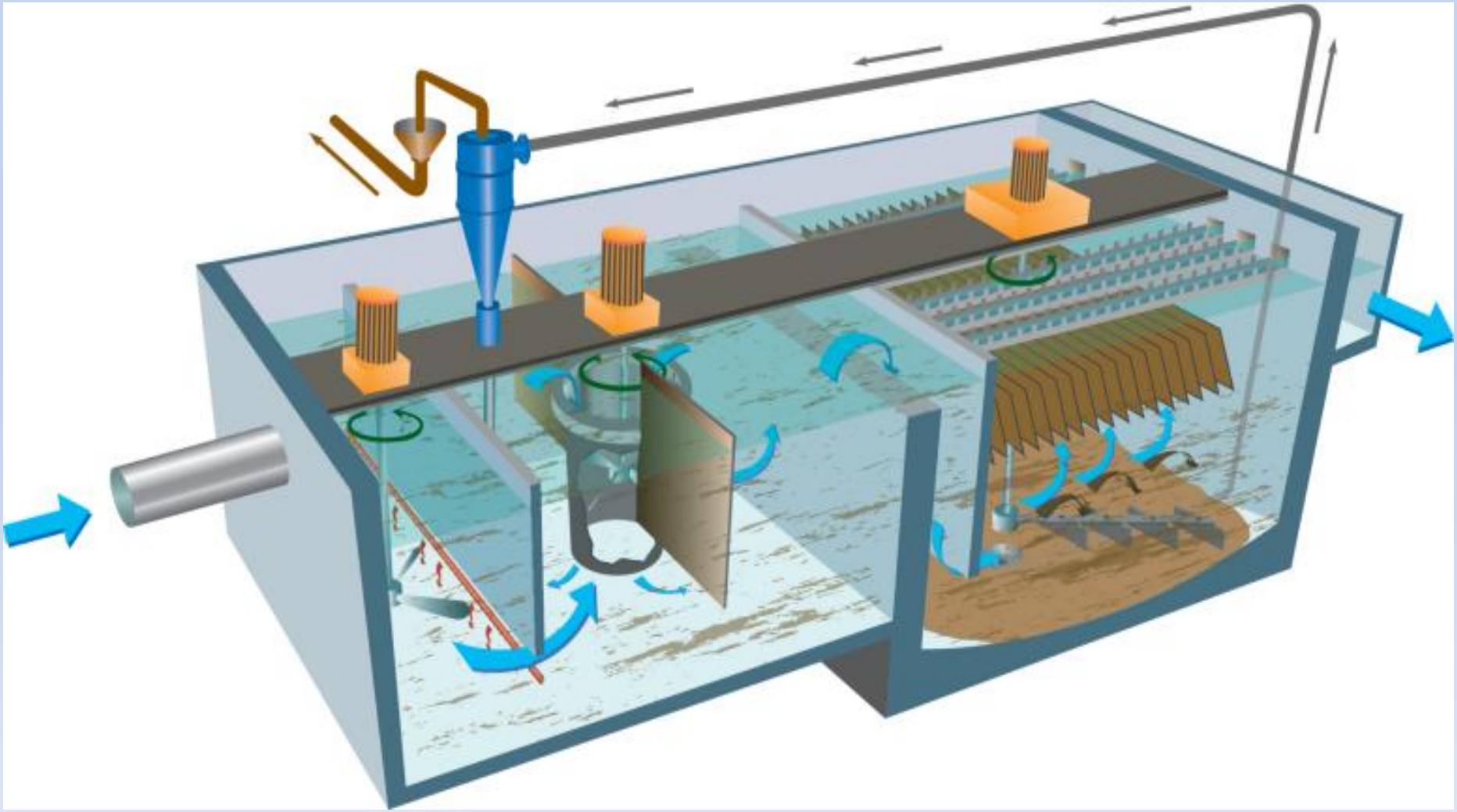
Screening/ Equalization/Drain Pumping

- EQ basin drain pumps
  - Submersible – rail mounted
  - WTD standard for CSO storage
- 100,000 gallons – 1.1 MG remaining to drain
- Empty basin in 24 hours
- 2 + 0 pumps

Treatment Isometric

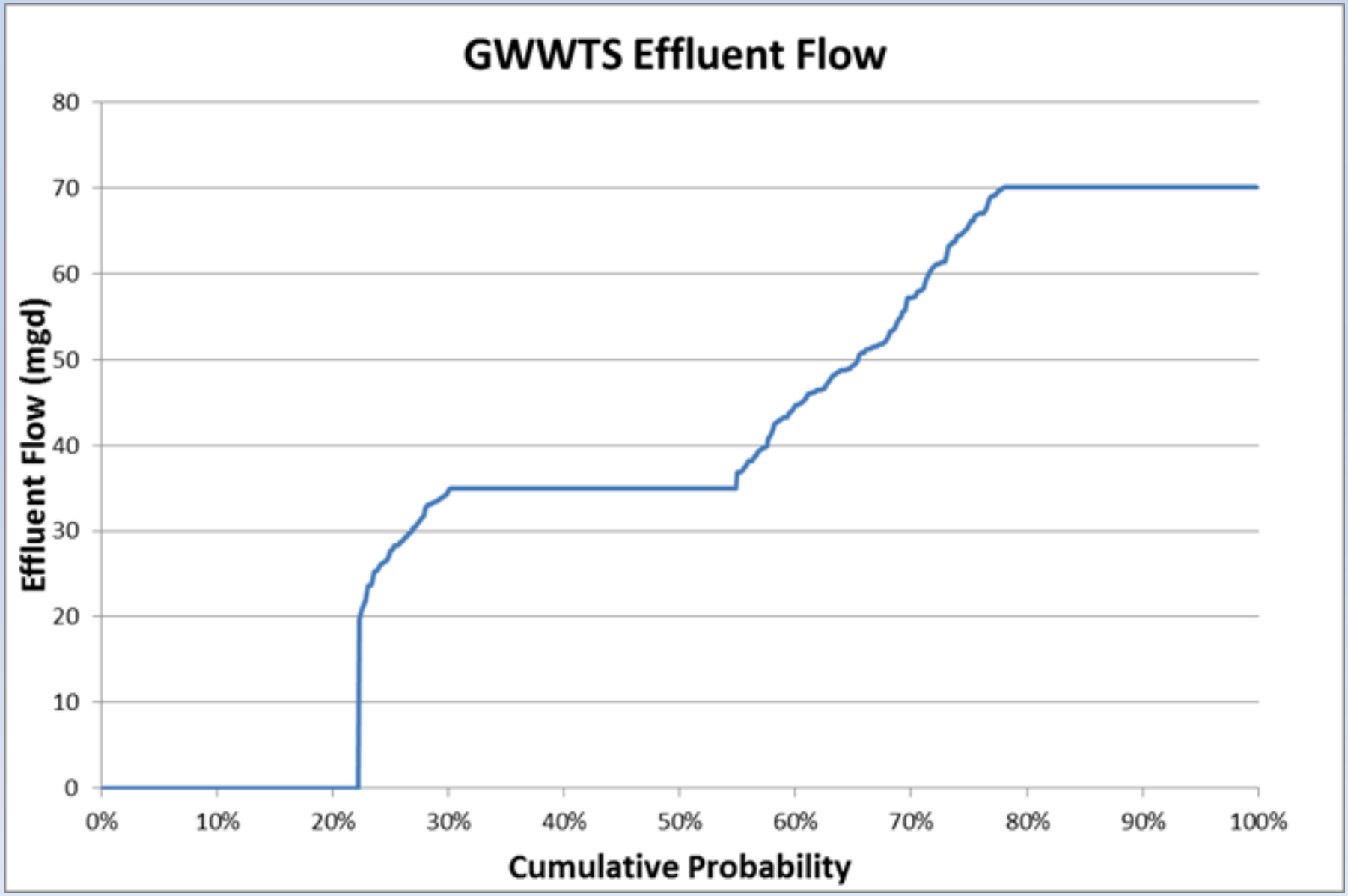


Treatment -Ballasted Sedimentation Schematic



Graphic from Veolia

Treatment Operation Scenario



Treatment - Ballasted Sedimentation

- Two 35 mgd trains
- Expected range 5.5 – 70 mgd
- Preselected – Sole source
- Redundancy in
  - Sand pumps & hydrocyclones (2+1)
  - Chemical feed pumps (?+1)

Graphics from City of Anacortes

Treatment System Operation

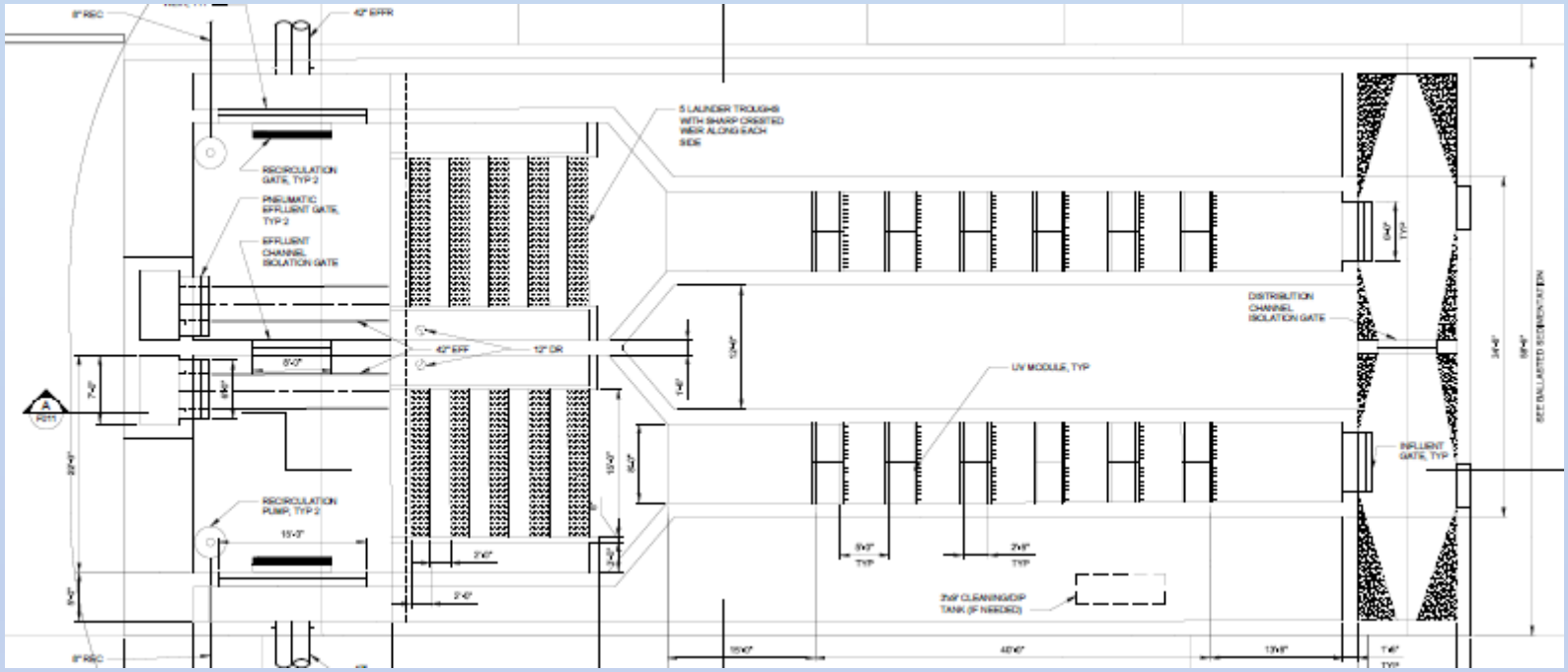
- Pumping and treatment starts when EQ basin reaches 100,000 gallon level
- Recycle flow until process stabilizes and EQ basin level reaches 400,000 gallons (15 minutes at peak inflow)
- Once process is stable discharge to outfall
- Pump and treat to match inflow up to 70 mgd
- Store influent > 70 mgd
- Aim is to keep EQ basin at 100,000 gallon level

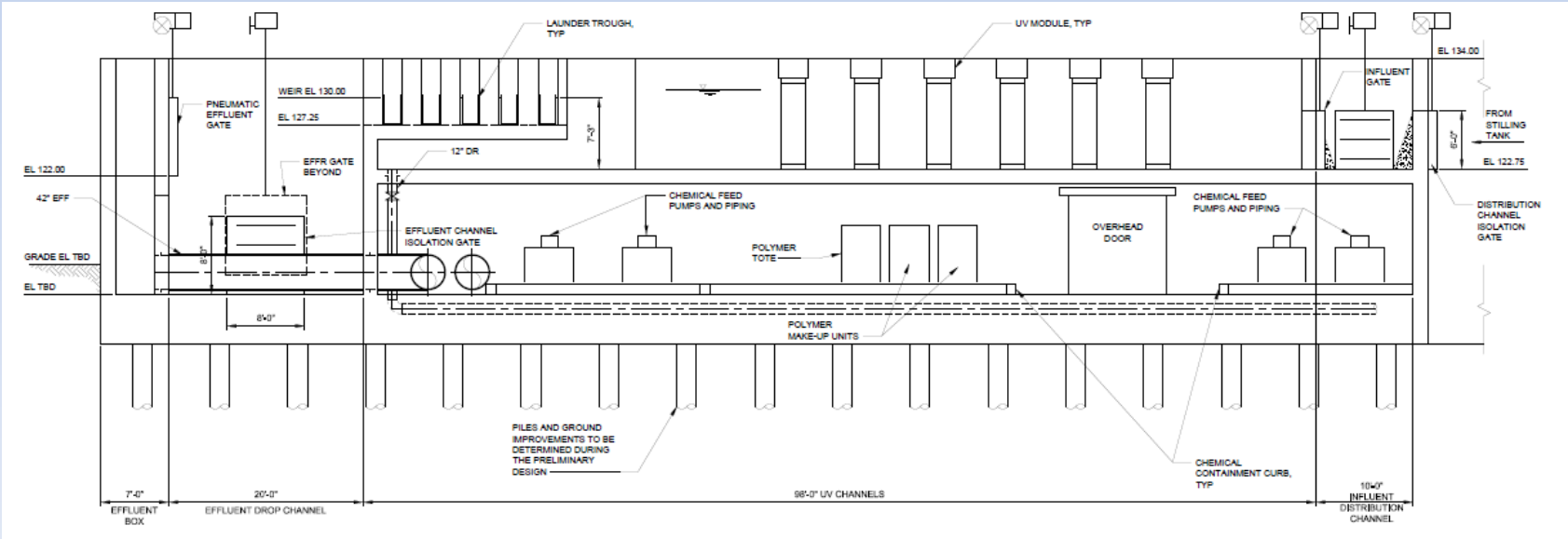
Treatment System Variations

- If operator is on site and storm has a certain end in sight operator can elect to store and not discharge

•Loss of train or partial capacity could result in increased storage and reaching CSO level
•Out of spec water could affect UV
•Experience shows a high degree of reliability in these systems

Treatment - Disinfection





Treatment - Disinfection

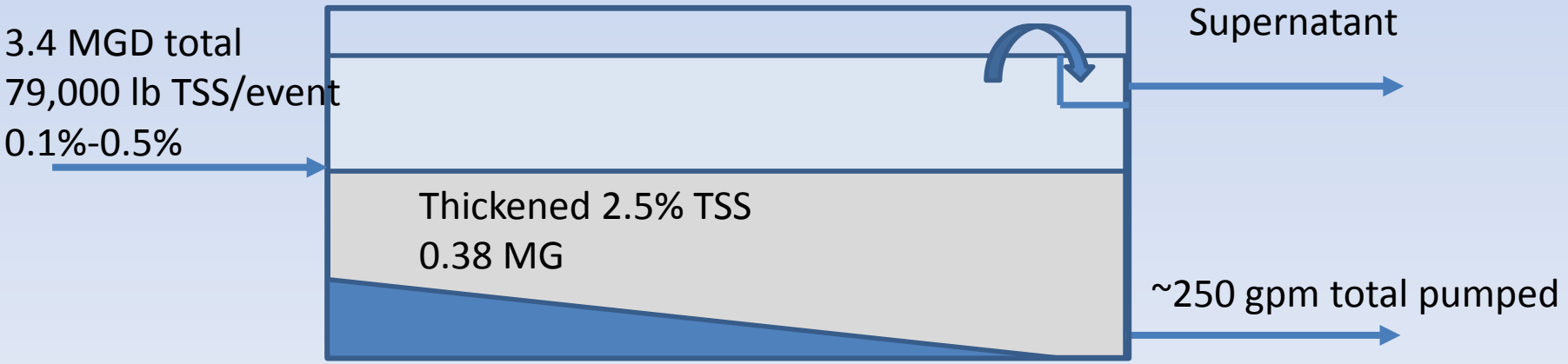
- UV – Two trains, 35 mgd each
  - Maybe multiple units for each train
  - Five manufacturers have expressed interest
  - Contact and non-contact style
  - Differences between models, size & configuration
- Disinfection criteria defined in RFP, intensity & kill
- RFP currently on the street – evaluated proposals – two phase contract
  - Design and shop drawings – contract to GWWTS consultant and County
  - Fabrication, shipping, installation assistance, startup and commissioning – contract with GWWTS GC

- UV started when ballasted sedimentation starts
- Some redundancy in the UV design
- Poor treatment means violation of WQ standards

Solids Storage

- Alongside treatment structure
- Solids from the overflow at the cyclones
- Very dilute (0.1- 0.5% solids)
- Gravity thickening to 2.5% solids - goal
- Decant returned to treatment process
- 1.7 MGD peak inflow and overflow

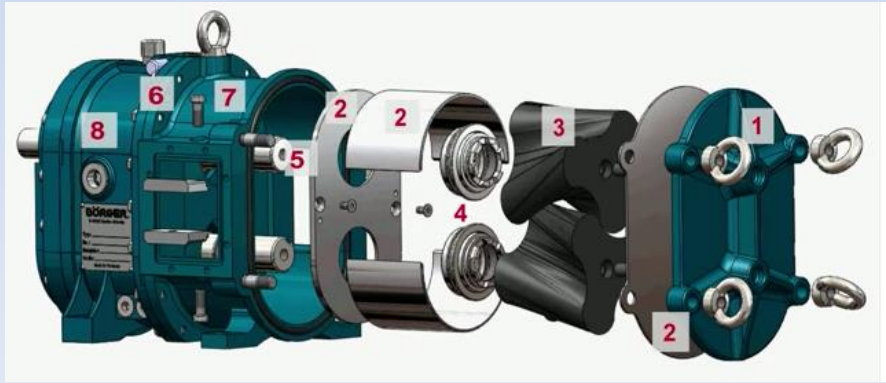
•Overflow rate is equal to inflow
•Could recycle solids if they don't thicken



Solids Pumping

- Empty the solids storage tank to EBI w/i 24 hours
- Must wait for EBI to drop level before pumping
- Criteria assumes 2 large storms back to back
- Common header from tanks
- Pumps (progressive cavity or rotary lobe) 2 + 0

•Pump failure means longer pump out time



Graphics from Boerger

Lessons Learned

- Modeling:
  - Modeling is a black art
  - Modelers are never satisfied or finished
  - New data continues to be added and muck up the process
  - Draw a line in the sand and call it good!
- Early decisions on process & equipment saves time and money
- Cooperative and interactive team of the owner's staff and consultants can produce excellent results

Thanks for Attending!

For additional information contact:

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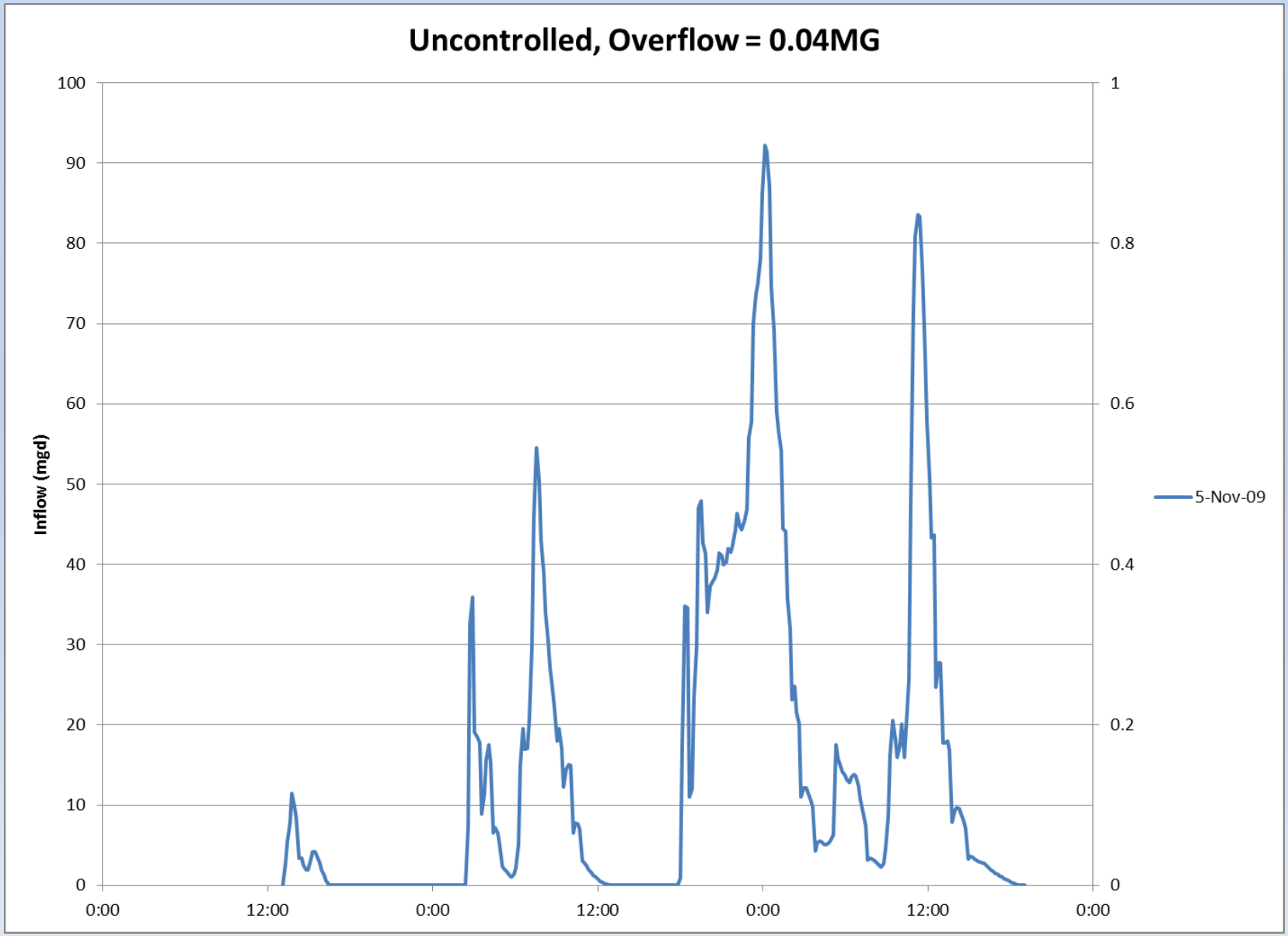
King County

Protecting Our Waters

Doing our part on rainy days

Influent Hydrographs



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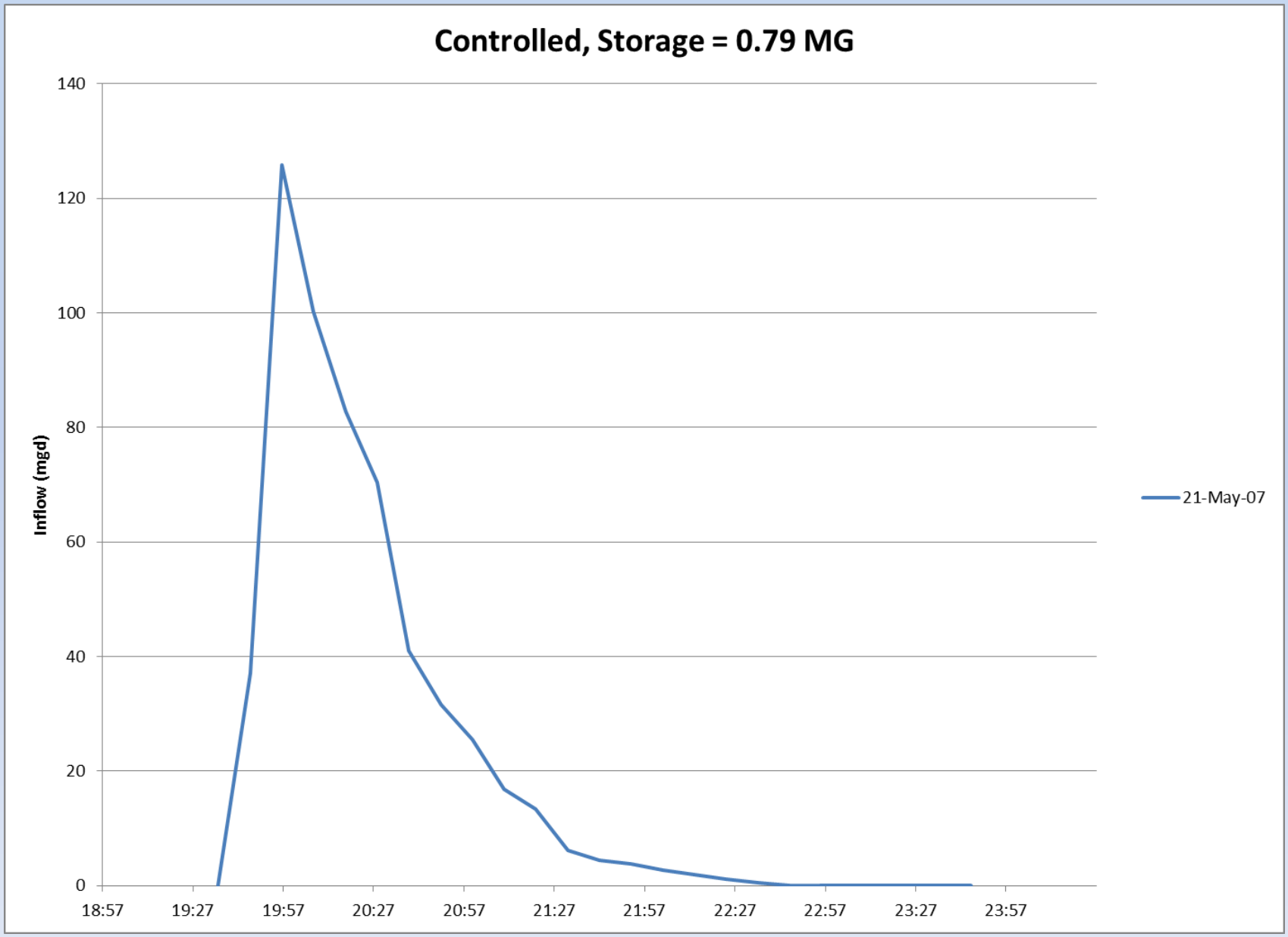

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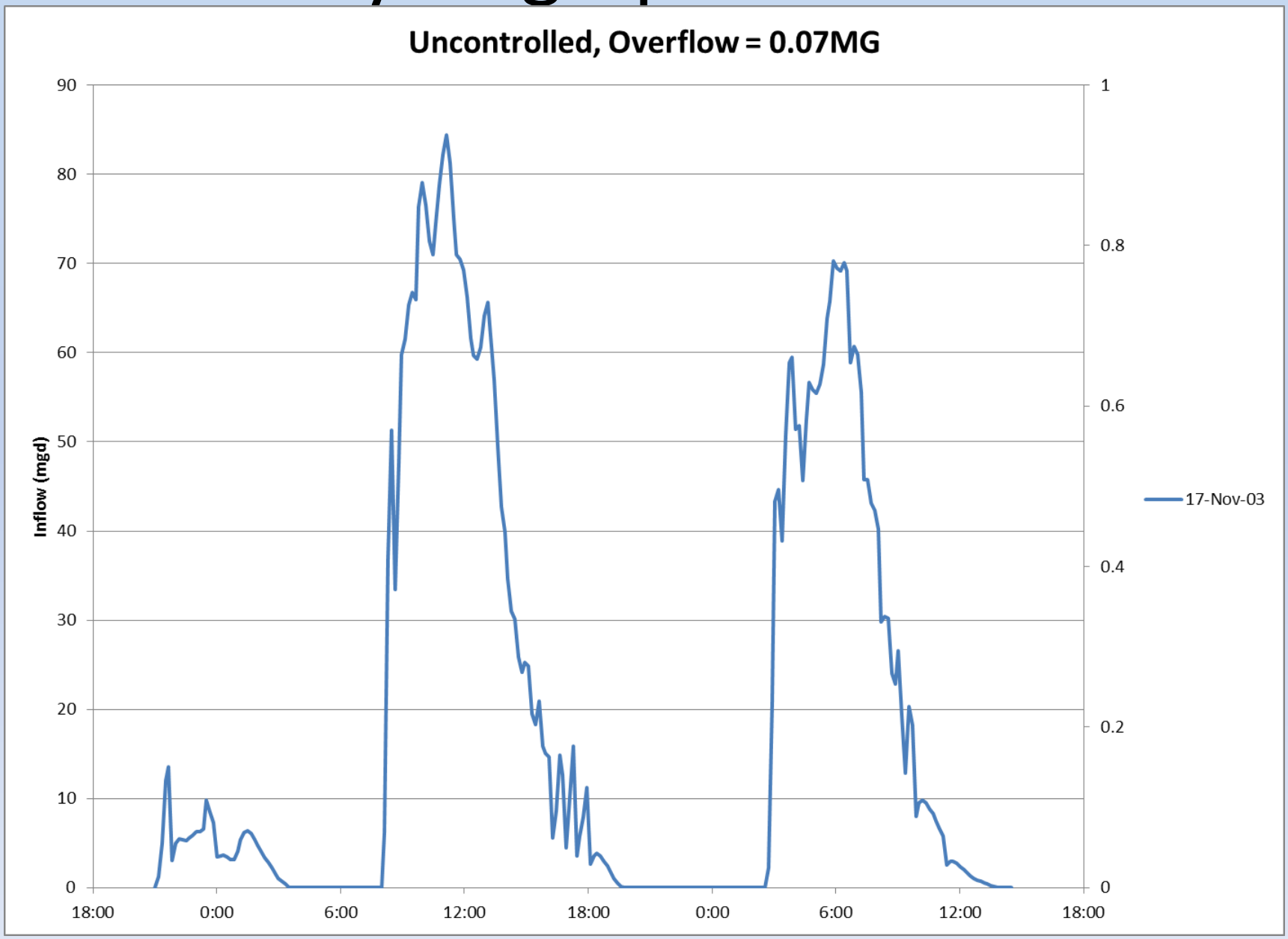

Influent Hydrographs