Presentation for

2014 IDEA Campus Energy Conference

Cooling Tower Basins

Design Considerations and Applications

February 20, 2014

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Agenda

- Basins? Really?
- Industry Standards
- Design Considerations
  - Geometry
  - Materials
  - Hydraulics & Flow
  - Pump Intakes
  - Maintenance
  - Basin Coatings
  - Acoustics
- Design Examples

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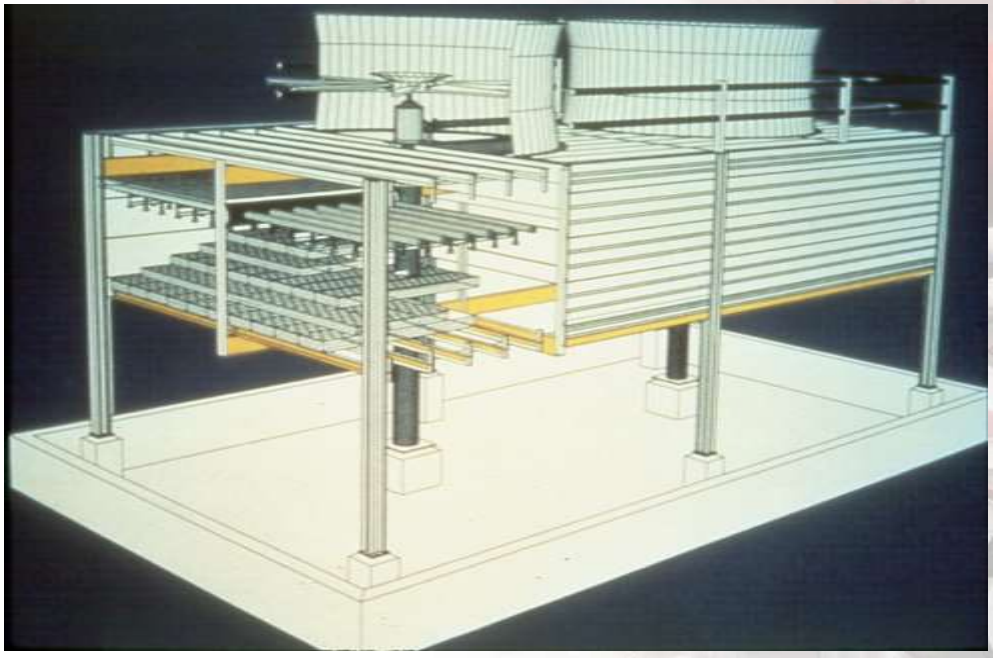
Why Should I Care?

- Typical Basin…



- Provide for:
  - Water retention
  - Tower support
  - Solids collection
  - Maintenance

- Vendor guidance:
  - *Basin design by others…*
  - *Hydraulic design of basin by others…*

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Industry Standards

- CTI Standards: 47; 0 address basin design
- CTI Technical Papers: >1000; 3 address basin design
  - TP10-26: Cooling Tower Basin Leakage Assessment & Mitigation
  - TP02-05: Concrete Basics, Materials, Selection in Design and Repair
  - TP71-07: Design of Concrete Basins for Cooling Towers
- ANSI/HI 9.8: Pump Intake Design - Geometry

- The rest is up to you…

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Design Considerations

- Geometry
  - Cooling tower size/layout
  - Site & available space
  - Water patterns with fan operation
  - Pump types & location
  - Storage volume

Design Considerations

- Materials - Concrete
  - Durability
  - Integrity
- 3 Most Important Concrete Factors
  - Quality Materials
  - Quality Design/Detailing
  - Quality Installation
- How does concrete fail?
  - Corrosion of Embedded Materials
  - Freeze-Thaw
  - Aggressive Chemical Exposure
  - Chemical Reactions of Aggregates

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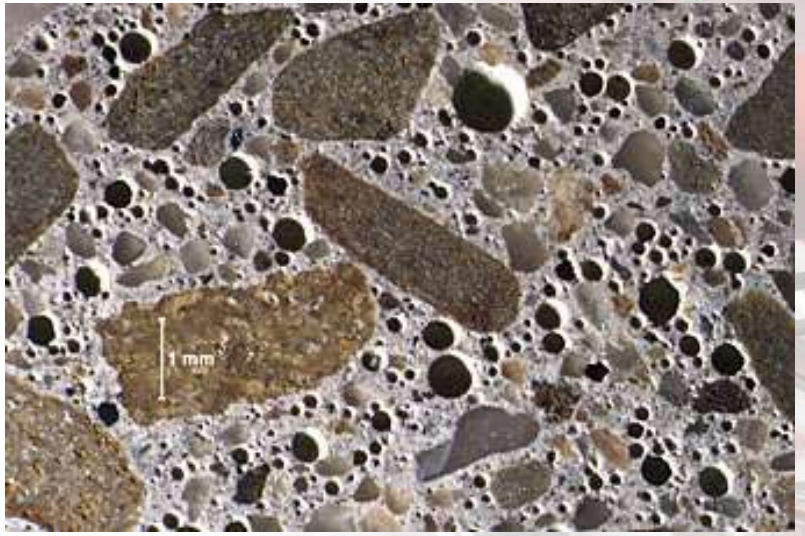
Design Considerations

- Concrete Design
  - Mixtures
  - Control joints
  - Waterstops
  - Pour temperatures
  - Embedded reinforcement



- Subsurface quality
- Structural loading
- Leakage

Design Considerations

- Concrete Specifications
  - Air entraining admixture for freeze thaw resistance
  - To reduce permeability, Fly Ash or Silica Fume
- Reinforcing Steel
  - Epoxy Coated A615 reinforcement - $2,200/ton
  - Hot Dip Galvanized A615 reinforcement - $2,540/ton
  - MMFX reinforcement - $2,500/ton (fewer tons req'd)
  - Stainless Steel - $4,800/ton
- Concrete Cover
  - Concrete cast against earth – 3"
  - Water Retaining Structures – 2"

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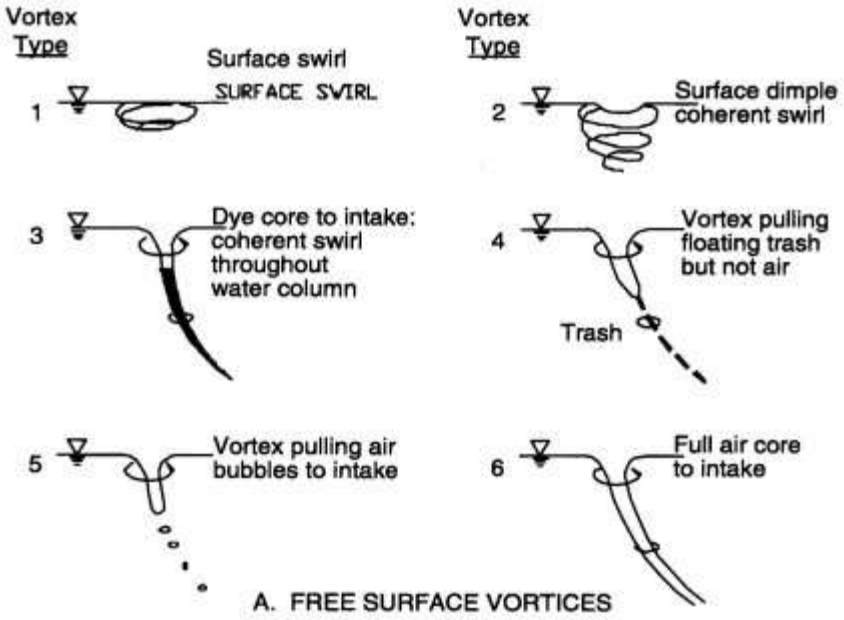
Design Considerations

- Specific phenomena that can adversely affect pump performance:
  - Submerged vortices
  - Free-surface vortices
  - Excessive pre-swirl entering the pump
  - Entrained air or gas bubbles



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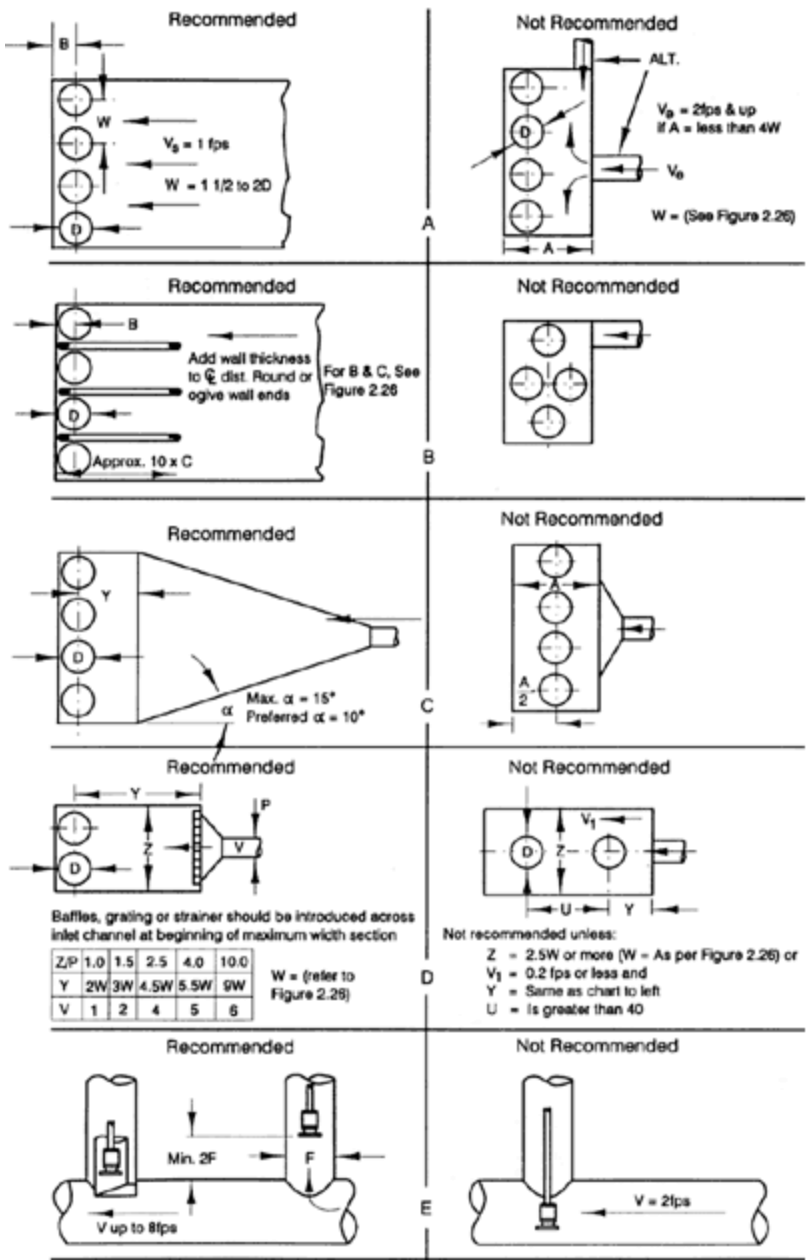
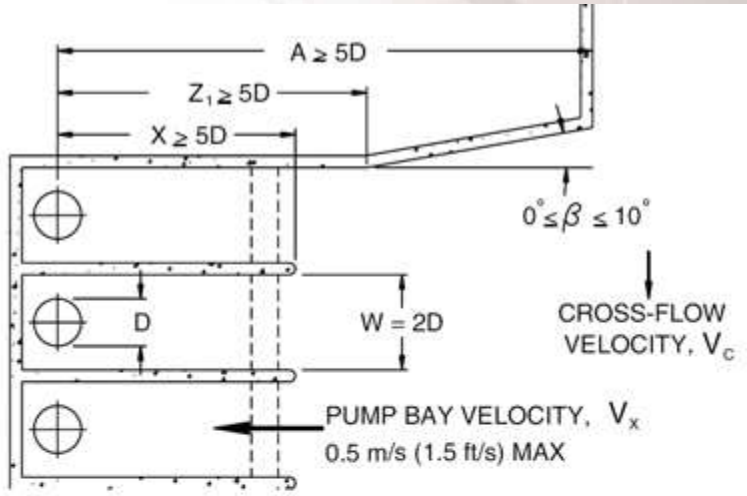
Design Considerations

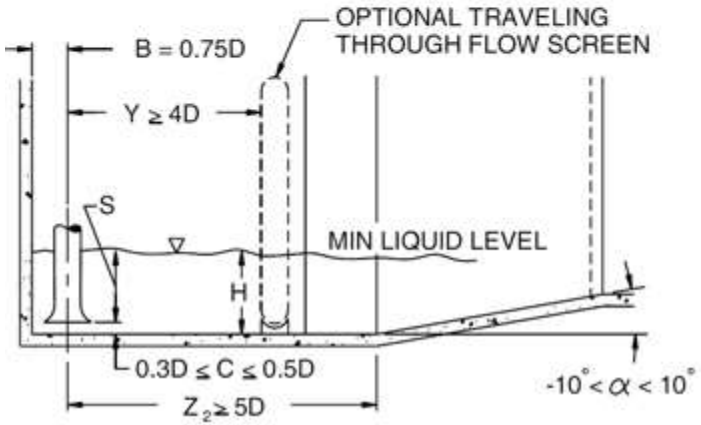
- Basin Hydraulics & Flow: CTI TP71-07
  - Limit water velocity at basin outlet (to pumps) to 1 to 2 FPS maximum
  - Use 6-inch tall mud sill to trap sludge that drops out of suspension
  - Maintain separation distances



Design Considerations

- Guidance from HI-9.8:
  - Channel approach velocity – 1.25 FPS max
  - Wing walls to allow parallel uniform inlet flow
  - Pump suction intake velocity 1 FPS max
  - Vented separation walls to prevent eddys and vortexing
  - Submergence exceed NPSHR
  - Usable sump volume exceeds 3X max of all running pumps





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Design Considerations

- Coatings
  - Chemical Resistance
  - "Bridgability"
  - Maintenance
- Acoustics
- Maintenance
  - Basins = Dirt
  - Partitioned basins
  - Basin flow velocity
  - Debris screens
  - Filters or separators

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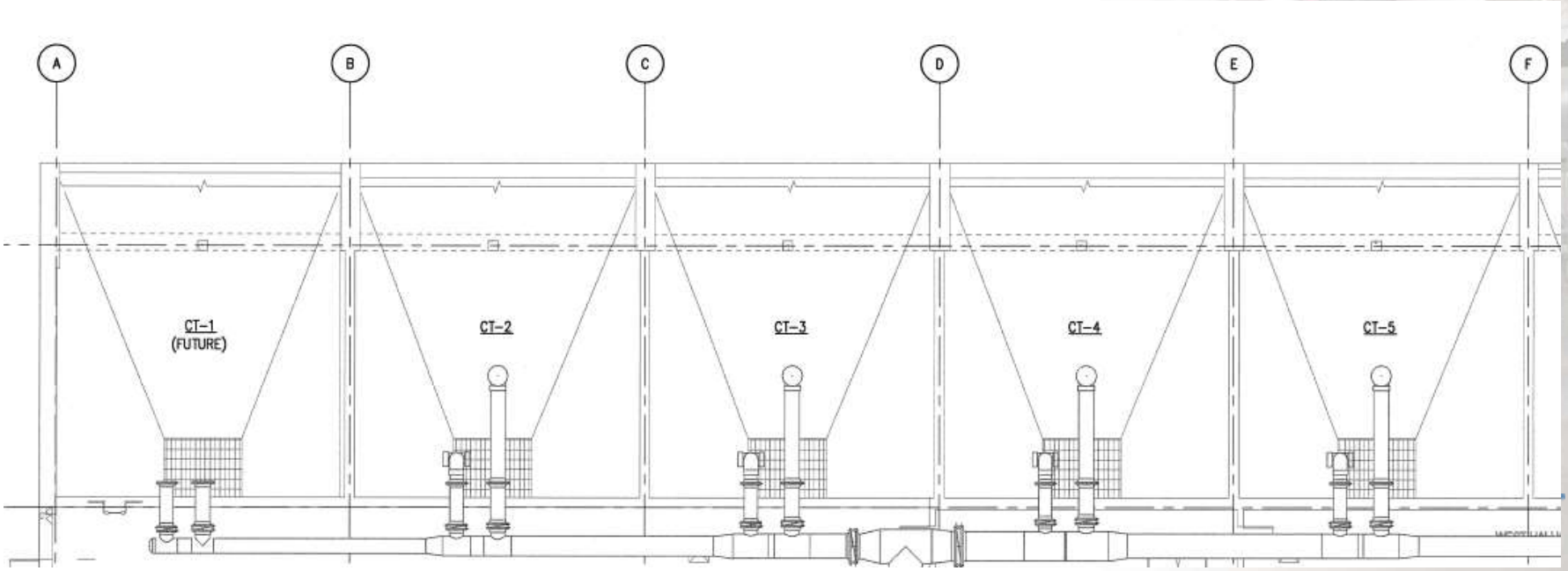
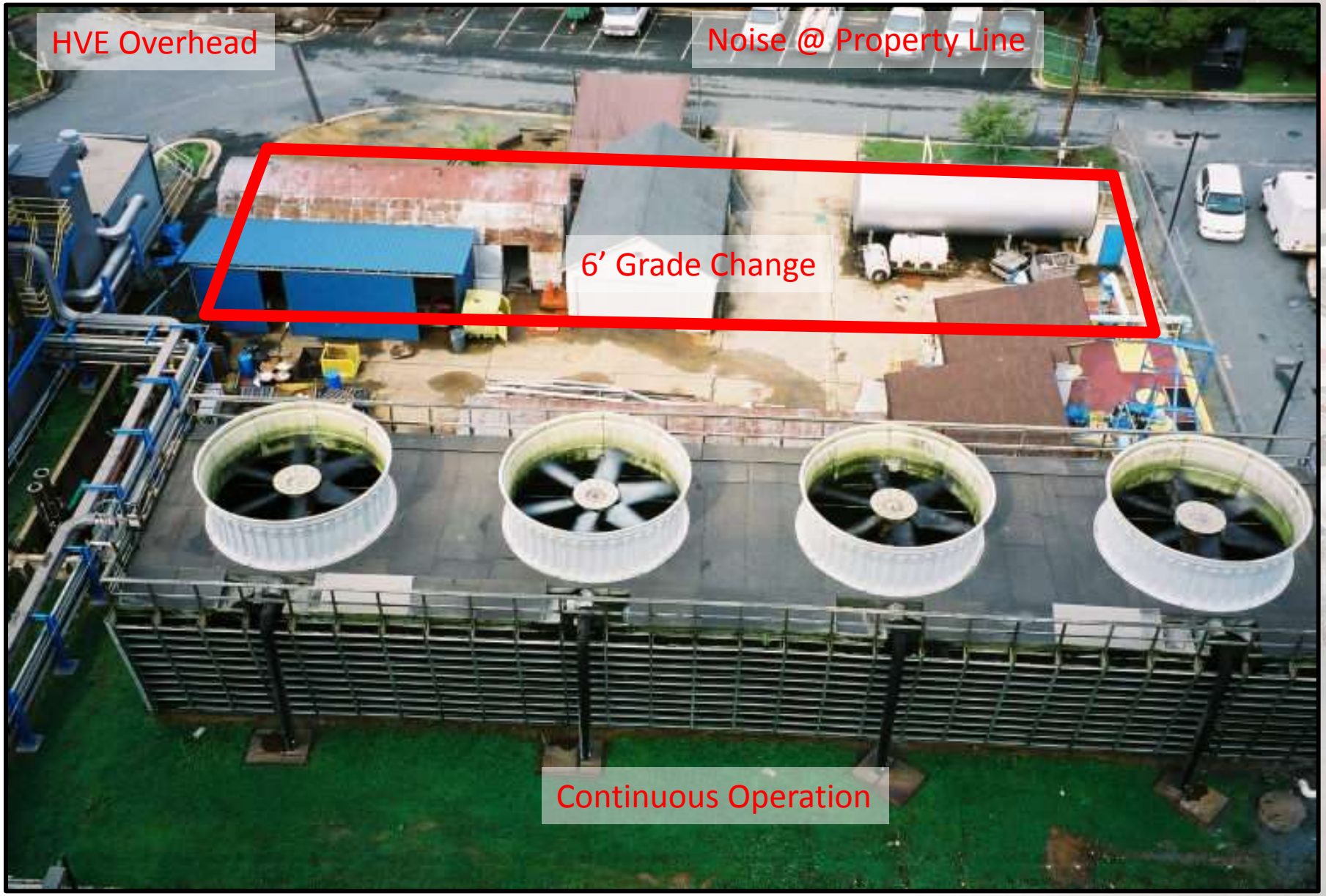


Design Example – UNC Chapel Hill

- UNC Chapel Hill – Cogen Plant Replacement
- 13,250 GPM, 3-cell tower
- Future expansion
- Continuous operation
- Constrained site
- Acoustic design

Design Example – UNC Chapel Hill



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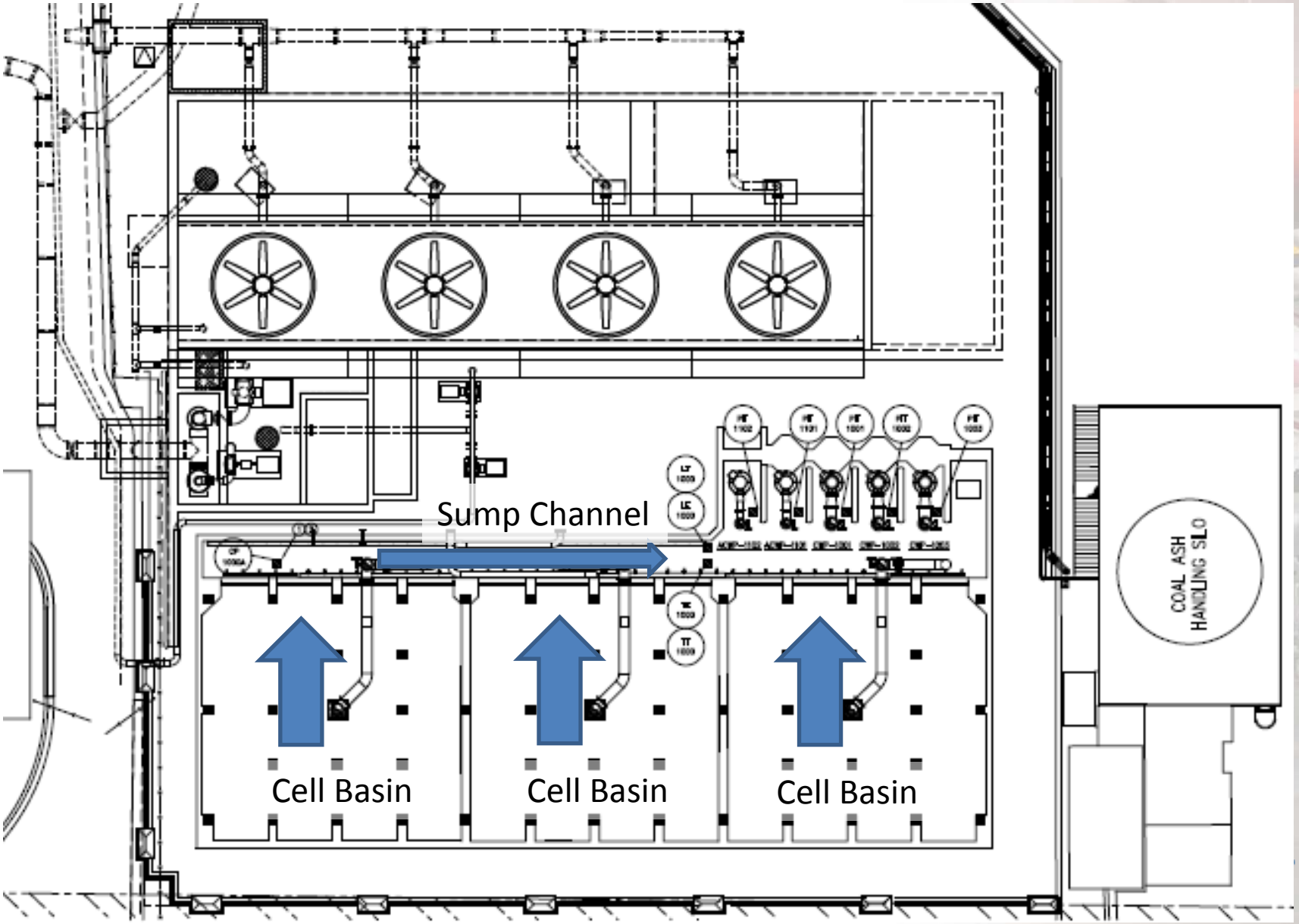

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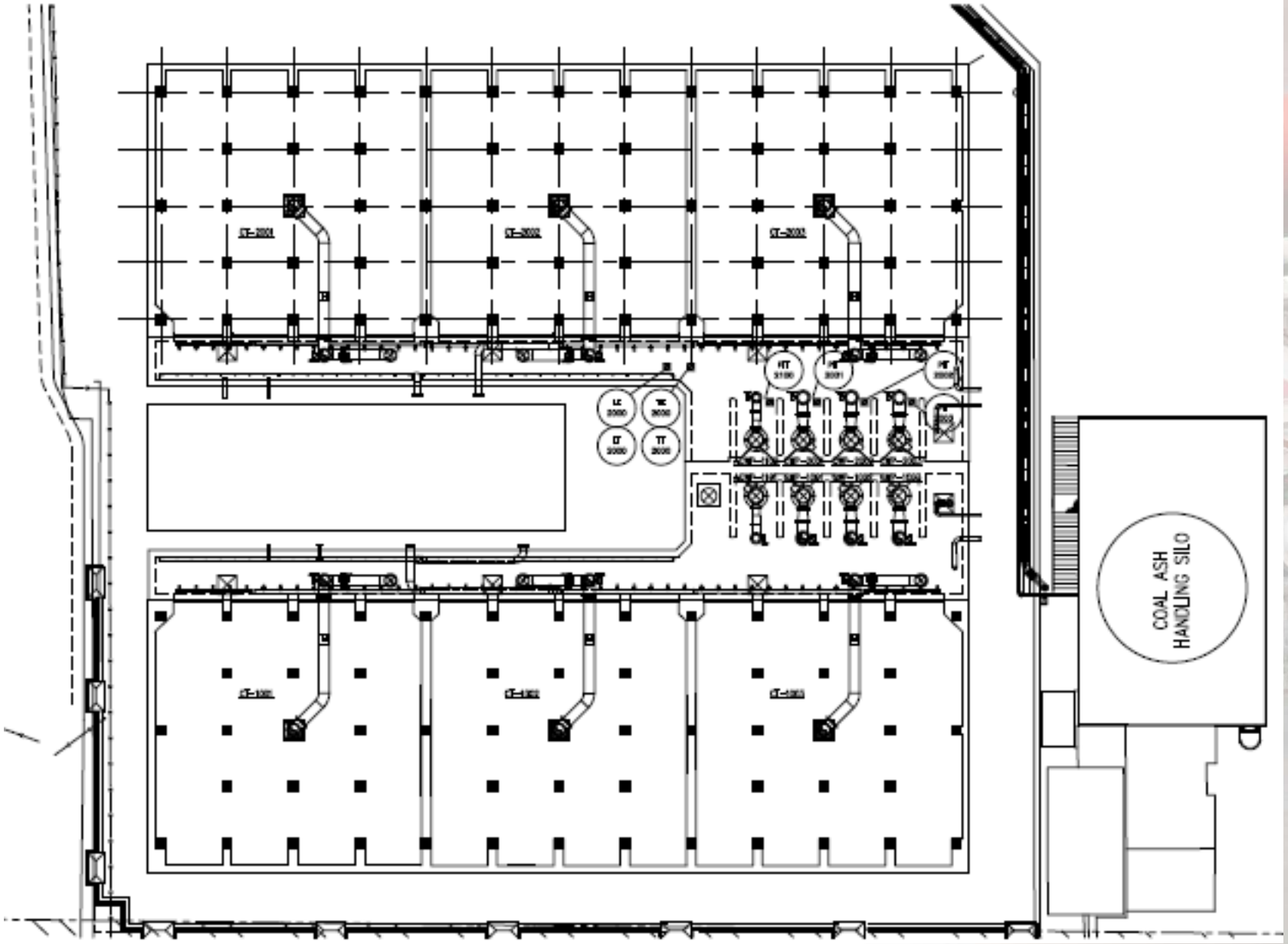

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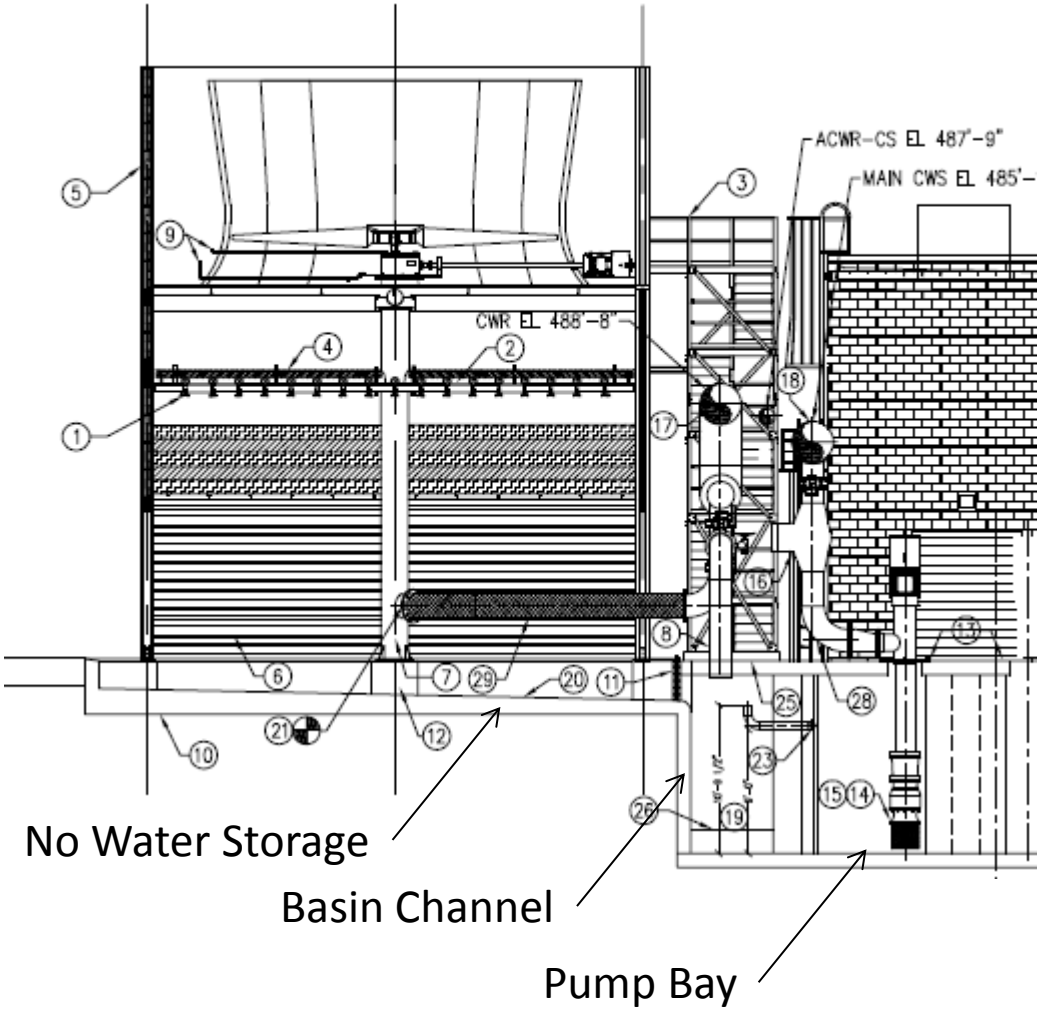
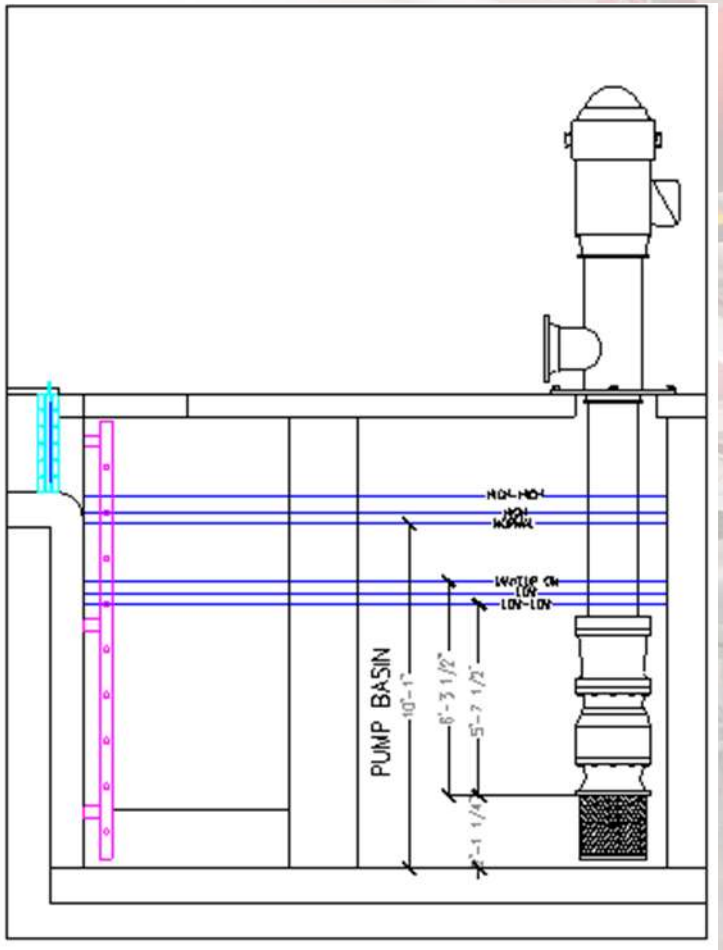


No Water Storage

Basin Channel

Pump Bay



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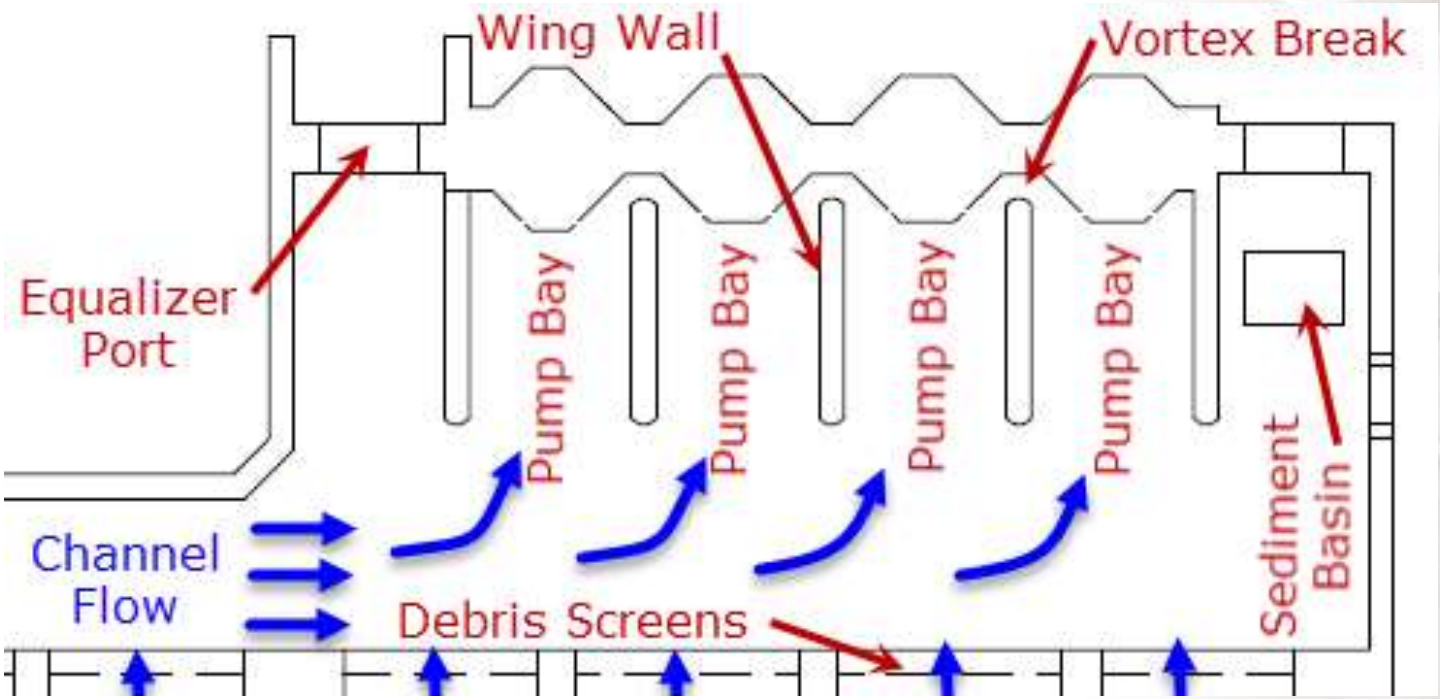
Design Example – UNC Chapel Hill

- Cell Basin Discharge – 1.75 FPS
- Sump Channel Velocity – 0.8 FPX
- Pump Bay Velocity – 0.3 FPS



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Design Example – UNC Chapel Hill

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Design Example – UNC Chapel Hill

Design Example – U of Missouri

- University of Missouri – Cooling Tower Replacement
- 50,000 GPM, 5-cell tower
- 4 steam turbine generators
- Selective shutdowns
- Constrained site

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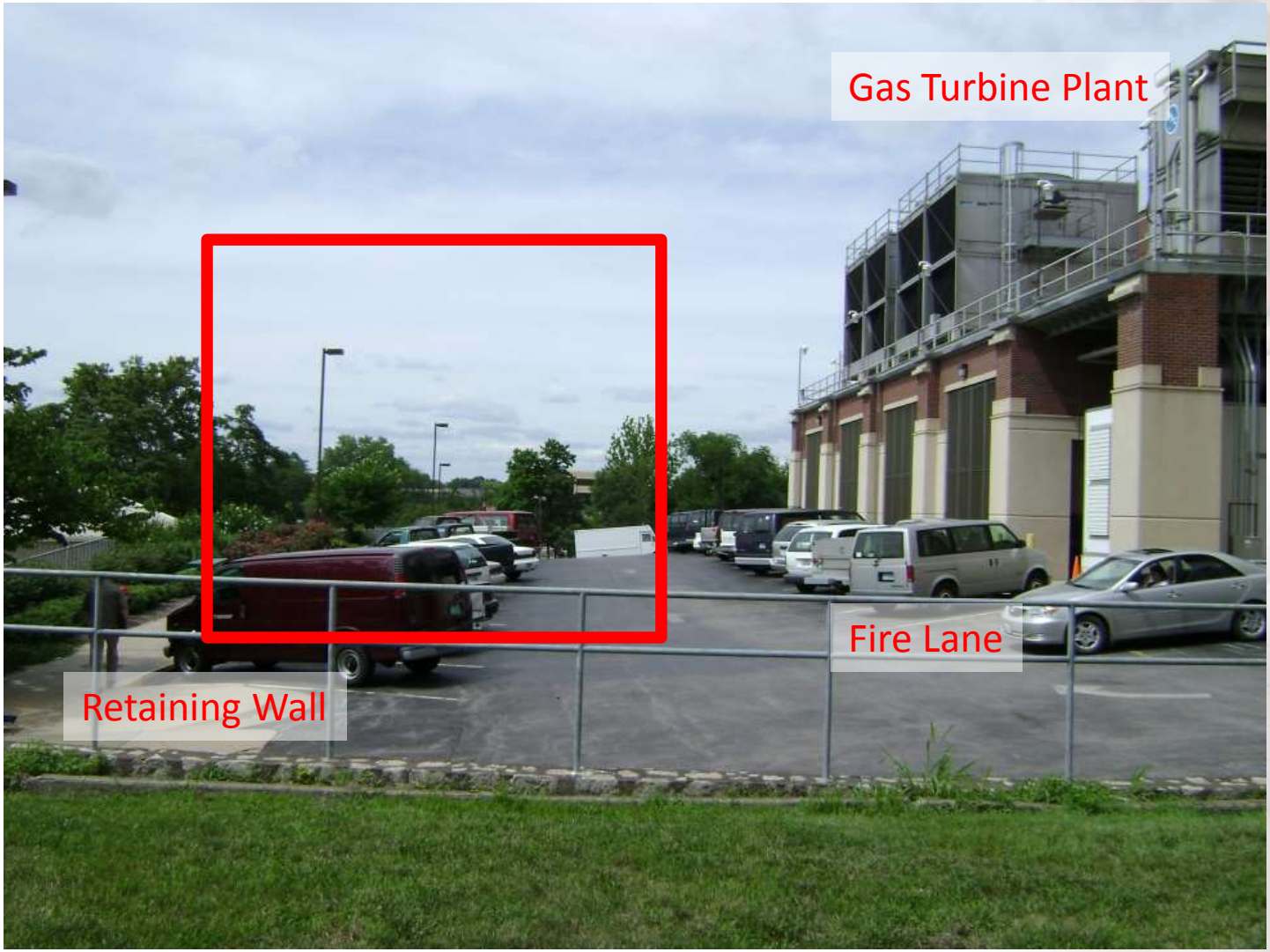
Design Example – U of Missouri



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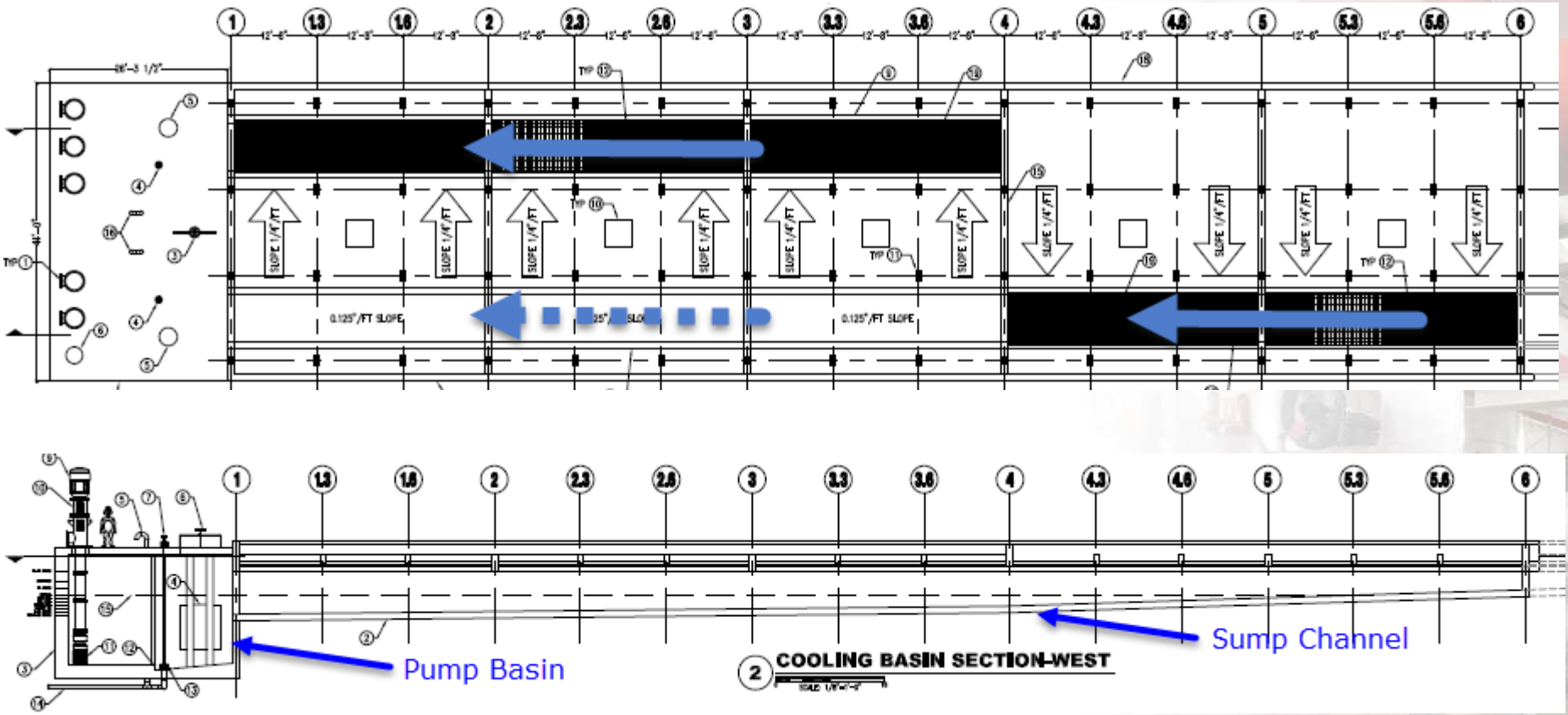
Design Example – U of Missouri



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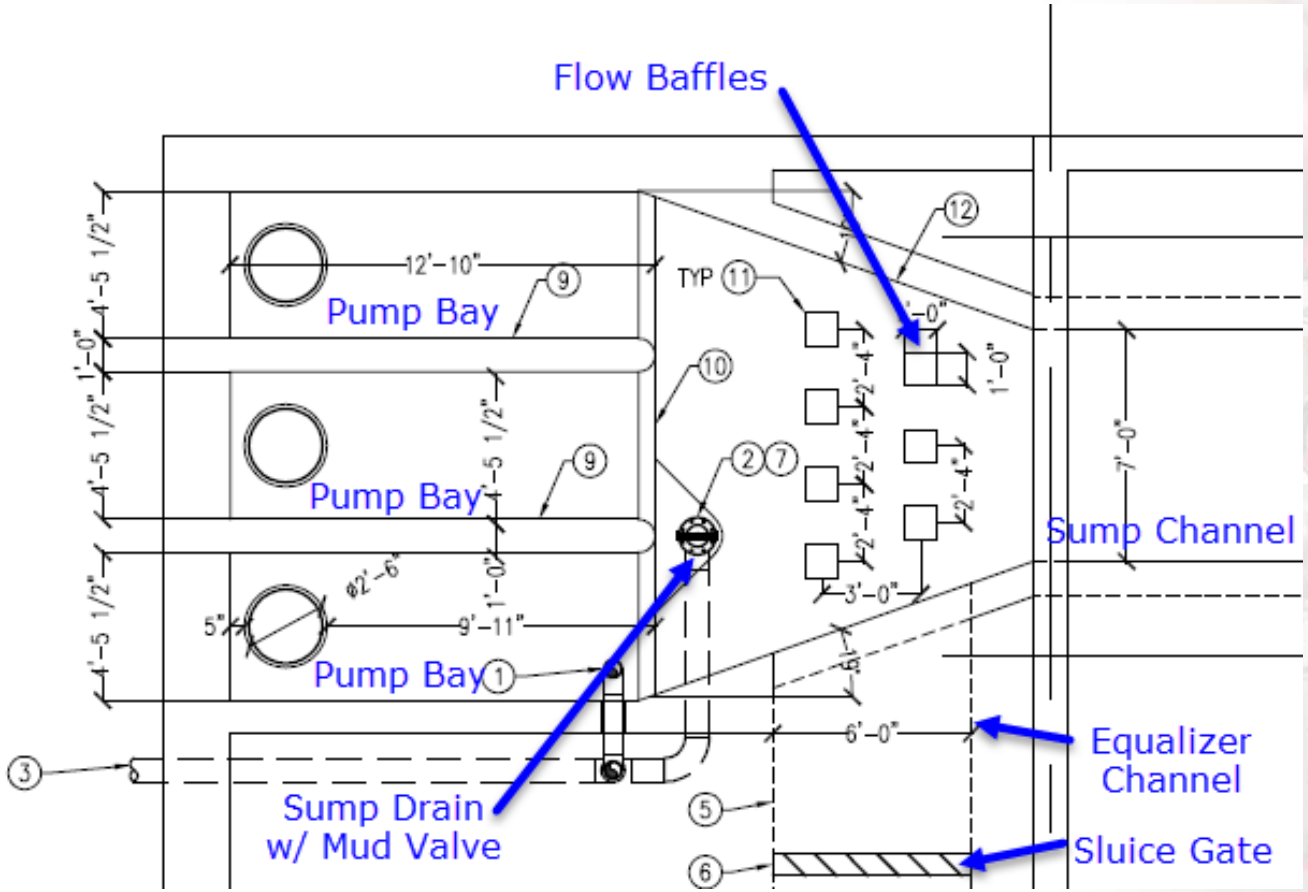

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