URS | URBAN DRAINAGE SYSTEM CSO AND FLOOD CONTROL

First Drainage Deep Tunnel in China

CSO and Flooding Control
Infoworks ICM Modeling
GuangZhou, China

AECOM

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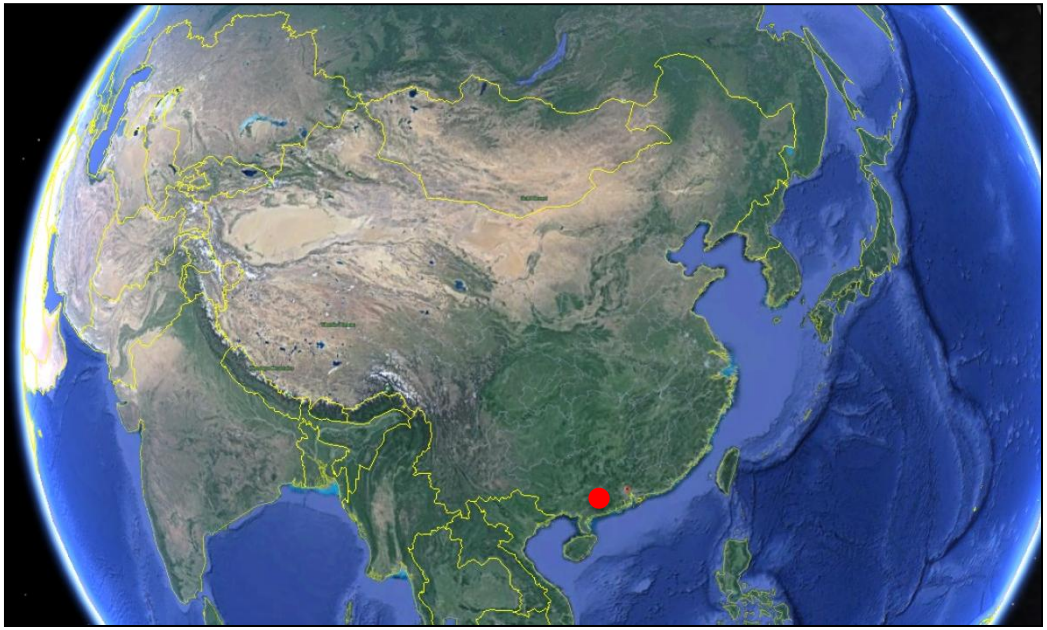
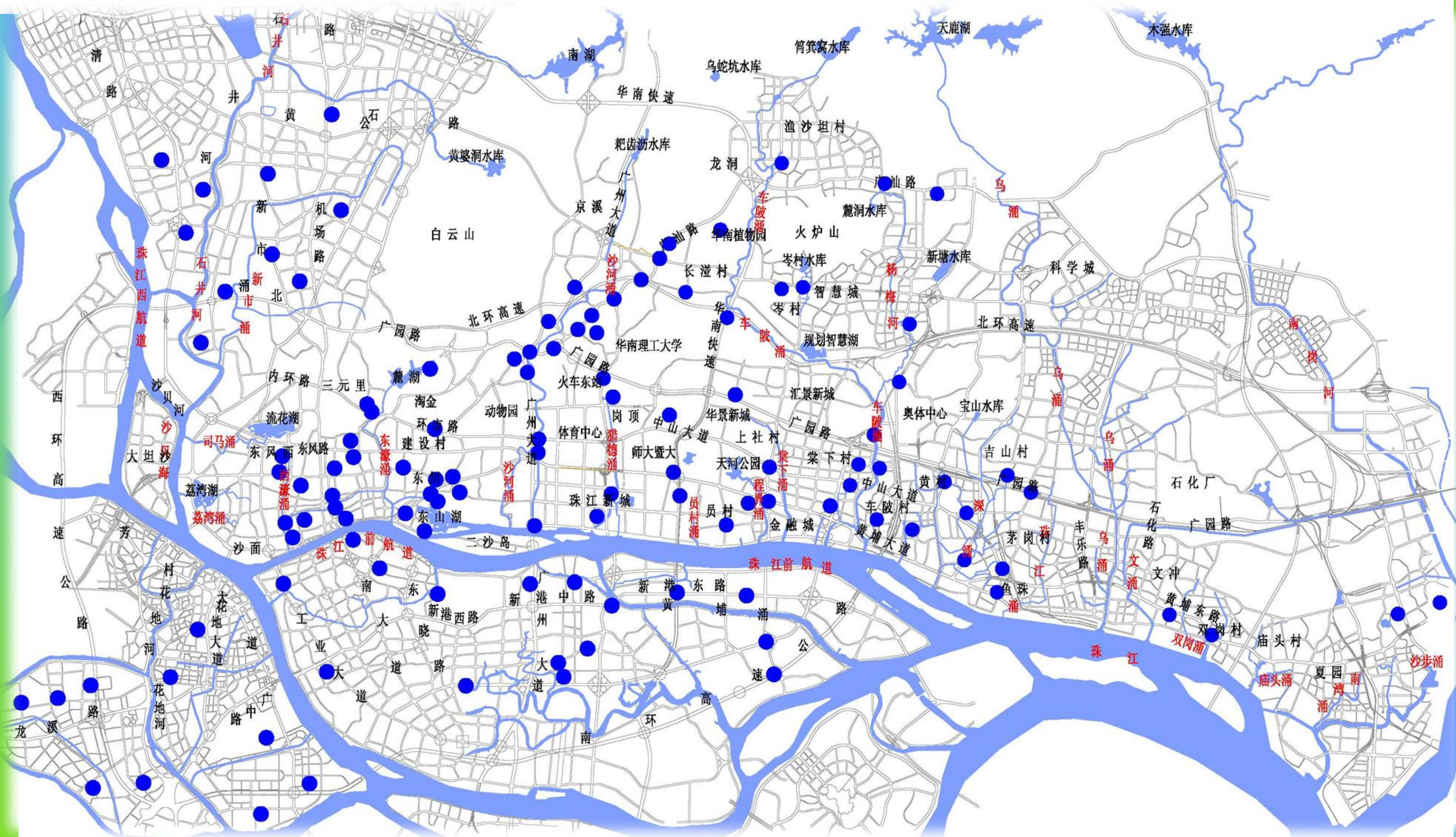
PROJECT BACKGROUND

- Guangzhou City, China
- Population: 12.9 million
- Planning Area: 150 sq-km (58 sq-mi)
- CSO and Flood Control



LOCAL FLOODING



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LOCAL FLOODING & SURFACE WATER POLLUTION

Last 20 years –

- Rapid expansion and construction. Ground hardening rate rising,
- Local Neighborhood Flooding: frequent; < 1 yr
- Combined Sewer Overflows (CSOs): ~60+ times/year
- Receiving Water Bodies Pollution: 1st flush
- Original reservoir, lakes, creek and gradually occupied more and more.

PROPOSAL

The State Council issued “Urban Drainage Improvement Plan”, Key Points:

- Develop a 10 year capital program
- Improve the city drainage systems to handle 50-year storm event.
- Capital Budget - US$600 billion for next 10 years, announced 12/2014.

Proposal:

- **Deep Tunnel System Master Planning for City of GU**
- **Pilot Project - DongHao Deep Tunnel**
- **Capital Investment: >US$5 Billion**

Assist City to Establish:

- **Flood and CSO Control Ordinances**
- **Drainage Design Standards, and**
- **Stormwater Management Regulations**

DEEP TUNNEL MASTER PLAN OVERVIEW

Proposed City Deep Tunnel System:

- **Main Deep Tunnel – 29.1 km (18.3 mi)**
- **Main Tunnel Dia=5.3 m (17 ft) & Depth=35 m (115 ft)**
- **Six Branch Deep Tunnel – 26.4 km (16.4 mi)**
- **Drop Shaft – 63**
- **Flood Control Pump Station – 6**

METHOD APPROACH FOR MASTER PLANNING:

1. Data Collection
2. Existing Condition
3. Develop and Select Preferred Alternatives
4. Integrate selections into City-Wide Master Plan

DongHao Stream Pilot Project

Deep Tunnel Master Plan

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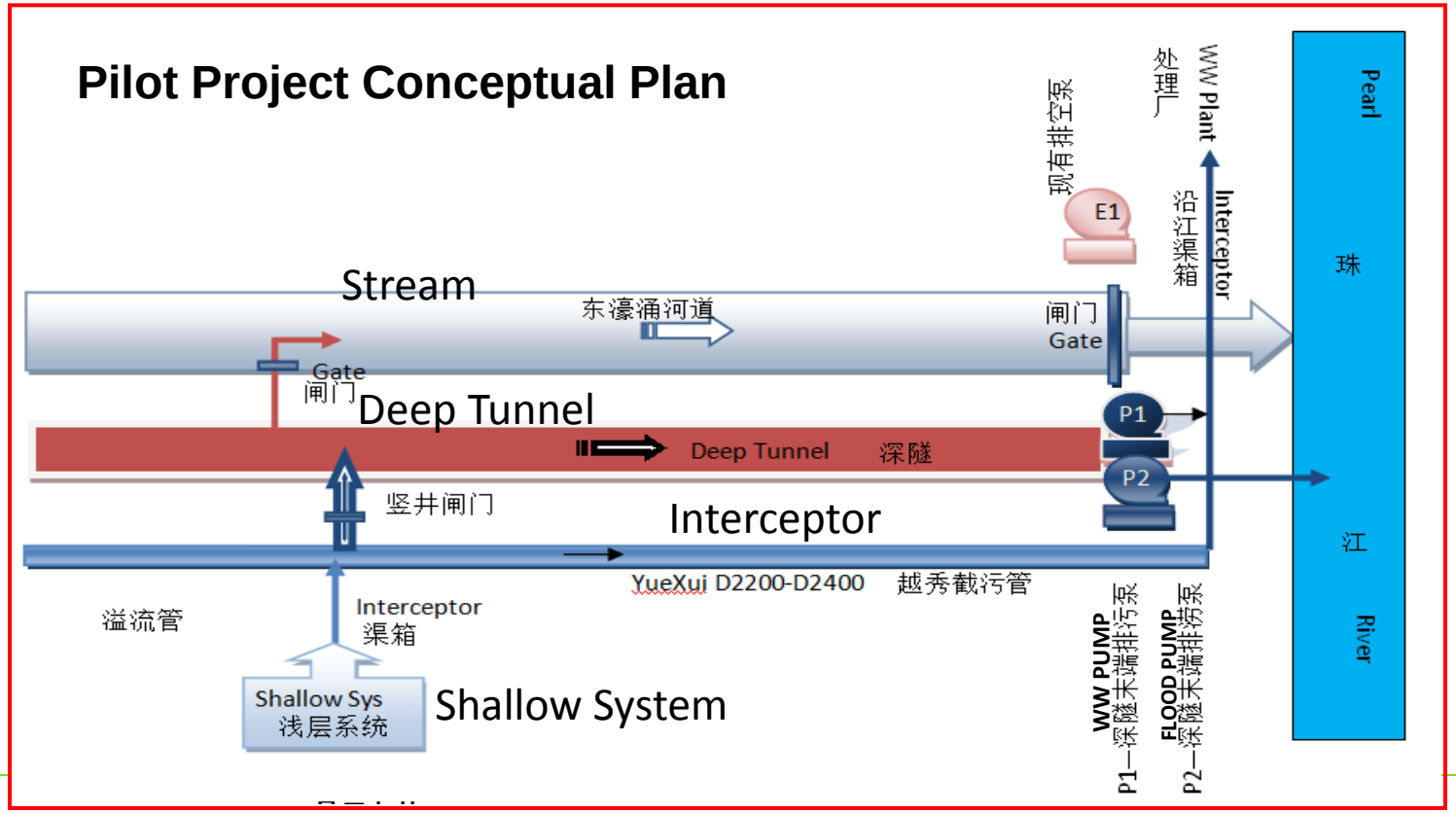
PILOT PROJECT INTRODUCTION

OBJECTIVES

- **Localized flooding mitigation - 2-5 yr Storm Event**
- **Interceptor capacity increase - 5 x ADWF**
- **CSO Capture Rate - 85%**
- **DT Design storm: 10-year/2-hour**



CONTRACTS WITH CLIENT (WATER AUTHORITY OF GU)

Design Guidelines

1. Sum of DT Worldwide
2. HH Modeling Flowchart
3. Model Calibration
4. Sewer Evaluation
5. Water Quality Model
6. Definition of DT Function
7. Transient Modeling
8. Surge Protection
9. Drop Shaft Design
10. Tunnel Lining
11. Tunnel Ventilation
12. Odor Control
13. Pretreatment Design
14. DT Operation Plan

Pilot Project Preliminary Design / Pilot Project HH Modeling

1. Objective & Targets
2. HH Model Objectives
3. Rainfall Analysis
4. Model Calibration
5. Existing System Evaluation
6. Proposed Systems
7. Alternative Studies
8. Flood Control Demo
9. Water Quality Model
10. Tunnel Transient Analysis
11. Operation Cases Analysis
12. Drop Structure Selection
13. Pump Station Design
14. Pretreatment Facilities
15. Lining/Ventilation/Odor Control
16. Equipment Selection

City Deep Tunnel Master Plan / City Master Plan HH Modeling

1. Control Targets
2. Deep Tunnel Case Studies
3. HH Base Model Development
4. Estimate Interceptor Capacities
5. Main Tunnel / Branch Tunnel
6. Main Tunnel Planning Parameters
7. Planning Strategy & Methodology
8. Main Tunnel Configurations
9. Environmental Impact Assessment
10. Tunnel Structure Evaluation
11. Tunnel System Operation Plan
12. Tunnel System Maintenance Plan

CSO & FLOOD CONTROL MODELING - INFOWORKS

Haider ISM, CFM

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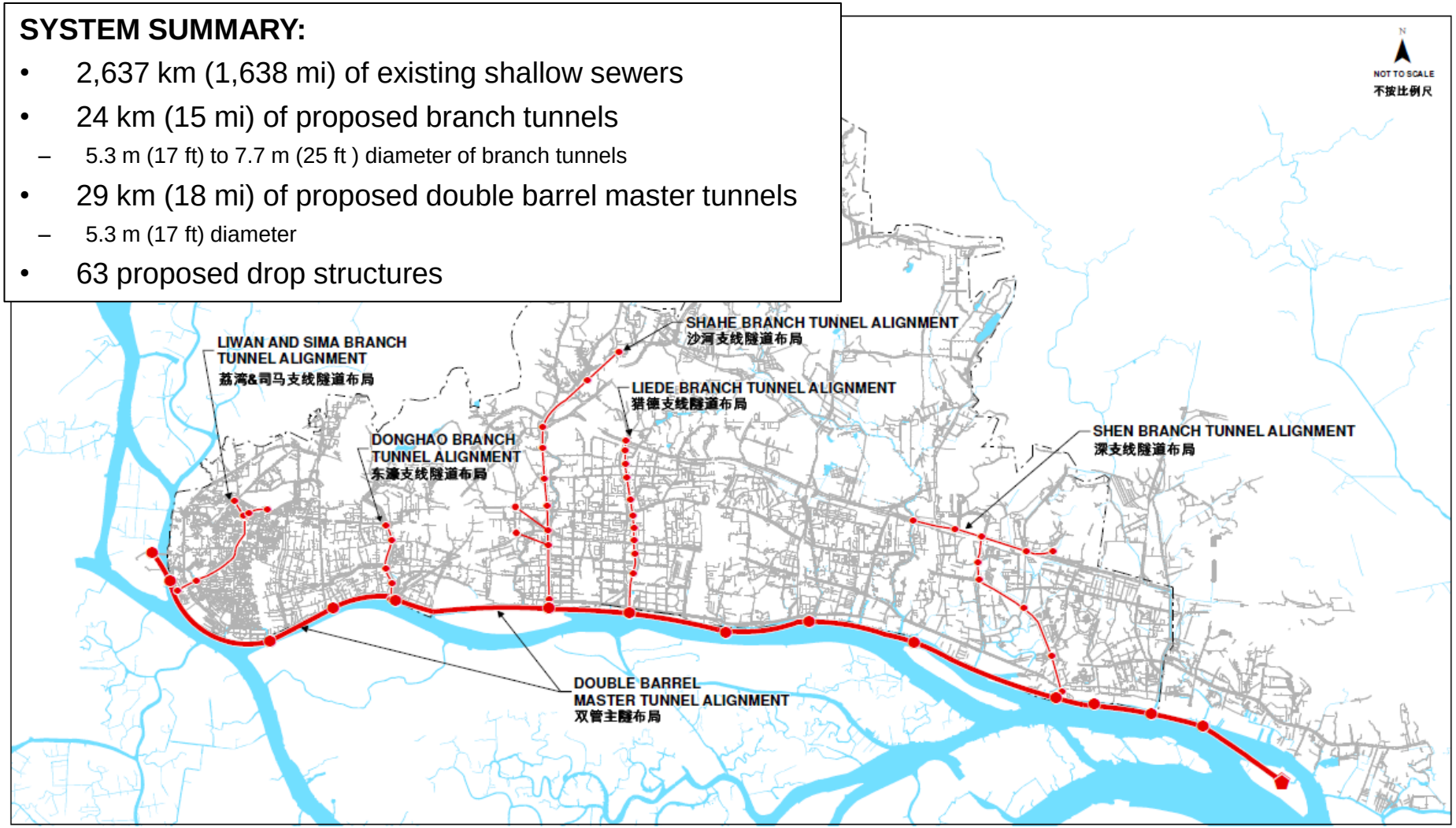
KEY NETWORK FEATURES – PLAN VIEW

SYSTEM SUMMARY:

- 2,637 km (1,638 mi) of existing shallow sewers
- 24 km (15 mi) of proposed branch tunnels
  - 5.3 m (17 ft) to 7.7 m (25 ft) diameter of branch tunnels
- 29 km (18 mi) of proposed double barrel master tunnels
  - 5.3 m (17 ft) diameter
- 63 proposed drop structures



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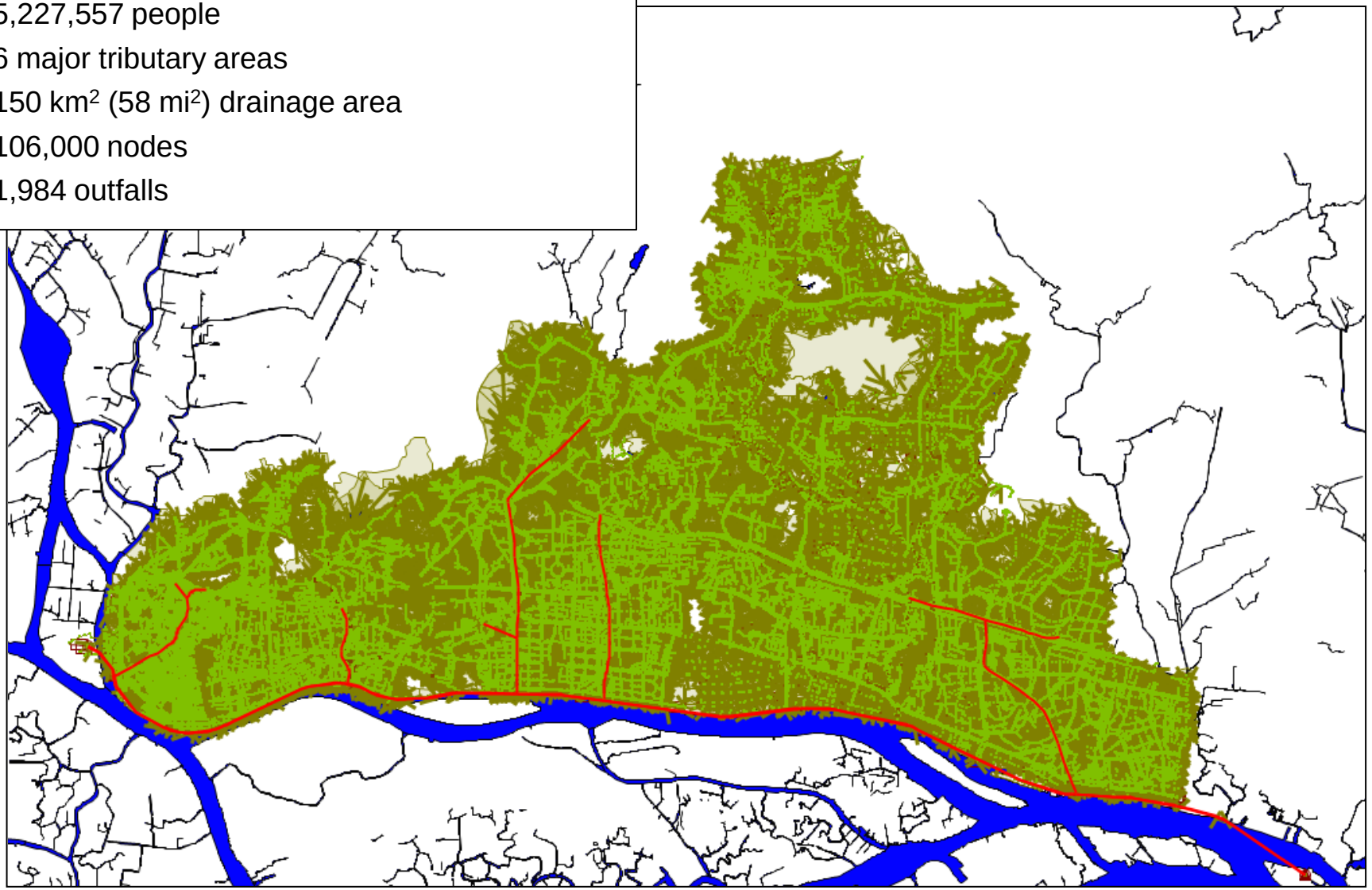
KEY NETWORK FEATURES – INFOWORKS MODEL VIEW

MODEL SUMMARY:

- 5,227,557 people
- 6 major tributary areas
- 150 km^2 (58 mi^2) drainage area
- 106,000 nodes
- 1,984 outfalls



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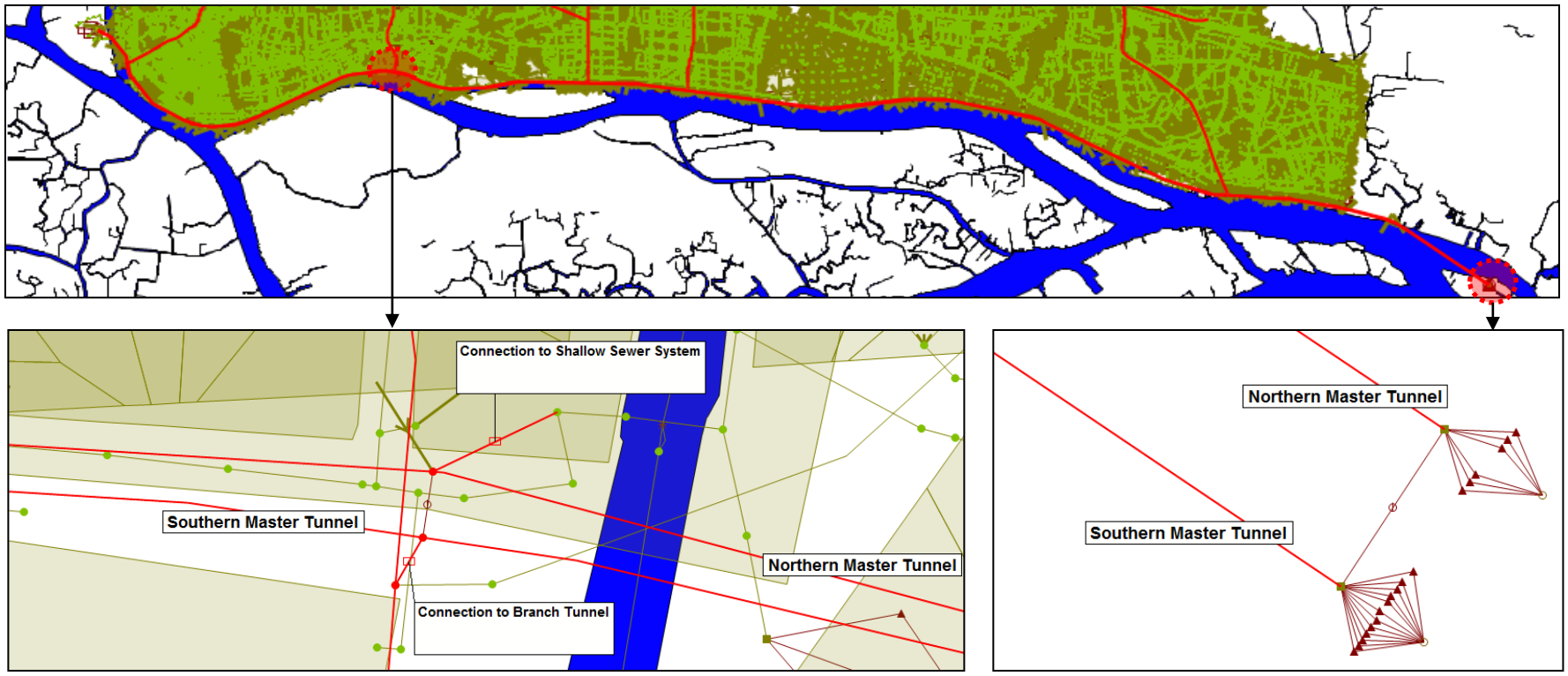
CONCEPTUAL OPERATIONAL PLAN



Example of Master Tunnel Connections (DongHao Area)

DaHaoSha Primary and Secondary WWTP

Network Operations Summary:

- Northern CSO Conveyance Master Tunnel:
  - Receives DWF and WWF up to 2xADWF and conveys to WWTP.
- Branch and Southern Storage / Conveyance Tunnels:
  - Receive WWF during storm events for conveyance to WWTP.
  - Function as storage tunnels during extreme storm events.

WWTP Operations Summary:

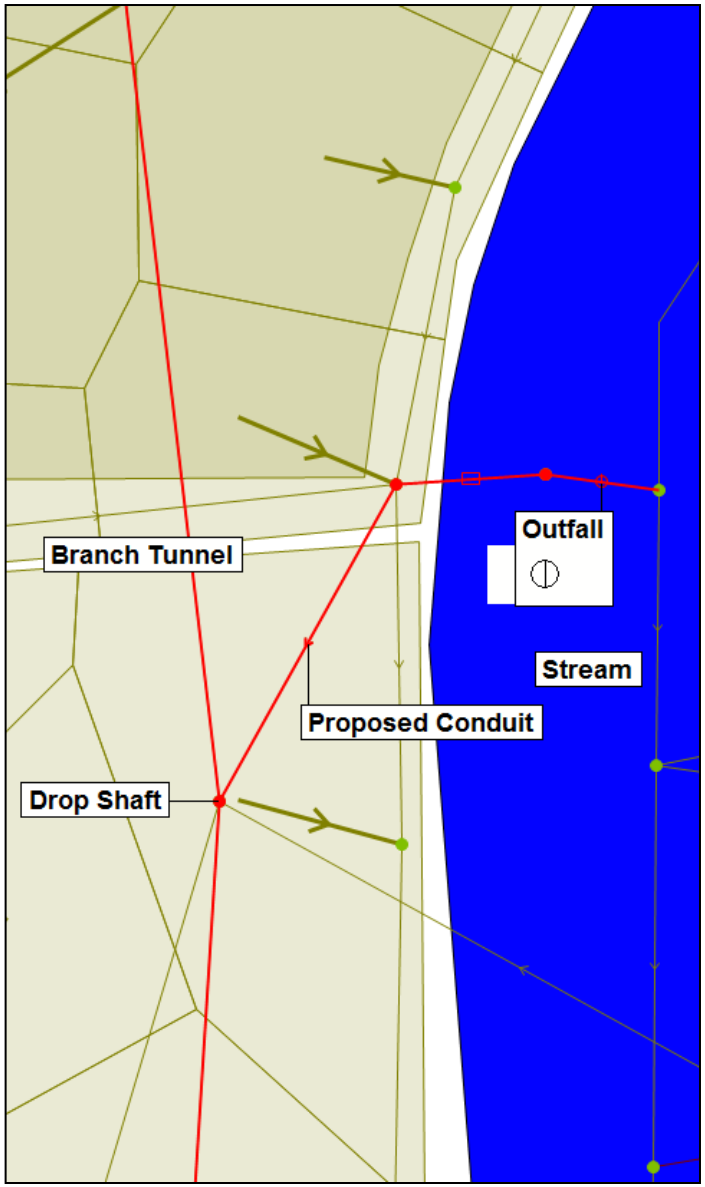
- DWF through moderate storms receive secondary treatment.
- Overflow in the southern tunnel treated through Primary WWTP only during large storms.

GENERAL MODELING METHOD

1. Synthetic storms and typical year development.
2. Received existing shallow sewer system network.
3. Create selection set.
4. Ran Existing Model to estimate network-wide, annual CSO capture.

$$\text{Capture Rate} = 1 - \frac{\text{Annual CSO Volume}}{\text{Annual CSO Volume} + \text{Annaul WW Treated Volume}} \text{ x } 100\%$$

5. Assisted client in developing tunnel and drop shaft alignments.
6. Set tunnel diameter.
7. Connected proposed tunnels to key shallow sewer system locations at drop shafts and implement other shallow sewer system improvements.
8. Ran Proposed Model.
9. Iteratively repeated Steps 6 through 8 until an annual CSO volume capture of 70% was reached.
10. Extracted data for preliminary design (ex: peak flow data and hydraulic grade lines for pump station design).
11. Assembled 6 major tributary areas and minor tributary areas into one Master Model.
12. Ran Master Model and verified an annual CSO volume capture of 70% was reached.



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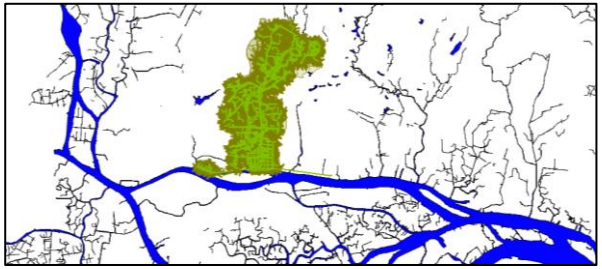
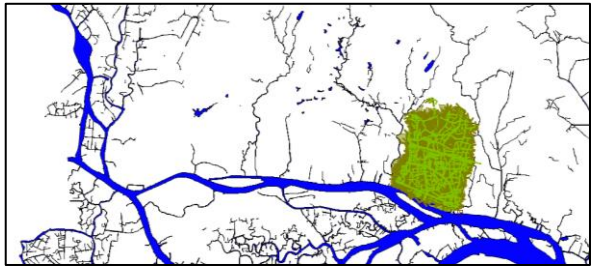
SYSTEM PERFORMANCE – ANNUAL CSO CAPTURE

(Existing % Annual CSO Capture to Proposed % Annual CSO Capture)

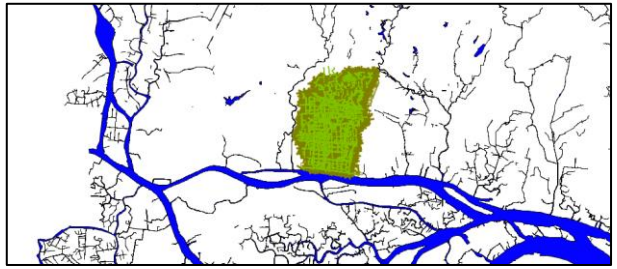
ShaHe Network – 31% to 72%



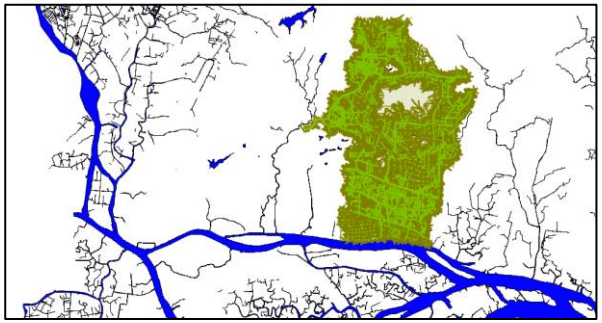
Shen Network – 25% to 71%



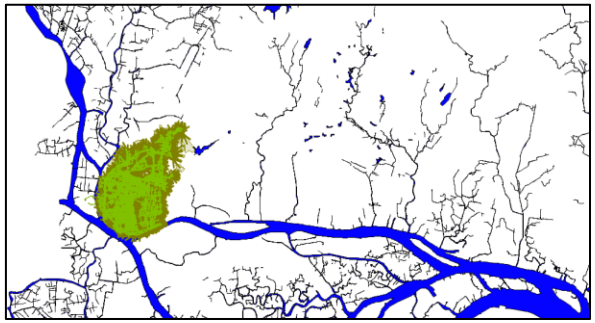
LieDe Network – 52% to 78%



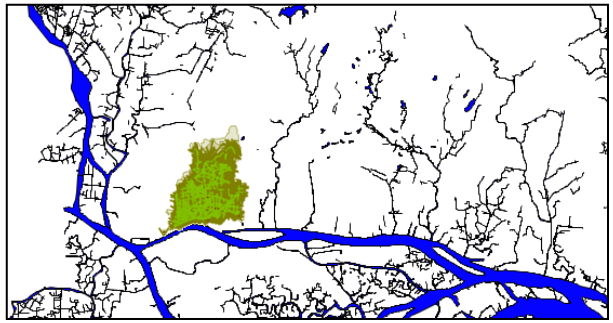
ChePo Network – 11% to 39%



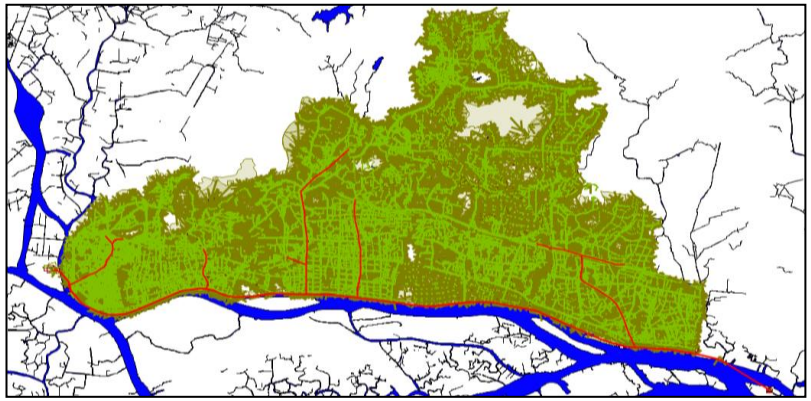
LiWan & SiMa Network – 70%



DongHao Network – 69% to 90%



Master Model – 78%



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PILOT PROJECT PRELIMINARY DESIGN

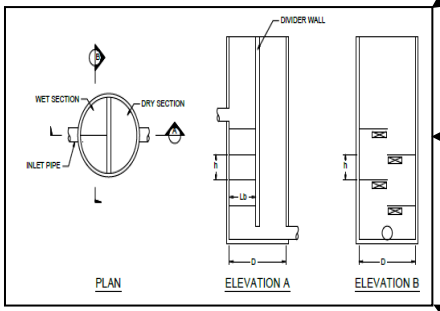
PRETREATMENT DESIGN

- **Minimize solids loading**
- **Reduce tunnel maintenance effort**
- **Bar Screen / Grit Chambers**

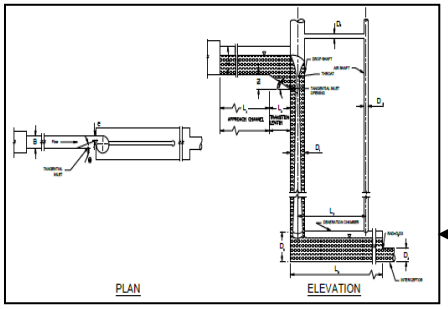
DROP SHAFT DESIGN

Evaluated Vortex, Helicoidal Ramp, Baffle, Plunge, and Boot Sewage drop structure alternatives.

Baffle Drop Structure

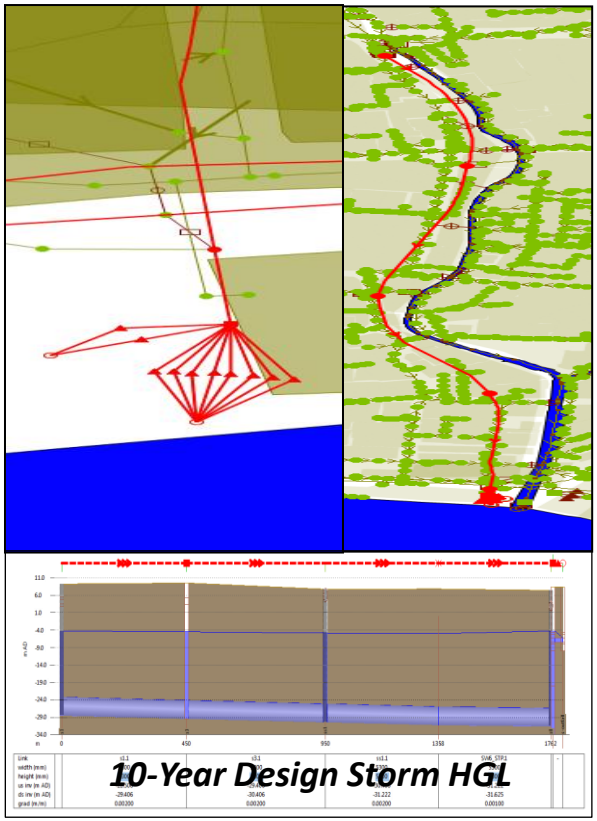


Vortex Drop Structure



PUMP STATION DESIGN

- **Tunnel Dewatering Pumps**
- **Flood Drainage Pumps:**
- **Landscape Replenishment Pumps**



10-Year Design Storm HGL

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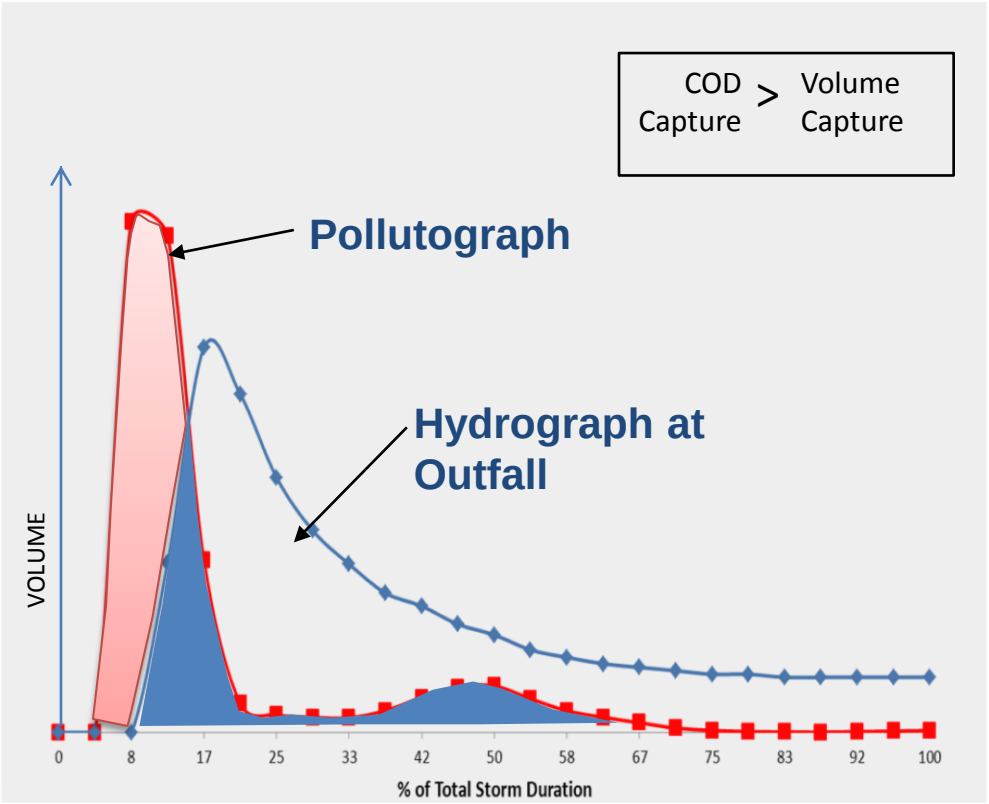
WQ MODELING AND SURGE MODELING

WATER QUALITY MODELING

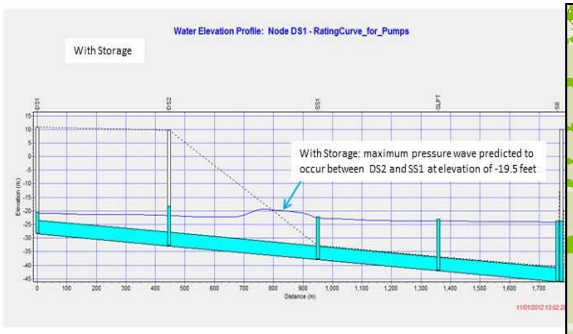
Design Criteria Approach

- Frontloaded pollutograph
- Design for COD capture
- Goal: >70% COD Capture

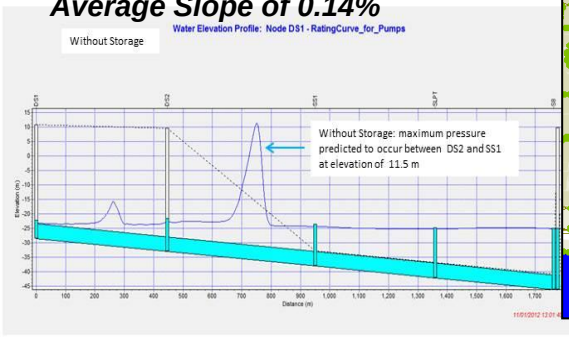


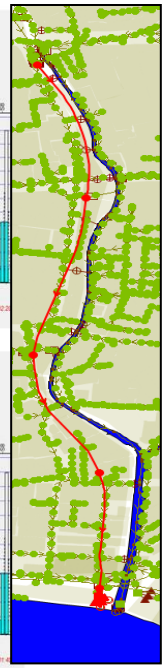
SURGE MODELING

- Illinois Transient Model (ITM) Software
- Ran for 10-year design storm.
- Modeled tunnel system at current gate and operational rules
- Additional Modeled Scenarios:
  - Sudden gate closure
  - Sudden stoppage of pumping
  - Slope optimization



Average Slope of 0.14%





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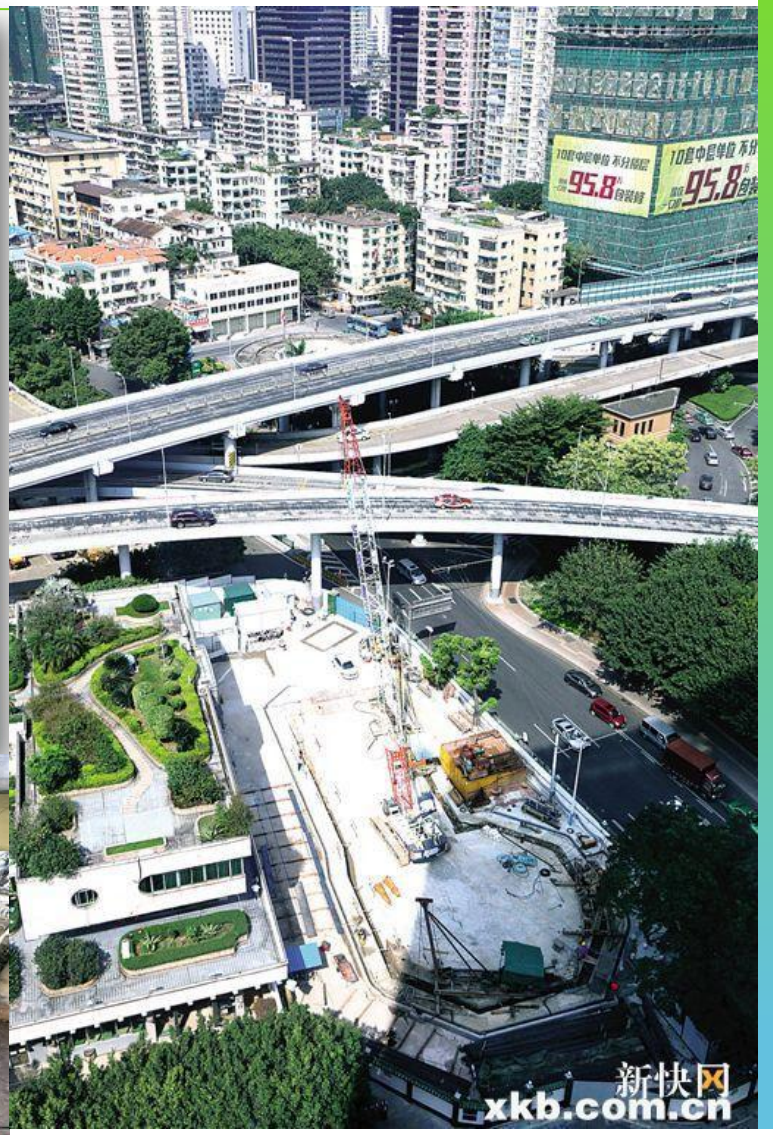
PROJECT STATUS

Pilot Project Started Construction in 10-2014



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Questions