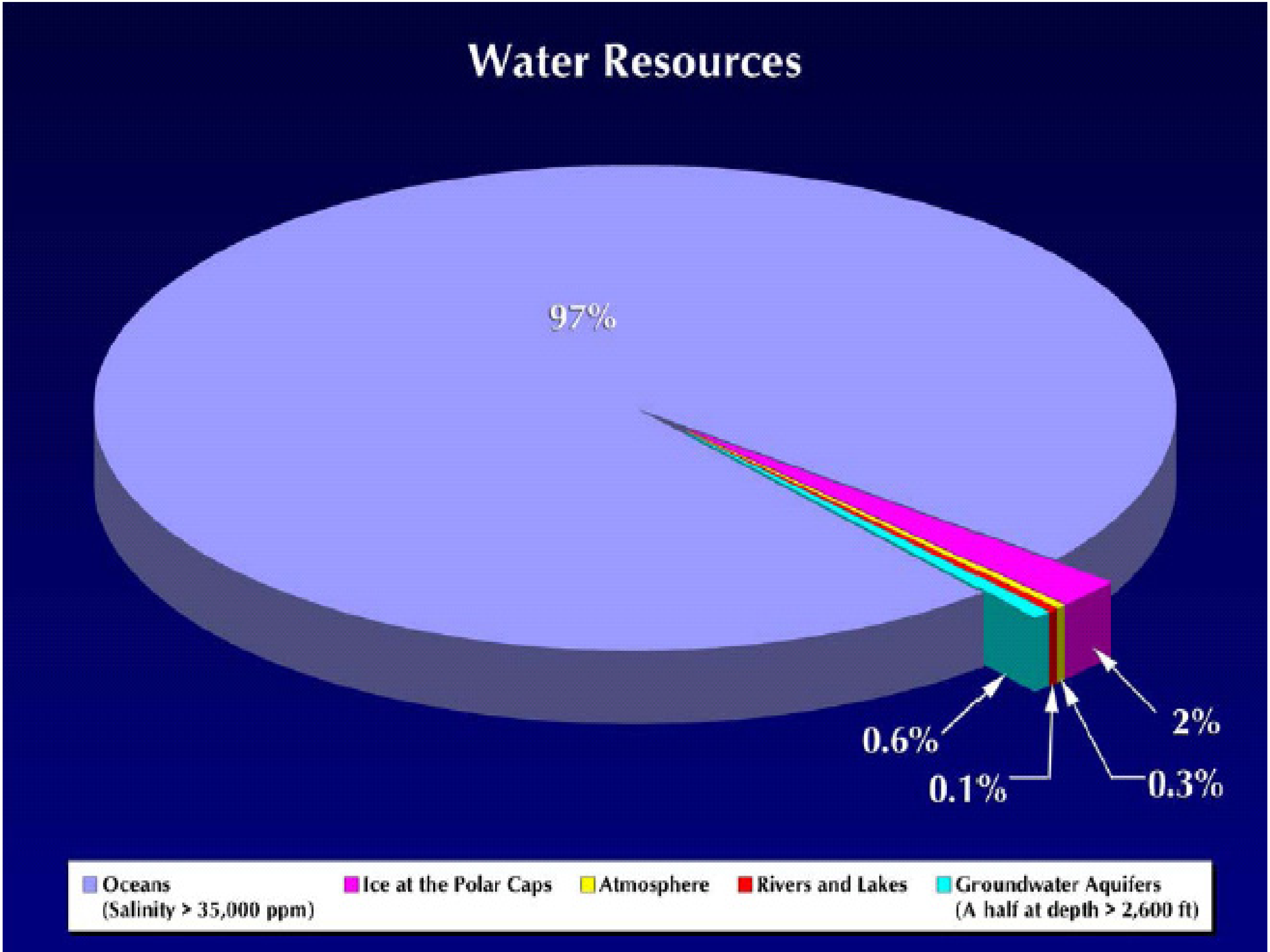
Protecting Our Water Environment

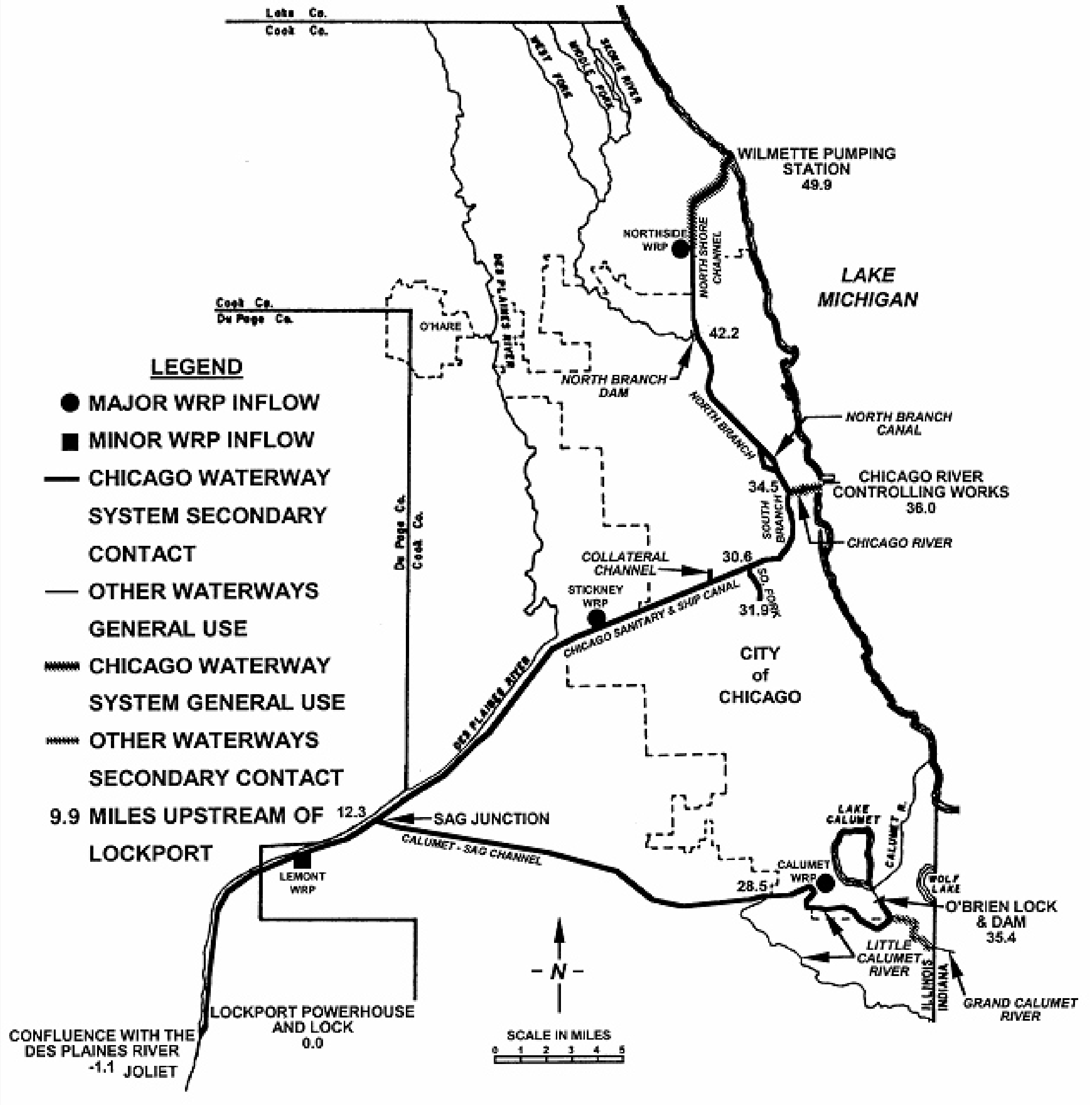
Metropolitan Water Reclamation District of Greater Chicago

Moving Towards Disinfection at the District's Terrence J. O'Brien and Calumet Water Reclamation Plants

Edward C. Brosius, P.E.
Supervising Civil Engineer


Water Resources
97%
2%
0.6%
0.1%
0.3%
Oceans
(Salinity > 35,000 ppm)
Ice at the Polar Caps
Atmosphere
Rivers and Lakes
Groundwater Aquifers
(A half at depth > 2,600 ft)

Chicago Waterway System

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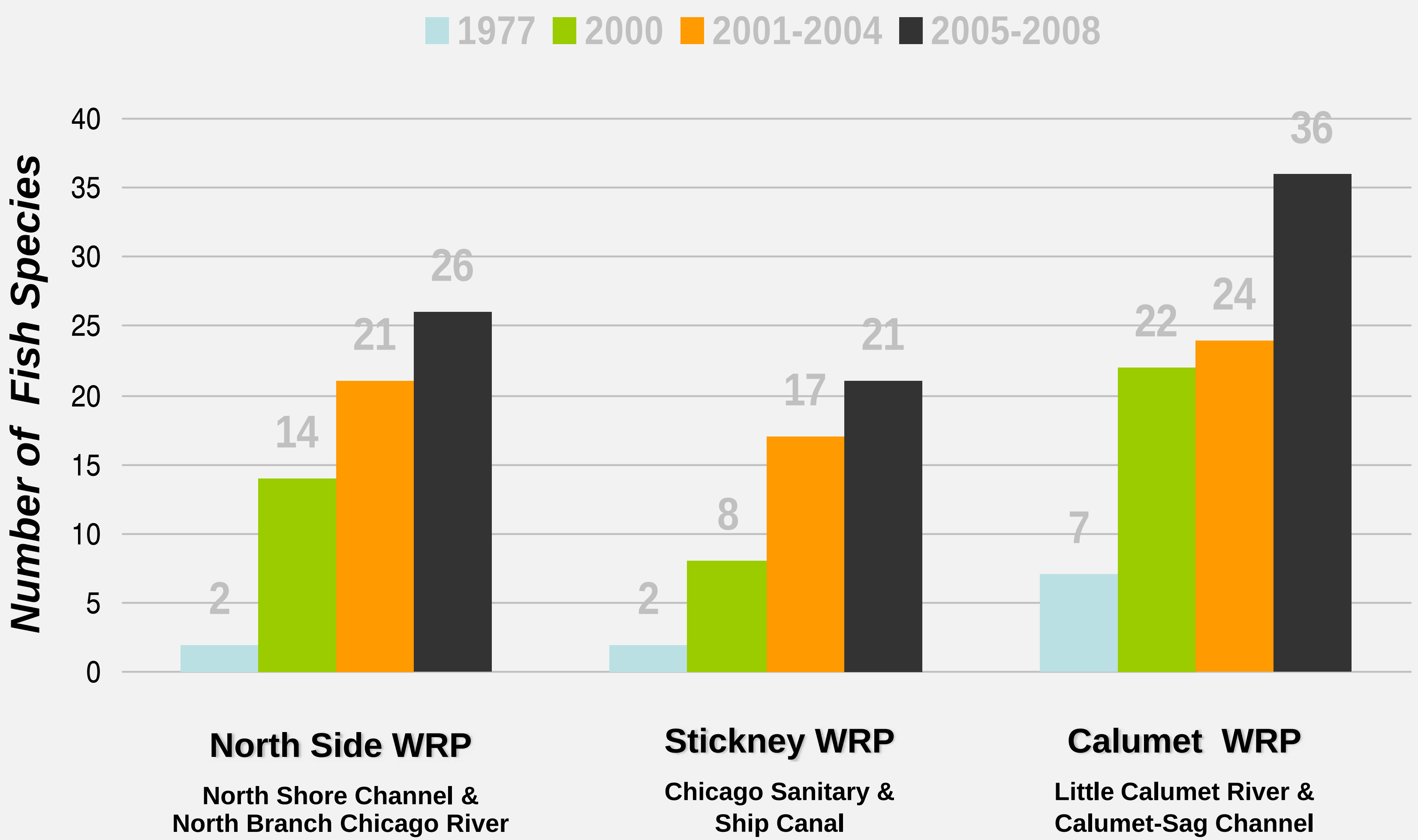
NEW TRIER
CREW

Number of Fish Species Below the Outfalls of Three MWRD Water Reclamation Plants



Use Attainability Analysis (UAA) for Chicago Area Waterways (CAWs) 2002 to ?

Use Attainability Analysis (UAA) for Chicago Area Waterways (CAWs)

- Recreational Use Designation (Disinfection)
- Aquatic Life Use Designation (Thermal Pollution) (Dissolved Oxygen)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 11 2011

OFFICE OF WATER

Lisa Bonnett
Interim Director
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62702

Dear Ms. Bonnett:

During the past 25 years, the Chicago Area Waterway System (CAWS) has been transformed into a valuable recreational asset that citizens increasingly use for boating, canoeing, kayaking, jet and water skiing, tubing and swimming. The State of Illinois is long overdue on updating its water quality standards to provide the Clean Water Act (CWA) protections that must accompany this transformation. Consequently, the U.S. Environmental Protection Agency has determined that new or revised water quality standards that protect recreation in and on the water are necessary for certain segments of the CAWS. EPA expects Illinois to expeditiously adopt new or revised water quality standards consistent with this determination. If Illinois fails to do so, EPA will promptly do so itself. In either event, to attain those standards, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) would likely be required to disinfect discharges from its North Side and Calumet Water Reclamation Plants.

Specifically, EPA has determined that new or revised use designations that provide for recreation in and on the water are necessary for the following segments of the CAWS (hereafter, "the relevant CAWS segments") that are currently designated as Secondary Contact Waters under 35 Ill. Adm. Code 303.441:

- Calumet-Sag Channel;
- Little Calumet River from its junction with the Grand Calumet River to the Calumet-Sag Channel;
- South Branch of the Chicago River;
- North Branch of the Chicago River from its confluence with the North Shore Channel to its confluence with the South Branch; and
- North Shore Channel, excluding the segment extending from the North Side Sewage Treatment Works to Lake Michigan.

These segments are shown below.


146 3P.M. 7-25-94
Rialto Bld.


THE METROPOLITAN SANITARY DISTRICT


FOR THE FREEDOM WE ENJOY. THANK A
The MWRD
Supports

Estimated Timelines for Implementation of UV Disinfection without Filtration[1]

	Stickney WRP[2]	North Side WRP	Calumet WRP
Procurement of Professional Services	0.5 years	0.5 years	0.5 years
Investigative Phase	3 years	3 years	3 years
Program Development and Conceptual Design	1.5 years	1.5 years	1.5 years
Final Design	2 years	1.5 years	1.5 years
Construction	4 years	2.5 years	2.5 years
Total	11 years	9 years	9 years
		2020	2020

[1] The need for Filtration will be assessed through water analysis and pilot testing

[2] The implementation schedule for SWRP is longer than NSWRP and CWRP because the SWRP facilities are both larger, and involve more extensive civil/site work related to the effluent conduits and outfall

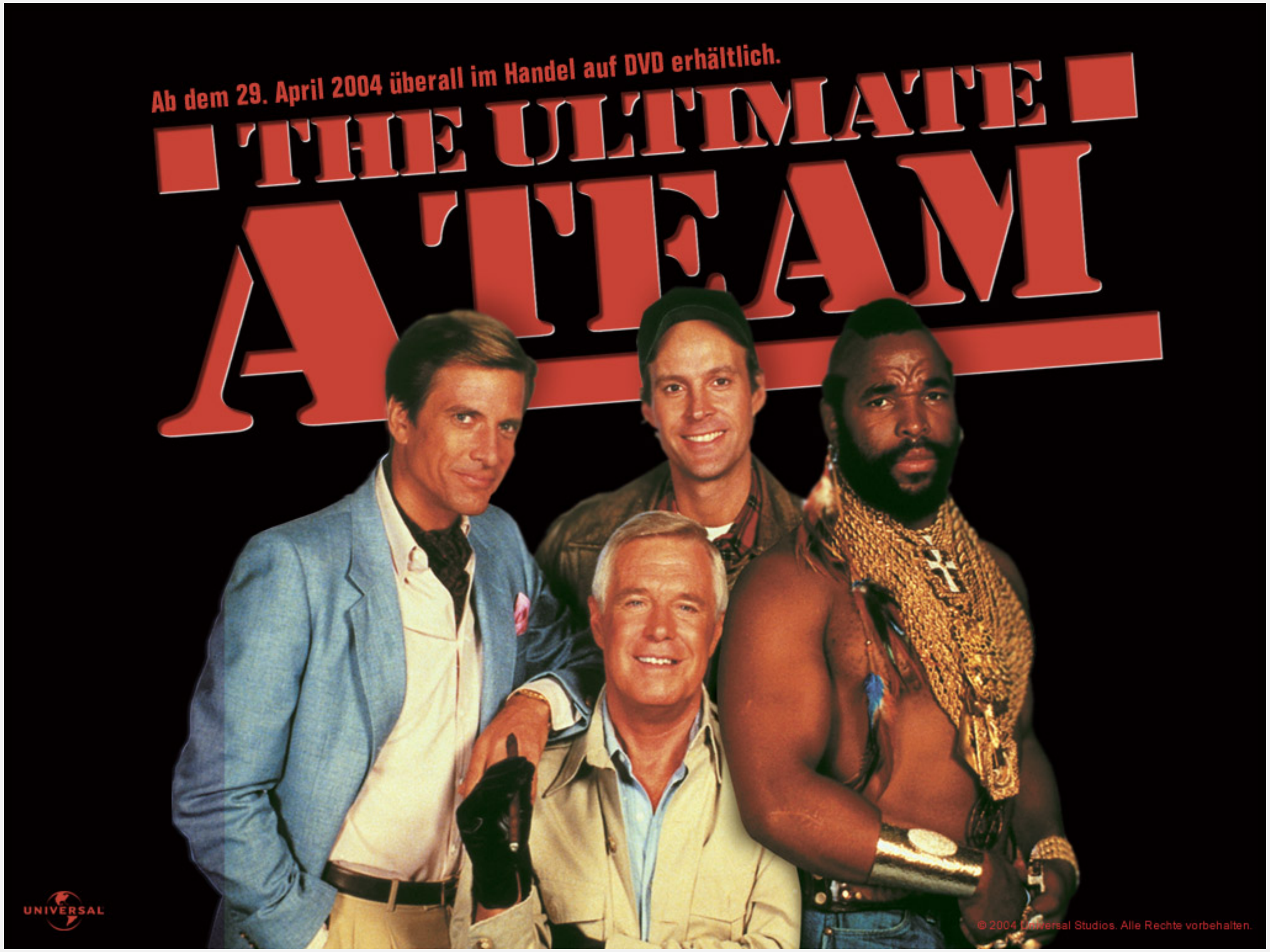
Metropolitan Water Reclamation District of Greater Chicago

Timetable for Implementation of Disinfection at the North Side and Calumet Water Reclamation Plants

Phase	Costs*		Schedule	
I. INVESTIGATION PHASE	Analytical tests and equipment: Transmittance meters: Site visits: Total	$350,000 $40,000 $10,000 $400,000	9/2011 to 3/2012	6 Months
II. DESIGN PHASE	Design Engineering:	$34,000,000	4/2012 to 3/2013	1 Year
III. CONSTRUCTION PHASE	Construction Cost: Post-Award Engineering: Total:	$240,000,000 $12,000,000 $252,000,000	Advertise, Bid, Award: 4/2013 to 10/2013 Construction: 11/2013 to 11/2015	2 Years
IV. START UP AND OPERATION PHASE	Annual Operation Cost:	$10,100,000	12/2015 and on	

*All costs are in year 2011 dollars

9/20/2011, ProFac


Ab dem 29. April 2004 überall im Handel auf DVD erhältlich.
THE ULTIMATE
A TEAM
UNIVERSAL
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Disinfection Task Force

- Edward Podczerwinski
- Beata Busza (Engineering)
- Judith Moran-Andrews
- Doris Berstein (M&R)
- Joe Ford
- Brian Perkovich (M&O)

7 WATER RECLAMATION PLANTS

Stickney	1200 MGD
Calumet	354 MGD
North Side	333 MGD
Kirie *	72 MGD
Egan *	30 MGD
Hanover Park *	12 MGD
Lemont	3 MGD

* Disinfection Facilities

Evaluation of Disinfection Technologies for the Calumet and O'Brien Water Reclamation Plants

Technical Memorandum 1
Date: December 12, 2011

Subject: Available Disinfection Technologies and Short List of Technologies for Further Evaluation

Evaluation of Disinfection Technologies for the Calumet and O'Brien Water Reclamation Plants

Technical Memorandum 2
Date: December 21, 2011

Subject: Historic Plant Flows, Water Quality Data, and Other Test Results

Evaluation of Disinfection Technologies for the Calumet and O’Brien Water Reclamation Plants

Technical Memorandum 3
Date: February 17, 2012

Subject: Evaluation Matrix Ratings and Results

Evaluation of Disinfection Technologies for the Calumet and O’Brien Water Reclamation Plants

Technical Memorandum 4
Date: May 4, 2012

Subject: Design Criteria and Conceptual Design for Selected Disinfection Technologies at the Calumet and North Side Water Reclamation Plants

Task Force Recommendations

- O'Brien WRP - Ultraviolet (UV) Disinfection
- Calumet WRP – Chlorine Disinfection/De-Chlorination
- Triple Bottom Line Approach

O’Brien WRP Design Parameters

- Flow Rates
  - Average Flow: 240 MGD
  - Maximum Flow: 450 MGD
- Disinfection Standard (Fecal Coliform)
  - Monthly Geometric Mean: 200 CFU/100 mL
  - Less Than 10% Greater Than 400 CFU/100 mL
  - Disinfection Season: March 1st - November 30th
- Disinfection Technology

ULTRAVIOLET IRRADIATION

USING LOW PRESSURE HIGH OUTPUT LAMPS

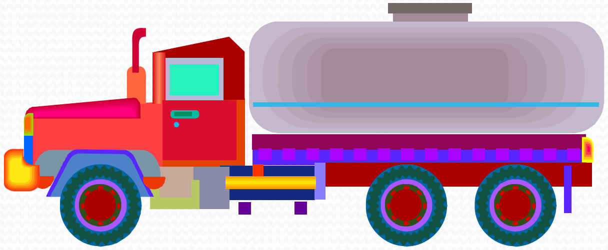
Calumet WRP Design Parameters

- Flow Rates
  - Average Flow: 270 MGD
  - Maximum Flow: 430 MGD
- Disinfection Standard (Fecal Coliform)
  - Monthly Geometric Mean: 200 CFU/100 mL
  - Less Than 10% Greater Than 400 CFU/100 mL
  - Disinfection Season: March 1st - November 30th
- Disinfection Technology

CHLORINATION

/DE-CHLORINATION

WITH PURCHASED CHEMICALS



$NaOCl$

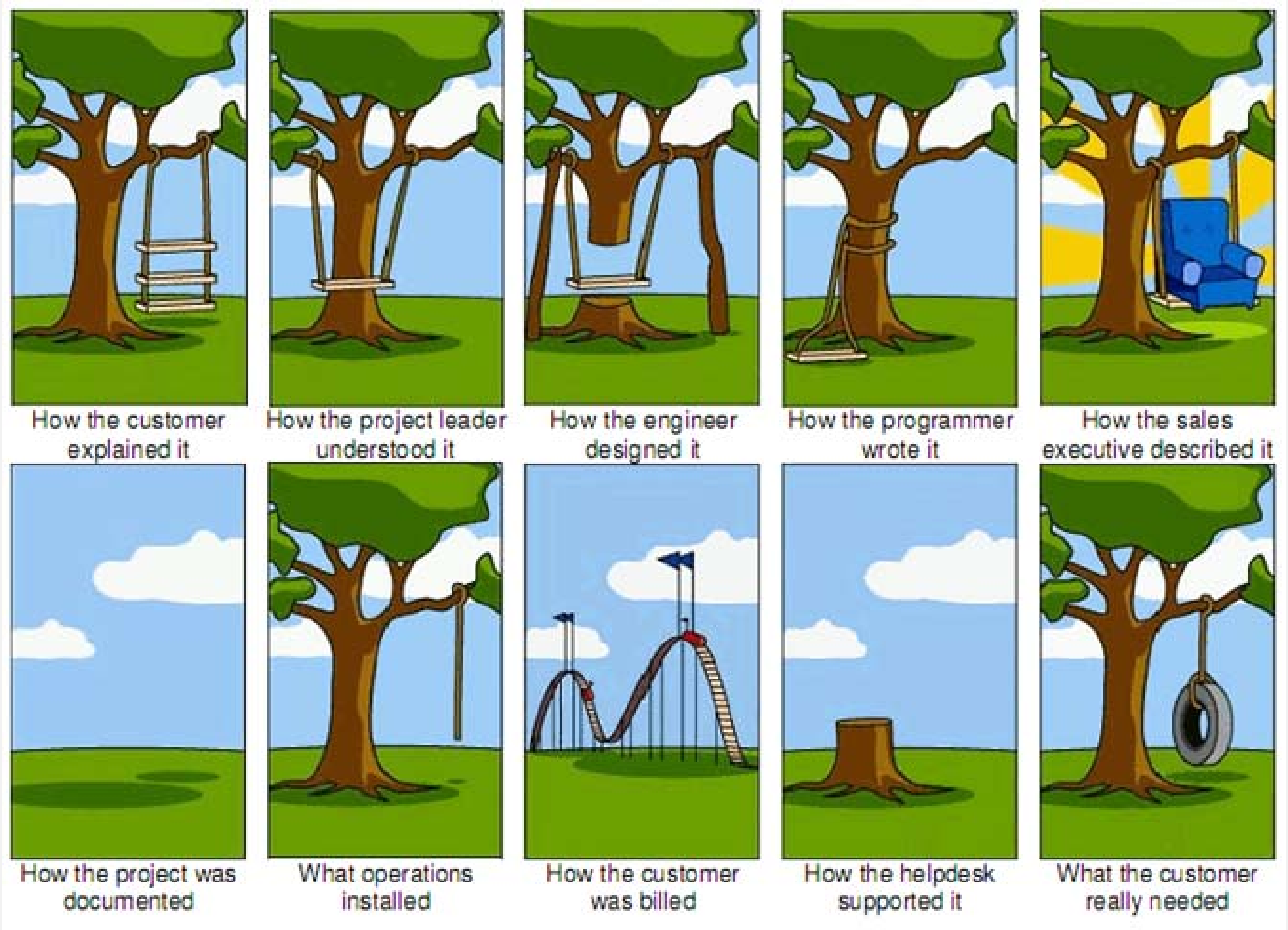
$NaHSO_3$

Consolidated Consultant Interviews

Monday October 10, 2011	Consultant
9:00 a.m.-10:00 a.m.	Greeley & Hansen LLP
11:00 a.m.-12:00 noon	Black & Veatch Corporation
2:00 p.m.-3:00 p.m.	~~Malcolm Pirnie, Inc.~~

Tuesday October 11, 2011	Consultant
9:00 a.m.-10:00 a.m.	MWH Americas, Inc.
11:00 a.m.-12:00 noon	Camp Dresser and McKee, Inc.
2:00 p.m.-3:00 p.m.	HDR Engineering, Inc.

Wednesday October 12, 2011	Consultant
9:00 a.m.-10:00 a.m.	AECOM
11:00 a.m.-12:00 noon	CH2M Hill, Inc.


How the customer explained it
How the project leader understood it
How the engineer designed it
How the programmer wrote it
How the sales executive described it
How the project was documented
What operations installed
How the customer was billed
How the helpdesk supported it
What the customer really needed

OWRP Project Timeline

- Chose Greeley and Hansen as Consultant
- Project Design Kick-off - April 2012
- Preliminary Design - June 2012
- 60% Design - November 2012
- Final Design - March 2013
- Construction Start - Fall 2013
- System On-line – December 2015

Terrence J. O’Brien WRP

- Commissioned in 1928
- Located in Skokie, Illinois
- Serves over 1.3 million people in 141 square miles
- Conventional activated sludge plant
- Effluent from final settling tanks discharges into the North Shore Channel
- Plant Flow Rates
  - Average: 240 mgd
  - Design: 333 mgd
  - Total Permitted Maximum Flow: 450 mgd
  - Peak Hydraulic Capacity: 530 mgd

Preliminary Design

- UV Dosage
  - 10 States Standards
    - UV Dose of 30 mJ/cm^2
  - Illinois EPA
    - UV Dose of 40 mJ/cm^2
  - 40 mJ/cm^2 dose selected

UV Doses

- Amount of energy needed to inactivate microorganisms
- Dosage units are in terms of the energy reaching the organism multiplied by the organism's contact time in the UV irradiation field
- Units: $\mu J/cm^2$, or $\mu Ws/cm^2$, or J/m^2

UV Transmittance

Typical UVT Ranges:

Type of Wastewater	UV% Transmittance [%, cm^{-1}]
Primary effluent	28 – 50
Secondary effluent	45 – 70
Nitrified effluent	56 – 79
Filtered nitrified effluent	56 – 79
Microfiltration and MBR	79 – 91
Reverse Osmosis	89 – 98

UV transmittance:

- Defined as the fraction of incident light at 254nm, remaining, after passage through a 1.0 cm pathlength of a sample of the water
- Measured in percent

Collimated Beam Testing

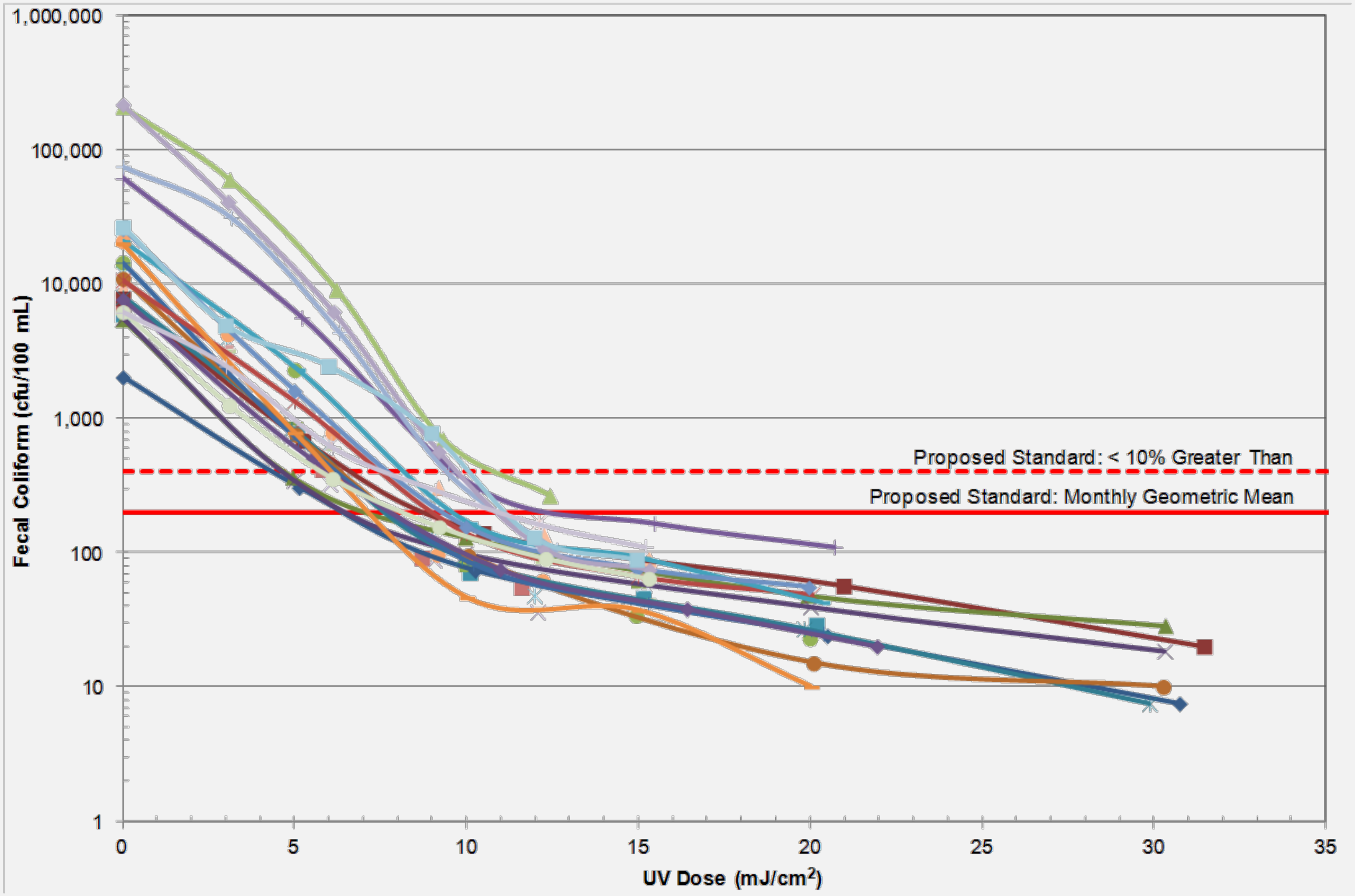
- UV Design Guidance Manual Recommended Test Procedure:
  - Samples are subjected to UV light through the testing apparatus.
  - Fecal coliform concentration is measured before and after the test.
  - UV Dose delivered to the sample is then calculated based on the factors of the apparatus setup, UV intensity, and exposure time.

Collimated Beam Testing Apparatus

OWRP - Collimated Beam Testing

- Samples were collected over 12 month period and at a variety of flow rates.
  - Dry, average, and wet weather conditions were sampled.
  - Various UVT levels.
- Various dosages were tested to determine the dosage required to meet regulatory requirements;
  - Both fecal coliform and e. coli limits were analyzed.

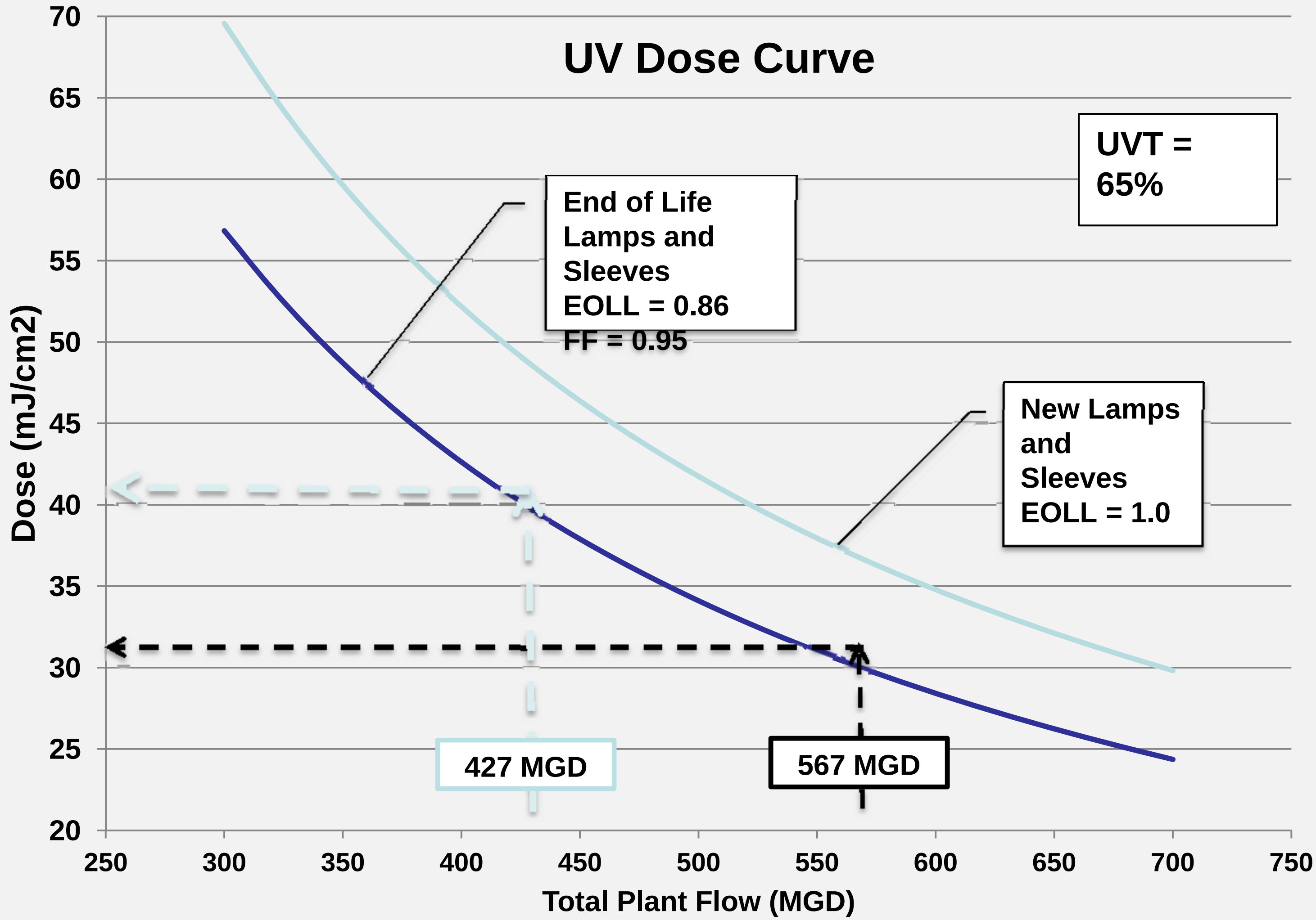
Collimated Beam Test Results



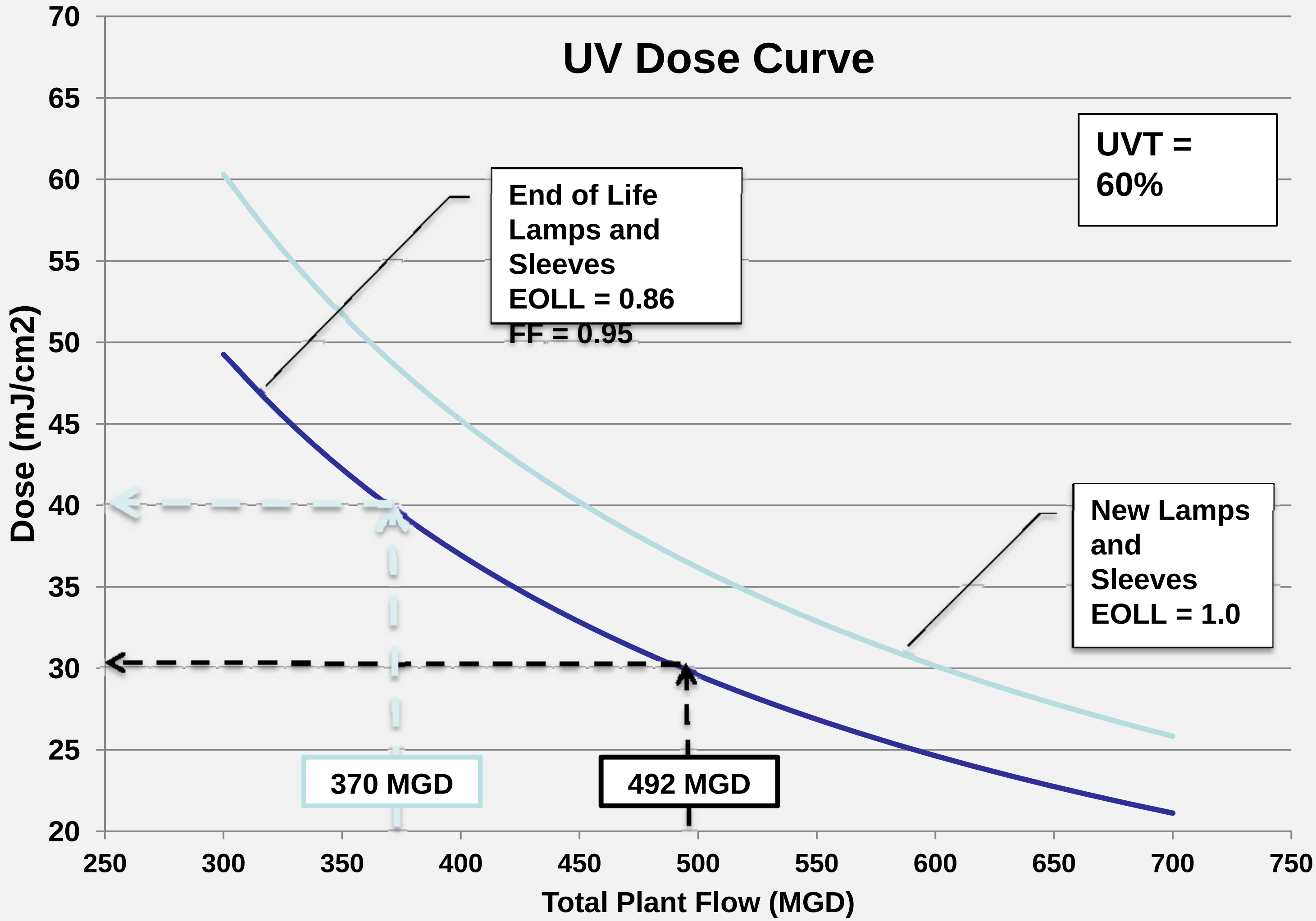
Results of Collimated Beam Testing

- UV Dose of 15mJ/cm^2 worked effectively to keep bacteria counts under the desired limits.
- UV Dose of 10 mJ/cm^2 worked effectively on over 85% of the samples to keep bacteria counts below the desired limits.
- What does this mean?
  - Using a factor of safety of 2 yields a Design UV dose of 30 mJ/cm^2.

UV Dose Curves



UV Dose Curves at Lower UVT

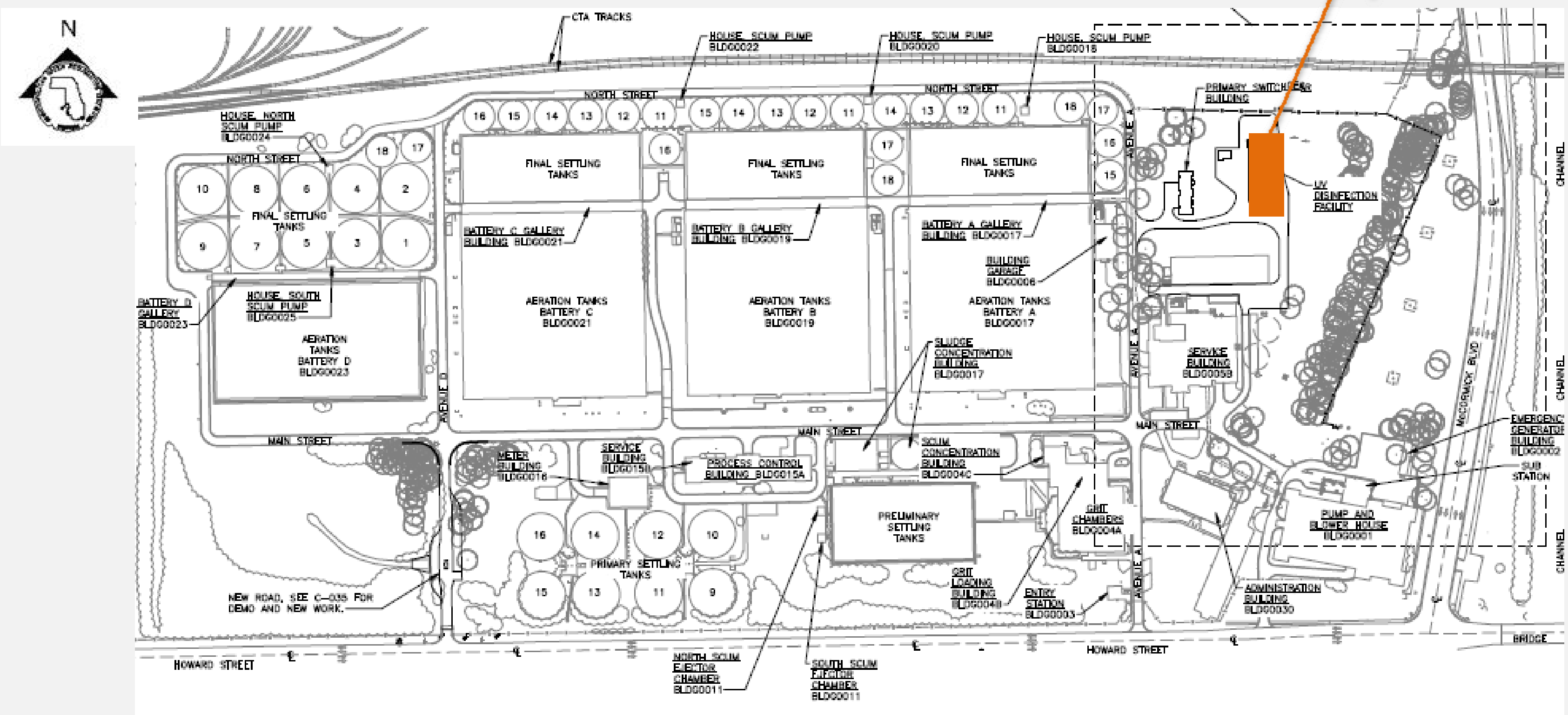


Basis of Design

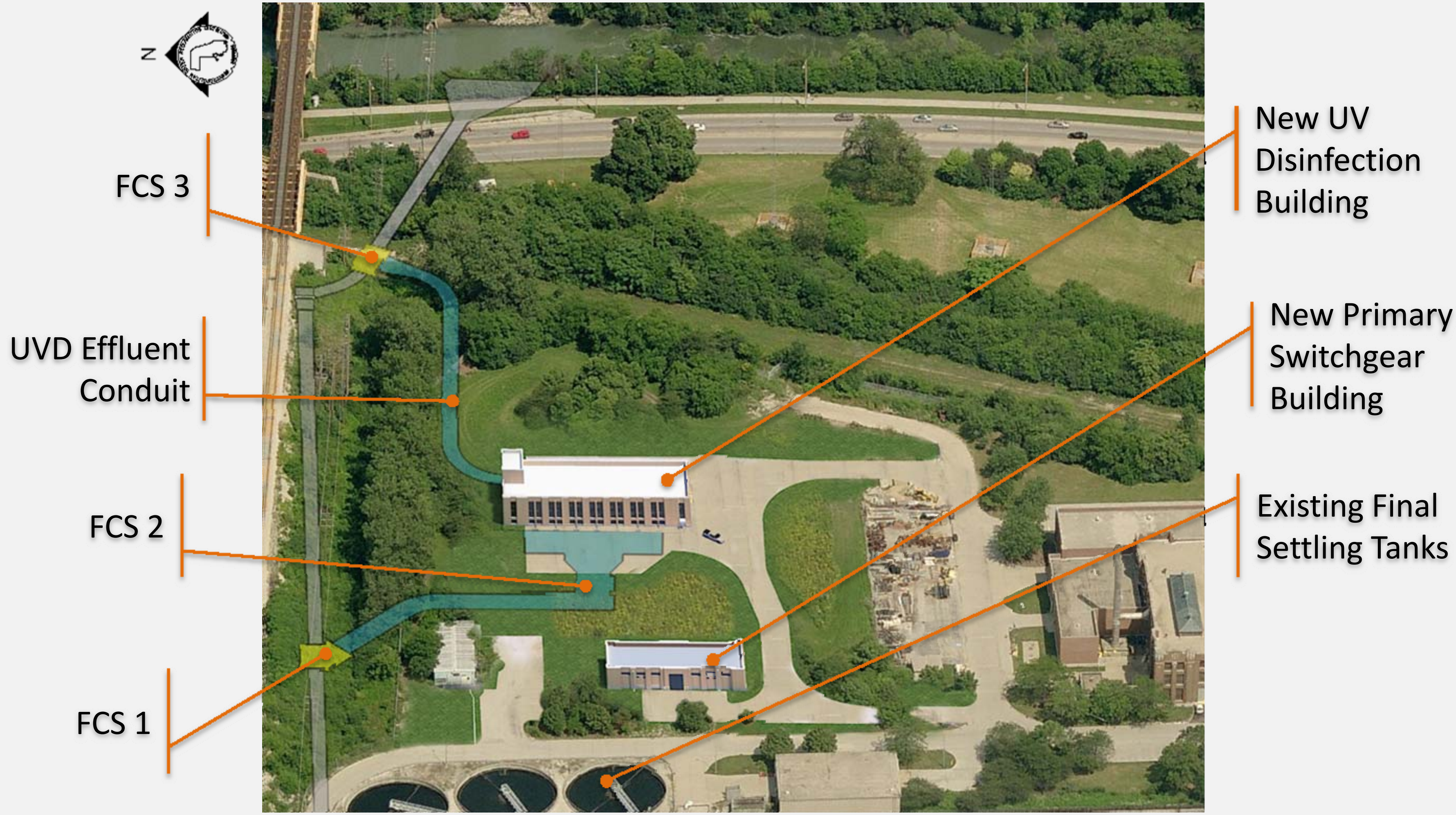
	Value	Unit
Total Permitted Maximum Flow	450	MGD
Total Average Flow	240	MGD
Number of Channels	7	
Peak Flow per Channel	75.7	MGD
Minimum UVT	65	%
Minimum UV Dose at Total Peak Flow	30	mJ/cm^2
End of Lamp Life (EOLL)	0.86	
Fouling Factor (FF)	0.95	
Fecal Coliform - 30-day Geo-mean Monthly Maximum - Less than 10% Above	200 400	cfu/100 mL cfu/100 mL
Lamp Life Warranty	15,000	hours

Site Plan - OWRP

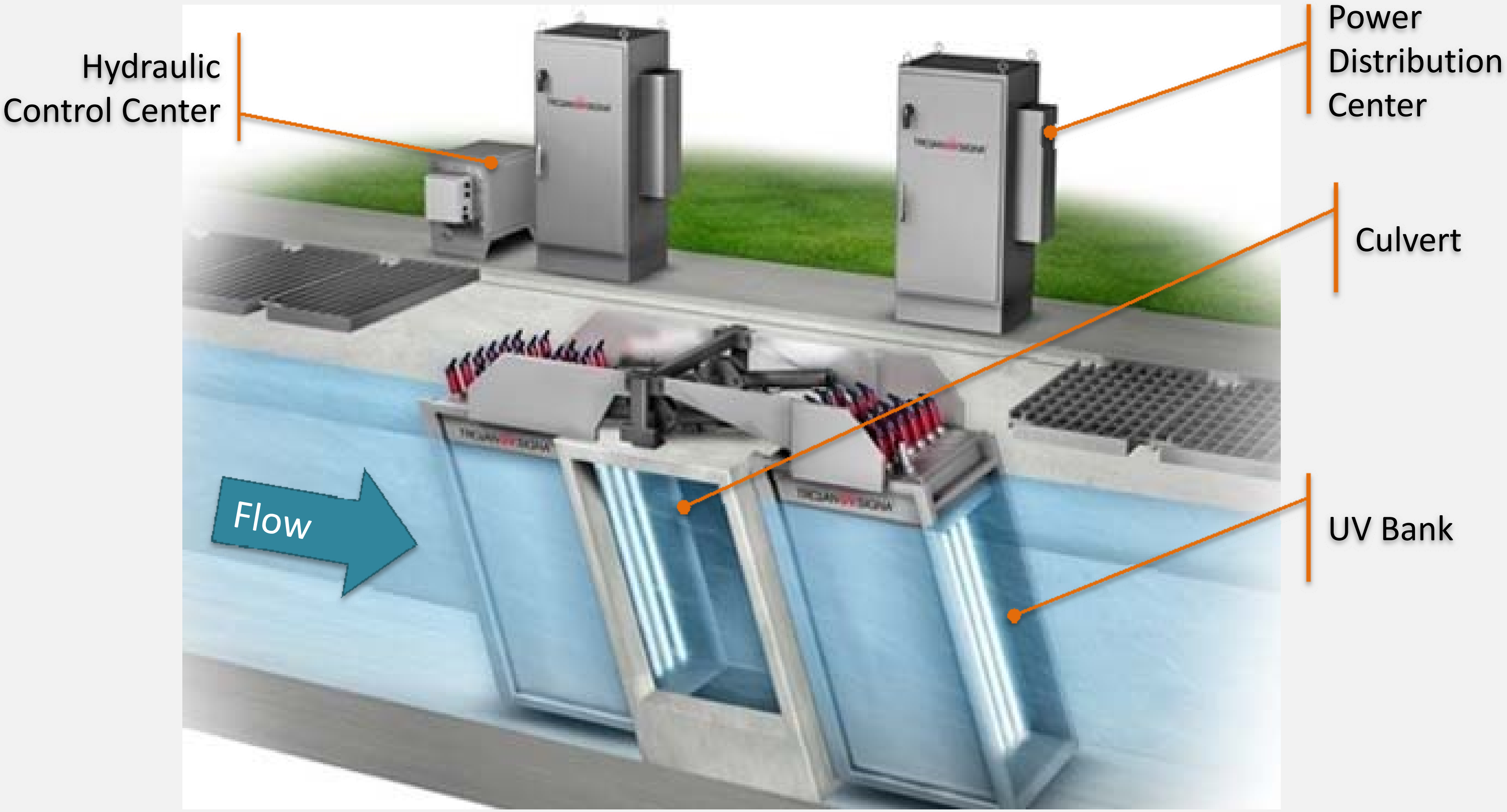
UV Disinfection Building



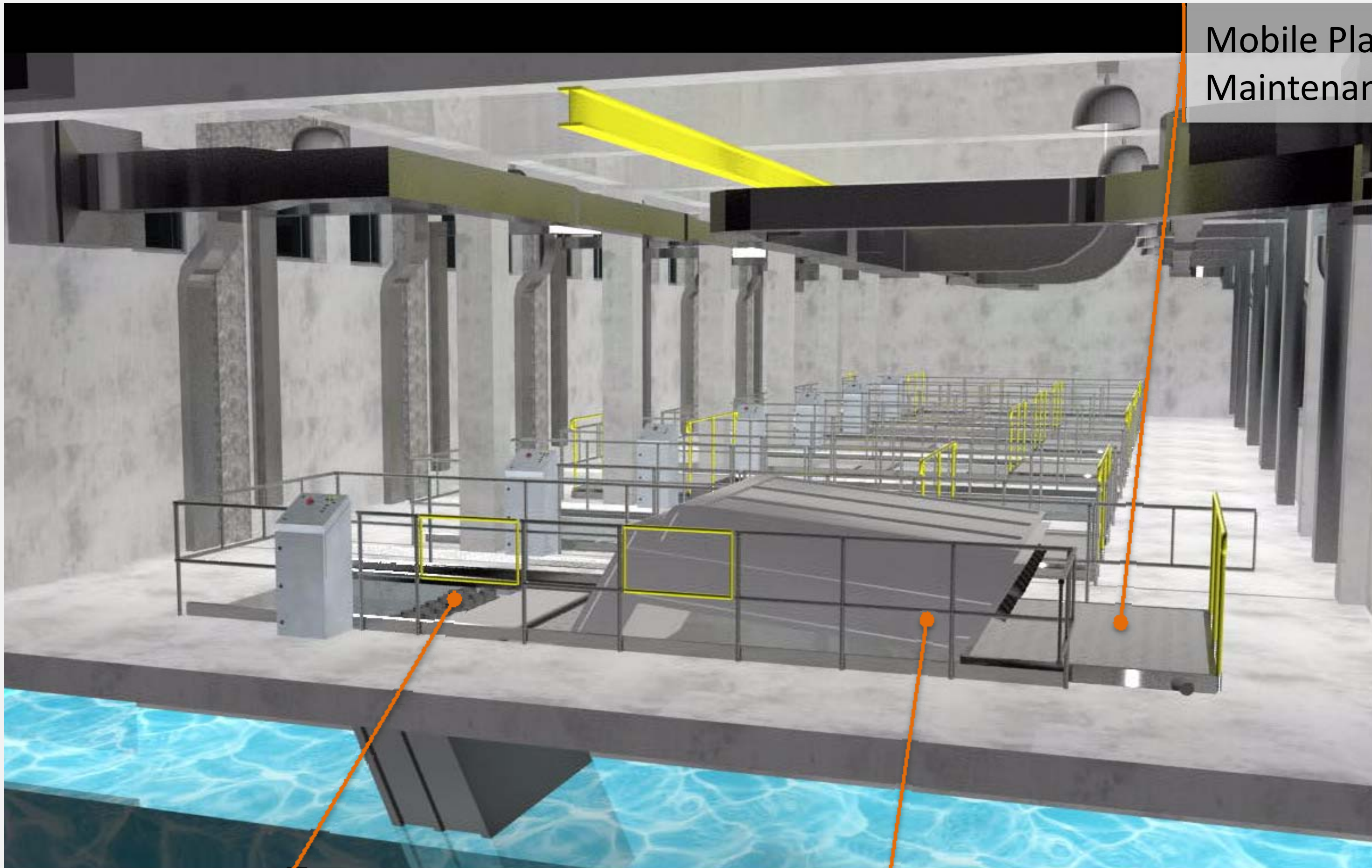
Proposed Facility Site Plan



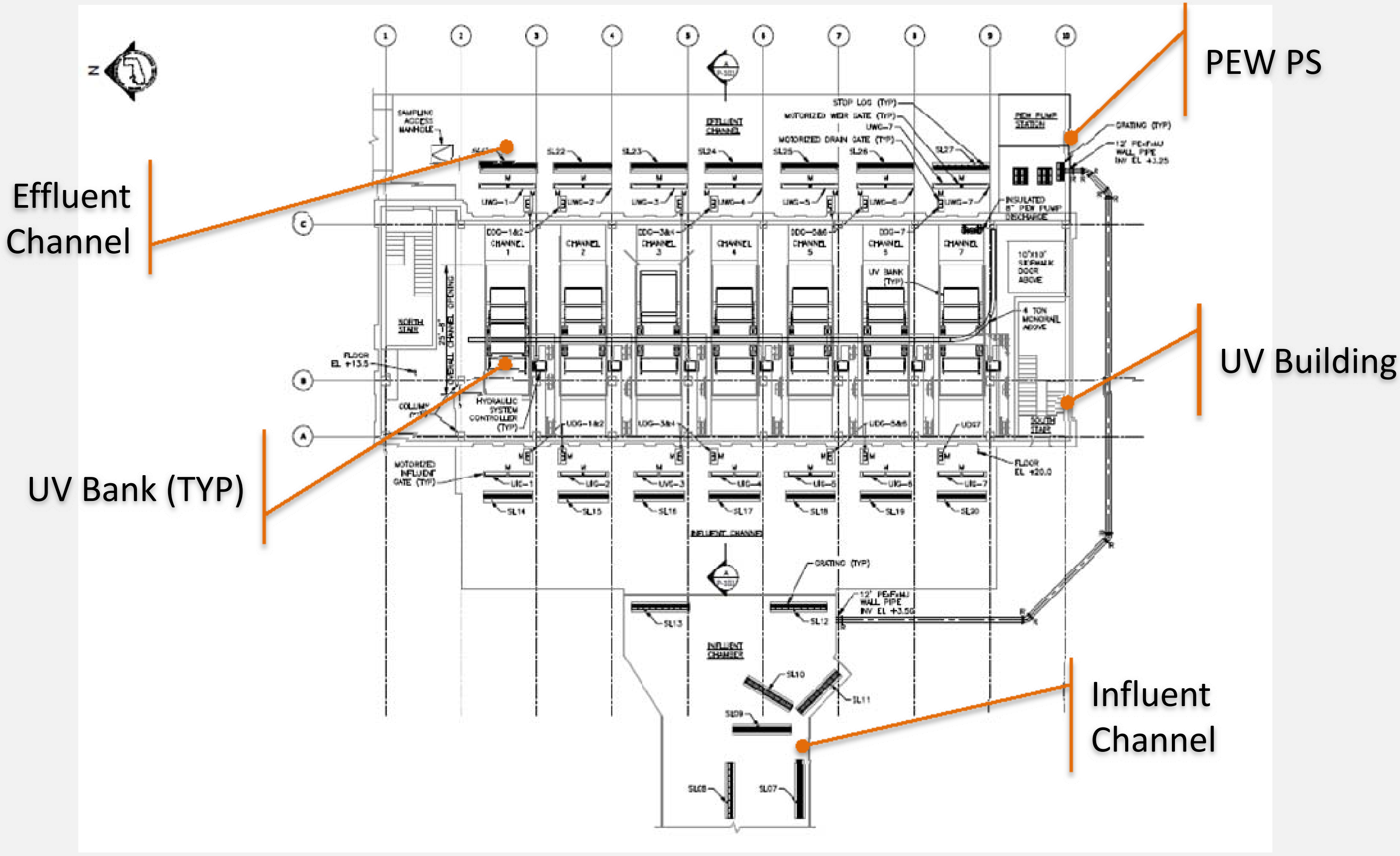
TrojanUV Signa System



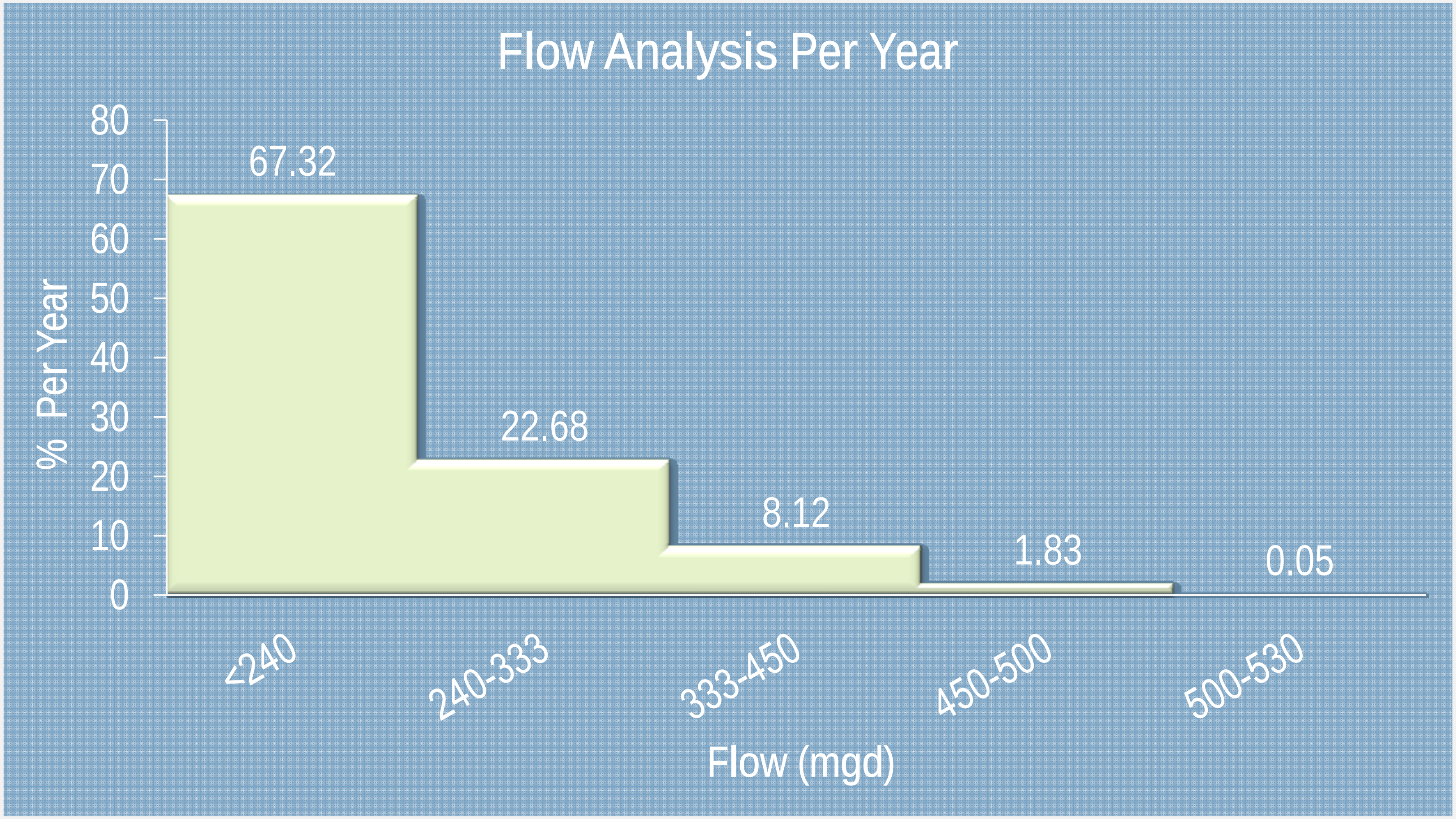
TrojanUV Signa Maintenance



UV Building Overall Plan



Typical OWRP Flows



Hydraulic Profile
Existing Conditions

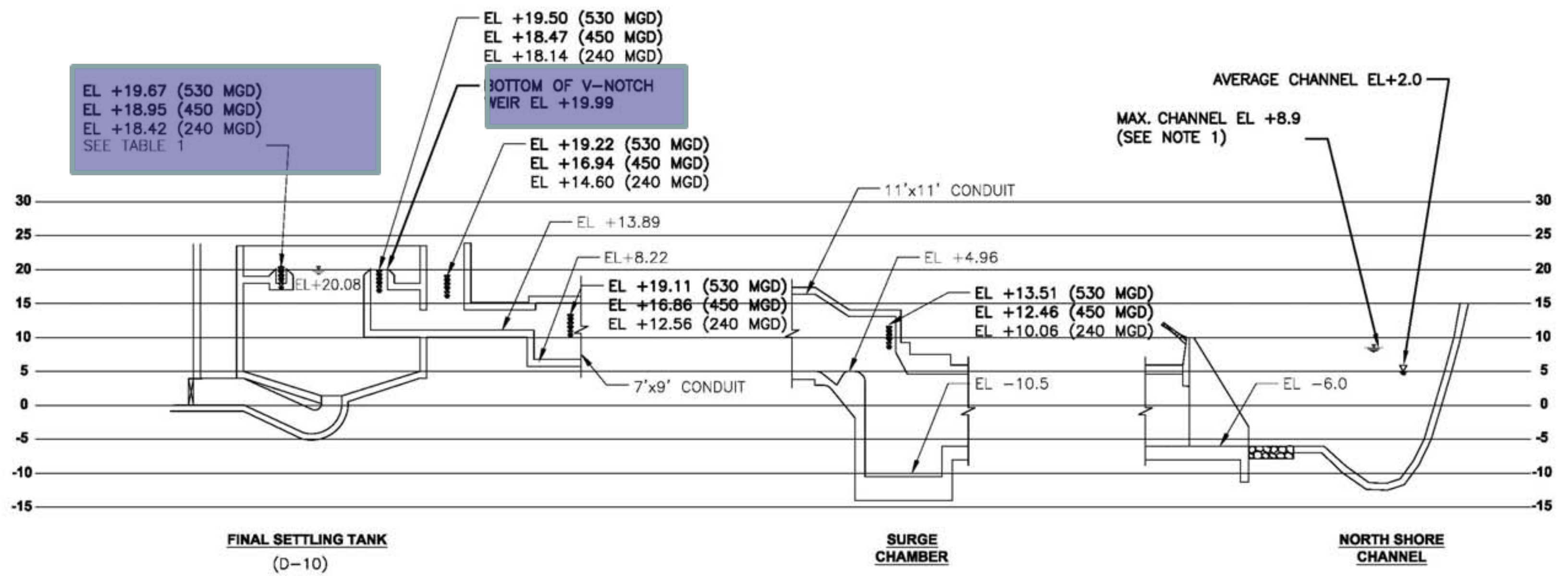


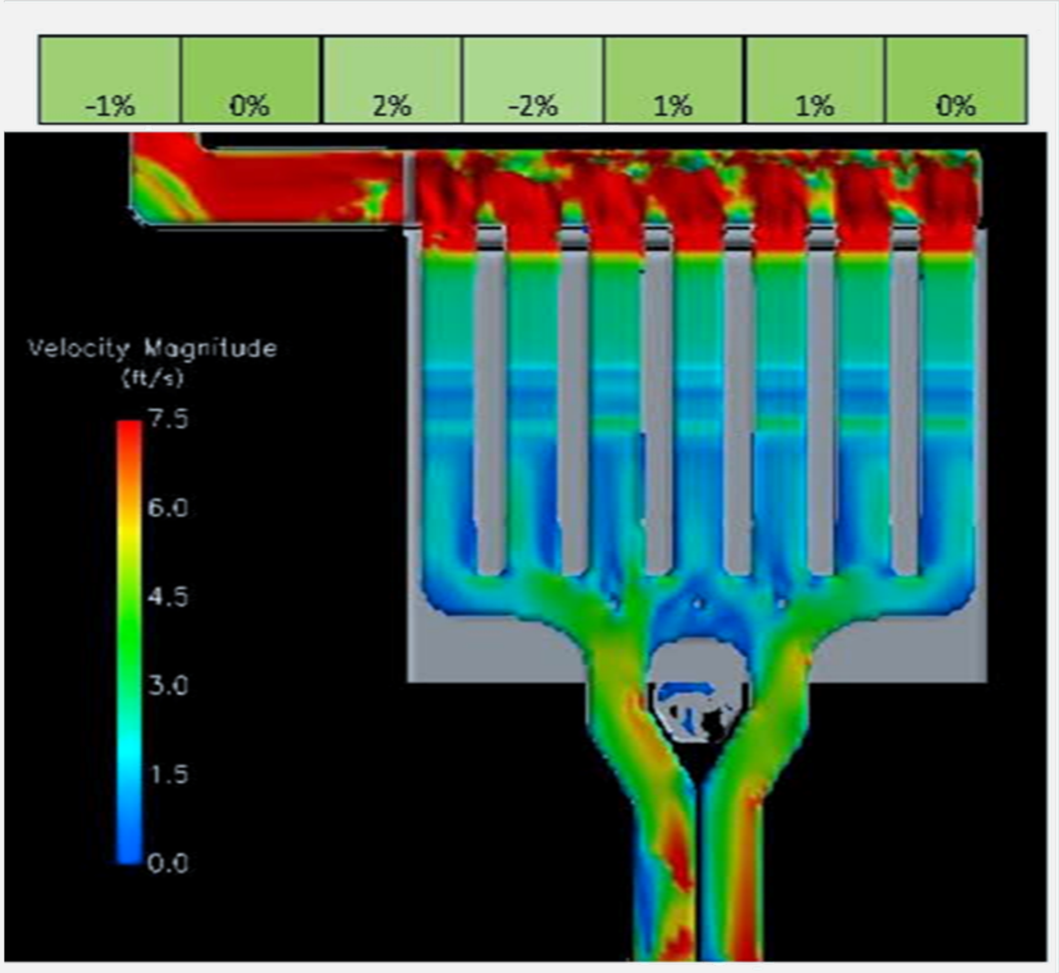
TABLE 1 – W/NORTH SHORE CHANNEL @ EL +2.0

LOCATION	530	450	240
FINAL SETTLING TANK (WSE IN FURTHEST POINT OF EFFLUENT TROUGH)	EL+19.08	EL+18.95	EL+18.42

NOTES:

1. MAX ELEVATION AS PROVIDED BY MWRDGC
2. WATER SURFACE EL BASED ON LONGEST FLOW PATH FROM NORTH SHORE CHANNEL TO FINAL SETTLING TANK #10 OF BATTERY D.
3. FLOWS TO BATTERY A THROUGH D BASED ON FOLLOWING SPLIT:
   a. NORMAL FLOW (230 MGD :25% TO EACH BATTERY)
   b. WET WEATHER FLOW (450 MGD): A= 22%, B=24%,
      (530 MGD): C=22%, D=32%)

Seven UV Channel Configuration CFD Modeling



Flow Conditions

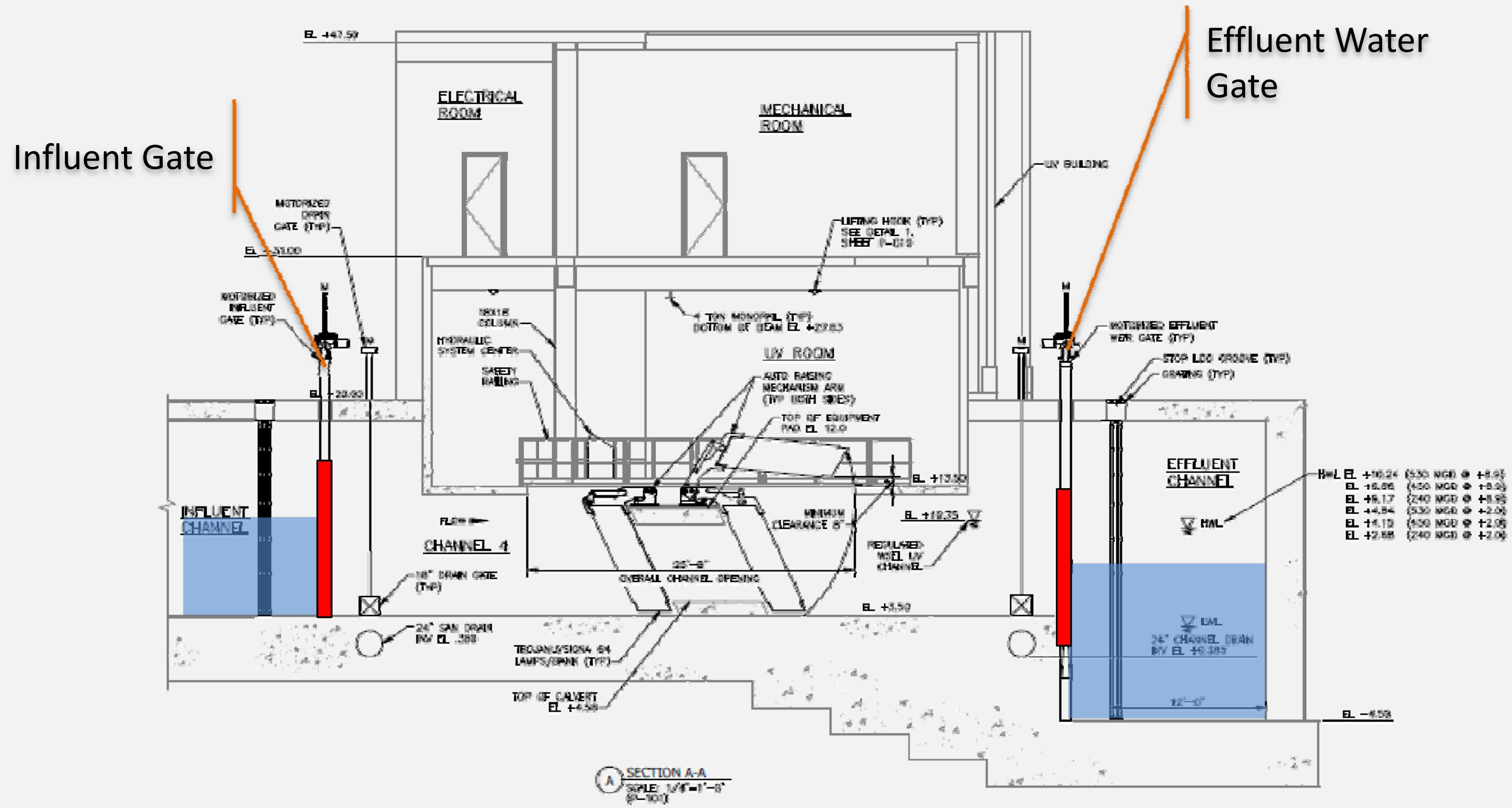
Total Flow (MGD)	Number of Channels in Service	Flow Per Channel (MGD)	UV Effluent Fixed Weir Elev. (ft)	Channels in Service						
				No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
530	7	75.7	+8.25	X	X	X	X	X	X	X
450	6	75.0	+8.25	X	X	X	X	X	X	
240	4	60.0	+8.61	X	X	X	X			
180	3	60.0	+8.61	X	X	X				

Operations and Control

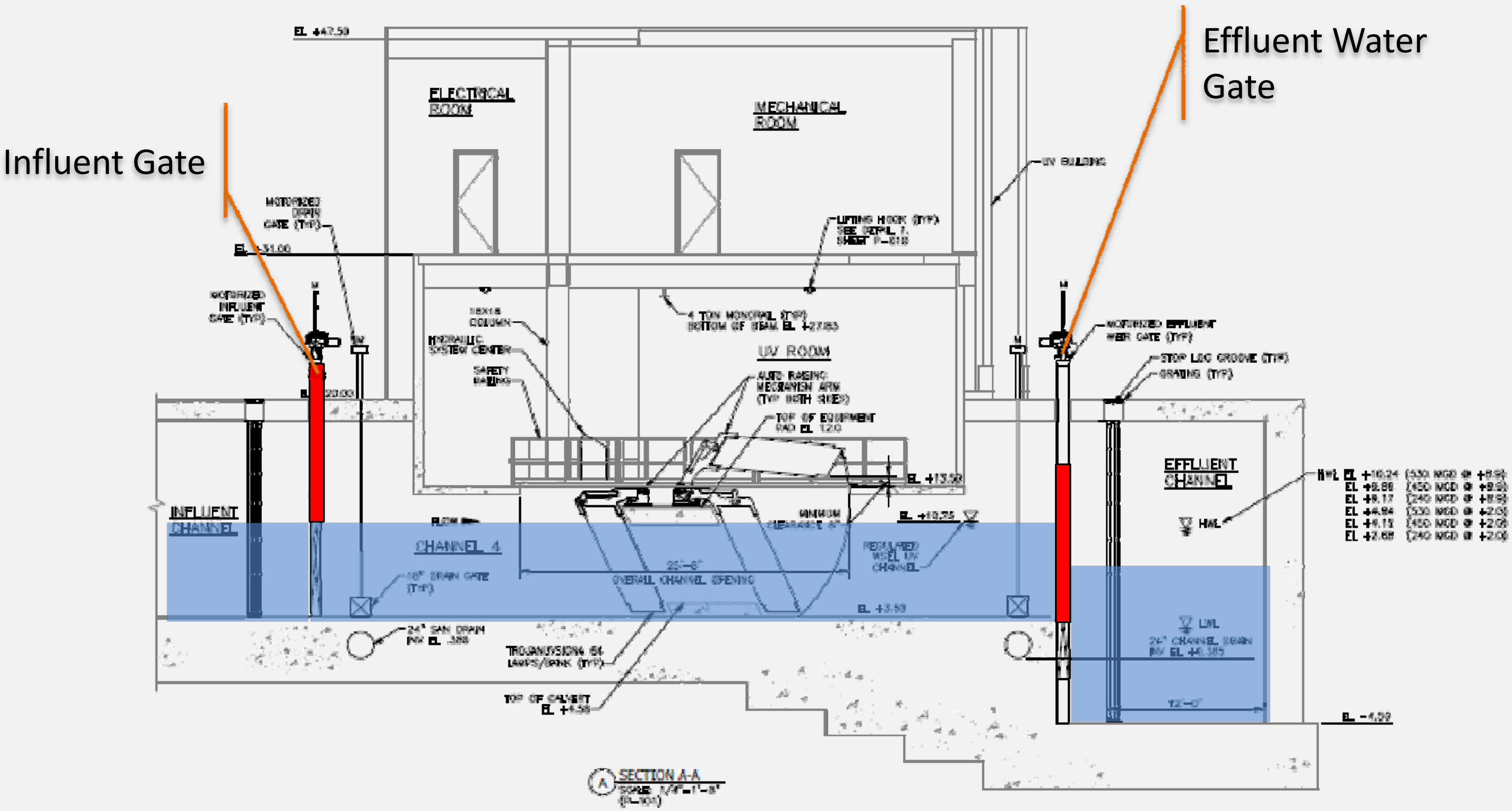
Condition	Influent Gate	Weir Gate	Drain Gate	Channel Water
Active	Open[1]	Modulating	Closed	Full
Ready	Open[1]	Raised	Closed	Full
Standby	Closed	Raised	Closed[2]	Empty

1. Normally, 100% open, but optionally less than 100% may be selected for better flow distribution.
2. When transitioning to Standby, drain gates to be open for preset period of time, then will close.

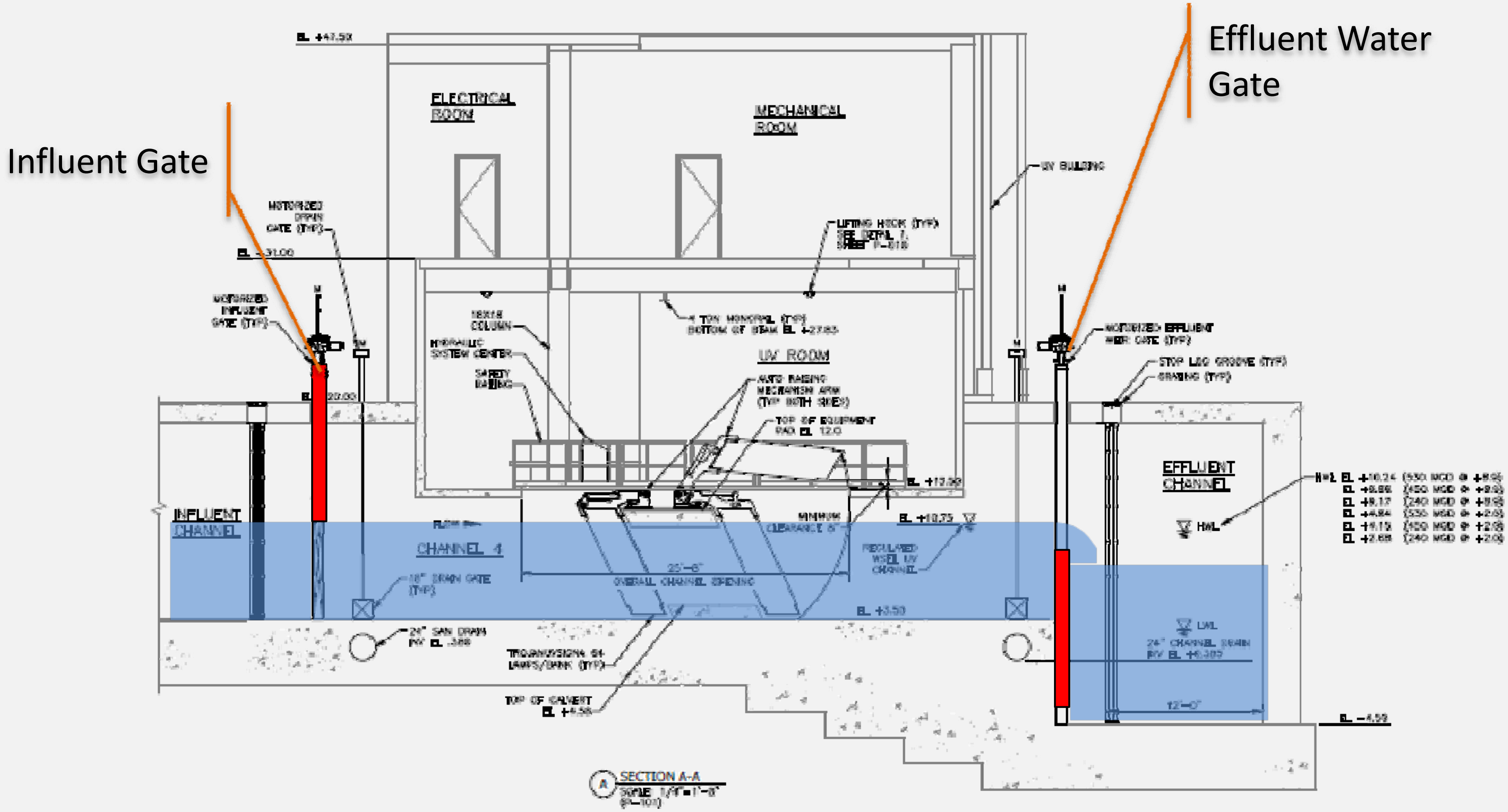
Standby Gate Position



Ready Gate Position



Active Gate Position



CWRP Project Timeline

- Chose CH2M HILL Engineers, Inc.
- Project Design Kick-off - April 2012
- Preliminary Design - June 2012
- 60% Design - November 2012
- Final Design - March 2013
- Construction Start - Fall 2013
- System On-line – December 2015

About the Calumet WRP

- 480 mgd peak hydraulic flow, 270 mgd average
- Primary and secondary treatment
- High-quality secondary effluent, with avg TSS of 5 mg/L

- Nitrification year-round, with average ammonia concentration of 0.21 mg/L as N
- Existing chlorine contact basin constructed in 1960s
- Chlorine is the most cost-effective option due to the existing CCB

Bench-Scale Testing Program

- *Testing conducted at ASL in Corvallis, OR*

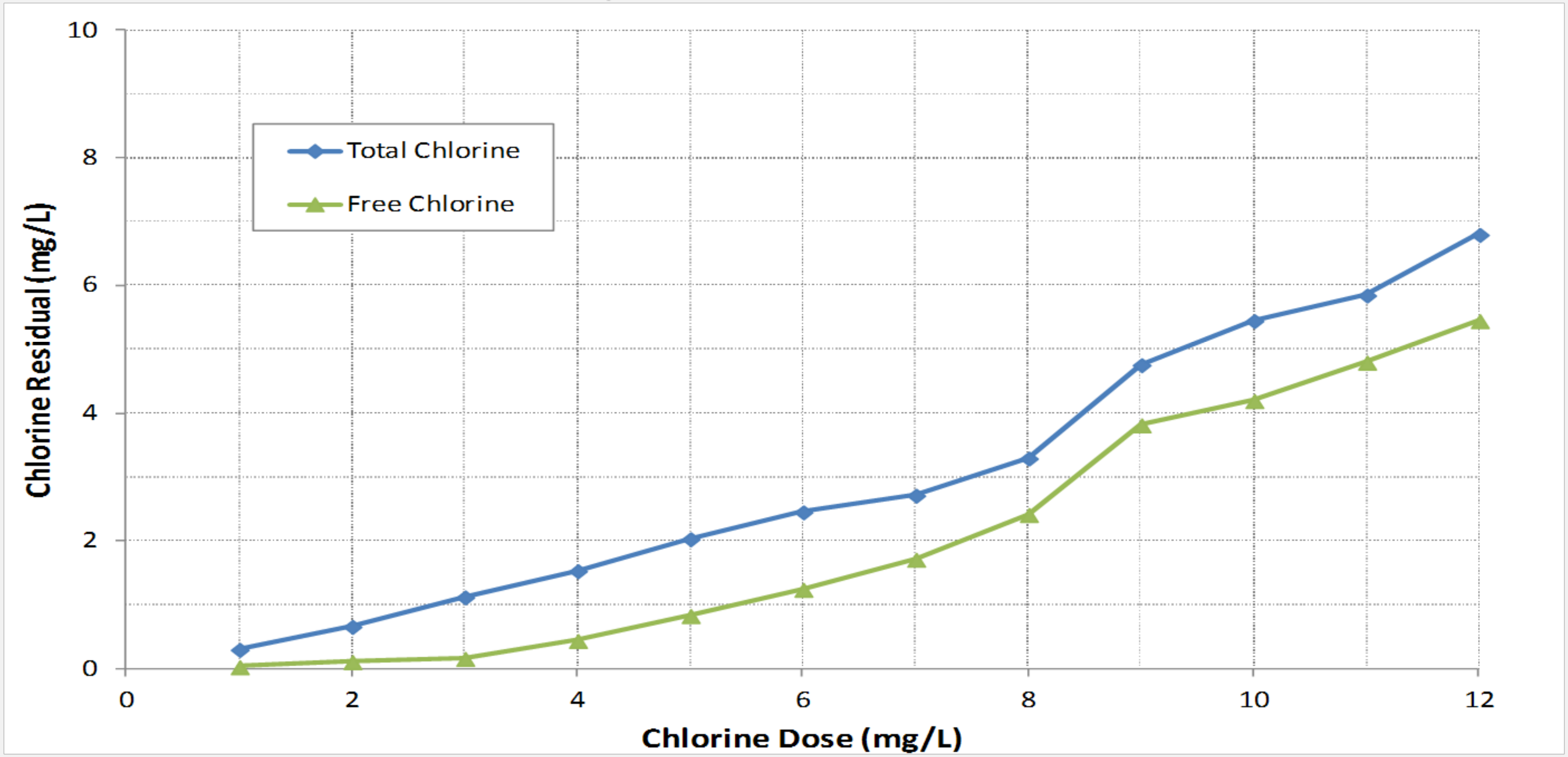
TABLE 1

Calumet Water Reclamation Plant Secondary Effluent Water Quality, April 30 and July 19, 2012

General Chemistry Analysis		Round 1 (4/30/12) Result	Round 2 (7/19/12) Result
Alkalinity	mg/L as $CaCO_3$	143	51.3
Ammonia	mg/L as N	<0.10	0.95
Nitrate	mg/L as N	13.0	12.0
Nitrite	mg/L as N	0.15	0.4
Phosphate, Ortho	mg/L as P	3.3	4.4
Phosphate, Total	mg/L as P	3.5	4.8
pH	units	7.16	7.37
TSS	mg/L	<2.0	10.0
Turbidity	NTU	2.2	7.5
TOC	mg/L	8.6	9.1
UV-254 Transmittance (UVT)	%	70.8	69.5
Fecal Coliform (geometric mean)	CFU/100 mL	35,537	21,799
E. Coli (geometric mean)	CFU/100 mL	2,974	11,730
Enterococci (geometric mean)	CFU/100 mL	N/A	2,044

Chlorine Demand Test Results, Round 1

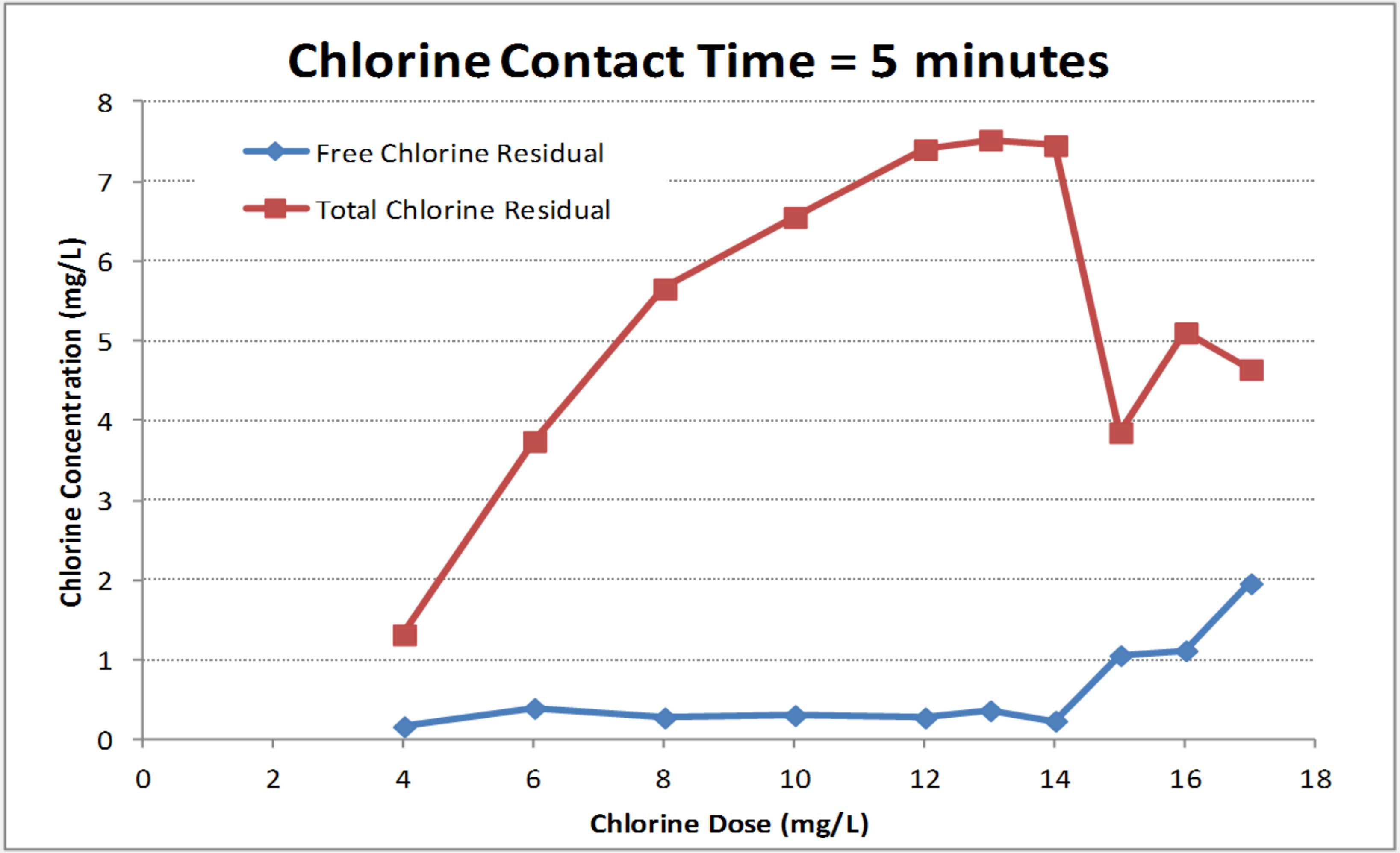
FIGURE 1
Chlorine Demand in Calumet WRP Secondary Effluent



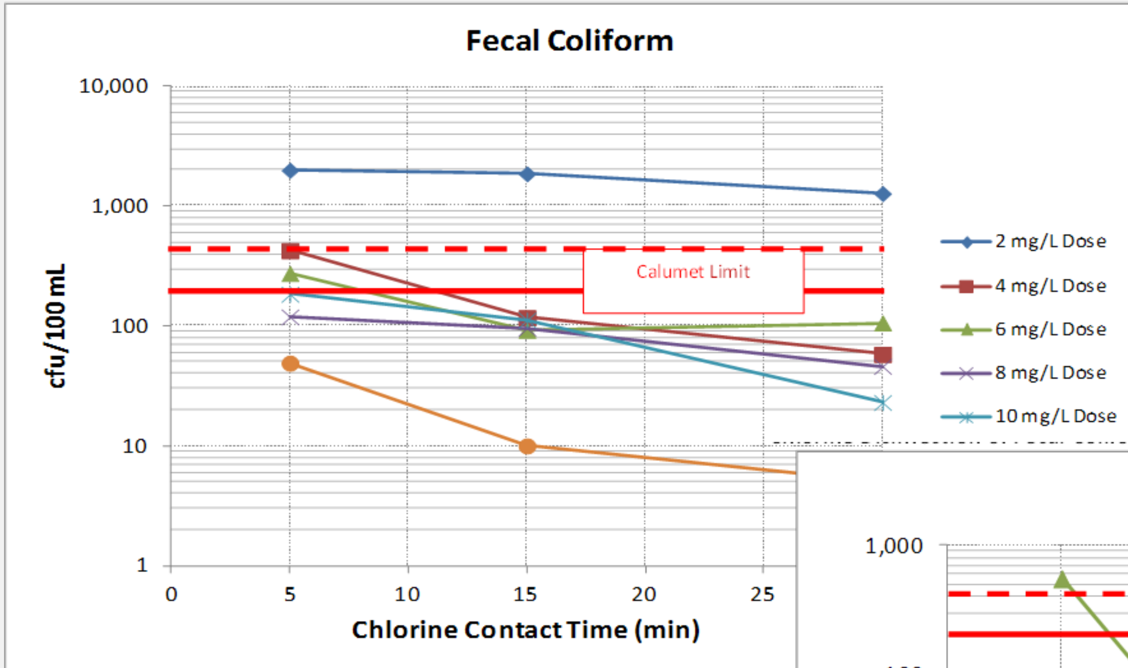
Chlorine Demand Test Results, Round 2

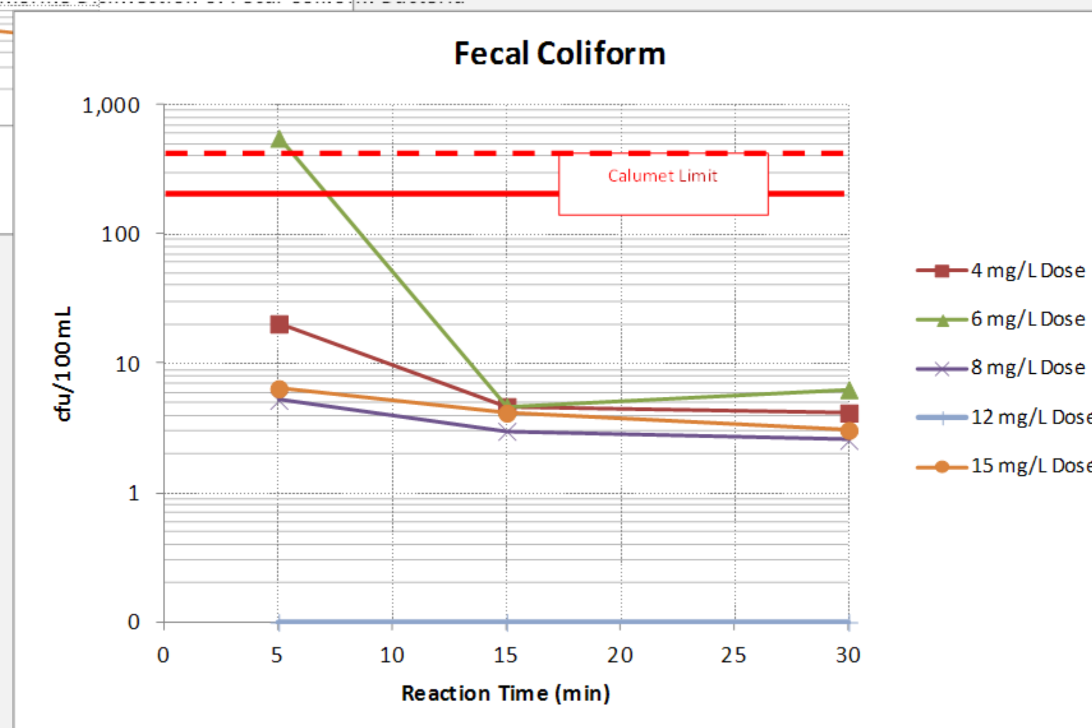
FIGURE 2

Chlorine Demand in Calumet WRP Secondary Effluent



Chlorine Is an Effective Disinfectant for Calumet

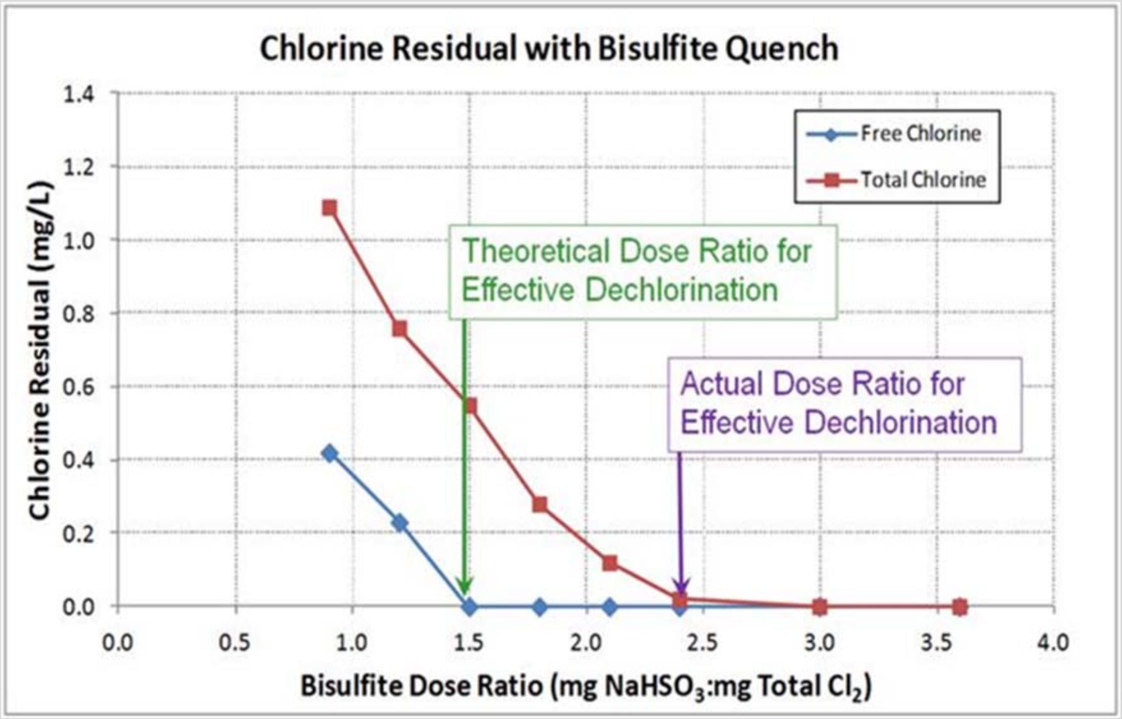




- *Adequate chlorine dose and contact time are required*

Sodium Bisulfite Will Be Used for Dechlorination

- Sodium bisulfite quenches remaining chlorine residual present to protect aquatic life
- Sodium bisulfite is effective in Calumet effluent



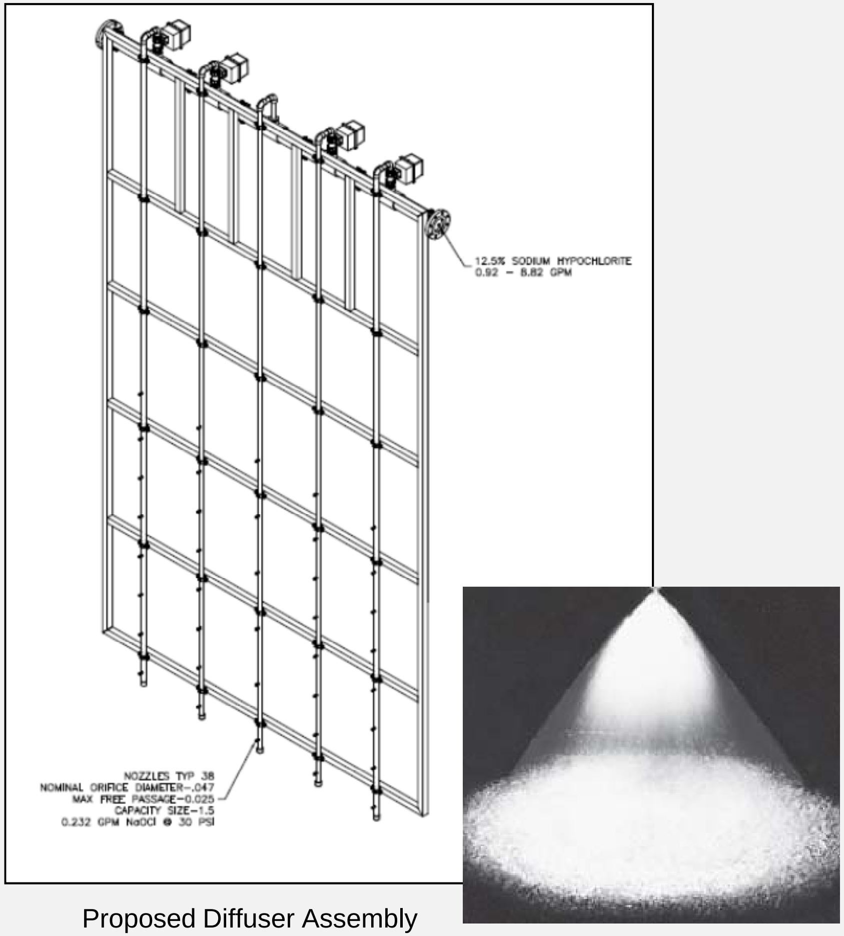
Design Requirements for the Disinfection Facilities

- 10-State Standards and Illinois Administrative Code (Title 35) require:
  - Chlorine Design Dose $\geq$ 6 mg/L for nitrified secondary effluent, 8 mg/L for activated sludge effluent
  - Chlorine Contact Time $\geq$ 15 minutes (after full mixing)
  - Sodium Bisulfite Dose $\geq$ theoretical dose + 10% excess
  - Dechlorination Contact Time $\geq$ 30 seconds (including mixing)

Basis of Design – Chemical Systems

- Hypochlorite and bisulfite in one “Disinfection Chemical Building”
- 7- days storage of each chemical at average conditions 4- days Max flow conditions
- Enclosed building provides:
  - Greater security
  - Minimal degradation of chemical inventory
  - Ability to store chemicals through winter

Basis of Design – Chemical Diffuser



Proposed Diffuser Assembly

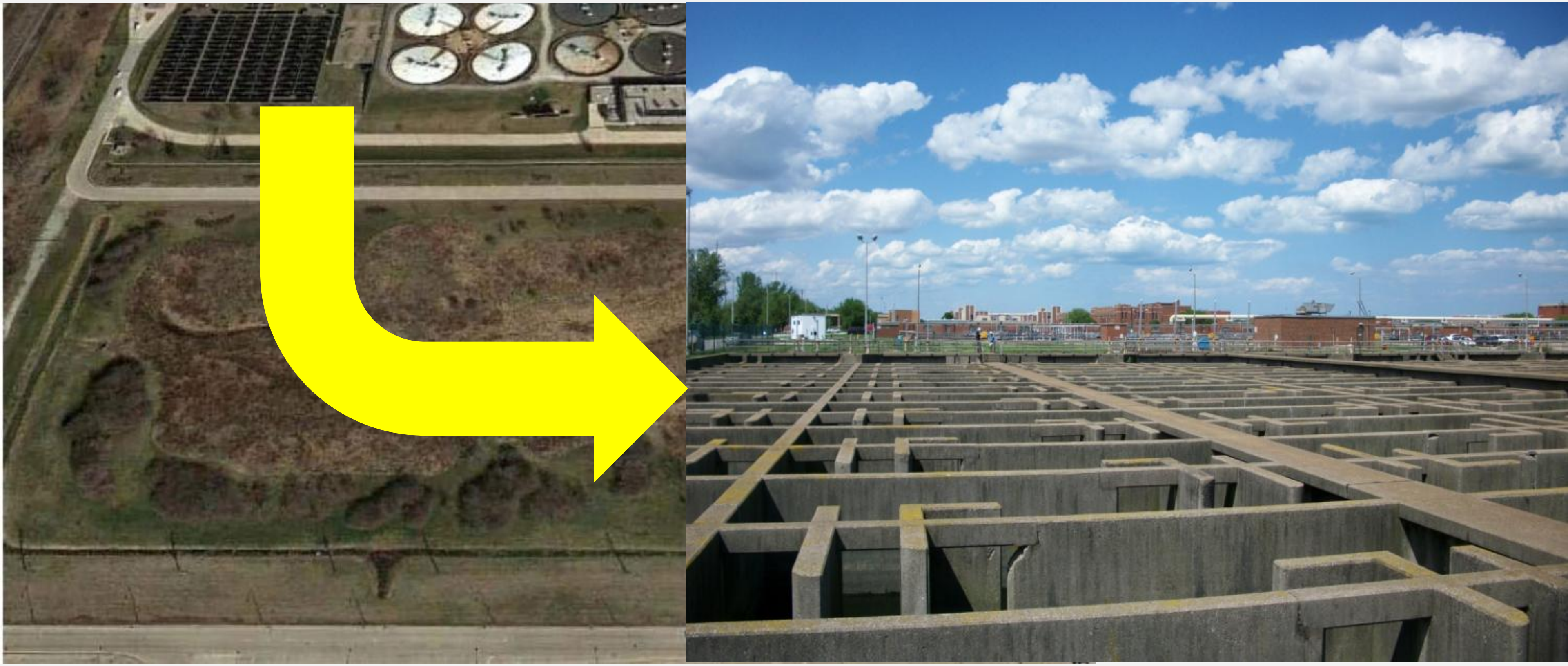
(inset - nozzle spray)

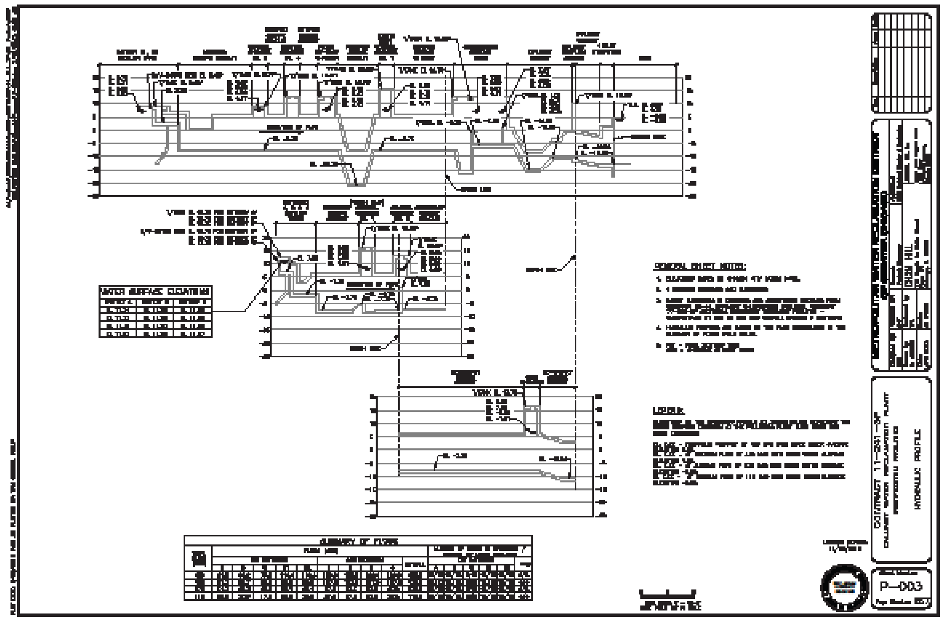
Proposed chemical diffuser system similar to systems used in the past, however, design improvements include:

- Smaller orifice holes to create backpressure and improve flow distribution
- Spray nozzles to improve coverage and initial mixing
- Isolation valves to maintain reasonable pressure and distribution at lower flows

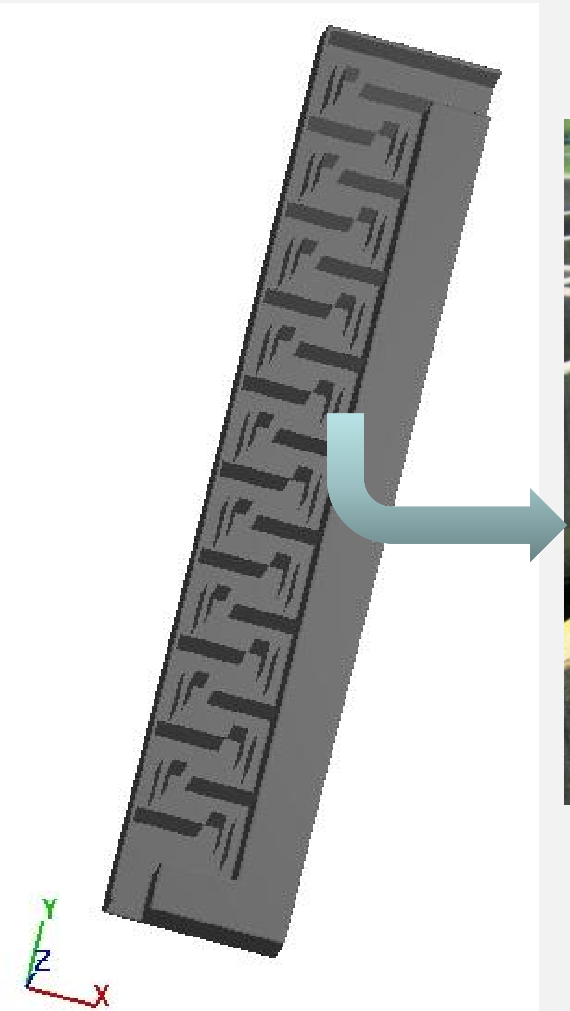
Basis of Design – Chlorine Contact Basin (CCB)

- Existing CCB:
  - Provides 15 minutes of contact time
  - Requires improvements to reduce headloss
  - Needs extensive concrete rehabilitation for use in current configuration

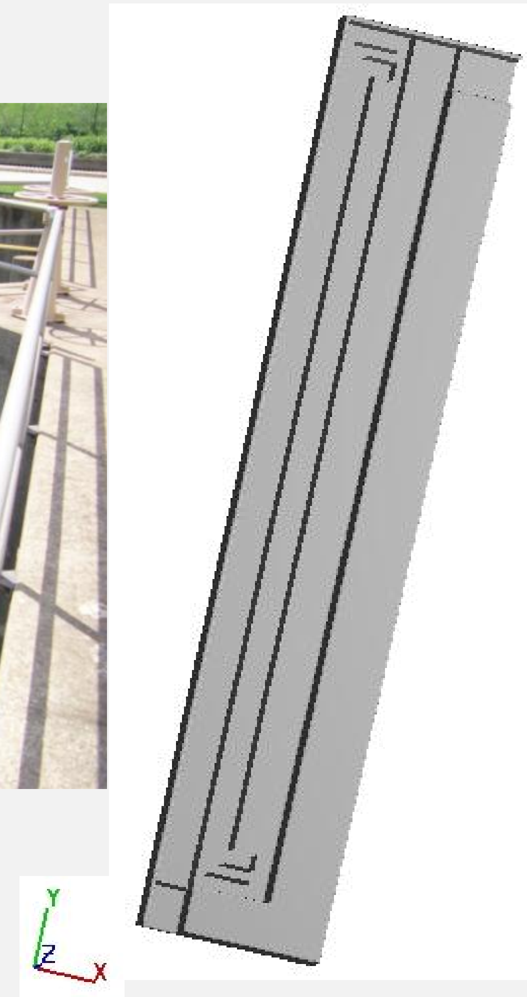



WATER SURFACE ELEVATIONS
SUMMARY OF FLOWS
GENERAL SHEET NOTES:
LEGEND:
HYDRAULIC PROFILE
P-003

Basis of Design – Chlorine Contact Basin (CCB)



As-Built CCB

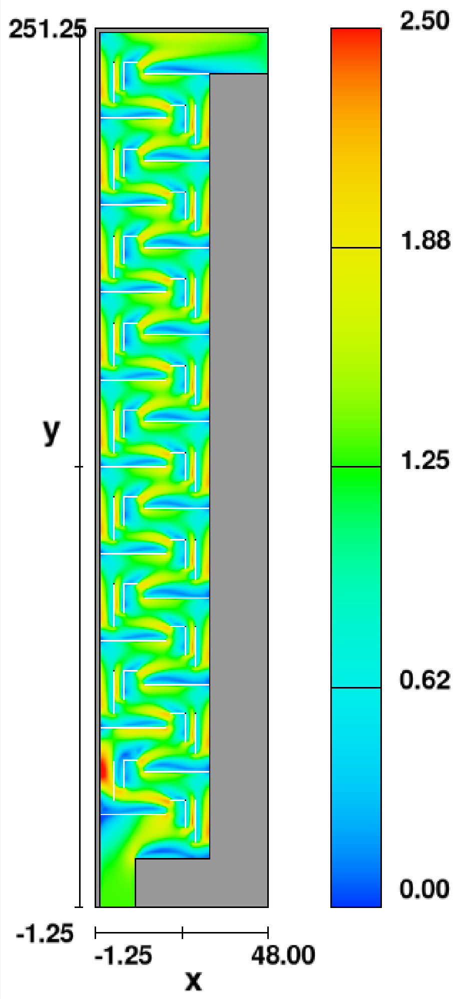


Proposed Configuration

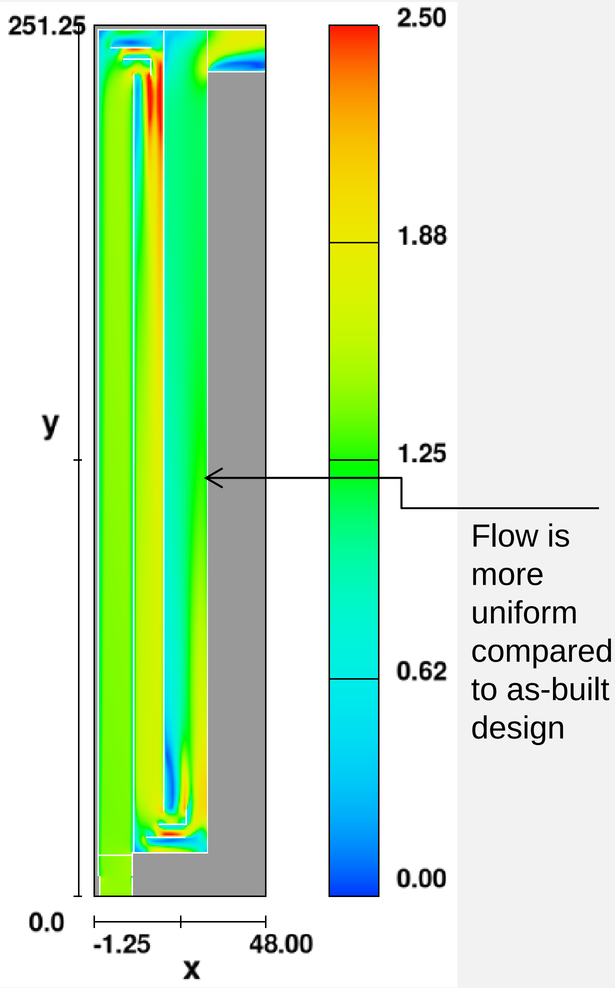
Basis of Design – Chlorine Contact Basin (CCB)

- Computational fluid dynamics (CFD) modeling performed
- Identified best improvements to CCB
- Modified CCB will provide 15 minutes contact time without reducing WRP flow capacity

Flow Speed Variation
(Half Outer Tank, Units ft/s)

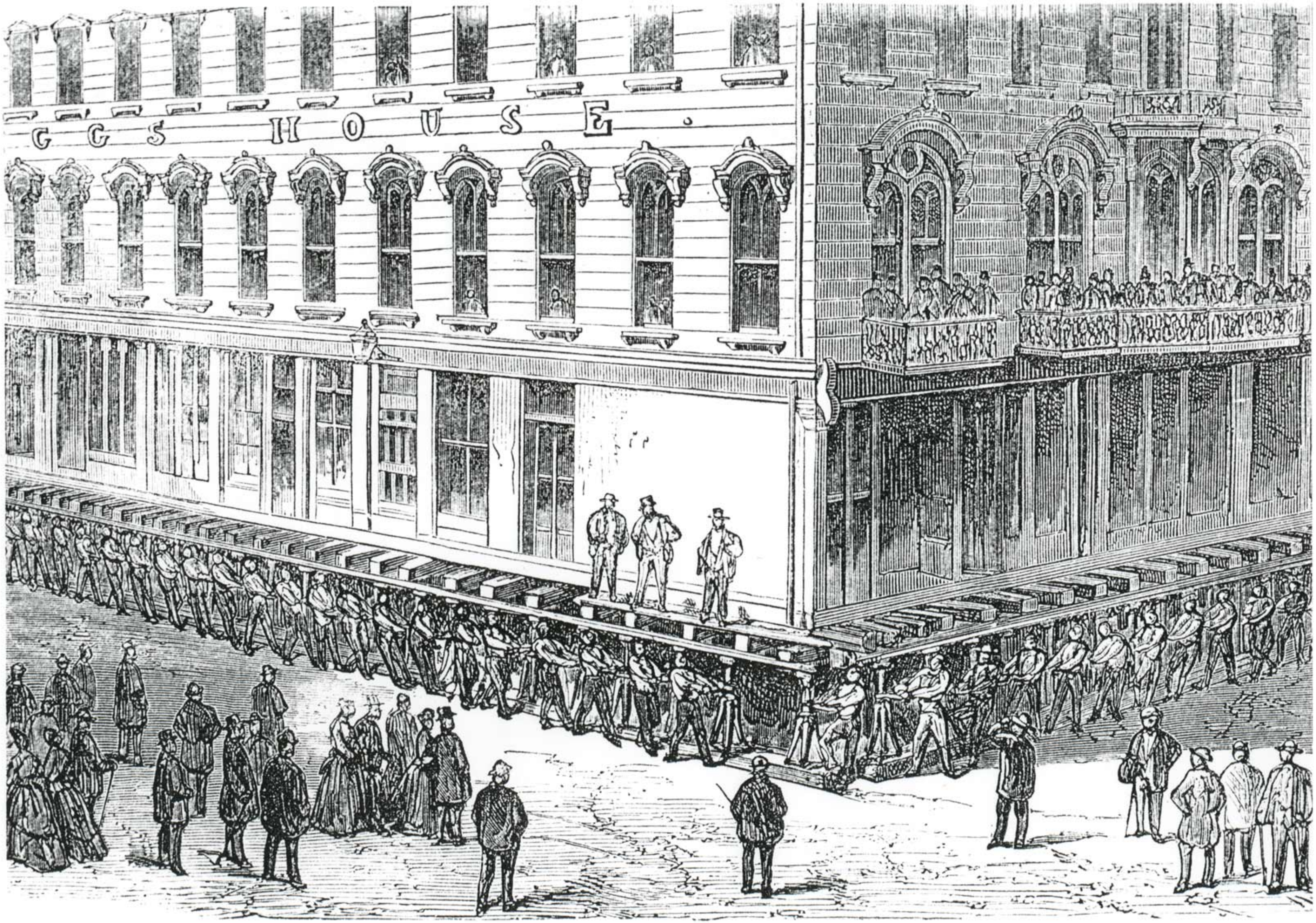


As-Built CCB



Proposed Configuration

Overview of Disinfection Facilities


GGS HOUSE.

Agreement with Greeley and Hansen
Contract 11-054-3P
Paul Vogel, Joe Gorgan, Catharine Richardson
Andrew Martin, Roger Linde, Ryan Christopher

HAGAN, DAVID CIVIL SAN ASSOCIATE
HOBBS, DAVID CIVIL SAN ASSOCIATE
DAKHIL, MUSTAQ CIVIL SAN ENGINEER
KERRIGAN, JAMES CIVIL SAN ENGINEER
GOUDEAU, LAMONT CIVIL SAN DESIGNER
VIRANYI, NORBERT ELECTRICAL ASSOCIATE
ATKINSON, MARK ELECTRICAL ENGINEER
SINGAL, SUBHASH ELECTRICAL ENGINEER
WHITE, TONY ELECTRICAL ENGINEER
CHAVEZ,OSCAR ELECTRICAL DRAFTER
TIENSVOLD, TIMOTHY ELECTRICAL DRAFTER
SMITH, GEORGE MECHANICAL ASSOCIATE
JOHNSON, GLEN MECHANICAL ENGINEER
POWELL, THOMAS INSTRUMENTATION
KATEHIS, DIMITRIOS UMC PROFESSIONAL
HAYES, DARIEN SUPPORT STAFF
DAKHIL, MUSTAQ
NICHOLS, WILLIAM
GOUDEAU, LAMONT
LEE, WAYNE
HEBBE, DAVID

Agreement with Greeley and Hansen
Contract 11-054-3P

MBE/SBE Subconsultants
Ground Engineering Consultants, Inc.
MPR Engineering Corp, Inc.
Rubinos & Mesia Engineers, Inc
Vistara Construction Services, Inc

WBE/SBE Subconsultants
Cotter Consulting, Inc.
Environmental Design International, Inc.
Intelligent Design and Construction Solutions, LLC
Raimonde Drilling Corp.

Non-PCE Subconsultants
Dr. Charles Haas, Drexel University
Alden Research Laboratory

Agreement with CH2M HILL Engineers, Inc.
Contract 11-241-3P

Paul Swaim, Dave Baxter
Tom Lachcik(ARCADIS)

CHRZANOWSKI, MARK FRANCIS
ERIKSON, ANDREW C
FISHER, JAMES H
FOLEY, MICHAEL J.
GILL, GRAHAM P
GLAWTSCHEW, THEODORE
JEYANAYAGAM, SAMUEL
PRATT, MARK H
SCHMIDTKE, DEAN
SRIVASTAVA, RAJEEV
YOLO, ROGER A
CARLSON, MARY L
HOFFMAN, LISA DIANE
LUCERO, TONI C
RUDZINSKAS, CHRISTINE
GAVIN, MATTHEW D
HAMMERSCHMIDT, MARK
KAVANAGH, AMY
LAMONT, WENDY
LANDERS, PAUL
LEE, JONG WOOK
TIAN, PING
ZHAO, MINXING

Agreement with CH2M HILL Engineers, Inc.
Contract 11-241-3P

MBE/SBE Subconsultants
Primera Engineers, Ltd.
M.P.R. Engineering Corp., Inc.
DB Sterlin Consultants, Inc.
Rubinos & Mesia Engineers, Inc.
Everest Engineering, Inc.

WBE/SBE Subconsultants
Intelligent Design & Construction Solutions, LLC
Busking Engineering Services, Inc.

Non-PCE Subconsultant
Arcadis- Malcolm Pirnie, Inc.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Design Obstacles

OWRP

- Existing underground facilities
- Transportation network (CTA) easement
- Above ground infrastructure
- Future expansion of Plant
- 4 – 72 hour Plant Shutdowns

CWRP

- Existing underground facilities
- Current Plant Entrance
- Future expansion of Plant

Contract 11-054-3P
Disinfection Facilities
OWRP

- 4 Volumes of Documents
- 204 Detailed Specification Sections
- 369 Contract Plan Drawings

Contract 11-241-3P Disinfection Facilities CWRP

- 5 Volumes of Documents
- 160 Detailed Specification Sections
- 337 Contract Plan Drawings

OWRP Contract Schedule

- Awarded August 8, 2013 to Walsh Construction Co.
- Contract Start August 22, 2013
- Construction Scheduled Completion August 22, 2015

How much?

Construction Cost:

$59.9 Million

Maintenance & Operation Cost (Annually):

$2.07 Million

Calumet WRP Contract Schedule

- Awarded August 8, 2013 to IHC/KED, A Joint Venture
- Contract Start August 20, 2013
- Construction Scheduled Completion August 20, 2015

What will it cost?

Construction Cost:

$30.9 Million

Maintenance & Operation Cost (Annually):

$3.55 Million


Questions?