# BUILDING A NORLDOF DIFFERENCE

## MCCOOK MTS BIFURCATION – A PARADIGM OF CRAFTSMANSHIP

**CLAY HAYNES** 

ENGINEERING MANAGER WATER SECTOR

**NASH WILLIAMS** 

PRESIDENT NATIONAL WELDING CORPORATION





# HISTORY OF THE CHICAGOLAND UNDERFLOW PLAN









#### **THE CHICAGOLAND UNDERFLOW PLAN** TARP - TUNNEL AND RESERVOIR PLAN



- Following the reversal of the Chicago River in the early 1900s, the Chicagoland area continued to develop & pollution of local waterways continued...
- In 1972, MWRDGC adopted the Tunnel and Reservoir Plan (TARP) in the largest water infrastructure undertaking in Chicago (\$3.5 billion)





### TARP SYSTEM MAP

- Phase I 109.4 miles of tunnel
  - Mainstream
  - Upper Des Plaines (O'Hare)
  - Des Plaines
  - Calumet
- Phase II Three large reservoirs:
  - McCook (under construction)
  - O'Hare (complete)
  - Thornton Composite (under construction)





# MCCOOK RESERVOIR OVERVIEW









### **MCCOOK RESERVOIR**



- Authorized in Water Resources Development act of 1999
- Will provide 10 BG of CSO and flood storage for TARP
  - Mainstream and Des Plaines Deep Tunnel System
  - Stored volume will be pumped to Stickney WWTP for treatment before discharge into Des Plaines River





## MCCOOK RESERVOIR – FACILITIES LAYOUT

Mainstream Pumping Station and McCook Distribution Tunnel System (complete)

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McCook Main Tunnel Connection System Ē



# MCCOOK MAIN TUNNEL SYSTEM









#### **MCCOCK MAIN TUNNEL SYSTEM** *KEY PROJECT ELEMENTS*



- Drill and Blast Tunnel connecting Mainstream Tunnel to McCook Reservoir
  - 1,600 ft long
  - 33 ft diameter
  - Bifurcated for 290 ft through Main Gate/Access Shaft



#### MCCOOK MAIN TUNNEL SYSTEM KEY PROJECT ELEMENTS

- Mainstream Tunnel Connection
  - Live connection
  - Geometry analyzed with CFD to determine best geometry
  - 45 degree elliptical mitre





Maximum velocity = 48ft/s Minimum absolute pressure = 0.6atm

Region with sub-atmospheric pressure





# HYDRAULIC ANALYSIS









### **HYDRAULIC ANALYSIS –** *PURPOSE*





#### **HYDRAULIC ANALYSIS** MAIN CONCERNS



#### Cavitation

- The formation of vapor bubbles in low pressure areas
- Vapor bubbles are carried downstream and in an area of higher pressure, will condense and collapse suddenly

#### • Abrasion

 Damage to tunnel lining caused by significant quantities of sand, gravel, rock, and other debris found in storm water, in high velocity flows

CFD Model of Energy Dissipation Structure in Reservoir

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#### **HYDRAULIC ANALYSIS** *MODELING APPROACH*

- Computational Fluid Dynamics (CFD)
  - ANSYS CFX Code
    - Set up a mesh which splits water into a large number of small elements
    - Predicts flow by solving iteratively a series of equations for conservation of mass momentum and energy

#### Peak flow

- During storm events, most of the flow in the Mainstream Tunnel will be routed through the Main Tunnel. Flows in the Mainstream Tunnel average 30 ft/s
- Assumes gates are in open position

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# MAIN GATE SHAFT















• 6 gates operated by hydraulic cylinders in guide slot by wheels



#### **MAIN GATE SHAFT GATE HYDRAULICS**

- All gates designed to resist static load 250 – 300 ft of hydraulic head
- 6 main gates
  - Resist flow in both directions
  - 15 20 ft wide, approximately 30 ft tall
  - Over 200,000 lbs each











#### THE RIGHT TEAM

- National Welding Corporation –Assemble, Fit, and Weld Steel Tunnel Liner
- Kiewit Infrastructure- General Contractor, Excavate, Concrete Lining, and oversight.
- Selway Corporation- Shop Drawings and Fabrication of Steel Liner Pieces.





#### **PREASSEMBLY PLANNING**

#### Design

- 108 m (354 ft) of steel liner
- Bifurcation from 10 m (33 ft) to 4x9.8 m (19x32 ft)





# Changing Geometry "T" Steel rings









### **FABRICATION OF STEEL LINER SECTIONS**

• Tolerances

"ortor Mares

- Connections
- Preassembly



# Shipping Considerations MT to IL using 48 special loads







SURFACE SUBASSEMBLY

# 10 m (33 ft) Diameter Pieces Assembled Onsite







### **RIGGING AND CONNECTIONS**







Bolted Connections Custom Rigging for each ring of liner









ATIONAL WELDING CORP.





## LINER SUPPORT



#### Cross-Bracing Installation









### **ENVIRONMENTAL CONTROLS**









### FINAL FIT UP AND WELD-OUT





## Seam Fitting Rounchess Tolerance



#### • FCAW Welding

#### NATIONAL WELDING CORPORATION

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	ATIONAL	WELDING PROCEDU	SPECIFICAT	TON NO.	NOC STTL BY		
POSITIONS (QW 409)							
Positions of Grozow	ALL	Temperature	Temperature Banga		200		
Welding Progression	UPHILL	Time Barge			NA		
Positions of Fillet	AlL						
PREHEAT (CW 409)		GAS 00/ 40s					
			Porcent Co	moniton	-		
Probeat Temperature Minimum	70 DEG	- Children	(accepts)	Discare Press	1 Division		
Interpass Temperature was much	225 000	- Indim	NA	Cangalan	CO'SE C'II		
Printisk erandeliance		Backing	NO				
Amps Range	185-357	Volts Range		23.25	29.95		
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Electrode Wire Feet	Speed Ranga	232.5-451					
TECHNIQUE (QW-410)							
Stringer or Wearo Bead	15	STRINGER OR WEAVE					
Critice or Gas Cup Size		\$25'					
Initial and Interpass cleaning		MECHANICINE POWER BRUSH					
Method of Hackgooging		10					
Contract Tube In Wheek Distance		25"+125-125					
Multiple or Sincle Fais (Per Side)		MULTIPLE					
Multiple or Single Electrodes		SINGLE					
Travel Feast Rassa		2.5x12.5 1208					









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 Magnetic Parti (MT) inspectio













## "J" ANCHOR LAYOUT AND WELDING



#### Over 16,000 Anchors-Field Installed











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### **CHANGING GEOMETRY**





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## HANDLING 33 FOO

### DIAMETER SECTIONS

ections Lowered Down 300 ft) Shaft



NATIONAL WELDING CORP.





## **TUNNEL INSTALLATION**













 Annular Bracing Installed







#### CIRCUMFERENTIAL SEAMS FITTING AND WELDING







 Over 937 m (3076 ft) of CJP tunnel welds performed

 Automatic and Semi-Automatic FCAW Welding











## FINISHED STEEL TUNNEL LINER



## **KEY ELEMENTS OF SUCCES**

Team Approach

2. Capable Team Members

3. Careful Planning and Development









# THANK YOU







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