Presenters

• **Matthew Duncan P.E., PMP** is a Principal Engineer at Metro Wastewater Reclamation District in Denver, Colorado. On the Northern Treatment Plant Project, Matthew served as the Project Manager for the Metro District. Matthew has managed many challenging and complex projects over his 18 year career at the Metro District. Matthew received his Bachelor of Science in Environmental Engineering from Tulane University and his Master of Science Degree in Engineering and Technology Management from the Colorado School of Mines. Matthew is a longstanding member of the Water Environment Federation and is a certified Project Management Professional through the Project Management Institute. Matthew lives in Arvada, Colorado with his wife and two daughters.

• **Erica Corbett P.E., PMP** is a Project Manager with Carollo Engineers, Inc. in Denver, Colorado. Erica has spent over 16 years of her career in the planning, design, and delivery of water and wastewater projects. She is now in Carollo’s Program Management Group and focuses on project controls, risk management, and procurement assistance for alternate delivery projects. On the Northern Treatment Plant Project, Erica served as Carollo’s Program Controls lead and assisted with communications and public outreach. Erica has a Bachelor’s Degree in Biology from Virginia Tech and a Master’s Degree in Civil Engineering from the University of Massachusetts. Erica is a member of the Design-Build Institute of America (DBIA) and is a Certified Project Management Professional through the Project Management Institute.

• **Douglas Cayko P.E.** has 18 years of experience in alternative project delivery including Design-Build-Operate (DBO), Design-Build (DB), and Construction Manager at Risk (CMAR). Over his 18-year career at CH2M now Jacobs, Doug has advanced through many project roles including design engineer, resident field engineer, design manager, preconstruction manager and project manager on dozens of projects in the water/wastewater industry. Since 2010 Doug has been the design lead for many fixed price DB, DBO and progressive DB pursuits and projects including the role of Design Manager for the delivery of the Metro Wastewater Reclamation District Northern Treatment Plant. In his current position Doug oversees the engineering and design delivery of all design-build/at-risk projects for the US water & wastewater markets. Doug holds M.S. and B.S. Degrees in Civil Engineering from Montana State University and is currently a licensed Professional Engineer in Colorado and Civil Engineer in California. Doug resides in Aurora Colorado with his wife and three children and enjoys skiing with his family in the Colorado high country.
Acknowledgements

- MWRD Board of Directors and Management
- MWRD Staff
- Project Stakeholders
  - City of Brighton
- Carollo, Jacobs, CH2M Hill now Jacobs

THANK YOU
AGENDA

- Project Background
- Project Delivery Approach
- Design Process & Construction
- Testing, Startup, & Beyond
PROJECT BACKGROUND
• Provides WW transmission + treatment to **1.8 million customers over 715-square mile service area** including Denver and surrounding areas

• Organization of **410 employees**

• Historical Design/Bid/Build project delivery
• Robert W. Hite Treatment Facility
  - Providing treatment of 134 mgd

• Interceptor System
  - 234 Miles
  - Size from 4 to 90 inch diameter

• METROGRO Farm
  - Beneficial reuse of biosolids
  - Land apply
REASON FOR NORTHERN TREATMENT PLANT (NTP)

- Growth within District’s northern service area
- New regional satellite treatment facility provides best long-term economic benefit:
  - Eliminates need for 9+ lift stations
  - Consolidates treatment and eliminates improvements at member agency facilities
- Implement using Program approach due to size, complexity, and multiple project components
NTP Program Highlights/Background

- **Site Restoration**
  - Preparing the site for construction

- **7-Mile Gravity Interceptor**

- **11-Mile Effluent Pump-Back Force Main**
  - Eliminated through intergovernmental agreements and cooperation

- **NTP Facilities**
  - New “Greenfield” Treatment Facility
  - 24 mgd (Phase 1); 60 mgd (Build-out)
  - Advanced Nutrient Removal

**Estimated Program Cost:** $475M

**Final Program Cost:** $412M
~13% Reduction
NTP Program Highlights/Background

• Owner: Metro Wastewater Reclamation District

• Owner’s Advisor: Carollo Engineers, Inc./Jacobs

• Design-Build: CH2M Hill now Jacobs
  – Designer: CH2M Hill
  – Contractor: Garney Construction

• Delivery Method:
  – Progressive Design-Build
PROJECT DELIVERY APPROACH
Project Delivery Approach

- Considered each of the project elements individually
- Considered attributes of available delivery methods against project needs

<table>
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<tr>
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<th>NTP Site Restoration</th>
<th>Interceptor/ Pump-Back</th>
<th>NTP Facilities</th>
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<tr>
<td>Procurement Method</td>
<td>Progressive Design/Build</td>
<td>Design-Bid-Build</td>
<td>Progressive Design/Build</td>
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<td>Procurement Steps</td>
<td>RFP</td>
<td>RFP</td>
<td>RFQ, RFP</td>
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<td>Selected Proposer</td>
<td>RMC, Inc. (Design/Builder)</td>
<td>HDR (Designer)</td>
<td>CH2M HILL/Garney (Design/Builder)</td>
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</table>
PROGRESSIVE DESIGN-BUILD SELECTED FOR THE DELIVERY
OF THE NTP FACILITIES

✓ Qualifications-based selection of DB

✓ Single contract/point of responsibility

✓ No forced relationship between designer and contractor

✓ Schedule reduction

✓ Risk allocation

✓ Owner input throughout design and involvement during construction

✓ Transparency of costs + cost certainty
Basis of Design Report (BDR) Established Design Definition

- BDR Comprised of Technical Memorandums + General Drawings
  - Constituting 10 to 15% design

- Established “Boundary Conditions” and Guiding Principles
  - District preferences
  - Fixed vs. Open parameters

- Hand-off Point to Design/Builder

- Basis for Evaluating Technical Proposals
  - Design/Builder design concepts and scope
NTP FACILITIES COST TRENDING HISTORY (TOTAL PROJECT COST)*

- Total project costs include NTP Facilities design and construction, site restoration design and construction and other miscellaneous contracts related to delivery of the NTP Facilities project.
* Total project costs include NTP Facilities design and construction, site restoration design and construction and other miscellaneous contracts related to delivery of the NTP Facilities project.
Design Process

- Co-location of the Owner, OA, and DB during design
  - Facilitates efficient decision-making
  - Provides continuous opportunity for Owner input

- Conducted VE session following submission of Amended BDR (by CH2M)

- BIM 3D modeling of all process areas
Design – By the Numbers

15-month design

2,500+ drawings & 300+ specifications

150+ design engineers
DESIGN & CONSTRUCTION
Technical Challenges

- Stringent effluent limits
- Future expansion
- Wetland impacts (Facility and Pipeline)
- High groundwater
- Metals in groundwater
- Community integration
NTP Facility

- Designed to meet some of the strictest effluent limits in CO
  - Total Nitrogen – 10 mg/l
  - Total Phosphorus – 0.1 mg/l

- Master planned to meet even lower effluent limits in the future
  - Total Nitrogen – 3 mg/l
  - Total Phosphorus – 0.04 mg/l
Overall Process Flow Diagram (Simplified)

Liquids Process
- Preliminary
  - Influent Pump Station
  - Fine Screens
  - Grit Removal

- Primary
  - Primary Clarifiers

- Secondary Treatment
  - Bioreactor
  - Secondary Clarifiers
  - RAS Pumps

- Tertiary Treatment
  - Tertiary Pump Station
  - Flocculation
  - Sedimentation
  - DBDF Granular Media Filters
  - Ultraviolet Disinfection

Discharge to wetland/natural channel system and to South Platte River

Solids Process
- Primary Sludge
- Gravity Thickener
- Secondary Sludge
- Rotary Drum Thickener

- Solids Dewatering
  - Land Application or Private Composter
  - Centrifuge

- Sludge Fermenters
- Pre-Digestion Storage
- Anerobic Digesters
- Post-Digestion Storage
Preliminary Treatment - Headworks

- Eliminates need for 9 lift stations in collection system
  - 78 inch diameter gravity interceptor

- Technical Challenges:
  - Pumping of Raw Sewage
  - Deepest structure at the Facility (50 feet deep)
  - >90 reinforced concrete piers installed into bedrock
Computational Fluid Dynamic Analysis
Groundwater & Construction Dewatering

• Issues:
  - Change in CDPHE Position From Traditional Dewatering Permitting
  - Several Wells Contain Higher Levels of Metals & Total Inorganic Nitrogen (TIN)

• Collaborative Approach for Resolution:
  - CPDHE Permit Based on Consideration of Established Limits for NTP
  - Development of Equalization Basins
  - Development of Additional Dewatering Wells in Areas with Better Water Quality (Dilution)
Preliminary Treatment – Screenings and Grit Removal

- Grit Removal
- Grit Classifier
- Pump Discharge
- Screenings Washing & Compacting
- Roll Off Bins For Off Site Disposal
Primary Treatment

- Covered primary clarifiers for odor control
- Removes readily settleable and floatable solids from the raw wastewater before the wastewater is treated biologically in the aeration basins.
Secondary Treatment

Solids Processing
Tertiary Treatment

- Flocculation/Sedimentation
  - Phosphorus removal

Lamella Plate Settling

Multi-Stage Flocculation

Solids Collection

Secondary Effluent Distribution

Distribution
Tertiary Treatment

- Granular Media Filtration
  - Phosphorus removal
Tertiary Treatment

- UV disinfection
Outfall/Effluent Channel

- Adjust DO & Temperature in the effluent
- Community Asset (Trails)
Solids Process

- Anaerobic Digestion
- Post-Aerobic Digestion
  - 2nd in the country
- Mechanical Dewatering
- Cogeneration

Diagram:
- Thickened Primary Sludge
- Thickened WAS
- Primary Scum
- Blend Tank
- Biogas Cleaning
- Mesophillic Anaerobic Digestion
- Biogas
- Combined Heat and Power (CHP)
- Anaerobically Digested Sludge to Post Aerobic Digestion
Odor Control
Amount of concrete poured...

Enough to build a 3-foot wide sidewalk between Denver and Kansas City (81,000 cubic yards)
Number of man-hours worked...

~2,400,000 hours, an average of ~300 FTE per day (Enough to walk around the world 300 times)
Construction - by the Numbers

• Project Safety

• Project Total Recordable Rate 0.9
  (Industry Average 3.9)

• Project DART – 0.25
  (Industry Average 2.0)
Administration Building/Visitors Center
TESTING, STARTUP & BEYOND
Testing During Construction

- Clean water loop operated for over a year prior to startup to facilitate functional testing
- Integrated startup team of 15+ people to facilitate a smooth startup
- Several Steps for Check out Systems & Equipment
  - Functional equipment testing (dedicated individual to task)
  - Operational Readiness Testing (ORT) to confirm proper installation, wiring, communication, and programming (over 100,000 individual I/Os to be validated and tested)
- Design-Builder Led Testing Effort
  - District had significant involvement from operations, engineering, & maintenance staffs to witness & confirm completion
Training and Testing

- 10 new staff to operate the new facility
  - Over 150 training sessions

- 4-Month process test with wastewater to confirm process performance

- District’s Staff Performed Facility Operations with Input/Guidance from Design-Builder

- Allowance in Contract
  - Final scope & fee was developed/negotiated during construction phase
Liquids Process Seeding and Acclimation – By the Numbers

180,000+ gallons of TWAS* to seed secondary process

30+ truck loads of TWAS

3 days to deliver TWAS from RWHTF to NTP

10 day acclimation period before wasting operations

*Thickened Waste Activated Sludge (TWAS) from the Metro District’s Robert W. Hite Treatment Facility
Performance Validation Testing

**Seeding**
- Substantial Completion
- Initial flow diversion to NTP

**October 2, 2016**
- Permanent flow diversion

**October 3, 2016**
- Effluent reaches South Platte River
- Start of 90-day validation period
- Effluent meets permit requirements
Operation Since Startup

Nutrient Removal

• Nitrogen
  - PAD: With supplemental alkalinity, ammonia can be driven from 1,500 mg/L to <10 mg/L
  - UFAT: Has nearly eliminated need for acetic acid for denitrification in bioreactor

• Phosphorus
  - PAD: Use of calcium hydroxide to PAD stabilized bio-P removal in bioreactor (average effluent TP is 0.16 mg/L)
  - Biological Phosphorus removal has greatly minimized need for Alum addition

Odor Control
Since Startup

- **No permit violations**

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<th>Actual Average Values</th>
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<td>TSS, mg/L</td>
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<tr>
<td>COD, mg/L</td>
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<td>NH3, mg/L</td>
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<td>9.61-14.47 (30-day average)</td>
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<td>Total P</td>
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<tr>
<td>TIN</td>
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<tr>
<td><em>E. Coli</em>, No./100mL</td>
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<td>8</td>
</tr>
</tbody>
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Questions??