



32nd

# WERC Environmental Design Contest

April 10-13, 2022

# WERC COMPETITION PUREPRO PURIFICATION CO.

CENE 476 – Rachel Sibayan, Hannah Robino, Isaac Nance, Gillian Neville, Daniel Herger – Dec 7, 2021

# INTRODUCTION

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**Purpose: Compete in the 32nd WERC Environmental Design Contest**

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**Client: Dr. Jeffrey Heiderscheidt**

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**TA: Dr. Terry Baxter**

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**Location: New Mexico State University**

# BACKGROUND

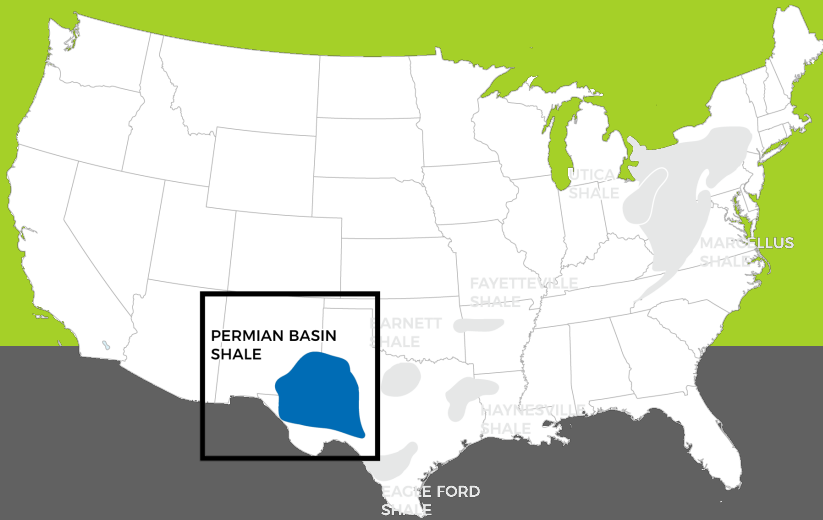


Figure 1: Delaware Basin Overview-U.S. Map

- Treatment of Produced Water (PW)
  - Removal of VOCs (Toluene)
  - Delaware Basin
- Bench Scale Model
  - Full-Scale Design: 50,000 bbl/day
- WERC Competition
  - Showcase model, report, and presentation
  - Solve real world environmental problems

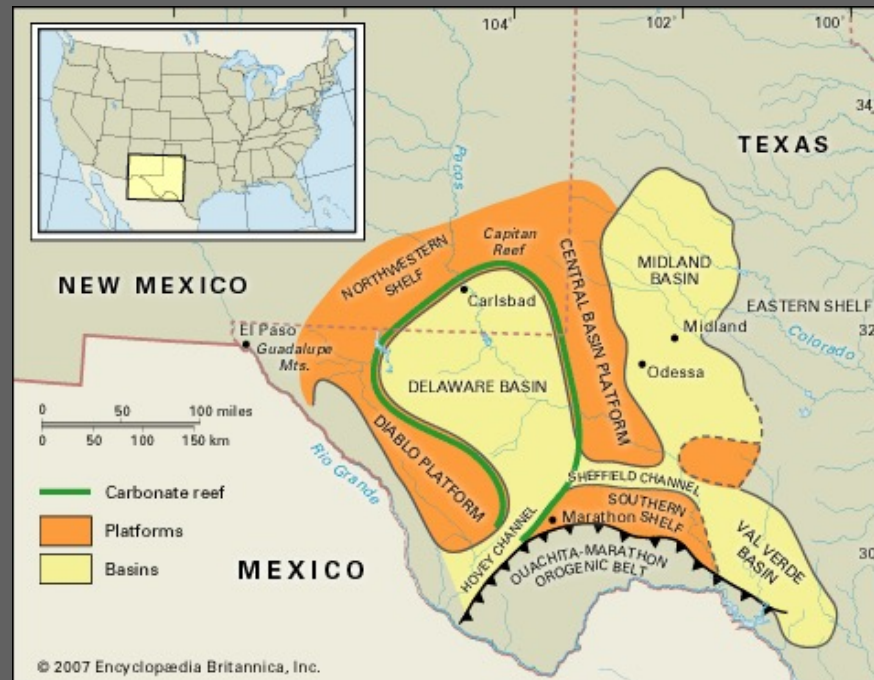


Figure 2: Delaware Basin Overview

# SCOPE OF SERVICES

- Task 1: Competition Preparation
  - Task 1.1: Competition Registration
  - Task 1.2: Obtain Laboratory Access
    - Task 1.2.1: NAU EnE Laboratory Rapid Request Form
    - Task 1.2.2: Laboratory Planning Document
  - Task 1.3: Short Course Enrollment
- Task 2: Analyze Treatment Options
  - Task 2.1: Treatment Research
    - Task 2.1.1: Literature Review
    - Task 2.1.2: Determine Criteria for Decision
  - Task 2.2: Preliminary Experiments
    - Task 2.2.1: Conduct Experiment Planning
    - Task 2.2.2: Conduct Experiments
    - Task 2.2.3: Sample Analysis
  - Task 2.3: Selection of Best Treatment Process
- Task 3: Bench Scale Model Design
  - Task 3.1: Process Flow Diagram
  - Task 3.2: Parts and Materials Selection and Sourcing
  - Task 3.3: Process Design
  - Task 3.4: Drawing Production

# SCOPE OF SERVICES

- Task 4: Bench Scale Model Fabrication & Testing
  - Task 4.1: Fabrication and Testing
  - Task 4.2: Post-Treatment Sample Testing
    - Task 4.2.1: QA/QC Procedure
    - Task 4.2.2: VOC Testing
    - Task 4.2.3: Additional Analysis
  - Task 4.3: Model Redesign
- Task 5: Full Scale Design
  - Task 5.1: Bench Scale Model Scaling
  - Task 5.2: Hydraulic Analysis
    - Task 5.2.1: Tank Design
    - Task 5.2.2: Pipe Design
    - Task 5.2.3: Pump Selection
- Task 6: Techno-Economic Analysis
  - Task 6.1: Short Course Attendance
  - Task 6.2: Economic Analysis
    - Task 6.2.1: Construction Cost
    - Task 6.2.2: Operation Cost
    - Task 6.2.3: Lifecycle Cost
  - Task 6.3: Techno Analysis
    - Task 6.3.1: Removal Efficiency
    - Task 6.3.2: Process Requirements and Investment

# SCOPE OF SERVICES

- Task 7: Impacts Analysis
  - Task 7.1: Economic Impacts
  - Task 7.2: Environmental Impacts
  - Task 7.3: Societal Impacts
- Task 8: Deliverables
  - Task 8.1: Competition Deliverables
    - Task 8.1.1: Experimental Safety Plan
    - Task 8.1.2: Preliminary Report
    - Task 8.1.3: Technical Report
    - Task 8.1.4: Presentation and Competition
  - Task 8.2: 30% Submittal
  - Task 8.3: 60% Submittal
  - Task 8.4: 90% Submittal
  - Task 8.5: 100% Submittal
- Task 9: Project Management
  - Task 9.1: Meetings
  - Task 9.2: Schedule Management
  - Task 9.3: Resource Management

# EXCLUSIONS



Drawings and construction of a full-scale PW treatment facility



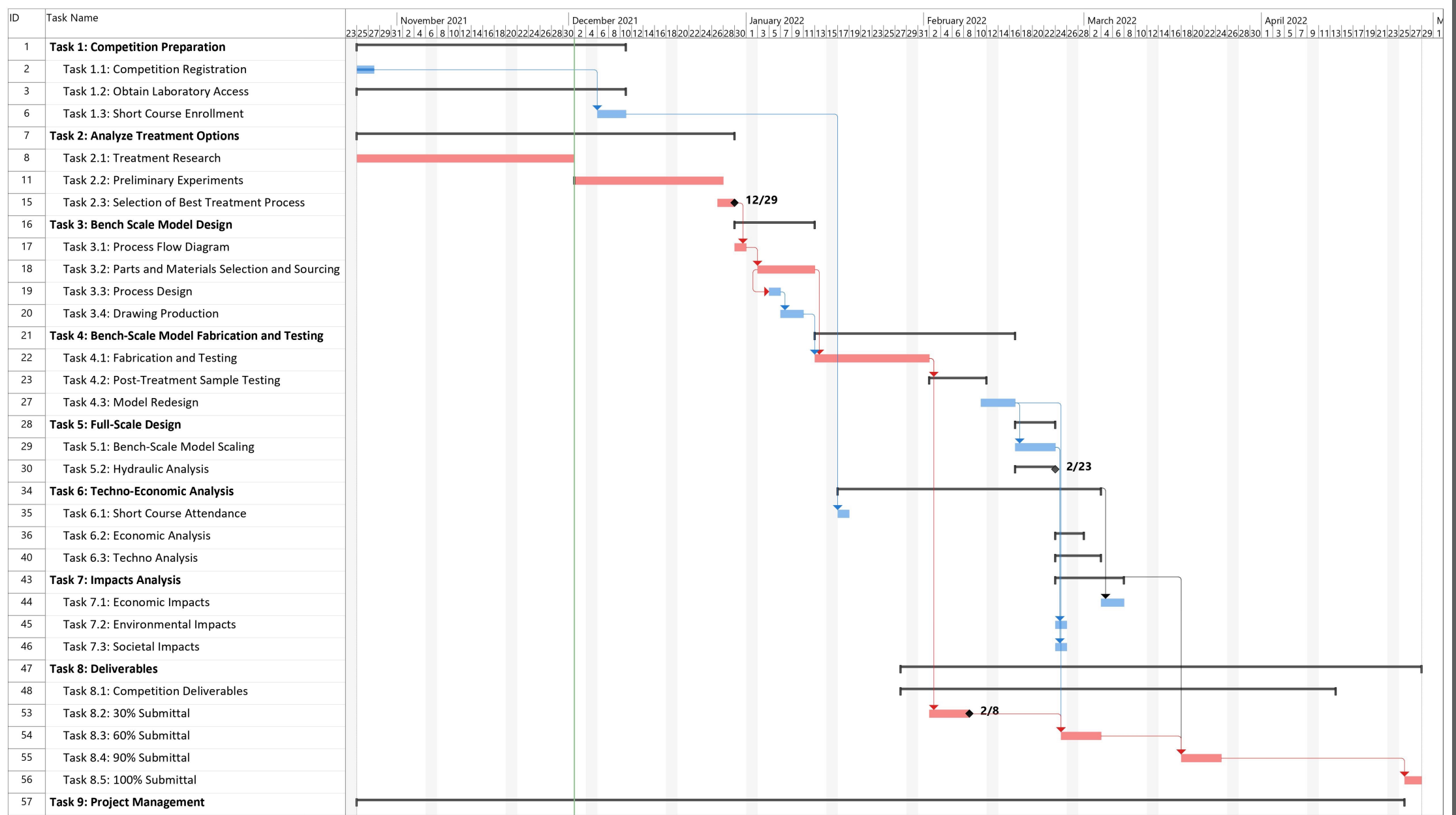
Budget and bench scale components will only be applied towards the removal of toluene



Site-specific treatment design

# SCHEDULE





Project: WERC Gantt Chart NEW Date: Thu 12/2/21	Task		Project Summary		Manual Task		Start-only		Deadline		Manual Progress
	Split		Inactive Task		Duration-only		Finish-only		Critical		
	Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Critical Split		
	Summary		Inactive Summary		Manual Summary		External Milestone		Progress		

# STAFFING PLAN

Table 1: Staffing Hours by Task

Task Name	SENG (hours)	ENG (hours)	TECH (hours)	INT (hours)	Task Total Hours
<b>Task 1.0: Competition Preparation</b>	2	0	40	17	59
Task 1.1 Competition Registration	0	0	0	1	
Task 1.2 Obtain Laboratory Access	2	0	40	8	
Task 1.2.1 NAU EnE Lab Rapid Request Form	0	0	0	8	
Task 1.2.2 Laboratory Planning Document	0	0	40	0	
Task 1.3 Short Course Enrollment	0	0	0	8	
<b>Task 2: Analyze Treatment Options</b>	6	60	76	48	190
Task 2.1 Treatment Research	0	40	0	48	
Task 2.1.1 Literature Review	0	0	0	40	
Task 2.1.2 Determine Criteria for Decision	0	40	0	8	
Task 2.2 Preliminary Experiments	2	12	70	0	
Task 2.2.1 Conduct Experiment Planning	0	4	20	0	
Task 2.2.2 Conduct Experiments	0	4	30	0	
Task 2.2.3 Sample Analysis	0	4	20	0	
Task 2.3 Selection of Best Treatment Process	4	8	6	0	
<b>Task 3: Bench Scale Model Design</b>	8	40	12	48	108
Task 3.1 Process Flow Diagram	2	4	0	24	
Task 3.2 Parts and Materials Selection and Sourcing	2	12	12	0	
Task 3.3 Process Design	2	12	0	12	
Task 3.4 Drawing Production	2	12	0	12	
<b>Task 4: Bench Scale Model Fabrication and Testing</b>	6	40	152	60	258
Task 4.1 Fabrication and Testing	2	0	60	60	
Task 4.2 Post-Treatment Sample Tests	2	0	92	0	
Task 4.2.1 QA/QC PROCEDURE	0	0	12	0	
Task 4.2.2 VOC Testing	0	0	40	0	
Task 4.2.3 Additional Analysis	0	0	40	0	
Task 4.3 Model Redesign	2	40	0	0	
<b>Task 5: Full-Scale Design</b>	4	44	0	32	80
Task 5.1 Bench Scale Model Scaling	2	8	0	32	
Task 5.2 Hydraulic Analysis	2	36	0	0	
Task 5.2.1 Tank Selection	0	12	0	0	
Task 5.2.2 Pipe Selection	0	12	0	0	
Task 5.2.3 Pump Selection	0	12	0	0	

Task Name	SENG (hours)	ENG (hours)	TECH (hours)	INT (hours)	Task Total Hours
<b>Task 6: Techno-Economic Analysis</b>	6	20	0	26	52
Task 6.1: Short Course Attendance	0	2	0	2	
Task 6.2: Economic Analysis	2	6	0	24	
Task 6.2.1 Construction Cost	0	2	0	8	
Task 6.2.2 Operation Cost	0	2	0	8	
Task 6.2.3 Lifecycle Cost	0	2	0	8	
Task 6.3: Techno Analysis	4	12	0	0	
Task 6.3.1 Removal Efficiency	0	8	0	0	
Task 6.3.2 Process Requirements and Investment	4	4	0	0	
<b>Task 7: Impacts Analysis</b>	6	12	0	0	18
Task 7.1: Economic Impacts	2	4	0	0	
Task 7.2: Environmental Impacts	2	4	0	0	
Task 7.3: Societal Impacts	2	4	0	0	
<b>Task 8: Deliverables</b>	18	16	12	24	70
Task 8.1 Competition Deliverables	2	0	12	0	
Task 8.1.1 Experimental Safety Plan	2	2	0	3	
Task 8.1.2 Preliminary Report	2	2	0	3	
Task 8.1.3 Technical Report	2	2	0	3	
Task 8.1.4 Presentation and Competition	2	2	0	3	
Task 8.2 30% Submittal	2	2	0	3	
Task 8.3 60% Submittal	2	2	0	3	
Task 8.4 90% Submittal	2	2	0	3	
Task 8.5 100% Submittal	2	2	0	3	
<b>Task 9: Project Management</b>	12	36	12	36	96
Task 9.1: Meetings	12	12	12	12	
Task 9.2: Schedule Management	0	12	0	12	
Task 9.3: Resource Management	0	12	0	12	
<b>Subtotal Hours</b>	68	268	304	291	
<b>Total Hours</b>	931				

# STAFFING HOURS SUMMARY

Table 2: Staffing Hours Summary

Staffing Hours Summary	
Position	Hours
Senior Engineer	68
Engineer	268
Lab Technician	304
Engineering Intern	291
<b>Total Hours</b>	<b>931</b>

# COST OF ENGINEERING SERVICES

Table 3 : Cost of Engineering

Cost of Engineering Services				
<i>Personnel</i>	<i>Classification</i>	<i>Hours</i>	<i>Rate (\$/hr)</i>	<i>Cost (\$)</i>
	Senior Engineer	68	\$ 180	\$ 12,240
	Engineer	268	\$ 80	\$ 21,440
	Lab Technician	304	\$ 50	\$ 15,200
	Engineering Intern	291	\$ 25	\$ 7,275
<b>Personnel Cost</b>				<b>\$ 56,155</b>
<i>Travel</i>			<i>Cost Per (\$)</i>	<i>Cost (\$)</i>
Transportation	1 Van 4-Day Trip		\$65/day	\$ 260
Mileage	868 mi Roundtrip		\$0.38/mile	\$ 330
Hotel	3 Rooms 3 Nights		\$100/night	\$ 900
Per Diem	5 People 4 Days		\$19/day	\$ 380
<b>Travel Cost</b>				<b>\$ 1,870</b>
<i>Lab Facilities</i>				
	ENE Lab 10 Days		\$100/day	\$ 1,000
<b>Lab Cost</b>				<b>\$ 1,000</b>
<i>Supplies</i>				
	See Itemized Supplies List			\$ 1,984
<b>Supplies Cost</b>				<b>\$ 1,984</b>
<i>Subcontract</i>				
	Analytical, 5 samples		\$50/sample	\$ 250
<b>Subcontract Cost</b>				<b>\$ 250</b>
<b>Total Cost</b>				<b>\$ 61,259</b>

# COST OF ENGINEERING SERVICES

Table 4: Cost of Supplies

Item	Quantity	Cost
Sea Salt (Sprout's)	240 g	\$10
DI Water	1500 mL	\$30
TrueSyn 200 I	184 mg	\$150
Toulene	100 mg	\$45
Fine-grade AZ Test Dust	100 mg	\$80
Sodium Bentonite	100 mg	\$70
Bench-scale construction materials		\$1,600
<b>Total Cost</b>		<b>\$1,985</b>

# REFERENCES

[1]	The 32nd Environmental Design Contest –The Ultimate Engineering Capstone Event, New Mexico State University, 2021.
[2]	J. Parshall, All 'Going Right' With Delaware Play, Journal of Petroleum Technology, 2018.
[3]	L. NGL Water Solutions and Jade Dragon, Task 5. Controlling VOC Emissions from Produced Water Recycling, New Mexico: NGL Water Solutions, 2021.
[4]	Northern Arizona University, "Vehicle Rental," 2021. [Online]. Available: <a href="https://in.nau.edu/university-transit-services/fleet-services/vehicle-rental/">https://in.nau.edu/university-transit-services/fleet-services/vehicle-rental/</a> . [Accessed 9 November 2021].



QUESTIONS