

LEGACY REMEDIATION

Introduction to Fate and Transport

May 24, 2022 Public Meeting







Meeting Agenda

- ► Welcome and Introductions
- Breakout Room Icebreaker
- Background, Timeline, & Recent Activities
- ► Fate and Transport Introduction
- ▶ Fate and Transport Q&A
- ▶ Fate and Transport Site Info
- ► Public Engagement Activities
- ▶ General Q&A





Welcome & Introductions

Evergreen 2022 Quarter 2 Public Meeting - Introduction to Fate & Transport

Welcome

Background

Fate & Transport

Fate & Transport Q&A

Fate & Transport - Site Info

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Who is joining us today?



Tiffani Doerr, P.G. Remediation Oversight



Denise Smith, Ph.D. Public Engagement







Jenny Kachel, P.G. Geologist



Andrew Klingbeil, P.G. Geologist













Background

Fate & Transport

Fate & Transport Q&A



Meeting Ground Rules

- 1. We welcome two-way communication. Use the chat and reactions to stay engaged, ask questions, and share feedback throughout the meeting.
- **1**. There will be specific opportunities for Q&A after each fate and transport presentation.
- 1. For the most part, questions will be answered in the order in which they are received. However, we want to prioritize the voices of residents. If you are a resident in a neighborhood close to the refinery who would like your question prioritized, include the name of your neighborhood when you submit your question.
- **1**. Be mindful that what you write in the chat will be monitored. Be respectful and honor different points of view.
- 1. If we do not get to your question during the meeting, we will answer it after the meeting.
- 1. This meeting will be recorded and posted on the website. We will also post a PDF version of the presentation and the Q&A.



Breakout Room Icebreaker

Go around your breakout room and introduce yourself by sharing:

- Your name
- Your affiliation
- What you are most excited about this spring or summer?
- What would you like to learn from this meeting?



Fate & Transport Q&A



Background, Recent Activities, and Submittals

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Who is Evergreen?

- ► Formed in 2013 to manage Sunoco's legacy environmental liabilities
- Mostly environmental engineers/geologists/scientists, located in Wilmington DE

Evergreen project managers use teams of consultants who are experts in their fields to perform required work at sites





What are we doing?

- Sunoco/Evergreen have been performing investigation and remediation at the Refinery for over 30 years
- Responsible for soil and groundwater contamination resulting from spills and operations prior to 2013
- Operate remediations systems that are protective of human health and the environment

Where are we in the process?

Subsurface investigations are mostly complete – Fate & Transport (F&T) is the last step of the Remedial Investigation (RI) process



Summary of Recent Activities

Site-Wide Remedial Investigation Report (RIR) Addendum Submitted

Additional Past RIR Follow-up Activities ongoing

- Unit Sampling ongoing
- Modifying some remediation systems to initiate discharge to Philadelphia Water Dept (PWD) vs onsite Wastewater Treatment Plant (WWTP)

Per- and Polyfluoroalkyl Substances (PFAS) sampling ongoing



2022 Act 2 Technical Submittals

Activity	Date
Site-Wide RIR Addendum	May 20 2022
Fate & Transport Model RIR	June 30, 2022*
Ecological Risk Assessment Report	June 30, 2022*
136 Area Drum Report	2022
Unit Sampling Report	2022

*These due dates are in accordance with Consent Order

Background

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Introduction to Fate and Transport

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Ecological Risk Assessment

Due June 30, 2022 Focus on threatened and endangered plant and animals

3 fish species:	Atlantic Sturgeon, Shortnose Sturgeon, Hickory Shad
1 reptile species:	Eastern Redbelly Turtle
3 bird species:	Marsh Wren, Peregrine Falcon, Least Bittern
5 plant species:	Waterhemp Ragweed, Walter's Barnyard- grass, Multiflowered Mud-plantain, Bugleweed, River Bulrush



Fate and Transport







What is it?

How does it fit in to Evergreen's investigation and clean up? How does it work?



Fate and Transport

- Q: What is Fate and Transport (F&T)?
- A: Prediction of how contaminants will move





What does the term mean?





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Why do we do F&T?

Program requirement

▶ Tool for remediation

Understand what the future could look like







Next steps and Q&A









The Water Cycle



Welcome



How does Fate and Transport work?

Former Philadelphia Refinery F&T Process





Groundwater Model

- What's important?

Geology -Affects how water moves

Hydraulic Conductivity -

Measurement of how fast water moves

Hydraulic Gradient -

Tells the direction water will move





Groundwater Model

- Balancing act

Welcome





Groundwater Model

- Balancing act

Welcome



Contaminant model

- Where are the sources?





Contaminant Model

- What else matters?

Degradation



Biological and Chemical Breakdown

Adsorption



Sticking to soil

Dispersion



Spreading



Surface Water Model

- Bring the data together



Welcome



Surface Water Model



Tide Cycles

Water Speed

Water Volume

Shape of River



How does Fate and Transport work summary

Former Philadelphia Refinery F&T Process





Where to Learn More:



https://www.usgs.gov/special-topics/water-science-school



Note: Publicly-available instructional video on <u>"Groundwater Model"</u> by Warren County Soil & Water Conservation District linked on Evergreen's website's Resources Page.

Fate & Transport Q&A



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Geology Model – What's Down Below?

(Schuylkill River Tank Farm)









Weathered rock (bedrock) below

Geology Model – Where's Groundwater?

(Schuylkill River Tank Farm)







- Groundwater occurs below a water table
 Most in sand/gravel layers (blue)
 - Muds can be wet or dry (green)

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REMEDIATION



Flows from high (**red** to **green**) to low (**blue** to **white**) areas

Fate and

Transport

Interacts with surface water and sewers Flows in many directions / 3 dimensions Recent patterns are consistent

Welcome

XXX Water

Flow

Geology

Contaminants – Where Are They Now? (Water Philadelphia Refinery Legacy Remedication

Table Benzene Concentration)







Higher



▶ E ▶ F

Benzene dissolved in shallow groundwater From "old" refinery spills (through 2012) Some benzene from other Act 2 facilities Recent data (2014 – Present) Blue areas are inputs to the model

Contaminants – Where Are They Now? (Lower Legacy Remediation

Aquifer Benzene Concentration)



Welcome

Geology Model to Groundwater Flow Model

(From Deposits to Building Blocks)



Break up geology model into mesh of blocks called cells (> 1.2 million)

- Cells are for computer calculations of groundwater flow
- Each cell has unique properties/conditions
- Groundwater can flow from cell to cell in 3 dimensions

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Geology Model to Groundwater Flow Model

(Layers of Building Blocks)



 Mapped geology versus model "slice"
 Geology mirrored by layers of blocks
 Model has 7 layers based on a published sequence for regional groundwater studies

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Groundwater Flow Model (Observed Versus Predicted)





Observation Based (Wells)

Model Predicted

 Water table example
 Similar patterns and levels produced by model
 Process called calibration

Contaminants – Where Do They Go? (Water

Table Benzene Predictions)



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Contaminants – Where Do They Go? (Water

Table Benzene Predictions)







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Contaminants – Where Do They Go? (Shallow

Aquifer Benzene Predictions)



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Contaminants – Why Don't They Spread More?



underground

Middle clay layer is protective of deeper groundwater

Local flow paths to sewers, Mingo Basin, and the Schuylkill

River







Background

12.00

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REMEDIATION

Schuylkill River Groundwater Discharges



(River Model Mesh Near the Former Refinery)





3-dimensional river model (water blocks)
 Water flows and levels calibrated to range of river conditions (tides, floods, droughts)
 Track groundwater particles and contaminants
 Groundwater seeps and mixes into the river

Climate Resiliency – How Might Changing Climate Impact Predictions?



phillyvoice.com

Philadelphia Water Department Sea Level Rise Planning and Design Scenarios					
Year	PWD Low Scenario (ft.)	PWD Primary Planning Scenario (ft.)			
	NOAA Int-Low	NOAA Int-High			
2000 (baseline)	0	0			
Near-term (2030s)	0.62	1.18			
Mid-century (2060s)	1.21	2.89			
End-of-century (2100s)	1.94	6.4			
(014/0-2022)					

(PWD, 2022)



(Maimone & Kulis, 2017)

- Assessment of anticipated changes; considers model sensitivity
- Sea-level rise (raise the river in the models)
- Increased flood/drought frequency (river flows; recharge)
- Future land use (buildings, pavement vs. grass)

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REMEDIA



Sitewide Fate & Transport RIR What to Expect



- Detailed documentation of the models
- Calibration info and sensitivity testing
- Predictions for additional petroleum compounds

in groundwater

- Predictions in surface water
- Environmental forensics reporting
- Microbiological tool data (DNA/RNA)
- Documentation of recent

characterization work



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Fate & Transport Q&A

Future Work



- Continued monitoring of environmental conditions (remaining oil, groundwater)
- Remediation pilot testing
- Cleanup plan
- ▶ Use models as predictive tools





Fate & Transport Q&A



Public Engagement Updates

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Ongoing & Upcoming Engagement Activities

► Quarterly public meetings

Quarterly newsletters

Public commenting on reports

Small group chats

► Youth Community Ambassador Program



Questions & Comments

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Thank You For Attending



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