



Petroleum Remediation Challenges Due to Extreme Events


**New Hampshire Waste Management Seminar
November 10, 2021**

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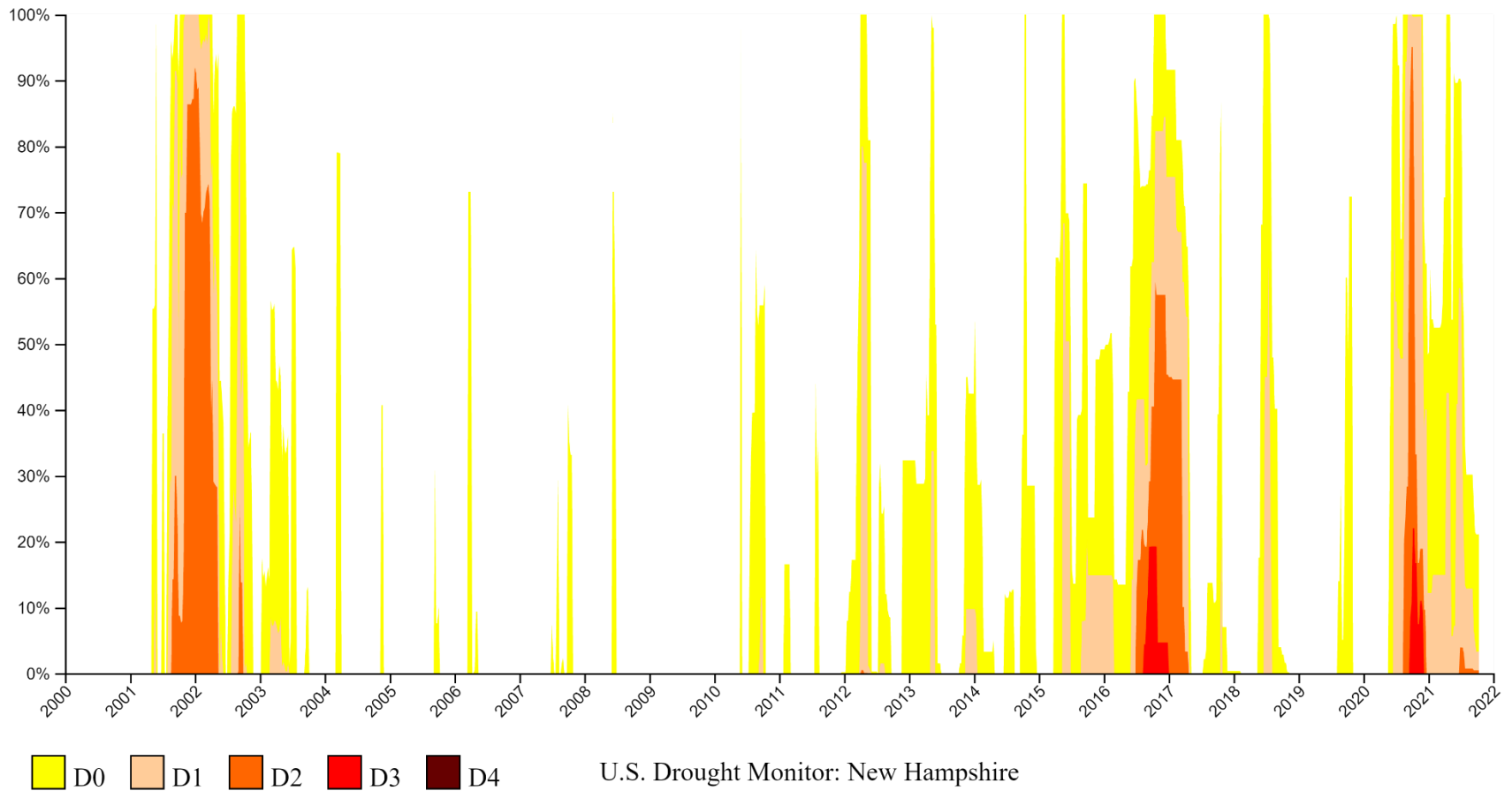
Overview

Groundwater systems respond to extreme events (storms, drought) by exhibiting greater fluctuations in groundwater levels.

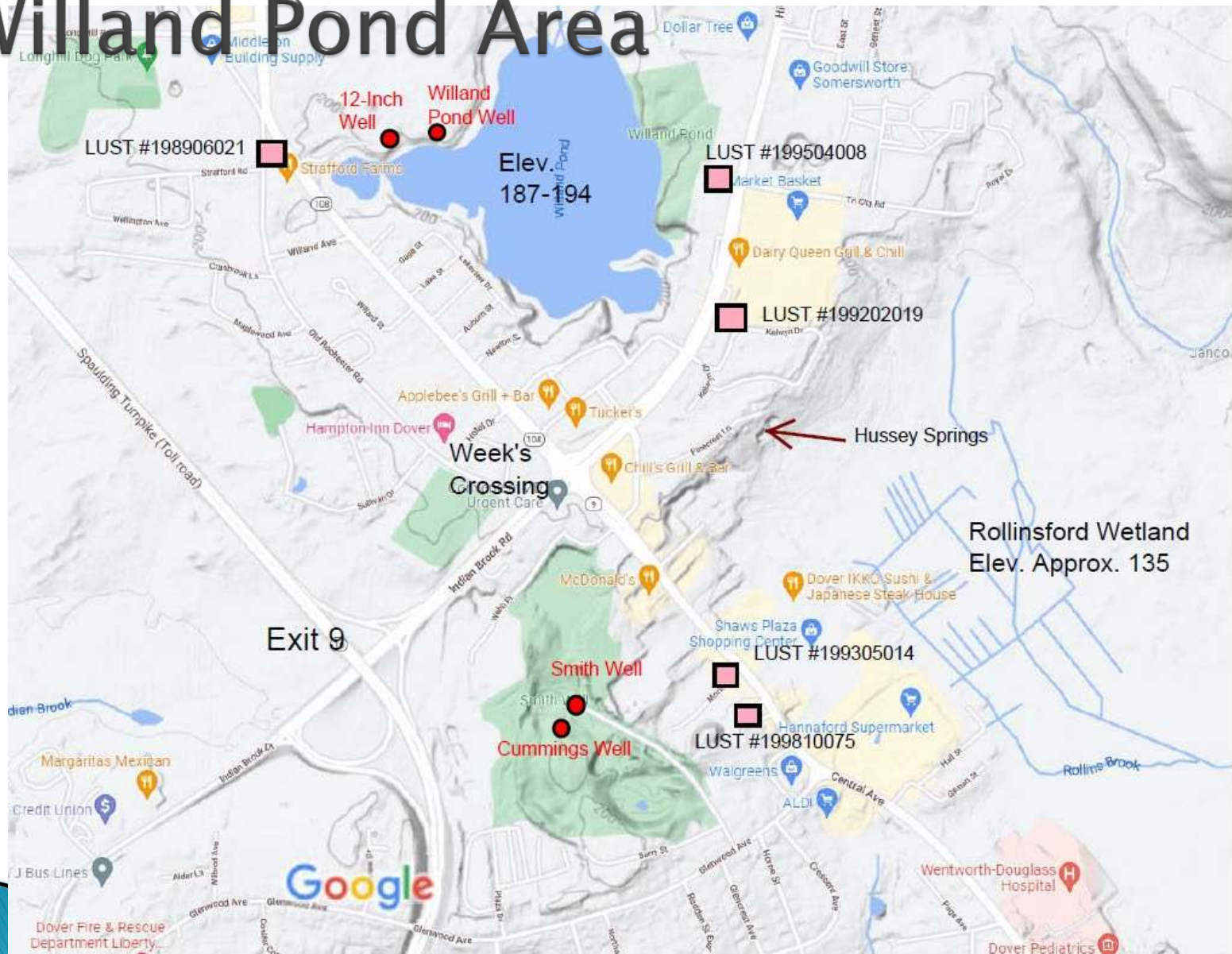
This presentation will examine how extreme events have made remedial activities at leaking underground storage tank (LUST) sites in the Dover–Somersworth area more challenging.



NH Drought Conditions 2000-2021



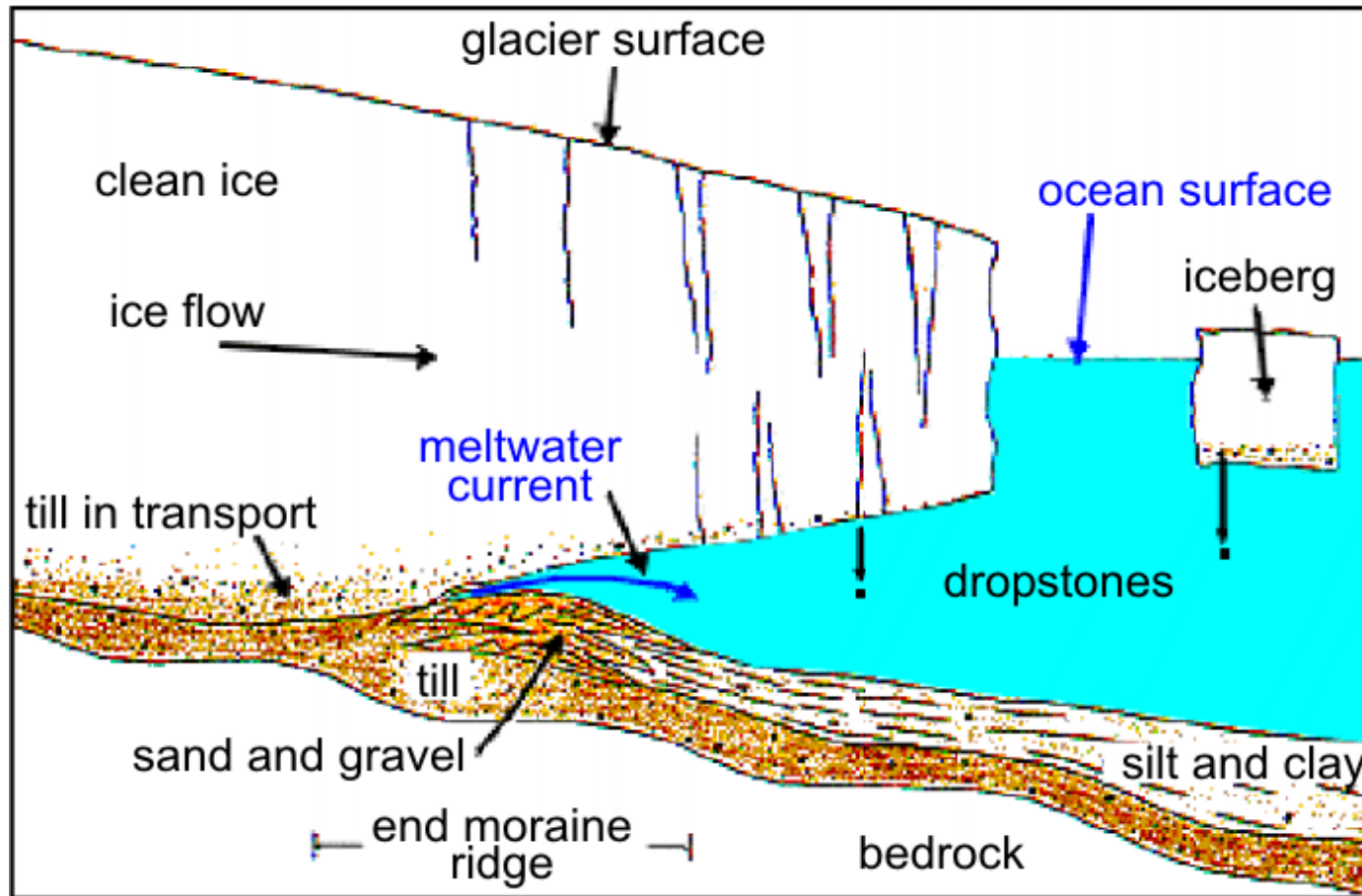
Dover-Somersworth Willand Pond Area



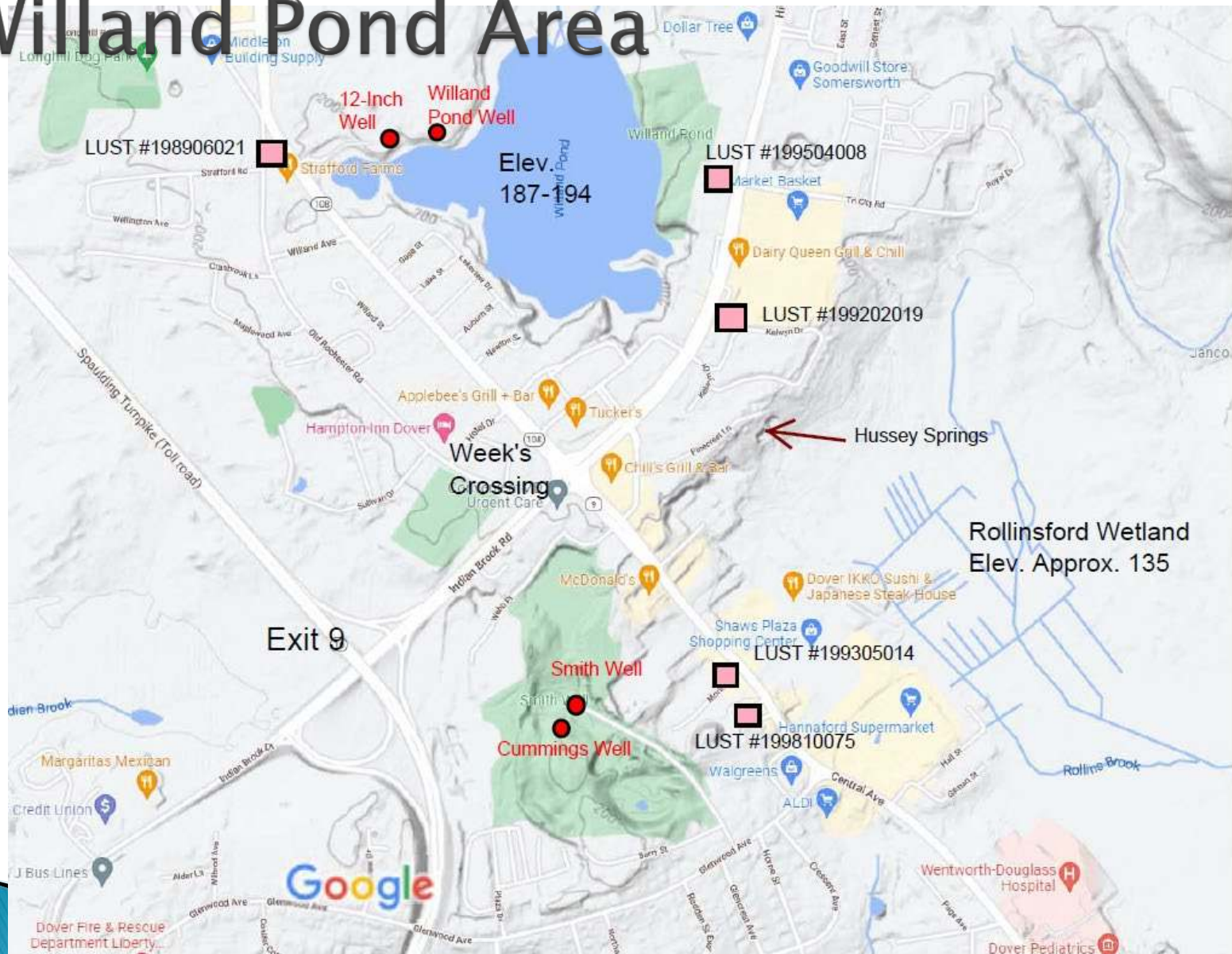
Setting of Willand Pond



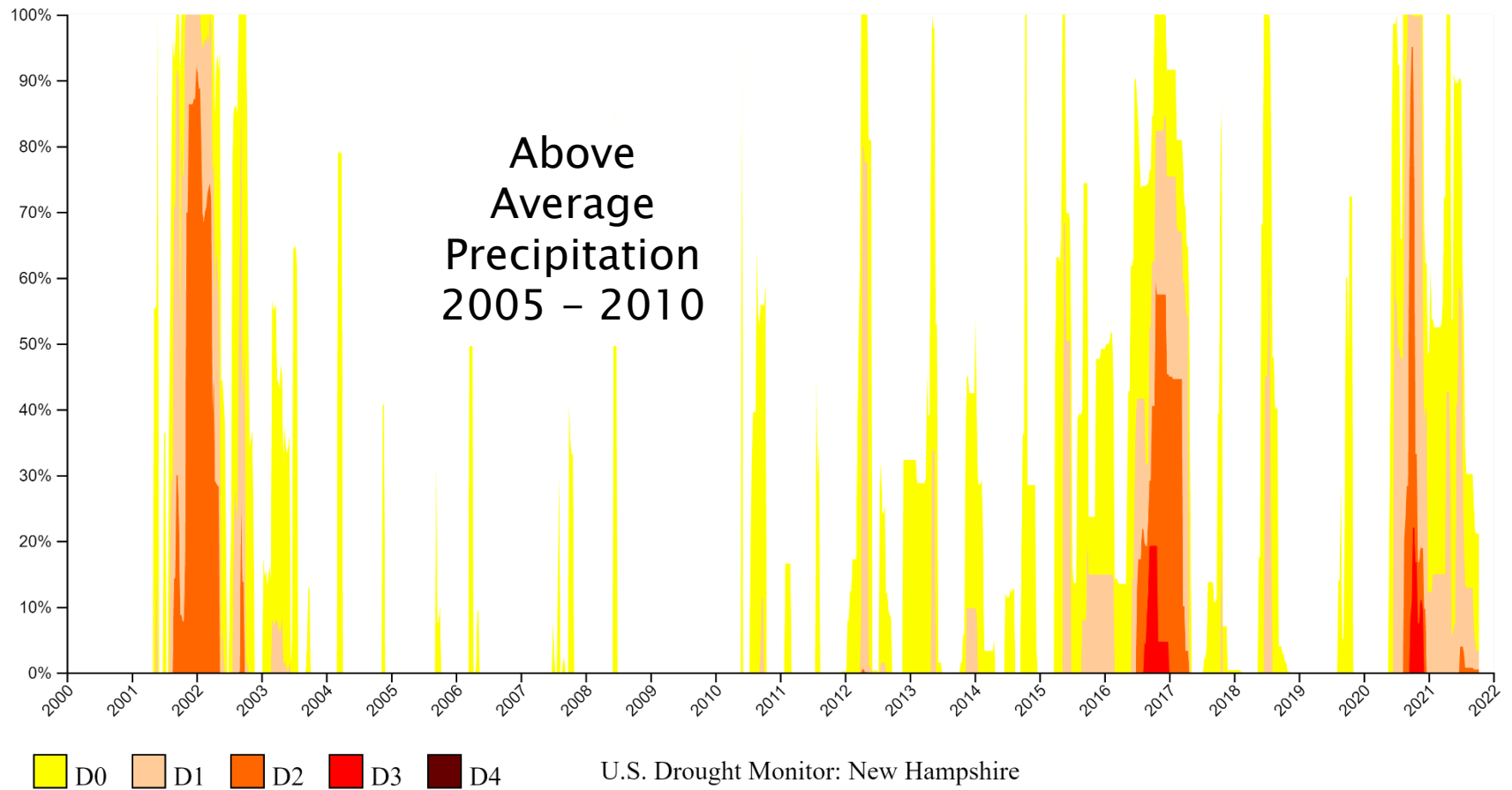
Willand Pond = Kettle Pond in Glacio-Marine Delta Complex



Dover-Somersworth Willand Pond Area



NH Drought Conditions 2000–2021



Extreme Weather Events: Above Average Precipitation

Dover–Somersworth Area

- ❑ NOAA Data for Durham, Eliot and Rochester
- ❑ Average Precipitation 2000–2020 = 46.4 inches
- ❑ Deviations Above Average
 - 2005 + 12.2 inches (+26%)
 - 2006 + 10.4 inches (+22%)
 - 2007 + 2.5 inches (+5%)
 - 2008 + 15.4 inches (+33%)
 - 2009 + 6.4 inches (+14%)
 - 2010 + 2.5 inches (+5%)

Extreme Weather Events: Above Average Precipitation

Dover–Somersworth Area

“Alstead Flood”

- October 7 through 12, 2005 = Approx. 14 inches

“Mother’s Day Flood”

- May 11 through 16, 2006 = Approx. 14 inches

“Patriot’s Day Storm”

- April 16 and 17, 2007 = Approx. 10 inches

“2008 = Wet Year” – 33% above average

- September – Wet Month = Approx. 10.8 inches in two multi-day storms

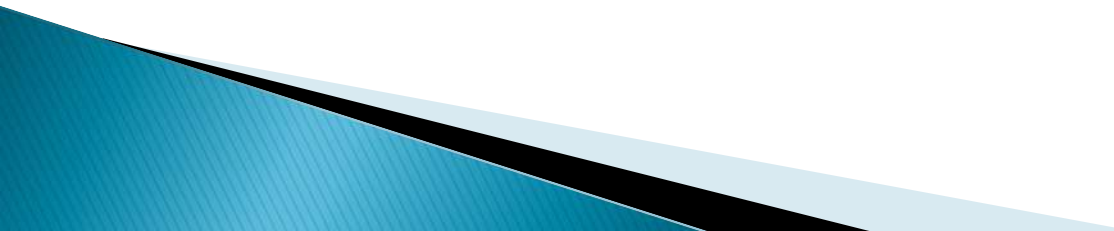
“March 2010 Storms”

- March 2010 – Wet Month = Approx. 12 inches in three multi-day storms

Extreme Precipitation Impacts on Willand Pond and Surrounding Groundwater

- ❑ Flooded basements
- ❑ Drowning of riparian trees and vegetation
- ❑ Increased nutrients & harmful algal blooms


Response:

- ❑ Dover City Council Created Ad-Hoc Committee
 - ❑ House Bill 1128 of 2008 – ITL
 - ❑ Testing and Permitting of Reactivation of “12-Inch” Dover Municipal Water-Supply Well
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Extreme Precipitation Impacts on Willand Pond and Surrounding Groundwater

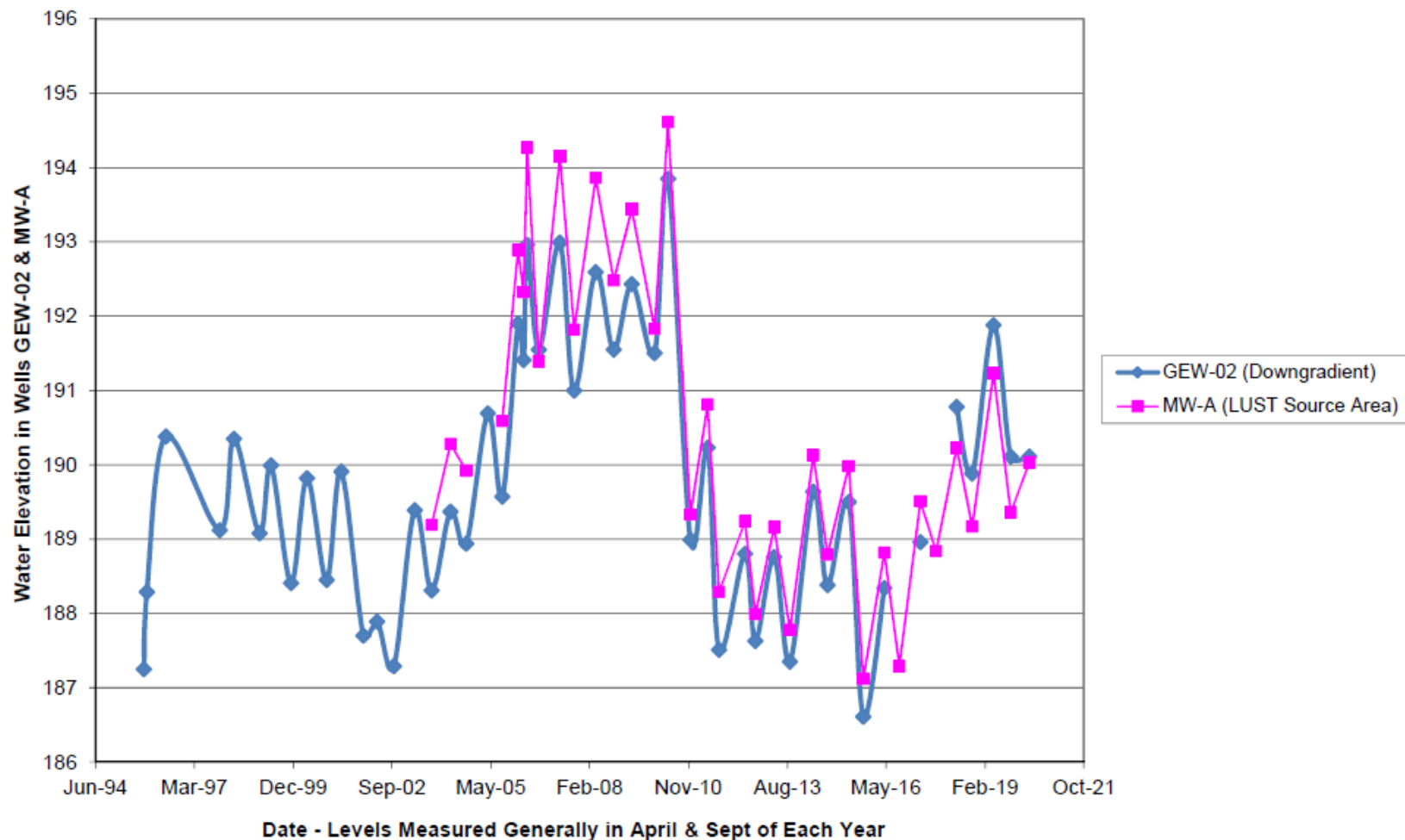


Synopsis of Petroleum Release Response at Willand Pond Auto – LUST #198406021

- ▶ 800 gallon inventory loss from USTs reported to New Hampshire Water Supply and Pollution Control Commission on January 23, 1986.
 - ▶ September 1986 – USTs removed, impacted soil aerated and placed back in tank excavation.
 - ▶ Initial Environmental Site Assessment August 1994
 - ▶ Remedial Action Plan approved December 1996 – Limited to monitored natural attenuation.
 - ▶ Monitoring under permit: May 1997– present
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Extreme Precipitation Impacts on Willand Pond and Surrounding Groundwater

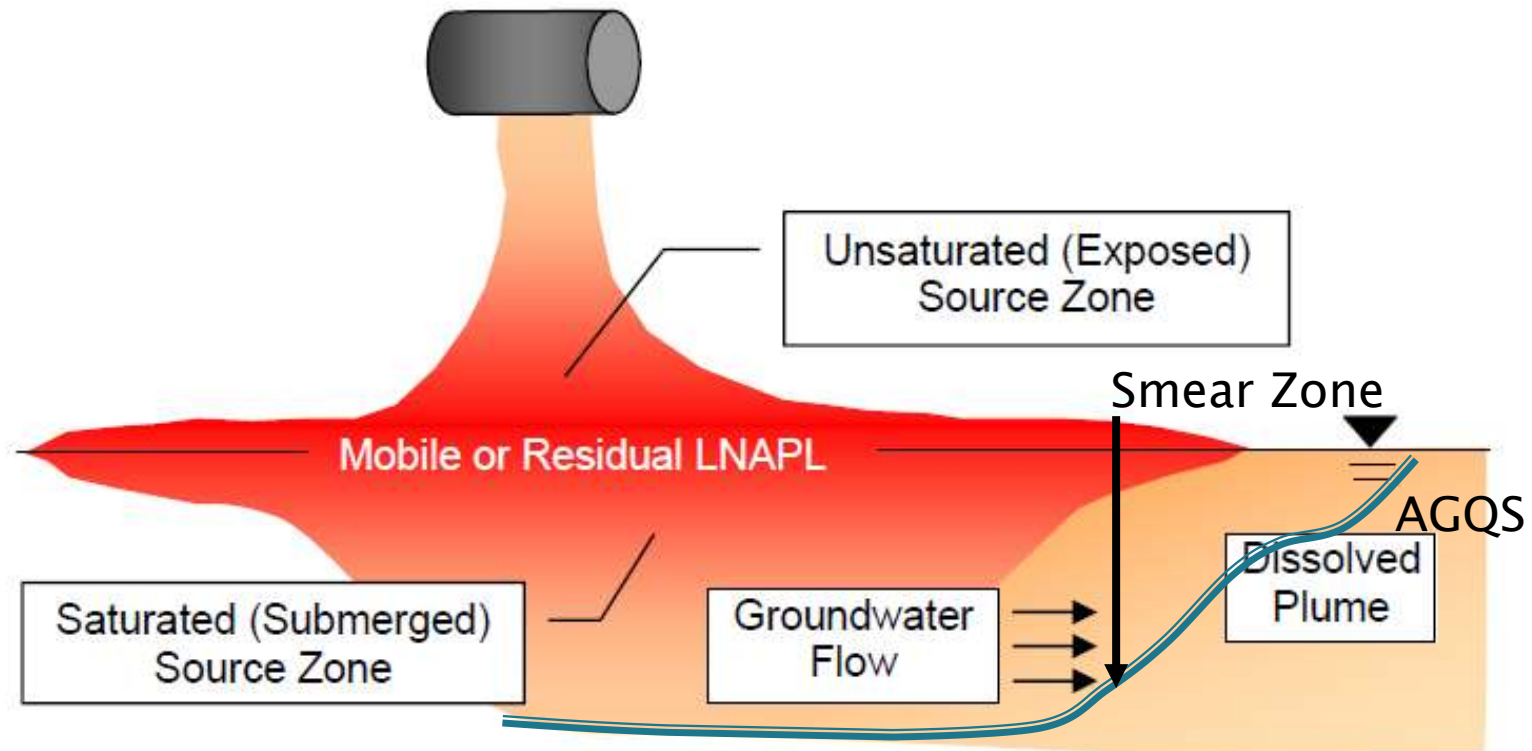
Groundwater Elevation Adjacent to Willand Pond, Dover



Extreme Precipitation Impacts on Willand Pond and Surrounding Groundwater

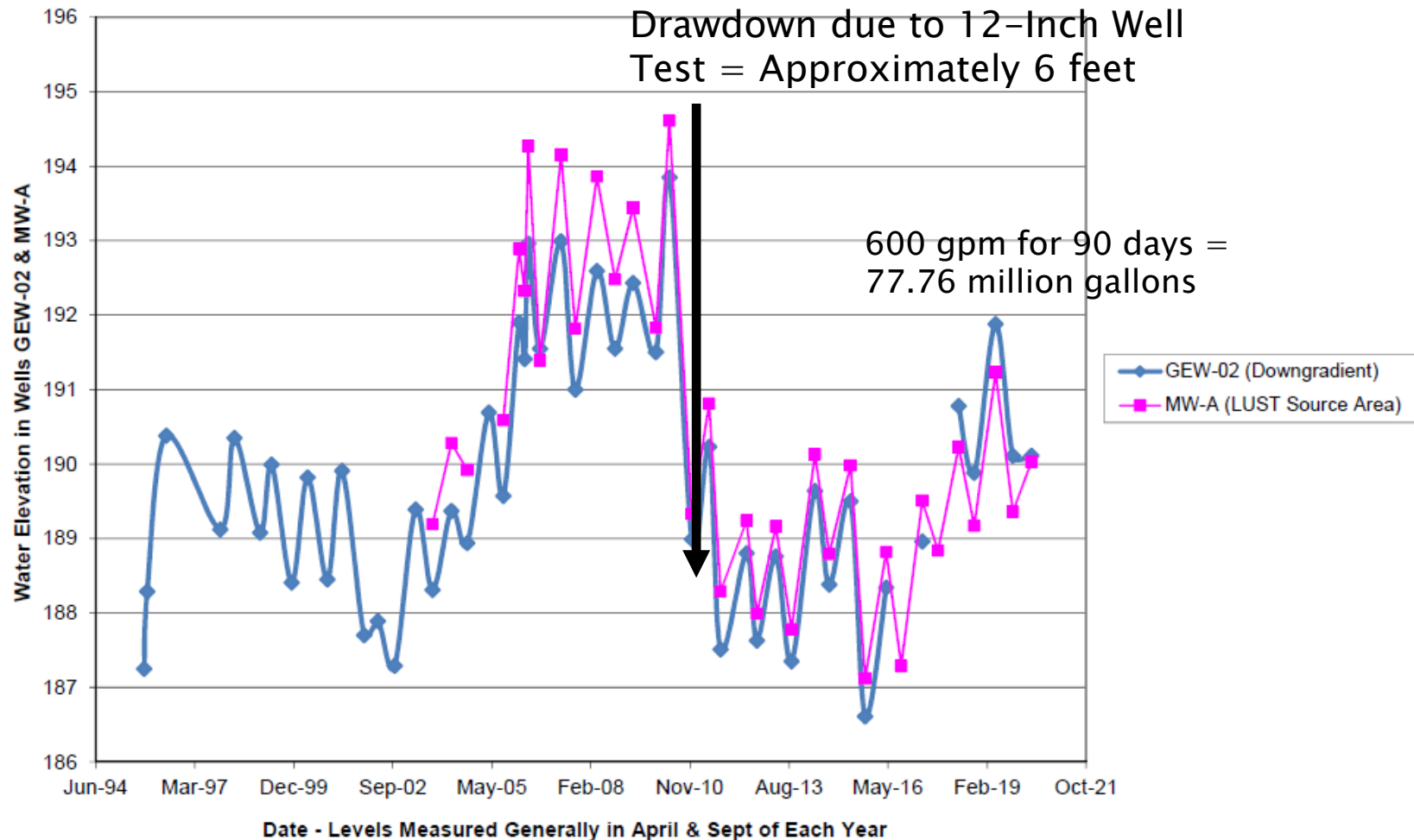
Need to Update LUST Site Conceptual Site Models

- Greater Water Table Variations
- Vertically Expanded Smear Zone
- Resulting Changes in Contaminant Concentrations

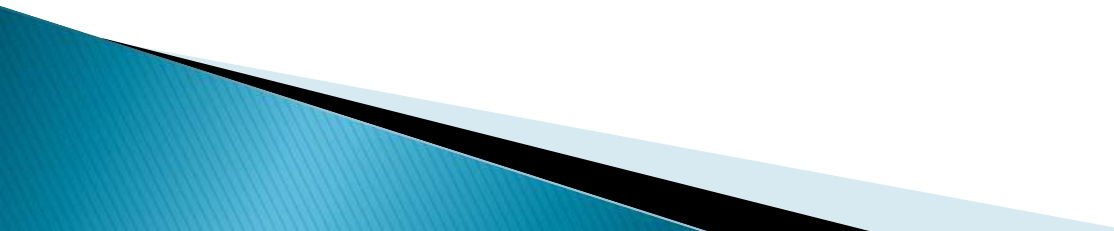


Extreme Precipitation Impacts on Willand Pond and Surrounding Groundwater

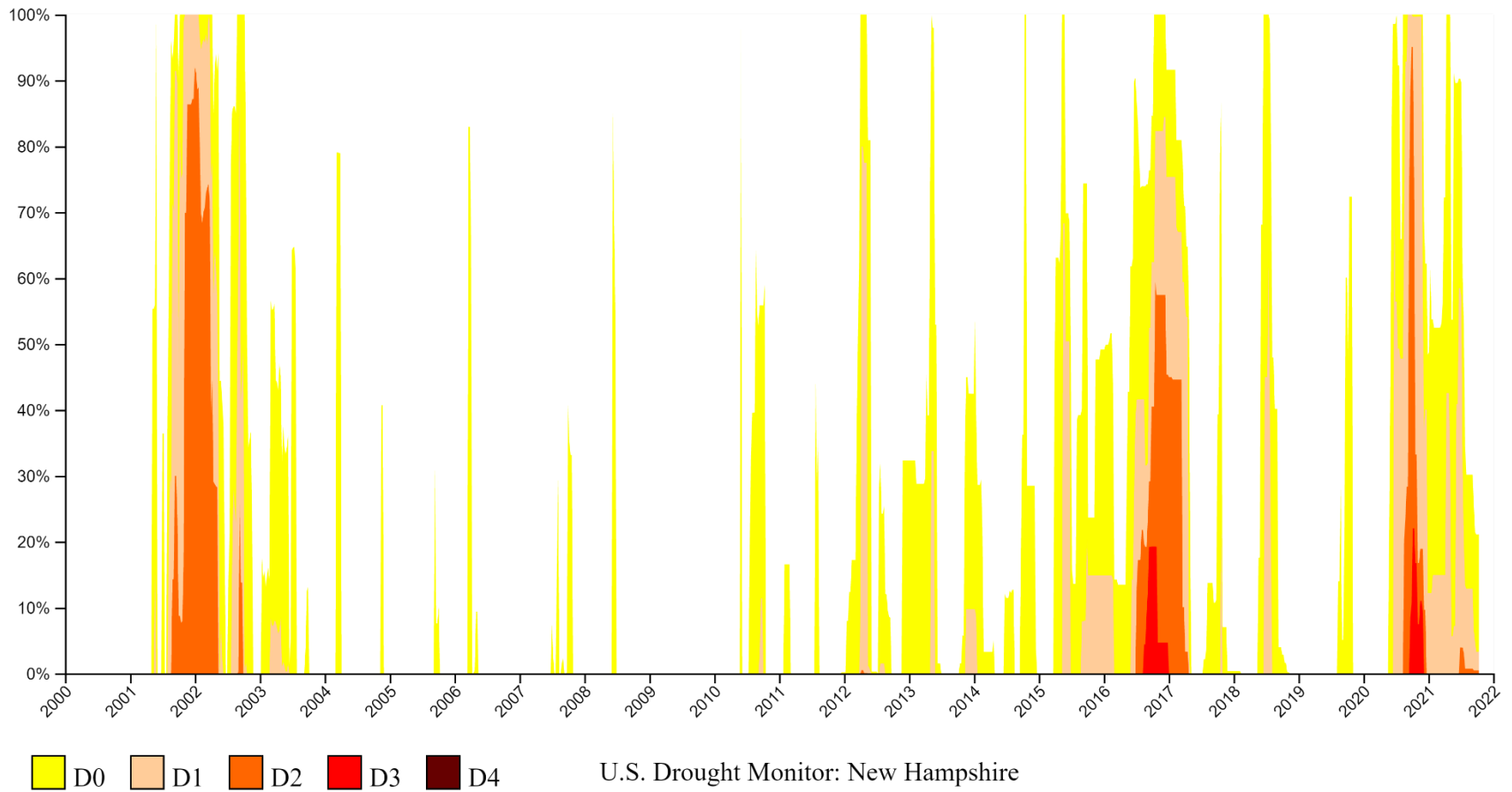
Groundwater Elevation Adjacent to Willand Pond, Dover



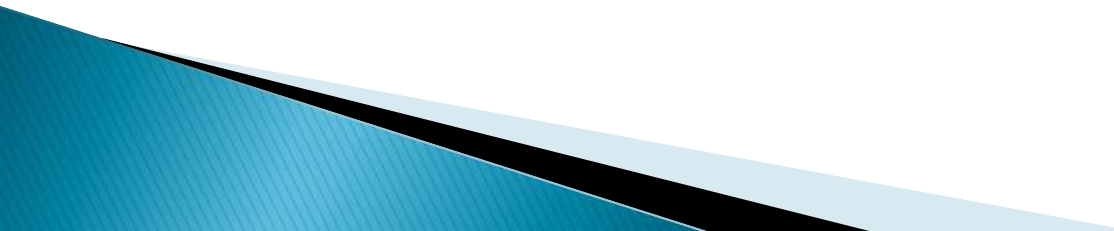
Consequences of Transient High Water Levels at Willand Pond Auto Site

- ▶ Increased petroleum VOC concentrations observed in several wells. However, below standards in all but one monitoring well.
 - ▶ Update Conceptual Site Model to consider influence of reactivated municipal water–supply wells.
 - ▶ Reactivated and approved new large groundwater withdrawal of approx. 600 gpm commenced in March 2020.
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NH Drought Conditions 2000-2021



What happens at LUST sites when there is drought?

- ❑ Lowering of water table
 - ❑ Lower hydraulic gradients – slowing of groundwater flow
 - ❑ Increased impacts of nearby groundwater withdrawals
 - ❑ Creation of dry to bedrock (unsaturated overburden) conditions
 - ❑ Remediation efforts made more difficult
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Dover-Somersworth Willand Pond Area



Impacts of Drought



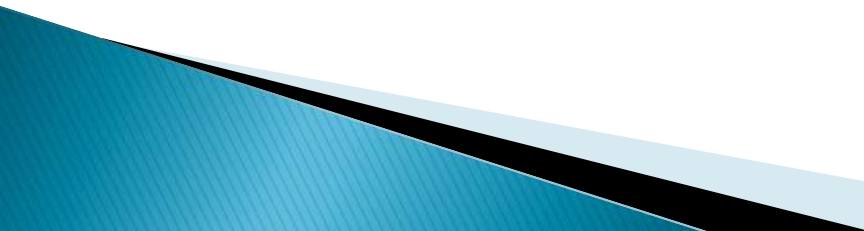
Impacts of Drought



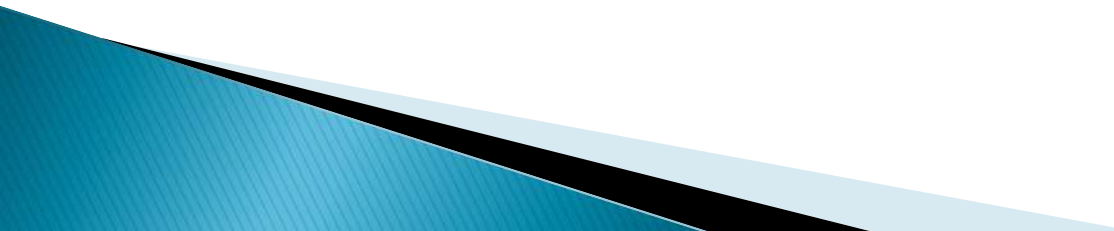
Impacts of Drought



Synopsis of Petroleum Release Response at “Dunkin Donuts”– LUST #199305014

- ▶ Soil and groundwater impacts observed during UST removal April 1993 for site redevelopment as a Dunkin Donuts.
 - ▶ 382 tons contaminated soil disposed off site.
 - ▶ Site Investigation August 1993. SSI April 1995. Excavation apparently missed petroleum impacts under former dispenser island.
 - ▶ Presumptive remedy: Monitored natural attenuation.
 - ▶ Monitoring under permit: March 1996– present
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Synopsis of Petroleum Release Response at “Dunkin Donuts”– LUST #199305014

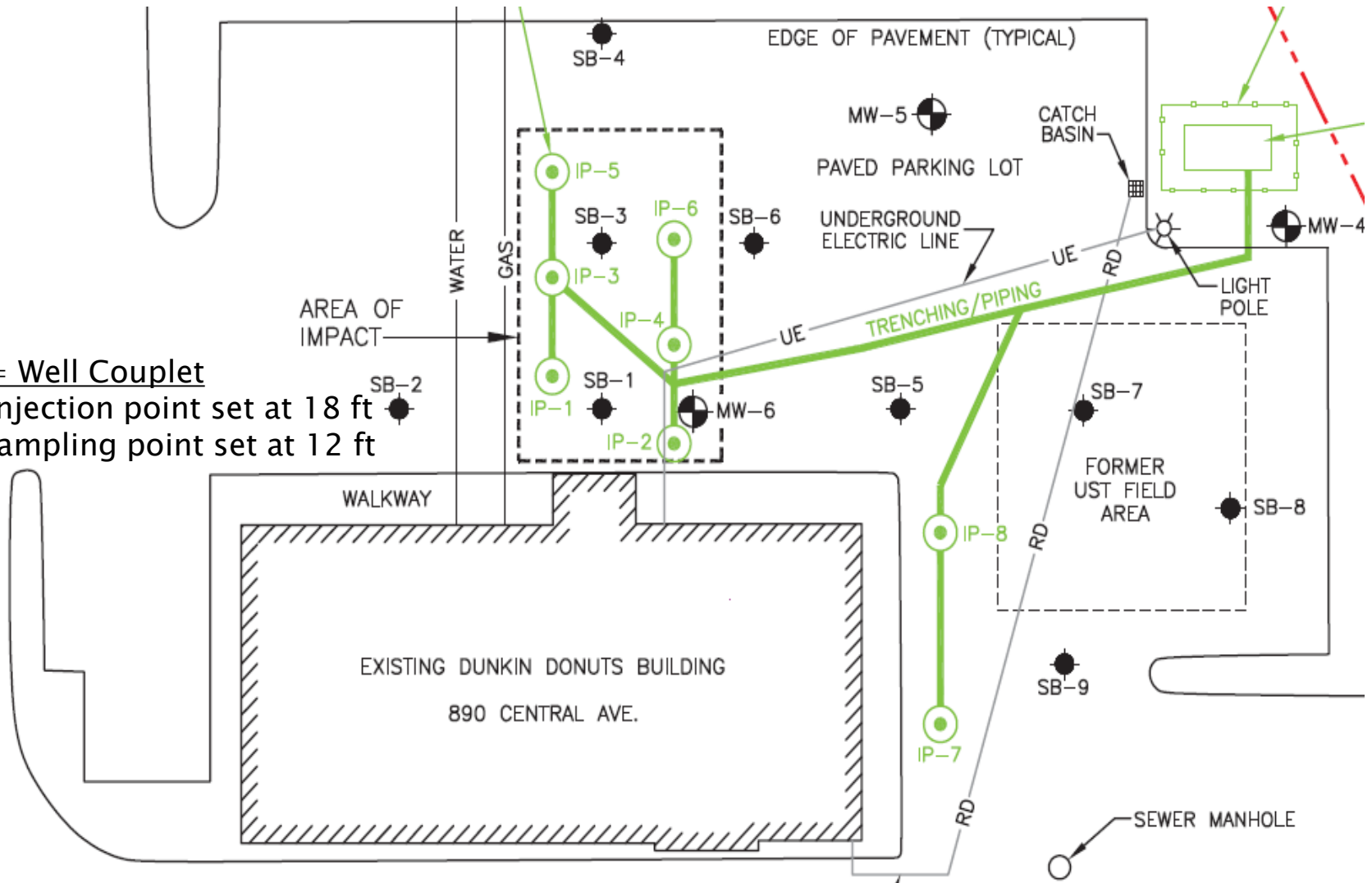
- ▶ Following 20 years of monitoring, NHDES approved enhanced remediation using in-situ oxygen injection in July 2013.
 - ▶ Matrix® System installed and activated September 2014.
 - ▶ System operated periodically through July 2017.
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Petroleum Release Response at “Dunkin Donuts” – LUST #199305014

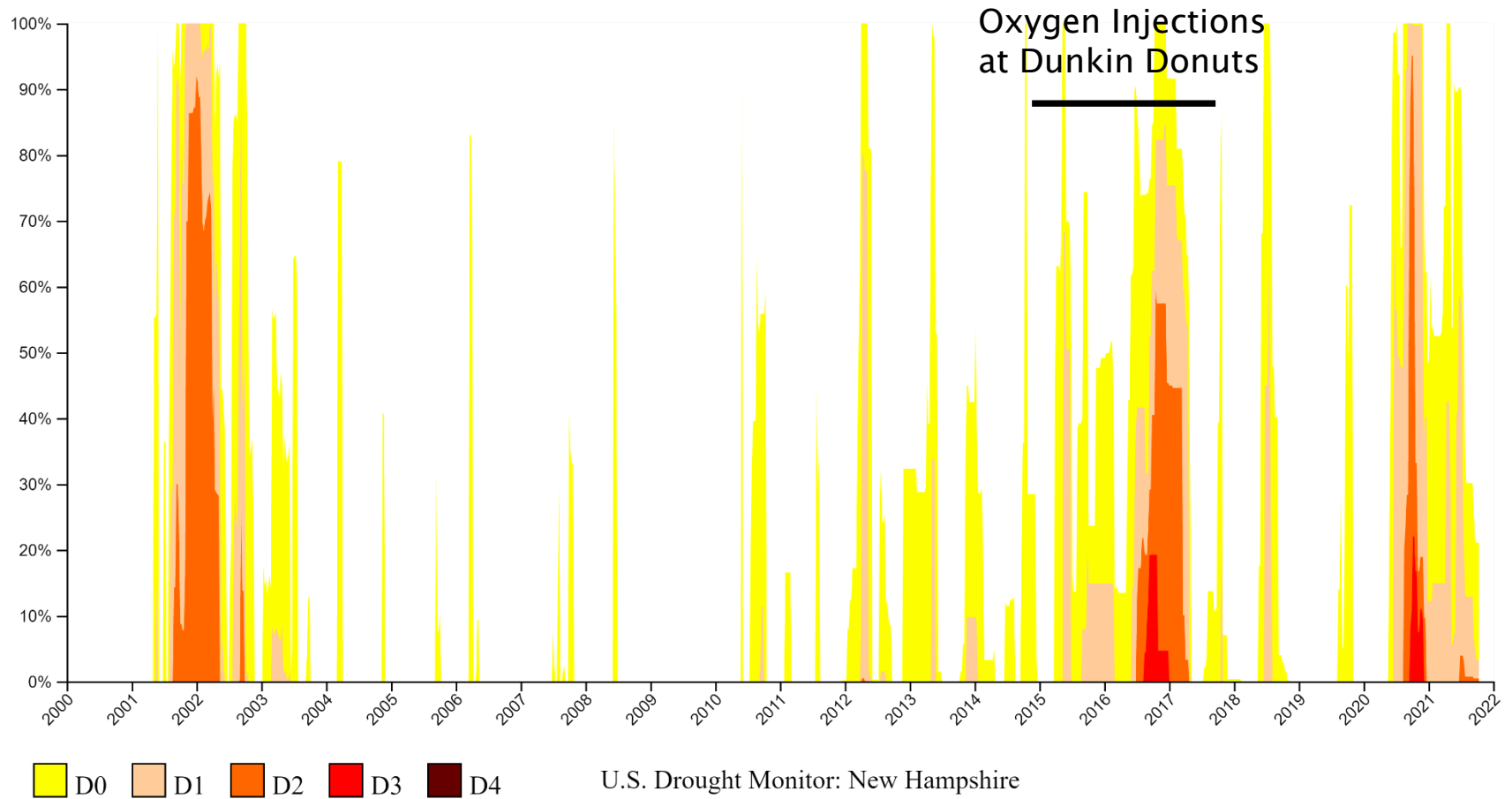
Each IP = Well Couplet

$\frac{3}{4}$ -inch injection point set at 18 ft

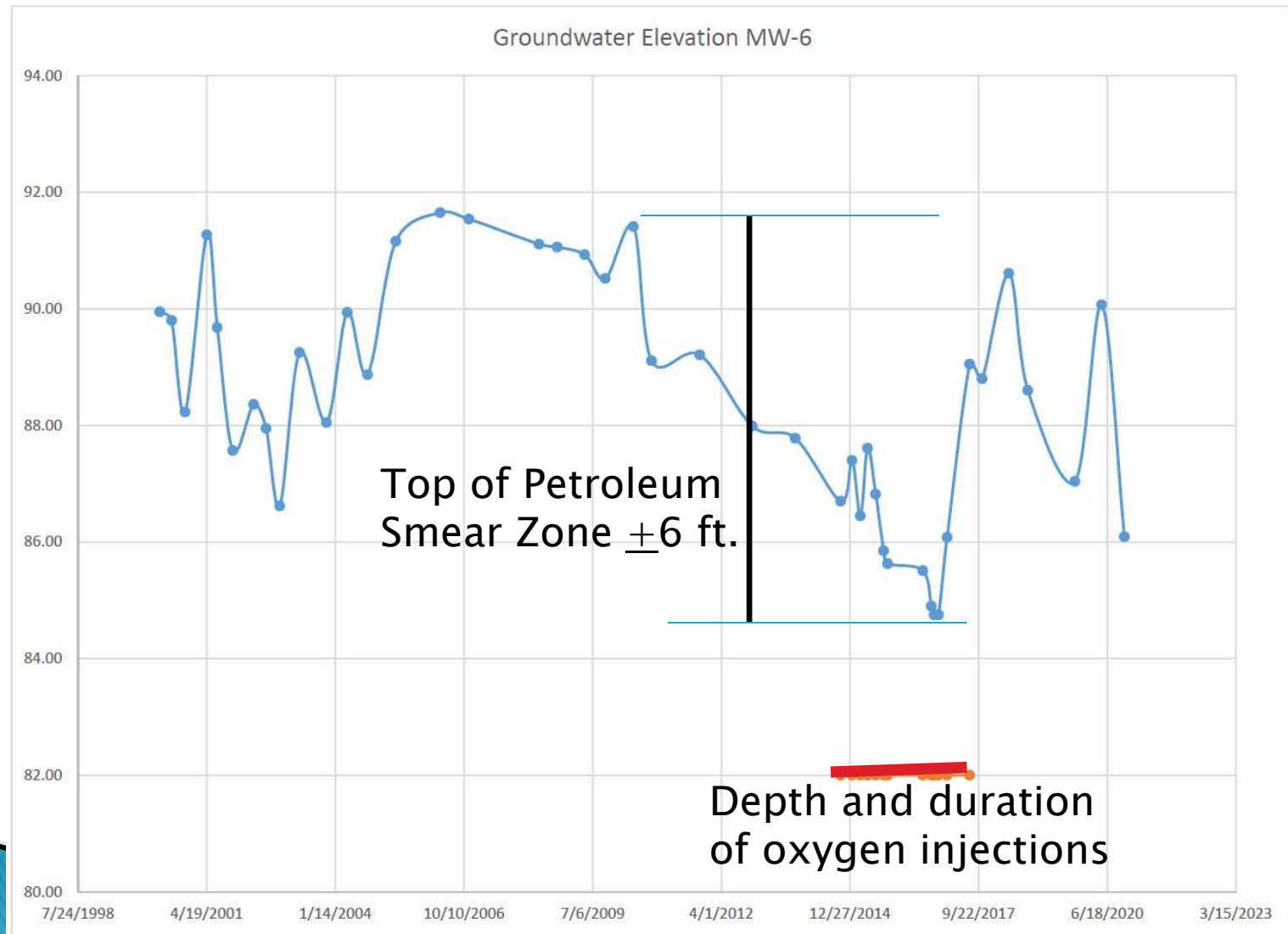
2-inch sampling point set at 12 ft



NH Drought Conditions 2000-2021



Petroleum Release Response at “Dunkin Donuts”– LUST #199305014



Impact of Drought on Remediation of “Dunkin Donuts” Site

- ❑ Decreased effectiveness of remedial effort
- ❑ Concentrations of dissolved naphthalene and 1,2,4-trimethylbenzene continue to exceed AGQS.

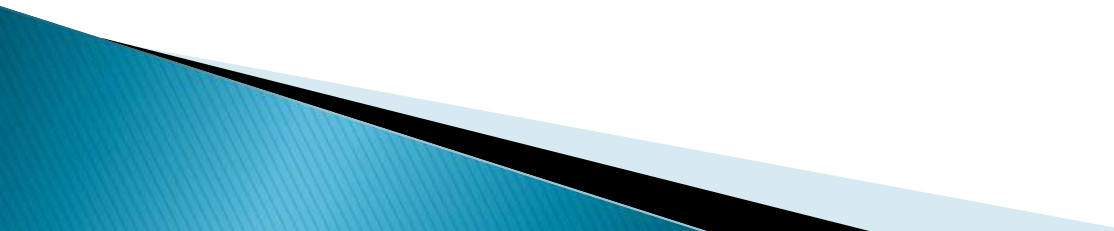
Impacts of Drought

Dover Plaza Citgo

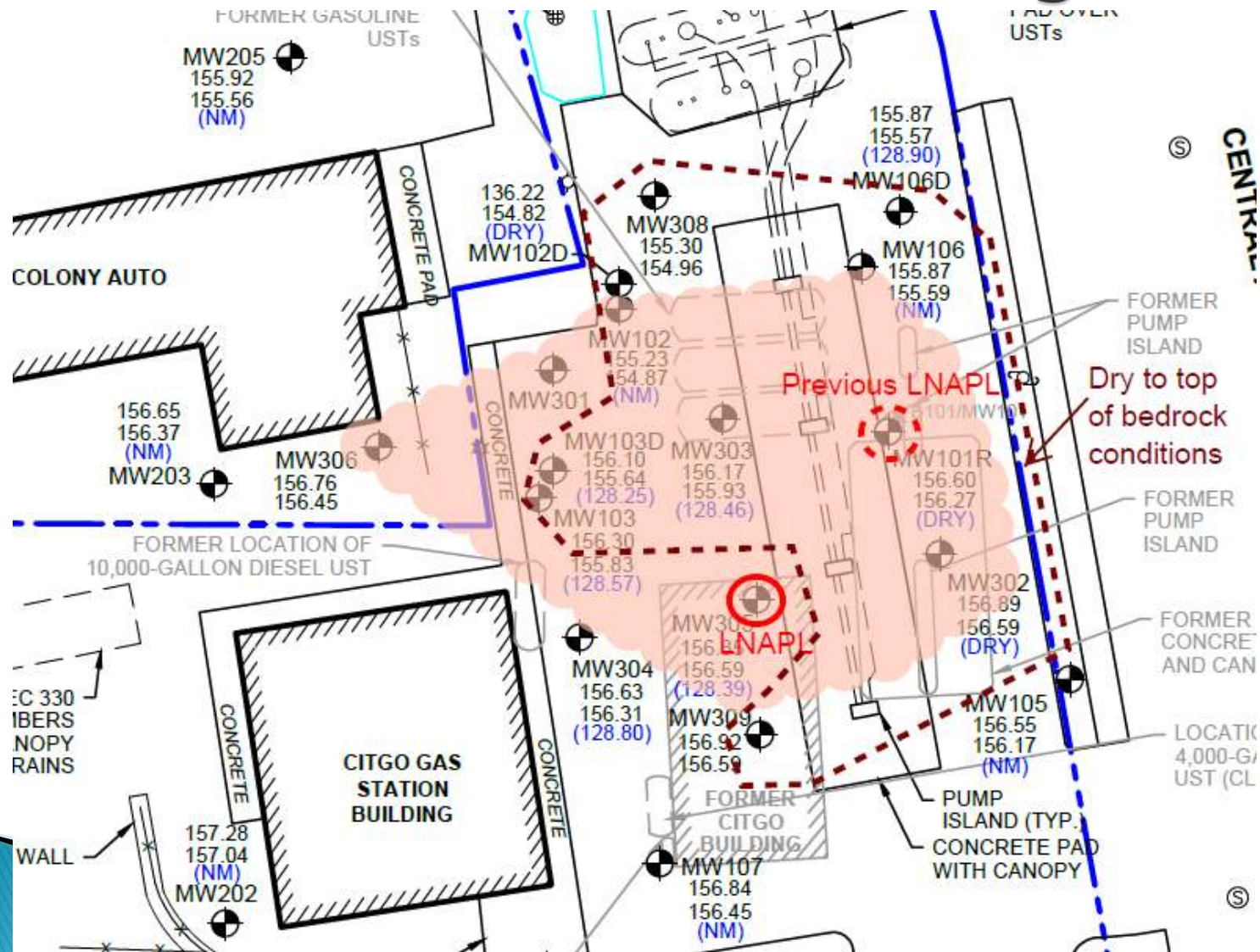
LUST #199810075



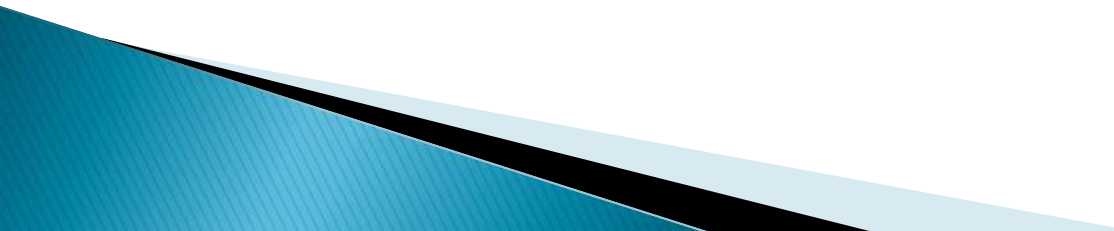
Synopsis of Petroleum Release Response at Dover Plaza Citgo– LUST #199810075

- ▶ Soil and groundwater impacts discovered during UST closure & system upgrades in November 2011. 15 tons impacted soil disposed off site.
 - ▶ Site Investigation November 2012. Petroleum impacts (LNAPL) under former dispenser island.
 - ▶ Monitoring under permit: May 2014– present
 - ▶ Deeper wells installed April 2017.
 - ▶ Pre–Remediation Investigation December 2019.
 - ▶ Remedial Action Plan Requested
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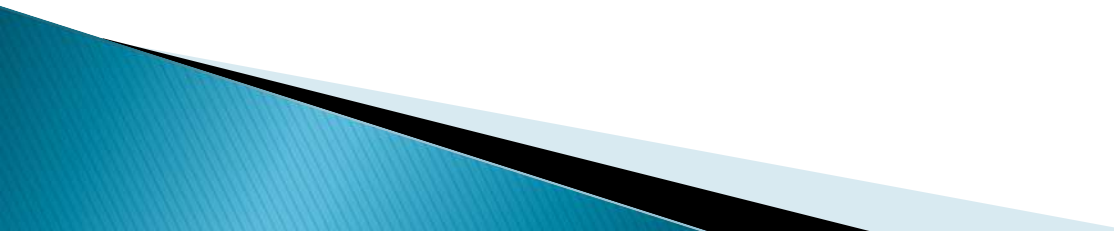
Impacts of Drought on Remedial Activities – Dover Plaza Citgo



Impact of Drought on Remediation of Dover Plaza Citgo Site

- ❑ Transient lowering of groundwater levels.
 - ❑ Current predominance of dry to bedrock conditions. Unable to pursue in-situ chemical oxidation.
 - ❑ LNAPL impacts in glacial till and to top of bedrock. Air sparge/soil vapor extraction not feasible.
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Summary

- ❑ Variations in geology can create highly variable hydrologic conditions among nearby sites.
 - ▶ Impacts of extreme weather events may be direct or indirect.
 - ▶ Extreme weather events may hamper petroleum remediation efforts by:
 - 1) making certain technologies unfeasible;
 - 2) extending time-frame to achieve clean-up goals.
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