



**Maryland**  
Department of  
the Environment

# Climate Change: Impacts to Solid Waste Management Facilities and Practices in Maryland

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# Anticipated Impacts

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- **Weather:** Expect more storms, and worse storms, and periods that are hotter or colder than now – the range of extremes will be larger.
- **Floods:** More rain = more temporary flooding, and soggy soils at the landfill at times.
- **Sea Level Rise:** This won't directly affect most landfills, but some roads will eventually be closed, and some bridges will have to be raised or lengthened, putting stress on DPW budgets, and perhaps making for longer haul routes.



## Global Sources of Sea Level Rise\*

	<u>1993-2015</u>	<u>2005-2015</u>
Thermal expansion of Sea due to Warming	1.30	1.30
Melting of Glaciers	0.65	0.74
Melting of Greenland Icecap	0.48	0.76
Melting of the Antarctic Ice Cap	0.25	0.42
Residual	0.37	0.28
<b>Total</b>	<b>3.05 mm/yr</b>	<b>3.50 mm/yr</b>

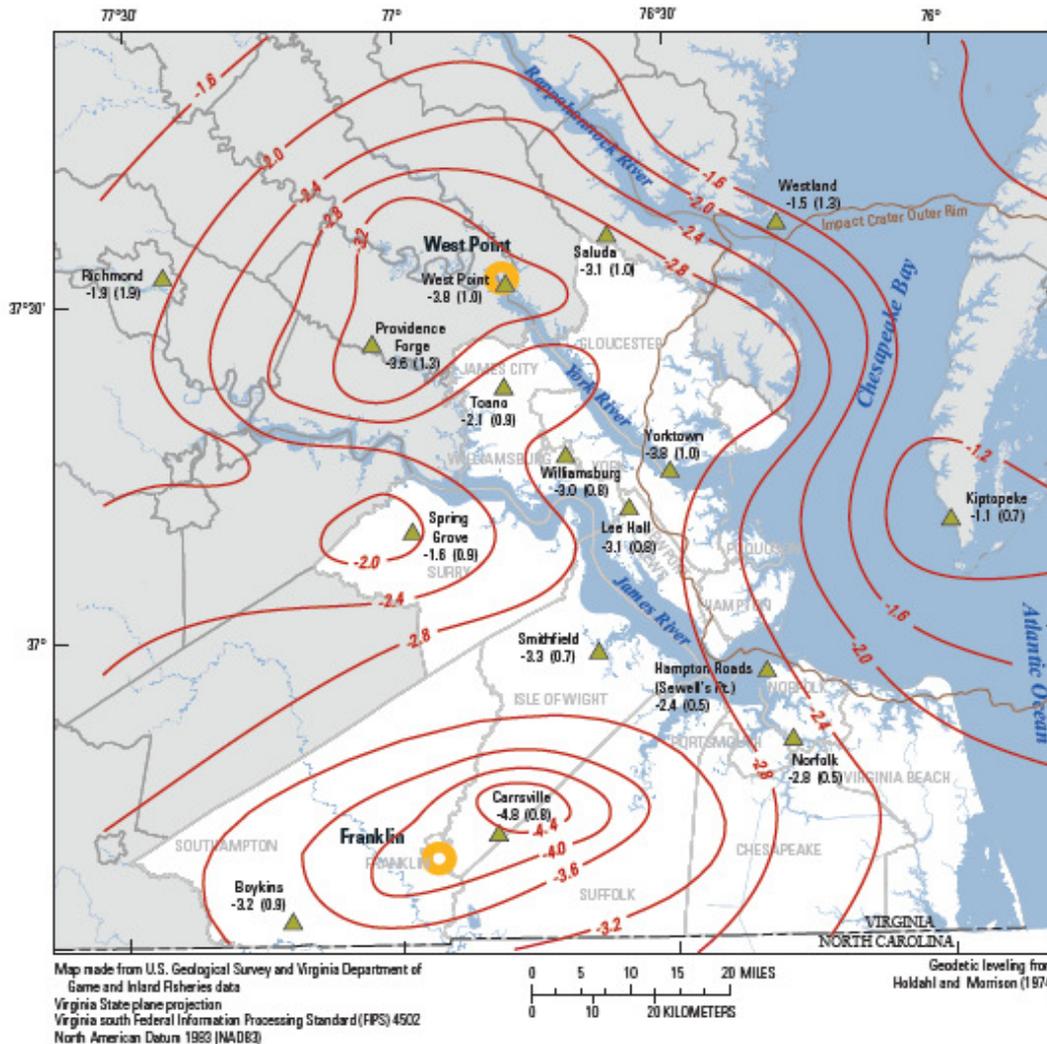
(\*From Table 1. Individual contributions to global mean sea-level rise in mm/yr., P.6, *Sea-level Rise: Projections for Maryland 2018*,)

PLUS: isostatic rebound due to the melting of the ice sheet in northern North America, causing the Mid-Atlantic to sink at about 1.3 mm/year over the last 2000 years\*\* –  
**so  $3.5 + 1.3 \text{ mm/yr} = \sim \underline{5 \text{ mm/year}} = \text{an inch every } 5 - 10 \text{ years!}$**

(\*\*From *Sea-level change and subsidence in the Delaware Estuary during the last ~2200 years*, Daria Nikitina, Andrew C.Kemp, Simon E.Engelhart, Benjamin P. Horton, David F. Hill, and Robert E. Kopp, in *Estuarine, Coastal and Shelf Science*, Volume 164, 5 October 2015, Pages 506-519)



# Land Subsidence in Lower Bay:



## EXPLANATION

- -3.2 — Line of equal land elevation change rate interpolated from leveling station measurements—Shown in millimeters per year. Interval is variable
- Groundwater withdrawal center
- ▲ Leveling station, and land elevation change rate in millimeters per year (standard deviation)  
 Boykins  
 -3.2 (0.9)

This map shows the effect of pumping on the aquifers in the Norfolk area, in millimeters per year from 1940 through 1971. Also note the gold line that indicates the perimeter of the large meteor crater that lies under much of the sediment.

From Figure 12 in *Land subsidence and relative sea-level rise in the southern Chesapeake Bay region*, by Eggleston, Jack, and Pope, Jason: U.S. Geological Survey Circular 1392, 30 p., 2013, available at <http://dx.doi.org/10.3133/cir1392>.



# Effects in Baltimore:

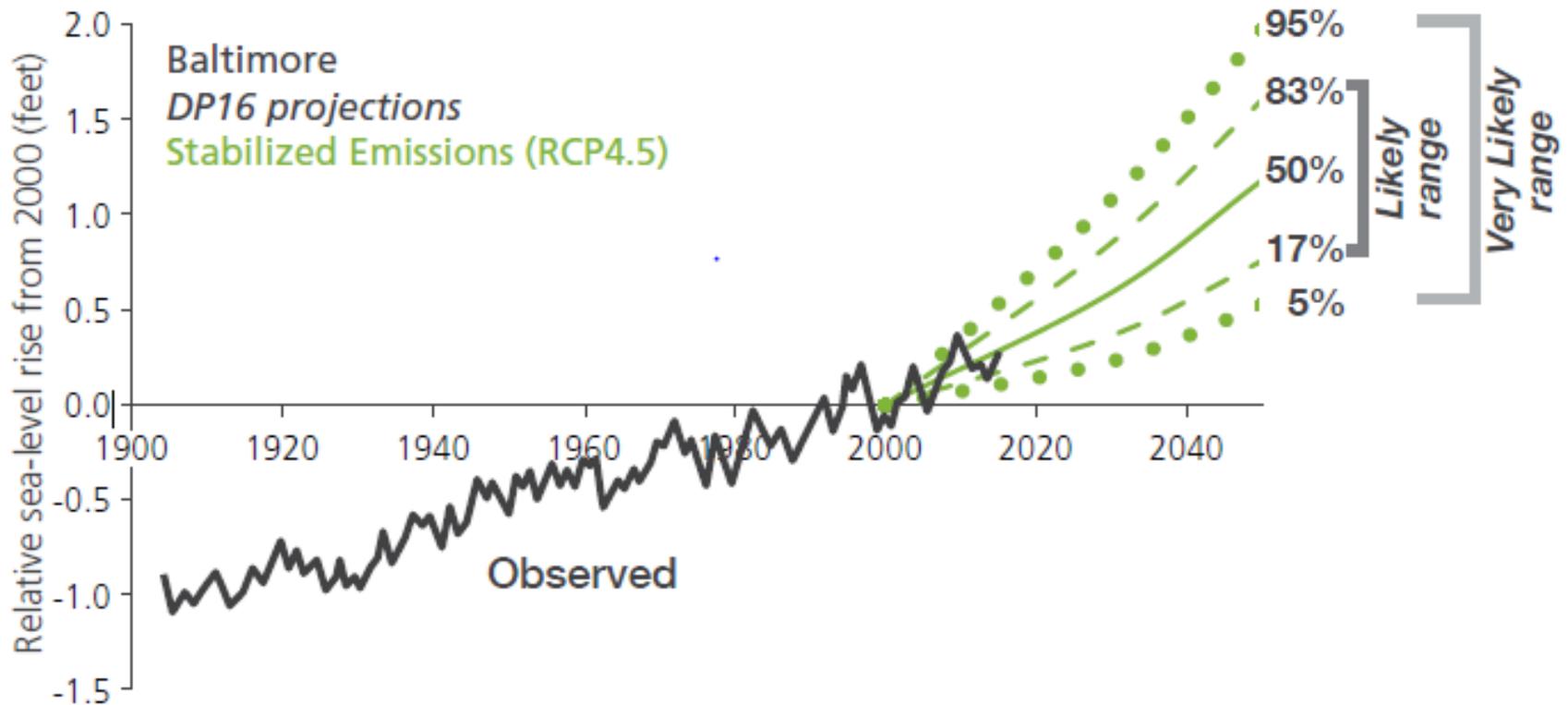


Figure 3. Observed relative sea-level rise at the Baltimore tide gauge and probabilistic projection of relative sea level rise through 2050.

From Sea-level Rise: Projections for Maryland 2018,  
Figure 3, P. 10.



# Solid Waste System Vulnerabilities

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**Solid waste facilities are vulnerable to climate-change-related impacts in at least these ways:**

- **Storms make getting around the landfill and covering trash etc. more difficult.**
- **Heavier rain events mean more maintenance of leachate, stormwater and sediment controls.**
- **Temporary flooding can make borrow pits or landfill cells inaccessible.**
- **Groundwater level increases can require cell redesign, raising cell floors and access roads.**
- **Ultimately a few facilities may have to be moved, e.g., the Ocean City or Transway Road transfer stations.**



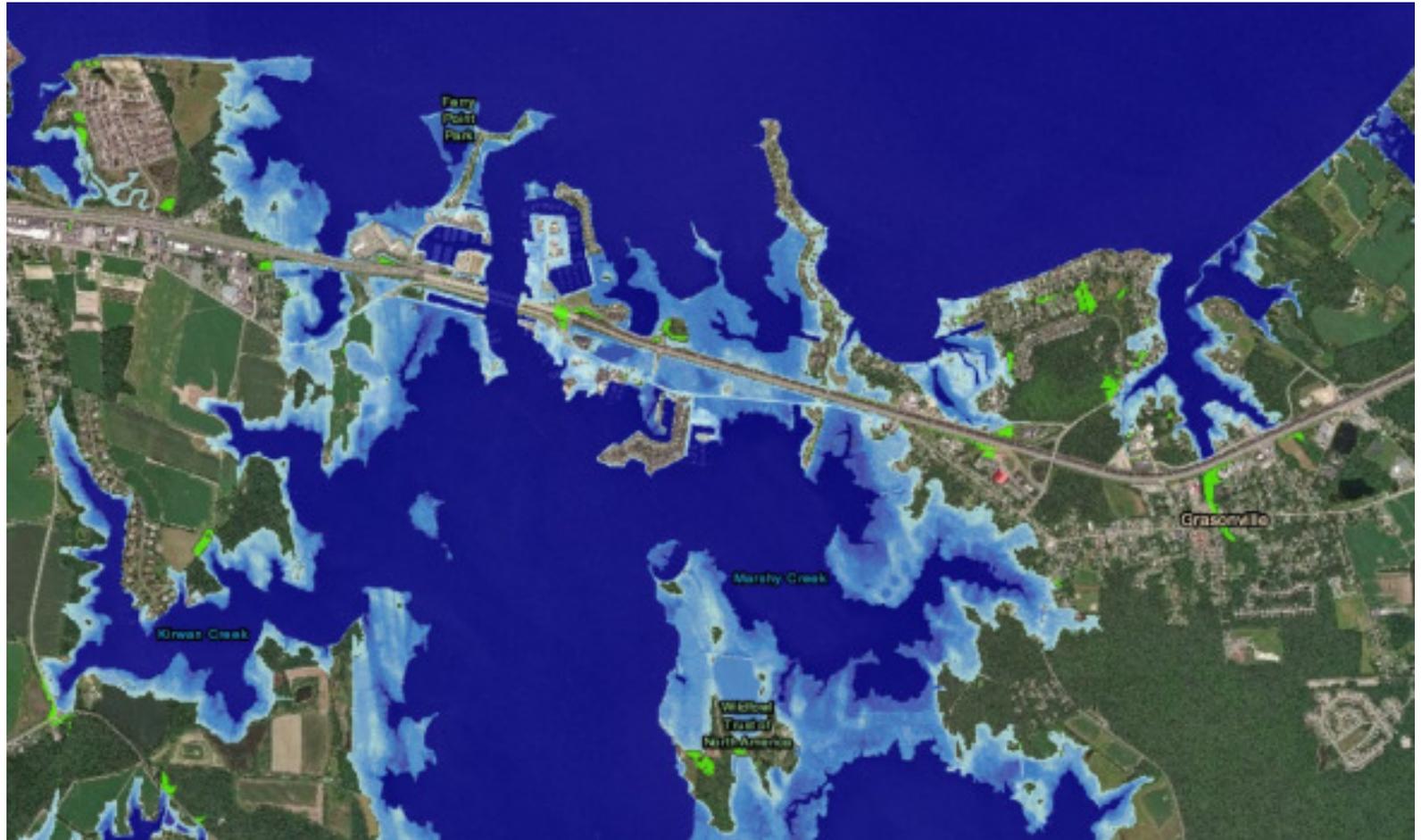
# Specific Sites at Risk

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- **Some older solid waste facilities in Maryland face inundation over the next few decades.**
- **The old, closed Dorchester County landfill at Golden Hill on the Honga River, and the Patuxent River NAS landfill, will be submerged, maybe others.**
- **Even where not inundated, flooding of roads may make access to facilities used now impractical or at least more expensive.**
- **For example, getting trash from Easton to the MES Midshore II landfill in Ridgely might require a new bridge or two over the Choptank.**
- **Dorchester's Beulah will be OK, but getting there will be harder.**
- **The Worcester Co Landfill will probably be OK.**
- **Somerset County's landfill near Westover will be problematic with a 3' rise – the area south and west will be flooded all the time, and the landfill will eventually become an island.**



# Solid Waste System Vulnerabilities II



From the NOAA Sea Level Rise Viewer at <https://coast.noaa.gov/slr/#/layer/slr/3/-8486756.619662217/4716882.181754704/14/satellite/none/0.8/2050/interHigh/midAccretion> , accessed 5/7/2019.



# Map of 1 Foot of Rise = ~2050?



From the NOAA Sea Level Rise Viewer



# Map of 3 Foot of Rise = ~2100?



From the NOAA Sea Level Rise Viewer



# Fells Point in the future:

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**Thames Street**



**Thames Street near the Baltimore Harbor in lower Fells Point today – when it's not flooded during a storm.**

**Thames Street**



**Thames Street with 3 feet of sea level rise.**

**Thames Street**



**Thames Street with 5 feet of sea level rise – a hundred years maybe.**

From the NOAA Sea Level Rise Viewer at <https://coast.noaa.gov/slr/#/layer/slr/5/-8528103.813249496/4763388.683966966/12/satellite/104/0.8/2050/interHigh/midAccretion>, accessed 5/7/2019



# So What is Maryland Doing?

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Maryland State Government is a firm believer in climate change science, and is taking steps to combat coming effects. You can learn more at:

- SHA Infrastructure vulnerability: Shows flooding potential model results relating to roads etc.  
<https://www.arcgis.com/home/item.html?id=86b5933d2d3e45ee8b9d8a5f03a7030c>
- SHA Climate Change Adaption Plan: What they hope to do -  
<https://www.adaptationclearinghouse.org/resources/maryland-state-highway-administration-climate-change-adaptation-plan-with-detailed-vulnerability-assessment.html>
- MD. Commission on Climate Change: Chaired by MDE Secretary, has lots of studies and other information:  
<https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Pages/index.aspx>



# What do we want YOU to do?

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For Maryland solid waste facilities, the Solid Waste Program recommends that you do the following:

1. Evaluate your own risks. There are models and reports etc., figure out how your area of operation and facilities will be affected.
2. Plan on weather events. Take pre-emptive actions to get ready for storms - keep the leachate tank levels down, make sure your sediment controls are well maintained, do covering ahead of time to the extent possible, protect your equipment from flying debris, train your staff for bad weather ops, etc.
3. Assess conditions. After an event, take a look around and address any damage before the next one hits. And do it before our inspector does - I tell them to go look ASAP too!
4. Ask for help. Several counties have mutual aid arrangements with surrounding jurisdictions, and MDE can give you relief, advice, and even legal help with FEMA.



# Sources:

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- **Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region**, by Eggleston, Jack, and Pope, Jason, 2013, Land subsidence and relative sea-level rise in the southern Chesapeake Bay region: U.S. Geological Survey Circular 1392, 30 p., 2013.  
<http://dx.doi.org/10.3133/cir1392>.
- **NOAA Sea Level Rise Viewer** at <https://coast.noaa.gov/slr/#/layer/slr/5/-8528103.813249496/4763388.683966966/12/satellite/104/0.8/2050/interHigh/midAccretion>.
- **Post-glacial isostatic rebound**: For basic information on isostatic rebound, start with Wikipedia at [https://en.wikipedia.org/wiki/Post-glacial\\_rebound](https://en.wikipedia.org/wiki/Post-glacial_rebound).
- **Sea-level Rise: Projections for Maryland 2018**, 27 pp., by D.F. Boesch, W.C. Boicourt, R.I. Cullather, T. Ezer, G.E. Galloway, Jr., Z.P. Johnson, K.H. Kilbourne, M.L. Kirwan, R.E. Kopp, S. Land, M. Li, W. Nardin, C.K. Sommerfield, and W.V. Sweet. 2018. University of Maryland Center for Environmental Science, Cambridge, MD, 2018. Available online at <https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/Sea-LevelRiseProjectionsMaryland2018.pdf>
- **Sea-level change and subsidence in the Delaware Estuary during the last ~2200 years**, by Daria Nikitina, Andrew C. Kemp, Simon E. Engelhart, Benjamin P. Horton, David F. Hill, and Robert E. Kopp, in Estuarine, Coastal and Shelf Science, Volume 164, 5 October 2015, Pages 506-519.

# Questions?

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