RISE
Resilience Innovations

2021 COASTAL COMMUNITY RESILIENCE CHALLENGE
FLOOD MANAGEMENT

FM 3: Rainbomb Flooding Reduction

The Rainbomb Flooding Reduction Problems

Many cities experience heavy localized rainfall induced ("rainbomb") flooding with increased intensity. These events generate a large amount of stormwater in a very short time leading to the stormwater systems being unable to transport the water. This leads to major flooding. When this occurs in urban environments it can significantly affect transportation, flood buildings and businesses, and can lead to loss of vehicles or life. The flooding often occurs at a very localized area, making an intersection impassable with other nearby roadways being unaffected.

The Pain Points in Current Solutions

Major infrastructure projects to mitigate or alleviate this situation: floodwalls, cisterns, ponds, large pump stations, take a long time and large amounts of funding to design and install, and are often not possible in an urban environment. These types of solutions are not considered in this Challenge.

The very flat topology of Hampton Roads does not provide the pressure head to generate flows in stormwater system, leading to the stormwater pipes having standing water and reducing their capacity to hold stormwater. Green infrastructure solutions such as roadside rain gardens and bioswales are quickly overwhelmed during rainbombs.

Solutions Being Sought

RISE is seeking solutions that take advantage of existing infrastructure to reduce the flooding effect that rainbombs have on major roadway intersections to a maximum of 3" of water roadway centerline depth on the street during a rain event.

Since this work must be installed and demonstrated by **May 2022**, solutions that require significant prior development or installation permitting and review may not be suitable. RISE is looking for implementable submissions not just designs.

Some examples of preferred approaches include:

- Installation of sensors and/or other equipment in/on existing infrastructure as long as it does not impede the operation of the infrastructure. If costs will be associated with installing and/or maintaining these sensors and/or equipment, they should be included in the proposal.

Also, it may be that the intersection(s) of interest are affected by infrastructure elements that are:

- Poorly installed
- Incorrectly sized
- Degraded
- Some other attribute(s) causing poor stormwater management

In these cases, RISE would accept equipment installation to mitigate these shortfalls. For example, if a segment of a pipe is seen to be undersized, it may make sense to add a pump to increase the mass flow through the undersized pipe.

It is likely that a series of mitigations may be needed, and they should work together in an integrated manner. Mitigations implemented to improve stormwater management should not result in another area being adversely affected.

The Location(s):

RISE will provide entrants with datasets on stormwater infrastructure, topography, and other model data upon request by the entrant. Entrants should use these data to develop their solutions and their estimated performance. If selected, RISE will work with the entrant and the City of Norfolk to get access to the intersection and surrounding infrastructure as needed.

The Level of Threat:

Instead of designing solutions to a particular rainfall event, RISE wants entrants to define, as part of their submission, the rainfall events that they believe their solution can maintain less than 3" depth of water in the intersection during an event. The rainfall events are defined by NOAA in the following table, also available here.[1]

NOAA Atlas 14, Volume 8, Version 2
Location name: Bronson, Kansas, USA*
Latitude: 38°, Longitude: -95°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF tabular | PF graphical | Maps & aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.415 (0.326-0.522)	0.481 (0.378-0.606)	0.589 (0.462-0.743)	0.679 (0.529-0.858)	0.801 (0.605-1.03)	0.895 (0.663-1.17)	0.989 (0.710-1.31)	1.08 (0.751-1.46)	1.21 (0.809-1.66)	1.30 (0.853-1.81)
10-min	0.608 (0.478-0.765)	0.705 (0.554-0.887)	0.863 (0.676-1.09)	0.994 (0.774-1.26)	1.17 (0.886-1.51)	1.31 (0.970-1.71)	1.45 (1.04-1.92)	1.59 (1.10-2.14)	1.77 (1.18-2.43)	1.91 (1.25-2.65)
15-min	0.741 (0.583-0.933)	0.859 (0.675-1.08)	1.05 (0.824-1.33)	1.21 (0.944-1.53)	1.43 (1.08-1.85)	1.60 (1.18-2.08)	1.77 (1.27-2.34)	1.94 (1.34-2.61)	2.16 (1.44-2.96)	2.33 (1.52-3.23)
30-min	1.08 (0.846-1.35)	1.25 (0.983-1.58)	1.54 (1.20-1.94)	1.77 (1.38-2.24)	2.10 (1.58-2.71)	2.35 (1.74-3.06)	2.60 (1.87-3.44)	2.85 (1.97-3.84)	3.19 (2.13-4.38)	3.44 (2.25-4.78)
60-min	1.42 (1.12-1.79)	1.66 (1.31-2.09)	2.05 (1.61-2.59)	2.38 (1.85-3.01)	2.83 (2.14-3.66)	3.19 (2.36-4.16)	3.54 (2.55-4.70)	3.91 (2.71-5.27)	4.39 (2.94-6.04)	4.76 (3.12-6.62)
2-hr	1.77 (1.41-2.20)	2.07 (1.65-2.58)	2.57 (2.04-3.20)	2.99 (2.36-3.73)	3.57 (2.73-4.57)	4.03 (3.02-5.20)	4.49 (3.27-5.89)	4.96 (3.48-6.64)	5.60 (3.79-7.63)	6.09 (4.03-8.39)
3-hr	1.99 (1.59-2.45)	2.33 (1.87-2.88)	2.90 (2.32-3.59)	3.38 (2.69-4.20)	4.07 (3.14-5.18)	4.61 (3.48-5.92)	5.16 (3.78-6.74)	5.73 (4.04-7.62)	6.49 (4.43-8.82)	7.09 (4.72-9.72)
6-hr	2.36 (1.92-2.88)	2.77 (2.25-3.38)	3.47 (2.80-4.24)	4.07 (3.27-4.99)	4.93 (3.87-6.23)	5.63 (4.31-7.17)	6.35 (4.72-8.23)	7.10 (5.08-9.38)	8.14 (5.62-11.0)	8.95 (6.03-12.2)
12-hr	2.75 (2.26-3.31)	3.22 (2.64-3.88)	4.03 (3.30-4.87)	4.75 (3.87-5.76)	5.80 (4.61-7.27)	6.66 (5.18-8.41)	7.57 (5.70-9.73)	8.53 (6.19-11.2)	9.87 (6.91-13.2)	10.9 (7.46-14.7)
24-hr	3.19 (2.65-3.79)	3.70 (3.08-4.41)	4.61 (3.82-5.50)	5.43 (4.48-6.50)	6.65 (5.37-8.27)	7.67 (6.04-9.60)	8.75 (6.68-11.2)	9.91 (7.29-12.9)	11.6 (8.20-15.3)	12.9 (8.88-17.2)
2-day	3.70 (3.12-4.35)	4.27 (3.60-5.03)	5.29 (4.45-6.24)	6.21 (5.19-7.35)	7.60 (6.23-9.35)	8.77 (7.01-10.9)	10.0 (7.75-12.6)	11.4 (8.47-14.7)	13.3 (9.54-17.5)	14.8 (10.3-19.6)
3-day	4.03 (3.42-4.70)	4.68 (3.97-5.46)	5.83 (4.93-6.82)	6.86 (5.78-8.06)	8.40 (6.92-10.3)	9.68 (7.79-11.9)	11.0 (8.61-13.9)	12.5 (9.39-16.0)	14.6 (10.5-19.1)	16.2 (11.4-21.4)
4-day	4.31 (3.68-5.00)	5.02 (4.28-5.83)	6.26 (5.33-7.29)	7.37 (6.25-8.62)	9.02 (7.47-10.9)	10.4 (8.39-12.7)	11.8 (9.25-14.7)	13.4 (10.1-17.0)	15.5 (11.3-20.2)	17.3 (12.2-22.6)
7-day	5.08 (4.39-5.84)	5.88 (5.07-6.76)	7.25 (6.24-8.36)	8.47 (7.25-9.79)	10.3 (8.56-12.3)	11.7 (9.55-14.2)	13.2 (10.5-16.3)	14.9 (11.3-18.8)	17.2 (12.6-22.2)	19.0 (13.5-24.7)
10-day	5.81 (5.05-6.63)	6.66 (5.79-7.61)	8.12 (7.04-9.30)	9.40 (8.10-10.8)	11.3 (9.45-13.4)	12.8 (10.5-15.3)	14.3 (11.4-17.6)	16.0 (12.2-20.0)	18.3 (13.5-23.5)	20.1 (14.4-26.0)
20-day	7.91 (6.98-8.91)	8.98 (7.91-10.1)	10.7 (9.44-12.1)	12.2 (10.7-13.9)	14.3 (12.1-16.7)	15.9 (13.2-18.8)	17.6 (14.1-21.2)	19.2 (14.9-23.8)	21.5 (16.0-27.2)	23.2 (16.9-29.8)
30-day	9.63 (8.56-10.8)	10.9 (9.69-12.2)	13.0 (11.5-14.5)	14.7 (12.9-16.5)	17.0 (14.5-19.6)	18.7 (15.6-21.9)	20.4 (16.5-24.4)	22.2 (17.2-27.1)	24.4 (18.3-30.6)	26.1 (19.1-33.3)
45-day	11.7 (10.5-13.0)	13.3 (11.9-14.8)	15.8 (14.1-17.6)	17.8 (15.8-19.9)	20.4 (17.5-23.3)	22.4 (18.8-25.9)	24.3 (19.8-28.7)	26.1 (20.4-31.7)	28.4 (21.5-35.4)	30.1 (22.2-38.2)
60-day	13.5 (12.2-14.9)	15.3 (13.8-16.9)	18.2 (16.3-20.1)	20.5 (18.3-22.8)	23.5 (20.2-26.6)	25.6 (21.6-29.5)	27.7 (22.6-32.5)	29.6 (23.3-35.8)	32.1 (24.3-39.7)	33.8 (25.1-42.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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Entrants should define the range of events for which their solutions will meet the criteria.

Datasets Available Upon Request

- Stormwater infrastructure maps
- Elevation maps
- SWMM models for the location

Please email all questions to KaterinaOskarsson@riseresilience.org

[1] https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html