Flood Management

Problem

Flooding is becoming more frequent and more severe throughout the Hampton Roads area and other coastal communities, resulting in asset damage and financial losses. Flooding affects residents (e.g., homes, vehicles, disruption to daily lives), businesses (e.g., loss in economic productivity), utilities, and governments alike (e.g., critical infrastructure).

The watershed management problem combines many of the following:

- Tidal flooding overtopping seawalls
- Tidal flooding tailwater in stormwater pipes producing flooding inland
- Aging and undersized stormwater infrastructure limiting effective drainage
- High water table/groundwater limiting ability to store water underground
- Large, paved areas (e.g., parking lots) increasing runoff and localized flooding
- Urban environment limiting access to existing infrastructure or new infrastructure installation

What We've Heard

Coastal communities seek innovative solutions for management of ground-storm-and/or tidal water, either as affordable short-term mitigations, or low-maintenance, longer-term options in a variety of environments with high water tables.

Below are priority areas identified by stakeholders in Hampton Roads and other coastal communities. Submissions do not need to be limited to these areas. However, to be eligible for funding from RISE, entrants **must focus on a Hampton Roads need**, while demonstrating the scalability to other communities.

- Tidal backflow prevention (see more details below).
- Rainbomb flooding reduction (see more details below).
- City hardscape adaptation (see more details below).
- Innovative solutions for wetland and floodplain restoration, living shorelines and vegetated buffers, stream bank restoration or stabilization, or any other nature-based approaches.
- Replacement of existing residential bulkheads with nature-based solutions.
- Improved stormwater management in dense urban environments with low operations and maintenance costs.
- Active watershed management and control for existing infrastructure optimization.
- "Rainbomb" detection, warning and applications.

Specific pain points associated with tidal backflow prevention, rainbomb flooding reduction, and city hardscape adaptation are detailed below.

RISE

1) Tidal Backflow Prevention

The Problem(s)

During high tide events, tidal water can flow into the stormwater system and out of drains, leading to significant "blue sky" flooding on roadways and intersections. Tidal valves (check valves) are placed in the stormwater system to prevent this backflow.

Coastal communities typically have many tidal outfalls requiring multiple valve installations. Installation, operation and maintenance costs can be significant to the city.

Many cities are looking for an affordable, effective, turn-key installation and operation at these outfalls that will prevent backflow into the stormwater system.

For instance, the City of Norfolk alone has hundreds of tidal outfalls. The City is very interested in sourcing a more effective and efficient solution to its backflow prevention problem and is willing to provide teams access to outfalls to demonstrate their solutions. This problem is expanded further in the seven other municipalities in the Hampton Roads region and beyond.

The Pain Points in Current Solutions

There are a variety of backflow prevention systems available. Typically, cities have installed different check valves and tested them for:

- Ease of installation
- Functionality of flood reduction
- Ease of maintenance

Of course, one of the biggest discriminators are the associated costs, which fall into three components:

Installation:	Procurement:	O&M:
• Difficulty and errors in installation lead to loss of function or blockage • Pipe infrastructure around the valve is in poor condition, requiring repairs and making it harder and more expensive to install • Valves sometimes do not fit well in the pipes • High labor costs	• Procurement of the check valve and associated materials	• Keeping the valve clear of debris, biological growth, and ensuring proper operation • In general, cities want to keep labor costs as low as possible, so automation or contractor labor (if more economical) is preferable to in-house Operations and Maintenance

RISE

For the purposes of our Challenge, we will use the following costs as a baseline relative to which improvements will be gauged. The costs include costs of purchasing an existing technology, installing it, and maintaining it. In effect, the total cost to install a tidal valve costing around $5,000 (e.g., Tideflex) can be over $50,000 per outfall. Breakdown of the costs is available from RISE upon request.

Solutions Being Sought

Due to cities' desire to reduce labor costs, RISE seeks solutions with end-to-end installation (check valves, liners, plus any other materials required for a working installation). The vendor providing the solution will take care of complete installation and maintenance (as opposed to procuring the valve and other materials from a vendor, then using another contractor to install it and using in-house city staff to maintain it).

RISE can only fund small businesses (including small business-led teams) to perform these pilot programs. Larger companies may be involved but can only be used as contractors to the small business prime. RISE is seeking an installed and maintained project(s) to assess the affordability and functionality of the installation over a period of several months. RISE would provide pilot sites for the installation in Norfolk, Virginia. Performance assessment is based on (relative to the baseline):

- Cost of install
- Functionality of flood reduction
- Ease and cost of maintenance

The evaluation period will last until June 2023.

Dates subject to change at RISE discretion.

Datasets Available Upon Request

- Tidal outfall maps for Norfolk
- Cost estimates for tidal valve installation, and O&M.

Please email all questions to info@riseresilience.org

2) Rainbomb Flooding Reduction

The Problem(s)

Many cities experience heavy localized rainfall-induced ("rainbomb") flooding with increased intensity. These events generate large amounts of water in a short amount of time, overwhelming stormwater systems and leading to major flooding. When this occurs in urban environments it can significantly affect transportation, flood buildings and businesses, and lead to loss of vehicles or life. The flooding is often localized, making one intersection impassable while other nearby roadways remain unaffected.

RISE

The Pain Points in Current Solutions

Major infrastructure projects to mitigate or alleviate this situation, such as floodwalls, cisterns, ponds and 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 the stormwater system, leading to 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 **June 2023**, 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 if 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 table below, which is also linked here.

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION - NOAA Atlas 14, Volume 8, Version 2

PDS-based 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.

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 info@riseresilience.org

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

3) City Hardscape Adaptation

The Problems

Impervious surfaces (roads, parking lots, sidewalks, etc.) constitute the majority of surfaces in many cities. Because of the prevalence of these impervious surfaces, stormwater systems can be overloaded quickly during heavy rainfalls (e.g., "rainbombs") and will back up onto the streets leading to significant flooding, impassable roads, traffic congestion, and loss of property and lives in extreme cases.

Many mitigations of this problem have been developed, proposed, and implemented in cities around the world including rain gardens, daylighting creeks, etc. However, these mitigations can take a long time and large amounts of funding to design, permit, and implement. They may be the preferred solution long-term but with climate change resulting in more intense storms, many cities need shorter-term solutions quickly.

The Pain Points in Current Solutions

1. Stormwater departments in cities are very attuned to the vulnerable areas that have deficient stormwater infrastructure or contribute most to localized flooding in rainfall events. Some departments do not have the resources and would benefit from an analysis of the infrastructure, its weak points, as well as identification and quantification of "high-payoff" areas suited for adaptation.
2. Once the "high-payoff" areas have been identified and quantified, the solution itself (e.g., excavation, demolition, etc.), may be expensive, time-consuming, disruptive, and require lengthy permitting and review processes.
3. The question always arises as to who will pay for this work. Municipalities often rely on government grants and other financing sources to pay for the implementation and upkeep of the solutions. This is time-consuming and expensive to apply for, receive, and manage, and is also unsustainable in the long-term.

RISE

Solutions Being Sought

RISE seeks solutions to this problem that address all three "pain-points," for example:

1. Stormwater problem area analysis, identification, and quantification
2. Solutions to mitigate the area that will be installed and working within **one year of city go-ahead** from 1 above
3. Financing of the implementation (including recurring O&M costs), without using government grants or bonds

RISE is seeking solutions that will provide **measurable benefits** to a region of a city. Given the short time and limited funding of the program, the demonstration area under consideration will be very localized and is not expected to fix the needs of an entire city.

RISE seeks total solutions comprising all three elements above. Companies may apply already in teams or may form (and amend) teams during the pilot process if selected. Each of the three elements above will be viewed by RISE as a separate Challenge from the funding perspective. For example, if one analysis company is selected, they may receive up to $300,000, and if they are teamed with a finance company they may, together, receive up to $600,000.

RISE can only fund small businesses (including small business-led teams) to perform these pilot programs. Larger companies may be involved but can only be used as contractors to the small business prime. Selection and funding of companies, and groups of companies is at RISE's sole discretion.

The evaluation period will last until June 2023.

Dates subject to change at RISE discretion.

Datasets Available Upon Request

- Elevation and flooding maps for City of Norfolk

Please email all questions to info@riseresilience.org