

# FROM ROCKET TESTING TO WILDERNESS

## Investigating Water Management Strategies and Impacts at Santa Susana

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<http://rocketoutfall.github.io>



### SANTA SUSANA'S GROUNDWATER

Boeing's 2,850-acre site, the Santa Susana Field Laboratory (SSFL), lies in the arid hills of Simi Valley. The site was a testing campus for space and energy technologies from 1947 to 2006. During early operations trichloroethylene (TCE, an industrial solvent) contaminated the groundwater. Boeing plans to pump & treat the groundwater, then release the clean water to a dry stream on-site.



The California Department of Fish and Wildlife will not issue a necessary permit until Boeing looks into two things: How the plants along the stream could respond to this new flow, and if the introduced water could favor the growth of invasive plants.

SSFL is one of few undeveloped areas connecting habitat in the region. Degradation in this area could have far-reaching effects. The results of this project help Boeing prevent exposure to TCE while maintaining the quality of this habitat link.

## PROJECT OBJECTIVES



Define the extent of the discharged water's impact on the property.



Assess the potential for growth of invasive species along the stream.



Develop management strategies to reduce growth of invasive species.

### KEY MANAGEMENT STRATEGIES



#### SUPPLEMENT VEGETATION COMMUNITY

To increase resistance to invasive species, Boeing could supplement shallow-rooted native plants and species that quickly establish canopy cover. This would be especially effective within the first 400 feet of the discharge location, where invasive grasses currently grow.



#### QUICK RESPONSE TO NON-NATIVE SPECIES

Monitor existing invasive grasses for growth, and watch for the invasion of new non-native species. Boeing could proactively remove invasive plants from the first 400 feet of proposed discharge location and replace them with native plants as noted above.



#### RELEASE WATER ON A SCHEDULE

Water could be released into the stream only from November to March. Cycling between discharge locations or methods would avoid shutting down the groundwater treatment system, while using the drought tolerant traits of native plants to their advantage.

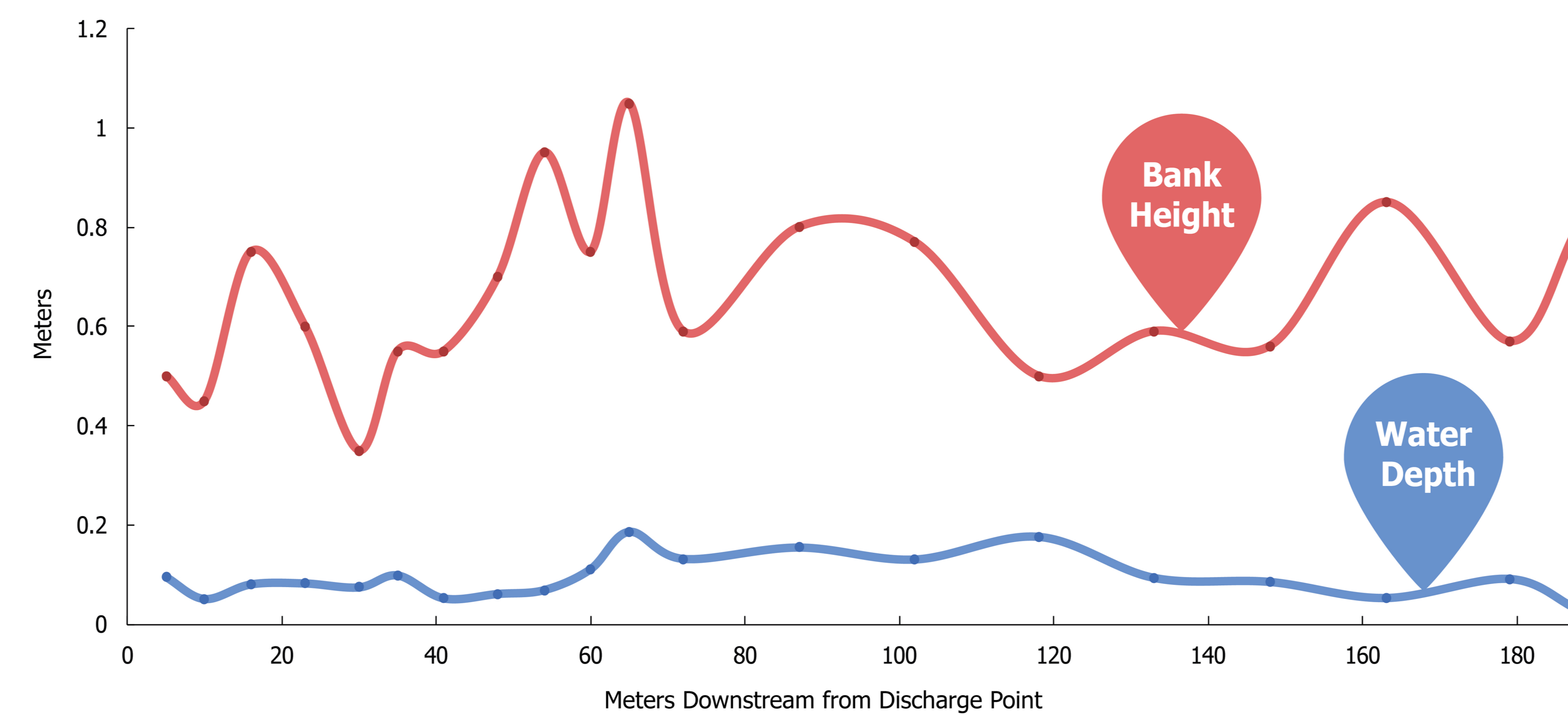
### Acknowledgements & References:

We would like to thank the SSFL staff, Colleen Devlin (UCSB), Dr. James Frew (UCSB), Juan Carlos Villaseñor Derbez, Zach Burke, the staff at NCEAS, and everyone else who took time to assist us. References Cited: (1) Goldstein, L.J. and Suding, K.N. 2014. Applying competition theory to invasion: resource impacts indicate invasion mechanisms in California shrublands. *Biol Invasions* 16(1), pp. 191-203. (2) Brooks, M.L., Brown, C.S., Chambers, J.C., D'Antonio, C.M., Keeley, J.E. and Belnap, J. 2016. Exotic Annual Bromus Invasions: Comparisons Among Species and Ecoregions in the Western United States. In: Gemini, M. J., Chambers, J. C., and Brown, C. S. eds. *Exotic Brome-Grasses in Arid and Semiarid Ecosystems of the Western US*. Cham: Springer International Publishing, pp. 11-60. (3) Eskelinen, A. and Harrison, S. 2014. Exotic plant invasions under enhanced rainfall are constrained by soil nutrients and competition. *Ecology* 95(3), pp. 682-692. (4) Heat map analyses use data from Dunn, Chris. (2016). *Biological Assessment Report 2016*. Padre Associates, Inc.

## 1 WATER AVAILABILITY CHANGES VEGETATION DISTRIBUTION

### HOW WILL THE DISCHARGED WATER BEHAVE IN THE STREAM?

The proposed flow is 60 gallons per minute – enough water to fill a bathtub in under a minute. The physical shape of the dry stream was surveyed at 20 points in order to calculate the depth of the water.



The water depth will vary along the length of the stream but never exceed the capacity of the stream's banks.



Most water will flow downhill beyond Boeing's property boundary. Evaporation and seepage into the ground are negligible.

### HOW WILL WATER ALTER THE VEGETATION DISTRIBUTION?



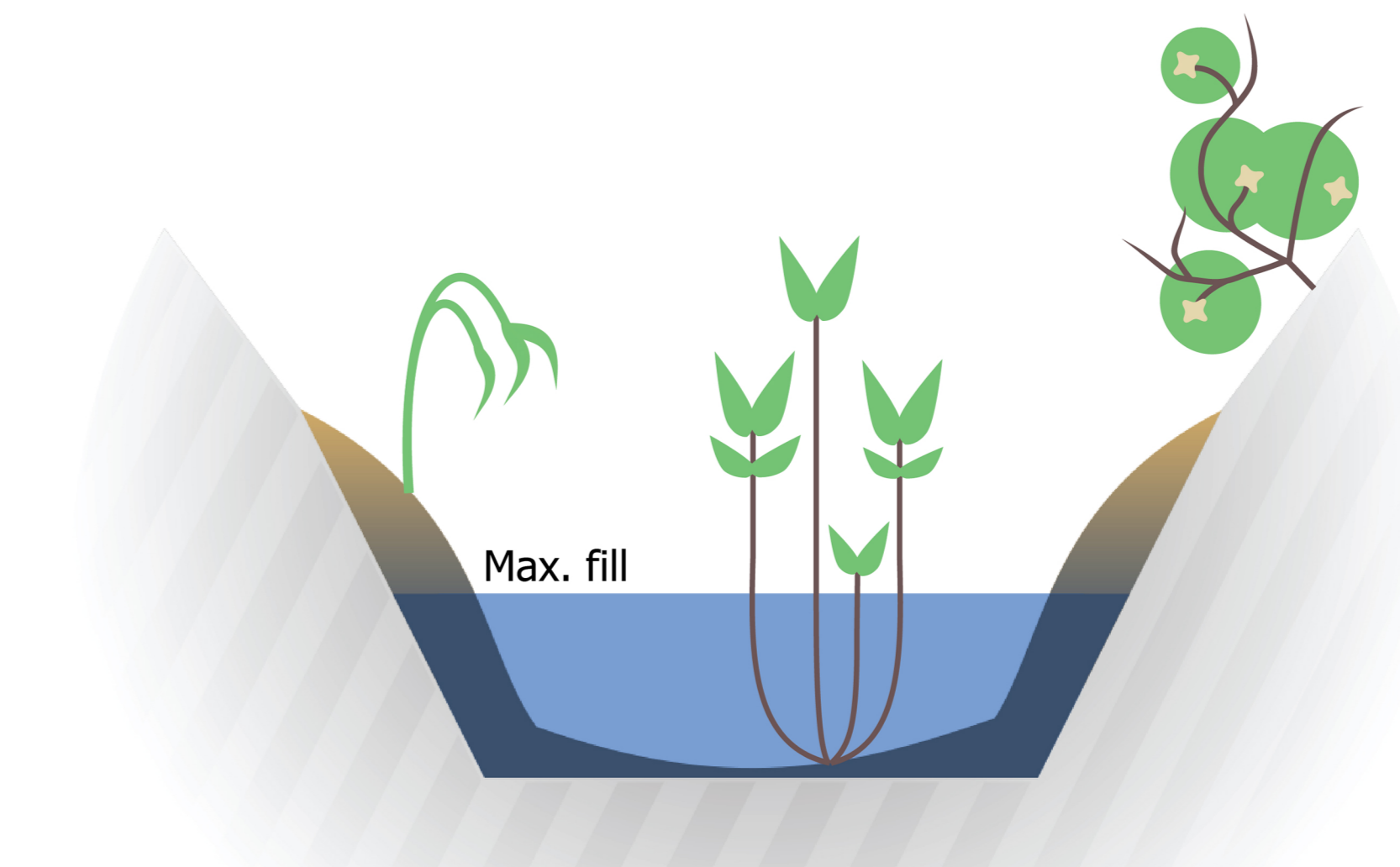
Currently, drought-tolerant species with low water requirements dominate even the bed of the stream. This makes sense, since water is usually scarce.



Downstream 600 ft, a natural wet zone supports plants that typically occur only in wetlands. White stripes indicate wetland plants on the map to the right.

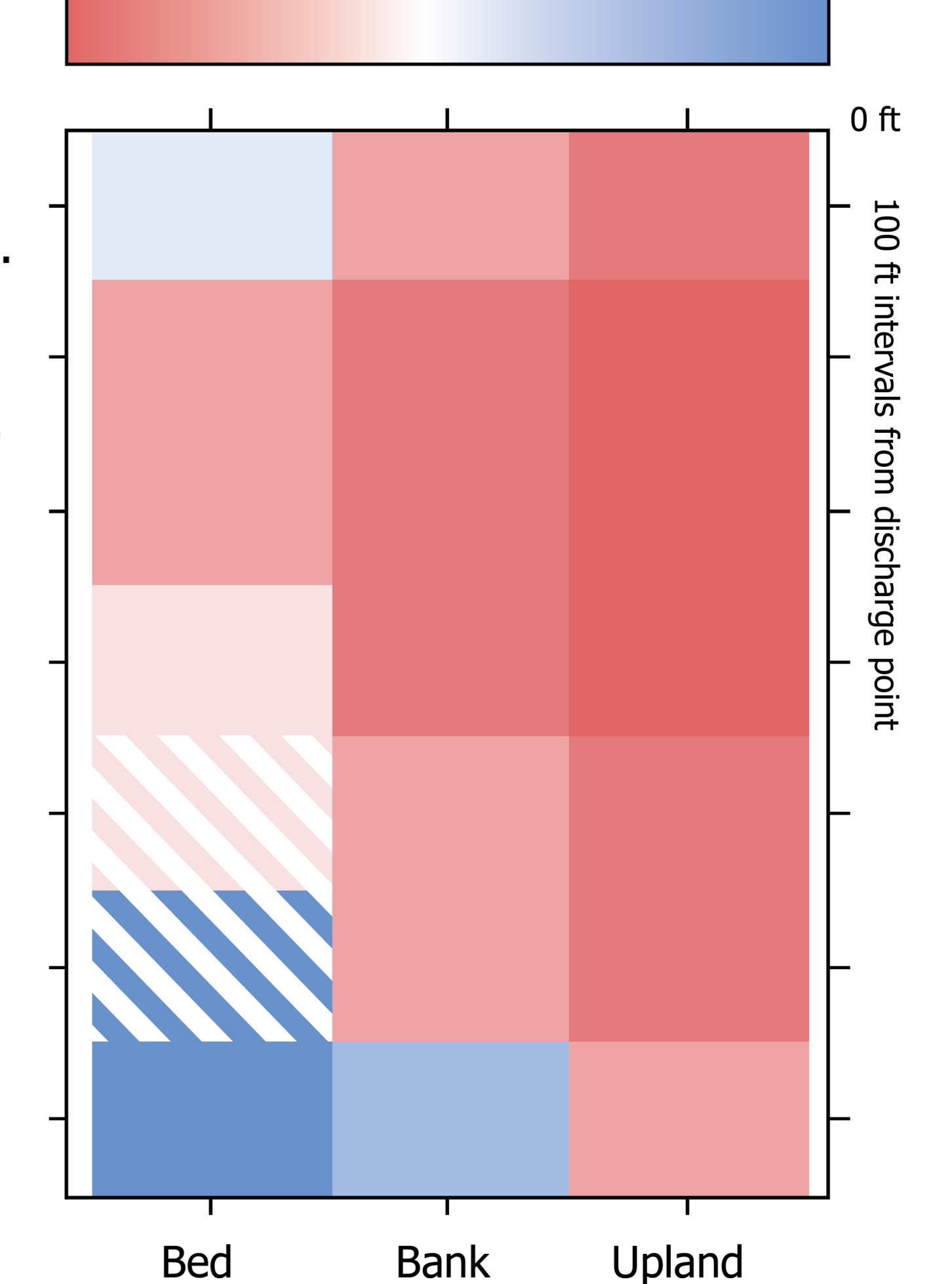


The introduction of a continuous water flow will permanently provide water to plants along the stream. This would result in a more uniform distribution of water-loving plants in the stream bed and banks.



Results of Species Distribution Analysis

Drought-tolerant Dominant -- Water-Loving Dominant



## 2 RESISTANCE TO INVASION

### WILL WATER FAVOR INVASIVE SPECIES?

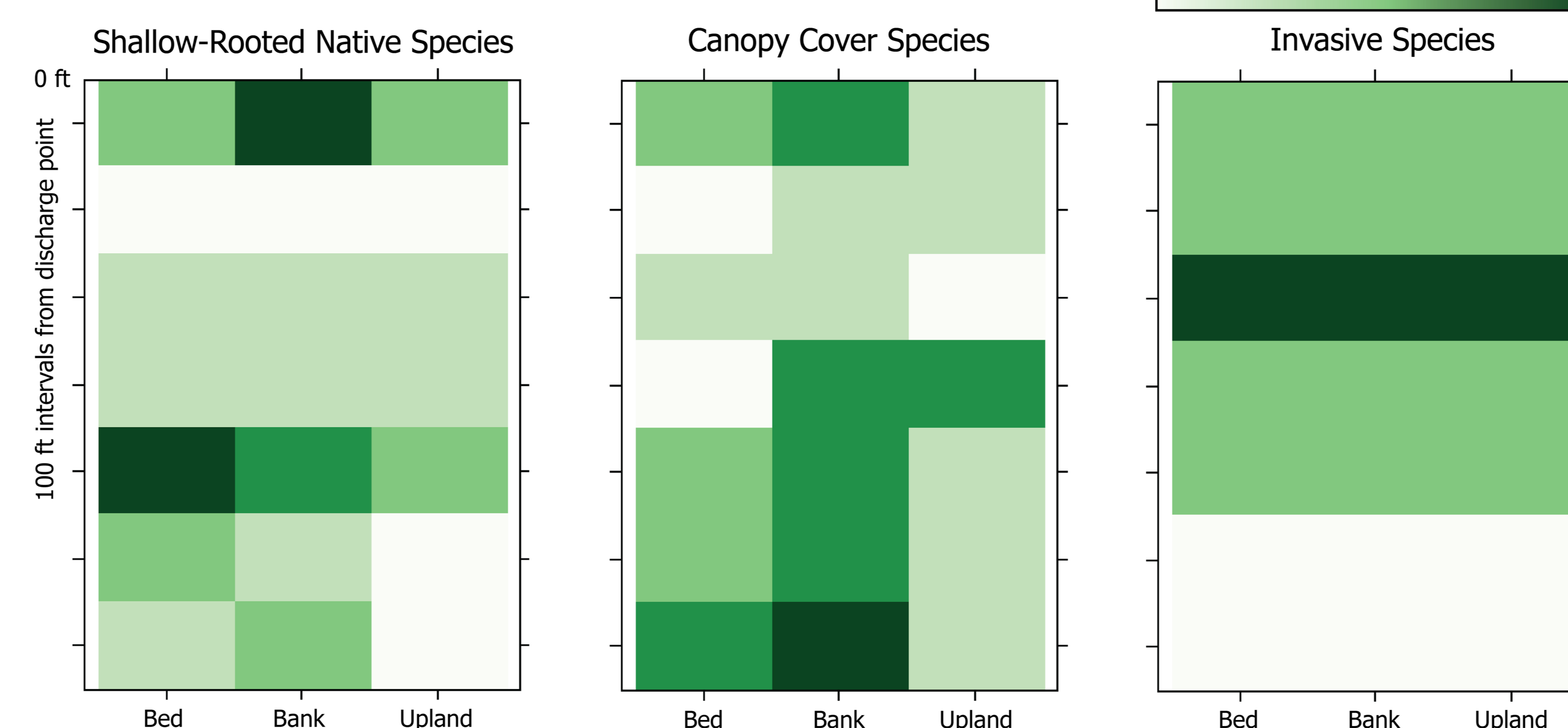


Added water has larger effects when combined with high concentrations of nutrients and disturbances to the ecosystem.<sup>1</sup> Boeing's discharge permits will put a strict limit on nutrient concentrations of the discharged water.

### DOES VULNERABILITY VARY ALONG THE STREAM?



This dry ecosystem resists invasion via canopy cover<sup>2</sup> & species diversity. These qualities decrease both soil water available to invasive grasses and sunlight. The current species distribution in the stream seems to reflect this relationship, as seen in the maps of the stream below.



## 3 CREATIVE FLOW SCHEDULING

Aquifer Reinjection  
Stream Discharge  
Sewer System  
Nearby Wetland Rehabilitation  
Water Markets

Legal Hurdles					
Infrastructure					
Maintenance					

Legend: Favorable (Blue), Unfavorable (Red), Unknown (Grey)

### CAN BOEING AVOID CONTINUOUS WATER DISCHARGE?



Watering less often allows the shallow soil layer, where invasive grasses colonize, to dry out. Under these conditions, native drought-tolerant species survive better and can compete better with invasive plants.<sup>1</sup>



Invasive plants can use unseasonal water more effectively than native plants.<sup>3</sup> Discharging water into the arid stream only during the rainy season (November to March) will limit this advantage of invasive species.



If Boeing needs to treat groundwater during a dry period, an alternative place to release treated water is not clear. Reinjecting the clean water to the aquifer has also been met with permitting issues. Options that transport treated water off the property would open Boeing to litigation over poorly defined groundwater rights. Alternating discharge between two streams may be feasible.