The influence of LANDSCAPE FACTORS on transportation systems

prepared by Iowa State University

Overview

This presentation explores the relationship between the landscape and built systems in your community. Specifically, we will examine:

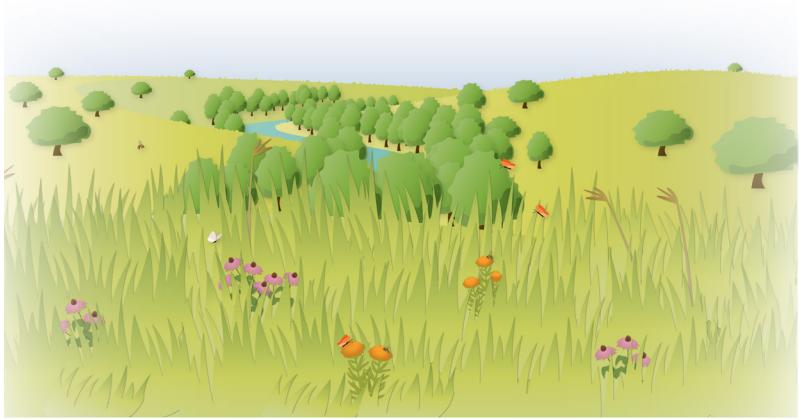
- The development of transportation systems and community land use over time
- How surface water and topography affect where communities and transportation systems develop
- The impact of groundwater (when present) on transportation and land use
- Benefits of trees and other vegetation and how trees in towns fit with transportation networks, main streets, and neighborhoods

Modern-day Stuart was originally settled in 1850 as a small Quaker community called Summit Grove. Situated in Central Iowa within the Des Moines Lobe ecoregion, the site was chosen for its high elevation where timber and prairie met. The community was eventually named after Charles Stuart, who played a role in bring the railroad to town.

Stuart straddles county line of Guthrie and Adair Counties at the intersection of two Iowa Scenic Byways—White Pole Road runs east-west through town and Western Skies enters town from the north and terminates there. In the 1960s, Interstate 80 was built across Iowa just south of Stuart, spurring additional growth.

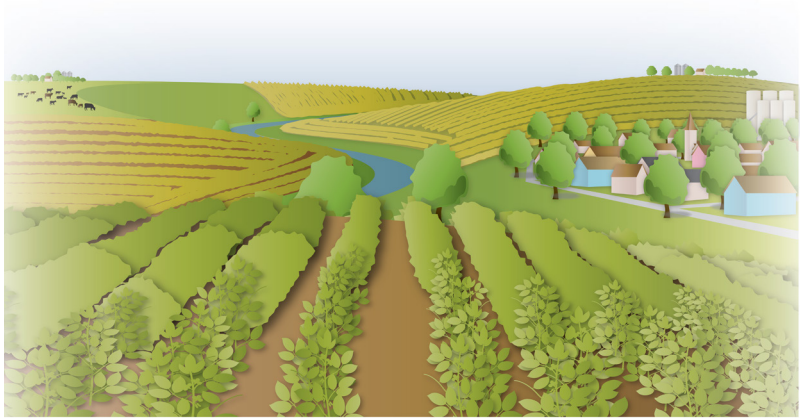
Stuart has restored several of its historic buildings, including the historic clock tower, train station, cultural center, and Hotel Stuart. The population of Stuart today is approximately 1,800 people.

Land Cover Changes Over Time



Historical Landscape

The historical landscape of Iowa was dominated by prairie and savannas. Tree canopy was typically found in valleys along river corridors adjacent to scattered savannas, because the fires that maintained the prairies could not spread as easily in those places. Native plants such as switchgrass, little bluestem, coneflower, and milkweed are some of the more recognizable plants found in the diverse prairie landscape.



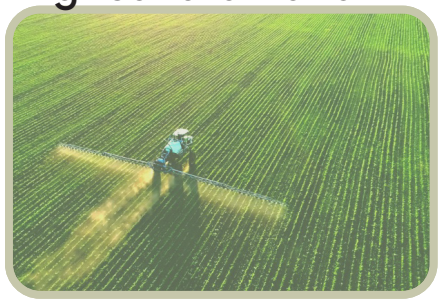
19th Century Landscape

The once-dominant prairie has been replaced by agricultural fields, pasture lands, and small towns in the post-settlement Iowa landscape. Fire suppression and development have allowed for greater growth of wooded areas among the rural landscape and in town. At the same time, many wooded river corridors have narrowed to make more room for cropland.

Current Land Cover

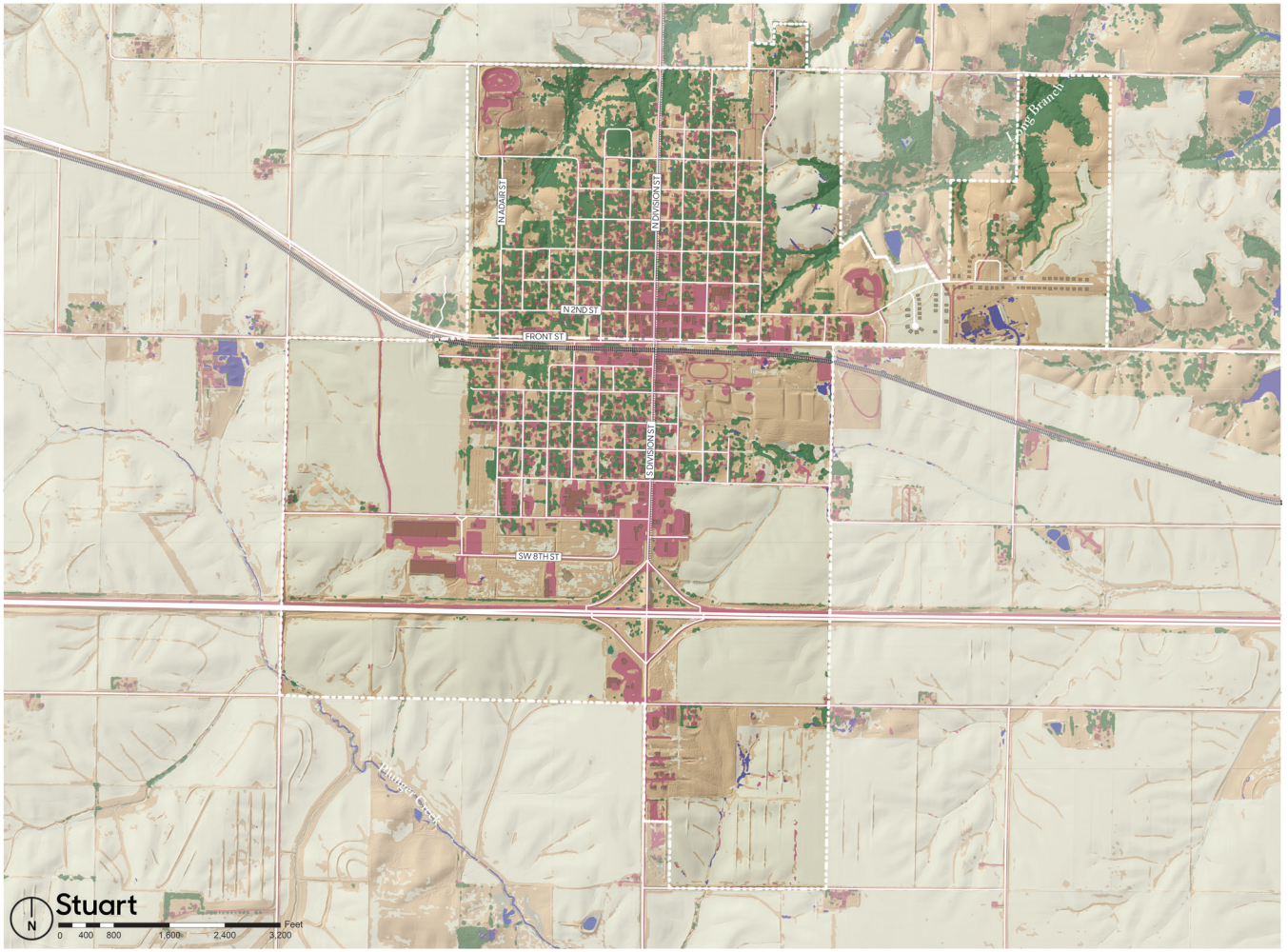
Impervious Surfaces

Agricultural Land



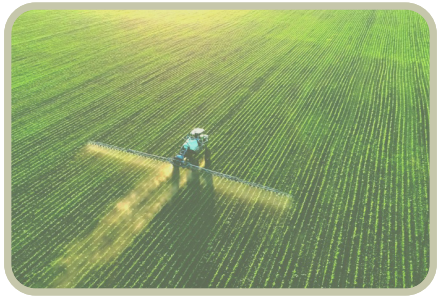
Grassland/Lawn

Tree Canopy



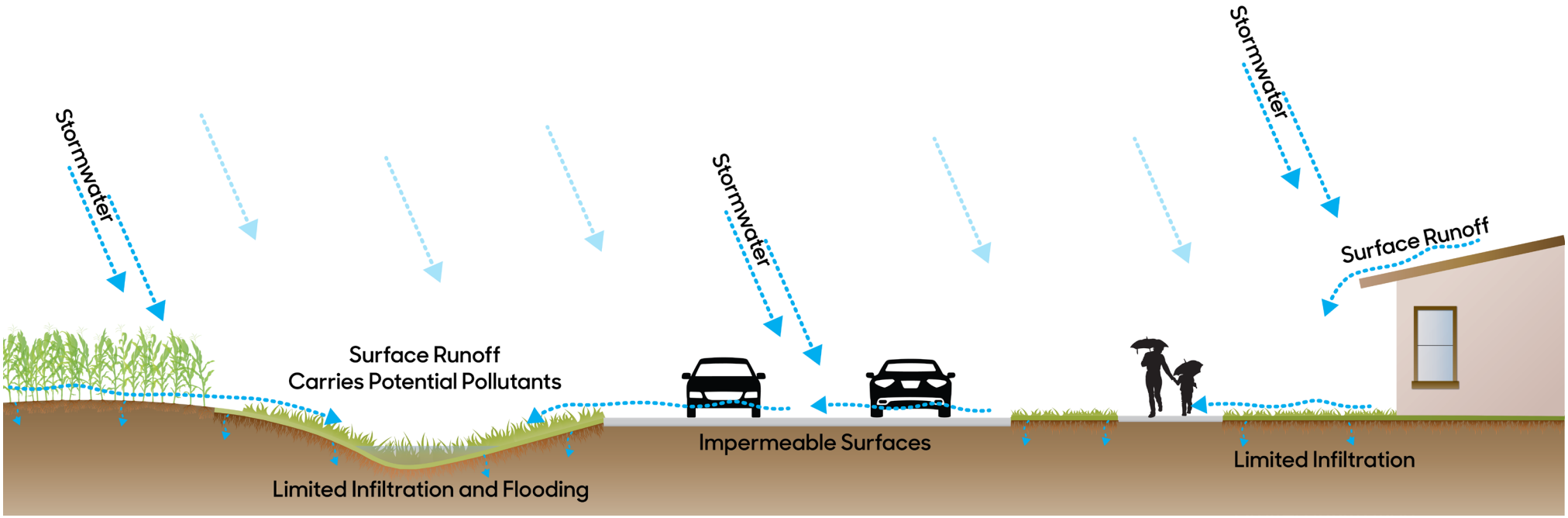
The land cover in most of Iowa's small towns today is a mix of residential lawns or neighborhood spaces dotted by trees. Streets and parking are paved and are sometimes flanked by sidewalks. Commercial and industrial zones are typically dominated by impervious surfaces.

Land cover in Stuart historically consisted of prairie and woodland that have since been transitioned to more impervious surfaces and agricultural fields. Most of the remaining timber is situated in the valleys on the outer edges of town.



Impervious Surfaces, Agricultural Land, & Lawns

Impervious surfaces limit or prevent stormwater from infiltrating the ground and, in expansive areas, can create heat-island effects through stored and reflected heat. Agricultural land that is in annual crops and tilled provides limited infiltration, which can contribute to local flooding. Lawns can also limit infiltration, especially over compacted soil. All of these factors contribute to stormwater runoff and localized flooding, especially during intense rainfall.



Groundwater Concerns

The depth to the water table refers to the distance from the surface that groundwater fully saturates soil. In places with a high water table (zero or only a few feet below the surface), groundwater can well up and cause localized flooding. Rivers and natural lakes are generally areas where the water table is above the ground. These rivers and lakes receive most of their water from groundwater with some surface-water runoff from rain or snowmelt. This is why rivers can still be seen even if it hasn't rained in a while.

High water tables can have effects beyond just surface pooling, such as in the case of "frost boils." Frost boils result from groundwater freezing during winter and forming bubbles of ice called "ice lenses" that expand and push up from the ground. When the ice thaws, the frost boils collapse, leaving a divot in the surface. With certain kinds of flexible pavement, such as asphalt or gravel, these frost boils form potholes.

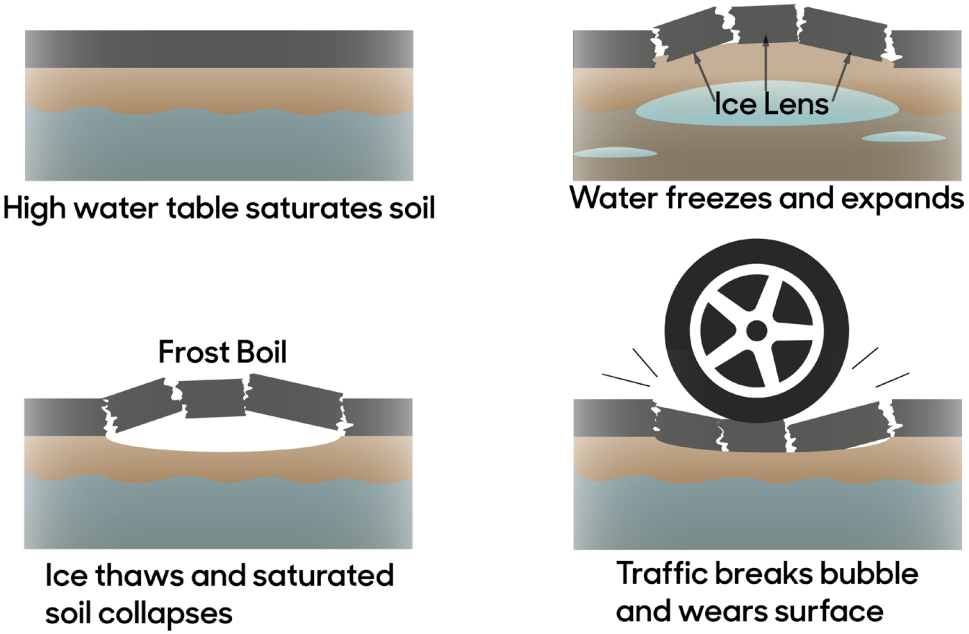


Diagram of the process by which frost boils affect roadways.

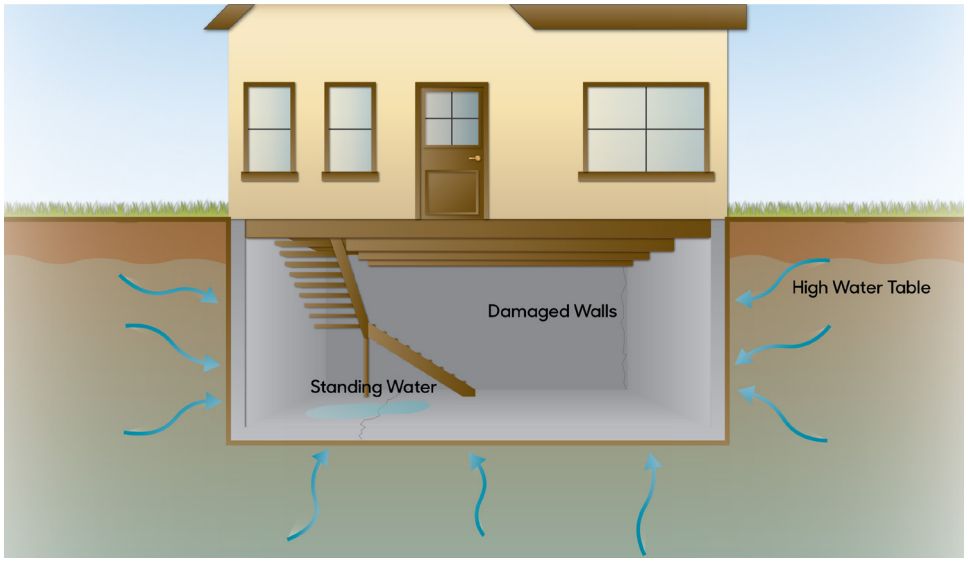


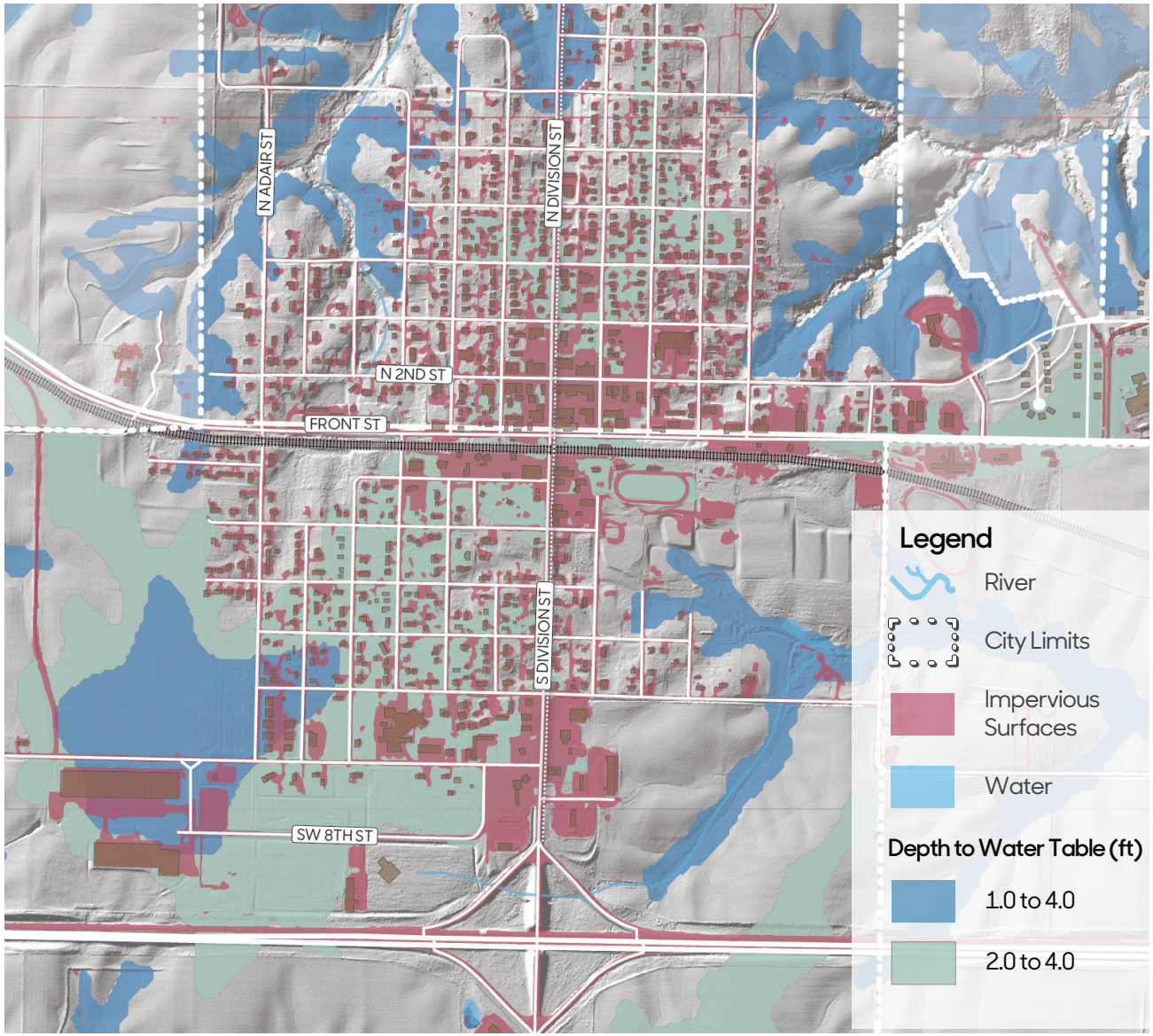
Diagram of the effects of a high water table on foundations and basements.

High groundwater tables can also have detrimental effects on one's home. Houses with basements surrounded by a high water table develop cracks or damaged walls due to water pressure. Typically a tile drain mitigates some of these effects, but wet foundations can require "dewatering," which can be expensive.

Developing landscapes with high water tables requires more expensive maintenance, construction, and paving. Creating public spaces or parks in these areas makes good sense.

Example Community

Emmetsburg's high water table has caused repeated damage on streets and even parking lots. The highway shows signs of continual repairs.



Groundwater and impervious surface map of Stuart, IA
The water table is fairly low in most areas of town, but there is a large portion of the residential area and the main downtown district where the water table depth is 2.0 to 4.0 feet.

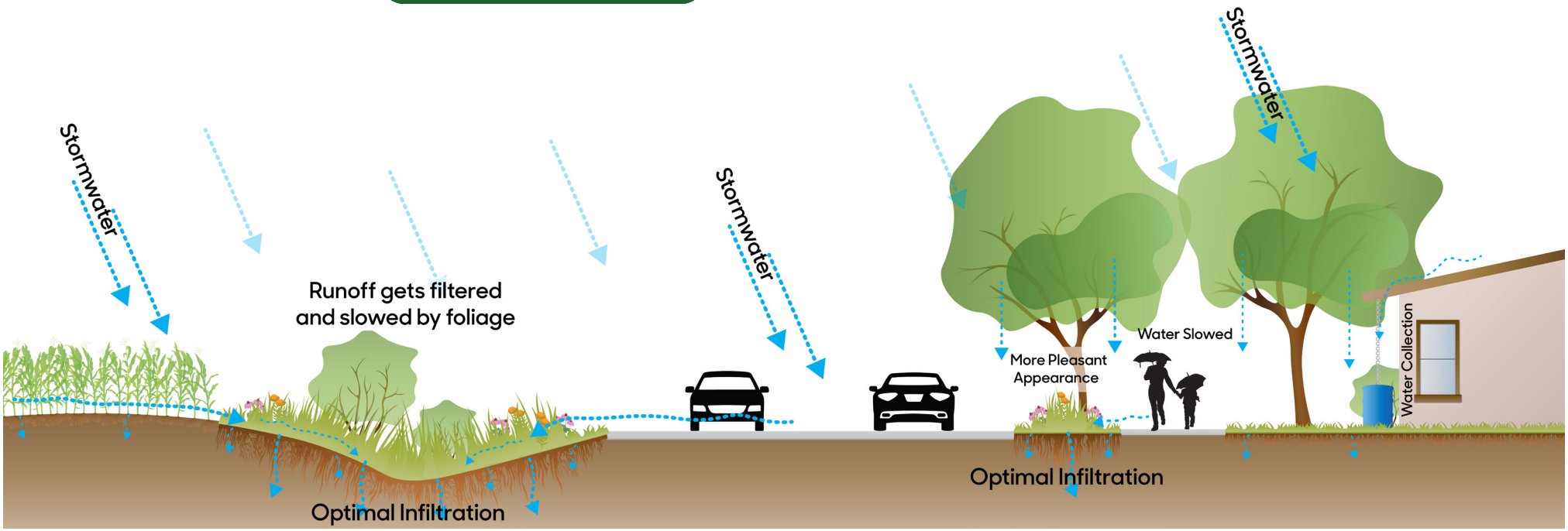
Looking at your town map, are there areas where the high water table and impervious surfaces overlap? Next time you are in this part of town, note local pavement conditions. Do you see signs of cracks or buckling? Has the surface been patched multiple times?

Vegetation Benefits

Grasslands & Tree Canopy

Native grasslands with deep-rooted plants aid in infiltrating stormwater, while dense foliage slows and filters stormwater from other areas. Practices such as bioswales and natural roadsides capitalize on these benefits to improve water quality.

Trees offer many advantages. They clean the air, create shade, and cool the atmosphere. They intercept rainfall, which helps mitigate stormwater runoff and flooding. They consume groundwater, which lowers the water table and makes space for water storage below ground. Carefully chosen and placed trees create community identity and make spaces comfortable for residents. Grasslands and trees provide habitat for pollinators and birds, which provides enjoyment for residents.



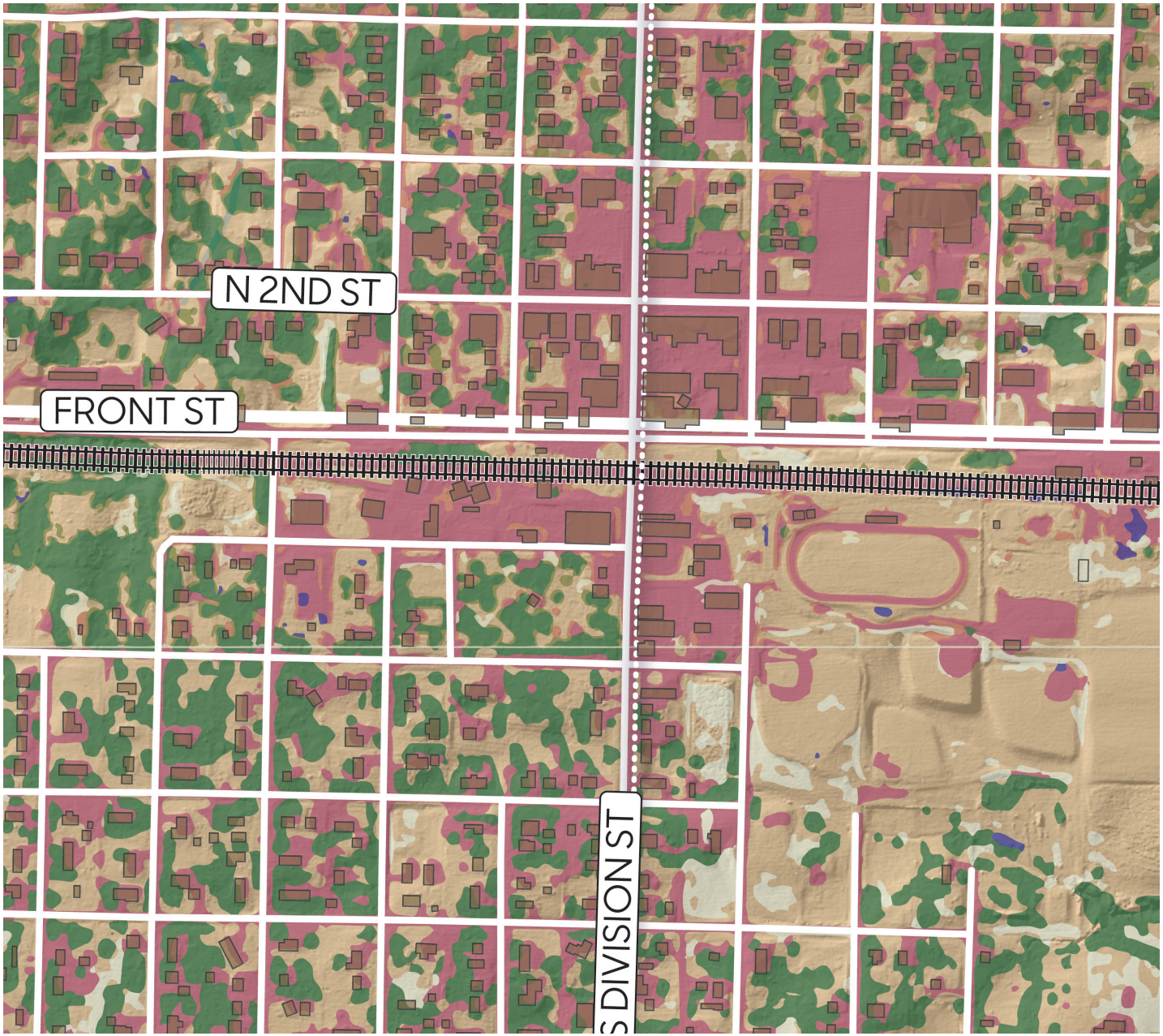
Example Streetscapes with Minimal Vegetation

Lack of street trees creates uncomfortable spaces that feel unwelcoming and exposed to the elements.

Example of Vegetated Streetscapes

Street trees, shrubs, and planters along a roadway offer shade and protection from the elements, while also enhancing the experience of the street.

Vegetation Benefits



Land Use Map of Stuart, IA
Twenty percent of Stuart is dominated by hard surfaces mainly in the downtown area. The tree canopy is primarily located in the residential neighborhoods.

Looking at the heart of your community, does your downtown core have trees?

How does this change as you move from the downtown into residential areas of town?

Reflecting on your own experiences, where do you feel most comfortable on a hot summer day?

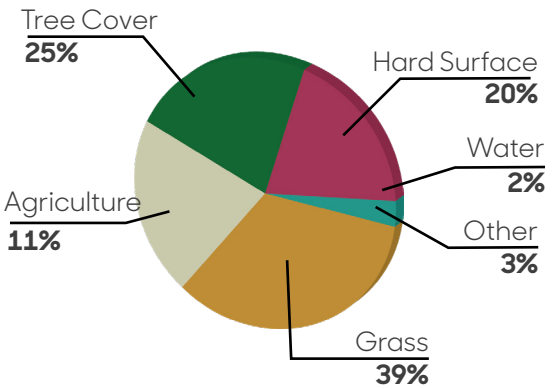
How do you think visitors see this space?

Legend

City Limits

Land Cover

- Water
- Agriculture
- Grass
- Tree Canopy
- Impervious



Aerial photograph of Stuart, IA
The downtown area has many paved surfaces such as parking lots with little vegetation and trees. In residential areas there are more trees and vegetation along streets and on properties.

Next time you are out in town, note what it feels like to be in areas where there are more trees and vegetated areas.

How does it feel to be in areas mostly dominated by impervious surfaces with minimal vegetation?

Do you notice a difference in how many people pause or gather in those spaces?

Surface Water Conditions

A watershed is an area defined by elevated boundaries that separate water flowing toward different rivers and creeks. These basins show the extent of a drainage area flowing to a single outlet point.

Where a community is located within its watershed(s) determines how much water flows into or through it. Location also influences the town's capacity to manage flooding issues. For example, a community located near the end of a watershed (close to the outlet point) will have little capacity for reducing the amount of water draining toward it from upland areas, and will receive greater volumes of water during flooding seasons than other communities located higher in the same watershed.

Development of channelized waterways, drainage tiles, and impervious surfaces also leads to increased quantities and speed of the water headed downstream; while a community located near the top of its watershed may not experience flooding, managing water will have a greater effect on neighboring communities downstream.

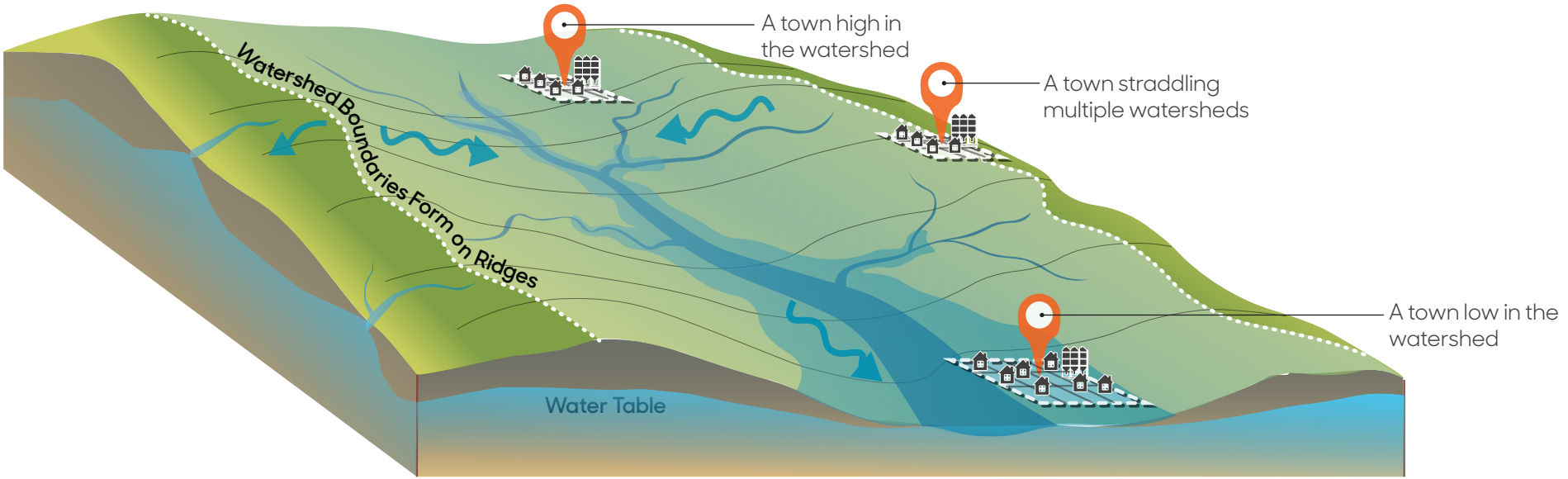
The map on the following page highlights your community within its surrounding watershed(s).

Where is your community located within the watershed(s)? Is water flowing to your community or away from it?

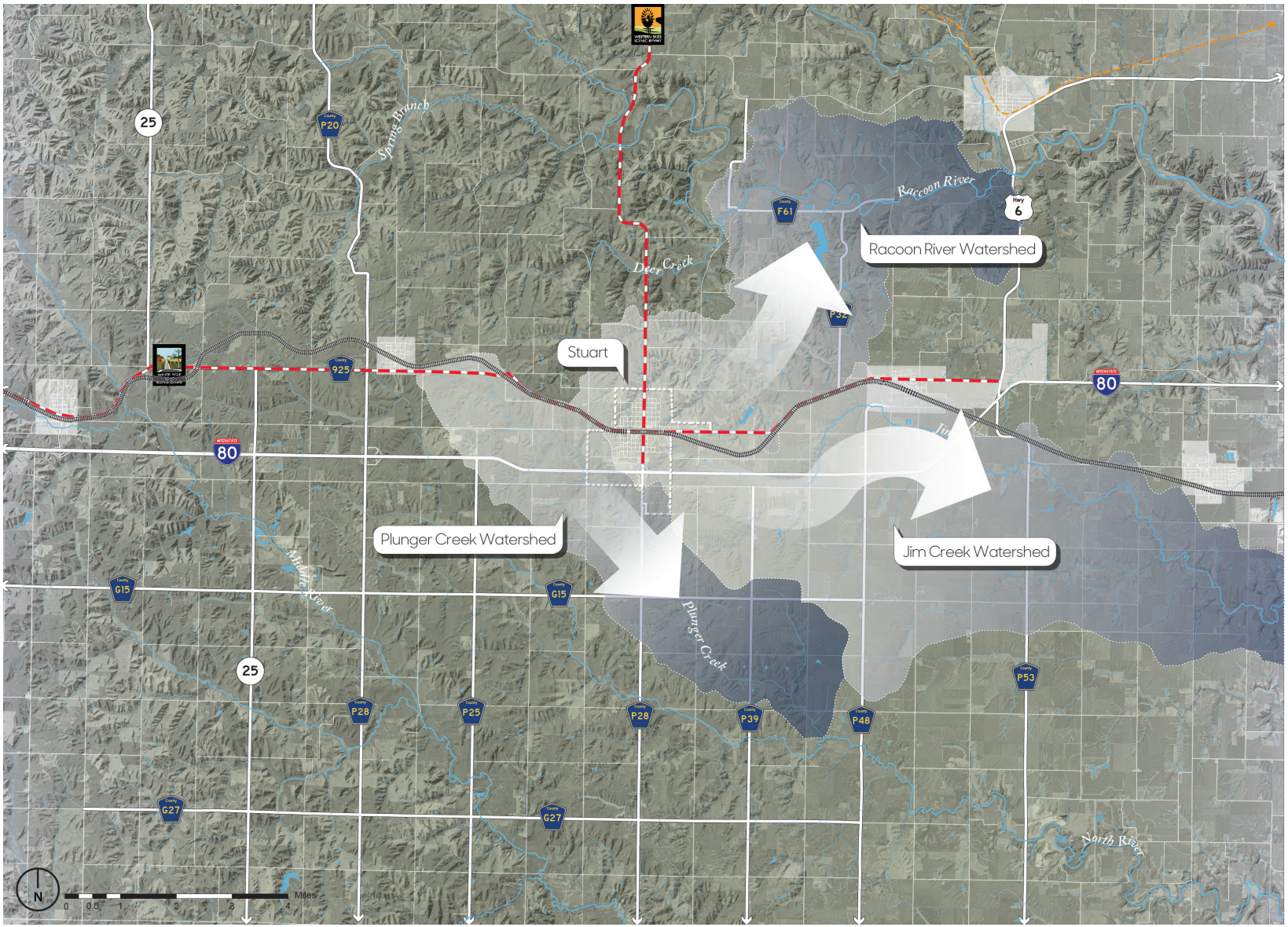
Is flooding an issue in your community?

How big is the watershed above your town? What conditions might increase or reduce flooding?

Are there conditions or practices happening in your community that could be creating risk for communities downstream from you?



Axonometric diagram of the physical characteristics of a watershed.



Legend

- Trail
- River
- Railroad
- Scenic Byway
- Highway
- City Limits
- [Native Tribe] Settlement
- Water
- Watershed
- Watershed Flow

Watershed map of Stuart, IA
Stuart is located at the top of three major watersheds. The watersheds that surround the city of Stuart all move away from the town into the valleys and minor or major rivers. Due to its position in the watershed, flooding in Stuart is unlikely.

Surface Water Conditions

The elevation and flow map displays differences in elevation. A combination of contour lines and the color gradient depicted in the legend show which areas are highest and which are lowest in the landscape.

If your community lies within or near a floodplain or floodway, the map on the following page reflects these features. Not all communities will have all of these elements; if they are absent on this map, none are present.

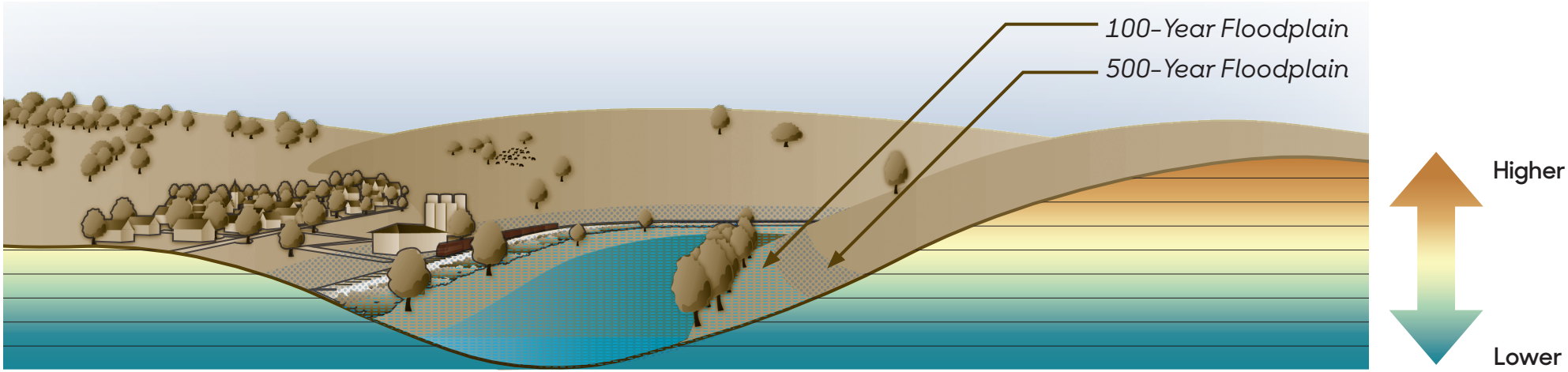
Flood risk is correlated to low-lying land. This map on the next page shows your community's 100- and 500-year flood risk as defined by the Federal Emergency Management Agency (FEMA) Flood Map Service Center. A floodway may also be shown, which signifies the greatest flow during a flood and is a zone that cannot be developed.

Note the position of your community in this landscape: is it located in a valley, on high ground, or between the two?

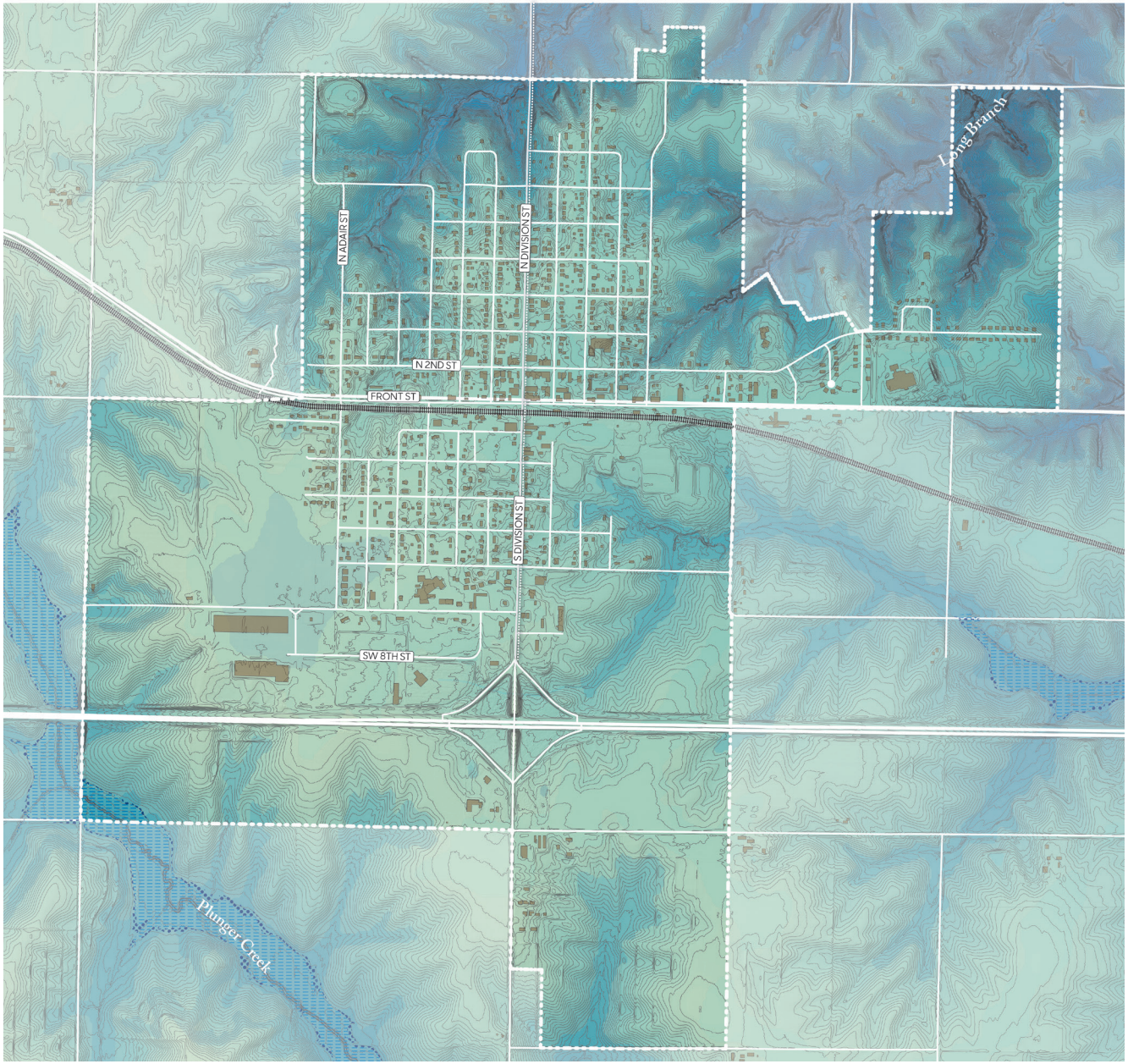
What parts of the community are in the floodplain or are at risk of flooding?

Why do you think these areas have developed in this location?

As the town grew historically, at what elevation did development happen? Has this changed over time?



Sectional diagram depicting the scale of elevation in relation to topographic features and development patterns.



Legend

- Trail
- River
- City Limits
- Road
- Water
- 2ft Contours
- 100 -Year Flood
- 500 -Year Flood
- Higher Elevation
- Lower Elevation

Elevation and flow map of Stuart, IA
Stuart was originally settled on the flat and higher part of the land. It is surrounded by several river valleys. Most of Stuart is outside the floodplain and most of the water flows away from the town through valleys. The north part of town has steeper valleys and lower elevations compared to the rest of the community.