# Coastal Flood Decision Support Tool for Forecast Operations in Alaska

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Weather-Ready Nation
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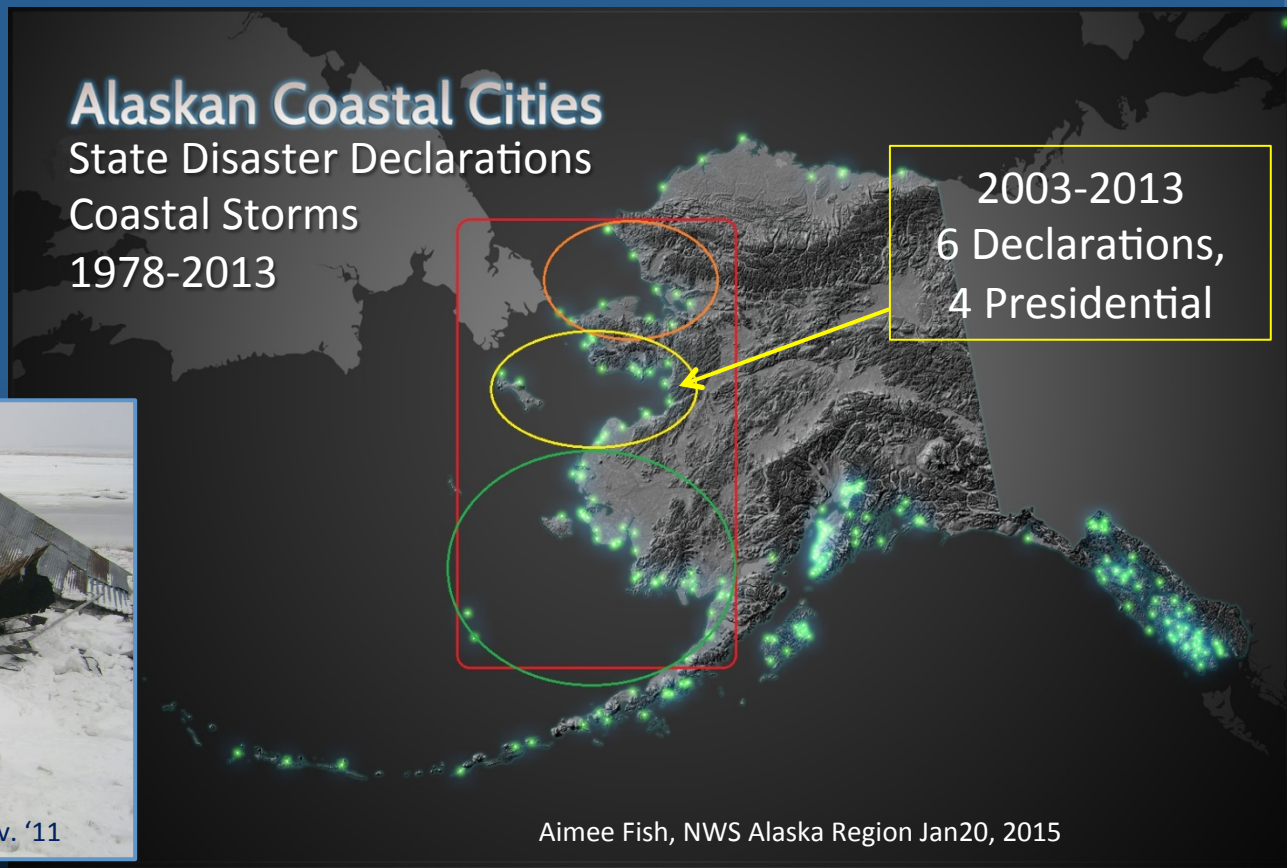
Photo: Barrow, AK October 1963

# Overview

- Background
- The Forecasting Gap
- The Communication Gap
- Project Goals
- Elevation Data
- The Coastal Guidance Tool

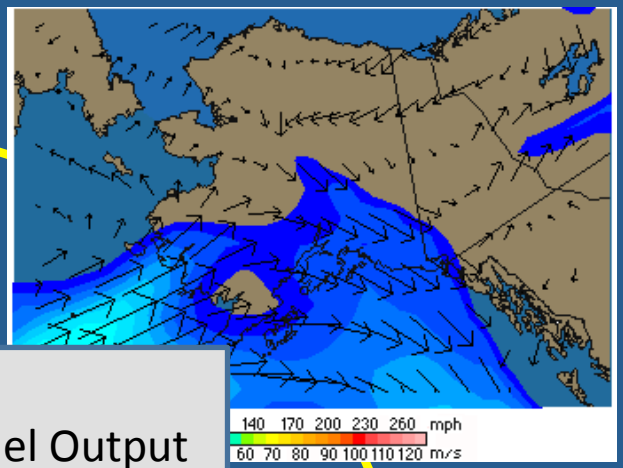
**Shore Near Kaktovik Airport during July 2008 Storm**

# "Since 2000, Alaska has had 15 federally declared [flooding] disaster declarations… collectively impacting over 58% of Alaska's organized communities…" - DGGS

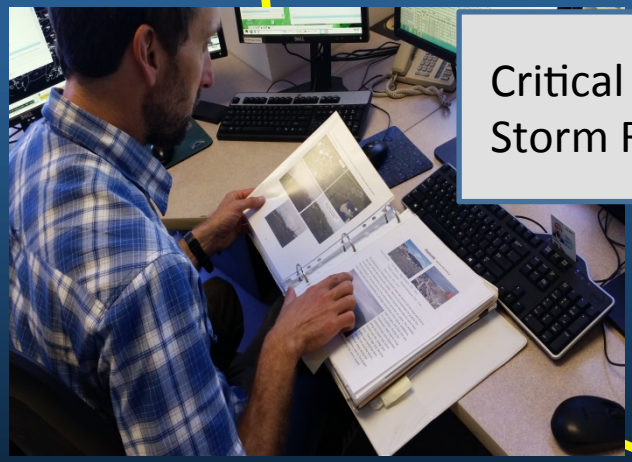


# The Forecasting Gap

Societal Impacts

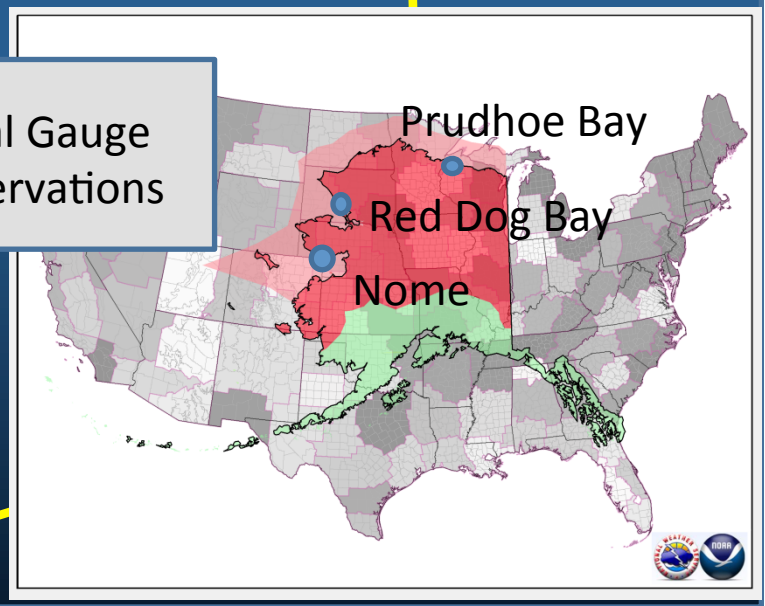



Model Output



Critical Values, Storm Records

Tidal Gauge Observations



# The Communication Gap

Common terms/references used by:

**Forecasters**

**Mean Lower Low Water**

**Wave Run Up**

**Mean Higher Tide**

**Nearshore Set Up**

**Village Residents**

**High Tide**

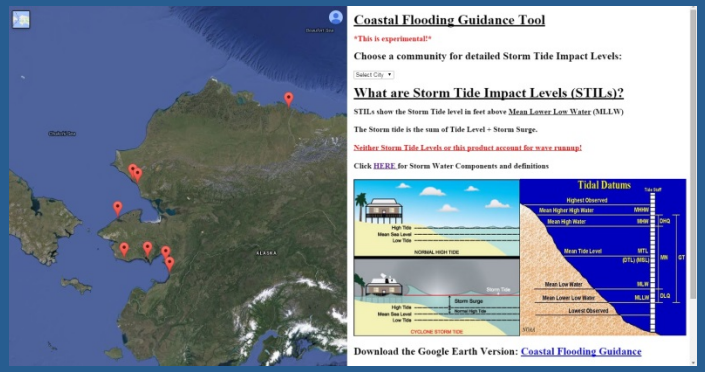
**Low Tide**

**The water level of the "Great Storm of 1963"**

# Project Goal: To "bridge" these Gaps

Create a "One Stop Shop" Coastal Decision Support Tool for Alaska:

- ✓ Meteorological and Tidal Model Data
- ✓ Archived Storm Data
- ✓ Observational Tidal Data
- ✓ Socioeconomic Impacts




This will help to build a Weather Ready Nation by mitigating disruption of life from high-impact events.

# Elevation Data

The Alaska Division of Geological and Geophysical Surveys (DGGS) acquired high-res elevation data for five of the most at risk communities.

# Elevation Data: Methodology

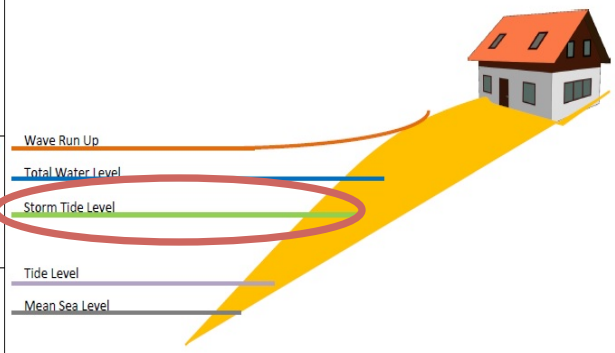
| COASTAL STORM WATER LEVEL COMPONENTS | Full Definition | How Determined | Easy Explanation |
|---|---|---|---|
| Mean Sea Level | The average height of all water levels in a local area under normal conditions | Tide gauge | This is where the water is usually located |
| Tide Level | Regular variation in the water level caused by sun/moon gravitational forces and the earth's rotation | Tidal predictions modeled by NOAA | This includes both high and low tide levels under normal conditions |
| Storm Surge | Elevated ocean levels that arise from a combination of onshore directed wind stresses and reduced atmospheric pressure | Forecasted by regional NWS ocean models | This is the overall rise in the open ocean water level due to storm conditions |
| Nearshore Setup | An increase in water level due to waves and the shoreward transport of water | Calculated of modeled based on local conditions and typical storm characteristics | An additional rise in the water level along open coastlines during a storm as waves 'pile up' against the shore |
| Wave Run up | The maximum height breaking waves can reach on a shore face | Calculated or modeled based on local conditions and typical storm characteristics | Breaking waves have extra energy that can cause water to rush up even higher in some locations. This is an elevation where your feet may be splashed but you are not standing in water |

Storm Tide Level

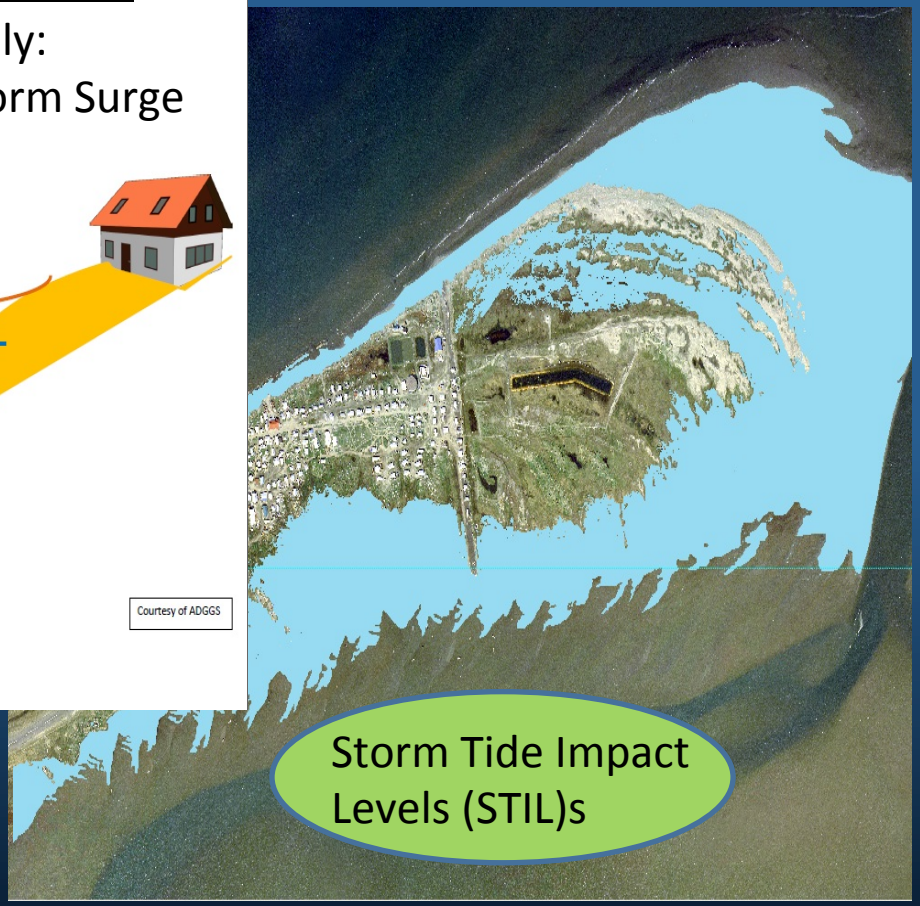
Total Water Level

## What is the Storm Tide?

Essentially:
Tidal Level + Storm Surge

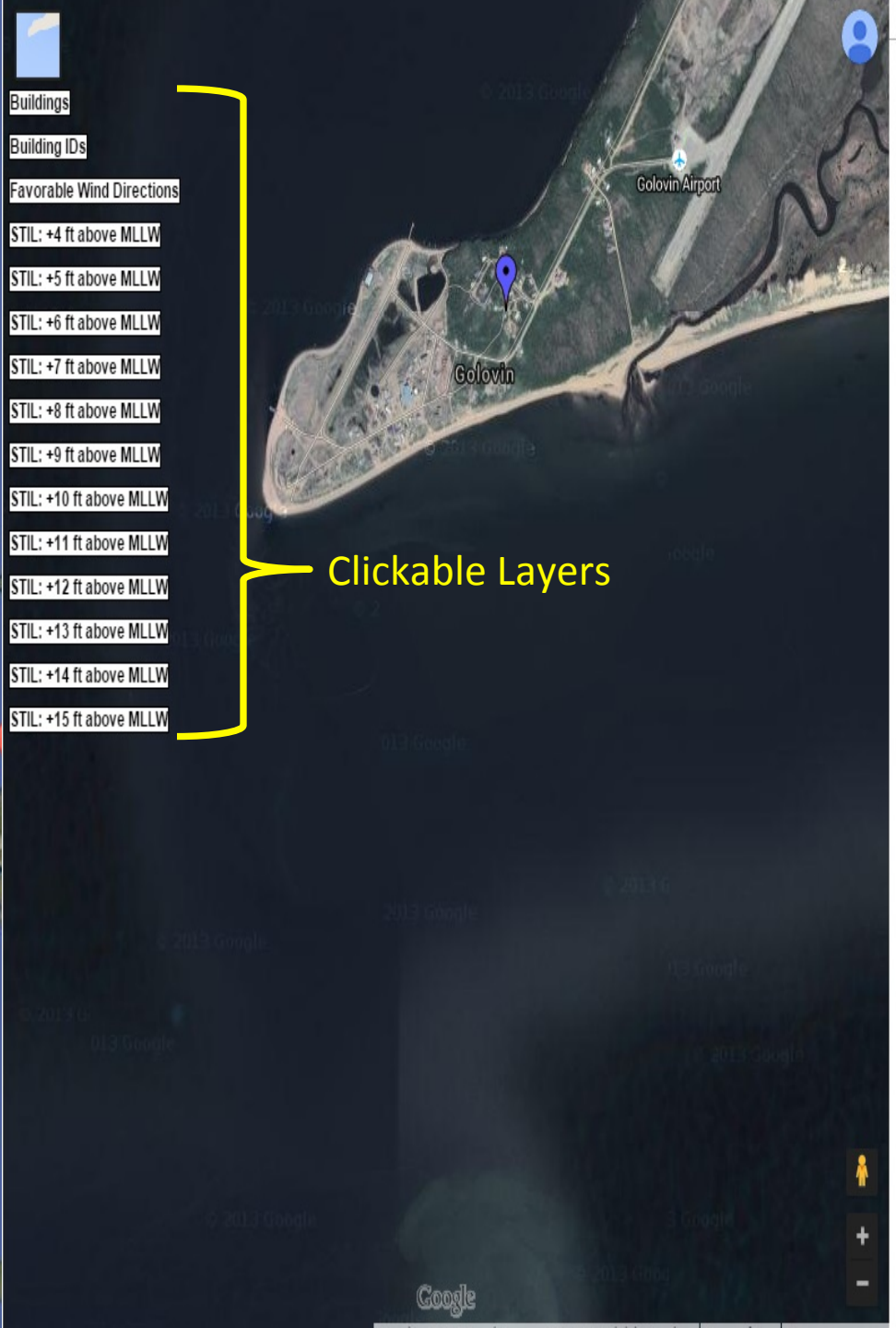



Courtesy of ADGGS



Storm Tide Impact Levels (STIL)s

# The Coastal Flooding Guidance Decision Support Tool




City & Tidestaff | DGGS Elevation Maps | **Additional Info**

# Additional Information

## Favorable Coastal Flooding Conditions:

Wind Direction: 90 to 170 degrees.

Wind Speed: sustained winds > 35 mph over 12 hours.

Critical Surge: 4ft.

## Useful links:

Coastal Flooding Guidance (Google Earth Download)

Image Archive

Village Vulnerabilities

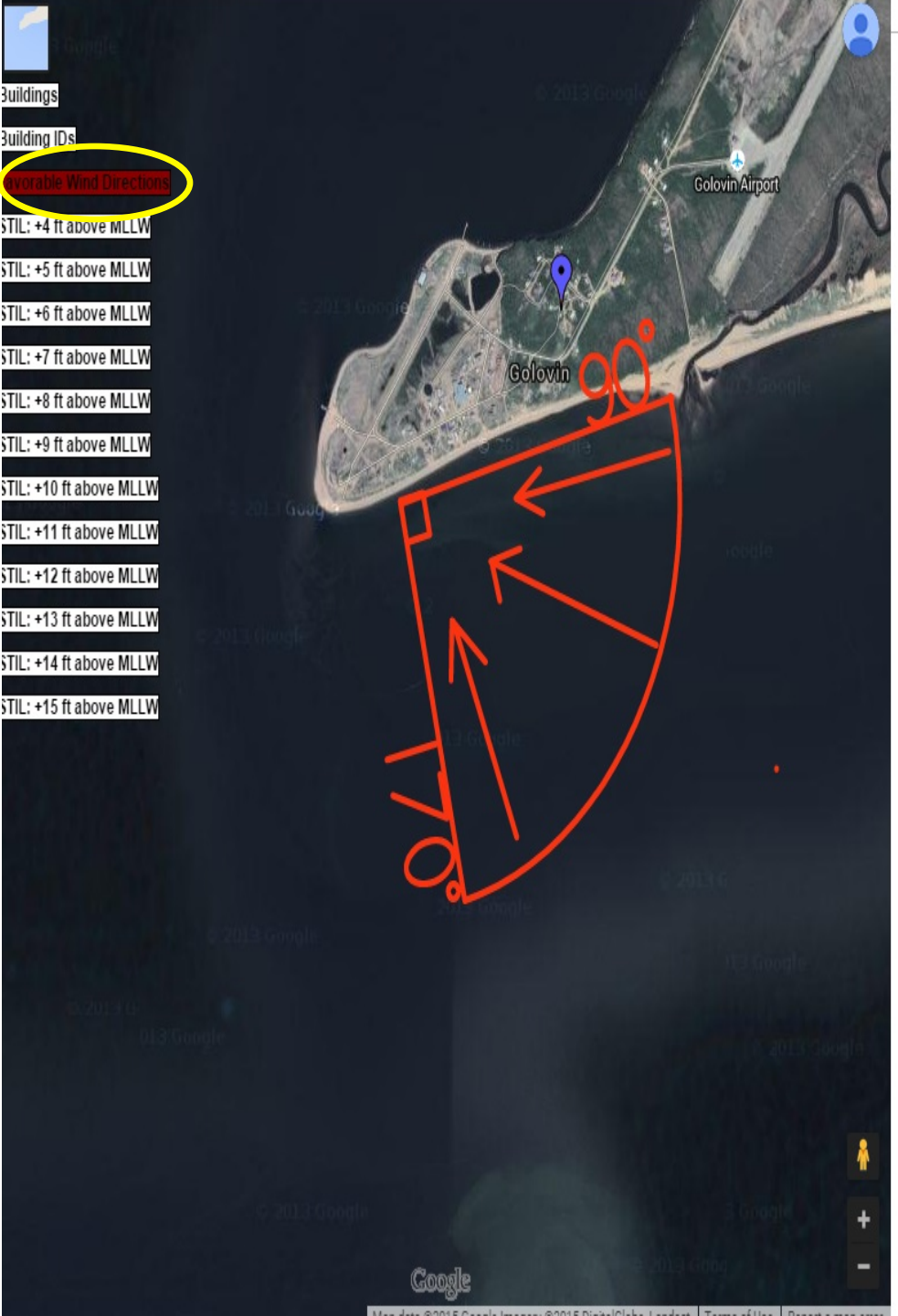
## From the Manual:

The semi-protected location inside Golovin Bay assists in minimizng the threat to coastal flooding. However, **SE through SW winds over a period of at least 12 hours** can push water up into the Golovin Bay to produce coastal flooding.

The critical values needed at Golovin to produce coastal flooding concerns are: SE through SW sustatined winds of **at least 30 to 35 mph and a 5 ft surge above high tide.** Coastal flooding will affect many residenses, the new school, power plant, tank farm, store, clinic, and washateria.

There are two storms in recent history that caused damage in Golovin: October 2004 and September 2005. The 2005 storm caused more damage than 2004. During the 2005 storm there was an estimated 7 to 9 foot surge with S/SE winds of 55 mph gusting to 66 mph, resulting in 3 feet of water overtaking the lower village including the school, tank farm, and many other buildings.

Similar, but less severe, flooding occurred during the 2004 storm (an estimated 5 to 6 ft surge with peak winds of 60 mph from the SE, turning to the E at peak wind strength). State and federal disaster declarations were made for both storms.

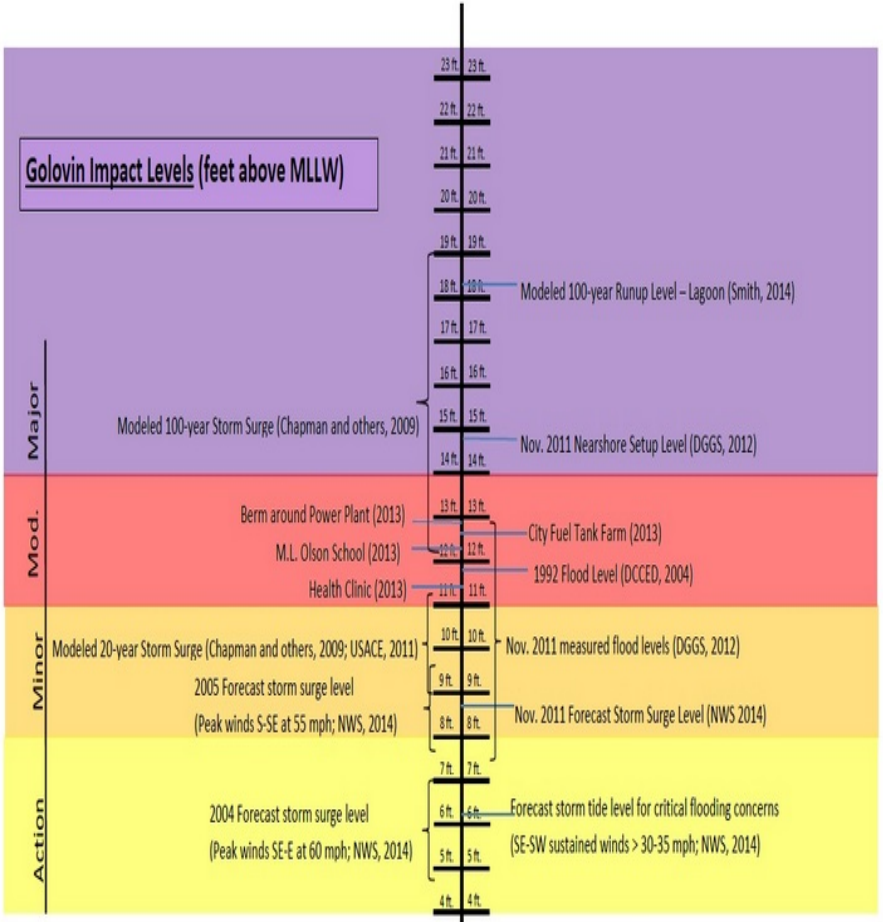



City & Tidestaff | DGGS Elevation Maps | Additional Info

# Current City: Golovin

## Storm Tide Impact Levels for additional communities:

Current City




**Local Contacts:**

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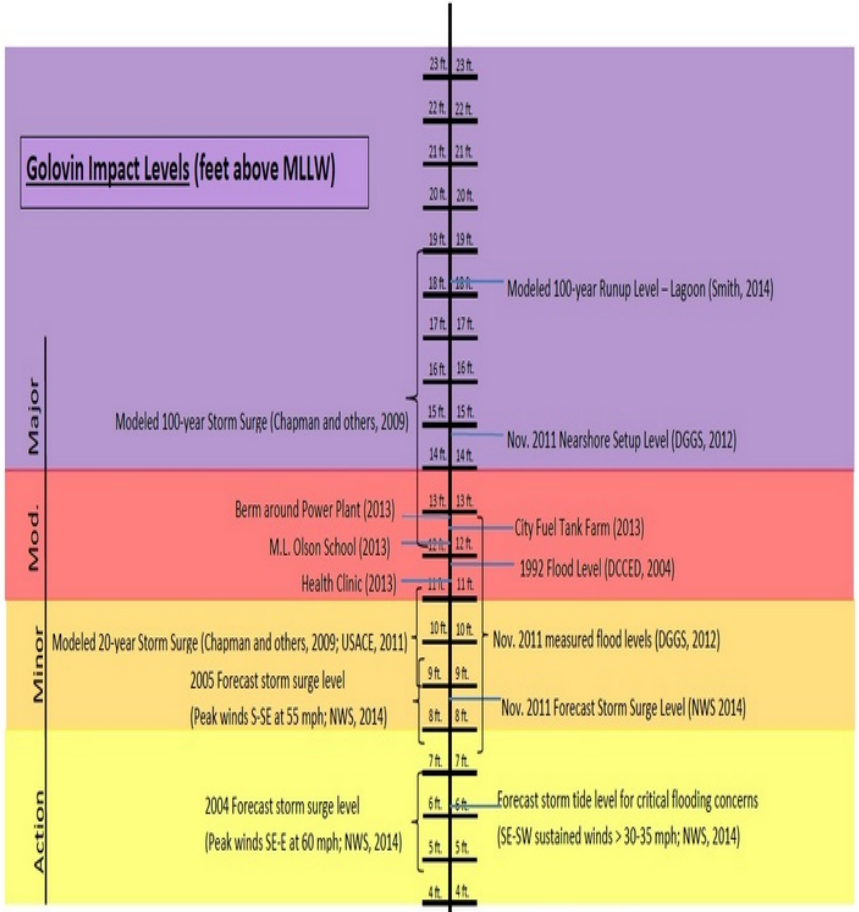


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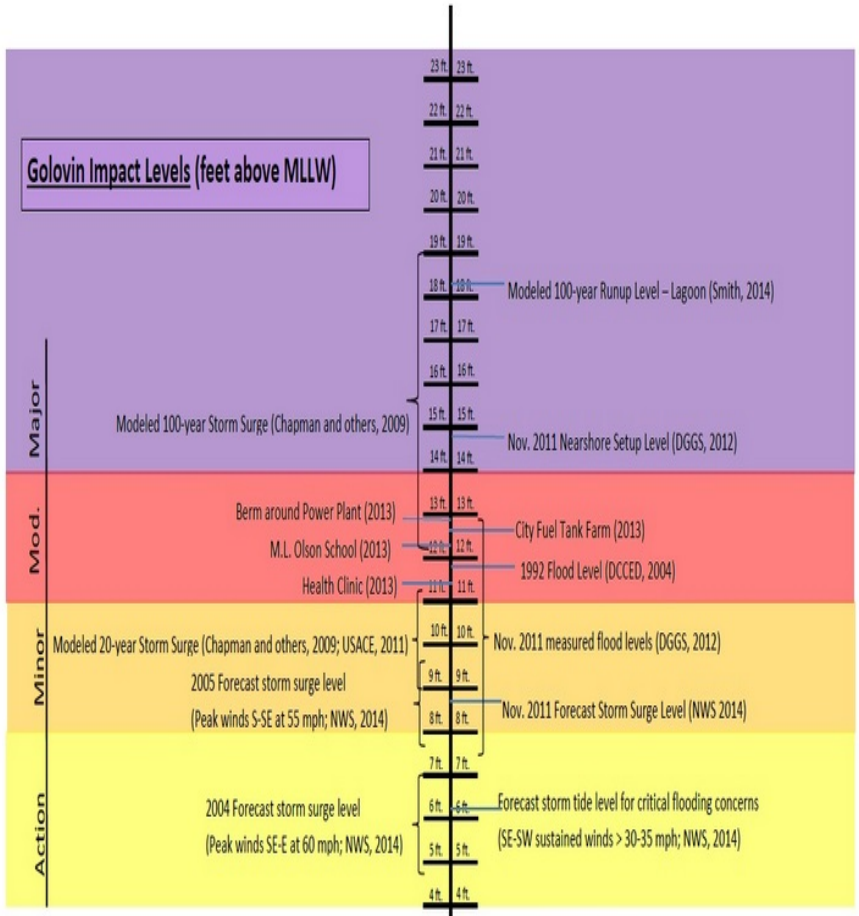


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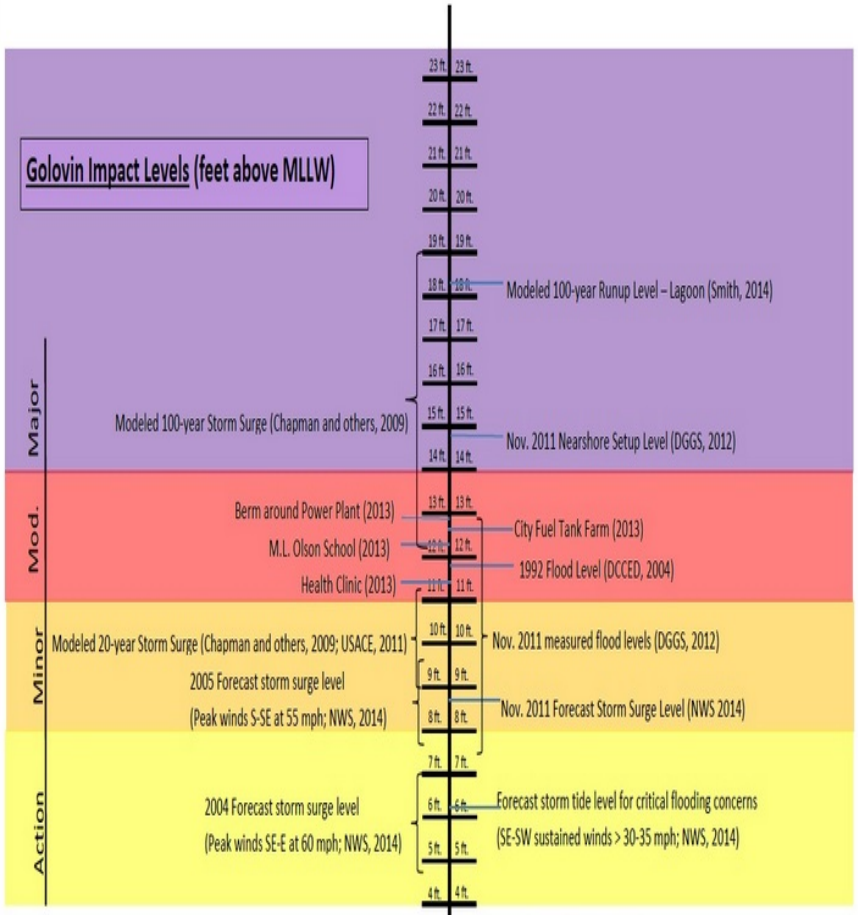


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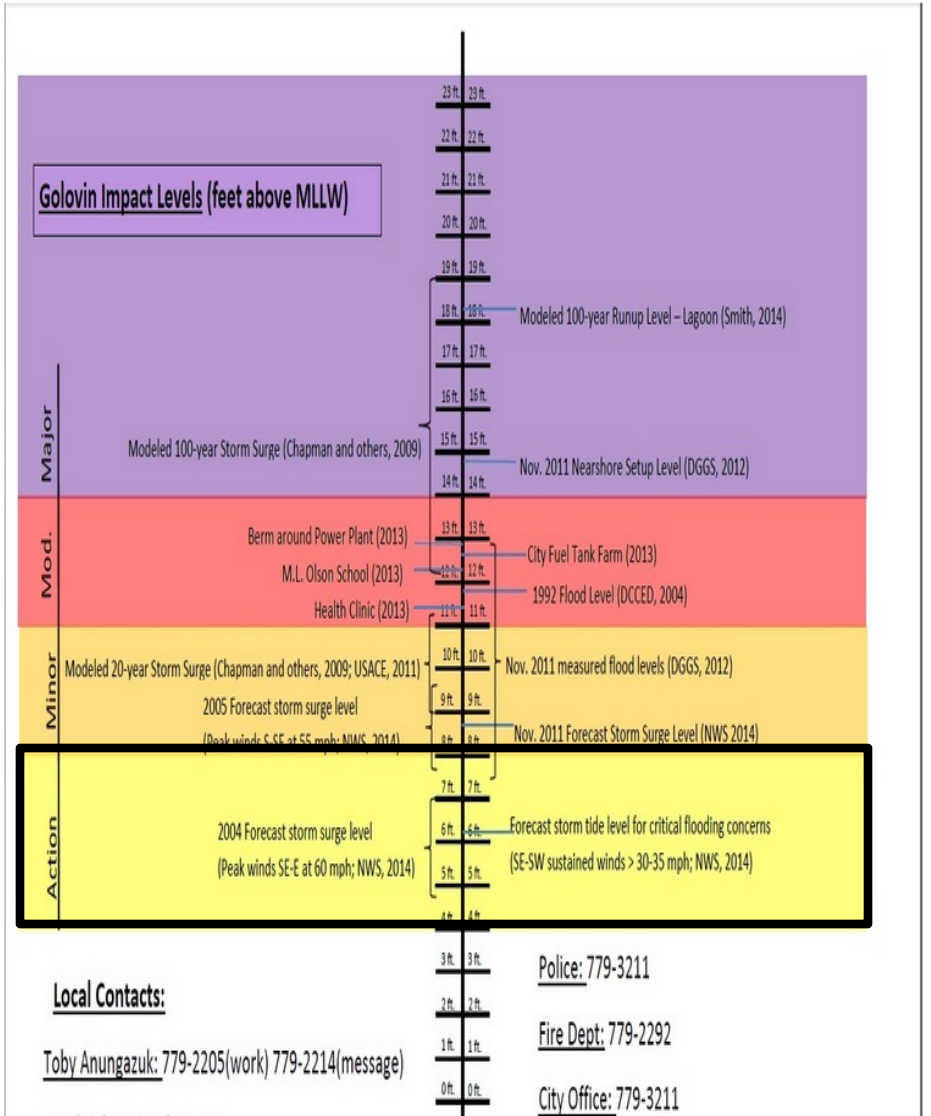


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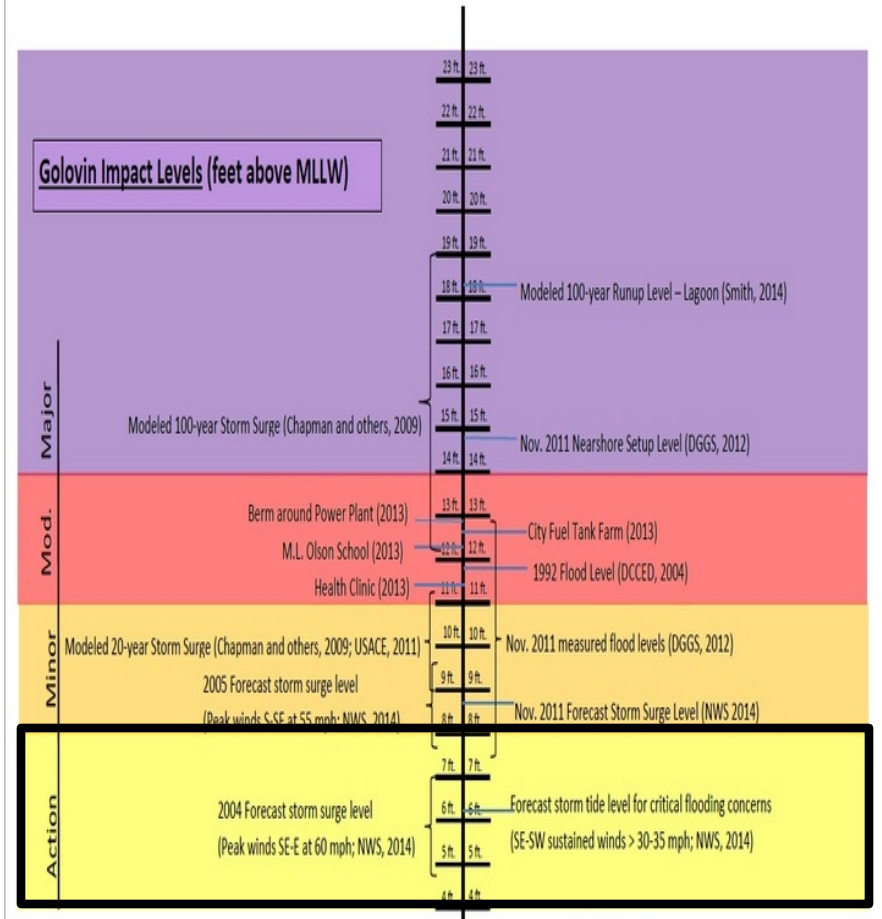


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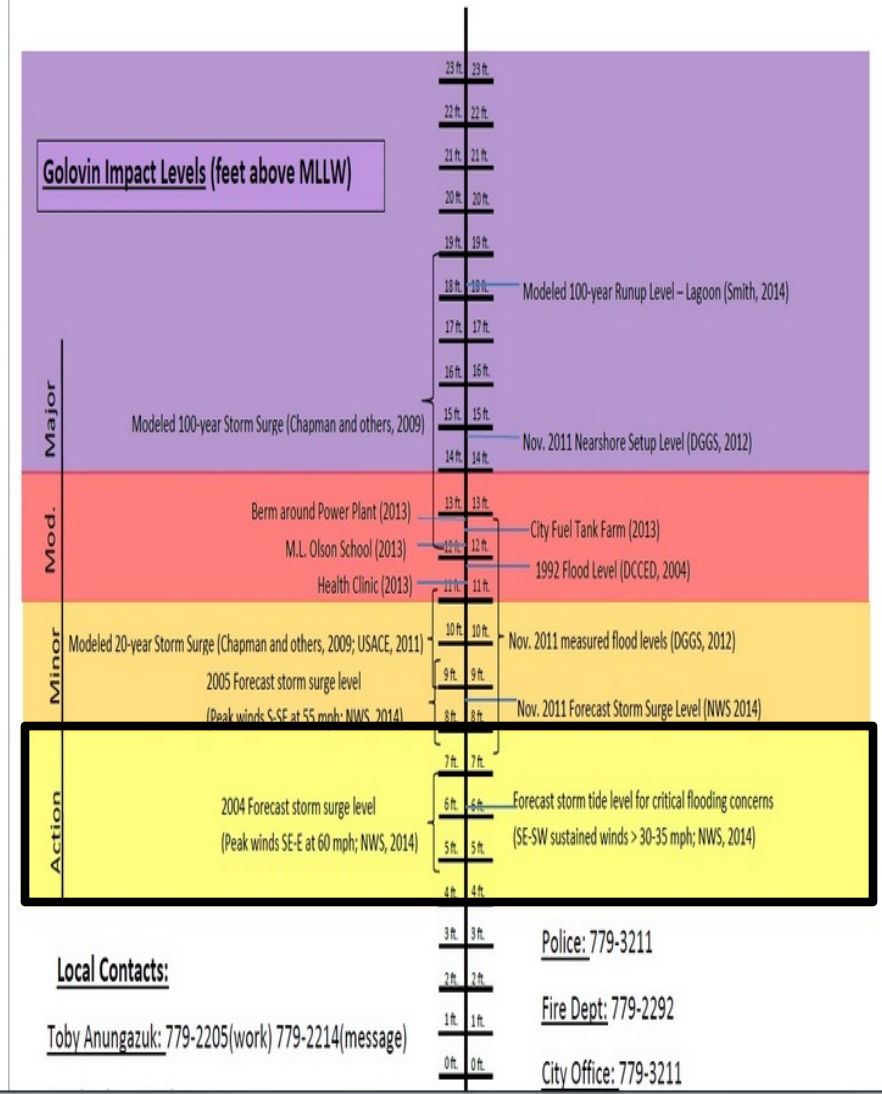


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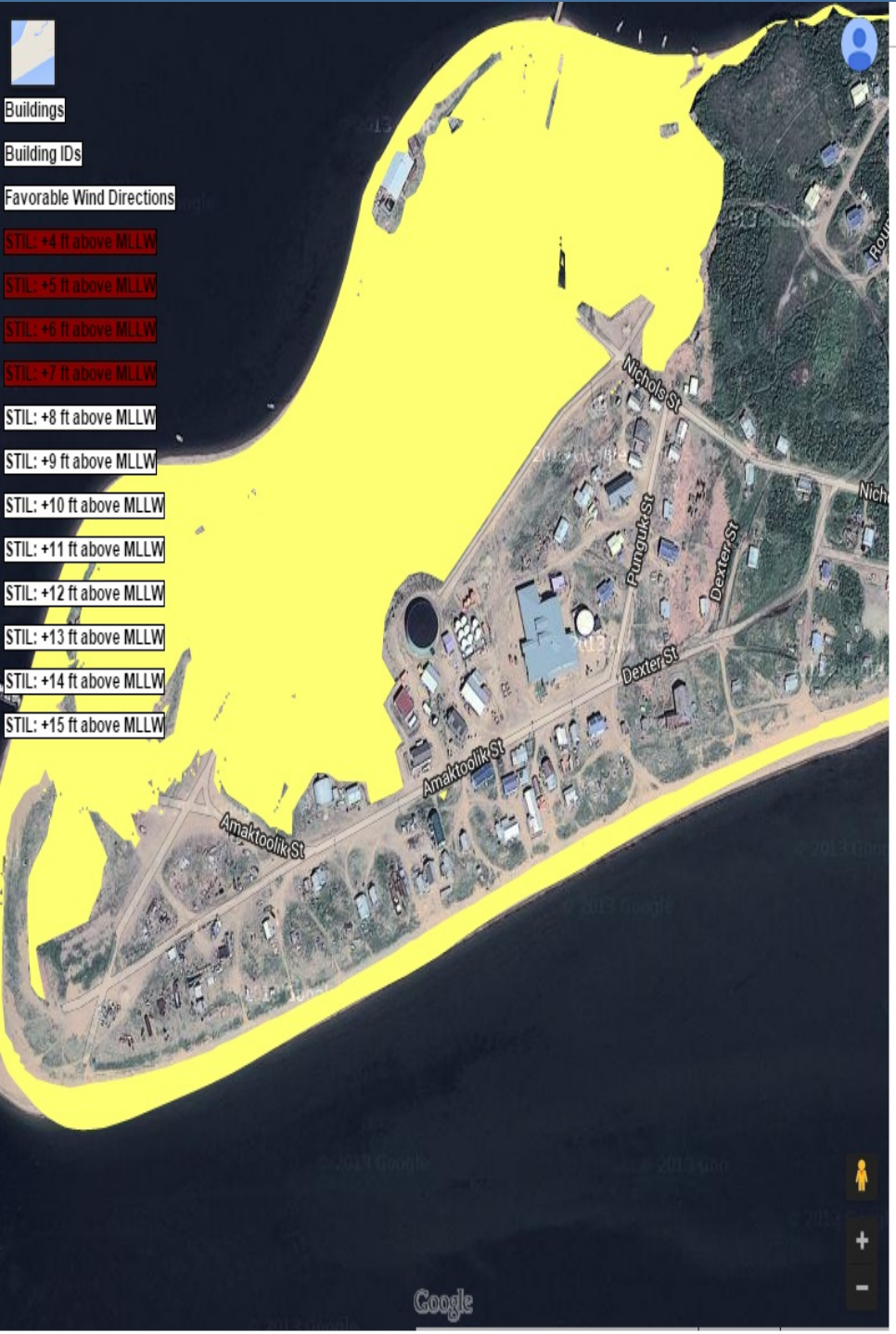


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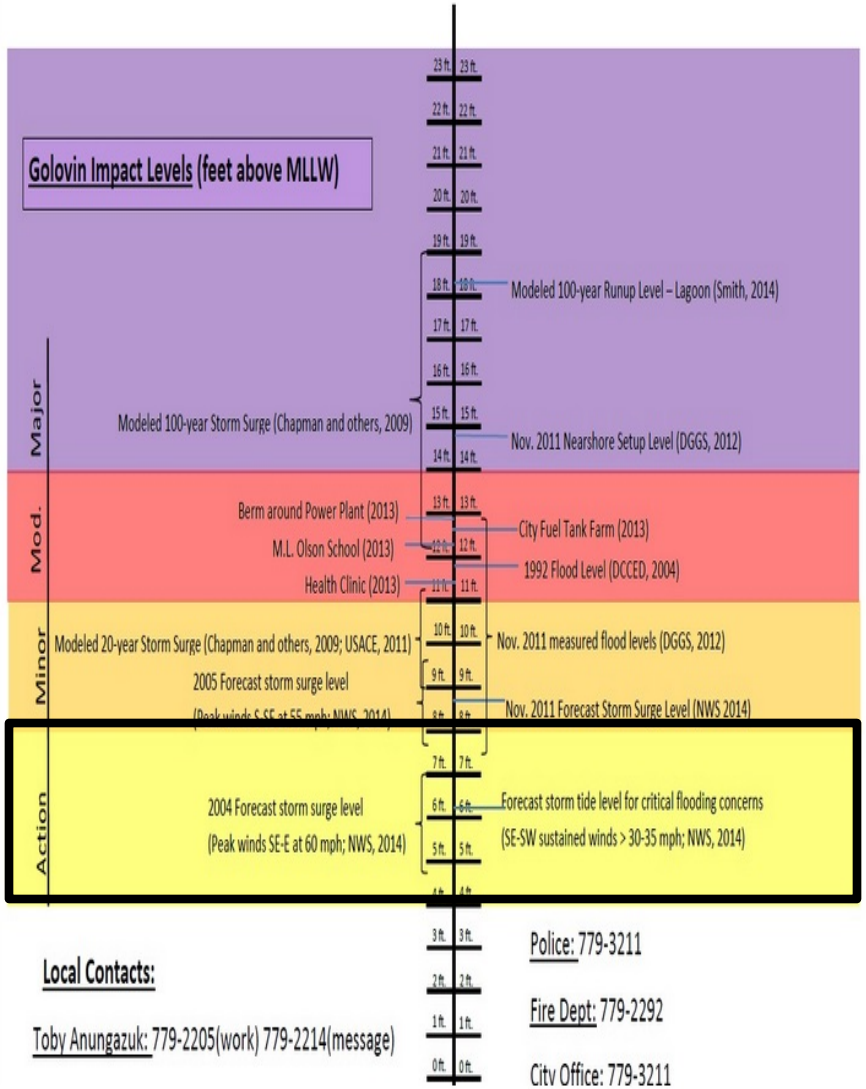


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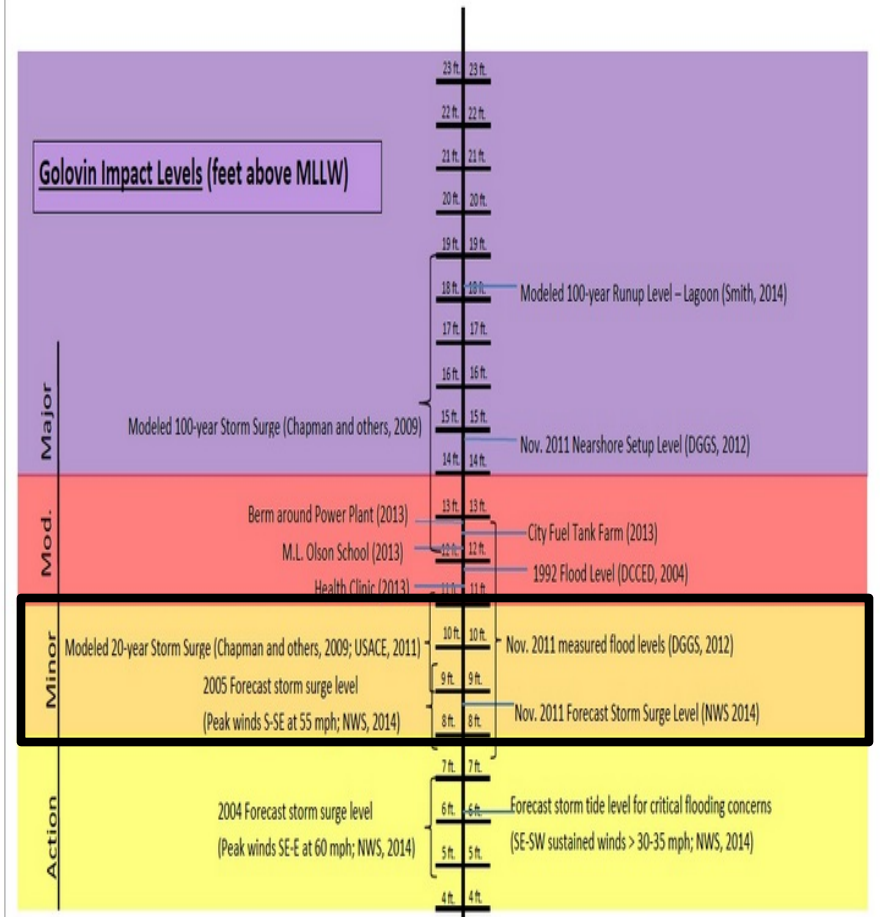


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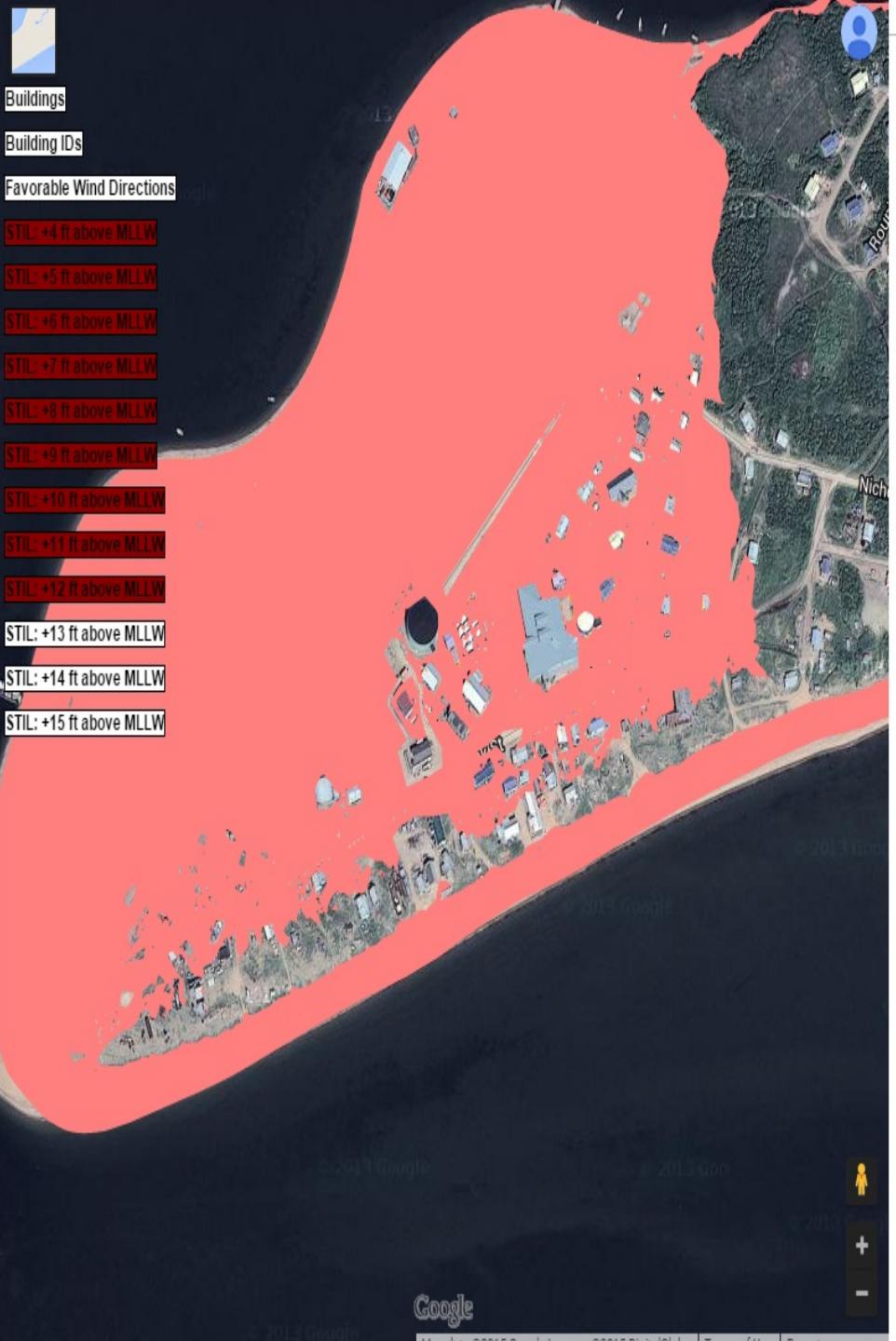


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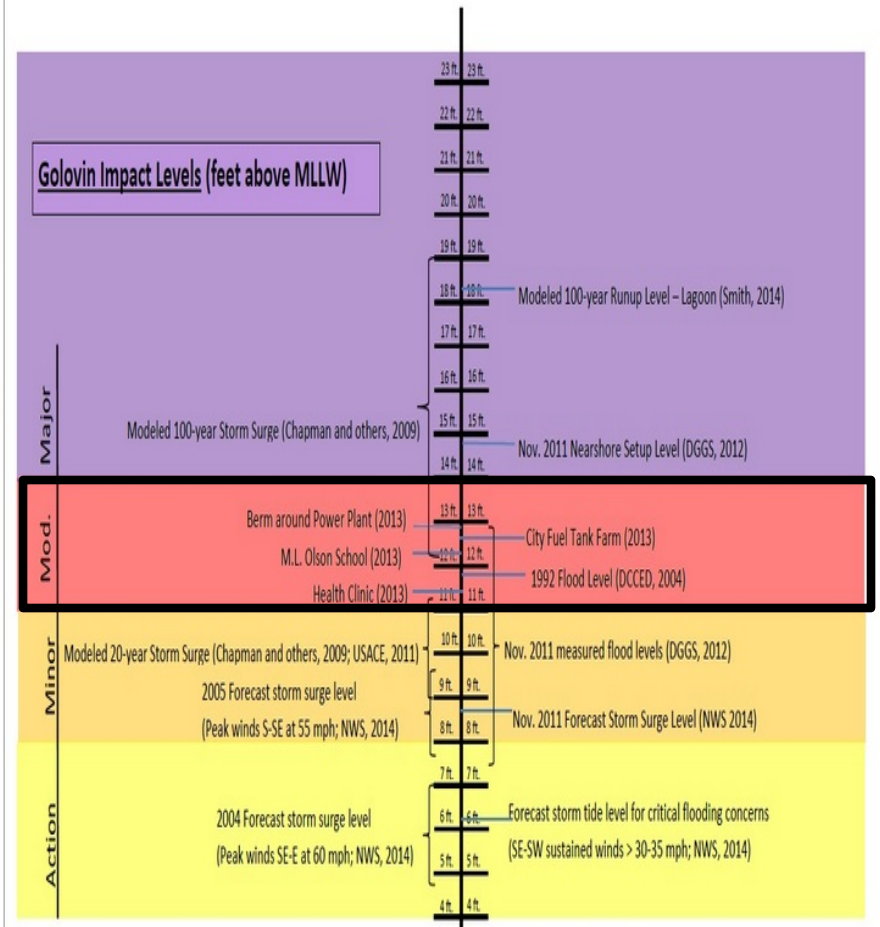


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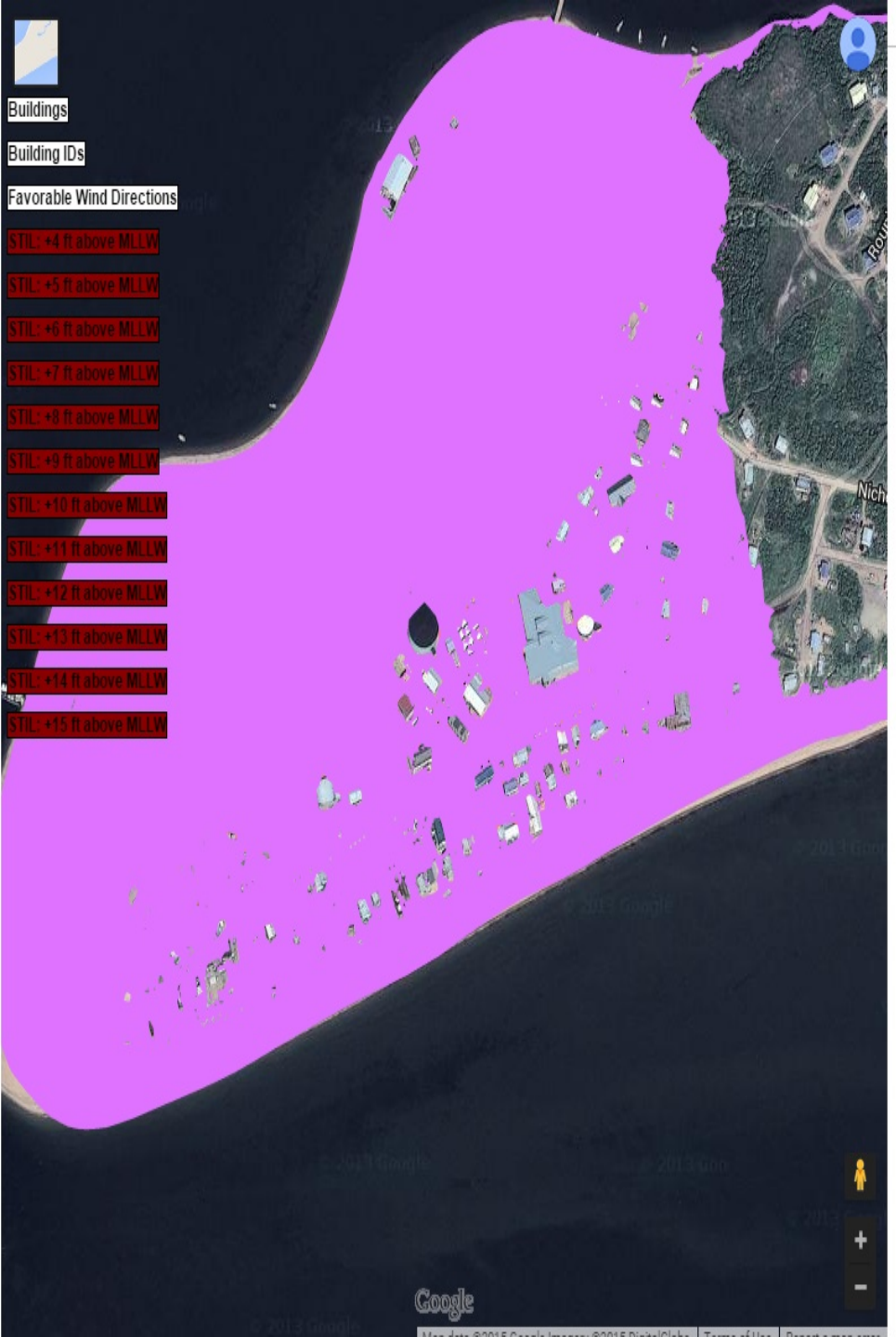


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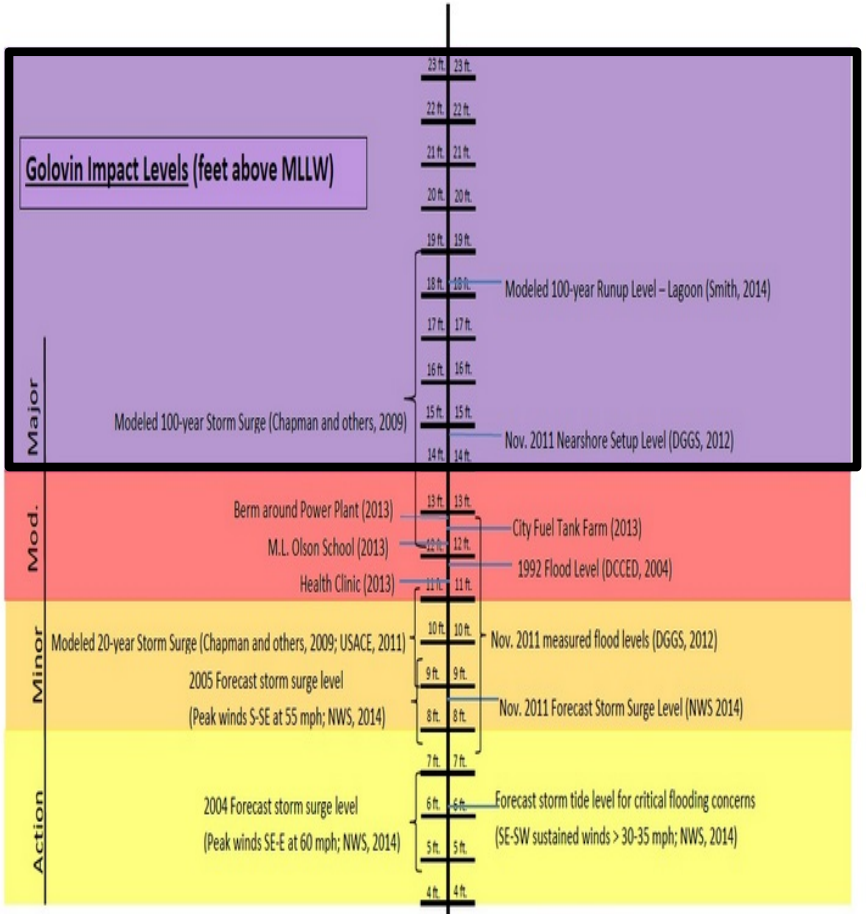


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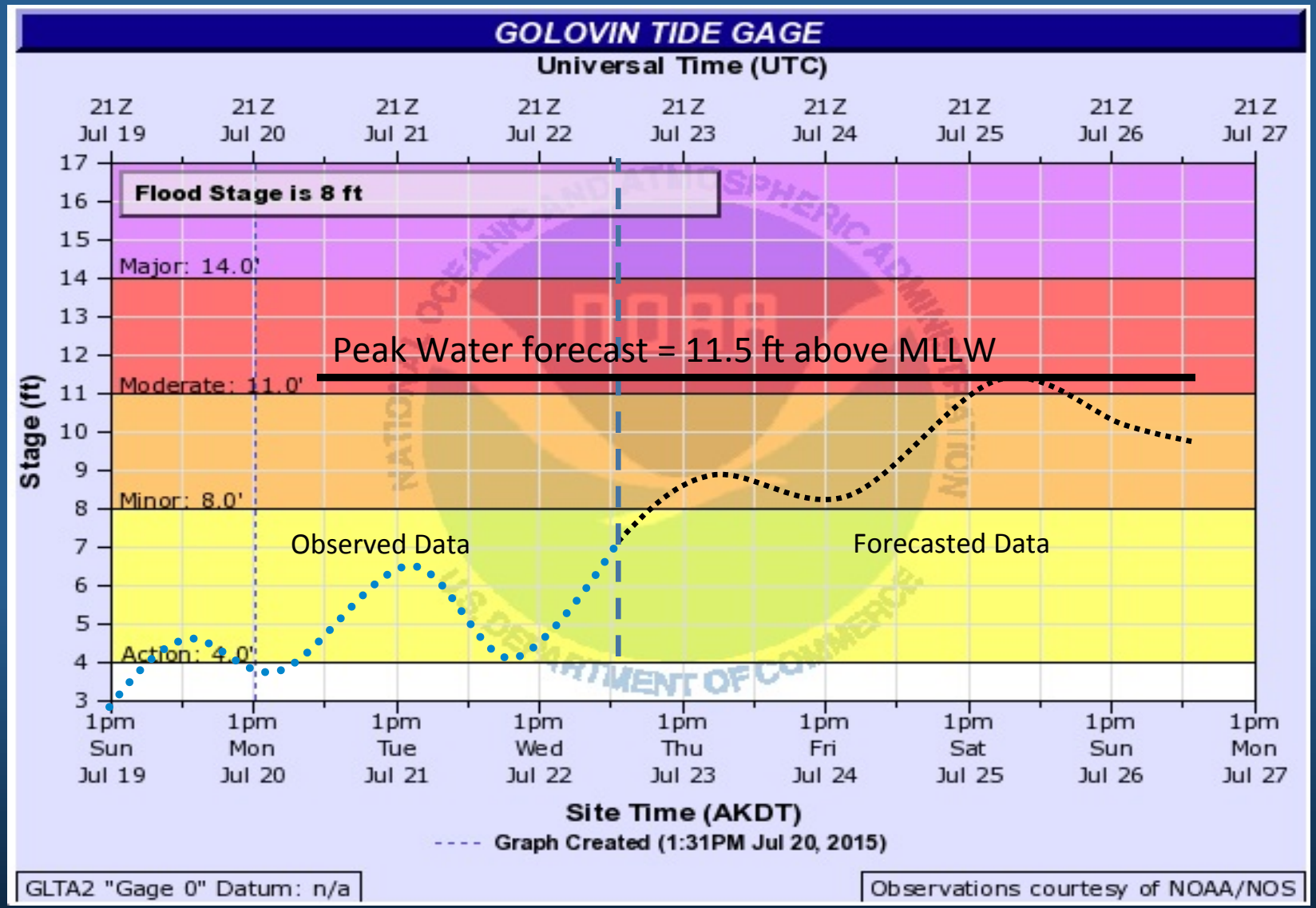
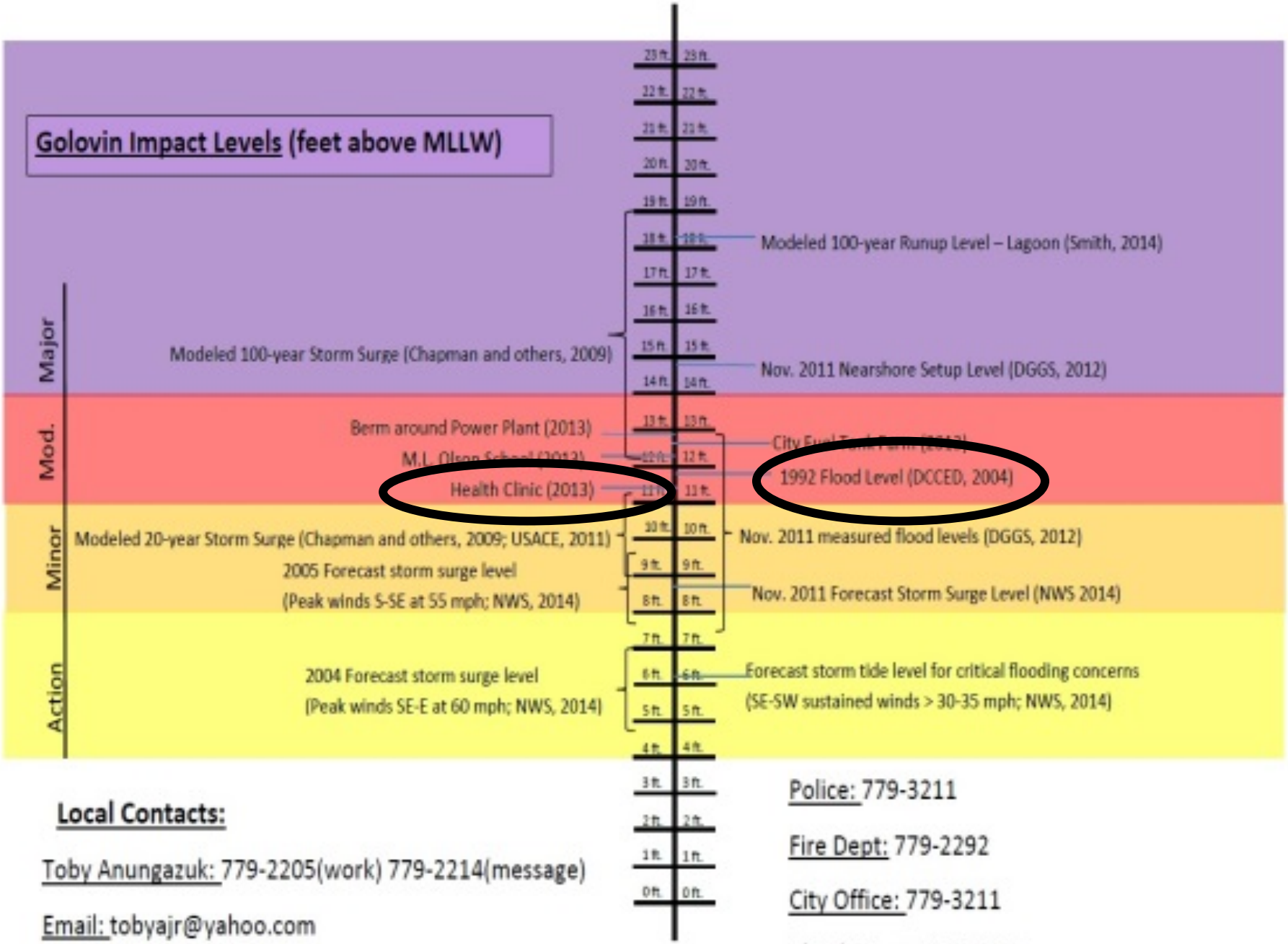
# Using the Tool: Example Scenario



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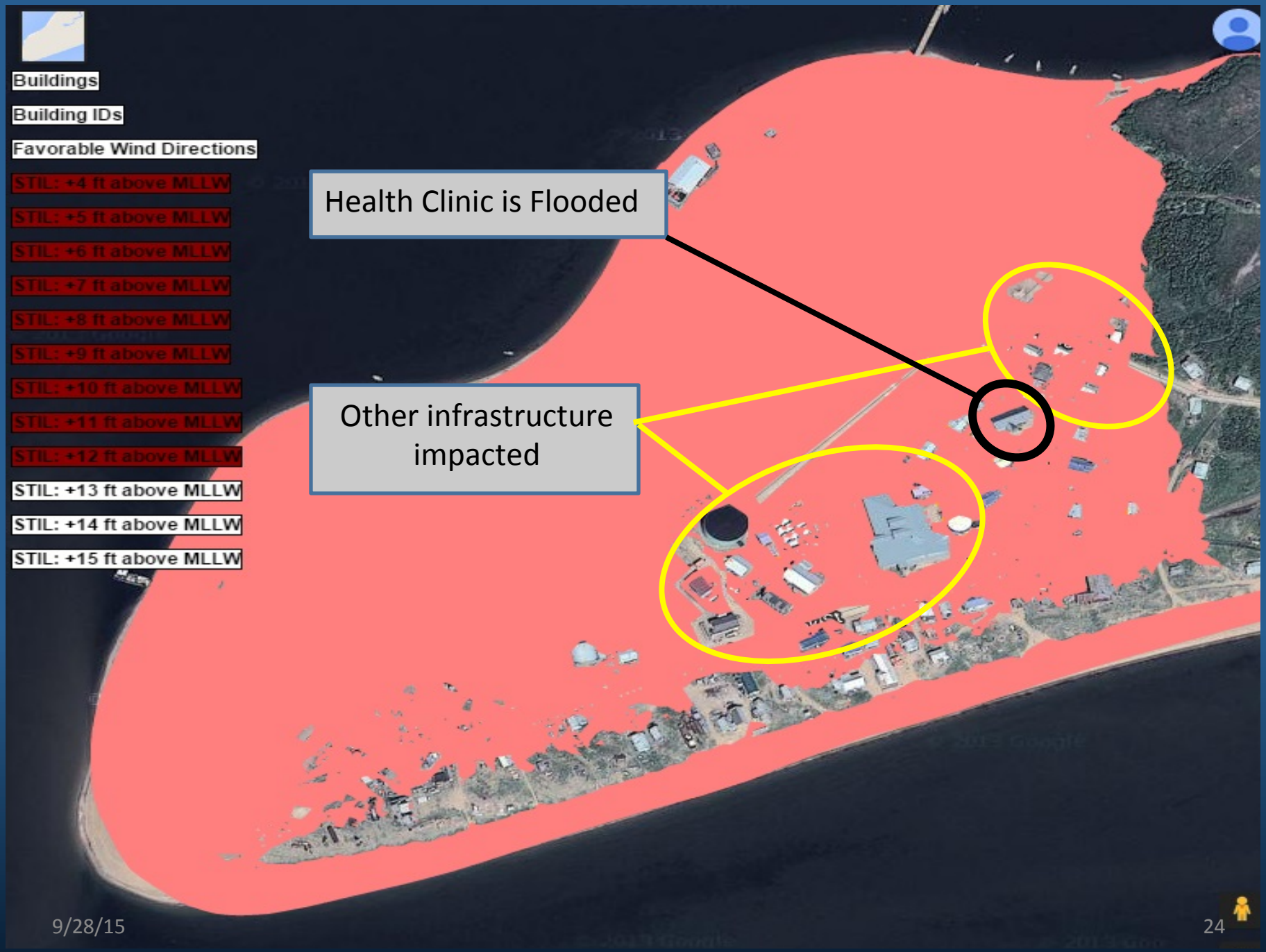

Buildings
Building IDs
Favorable Wind Directions
STIL: +4 ft above MLLW
STIL: +5 ft above MLLW
STIL: +6 ft above MLLW
STIL: +7 ft above MLLW
STIL: +8 ft above MLLW
STIL: +9 ft above MLLW
STIL: +10 ft above MLLW
STIL: +11 ft above MLLW
STIL: +12 ft above MLLW
STIL: +13 ft above MLLW
STIL: +14 ft above MLLW
STIL: +15 ft above MLLW
Health Clinic is Flooded
Other infrastructure impacted

# Future Development

- The product will be refined in time as more storms impact the communities.
- Plans are being made for the addition of 15 more communities by 2018 through collaboration with DGGS.
- Continue to build a Weather Ready Nation within Alaska.

# Acknowledgements

Ed Plumb (NWS WFO Fairbanks)

Melissa Kreller (NWS WFO Fairbanks)

Nic Kinsman and Coastal Hazards team (DGGS)

WFO Fairbanks Staff

Aimee Fish (NWS Alaska Region HQ)

# Thank you!

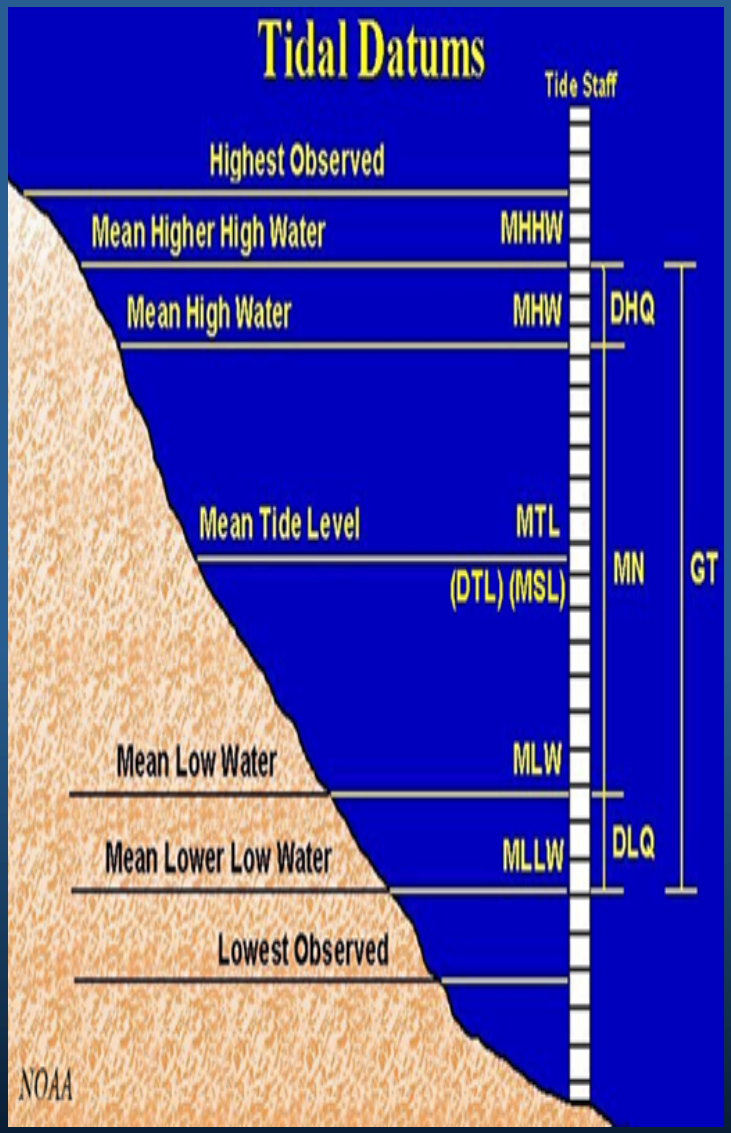
# Questions?

House Collapsing in Shismaref.

Courtesy of EPA

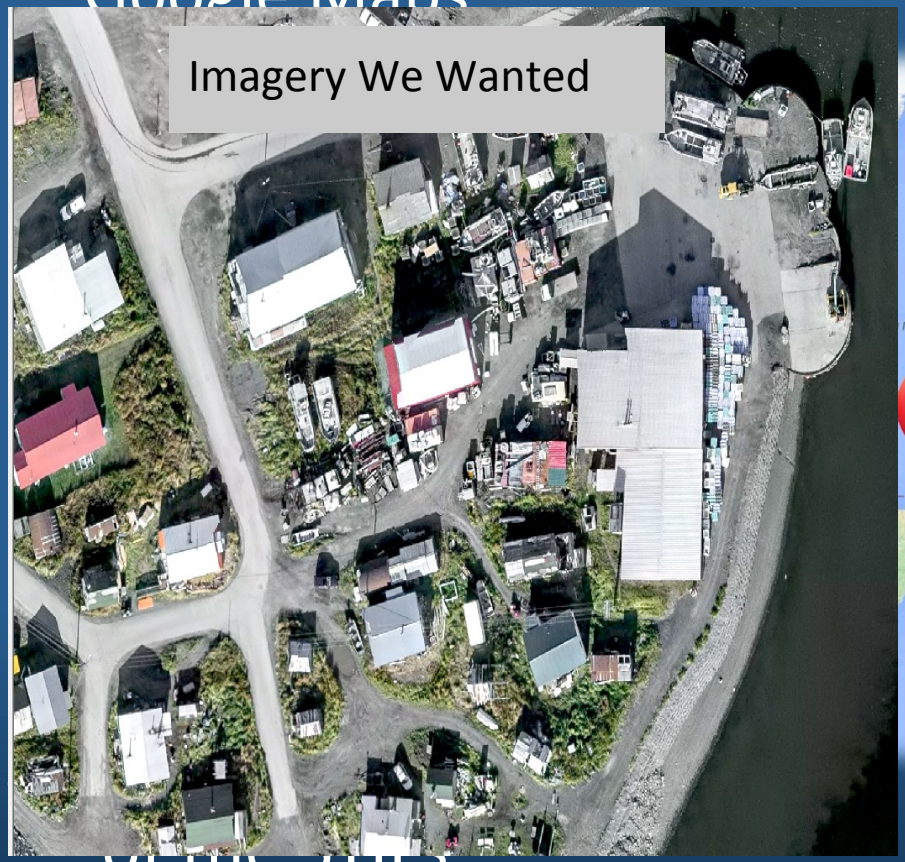
# The Communication Gap

- Tidal datums, such as Mean Lower Low Water (MLLW), are outputted by models to indicate flood levels.
- While the meteorology community may be familiar with such datum, local emergency managers are not.
- This makes it difficult for them to gauge exactly how high the water will rise & which structures will be impacted.

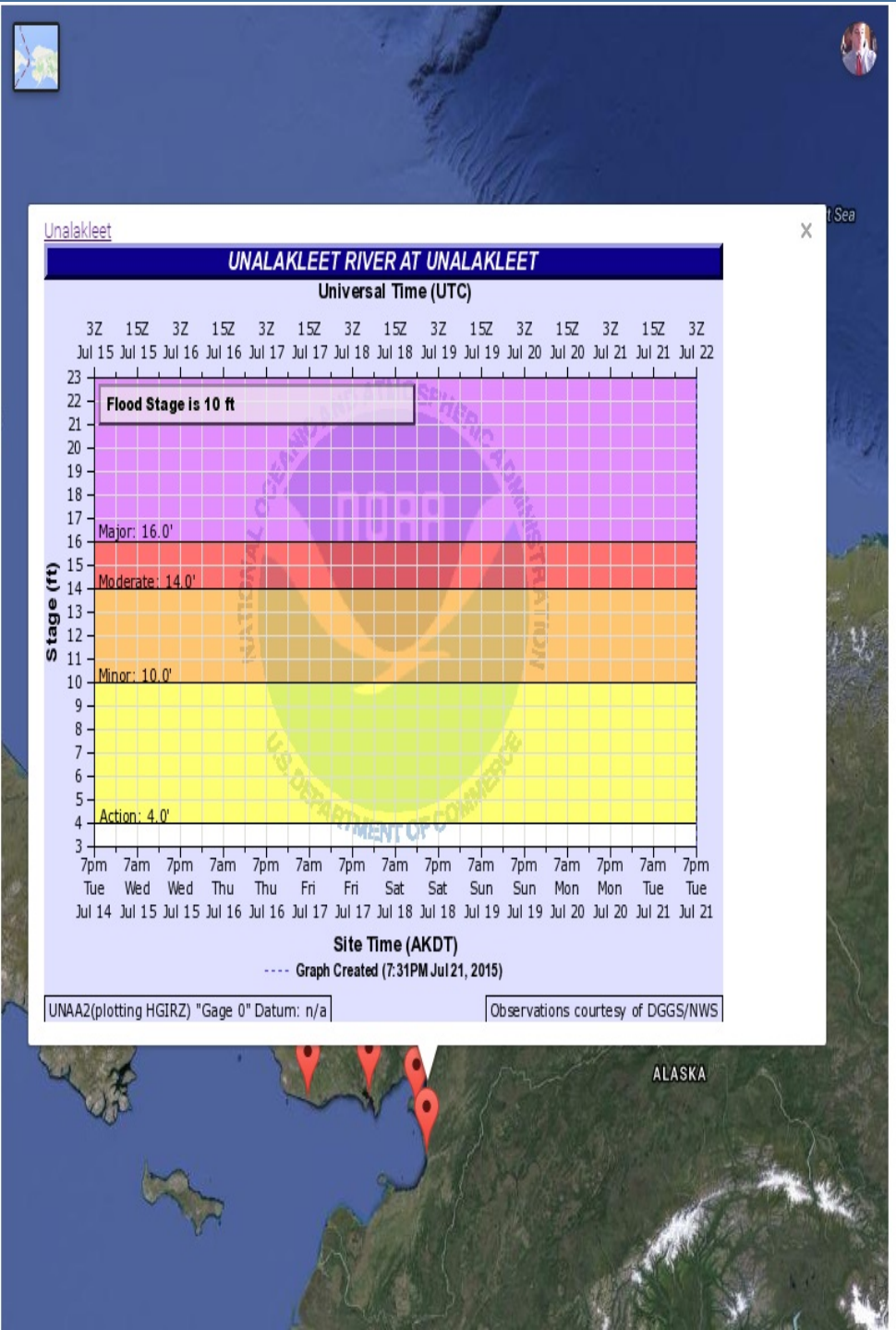


# Web Development

Google Maps



of the SITES.




# Coastal Flooding Guidance Tool

*This is experimental!*

## Choose a community for detailed Storm Tide Impact Levels:

Select City

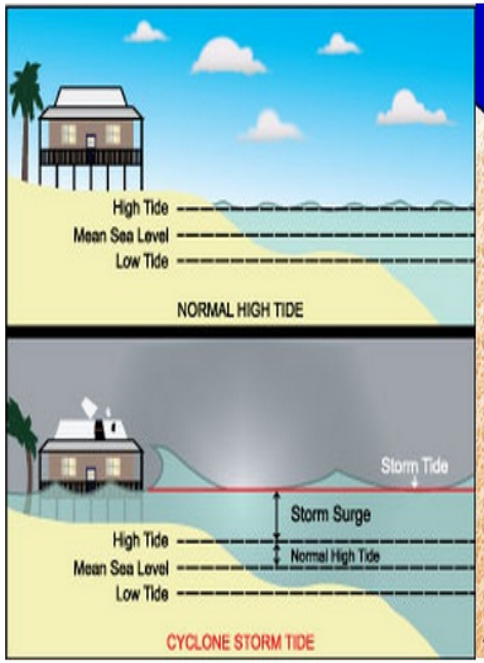
# What are Storm Tide Impact Levels (STILs)?

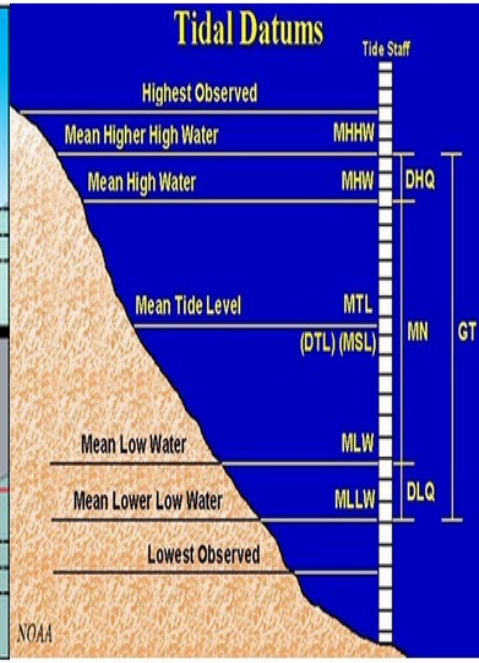
STILs show the Storm Tide level in feet above Mean Lower Low Water (MLLW)

The Storm tide is the sum of Tide Level + Storm Surge.

Neither Storm Tide Levels or this product account for wave runnup!

Click HERE for Storm Water Components and definitions



# Project Goals as they Pertain to NOAA

Primary Objective:

- Create a comprehensive and streamlined Decision Support Tool to help mitigate the impacts of coastal flooding in Alaska.

NOAA Goal/Objective:

- Weather-Ready Nation: Reduced loss of life, property, & disruption from high-impact events.

# How to "Bridge" These Gaps?

## What is needed:

A "One Stop Shop" Decision Support Tool for forecasters that combines:

- Meteorological and Tidal Model Data
- Archived Storm Data
- Observational Tidal Data
- Community Elevation and Impact Data

# What is the
# Tide?

entially:

Tidal Level + Storm Surge

IMPORTANT NOTE:
Storm Tide Levels do NOT include Wave Run Up!

| COASTAL STORM WATER LEVEL COMPONENTS | Full Definition | How Determined | Easy Explanation |
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| Tide Level / Storm Tide Level / Total Water Level | Regular in the w caused b sun/moo gravitati forces a earth's rotation | | |
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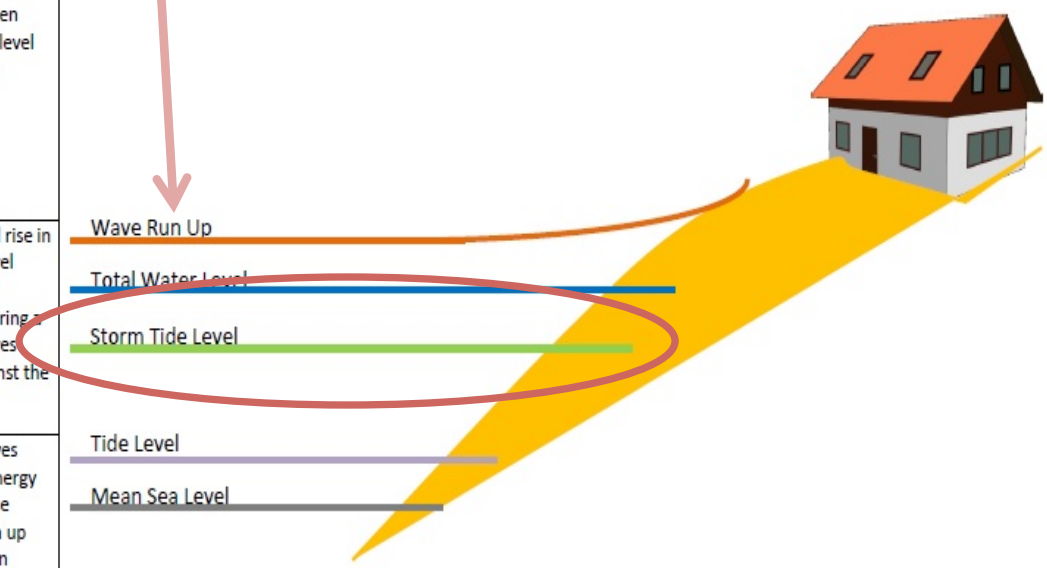
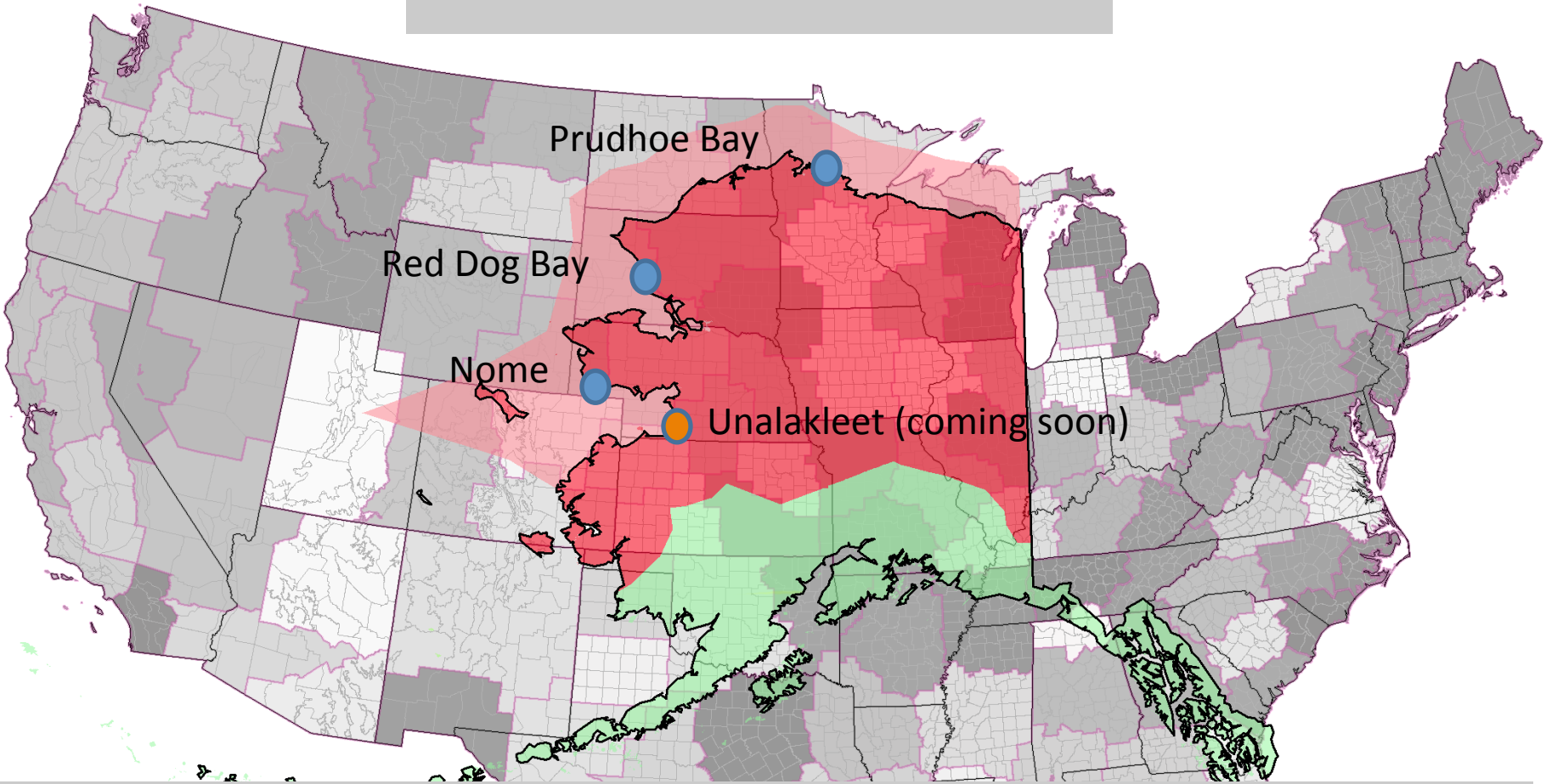



Courtesy of ADGGS

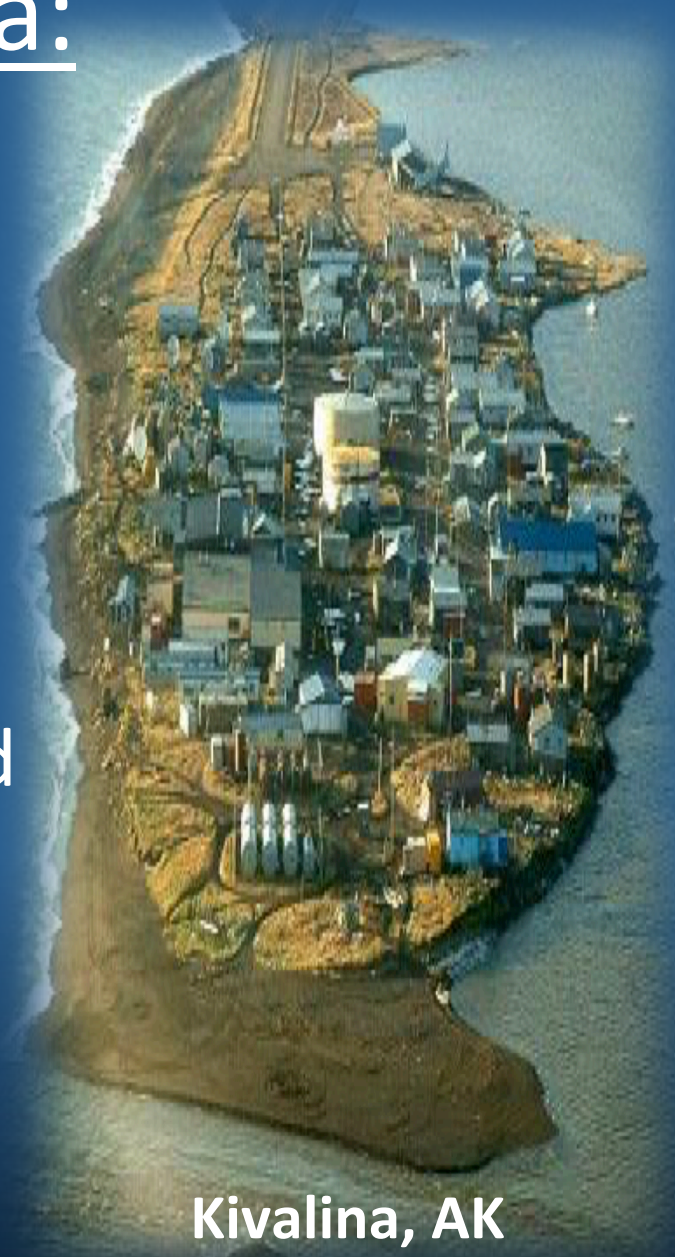
# Data Scarcity




**Only 3 tidal gauges along the entire Fairbanks WFO coast!**

# Coastal Flooding in Alaska: Fast Facts

- 26 villages are annually at risk for severe coastal flooding.
- Village populations: ~100 to several thousand.
- On average, 25 to 50 ft. of land is lost per flooding event
- Cost to relocate each village:
  - ~ $200 million.



**Kivalina, AK**

City & Tidestaff | DGGS Elevation Maps | Additional Info

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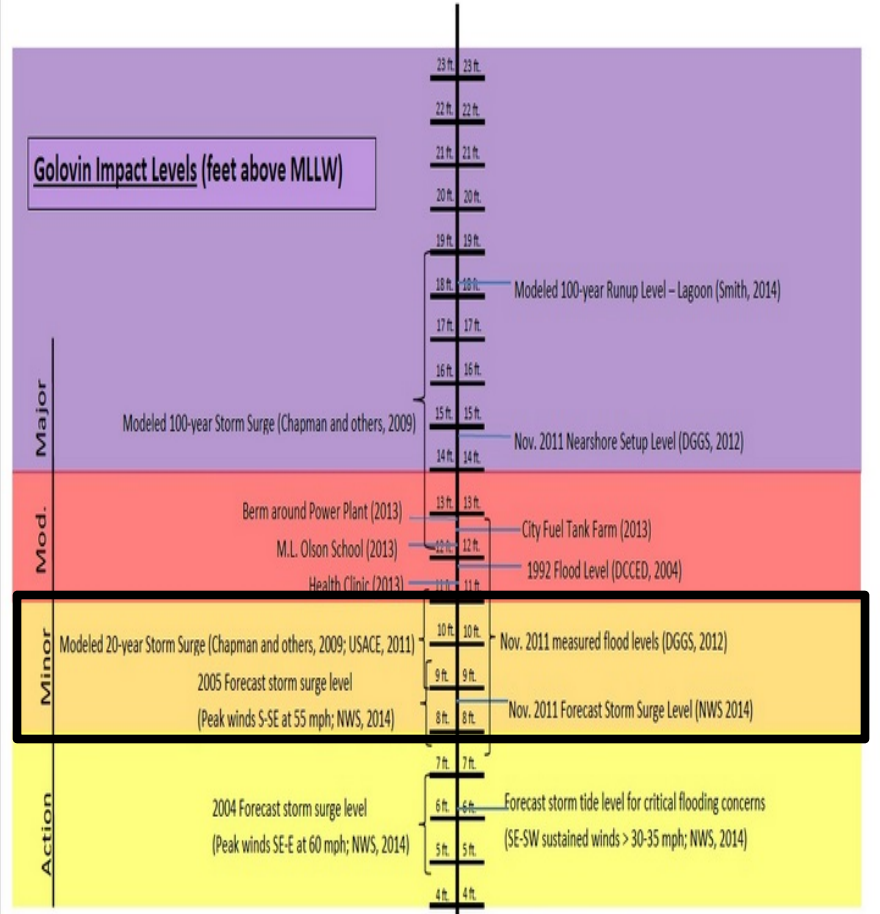


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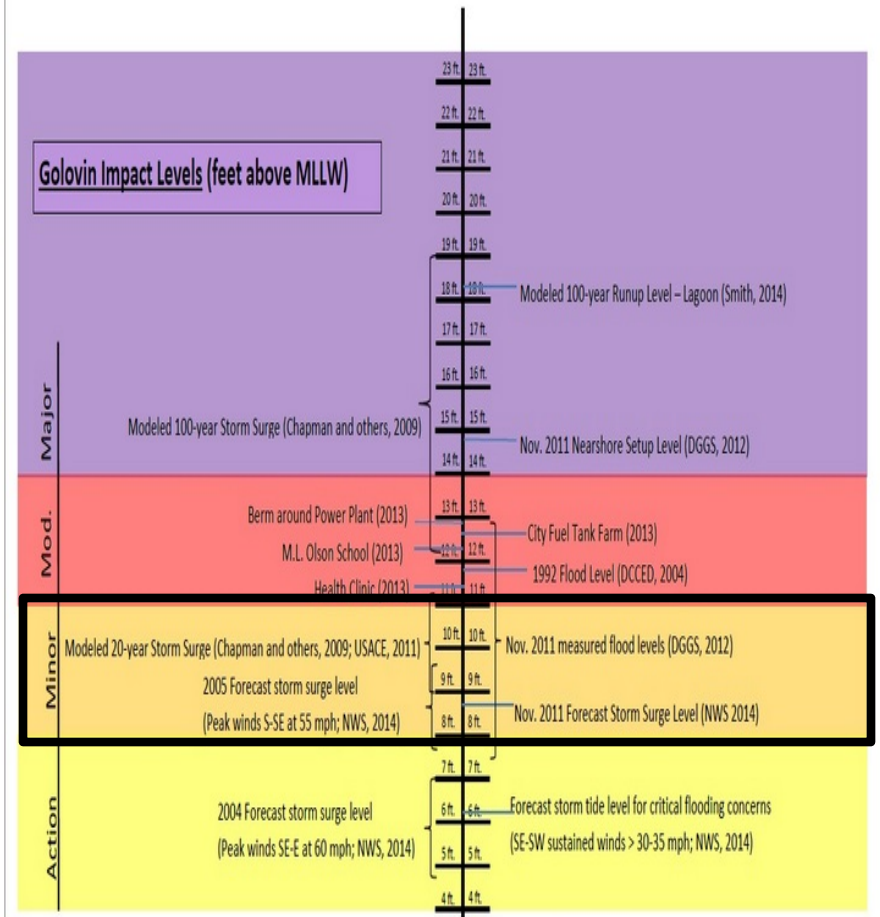


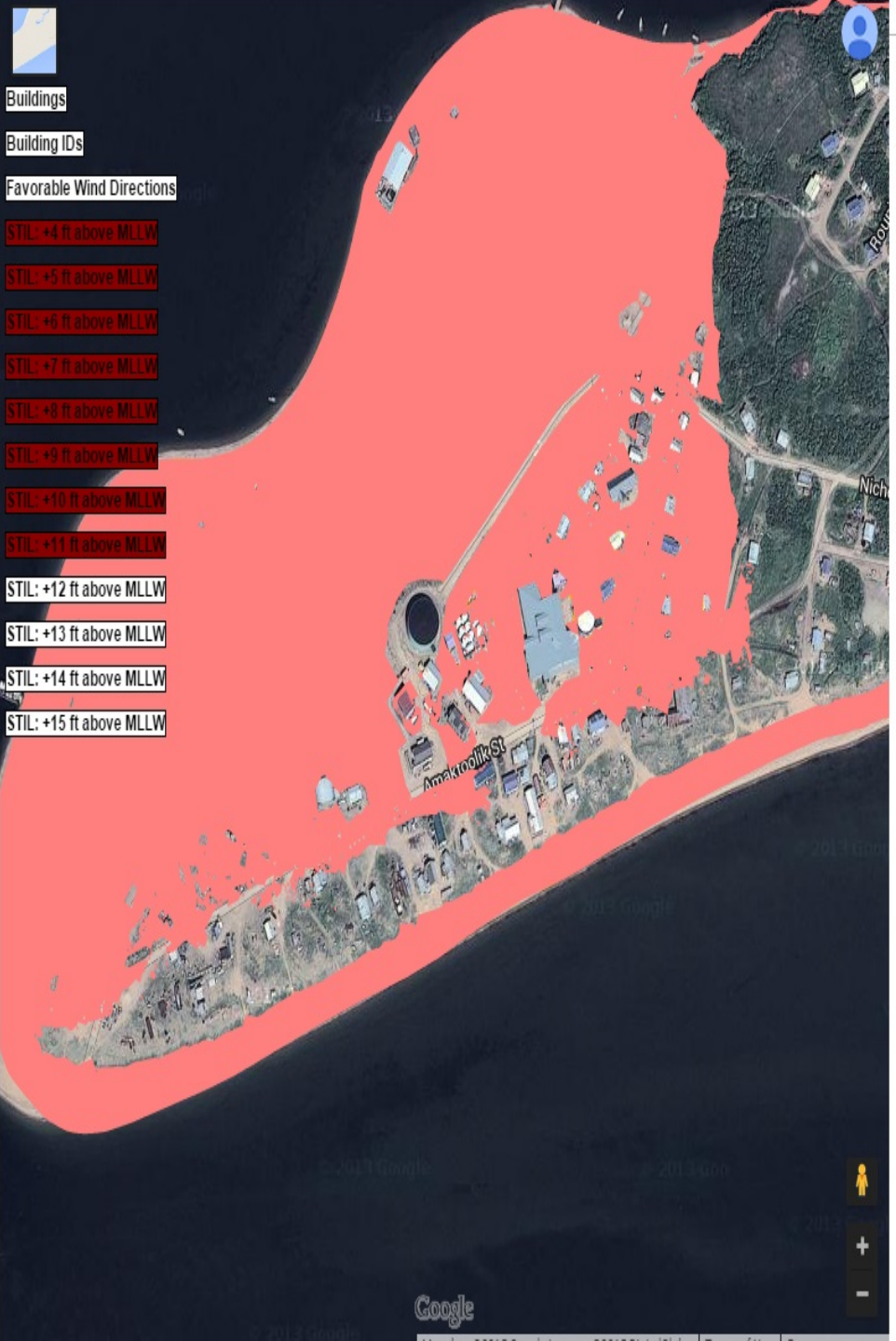

**Local Contacts:**

Toby Anungazuk: 779-2205(work) 779-2214(message)

Police: 779-3211

Fire Dept: 779-2292

City Office: 779-3211

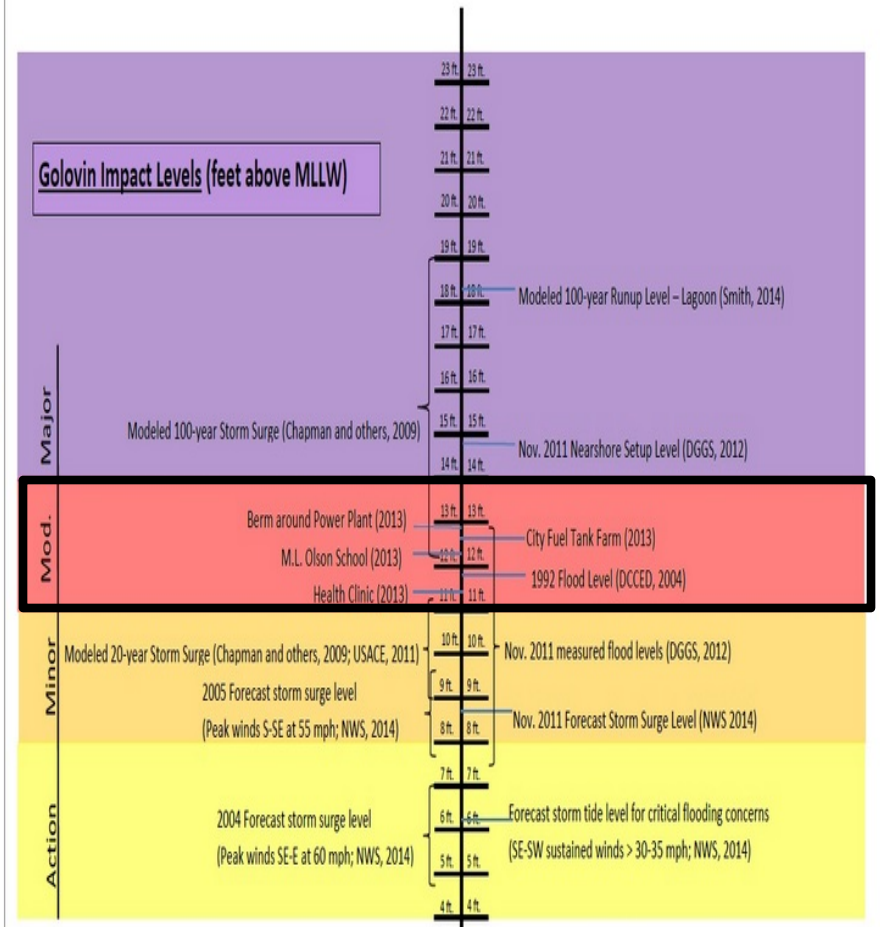



City & Tidestaff | DGGS Elevation Maps | Additional Info

# Current City: Golovin

## Storm Tide Impact Levels for additional communities:

Current City

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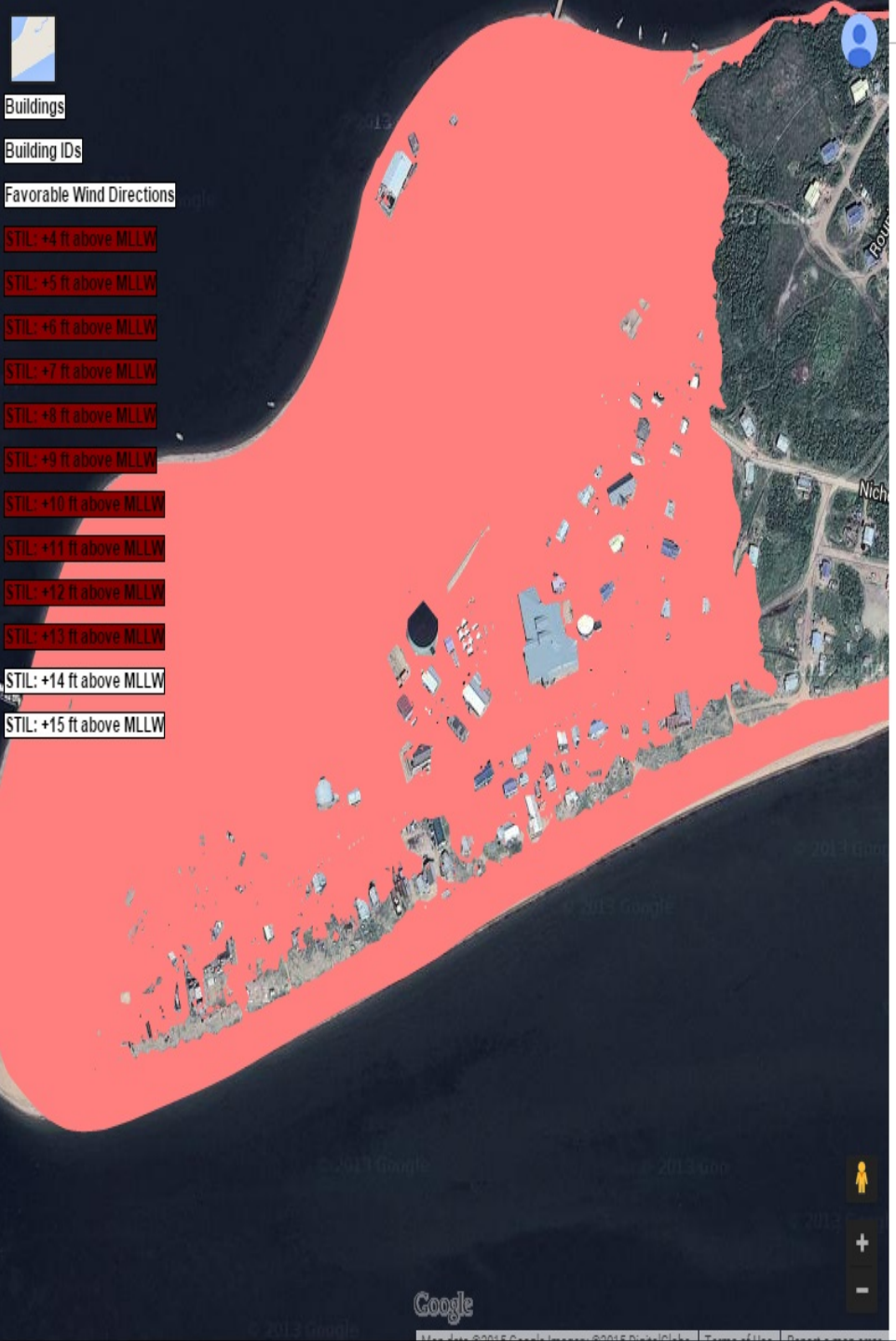
City Office: 779-3211

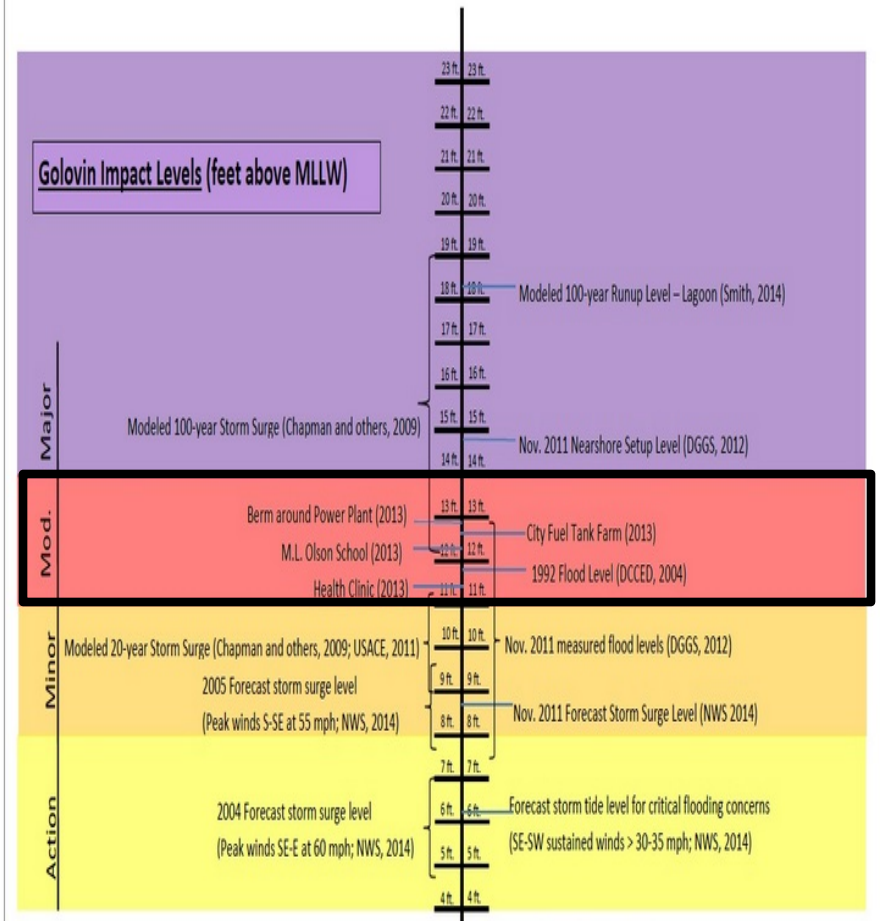



City & Tidestaff | DGGS Elevation Maps | Additional Info

# Current City: Golovin

## Storm Tide Impact Levels for additional communities:

Current City

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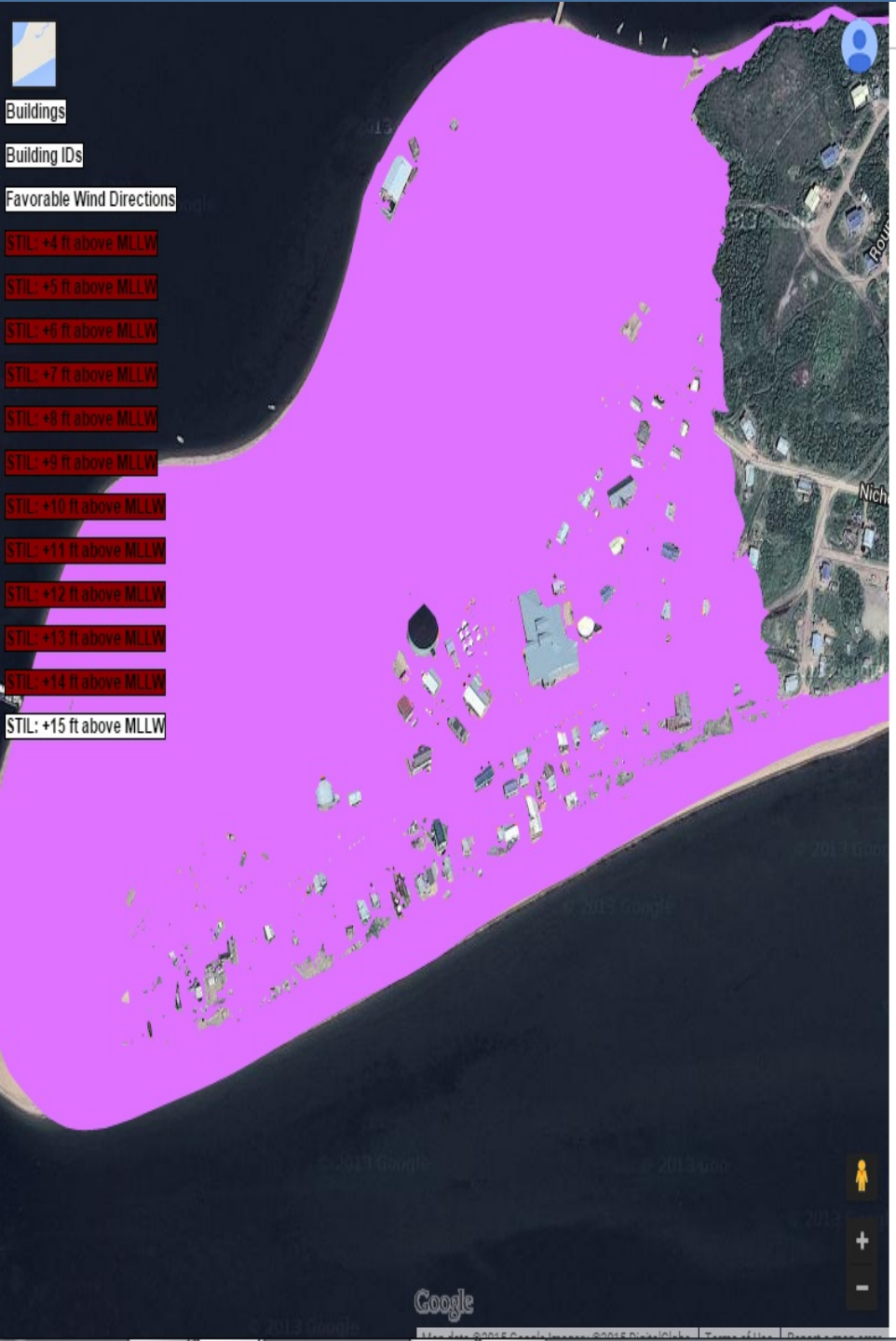
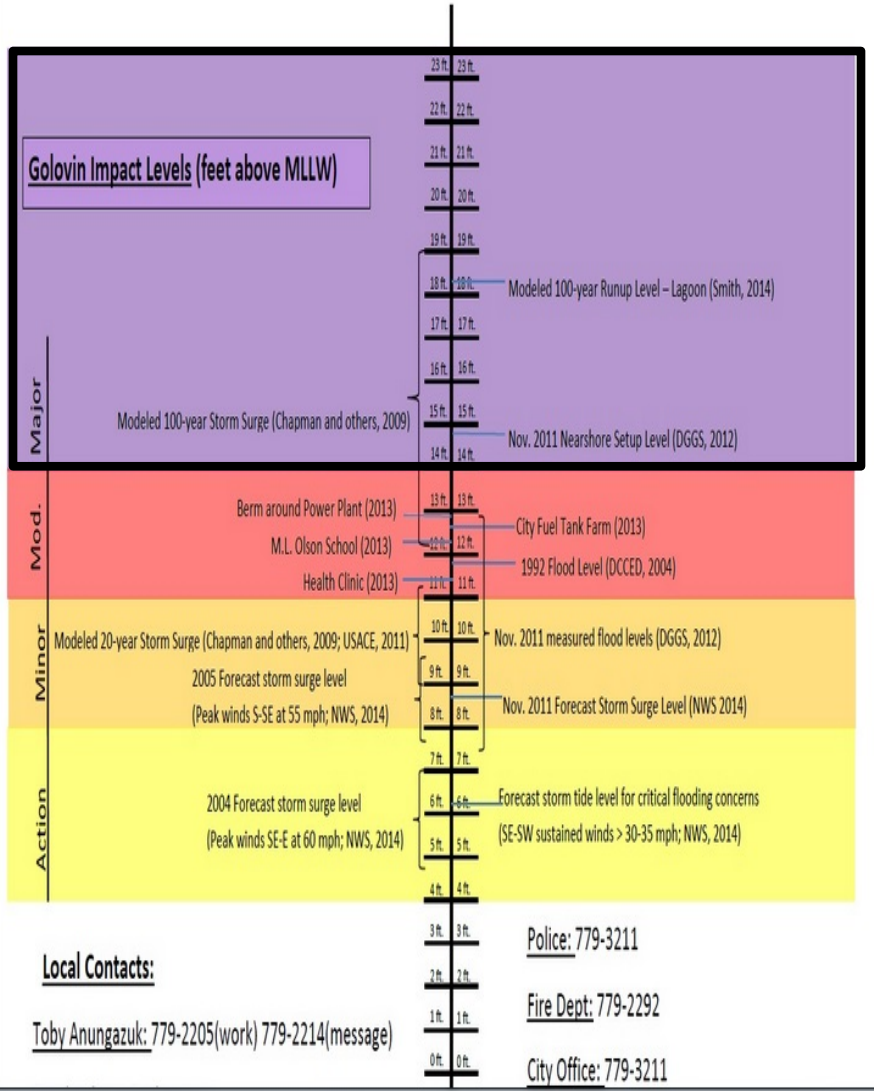



City & Tidestaff | DGGS Elevation Maps | Additional Info

# Current City: Golovin

## Storm Tide Impact Levels for additional communities:

Current City




**Local Contacts:**

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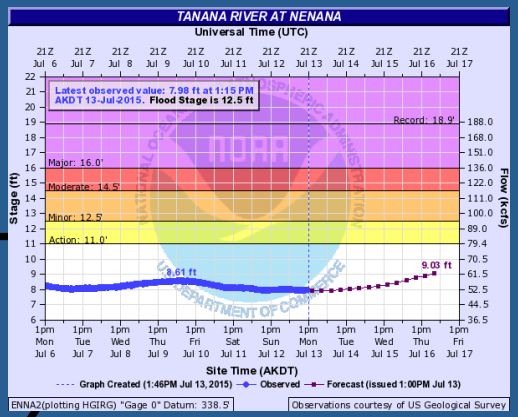
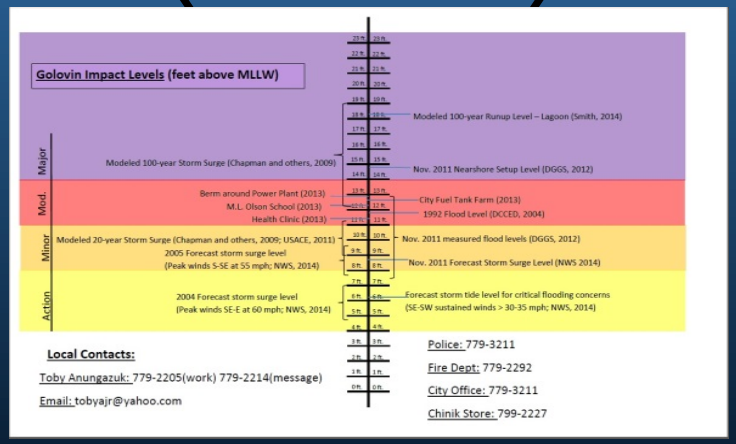
# Building the Tool

## Elevation Data

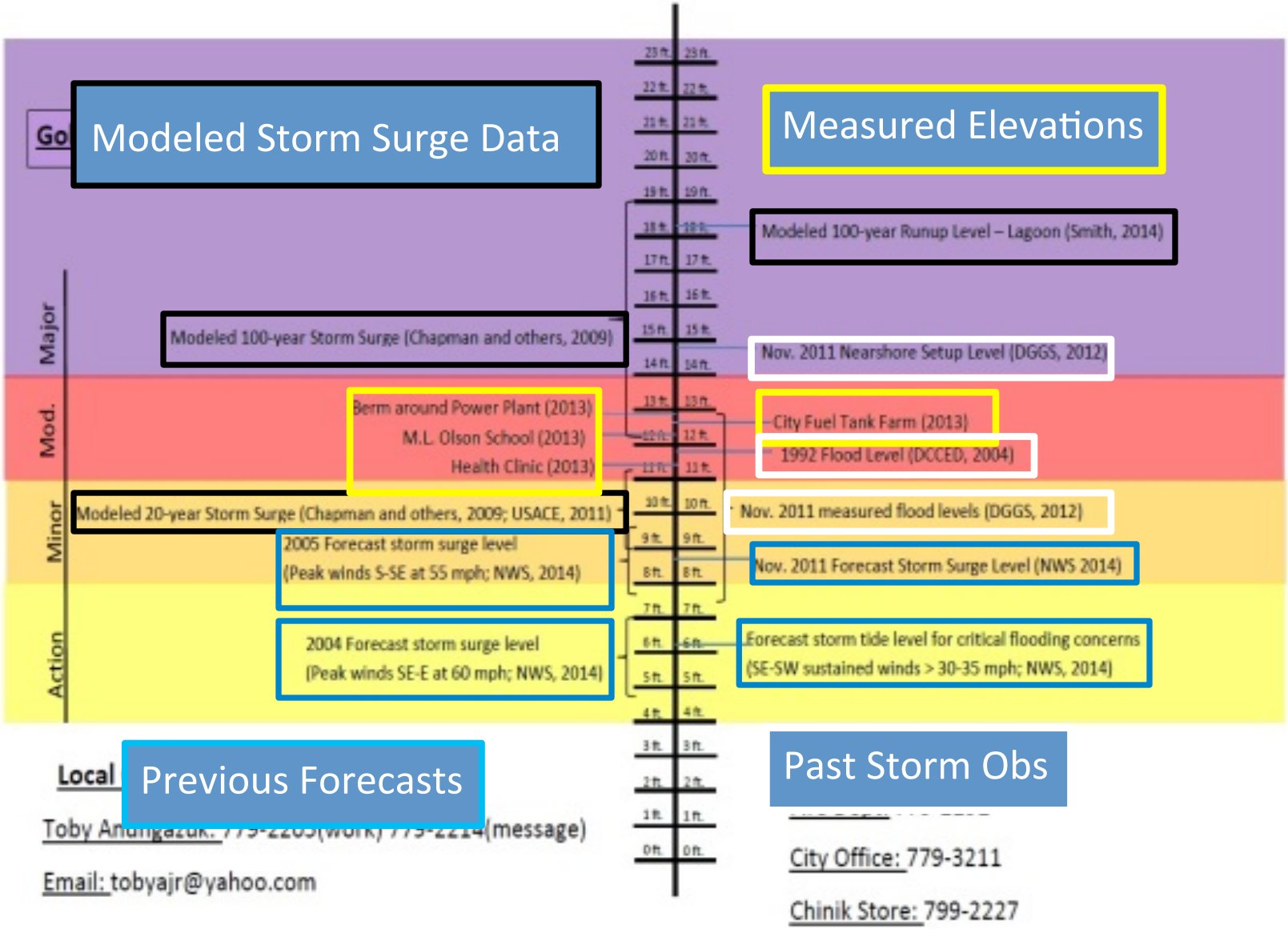
## Graphical Tidal Data



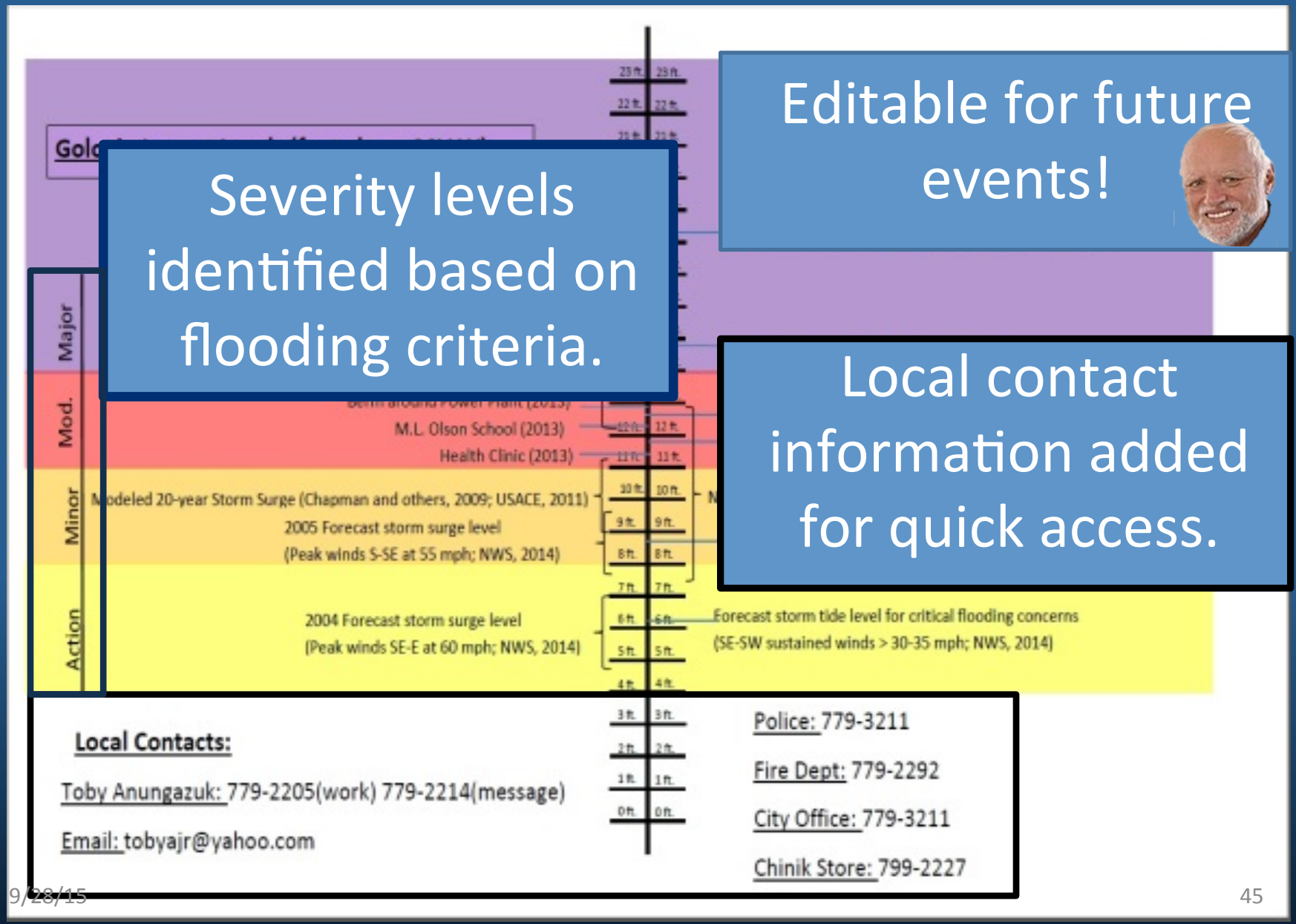

## Impact Tide Staffs



# Impact Tide Staffs



# Impact Tide Staffs

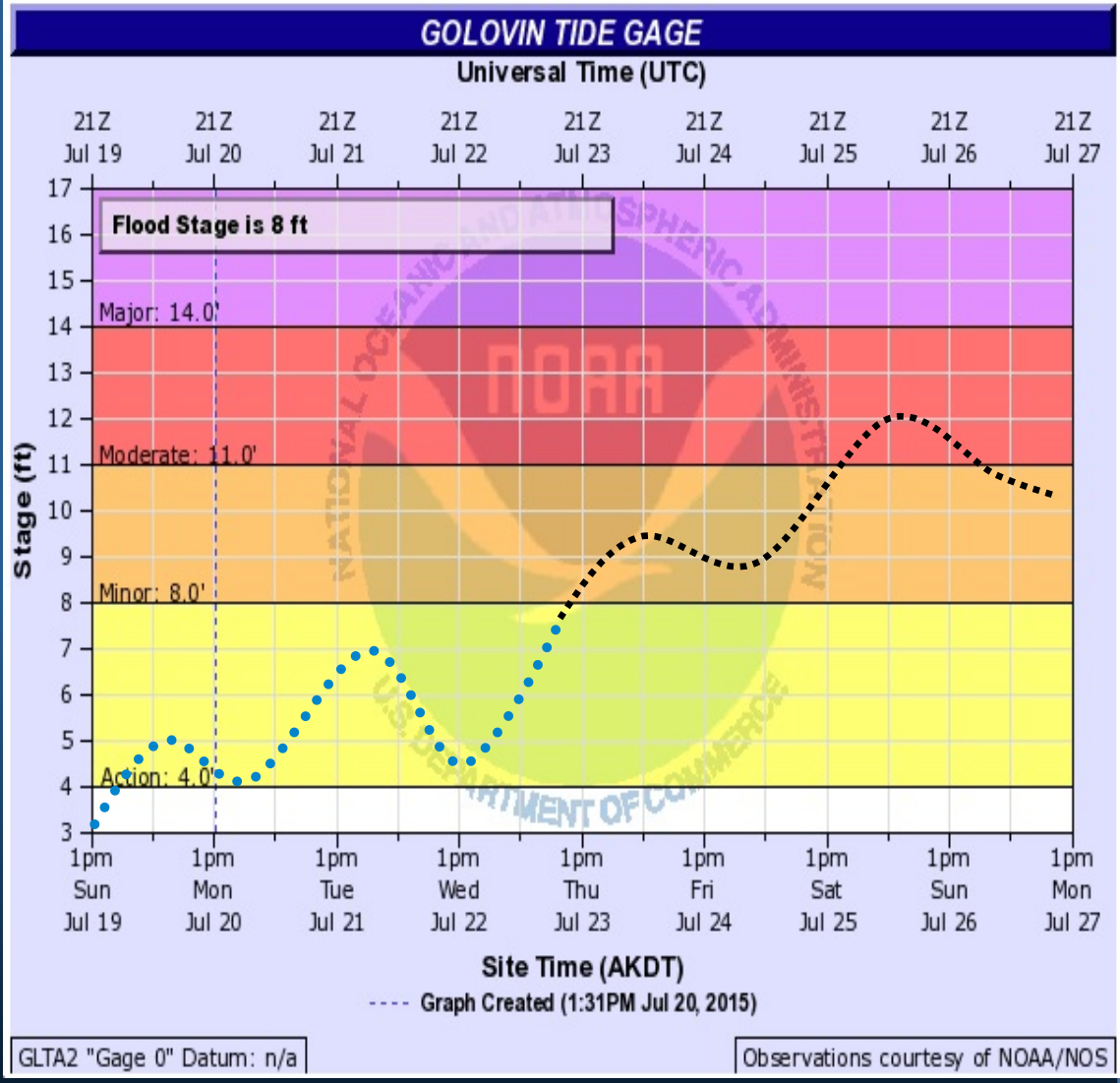



Severity levels identified based on flooding criteria.

Editable for future events!

Local contact information added for quick access.

# Graphical Tidal Data

Model forecasted tidal information is available for each site

Allows forecasters to get a first guess as to which locations may experience coastal flooding