San Rafael ELEVATE

RESILIENT BY DESIGN | BAY AREA CHALLENGE

DESIGN REPORT
5 / 31 / 2018

bionic TEAM

RESILIENT BY DESIGN
BAY AREA CHALLENGE

VERSION 2
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RAD Urban
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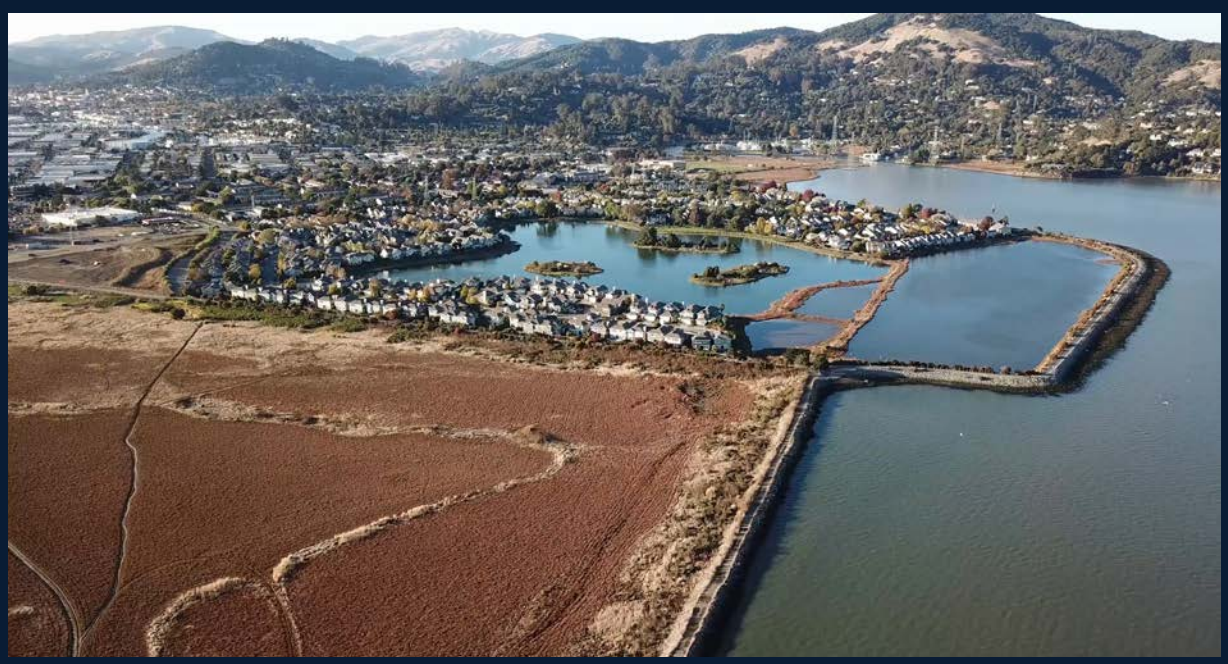
Introduction +

ELEVATE FRAMEWORK

INTRODUCTION

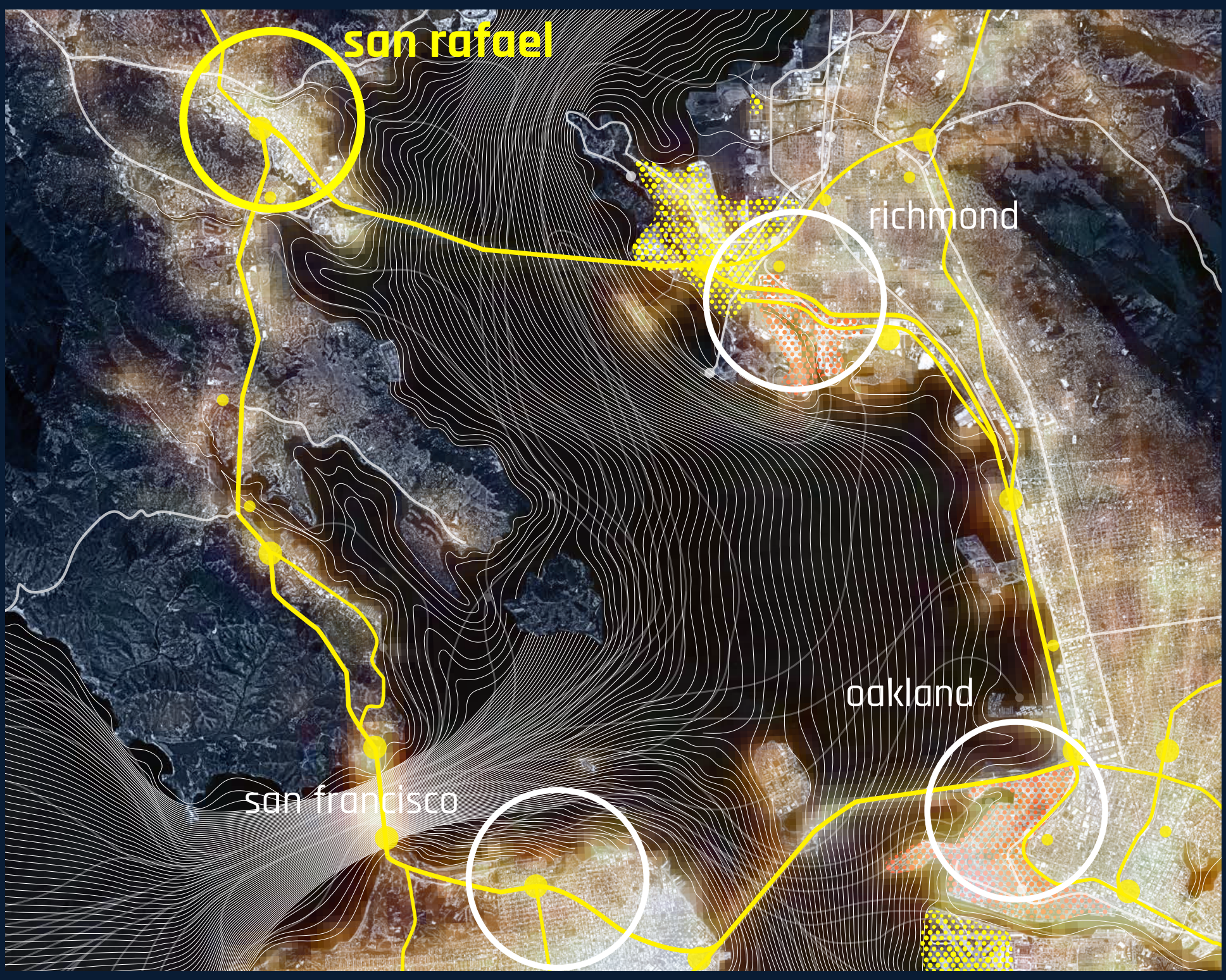


Aerial View of Canalways Tidal Marsh and Spinnaker Lagoons

The Bionic Team was organized around the cause of finding the area that needs help the most in the face of Sea Level Rise. An in-depth research and analysis process of the San Francisco Bay Area identified San Rafael as the area in greatest need.*

San Rafael is a small city of 59,000 that exhibits all the stresses of the Bay area metropolis, because it is one of its vital infrastructural, logistical, and workforce centers. It is home to vibrant communities and industry all located in low-lying areas. Today it is threatened by flooding.

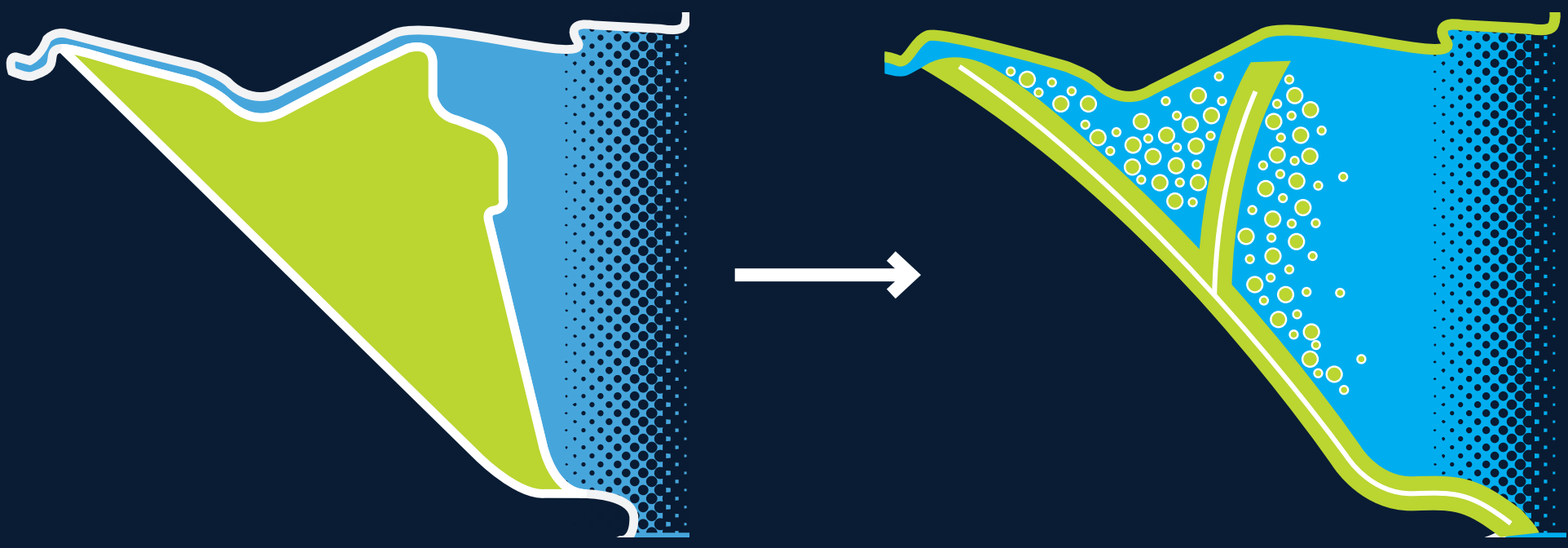
* See Research Report from Phase I.



Forces + Flows: infrastructural, logistical, and workforce centers define the region

Subsidence in the San Francisco Bay Area: San Rafael will subside 15" by 2040.

http://www.esa.int/spaceinimages/Images/2016/11/Bay_Area_displacement



Life versus Bay

San Rafael is threatened by the old paradigm of mono functional infrastructure. For good, practical, and humane reasons, the easiest solution for the complex pattern of urbanism and coastal dynamics in San Rafael would be to gate off the creek, raise the levees, and proceed with life as it is known today. To continue with this paradigm would compound risk. It would increase the separation that the city has with its waterfront. It would perpetuate the deep issues of urban stress placed on businesses and the community, all located below sea level. It would further eradicate coastal habitats and interrupt coastal processes. It would be hugely expensive. If there were a failure it would be a humanitarian crisis. As sea levels rise it would ultimately become obsolete, and a legacy offering danger with even fewer options remaining for future generations.

The old paradigm is disaster that would define us. It is reactive, not proactive.

Life with Bay

Through the course of the challenge the big questions became clear.

Is the cost, effort, and ecological impact of the conventional solution worth it, and for whom?

Or can San Rafael initiate a process of strategic change?

The Bionic Team asked the San Rafael community at large:

How do you want to live?

And the Team asked themselves:

Is there another way?

Finding a new paradigm is the challenge for San Rafael.

bionic TEAM

San Rafael ELEVATE

The BionicTeam project is titled Elevate San Rafael. It is the simplest way to describe what needs to be done: to occupy higher elevations and raise the quality of life and social connection for everyone. The project does not propose that the city should merely adapt, retreat, or resist. Instead, it proposes that the city should evolve with intention. Elevating is to physically elevate habitation, and the bonds of community and dignity; to elevate ones social and financial position in life, and policy for urban change; to lift infrastructure to a new level, and allow for ecology to expand.

Elevating employs coastal management approaches in combination with a moral, financial, and infrastructural agenda for large scale preparation. In this process of strategic change and redefining the relationship to the bay, the project proposes a singular opportunity to elevate all aspects of life.

San Rafael ELEVATE

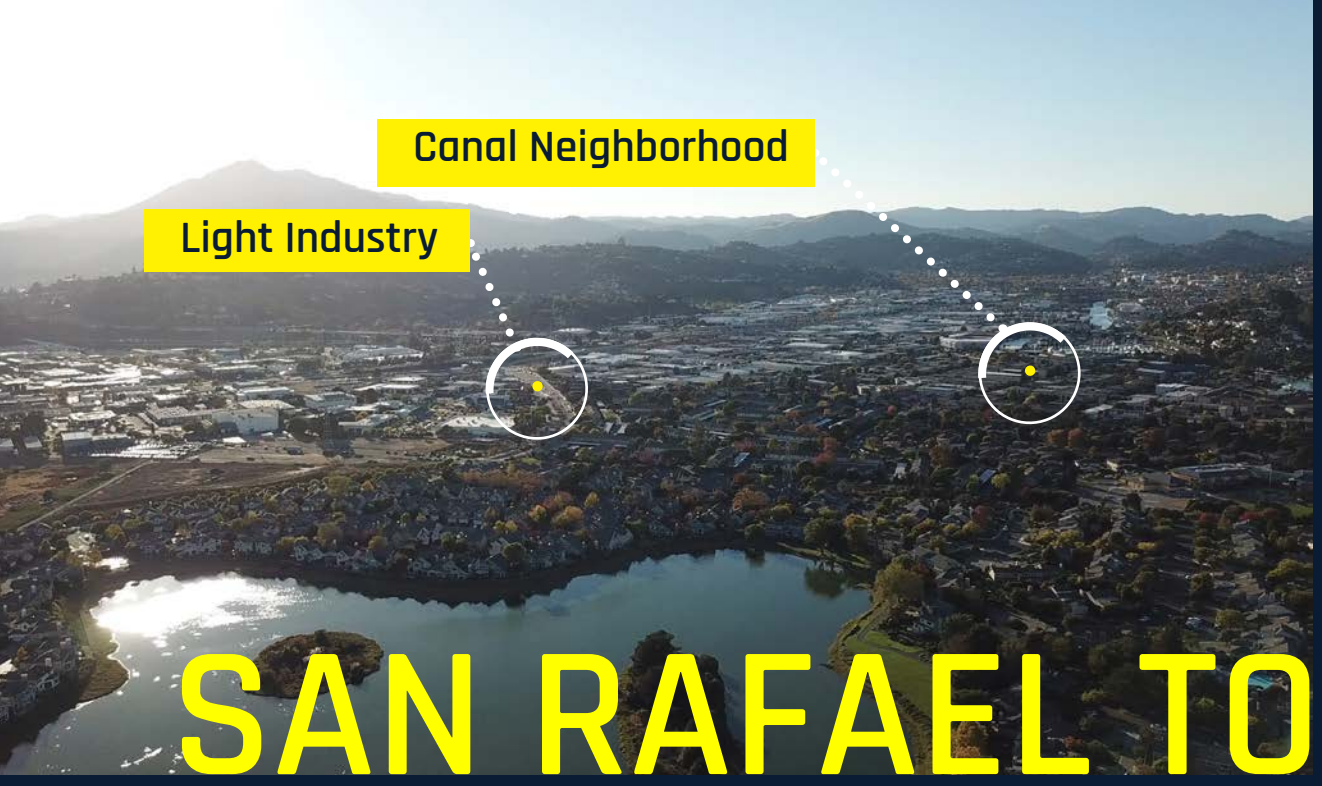
Elevating is an opportunity to improve both housing and bay ecology. It is expansive and inclusive, simple and synthetic, multi-generational, urgent and patient, real and futuristic, sensitive and bold, policy and practice.

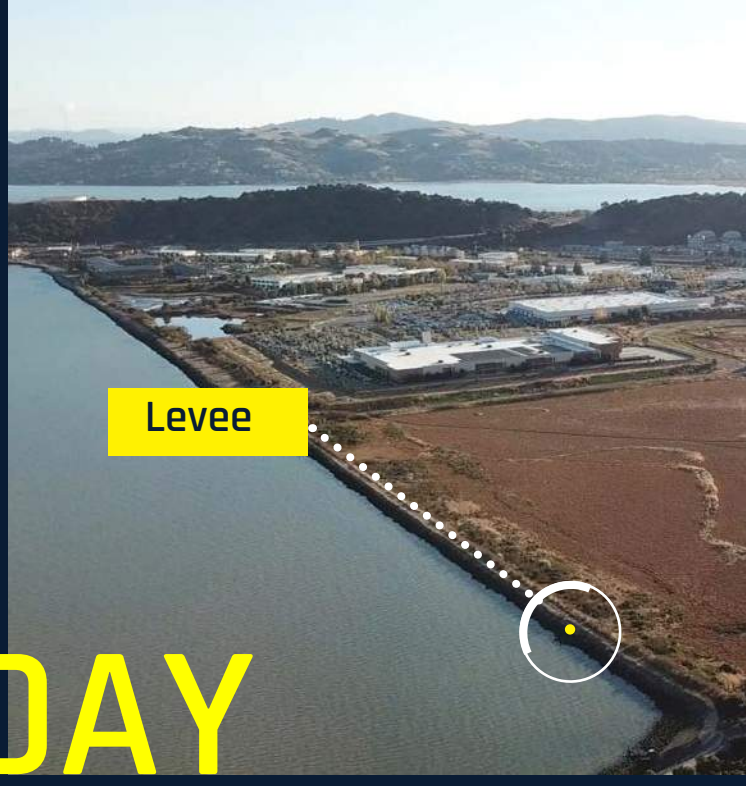
It must be done by design, not by disaster; it must done for the benefit of all, not the few; it must begin now, not later, and it will require changing our policy and financing mechanisms to make it possible and equitable.

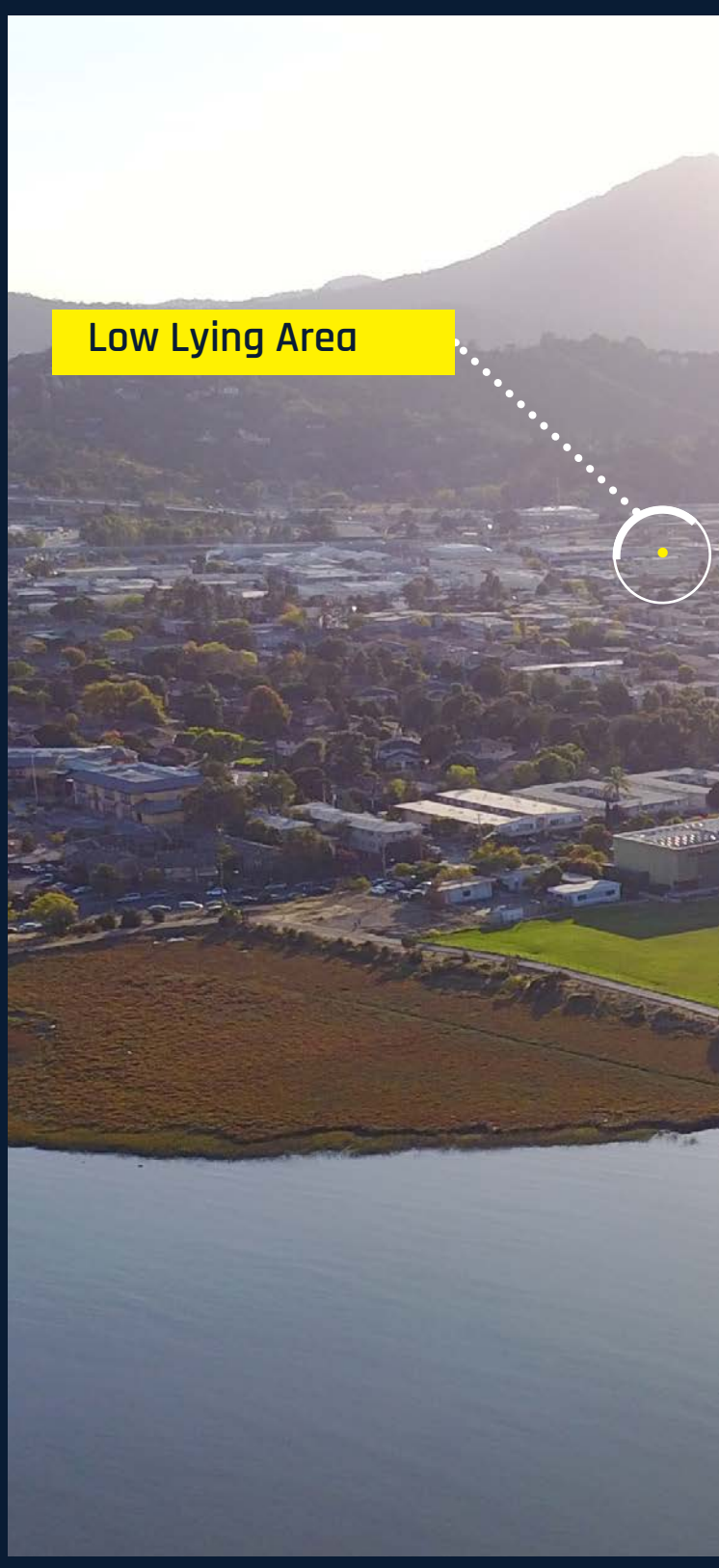
bionic TEAM

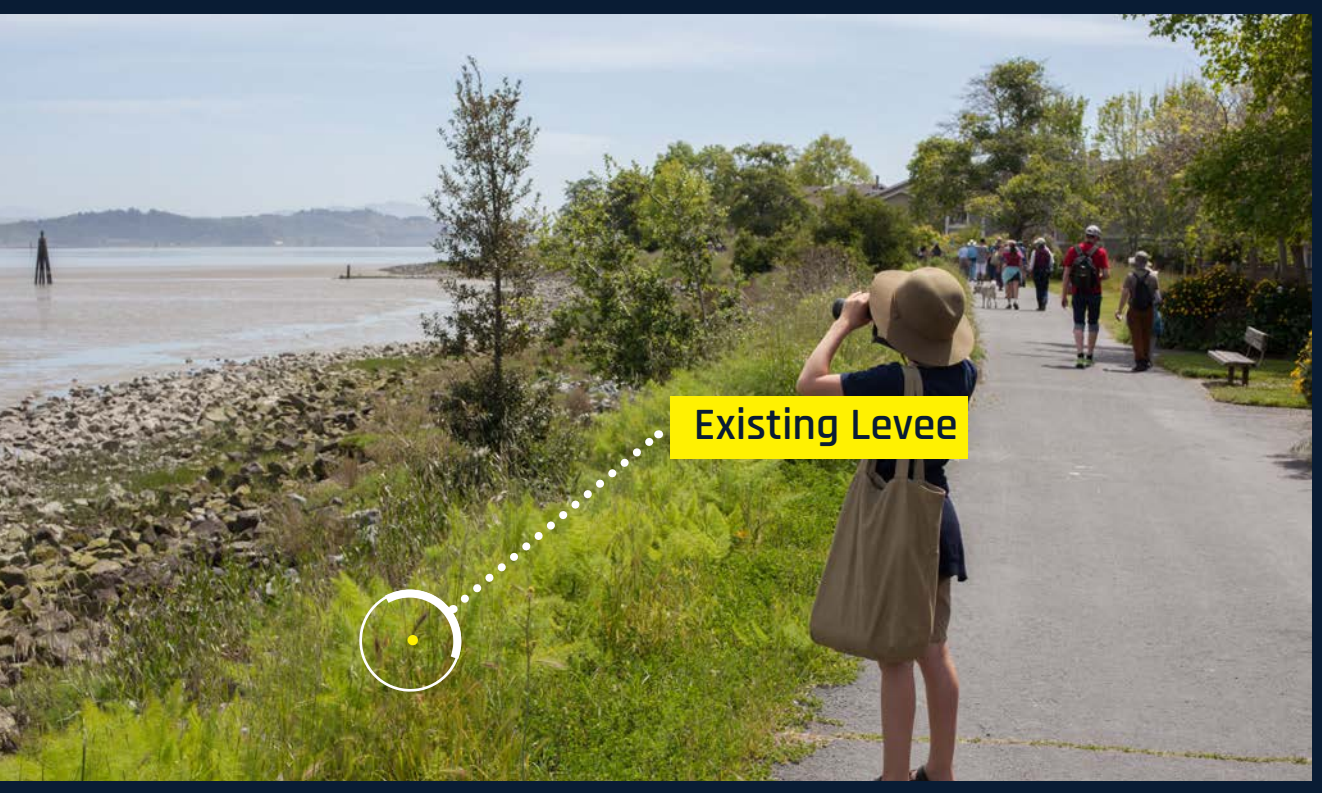
Understanding COMMUNITY

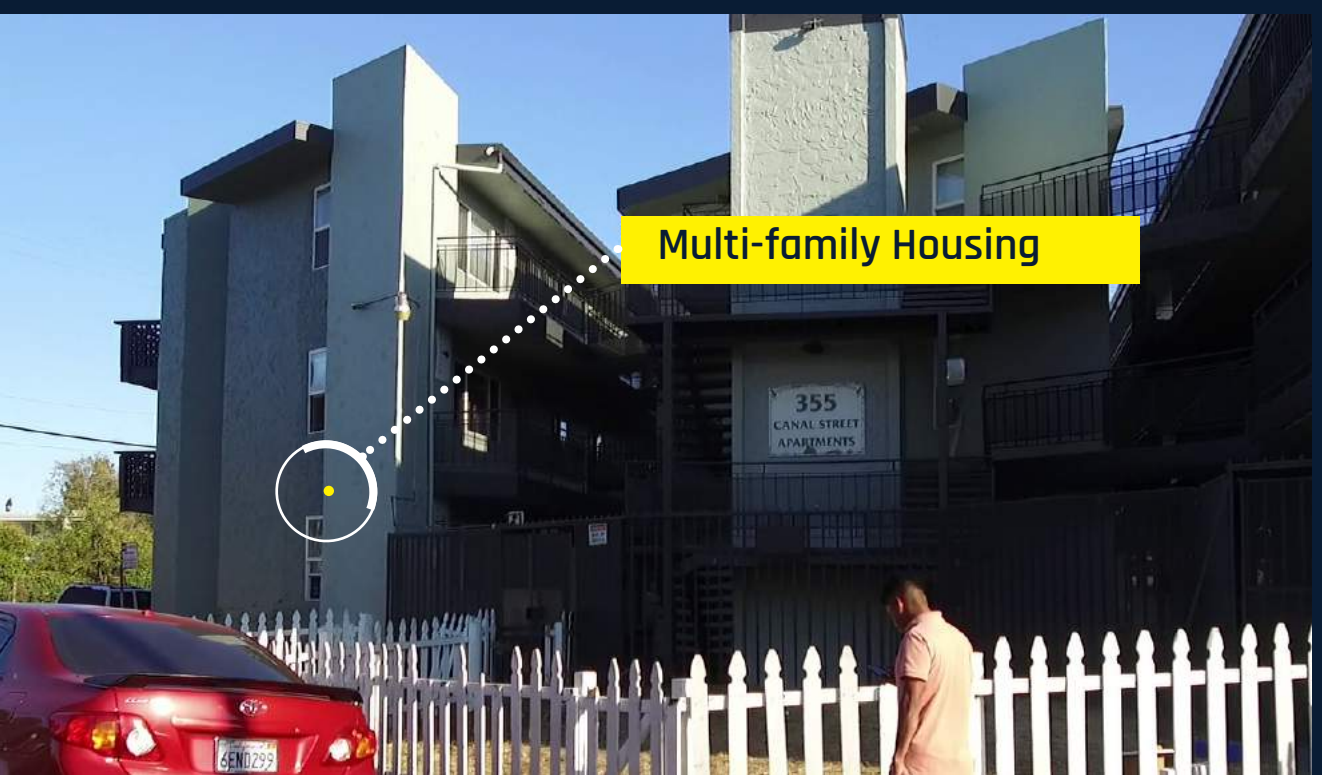
SAN RAFAEL TODAY

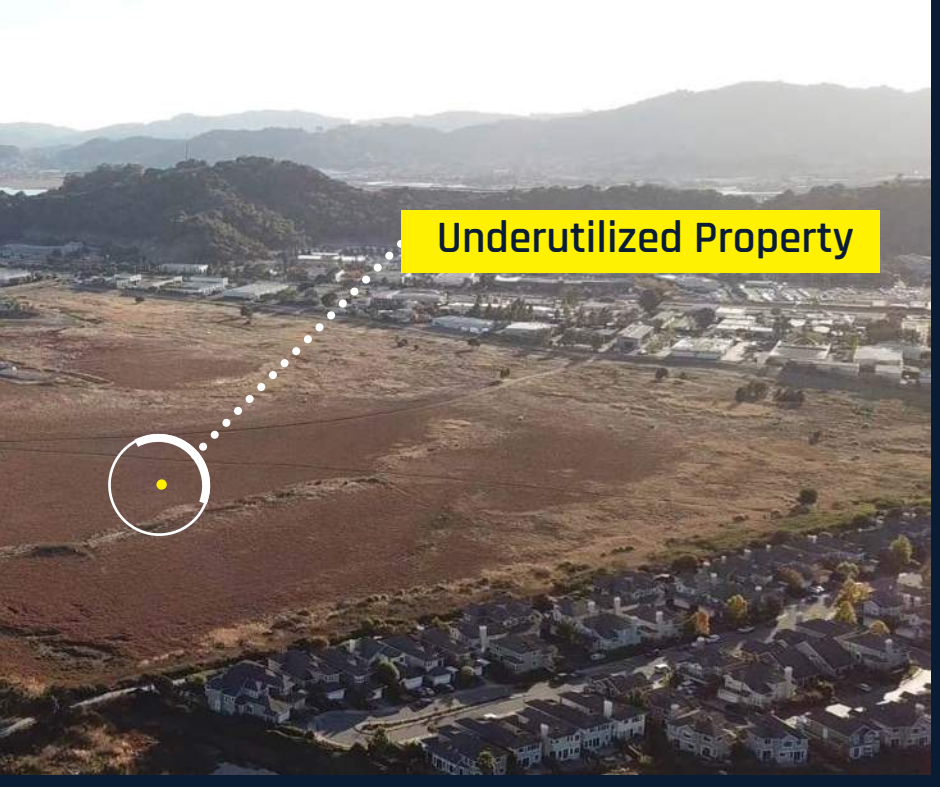


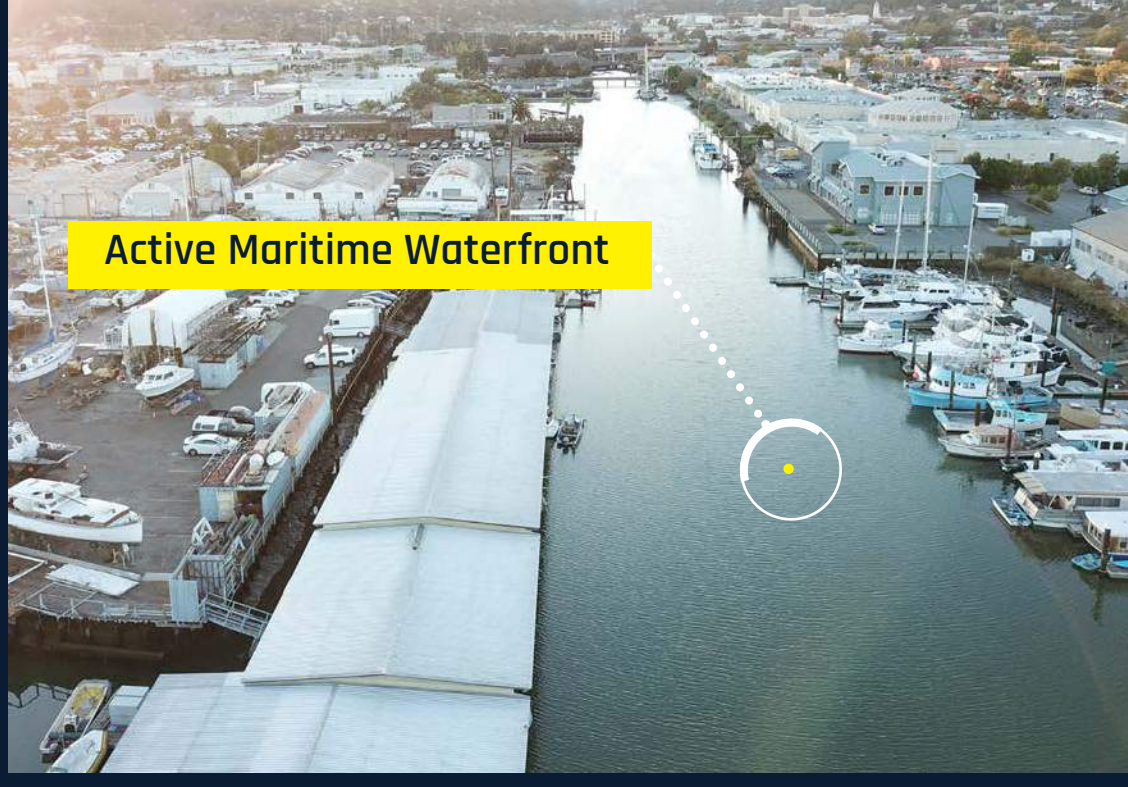






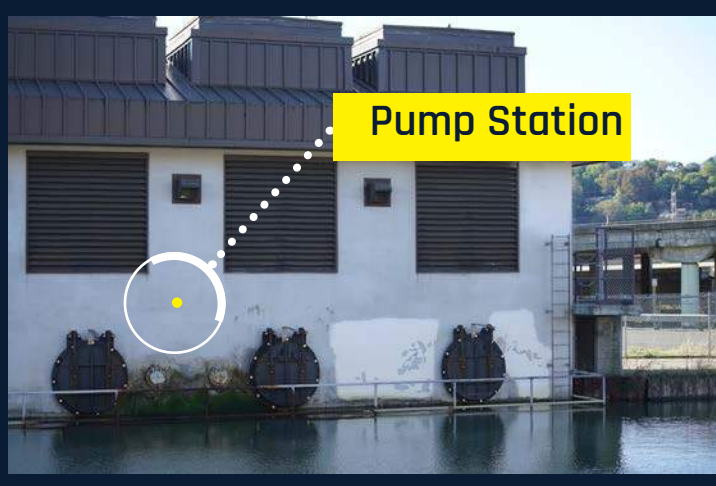


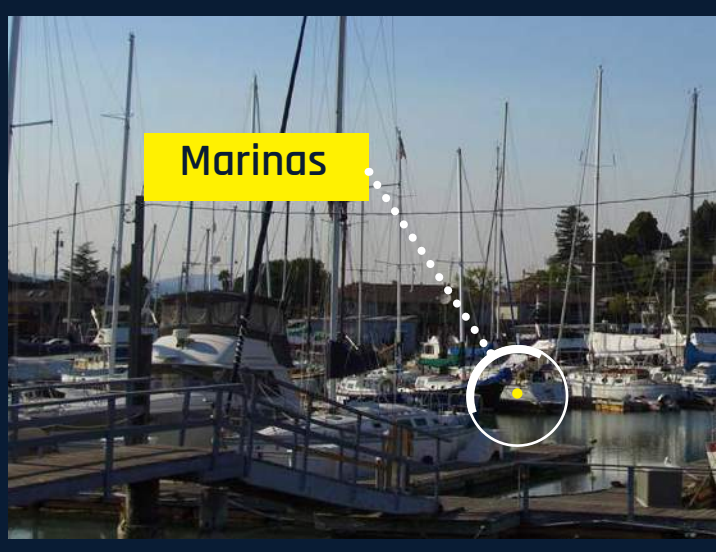

Underutilized Property


Active Maritime Waterfront


Canal
Pickleweed Park + Community Center


Drain Discharge


Pump Station

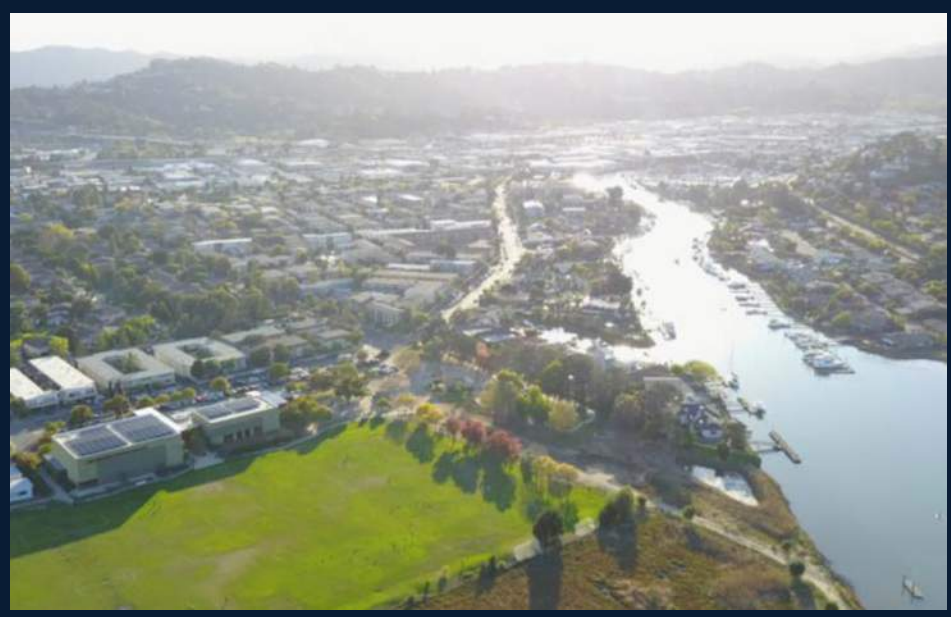

Marinas

Tidal Marsh

LOCAL COMMUNITIES

East San Rafael

East san Rafael is home to thousands of people and businesses. It is built on what was formerly salt marsh and mud flats. San Rafael Creek, also know as the canal, flows through the area. A portion of the community lives and works on the water. The infrastructure, roads, housing stock, and natural environment are all showing signs of urban stress and environmental change. A large portion is light industrial and auto retailers. Downtown is located along the creek. And there are existing neighborhoods and community facilities, all in low lying areas.

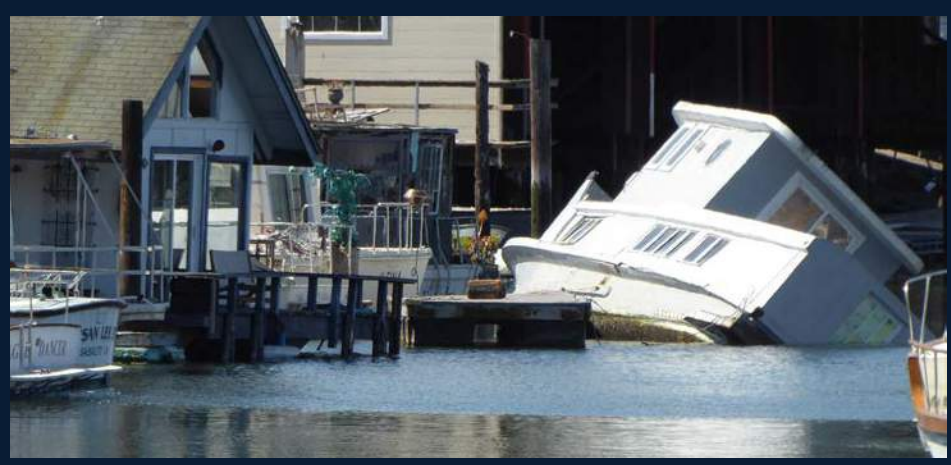


San Rafael Canal District, Pickleweed Park, and Creek

San Rafael, 1871

San Rafael, 2018

Low-lying housing



Canal housing

Active maritime waterway

Industry and commercial businesses throughout low-lying area

COST BURDENED RENTER

71%

PERCENT WORK LESS THAN 10 MILES FROM HOME

50.8%

IMMIGRATED IN LAST 10 YEARS

36%

PREDOMINANT RACE / ETHNICITY

HISPANIC

MEDIAN HOUSEHOLD INCOME

$43,448

LIVING BELOW POVERTY LINE

2,920 FAMILIES

FOREIGN BORN

60%

PERCENT WORK IN SAN RAFAEL

24%

The Canal District Community

The data behind the Canal District Community describes a population that is hard working, industrious, and resourceful. It also describes a community in need of more resources, better housing, and employment opportunities.

*Data Source: "Crispell, Mitchell; Canal: An Immigrant Gateway in San Rafael At Risk, University of California Berkeley, Center for Community Innovation, June 2015"

ENGAGEMENT

Our approach has been to engage in the complexity of the forces and cultures that created the conditions of postindustrial cities, and to forecast how they can be employed over time to correct them. And to elevate solutions and their cumulative effects on life to a higher level of sophistication and equity.

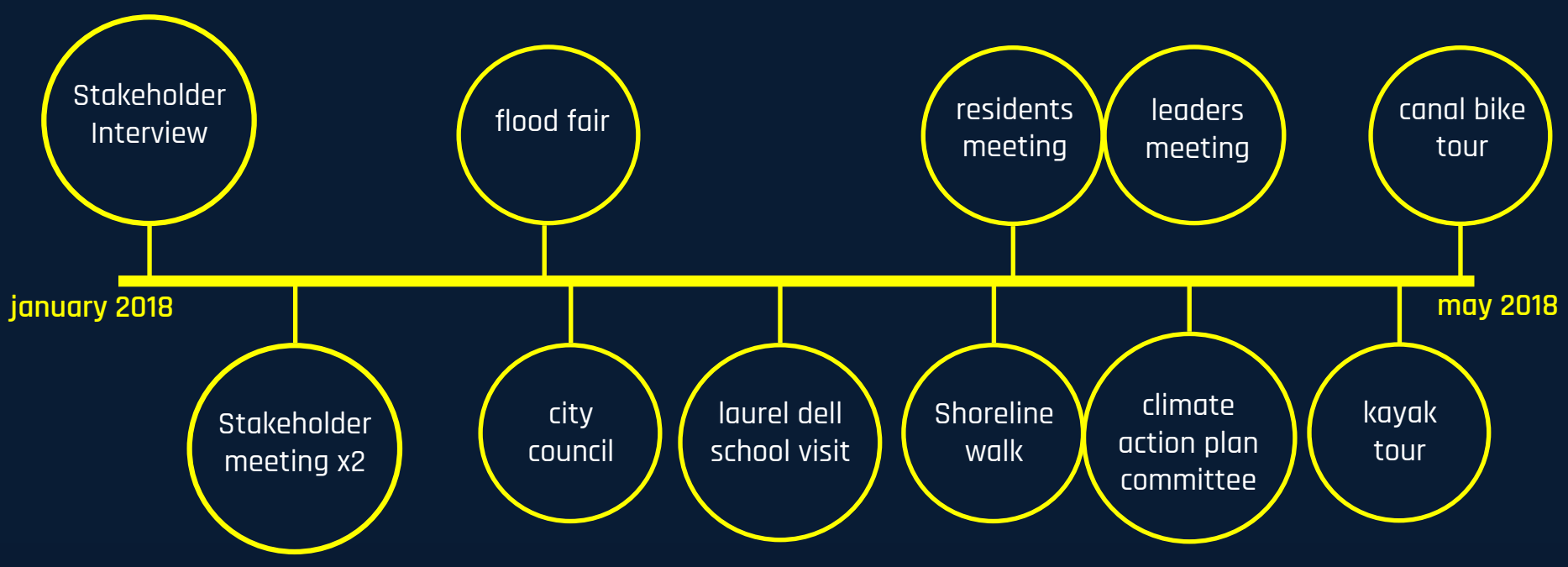
And to ask the community how they want to live.

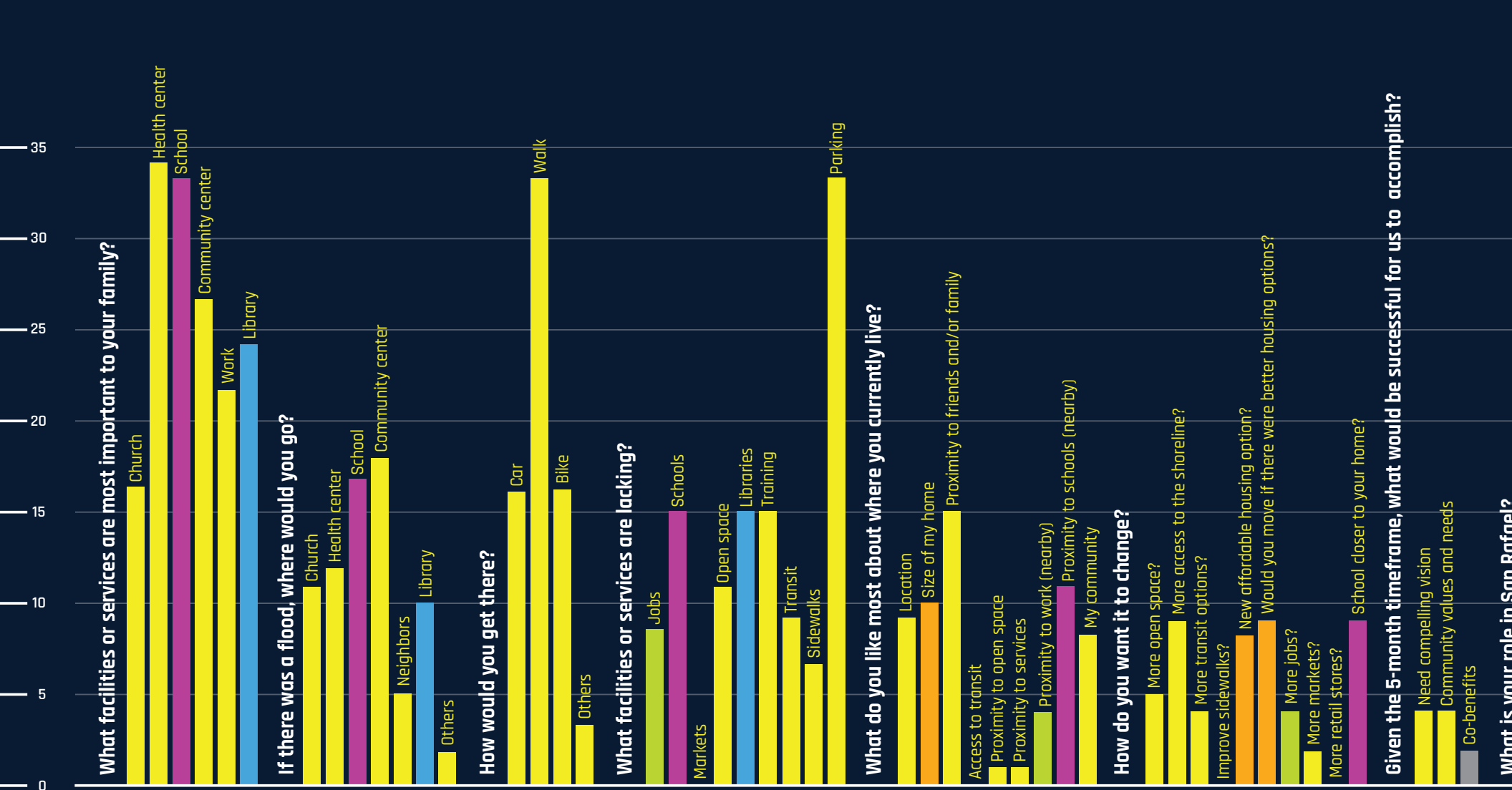
There are many occupations and ways of life in San Rafael. The design of our engagement strategy used community partners and the Team's resources to create a net of outreach. Through this approach, the team created a broad reach to the community at large and to groups with special interests to learn about their needs.

In a short amount of time, the Bionic Team wanted to understand the details of life in San Rafael, and the everyday issues that matter for people, their families and businesses now. The Team also wanted to reach a deeper level of conversation with the people that live there about the threat of flooding and sea level rise. From these interactions, common themes and patterns emerged to inform short and long term design thinking. It was clear: People share the desire for essentials that allow them to thrive - safety, secure housing, a livelihood, equal access to resources, a community to rely on. Through this process, the Team also gained an appreciation for the community members themselves and their social cohesion. It is complex and interwoven. It is also highly resilient.

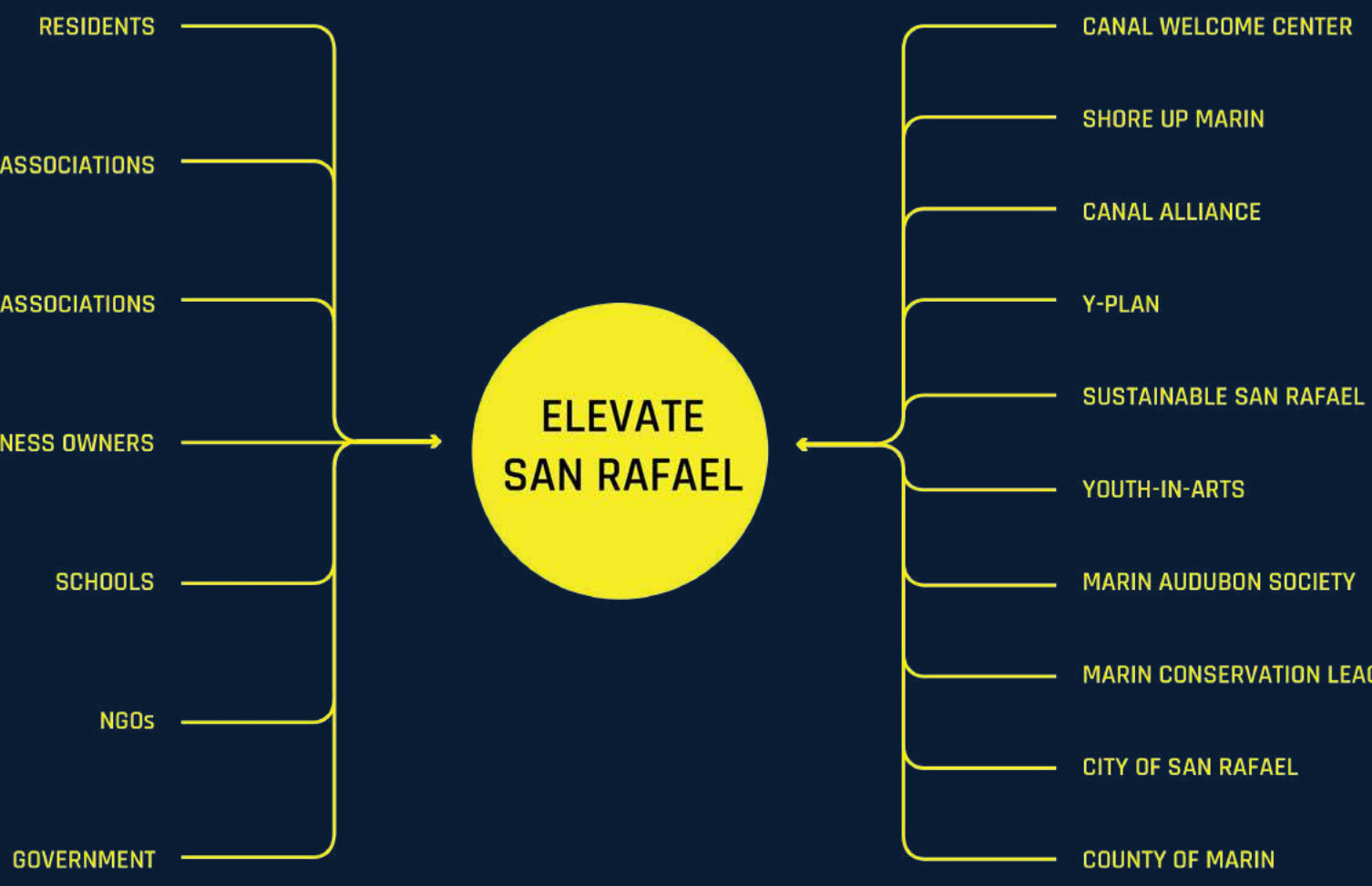
For the Bionic Team it raised an important question-What are the physical structures and relationships that help to grow the social cohesion of the canal district?

TIMELINE





PARTNERS + STAKEHOLDERS



KEY TAKEAWAYS FROM SURVEYS

Protect the community center

Improve parking

Improve traffic

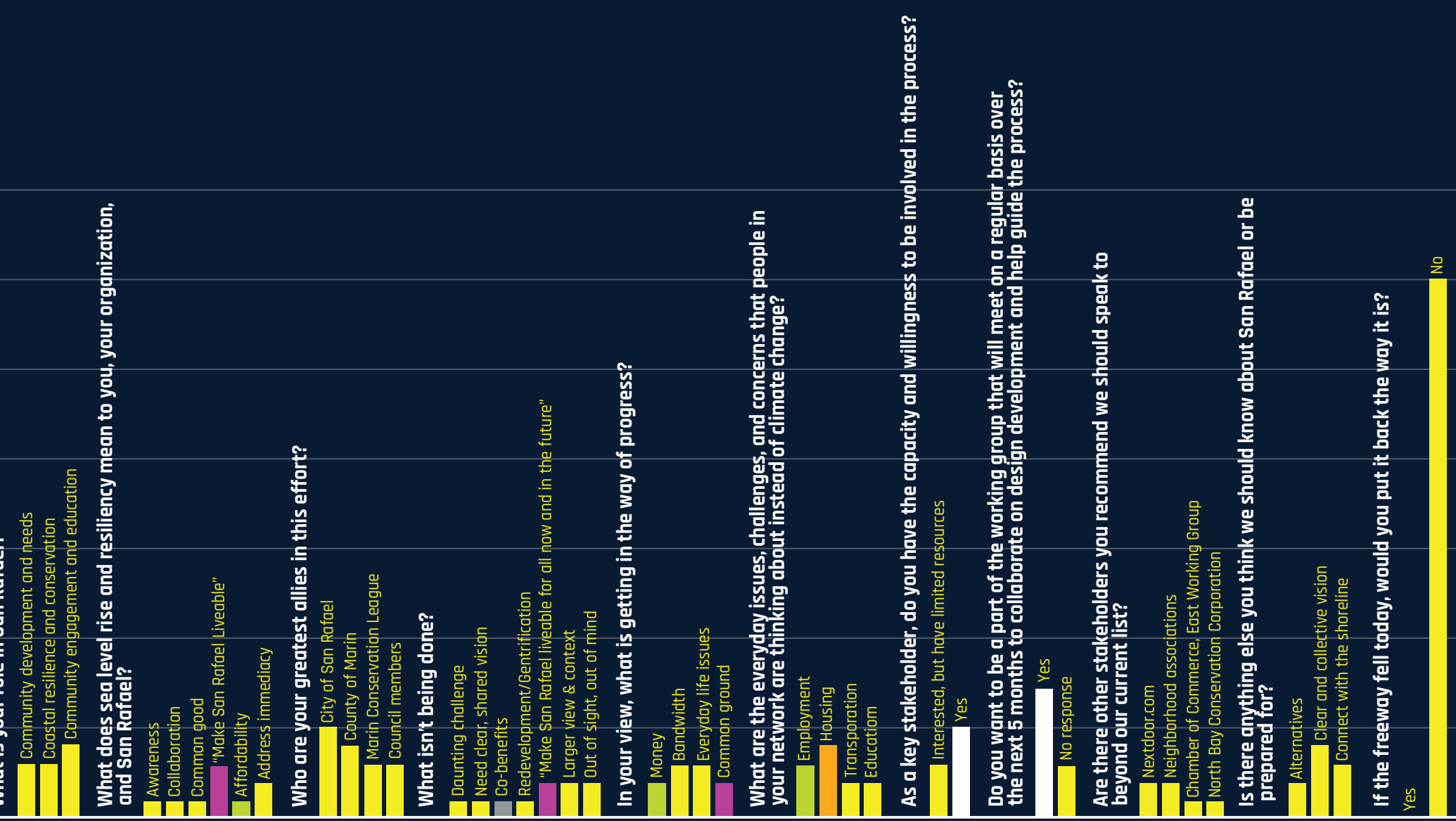
"Make San Rafael liveable for ALL now and in the future"

Protect the schools and health center

Need affordable housing options

Improve access

Identify multi-benefit projects



AGENCY OF DESIGN

The optimization and engineering paradigm of the last century used plans and the abstraction of calculations and formulas to forge solutions. These methods are detached from the nuance, complexity, and specificity of life that is critical. A new paradigm requires new methods, tools, and techniques. At every stage of the challenge, the Bionic Team asked "how can design and our methods be used to find another way".

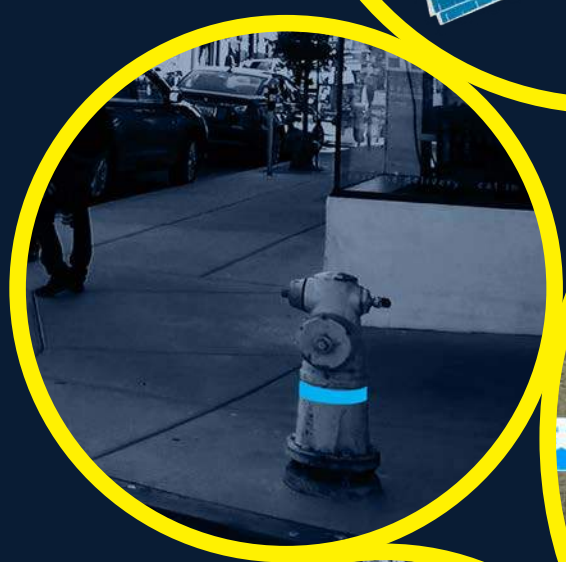
The Bionic Team used drones, under water cameras, time lapse video, simulation software and sensory data in the analysis and visualization. To communicate with the community and stakeholders, the Team designed logos, stickers, books, posters, digital graphics, and surveys. To engage and educate people who have differences in learning, the Team designed a 3d printed flood kit.

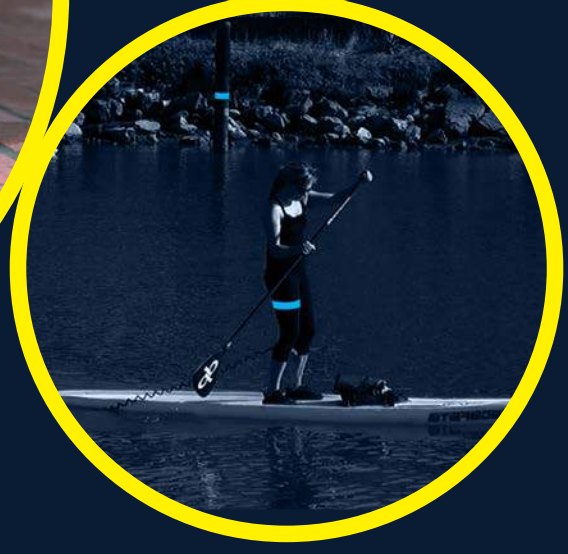
To increase the visibility of the issue and the cause, the Team designed a van, the Flood Mobile / The Flo-Mo and left it as a gift and tool for community partners to continue their work.

The Team designed multiple tours and curated events that offered access to experts and opportunities to discuss ideas. And the Team designed pilot projects, places, new forms for the city, and long-term strategies that will benefit future generations and the region.

Through these techniques, the Bionic Team was able to speed up time, get more people's attention, move faster, provoke deeper questions and answers, and transcend educational, language, and age barriers to engaging people.

The agency of design in all forms creates access to the information necessary to elevate the dialogue and the process.





STICKERS

FLOOD KIT

The Flood Kit is designed to teach people of all ages and learning abilities how flooding works in San Rafael.

After teaching 4th and 5th grade students and other community members how flooding works in San Rafael, Bionic donated 2 Flood kits to San Rafael elementary schools and the organization Y-Plan to utilize as a tool to teach the greater community about flooding and the risks.

Canal District youth learn about flooding.

San Rafael Flood Kit

4th + 5th grade students learn about flooding and how to use the flood kit

FLOOD MOBILE

To increase the visibility of the issue and the cause, the Bionic Team designed an Econoline Ford van wrap, the **Flood Mobile / The Flo-Mo,** and left is as a gift and tool for community partners to continue their work. The Flood Mobile documents how floods affect everyone and everything in San Rafael to generate awareness and a commitment to building resilience.

FLOODS AFFECT EVERYTHING
LAS INUNDACIONES AFECTAN TODOS
Yep, that's pretty much everything...
HOMES & APARTMENTS
SCHOOLS
GAS STATIONS
GROCERY STORES
BUSINESSES
PHARMACIES
RESTAURANTS
POST OFFICES
INFRASTRUCTURE
What about SHARTT
Wow, this is it at all traffic!
SAN RAFAEL FLOOD


UTILITIES DON'T WORK
PROPERTY DAMAGE
EROSION
ROADS CLOSED
MUDSLIDES
NO ACCESS TO GOODS AND SERVICES
WE KNOW... CARBON EMISSIONS CONTRIBUTE TO CLIMATE CHANGE.
2,845 LBS OF CARBON OFFSETS WERE PURCHASED FOR THIS VAN
HEAVY RAIN
HIGH TIDES
HEAVY RAIN + HIGH TIDE
SEA LEVEL RISE
HEAVY RAIN + HIGH TIDE +
WHAT COULD CAUSE FLOODS IN SAN RAFAEL?
California
FLO·MO
SAN RAFAEL FLOO


FLOODS AFFECT EVERYTHING
LAS INUNDACIONES AFECTAN TODOS
HOMES & APARTMENTS
SCHOOLS
GAS STATIONS
GROCERY STORES
BUSINESSES
PHARMACIES
POST OFFICES


RAFAEL
MISSIONS
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#BionicLandscape

FLOOD FAIR

March 24, 2018

The Flood Fair reached out to San Rafael residents to:

- teach people about the flooding challenges San Rafael is facing
- meet people who want to be part of the solution
- hear what flooding means to residents
- hear views, concerns, and hopes for a resilient San Rafael
- introduce the Flood Mobile
- explore some preliminary ideas
- display young students' work on the challenge

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did you learn today that you didn't already know?
What can people do to be prepared?
What is 1 thing that would make life better for you?


Have you seen one?

Flooding Affects Everything

How would you get there?

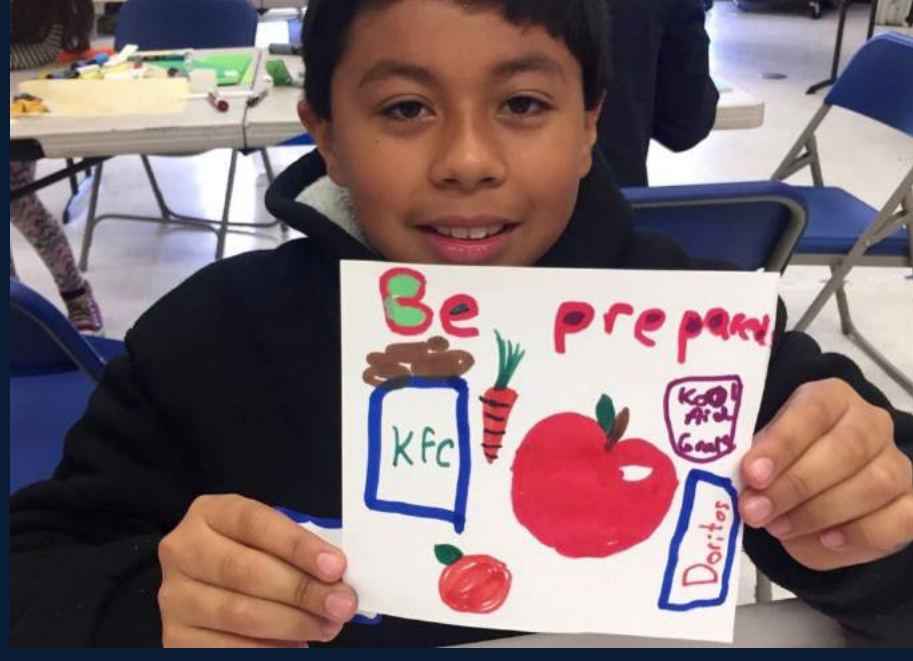
LAUREL DELL ELEMENTARY SCHOOL VISIT

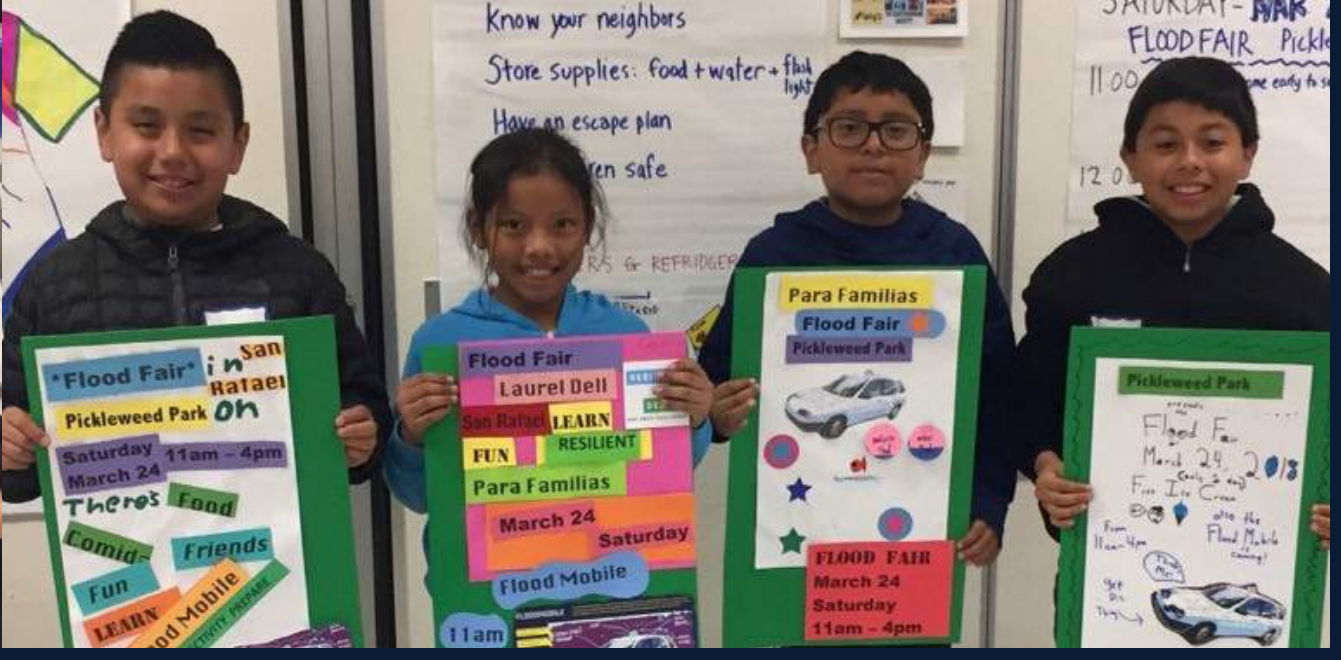
April 2, 2018

The Bionic Team visited Laurel Dell Elementary School to teach students about flooding and sea level rise in San Rafael, and to hear from the students their ideas on how to adapt and live with water. The students' ideas inspired design strategies captured in the Elevate San Rafael Proposal.

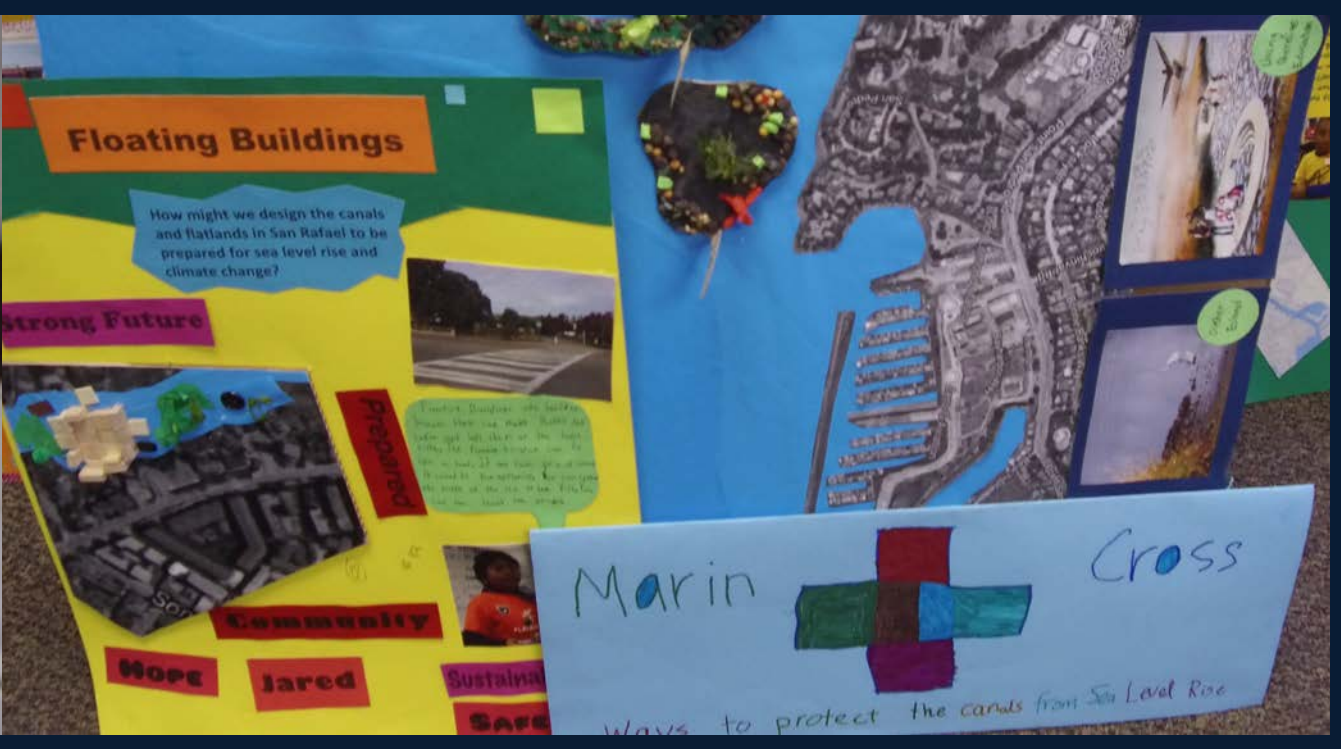
"I hope everyone in this fantastic world to be safe from the flood."

Hernando, Laurel Dell School




Know your neighbors
Store supplies: food + water + flash light
Have an escape plan
Flood Fair in San Rafael
Pickleweed Park on
Saturday March 24 11am – 4pm
Theres Food
Comida Friends
Fun
LEARN
Flood Fair
Laurel Dell
San Rafael LEARN
FUN RESILIENT
Para Familias
March 24 Saturday
Flood Mobile
11am
Para Familias
Flood Fair
Pickleweed Park
FLOOD FAIR
March 24
Saturday
11am – 4pm
Pickleweed Park


MARIN
Ways to protect the canal from Sea


Floating Buildings
How might we design the canals and flatlands in San Rafael to be prepared for sea level rise and climate change?
Strong Future
Prepared
Community
Hope
Jared
Marin Cross
Ways to protect the canals from Sea Level Rise

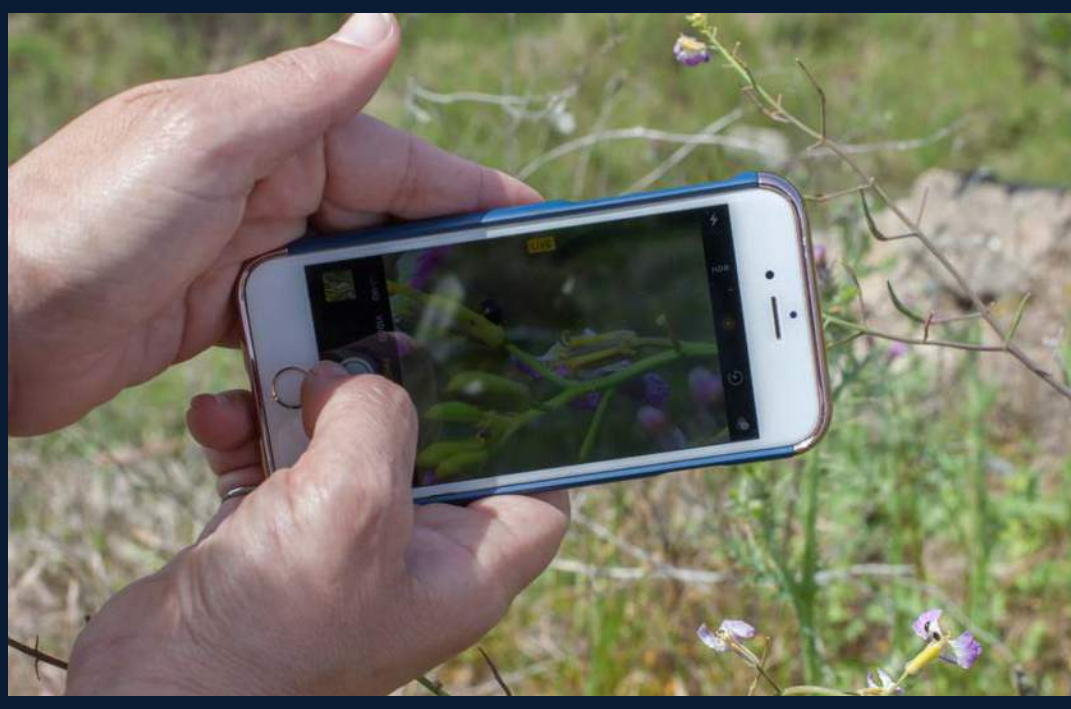

Chris


GAP
CAUSE
SAN RAFAEL

SHORELINE WALK

April 22, 2018

The Bionic Team hosted a shoreline walking tour that commenced at Pickleweed Park and ended at the Marin Rod and Gun Club with an oyster shucking party. Along the way, the tour saw the Flood Mobile, documented flora and fauna, studied the living shoreline pilot project, learned about existing projects, and discussed ideas for San Rafael's future.



CAMINATA

POR LA COSTA

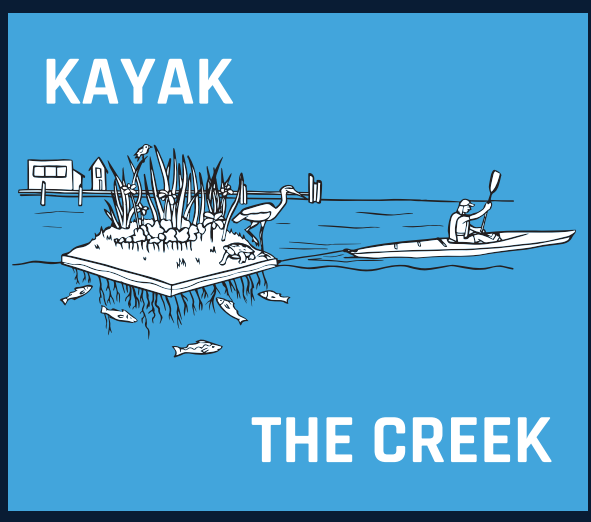
WALK

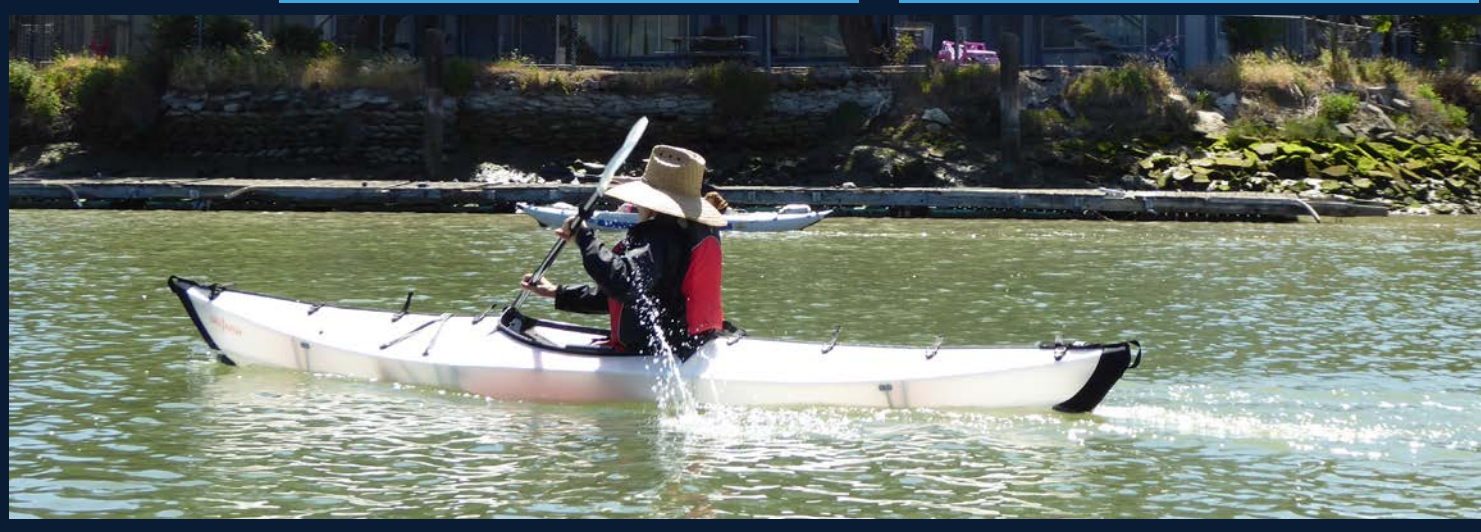
THE SHORELINE

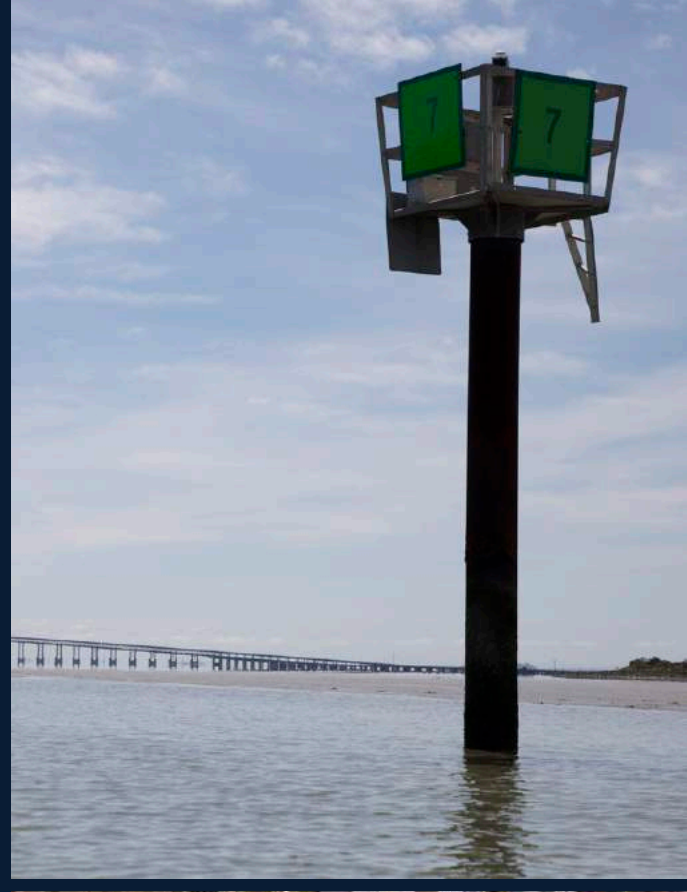
KAYAK TOUR

May 5, 2018

The Bionic Team hosted a kayaking tour of the Canal and shoreline, making stops at the living shoreline pilot project, Pickleweed Park, and mudflats. It explored a way of living with water that may be the future for San Rafael.





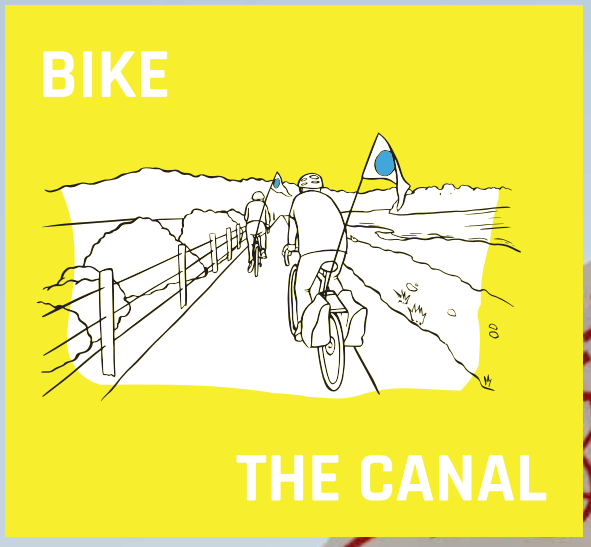


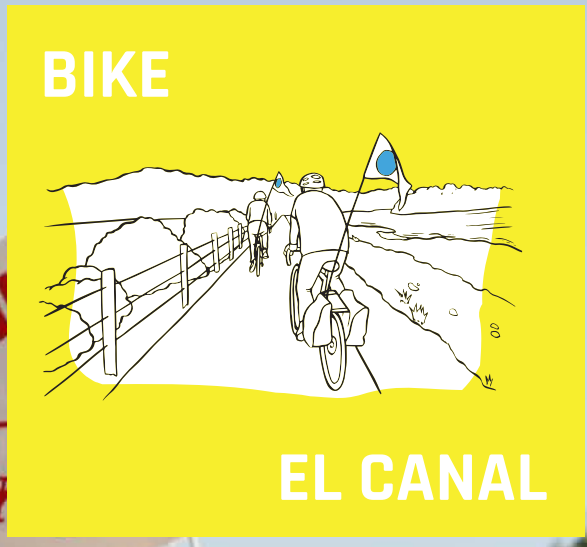

OCEAN KAYAK

BICYCLE TOUR

May 12, 2018

The Bionic Team hosted a bicycle tour through the Canal District and East San Rafael to generate awareness about bicycle safety and lack of safe conditions in San Rafael.






BIKE & PEDESTRIAN
29 COLLISIONS
2 FATALITIES
IN THIS INTERSECTION

MEETINGS + EVENTS

Community Meeting


Shoreline Walk


Key Stakeholder Presentation


Canal District Community Meeting


Bicycle Tour

City Council Presentation


City of San Rafael Presentation

Kayak Tour

Flood Fair

Flood Fair

Flood Fair

What's at RISK?

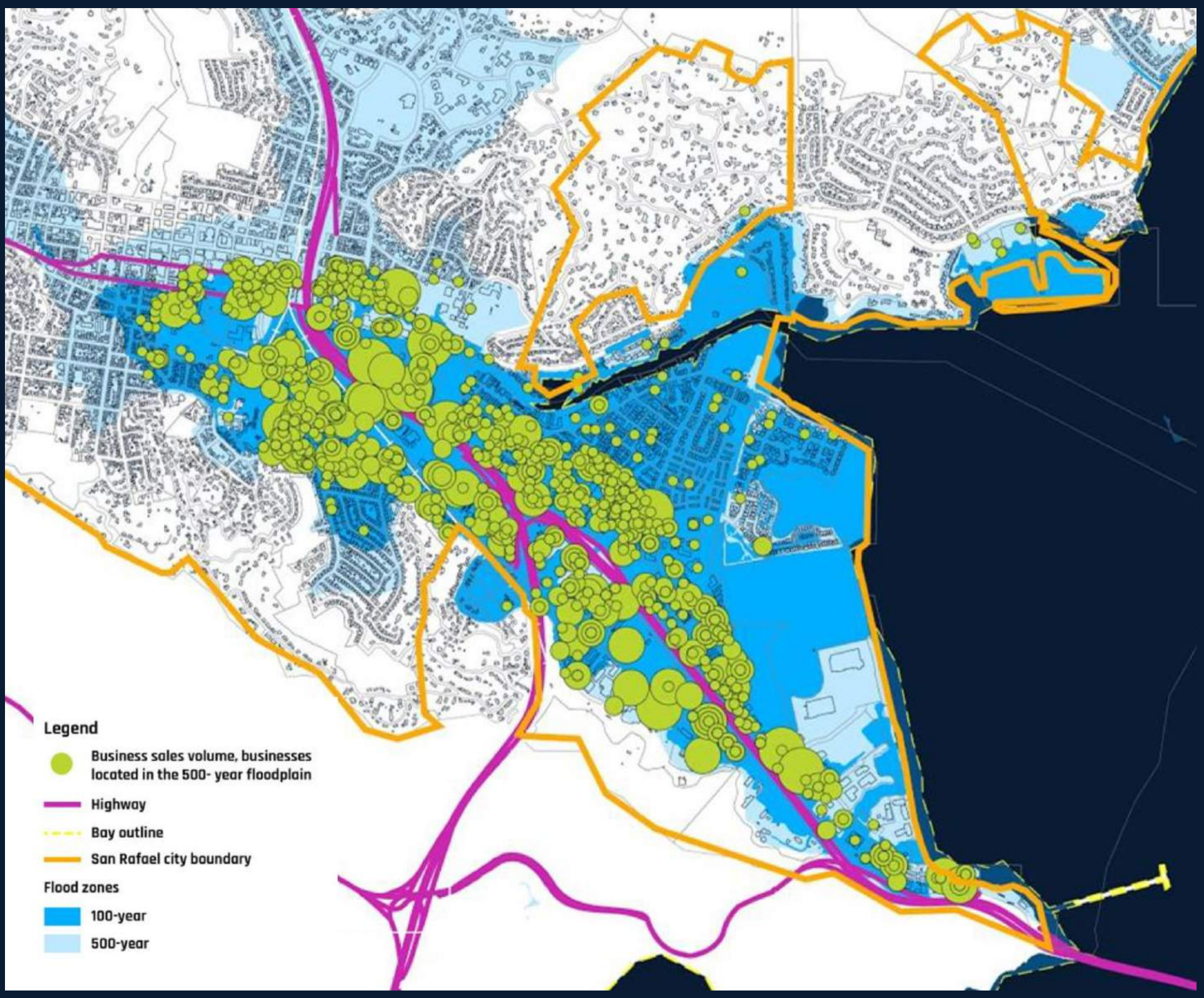
WHAT IS AT RISK?

San Rafael has assets and risks at all scales from the size of an individual property to the scale of the Bay Area Metropolis. The combination of climate events, subsidence, and tides could create flooding now. This will only get worse with sea level rise.

The Bionic Team quantified and measured these risks to help educate stakeholders, and to inform design.

There are several clear sharp conclusions:

- San Rafael is critical to the regional economy and workforce.
- The tax base of the city is at risk because much of its business taxpayers are located in the flood plain.
- Business owners are at risk because the lowest areas have old failing infrastructure.
- The pump system is a major vulnerability, and human or technical failure could devastate the local economy.
- The housing stock in the canal district is at risk of condemnation if there were a flood event.
- Human life is at risk due to the number of ground floor units, lack of emergency preparedness, and few escape routes.



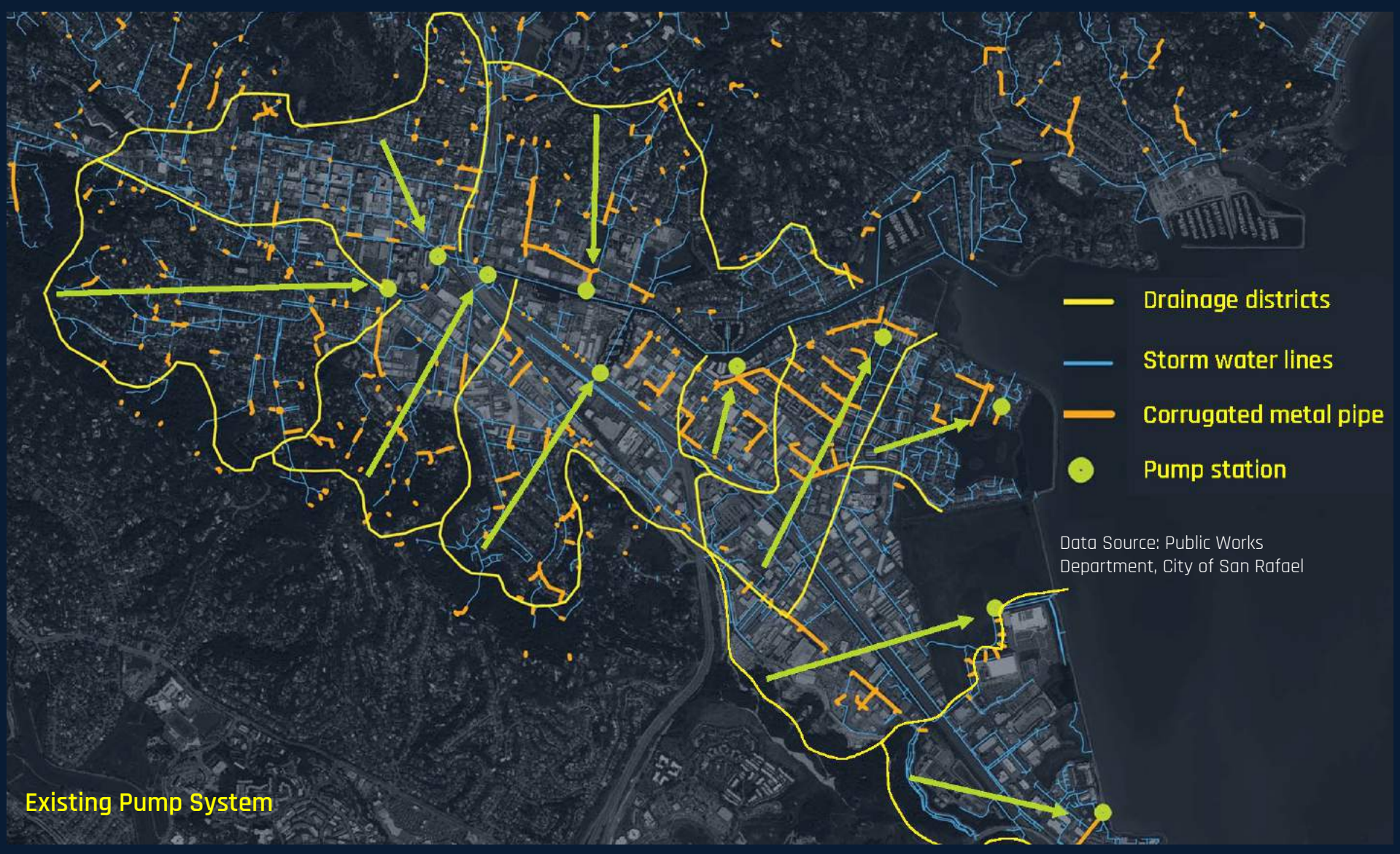
Data Source: Marin County Accessors Office

ASSETS AT RISK			
100-year event		500-year event	
Residential Units	5,019	Residential Units	5,423
Jobs	10,852	Jobs	12,826
Land Value	$1.95 Billion	Land Value	$3.95 Billion
Business Revenue	$2.68 Billion	Business Revenue	$2.95 Billion

Watershed Extents

These risks exist due to a range of existing conditions and outdated infrastructure. Downtown and East San Rafael are located within a singular watershed. All rain eventually flows to and under the canal district which is the lowest lying area of San Rafael and thus will be the most severely impacted by storms and sea-level rise.

The area usually stays dry now because it is pumped. However there are many corroded and undersized pipes. This system is a major vulnerability: any human or technical failure could devastate the residents and local economy at any time.



Existing Pump System

Existing pumps, tide gates, and outfalls

SYSTEM FAILURE

If the pumps failed today, flooding could cause significant damage. With near-term sea level rise, even without a major rain event, the damage will be extensive. The further out in time, the greater the potential of human suffering and loss of life.

FLOOD DEPTHS IN FEET
(includes storm events)
2018
MHHW 6.60 ft

FLOOD DEPTHS IN FEET
2040
MHHW 7.87 ft

FLOOD DEPTHS IN FEET
2060
MHHW 10.06 ft

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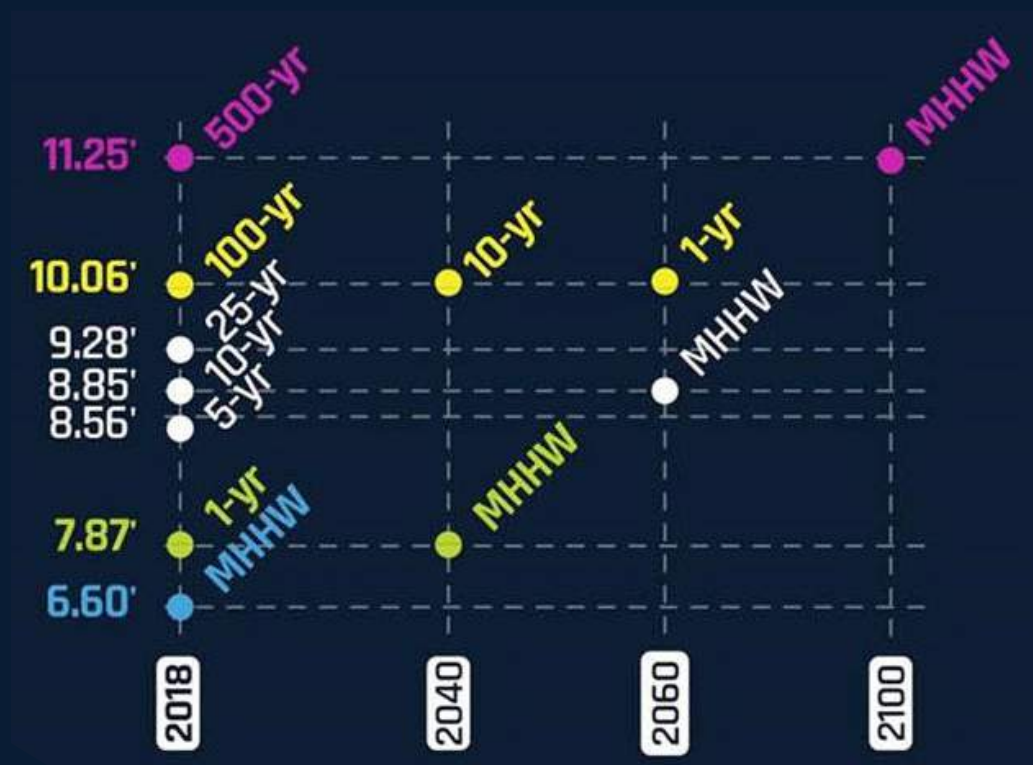
Flood Impacts with a Single Pump Failure

Flood Impacts with a Total Pump System Failure

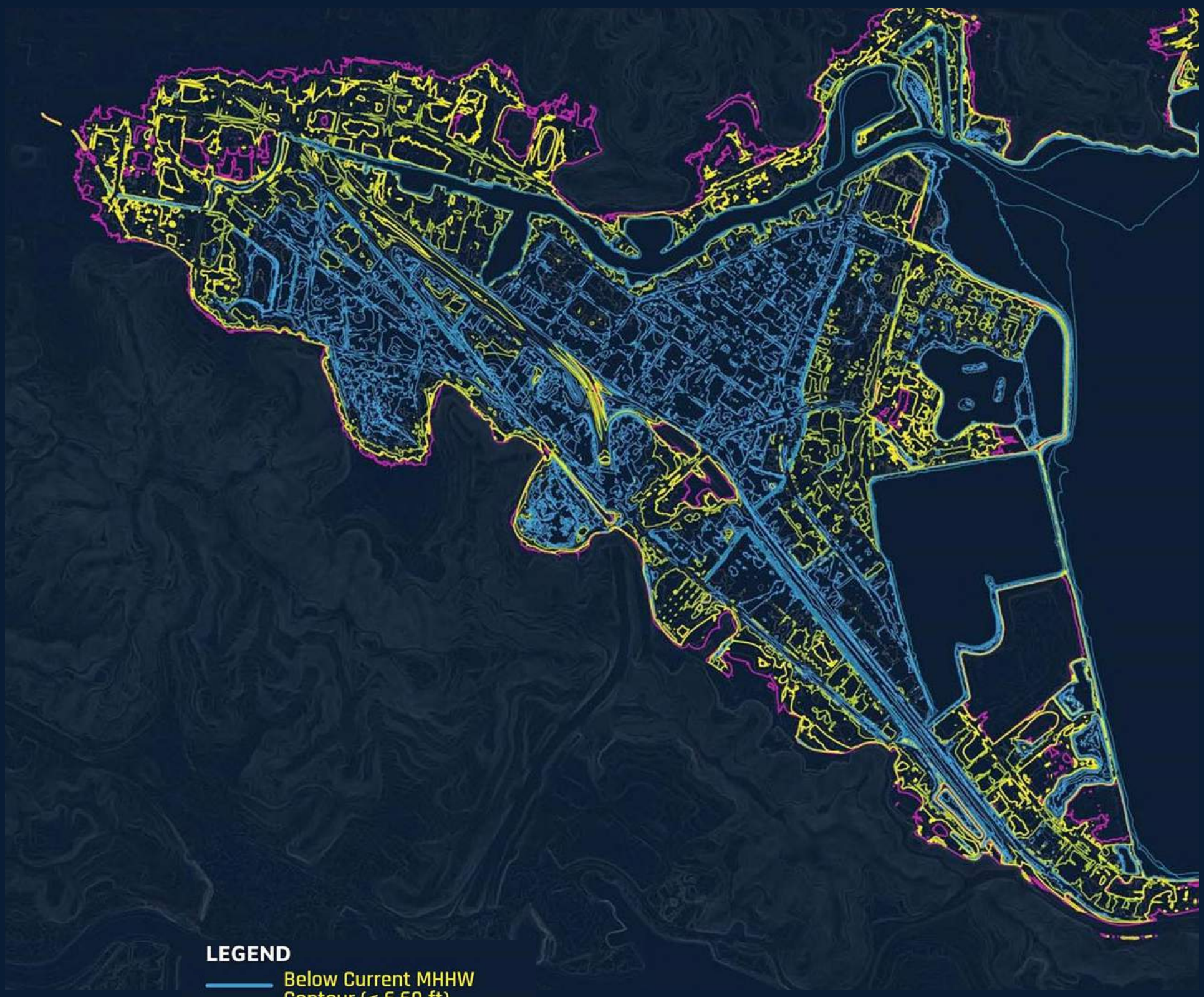
The economic losses of just one pump district failing are huge. A total power outage could have potential losses in the billions of dollars.

FLOODING DEPTHS + TOPOGRAPHY

A detailed look at topography shows that most of the Canal District is already below sea-level. In 20 years, that area will expand. A 500-yr storm event, which could happen today, would flood the full extent of this area, and represents the possible projected sea-level by centuries end.



*from "San Francisco Bay Tidal Datums & Extreme Tides Study," February 2016



LEGEND

- Below Current MHHW Contour (< 6.60 ft)
- 1-yr Event Contour (7.87 ft)
- 100-yr Event Contour (10.06 ft)
- 500-yr Event Contour (11.25 ft)

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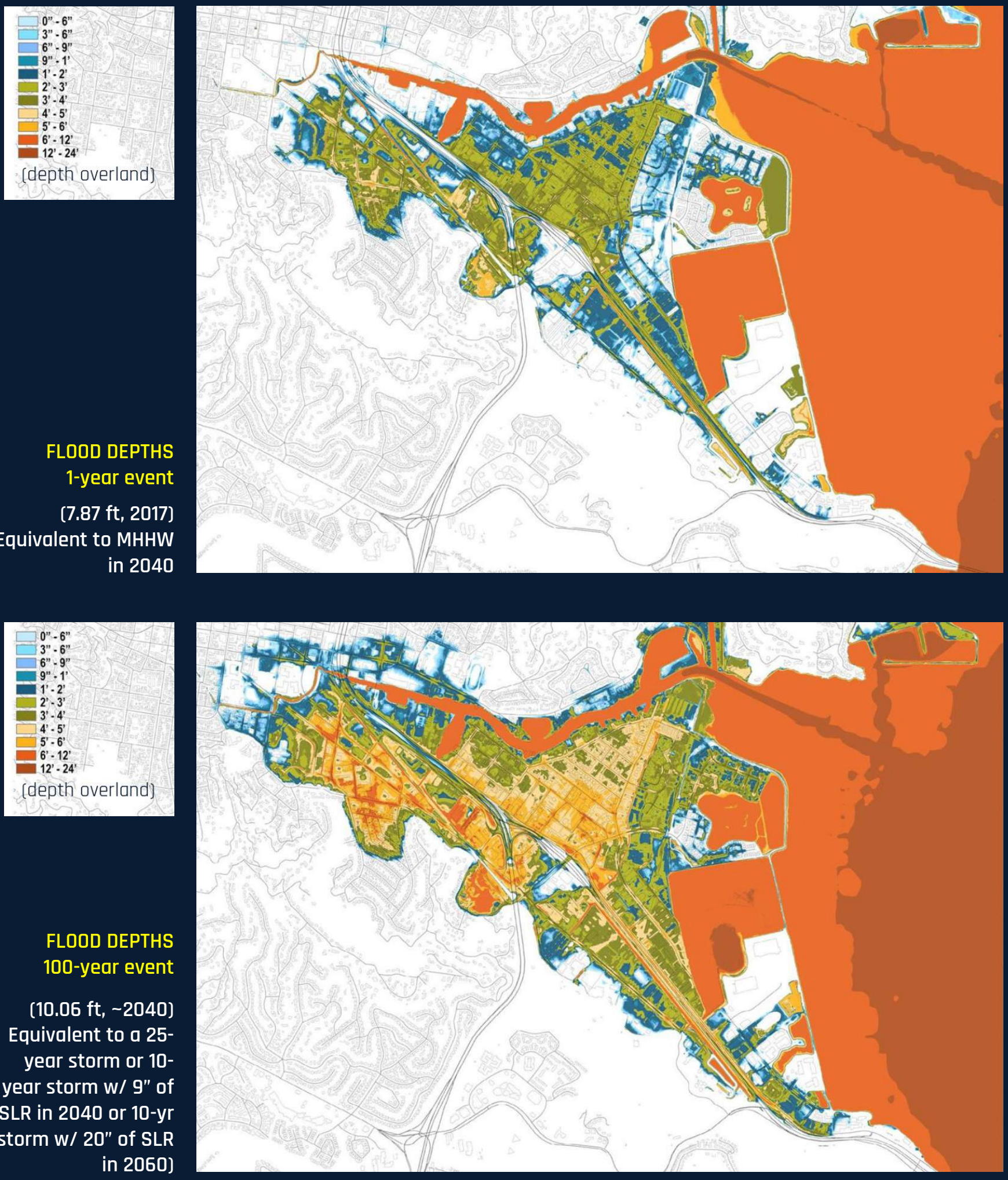

FLOOD DEPTHS
1-year event

(7.87 ft, 2017)
Equivalent to MHHW in 2040

FLOOD DEPTHS
100-year event

(10.06 ft, ~2040)
Equivalent to a 25-year storm or 10-year storm w/ 9” of SLR in 2040 or 10-yr storm w/ 20” of SLR in 2060)

FLOOD DEPTHS
500-year event

(10.06 ft, ~2040)
Equivalent to a 25-year storm or 10-year storm w/ 9” of SLR in 2040 or 10-yr storm w/ 20” of SLR in 2060)

Data Source: “San Francisco Bay Tidal Datums & Extreme Tides Study,” February 2016

HOUSING AT RISK

The wood-frame housing stock in the canal district is at risk of condemnation if there was a flood event. Human life is at risk due to the number of ground floor units that are occupied as well as lack of emergency preparedness, and few escape routes. The largely immigrant population of renters in the Canal District are economically vulnerable and therefore less able to recover from floods or earthquakes, and with fewer means to move out of harm's way.

Wood Frame Buildings
Partially-Occupied
Fully-Occupied
Not Occupied

FLOOD IMPACTS
4,100 residential units - 2,560 multi-family / 1,545 single-family
2,300 ground floor units (est.)
2,779 wood frame structures

Canal district multi-family housing

CONVENTIONAL SOLUTION

The conventional solution would be to gate off the creek, raise the levees, add flood gates and seawalls, and proceed with life as it is known today. To continue with this paradigm would compound risk. It would increase the separation that the city has with its waterfront. It would further eradicate coastal habitats and interrupt coastal processes. It would be hugely expensive. If there was a failure it would be a humanitarian crisis. As sea levels rise it would ultimately become obsolete, and a legacy offering danger and even fewer options would be left to future generations. The Bionic Team studied the conventional solution and asked a critical question:

Is there a different way?

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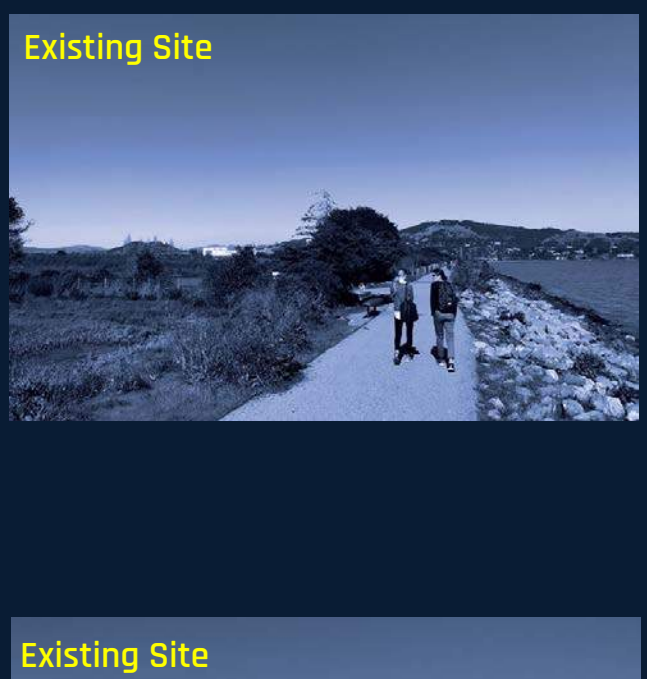
Existing Site


Conventional Levee Solution
500-yr storm+ 3' freeboard = 14.25'
100-yr storm+ 3' freeboard = 13.06'
14'
13'
12'
11'
10'
EXISTING LEVEE ELEVATION


Existing Site

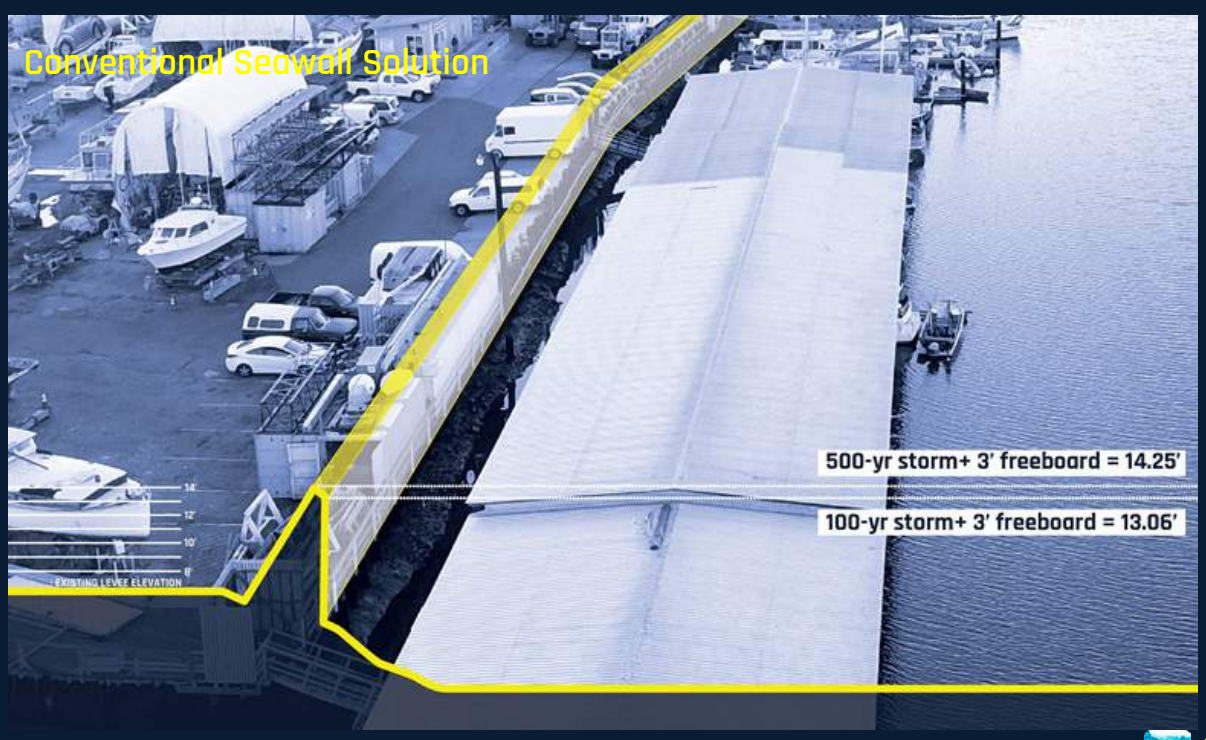

Conventional Levee Solution
500-yr storm+ 3' freeboard = 14.25'
100-yr storm+ 3' freeboard = 13.06'
14'
13'
12'
11'
10'
EXISTING LEVEE ELEVATION


Existing Site

Conventional Levee Solution
500-yr storm+ 3' freeboard = 14.25'
100-yr storm+ 3' freeboard = 13.06'
EXISTING LEVEE ELEVATION


Existing Site

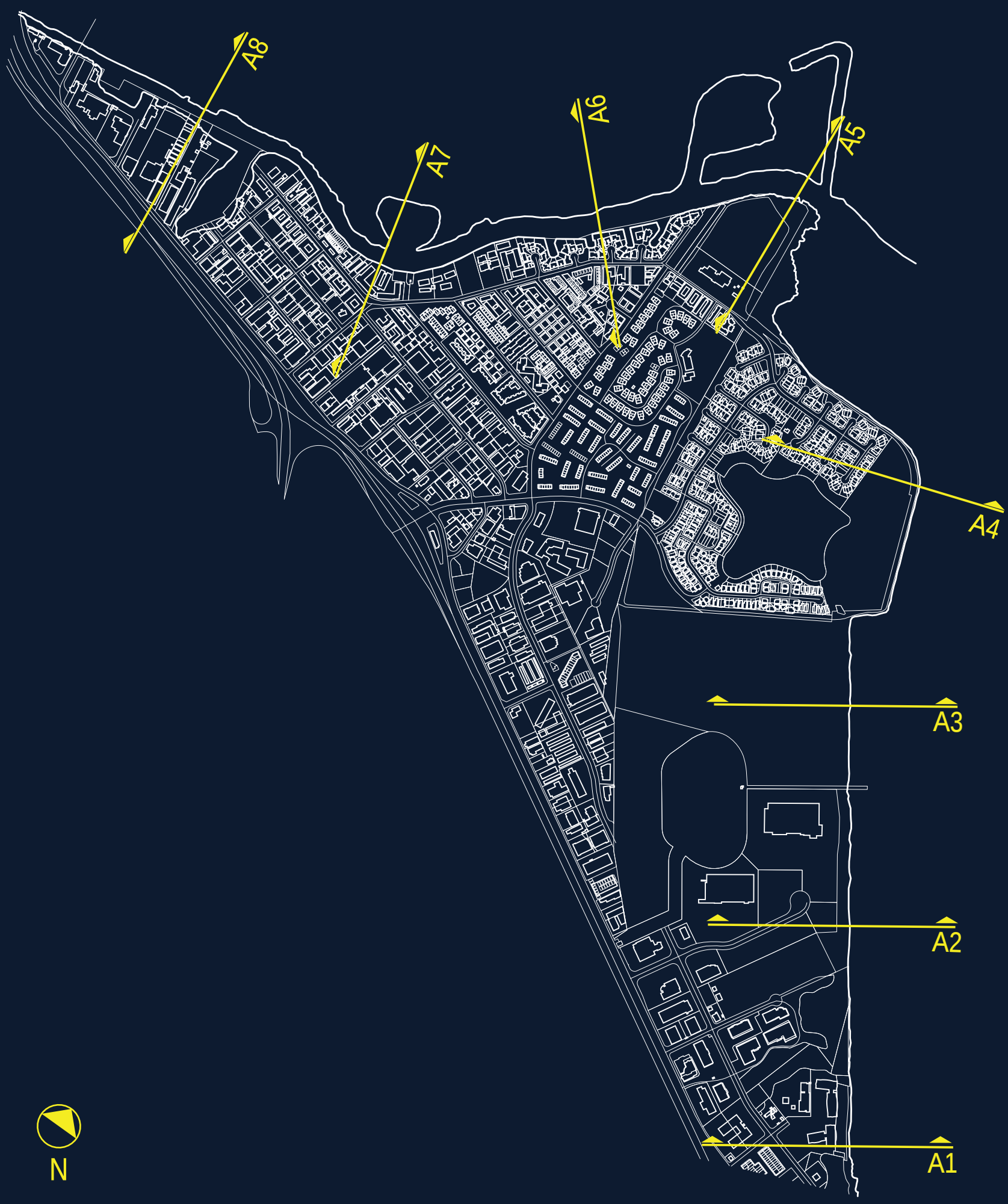

Conventional Seawall Solution
500-yr storm+ 3' freeboard = 14.25'
100-yr storm+ 3' freeboard = 13.06'
14'
13'
12'
11'
10'
9'
EXISTING LEVEE ELEVATION

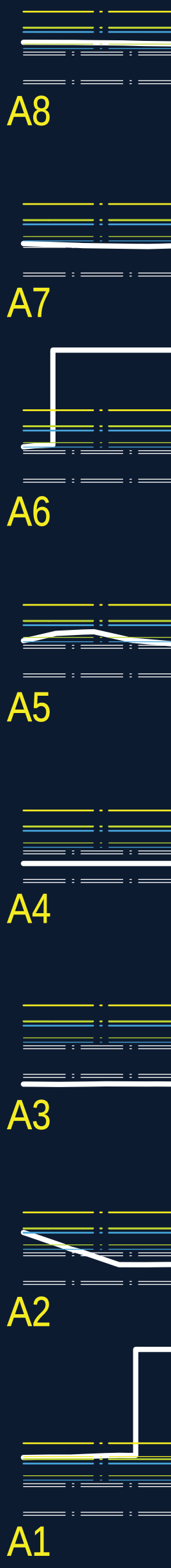

Conventional Seawall Solution
500-yr storm+ 3' freeboard = 14.25'
100-yr storm+ 3' freeboard = 13.06'
14'
12'
10'
8'
EXISTING LEVEE ELEVATION


Existing Site

EVALUATION OF CURRENT ELEVATIONS

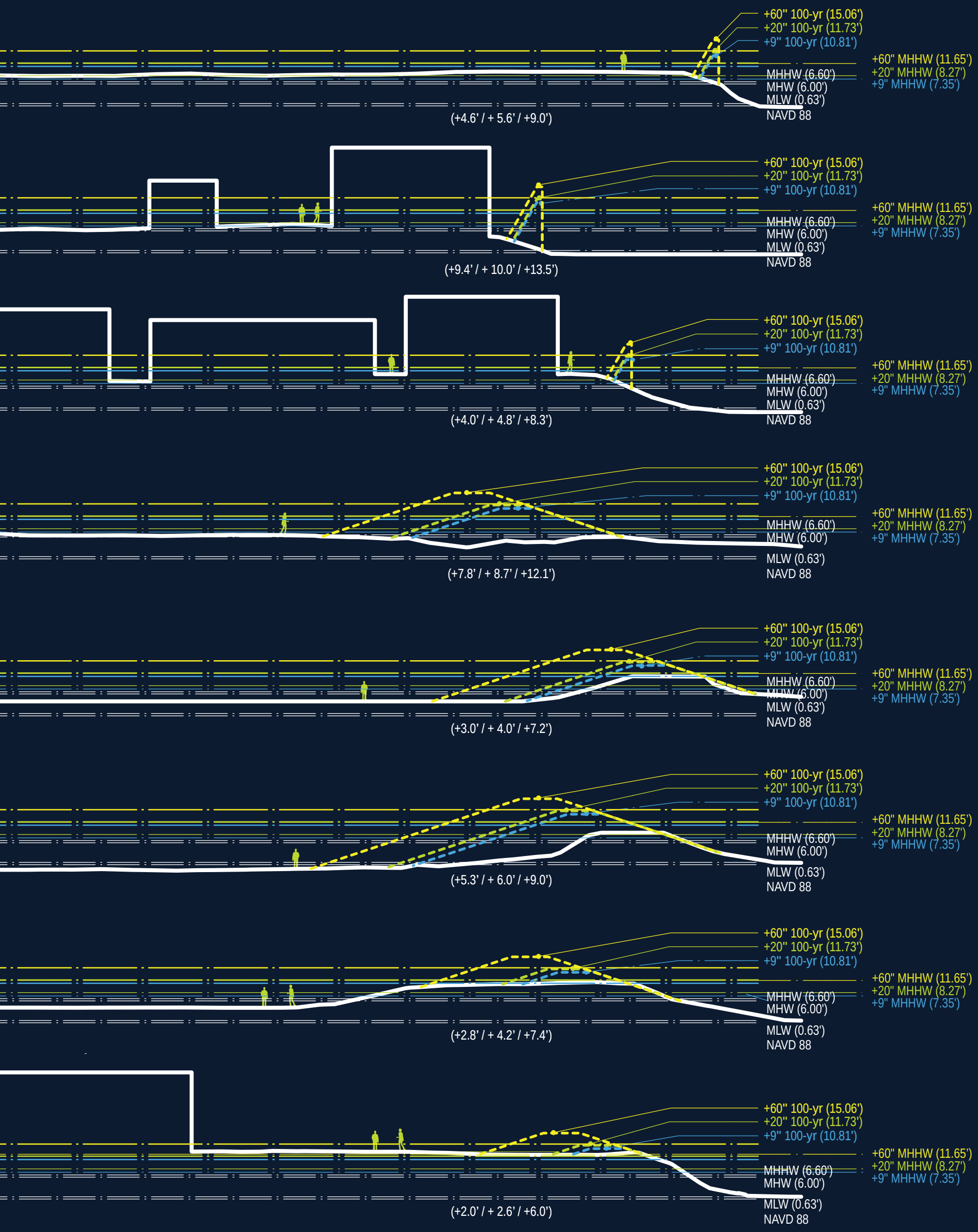
Analysis of current elevations along the San Rafael shoreline suggest the heights required for convention solutions such as levees and seawalls. These require large amounts of land to provide protection to approximately end of century.





*NOTE: All levee/ wall heights include 3’ of freeboard above water elevation

**Water elevations & datums from “San Francisco Bay Tidal Datum & Extreme Tides Study, February 2016


+60" 100-yr (15.06')
+20" 100-yr (11.73')
+9" 100-yr (10.81')
+60" MHHW (11.65')
+20" MHHW (8.27')
+9" MHHW (7.35')
MHHW (6.60')
MHW (6.00')
MLW (0.63')
NAVD 88
(+4.6' / + 5.6' / +9.0')
(+9.4' / + 10.0' / +13.5')
(+4.0' / + 4.8' / +8.3')
(+7.8' / + 8.7' / +12.1')
(+3.0' / + 4.0' / +7.2')
(+5.3' / + 6.0' / +9.0')
(+2.8' / + 4.2' / +7.4')
(+2.0' / + 2.6' / +6.0')

PRESERVING COMMUNITY

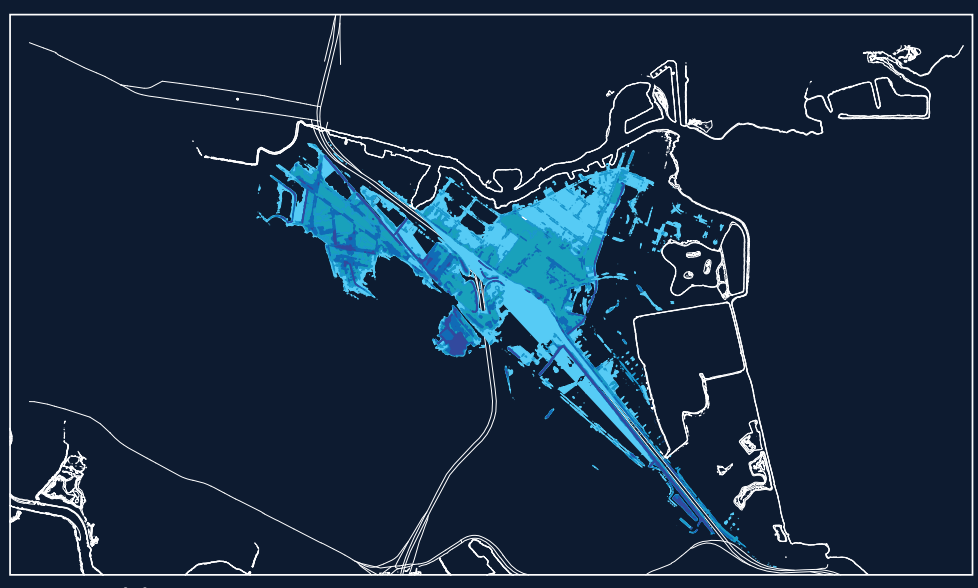
The Bionic team identified the areas in San Rafael with the greatest risk of climate-change related flooding. An analysis synthesizing the lowest lying areas, the areas with the greatest amount of corroding pipes, the greatest amount of multi-family and wood framed structures, and the highest population densities, revealed the sites with the highest vulnerability. The Canal District neighborhood is particularly vulnerable.

To preserve community, the Bionic Team evaluated San Rafael's capacity to retain this population within the city limits. According to the 2020 General Plan, San Rafael has a number of underutilized sites where new housing could be constructed. However, it is spread out through the city limits and would separate a cohesive community.

The City of San Rafael must reevaluate their housing policy to ensure social cohesion of the existing community and that all residents will have equal access and opportunity to housing in San Rafael.

From discussions with the community, it became evident that a new process is needed where the city and residents work together to prioritize equity, housing affordability, stability, and design. This would require state level commitment in policy and legislation, and city level housing policies. This type of commitment is critical to prevent against displacement and preserve a vibrant community.

Contributing Factors

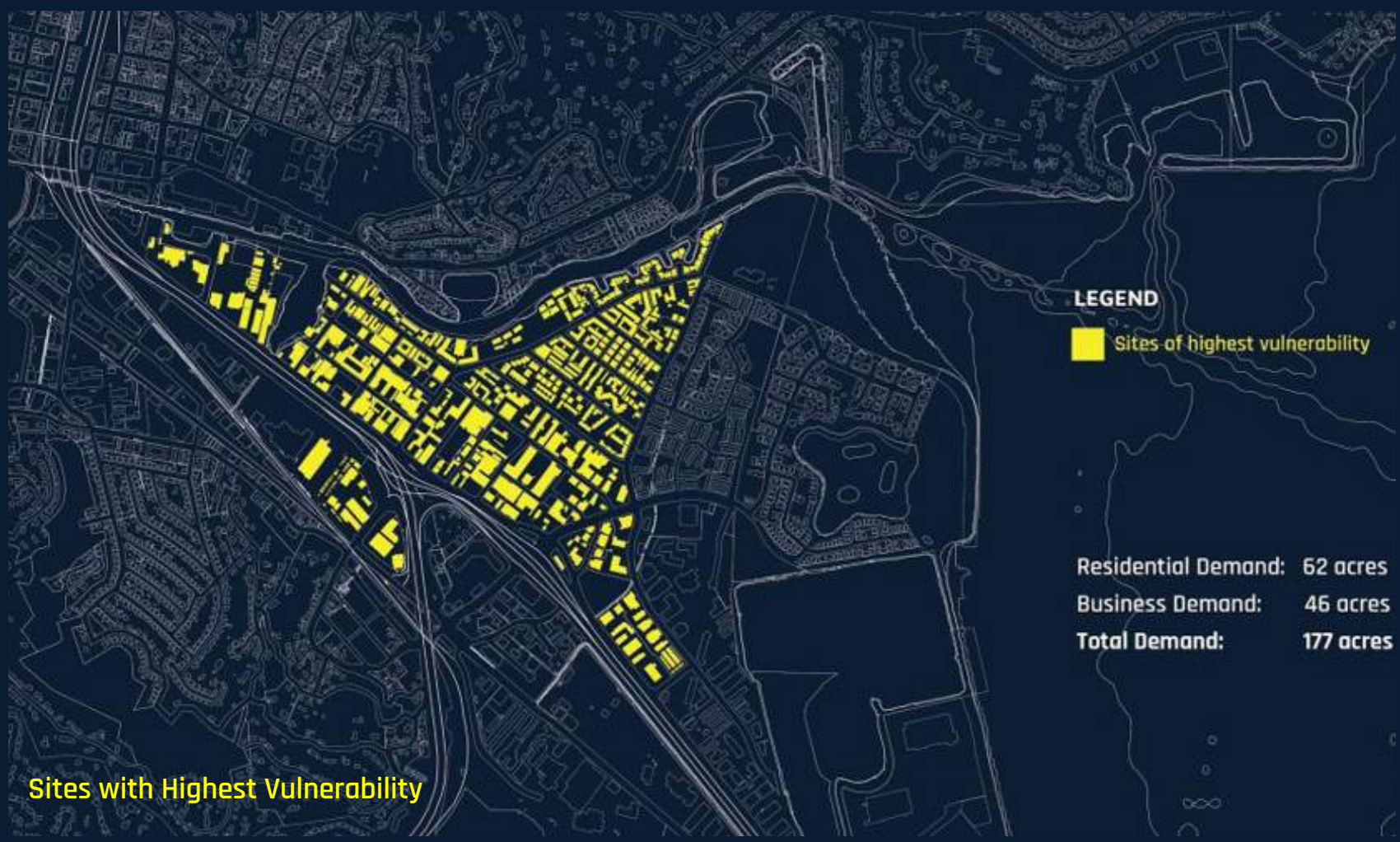


1) Lowest lying areas

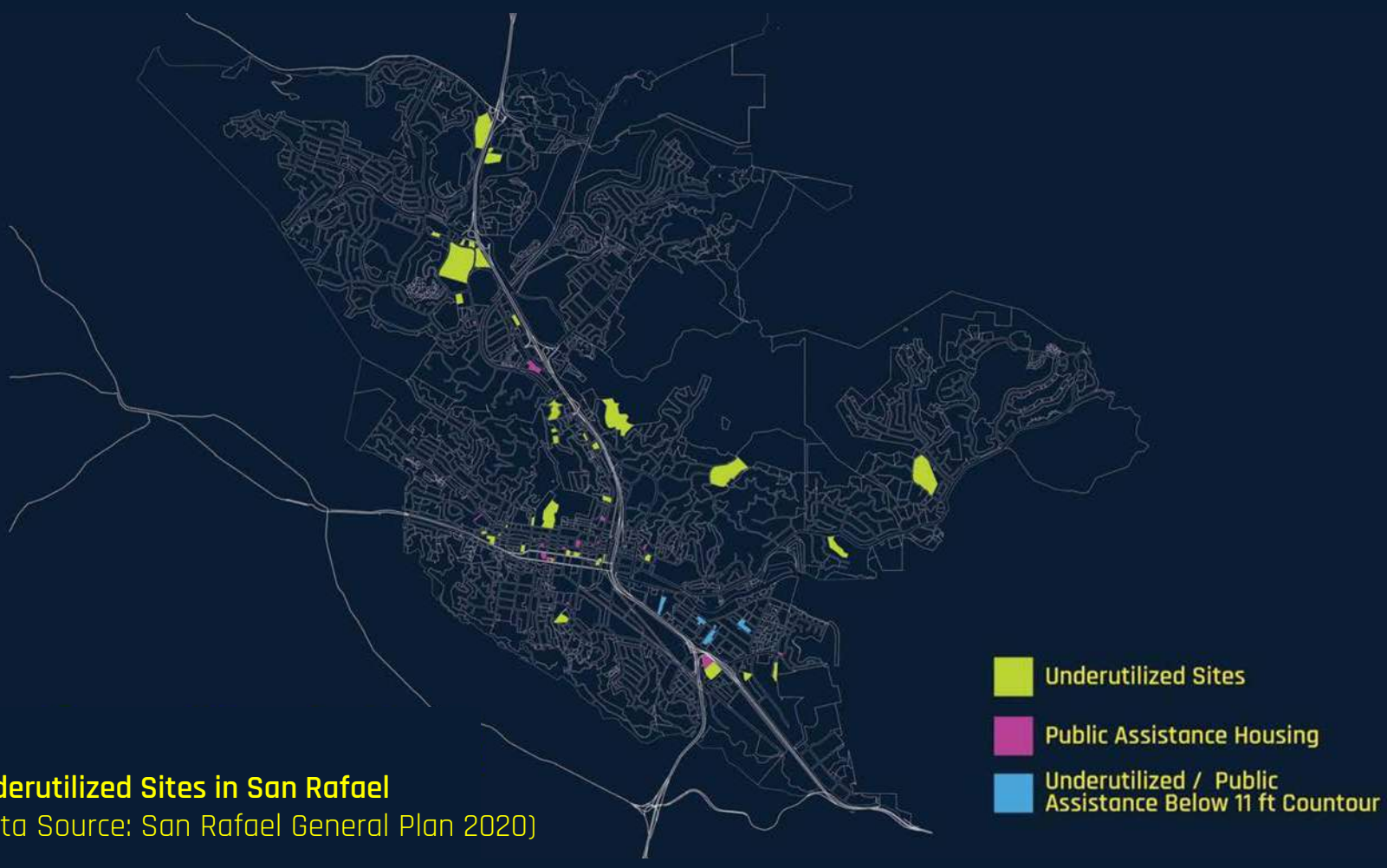
2) Sewer catchments w/ highest corrugated metal pipe

3) Multi-family & wood framed residential

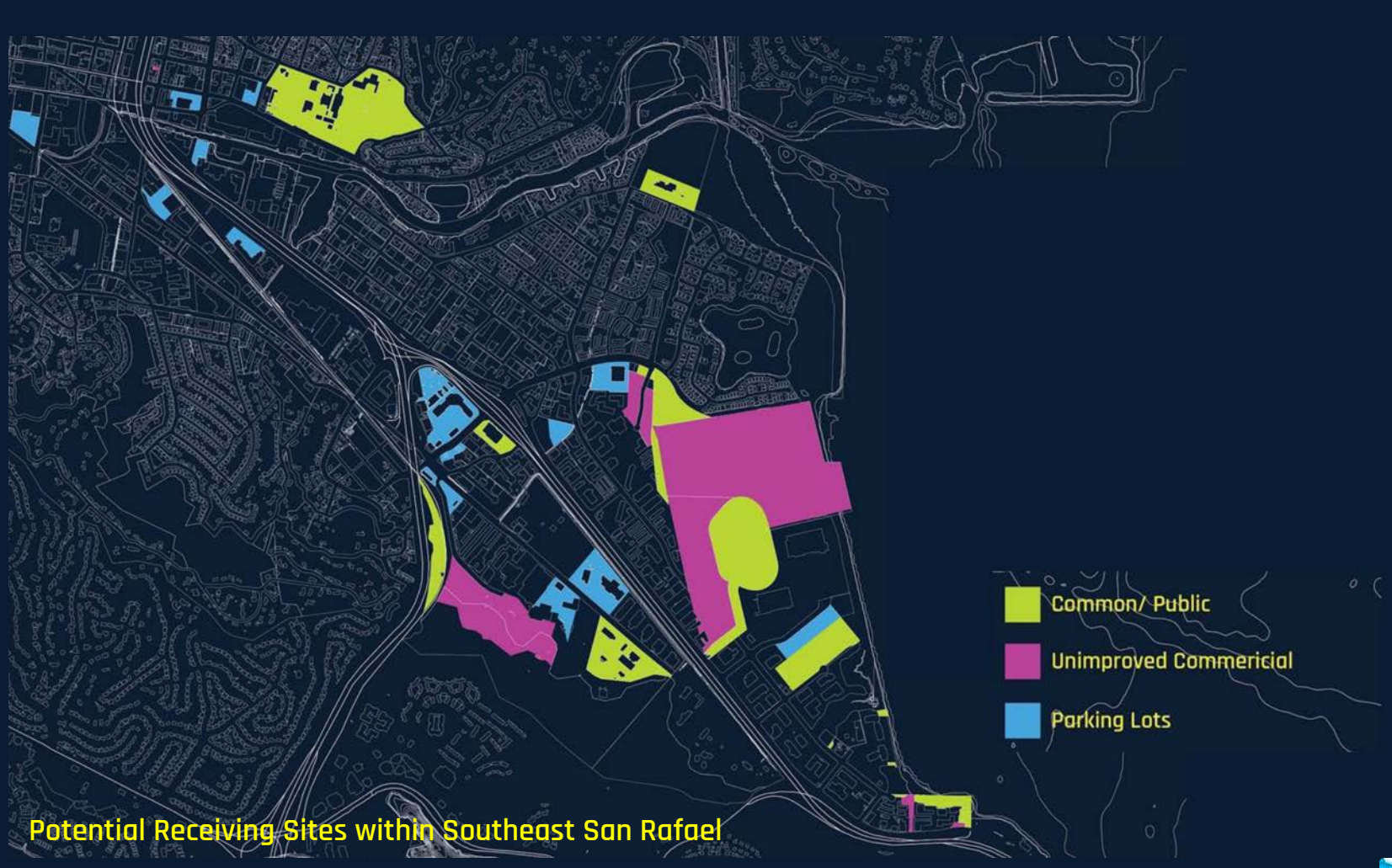
4) Highest population densities



Sites with Highest Vulnerability



Underutilized Sites in San Rafael
(Data Source: San Rafael General Plan 2020)



Potential Receiving Sites within Southeast San Rafael

Catalyst Projects

DESIGN SOLUTIONS

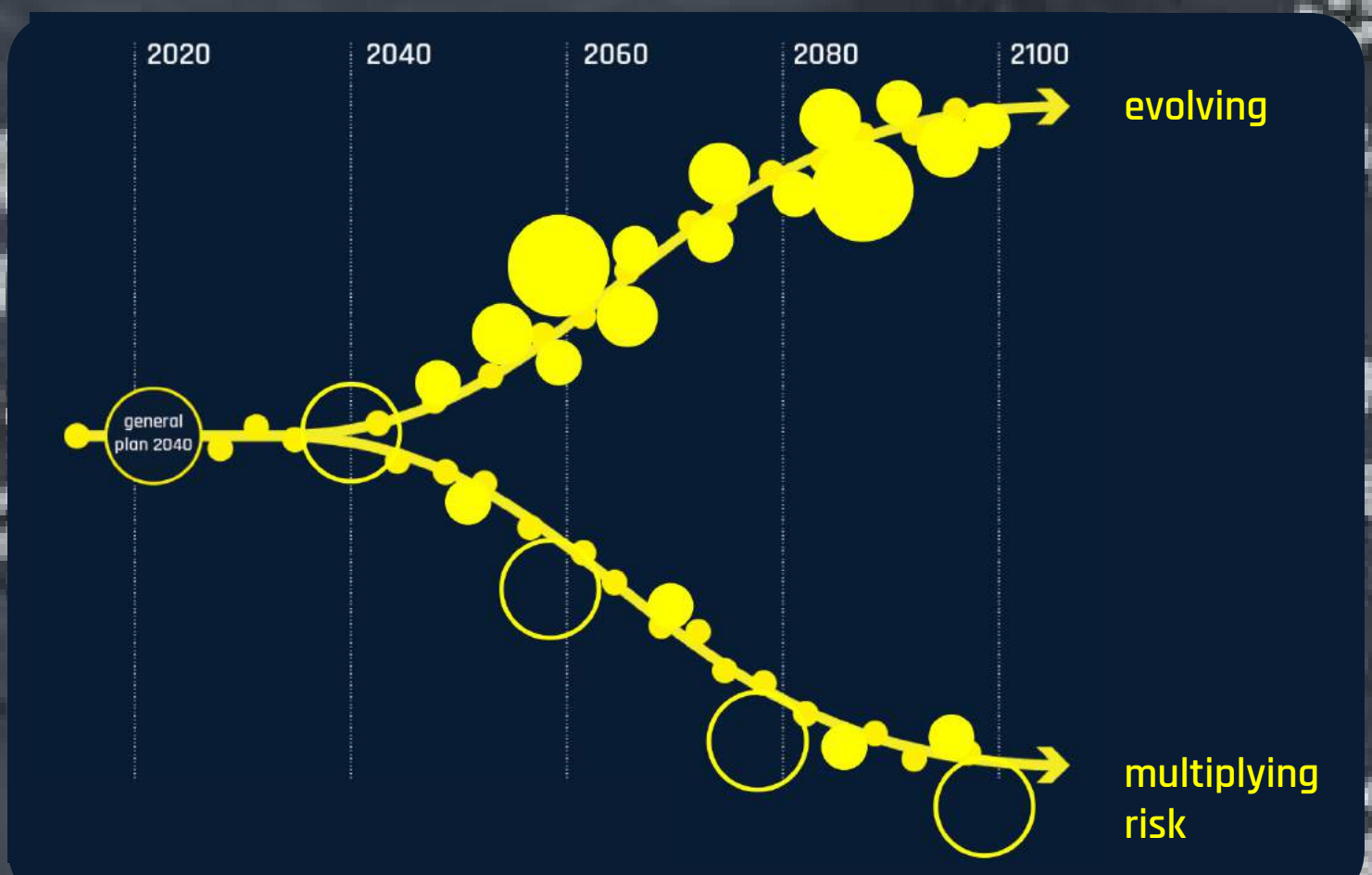
The geographic scale of the challenges facing San Rafael is growing, and the cost and management of mono-functional infrastructure over time does not appear to be sustainable in the long term. The city needs to think big and be strategic with its limited resources to make investments that build large scale resilience for itself and the region.

The Bionic Team's Elevate San Rafael Proposal is a two-part proposal to set the City of San Rafael on a trajectory of evolving and living with water:

1) Pilot and catalyst projects could protect San Rafael now, test new technologies, and buy time to prepare for the future.

2) A long-term strategy that plans for a new city structure with increased mobility, reinvented infrastructure, recreation, new forms of life and work, and enduring protection.

The two parts of the proposal are related. The pilot and catalyst projects are designed to activate change, test and improve methods, and scale into larger resilience structures and logics.



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Complete the Bay Trail
Canal Ecology
Protect Pickleweed Park
New Forms of Living
The Reef

CATALYST PROJECTS

GENERAL PLAN

POLICY + LAND USE + ZONING UPDATES
PUBLIC ACQUISITION INITIATIVE
INCENTIVE PROGRAM

CLASS I
MULTI-USE PATH +
FLOOD WALL

- PREVENT HUMANITARIAN CRISIS
- IMPROVE ACCESS
- BUY TIME

PUMP
SYSTEM UPGRADE

PICKLEWEED PARK
RENOVATION

LONG TERM PROTECTED
COMMUNITY CENTER + EMERGENCY
RESPONSE CENTER

CANALWAYS
- 50% AFFORDABLE
HOUSING
- MARSH RESTORATION
- PARKING SUPPLY
- TRANSPORTATION/
CONGESTION PROJECT

BUILD AFFORDABLE HOUSING NOW +
PARKING

FREEWAY OVERPASS (3RD LINE
PROJECT)

TIDAL MARSH RESTORATION OVERTIME
+ SEDIMENT RAMP

CANAL DREDGING
MARIN SEDIMENT
SURGE

SPECIAL ASSESSMENT DISTRICT FOR
LOCAL SEDIMENT HARVESTING

LIVING REEF PILOT
PROJECT

TEST HABITAT TYPES + ORIENTATION

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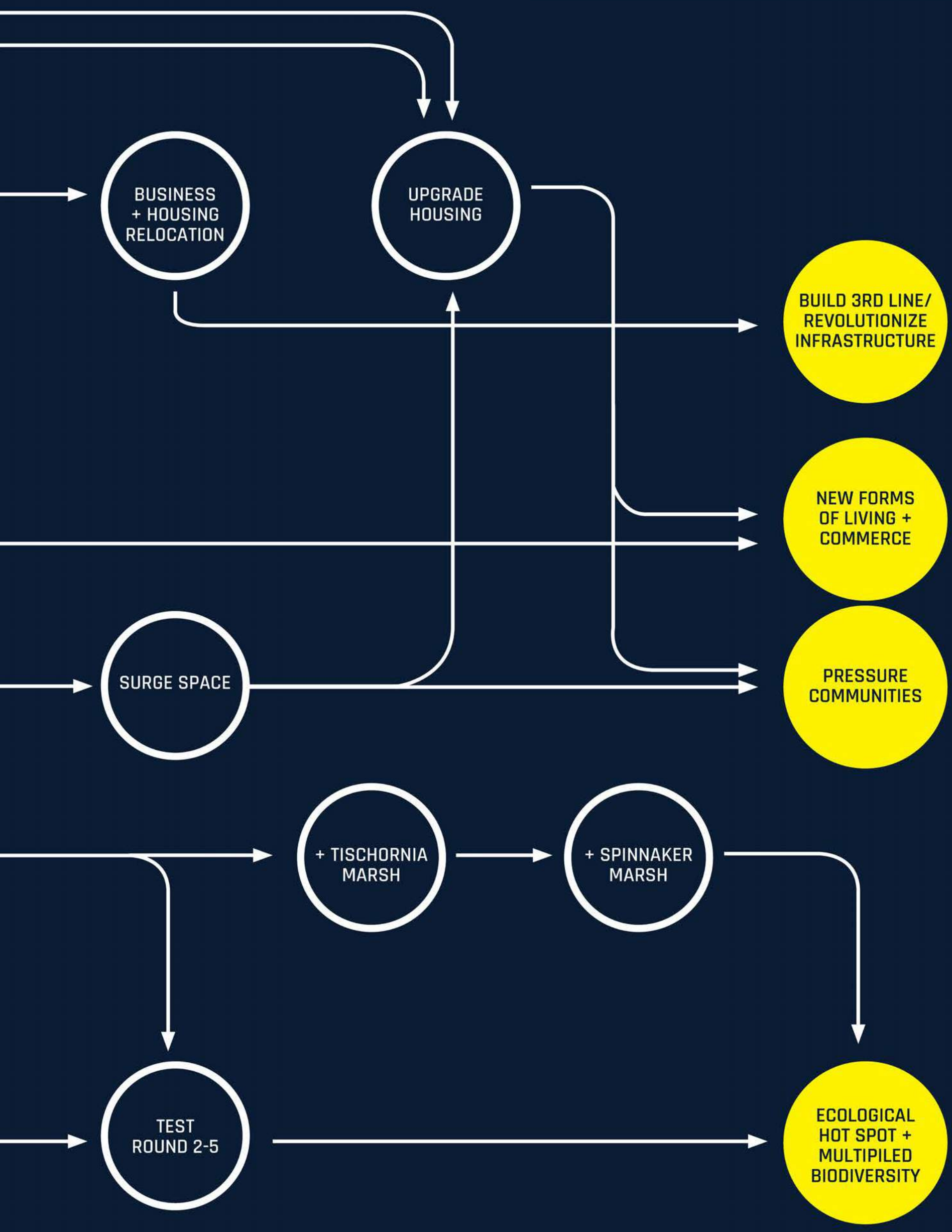
BUSINESS
+ HOUSING
RELOCATION
UPGRADE
HOUSING
BUILD 3RD LINE/
REVOLUTIONIZE
INFRASTRUCTURE
NEW FORMS
OF LIVING +
COMMERCE
SURGE SPACE
PRESSURE
COMMUNITIES
+ TISCHORNIA
MARSH
+ SPINNAKER
MARSH
TEST
ROUND 2-5
ECOLOGICAL
HOT SPOT +
MULTIPILED
BIODIVERSITY

CATALYST PROJECT 1 //

Protect Pickleweed Park (P3)

The Park is the community's most important resilience infrastructure. P3 proposes to upgrade flood infrastructure and a pump station with a multi benefit project that would also create an event space, a new playground, sports facilities, and a water sports access. In the case of emergency, this project would be stout enough to withstand flooding and provide a safe haven for the community in a time of crisis.

Community Center

Emergency
Response Center

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Protect + Elevate

Upgraded Playground

New Pump Station

Event Space

Water Sports

Upgraded Sports Facilities

Levee / Bay Trail

Upgraded sports facilities

Community event space

CATALYST PROJECT 2 //
Complete the Bay Trail

The Bay Trail currently runs along the San Rafael shoreline, but does not connect the shoreline to the neighborhoods, to downtown, or the creek. A new bike lane levee on Canal Street (City owned land) would complete the Bay Trail with a Class-I multi-use path that doubles as flood protection for the majority of at-risk housing and businesses. Equally important, the new facility would future-proof essential utility services.

Class-I Multi-Use Path

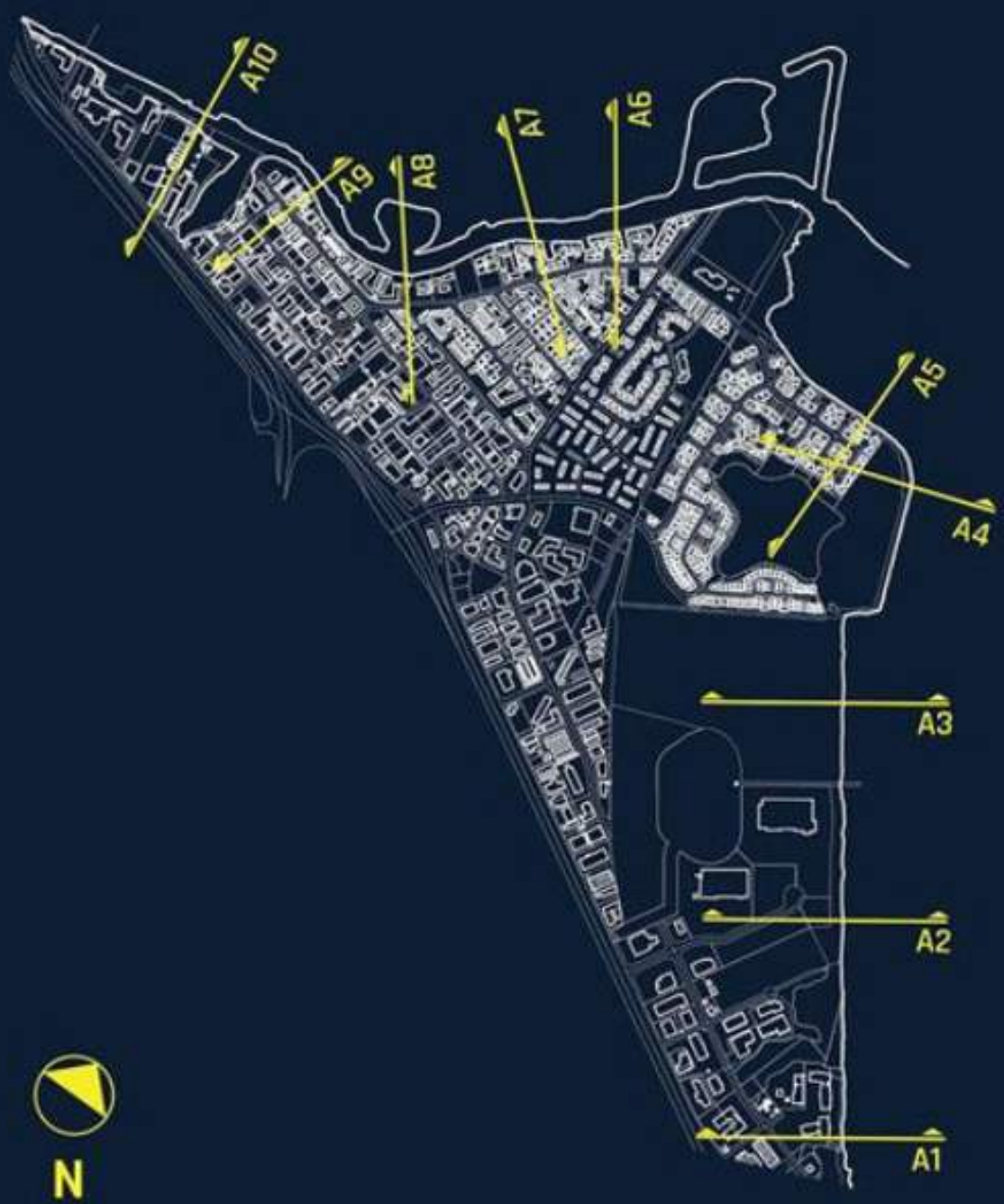
Upgraded + Protected Utilities

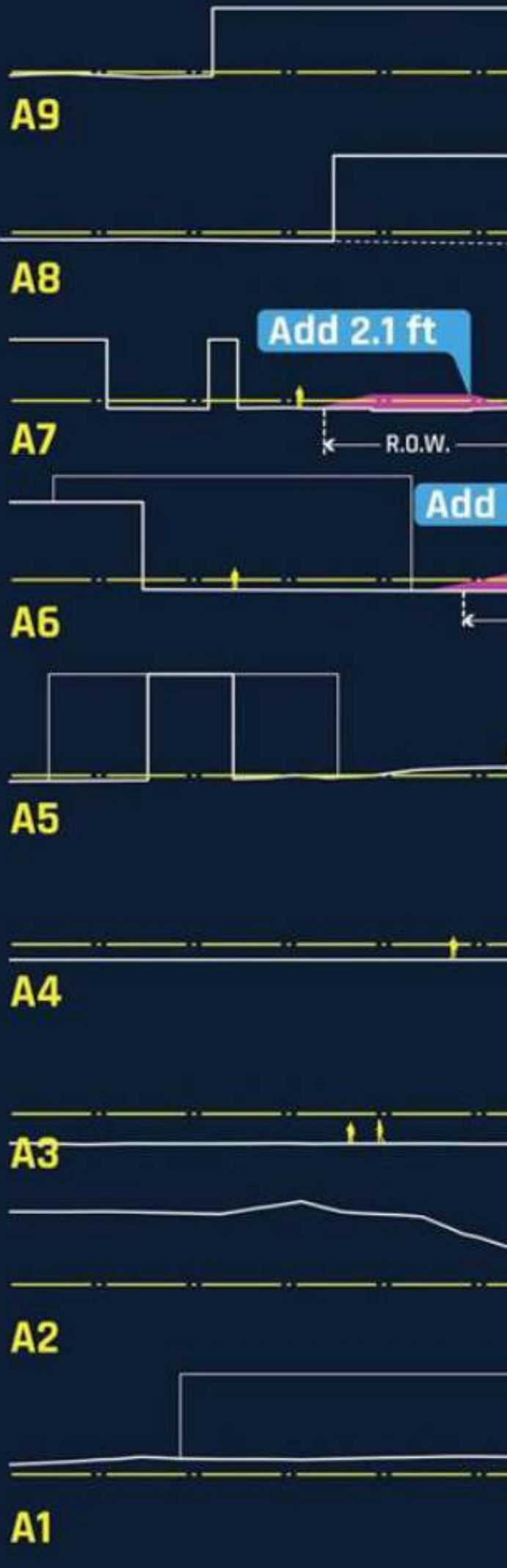

Class-I Multi-Use Path / Levee
Existing Bay Trail / Levee
Existing Inland Bay Trail Connectors
Flood Gate


COMPLETE THE BAY TRAIL:
Create a Class-I multi-use path
Upgrade utilities
Increase access and protection
CONNECT TO EXISTING LEVEE:
Remains in place with
protection to mid-century

ELEVATIONS REQUIRED FOR PROTECTION

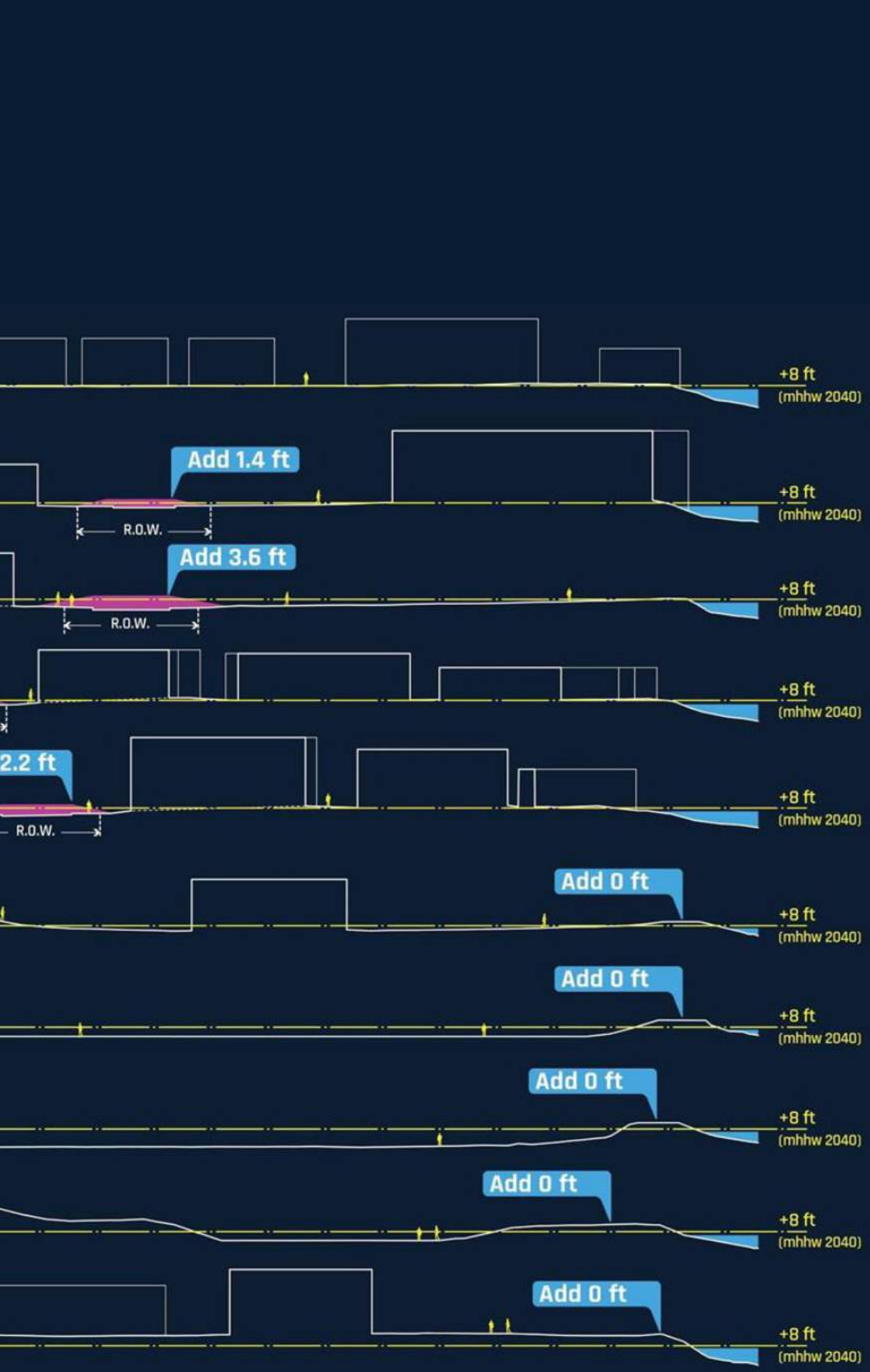
Along Canal Street and Francisco Boulevard, the Bay Trail would need to be raised anywhere from 1 to 4 feet to provide protection for the existing community until approximately mid-century. The existing levee at the shore edge is currently at an elevation that would provide protection until approximately mid-century, reducing the need for additional near-term protection measures along the shoreline.





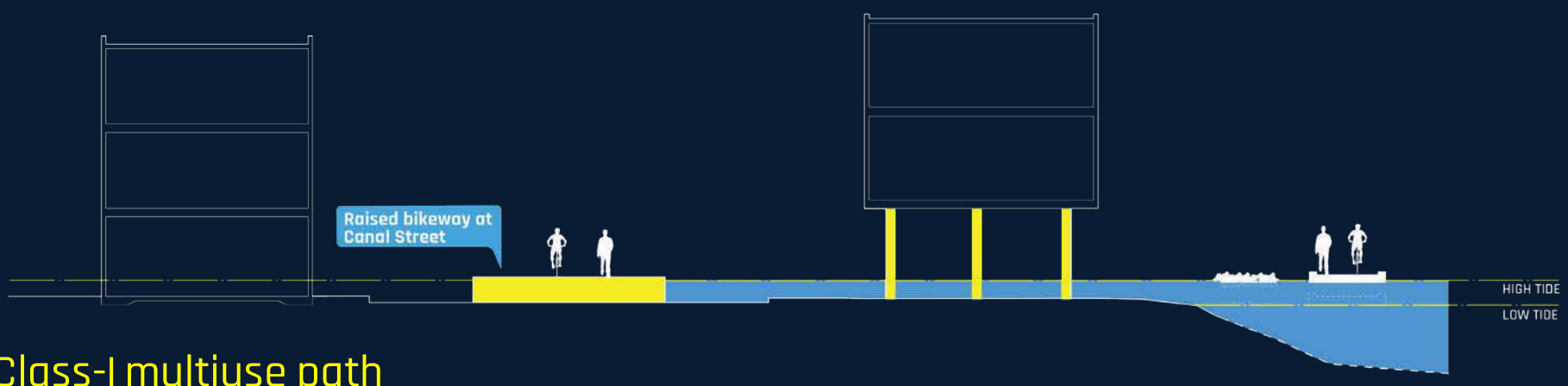
*NOTE: additional heights include 1 ft of freeboard

NEAR TERM PROTECTION DATUMS (2040)

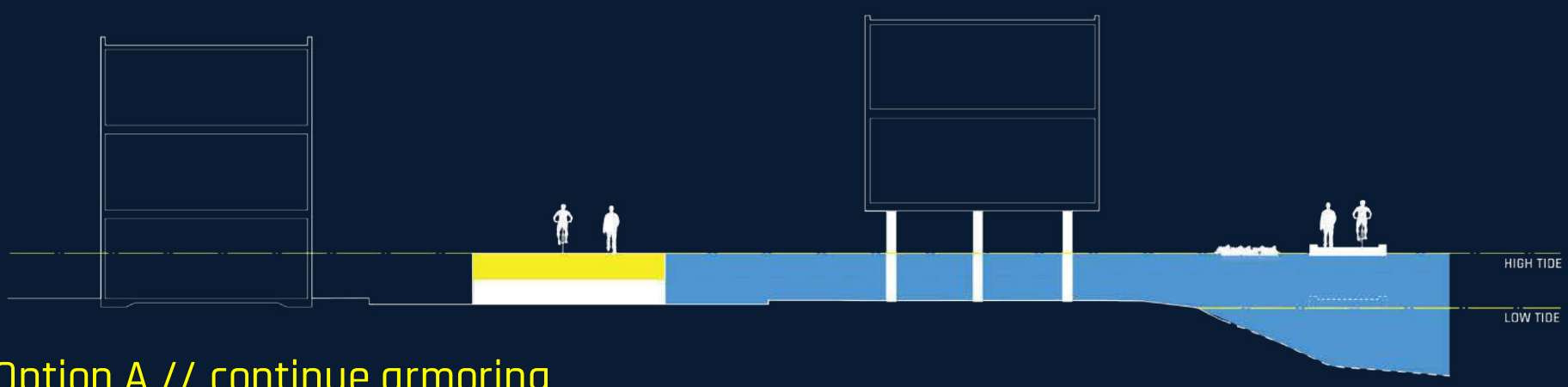

+8 ft
(mhhw 2040)
Add 1.4 ft
R.O.W.
+8 ft
(mhhw 2040)
Add 3.6 ft
R.O.W.
+8 ft
(mhhw 2040)
+8 ft
(mhhw 2040)
2.2 ft
R.O.W.
+8 ft
(mhhw 2040)
Add 0 ft
+8 ft
(mhhw 2040)
Add 0 ft
+8 ft
(mhhw 2040)
Add 0 ft
+8 ft
(mhhw 2040)
Add 0 ft
+8 ft
(mhhw 2040)

BUILDING UPGRADES

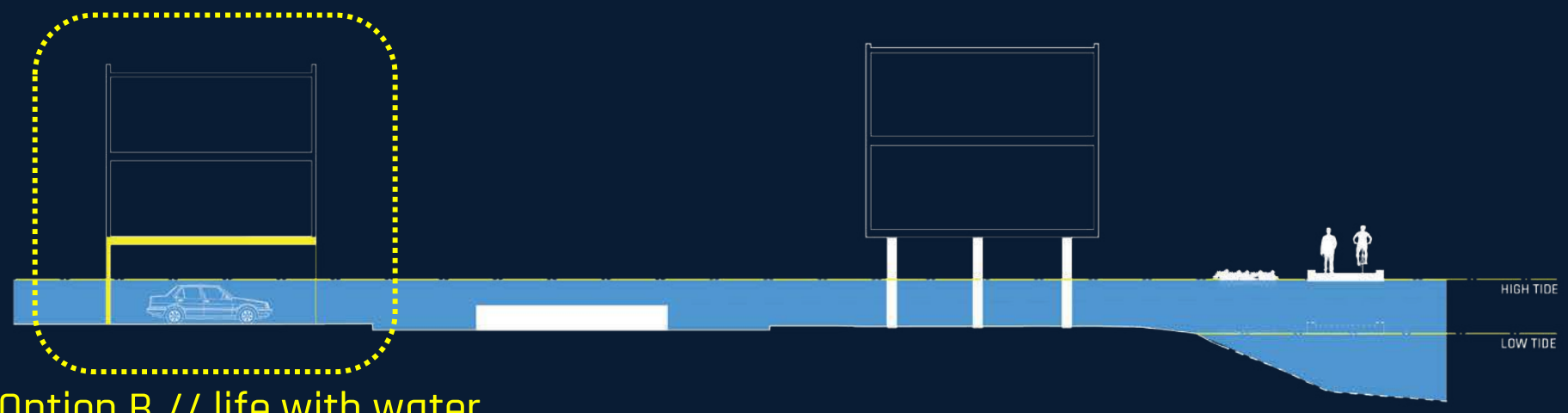
The Class-I multi-use path solution activates new priorities and requirements for upgrading buildings. Similar to the seismic upgrade programs in San Rafael, this approach requires safety upgrades for flooding and offers owners choices on how to adapt.



Class-I multiuse path



Option A // continue armoring



Option B // life with water

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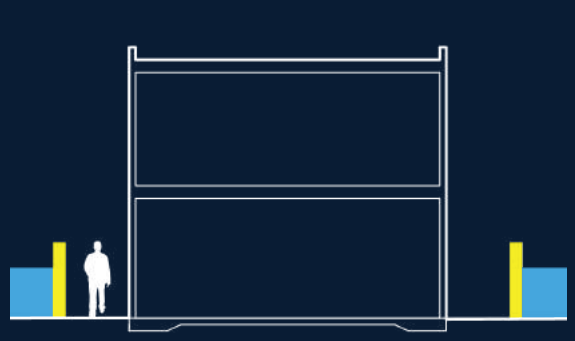
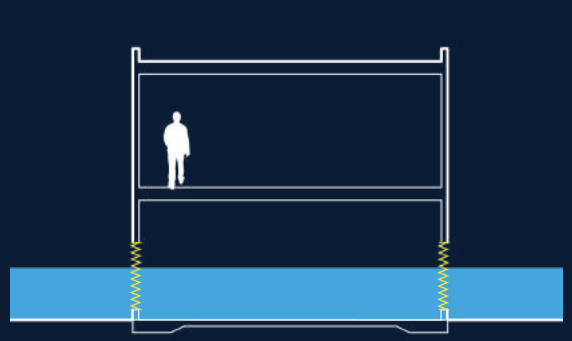
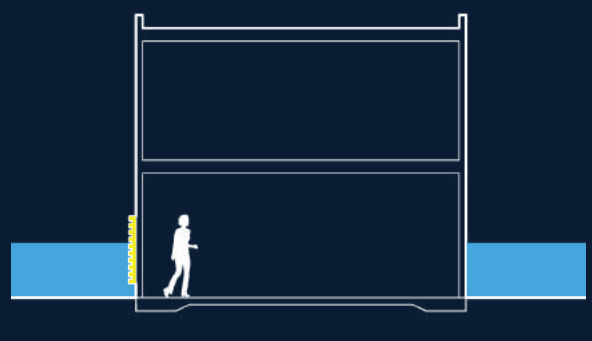


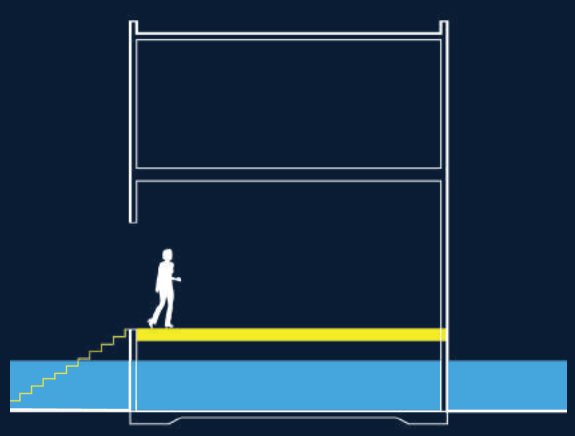
Wall



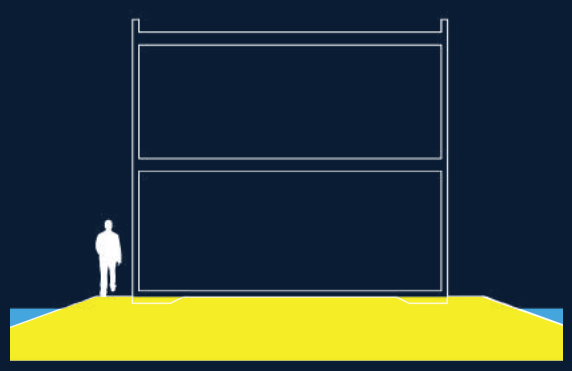
Wet Flood Proofing



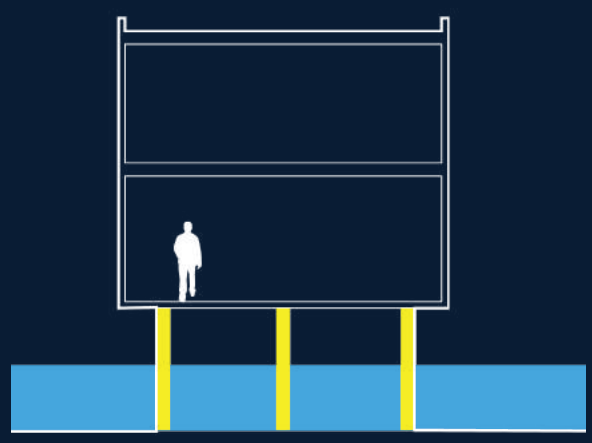
Flood Proofing



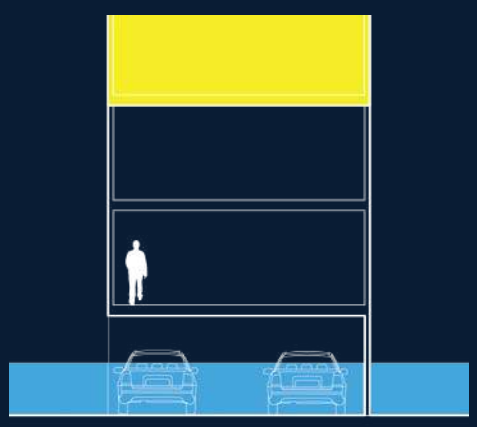
Raised Ground Floor



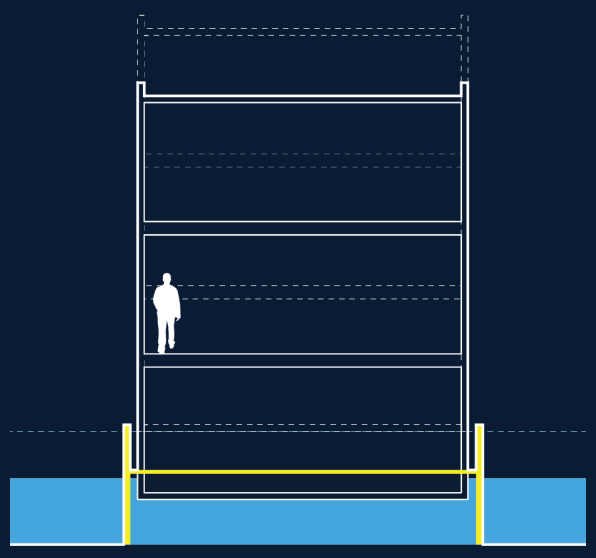
Mound



Raised



Floodable Ground Floor



Floating

CATALYST PROJECT 3 //

New Forms of Living

To accompany new policy for community values, resilience planning, and adaptation incentives, an upgrade to the housing stock would be created on a large underutilized site adjacent to the existing community. This project would establish a new datum for flood protection through the creation of a large parking podium. This seemingly common construction would solve a basic need to park a car for many canal residents and enhance their financial security. It would also reduce the amount of fill required to construct the project at a future-proof elevation. The new datum would also sponsor the creation of a large re-stored marsh and recreation area.


Wetland Restoration

New upgraded housing and commercial stock as surge space for existing community

Parking garage reduces fill required and addresses community's parking concerns

New waterfront open space serves as buffers from rising tides for long term and increased projections

Wetland Restoration

MHHW 2100++
MHHW 2100
MHHW 2060

New Bay Trail connection

New tidal marsh restoration

New Neighborhood + Amenities for Community

CATALYST PROJECT 4 //
Canal Ecology

The pattern of parcelization, ownership, and maritime uses along the canal is the source of its charm and its greatest weakness. To add to San Rafael's resilience, the canal requires incremental transformation. To prime its potential as a waterfront and a destination, a program of floating wetlands could be installed along underutilized portions of the creek to provide a range of ecological services. The wetlands could stimulate activity, test their viability, create habitat, reduce erosion, and build stewardship.

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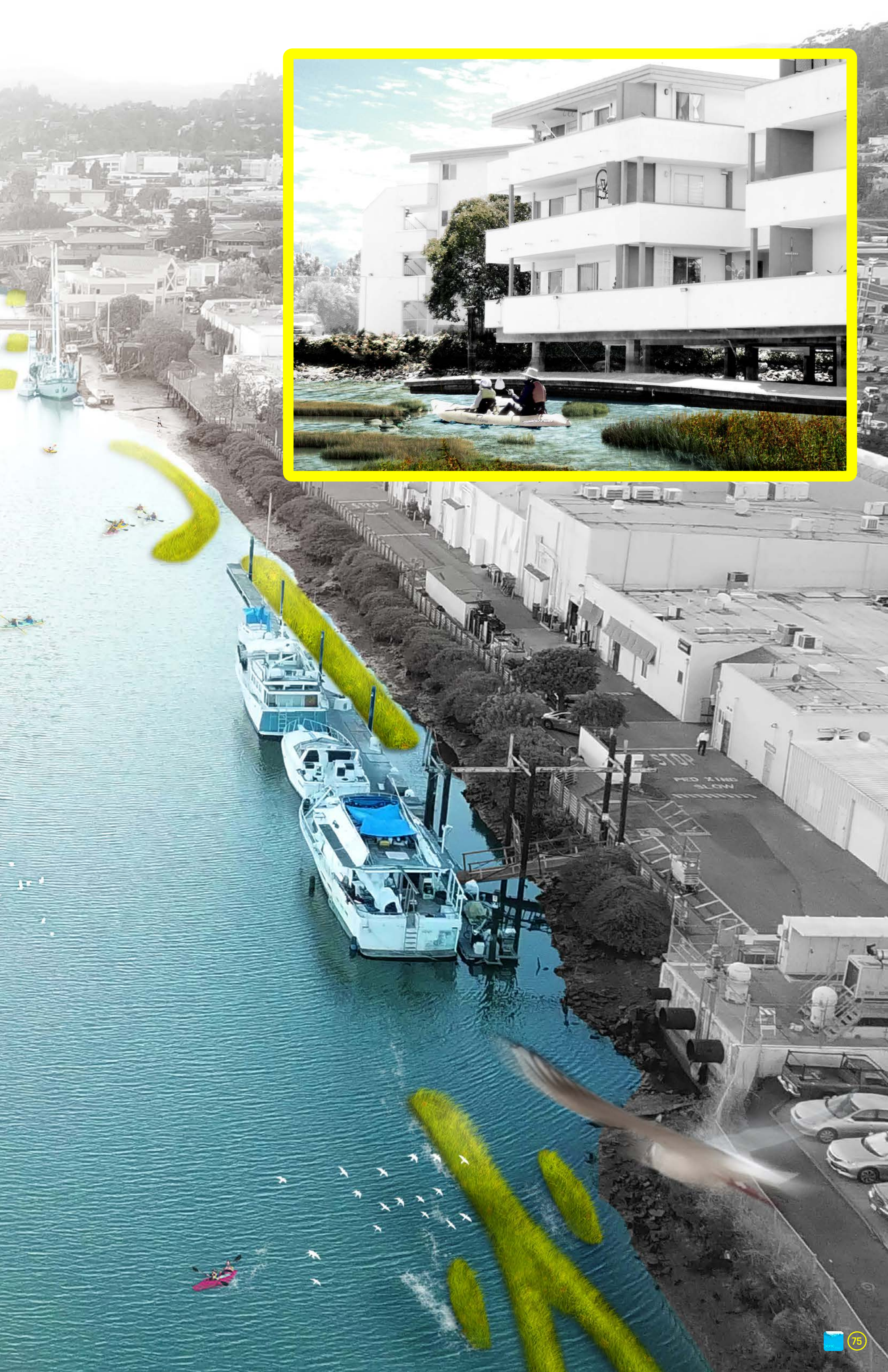

STOP
RED X IND
SLOW

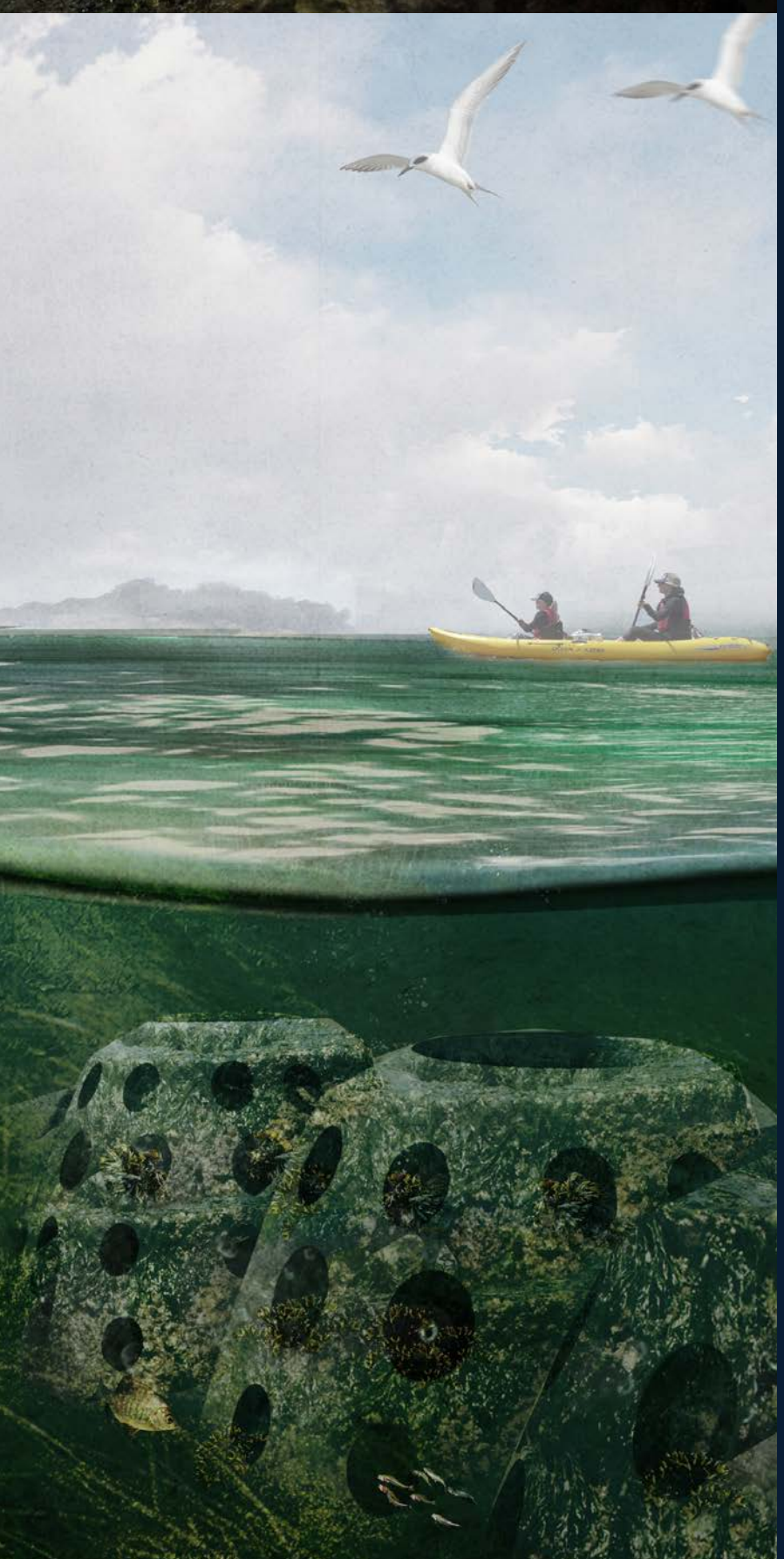
CATALYST PROJECT 5 //
The Reef

With the need to integrate the ecologies of the bay edge, the existing living shoreline program could be expanded to test the ability of this technology to influence coastal processes. A sediment surger array could be installed in open water to build upon existing living shoreline pilot projects and test their viability for sedimentation, habitat creation, and wave energy dissipation.

Recreation +
Research Lab

bionic TEAM

Living Reef



The pilots would test their capacity for habitat creation including eel grass beds in a greater range of bathymetric conditions. These pilots should be initiated early with the inland marsh restoration. They take time to establish, and their ecological benefits are of value now.

Recreation + Research Lab

bionic TEAM

THE REEF //
Long Term

The ecology of the edge is a series of disconnected projects and resources. In the center of the shoreline there is an existing pilot project testing constructed oyster habitats and how they react to coastal processes.

Existing Habitats

Proposed Soft Marsh Edge

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A more resilient and diverse edge would be interconnected, related, culturally valued more broadly, and equipped to adapt to more environmental change and less sediment supply.

Coastal Processes

North Bay Ecology

The reef is a pilot for an even larger scale ecological initiative in San Pablo Bay where there are similar coastal dynamics. San Rafael fills a gap in this greater connectivity, and the reef is an intermediate step in scaling the enhancement of ecological services from the size of a pilot, to the size of a city, to the size of the county and the ecology of its entire shoreline. That could inform the adaptation of the entire north Bay edge.

THE REEF //

Reef Arrays + Sediment

The Bionic Team proposes an array of constructed reefs to support the main marsh areas. The arrays would build upon the existing pilot and test the viability of these structures for sedimentation, habitat creation, and wave energy dissipation on a large scale.

The Team specifically studied sediment transport in near shore conditions through hydrodynamic modeling. The models suggest patterns for sediment deposition and the scale necessary to influence this coastal process. The initial pilots would test different forms, orientations, and exposures in San Rafael Bay. Learning from the pilots, the reef sites could be multiplied to form an enormous array.

Sediment Supply

LEGEND
Suspended Sediment Assumptions*
mg/L (Low - High)

- 25-50
- 25-100
- 50-100
- 50-150
- 100-150
- 100-300
- 150-300

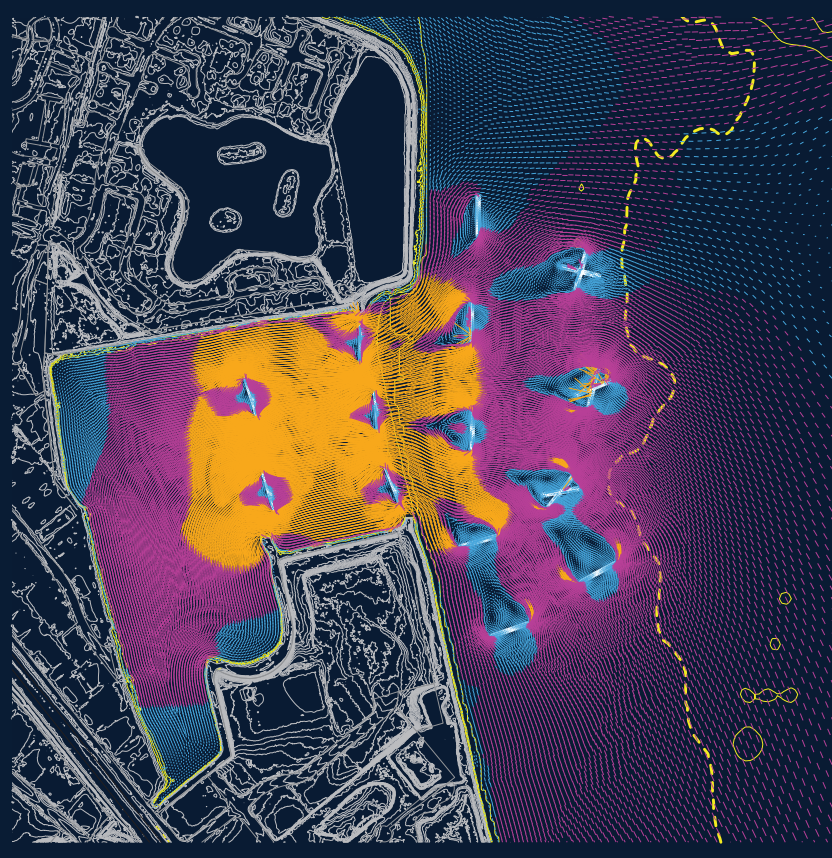
* Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay

LEGEND

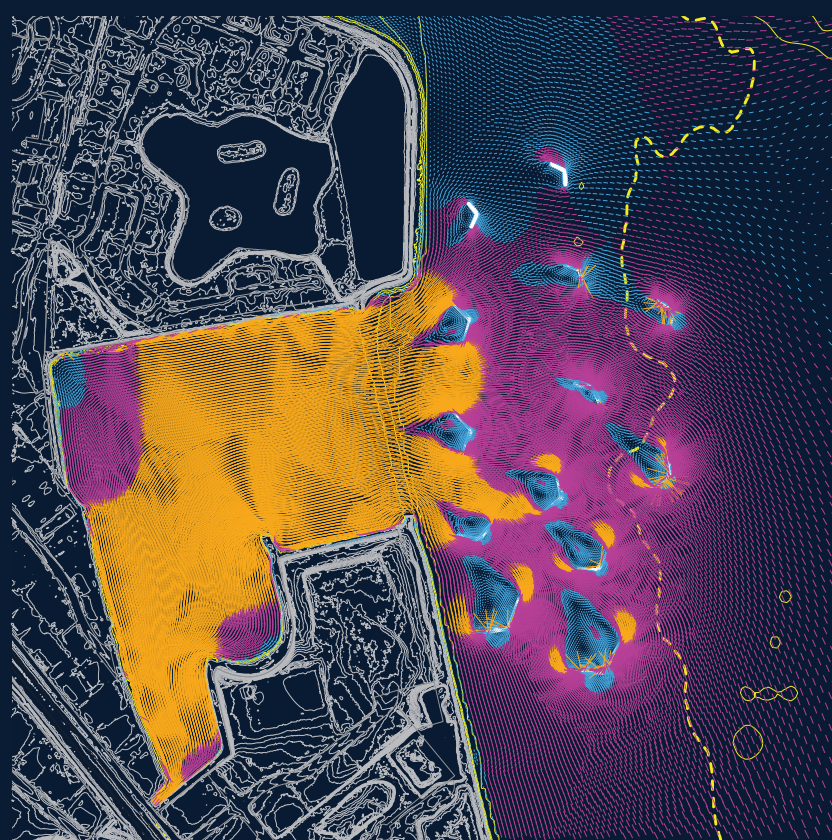
- Sediment Velocities (0.2 - 1 cm/s)*
- Suspension Velocities (1.1 - 15 cm/s)*
- Erosion Velocities (15.1 - 1000 cm/s)*
- Line of optimal Eelgrass bed depth

*per Hjulstrom diagram

Sediment Array Model 1

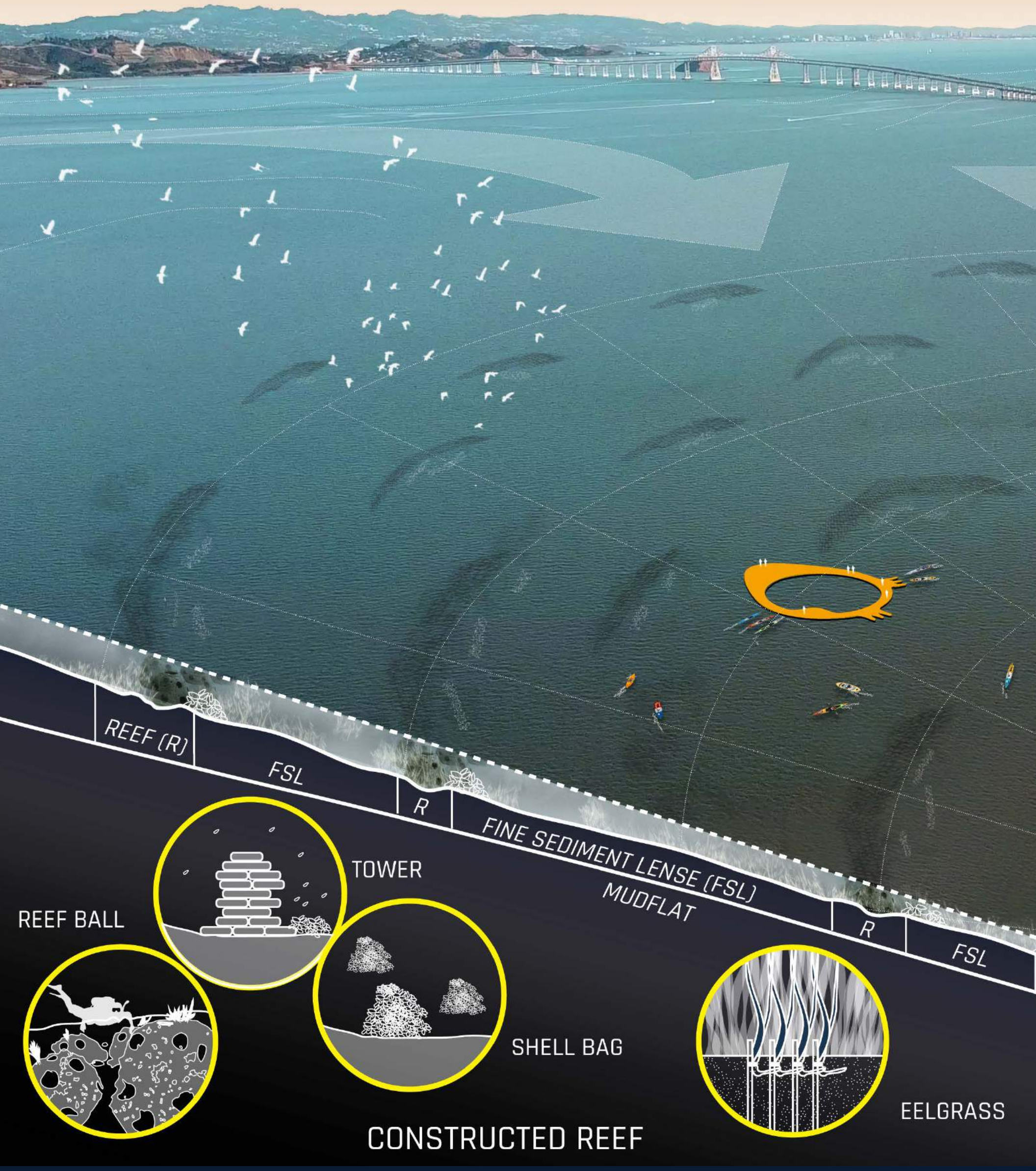


Sediment Array Model 2



THE REEF //

The tidal zone could become a nursery for a diversity of marine species, a wave attenuator, and sediment surging device for marshes, and a gradient of integrated ecological niches



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BRACKISH
MARSH
ROCKY INTERTIDAL
SALT MARSH
SALT MARSH

Elevating in the LONG TERM

INVISIBLE FORCES

The current pattern of urbanism and social dynamics in San Rafael has evolved slowly over decades. Today it appears to be intractably stuck with no room to move. Even though it is a small city of 59,000 people, the pressures and forces that have changed it over time are local, regional, global, and technological.

Invisible to the eye but obvious in the data of land use patterns and global trends, the business tax base of San Rafael in the 100-year flood plane is largely comprised of uses that are undergoing industry transformation.

Incremental change is happening in automobiles, retail, logistics and supply chains, labor, and building trades. These changes are occurring over the San Rafael terrain at a steady but difficult to perceive pace. In addition, the economics of the insurance market for flood prone areas like East San Rafael is rapidly changing the value of property and patterns of urbanization.

These invisible forces will shift the ownership of large parcels of land throughout the East San Rafael flood plane in the coming decades.

The urbanization pattern of San Rafael was optimized for industry and the efficient movement of automobiles. The combined effect of the invisible forces shaping San Rafael could be understood and engaged as an opportunity to gradually reposition the urbanization pattern of today, to an urban form that can sustain life in the uncertain future of rising sea levels.

Shifting Land Uses

- Retail
- Auto Dealership
- Industrial

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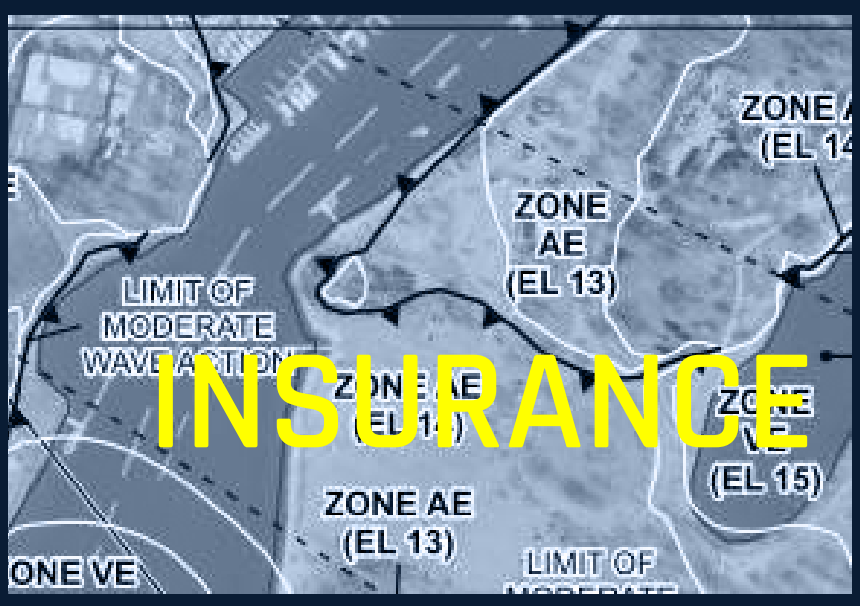
Smaller Format
Higher Performing Land Uses

Decrease in Ownership
New Sales + Service Models

New Logistics
Models + Patterns



New Incentives
Programs + Markets

LONG-TERM STRATEGY

The long-term strategy engages the invisible forces to enhance mobility, reinvent infrastructure, enable ecology, and provide enduring protection.

The city will need to use incentives to shift the pattern of urbanization from diffuse and auto centric, to a more equitable and resilient urban form.

Using enhanced zoning, density bonuses, housing subsidies, and community land trusts, property owners could be motivated to face the creek, add housing and business space, provide continuous water access, and nature based solutions to define the edges.

In the canal district and areas currently protected by levees, property owners could be incentivized to build flood proof housing and add to the supply where allowable.

Businesses could be incentivized to become flood proof as well, or to move their operations in San Rafael to the area West of the freeway where conventional risk reduction is in place and reliably stout.

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2060
NEW HOUSING ON HIGHER GROUND
BUILDING RETROFITS TO FLOODABLE STRUCTURES
NEW HOUSING ON HIGHER GROUND
housing transformation


2060
NEW BUSINESSES ON HIGHER GROUND
BUILDING RETROFITS TO FLOODABLE STRUCTURES
NEW BUSINESSES ON HIGHER GROUND
business transformation

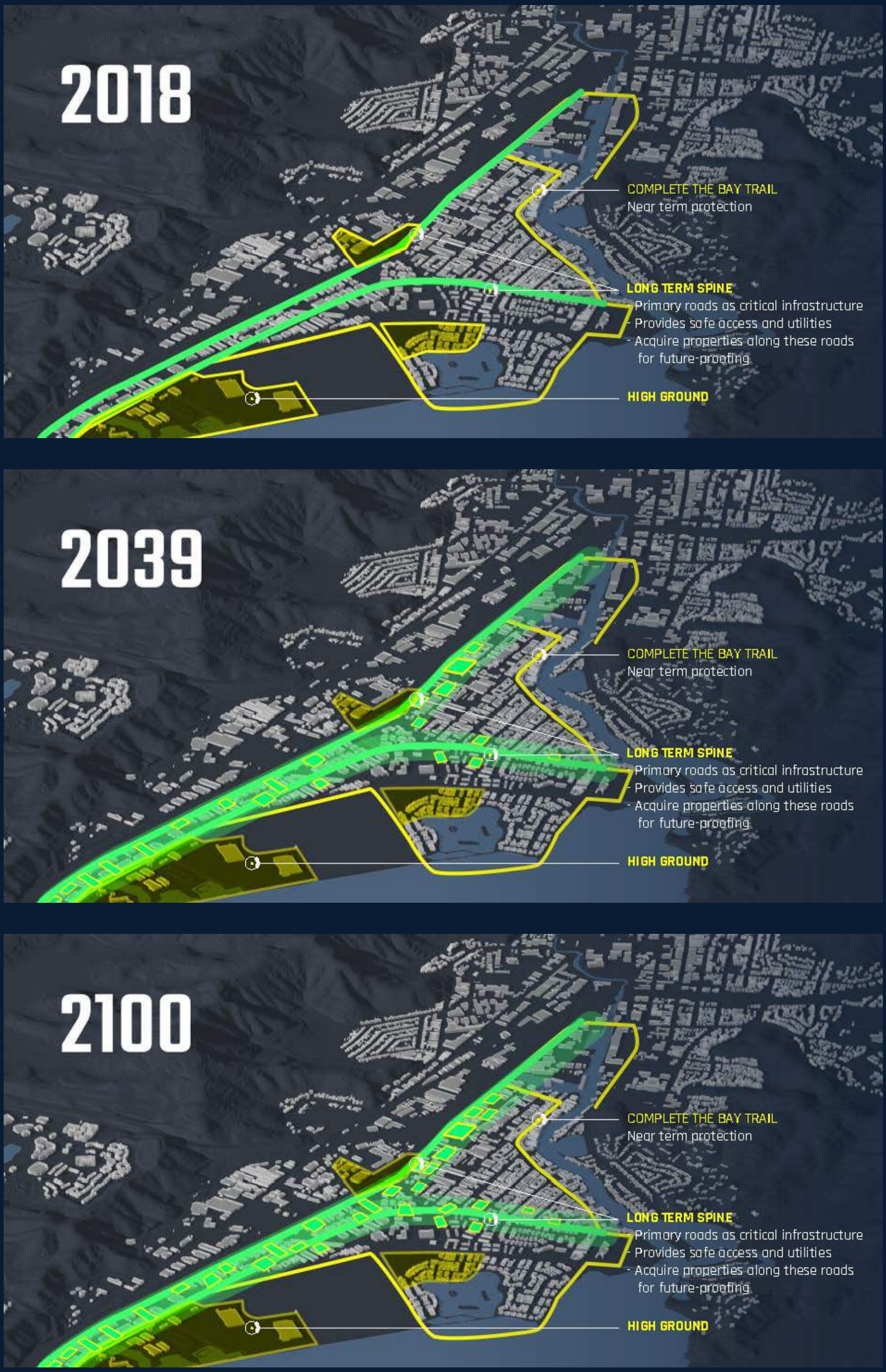
ELEVATING IN THE LONG TERM

The 101 and 580 freeway run through San Rafael. They are critical infrastructure for the region and need to be protected.

Kerner Boulevard connects the high ground to the south with Pickleweed Park. Francisco Boulevard parallels the transportation corridor and leads to the down town area. These 2 corridors should be the future spines of development, services, infrastructure, and movement.

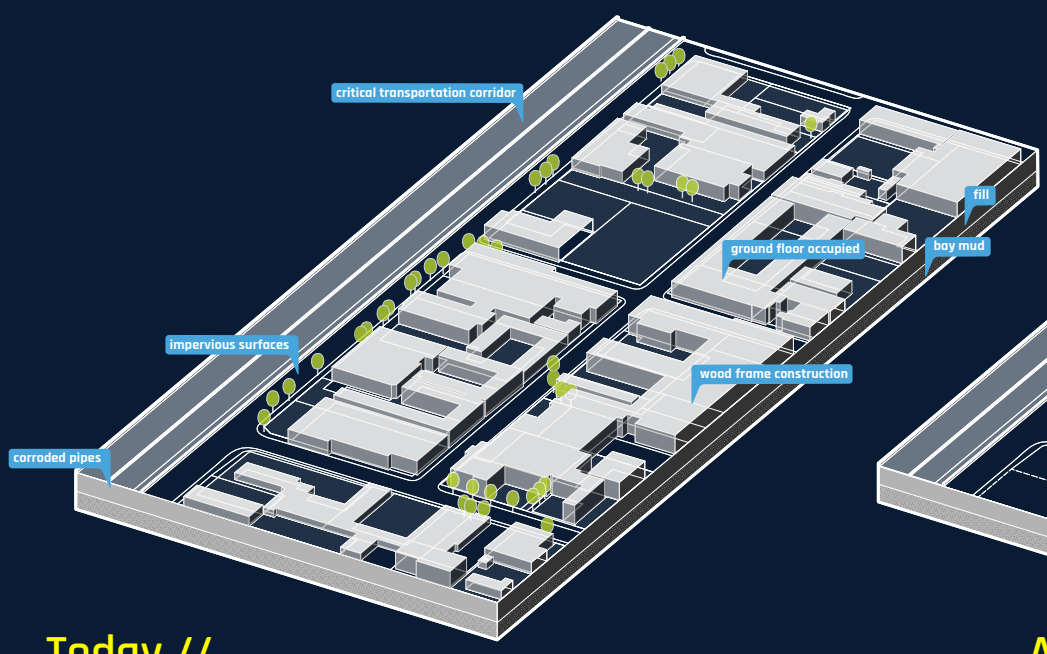
Along these city owned streets, acquired properties could be raised to higher elevations and connect higher ground. Infrastructure in these elevated alignments could be buffered from destructive forces of water and seismicity by new edges that host ecologies, culture, and maritime activities. Infrastructure could also influence the pattern of development away from the most hazard prone and subsided areas. Pickleweed park would remain connected to the community and a center for maintaining social resilience.

Existing Infrastructure

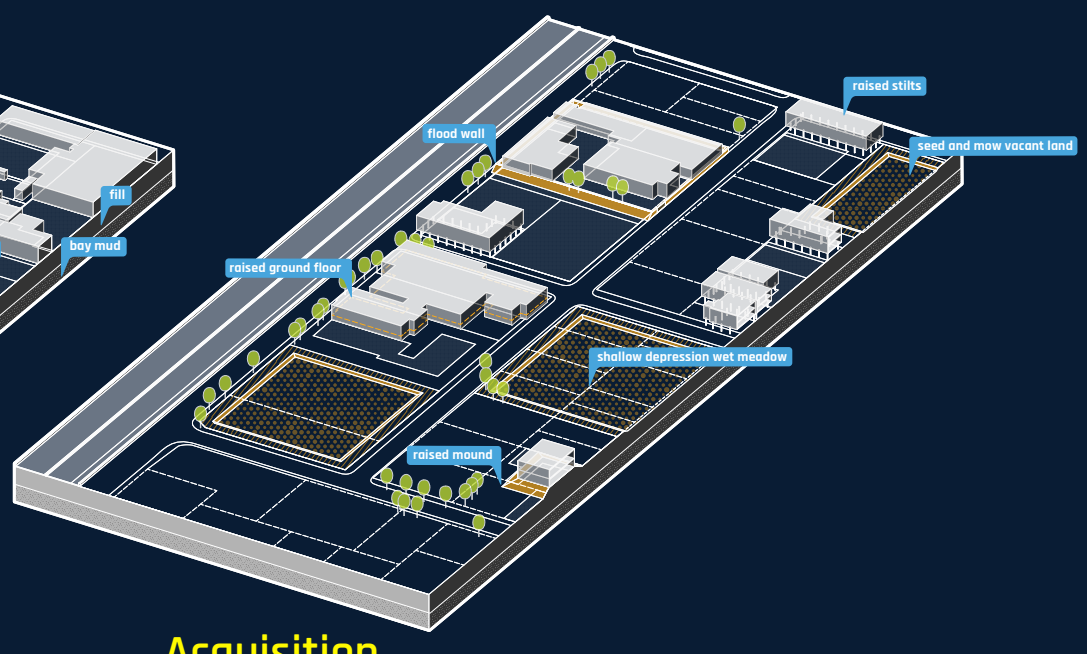


Acquisition + Evolution along Kerner and Francisco Boulevards

ELEVATING //
Francisco Boulevard



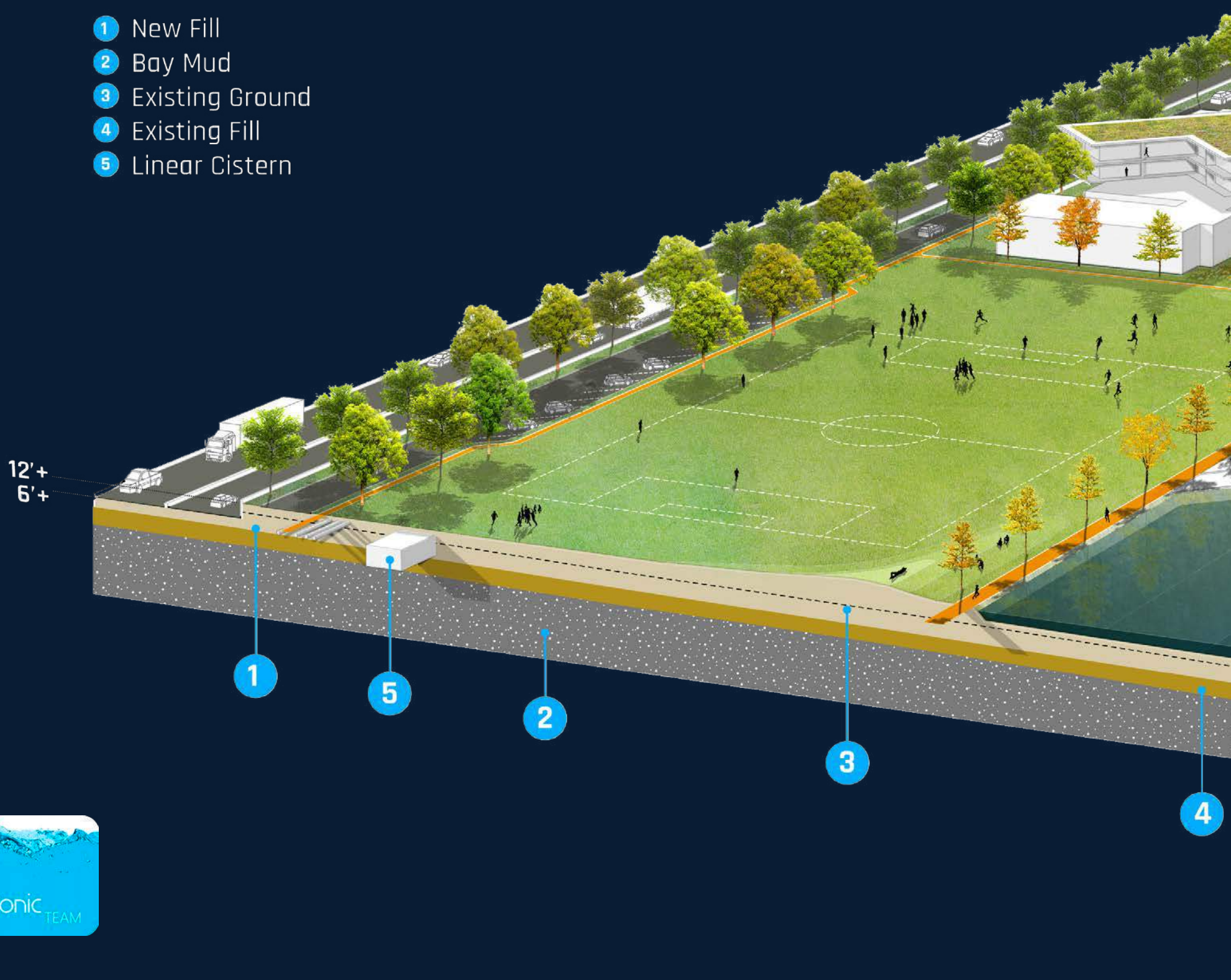
Today //
Residential



Acquisition
+ Adaptation

Freeway

1. New Fill
2. Bay Mud
3. Existing Ground
4. Existing Fill
5. Linear Cistern



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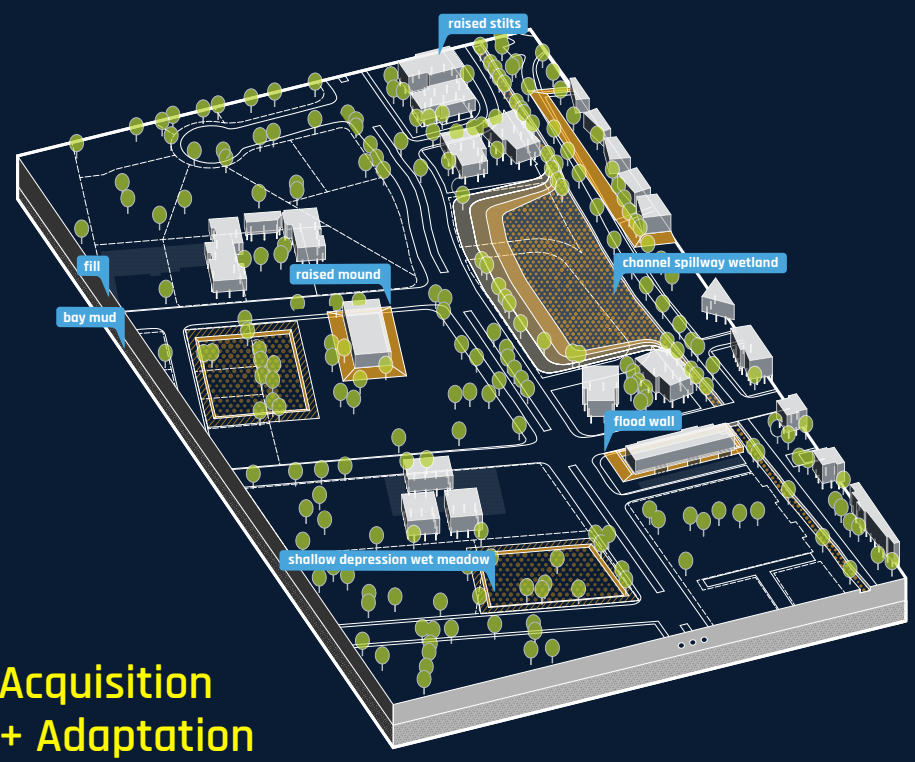
In the industrial conditions, the 101/580 transportation corridor is highly exposed to flooding. Along this edge there is clear opportunity for the city and the regional transportation agencies to anticipate the future and combine resources. Along the critical spine of Francisco Boulevard, owners could choose to protect in place or sell, and parcels could be acquired for the creation of green infrastructure. Over time properties could reorient their position to the environment and the infrastructure that support them.

ELEVATING //
Kerner Boulevard

Today //
Residential



Acquisition
+ Adaptation

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Along the critical spine of Kerner Boulevard, which is primarily residential today, some properties could raise and some could change ownership leading to opportunities to build greener infrastructure. Over time properties could reorient their position to the environment and the infrastructure that support them.

ELEVATING //
The Long Term

The future with Sea Level Rise is uncertain, but there are credible scenarios that project over 10′ of increase by the end of this century. It is certain that over time sea levels will continue to rise. Understanding the complexity of the current situation and human life at risk, the Bionic Team proposes a strategy for large scale resilience that future generations could pursue. This is to say that the Team is not proposing projects and initiatives that will further complicate or preclude change. But rather, on the longer-term time scale, measuring resilience as a question of the options that have been made possible for future generations.

Building on the catalyst and pilot projects of the near term, the Bionic Team proposes that the city gradually shift resources away from the current pump and levy system, and reduce the perimeter that the City maintains for risk reduction. Paired with programs for upgrading to floodable buildings, acquisition of property for infrastructure protection, and equitable housing, this strategy proposes to build a city scale apparatus of green infrastructure that would elevate life in San Rafael and the systems that support it. Through this framework future generations would have options, space, and resources for how they continue to build resilience, and could choose to persist in this place for another hundred years or more.

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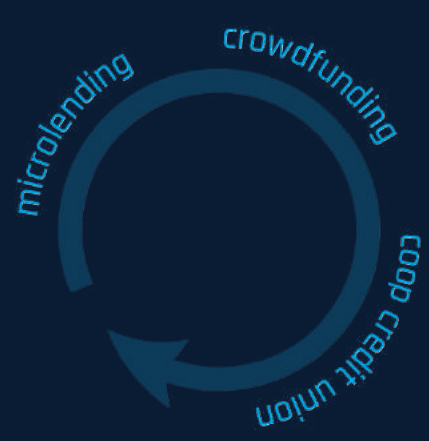
Implementation STRATEGY

POLICY MECHANISMS

Through conversations with community members, it became clear that there are many stakeholders with overlapping yet distinct priorities. To elevate life and put housing first, there are a range of mechanisms at different levels of government. These will have to incorporate acquisition, adaptation, and enhancements, and a range of financing and regulatory tools to subsidize housing, incentivizing housing, and promote community based ownership of improvements.

The City of San Rafael must reevaluate their housing policy to ensure social cohesion of the existing community and that all residents will have equal access and opportunity to housing in San Rafael. A new process is needed where the city and residents work together to prioritize equity, housing affordability, stability, and design. This would require state level commitment in policy and legislation, and city level housing policies. This type of commitment is critical to prevent against displacement and preserve a vibrant community.



COMMUNITY FINANCE

PUBLIC-PRIVATE FINANCE

Permanent affordability & wealth creation

Density & infill

Community

Community Land Trusts

Zoning & FAR

City

Infrastructure upgrades

Subsidized housing supply

State

Enhanced Infrastructure Finance Districts

Low Income Housing Tax Credits & Project Based Section 8 Vouchers

Federal

COMMUNITY ORGANIZATIONS

PRIVATE LANDOWNERS

HOMEOWNERS ASSOCIATIONS

RESIDENTS

BUSINESSES

PUBLIC LEADERS

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PRINCIPLE	RATIONALE	TACTIC
MORAL IMPERATIVE: The City/County must address the conditions and risks of housing in the Canal District NOW to prevent a humanitarian crisis in the near term.	Severe flood damage in the Canal District represents the potential displacement of significantly more families than units damaged. (Need number)	Lead with policies to protect Canal District residents from displacement AND risk of displacement
	Rents in the Canal District are lower than anywhere else in the County and all rental housing in Marin is highly impacted. Displacement of Canal residents will lead to homelessness and displacement from the City and County.	Build new housing first, relocate residents second. No residential unit should be taken off the market without first providing a replacement unit
	The generally accepted timeline for building affordable housing in the bay area (without opposition) is 5-7 years.	Involve existing residents in the design and selection of tactics to protect residents currently living in the Canal.
PREVENT AVOIDABLE DISPLACEMENT: Any plans to improve or protect housing stock in the Canal District against flood risks must be paired with tactics to protect existing residents from displacement due to gentrification.	The strongest displacement-risk indicators include: proximity to rail transit, high percentage of renter-occupied housing, a high share of renters paying more than 35% of their income in rent, and a high percentage of non-white occupants – all of which are indicators that are present in the Canal district.	Offer buyout option to existing property owners in the Canal by City- or County-controlled Community Land Trust (CLT) or other mission-minded affordable housing organizations.
	Renovation/retrofit/redevelopment of existing housing runs the risk of seeding gentrification	Offer right to return for Canal residents displaced by retrofits to buildings acquired by CLT.
	Areawide improvement (trail access, waterfront access/amenities, etc.) also run the risk of seeding gentrification	Involve existing residents in improving community access. Ensure that strategies to protect residents are in place prior to implementing new plans.
PRESERVE COMMUNITY AND REDUCE ISOLATION: Replacement housing should be built within the same, existing "social catchment area" and improve connectivity to resources outside of the catchment.	Canal residents report heavy reliance on the services located within the district	Plan for the protection and replacement of critical public and community assets alongside housing
	Low-income and immigrant families often rely very heavily on social and familial networks to bridge for stability and advancement.	Involve existing residents in designing connectivity between existing and replacement housing.
DO NOT REPLICATE OVERCROWDING: Replacement housing must be built in appropriate quantities representing the TRUE number of residents living in this area	(Overcrowding statistic)	Involve existing residents in the assessment of size and scope of the need for replacement housing Canal, including culturally sensitive evaluation of household configurations.
	Community can be densified more successfully with appropriate public transit services	Increase building heights and FAR limits; Adjust envelope restrictions
	Overcrowding of housing has created overcrowding of on and off-street parking spaces	Site replacement housing with the transit needs of the community in mind
MAKE LEMONADE: Replacement strategy should reduce housing cost burden and create new opportunities for housing mobility (in place)	Many existing Canal residents are housed but remain housing insecure due to excessive housing cost burdens, overcrowding and challenging housing conditions.	Ensure that any new housing is operated with affordability restrictions that reflect the needs of the existing community
		Build housing ladder into new and retrofitted housing Canal Catchment to enable housing and economic mobility, including lease-to-own and other opportunities.

NEXT STEPS

San Rafael needs to act now. The risks are eminent and protection measures are needed for the near-term. The Bionic Team recommends that the City take urgent measures to buy time and protect a vibrant community currently in harms way.

The process will require the participation of many stakeholders and funding from a range of different sources. Collective action will allow San Rafael to advance down a trajectory of elevating and evolving, and will prevent an unnecessary humanitarian crisis.

Resilience planning for San Rafael will be a multi-year and multi-generational commitment from the city and its residents.

Beyond initiating catalyst projects to protect San Rafael now and buy time, the City could advance the resilience conversation and planning in the near term, with the support of the County of Marin, by creating a new position of **Resiliency Officer** that reports to the city mayor.

The Resiliency Officer could be tasked with:

- adaptation planning for San Rafael

- working across various departments to coordinate and activate city's resiliency strategy

- work with the community to build support for various resiliency strategies

- liaise with the General Plan Steering Committee to incorporate adaptation measures into the City's 2040 General Plan

- prioritize projects based on stakeholder input

- build a coalition to implement the City's adaptive measures.

- work with the City's Planning department to advance the specific area plans for the Canal Area

- work with the various city departments to coordinate pursuing of various Federal and State funding sources.

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Link between Stakeholder Interests and Canal Resiliency Plan Elements

The San Rafael Canal District has a number of key attributes that would be beneficial to securing funding. The first is that there are several key stakeholders that will be seriously impacted by flooding and have a vested interest to address sea level rise. The second is that the projects align with the goals of multiple public funding sources such as affordable housing, multi-modal transportation, increasing connectivity, incentivizing in-fill development at floodable elevations / conditions, and enhancing access to the Bay.

The target funding source(s) will be identified from discussions with the City of San Rafael and beneficiaries, and the ultimate agreed upon vision for the Canal Area. A robust outreach program to stakeholders and potential funding sources will be needed to secure funding.

Figure: Key beneficiaries and vision elements that address the interests of the stakeholders

FUNDING & FINANCE MECHANISMS

Financing Framework

Given the regulatory and funding processes in California, it will be important for the San Rafael Canal Area to be embodied in a planning document that is sponsored by the governing jurisdiction.

One possible tool that could be very effective is a General Plan update through 2040. The city is currently updating the General plan. The plan update is ongoing and will be completed by 2020. **It is recommended that the resiliency planning will be incorporated in the ongoing General Plan update, and the General Plan update incorporate the data and analysis prepared as part of this challenge.**

Another tool for the city is to prepare Specific Plans for the Canal Area to provide detailed guidelines for future developments. Specific Plans could be prepared in conjunction with the General Plan 2040 preparation.

Traditional funding sources do not specifically target sea level rise resiliency systems and projects. Resiliency projects do, however, overlap with many traditional needs, such as improving transportation systems. As a result, many existing funding programs can potentially be layered to fund resiliency programs and projects.

Rising sea levels will have impacts throughout the Bay Area and will require costly solutions. As a result, it is envisioned that new regional public funding sources will be needed and developed to specifically fund resiliency systems. Examples of potential new sources might include a market system for incentivizing the dedication of land to wetlands or the Bay, a regional bond issue for sea level rise improvements, or the dedication of State matching funds for improvements.

	GENERAL PLAN, SPECIFIC PLAN, ADAPTATION PLAN	PUMP SYSTEM UPGRADE (STORMWATER, WASTEWATER, AND UTILITIES)	CANALWAYS AFFORDABLE HOUSING AND PARKING
assessment districts			
community facility district (CFD)		●	
development impact fees		●	●
developer credits and reimbursements		●	
development agreements and enhanced entitlements		●	●
economic incentive agreements		●	
development standards			
CEQA mitigations		●	
user and enterprise fees		●	
general fund	●	●	
capital improvement plan (CIP)		●	
tax increment financing (CRIA or EIFD)		●	●
cap and trade funds, one bay area grant program, TAP program	●		●
measure AA parcel tax			
Marin community foundation grants	●		●
infill infrastructure grant program			●
SB 2 funds			●
clean water state revolving fund		●	
state infrastructure bank		●	
community infrastructure program (SCIP)		●	
future regional sea level rise resiliency funding			
army core of engineers (ACOE)			
EPA grant	●		

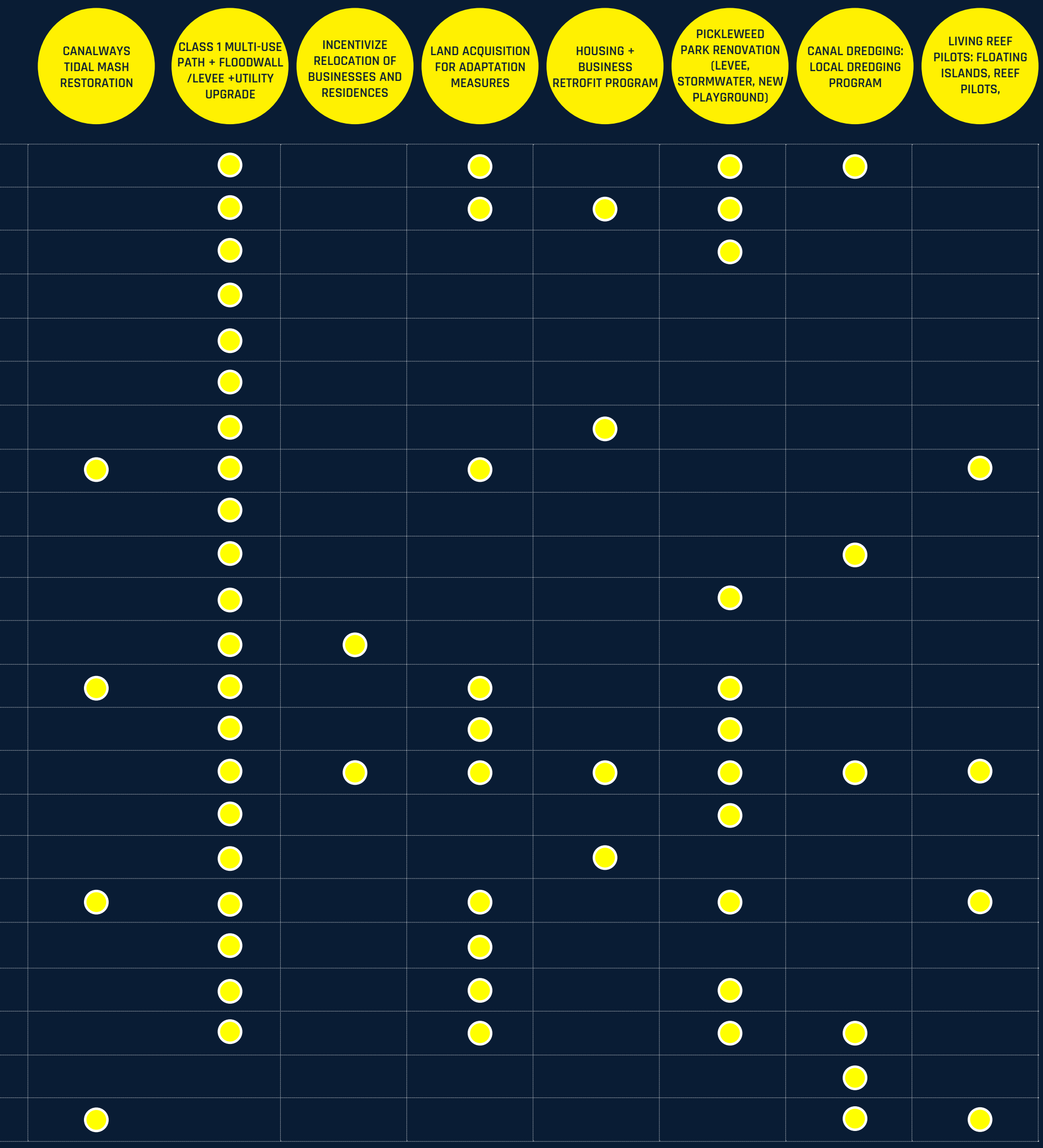
Existing Potential Funding Sources

A spectrum of potential funding sources and mechanisms exist for implementing projects proposed for San Rafael, as shown in Table 2. This section describes the sources, mechanisms, and potential uses.

Although the terms “funding” and “financing” are often used interchangeably, there is an important distinction between the two terms.

“Funding” typically refers to a revenue source such as a tax, fee, or grant that is used to pay for an improvement. Some funding sources, such as impact fees, are one-time payments, while others, such as assessments, are ongoing payments.

“Financing” involves borrowing against future revenues by issuing bonds or other debt instruments that are paid back over time through taxes or fee payments, enabling agencies to pay for infrastructure before the revenue to cover the full cost of the infrastructure



is available. The funding sources and financing tools have been evaluated relative to their purpose, process of adoption and implementation.

Funding and financing mechanisms are organized under four broad categories:

1. Existing Federal and State funds.
2. Existing City resources;
3. Tax increment financing; and
4. Developer, property owner, and user funding, financing and resources;

A range of funding and finance sources could be utilized for the catalyst and pilot projects, as well as long-term strategies, depending on the scope and scale of the targeted improvements. Details of different type of funding sources listed below are included in the Appendix section.

FUNDING & FINANCE MECHANISMS

We propose a model using existing funding and finance mechanisms to prioritize new housing and neighborhood preference for existing residents, upgrades to exiting housing and businesses, and upgrades to public infrastructure in the near term. The long term will require a new model for funding and financing large scale resilience.

Elevate San Rafael envisions a multi-pronged approach that creates surge housing and new housing on a large underutilized site adjacent to the existing neighborhood for current residents to occupy while existing housing is retrofitted and upgraded to floodable typologies. A Community Finance District [CFD] would be employed at a neighborhood or city scale to issue retrofit grants and low interest financing to support the housing and business upgrade program, along with near term public infrastructure projects that protect San Rafael in the near term. A Tax Increment Finance [TIF] or Enhanced Infrastructure Finance District [EIFD] would also support public infrastructure improvements. Paired with an agreement with the city to master lease units, the City could ensure a stable supply of surge housing for current residents while their homes are upgraded, and a neighborhood preference program to prioritize first right of return to their homes.

Given the community disenfranchisement that has historically resulted from Urban Renewal-style projects, we believe this more nuanced approach is critical.

The following outlines supply and demand-side subsidies to support residents in this process.

TIMELINE

NOW

- GENERAL FUND
- DEVELOPMENT IMPACT FEES
- LOANS
- TRANSPORTATION FEES
- PUBLIC + GOVERNMENT GRANTS
- CAPITAL IMPROVEMENT FUND
- RESILIENCY COORDINATOR/ DEPARTMENT
- ZONING OVERLAY DISTRICTS
- BUILDING CODE ADAPTATIONS

+

- CFD
- EIFD

- RETROFIT GRANTS
- LOW INTEREST FINANCING
- RETROFIT PROGRAM

EXISTING HOUSING BUSINESS RETROFIT PROGRAM

- PUBLIC INFRASTRUCTURE

INFRASTRUCTURE

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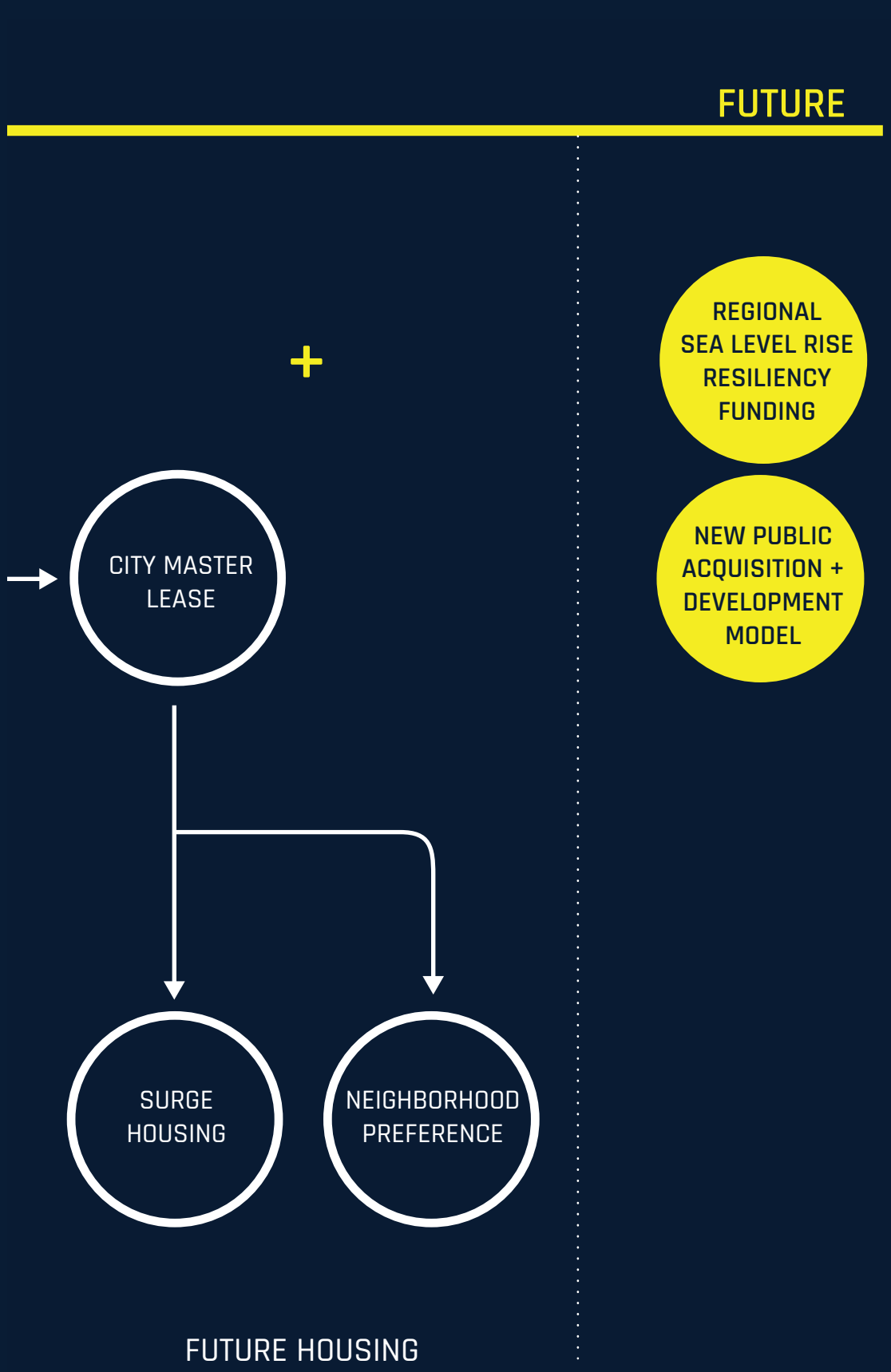
The supply-side involves the development of new housing suitable for the residents currently residing in lowland areas. Many of these strategies are covered in the report titled "Conceptual Preliminary Financing Strategy Sea Level Rise Resiliency—San Rafael Canal Area." This report does a great job covering the local, state, and federal subsidies and grant programs that could be leveraged for new development. For the purposes of developing affordable housing, the County should consider a combination of Tax Increment Financing (TIF), Low Income Housing Tax Credits (LIHTC) and Project-based Section 8 vouchers.



Model for San Rafael to prioritize upgrades to the existing housing and businesses, public infrastructure, and surge housing and neighborhood preference.

California's TIF law was approved in the early 1950s and dissolved in 2012. The **Enhanced Infrastructure Finance District (EIFD)** program has emerged in its place, allowing jurisdictions to use the incremental increase in property tax revenues to pay off the initial development bonds. The EIFD program "emphasizes projects that support sustainable community goals, energy efficiency, and reducing the carbon footprint of California's economy." This mechanism can be used to finance the necessary infrastructure required to develop new housing.

The Low-Income Housing Tax Credit (LIHTC) program is a federally-funded, state administered subsidy program designed to provide gap financing toward the development of affordable housing. Affordable housing developers compete for tax credits by responding to a State authored Qualified Allocation Plan (QAP), detailing development priorities. California's current QAP requests a host of LEED-centric sustainable building practices, but makes no mention of "sea-level rise", "flooding," or "climate change." It is possible that the use of LIHTC for this purpose would require a change at the State level.

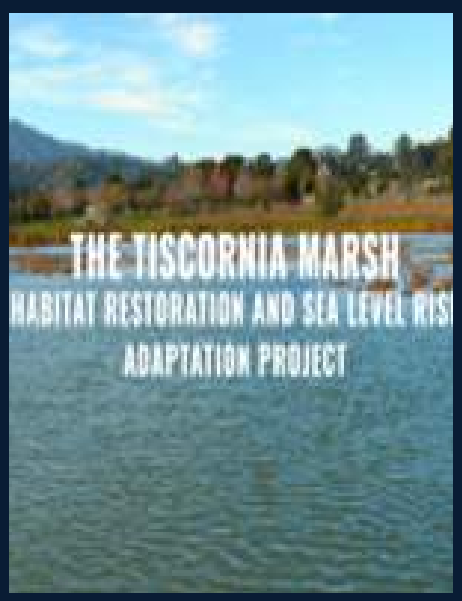
Project-based Section 8 could provide rent subsidy to residents living in the new affordable housing development. Local Public Housing Authorities can allocate 20% of its authorized voucher units to project-based developments. Unlike traditional housing vouchers, which are allocated to families, project-based vouchers are attached to a given building. To understand if this program could be relevant in this case, more detail would need to be developed on how the voucher program would be administered in San Rafael.

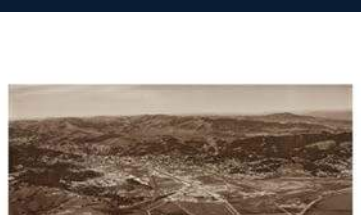
Finally, it is worth noting that any successful relocation and return program hinge on the County's ability to assemble the appropriate land. California is in the middle of a massive housing crisis, brought on in part, by a general unwillingness to develop new housing. For this strategy to be valid, local officials and members of the community must gather the political capital to support new housing development and policy. What's more, land selected as suitable for new housing must be in a place that will allow the target population's existing social and economic networks to thrive.

Appendix

EXISTING STUDIES

The Bionic Team could not have gotten as far as the Team did in terms of understanding the social and ecological conditions on the ground without the immense amount of work already completed by the city, county, and various agencies. The Team built on this body of research with San Rafael specific economic and topographic analyses to inform design strategies.



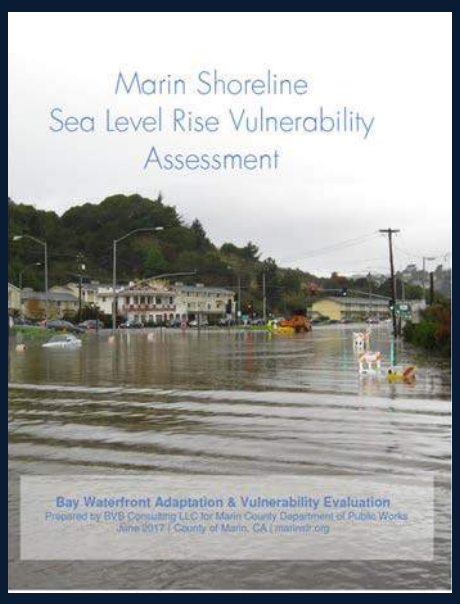


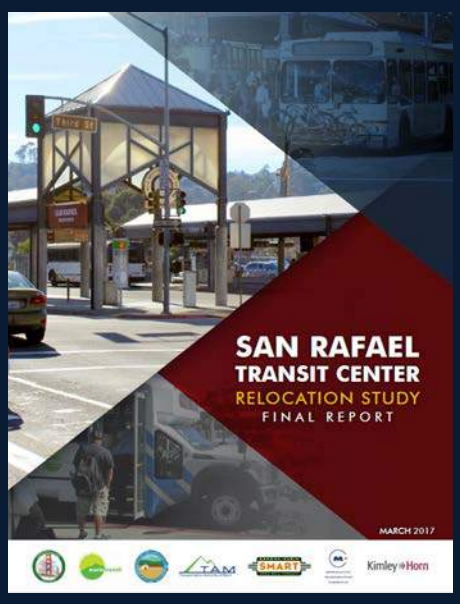
San Rafael Shoreline - 1953

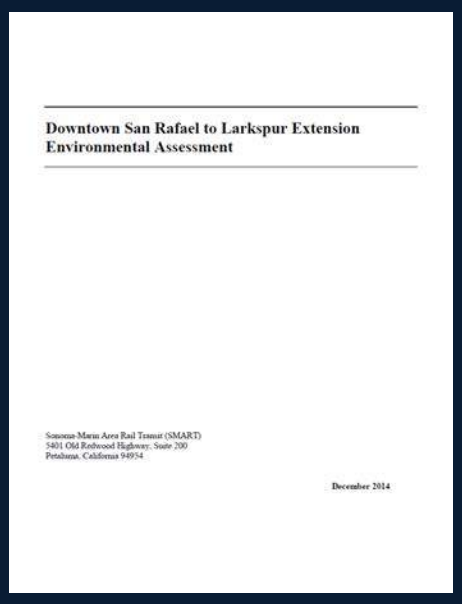
"CLIMATE ADAPTATION - SEA LEVEL RISE"
SAN RAFAEL, CA
WHITE PAPER

January 2014

Prepared by the
City of San Rafael
Department of Community Development
Paul A. Jensen, AICP, Community Development Director
with the Assistance of Jessis Hall, Sustainability Volunteer and
The Department of Public Works
File No. P13-002



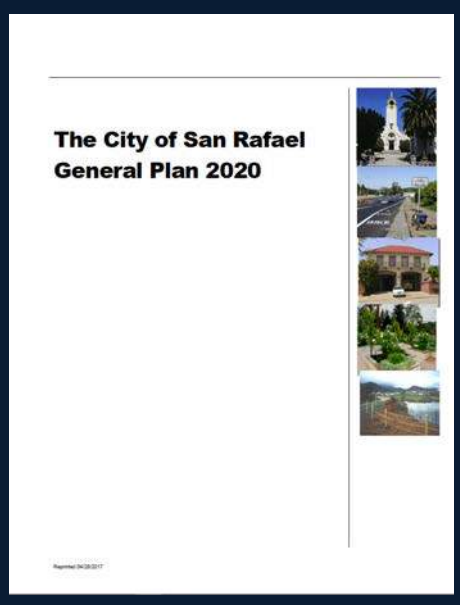


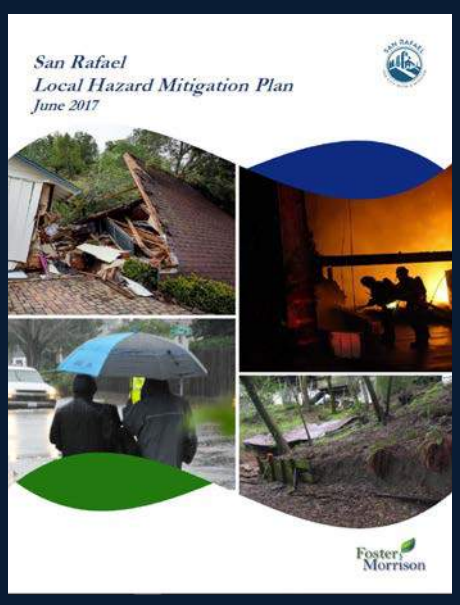


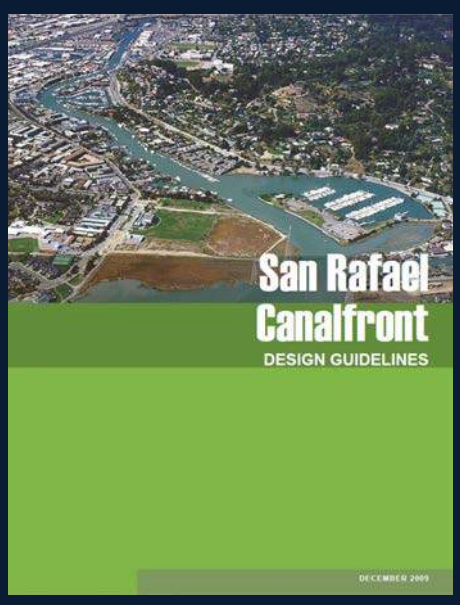
Downtown San Rafael to Larkspur Extension
Environmental Assessment

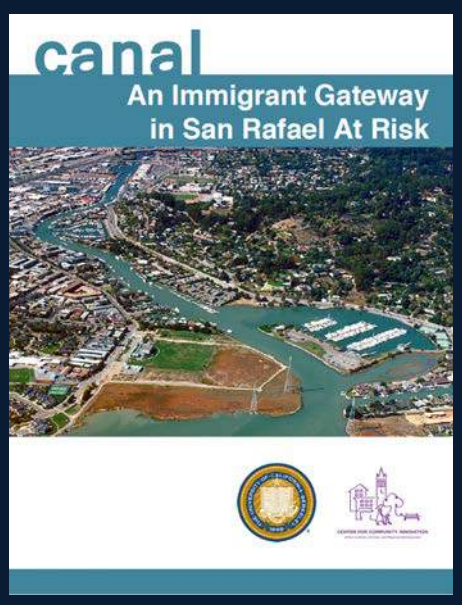
Sonoma-Marin Area Rail Transit (SMART)
5401 Old Redwood Highway, Suite 200
Petaluma, California 94954

December 2014









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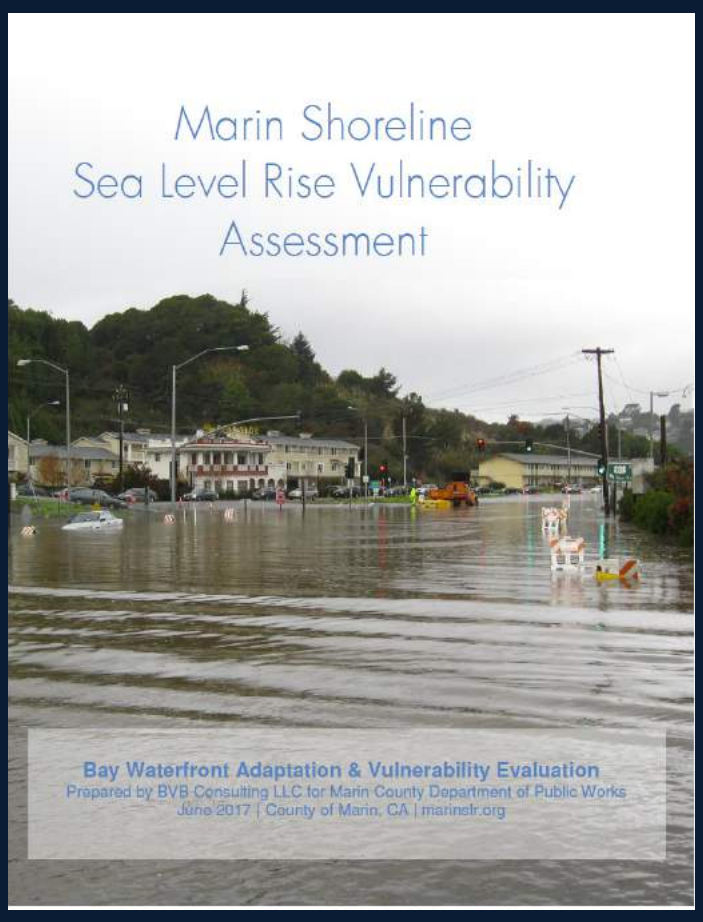


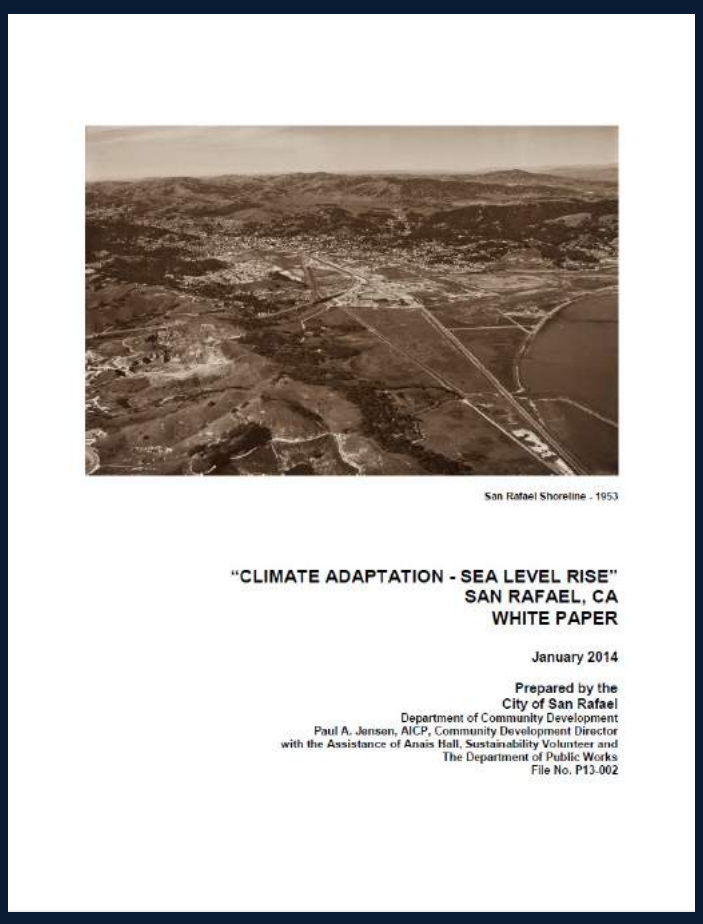
VULNERABILITY ASSESSMENT:
Prioritize preparation of an assessment.

FUNDING SOURCES:
Investigate and pursue funding sources for staffing, studies and adaptation.

ENGAGE:
Engage in countywide and regional efforts.

STAKEHOLDERS:
Identify key stakeholders and initiate outreach.

IMPLEMENTATION:
Commit to long-term implementation and programming.



OVERLAY ZONE:
Study sea level rise impacts to areas prone to sea level rise.
Based on study, impose adaptive measures.

HOLD THE LINE:
Some areas with existing levees may be suitable for a raised levee solution.

RETREAT & CONVERT:
Some undeveloped or dikes baylands may be suitable for retreat and conversion to tidal marsh.

DREDGE THE CANAL:
Continued dredging will increase navigable channel and help runoff flow from upstream.

HORIZONTAL LEVEE:
Convert mudflats to marsh plain where suitable.

BARRIER:
Could install a tide gate at the mouth of the creek.

PRECEDENTS

ARMOR

New Orleans

West Closure Complex: $14.5 billion Corps project including fortifications to protect 900,000 peo-ple (designed to withstand a 100-yr storm and reduce flooding from a 500-yr)

The Corps has changed their language from “flood protection” to “risk reduction” since people have a false sense of security; if any levee or pumps fail, a repeat of Katrina will happen

RETROFIT

Miami Beach

$500 million plan to elevate streets and install pumps

Buys time but limestone foundation means levees will not protect; pumps fail under power out-ages caused by storms

RETREAT

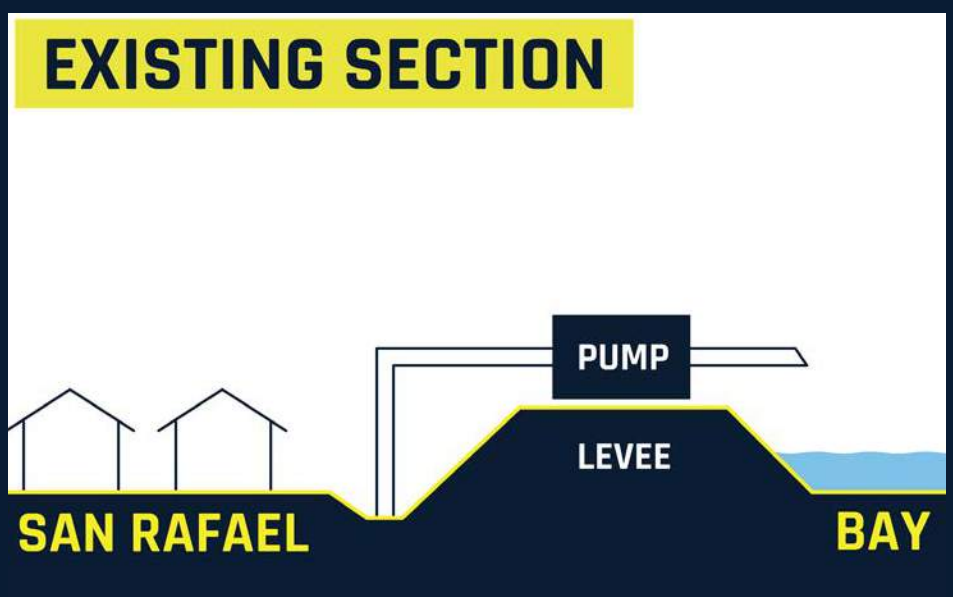
Biloxi-Chitimacha-Choctaw Tribe of Louisiana awarded $48 million to relocate

Residents of Shishmaref, Alaska voted to relocate

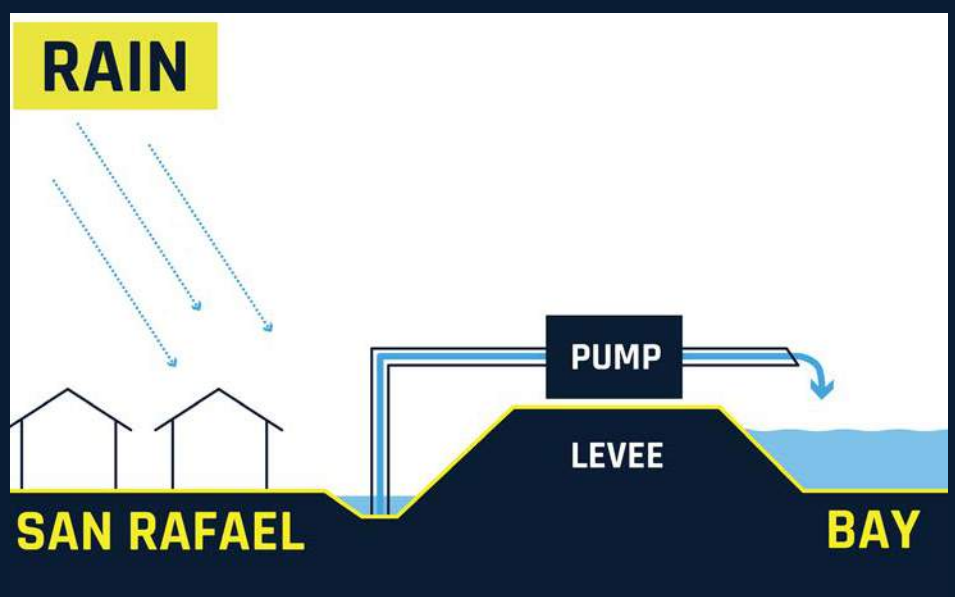
Kinston, NC decided to remove all residential structures from floodplain through voluntary acquisitions.

97% relocated within the city as neighborhoods, preserving the tax base.

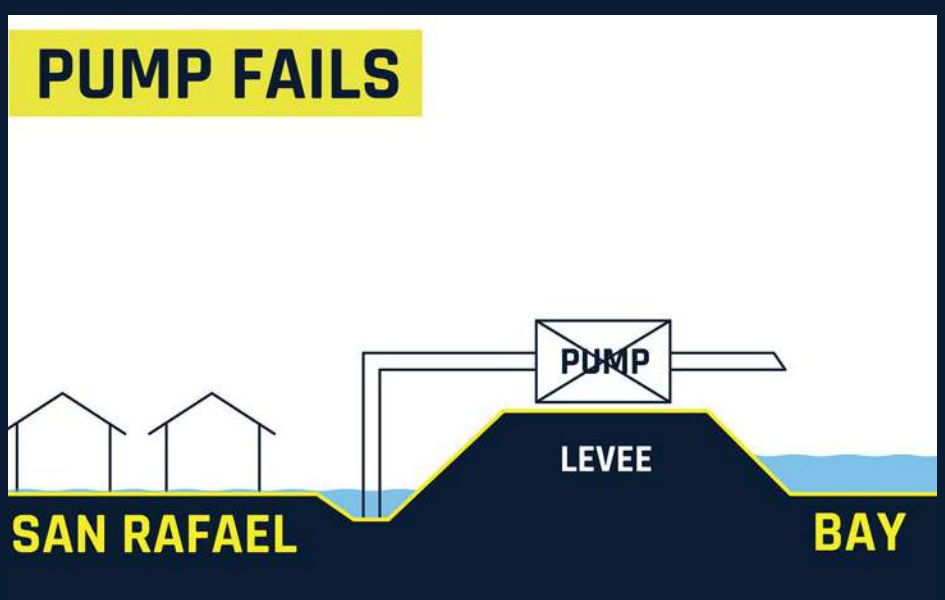
HOW FLOODING WORKS



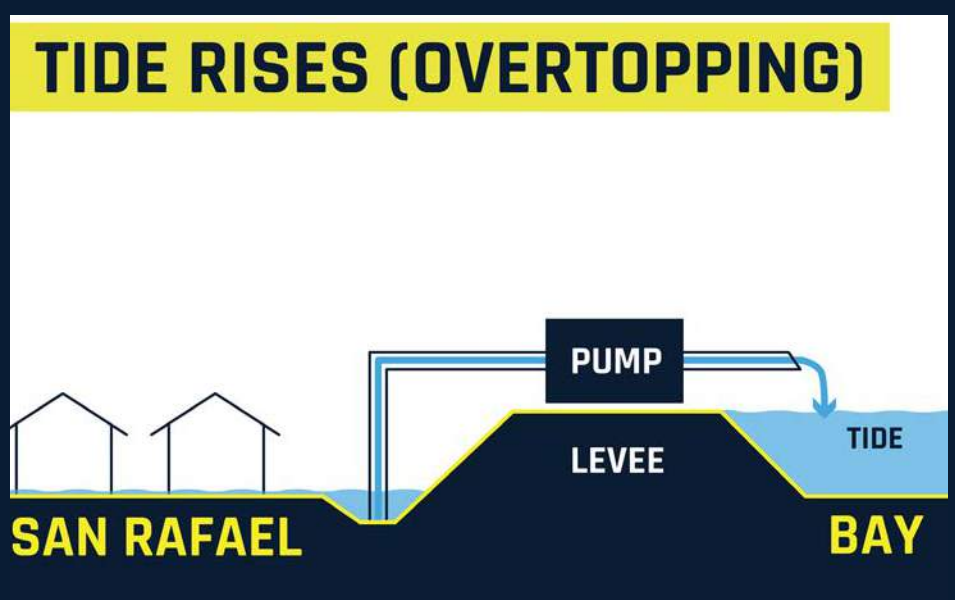
San Rafael has levees and pumps to manage its storm water.



When it rains, the pumps pump water over the levee and into the bay.



If the pumps stop working, the city will flood.



The Bay gets really big tides called king tides. A king tide can overtop the levees and flood the city.

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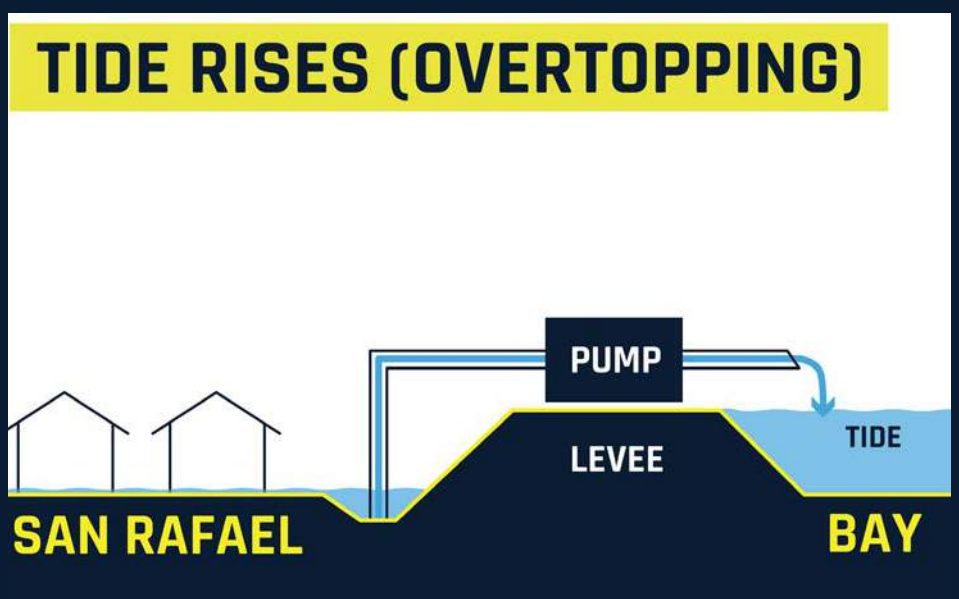

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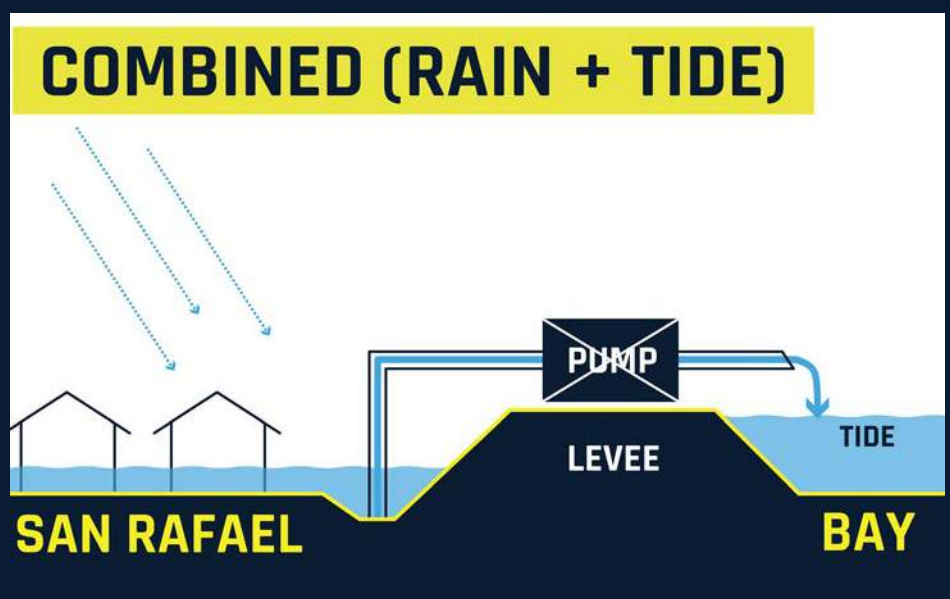
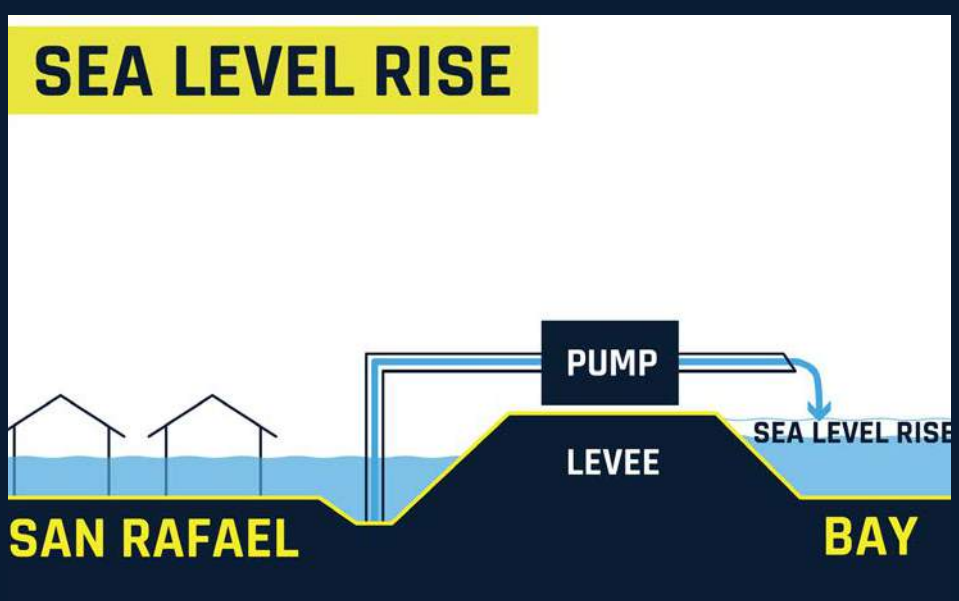
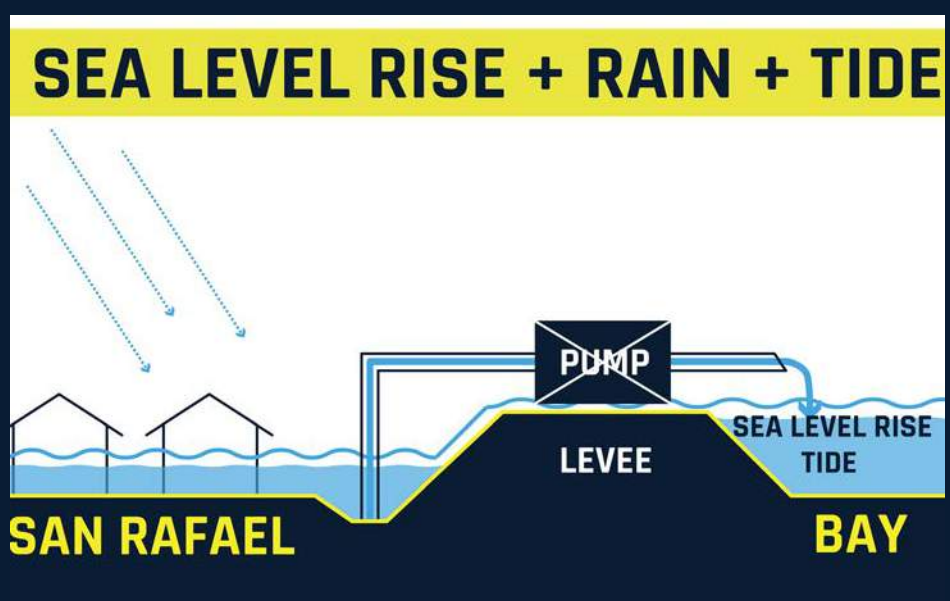


If there is a king tide plus a big rain storm, the city will flood.



Sea level rise means there will be higher tides and more salt water all of the time. The salt water will go over the levees and flood the city.



If there is a king tide plus a big rain storm plus sea level rise, the city will flood.

RAISING LEVEES + ROADS STUDY

*NOTE:
1-yr storm (7.87 ft) is equivalent to MHHW in **2040**
100-yr storm (10.06 ft) is equivalent to a 25-yr storm or 10-yr storm w/ 9 in of sea level rise in **2040**
500-yr storm (11.25 ft) is equivalent to a 100-yr storm in **2040** or MHHW w/ 60 in of sea level rise in **2100**

**Water elevations & datums from "San Francisco Bay Tidal Datum & Extreme Tides Study, February 2016

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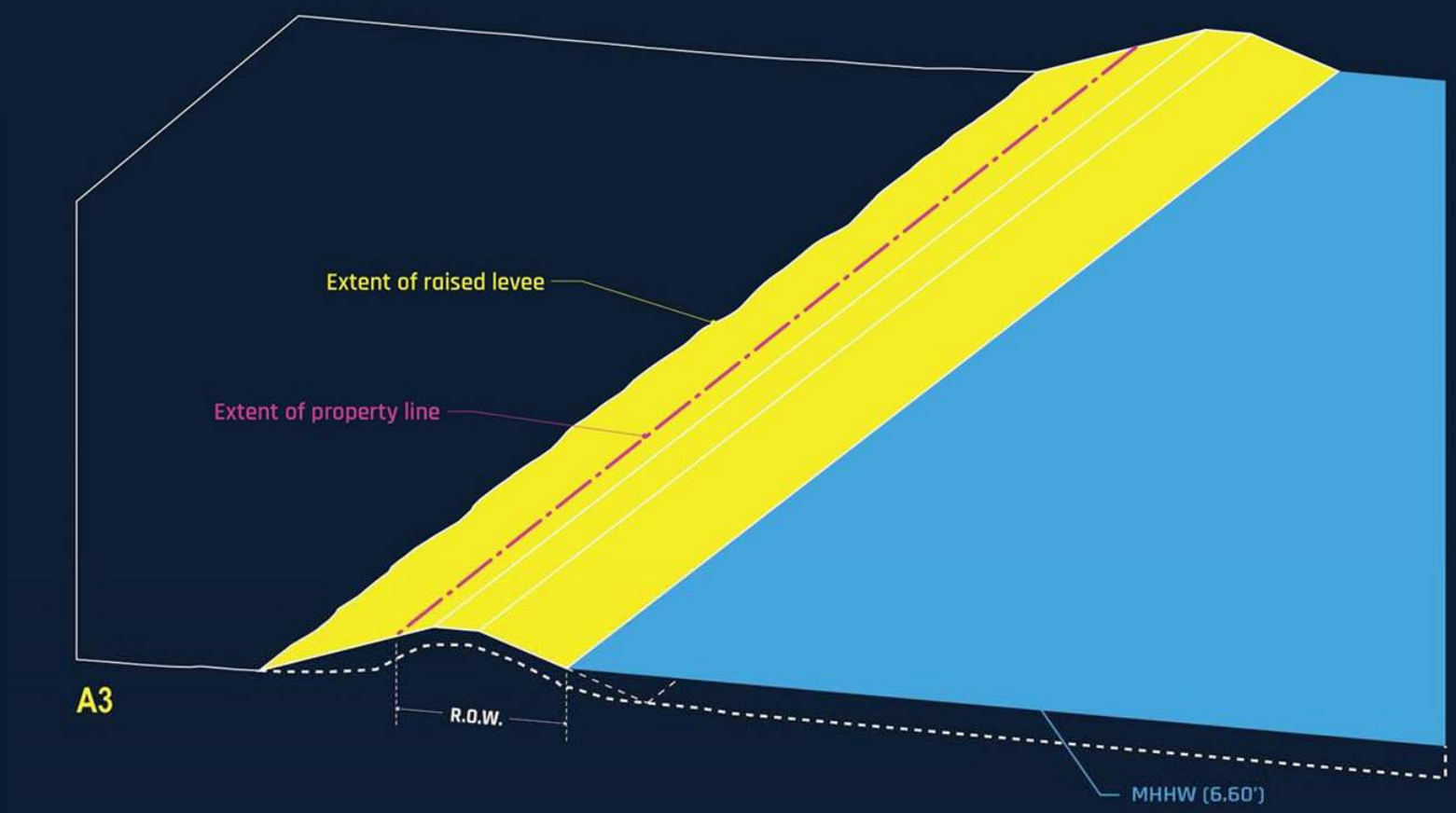
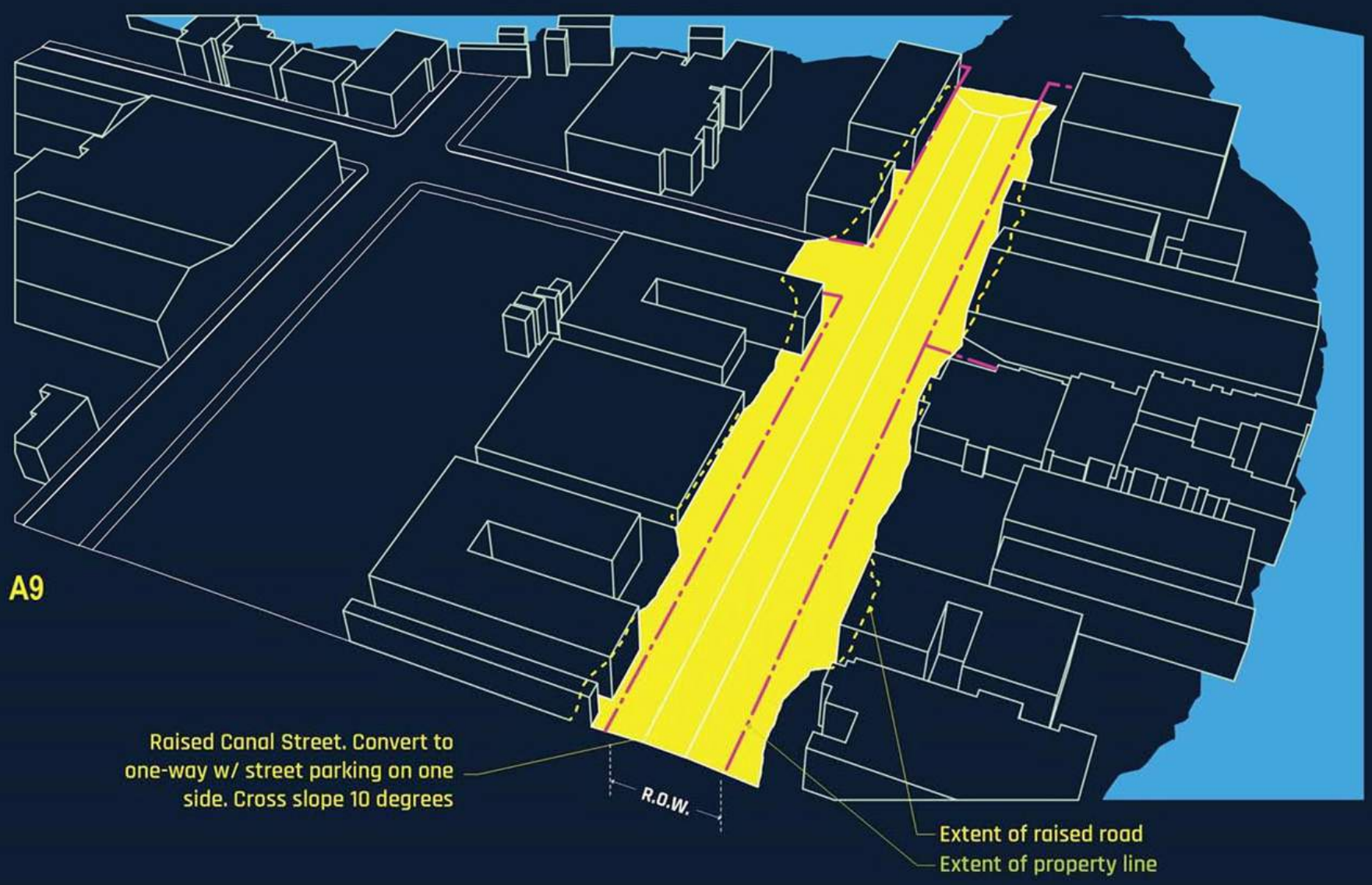


Raised Levee (100-yr bfe + 3' freeboard)

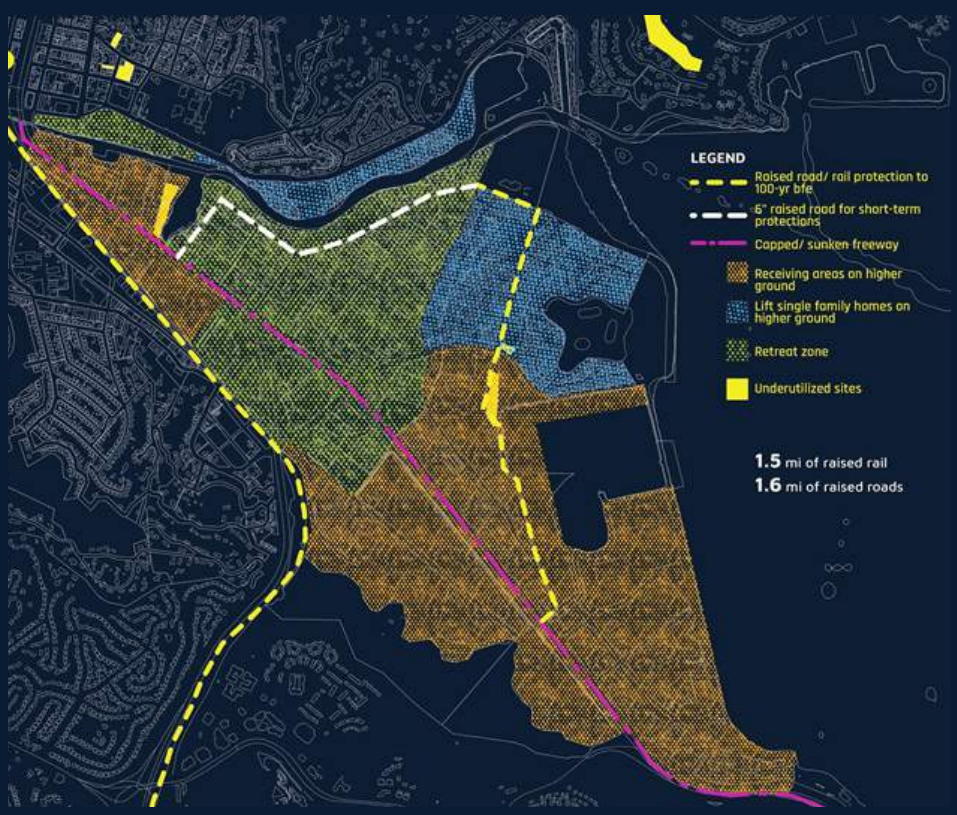


Raised Canal Street (100-yr bfe + 1' freeboard)

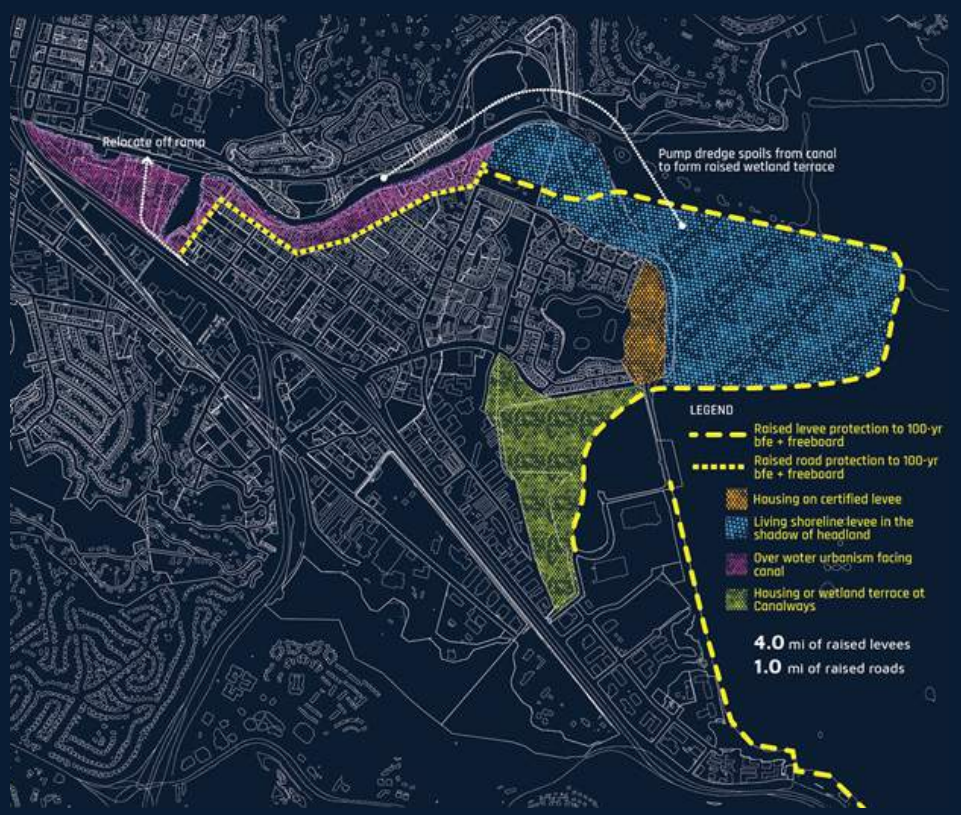
ADAPTATION DESIGN STUDIES

PROTECT / GATE

PROTECT / LEVEE



MIGRATE / UPLAND



EXPAND / LIVING SHORELINE

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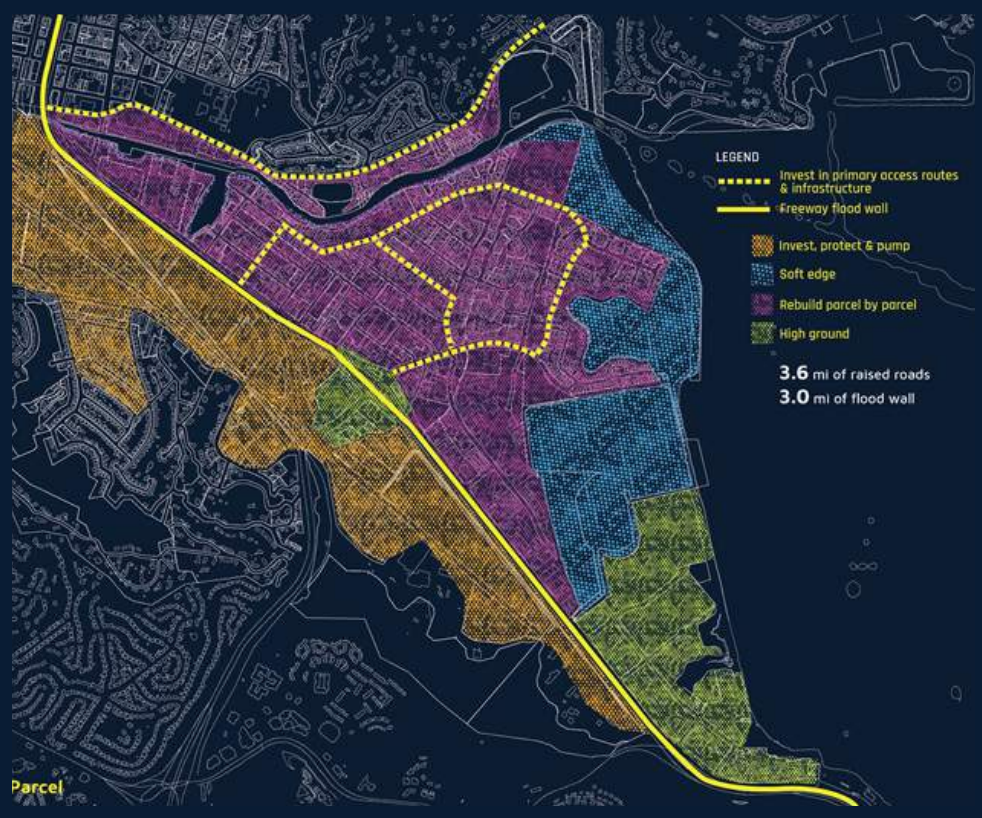
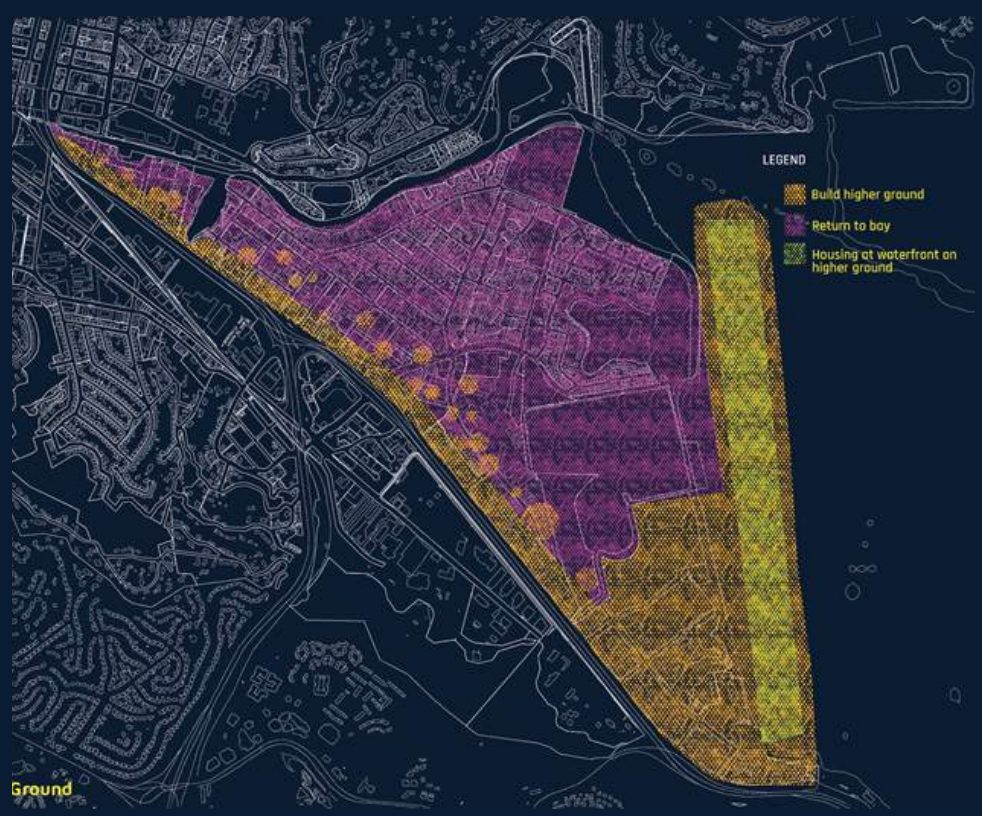
MIGRATE BUSINESSES



REBUILD / PARCEL BY PARCEL

RETREAT / UPLAND



RETREAT / UPLAND

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PennDesign
WXY architecture + urban design
Studio for Urban Projects

Enterprise Partners
SF State University
Michael Yarne
Keyser Marston Associates
WRA Environmental
RAD Urban
Moffatt & Nichol