Sea Level Rise Mitigation for the City of Arcata and Humboldt Bay: Utilizing Zoning, Economic Development, and Urban Design

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Abstract

Sea level rise is a growing issue for the state of California. Nowhere may the effects of sea level rise be felt more in California than in the City of Arcata. Situated adjacent to Humboldt Bay, the second-largest natural bay in the state, Arcata is projected to face severe sea level rise over the course of the next century. Studies conducted by the California Ocean Protection Council predict that sea level rise around the City of Arcata may reach 1 foot by 2050, 1.6 to 3.1 feet by 2100, and between 2.6 to 11.9 feet by 2150. The present moment serves as a crucial window of opportunity for the City to enact mitigation measures to minimize the potential harmful effects of sea level rise. This project implements qualitative and quantitative analysis to recommend an approach that Arcata may take in its mitigation measures. The project's specific area of focus within the City is referred to as the "South G Street Area". The project's approach involves two phases. The first phase involves rezoning the South G Street Area from its current mixed-use to exclusively commercial use. This rezoning will require an area of the City adjacent to the South G Street Area, referred to as the "Barrel District", to be redeveloped into high-density, mixed-use, housing. The second phase will see the South G Street Area be rezoned into exclusively open space, as an extension of Arcata's existing Marsh and Wildlife Sanctuary. An already existing network of berms will be greatly expanded and further integrated into the redeveloped open space to help protect the City from rising sea levels.

Keywords: sea level rise mitigation, zoning, urban design, Local Coastal Program.

Project Goals

Primary Objective
Through the utilization of zoning, economic development, and urban design this project aims to assist the City of Arcata with developing a coherent strategy to mitigate the harmful effects of sea level rise.

Phase 1
The first phase of this project involves increasing the financial assets of the South G Street Area through rezoning and economic development. The current mixed-use zoning (which contains uses such as industrial, commercial, and industrial) will be switched to exclusively commercial zoning. Due to an increase in financial assets in the South G Street Area, the City of Arcata will increase its eligibility for funding from the State of California for further sea level rise mitigation projects. If the City can generate a considerably higher amount of tax revenue from the South G Street Area (through commercial property taxes), then the State of California will be incentivized to protect this source of tax revenue.

However, being only the first phase of this project, the South G Street Area will not be intended for commercial zoning for the long-term. Rather, commercial uses in this district of the City will only be permitted for twenty-five to thirty years. This is due to the fact that around the year 2050 sea level rise around the City of Arcata may reach 1 foot, severely impacting the South G Street Area. Therefore, emphasis will be placed on allowing commercial uses that have a low infrastructure footprint, and a high return on investment. The purpose of these parameters is to streamline the inevitable need for managed retreat from the South G Street Area (a process that is estimated to begin around the year 2050).

Barrel District
While technically part of Phase 1 of this project, the redevelopment of Arcata's Barrel District requires special attention. This is due to the fact that over half of the parcels in the South G Street Area of Arcata are zoned for residential units. Rezoning the South G Street Area to exclusively commercial use will require the eventual relocation of residents from this district. However, the City does not currently possess alternative housing stock for the residents of the South G Street Area to move to. Therefore, it is crucial for this project to include design recommendations for new housing for the City.

The Barrel District, which sits directly above the South G Street Area, is part of the City's larger plan for development known as the "Arcata Gateway Area Plan". This Specific Plan envisions redeveloping/infilling a 138-acre portion of the City that is currently predominantly derelict industrial land into mixed-use high-density housing. My project will be focusing on designing

housing for the 35-acre Barrel District. Design criteria requires 1,200 new dwelling units, spread across seven-story, mixed-use, mid-rise buildings.

Phase 2

The second phase of this project involves envisioning the City of Arcata's gradual managed retreat from the South G Street Area. During the years 2050 to 2100, sea level is anticipated to rise around the City of Arcata between 1.6 to 3.1 feet. This projected rise in sea level will pose major flooding threats to the South G Street Area of Arcata. Therefore, starting around the year 2050, the South G Street Area will again be rezoned, but now instead of commercial use the area will be zoned for open space exclusively. The pre-existing Arcata Marsh and Wildlife Sanctuary, which sits adjacent to the South G Street Area, will be expanded to encompass the entirety of the South G Street Area. The Arcata Marsh and Wildlife Sanctuary already incorporates berms into its design; berms are an excellent form of defense against sea level rise. The expansion of the Arcata Marsh and Wildlife Sanctuary over the South G Street Area will add a significant layer of defense for the City of Arcata from future rising sea levels.

Local Coastal Program

Ultimately, this project aims to assist the City of Arcata with further developing its Local Coastal Program. In 2015, California Senate Bill 272 was approved. This bill is imposing a mandate for all cities that lie, wholly or partially, within California's coastal zone to have a fully developed Local Coastal Program (LCP) by January 1st, 2034. Any coastal city within California that does not meet the requirements of having a fully developed LCP by this date will be subject to annual fines. SB 272 supports local, regional, and other state agencies for the identification, assessment, planning, and, where feasible, the mitigation of the adverse environmental, social, and economic effects of sea level rise within California's coastal zone. This bill would require local governments that receive approval for a sea level rise plan to be prioritized for funding, upon appropriation by the Legislature, for the implementation of sea level rise adaptation strategies and recommended projects in the local governments approved sea level rise plan.

Introduction

Although sea level rise may appear to be progressing slowly, it is an inevitable challenge that will ultimately impact the entire planet. The State of California, which has approximately 840 miles of coastline, will be significantly impacted by rising sea levels. California is taking the threat of sea level rise very seriously, as reflected by passed measures such as SB 272. It is imperative now that coastal cities throughout California take the initiative to prepare, plan, and act on sea level rise mitigation strategies. The next couple of decades provides a narrowing window of opportunity to do so.

The California Ocean Protection Council adopted The State of California Sea Level Rise Guidance: 2024 Science and Policy Update in June of 2024. The most recent data on sea level rise, and its potential impacts, was used in this report. Recommendations for practical strategies, integrating information/data from COPC's report, for sea level rise planning and decision-making are provided. Amid growing threats from sea level rise and climate-driven flooding, the COPC strongly supports building resilience for California's coastal communities and ecosystems. The COPC recommends a precautionary, phased approach, towards addressing sea level rise. The COPC encourages decision-makers to evaluate the range of sea level rise scenarios for their respective areas (from "intermediate" to "high"), to consider local conditions, and to assess their area's level of risk tolerance. The COPC report also encourages decision-makers to factor in storm impacts on sea level rise (where relevant). This report was developed in collaboration with the California Ocean Science Trust, multiple state agencies, and California Native American tribes.

State of California Sea Level Rise Scenarios from 2020 to 2150

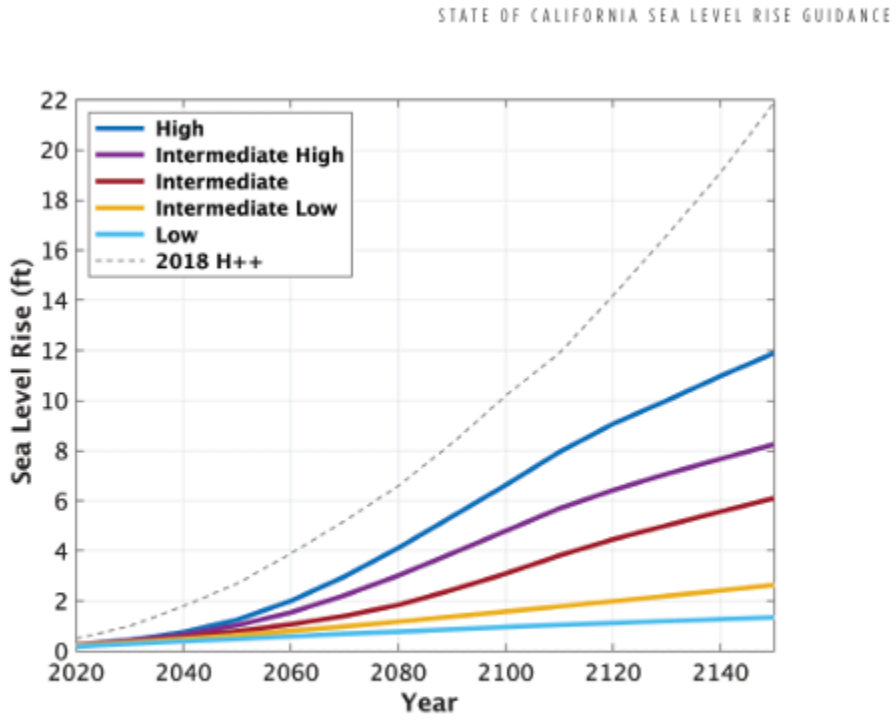


FIGURE 2.3. *Sea Level Scenarios from 2020 to 2150, in feet, with a baseline of 2000. For comparison, the H++ from the 2018 California Sea-Level Guidance is included illustrating that this scenario is above scientifically plausible sea level rise for all dates.*

Source: The State of California Sea Level Rise Guidance: 2024 Science and Policy Update, June 2024

The figure above was taken from the California Ocean Protection Council's most recent sea level rise guidance science and policy update. The graph shows projected sea level rise scenarios for California from 2020 to 2150 (in feet), using 2000 as the baseline. It compares five scenarios based on updated science from 2024 (Low, Intermediate Low, Intermediate, Intermediate High, High) and includes the dashed line of the 2018 H++ scenario for reference (now considered scientifically implausible). By 2050, all scenarios project less than ~ 2 ft. of rise, with little divergence. By 2100, sea level rise ranges from ~ 1.5 ft. (Low) to ~ 6 ft. (High). By 2150, the range widens dramatically, from ~ 2.5 ft. (Low) to nearly 12 ft. (High). The 2018 H++ line (dashed) projects up to ~ 21 ft. by 2150, much higher than the updated plausible projections, and now excluded from official COPC guidance. In summary, the farther into the future that sea level rise predictions go, there is more uncertainty and a greater range of possible scenarios for sea level rise. However, based on the data of this graph, it is almost certain that sea level rise will reach approximately 2 ft. by the year 2100.

Literature Review

To better understand the threat that sea level rise poses now and into the future, this project reviewed an article published by the *Journal of Marine Science and Engineering* in 2022 titled "Recent Developments in Sea-Level Rise and Its Related Geological Disasters Mitigation: A Review" by Liuqun Dong, Jiming Cao, and Xian Liu. This article describes the global significance of sea level rise, and emphasizes its negative impacts on coastal populations. Citing satellite altimetry, this article notes how in recent years sea level rise has accelerated. Several geological disasters caused by rising sea levels are mentioned such as: coastal submergence, wetland destruction, storm surges, seawater intrusion, and negative impacts on coastal infrastructure.

The article goes on to focus on factors that are contributing to sea level rise. Contributing factors mentioned include: thermal expansion of the ocean and the melting of polar ice sheets and glaciers. Using data from remote sensing, the article presents evidence that the rate at which polar ice sheets and glaciers are melting is accelerating. Secondary factors that are contributing to sea level rise that were mentioned included: groundwater extraction and deforestation. There was also a focus on structural contributing factors, particularly tectonic plates' movements, and how this can have an effect on sea level rise in certain regions of the world. Using hydrodynamic models and GIS-based approaches, negative impacts of sea level rise on storm surge frequency and intensity are mentioned. These impacts include: seawater intrusion, storm surge overtopping, increased hydrostatic pressure, and changes in river flow dynamics. The article explains how sea level rise contributes to the decrease in coastal wetlands. This decrease in wetlands can lead to: submergence, erosion, and loss of critical ecosystem services. An explanation is also given on how sea level rise can induce seismicity by altering stress states in coastal areas. Seismic liquefaction potential rises through an increase in groundwater levels and decreasing effective stress in susceptible soils. All of these factors contribute towards triggering submarine mass failures, the downslope movement of sediment or rock under the influence of gravity, which can cause tsunamis.

After thoroughly discussing the potential threats that stem from sea level rise, the article focuses on possible mitigation measures. Mitigation measures mentioned included: greenhouse gas emission reduction, afforestation, carbon sequestration technologies, groundwater management for seawater intrusion, coastal habitat restoration for storm surge protection, and liquefaction vulnerability assessments. The need for improved monitoring networks and data sharing to reduce sea level rise projection uncertainties and inform mitigation efforts was highlighted. The concept of resilience as a framework for assessing the capacity of coastal urban systems to withstand and recover from sea level rise disasters is earnestly promoted by this article. It was also mentioned that it is extremely important for coastal communities to develop various

guidance maps, flood maps, wetland vulnerability maps, and liquefaction risk maps that are all based on resilience assessment results.

Now that this project has thoroughly examined the various threats that sea level rise poses, it must be further examined what forms of sea level rise mitigation would be appropriate for the City of Arcata. An article written by Niki Pace from 2011 titled "Wetlands or Seawalls - Adapting Shoreline Regulation to Address Sea Level Rise and Wetland Preservation in the Gulf of Mexico" published by the *Journal of Land Use & Environmental Law* addresses adapting to sea level rise in the Gulf of Mexico. This article examines how living shorelines help prevent coastal erosion, and are a preferential form of defense against sea level rise vs coastal armoring. The economic and environmental costs of coastal/shoreline armoring are discussed, revealing how this form of defense results in: loss of natural habitats, ecosystem services, and public access to shorelines. The article provides scientific consensus on sea level rise and climate change, and discusses potential negative impacts to coastal communities as a result of sea level rise such as: flooding, erosion, and wetland loss.

Managed retreat and coastal defense are presented as the two primary forms of adaptation to sea level rise. Examples of managed retreat strategies in various parts of the United States are examined, such as rolling easements in Texas, and building setbacks in Florida. The high cost of managed retreat is stated, much of the existing infrastructure on coastlines is both expansive and expensive, and moving this infrastructure inland will not be cheap. Therefore, managed retreat is not an option that most communities will be able to act upon immediately, and the approach towards managed retreat must be multi-phased, spread across a long period of time. Historic approaches towards sea level rise, such as bulkheads and seawalls, are harmful because they transform shorelines into fixed/static states, rather than allowing for a dynamic and natural process of change. Even more troubling is the ever-increasing cost of maintenance that is required to keep these static forms of defense effective against sea level rise. Ecological and societal harms are a consequence of coastal/shoreline armoring, preventing both the environments and communities from being able to access/reside in shoreline areas.

Living shorelines are the desirable alternative that this article promotes for building out defense against sea level rise. The article defines living shorelines as "living plant material, oyster shells, earthen material, or a combination of natural structures with riprap or offshore breakwaters to protect property from erosion." Benefits from living shorelines include: habitat creation, sustaining biodiversity, erosion control, preservation of public access, and a lower cost of maintenance vs hard armoring (i.e. seawalls, etc.). The article advocates for a streamlined permitting process to facilitate the creation of more living shorelines along coastal communities. A key major advantage that living shorelines have over hard coastal/shoreline armoring is that while the latter serves the singular purpose of preventing flooding from sea level rise, the former provides a multitude of additional benefits beyond simply protecting against sea level rise

flooding. The article recommends a multifaceted approach to shoreline management which discourages coastal development through land-use policies, restrictions to hard coastal/shoreline armoring such as seawalls, and the promotion of living shorelines as a viable and sustainable alternative for coastal/shoreline defense.

An article published by *PLOS One*, titled "Valuing Natural Habitats for Enhancing Coastal Resilience: Wetlands Reduce Property Damage from Storm Surge and Sea Level Rise", written by Ali Mohammad Rezaie, Jarrod Loerzel, and Celso Ferreira in 2020 examines the increasing threat to coastal communities from sea level rise and storm surges and highlights the role that coastal ecosystems, such as marshes and wetlands, play in mitigating the negative impacts from these hazards. This article has the goal of determining the value of flood protection services provided by marshes and coastal wetlands which are located next to the Jacques Cousteau National Estuarine Research Reserve in New Jersey. The JCNERR is a protected natural area, home to a diverse range of ecosystems, and made up extensively of coastal marshland. Due to the JCNERR being located adjacent to open water, this area is threatened by coastal flooding.

The coastal hydrodynamic model, known as ADCIRC, was coupled with the nearshore waves model, known as SWAN, to simulate coastal flooding from storm surge and waves in the JCNERR. ADCIRC uses an asymmetric hurricane vortex formulation to calculate the wind velocity and atmospheric pressure from hurricanes. SWAN computes full wave spectrums in nearshore and offshore regions using a wave action balance equation. When ADCIRC and SWAN are coupled, the article's researchers were able to compute: water levels, currents, wind information, wave radiation stress, and flood depth. The study was trying to determine how severe sea level rise flooding would affect the area by 2050. The financial cost from the associated flood damage was calculated using a parcel-level analysis, with a focus on residential parcels and their associated "improvement" value.

The results of this study revealed that sea level rise would reduce JCNERR's total marsh area by around 5.4%, causing marsh and wetlands to shift inland and convert into tidal flats. Due to natural habitats being present during sea level rise flooding, 23.1% fewer residential parcels would be damaged vs if there were no natural habitats present. The presence of natural habitats also reduced the depth of flooding by almost 14%. The results of the study suggest that the presence of natural habitats in areas threatened by sea level rise may reduce total property damage. Specific to the JCNERR study, researchers were able to determine that the presence of natural habitats in the area saved the JCNERR and surrounding areas from as much as $32,000,000 in damage by the year 2050. The article concludes that further research must be carried out to better understand how natural habitats can be used as a form of defense against sea level rise, but that their study's results were promising in showing a correlation between natural habitats and a reduction in damage from sea level rise.

When observing the City of Arcata's Marsh and Wildlife Sanctuary, focus must be given to the network of berms and ponds that encompass this area. An article from 2021 titled "Berms, Floodwalls, and Dunes - How High? Considering Sea-Level Rise in Coastal Projects", published by *IEEE Xplore* and written by Renee Collini and Stephanie Smallegan, examines the challenges of integrating planning and project design with sea level rise. A risk-based framework for determining how much sea level rise should be considered for coastal projects is provided. Future high tide and future storm surge levels are highlighted as essential conditions to consider. Accurately understanding future high tide conditions enables planners to assess areas that could be threatened by sea level rise flooding such as roads and coastal infrastructure. This information provides planners the ability to strategize how to mitigate damage to infrastructure, services, and various forms of commerce. Furthermore, accurately understanding future storm surge levels provides planners with guidance on many aspects of community and project planning such as: zoning, construction standards, and emergency management response.

The article had a case study focusing on critical infrastructure in Jackson County, Mississippi. The Jackson County Utility Authority had begun the process of constructing a new water reclamation facility. Considering future sea level rise conditions, the JCUA was determining where to construct the new facility. Using projections of future levels of sea rise, the JCUA decided on a location least impacted and also made the decision to construct a network of berms around the facility. When deciding on the design for these berms, the JCUA partnered with Mississippi-Alabama Sea Grant and Mississippi State University to assess which scenario of sea level rise to consider. The result was designing the berm network for Jackson County's highest projected level of sea rise by the year 2080 (6 feet). The purpose of the berm network is to provide protection from storm surges and sea level rise. Berms are raised artificial ridges or embankments, typically made from soil, gravel, stone, and crushed rock.

The purpose of this article is to demonstrate how data from different sea level rise scenarios can/should influence decision-makers' approaches towards developing actionable strategies for mitigation and/or defense. The article highlights the importance of ensuring access to the most updated data on sea level rise projections, to avert the possibility of making decisions based on aging information. The article cautions against cognitive biases, optimism, and mental shortcuts to influence risk tolerance assessments. Recommendations to avoid cognitive biases, optimism, and mental shortcuts include: always discussing exceedance probabilities and risk tolerance of sea level rise projections, assessing risk through a systematic process, and opting to work with neutral parties which are experienced with risk communication. The article emphasizes the importance of integrating sea level rise scenarios into coastal planning and project design, with a focus on increasing coastal resilience.

Considering Phase 2 of this project prominently features the City of Arcata undergoing the process of managed retreat for the South G Street Area so that it may be converted into an

expansion of the Arcata Marsh and Wildlife Sanctuary, the process of managed retreat itself should be better understood. *One Earth* published an article in 2019 titled "Managed Retreat in the United States", written by A.R. Siders, which focuses on managed retreat as a tool/strategy for climate change adaptation. Managed retreat is defined as "the purposeful, coordinated movement of people and assets out of harm's way". In the United States, managed retreat has occurred primarily via federally funded property acquisition programs. The article casts doubt on the ability of managed retreat to be able to scale up to the level that it will need to be at to adequately meet the demands of future climate change threats. Emphasis is placed on the numerous psychological, institutional, and practical barriers to managed retreat, and the article recommends that communities across the United States need to better understand how to overcome these barriers, even if at a small scale. The article champions the United States developing a national vision for coastal adaptation.

Coastal adaptation strategies most commonly consist of: resist, accommodate, or retreat. Resistance measures include methods such as constructing seawalls or levees, but are susceptible to failing or being breached. Managed retreat is cited as "the strategy that most effectively eliminates risk", as people and assets are physically moved away from climate change risks. However, the article takes note that managed retreat will not be an option for everyone, and that certain areas already have and/or will resort to adaptation measures such as resistance (i.e. building seawalls). The article explains that most communities, especially smaller ones, will need support to successfully go through the process of managed retreat. In order for retreat to be managed, the process must be coordinated through government agencies and community organizations/networks. Unmanaged retreats risks creating greater costs and missed opportunities. Unmanaged retreat may result in: falling real estate prices in at-risk areas, risk of living through storms/flooding, abandoned properties which drain local government's maintenance budgets, loss of property tax revenue, and empty lots destroying the sense of community. The National Climate Assessment notes that these previously stated negative consequences of unmanaged retreat will increase in frequency with rising sea levels.

However, managed retreat can mitigate the harms of rising sea levels/unmanaged retreat, and maximize the benefits of climate adaptation/resilience. Through managed retreat, funding mechanisms/programs may assist people with leaving impacted/threatened areas. Through managed retreat, impacted/threatened areas will be able to utilize land for more beneficial uses such as: public parks, wetland restoration which has the ability to absorb floodwaters, or protected habitat creation for endangered species of wildlife. Managed retreat provides the opportunity for social, economic, and ecological transformation. Communities benefit from managed retreat because they are provided with the opportunity to "forge new beginnings on safer ground."

An example of successful managed retreat was examined in the town of Soldiers Grove, Wisconsin. In 1979, the City's business district had to relocate away from the Kickapoo River, and the decision was made to facilitate the process of managed retreat in a manner that would result in a reinvigorated economy. The chosen location for the new business district was in an area safe from flooding, and also physically closer to the local highway which allowed the business district to grow economically. The City's well was also relocated to prevent contamination from flooding, saving money from potential maintenance costs. The City introduced regulation to promote solar power in the new business district, and new businesses were incentivized to establish themselves there. Soldiers Grove would eventually earn the nickname "Solar Town", and its economy and population grew as a result of its managed retreat and creation of a new business district.

This article presents managed retreat as an opportunity for cities to "breathe new life" into their communities, stimulate economic growth, and promote nature conservation. In order for managed retreat to be successful: proper evaluations must be carried out, a diversity of actors must be involved (such as researchers, policymakers, private sectors, and community organizations), a vision to address barriers to managed retreat must be created, and goals, metrics, and best practices must be identified. The article concludes that urgency must be placed on preemptively setting up plans for managed retreat in coastal areas. Clear leadership must be established for climate adaptation and managed retreat to facilitate successfully. Managed retreat should be reconceptualized as an opportunity for coastal communities to get a fresh start and rethink their relationship with the coast.

For the City of Arcata to successfully implement managed retreat, it must preemptively plan the process. An article from 2020 titled "Implementing Pre-Emptive Managed Retreat: Constraints and Novel Insights", written by Judy Lawrence et al., and published by *Springer Nature Link*, explores effective strategies for successfully implementing managed retreat. The article states that coastal communities face huge adaptation challenges in the future due to rising sea levels. It has been observed that past cases of managed retreat occurred as a reaction following major climate hazard events. The article argues that the current approach towards managed retreat needs to shift from a reactive stance to a preemptive one. A need for new national policy frameworks and planning processes that address the ever-increasing scale of retreats that will occur over the next 50 years must be established.

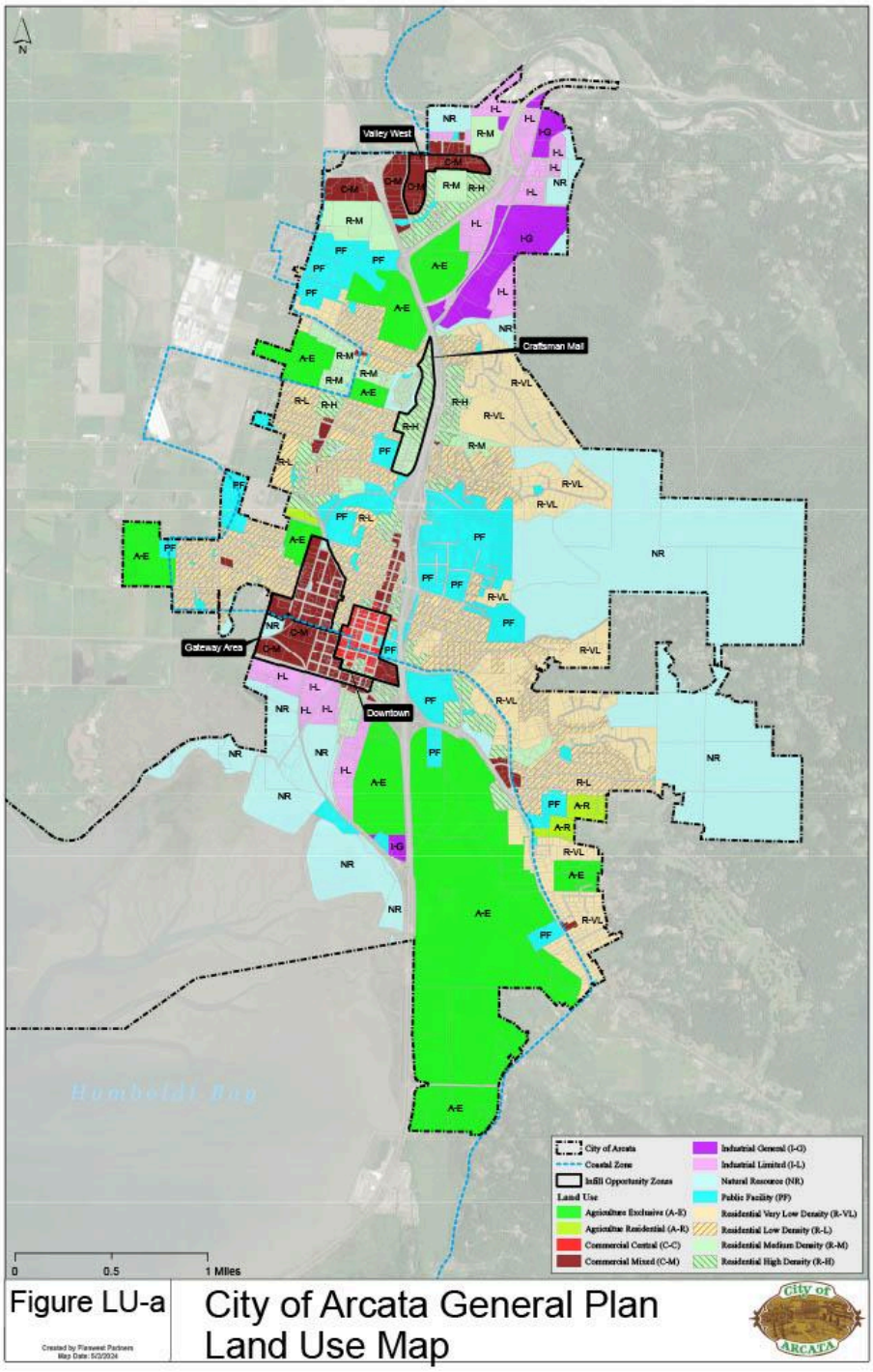
The article states that managed retreat is controversial, due to the nature of relocating well-established human settlements, and is a costly and time-consuming endeavor. Beyond the physical difficulties, there are: complex governance, legal, planning, distributional, cultural, place-attachment, and funding issues. This article is trying to find the answer to how communities can best implement managed retreat in the most efficient and effective manner. Examples of successful publicly-funded preemptive managed retreats are shared. A managed

retreat program in the Netherlands, known as the “Delta Programme”, was enacted through a national institutional framework which involved community engagement and a dedicated “buy-back” fund. The banks along rivers in the Netherlands’ delta region were physically expanded to allow for a greater flow of water, thus diminishing the chances of overflow and flooding. Simultaneously, a major preemptive beach nourishment program funded by the government was launched that oversaw the expansion of dikes along the shoreline.

Research Design

Background

City of Arcata Land Use Map

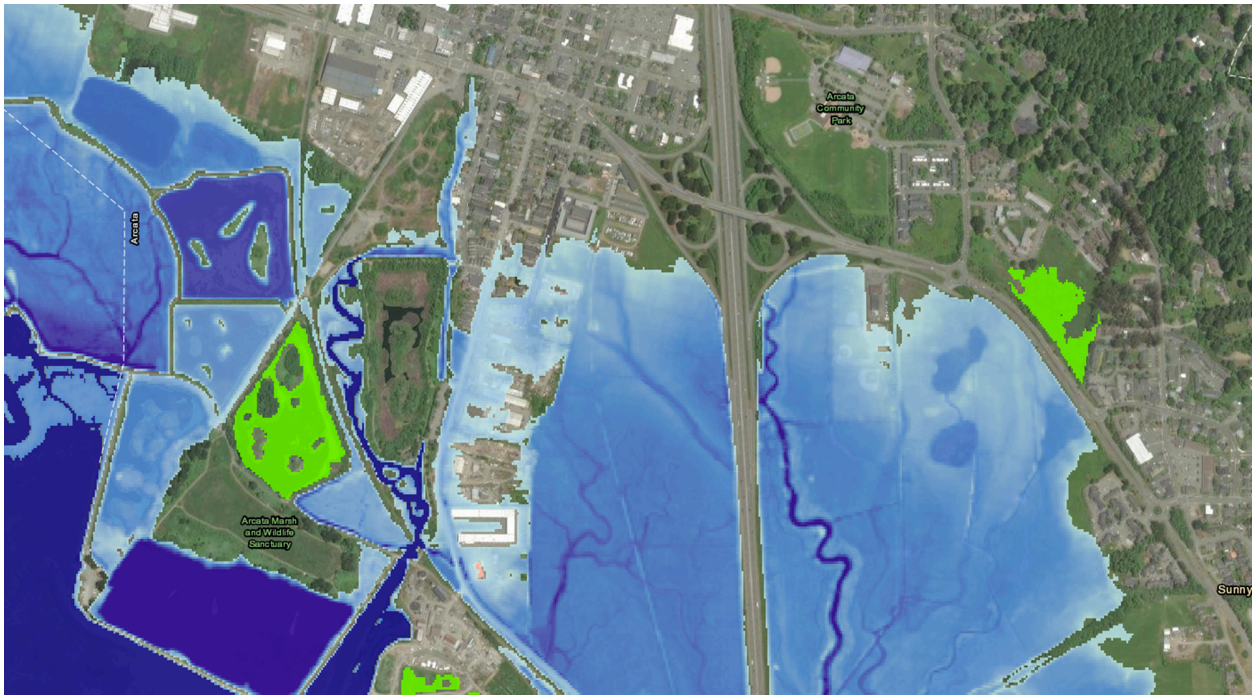


Source: City of Arcata Land Use Element, May 2024

The City of Arcata is a small, rural, college town located in the northern coastal region of California. The United States Census Bureau estimated Arcata's population at around 19,000 for the year 2023 (most recent data). It is worth mentioning that Arcata's California State Polytechnic University, Humboldt brings in an additional several thousand residents each year, but this influx of residents are often non-permanent and tend to leave the area once their schooling has finished. Arcata's residential density tends to be greater near the City's downtown area and Gateway Area, with lower-density residential zones being located more towards the peripheral areas of the City. Commercial areas are also for the most part concentrated in the City's downtown area and Gateway Area. Industrial areas are located for the most part along the northwestern part of the City, but there is a significant amount of industrial zoning located near (and within) the Gateway Area. Public facilities, parks, and institutions are spread throughout Arcata, with notable concentrations around Cal Poly Humboldt, Arcata High, Mad River Hospital, Redwood Park, and the Arcata Marsh and Wildlife Sanctuary. There are several open-space agricultural areas around the City, with the highest concentration located in the southern portion of Arcata.

The issue of sea level rise is particularly relevant to the City of Arcata. The threats from sea level rise are considerable for Arcata due to the fact that this city is adjacent to Humboldt Bay, a large inland body of water that is directly connected to the ocean. The threat of flooding is multiplied because of several perennial streams that flow through very low-gradient farmland which surrounds both the City of Arcata, as well as Humboldt Bay. These perennial streams are susceptible to tidal flooding, as well as upstream flooding. Southern and western districts of the City of Arcata could be expressly threatened by floods due to rising sea levels. The damage from potential flooding would negatively affect Arcata in financial, environmental, and social terms.

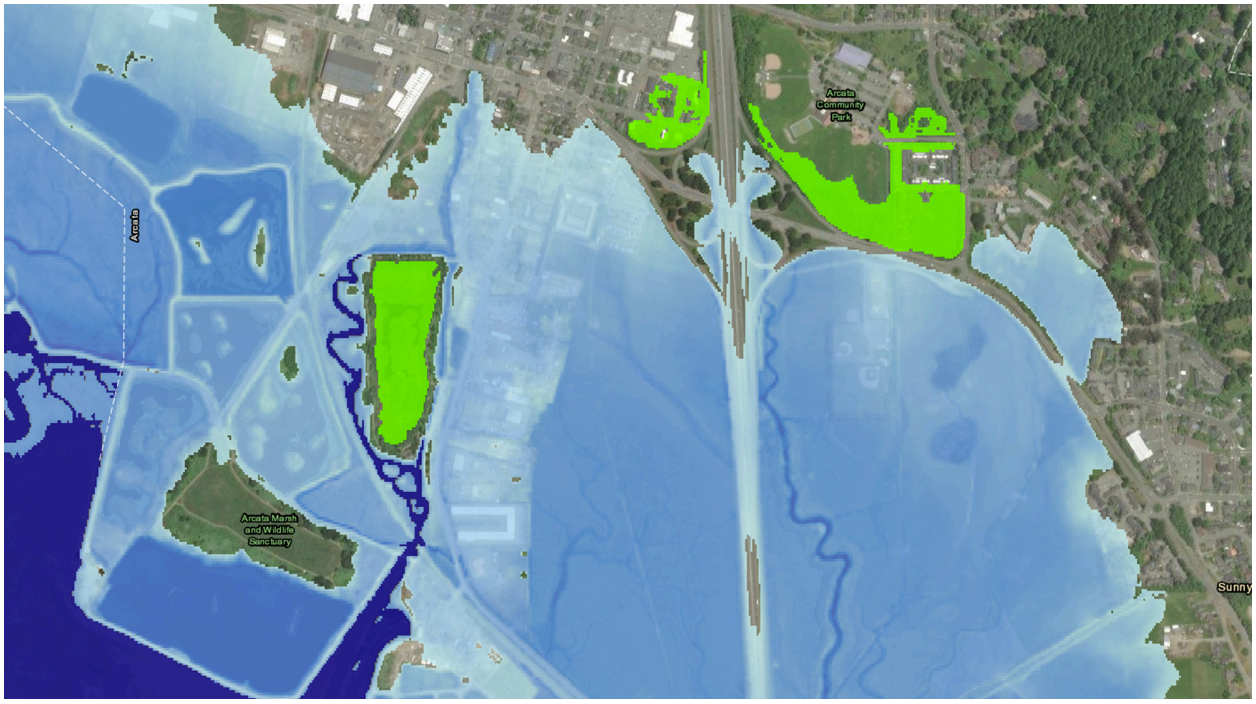
Near Certain Scenario of 3 Feet of Sea Level Rise by the Year 2150



Source: City of Arcata Sea Level Rise Adaptation Planning, February 2025

This image depicts the near certain scenario of at least 3 feet of sea level rise affecting the City of Arcata by the year 2150. The likelihood of this scenario is almost certain, based on studies conducted by the California Ocean Protection Council. As the image depicts, enormous swaths of Arcata's South G Street Area are either wholly, or partially, submerged beneath water. Specifically, the open-space agricultural areas west and east of California Highway 101 have been almost completely submerged. The Arcata Marsh and Wildlife Sanctuary has also experienced significant flooding, but it is important to observe that the berms dividing this area's various ponds remain mostly intact. This is an important feature to consider when thinking about how Arcata's Marsh and Wildlife Sanctuary may be expanded in the future to better shield the City from rising sea levels.

Possible Scenario of 6 Feet of Sea Level Rise by the Year 2150



Source: City of Arcata Sea Level Rise Adaptation Planning, February 2025

This image depicts the possible (but unlikely) scenario of at least 6 feet of sea level rise affecting the City of Arcata by the year 2150. The chances for this scenario materializing are unlikely (5% or less), based on studies conducted by the California Ocean Protection Council. As can be seen from this image, the South G Street Area, and neighboring Arcata Marsh and Wildlife Sanctuary, have both been almost completely submerged beneath water. Sections of the Arcata Marsh and Wildlife Sanctuary have effectively become islands, and flooding from Humboldt Bay has completely overtaken the agricultural lands and much of California Highway 101. At this extremely severe level of flooding, other districts of Arcata besides the South G Street Area are also being negatively affected.

It is important to state that the two previous scenarios of potential sea level rise depicted above would only have the extent of flooding shown if nothing was done by the City of Arcata to manage tidal waters. However, what these images do a good job of conveying is explicitly depicting just how vulnerable the City of Arcata currently is to rising sea levels. If nothing is done to mitigate the threat of sea level rise, then the City can expect catastrophic flooding by next century.

The South G Street Area of the City is particularly vulnerable to sea level rise threats due to its close proximity to Humboldt Bay. In order to better prepare for meeting these challenges, the South G Street Area must undergo significant economic development and a change to its overall zoning. Building up the economic assets of the South G Street Area will open up avenues for

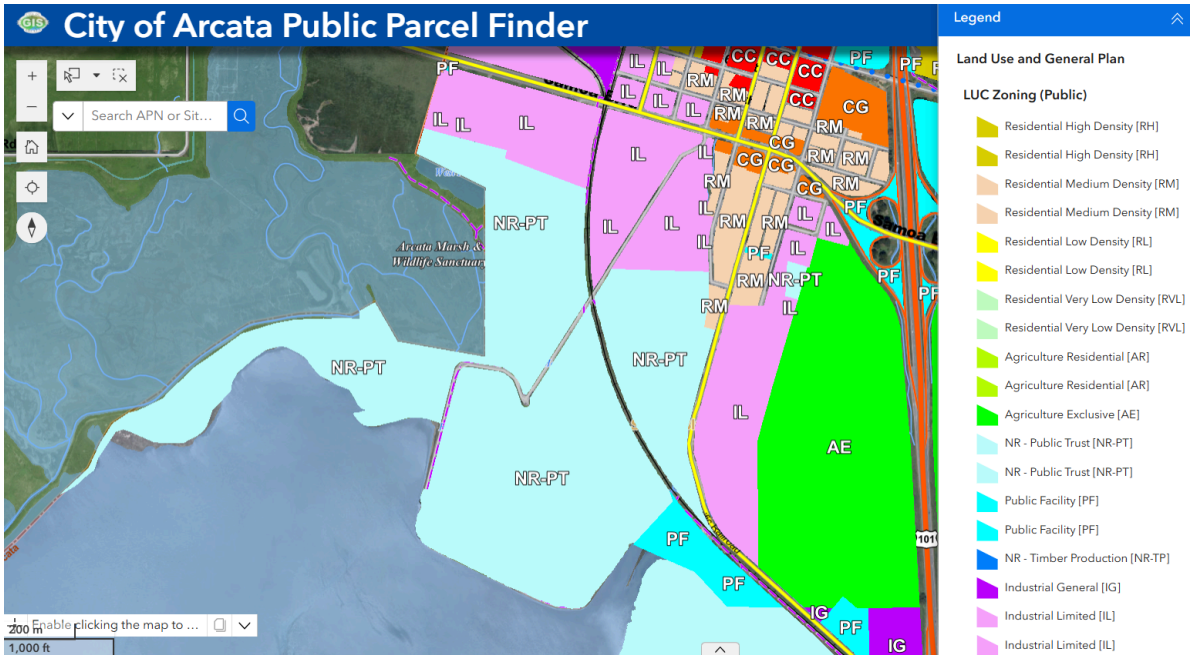
funding by the State of California to assist with sea level rise mitigation strategies/infrastructure. Once the South G Street Area has had a significant amount of time to generate revenue from commercial uses, and once sea level rise starts approaching truly dangerous levels (around 1 ft. by 2050), this area will need to undergo a process of managed retreat to gradually convert into solely open-space (ideally an extension of Arcata's Marsh and Wildlife Sanctuary).

Arcata's South G Street Area

Source: City of Arcata Parcel Finder, April 2025

This image depicts the South G Street Area of Arcata, the primary focus area of this report. This area is located in the southwestern region of the City of Arcata. As can be seen in this image, the entire eastern portion of this area is open-space agricultural land (with perennial streams visible), while to the west the Arcata Marsh and Wildlife Sanctuary dominates the region. The majority of this area's infrastructure is located to the north along Samoa Boulevard, and runs down the center of the South G Street Area towards Humboldt Bay.

South G Street Area Land Use Map



Source: City of Arcata Parcel Finder, April 2025

The South G Street Area of Arcata is currently zoned for mixed-use. There is an assortment of industrial, commercial, residential, public facility, public trust, and open-space agricultural zoning throughout this area. As can be seen in this image, the entire southwestern portion of the South G Street Area is zoned as “public trust” and constitutes the land used for Arcata’s Marsh and Wildlife Sanctuary. Nestled between this public trust land is the City’s wastewater treatment facility, zoned as “public facility.” Arcata’s wastewater treatment facility is an environmentally sustainable operation which integrates conventional wastewater treatment with the natural treatment processes of constructed wetlands. This facility’s natural treatment process allows for plants, algae, and bacteria to break down the waste produced by over 16,000 of Arcata’s residents. The unique treatment process that Arcata’s wastewater treatment facility has adopted serves as a model for environmentally sustainable wastewater treatment worldwide. To the east of the South G Street Area is a large swath of land that is zoned as “agricultural exclusive” and contains many perennial streams that feed directly into Humboldt Bay. There are two large belts of industrial zoned land that stretch down the middle and northwestern portions of the South G Street Area. In between these two industrial belts is zoning for residential and commercial uses.

Research Question

How can the City of Arcata take action to alleviate the negative impacts from rising sea levels in Humboldt Bay through zoning, economic development, and urban design?

Plan of Action

Through the utilization of zoning, economic development, and urban design this project aims to assist the City of Arcata with developing a coherent strategy to mitigate the harmful effects of sea level rise. Both qualitative and quantitative research methods are used to develop design recommendations. Information provided by this project's literature review and background are used as a guide when developing sea level rise mitigation recommendations for the City of Arcata.

A parcel-level analysis of Arcata's South G Street Area will be conducted to gain an in-depth understanding of the existing conditions of the affected site area. Next, to better understand the City of Arcata's vision of a redeveloped Barrel District, there will be an analysis of the City's Gateway Area Plan (specifically its Land Use and Design and Architectural Standards sections). Afterwards, design proposals will be created for both the South G Street Area, as well as the Barrel District, using a combination of AutoCAD and SketchUp software. The design proposals will be split into two phases. Phase 1 is meant to occur until approximately the year 2050, and envisions rezoning Arcata's South G Street Area exclusively for commercial use. During Phase 1, Arcata's Barrel District will be redeveloped from its existing industrial land use into high-density, mixed-use, residential zoning. Phase 2 is meant to occur gradually after the year 2050, and envisions the City conducting a managed retreat from the South G Street Area. This area will be rezoned to eventually be exclusively open-space (or as Arcata designates it, "public trust") and will serve as an extension of Arcata's Marsh and Wildlife Sanctuary. After both phases have been completed, the City of Arcata will have new housing stock, increased revenue from property taxes, and a greatly expanded network of natural defenses against sea level rise via a much larger Marsh and Wildlife Sanctuary.

Analysis

Parcel-Level Analysis (Table in Appendix)
Using the City of Arcata's Public Parcel Finder tool via the City's website, a table has been created which categorizes the number of affected parcels within the South G Street Area, and includes information about each affected parcel such as: Assessor Parcel Number, GIS Acres, Type of Zoning, Land Value, and Improvement Value. Note that parcels listed in this table contain some form of infrastructure, and parcels that are zoned as "Open Space" without any form of infrastructure are not listed. Notable locations of this project's site area that have been excluded from this table are the farm fields directly west of California Highway 101, as well as the Arcata Marsh and Wildlife Sanctuary.

Table Summary
Total Parcels Affected: 148
Total Buildings Affected: ~ 208
Total GIS Acres Affected: 95.69
Total Assessed Land Value: $19,633,653.00
Total Assessed Improvement Value: $34,024,639.00
Total Assessed Value: $53,658,292.00
Total Commercial Parcels: 13
Total Industrial Parcels: 46
Total Residential Parcels: 89

General Parcel Averages
Average Assessed Land Value per Parcel: $132,655
Average Assessed Improvement Value per Parcel: $229,884
Average Total Assessed Value per Parcel: $362,539
Average Parcel Size (in GIS Acres): 0.65

Parcel Type Distribution
Commercial Parcels: 9%
Industrial Parcels: 31%
Residential Parcels: 60%

Development Intensity
Key insight for development intensity and redevelopment potential may be determined using a value-to-land ratio.

Improvement-to-Land Value Ratio (ILV Ratio): $34M ÷ $19.6M ≈ 1.73

A ratio < 1.0 can suggest underutilized land, such as parking lots and/or vacant structures. A ratio > 1.0 shows active use, though 1.5–2.5 may still be considered underbuilt in dense urban areas. With a ratio of 1.73, this project's site suggests a moderate level of development, and some parcels may be underutilized, especially considering that the parcel distribution isn't even.

Buildings-to-Parcels Ratio
208 buildings ÷ 148 parcels ≈ 1.4 buildings per parcel

The ratio of 1.4 buildings per parcel indicates that some parcels in the project's site area contain multiple structures. This ratio is reflected by the fact that most of the industrial parcels in the South G Street Area contain more than one structure, and many of the residential parcels also contain more than one structure.

Preliminary Observations
Constituting a significant portion of the project's site area (31%), the industrial parcels of the South G Street Area are prime for redevelopment to commercial use. For ease of transition, it may be most efficient to begin with transitioning industrial parcels to commercial use (residential parcels will most likely face greater pushback and legal barriers to redevelopment). The ILV Ratio of 1.73 suggests moderate development intensity for the South G Street Area, indicating that portions of this area's land are being underutilized. Considering that the average parcel size in the project's area is 0.65 GIS acres, parcel assembly will most likely be necessary for larger commercial-use developments. The existing commercial footprint of the South G Street Area is relatively small (9%), but will dramatically increase if the City of Arcata follows the recommendations of this project. Residential parcels make up the majority of the South G Street Area (60%). It will be absolutely crucial for the City to relocate these residents to new affordable housing, while ensuring that these residents are justly compensated for the value of their land and homes. It is in the best interest of the residents of the South G Street Area to relocate out of this location before the effects of sea level rise have impacted them. The City must effectively communicate to these residents how their relocation out of the South G Street Area will be sparing them from the "slow violence" of environmental degradation caused by sea level rise.

Arcata Gateway Area Plan Analysis
The Arcata Gateway Area Plan is a Specific Plan that the City adopted on July 17th, 2024. The Arcata Gateway Area Plan will redevelop/infill 138-acres of the City of Arcata into a mixed-use, high-density, residential area. Located adjacent to Arcata's core downtown area, the Gateway Area will become a vibrant center of the city. Currently, the existing conditions of this area consist of blighted legacy industrial land, open space, and is overall underutilized considering the strategic significance of this area's location. The Gateway Area makes an emphasis on adding thousands of additional housing units to the City of Arcata, something that the City desperately

needs. The Gateway Area is divided into several separate districts. This project is focussing specifically on the Barrel District.

Arcata Gateway Area Plan Boundary

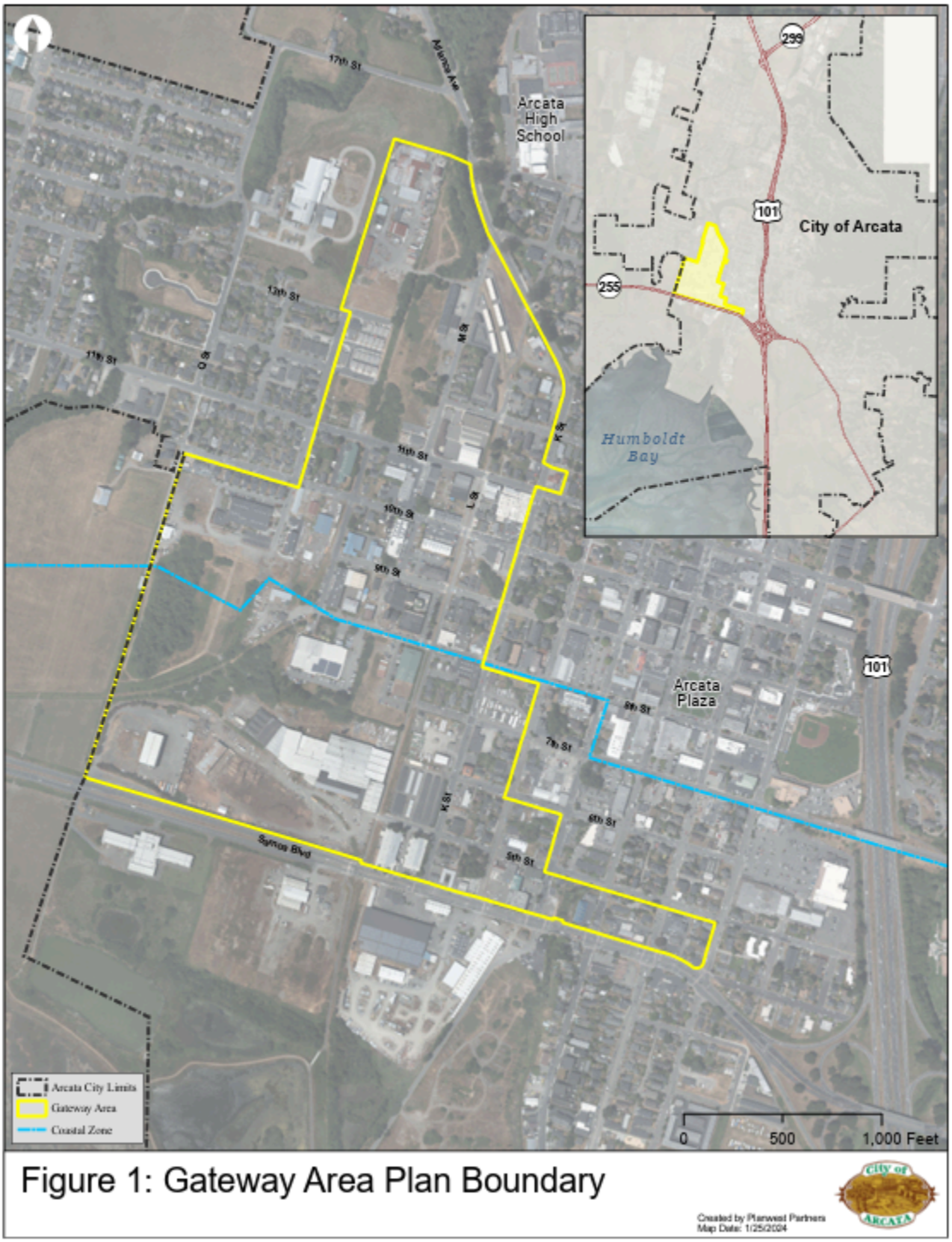
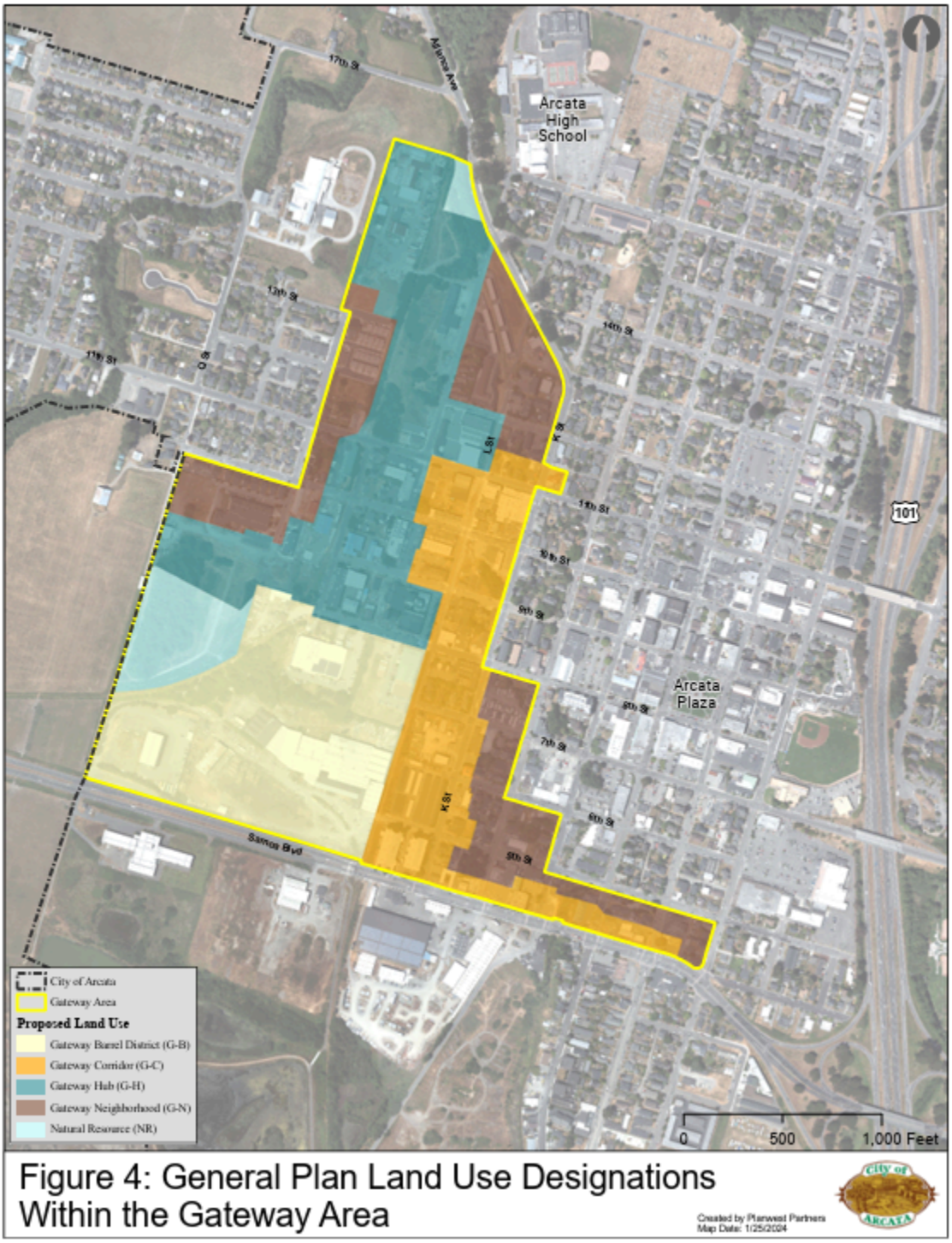


Figure 1: Gateway Area Plan Boundary

Source: City of Arcata Gateway Area Plan, July 2024

Barrel District



Source: City of Arcata Gateway Area Plan, July 2024

The Arcata Gateway Area's Barrel District (bottom left corner in the figure above) encompasses approximately 35-acres of land. The Gateway Area Plan calls for this district to be developed

into a high-density walkable residential campus. Internal circulation is meant to be based primarily on pedestrian and bicycle modes of travel. Infrastructure for vehicles is intended to be minimal, with a de-emphasis on internal roadways. While some mixed-use commercial space is allowed in this district (along Samoa Boulevard), the primary purpose of this district's zoning is for high-density residential use. This primary purpose is reflected by the fact that the Barrel District has the highest height limit out of all the districts in the Gateway Area; up to seven stories for developments which provide community benefits.

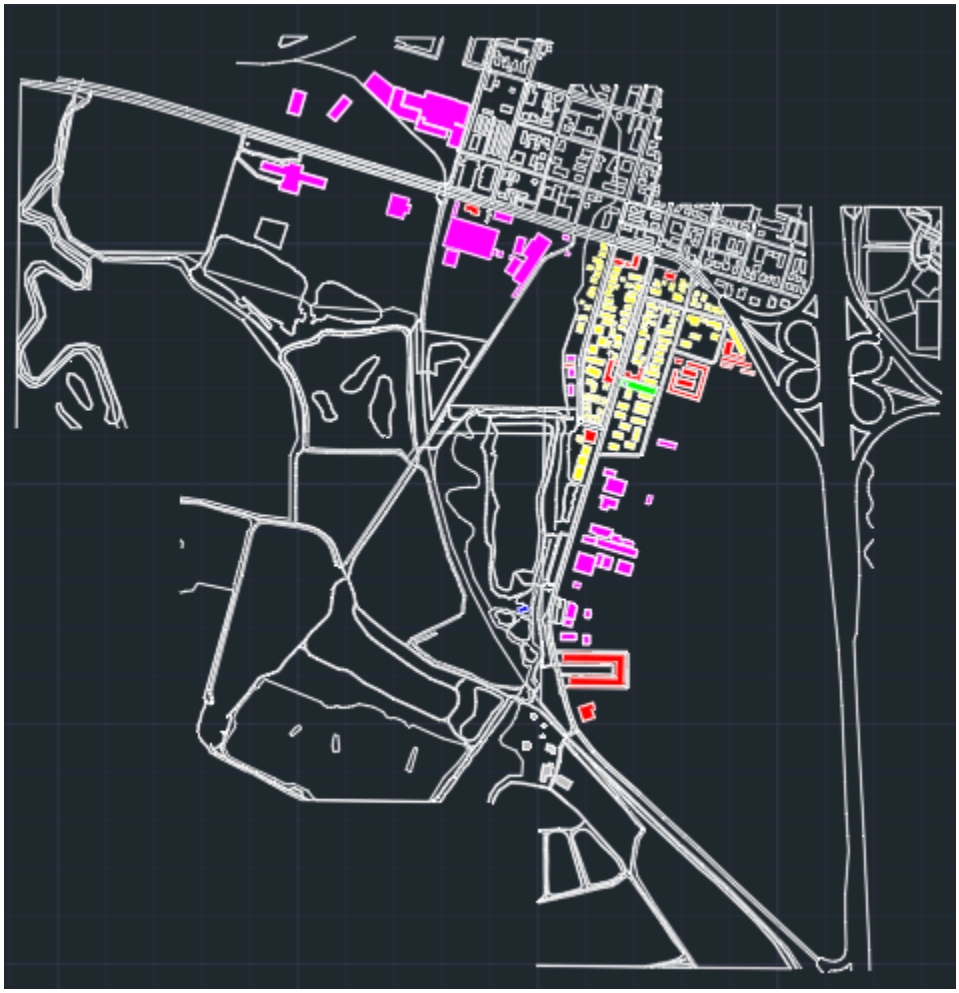
The Gateway Area Plan calls for the Barrel District to have between 1,015 to 1,200 new residential units. Each residential unit will be approximately 1,000 square feet in size. Buildings should be arranged with the long sides facing a north-south axis to maximize exposure to daylight, and to reduce the amount of shadow created as the day progresses. Building setbacks need to be between 10-15 feet from the sidewalk behind landscaping. Some primary buildings' (mixed-use) entrances need to be oriented towards the street, while other buildings' (residential) entrances are inward-facing. On-site parking needs to be placed on the sides or behind buildings, and only in front of buildings as a last option. Parking areas will be hardscape, and should be permeable wherever possible. All roadways in this district must have tree coverage, with internal roadways having tree coverage on both sides of the street.

A community square (0.5 to 1.6 acres in size) must be located at the center of this district. The square is meant to serve as a focal point for civic use, social interactions, and serve residents and workers alike. The square should be lined on all sides by tree coverage. This square is intended for pedestrian use only, and no parking shall be permitted along this square. Community gatherings and events are intended for this square (e.g. farmers' markets, food trucks, movies, and art exhibitions). Public seating (such as benches/tables) should be included to encourage gathering and socialization. The Barrel District must also include linear parks for community gathering, strolling, and access to nature. The width of these parks must be at least 15 feet. The linear parks must provide space for both active and passive forms of recreation (e.g. picnics, jogging, walking, and play areas). The Los Harbors Wetland located to the northwest of the Barrel District is protected by the City, and must not be developed for infrastructure. This passive open space must be left in a natural state for conservation and/or outdoor recreation. Wildlife viewing, environmental interpretation and education, as well as nature photography will all be permitted uses for this wetland.

Design Proposals

AutoCAD Visualizations

South G Street Area with Existing Infrastructure



Source: AutoCAD (Original)

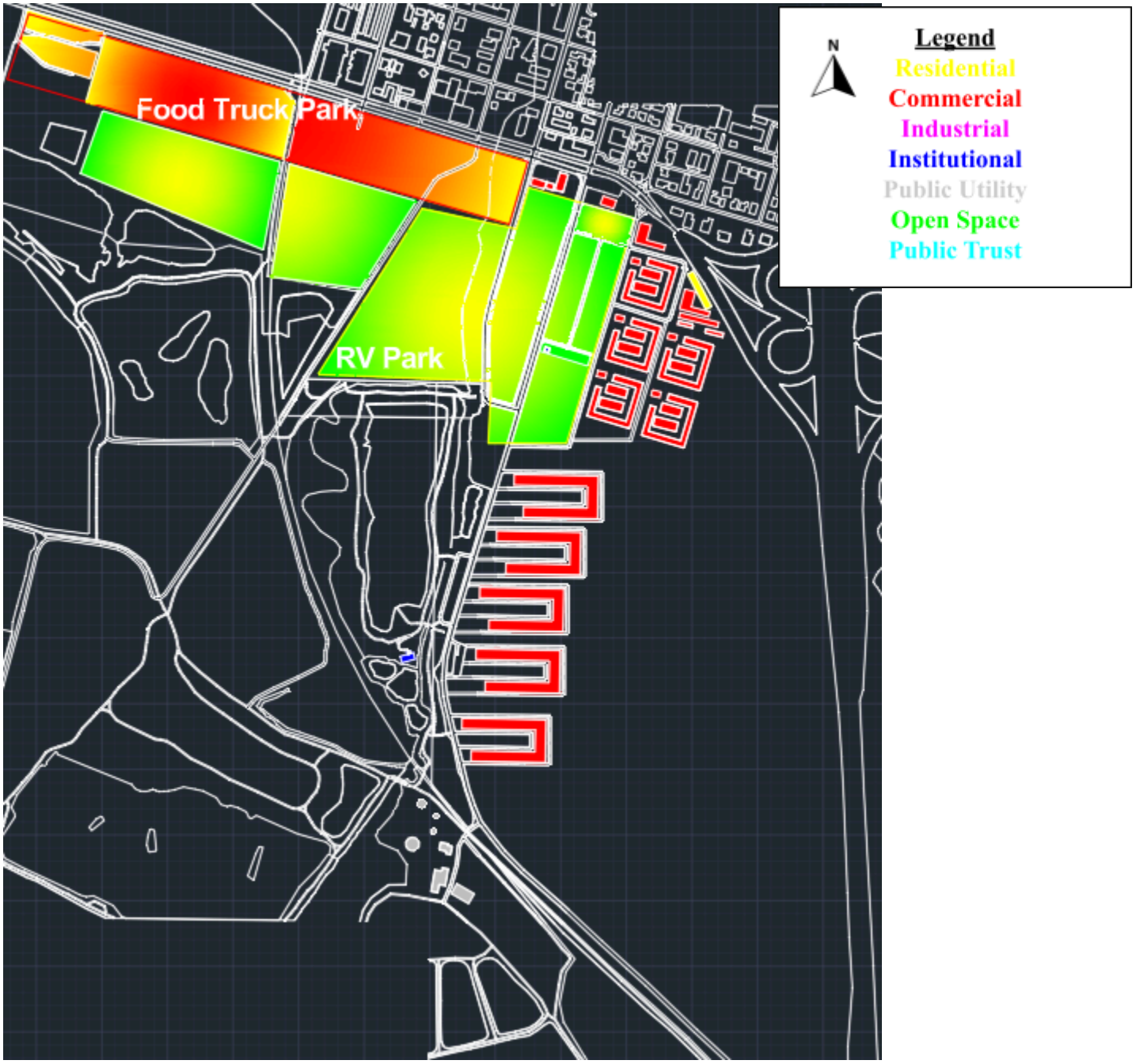
This AutoCAD generated image depicts the City of Arcata's South G Street Area with its existing infrastructure. Buildings in purple are industrial and are located in the northwestern corner (along Samoa Boulevard), as well as down the middle of the area (along South G Street). Residential buildings (yellow) are clustered around the upper-middle of the area. Commercial buildings (red) are more spread out, and can be found along Samoa Boulevard, South G Street, and to the west of California Highway 101. A few additional key areas have been highlighted including: Rotary Park (green), Arcata Marsh Interpretive Center (blue), and Arcata's wastewater treatment facility (grey). In its current state, the South G Street Area has mixed-use zoning.

South G Street Area with Removed Infrastructure

Source: AutoCAD (Original)

In this AutoCAD generated image all non-commercial infrastructure in the South G Street Area has been removed. Notable exceptions include: Rotary Park (green), Arcata Marsh Interpretive Center (blue), Arcata's wastewater treatment facility (grey), and Arcata Bay Crossing (yellow). These four sites will be maintained in their current use during Phase 1 of this project. The Rotary Park contains minimal infrastructure, and will be incorporated into Phase 1's planned RV Park. The Arcata Marsh Interpretive Center is a key feature of Arcata's Marsh and Wildlife Sanctuary, and will continue to serve this area during both Phase 1 and Phase 2. Arcata's wastewater treatment facility is some of the City's most critical infrastructure, and its operations are directly intertwined with Arcata's Marsh and Wildlife Sanctuary, and will continue to serve this area during both Phase 1 and Phase 2. Arcata Bay Crossing is a crucial source of affordable (and sustainable) housing for the City, as well as a key provider of shelter for the City's unhoused population, and will continue to serve the City during Phase 1 of this project.

South G Street Area Phase 1



Source: AutoCAD (Original)

This AutoCAD generated image depicts Phase 1 of this project. The commercial zoning for the South G Street Area has been greatly expanded, with emphasis placed on commercial uses that have a low/minimal footprint, high profitability, and modular/deconstructable infrastructure. These design characteristics will greatly assist the City of Arcata during the process of managed retreat leading into Phase 2 of this project.

The yellow and red gradient zone to the northwest along Samoa Boulevard is a food truck park. This zone serves the City as a lucrative opportunity to consolidate its existing food trucks into a bustling business/entertainment center, and could serve as an incubator for new and exciting culinary options. Infrastructure would be limited in this zone, consisting of: electricity hookups, water supply, wastewater disposal, solid waste management (trash/recycling bins), restrooms (portable), seating (benches, optional to make them covered), and parking (bike racks included). Additional infrastructure centered around entertainment use (e.g. stages for music performance) could be easily assembled/disassembled when appropriate. The location of this food truck park along Samoa Boulevard, and importantly across the street from future high-density housing in the Barrel District, ensures that this zone is easily accessible to the City/customers.

The green and yellow gradient zone in the center and to the west is an RV park. The location of this RV park next to Arcata's Marsh and Wildlife Sanctuary is an ideal location as many RV owners tend to be nature enthusiasts. Having the RV park zone placed next to the food truck park zone will offer the RV park easy access to freshly cooked food on a daily basis while providing the food truck park with a steady stream of customers. Similar to the food truck park, the RV park zone would require little infrastructure, consisting of essentially the same infrastructure that the food truck park would need.

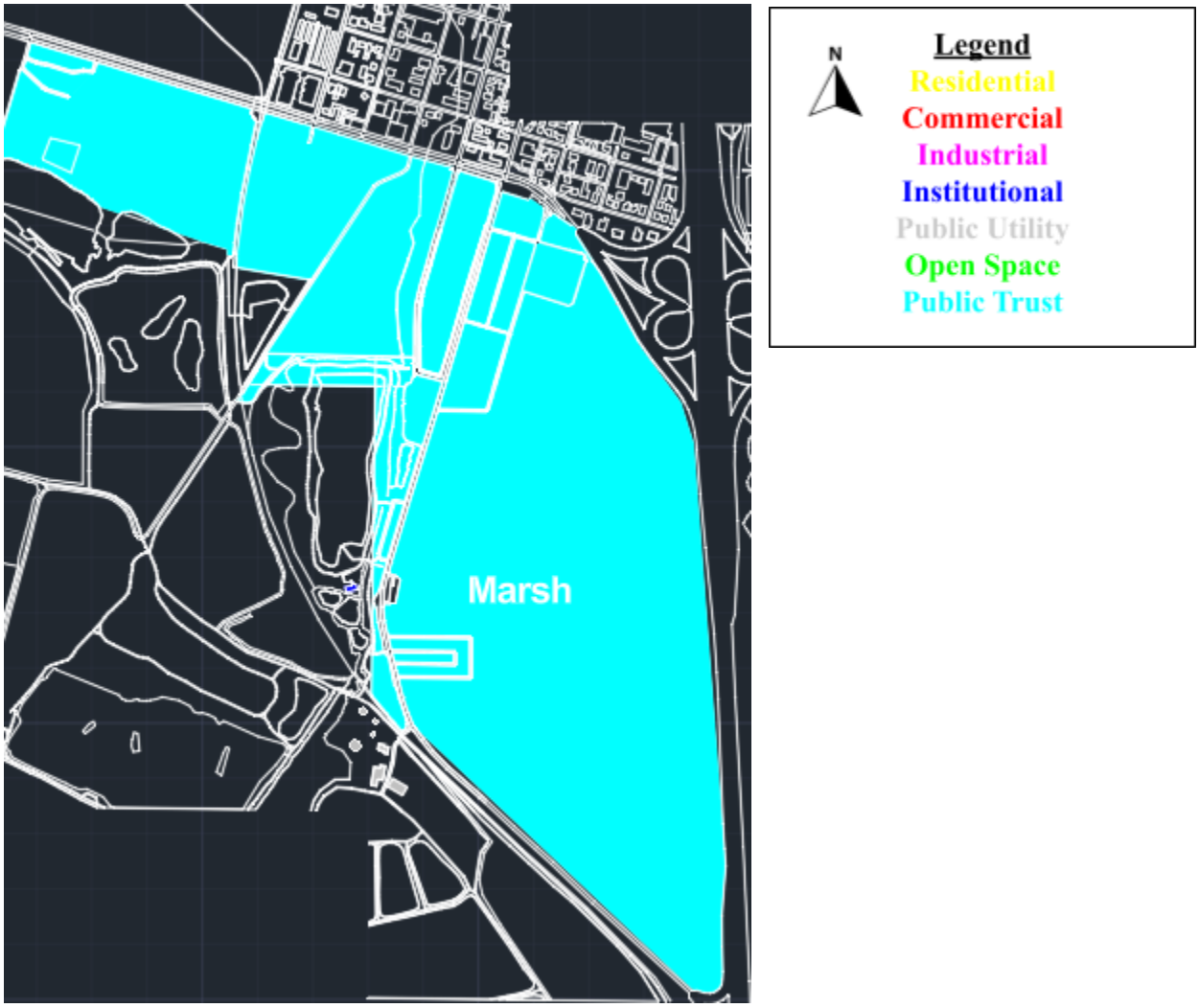
The existing self storage units of the South G Street Area (to the east) have been significantly expanded along Samoa Boulevard and south into agricultural land. Self storage units are in short supply in Humboldt County, and Arcata with its growing population would benefit from additional storage space. The infrastructure for these storage units can be modular, easing the facilitation of construction/deconstruction, and requires little additional infrastructure (such as large parking spaces). These additional storage units can also serve the current residents of the South G Street Area well as they relocate into new housing. With low maintenance, and high demand, storage units are a stable and profitable investment for the City.

In the southern portion of the South G Street Area, the Bayview Industrial Center has been converted into a micro business park, and replicated several times north along South G Street to create a micro business hub for the City of Arcata. The micro business hub can serve as a lucrative/affordable opportunity for Humboldt County's (and Arcata's) entrepreneurs. Key features for this hub include: small retail space, office space, business support resources (business development programs, mentorship, and training), and community amenities (collaborative spaces, meeting rooms, computer labs, etc.). The infrastructure for this hub can be modular, and offers the opportunity for people to pool their resources together to operate their businesses.

Along Samoa Boulevard, the existing commercial uses: 4th Street Market, Chan's Restaurant, and Paul's Live from New York Pizza would all remain during Phase 1 of this project. None of

these businesses are critically threatened by sea level rise in the near-term, and all three operate as commercial uses serving the City and its residents.

South G Street Area Phase 2



Source: AutoCAD (Original)

In this AutoCAD generated image Phase 2 of this project is depicted. Around approximately the year 2050, the City of Arcata will begin the process of managed retreat from the South G Street Area. All commercial uses will gradually be phased out of this area, and replaced by an enormous expansion of Arcata's Marsh and Wildlife Sanctuary. This public trust land will serve as a physical barrier for the City between Humboldt Bay and rising sea levels. An already existing network of berms will be greatly expanded and further integrated into the redeveloped Arcata Marsh and Wildlife Sanctuary to help protect the City from rising sea levels. This area will serve the City as a premiere recreational space, will greatly enhance the City's ability to process waste, and serves the City as an excellent form of natural defense against sea level rise.

Sorrel Place

When conceptualizing what the physical infrastructure of a redeveloped Barrel District will look like, examples/inspiration are pulled from the already existing "Sorrel Place" residential mid-rise building in the City of Arcata. Sorrel Place, constructed in 2021, is one of Arcata's newest and most modern buildings. This project provides 43 affordable residential units, and uses 100% solar power. Being such a modern building, and having the footprint and height that it does, Sorrel Place serves as a good approximation for the massing of future residential buildings in Arcata's Barrel District. The building height for the Barrel District is seven stories, thus the footprint for these buildings will be slightly larger than Sorrel Place. However, the total unit square footage offered per building will be around double of what Sorrel Place offers.

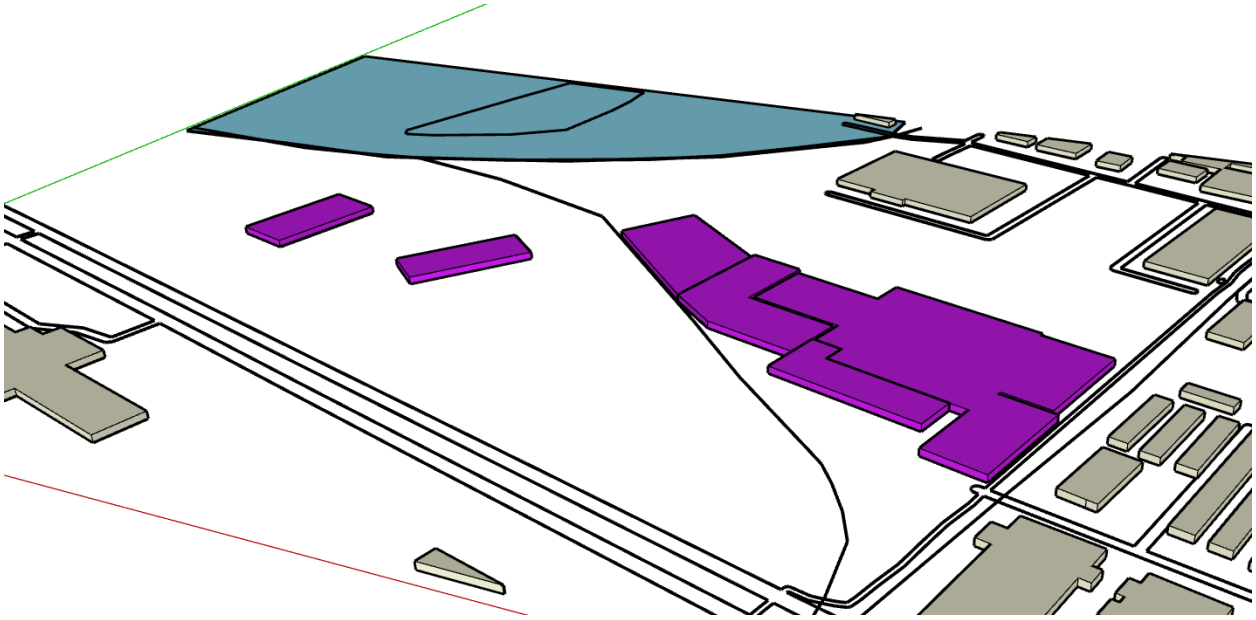
Source: Apartments.com, April 2025

Sorrel Place Dimensions

Width: 101.60 ft
Length: 250.20 ft
Height: Four-Story
Total Site Area: 29,948 S.F.
Building Footprint: 13,938 S.F.
Units: 44-16 one-bedroom units (609 sq. ft.), 16 two-bedroom units (835 sq. ft.), 11 three-bedroom units (1,110 sq. ft.), 1 two-bedroom on-site manager's unit (959 sq. ft.)
Unit Total: 36,273 S.F.

SketchUp Visualizations

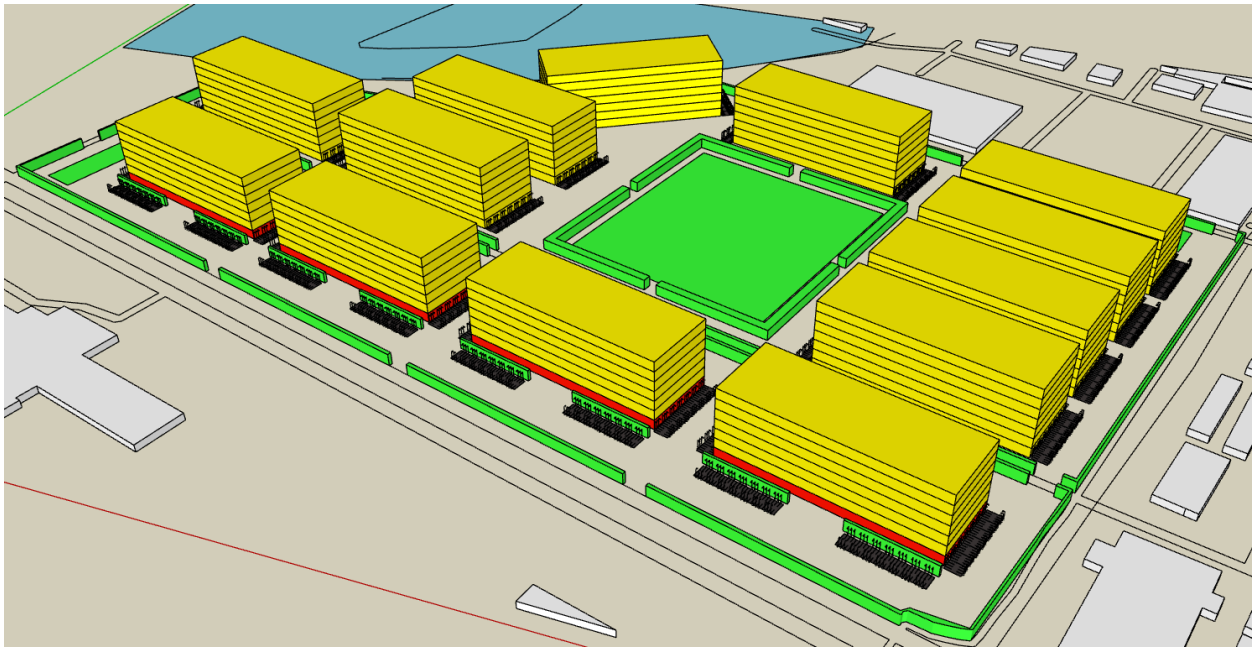
Barrel District with Existing Infrastructure



Source: SketchUp (Original)

This SketchUp generated image depicts the existing conditions of Arcata's Barrel District. As can be seen in the image, This district is currently occupied by industrial infrastructure (purple), namely R&L Lumber and Wing Inflatables. To the northwest, the blue area indicates Los Harbors Wetland. This wetland is protected by the City, and will not be developed for infrastructure in this project. The Barrel District encompasses roughly 35-acres of land.

Barrel District after Proposed Redevelopment



Source: SketchUp (Original)

In this image generated using SketchUp, the redevelopment of Arcata's Barrel District is envisioned. 13 residential and mixed-use buildings have been placed within the district. 9 of the buildings are exclusively residential (yellow), while 4 buildings (along Samoa Boulevard) are mixed-use with the first story zoned for commercial use (red). Emphasis has been placed on designing this district to be a high-density walkable residential campus. Internal circulation is meant to be based primarily on pedestrian and bicycle modes of travel. A single internal roadway has been created, extending from 5th Street, and running from one end of the Barrel District to the other. This internal roadway is lined on both sides by tree coverage (green elevated), and offers on-street parking, protected bike lanes, and sidewalks for pedestrians. Direct access to this district is provided via 5th Street, an extension of 7th Street, and Samoa Boulevard. On-site parking is placed only on the sides of buildings (with the exception of the 4 mixed-use buildings along Samoa Boulevard, which have included parking at the front of the buildings for customers).

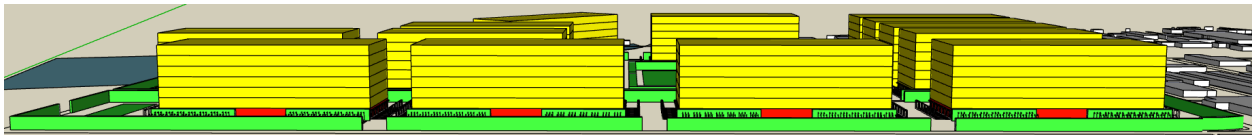
Tree coverage lines the entire perimeter of the district, along parking that is in front of commercial uses, and entirely around the community square. The community square (green flat) is placed roughly at the center of the Barrel District. No parking has been placed along the community square, keeping this area pedestrian-friendly. Entry points into the square have been included on each side, providing direct access to the entire district. Two linear parks (green flat) are included in this design (one along 7th Street, and the other along Samoa Boulevard) and provide an equitably distributed spread of green open space to the district. The Los Harbors

Wetland located to the northwest of the Barrel District has been protected, and left undeveloped. The extension of 7th street provides access to this wetland for outdoor recreation.

Each of the 13 buildings is seven stories in height. The 9 exclusively residential buildings provide 70 residential units each (10 units per story) at 1,000 square feet per unit. The 4 mixed-use buildings provide 60 residential units each, following the same parameters of 10 units per story at 1,000 square feet per unit. 870 residential units are provided in total by this design. Each of the 13 buildings provide 56 parking spaces on both ends of the building (for a total of 112 parking spaces per building), while an additional 448 parking spaces for customers (lined with trees) are provided along Samoa Boulevard in front of the commercial uses. All of the parking areas are hardscape, and permeable wherever possible. Each of the buildings (except for one adjacent to Los Harbors Wetland) have been arranged with the long sides of the building along a north-south axis to maximize exposure to daylight, and to reduce the amount of shadow created as the day progresses. Building setbacks are between 10-15 feet from external streets, and behind landscaping. The 9 exclusively residential buildings all have inward-facing entrances, while the four mixed-use buildings have entrances facing outwards towards Samoa Boulevard.

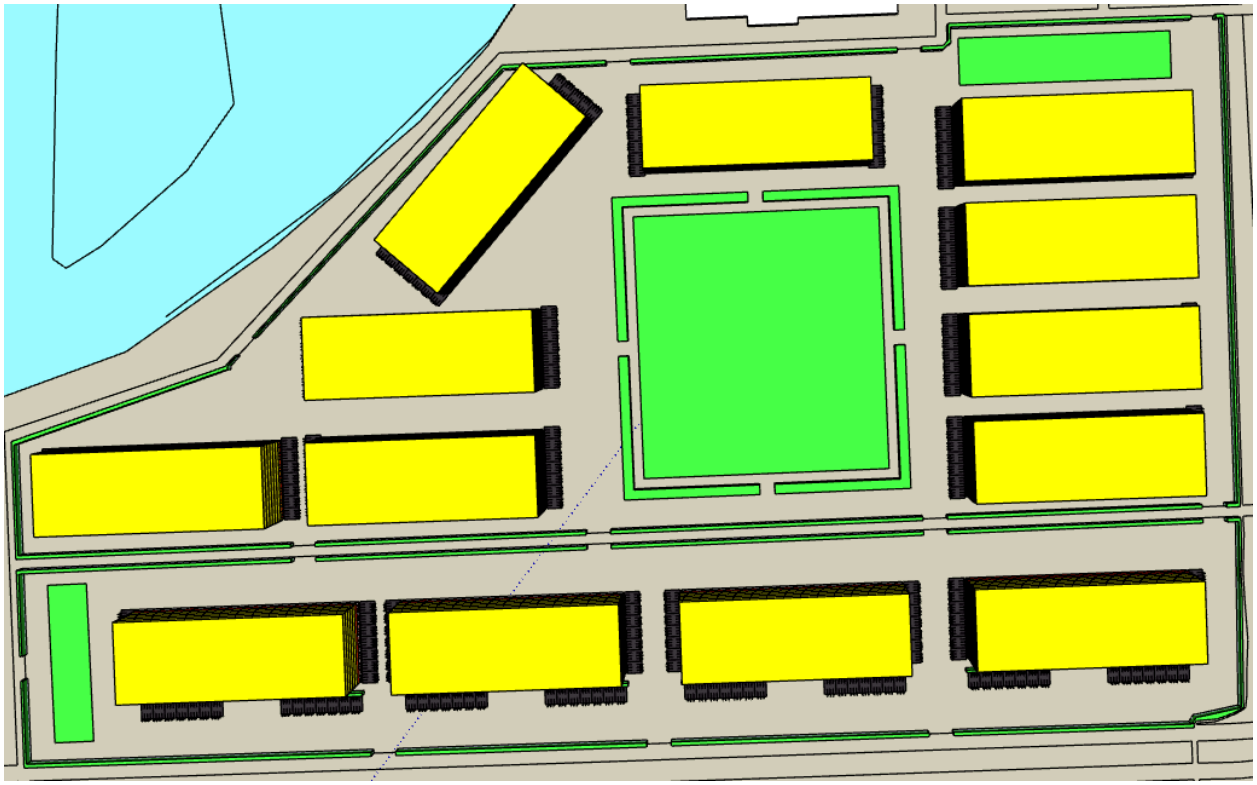
This design for Arcata's Barrel District is meant to create an inclusive, pedestrian-friendly, area which promotes: accessibility, social interaction, civic use, recreation, open space, access to nature, mixed-use, and affordable housing. Through this design, the Barrel District has been reimagined and revitalized into a new vibrant center for the City of Arcata. Importantly, the residential units created for the Barrel District should prioritize housing residents that must relocate from the South G Street Area. Preference towards this specific group of Arcata's residents must be given. It cannot be stressed enough that the Barrel District must also strive to ensure that affordable housing makes up a significant portion of the 870 residential units in this design. The last thing that this project intends is for the expedited gentrification of the City of Arcata. The Barrel District has an incredible opportunity to showcase how the City is approaching inclusivity by designing/creating spaces that are occupied by all socioeconomic status, gender, and age.

Barrel District Perspective



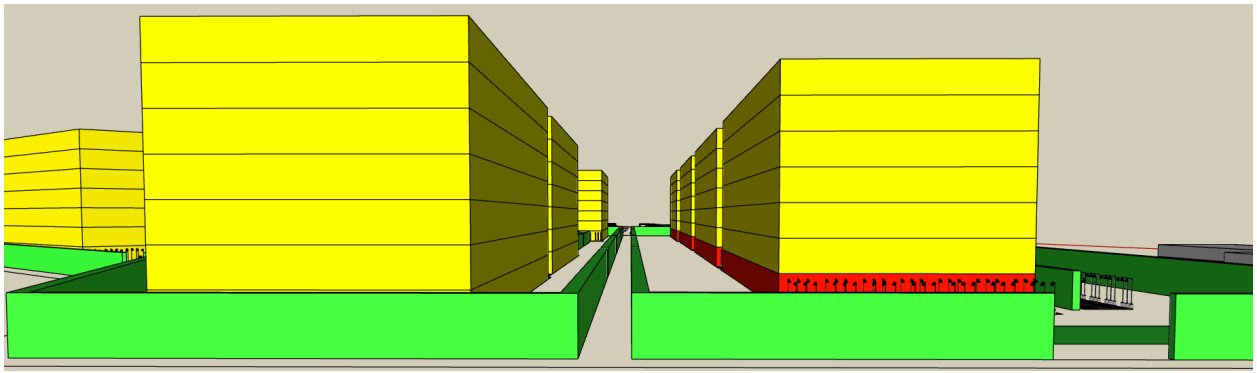
Source: SketchUp (Original)

Barrel District Top-Down Perspective



Source: SketchUp (Original)

Barrel District Street Perspective



Source: SketchUp (Original)

Implementation Timelines and Pathways

Phase 1 of this project is intended to occur between the years 2025 to 2050. During this timeframe, the California Ocean Protection Council predicts that sea levels will rise by at least one foot. If these predictions are correct, this would mean that the City of Arcata will only have roughly 25 years to collect value from using the South G Street Area for commercial purposes. The Arcata Chamber of Commerce, as well as Cal Poly Humboldt, are two local stakeholders which the City of Arcata should strive to work with during Phase 1 of this project. The Arcata Chamber of Commerce supports entrepreneurship, innovation, & builds community. The Arcata Chamber of Commerce serves as the primary hub for connectivity and collaboration. Cal Poly Humboldt is instrumental in educating/training Arcata's future professionals and leaders. Cal Poly Humboldt's ethos for education comes from its distinction as a polytechnic university, subscribing to the motto "learn by doing", integrating practical experience into its curriculum and student life to enhance learning and prepare students for their careers. Both of these stakeholders can help the City with organizing local businesses and entrepreneurs to set up operations within the South G Street Area. Of particular potential is the role that both Arcata's Chamber of Commerce and Cal Poly Humboldt can play in helping the City set up a microbusiness hub in the South G Street Area. Arcata's Chamber of Commerce could help oversee the organization and financing of this microbusiness hub, while Cal Poly Humboldt can create a direct pipeline for students and graduates to gain employment and experience within the microbusiness hub.

Changing the South G Street Area's current mixed-use zoning to only commercial zoning inevitably means that residents which live in this district will need to leave. Unfortunately, many of the South G Street Area's residents are private homeowners, and handling the acquisition of their properties will not be an easy task for the City. However, it is crucial that Arcata facilitates the relocation of the South G Street Area's residents during Phase 1 of this project while sea level rise is still moderately low. Beyond the year 2050, sea level rise will exponentially become worse for Humboldt Bay, and the City of Arcata has a responsibility to the residents of the South G Street Area to spare them from the destruction of sea level rise flooding. While pushback from the South G Street Area's residents to being relocated is certainly understandable/expected, the City must effectively communicate that relocation before 2050 is preferable/desirable for local residents if they wish to be able to sell their homes/properties while these assets still hold value (i.e. not damaged/destroyed by sea level rise flooding). Preemptively relocating the South G Street Area's residents during Phase 1 of this project will spare these residents from the threat of sea level rise, while also ensuring that they will be receiving just financial compensation for their homes and land.

Financial compensation is most likely the surest way that the City of Arcata can convince residents of the South G Street Area to leave. As was revealed through this project's parcel-level

analysis, the total assessed value for the South G Street Area's parcels was $53,658,292.00. However, it must be stressed that this dollar amount is the *assessed* value of the South G Street Area's parcels, not the actual market value. Therefore, the City must prepare a much larger amount of money for any potential buyouts of privately owned parcels in the South G Street Area, the total value very likely being at least double the figure given by this project's parcel-level analysis. Ideally, the City should begin with buying out the industrial uses in the South G Street Area, while actively communicating to residents who live in this area that they should begin the process of searching for new homes and placing their current homes on the market. The City should assist South G Street Area residents with finding/acquiring new homes, preferably homes that are still within City limits.

During Phase 1 of this project, the Barrel District will also be under construction to be redeveloped into high-density housing. The City should provide funds for relocation assistance, rental support, and preferential selection so that residents from the South G Street Area would have the option to relocate to the Barrel District. However, it is likely that not all residents from the South G Street Area will want to switch from living in a single-family home to living in an apartment within the Barrel District. Although outside of the design proposals provided by this project, the City should seriously consider building additional single-family homes in areas of Arcata that are safe from sea level rise. It must be emphasized that the City needs to build community trust, and maintain social cohesion, during the relocation process of the South G Street Area's residents. Private landowners must feel incentivized to leave this area. Most likely not a suitable option for Phase 1 of this project, eminent domain should be resorted to as the last option during Phase 2, when the South G Street Area will ultimately be zoned as public trust land and expanded into the Arcata Marsh and Wildlife Sanctuary.

Phase 2 of this project is intended to occur between the years 2050 to 2100. During this timeframe, the California Ocean Protection Council predicts that sea levels will rise to around 3 feet higher than current levels. By the year 2050, sea level will have risen by one foot, putting the South G Street Area directly at risk from flooding. The City of Arcata will need to begin the process of managed retreat in 2050, eventually deconstructing and removing all commercial uses from the area. Simultaneously, the City will need to begin the construction of a greatly expanded Arcata Marsh and Wildlife Sanctuary, which will eventually encompass the entire South G Street Area by the year 2100. The expansion of the Arcata Marsh and Wildlife Sanctuary will be an extensive nature restoration project that will take many years to fully complete. A network of berms and ponds will need to be constructed within this expansion. The City may have an opportunity to collaborate with the U.S. Army Corps of Engineers, which specializes in ecosystem restoration construction projects. Through the combined efforts of both the City and the U.S. Army Corps of Engineers, with funding provided by the State of California through SB 272, Arcata will effectively be building a natural shield of defense against sea level rise.

Conclusion

Through the literature that this project has reviewed, the analysis conducted, and the designs created the question “How can the City of Arcata take action to alleviate the negative impacts from rising sea levels in Humboldt Bay through zoning, economic development, and urban design?” has been answered. Through a multi-phase approach, increasing the tax revenue of the South G Street Area, providing new high-density housing in the Barrel District, and expanding Arcata’s Marsh and Wildlife Sanctuary the City will be taking crucial steps to mitigate the negative impacts from sea level rise. Ultimately, this project will help the City of Arcata to provide its residents with health, safety, and economic well-being.

Phase 1 of this project oversees the South G Street Area’s zoning being changed from mixed-use to predominantly commercial use. This phase is intended to occur until approximately the year 2050. The four primary forms of commercial use that the South G Street Area will have includes: a food truck park, an RV park, self storage units, and a microbusiness hub. Legacy restaurants and a convenience store market along Samoa Boulevard are also permitted forms of commercial use for the project area. The four primary forms of commercial use for the South G Street Area comply with the desired parameters that the City has requested for commercial uses in this area: a low building footprint, a high return on investment, and modular/deconstructable infrastructure.

During Phase 1 of this project, the 35-acre Barrel District of Arcata will be redeveloped from legacy industrial use into a high-density, mixed-use, residential area. The design proposed envisions the Barrel District constructing 13 seven-story tall residential and mixed-use buildings. This design provides the district with 870 1,000 square foot residential units, 10 units per floor, 70 units per residential building, and 60 units per mixed-use building. Each of the 13 buildings provide residents with 112 parking spaces, while the commercial uses in this design provide customers with 448 parking spaces. Two linear parks are located on opposite ends of the district, and a pedestrian-friendly community square is located at the center. Tree coverage lines all streets in this district, the community square, as well as parking for commercial uses. The Los Harbors Wetland adjacent to this design is protected by the City and has been left undeveloped.

Phase 2 of this project sees the South G Street Area eventually being developed into an extension of Arcata’s Marsh and Wildlife Sanctuary. Through a gradual process of managed retreat, that will begin approximately around the year 2050, the City will deconstruct all commercial infrastructure in this area and change the zoning to public trust land. The Arcata Marsh and Wildlife Sanctuary will be expanded all the way to Samoa Boulevard and California Highway 101. The already existing network of berms and ponds that the Arcata Marsh and Wildlife Sanctuary possess will be greatly expanded to encompass this much larger public trust land. The Arcata Marsh and Wildlife Sanctuary will serve as a bulwark for the City against rising sea levels, and a primary destination for outdoor activities and recreation.

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Appendix

Parcel-Level Analysis Table

Number Of Affected Parcels	Assessor Parcel Number	GIS Acres	Type of Zoning	Land Value	Improvement Value
1	021-185-009	0.17	Commercial General	$224,400.00	$183,600.00
2	021-185-010	0.17	Commercial General	$110,821.00	$153,921.00
3	021-111-001	0.23	Commercial General	$153,109.00	$10,935.00
4	503-224-014	0.13	Commercial General	$174,981.00	$262,473.00
5	503-224-042	0.02	Commercial General	$1,131.00	$0.00
6	503-224-015	0.13	Commercial General	$11,305.00	$20,315.00
7	021-111-002	0.35	Commercial General	$60,251.00	$638,007.00 *$27,500.00
8	503-224-043	0.02	Commercial General	$79.00	$0.00
9	503-224-012	0.17	Commercial General	$12,798.00	$290,494.00
10	503-221-001	0.41	Commercial General	$221,129.00	$180,269.00 *$141,040.00
11	021-118-002	0.16	Commercial General	$79,315.00	$0.00
12	021-028-008	0.29	Commercial General	$64,563.00	$121,002.00
13	021-028-010	0.25	Commercial General	$16,498.00	$39,171.00

14	505-251-013	3.58	Industrial Limited/ Commercial	$541,410.00	$0.00
15	021-191-006	2.54	Industrial Limited/ Commercial	$294,470.00	$1,749,832.00
16	021-191-002	8.47	Industrial Limited/ Commercial	$167,169.00	$80,507.00
17	503-251-011	2.95	Industrial Limited/ Commercial	$52,859.00	$0.00
18	021-185-017	0.39	Industrial Limited/ Commercial	$7,843.00	$494,652.00
19	503-251-017	8.61	Industrial Limited/ Commercial	$122,041.00	$1,566,264.00
20	503-251-015	4.42	Industrial Limited/ Commercial	$26,136.00	$0.00
21	503-232-009	0.04	Industrial Limited/ Commercial	$10,404.00	$0.00
22	021-185-014	0.14	Industrial Limited/ Commercial	$208,080.00	$130,050.00
23	021-185-015	0.24	Industrial Limited/ Commercial	$64,211.00	$50,214.00
24	503-232-015	0.13	Industrial Limited/ Commercial	$29,628.00	$0.00
25	503-232-014	0.14	Industrial Limited/ Commercial	$37,041.00	$0.00

26	503-232-013	10.55	Industrial Limited/ Commercial	$0.00	$0.00
27	503-232-004	0.99	Industrial Limited/ Commercial	$0.00	$0.00
28	503-231-022	0.06	Industrial Limited/ Commercial	$75.00	$0.00
29	503-231-019	0.49	Industrial Limited/ Commercial	$271,633.00	$150,904.00
30	503-231-020	0.07	Industrial Limited/ Commercial	$55,870.00	$50,282.00
31	503-231-015	0.21	Industrial Limited/ Commercial	$227,563.00	$199,117.00
32	503-231-021	0.27	Industrial Limited/ Commercial	$62,850.00	$85,570.00
33	503-231-010	0.10	Industrial Limited/ Commercial	$23,016.00	$0.00
34	503-211-013	1.12	Industrial Limited/ Commercial	$91,611.00	$164,280.00 *$230,880.00
35	503-211-012	0.87	Industrial Limited/ Commercial	$118,173.00	$147,719.00
36	503-211-027	1.43	Industrial Limited/ Commercial	$111,509.00	$56,681.00
37	503-211-035	0.45	Industrial Limited/ Commercial	$142,625.00	$27,340.00

38	503-211-037	0.36	Industrial Limited/ Commercial	$114,099.00	$21,871.00
39	503-211-036	0.42	Industrial Limited/ Commercial	$133,116.00	$300,751.00
40	503-211-038	0.34	Industrial Limited/ Commercial	$107,759.00	$136,703.00
41	503-211-029	4.37	Industrial Limited/ Commercial	$230,534.00	$1,461,982.00 *$5,680.00
42	503-211-030	1.44	Industrial Limited/ Commercial	$328,093.00	$109,363.00 *$133,730.00
43	503-211-011	1.97	Industrial Limited/ Commercial	$574,691.00	$212,241.00
44	503-211-023	1.11	Industrial Limited/ Commercial	$274,272.00	$0.00
45	503-211-015	1.01	Industrial Limited/ Commercial	$130,631.00	$238,896.00
46	503-211-024	3.23	Industrial Limited/ Commercial	$147,596.00	$1,644,682.00 *$10,380.00
47	503-211-026	4.51	Industrial Limited/ Commercial	$465,417.00	$418,286.00
48	021-122-005	0.51	Industrial Limited/ Commercial	$177,480.00	$362,075.00
49	021-122-002	0.72	Industrial Limited/ Commercial	$18,750.00	$35,858.00

50	021-121-011	1.86	Industrial Limited/ Commercial	$469,580.00	$1,953,377.00 *$10,490.00
51	503-225-002	1.30	Industrial Limited/ Commercial	$78,114.00	$60,087.00
52	021-121-005	1.05	Industrial Limited/ Commercial	$49,272.00	$0.00
53	021-121-001	0.18	Industrial Limited/ Commercial	$4,802.00	$0.00
54	503-211-033	1.98	Industrial Limited/ Commercial	$14,934.00	$0.00
55	503-211-021	1.66	Industrial Limited/ Commercial	$65,331.00	$0.00
56	021-122-006	0.20	Industrial Limited/ Commercial	$120,682.00	$42,587.00
57	021-122-008	0.37	Industrial Limited/ Commercial	$318,130.00	$1,162,528.00 *$308,580.00
58	021-122-009	0.80	Industrial Limited/ Commercial	$375,269.00	$857,760.00
59	021-121-010	1.77	Industrial Limited/ Commercial	$428,879.00	$0.00
60	021-185-013	0.19	Residential Medium Density	$42,838.00	$46,370.00
61	503-231-002	0.11	Residential Medium Density	$30,461.00	$57,670.00

62	503-231-018	0.12	Residential Medium Density	$54,096.00	$70,755.00
63	503-231-017	0.11	Residential Medium Density	$33,502.00	$45,689.00
64	503-231-004	0.11	Residential Medium Density	$153,228.00	$159,358.00
65	503-231-005	0.14	Residential Medium Density	$75,038.00	$56,060.00
66	503-231-006	0.13	Residential Medium Density	$69,330.00	$46,728.00
67	503-231-007	0.12	Residential Medium Density	$208,080.00	$223,686.00
68	503-231-008	0.22	Residential Medium Density	$218,727.00	$230,756.00
69	503-224-016	0.10	Residential Medium Density	$70,898.00	$98,967.00
70	503-224-017	0.10	Residential Medium Density	$34,708.00	$45,961.00
71	503-224-018	0.14	Residential Medium Density	$159,295.00	$215,045.00
72	503-224-019	0.14	Residential Medium Density	$8,281.00	$41,445.00
73	503-224-020	0.14	Residential Medium Density	$70,836.00	$165,295.00

74	503-224-029	0.14	Residential Medium Density	$86,888.00	$145,545.00
75	503-224-028	0.14	Residential Medium Density	$156,171.00	$167,325.00
76	503-224-021	0.14	Residential Medium Density	$87,041.00	$244,050.00
77	503-224-037	0.21	Residential Medium Density	$79,826.00	$138,906.00
78	503-224-038	0.18	Residential Medium Density	$79,826.00	$138,906.00
79	503-224-039	0.19	Residential Medium Density	$79,826.00	$138,906.00
80	503-224-036	0.20	Residential Medium Density	$82,957.00	$112,700.00
81	503-224-054	0.69	Residential Medium Density	$232,312.00	$1,325,204.00 *$32,032.00
82	503-224-048	0.23	Residential Medium Density	$30,016.00	$132,167.00
83	503-224-046	0.65	Residential Medium Density	$969,371.00	$261,223.00
84	503-241-021	0.30	Residential Medium Density	$92,469.00	$549,090.00
85	503-241-034	0.05	Residential Medium Density	$78,085.00	$242,624.00

86	503-241-033	0.02	Residential Medium Density	$91,412.00	$182,563.00
87	503-241-035	0.31	Residential Medium Density	$0.00	$0.00
88	503-241-032	0.03	Residential Medium Density	$88,366.00	$90,723.00
89	503-241-031	0.03	Residential Medium Density	$66,929.00	$172,903.00
90	503-241-030	0.04	Residential Medium Density	$84,503.00	$199,196.00
91	503-241-029	0.04	Residential Medium Density	$78,085.00	$294,495.00
92	503-241-028	0.04	Residential Medium Density	$106,120.00	$317,300.00
93	503-241-027	0.03	Residential Medium Density	$87,489.00	$306,219.00
94	503-241-026	0.04	Residential Medium Density	$96,012.00	$192,038.00
95	503-241-025	0.05	Residential Medium Density	$94,129.00	$181,031.00
96	503-241-024	0.04	Residential Medium Density	$70,000.00	$175,000.00
97	503-241-023	0.04	Residential Medium Density	$78,085.00	$327,959.00

98	503-224-040	0.16	Residential Medium Density	$10,795.00	$75,409.00
99	503-224-041	0.04	Residential Medium Density	$3,181.00	$0.00
100	503-224-022	0.23	Residential Medium Density	$265,302.00	$438,278.00
101	503-224-023	0.14	Residential Medium Density	$139,266.00	$116,705.00
102	503-224-009	0.14	Residential Medium Density	$35,422.00	$46,124.00
103	503-224-030	0.14	Residential Medium Density	$187,272.00	$208,080.00
104	503-224-007	0.14	Residential Medium Density	$150,874.00	$150,874.00
105	503-224-006	0.23	Residential Medium Density	$79,826.00	$178,450.00
106	503-224-026	0.18	Residential Medium Density	$228,888.00	$208,080.00
107	503-224-004	0.16	Residential Medium Density	$106,426.00	$127,575.00
108	503-224-053	0.12	Residential Medium Density	$73,760.00	$69,816.00
109	503-224-052	0.12	Residential Medium Density	$100,000.00	$0.00

110	503-221-004	0.18	Residential Medium Density	$204,979.00	$235,042.00
111	503-221-005	0.19	Residential Medium Density	$93,471.00	$101,797.00
112	503-221-006	0.05	Residential Medium Density	$1,187.00	$0.00
113	503-222-012	0.13	Residential Medium Density	$76,422.00	$128,027.00
114	503-222-011	0.13	Residential Medium Density	$35,642.00	$81,153.00
115	503-222-010	0.13	Residential Medium Density	$150,000.00	$165,000.00 *$1,980.00
116	503-222-009	0.13	Residential Medium Density	$84,972.00	$117,680.00
117	503-222-008	0.13	Residential Medium Density	$150,000.00	$145,000.00
118	503-222-024	0.13	Residential Medium Density	$88,405.00	$67,351.00
119	503-222-025	0.13	Residential Medium Density	$86,668.00	$208,700.00
120	503-222-016	0.13	Residential Medium Density	$145,527.00	$168,801.00
121	503-222-006	0.13	Residential Medium Density	$153,109.00	$257,005.00

122	503-222-005	0.26	Residential Medium Density	$229,376.00	$132,794.00 *$5,380.00
123	503-223-021	0.27	Residential Medium Density	$260,100.00	$467,139.00
124	503-223-018	0.40	Residential Medium Density	$258,595.00	$603,396.00
125	503-223-003	0.22	Residential Medium Density	$98,806.00	$273,399.00
126	503-223-015	0.23	Residential Medium Density	$306,000.00	$336,600.00
127	503-223-016	0.24	Residential Medium Density	$12,002.00	$173,319.00
128	021-118-003	0.06	Residential Medium Density	$197,021.00	$187,822.00
129	503-221-002	0.07	Residential Medium Density	$97,563.00	$111,503.00
130	021-118-004	0.10	Residential Medium Density	$104,533.00	$107,321.00
131	503-221-007	0.18	Residential Medium Density	$141,608.00	$178,430.00
132	503-222-013	0.17	Residential Medium Density	$192,995.00	$327,020.00
133	503-222-014	0.09	Residential Medium Density	$183,884.00	$312,445.00

134	503-222-002	0.13	Residential Medium Density	$12,441.00	$66,518.00
135	503-222-027	0.13	Residential Medium Density	$104,269.00	$280,967.00
136	503-222-026	0.13	Residential Medium Density	$110,468.00	$268,121.00
137	503-222-023	0.13	Residential Medium Density	$76,838.00	$159,761.00
138	503-222-022	0.13	Residential Medium Density	$208,080.00	$278,307.00
139	503-222-021	0.13	Residential Medium Density	$36,355.00	$153,387.00
140	503-222-020	0.13	Residential Medium Density	$160,000.00	$200,000.00
141	503-222-019	0.13	Residential Medium Density	$228,888.00	$323,181.00
142	503-222-018	0.13	Residential Medium Density	$150,000.00	$190,000.00
143	503-223-010	0.19	Residential Medium Density	$150,000.00	$190,000.00
144	503-223-019	0.19	Residential Medium Density	$150,000.00	$190,000.00
145	503-223-020	0.19	Residential Medium Density	$243,831.00	$221,192.00

146	503-223-011	0.18	Residential Medium Density	$243,831.00	$221,192.00
147	503-223-012	0.23	Residential Medium Density	$189,820.00	$177,165.00
148	503-223-014	0.24	Residential Medium Density	$185,691.00	$278,537.00