RESILIENT FUTURES

EXPLORING RESILIENCE IN THE ST. LOUIS RIVER ESTUARY COMMUNITIES

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INTRODUCTION

River as Community

On the 19th and 20th of June 2012, a large storm dropped 7.24 inches of rain over a 24-hour period.[1] In the week leading up to the storm, 2–4 inches of rain fell over parts of northeast Minnesota, as numerous storm systems moved across the area. These storms saturated the soil and primed the Duluth area for the extreme runoff from the large storm. Damage from the storm was well over $100 million, as city streets, bridges, and the stormwater and sewer infrastructure were damaged, many hiking trails washed out, and stream habitats, including protected trout streams, destroyed. Following the devastating floods of June 2012, the University of Minnesota's Department of Landscape Architecture and School of Architecture were motivated to action, and began working with the City of Duluth and additional stakeholders including future partners the Saint Louis River Alliance (SLRA) and Duluth LISC to create an interdisciplinary design studio to explore issues of a resilience and sustainability in Duluth neighborhoods affected by the flood.

Duluth is located on Lake Superior and the St. Louis River Estuary. Lake Superior is the largest lake in the world by surface area, and third largest by water volume,[2,3] while St. Louis River is the largest US river flowing into Lake Superior.[4] Where the lake and river meet, 12,000 acres of freshwater estuary create unique biological productivity for fish, birds, and other wildlife. This habitat is one of the largest of its kind in the world.[5] Historically, the estuary and the communities it supports have been dominated by industrial and manufacturing processes, including lumber mills, paper mills, iron and ore transportation, and US Steel Duluth Works. Over the many decades of operations these industrial processes dramatically affected the estuary's ecological health and resilience. The historic beds of wild rice have vanished as the pollution and increased turbidity made it impossible for the sensitive plant to survive. In addition to the water pollution, more than half of the estuary has been physically altered since 1861, with nearly 3,000 acres of wetlands filled and 4,000 acres of dredging and navigation alterations.[6]

In 1987, the lower 39 miles of the St. Louis River was declared an Area of Concern (AOC) due to legacy industrial pollution. As a result, a jointly developed Remediation Action Plan (RAP) was implemented to address environmental concerns. Much progress has been made to remove contamination and restore habitat in and along the river, with over $420 million invested in the remediation effort. The St. Louis River AOC is set to be delisted by 2025. Neighborhoods along the river have also been negatively impacted by legacy land uses and the loss of manufacturing jobs. These neighborhoods lag in critical demographic indicators including per capita income, life expectancy, and employment. They also have limited access to critical services such as healthy food, public transportation, adequate housing, public health, and open space. In 2014, the City declared the St. Louis River Corridor a priority, and levied additional taxes on hotel guests to generate funding for projects in the St. Louis River Corridor. With large investments on the horizon, the construction of a shared and deliberate vision for an equitable and resilient future in the St. Louis River Corridor became an imperative for the Collaborative. The studio began to investigate alternate economic and cultural futures in the St. Louis River Estuary.

Strength Through Collaboration

A Community Innovation Grant from the Bush Foundation supported ongoing academic and community-based initiatives by the Saint Louis River Alliance (SLRA), Duluth Local Initiatives Support Corporation (LISC) and the University of Minnesota – Twin Cities Department of Landscape Architecture and School of Architecture (UMN). As the Design Duluth Collaborative, the three organizations began investigating the possibility of "Creating a

1 An estimated 17.5cm of rain fell over a 24-hour period. (http://www.crh.noaa.gov/images/dlh/StormSummaries/2012/June19_flood/Records.pdf. 04 September 2012).

2 Lake Baikal and Lake Tanganyika have a greater volume of fresh water at 23.6 km^3 and 18.9 km^3 respectively.

3 While the Basin contains 31% of the world's fresh water, only 1% of that supply is replenished each year and Lake Superior has a retention time of 191 years.

4 The St. Louis River is 192 miles long and has a watershed of 3,634 square miles

5 "St, Louis River Estuary: Radio Tower Bay and Wild Rice Restoration." Minnesota Land Trust.

6 The St. Louis River Estuary: The Stories and the Science. http://stlouisriverestuary.org/fishing.php.

Resilient and Equitable Future for the Saint Louis River Corridor." Over a period of three years, the Collaborative has studied physical and community resiliency and speculated on the future of the St. Louis Corridor. Through the grant, the Collaborative created and supported a series of community engagement events at various locations in the Corridor, as well as three years of academic design studios that investigated resilient futures in the Corridor, and the distribution of seed grants to community organizations and stakeholders to assist in the implementation of new community initiatives.

The partnership relies on the leadership and expertise of the grant partners who are trained in community development, facilitation, and engagement to ensure that the project is developed collaboratively. The process utilizes community resources and capacities developed by Duluth LISC and the Saint Louis River Alliance (SLRA). The process also engages the resources of the University of Minnesota, who utilize additional capabilities in analysis, facilitation, community engagement, and creative visioning. This innovative partnership, along with existing and new community networks, works together to ensure that the project is inclusive of all potential community stakeholders and resources.

Saint Louis River Alliance
Established in 1996, the SLRA is a non-profit based in Duluth, Minnesota whose mission is to protect, restore, and enhance the St. Louis River. The SLRA is a key partner with local, state, federal, and tribal governments working to improve the quality of the St. Louis River. The SLRA has an established record of civic engagement and public outreach through educational programs and stewardship activities. The SLRA has over 19 years of advocacy, engagement, and organizing experience in the St. Louis River Corridor and has overseen the investment of $420 million in the St. Louis River Estuary.

Duluth LISC
Established in 1997 as the local office of the national Local Initiatives Support Corporation, Duluth LISC brings resources, expertise, and technical assistance to help non-profit community development organizations transform distressed neighborhoods into healthy and sustainable communities of choice and opportunity. Duluth LISC has been working with Duluth's neighborhoods for over 20 years, including many of the St. Louis River Corridor communities. Duluth LISC has invested over $90 million in neighborhood revitalization resources in Duluth, and has a network of local non-profit and public-sector partners, including the At Home in Duluth collaborative, to engage residents, local businesses, and other key stakeholders.

Design Duluth Studio
Established in 2012, Design Duluth is a nationally recognized Design Studio (with awards from the Association of Collegiate Schools of Architecture for Collaborative Practice) and a joint project of The University of Minnesota's School of Architecture and Department of Landscape Architecture. Students work in interdisciplinary teams for the semester and one of the key objectives of the studio is to rigorously investigate processes of design, and to develop critical and creative responses to issues of resiliency and infrastructure.

COMMUNITY PARTNER ORGANIZATIONS

City Of Duluth
Various departments within the City of Duluth have donated their time and expertise to the Design Duluth Studio. Business and Economic Development has been instrumental in providing students with information on the remediation of brownfield sites and financial information on project funding. Community Planning has provided vast amounts of geographic information to students. Parks and Recreation has shared current and future plans for developing recreationl facilities and parks in the St.Louis river Corridor. Through the tenure of both Don Ness and Emily Larson, the Office of the Mayor has set the tone of exploration for the Design Studio and helped identify geographies and critical issues for exploration that coincide with investments from the City.

Ecolibrium3
Ecolibrium3 is a Duluth-based nonprofit with nationally recognized programs. Their community work spans from direct assistance of neighborhood residents and businesses to informing approaches to energy, resilience, and revitalization. Their mission is to inspire and lead change in the community toward an equitable and sustainable future.

River Corridor Coalition
The River Corridor Coalition (RCC) was a group of individuals representing the neighborhoods of the Estuary Communities with the mission to generate and facilitate respectful conversation to advance the positive development of the St. Louis River corridor communities. Representation included leadership from Community Clubs, citizens living in a neighborhood, business interests, and other area leaders that investigated parks, trails, housing, economic and community development from 2014–2016.

COMMUNITY EVENTS

2015 Lakeview Store Centennial Pop-Up
This engagement introduced the Design Duluth Collaborative to a larger audience, and seeded programming for the coming year. The event asked attendees, through conversation and written feedback, to assess critical issues and proposed resilient practices in the River Corridor. The pop-up was staged at a neighborhood centennial event, with participation from the City of Duluth, the Duluth Public Arts Plan, Ecolibrium 3, and the River Corridor Coalition. The Collaborative designed and installed a series of galleries within the Lake View Store in the vacant storefront next to the Iron Mug Coffeshop where partners showcased ongoing initiatives, offered public education about programs, and solicited feedback on issues connecting the communities of the Corridor such as the Cross-City Trail. It was an important event to extend and communicate our efforts to a broader audience, and also to connect (and partner) with several new constituent groups.

2015 Dredgefest Great Lakes
DredgeFest Great Lakes was a symposium, field expedition, and speculative design workshop about the human manipulation of sediments. It was an encounter between government agencies, designers, theorists, academics, corporate practitioners, industry experts, students, and the public. DredgeFest was held in Minneapolis and Duluth from August 14–21, 2015. This event gave a greater understanding of the dredge process in Duluth and allowed professionals, academics, students, and policy makers to exchange best practices, trends, and techniques to address the dredge process and sediment disposal from the St. Louis River Estuary by the Port of Duluth.

2016 Morgan Park Summer Pop-Up
Coinciding with the 2016 Morgan Park Summer Celebration, the Collaborative hosted on July 2016 at the Iron Mug Coffeshop. The event featured speakers from One River, Many Voices, City of Duluth Housing and Redevelopment Authority, and a local developer, as well as historic walking tours of Morgan Park with the Duluth Preservation Alliance. The event focused on creating and sharing dialogues around housing and development in the historic communities of the St. Louis River Corridor as well as sharing new information about development plans for the former Morgan Park School.

2016 Lincoln Park Fall Pop-Up
Led by Duluth LISC, the Collaborative, the Entrepreneur Fund, and Ecolibrium3 planned, executed, and hosted a pop-up in Lincoln Park on weekends in November leading up to Small Business Saturday. The pop-up was part of Advancing Lincoln Park — a group of entrepreneurs united by the vision of creating a Craft District in the neighborhood of Lincoln Park. The event was presented in partnership with Lincoln Park businesses (Aerostich, Bent Paddle, Birchhaus Market, Duluth's Best Bread, Duluth Coffee, Duluth Grill, Frost River Outfitters, Hemlock Leather, Love Creamery and Zenith Bread Project). Pop-up space was provided by Frost River Outfitters. Over the course of the month, the pop up saw over 900 visitors.

The pop-up culminated in a major event on the future of the local community, a round-table discussion convened by LISC and hosted by the UMD Cultural Entrepreneurship Program. The momentum created by Advance Lincoln Park resulted in a new graphic brand for Lincoln Park and attracted six new businesses to the area.

Design Duluth October & December Exhibitions
The Design Duluth studio at the University of Minnesota focuses on developing resiliency in the St. Louis River Corridor. Student work is shown to the community in October and December each year. The community is invited to the events at Clyde Ironworks, where the community provides critical feedback to the students. Students projects are shared with the community under a Creative Commons license.

STRUCTURE OF THE PUBLICATION

The publication is structured in three sections and progresses from a restatement of Duluth's history to proposals for Duluth's future and a consideration of actions being taken to ensure future resiliency in the present. The first section of the publication, *The Recent Past*, restates some of Duluth's history to establish the conditions for a discussion of Duluth's future. The history of Duluth, is critical to the discussion of the

future as the identity of Duluth and the relationship between resource extraction, heavy industry, and prosperity is slowly replaced by a new identity of Duluth as an outdoor city of youth, sport, and outdoor lifestyles. The first section of the publication also introduces the concept of resiliency. While often used as a measure of disaster recovery, resilience deals with the shocks and stressors to a system and the ability of the system to adaptively respond to those shocks and stresses. These disruptions are not limited to disasters or crises like extreme weather events or economic recessions; resilience must consider community resilience, and identify issues of equity and the gaps in mobility, jobs, housing, food, and healthcare to move toward a more resilient future for all the residents of Duluth.

The second section of the publication, *Duluth Futures*, discusses the future of the St. Louis River Corridor and explicitly covers issues of physical and social resiliency. The section acknowledges current opportunities and proposes solutions to many issues that face or will face the residents St. Louis River Corridor. Student proposals address education, food, energy, and recreation and access to the St. Louis River. The proposals are expansive and future-oriented, and are included to provoke discussion of long-term changes and larger ideas of climate adaptation, physical and social resiliency, and speculation on imaginable and unimaginable futures. The Bush Foundation Community Innovation Grants were created to support organizations using creative processes to develop effective, equitable, and sustainable solutions to future challenges. The student work functions as forward-looking "civic R&D, allowing communities to develop and test new solutions to community challenges."

The document concludes with a recap of current efforts in the St. Louis River Corridor, including efforts undertaken or sponsored by the Design Duluth Collaborative, and considers the effect of these efforts on "kick-starting" the process of debating, testing, and implementing proposals that move the neighborhoods in the Corridor towards a resilient future. With community stakeholders and municipal institutions, we hope the document becomes a tool to help build knowledge around resilience and empower residents to identify opportunities to build resilience in their own neighborhoods. The resources, analysis, and projects in the document are included to help residents participate in the ongoing public, private, and institutional efforts to plan for the ecological and economic future of the St. Louis River Estuary.

Living Document

This publication is a living document, a catalyst for additional collaborative work and is meant to be catalogued, shared, and amended. The creators (SLRA, Duluth-LISC, UMN) of this publication have focused on identifying strategies and resources to help develop resilience in St. Louis River Corridor. This includes the recognition of best practices and alternative strategies for community engagement to best assist in the implementation of resilient futures for the neighborhoods and residents in the St. Louis River Corridor. By creating a flexible framework for future collaborations to build awareness around both the achievements and inequities related in the neighborhoods in the St. Louis River Corridor, the publication hopes to connect new and underrepresented voices to ongoing conversations as Duluth plans for the future of the Corridor neighborhoods. Though the publication is shared as a physical document, the digital form of the document will allow for ongoing change and improvement as future work addresses issues and development.

DULUTH FUTURES

The Recent Past

Duluth's early existence was dependent on the boundless optimism and patience of the early settlers. The settlements of Duluth and Superior survived for 15 years on the promise of an unbuilt **railroad connection** to the Mississippi River. The settlers of Duluth waited through numerous financial panics and the Civil War for the railroad, "reduc[ing] the population at the head of the lakes to those who had the supreme energy to stay and those who did not have the energy to move."[1] Until the railroad was constructed, Duluth was geographically isolated from the commercial markets in eastern and western US (**Figure 1**). The railroad and the discovery of iron ore in the Mesabi Range drastically changed Duluth's fortunes and by the end of the 19th century, Duluth was home to more millionaires per capita than any other city in the world. The city's port was the largest in the United States, surpassing both New York and Chicago in gross tonnage handled. Ore from the Iron Range was shipped to steel plants in Buffalo, Chicago, Cleveland, Detroit, and Pittsburgh. Duluth was the main connection between ore from the Iron range and steel plants in the East.

The newly consolidated **US Steel** became the largest steel producer in the country with $1.466 billion in assets, including 213 mills, 1,000 miles of railroad, and 41 mines. Iron ore is a critical raw material in the steel making process and there were huge profits and a multitude of jobs connected the production of steel and steel products like wire and fencing went to the states with steel mills. Minnesota held large deposits of iron ore and to capitalize on the demand the state legislature discussed adding additional taxes to iron ore shipped out of Minnesota. The threat of

1 Woodbridge and Pardee 1910: 86.

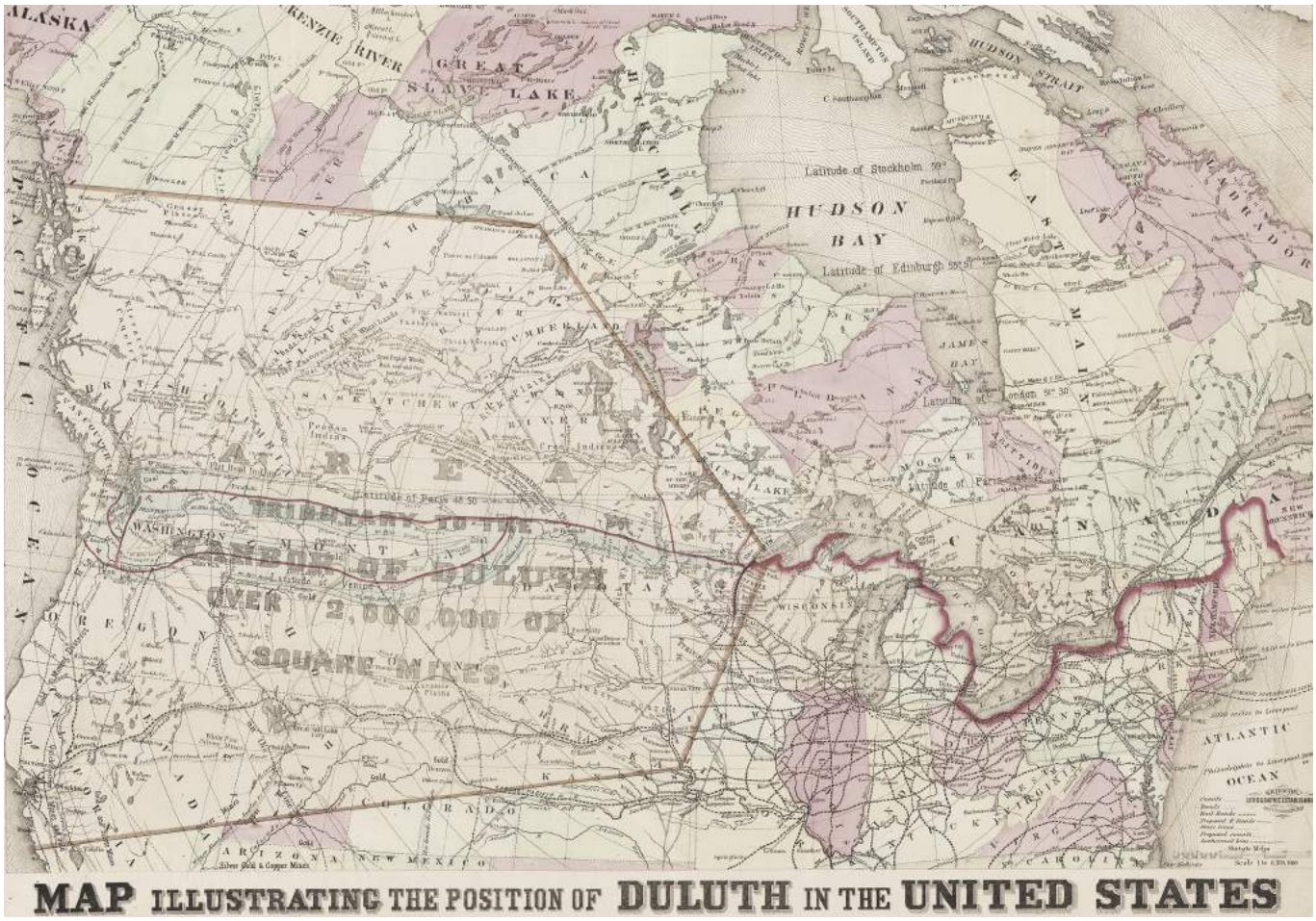


Figure 1. *The Position Of Duluth In The United States*. An optimistic map of the "service area" of the Port of Duluth. Note the notations for the "Latitude of Venice" and the "Latitude of Paris" in an attempt to downplay the weather. 1878. Morris H. Traubel & Company.

Table 1. Output from iron mines

MINE	OWNER	LOCATION	OUTPUT
HAMERSLY	RIO TINTO	AUSTRALIA	163 MT
CARAJAS	VALE	BRAZIL	120 MT
CHICHESTER HUB	FORTESCUE METALS	AUSTRALIA	90 MT
YANDI	BHP BILLITON	AUSTRALIA	79 MT
MOUNT WHALEBACK	BHP BILLITON	AUSTRALIA	77 MT
SOLOMON HUB	FORTESCUE METALS	AUSTRALIA	58 MT
AREA C	BHP BILLITON	AUSTRALIA	57 MT
HOPE DOWNS	RIO TINTO/HANCOCK	AUSTRALIA	43 MT
MARIANA HUB	VALE	BRAZIL	39 MT
SISHEN	ANGLO AMERICAN	SOUTH AFRICA	36 MT
MINN TAC	US STEEL	US, MINNESOTA	13 MT

Basov 2017 and Minnesota Department of Revenue 2016
Total Mesabi Range output is 29.3 MT

an additional tax was used a leverage to commit US Steel to the construction of a steel plant in Duluth. After eight years of deliberation and planning, US Steel constructed a $45 million plant[2] south of the city. Steel production began in 1915,[3] and many predicted that Duluth would become the next Pittsburgh.

As high-grade ore played out in the Iron Range in the 1950s, any hopes that Duluth would become the next Pittsburgh were laid to rest. Ore shipments through Port of Duluth, critical to the city's (and state's) economy dropped sharply. Shipments of low-grade ore continued with the development of a new **taconite pellet technology**, but the discovery of **new sources of high-grade low-cost iron ore** in Brazil and Australia[4] (**Table 1**) and the inconsistent economy and fluctuating demand for steel decreased demand for taconite.

The 1972–1973 OPEC **oil embargo**, a direct response to $2.2 billion in US emergency aid to Israel during the Yom Kippur War, resulted in the "manipulation of oil prices and supplies…at a most inopportune time for the United States. In the middle of 1973, wholesale prices of industrial commodities were already rising at an annual rate of more than 10%; our industrial plant was operating at virtually full capacity; and many major industrial materials were in extremely short supply."[5] The rise in oil prices along with the devaluation of the US dollar began a long period of inflation in the US (over 14.8% annually in 1980) and stagnant economic growth (**stagflation**). To control inflation, the Federal Bank raised interest rates to 20% in 1981. This led to an recession in 1981–1982, the most severe economic crisis since the Great Depression.[6]

2 The plant occupied 1500 acres, and was an equivalent investment of $462 million in monetary cost and $7.8 billion as share of GDP in 2012 dollars.
3 Labor costs in Duluth were higher than in other American steel centers because "Duluth is distant from other steel mill communities and is located where the accustomed lack of sustained employment in one occupation had made for a migratory common labor." White and Primmer. 1937, 89.
4 Basov 2017. Seven of the top producing iron ore mines are located in Australia, a short distance to China, the largest consumer of iron ore in the world.
5 Burns 1979. Oil prices quadrupled from quadrupled from $2.90 to $11.65/barrel. For reference, current prices are $48/barrel, down from a high of $140/barrel in early 2008.
6 Corbett 2013.

The recession significantly reduced demand for steel and began a decade long **restructuring of the US and global steel industries**. The steel industry was spectacularly unprofitable. Despite price controls on imported steel imposed by both Presidents Carter and Reagan, the industry lost over $3 billion in 1982. Government intervention was limited to price controls and the industry was forced to radically restructure and contract, shuttering old plants, laying off workers, and cutting pay and benefits for the remaining workers. Between 1979 and 1982 more than 150,000 US steelworkers lost their jobs and hundreds of steel facilities were closed. By the end of the recession in 1986, over 300,000 steel-related jobs were lost.[7]

Like other manufacturing centers, Duluth entered a period of crisis, losing jobs and population. Between 1970 and 1990, Duluth lost over 15% of its residents and the unemployment rate reached a high of 18.2% in 1982.[8] The situation was so dire that in the late 1980s a billboard along I-35 featured the phrase, "Will the last one leaving Duluth please turn out the light?" (**Figure 2**)

Through numerous economic downturns, including **the Panic of 1857**, **the Panic of 1873**, the Great Depression, the decline of high-grade ore stocks in the Iron Range, and the recessions of the 1970s and 1980s, Duluth has shown a remarkable resilience and an ability to recover from difficult economic (and social) crises. Since the late 1980s, Duluth has reinvented itself (again) as a destination for tourists, the healthcare industry, and high-tech manufacturing, and most recently a place of creative small-scale manufacturers. The long economic recovery has resulted in a new Duluth that is markedly different from the industrial Duluth of the 1980s. The following sections will explore the potential of what a new Duluth means for residents in the St. Louis River Corridor through design proposals from students in the Design Duluth studio. Their work, prompted by conversations with stakeholders and residents, addresses issues that are critical to future of the St. Louis River Corridor. Each section will address an important issue for the development of a resilient future for the Corridor that will, hopefully, increase equity, expand economic opportunity, and increase the quality of life for residents and visitors to the St. Louis River Corridor.

Duluth and Resiliency

Duluth has been resilient to large-scale economic and social changes throughout its history. Historical resilience in Duluth was typically reactive, unplanned, and dependent on the strength of institutions or individuals to provide resources that were systemically unavailable to lessen the degree of damage or to aid in recovery efforts. Duluth has recovered quickly from previous weather-related disasters, and these are expected to increase in intensity and frequency

7 Graefe 2013.
8 Associated Press 1982.

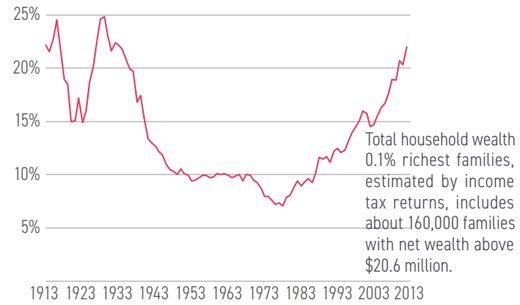
Figure 2. "*Turn out the lights*" *Billboard*. There are no firm details on who might have been behind placing the billboard in Duluth or what day and year it went up. Almost everyone says it was placed next to the southbound lanes of Interstate 35 somewhere between downtown and the Can of Worms interchange. Fedo, who was mayor from 1980–92, said he thinks a manager at Skoglund Outdoor Advertising "thought it was humorous. I think he underestimated the reaction and quickly removed it."

Figure 3, 4, and 5. Scenes of flooding and flood damage from the June 2012 Flood. Photographs courtesy of Cynthia Lapp.

in the future. The storm of 1972 caused an estimated $20 million in damages, while the **latest storm in 2012** caused over five times the damage at over $100 million (**Figures 3–5**). The increase in developed area and infrastructure makes future weather-related disasters a critical issue that requires more attention.

The other critical resiliency issue is social resiliency. Social mobility, the ability to move up in social/economic class is now more difficult in the US than in notoriously class-centric British society. In the US, measures of economic inequality are almost similar to those of the 1920s when the top 1% held over 50% of all household wealth[9] (**Figure 6**). Resiliency must consider these social and economic issues when planning for the future. An inequitable society makes the onset of crises more probable and the recovery from crises more difficult. Design and planning cannot solve the structural issues and resolve the differing political philosophies behind inequality, but can ameliorate economic and social differences and attempt to imagine/propose ways of reconfiguring the city to provide greater economic and social opportunities and to lessen the resiliency-related problems of residents in the St. Louis River Corridor.

Figure 6. Wealth inequality from 1913–2013. The share of wealth owned by the 0.1% richest families, has risen from from 7% in 1978 to 22% in 2012. There are 125.82 million households in the US, about 160,000 households own 22% of all wealth in the US.



With severe weather events projected to be more frequent and economies becoming more interlinked and unmanageable — planning for the changes that can occur when stresses or shocks disrupt modern economies or infrastructures requires the massive deployment of social, physical, and fiscal resources. Planning for, or preventing damage during disasters such as the 2012 storm is generally based on the principle of ALARP,[10] for example spending $100 may limit damages to 10% of the system, while spending $200 may only limit damages to 8% of the system, in other words, spending more money may not add significantly more protection to a system.

Duluth is currently developing a new Comprehensive Land Use Plan through the Imagine Duluth 2035 process. The plan hopes to address issues that

9 Saez and Zucman 2014: 22.

10 ALARP (as low as reasonably possible) principle states that money must be spent to reduce risks until they are reasonably low, and must continue to be spent for as long as it is cost effective to do so and the risk is not negligible. If a "tolerable" level of risk can be reduced further at a reasonable cost and with little effort, it should be.

were omitted from the 2006 Comprehensive Plan, particularly housing, transportation and accessibility, economic health, and open space. The new plan also promotes health and equity as cornerstones for future development. The principles that underlie for the Plan are clearly spelled out:

1. Reuse previously developed lands
2. Declare the necessity and secure the future of undeveloped places
3. Support traditional economic base
4. Support emerging economic growth sectors
5. Strengthen Neighborhoods
6. Reinforce the place-specific
7. Create and maintain connectivity
8. Encourage mix of activities, uses, and densities
9. Support private actions that contribute to the public realm
10. Take sustainable actions
11. Include consideration for education systems in land use actions
12. Create efficiencies in delivery of public services

While Duluth is proactively planning for the future, there is no explicit mention of climate change or resilience[11] in the principles or core areas of attention. Mayor Larson's *Welcome Statement* does mention resilience, but only in direct relation to climate change. Urban plans are forward looking instruments for change, imagining new neighborhoods, districts, or transit systems ten years into the future (Duluth's last approved Comprehensive Land Use Plan was in 2006). Resiliency and resilient thinking should be embedded in all large- and small-scale planning efforts as resiliency requires working with long time frames that are much longer than the typical Comprehensive Plan. Such investments are large and must, by necessity, be considered and implemented over long periods of time. Considering resiliency when planning for such investments is critical as governments and non-governmental agencies have fewer and fewer resources to deploy.

Defining Resiliency

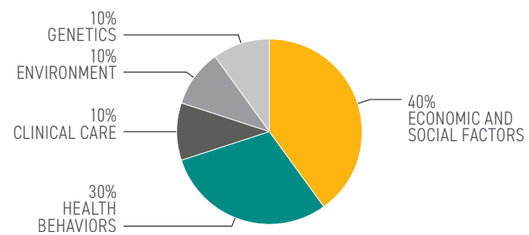
Modern resilience is focused on the internal and external dynamics of systems and the system's ability to absorb or resist disturbance and develop alternate forms of stability. Disciplines that employ resiliency thinking, strategies, or concepts include economics, security and disaster planning, and, increasingly, urban planning and design. Concepts of economic resiliency are directly derived from an ecosystem model. Economic resilience is based on the two concepts: "The first is based on 'equilibrium analysis,' in which resilience is the ability to return to a pre-existing state in a single equilibrium system or shift to new 'normals' in multiple equilibrium systems. The second defines resilience in terms of complex adaptive systems and relates to the ability of a system to adapt and change in response to stresses and strains."[12] Security and disaster planning have adopted resiliency strategies as part of prevention and response policy. While the visible security apparatus is focused on the prevention of attacks, "resilience strategies…assume that resistance may not always be possible and thus include the provision of or access to alternative resources and services if the resistance strategy fails."[13] While security planning focuses on redundancy (multiple layers of resistance), disaster planning acknowledges the possibility of multiple systemic failure(s), such that resiliency is "the ability to survive future natural disasters with minimum loss of life and property."[14] Disaster resiliency also places a premium on the ability to recover and the speed of recovery, where speed is a measure of infrastructural and economic robustness (supply chains, damage repair, and relief payments — think of post-war Berlin and post-earthquake Haiti).

Developing/designing for resilience requires an adaptive, open approach. There are three dimensions of resilience: specific resilience, general resilience, and transformational change. Specific resilience is concerned with the performance of a system or a part of a system that may be vulnerable or subject to many disturbances. Though reinforcing or "increasing resilience of particular parts of a system to specific disturbances may cause the system to lose resilience in other ways…systems that become very robust to frequent kinds of disturbance necessarily become fragile in relation to infrequent kinds. For example, international travel in Europe became increasingly focused on improving and elaborating air travel, with less emphasis on international ground and water transportation."[15] The eruption of the Icelandic volcano Eyjafjallojökull in 2010 exposed the lack of resilience in this system. General resilience on the other hand "is about coping with uncertainty in all ways."[16] This is an important, as most efforts toward achieving resiliency focus on specific resilience "and in doing so they may be narrowing options for dealing with novel shocks and even increasing the likelihood of new kinds of instability."[17] Transformational change is concerned with fundamental changes within or to systems. "Transformational change often involves shifts in perception and meaning, social network configurations, patterns of interactions among actors including leadership and political and power relations, and associated organizational and institutional arrangements."[18] Transformational change typically occurs across many scales and requires support from many scales of governance, including local governance. Student work shown in this section derives strategies and approaches from all three types of resilience outlined above, but is mostly focused on effecting transformational change in the St. Louis River Corridor.

Equity and Duluth

The one of the major goals for Healthy People 2020 (a nationwide data and science framework for advancing public health priorities and policies) is the promotion of policies that help achieve health equity and eliminate health disparities for all groups. This is important as research has shown that health outcomes and equity go beyond individual choices and are not solely determined by access to health care or exposure to illness. Social determinants (**Figure 7**) have a greater impact on health outcomes than traditional determinants of health (i.e. genetics, access to care, diet). The University of Wisconsin Population Health Institute estimates that social determinants of health have a larger impact (40%) than either clinical care (20%) individual behavior (30%) or physical

Figure 7. Chart showing the influence of various determinants of health. Economic and social factors have the greatest influence on health outcomes.



11 "We need all areas of our City to be safe, healthy, affordable and connected. We need to ensure that our city will be resilient to climate change." (http://www.imagineduluth.com/media/541285/mayorswelcomestatement.pdf, 23 September 2017).

12 Hill *et al.* 2010.

13 Longstaff *et al.* 2010: 3.

14 Berke and Campanella 2006.

15 Folke *et al* 2010: 4.

16 Folke *et al* 2010: 5.

17 Folke *et al* 2010: 5.

18 Folke *et al* 2010: 5.

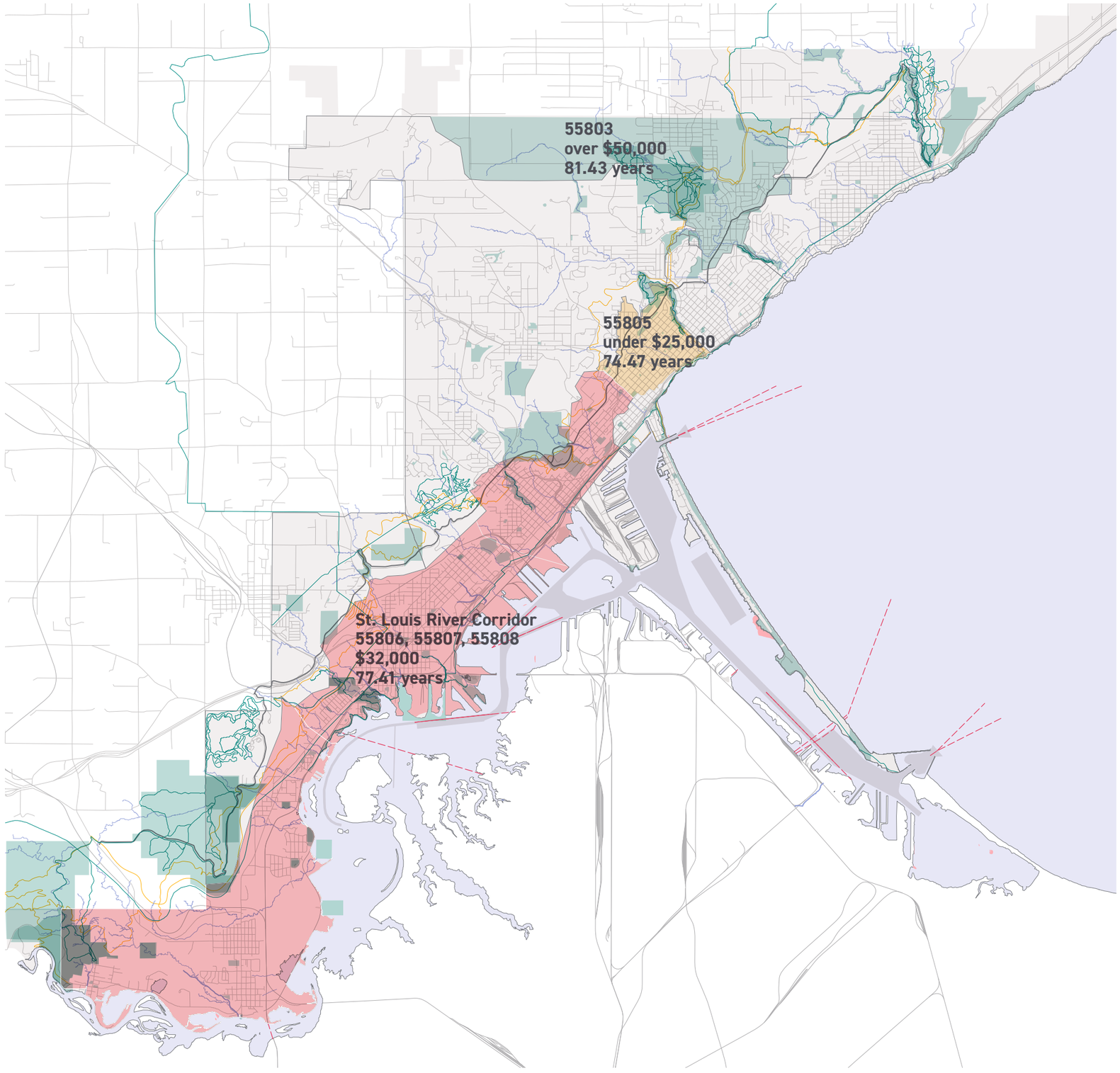


Figure 8. Health outcomes also vary radically across Duluth, but clearly correlate to household income. Residents of Duluth in Central Hillside, in Zip Code 55805, have the lowest median household income (under $25,000) *and* the lowest projected life expectancy at 74.47 years, while residents in Zip Code 55803 with the highest median household income (over $50,000) have the highest projected life expectancy at 81.43 years. In the St. Louis River Corridor, the median household income is about $32,000 and the projected life expectancy is 77.41 years.[1] Equity is a critical factor in health outcomes and quality of life.

1 St. Louis County Public Health and Human Services. 2013.

Figure 9. Median household income by education. Workers with a college degree earn substantially more than workers with only a high school degree. This wage gap is exacerbated by the massive drop in manufacturing jobs — one of the few remaining job sectors where high wages are possible without a college education.

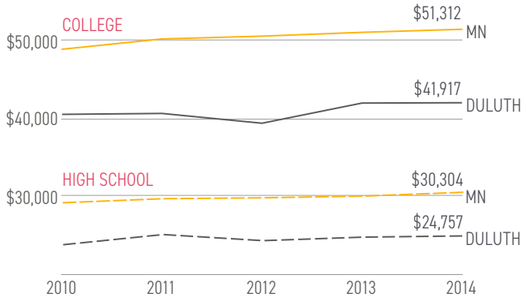
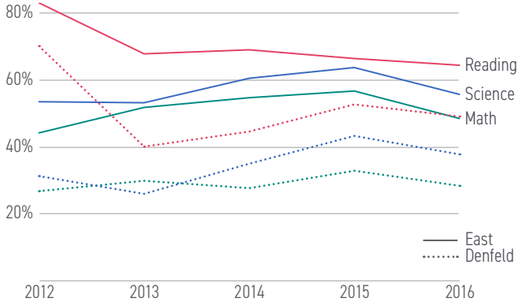


Figure 10. Standardized school test scores for East and Denfeld High Schools. Test scores for Denfeld are lower across reading, science, and mathematics.



environment (10%).[19] Socio-economic status and the distribution of resources (how money and other resources are shared within society) have been found to be the strongest predictors of health outcomes.

Low levels of educational attainment have been linked to poor health, increased stress, and lower self-confidence. A person's level of education will impact the resources available to live a longer, healthier life. People with more access to resources have a greater opportunity to control their environment and live longer and healthier lives. People who like their jobs or working environment are healthier than those who dislike their jobs or working environment. Research has also shown that chronic stress has a negative impact on an individual's health outcomes. One of the clearest examples of chronic stress is racism, as it adds an additional burden on top of the other social and economic factors making up the social determinants of health.

Educational Opportunity

For many years, the achievement of a high school diploma was a path to a comfortable middle-class life, especially on the Iron Range through employment in the mines. However, in the current economy, a high school diploma no longer ensures a middle-class standard of living (**Figure 9**). The highest wages are connected to jobs requiring a post-high school education, though some high-paying trade careers are still in demand. Education is so important that homes located near a school with high standardized test scores have significantly higher sale prices as "a large number of empirical studies economists have found that student exposure to high quality schools—measured by test scores, peer effects, and teacher quality—substantially increases the probability of economic success later in life."[20]

Educational disparities are very apparent in the St. Louis River Corridor. Historical census data shows

19 Kindig 2014.

20 Rothwell. 2012: 3. In the 100 largest metropolitan areas in the US, housing prices are 2.4 times higher when near a high-scoring public school than a low-scoring public school. The largest gap in home prices was 3.5 times between high achievement and low achievement schools (based on standardized testing), while the smallest gap was 1.3 times. For Duluth, this could add a minimum of 30% to a home valuation.

that residents in the Corridor have lower educational attainment than the city of Duluth as a whole and the state of Minnesota.[21] Public schools in the St. Louis River Corridor have significantly lower standardized test scores (**Figure 10**), fewer advanced placement college courses, and no international baccalaureate programs. Students of color at Denfeld High have significantly lower rates of participation in Science, Technology, Engineering, and Mathematics (STEM) courses than East High and the State of Minnesota. Children (especially children of color) living in the St. Louis River Corridor have less access to an education that prepares them for college and the opportunity for better social and economic outcomes in their lives. The Duluth Community School Collaborative (an outgrowth of the Meyers-Wilkins Community School Collaborative),[22] has been working to augment the in-class learning experience with an after-school program that better prepares children for college and builds educational and social connections between children, their families, and the educational community.

Adults hoping to improve their lives face similar obstacles,. The St. Louis River Corridor communities have some of the lowest car ownership rates in Duluth making access to local community colleges and the University of Minnesota-Duluth difficult and time consuming. Travel by public transit from the St. Louis River Corridor to community colleges and UM-Duluth can add over an hour of travel time each way. Community Action Duluth is also working to address issues of accessibility to education and career pathways, but the critical issue of retraining and life-long learning is a national issue that is often discussed, but never seriously addressed.

Historically it has always been difficult to find labor in Duluth. US Steel felt that they had to provide extra incentive to new workers at the Duluth Works plant, as "most employment opportunities in the region were highly seasonal…it was surmised that a dependable work force could be provided only if certain inducements were used. In the case of Morgan Park the major inducement was the provision of housing and services qualitatively better than that offered in the surrounding area."[23,24] Duluth Works was also "obliged to train men for every new operation."[25] This level of investment in workers is rare outside of the tech industry, and programs on the local, regional, state and federal levels must be strengthened to reduce the barriers for adults hoping to improve their lives. Increased access to continuing or lifelong education is critical as the new economy does not provide lifetime employment or reward fixed skill sets.

Students in the Design Duluth Studio have attempted to address the educational disparities through proposed physical interventions that include expanded educational programs and facilities that will take advantage of the unique assets in the St. Louis River Corridor, and have proposed that new educational centers be located at the Duluth Zoo and on the St. Louis River in the Riverside neighborhood (*see* **Pages 12–15** *and* **Figures 11–12** *for student design proposals related to education: Zoo School and River Education Center*). The proposals take advantage of new assets in the St. Louis River Corridor, as investments in infrastructure for the National Water Trail and expansion of trailheads for hiking and cycling can be strategically linked to educational opportunities. The addition of many different programs and constituencies to proposed recreational tourism investments can provide amenities and services to local residents and increase the value of Duluth's public investments.

21 United States Census Bureau. 2015. While 34.1% of Duluth residents have a bachelor's or advanced degree (compared to 33.7% of MN residents), only 14.7% of residents in the St. Louis River Corridor have similar levels of education.

22 The program is supported by a diverse group of member and partner organizations including the City of Duluth Parks and Recreation, Myers-Wilkins Elementary School, YWCA—Girl Power!, Duluth Family YMCA, Men as Peacemakers, Arrowhead Youth Soccer Association, East Hillside Patch, University of MN Duluth, College of St. Scholastica, True North AmeriCorps, Duluth Community Garden Program, Girl Scouts, Boy Scouts, Arrowhead Youth Soccer Association, Kako's Foundation.

23 White and Primmer 1937: 89.

24 Alanen 2007: 186.

25 "…during the war we had 3,500 men in our employ and careful analysis showed that only 366 had ever worked in any part of a steel works before or any of its appurtenances." Warren 2001: 75.

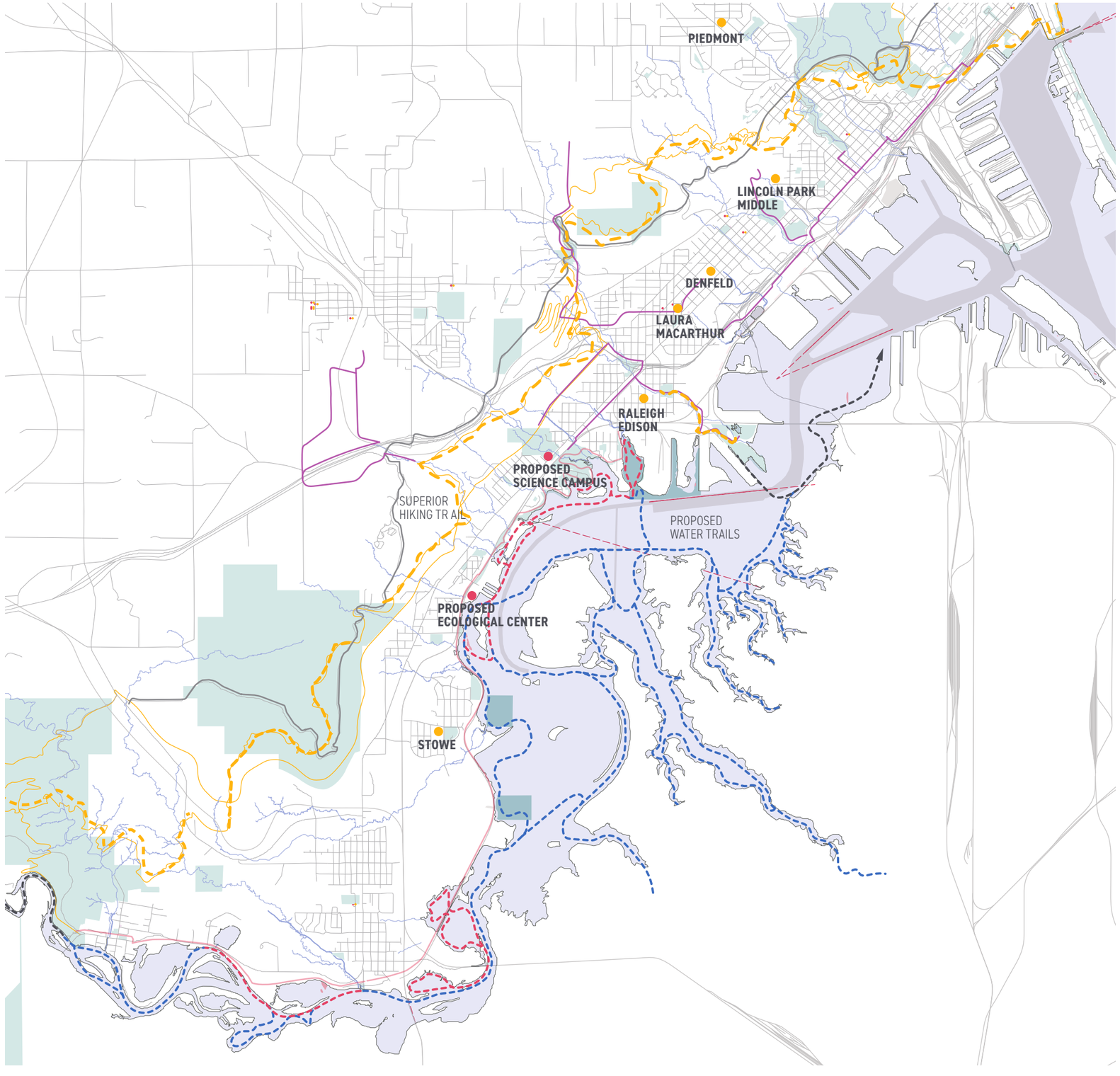


Figure 11. *Proposed Zoo Science Campus and Riverside Ecological Center.* The proposed Zoo Science Campus and Ecological Center would serve Elementary, Middle, and High Schools in the St. Louis River Corridor. The Science Campus would take advantage of the Zoo and Kingsbury Creek and connections to the Superior Hiking Trail to bring advanced science and biology courses to students, while the Ecological Center would take advantage of the St. Louis River, Clough Island, and the proposed National Water Trail to allow students to enroll in advanced science and biology field courses. These educational facilities would be located at trailheads or water access points.

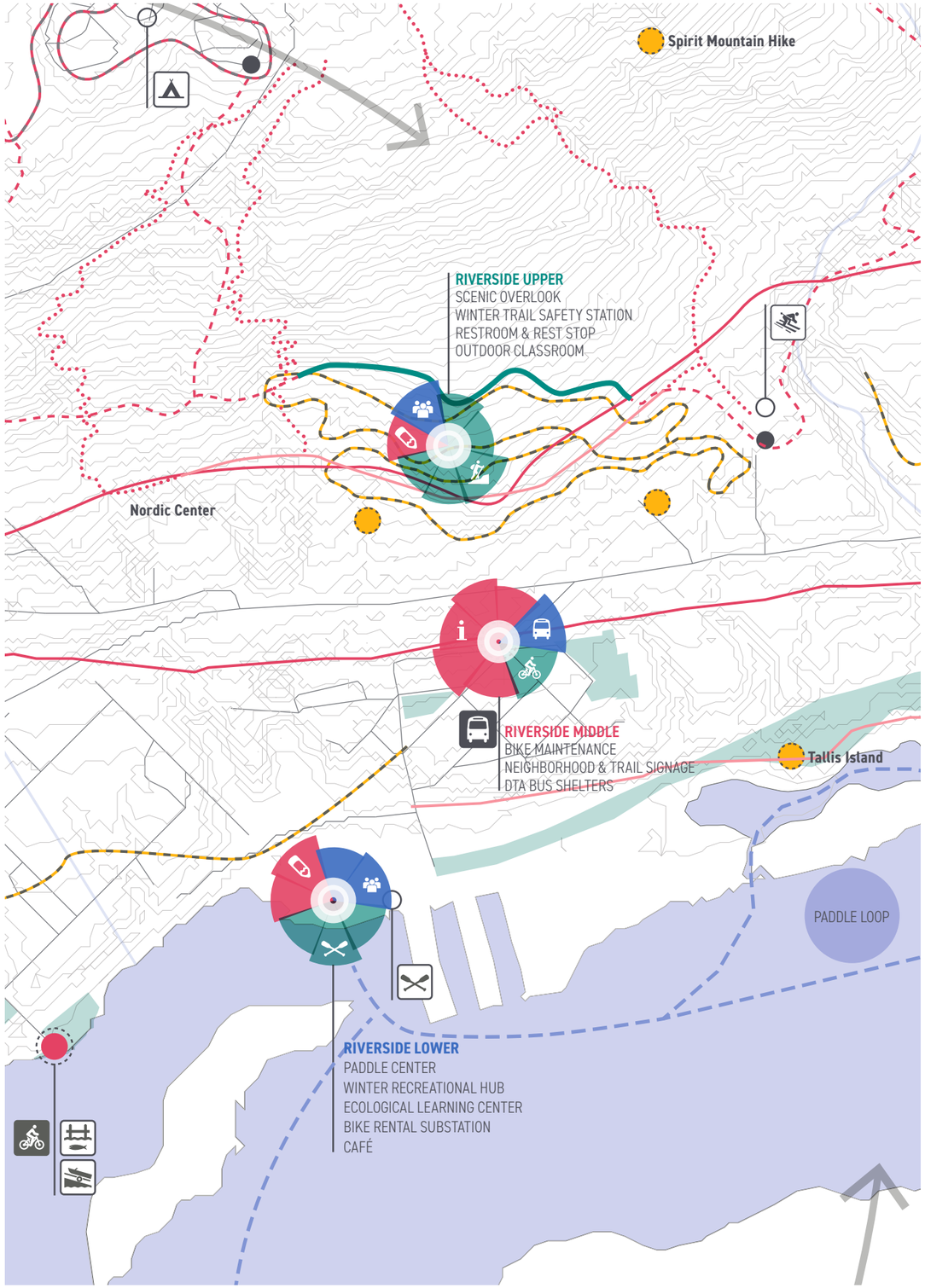


Figure 12. *Proposed Riverside Ecological Center*. The proposed Center would have three distinct program areas with a Scenic Overlook, Outdoor Classroom, and Trail Center at RIVERSIDE UPPER.

At RIVERSIDE MIDDLE, a bus shelter would allow increased access by students to UPPER and LOWER learning areas.

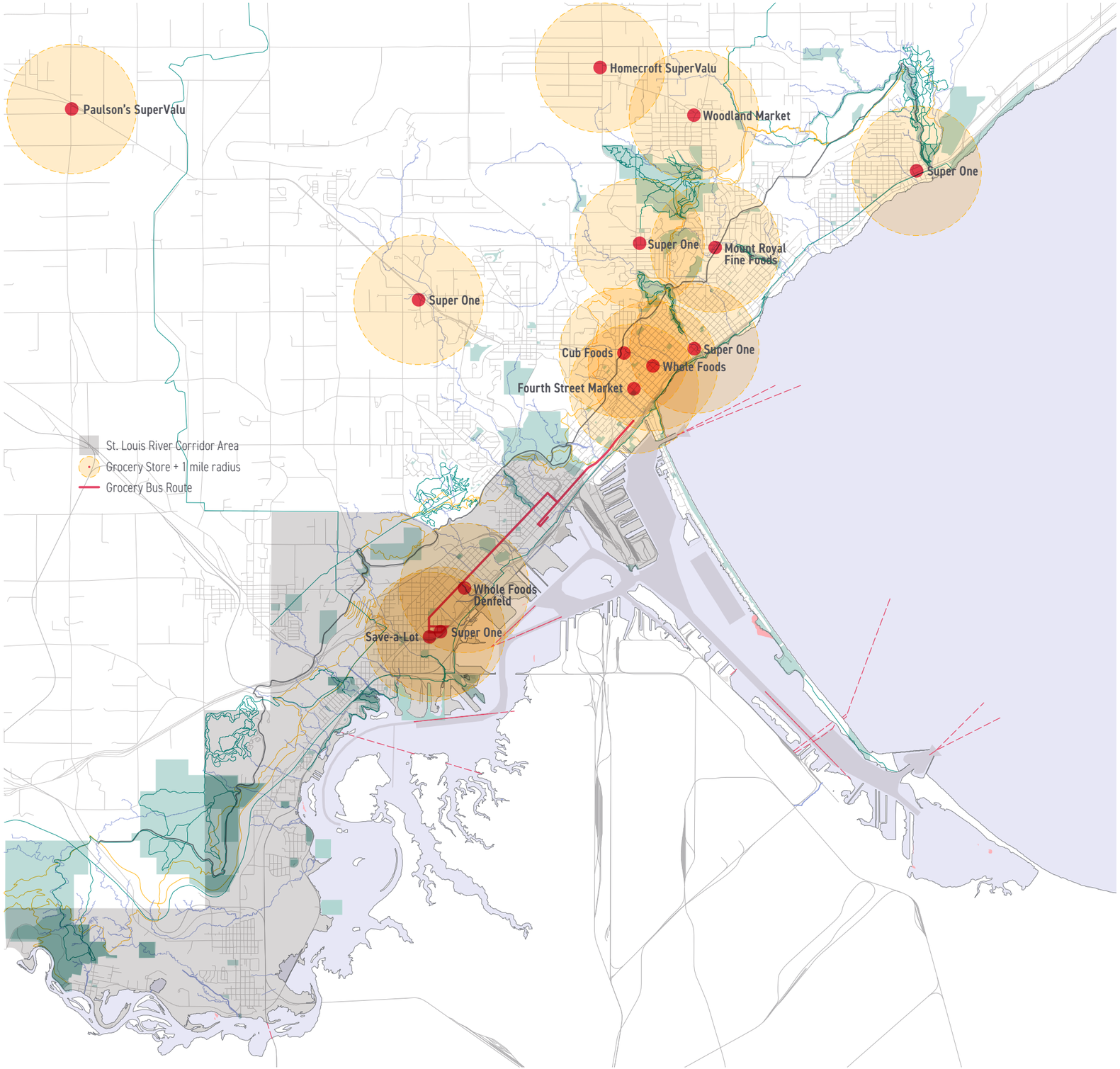
A Paddle Center, Ecological Learning Center, Café, and Bike Rental Station are proposed for RIVERSIDE LOWER. The Paddle Center would be part of the proposed National Water Trail.

FOOD AND RESILIENCY

This section addresses two issues related to resiliency and food: access to food and food safety/local food. The first is directly related to issues of equity as households with limited incomes are more likely to be located in areas defined as food deserts and more likely to deal with food insecurity. The latter, food safety, is an issue of infrastructural resiliency and sustaining local economies. The US food system is an example of specific resiliency as it is designed to reduce extreme price fluctuations and to provide food that is free of contamination and disease. The system is dependent on the movement of food across large distances and can collapse when delivery and storage systems are disrupted. Food systems also export large amounts of money out of communities as most food distribution systems are national or global is scale and the majority of the money flowing into the food system benefits corporations outside the community.

A 2011 University of Minnesota Extension study classifies much of the St. Louis River Corridor as a **food desert** (**Figure 13**). The USDA defines food deserts as low-income neighborhoods that have relatively poor access to healthy and affordable food. These neighborhoods may have other shopping venues like convenience stores and liquor stores, but residents lack access to a reasonably-priced well-stocked grocery store. Researchers from University of Minnesota have found that residents in food deserts are remarkably resourceful and "engage in complex and difficult strategies in order to survive: they shop at grocery stores both close and far away from their neighborhood and utilize a wide-variety of government programs to increase their food access."[26]

Access to healthy food options in the St. Louis River Corridor is a consequence of the consolidation and increase in size and services offered (i.e. banking, coffee shops, etc.) by traditional supermarket retailers. These supermarkets are typically 46,000 square feet,[27] while non-traditional retailers like ALDI and Traders Joe's have store sizes of 20,000 square feet. These retailers are also hesitant to locate new stores in urban communities, leading to "a food system in which cars are necessary for accessing healthy food because it is not available within walking distance from people's



26 Pine and Bennett. 2014a: 9.

27 Food Marketing Institute 2015.

homes."[28] Convenience stores, often located in or near food desert neighborhoods, are increasingly important sources of daily food for these residents.

Access to typical sources of food (grocery stores or farmers markets) is limited as 12.6% of Corridor residents do not own a vehicle and over half of households (52.5%) only own one vehicle. People frequenting alternate systems, like the CHUM food bank had even more difficulty accessing food with 42% walking, 32% using the city bus, and 20% finding a ride or borrowing a car; only 15% of people frequenting the food bank had their own car and 34% reported that it was difficult or very difficult to bring food orders home. In Duluth, which has a hilly landscape and long snowy winters, shopping for food without a car is even more difficult. Despite the opening of a Whole Foods Coop on Grand Avenue and the implementation by Duluth Transit Authority (DTA) of Line S1, the grocery bus, residents face difficulties accessing healthy and affordable food options.

Residents living in food deserts face potentially serious health concerns, such as higher rates of obesity and increased risk of cardiovascular disease. Residents also typically pay higher prices at neighborhood convenience stores and spend more time and money traveling to grocery stores outside their neighborhoods. While access to local food options is important, recent studies have found the link between poverty and educational attainment to be a much stronger predictor of poor nutrition. Policy initiatives that focus on increasing access to affordable, healthy food may not entirely solve the problem. New models of nutritional disparity attribute differences in consumption to variations in demand (food consumption habits) and a lack of knowledge regarding food choices rather than access to supply.

Food Access and Security

The United States Department of Agriculture (USDA) defines food scarcity, the inability to "acquire acceptable [nutritionally adequate and safe] foods in socially acceptable ways is limited or uncertain."[29] An estimated 12.7% of American households were food insecure at least some time during the year in 2015. In Duluth, the figure is substantially higher with 20% of households experiencing food insecurity.[30] Food insecurity rates are even higher for African-American, Latinx, non-traditional (single-parent or single person) households and households near of below the poverty threshold. A high percentage of food-insecure households (about 60%) participate in one or more of largest Federal food and nutrition assistance programs (i.e. **Supplemental Nutrition Assistance Program** (SNAP), **National School Lunch Program** (NSLP), and **Special Supplemental Nutrition Program for Women, Infants, and Children** (WIC).[31]

There are many local organizations addressing the food access issue, including CHUM, Community Action Duluth's Lincoln Park Fair Food Access Campaign and Seeds of Success Program, the Duluth Community Garden Program, and Zeitgeist.[32,33] There is excellent cooperation, at least in Lincoln Park, among groups addressing food access as Healthy Duluth Area Coalition, CHUM, Duluth LISC, the Duluth Community Garden Program, and Community Action Duluth are partners in the Lincoln Park Fair Food Access Campaign, and all organizations have additional programs dealing with food access in Lincoln Park.[34] Seeds of Success, in an effort to increase the availability of alternative food options throughout the year, is working with Zeitgeist and the Junior League of Duluth to develop a **deep winter greenhouse** near Denfeld High. The greenhouse, currently under construction, includes a classroom and root cellar, and will allow the production of food through winter. The greenhouse will "help with

28 Pine and Bennett. 2014a: 9.
29 Coleman-Jensen *et al* 2016.
30 Guidinger 2016.
31 Coleman-Jensen *et al* 2016.
32 National Association for State Community Services Programs. 2012. Seeds of Success creates jobs and provides fresh food options in the community by turning vacant lots into gardens growing fresh produce. Seeds of Success teaches participants sustainable farming methods that eliminate the use of chemicals and fertilizers and also provides work for community members who are unemployed or underemployed.
33 CHUM, a coalition of 40 faith communities, operates Duluth's largest food shelf, providing affordable food (and many other critical services for homeless or underserved populations) for over 7,000 people annually (http://www.chumduluth.org, 23 September 2017).
34 Significant funding is also provided by Blue Cross Blue Shield of Minnesota.

employment, the amount of produce grown and to extend the timeline of farmers markets."[35]

Solutions to food access must move *beyond mere recognition of food deserts*. The coordinated efforts in Lincoln Park could become a model for increasing access to healthy food choices in the St. Louis River Corridor. Coupled with education programs designed to modify consumption and eating habits, residents[36] in the St. Louis River Corridor could have substantially improved health outcomes. A recent book by food scholar Bee Wilson examines changes in the post-World War II Japanese diet. Since the 1950s, "the consumption of grains in Japan fell by almost half, replaced by eggs, meat, fresh fruit and vegetables, and, most of all, fish. New influences were incorporated into Japanese cuisine…[and] by the 1970s, the country's food culture had been utterly transformed. Today, Japan…has one of the lowest rates of obesity in the world."[37] Japan is an example of how radical dietary changes can take place on a national scale in a short period of time. Students in the Design Duluth Studio have attempted to address the food access and security issues by proposing facilities that focus on both food access and community education. Small- and large-scale agricultural production, food storage, commercial kitchens, classrooms, and traditional food purchasing sources, like supermarkets, have been proposed for Lincoln Park and Riverside (*See* **Pages 20–25** and **Figures 14–21** *for student design proposals related to food access and security in Lincoln Park and The Can of Worms*).

Lincoln Park Eats is a student proposal for creating local access to food and health resources, capitalizing on the existing assets and infrastructure of the neighborhood. Located on multiple sites in Lincoln Park, the project strategically utilizes tax forfeit properties and existing buildings to reduce investment costs and project development time lines to bring new food and community resources to the neighborhood.

Conceived as a three-part grouping of community spaces, Lincoln Park Eats provides multiple food resources to a neighborhood that is classified as a USDA food desert. The greenhouse adjacent to Walbank's Park will have winter garden beds, an apple orchard, a greenhouse with a root cellar in the lower floor and a cider bar and lounge on the upper floor. A cornerstore at 3rd Street and 28th Avenue revives the historical neighborhood food resource, while adding a tool library, community gardens, and café. The final piece of the ensemble, a grocery store, community meeting hall, and commercial kitchen located at Superior Avenue and 23rd Street provides Lincoln park with a much needed retail food source.

The Food Processing and Grow Center at the intersection of Interstate 35 and Highway 53 takes as its starting point the reconstruction of the "Can of Worms" interchange, proposing a food hub with a greenhouse, food processing and storage center, commercial kitchen, urban agriculture education center, and winter market. The programs within the building are tightly connected. Crops are produced throughout the year in the greenhouse on the top floor. The crops are then moved to the ground floor to be washed, dried, and stored or processed. Finally, these products are sold in the open market on the middle floor. Each partof food production process creates an opportunity for the local community to participate. Products from local farmers can be stored, processed, and sold at the Grow Center, while local business can use the commercial kitchen and sell their products at the open market.

The site recycles highway bridges and on-ramps from the "Can of Worms" highway interchange, with a new urban agriculture plant walk, orchards, public gathering space, and water treatment gardens on and below the recycled bridges.

35 Johnson, Brooks 2017.
36 Guidiger 2016. In a recent survey of CHUM users, 64% of respondents wished to learn more about food preparation.
37 Wilson 2014.

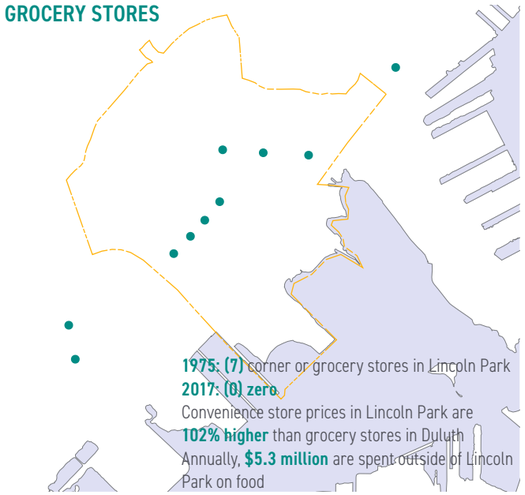


Figure 14. GROCERY STORES. Locations of grocery stores in Lincoln Park in 1975. There are currently no grocery stores in Lincoln Park. The closest store in the Whole Foods Coop in Denfeld. A 2011 University of MInnesota Extension study classifies most of the St. Louis River Corridor as a **food desert**, following the USDA definition of a food desert as *a low-income census tract where a substantial number or share of residents has limited access to a supermarket or large grocery store.*

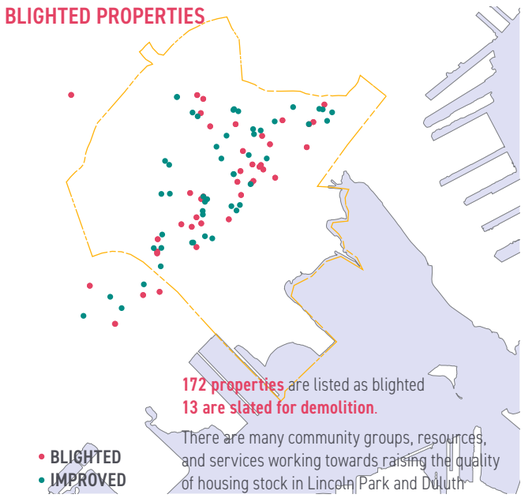


Figure 15. BLIGHTED PROPERTIES. Locations of tax-forfeit and blighted properties in Lincoln Park. In the **Lincoln Park Eats** project, these assets are used to provide more food, community, and social resources to Lincoln Park.

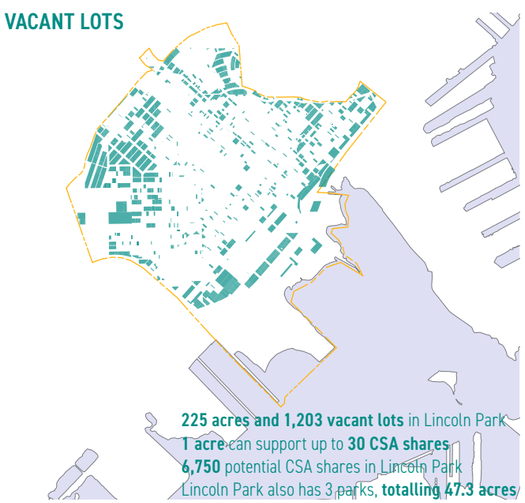


Figure 16. VACANT LOTS. Locations of vacant lots in Lincoln Park. The lots are proposed as potential sites for urban farming in Lincoln Park. As shown by the *Seeds of Success* program, an urban CSA can provide food and jobs to low-income residents.

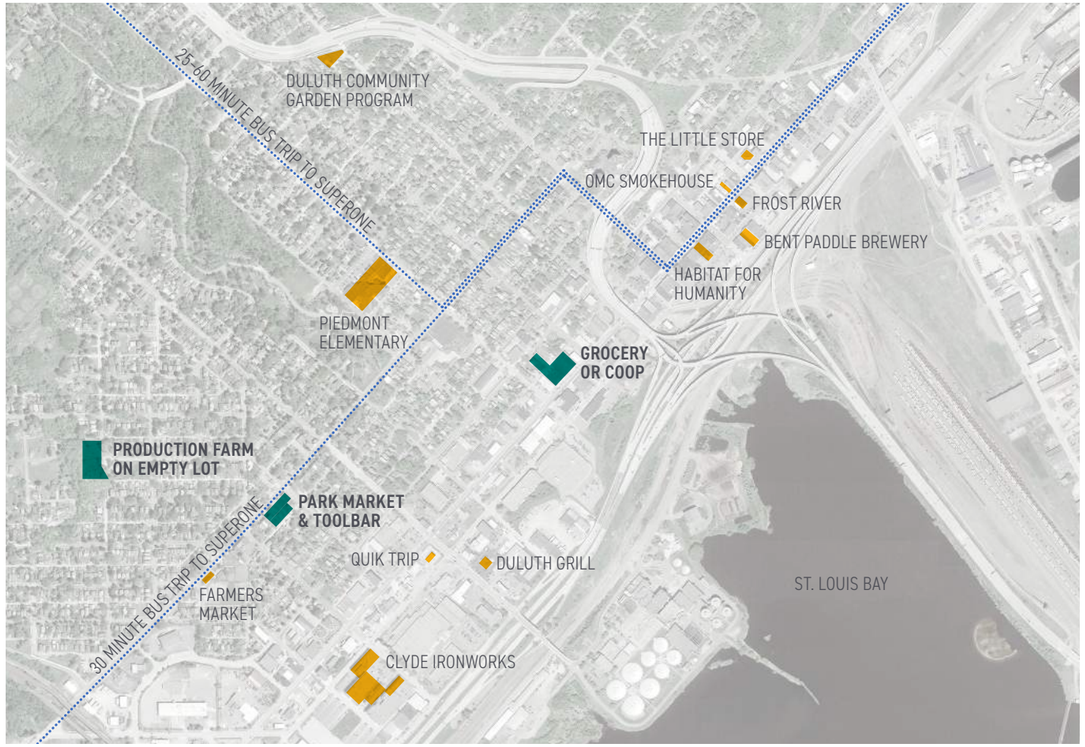


Figure 17. Map showing proposed locations of Greenhouse, Tool Bar and Tool Bank, and Lincoln Park Foods grocery store.

LINCOLN PARK EATS

The project is made up of three programs and locations in Lincoln Park. The orchard/greenhouse/root cellar is located on Wicklow Street north of Walbank's Park. The orchard/greenhouse/root cellar provides an place for residents to grow, store, and enjoy food in the winter. A unique corner store/tool bar located on the corner of 3rd Street and 28th Avenue provides an active place for community socializing and making, while the tool loan bank gives the community resources to renovate homes and businesses. The centerpiece of the project, Lincoln Park Foods located on Superior Street and 23rd Avenue, is a small, innovative grocery store in Lincoln Park, providing a critical retail food resource, commercial kitchen for local startups, and community gathering space along the burgeoning West Duluth retail corridor.

LINCOLN PARK FOODS

Figure 18. Lincoln Park Foods is a fresh take on the neighborhood grocery store. Located in the heart of of the Lincoln Park Commercial Corridor on the corner of Superior Street and 23rd Avenue, the grocery store is easily accessable from the Interstate 35, and adjacent to local bus lines and trails. Lincoln Park Foods will provide a grocery shopping experience focused on fresh and healthy eating. The ground floor of the existing commercial building is converted into a grocery store and a commercial kitchen for community cooking classes and enterpreneurial use, while the second floor will have a community gathering space.

PARK MARKET + TOOL BAR

Figure 19. The Park Market and Tool Bar is proposed for the corner of 3rd Street and 28th Avenue. The Market is located on the former site of a corner store, and returns the site to neighborhood-scale retail. An existing commercial building will be renovated to host the Tool Bar, a place for eating and drinking. In the open lot next to the Tool Bar are the community garden plots, an outdoor workspace, a bocce-ball court, and cafe seating. A tool bank at the rear of the property will provide residents with the resources to improving homes and businesses in the Lincoln Park Neighborhood.

LINCOLN PARK GROWS

Figure 20. Lincoln Park Grows, a proposed community apple orchard, garden, and greenhouse is located to the north of Walbank's Park at the end of Wicklow Street. Lincoln Park Grows will have winter garden beds, an apple orchard, and a greenhouse with a root cellar in the lower floor and a cider bar and lounge on the upper floor. Nestled into the dramatic topography, the building affords residents the opportunity to grow their own food, experience the beautiful views of the Duluth Harbor, and warm up during a cold winter's day.

Figure 21. CAN OF WORMS FOOD CENTER at Interstate 35 and Highway 53. View from repurposed overpass looking to orchard and community agriculture space.

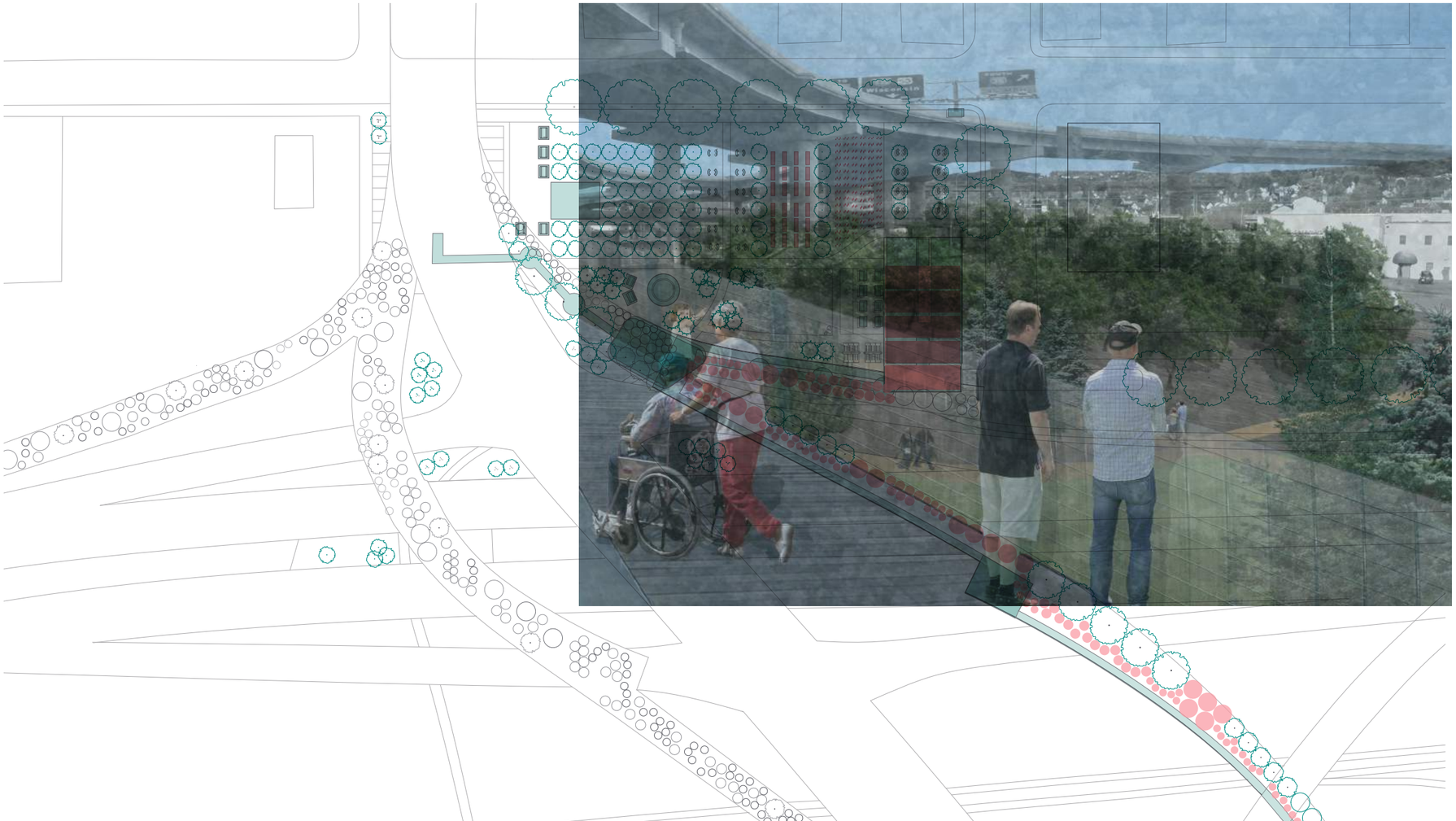
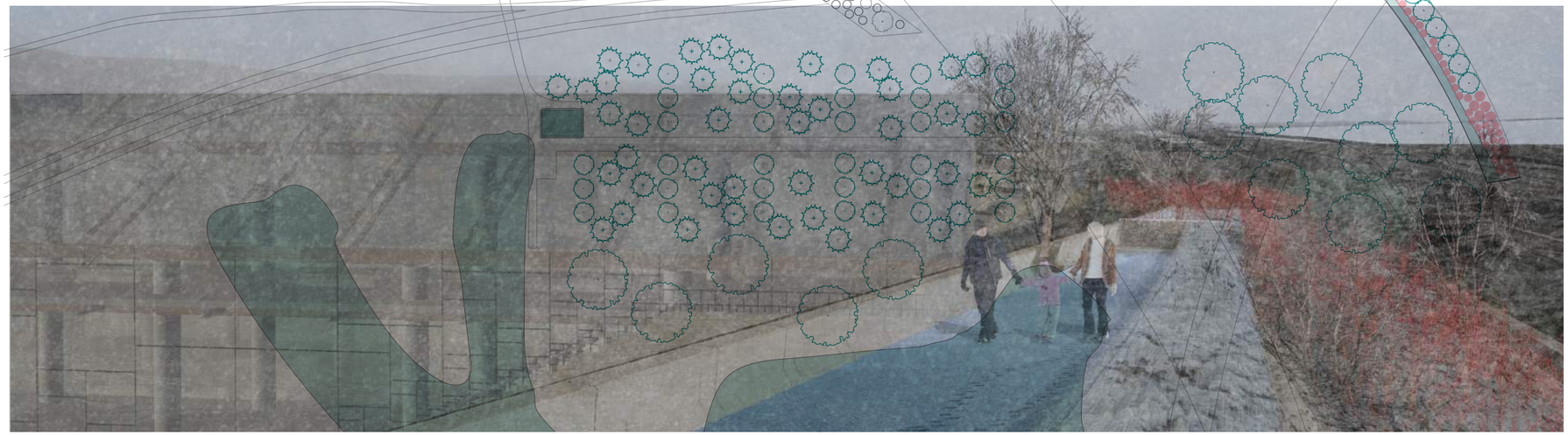


Figure 22. CAN OF WORMS FOOD CENTER at Interstate 35 and Highway 53. View from repurposed overpass looking toward Food Hub building.



Local Food and Food Safety

Food safety and food waste are issues directly related to the food production and distribution system. Food (along with Agriculture) is one of 16 critical infrastructure sectors defined by the Department of Homeland Security (DHS).[38] The modern food production chain, the system by which food is produced, processed, distributed, marketed, and consumed, has redesigned food itself, both in terms of the selective breeding that favors cold tolerance over taste and the fundamental transition from food as daily nourishment to food as global commodity.[39] More than 70% of the food consumed in the United States today is processed, packaged, shipped, stored, and sold under artificial refrigeration.

The food system's dependencies on large-scale processing, transportation, and storage, and centralized center of distribution make the system extremely fragile. Disruptions to any part of the system can cause large-scale health problems. The Centers for Disease Control (CDC), "estimates that each year roughly 1 in 6 Americans (or 48 million people) get sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases." Large population centers also only have from 3 to 5 days of food because of dependencies on distribution and the requirements of cold storage for a majority of foods.[40]

Then there is the issue of food waste. Produce is lost in fields, warehouses, packaging, distribution, supermarkets, restaurants and refrigerators (**Figure 22**). A recent UK Government study found that $160bn is wasted by retailers and consumers every year, while on the production side, scarred vegetables are regularly abandoned in fields to save labor costs or left to rot in a warehouse because of minor blemishes that do not affect freshness or quality.[41] In developed nations, about 50% of all food produced is wasted. There is also a growing awareness that hunger *and* climate change cannot be solved without reducing food waste. Food waste accounts for about 8% of global climate pollution, not counting the waste of water, soil, pesticides, fertilizers and fossil fuels. **Discarded food** is the biggest single component of landfill and incinerators and a large source of methane. Students in the Design Duluth Studio have attempted to address the local food production and food safety issues in the same project by proposing large urban agriculture facilities that focus on small-scale and large-scale production, processing, and storage. These projects hope to provide local jobs and local food sources that are healthier and safer than what is currently available in the industrialized food system (*See* **Pages 28–33** and **Figures 23–28** *for student design proposals related to local food and food safety in Irving*).

Large-scale Urban agriculture

Irving Fresh and **Irving Grow** are proposals for large-scale industrial agriculture in the Irving neighborhood. Both projects utilize vacant, former-industrial land to provide local food, food security, jobs, and community amenities for residents of the St. Louis River Corridor. Both Irving Fresh is an adaptive project that can grow over a 25-year period, occupying industrial sites as they become disused. Irving Grow is a more traditional large-scale investment project that provides jobs and community amenities along with local food.

38 See the *National Infrastructure Protection Plan* (https://www.dhs.gov/food-and-agriculture-sector, 23 September 2017) and the *Food and Agriculture Sector-Specific Plan* (https://www.dhs.gov/sites/default/files/publications/nipp-ssp-food-ag-2015-508.pdf, 23 September 2017).

39 In U.S. homes, the size of the average domestic refrigerator has also increased by 20% since 1975. "So many people these days have these massive refrigerators, and there is this sense that we need to keep them well stocked...[b]ut there's no way you can eat all that food before it goes bad." A study of families carried out by UCLA confirmed a tendency to stockpile food in not just one *but in multiple refrigerators*. "[F]or most Americans...home refrigerators simply 'serve as cleaner, colder trash bins.'" Twilley 2012.

40 America's Fragile Food Supply Chain

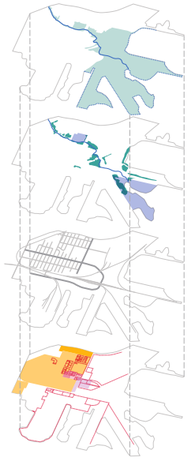
41 Goldberg 2016. "I have delivered products to supermarkets that was [sic] absolutely gorgeous and because their sales were slow, the last two days they didn't take my product and they sent it back to me," said the owner of a mid-size east coast trucking company. "They will dig through 50 cases to find one bad head of lettuce and say: 'I am not taking your lettuce when that lettuce would pass a USDA inspection.' But as the farmer told you, there is nothing you can do, because if you use the PACA [Perishable Agricultural Commodities Act of 1930] on them, they are never going to buy from you again. Are you going to jeopardize $5m in sales over an $8,000 load?" He said he experienced such rejections, known in the industry as kickbacks, "a couple of times a month," which he considered on the low side for the industry. But he said he was usually able to sell the produce to another buyer.

Figure 22. You are what you eat, Mark Menjivar. Mark Menjivar photographed refrigerators for his series "You Are What You Eat" in 2007. Menjivar spent almost four years on the project, traveling to 20 communities throughout the United States and peeking in the refrigerators of 60 people in an effort to explore the intersection between eating habits and identity.

Left. Street Advertiser, San Antonio, TX
1-Person Household
Lives on $432 fixed monthly income

Right. Midwife/Middle School Science Teacher, San Antonio, TX
3-Person Household (including dog)
First week after deciding to eat all local produce

SITE CONDITIONS



FLOODING
Properties in the 500-year flood plain have low value and are less likely to be well maintained

GREENSPACE
Recreational areas along the creek could be better connected from irving park to grassy point

INFRASTRUCTURE
To maintain residential irving's character development should take place along connector streets

ZONING
Zoning policy and property ownership determine which sites are viable to use and improve in future phases

STAKEHOLDERS

Key stakeholders are the residents and land owners in Irving

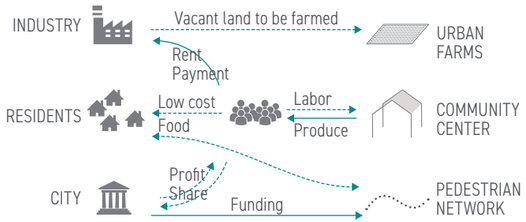
[Residents] [City of Duluth] [IndustrIAl] MN Light and Power Verso, Hallet, XIK [Schools + Library]

PROGRAM

Growspace in Irving supports the community center and food hub for the area
A pedestrian network links the Growspace to existing trails and parks.

[Urban Growspace] [Community Center] [Pedestrian Network]

ORGANIZATION



FOOD PRODUCTION

Use Growing season and scale to develop a planting strategy

9,375sf

3,125sf	sweet peas	900lb
3,125sf	carrots	1,500lb
3,125sf	sweet corn	800lb

18,600sf

6,200sf	tomatoes	8,300lb
6,200sf	peppers	1,550lb
6,200sf	cauliflower	2,480lb

125,000sf

25,000sf	beans	12,500lb
37,500sf	potatoes	12,500lb
37,500sf	sweet corn	9,600lb
25,000sf	cucumber	6,250lb

IRVING FRESH & IRVING GROW

Large-scale Urban agriculture

Irving Fresh and Irving Grow are proposals for large-scale industrial agriculture in the Irving neighborhood. Both projects utilize vacant, former-industrial to provide food, jobs and community amenities for residents of the St. Louis River Corridor. Irving Fresh proposes a system of food growing spaces along Keene Creek, within the Irving neighborhood and the nearby industrial area. A community center, food processing hub, and seasonal food market is located across Keene Creek from Irving Park. The growing spaces is connected by trails along Keene Creek.

Irving Grow proposes a large-scale production greenhouse and food processing center on Waseca Industrial Road. Irving Grow also proposes that public gardens be located in the farm fields and a community center be established in the greenhouse building. The project hopes to re-connect the Irving neighborhood to the manufacturing businesses on Waseca Industrial Road.

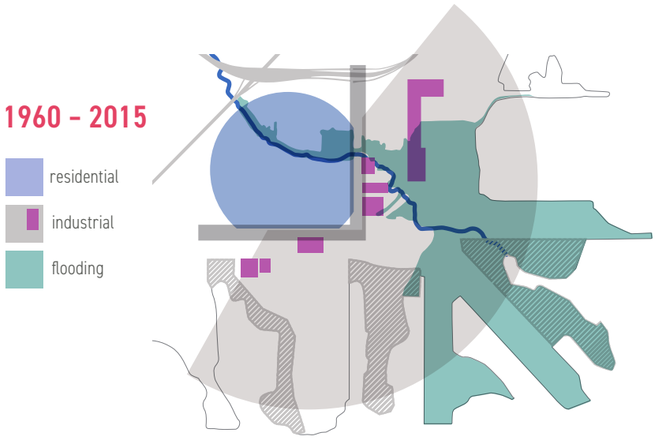
Figure 23 (left). IRVING FRESH. Existing and proposed future conditions in the Irving neighborhood. Existing land-uses and areas susceptible to flooding are shown at top, while the two lower diagrams show proposed urban farming areas to be implemented over a 25-year period. The Growspace areas connect to a proposed trail and openspace network that will allow residents to travel from the Grand Avenue business core to the St. Louis River.

Figure 24 (right). IRVING FRESH. Diagrams showing strategies for stakeholder engagement, project financing, and potential crop yields.

PRESENT

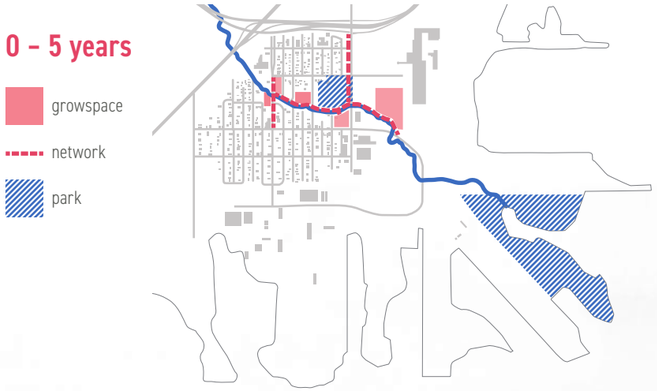
changing industrial and commercial economies have resulted in a **hard edge** between both residential and industrial landscapes and stakeholders

sites are evaluated for
ease of access
community connection
land availability



FUTURE(S)

as more sites are converted,
a **pedestrian network**
connects the system.



the system can grow to include
idle industrial sites
secured with **long-term lease agreements**

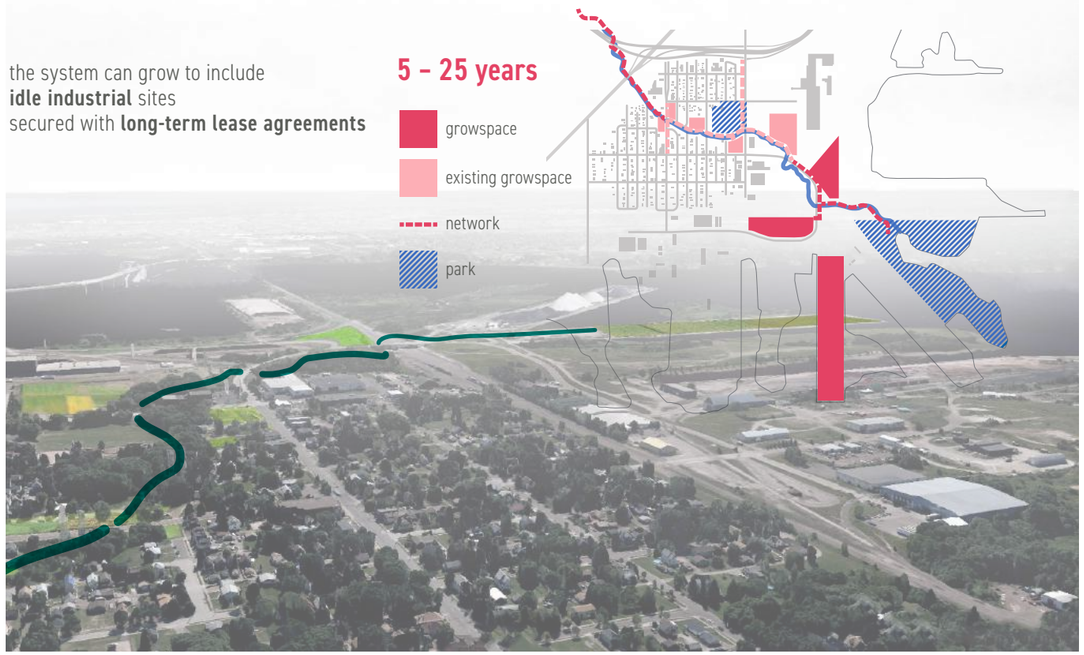


Figure 25 (above). IRVING GROW. View of the Irving Grow greenhouse building in winter.

Figure 26 (right). IRVING GROW. View of the Irving Grow project, with orchard, large-scale agriculture fields, public gardens, and greenhouse building.

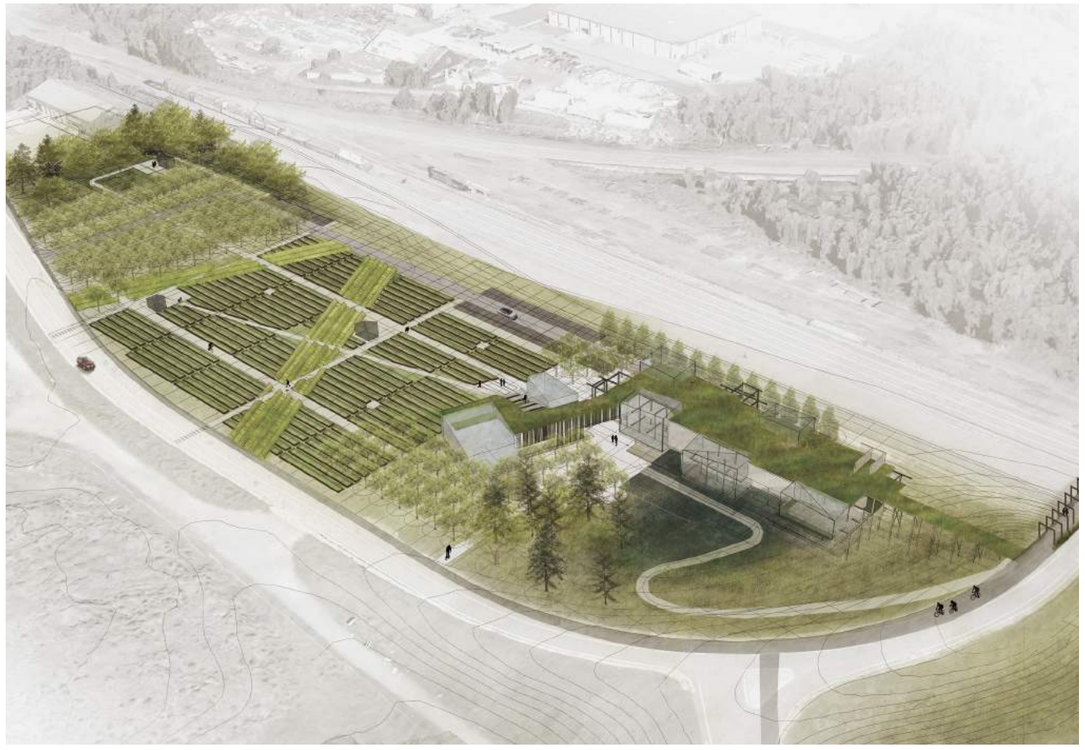


Figure 27. IRVING GROW. View of agriculture fields and public garden pavilions.

Figure 28. IRVING GROW. View of orchards and public gardens within the orchards.

Energy Security

Energy production and consumption are embedded in a number of discrete infrastructures. The use of energy in the movement of goods of people and the heating, cooling, and lighting of structures are the contribute to the majority of all carbon emissions in the US. Energy use is also directly connected to water, as about 4% of all energy used in the US is directed toward the treatment of drinking and waste water.[42] In Duluth this is the equivalent of the energy consumed by 170 homes over the course of a year. Energy use is also determined by the physical form of the city. Duluth is an expansive city, over 27 miles long and 2 miles wide, with an historical peak population of over 106,000. The city has 450 miles of road[43] that must be repaired and maintained. The climate, with a temperature range of 120°F and heavy snows and frequent icing, makes it difficult to maintain the roads and the topography and lack of density makes bicycle accessibility challenging and public transit inefficient from the standpoint of both cost and frequency. Because energy use is such an expansive subject, this section will focus on residential energy use.

Duluth's unique location and climate contribute to the beauty of the city and also creates difficulties for many of its residents. Energy costs are critical to the future of Duluth because of the age of the housing stock,[44] the large percentage of elderly residents, high poverty rates, and low median household incomes (for residents above the poverty threshold).[45] Even minor increases to cost of electricity or natural gas can have a significant effect on the economic security of households.[46] Energy costs and energy efficiency are addressed on many levels as Federal, State, and Local Governments and non-profits have developed programs to assist with household energy costs and the costs for implementing home energy efficiency upgrades.

The Federal Low-Income Home Energy Assistance Program (LIHEAP) distributes block grants to states to develop programs that help low income households pay their home energy costs or home energy efficiency upgrades. Funded by a LIHEAP Block Grant,[47] Minnesota's Energy Assistance Program (EAP) provides help with the payment of energy bills, help with service interruptions, and funding for residential weatherization and energy-related home repairs to households with an income at or below 50% of the state median. The Department of Energy (DOE) also funds the Weatherization Assistance Program that provides free home energy upgrades to low-income homeowners and renters (income limits are based on Federal poverty schedules, but are similar to the income thresholds set by EAP). The City of Duluth also has an Energy Loan program that provides low interest loans for energy improvements (4.9% over 10 years).[48]

Ecolibrium3 is a major non-profit advocating for alternate energy generation, the development of programs to assist in the installation of alternate energy systems, and in the integration and coordination of the various energy efficiency programs in Duluth. Ecolibrium3 has engaged in the Imagine Duluth 2035 processes to incorporate an energy generation overlay in the city's land-use planning and worked with the University of Minnesota to develop a Duluth-specific version of the Minnesota Solar Suitability Analysis. The web-based tool analyzes the solar energy potential for any building within the City of Duluth, delivering a full report of potential solar energy generation and installation costs. Ecolibrium3 has also been working with the DOE's SunShot Initiative to develop residential, community, and commercial solar projects by focusing on reduction of non-hardware costs through community policy and streamlining of the permitting and interconnection process.[49,50]

The non-profit Solar Commons, with UM-Duluth faculty member Kathryn Milun on the Board of Directors, develops demonstration projects with community partners to support clean energy and social equity for low-income communities. Solar Commons is working with the Vermont Law School Energy Clinic to prototype and refine the legal structure of low-income community solar trusts so that non-profits and solar installers can provide a local income source to fund energy assistance programs, homeless shelters, community gardens, and other needs. Modeled on historic agricultural commons of England, the Solar Commons would be owned as community trusts and managed by non-profits for the benefit of low-income neighborhoods. Students from Design Duluth have developed projects using the Solar Commons right-of-way approach, proposing that Interstate 35 become a "common" energy-corridor that generates energy to benefit energy assistance and energy efficiency programs in Duluth, while the Slip 7 takes a more conventional approach in proposing a solar park on the legacy industrial site (*See* **Pages 36–41** and **Figures 29–36** *for student design proposals related to energy*).

The **Solar Commons at Slip 7** proposes an alternative to the traditional bulk storage and shipping planned for Slip 7 in Irving. The project proposed a unique program that combines a recreational hub and connection to the Duluth trail networks with the production of solar energy. The project goals are to make a unique and vibrant recreational space along the St. Louis River, connect an existing gap in the Duluth trail networks, provide river access, and provide economic benefits through solar energy production for the community of Irving. The project provides a solar potential of 10,600 mWh/year and could provide power for 1,000 households.

Powering Duluth is a student proposal to re-pave Interstate 35 with piezoelectric tile below an asphalt surface. An asphalt road has visco-elastoplastic qualities which make it flexible. Compression from vehicles passing over the asphalt causes it to deflect vertically, releasing mechanical energy. Piezoelectric tiles captures the energy and converts it into electricity which is sent back to the power grid. The cost to install 6 miles of piezoelectric tiles on Interstate 35 would cost $4,389,000 with $2,565,000 of the cost offset by available alternative energy grants.

The energy would be sold to Minnesota Power through a Feed In Tariff program at 8.734 cents per kWh. At current FET rates, the installation would generate $1,900,000 in revenue for the city of Duluth each year. The proposal uses this fund to pay for further installation of piezoelectric tiles along Lake Avenue, Superior Street, and more locations on Interstate 35. Other monies would fund a home energy efficiency program, making $2,500 grants to low- or fixed-income households. This program would reduce the energy burden on many households in Duluth and reduce Duluth's carbon footprint.

42 Average person consumes 26,928–44,880 gallons of treated water per year. The same amount is assumed to be sent to the WLSSD as black- or graywater. The Department of Energy estimates that 700 to 1800 kWh are used treat 1 million gallons of water.
86,000 persons * 30,000 gallons = 2.58 billion gallons of treated water per year consumed in Duluth
2.58 billion gallons ÷ 1000 kWh /1 million gallons = 2,580,000 kWh
Average home consumes 10,812 kWh/year
2,580,000 kWh ÷ 10,812 kWh/home/year = 170 homes for one year

43 http://duluthmn.gov/media/WebSubscriptions/31/20170808-31-4711.pdf. By comparison, Rochester has a population of 114,011 and approximately 467 miles of streets.

44 Community Planning Division. 2015a. 65% of dwellings in Duluth were built before 1960.

45 Department of Energy. 2017: 1. Low-income households carry a larger burden for energy costs, typically spending 16.3% of their total annual income versus 3.5% for other households. Duluth has a poverty rate of 21.5% and 14.6% of residents are 65 or older.

46 The average residential electricity rate in Duluth is 9.18¢/kWh, about 22% below the national average rate of 11.88¢/kWh. In 2016, Minnesota Power, the electricity provider for Duluth, requested an 8% rate increase to cover costs for alternative energy investments (in 2016 31% of energy generated was from renewable sources and is projected to increase to 44% by 2025) and the decommissioning a coal-fired power plant and a 10% rate increase to shift energy costs from taconite mines and paper mills to residential customers (this shift is mandated by State Legislation, 216B.1696 Competitive rate for energy-intensive, trade-exposed electric utility customer). See Meyers 2016.

47 Title XXVI of the Omnibus Budget Reconciliation Act of 1981, Public Law 97–35.

48 The maximum loan amount is $15,000 for an owner-occupied house or $5,000 per rental unit for non-owner occupied or multi-unit properties (http://www.comfortsystemsduluth.com/conservation/home-energy-loans/, 23 September 2017).

49 http://www.ecolibrium3.org/wp-content/uploads/2015/12/Solar-Market-Landscape-Report.pdf: 3

50 Installation costs in Duluth are between $3.00 and $6.62 per watt and $2.87 and $3.85 per watt nationwide (http://umd-cla-gis04.d.umn.edu/duluthshines/ and http://news.energysage.com/how-much-does-the-average-solar-panel-installation-cost-in-the-u-s/, 23 September 2017).

Figure 29. SOLAR COMMONS AT SLIP 7. Illustrated plan of Slip 7 Solar Commons showing Buffer Forest and BMX track, Marina, Community Center, and Solar Education Classrooms, Solar Array Field and Recreation Area, Wetland Zone, and Estuary Beach.

The solar array would provide power for 1,000 households in the Irving neighborhood.

Figure 30. SOLAR COMMONS AT SLIP 7. Exploded axonometric showing site water collection, site circulation, site green space, and site recreational programming.

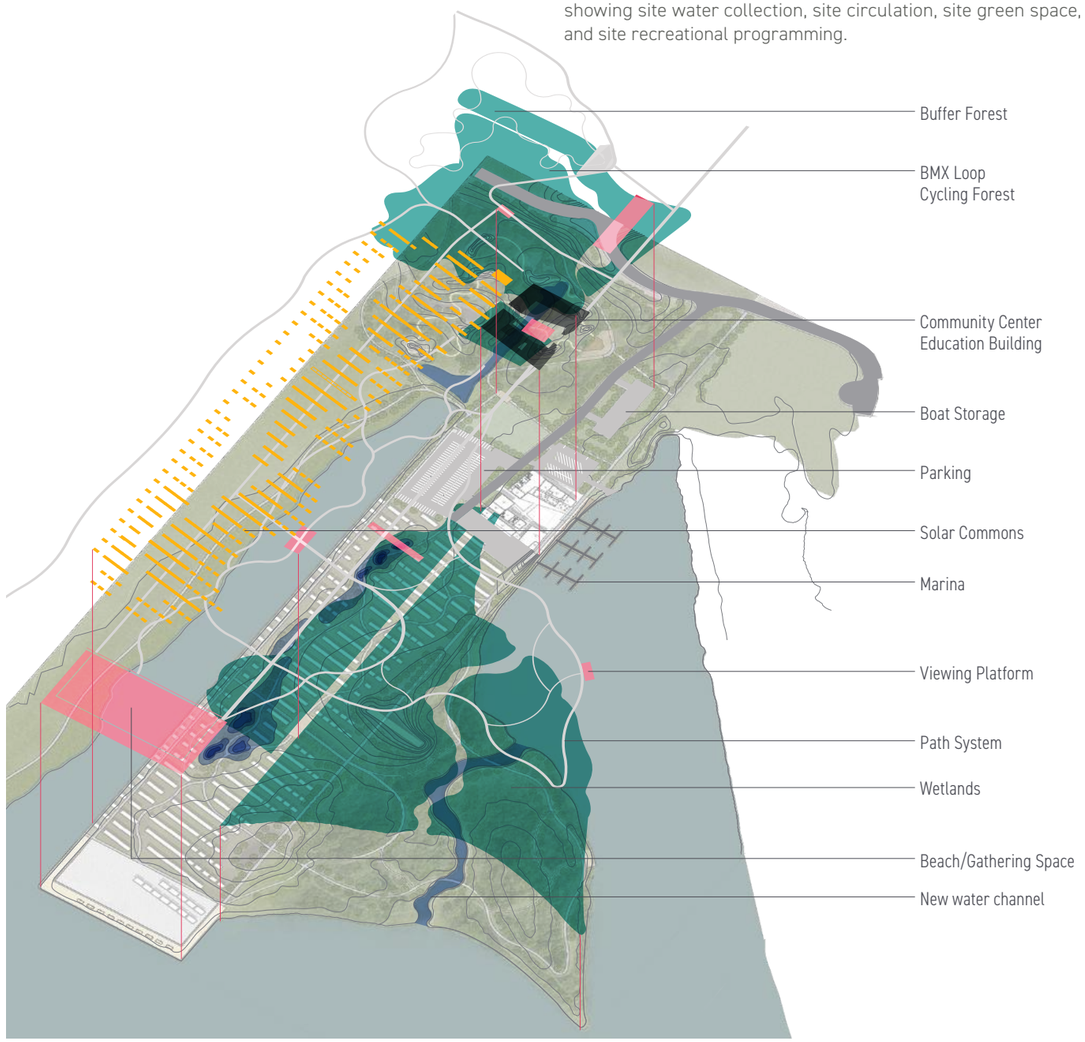


Figure 31 (above). SOLAR COMMONS at SLIP 7. Viewpoint platform overlooking solar array and recreation area.

Figure 32 (top right). SOLAR COMMONS at SLIP 7. View of solar array trail in winter.

Figure 33 (bottom right). SOLAR COMMONS at SLIP 7. View of wetland boardwalk solar trail.

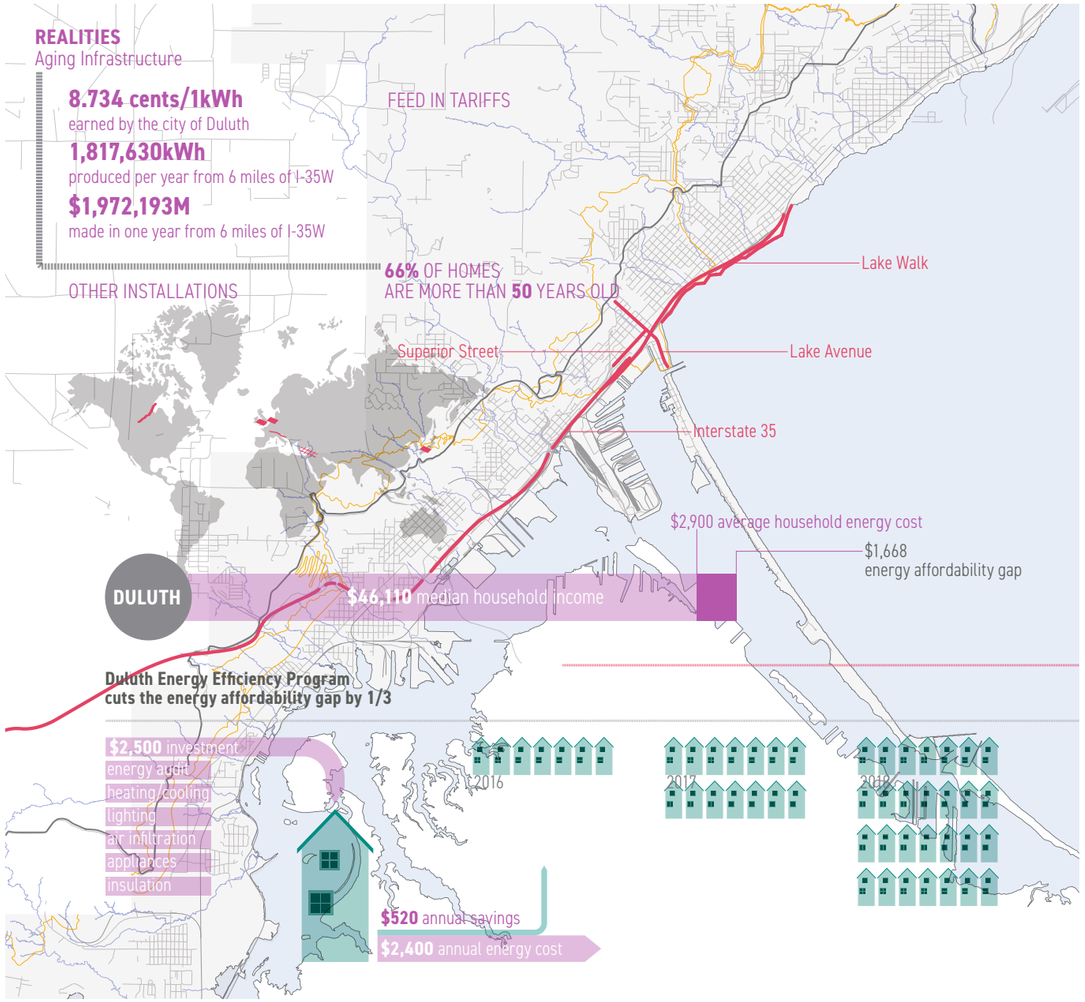


Figure 34 (left). POWERING DULUTH. Power generation and cost analysis and location diagram of Powering Duluth project.

Figure 35 (right). POWERING DULUTH. Installation cost analysis and section diagram of piezoelectric paving system.

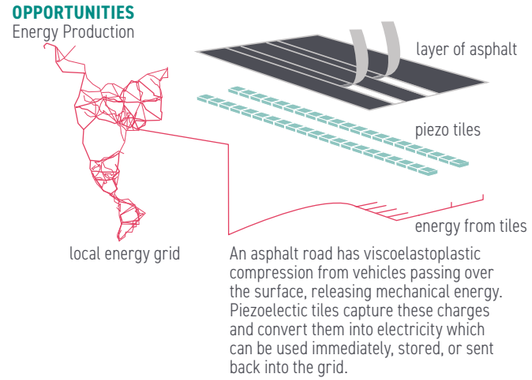
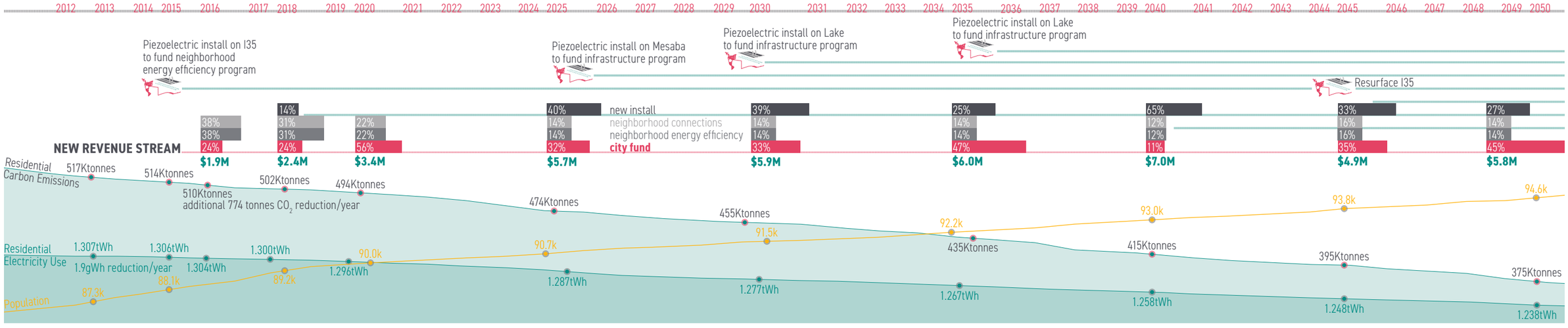
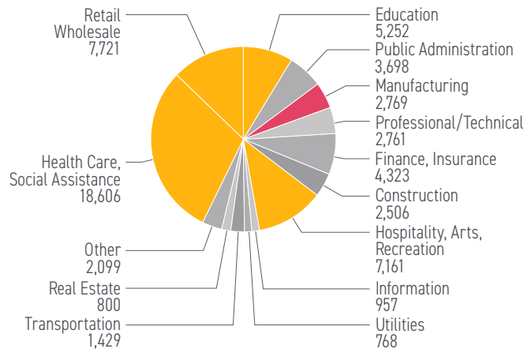


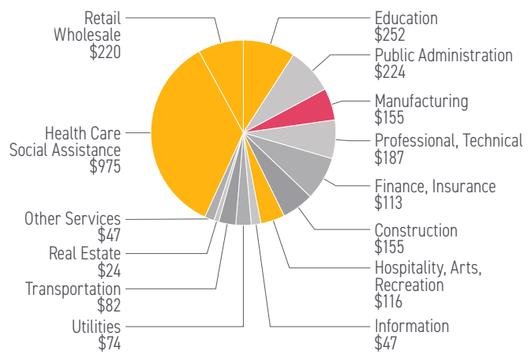
Figure 36 (below). POWERING DULUTH. Timeline of proposed projects, energy generation and revenue stream, and potential energy and carbon emissions reduction connected to Power Duluth project.



Figures 37. Student proposal for an innovative manufacturing district in Lincoln Park centered on Aerostitch, Frost River, Bent Paddle Brewery.

Figures 38 and 39. Charts showing numbers of jobs per industry sector and payroll dollars per industry sector (in millions of dollars).





NEW ECONOMIES IN THE NEW DULUTH

Duluth's unemployment rate dropped below 3% in 2016 before rising slightly to the current rate of 3.3% in 2017. The population has stabilized at 86,000 with a demographic that is somewhat younger, more outdoor oriented, and less affluent than the rest of the state. This conscious shift (as policy, physical intervention, and marketing bravado) away from the legacy of, and dependencies on large-scale manufacturing has redefined Duluth and attracted an admiring audience of recreation-oriented young professionals. The interest of young professionals is critical to the future of Duluth as "[t]he region has lower labor force participation rates than the state in every age group except teenagers, and the gaps are especially notable for people in the oldest age groups.…As the population ages, the labor force will continue to decline."[51]

The city's new economy is now driven by recreational tourism, healthcare corporations, institutions of higher education, technically advanced manufacturers (Cirrus Aviation and AAR), and small-scale manufacturing (LOLL Furniture, Bent Paddle Brewing, Frost River, and Aerostitch). Arts and entertainment offerings, as well as year-round recreation and the natural environment, have contributed to expansion of the tourist industry. Tourism is now a major component of Duluth's economy, bringing 3.5 million visitors to the city each year with an estimated economic impact of $780 million.[52] The healthcare services, education, and hospitality/tourism industries provide over 50% of all payroll and jobs in Duluth (**Figures 38 and 39**). Geographically, the concentration of jobs has shifted away from the St. Louis River Estuary towards the concentration of hospitals at the northern edge of Downtown Duluth, Canal Park, and the area surrounding the University of Minnesota Duluth and St. Scholastica campuses (**Figure 40**). The newly instituted half-percent tax on hotel stays and a half-percent tax on food and beverages to fund recreation-based investments in the St. Louis River Corridor along with a bonding bill to improve Spirit Mountain is another mechanism to "grow" jobs in the historical industrial area. The city's acknowledgment of the river as a major asset places the focus back on the Corridor as another potential recreational and economic center.

51 Johnson, Brooks. 2016.
52 Ruff 2014.

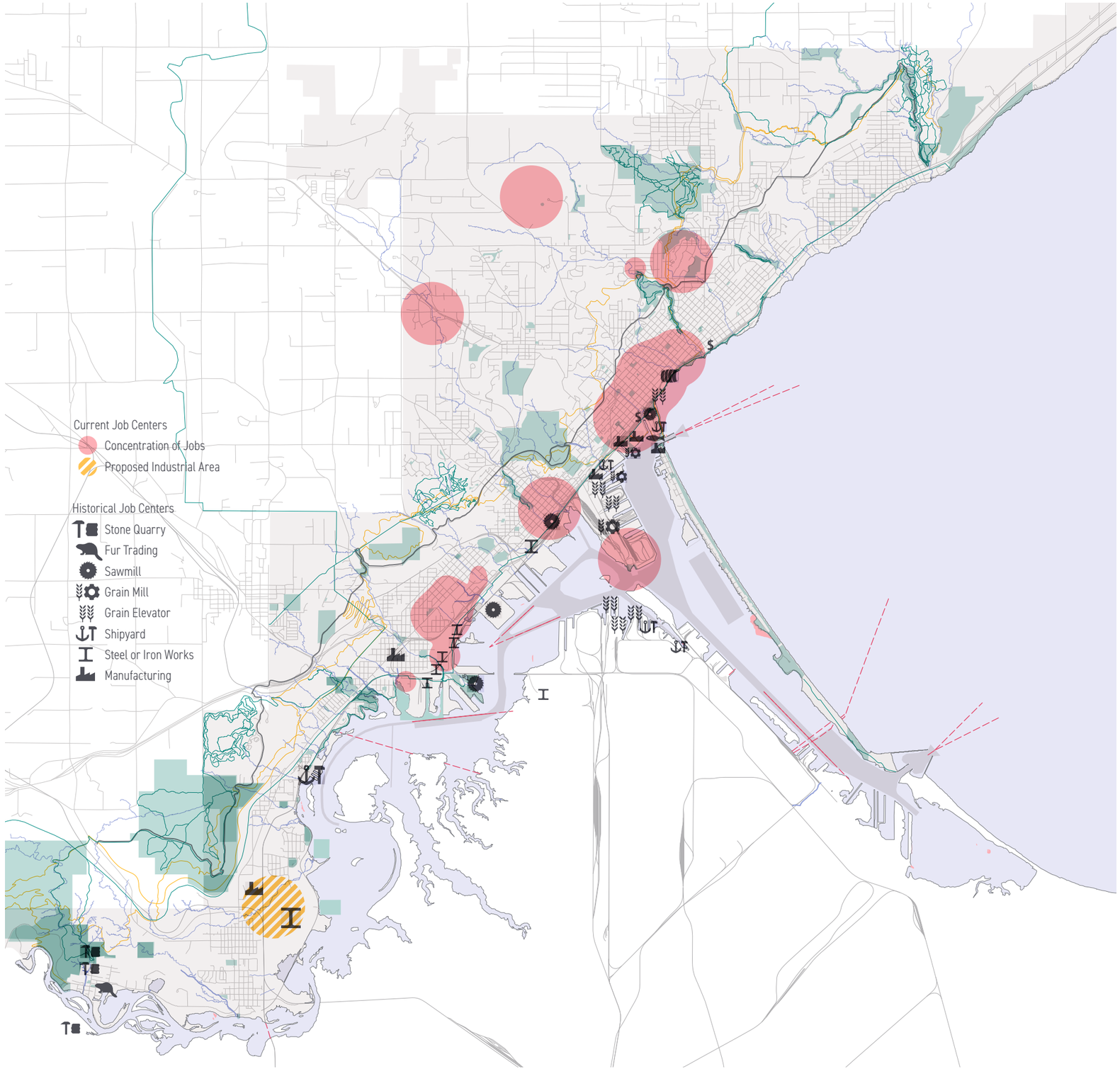


Figure 40. Map showing location of historical industries and businesses and current job centers in Duluth. New businesses and industries centered around healthcare, higher education, small-scale manufacturing, and tourism have replaced large-scale manufacturing in the St. Louis River Estuary as the main economic force in Duluth.

Note the craft-oriented jobs located in Lincoln Park and new job center between Gary/New Duluth and Morgan Park at the former US Steel/Atlas Cement sites.

Recreation and the River

The St. Louis River is the largest river in the Lake Superior watershed. The St. Louis River flows 179 miles from north of Two Harbors and through the Mesabi Range before entering the Lake Superior between the twin ports of Duluth and Superior.[53] Where lake and river meet, 12,000 acres of **freshwater estuary** create unique habitat for fish, birds, and other wildlife. One of the largest freshwater estuaries in the world, the St. Louis River Estuary is an ecological and biological hub.[54] The diversity of habitats around the estuary — including upland boreal, hardwood, and pine forests, estuarine wetlands, shallow open water, and baymouth bars — is unique. Over 45 native species of warm water fish live in the 2,000 acres of remaining wetlands and the rivers tributaries. As the largest wetland complex in Lake Superior, the Estuary is also a key stopover for birds on the Mississippi Flyway migratory route. The Estuary has been designated as an Important Bird Area (IBA) by the Audubon Society, as the diversity of habitats and location of the site attracts over 238 bird species.

The St. Louis River Estuary is also a regional economic driver. Home to the nation's busiest freshwater harbor, the Twin Ports of Duluth and Superior supports 11,510 direct and indirect jobs and generates over 1.5$ billion dollars in annual revenue.[55] Historically, the estuary have been dominated by industrial and manufacturing processes, including lumber mills, paper mills, iron and ore transportation, and the US Steel Duluth Works. After the many decades of operation, this industrial legacy has dramatically affected the Estuary's ecological health and resilience. In addition to the legacy contamination, more than half of the Estuary has been physically altered since 1861, with nearly 3,000 acres of wetlands filled and 4,000 acres of dredging and navigation alterations. In 1989, the St. Louis River Estuary was formally designated as one of 43 **Areas of Concern** (AOCs) by the Environmental Protection Agency (EPA) under the Great Lakes Water Quality Agreement. The GLWQA, signed in 1972, is a non-regulatory agreement between the US and Canada that requires both governments to reduce discharge of conventional pollutants, and demonstrates a common commitment to reverse the decline and deterioration of the Great Lakes ecosystem. The GLWQA indicates both country's commitment "to restore and maintain the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem."[56] Since being designated an AOC by the EPA in 1989, sites along the estuary have been remediated in conjunction with city-wide efforts to reduce pollution in the St. Louis River (**Figure 41**).

Designation as an AOC indicates the severity of the ecological impacts and requires local stakeholders and regulatory agencies to address the specific problems (**Beneficial Use Impairments** or BUIs) of the AOC. The ultimate goal is remediate all nine listed BUIs, and the delisting of the St. Louis River Estuary as an AOC.[57] Addressing the widespread nature of these BUIs requires working with a diverse coalition of stakeholders, communities, and regulatory agencies. Actions to date include the reduction of pollutants entering the river through sewage overflows, household and industrial uses, storm water infrastructure upgrades, creek restoration projects, wetland restoration, and the removal of legacy contamination (**Table 2, Figures 42 and 43**). The process of delisting the Estuary as an AOC is ongoing, and the river has already seen great improvement in water quality and ecological viability.

Organizations such as the St. Louis River Alliance (SLRA) and local residents have played a large role in galvanizing local support and increasing the cultural importance of the river for residents of west Duluth. The clean-up of the St. Louis River AOC will bring economic benefits to the city of Duluth, by directly increasing riverside property values by remediating legacy contamination and making residential, business, and recreation investment possible.

The clean-up of the St. Louis River has brought a new recreation-based focus to the St. Louis River Corridor.

53 The Nature Conservancy. https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/minnesota/placesweprotect/st-louis-river-estuary.xml

54 "St, Louis River Estuary: Radio Tower Bay and Wild Rice Restoration." Minnesota Land Trust.

55 Martin Lancaster 2011.

56 Minnesota Pollution Control Agency and Wisconsin Department of Natural Resources. 2015: 3.

57 Minnesota Pollution Control Agency 2013.

Table 2: BUI Removal Timeline

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Degradation of Aesthetics	BUI 8_The Stage I RAP described the aesthetic values of the St. Louis River AOC as impaired at some locations. A systematic collection of data was recommended to determine locations that are degraded.Removed 2014.	✖											
Fish Tumors and Deformities	BUI 3_Observations at the time of AOC listing suggested that fish tumors and deformities were an impaired use in the St. Louis River estuary. However, no studies of the incidence rates of tumors in fish were available at the time.				●								
Excessive Loading of Sediment and Nutrients	BUI 6_Prior to the improvements in wastewater treatment in the late 1970s, water quality investigations characterized the St. Louis River estuary as low in dissolved oxygen and high in total phosphorus and total suspended solids.				●								
Degraded Fish and Wildlife Populations	BUI 2_The potential impacts on fish population health from toxic substances in the AOC are unknown. At the time of AOC listing, loss of physical habitat and invasive species contributed to declining fish and wildlife populations.					●							
Beach Closings and Body Contact Restrictions	BUI 7_Microbial contamination from sewage bypasses into the AOC in both MN and WI occurred during storm events. Because of the sewage bypasses in both MN and WI, body contact recreation was deemed a BUI.							●					
Degradation of Benthos	BUI 4_At the time of AOC listing, reduced benthic macroinvertebrate density and species richness were reported in areas subjected to habitat alteration, physical disturbance, or in close proximity to known contamination.									●			
Restrictions on Dredging	BUI 5_At the time of AOC listing, restrictions on dredging was a use that was clearly identified as impaired in the St. Louis River AOC. Sediments in many parts of the AOC exceeded guidelines developed by regulatory agencies.										●		
Fish Consumption Advisories	BUI 1_Fish samples taken from the St. Louis River exceeded standards established by MN and WI for the unrestricted consumption of sport fish. Consumption advisories are issued based on fish species and size classes.											●	
Loss of Fish and Wildlife Habitat	BUI 9_Habitat was threatened by water quality impairment and physical habitat loss. Impairments included contaminated sediments, inadequately treated waste, degraded benthic communities, and high sedimentation rates.											●	

The proposal to complete the Western Waterfront Trail, new investments in the Spirit Mountain ski area, including a new lodge, snowmaking facilities, and Nordic ski center, the ongoing work to complete the Duluth Traverse mountain bike trail, and the city's application for **National Water Trail** designation on the lower St. Louis River shows the wealth of recreational opportunities in the Corridor. While many of these projects are still in progress or in the planning stage, most do not explicitly address climate change adaptation or resiliency. There is an historic opportunity to engage in both large- and small-scale planning that engages with recreational development, economic development, climate resilience, and habitat conservation or restoration. Proposed projects can leverage recreational tourism to bring added benefits for residents in the way of commercial and social services, flood protection, and economic opportunity.

Students have proposed expanding conservation easements to tax forfeit lands to preserve open space, allow the expansion of trails, and to provide space to infiltrate rain and runoff, while another team has proposed combining soft (storm water) infrastructure with trails to reduce runoff from extreme rain events. These types of projects provide infrastructural benefits at substantially lower costs than hard infrastructure while also allowing for recreational uses (*See* **Pages 56–59** and **Figures 47–52** *for student design proposals related to recreation*).

The **Merritt Creek Project** proposes resilient stream ecology practices and flood prevention measures along Merritt creek, while also provide urban recreation opportunities within the city of Duluth. The proposed water management strategies work in conjunction with a trail system that links existing trail networks to the river, providing residents with access to a mountain bike terrain park, multi-use hiking trails, winter warming hut, and cross country skiing.

The **Keene Creek–Irving Project** proposes a new trail along Keene Creek, connecting Grand Avenue and the St. Louis River. The trail, which runs alongside the Creek, is constructed to relieve flooding while providing other programming, including a community center, urban farming plots, and indoor and outdoor classrooms.

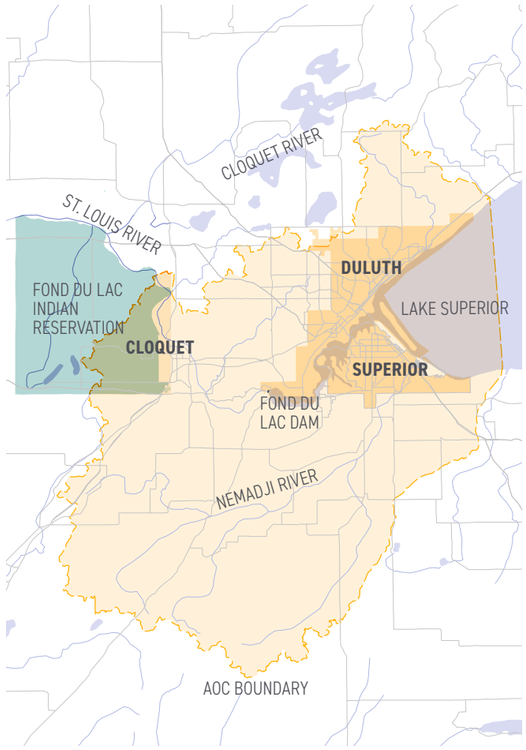


Figure 41. Map showing area of AOC. The AOC boundary includes the lower 39 miles of the St. Louis River, from upstream of Cloquet to its mouth at the Duluth/Superior Harbor, and that portion of the watershed; the Nemadji River watershed; and the western portion of Lake Superior defined on its eastern edge by a line drawn from the eastern HUC 12 Dutchman Creek watershed boundary in Wisconsin where it intersects the Lake Superior shoreline north to where the eastern HUC 12 Talmadge Creek watershed boundary in Minnesota intersects with the Lake Superior shoreline north to the intersection of the Cloquet River HUC 8.

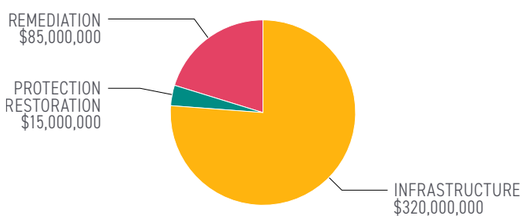
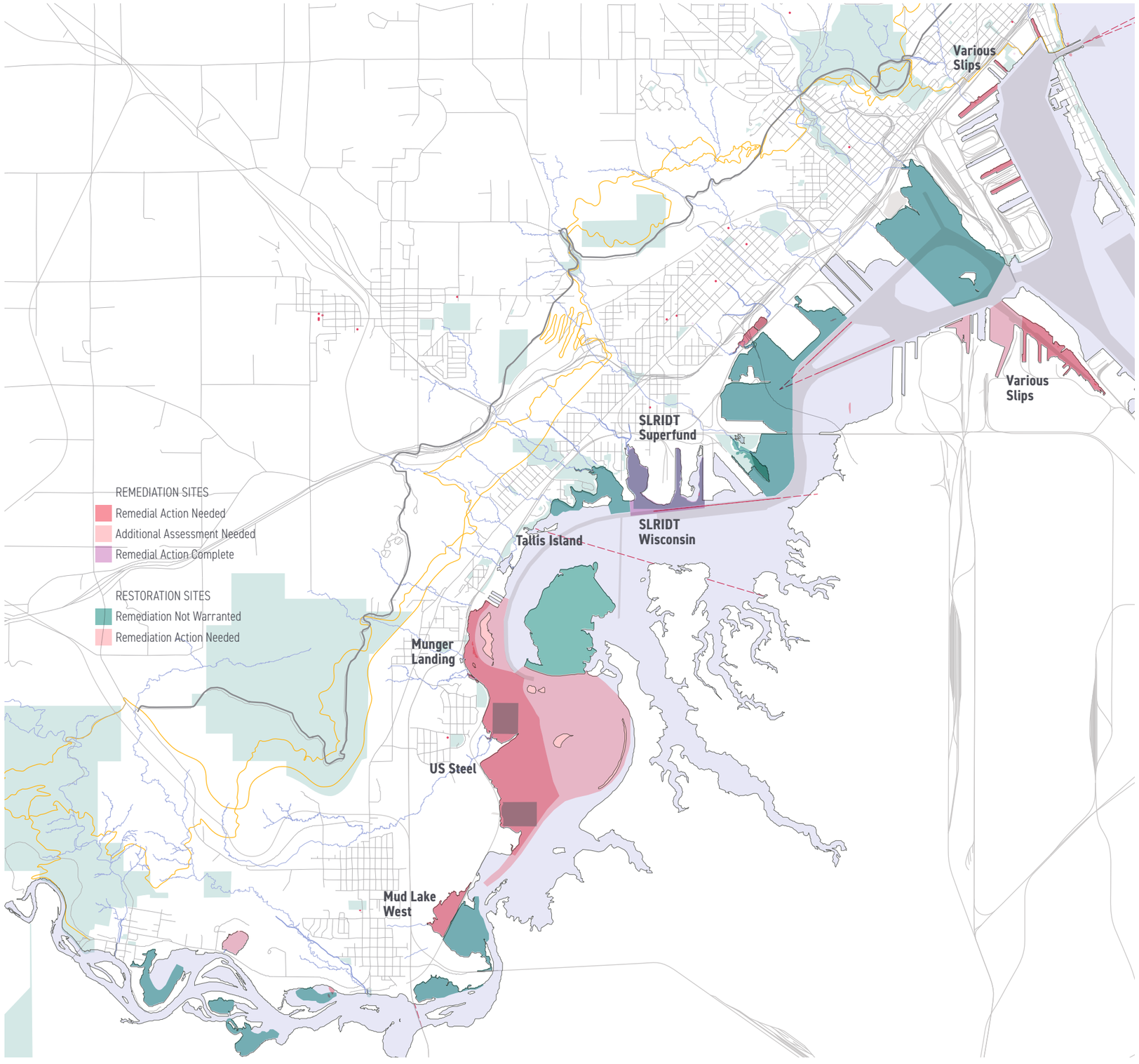


Figure 42. Chart of investments made in the St. Louis River Estuary AOC.

Figure 43. Map showing remediation and restoration sites on the St. Louis River Estuary.



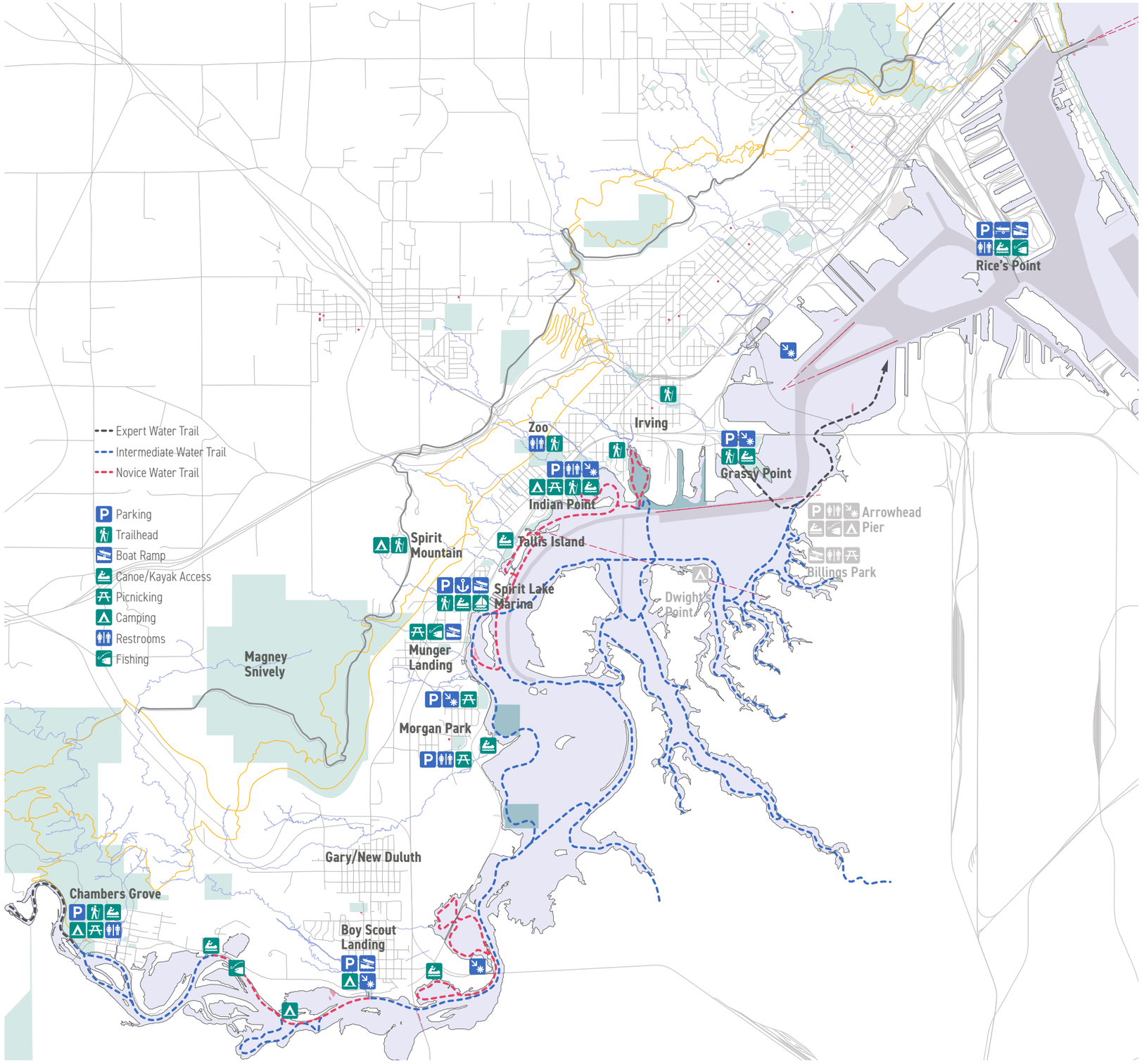


Figure 44. Map showing proposed locations of National Water Trail and landside facilities in the St. Louis River Estuary (after drawing by HKGi)

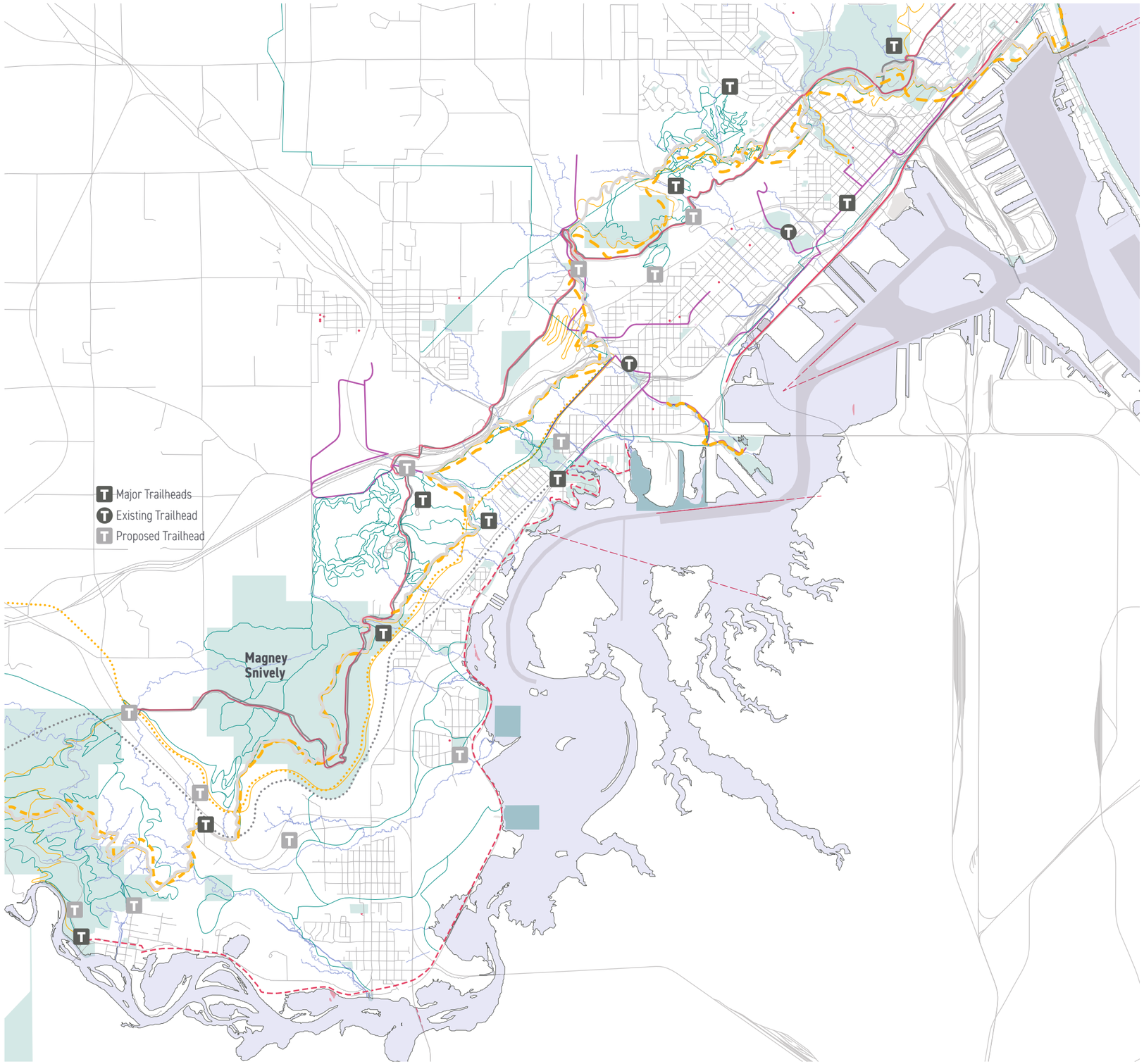


Figure 45. Map showing existing and proposed locations of trailheads and trails in the St. Louis River Estuary (after drawing by HKGi)

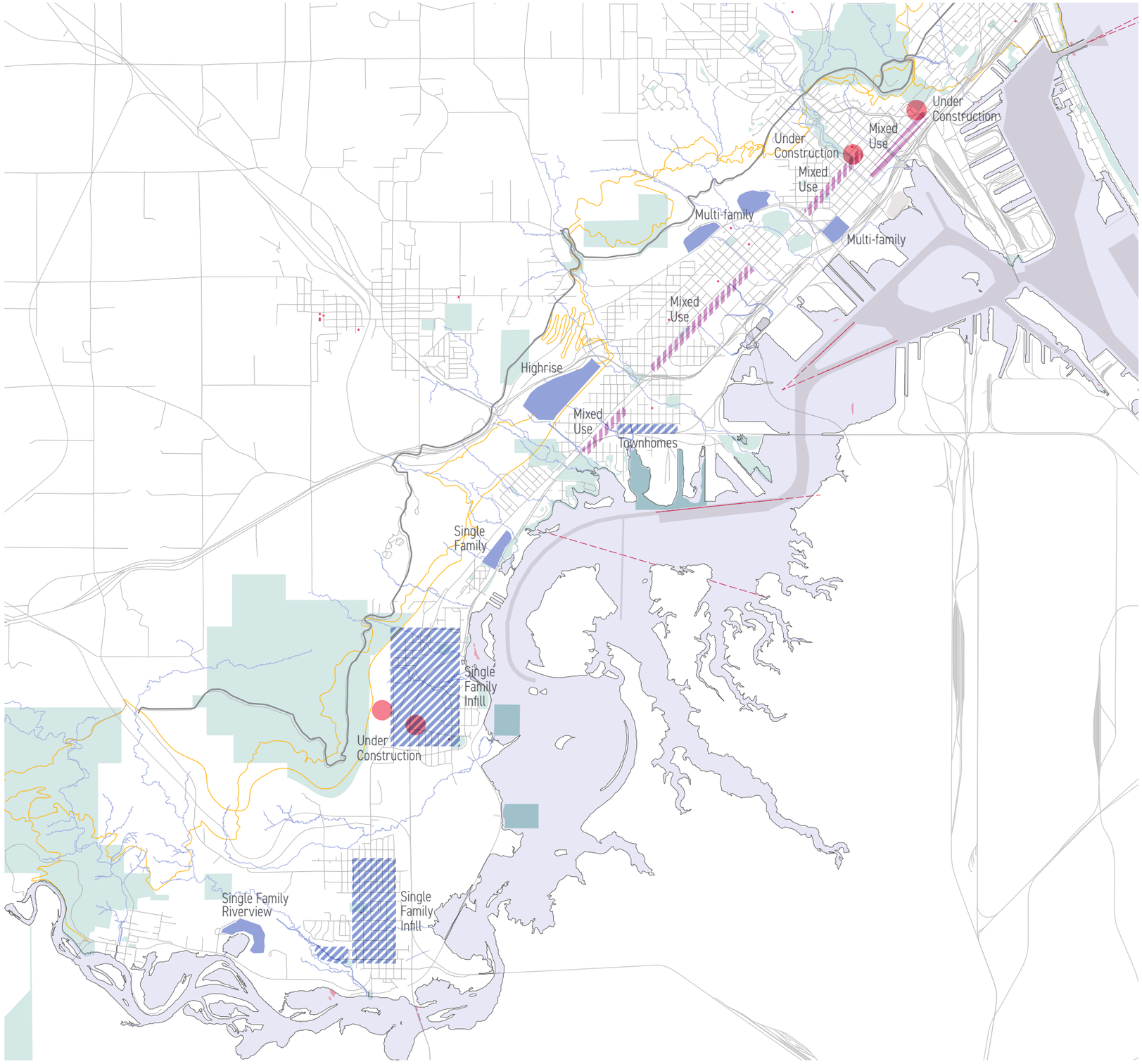
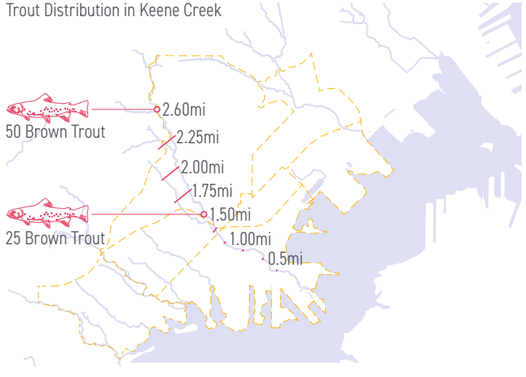
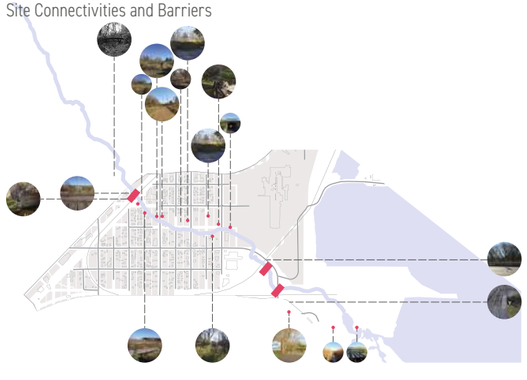
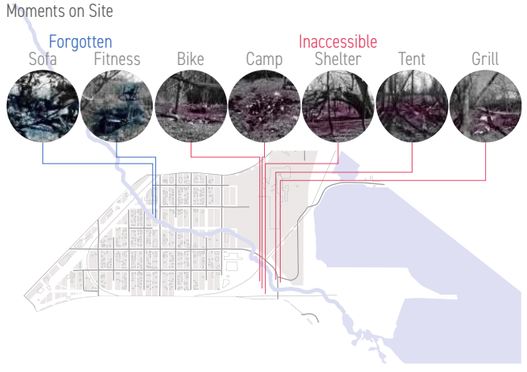


Figure 46. Map showing proposed housing locations from Imagine Duluth 2035 Neighborhood Engagement Brainstorming District maps and housing projects under construction.







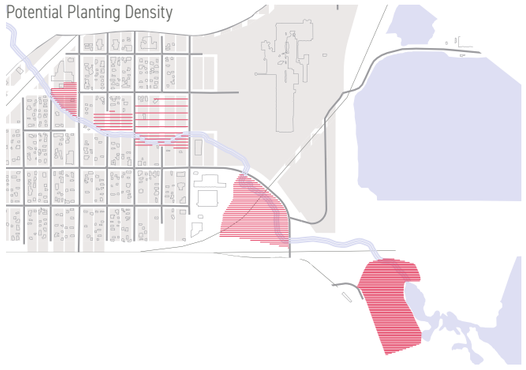


Figure 47. KEENE CREEK PROJECT. View of Fish Watching Platform along restored Keene Creek.

Figure 48. KEENE CREEK PROJECT. View of outdoor classroom and community gardens.

Figure 49. Analysis of Keene Creek showing trout distribution (**Diagram 1**), barriers and connection points along the creek (**Diagram 2**), significant moments along the creek (**Diagram 3**), and potential planting density for proposed vegetation (**Diagram 4**).

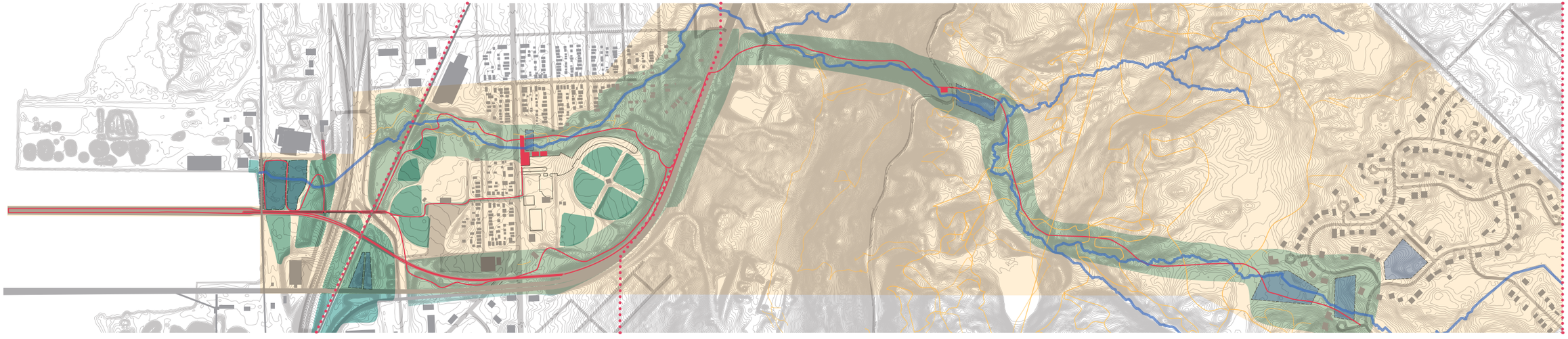


Figure 50. MERRITT CREEK PROJECT. Site Plan. A series of water quality and water quantity practices will be applied to reduce discharge and increase water quality in Merritt creek. These practices are combined with trail networks to create novel recreation activities.

Figure 51. MERRITT CREEK PROJECT. Example of a combined water control and recreational amenity. This combined system improves water quality and reduces runoff, while providing an exciting experience for bikers.

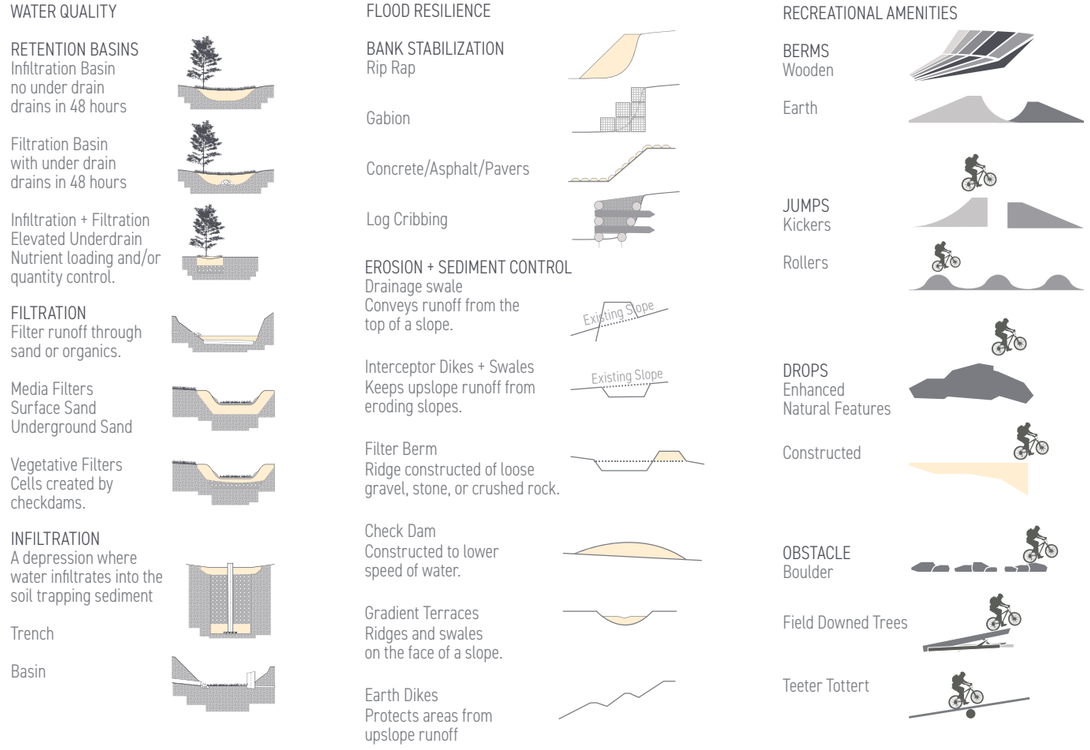
RECREATIONAL ECOLOGIES. Water runoff from adjacent neighborhoods is treated by dry swales and rain gardens.

UPLAND STRATEGIES. Dry Ponds control water runoff at high volumes and clean water during small rain events.

UPLAND STRATEGIES. Retention Basin hold water on top of the slope, before the potential energy associated with large elevation drops is released.

UPLAND STRATEGIES. Rain gardens can be incorporated within residential cul de sacs in order to reduce runoff further up in the watershed.

Figure 52. MERRITT CREEK PROJECT. Types of water quality, flood resilience, and recreational amenities that can be combined in the construction of trails for bikers and hikers.



Makers and Craft

In 2014, the owners of Frost River Trading Company, Bent Paddle Brewing Company, and Duluth Grill, all located in the Lincoln Park neighborhood, united with a vision for a district composed of craft-centered manufacturers and retailers. The business owners envisioned a craft district, which would include specialty restaurants and niche retailers who made their wares on site. Along with Aerostitch Rider Wearhouse, a maker of apparel and gear for motorcyclists, and the Duluth Pack factory (handcrafted bags and packs),[58] there was a sufficient concentration of makers to make the Craft District a popular location for visitors to Lincoln Park. To help develop the District, the city of Duluth and the Duluth 1200 Fund Board designed a new loan program to finance the renovation of older commercial buildings and create jobs in the Lincoln Park, West Duluth, and Spirit Valley business districts.[59]

The success of the Lincoln Park Craft District demonstrates the business opportunities in the St. Louis River Corridor. Student proposals from the Design Duluth studio have sought to take advantage of the unique assets of the Corridor, utilizing existing business infrastructure, abandoned lots, unoccupied buildings, derelict industrial properties to bring more jobs and public amenities to the Corridor. These design proposals also attempt to increase access to healthy food options and provide some degree of food security to the St. Louis River Corridor food desert.

The **cleanup of the US Steel site** adjacent to Morgan Park will provide additional economic benefits to the St. Louis River Corridor. The US Steel site is the largest unoccupied site in Duluth, with easy access to Grand Avenue, Interstate 35, the St. Louis River, and the BNSF railway line. With the proposed Duluth Economic Development Agency (DEDA) industrial park and Duluth Seaway Port Authority's purchase agreement for 132 acres of the site,[60] there is the potential for unique, innovative business proposals that will bring jobs, services, and neighborhood amenities to Morgan Park and Gary/New Duluth (*See* **Pages 61–63** and **figures 53–55** *for student design proposals related to economic development at US Steel*).

58 Renalis 2016.

59 Brochu 2016. "Advance West" is a pilot program providing loans of up to $50,000 in the 55806 and 55807 zip codes.

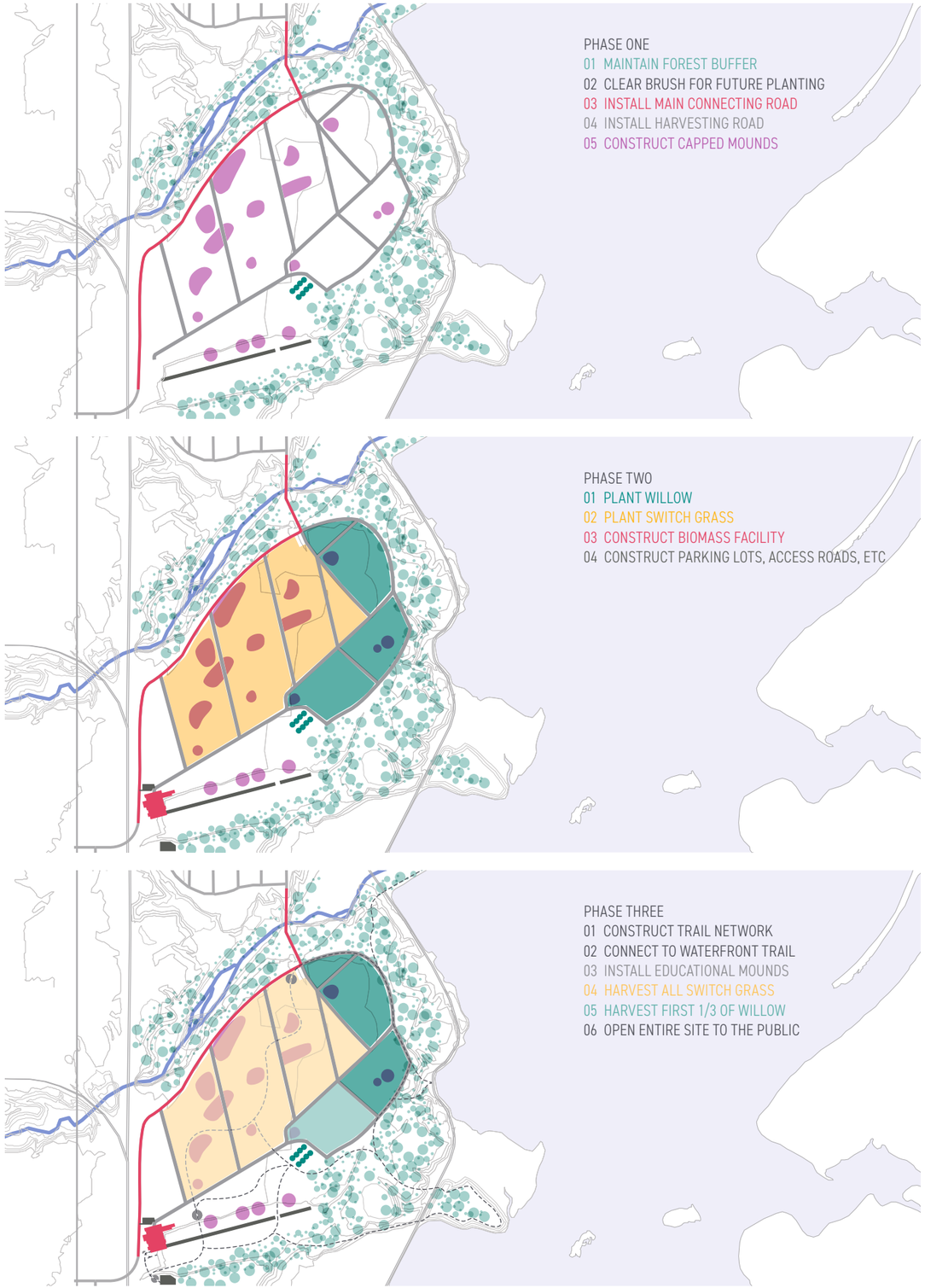
60 Johnson 2013.

Figure 53. ENERGY PARK PROJECT. The project proposes an energy park at the US Steel site. The energy park would be constructed from contaminated soil from the US Steel clean-up process, with the contaminated soil arranged in mounds capped with clean soil. The mounds would provide interested places for residents to play and relax, while providing more planting area for the switchgrass and willows. The switchgrass and willow plantings are harvested on rotation as biofuel and burned in a plant on the US Steel site to provide district heat to the proposed DEDA and Port Authority industrial park.

Phase One (Top). Phase One of the project clears invasive species from the forest buffer area; clears brush from the "park" area; constructs the main road connecting the industrial sites and park with Morgan Park and Gary/New Duluth; constructs internal site harvesting roads; and constructs the capped mounds from contaminated soil.

Phase Two (Center). Phase Two of the project plants willows and switchgrass for biofuel harvesting; constructs the Biomass Power Generation Facility; and constructs visitor parking lots and park access roads.

Phase Three (Bottom). Phase Three of the project constructs the trail networks inside the park and a connection to the Western Waterfront Trail; constructs interpretive mounds and exhibits; harvests all switchgrass and part of the willows in a three-year harvesting rotation.



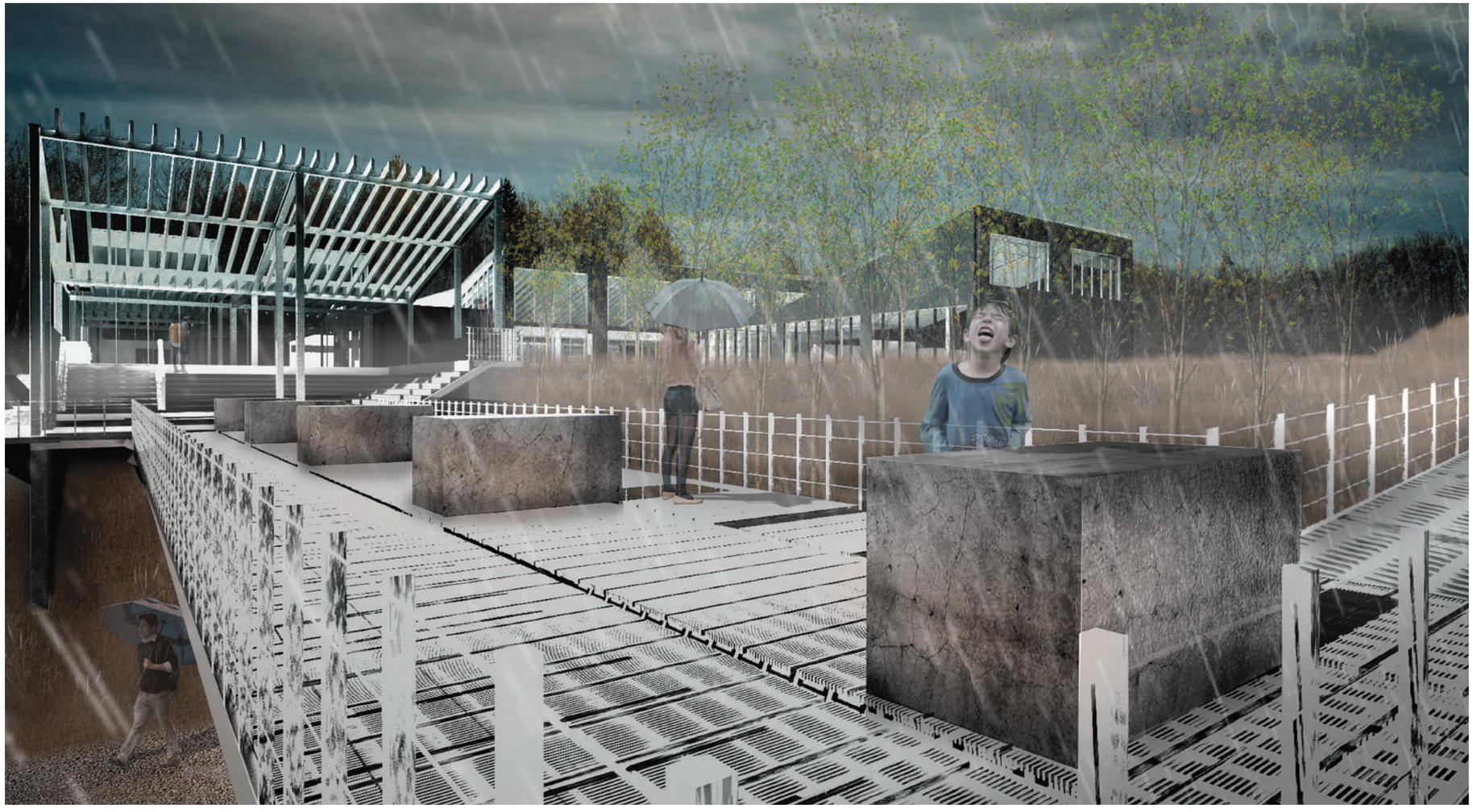


Figure 54. ENERGY PARK PROJECT. View of the biofuel facility and park spaces..

Figure 55. ENERGY PARK PROJECT. View of the park trails.

CONCLUSION

Diverse Economies

Manufacturing jobs in the Great Lakes Region peaked in the mid-1950s, at the height of the post-World War II recovery, at manufacturing providing about 30% of all jobs in the region.[61] Currently manufacturing provides only 7.7% of all jobs in Duluth. While the percentage of manufacturing jobs has been declining, "manufacturing's output share of GDP has remained stable over 50 years, and manufacturing retains a reputation as a sector of rapid productivity improvements."[62] This is a consequence of rapid technological advances in computer manufacturing, "[m]eanwhile, the 90% of manufacturing that lies outside the computer and electronics industry has seen its share of real GDP fall substantially, while its productivity growth has been fairly slow."[63] These technological innovations have not translated into increases in manufacturing output as many US tech firms have shifted manufacturing overseas (to Southeast Asia) and developed complex supply chains and employment dependencies that cannot be replicated locally.

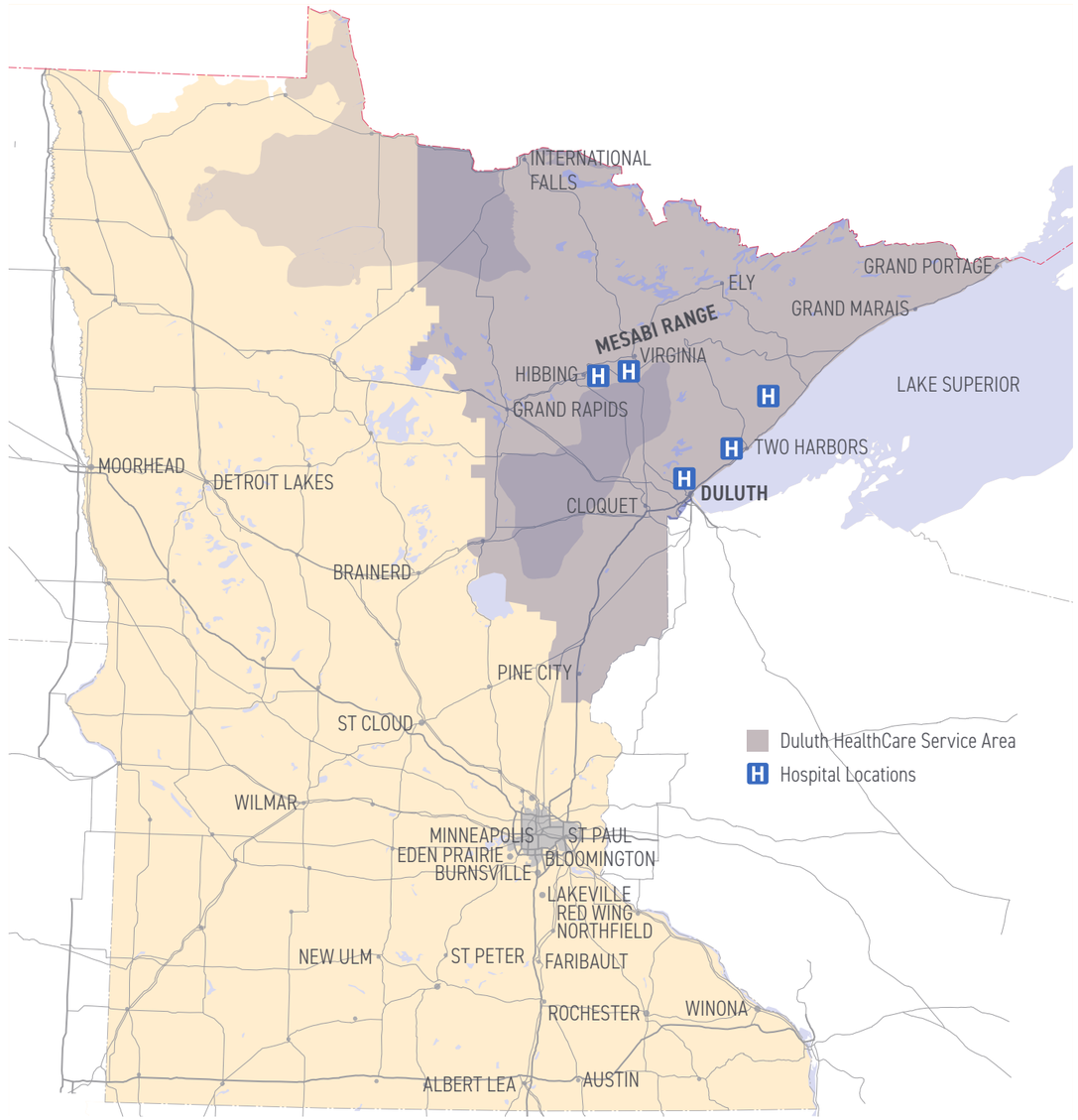
This steady decline in manufacturing jobs is of great concern as this job sector has typically paid well and afforded workers without a college education a share of upward mobility. The decline in manufacturing jobs is compounded by a workforce that lacks the skills to deal with new technologically-oriented manufacturing processes. The US "lags behind many other countries in developing effective vocational education and job-training programs, and the educational attainment of young workers is falling behind that of countries like Canada, Japan, and Korea."[64]

The new Duluth economy has shifted to employment concentrations other than manufacturing. The healthcare sector provides over 18,000 jobs in Duluth (about 30% of all jobs),[65] with over 8,000 employees working in its two hospitals. The University of Minnesota Duluth (UM-D) Medical School educates healthcare professionals to serve the needs of rural Minnesota and Native American communities, and the Duluth area is a healthcare hub for the Iron Range and most of northern Minnesota (**Figure 56**). The service area is large with difficult and often unsafe travel conditions. Duluth healthcare providers are pioneering with remote care treatment and services, including telemental care and telepharmacy services to reduce travel. The healthcare industry is projected to grow in the next decade (the healthcare and social assistance major sector is expected to become the largest employing major sector, overtaking the state and local government major sector and the professional and business services major sector). While the projections are positive for Duluth's largest employment sector, Duluth's economy may be over-concentrated in one sector (as it was historically with manufacturing). Growth in the healthcare sector in dependent on demographics, advanced technologies, and government policy, and is subject to the same corporate consolidation trends as other business sectors. Disruptions or shocks to the healthcare industry would be disruptive to the economic future of Duluth, similar to historical disruptions to manufacturing industry.

To diversify Duluth's economy, the city must continue to attract or retain talented individuals and families. Young individuals and are attracted to the quality of life. Factors that contribute to strong economic development are also those that attract businesses. These include:

- Quality of Life
- Cost of Living
- Infrastructure
- Education
- Workforce

Employees seeking new jobs and potential relocation opportunities prioritize base pay/salary, job security, and then quality of life. Wage growth in Duluth has



61 Detailed statistics for Duluth are unavailable. Information is for the Great Lakes Region and taken from Testa 2012.

62 Baily and Bosworth. 2014: 3.

63 Baily and Bosworth. 2014: 3–4. Manufacturing in the US was decimated by the recent recession: "[a]fter holding steady at about 17 million jobs through the 1990s, manufacturing payroll employment dropped by 5.7 million between 2000 and 2010. This decline in employment—"about 14%—is equivalent to the average of the G-7 economies (that is, Canada, France, Germany, Italy, Japan, and the United Kingdom, along with the United States)."

64 Baily and Bosworth. 2014: 23.

65 United States Census Bureau 2015. Duluth's largest job provider is the healthcare industry, employing 18,606 people with a payroll of $975 million. Healthcare provides, 29.9% of all jobs in Duluth and 35% of all payroll dollars.

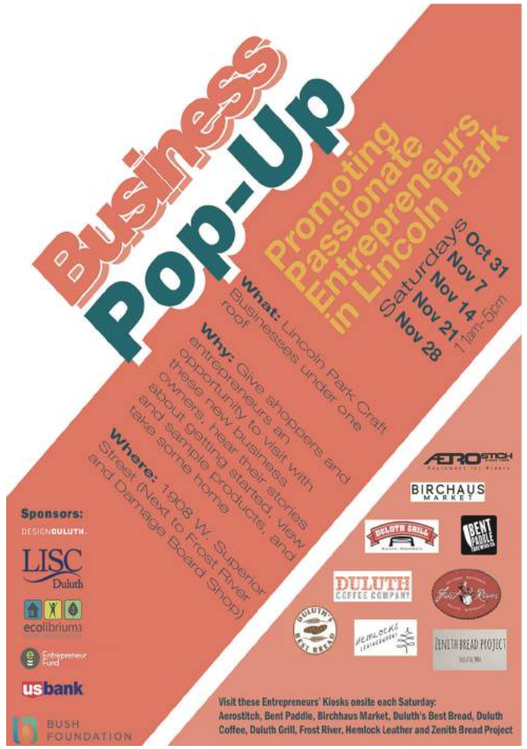


Figure 57. Lincoln Park Pop-up poster.

been lower than Minnesota and the country overall. Jobs are set to grow in health care, social services, professional and technical services and education, but median wages have typically been much lower in Duluth. The St. Louis River Corridor has a high quality of life and reasonable cost of living, but wages must rise significantly for the Corridor to be attractive to future Duluth residents.

Pop-Ups and Opportunities

The future of American manufacturing will largely be determined by the extent to which it can take advantage of various new technologies that will influence the structure of manufacturing in future years. Duluth has had manufacturers that have used advanced technologies to produce goods, beginning with Epicurian and the sister companies of LOLL Designs, Good Sheet, and Intectural. The relocation of Cirrus Aircraft to Duluth has added another company that utilizes innovative design and manufacturing to bring unique products to market. Duluth must provide other amenities besides a recreational lifestyle to attract similar businesses.

Along with technology-oriented manufacturers, Duluth has become a hub for traditional "skills-based" companies, including Aerostitch and Frost River. The new Lincoln Park Craft District was the focus of a series of events held during the summer and fall of 2016. The pop-up kickoff event was a panel discussion with UMD's Cultural Entrepreneur Program students on Tuesday, 27 October 2016. OMC, the Duluth Grill's new restaurant, hosted the event where a Craft Business Owner Panel discussed the Lincoln Park Craft District and the "craft industry" (**Figures 57 and 58**). Participating in the discussion were representatives from Aerostitch, Bent Paddle, Duluth's Best Bread, Birchaus Market, Duluth Coffee, Duluth Grill/OMC Smokehouse, Frost River, Hemlocks Leatherworks, Zenith Bread Project, and Love's Creamery. The Popup also created a temporary event space in a vacant storefront next door to Frost River. The pop-up space, open every weekend from the end of October until Small Business Saturday, hosted businesses from the craft district and gave the public an opportunity to talk to business owners and purchase craft goods and food. The Lincoln Park Pop-Ups were hosted by Duluth Local Initiatives Support Corporation (Duluth

Figure 58. Lincoln Park Pop-up event at the under renovation space of OMC restaurant.

LISC), Entrepreneur Fund, Ecolibrium3, and The Design Duluth Collaborative.

Since 2014, Duluth's Best Bread, Duluth Coffee, Duluth Folk School, Duluth Pottery, OMC Smokehouse, Hemlocks Leatherworks, Lynette Steen Photography, Erika Mick's Gallery, and Two Loons Studio and Gallery have moved into the Lincoln Park Craft District.[66] American Indian Community Housing Organization (AICHO) has purchased a fire-damaged building on W. Superior Street. AICHO will renovate the building, with affordable housing on two upper floors and an American Indian art gallery and coffee shop of the ground floor. The $1.4 million project is currently awaiting funding with construction planned for 2018. The Duluth MakerSpace, which adds over 10,000 square feet of digital and traditional fabrication capacity to the Lincoln Park Craft District had its grand opening on September 2016. The new Duluth Folk School also brings an additional craft focus to area, teaching traditional craft skills and the use of modern tools and techniques. More businesses are moving to the area, including more food (Love's Creamery and Corktown Taphouse and Delicatessen), mixed income housing, and more job opportunities for Lincoln Park residents that are directly connected to the Craft District.

THE PRESENT IS THE FUTURE

> "Transformational change often involves shifts in perception and meaning, social network configurations, patterns of interactions among actors including leadership and political and power relations, and associated organizational and institutional arrangements."[67]

Duluth has recovered from many financial crises and reinvented itself as a destination for tourists, the healthcare industry, and high-tech manufacturing, and most recently a place of creative small-scale manufacturers. The city is now financially sound, surviving a difficult period from 2006 to 2014, when state aid declined along with sales tax and investment earnings. The city's budget outlook was so difficult that in 2008 the city had a $4.4 million budget deficit and post-employment benefits were responsible for 15% of the city's annual general fund budget. In 2009, $10 million of the $80 million general fund budget was set aside for retiree health claims. After 2009, Duluth made deep cuts to retiree benefits and was able to reduce spending on retiree benefits by 23%. From 2008 to 2012, Duluth outsourced the "staffing of programs such as the zoo, golf courses, senior bus and dining services, and many recreation facilities. By 2012, approximately 130 temporary and full-time workers had been laid off, and non-public safety employment was 20% lower than in 2000."[68] The city also doubled property tax income between 2007 to 2013 to help balance and stabilize the budget. In 2016, the City is moving into the 2035 Comprehensive planning process with a budget surplus, low unemployment, a stable local economy.

Duluth's Imagine Duluth 2035 process will focus housing, transportation and accessibility, economic health, and open space. The new plan also promotes health and equity as the foundation for future development, but does not explicitly mention climate change or resilience. The long-time scales (50+ years) involved with resilience almost requires that efforts to make Duluth more resilient be embedded in current planning efforts. Duluth now has the opportunity to plan carefully and critically for the future as the city's stable finances and forward-looking leadership allows proactive approach toward making deliberate and considered decisions that increase the ability of the city and residents to deal with change and stresses whether they are climate driven or economic based.

66 Nicklawske 2017.
67 Folke *et al* 2010: 5.
68 Ruff, Mark. 2014. Once a Troubled Rust-Belt City, Duluth Turns Its Finances Around. *Government Finance Review* 6 (12): 26–32 (http://www.gfoa.org/sites/default/files/GFR61528.pdf, 23 September 2017).

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GLOSSARY

Areas of Concern (AOC)
AOCs are described by the Great Lakes Water Quality Agreement as "geographic areas designated by the Parties where significant impairment of beneficial uses has occurred as a result of human activities at the local level." An AOC is a location that has experienced environmental degradation. Numerous industrial harbors and rivers of the Great Lakes and Upper Midwest have been designated as such. Of the original 43 designated sites, 37 are still undergoing clean-up.

Beneficial Use Impairment (BUI)
BUIs indicate a "change in the chemical, physical, or biological integrity of the Great Lakes system." The BUIs targeted vary in each Area of Concern, and are aimed at particular problems and qualities of each region. The BUIs identified in the St. Louis River Estuary AOC are:

1. Restrictions on Fish and Wildlife Consumption
2. Degraded Fish and Wildlife Populations
3. Fish Tumors or Other Deformities
4. Degradation of Benthos
5. Restrictions on Dredging Activities
6. Excessive Loading of Sediments and Nutrients
7. Beach Closings
8. Degradation of Aesthetics
9. Loss of Fish and Wildlife Habitat

Freshwater Estuaries
Freshwater Estuaries are semi-enclosed areas of the Great Lakes in which the waters become mixed with waters from rivers or streams. Although these freshwater estuaries do not contain saltwater, they are unique combinations of river and lake water, which are chemically distinct and convey unique sedimentary properties.

Iron Ore Prices
Iron ore traded for less than $20 a tonne for 40 years before China's rapid expansion transformed the steelmaking industry and made iron the second most traded commodity after crude oil. Iron ore reached a record high of $190 a tonne in February 2011 and currently trades at around $60 a tonne. Due to rapid global urbanization, world steel consumption has doubled over the past decade, from about 800 million tonnes in 2000 to more than 1,500 million tons in 2014. China is the leader in both steel production (50% of world total) and iron ore mining (47% of global output in terms of tonnage).

National Water Trail
The National Water Trail System is a national network of outstanding water trails designated by the Department of Interior. National Water Trails are recreational routes on waterways with a network of public access points supported by broad-based community partnerships. National Water trails provide both conservation and recreational opportunities.

Oil Embargo
The 1972–1973 OPEC oil embargo was a direct response to $2.2 billion in US emergency aid to Israel during the Yom Kippur War. This led to a severe recession in 1981–1982, the most significant economic crisis since the Great Depression.

Panic of 1857
The Panic of 1857 was a worldwide economic crisis caused by a declining international economy and over-expansion of the domestic economy. The panic began with the failure of the New York branch of the Ohio Life Insurance and Trust Company on 24 August 1857. After the failure of Ohio Life, a series of other setbacks shook the public's confidence, including:

1. Removal of funds from banks by British investors
2. End of the Crimean War, the return of Russia to global grain markets, and the collapse of US grain prices
3. Failure of railroads and the collapse of land prices along new rail routes

Panic of 1873
In 1873, countries in Europe and North America allowed exchange of paper money (script) for precious metals (gold or silver) at a fixed valuation — a precious metals standard. During economic crises, many governments deviated from the standard and supplied paper money not fixed to the value of gold or silver. In the early 1870s, several large nations made significant changes to their national currencies which started the Panic. In 1871, Germany ended the use of silver as a monetary metal, increasing the value of the deutschmark against other currencies. This created a worldwide glut of silver, devaluing silver *and* the currencies that allowed exchange between silver and gold (the dollar). In 1873, Congress passed the Coinage Act to retire silver currency and to bolster the value of the dollar. Currency in circulation was now limited by the amount of gold held by the US Treasury and credit contracted, interest rates skyrocketed, and investors were forced to repay speculative investments with gold.

The depression lasted from October 1873 to March 1879, and is the longest recorded economic downturn in modern history as thousands of American companies defaulted on over a billion dollars in debt, 90% of US railroad concerns failed, and the country faced double-digit unemployment for over a decade. Average wages fell by 25% and economic productivity dropped by 24% during the two decades that followed the Panic. Economically, the long downturn concentrated capital in the hands of fewer and fewer suppliers. Large, wealthy manufacturers, like Andrew Carnegie, John Rockefeller, and Cyrus McCormick, solidified their hold over their industries and increased their influence in the halls of government. By 1890, 71% of the nation's wealth belonged to less than 9% of the public.

Public Water Access
Riparian rights are property rights arising from owning property abutting water. They include the right to wharf out to a navigable depth; to take water for domestic and agricultural purposes; to use land added by accretion or exposed by reliction; to take ice; to fish, boat, hunt, swim; and to such other uses as water bodies are normally put. The riparian owner has the right to use the water over its entire surface [see Johnson v. Seifert, 257 Minn. 159, 100 N.W. 2d 689 (1960)]. Where the public is a riparian landowner, such as where there is a public access site, the public has riparian rights. [See Flynn v. Beisel, 257 Minn. 531, 102 N.W. 2d 284 (1960).]

The general public can access water bodies or watercourses via public property, but not through private property. Individuals entering private property without permission from the landowner are trespassing and may be prosecuted under the state trespass laws. A person who has legally gained access to a water body may use its entire surface for recreation, such as boating, swimming, or fishing.

Sequestration
Following the 2010 elections, as Congress passed program budgets for the 2011 fiscal year, it made the first in a series of cuts to the programs that are not mandatory for the federal government to fund. Congress also passed the Budget Control Act, which established spending caps for fiscal years 2012 through 2021, as well as sequestration (permanent, across-the-board cuts to discretionary programs) if Congress failed to approve additional deficit reduction measures. As a result of the Budget Control Act spending caps, Congress made a second series of cuts in FY 2012. For HCV and public housing, 2012 cuts were somewhat offset by requirements that housing authorities use their reserves to maintain program levels. Without this requirement, the magnitude of the cuts would have been even larger. Because deficit reduction measures were not ultimately approved after the Budget Control Act was passed, sequestration went into effect for FY 2013.

Stagflation
Stagflation is a combination of inflation and slow economic growth. There was a mild recession in 1970 as the GDP contracted for three quarters and unemployment was at 6.1%. Running for re-election in 1972, President Nixon wanted to boost growth without triggering inflation. In August of 1971 Nixon instituted fiscal policies that secured his re-election:

1. Instituted a 90-day freeze on wages and prices and created a Pay Board and Price Commission to approve increases after the 90 day freeze.
2. Imposed a 10% import tariff to protect domestic industries.
3. Removed the United States from the gold standard. The 1944 Bretton Woods Agreement, set the value of the dollar to the value of gold.

The crisis occurred when the UK attempted to redeem $3 billion of paper dollars for gold. The United States hold that much gold in reserve and Nixon stopped redeeming dollars for gold. This increased the price of gold and devalued the dollar. That increased the price of imports even more after the 10% import tariff. The import tariff and removal of the US dollar from the gold standard raised import prices, and costs for US companies. Limited by the Pay Board and Price Commission, US companies could not raise prices or cut wages. The only option to reduce costs was to lay off workers, increasing unemployment, reducing consumer demand, and further slowing economic growth. The policies imposed by Nixon has the opposite effect, curtailing growth and increasing inflation.

Taconite Pellet Technology
Taconite is a sedimentary rock, with iron minerals interlayered with quartz, chert, or carbonate. In the late 19th and early 20th centuries, taconite, with an iron

content of 25% to 30%, was considered a waste product. By the end of World War II, high-grade iron ore was exhausted. With the development of taconite processing, taconite became a commercially viable form of iron ore. To process taconite, the ore is ground into a fine powder, the magnetite is separated out by strong magnets, and the powdered iron concentrate is combined with a bentonite clay and limestone binder. The mixture is rolled into pellets about one centimeter in diameter that contain approximately 65% iron. The pellets are fired at high temperatures to harden them and make them durable for the transport process. E. W. Davis of the University of Minnesota Mines Experiment Station is credited with developing the pelletizing process.

US Steel

The history of iron ore in the Mesabi Range is also a history of modern American capitalism. Iron ore was discovered by the Merritt brothers in 1887. By 1893, the seven brothers owned the largest iron ore mine in the world, had staked claims to a large portion of the Mesabi Range, and constructed the Duluth, Missabe & Northern Railway (DM&N) to move the ore from the Range to the Port of Duluth.

During the economic downturn of 1893, the Merritts borrowed money from John D. Rockefeller to complete construction of the railroad. Rockefeller eventually took over the Merritts holdings and began a bitter rivalry with Andrew Carnegie. Rockefeller owned the iron and ships that moved the ore, while Carnegie owned the plants that converted the ore to steel. Various trust agreements were broken as Rockefeller raised the price of ore and Carnegie sought to purchase ore mines that Rockefeller had overlooked.

The rivalry between Carnegie and Rockefeller soon attracted the attention of JP Morgan, whose many businesses were affected by the battle between Carnegie and Rockefeller. Morgan began buying up smaller steel manufacturers, and eventually purchased Carnegie Steel for $480 million — about $13.5 billion today. Rockefeller soon sold his holdings to Morgan and US Steel was formed.

US Steel Cleanup

The former US Steel is the last large contaminated site in the St. Louis River Estuary. A $69 million plan to address contaminated sediment on the site has been proposed. The second cleanup at US Steel was required as the natural dispersal of contaminants remaining from the first clean-up effort did not occur as predicted. The clean-up will remove lead, copper, zinc, and polycyclic aromatic hydrocarbons from the site and surrounding waters. The plan calls for dredging 697,000 cubic yards of material and placing it into three confined disposal facilities (CDFs) onsite and capping 109 acres of contaminated sediment.

US Steel Crisis

From 1974 to 1986, the American economy was in a economic downturn sparked by the OPEC oil embargo and the Iranian revolution. During these recessions consumer markets contracted significantly and demand for steel weakened considerably. With markets for steel shrinking, US steel manufacturers were forced to cut their production and sell steel at unprofitable prices, losing money on every tonne of steel sold (in 1982 losses were over $3 billion). The manufacturer's attempted to cut losses by laying off large numbers of workers and permanently closing a number of steel mills. Between 1979 and 1982 more than 150,000 steelworkers were made laid-off and hundreds of steel facilities were closed. Steel manufacturers also requested that the government impose trade restrictions and take action against countries selling steel below cost (dumping).

In 1977 and 1979, the Carter administration established minimum prices for the sale of foreign-produced steel. The Carter administration refused to provide financial support to community leaders in Youngstown, Ohio who were attempting to buy mills abandoned by large steel corporations. Convinced that the largest steel corporations had to solve their own problems, Carter also dismissed a $10 billion publicly-funded modernization plan suggested by a government taskforce. Unable to garner direct financial support from the government, steel executives closed factories that were uncompetitive or too expensive to modernize, radically reduced their workforces, and demanded that remaining workers take wage and benefits cuts. The massive restructuring campaigns of the 1980s were successful from a business perspective. These companies survived the deep manfacturing depression of the late 1970s and early 1980s and by 1987, the largest steel producers reported profits. The reality of the US steel industry's reinvention is more complex as production was slashed dramatically and 300,000 steelworkers lost their jobs, while whole communities were left devastated by plant closures.