★ **Roll Call Number**

Agenda Item Number

56

Date November 4, 2019

APPROVAL OF THE MARKET DISTRICT OF THE EAST VILLAGE MASTER PLAN AS AN ELEMENT OF THE PLANDSM: CREATING OUR TOMORROW PLAN

WHEREAS, on April 25, 2016, by Roll Call No. 16-0717, the City Council adopted Plan DSM: Creating Our Tomorrow, which identified preparation of plans and programs to identify infill and redevelopment properties as an intermediate action step of implementation, including areas such as the southern portion of the downtown Historic East Village neighborhood referred to as the "Market District"; and

WHEREAS, Market District Development was identified as a high priority in the 2017-2018 Action Agenda for the GuideDSM strategic plan, and the District area is recognized for its significant redevelopment potential as an emerging mixed-use downtown neighborhood that could incorporate green building techniques and design, and further bolster the strength of the Historic East Village; and

WHEREAS, on December 4, 2017, by Roll Call No. 17-2042, the City Council approved a Professional Services Agreement with HDR Engineering, Inc. for master planning and an infrastructure analysis for the Market District Study, which study was intended in part to build from the basic ideas proposed in the 2010 "Market District of East Village Urban Design Study"; and

WHEREAS, the Market District of the East Village Master Plan prepared by HDR Engineering, Inc. focuses on mobility enhancements, key infrastructure that needs to be addressed to support the development, a park and open space system, and urban form within the District, as well as sustainability features proposed through the District; and

WHEREAS, the intent for the Market District as demonstrated through the Master Plan is a dense, walkable, urban, mixed-use neighborhood providing a variety of housing options, office/workplace opportunities, neighborhood retail, and recreational, quality of life and park amenities, by bolstering, supporting and integrating into and with the more established and existing Historic East Village Neighborhood; and

WHEREAS, if developed according to the Master Plan, the Market District could add approximately 3,400 housing units and approximately 300,000 square feet of new commercial office and retail space; and

WHEREAS, the Master Plan was developed by HDR Engineering, Inc. with input from the East Village Master Plan Steering Committee comprised of area business and property owners, developers, design professionals, and similar stakeholders; and

WHEREAS, on October 3, 2019, the City Plan and Zoning Commission considered the proposed Market District of the East Village Master Plan District and voted 10-0 to recommend approval of the Master Plan as an element of the existing PlanDSM: Creating Our Tomorrow Plan, as stated in the attached communication from the Commission.

★ **Roll Call Number**

Agenda Item Number

56

Date November 4, 2019

NOW, THEREFORE BE IT RESOLVED, by the City Council of the City of Des Moines, Iowa, that the attached communication from the Plan and Zoning Commission is hereby received and filed, and that the Market District of the East Village Master Plan is hereby approved and adopted as an element of the existing PlanDSM: Creating Our Tomorrow Plan.

(Council Communication No. 19-481)

MOVED BY _______________ TO APPROVE.

APPROVED AS TO FORM:

Glenna K. Frank

Glenna K. Frank, Assistant City Attorney

(21-2019-4.19)

COUNCIL ACTION	YEAS	NAYS	PASS	ABSENT
COWNIE				
BOESEN				
COLEMAN				
GATTO				
GRAY				
MANDELBAUM				
WESTERGAARD				
TOTAL				

MOTION CARRIED APPROVED

_______________ Mayor

CERTIFICATE

I, P Kay Cmelik City Clerk of said City hereby certify that at a meeting of the City Council of said City of Des Moines, held on the above date, among other proceedings the above was adopted.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my seal the day and year first above written.

_______________ City Clerk

CITY OF DES MOINES
COMMUNITY DEVELOPMENT

Date________
Agenda Item 56
Roll Call #________

October 15, 2019

Honorable Mayor and City Council
City of Des Moines, Iowa

Members:

Communication from the City Plan and Zoning Commission advising that at their October 3, 2019 meeting, the following action was taken regarding a City initiated request to Amend the PlanDSM Creating Our Tomorrow Plan to adopt the Market District of the East Village Master Plan as an element.

COMMISSION RECOMMENDATION:

After public hearing, the members voted 10-0 as follows:

Commission Action:	Yes	Nays	Pass	Absent
Francis Boggus	X			
Dory Briles	X			
Abby Chungath	X			
David Courard-Hauri	X			
Jacqueline Easley	X			
Jann Freed				X
John “Jack” Hilmes				X
Lisa Howard	X			
Carolyn Jenison	X			
Greg Jones	X			
William Page	X			
Rocky Sposato				X
Steve Wallace	X			
Greg Wattier				X
Emily Webb				X

APPROVAL of an amendment to the PlanDSM - Creating Our Tomorrow Comprehensive Plan to adopt the Market District of the East Village Master Plan as an element.

(21-2019-4.19)

STAFF RECOMMENDATION TO THE COMMISSION

Staff recommends approval of an amendment to the *PlanDSM - Creating Our Tomorrow* Comprehensive Plan to adopt the *Market District of the East Village* Master Plan as an element.

STAFF REPORT TO THE PLANNING COMMISSION

I. GENERAL INFORMATION

Background: The *PlanDSM – Creating Our Tomorrow* Comprehensive Plan was adopted on April 26, 2016. *PlanDSM* specifically recognized the paramount linkage between land use, transportation, housing, economic development, public infrastructure and utilities, parks and recreation, and social equity to develop a sustainable community. Preparation of plans and programs to identify infill and redevelopment properties (*Market District of the East Village*) was identified as an intermediate action step in the Implementation Chapter. Focusing economic development efforts in strategic locations for continued vitality and growth was also identified in the Goals and Policies of the Economic Development Chapter of PlanDSM. The goal of the *Market District of the East Village* Master Plan is to create a walkable urban neighborhood that will support and supplement the on-going redevelopment activity in both Downtown Des Moines and the East Village. The Des Moines' City Council provided funding for these action items as a result of the *GuideDSM* Strategic Plan process.

1. **State and Regional Planning Influences:** The City has participated in several State and regional planning efforts that serve as background to and provide general land use and economic development planning guidance for the future.

<u>*Iowa Smart Planning Legislation*</u>

The Iowa Smart Planning Act (Iowa Code Chapter 18B) was approved in 2010. The legislation articulated 10 Iowa Smart Planning Principles to be considered when any development decision is made and recommended core elements for inclusion in Comprehensive Plans. Land Use and Economic Development are two of the core elements on that list.

<u>*DART Forward 2035*</u>

DART Forward 2035 was initially adopted in 2011 and provided a long-range vision for what the Transit Authority and the transit system could become. Residents of Des Moines were active participants in the planning process which resulted in a new transit system that added service in growth areas; provided for faster travel with less wait time; offered an increased number of transfer points; and, provided additional crosstown service. Transit is a key element in planning for the future of Des Moines. The DART Forward 2035 document serves as the background for transit growth in the City. During 2016, DART provided a 5-year update to the Plan. This plan for investment in transit has resulted in:

- A 9 percent increase in ridership from 2013 to 2015;

- Opening of a new transit station in downtown Des Moines with launch of a redesigned route network;
- Shorter wait times between trips;
- Service later on weekdays and earlier and later on weekends to better align with retail hours; and
- Additional or expanded routes to serve more places in the region.

The Tomorrow Plan

Coordinated by the Des Moines Area Metropolitan Planning Organization, The Tomorrow Plan was a three-year planning process that included 17 cities and four counties within the greater Des Moines area. This collaborative effort aligned economic, social and environmental issues to provide for the long-term health of the region. The Tomorrow Plan focuses around four overarching goals and includes initiatives for their implementation:

- Create a resilient regional economy;
- Improve the region's environmental health and access to the outdoors;
- Further the health and well-being of all residents in the region; and,
- Increase regional cooperation and efficiency at all levels.

Mobilizing Tomorrow

Also coordinated by the Des Moines Area Metropolitan Planning Organization, The Mobilizing Tomorrow Plan is the Long-Range Transportation Plan vision and implementation follow-up to The Tomorrow Plan regional comprehensive plan. This Plan focuses around four overarching transportation goals for the region and includes an implementation:

- Enhance multimodal transportation options.
- Manage and optimize transportation infrastructure and services.
- Improve the region's environmental health.
- Further the health, safety and well-being of all residents in the region.

PlanDSM - Creating Our Tomorrow

PlanDSM is the City of Des Moines' Comprehensive Plan consists of a vision priorities and goals that will guide Des Moines into the future; goals and policies for eight different Plan elements (including Land Use and Economic Development); an implementation chapter describing how the Plan can be realized; and a Future Land Use Map.

Economic Development Goals from *PlanDSM* include:

- Foster economic prosperity and stability by retaining existing businesses and recruiting new businesses.
- Focus economic development efforts in strategic locations for continued vitality and growth.
- Recognize livability as a key aspect to economic development.
- Foster a sustainable economy.

GuideDSM – Des Moines Strategic Plan 2015-2020-2031

GuideDSM, the City of Des Moines' Strategic Plan, consists of missions, vision priorities, and goals to address future needs and inform development of yearly budgets and capital improvements over a five fiscal year period.

Economic Development Goals from *GuideDSM* include:

- Involved community – residents and businesses.
- Thriving regional economy.
- Recognized leader in community sustainability.

2. **Project Funding:** In 2016, the City Council appropriated $452,747 in funding for completion of the *Market District of the East Village* Master Plan.

3. **Plan Process:** *Market District of the East Village* Master Plan (see attachment) was broken into phases emphasizing extensive public outreach to allow City residents to provide continuous community input into Plan development:

   - *Inventory and Analysis* phase involved staff and consultants gathering information to learn about the existing environment of the Market District.

   - *Market Assessment* phase involved a real estate market assessment and evaluating development potential.

   - *Visioning* phase involved specific key stakeholder interviews, a visioning session, and a three-day interactive design workshop.

   - *Development Program* phase involved creation of a development program for use during the three-day design workshop and comprised key findings, specific elements necessary to achieve objectives of the *Market District of the East Village* Master Plan.

   - *Master Plan* phase involved the three-day iterative Design Charrette to test and refine key framework elements and development concepts for the *Market District of the East Village* Master Plan.

4. **Plan Organization:** *Market District of the East Village* is organized into eight sections: Inventory and Analysis, Market Assessment, Visioning, Development Program, Master Plan, Framework Elements, Development Opportunities, and Design Guidelines.

   The section entitled Framework Elements investigates and identifies factors and guidelines that support the development of the Market District into a sustainable neighborhood including Mobility, Key Infrastructure, Park and Open Space System, Sustainability, and Urban Form.

5. **Plan Preparation:** *Market District of the East Village* has been prepared by Economic Development staff, Engineering staff, HDR, SBFriedman Co., Walker Consultants, and

under the guidance of the *Market District of the East Village* Steering Committee.

Members of the *Market District of the East Village* Steering Committee are as follows:

Lou Rizzuti, Artistic Iron Works
Hugh O'Hagan, Blackbird Investments
Kevin Nordmeyer, BNIM Architecture
Jake Christensen, Christensen Development
Tim Leach, Greater Des Moines Partnership
Jim Kottmeyer, GPS Impact/PDM Precast
Sam Erickson, Historic East Village Board
Kris Saddoris, Hubbell Realty Company
Jim Geeertz, Iowa Economic Development Authority
Tim Waddell, Iowa Economic Development Authority
Eric Heikes, MidAmerican Energy
Kathryn Kunert, MidAmerican Energy
Alexander Grgurich, Nelson Development
Adam Peterson, PDM Precast
Greg Wattier, Plan and Zoning Commission
Tim Rypma, Rypma Properties
Sadie Kleppe, Simonson & Associates
Dan Drendel, Slingshot Architecture
Eric Cannon, Snyder & Associates
Jill VanDerPol, Two Rivers Marketing
J. B. Curry, TWG, Inc.
Dennis Reynolds, Urban Design Review Board
Stephanie Weisenbach, Urban Design Review Board
Scott Allen, Urban Design Review Board

6. **Plan Adoption:** Pursuant to City Code Chapter 82, Article III of the City Code, adoption of the Comprehensive Plan or any substantial amendment thereof (i.e. *Market District of the East Village*), requires at least one public hearing with published notice. The adoption of the amendment requires affirmative vote by not less than two-thirds of the members of the Commission present at the time of the vote. After adoption of the plan or amendment by the Commission, a copy of the amendment, together with the report and recommendation of the Commission, shall be forwarded to the City Council, and the Council may approve the amendment. When the plan or any modification or amendment receives the approval of the Council, the plan shall constitute the official City plan. This consideration would adopt the *Market District of the East Village* Master Plan as an element of *PlanDSM*.

SUMMARY OF DISCUSSION

Jacqueline Easley asked if any member of the audience or the commission desired to speak regarding the item. None were present or requested to speak.

COMMISSION ACTION:

Francis Boggus made a motion for approval of an amendment to the PlanDSM - Creating Our Tomorrow Comprehensive Plan to adopt the Market District of the East Village Master Plan as an element.

Motion carried 10-0.

Respectfully submitted,

Michael Ludwig, AICP
Planning Administrator

MGL:tjh
Attachments

**MARKET DISTRICT
OF THE EAST VILLAGE**
MASTER PLAN

DES MOINES, IA
DRAFT

This document is a flexible tool, which presents a vision, framework, principles, and guidelines for the development of the Market District of the East Village in Downtown Des Moines, Iowa. **It is important to note that specific buildings/physical designs have not been determined.** Rather, these designs are conceptual in nature, depicting possible improvements that will fulfill the vision, follow the framework initiatives, and create the desired district identity. Changes in priorities, budgets, programming, and/or physical constraints will almost certainly occur over time. However, this plan will provide a foundation and cohesive approach to future development initiatives, that if generally followed will achieve the vision described here within.

ACKNOWLEDGMENTS

CLIENT TEAM

CITY OF DES MOINES
Erin Olson-Douglas
Ryan Moffatt
Matt Radermacher

PARTICIPATING STAKEHOLDERS

ARTISTIC IRON WORKS
Lou Rizzuti

BLACKBIRD INVESTMENTS
Hugh O'Hagan

BNIM ARCHITECTURE
Kevin Nordmeyer

CHRISTENSEN DEVELOPMENT
Jake Christensen

GDM PARTNERSHIP
Tim Leach

GPS IMPACT/PDM PRECAST
Jim Kottmeyer

HISTORIC EAST VILLAGE BOARD
Sam Erickson

HUBBELL REALTY COMPANY
Kris Saddoris

IOWA ECONOMIC DEVELOPMENT AUTHORITY
Jim Geertz
Tim Waddell

MIDAMERICAN ENERGY
Eric Heikes
Kathryn Kunert

NELSON DEVELOPMENT
Alexander Gugrich

PDM PRECAST
Adam Peterson

PLAN AND ZONING COMMISSION
Greg Wattier

RYPMA PROPERTIES
Tim Rypma

SIMONSON & ASSOCIATES
Sadie Kleppe

SLINGSHOT ARCHITECTURE
Dan Drendel

SNYDER & ASSOCIATES
Eric Cannon

TWO RIVERS MARKETING
Jill VanDerPol

TWG, INC.
J.B. Curry

URBAN DESIGN REVIEW BOARD
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Stephanie Weisenbach
Scott Allen

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Doug Bisson
Andy Gorham
Kristen Veldhouse
Austin Vachal
Alex Robinson
Thomas Schneider
Laura Luts Zimmerman

SBFRIEDMAN CO
Geoff Dickinson
Ryan Schmidt

WALKER CONSULTANTS
John Dorsett
Elspeth McGarvey

A special thanks to all those who attended the visioning workshop and Charrette; called, emailed, or visited with suggestions and ideas; provided insights, thoughts, and guidance; and assisted through the course of the planning process. If your name has been inadvertently omitted, we apologize and thank you for your contribution.

CITY OF DES MOINES

SBFRIEDMAN HDR WALKER CONSULTANTS

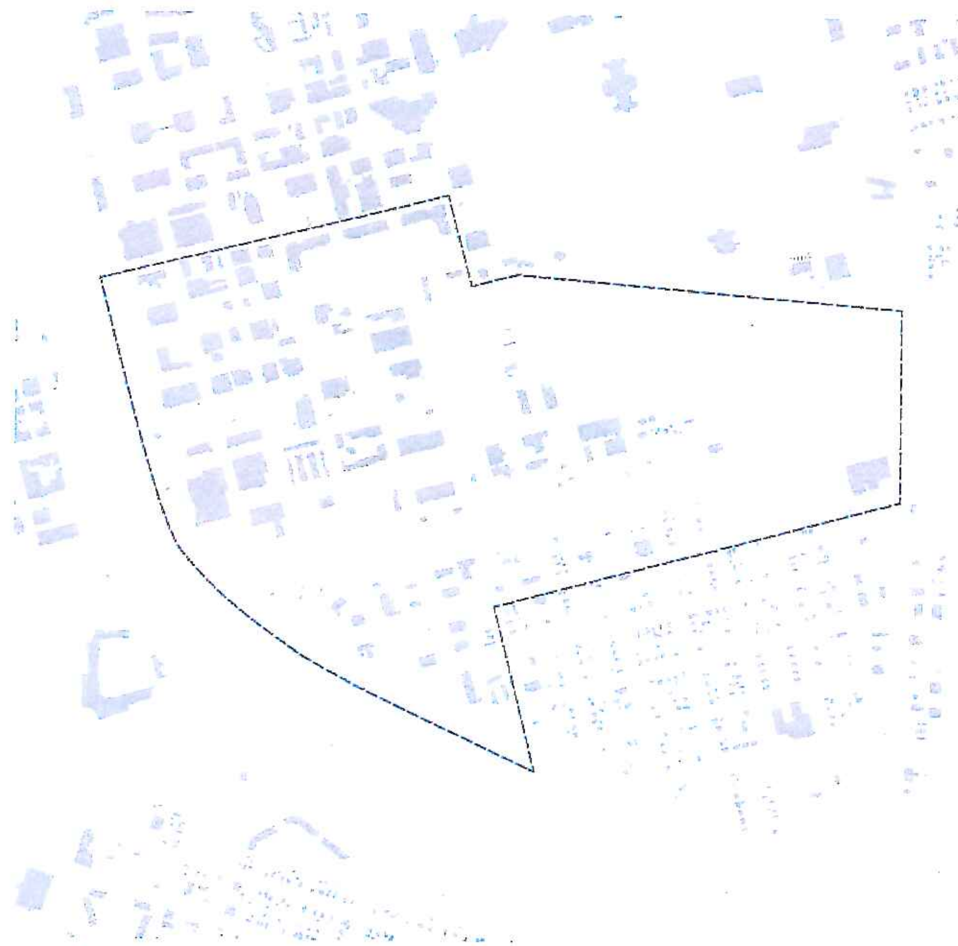
Table Of Contents

EXECUTIVE SUMMARY

The Market District is located on the east side of the Des Moines River, across from Downtown Des Moines and immediately south of the East Village. It is currently dominated by industrial uses, but is beginning to experience redevelopment pressure, with several active redevelopment projects currently in the pipeline. Guided by a multi-faceted master planning process, including a market assessment, public and stakeholder visioning, and a three-day iterative design charrette, a conceptual master plan was developed for the neighborhood. The goal of the plan was to create a walkable urban neighborhood that will support and supplement the on-going redevelopment activity in both Downtown Des Moines and the East Village. The neighborhood should be characterized by low- to mid-rise buildings with urban character, whereby buildings, and the uses contained within them, will address the street and help activate the sidewalks. New development should be pedestrian-oriented in order to encourage walking and dynamic street-level activity. A variety of uses and building typologies will be encouraged. Uses will be mixed both horizontally and vertically within individual buildings. Active uses, such as restaurants and retail stores, will be located on the first level of buildings located at key nodes, while office, hospitality, and residential uses will be encouraged on upper floors. Elsewhere within the district, residential options will be developed to encourage a variety of household types and income levels within the neighborhood, from Millennials, young professionals, and families to empty nesters, retirees, and seniors. Residential options should range from condos and apartments to missing middle typologies and townhomes. Residential options should also range in affordability. These uses will be interconnected by a robust mobility network equally serving the needs of pedestrians, bicyclists, vehicles, and transit. The neighborhood will be interspersed with a network of active and passive parks, open spaces, and trails, which will also function as the backbone of the district's green infrastructure network. Sustainability features are to be incorporated throughout the district, and will help define it as one of the most "green" neighborhoods in the State of Iowa.

To help ensure that the goals of the Market District Master Plan are met, several key Framework Initiatives are identified in the plan and should be implemented. Mobility enhancements include the appropriate design and construction of several new street segments, the establishment of a hierarchy of streets, the implementation of a comprehensive bicycle and pedestrian network, and the realization of a more robust transit system within the district. New development within the district will require the completion of a number of key infrastructure projects, including new sanitary sewer improvements, storm water conveyance improvements, and the construction of two large storm water detention areas. Because the area will transition into a dense neighborhood, several important park and open space enhancements must be made, including a new destination riverfront park that will act as a catalyst for new development projects, and a large, naturalized passive park that will also function as a storm water detention area. In addition, an entire suite of sustainability initiatives should be considered, analyzed for effectiveness and practicality, and implemented.

If developed according to the master plan, the Market District should yield over 3,400 housing units, with 3,300+ multi-family units and 100+ townhomes. The mixed-use structures will contain approximately 210,000+ square feet of office space and an additional 135,000+ square feet of retail space. Over 7,500 parking stalls are provided in a number of configurations, including on-street parking, surface parking lots, and parking structures. Details of the master plan, framework initiatives, and development yield are included on the following pages.



STUDY AREA BOUNDARY / EXISTING CONDITIONS

PROPOSED MASTER PLAN

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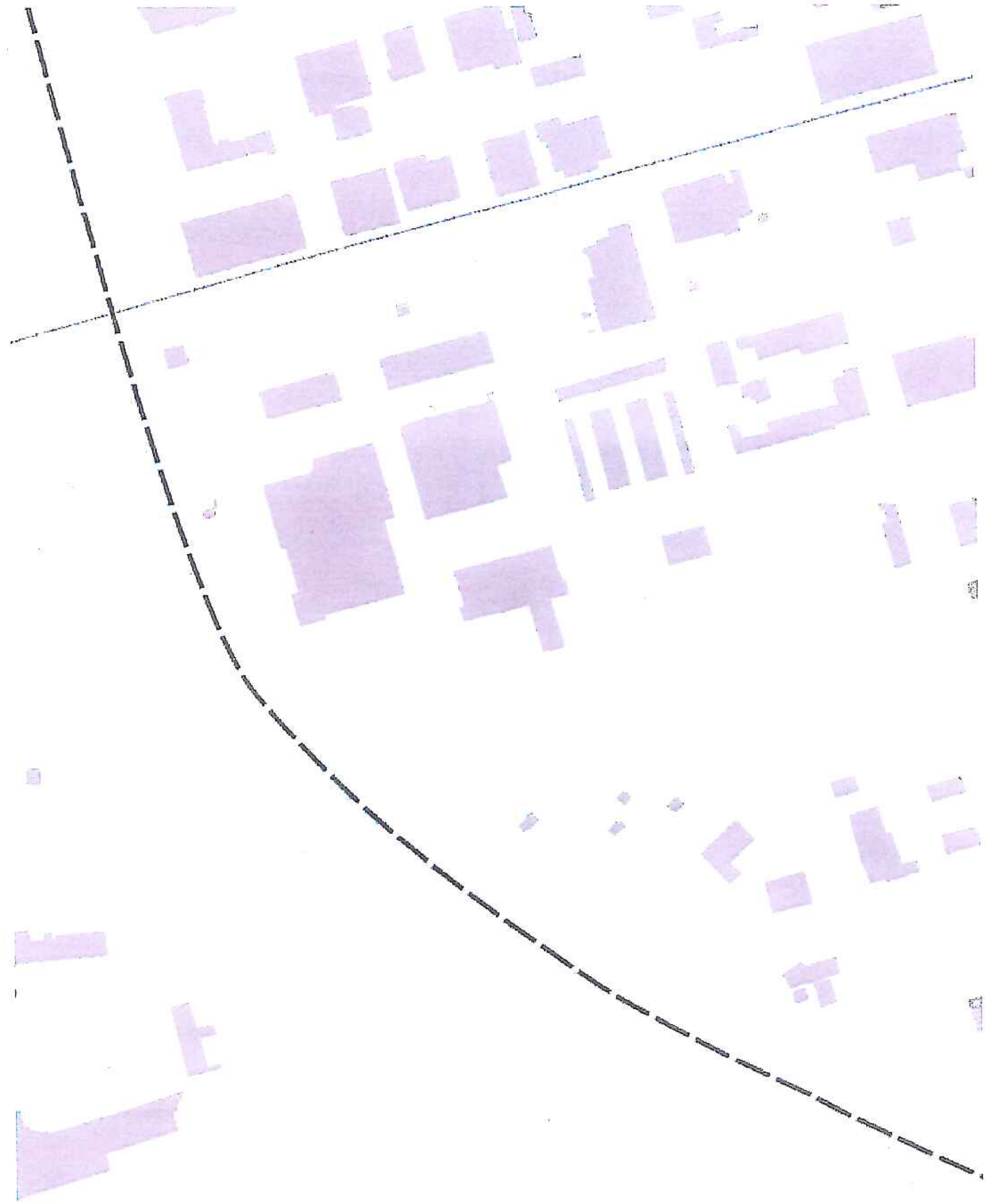
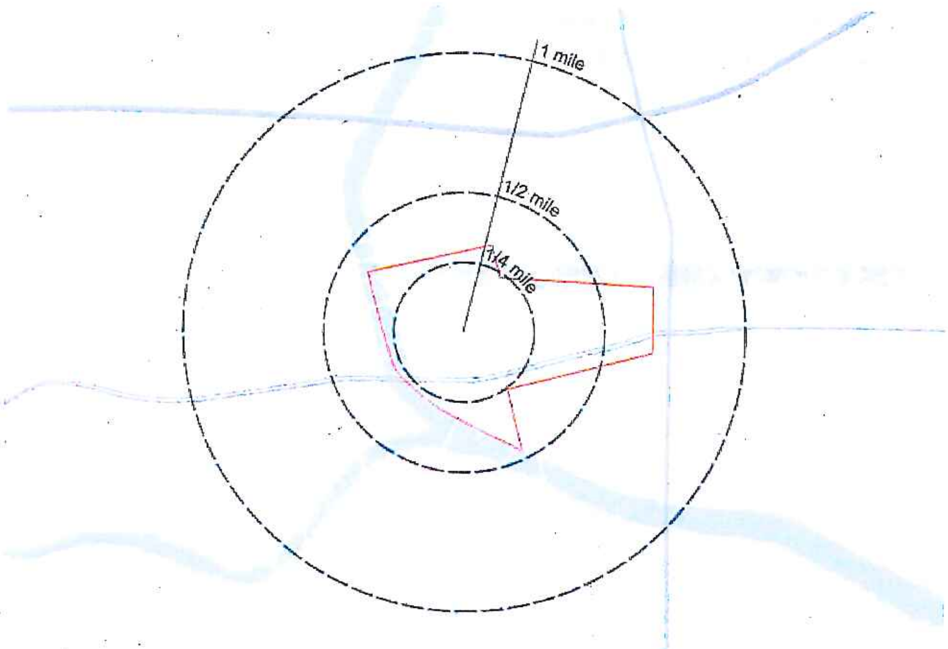


INVENTORY AND ANALYSIS

Vicinity Map
Study Area
Topography
Floodplain
Property Ownership
Existing Figure Ground
Building / Business Viability
Proposed Figure Ground

INVENTORY + ANALYSIS



VICINITY MAP

The Market District is located directly to the east of Downtown Des Moines and to the south of the core of East Village. The Iowa State Capital is located on the bluff line overlooking the district, approximately 1/2 mile to the northeast. The Market District is separated from downtown proper by the Des Moines River, which acts as a barrier between the two districts. The majority of the Market District is located within a 5-minute walk (1/4 mile) of the geographic center of the district (the intersection of E. 4th Street and E. Market Street). A large portion of East Village is located within a 10-minute walk (1/2 mile) of the center of the Market District. Due to the dynamics of its location, the Market District will likely function as a predominantly residential neighborhood that will support the office, retail, and cultural functions of East Village and Downtown Des Moines.

KEY:

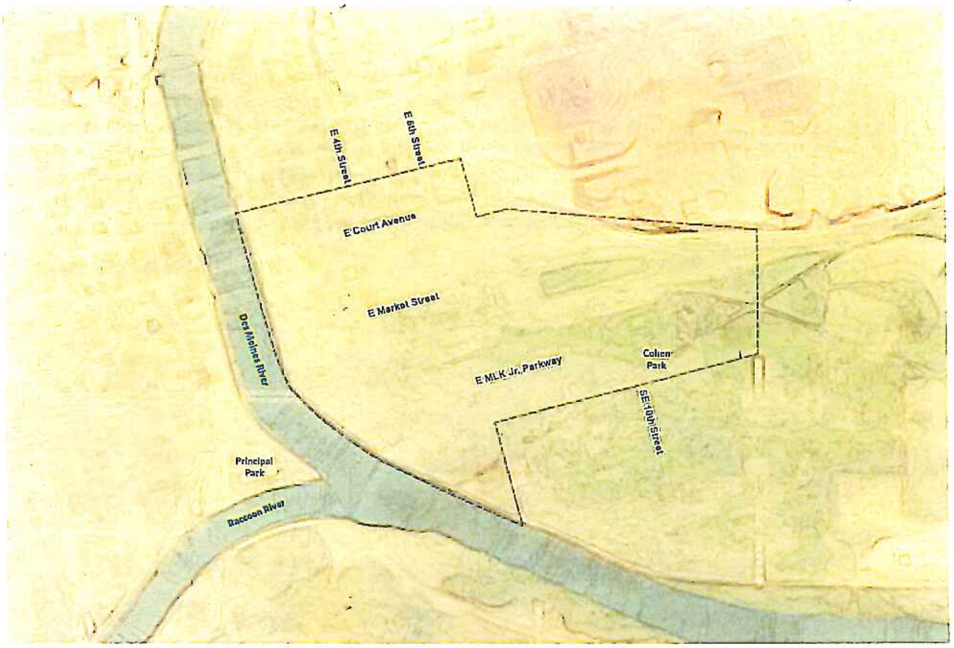
- Study Area
- Walk Distances

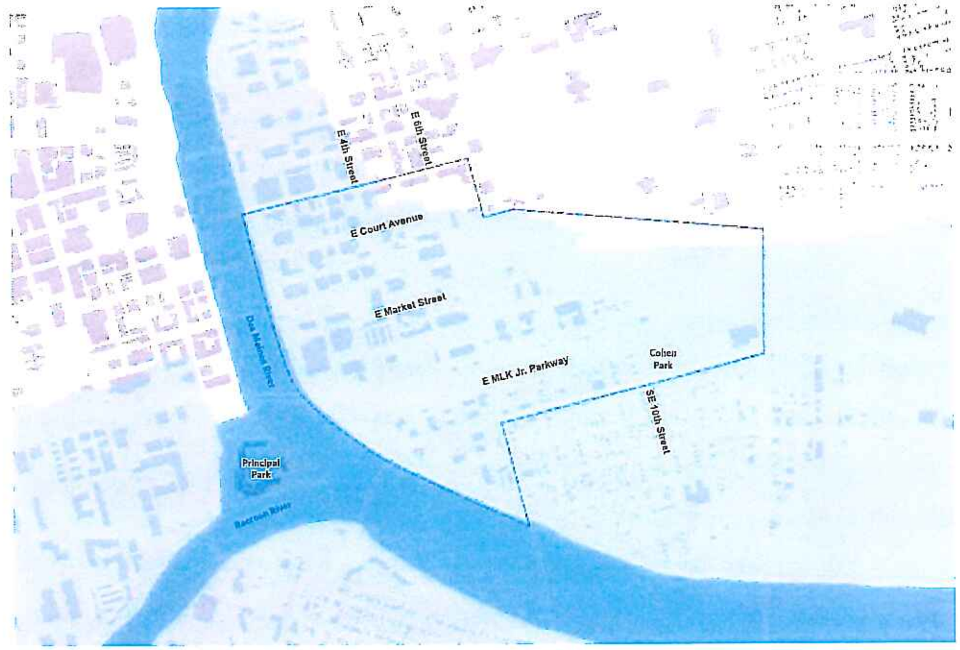
STUDY AREA

The Market District Study Area contains a variety of uses, including office, retail, residential (apartments and single family homes), and industrial. A majority of the area is industrial in nature, although it will continue its transition away from this use with the pending departure of both the MidAmerican Energy facility and the City-owned Public Works yard sites. South of MLK Jr. Parkway, single-family homes, small apartments, and civic uses predominate. The eastern portion of the Study Area is dominated by heavy industrial uses, aging railroad infrastructure. and vacant open space.

KEY:

- Study Area





TOPOGRAPHY

The Study Area is located between the Des Moines River and the river bluff overlooking Downtown Des Moines. Because the majority of the Study Area is former river floodplain, it is extremely flat, with little to no relief. This flatness has caused challenges with storm water during past heavy rainfall events. Only a small sliver of the Study Area (on the northeast corner) is located on the bluff, resulting in an extremely steep slope.

KEY:

Elevation

780' 840' 900'

FLOODPLAIN

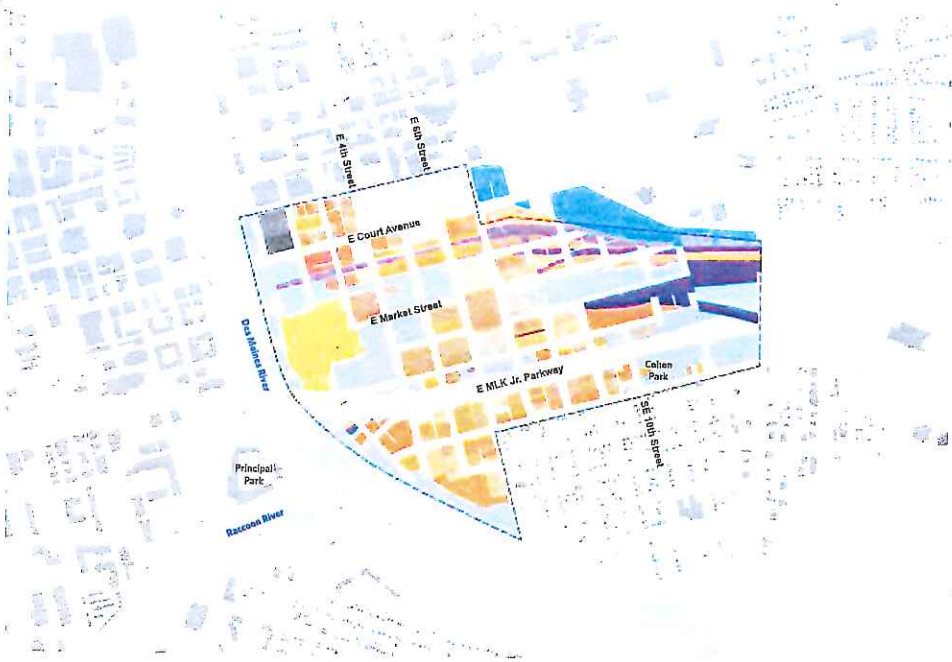
As mentioned in the previous section, the Study Area is former Des Moines River floodplain. However, a levee now protects the Study Area from river flooding. This levee will be reconstructed in the future, and pump stations will be enhanced providing additional protection from high water levels on the river. That said, heavy rainfall and flat topography cause storm water challenges during extreme events. The planning process for this study has identified potential storm water solutions to address these concerns, and will highlight them later in the document.

KEY:

100-Year Floodplain

Protected by Levee

INVENTORY + ANALYSIS

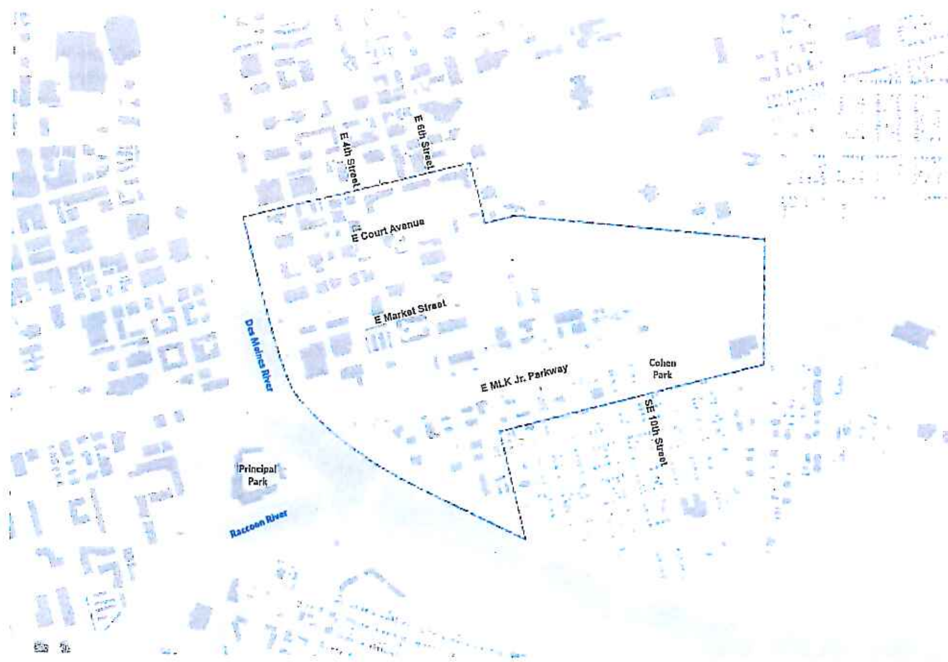


PROPERTY OWNERSHIP

Property within the Study Area is owned by a variety of owners. However, significant acreage is owned by the two largest property owners within the district – the City of Des Moines and MidAmerican Energy own a combined total of 50 acres of the 260 acre study area. Both owners have agreed to relocate to sites outside the district in the future. This presents a significant opportunity to transform their existing property with new projects that will act as catalysts for future growth and redevelopment within the district.

KEY:

- MidAmerican Energy
- City of Des Moines
- Federal Courthouse
- Salvation Army
- Railroads
- Various Ownership



EXISTING FIGURE GROUND

The Existing Figure Ground diagram identifies the built form within the Study Area. The northwest quadrant of the district (along Walnut Street and Court Avenue) contains good urban form (density, urban frontages, etc.) and is inherently walkable. As one moves to the south and east within the district, the urban form and walkability deteriorate as heavy industrial uses, parking lots, railroad tracks, right-of-way, and open space become the dominating features.

KEY:

- Existing Buildings

BUILDING / BUSINESS VIABILITY

The Building / Business Viability diagram identifies businesses within the Study Area that have long-term viability and are therefore likely to remain within the district, and buildings, regardless of their current use, that are candidates for restoration / renovation. Businesses highlighted as contributing structures are seen as vital and able to contribute to the goals and vision of the master plan.

KEY:

Contributing Structures

PROPOSED FIGURE GROUND

The Proposed Figure Ground diagram identifies the Market District Study Area with the buildings and businesses identified as not viable removed. The viable buildings and businesses remain, highlighting the anticipated future fabric upon which all new development will occur. With the exception of a handful of buildings, most everything between Market Street and MLK Parkway will be a clean slate for new development.

KEY:

Remaining Buildings

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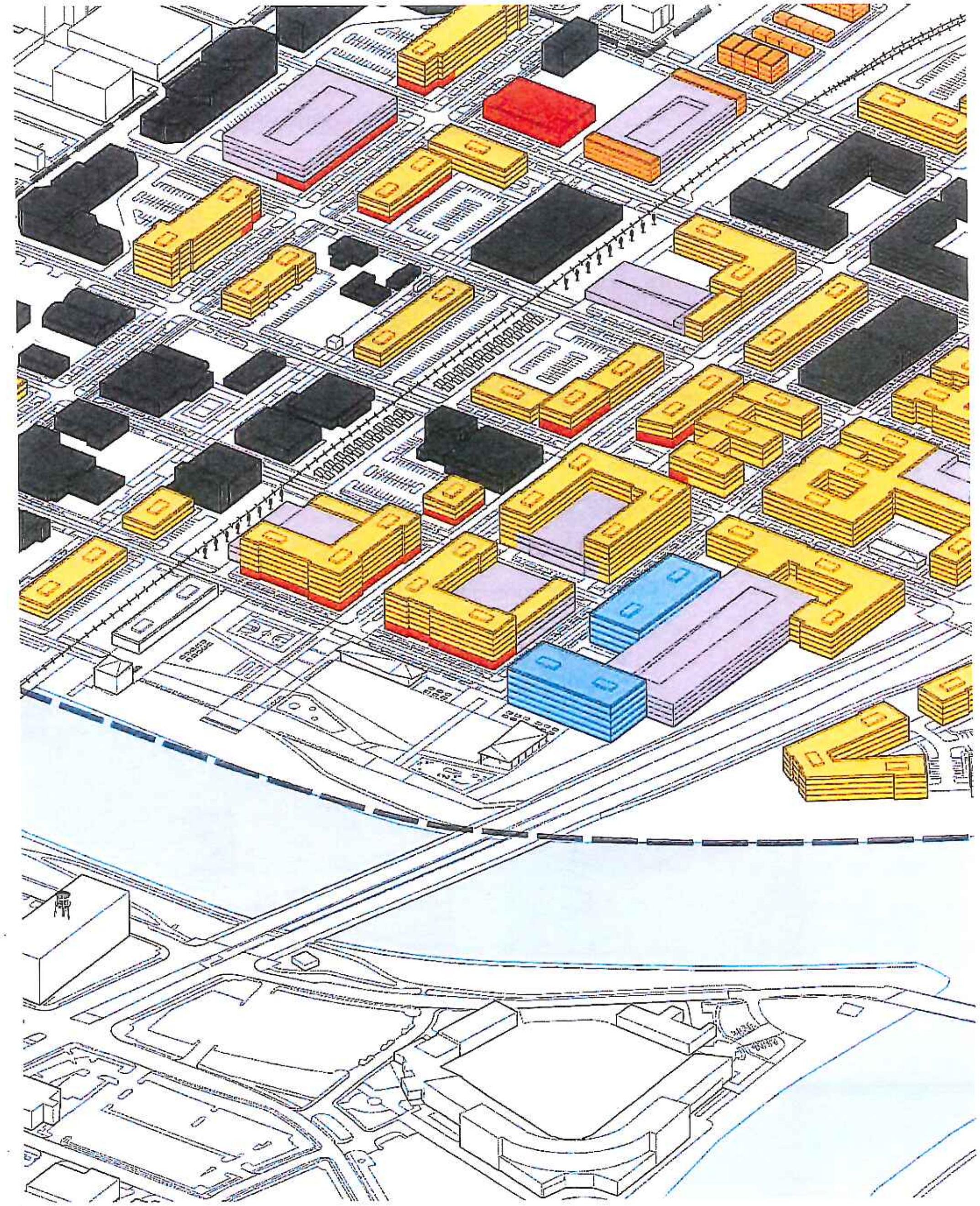
MARKET ASSESSMENT

Competitive Supply and Planned Projects
Development Potential
Preliminary Financial Projections



MARKET ASSESSMENT

INTRODUCTION

A real estate market assessment for various uses within the Market District of the East Village Study Area was performed. This section examines the district's competitive supply and planned projects, its development potential, and provides preliminary financial projections.

COMPETITIVE SUPPLY AND PLANNED PROJECTS

The competitive supply and development context for each of the four product categories/uses are summarized below. Key findings include the following:

MARKET RATE RENTAL APARTMENTS

Greater downtown Des Moines has seen substantial new market rate rental apartment development in recent years. This appears to be partly a function of changing housing preference and demographics and partly a function of the City's property tax abatement program for downtown rental apartments. Two projects are currently under construction within the Study Area. Workforce rental apartments should also be encouraged. **Figure 1** describes the competitive pattern for market-rate rental apartments.

RETAIL

Larger regional shopping centers in the Des Moines area tend to locate near major interchanges or along high-traffic, high-accessibility corridors. **Figure 2** summarizes major retail clusters in metro Des Moines.

In the greater downtown, there has been recent retail development including the new Hy-Vee store and smaller tenant retail development north of the Study Area in the East Village. All of which are being supported, in part, by new housing development that has been developed in the greater downtown in recent years.

OFFICE

Regionally, larger, newer Class A office buildings are located in West Des Moines and greater downtown Des Moines. **Figure 3** shows the distribution of corporate office development in the Des Moines market.

In the greater downtown, there has been recent office development including some smaller buildings on the east side of the Des Moines River. **Figure 4** shows the distribution of corporate office development in the greater downtown.

HOTEL

Hotel properties in the Des Moines market generally follow the freeway network with notable clusters downtown, near the airport, and in the West Des Moines area. **Figure 5** shows the locations of non-economy class hotels in the region.

In the greater downtown, there has been significant recent hotel development. See **Table 1** for a summary of non-economy class downtown hotels, building ages and room counts. **Figure 6** shows the distribution of non-economy class hotels in the greater downtown area.

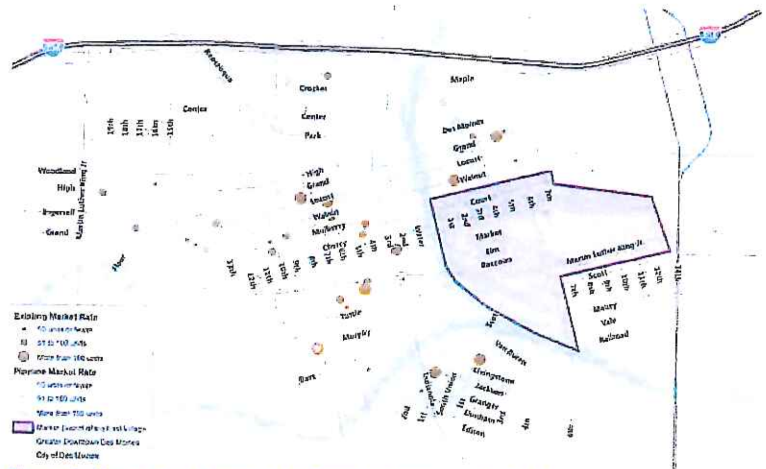


Figure 1: Market-Rate Rental Apartments in Downtown Des Moines

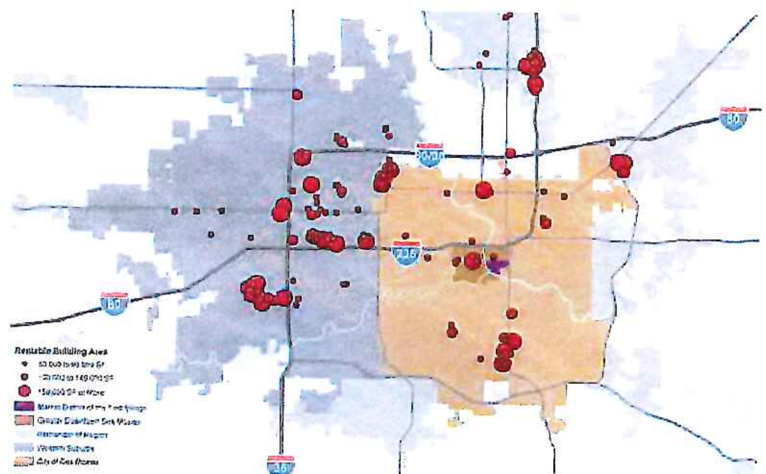


Figure 2: Major Retail Clusters in Metro Des Moines

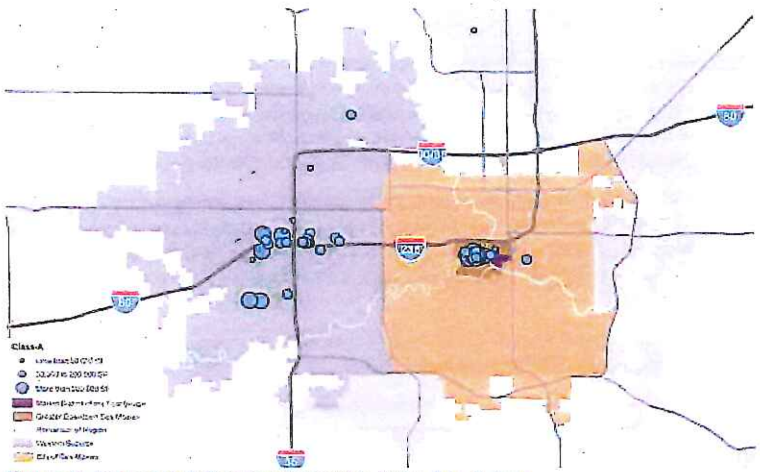


Figure 3: Corporate Office Development in Metro Des Moines

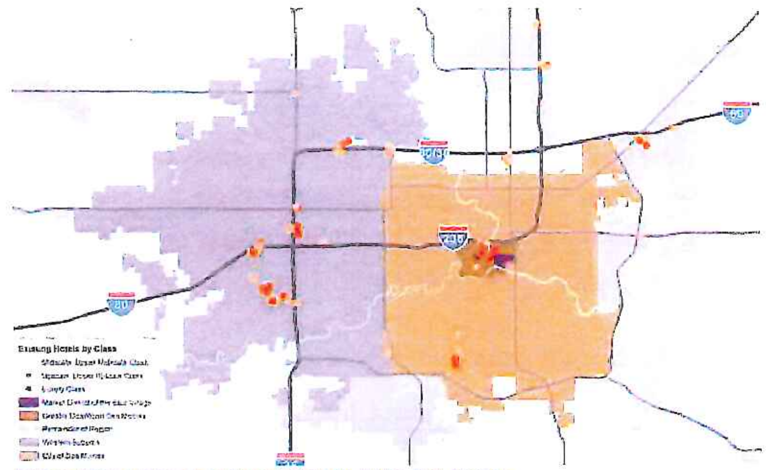


Figure 5: Non-Economy Class Hotels in Metro Des Moines

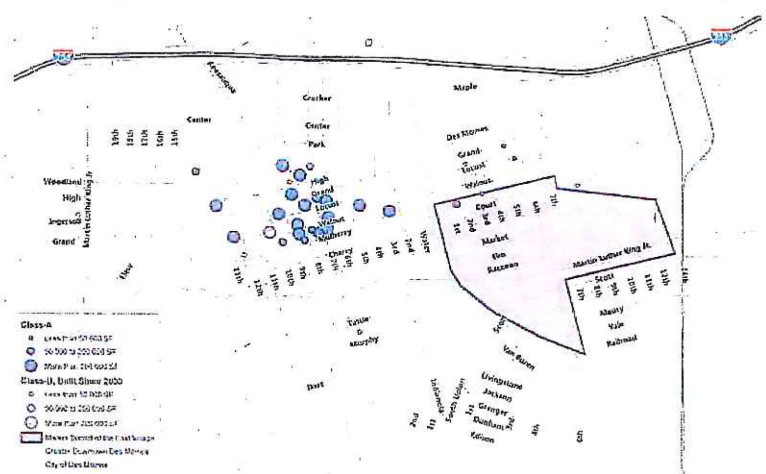


Figure 4: Corporate Office Development in Downtown Des Moines

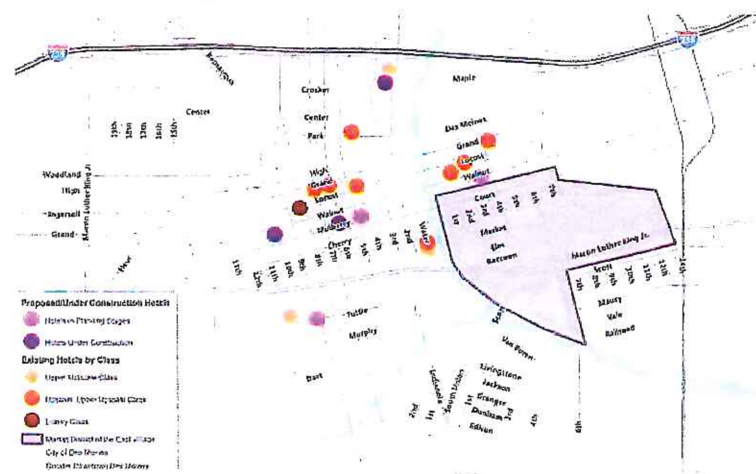


Figure 6: Non-Economy Class Hotels in Downtown Des Moines

DEVELOPMENT POTENTIAL

INTRODUCTION

Based on the analysis of competitive supply, demographic trends, demand and existing conditions within the Study Area, potential opportunities for development within the Study Area have been identified. Note that many of the sites in the Study Area are encumbered by buildings and/or other land uses that may complicate redevelopment. Further, it is assumed that the City will relocate the public works facility out of the Study Area in the near term and make the parcels available for redevelopment. It is also assumed that off-site infrastructure needs will be resolved and that a sufficient acreage of buildable land exists or can be made shovel ready at market-competitive land prices to accommodate projected demand.

DEVELOPMENT POTENTIAL

Development products that may be feasible in the near to middle term (next 10 years) include:

- **Residential:** There are still multiple potential residential sites available in and around downtown Des Moines. Thus, the Study Area will need to compete for housing demand going forward. The following potential for the Study Area is projected:
  - Market-Rate Multi-Family Rental Housing: Up to 1,000 units could be potentially developed (in addition to those currently in the development pipeline).
  - Workforce Multi-Family Rental Housing: It is assumed that City policy and/or other actions will be taken to support the development of workforce housing within the Study Area. Based on other developments in downtown, it is assumed that for every 10 units of housing built, one unit will be workforce rental housing affordable to households earning up to 80% of the area median income (AMI).
  - Affordable Multi-family Rental Housing: Similarly, housing for lower income households will need external funding support beyond the private sector. For modeling purposes, it is assumed that for every 10 units of housing built, one unit will be income-restricted for households earning up to 60% of AMI.
- **Retail:** There are multiple strong dining nodes in greater downtown already, as well as a retail cluster in the East Village area north of the Market District. Thus we see the retail potential in the Study Area focusing on serving the needs of new residents. We project there may be retail potential for up to 70,000 square feet of new retail space over the next 10 years. This square footage could include a drug store or small format grocer. Smaller in-line retail providing services to residents and visitors would also be included in this projection.
- Office development on the east side of the river has occurred in roughly 50,000 square foot buildings and has been a mix of Class A and B space. It is projected that over the next decade up to four of these 50,000 square foot buildings (for a total of 200,000 square feet) could elect to locate in the Study Area. Again, there are office sites in other parts of downtown, and the Study Area will have to compete for opportunities. In addition, a "wild card" major office user could elect to not locate near the Pappajohn Sculpture Park and instead locate in the Study Area. It is difficult to project the frequency of such decisions but, ideally, a master plan would be flexible enough to accommodate an opportunity like that should one materialize.
- **Hotel:** Recent hotel activity has occurred elsewhere in the downtown. Again, should an hotelier want to locate within the Study Area, the plan should be flexible enough to accommodate it. However, given the locations of dining amenities and corporate offices, if the market desires more hotel rooms in greater downtown. locations outside of the Study Area seem more attractive.

Name	Class	Open Date	Rooms
Comfort Inn & Suites Event Center	Upper Midscale Class	Jun 1973	155
Embassy Suites	Upper Upscale Class	Oct 1990	234
Des Lux Hotel	Luxury Class	Dec 2000	51
Hyatt Place	Upscale Class	Dec 2010	93
Residence Inn	Upscale Class	Jan 2014	127
Hampton Inn & Suites	Upper Midscale Class	Jun 2014	131
Holiday Inn Express & Suites	Upper Midscale Class	Feb 2016	102
Staybridge Suites	Upscale Class	Nov 2016	111
AC Hotels by Marriott East Village	Upscale Class	Feb 2017	109
Hilton Iowa Events Center	Upper Upscale Class	Mar 2018	330
Renaissance Savery Hotel	Upper Upscale Class	Oct 2018	140
Marriott	Upper Upscale Class	Renovated Oct 2018	417
Fairfield Inn and Suites	--	*Under Construction*	*91*
Hotel Fort Des Moines	--	*Under Construction*	*275*
Midland Building Conversion / Aporium	--	*Under Construction*	*138*
21C Hotel	--	*Proposed*	*120*
Element Hotel East Village	--	*Proposed*	*112*
Gray's Landing Hotel	--	*Proposed*	*98*

Table 1: Summary of Non-Economy Class Downtown Hotels, Building ages, and Room Counts

PRELIMINARY FINANCIAL PROJECTIONS

Building on the market assessment work, projections of incremental property taxes that would result if development occurred as projected above were developed. Key finding are summarized, below:

INCREMENTAL PROPERTY TAXES

Incremental property taxes within the Study Area over a 20 year period were projected. The goal of these projections was to estimate the amount of locally generated funding that could be available to fund infrastructure improvements and other potentially extraordinary costs of development within the Study Area.

The overall base value of the Study Area is approximately $25,000,000. The model projected incremental property taxes from (1) redevelopment based on the market projections above and (2) growth in the property value of parcels that do not redevelop but appreciate over time.

Preliminary projections indicate that the Study Area could produce approximately $111,000,000 in undiscounted incremental property taxes over the next 20 years. For estimation purposes, we estimated the present value of those projected taxes assuming a 3% cost of funds. The estimated 2018 value of this cash flow is roughly $77,000,000.

Key assumptions include the following:

- **Analysis Period.** Incremental property taxes were analyzed over a 20-year period starting in 2020.
- **Inflation, Reassessment, Rollback, and Tax Collection.** Annual inflation of 2% with biennial reassessments. Rollback values were applied per assumptions provided by the City of Des Moines (56% and 90% of residential and commercial EAV was taxed respectively). It is assumed that property tax collections occur one year in arrears.
- **Estimated Frozen Base Equalized Assessed Value (EAV).** For this analysis, the frozen base EAV has been estimated using the ratio of Market District properties' total current taxable value to the total current taxable value of the four TIF tax districts in which they are located. This ratio was applied to the total frozen base value of the four TIF tax districts in which Market District properties are located to generate an estimated frozen base value for the Market District properties.
- **Estimated Current EAV.** Current EAV of the Market District properties, inflated from 2018 values.
- **Allocation of Estimated Frozen Base EAV and Estimated Current EAV.** SB Friedman estimated projected incremental taxes from both new development and inflationary growth in the value of the parcels which do not see new development. Estimated Base and Current EAV were allocated to each of these respective analyses based on the estimated land consumption of new development versus the total area of the Market District. Land needs for new development were based on SB Friedman's market research and was estimated to be approximately 10 acres. Land subject to inflationary growth only was estimated to be approximately 120 acres.
- **Phasing and Timing of New Product.** The volume of new development brought online and flowing into the TIF projections was based upon the Development Potential outlined in the Market Assessment.

  1. Residential. Assumed to come online evenly, 100 units per year for the first 10 years of the analysis period. 80% were assumed to be market-rate units, 10% were assumed to be affordable units affordable to households at 60% AMI, and 10% were assumed to be affordable units affordable to households at 80% AMI.
  2. Office. Assumed to come online every other year starting in the first year of the analysis period in 50,000 SF chunks until reaching 200,000 SF of total new office.
  3. Retail. Assumed to come online in 5,000 SF chunks in each new residential or office development.
  4. Parking. Assumed to come online per standards for other land uses (1 space per each residential unit; 4 per 1,000 SF of office, 5 per 1,000 SF of retail).

- **Valuation Assumptions.** Assessed valuation was based on estimates provided by the City of Des Moines:

	Assessment Year Value (2017$s)	Assessment Year Value (2020$s)	Note
Residential (Market-rate) (per unit)	$105,000	$109,242	
Residential (80% AMI) (per unit)	$84,000	$97,394	SB Friedman adjustment of City of Des Moines data
Residential (60% AMI) (per unit)	$63,000	$65,545	SB Friedman adjustment of City of Des Moines data
Office (per SF)	$150	$156	
Retail (per SF)	$135	$140	
Parking Structure (per space)	$9,500	$9,884	

- **Property Tax Abatement for Residential Property.** SB Friedman's model accounts for the City's property tax abatement for new multifamily properties. No new value is realized on new multifamily value for the first 8 years, then phases in at 40% of value in year 9, 60% of value in year 10, and full value thereafter.
- **Deductions Assumption.** SB Friedman generated a blended base value of all property within the TIF district. Then, as new development comes online, a blended, average value per land square foot was deducted (based on the land needs of the development coming online).
- **Share of TIF Increment Eligible for Collection.** According to the City of Des Moines, it is estimated that only 80% of increment is eligible for collection by the TIF.
- **Tax Rate.** The City of Des Moines provided an estimated consolidated tax rate of 5.00% which was assumed to remain constant throughout the analysis period.
- **Land Use Intensity.** The following estimates of land use intensity were assumed:

	Land Use Intensity
Mid-rise Apartment	105 dwelling units/acre
Office	2.3 FAR
Parking	600 stalls/acre

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VISIONING

INTRODUCTION

A key element of the planning process was the establishment of a consensus-driven vision for the Study Area. The visioning process was comprised of three key components: specific interviews with key stakeholders, a visioning workshop, and a 3-day interactive design workshop. The vision, when combined with the site analysis and market assessment, helped form the principles necessary to guide the effort and was manifested in the development program that was used as the basis of design during the design workshop. To guide the planning effort, a thorough process for soliciting community input and establishing a consensus-driven vision was undertaken, and is highlighted on the following pages.

DATA ANALYSIS / CONTEXT ASSESSMENT WORKSHOP

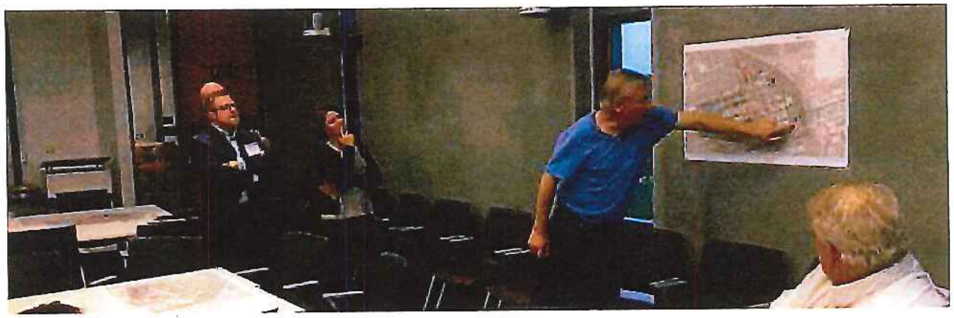
A day-long workshop was held on March 28, 2018. This Workshop was attended by key City Staff representing a number of City Departments. Key topics of discussion included an overview of the planning process; a discussion of existing, planned, and potential development within the Study Area; public realm conditions, including streets, rights-of-way, and public spaces; infrastructure needs; and a discussion of local, regional, and national precedents. Workshop discussion led to an enhanced understanding of the Study Area and provided future planning direction.

SPECIFIC INTERVIEWS

Twenty-five individuals were selected and took part in one-on-one and group interviews held on May 2nd, 7th, and 8th, 2018. The specific interviews were based on a standard list of questions and were meant to elicit feedback on the opportunities and challenges impacting future development within the Study area. Interviewees represented a variety of stakeholder groups, including local property owners, local business owners, developers, designers, Urban Design review Board members, and Planning and Zoning Commissioners.

VISIONING WORKSHOP

A visioning workshop was held on the evening of May 8th, 2018. City staff, key stakeholders, and the general public were invited to attend. Participants were provided an overview of the planning process and participated in a SWOT Analysis (Strengths, Weaknesses, Opportunities, and Threats) and performed a Geographic Mapping Exercise for the Study Area. The SWOT Analysis allowed participants to identify and vote on their top priorities in each category. The numbers next to each response on the following page identify the top vote receivers based on workshop participant responses. The Geographic Mapping Exercises allowed groups of participants to design their "dream" district. Details of the Visioning Workshop are provided on the following page.



VISIONING

Introduction
Data Analysis/Context Assessment Workshop
Specific Interviews
Visioning Workshop

SWOT ANALYSIS

STRENGTHS

Proximity to river	14
Walkability and proximity to other districts	10
History of area	6
Bike/Ped friendly	6
Nice scale	5

WEAKNESSES

Poor condition of existing infrastructure	10
Lack of workforce housing	7
No public transit	7
Lack of sidewalks / streetlights	6
Railroad	5

OPPORTUNITIES

Affordable housing	14
Proximity to water trails	10
Proximity to other districts	6
Fix MLK intersections / size	6
Highlight the river	5
Create a tourist attraction	4
Future development on City-owned parcels	4

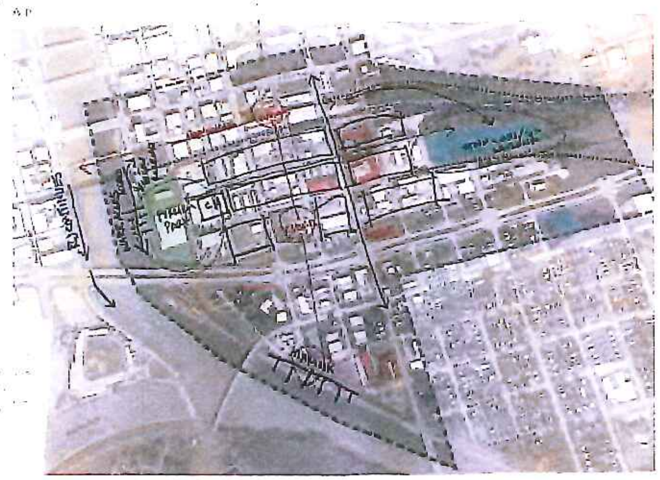
THREATS

Overabundance of unfordable housing	11
Not finding it's uniqueness	9
Odor	8
Gentrification of Bottoms neighborhood	7
Improper mix to draw from region	6

GEOGRAPHIC MAPPING EXERCISE

GROUP 1

- Riverfront Park on MidAmerican Energy site
- Wetlands on the eastern open space
- A "parkway" connecting the two spaces
- A bus line on 6th Street
- MU/Residential as a catalyst for development on the joint MidAmerican/City property
- Missing Middle residential lining MLK Parkway
- A new elementary school to act as a catalyst to draw families



GROUP 2

- Continue riverwalk to the south
- Provide River Trail water access
- Develop a small marina south of MLK Parkway
- Develop a public park on the MidAmerican energy site
- Develop storm water wetlands/ green space on the eastern open space
- Turn the old RR ROW into a promenade
- Scatter outdoor public event space throughout the district

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DEVELOPMENT PROGRAM

INTRODUCTION

GOALS

Ideas to Test on Monday

- Parking: Project by project or district solutions (structures)
- Parks/Open Spaces: Riverfront Programmed, eastern naturalized, plazas, and/or others
- Elementary School: Yes or no, test locations

South of MLK
detention

- Court Avenue: Preservation, restoration and infill or new development
- Large contiguous ownership sites: Preservation, restoration and infill or new development
- Primary N/S Corridors: 4th and 6th
- Primary N/S Corridors: Character - Vehicular or calmed
- Primary E/W Corridors: Court and MLK
- Primary E/W Corridors: Character - Vehicular or calmed
- E/W Complete/Green Corridors: Market Street and/or vacated RR corridor
- Drug Store/Critical Care: Test locations
- Sustainable Elements: Test
  - Green Infrastructure
  - E/W stormwater corridors connecting to river
  - Shared Space Streets
  - Complete/Green Streets Concepts
  - JOE → Permeable Paving Options
  - District Energy/Geothermal Loop – Where?
  - Waste Heat Options
  - Other
- Street Grid: Test reconnections
- TOMORROW Density: Test building typologies
- Trail Connections: Test locations
- TOMORROW Neighborhood Service Uses: Test locations, must be strategic
- Move Market to East side of river: Yes or No
- Vacate Raccoon Street to create better development parcels: Yes or no
- Vacated Rail Corridor: Promenade/trail and/or Novelty Streetcar line?
- Active rail corridor: How address street/ROW on south side?
- JOE → RR Quiet Zone: Test (identify requirements and ramifications)
- Applicable Design Standards: Review and test for ramifications
- Transit: Need and Potential Locations (routes and stops)
- Rail Transit: Stop in district? Ramifications?
- [illegible] Connections across river to Downtown: How address?
- Connections across Court Avenue: How address?
- Park/Open Space Programming – Family Oriented: Test
  - Passive
  - Active
  - Playgrounds
  - Dog Parks
  - Community Gardens
  - Skate Parks
  - Food Trucks
  - Art
  - Performance/Programmable
  - Other
- Other

• Water Trails: where to have axis?

DEVELOPMENT PROGRAM

INTRODUCTION

Based on the findings of the inventory and analysis, the market assessment, and the visioning process, and guided by discussions with City staff and key stakeholders, a development program was created for use during the 3-day design workshop. The development program was comprised of key findings and specific elements deemed necessary to achieve the objectives of the master planning process, and contained key elements to be explored and tested during the interactive workshop.

GOALS

The goal for the Market District was to create a walkable urban neighborhood that will support and supplement the on-going redevelopment activity in both Downtown Des Moines and the East Village. The neighborhood will be characterized by low- to mid-rise buildings and urban character, whereby buildings, and the uses contained within them, will address the street and help activate the sidewalks. New development should be pedestrian-oriented in order to encourage walking and dynamic street-level activity. A variety of uses and building typologies will be encouraged. Uses will be mixed both horizontally and vertically within buildings. Active uses, such as restaurants and retail stores will be located on the first level of buildings located at key nodes, while office, hospitality, and residential uses will be encouraged on upper floors. Elsewhere within the district, residential options will be developed to encourage a variety of household types and income levels within the neighborhood, from Millennials, young professionals, and families to empty nesters, retirees, and seniors. Residential options will range from condos and apartments to missing middle typologies and townhomes. These uses will be interconnected by a robust mobility network equally serving the needs of pedestrians, bicyclists, vehicles, and transit. The neighborhood will be interspersed with a network of active and passive parks, open spaces, and trails, which will also function as the backbone of the district's green infrastructure network. Additional sustainability features will be incorporated throughout the district and help define it as one of the most green neighborhoods in the State of Iowa. The images below show examples of various building typologies that would be appropriate within the Market District.

Example of Mixed-Use Building Typology

Example of Multi-Family Building Typology

Example of Townhome Building Typology

Des Moines Market District

Overview
- Create a great, walkable, urban district
- Do not rename it, call it East Village
- Should be primarily residential, providing rooftops and feeding the other adjacent districts
- Limited neighborhood service retail in strategic locations
- Do not move the farmer's market from across the river
- District should be urban, walkable, and bike friendly
  - Too much recent emphasis on bike facilities instead of pedestrian facilities
- Goal is to create critical mass and housing options to support other areas

Development Program
- Mid to long-term (2040)
- Residential
  - Apartments – 4 to 6 projects
    - 100 to 200 units in each
  - Townhomes (?)
- Office
  - 200,000 sq. ft.
    - 50,000 sq. ft. increments
- Retail
  - 50,000 sq. ft.
    - neighborhood service
    - Strategic locations
- Hospitality
  - Possible

Framework Elements from Previous Plan
- Existing Buildings (figure Ground)
- Buildings and Business Viability (figure ground, with economically viable buildings in bold)
- Potentially Viable Buildings and Businesses to remain (figure ground, others deleted)
- Property Ownership
- Site Importance
- Views and Corridors
- Nodes and Gateways
- Building Use
- Open and Public Space
- Transit Routes
- Bicycle Routes and Trails
- Sustainability and Infrastructure
- Master Development Concept Plan

Ideas to Test on Monday
- Parking: Project by project or district solutions (structures)
- Parks/Open Spaces: Riverfront Programmed, eastern naturalized, plazas, and/or others
- Elementary School: Yes or no, test locations
- Court Avenue: Preservation, restoration and Infill or new development
- Large contiguous ownership sites: Preservation, restoration and Infill or new development
- Primary N/S Corridors: 4th and 6th
- Primary N/S Corridors: Character - Vehicular or calmed
- Primary E/W Corridors: Court and MLK
- Primary E/W Corridors: Character - Vehicular or calmed
- E/W Complete/Green Corridors: Market Street and/or vacated RR corridor
- Drug Store/Critical Care: Test locations
- Sustainable Elements: Test
  - Green Infrastructure
  - E/W stormwater corridors connecting to river
  - Shared Space Streets
  - Complete/Green Streets Concepts
  - Permeable Paving Options
  - District Energy/Geothermal Loop – Where?
  - Waste Heat Options
  - Other
- Street Grid: Test reconnections
- Density: Test building typologies
- Trail Connections: Test locations
- Neighborhood Service Uses: Test locations, must be strategic
- Move Market to East side of river: Yes or No
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  - Passive
  - Active
  - Playgrounds
  - Dog Parks
  - Community Gardens
  - Skate Parks
  - Food Trucks
  - Art
  - Performance/Programmable
  - Other
- Other

Development Program

Photos of current Conditions in Market District Study Area

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DESIGN CHARRETTE

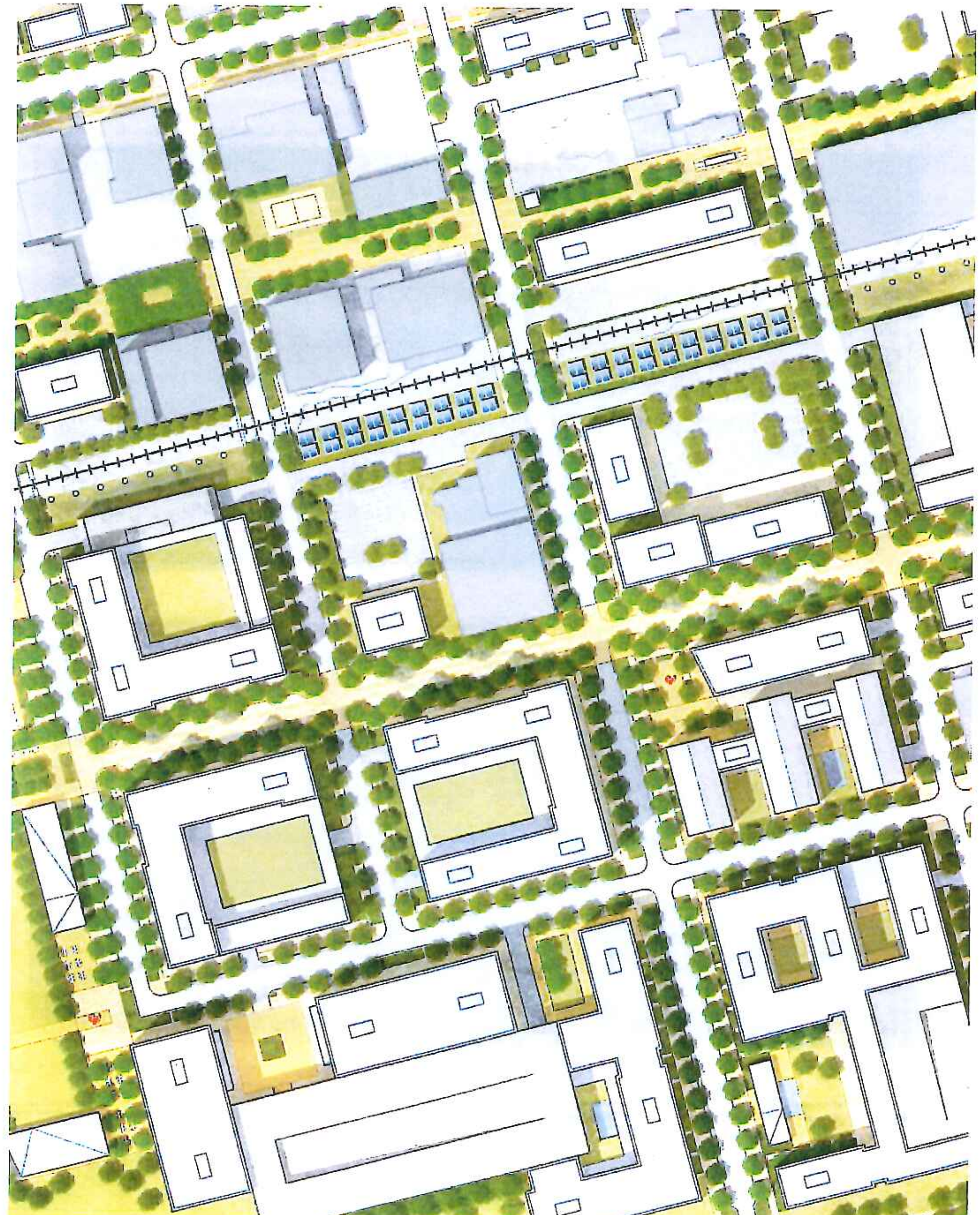
INTRODUCTION

The focal point of the Market District master planning process was the Design Charrette. The Charrette was held over a three-day period from June 4th – 6th, 2018. The Charrette merged the results of the site inventory and analysis, market assessment, visioning process, and development program. The focus of the Charrette was to develop a conceptual master plan for the Market District Study Area.

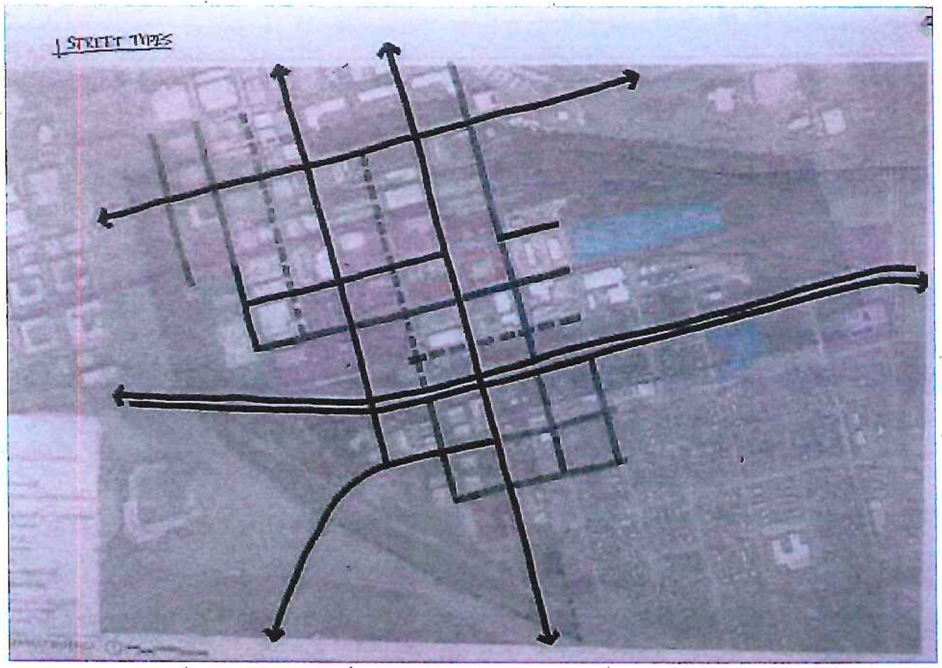
The Charrette was staffed by design professionals from a variety of backgrounds and specialties, including urban planning and design, landscape architecture, transportation planning, site/civil engineering, and market/real estate advisory services. Held over the course of three days and attended by City staff, elected officials, key stakeholders, and the general public, the iterative process continually tested ideas and concepts and made revisions based on input received from the participants during evening pin-up sessions. Ideas were continually refined, so that by the end of day three, general consensus on the key framework elements and development concepts to be included in the master plan had been achieved. The results of the Design Charrette are included on the following pages.

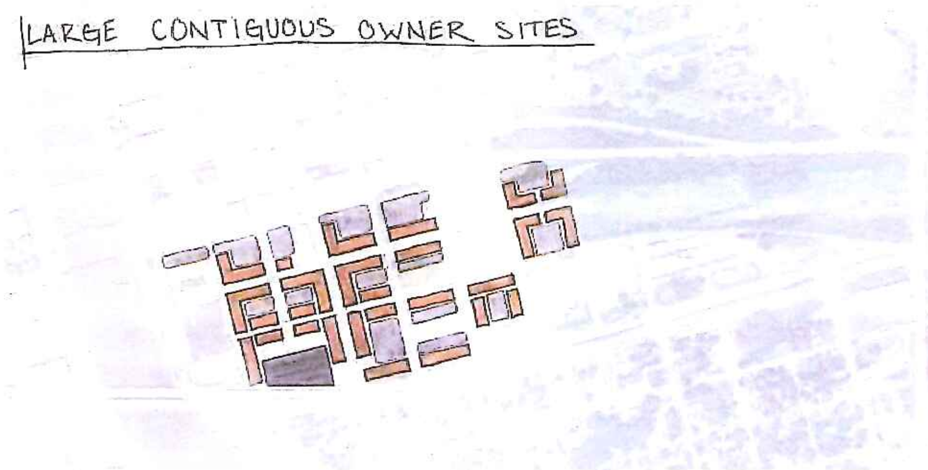
Photos of current Conditions in Market District Study Area

MASTER PLAN
Design Charrette
Master Plan



DAY 1:



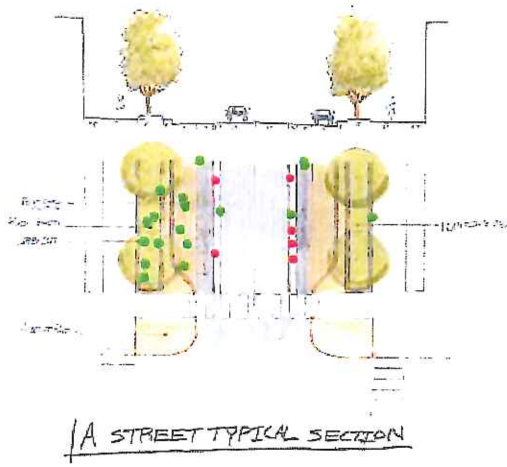


JUNE 4TH, 2018

Day one of the Charrette explored a number of concepts for the Study Area. These concepts focused on key "big picture" organizational aspects of the district, including future street typologies, the future street grid, district parking, conceptual park and open space system, and initial sustainability elements. A number of site specific elements were also examined. These included infill development along Court Avenue, development options for the large contiguous parcels owned by MidAmerican Energy and the City, locations for neighborhood service retail, and contextual development options south of MLK Parkway. These elements were presented and discussed during the day-one evening pin-up session

DESIGN CHARRETTE

DAY 2:

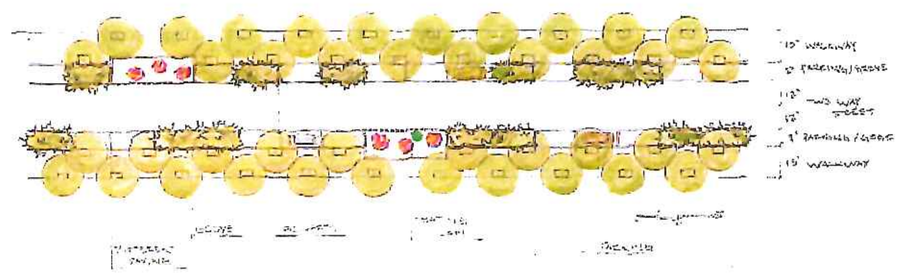


JUNE 5TH, 2018

Based on voting and comments received during the previous evening's evening pin-up session, revisions and refinements to these elements were made on day two of the Design Charrette. Refinements were made to the district's key framework elements, including the street typologies and street grid, the park and open space system, and sustainability elements. Details were added to a number of features and site-specific elements, including the riverfront and naturalized parks, potential street sections, the promenade, and south of MLK Parkway development typologies. All elements were then consolidated into an overall conceptual plan diagram of the district, and then presented and discussed during the day-two evening pin-up session.

DAY 3:

MARKET STREET
SHARED SPACE STREET



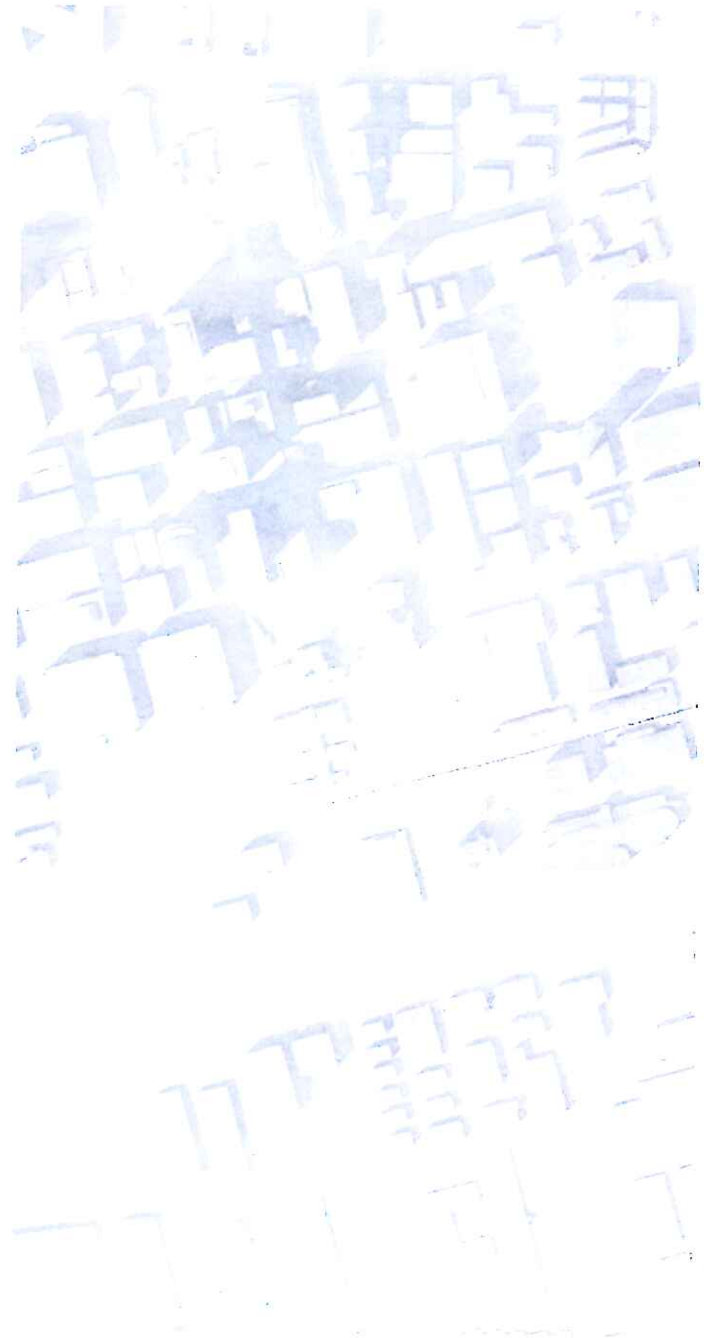
JUNE 6TH, 2018

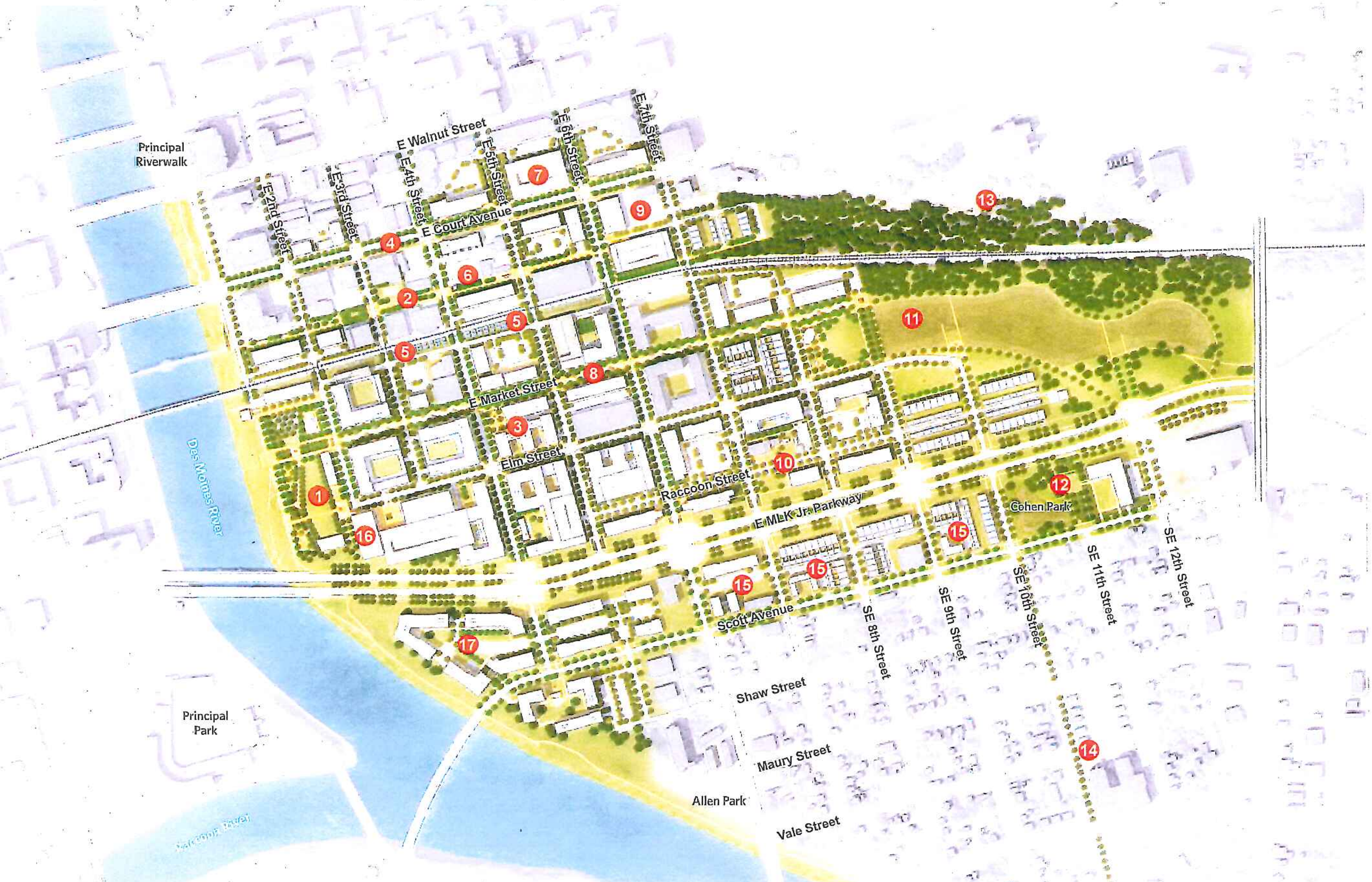
Based on voting and comments received during the previous evening's evening pin-up session, revisions and refinements to these elements were made on day three of the Design Charrette. Refinements were made to the district's key framework elements, including preferred street typologies and street grid, preferred south of MLK Parkway development typologies, and preferred park and open space elements. Final details were added to a number of features and site-specific elements, including the riverfront and naturalized parks and preferred street sections. The refined elements were then consolidated into an overall preferred conceptual plan diagram of the district, and then presented during the day-three evening pin-up session.

MASTER PLAN

During the weeks following the Design Charrette, key findings were vetted with City of Des Moines staff and members of the Urban Design Review Board. Where necessary, minor revisions and clarifications were made, and details were added. Images and graphics prepared in color pencil and marker during the 3-day charrette were digitally re-drawn and rendered in color. The results are highlighted and documented on the following pages.

1. DESTINATION RIVERFRONT PARK
2. EAST VILLAGE PROMENADE
3. MARKET STREET PLAZA
4. COURT AVENUE CYCLE TRACK
5. SUSTAINABLE ENERGY - SOLAR
6. SUSTAINABLE ENERGY - GEOTHERMAL LOOP
7. STRUCTURED PARKING W/ RETAIL LINER
8. SHARED SPACE / GREEN STREET
9. NEIGHBORHOOD GROCERY
10. STANDARD OIL COMMONS
11. NATURALIZED STORM WATER PARK
12. COHEN PARK ENHANCEMENTS
13. CAPITOL TRAIL CONNECTION
14. EAST VILLAGE LOOP
15. MISSING MIDDLE HOUSING
16. SIGNIFICANT OFFICE SITE
17. SIGNIFICANT SITE FOR HOUSING, OFFICE, OR CULTURAL USE





Principal Riverwalk
E Walnut Street
E 2nd Street
E 3rd Street
E 4th Street
E 5th Street
E 6th Street
E 7th Street
E Court Avenue
E Market Street
Elm Street
Raccoon Street
E MLK Jr. Parkway
Cohen Park
Scott Avenue
SE 8th Street
SE 9th Street
SE 10th Street
SE 11th Street
SE 12th Street
Shaw Street
Maury Street
Allen Park
Vale Street
Principal Park
Des Moines River
Raccoon River
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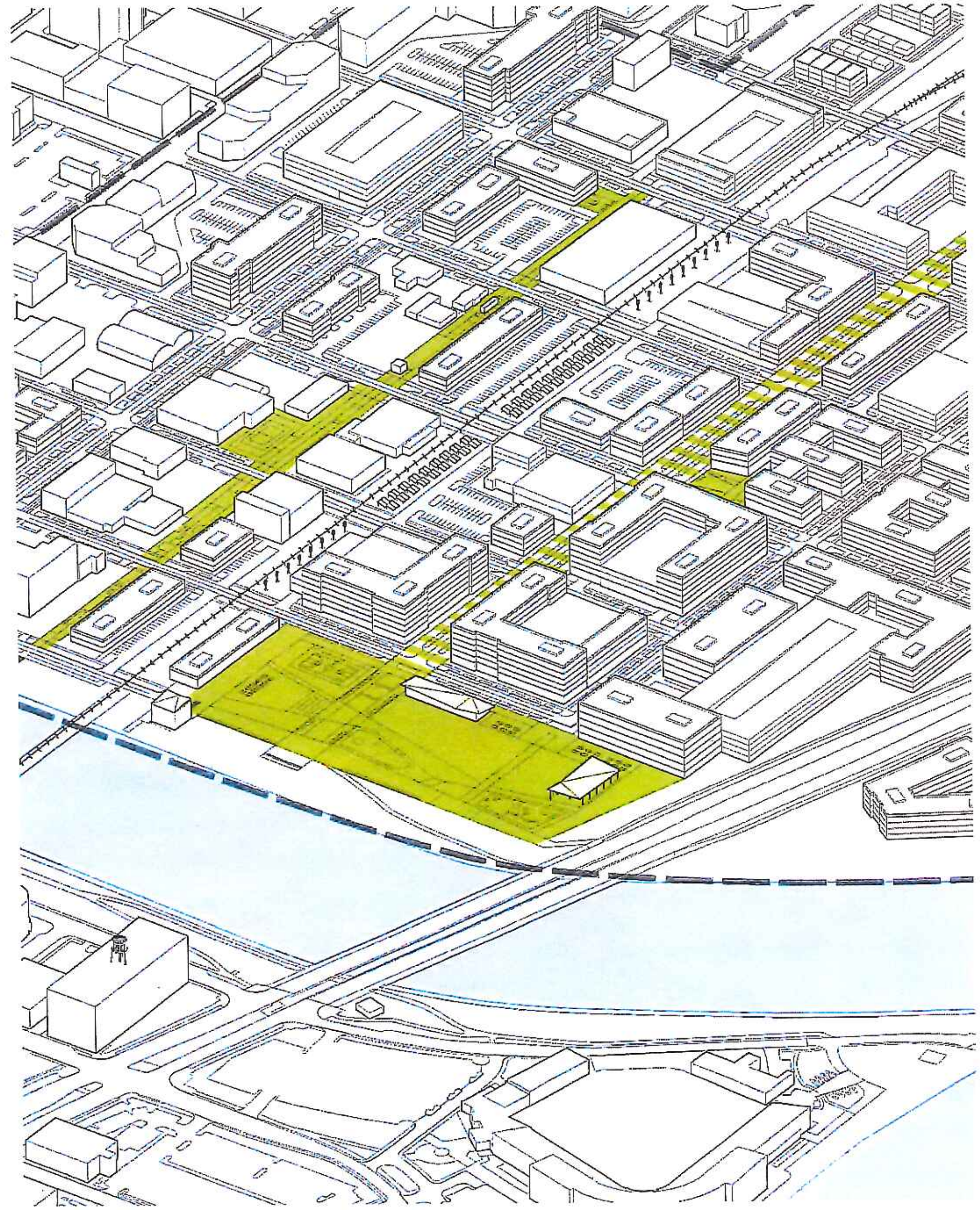
FRAMEWORK ELEMENTS

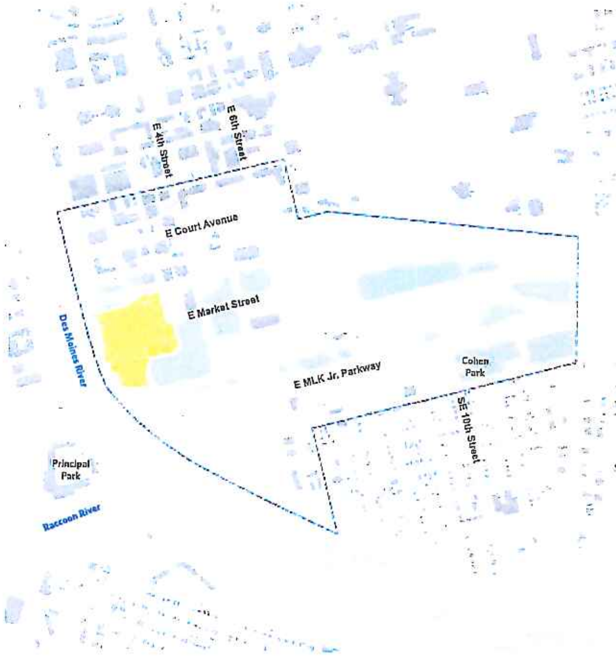
Overview
Mobility
Key Infrastructure
Park and Open Space System
Sustainability
Urban Form



OVERVIEW

INTRODUCTION

During the course of the master planning and design process, several prominent features and initiatives were discussed on a recurring basis. Due either to their prominent role in the plan, or their relevance and impact on other elements, these features came to be known as Framework Elements. These Framework elements are discussed in further detail on the following pages.

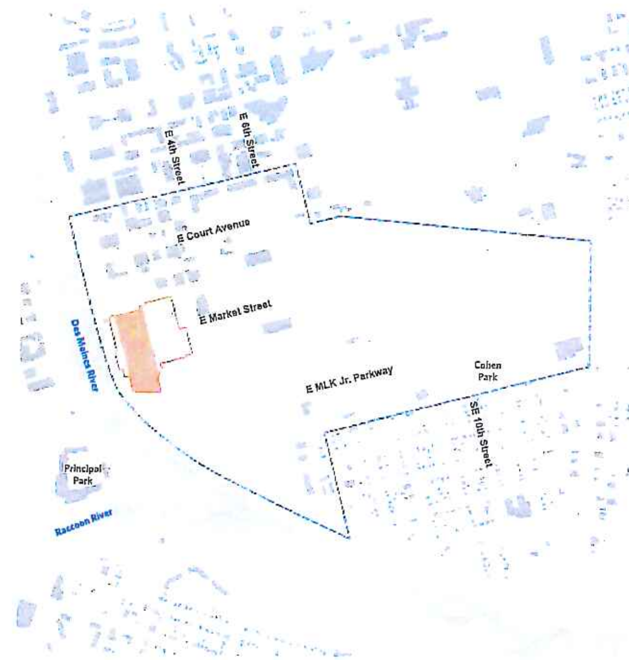


SITE IMPORTANCE

A significant amount of property within the Study Area is owned by two key property owners – The City of Des Moines and MidAmerican Energy. Both of these property owners have pledged to vacate their facilities within the district, ultimately making their respective properties available for redevelopment. It can't be overstated how significant and unique of an opportunity it is to have such an abundance of well-located property positioned to act as a catalyst for redevelopment within the district. It will be important to work with both entities to ensure that their respective properties transition into projects that add value and benefit to the Market District.

KEY:

- MidAmerican Energy Site
- City Property



MIDAMERICAN ENERGY SITE

As discussed in the previous section, MidAmerican Energy owns a significant amount of land within the Study Area. However, a large portion of its property is contaminated. Due to its strategic location along the riverfront, the planning process identified the portion of their property as the preferred location for a destination riverfront park that would act as a catalyst for district-wide redevelopment. In order to realize this vision, all appropriate jurisdictions, including MidAmerican Energy, will need to work together to ensure that the design of this park abides by the restrictions placed on this property and achieves the vision and goals for this park as set out in the Market District Master Plan.

KEY:

- Contaminated Area
- MidAmerican Energy Site

R.O.W VACATION + NEW STREETS

Due to the presence of several industrial uses, existing and former rail lines, and a number of street vacations that have occurred over the years, a large portion of the historic street grid no longer exists within the Study Area. In order to add value by providing opportunities for additional street frontages, calm traffic by developing a street system that widely distributes traffic, and enhance the walkability of the district by creating smaller blocks and more intersections, a number of new street segments have been proposed for the Study Area. Alternatively, there are a few instances where it will be advantageous to vacate a street. When the new E. MLK Jr. Parkway was established, it left a number of small blocks north of the Parkway that are hard to develop. One block of E. 2nd Street and 3 blocks of Raccoon Street have been identified as vacation candidates in order to create blocks / building sites that are large enough to accommodate new development projects.

KEY:

- New Street Segments
- Street / ROW to Vacate

PROPOSED BLOCK STRUCTURE

A new block structure for the Market District emerges with the addition of 25 new street segments and the vacation of four street segments. What was once an industrial district with a rather disconnected street network will now be transformed into a neighborhood with a nearly intact street grid. The ensuing block structure that is created is ideal for creating the desired pedestrian-oriented, mixed-use neighborhood that is desired.

KEY:

- Development Blocks

MOBILITY

INTRODUCTION

Traveling to and from one's daily destinations is a key part of most everyone's typical day. As a result, ensuring mobility and accessibility should be a key element of any master planning process. This means designing not only for personal vehicles, but for pedestrians, bicyclists, transit, and the distribution of goods. With this as a goal, there are a number of Market District Framework Elements that relate to mobility, which are described on the following pages.

STREET HIERARCHY

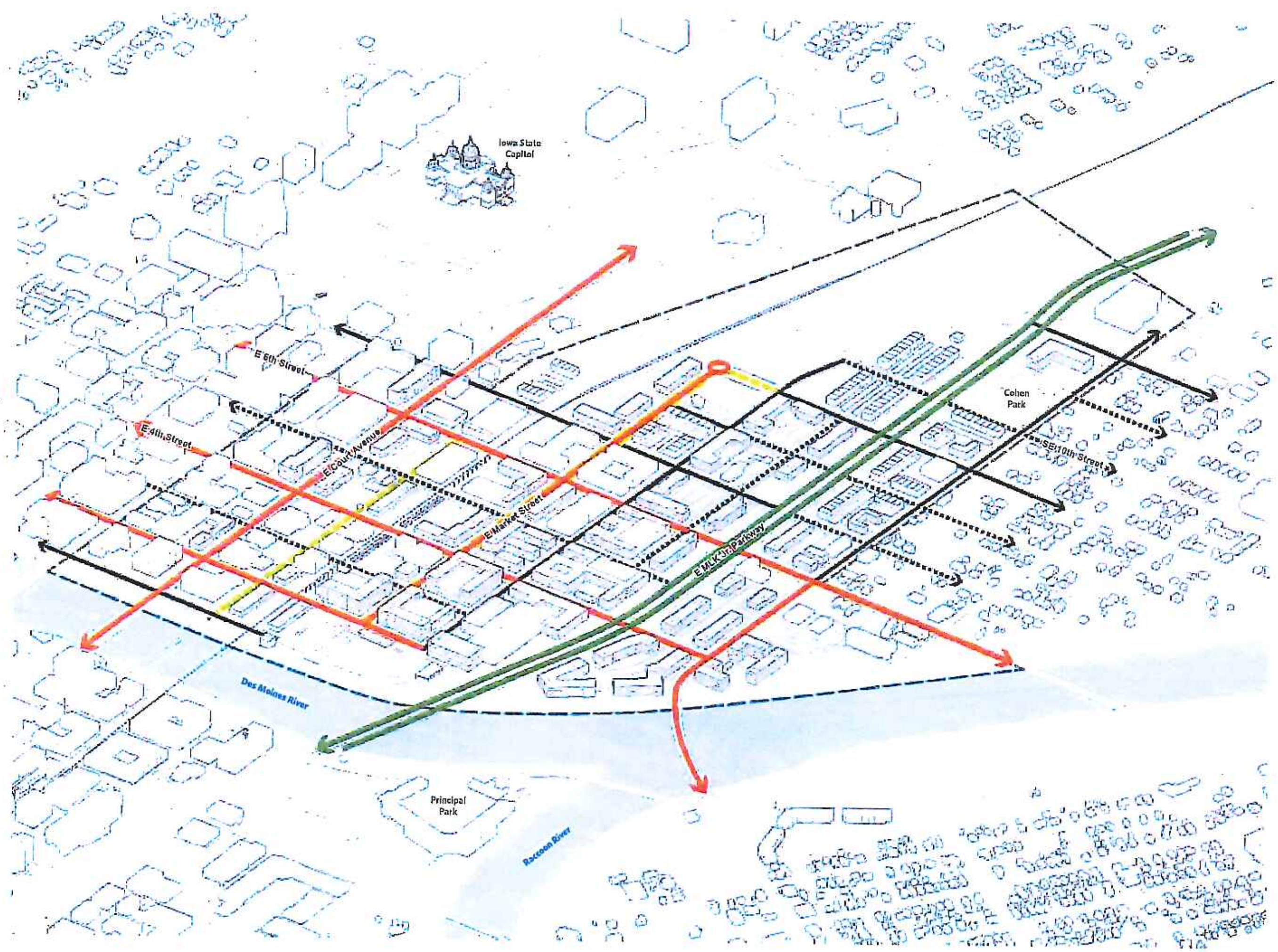
When crafting a new district, it is extremely important to identify and establish a hierarchy of streets. It is important to note that all streets do not, and should not, look and function alike. Instead, they should be contextual with their purpose and location. For the Market District, this means establishing a variety of street typologies, including **Special Streets, A Streets, B Streets, and C Streets.**

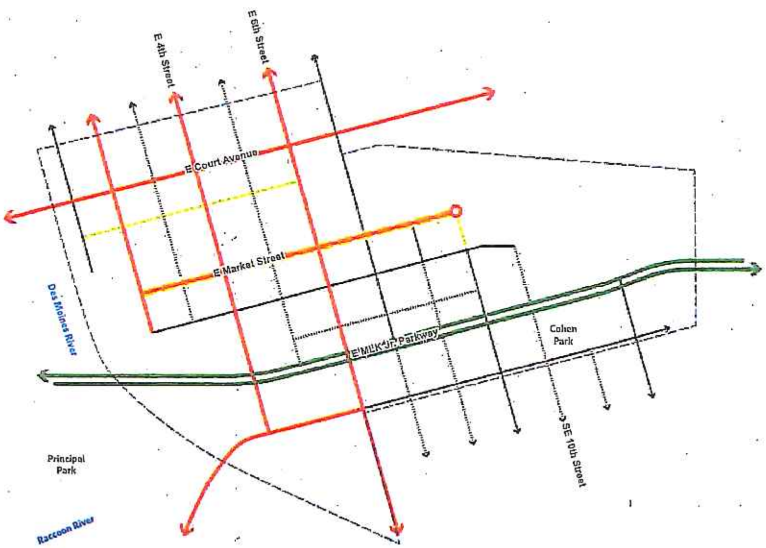
Special Streets are those unique, one-of-a-kind streets that have no equal within a given area. A good example of this is MLK Parkway. This existing street functions as a regional arterial, but is designed as a parkway, with wide landscaped medians and parkway strips, bike lanes, a parallel shared-use path, and streetscape enhancements at key intersections. With the exception of reducing the turning radii at key intersections and providing enhanced pedestrian refuge islands at key crossings, this street should remain as it is. In terms of new Special Streets, three are proposed for the district. One is the East Village Promenade, another is a new pedestrian street that bisects the proposed naturalized park on the east end of the Study Area, and the third is Market Street which links the two large parks. Each of these will be highlighted in the Parks + Open Space Framework section.

A Streets are the primary streets within a district and are lined by mixed-use buildings that front onto, and address, the street. Buildings fronting onto A Streets often have street level active uses, including retailers and restaurants. Residential uses along A Streets should have ground level doors into each unit. Urban

KEY:

- MLK Parkway
- A Streets
- B Streets
- C Streets
- Pedestrian Streets





frontage is required, but blank walls are avoided. Parking is provided on-street, or in surface parking lots or parking structures that are located on the interior of their blocks. Streetscape enhancements on A Streets are significantly more robust than those on other street typologies. As a result, A Streets are typically sought after addresses due to their special character and high level of street-level activity.

C Streets are the opposite of A Streets. C Streets function as service and access streets, and are often lined by surface parking lots, entrances to parking structures and lots, service courts and docks for adjacent buildings, secondary and tertiary pedestrian entrances, and blank walls. Building frontage is optional. As a result, pedestrian activity on C Streets is typically rather limited. Because of this, streetscape enhancements are provided, but to a lesser degree than either A or B Streets.

B Streets fall in-between A Streets and C Streets. Urban frontages are recommended, but not required. Where buildings do not front onto the street, parking lots and structures and service courts and docks are permitted with measures to disguise, screen, and soften them. Streetscape enhancements should not be as robust as those for A Streets, but greater than those that occur on C Streets.

A Street Example

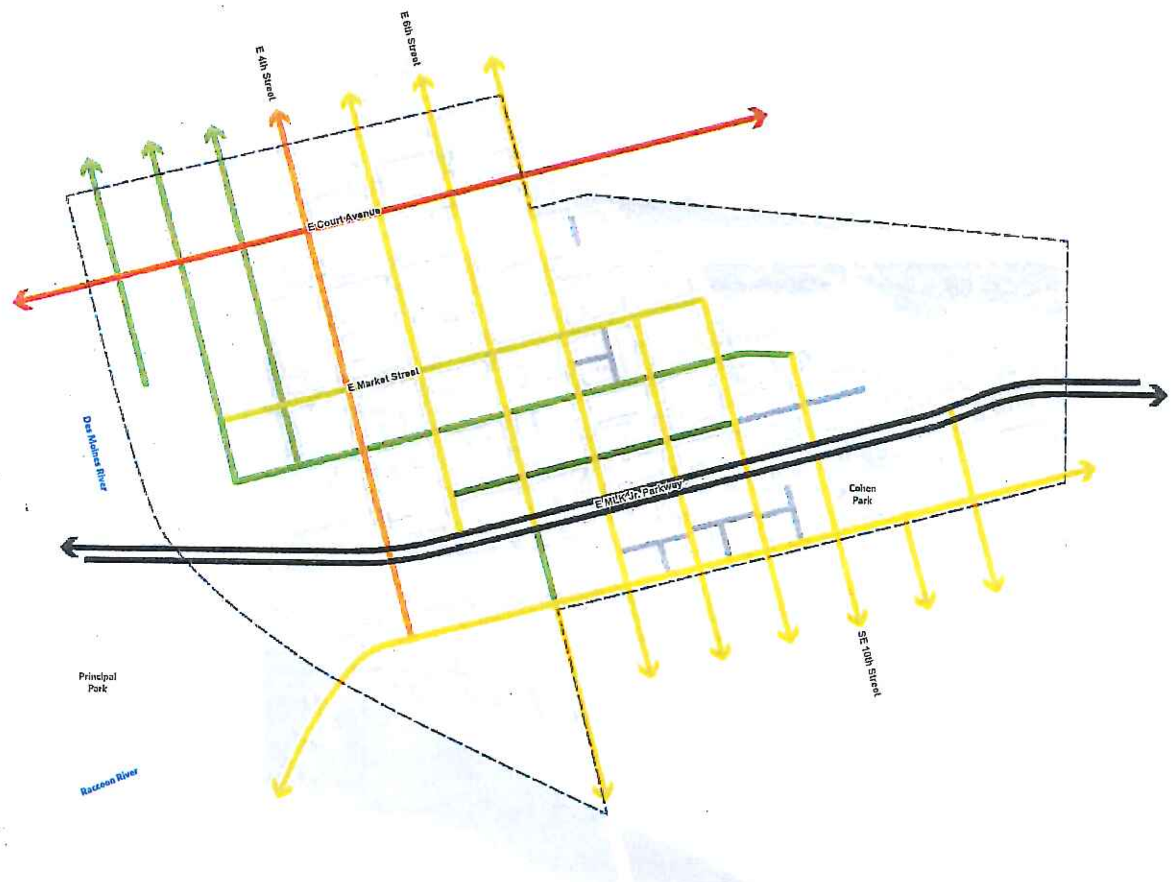
B Street Example

C Street Example

MOBILITY

STREET SECTIONS

The street network within the Market District is designed to accommodate pedestrians, bicyclists, and vehicles. Traffic calming elements such as narrow traffic lanes, on-street parking, corner bulb-outs, landscaped parkway strips, and generous sidewalks are incorporated throughout the neighborhood. The district's interconnected street network will help disperse traffic within the neighborhood and allow multiple options and flexibility for those moving through the site. The illustrated street sections on the following pages conceptually identify the proposed rights-of-way and recommended functions for the various street sections. A traffic study will be needed to finalize roadway design recommendations, as achieving the intended street character will require balancing the needs of pedestrians, bicyclists, and vehicles. All streets within the district, except for MLK, are intended to meet the design criteria set forth in the MoveDSM and Connect Downtown studies. Move DSM recommends a maximum speed limit of 25 mph, a maximum travel lane width of 10', and a maximum curb Radii of 20'. 11' lanes and 25' curb radii are acceptable if the street is a DART, truck, or emergency vehicle route.



KEY:

- 100' ROW - E Court Avenue
- 84' ROW - SE 4th Street
- 80' ROW
- 80' ROW - E Market Street
- 66' ROW
- 66' ROW - Raccoon Street
- Alleys
- E MLK Jr. Parkway

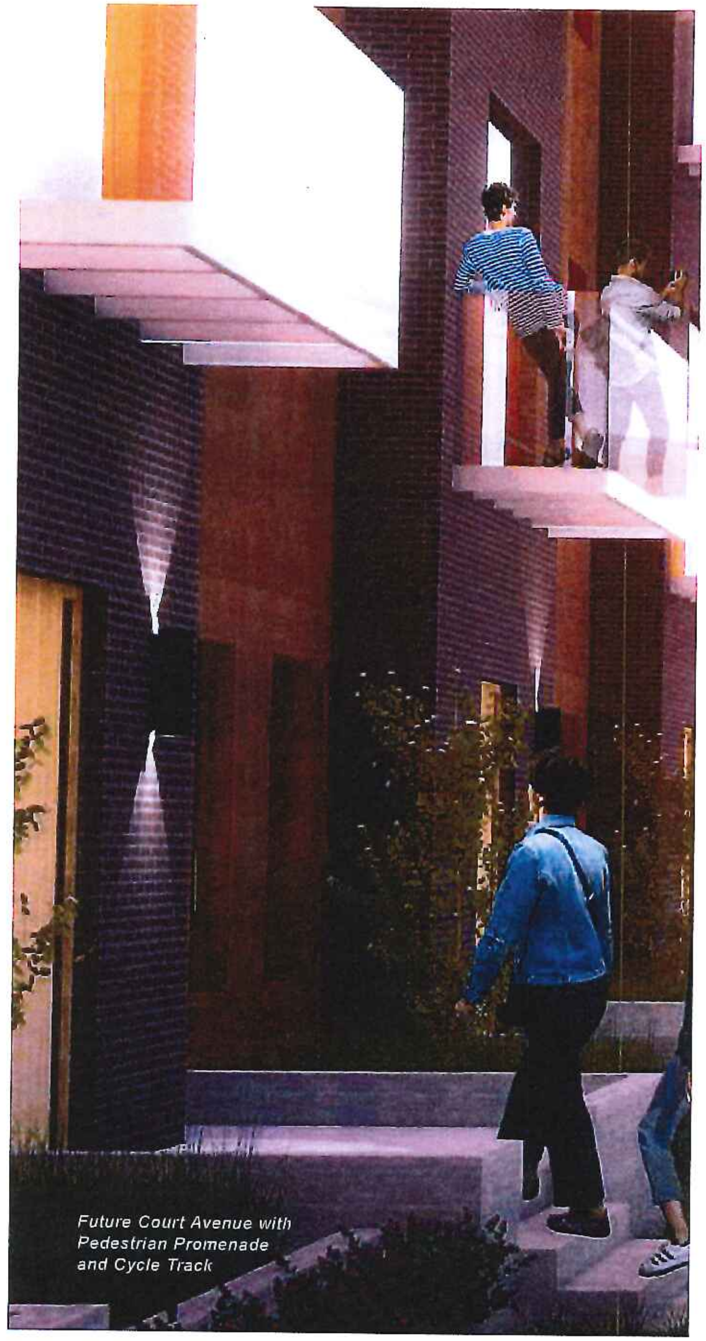
100' ROW: COURT AVENUE

East Court Avenue is an **A Street** with a 100' ROW. As one of the primary east-west streets in the district, it links Downtown Des Moines with the State Capital complex. Over time, the street will be lined with mixed-use buildings and active frontages. Within the ROW, it will contain a traffic lane in each direction, parking lanes with permeable pavers, wide landscaped parkway strips, storm water planters, a cycle track, and a generous pedestrian promenade on each side of the street.

MOBILITY

Examples of a cycle track located along an A Street

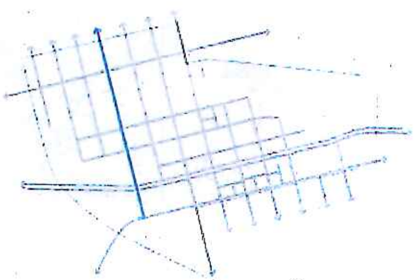
Rendering Location Key

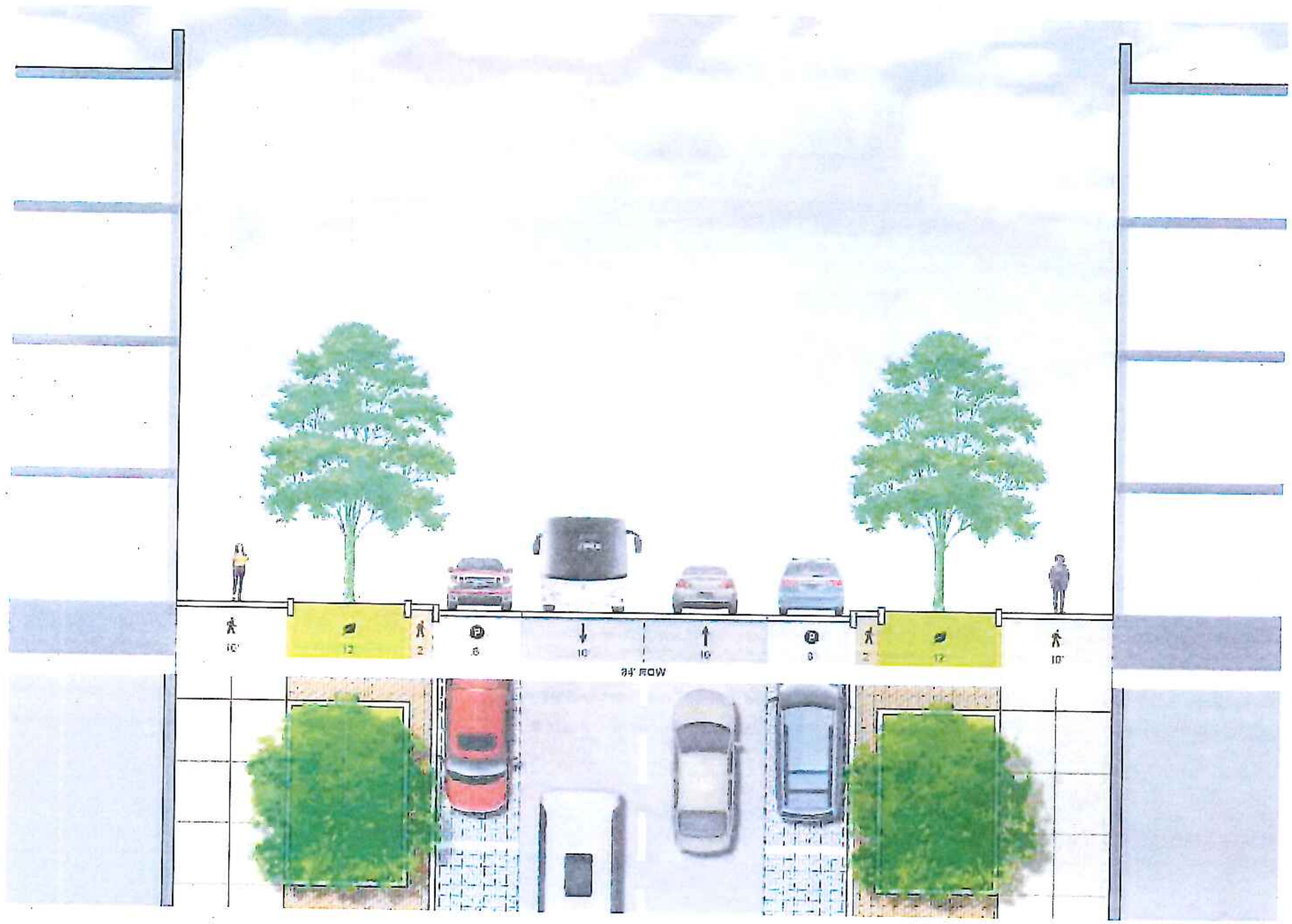


Future Court Avenue with Pedestrian Promenade and Cycle Track

84' ROW: SE 4TH STREET

SE 4th Street is an **A Street** with an 84' ROW. As one of the primary north-south streets in the district, it links MLK Parkway with the East Village district. Over time, the street will be lined with mixed-use buildings and active frontages. Within the ROW, it will contain a traffic lane in each direction, parking lanes with permeable pavers, wide landscaped parkway strips, storm water planters, and generous sidewalks on each side of the street.

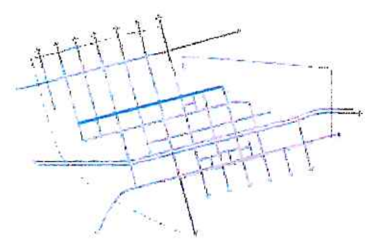




80' ROW: E MARKET STREET

E Market Street is an **A Street** with an 80' ROW. It is a Special Street, functioning as a green connection between the destination riverfront park and the naturalized park on the east edge of the district. It should be designed as a shared-space street, accommodating pedestrians, bicyclists, and vehicles equally. The curb-less street section will be lined with mixed-use buildings and active frontages. Within the ROW, it will contain a traffic lane in each direction, parking lanes with permeable pavers, wide pedestrian promenades containing storm water planters and extensive landscaping, and amenity zones accommodating outdoor dining, food trucks, and vendor kiosks.

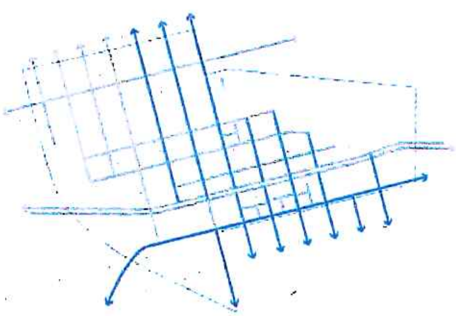
A double row of trees should be used on each side of the street. Paving should extend from back of curb to building face only being interrupted for street trees. Trees should utilize a tree grate system including permeable pavers and structural soil cells to maximize soil conditions for each tree while accommodating a large amount of paved pedestrian space. Buildings are allowed up to a 5' setback to accommodate outdoor seating and patio zones. Outdoor seating and other furnishings may reside in the ROW but may not encroach on the middle 7' sidewalk zone. Bollards or other vertical elements are encouraged to help delineate space in winter months.

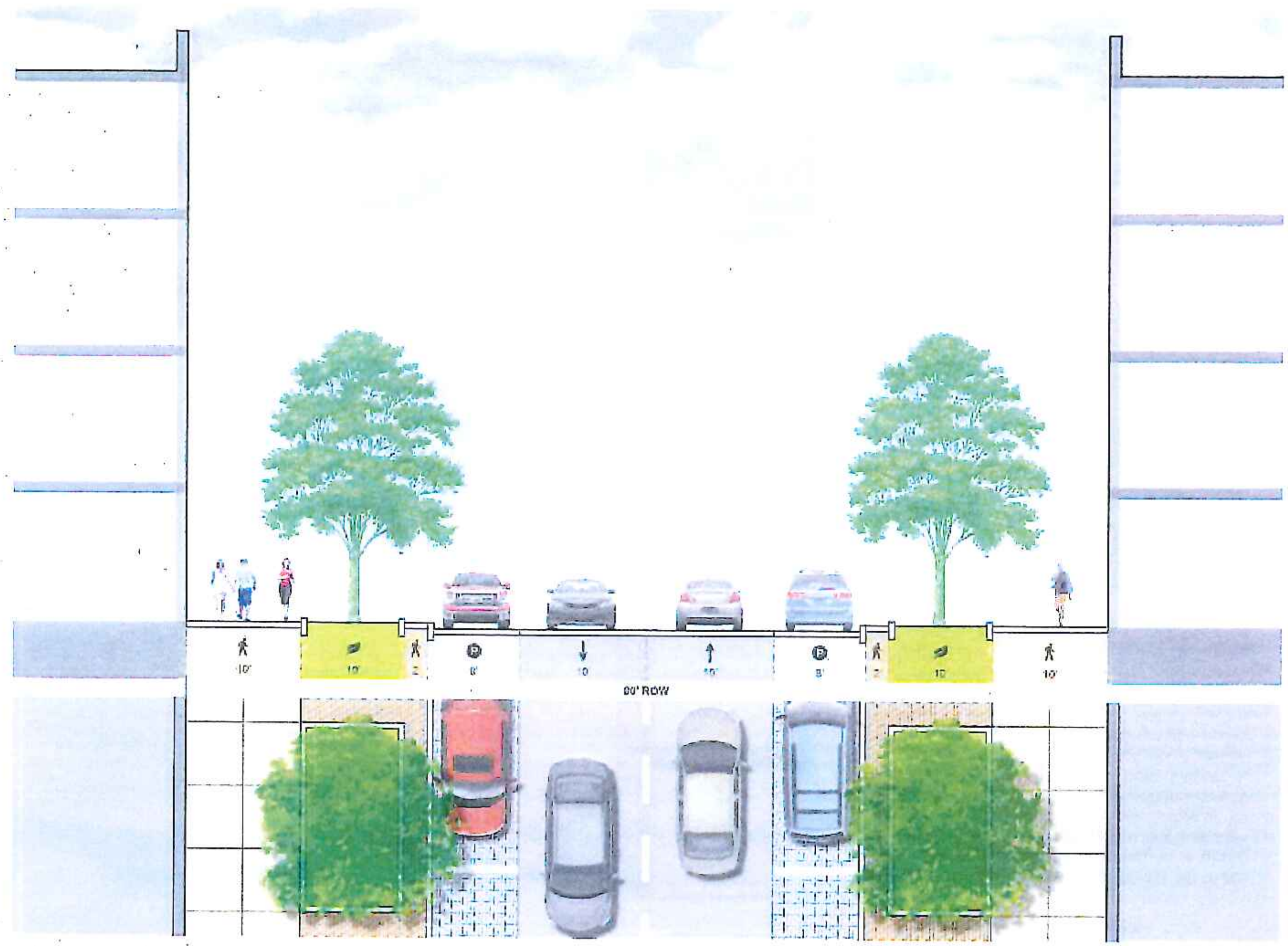


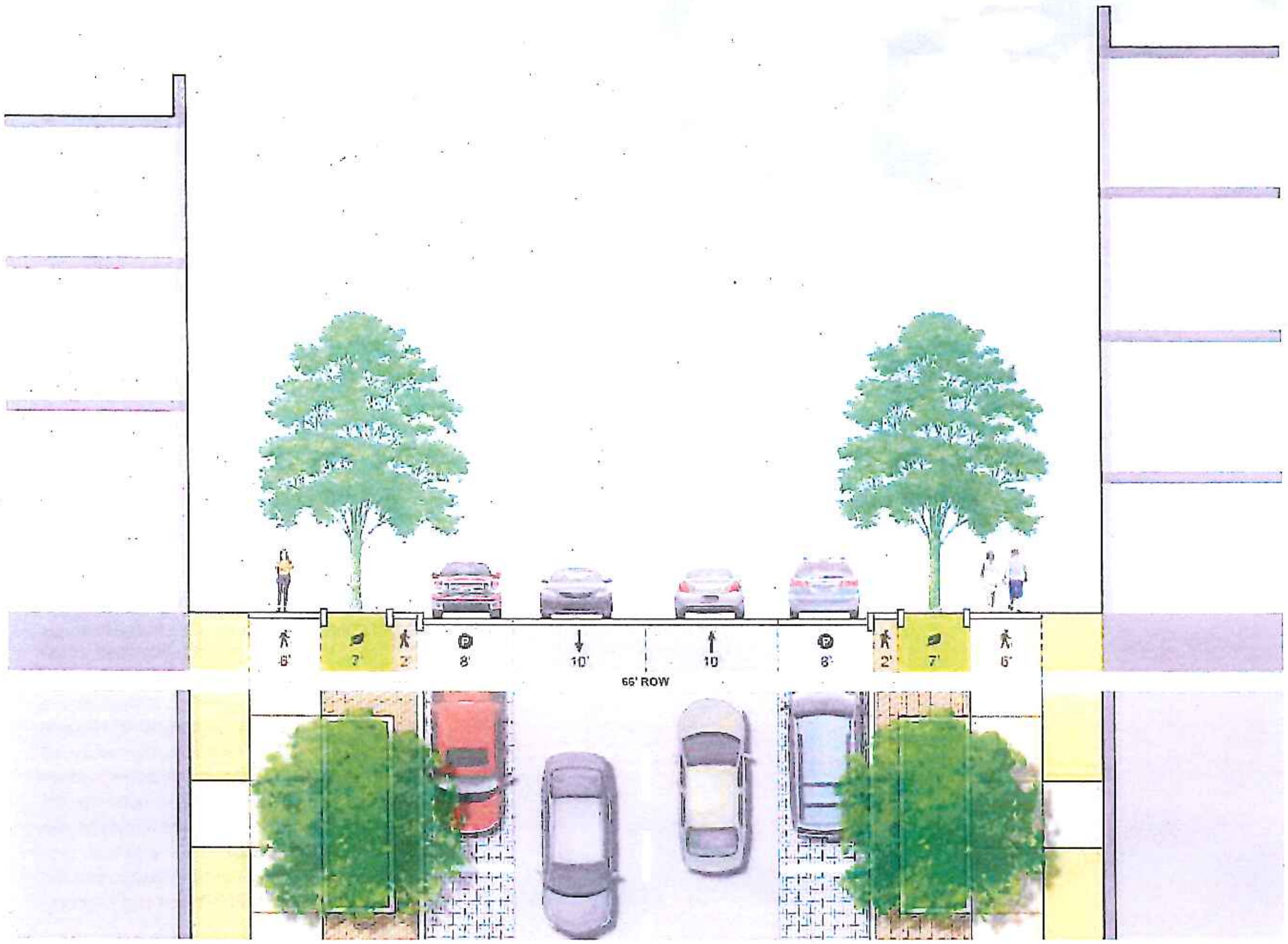
MOBILITY

80' ROW

Multiple streets within the district will have an 80' ROW. These will include A, B, and C Streets. Within the ROW, these streets will contain a traffic lane in each direction, parking lanes, landscaped parkway strips, and generous sidewalks on each side of the street. A Streets will be more generous in their amenity package, with permeable pavers in the parking lanes, extensive landscaping along the parkway strips, and storm water planters. B and C Streets will have a diminishing gradient of amenities (permeable pavers, landscaping, street furniture, green infrastructure, etc.), with B Streets less generous than A Streets, and C Streets less generous than B Streets.

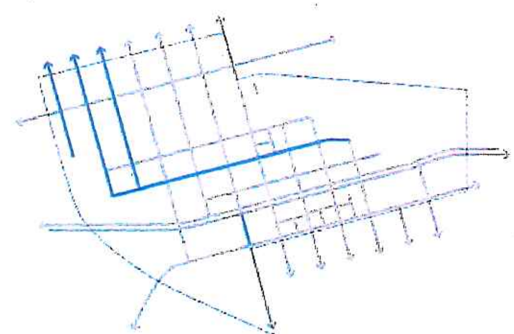






66' ROW

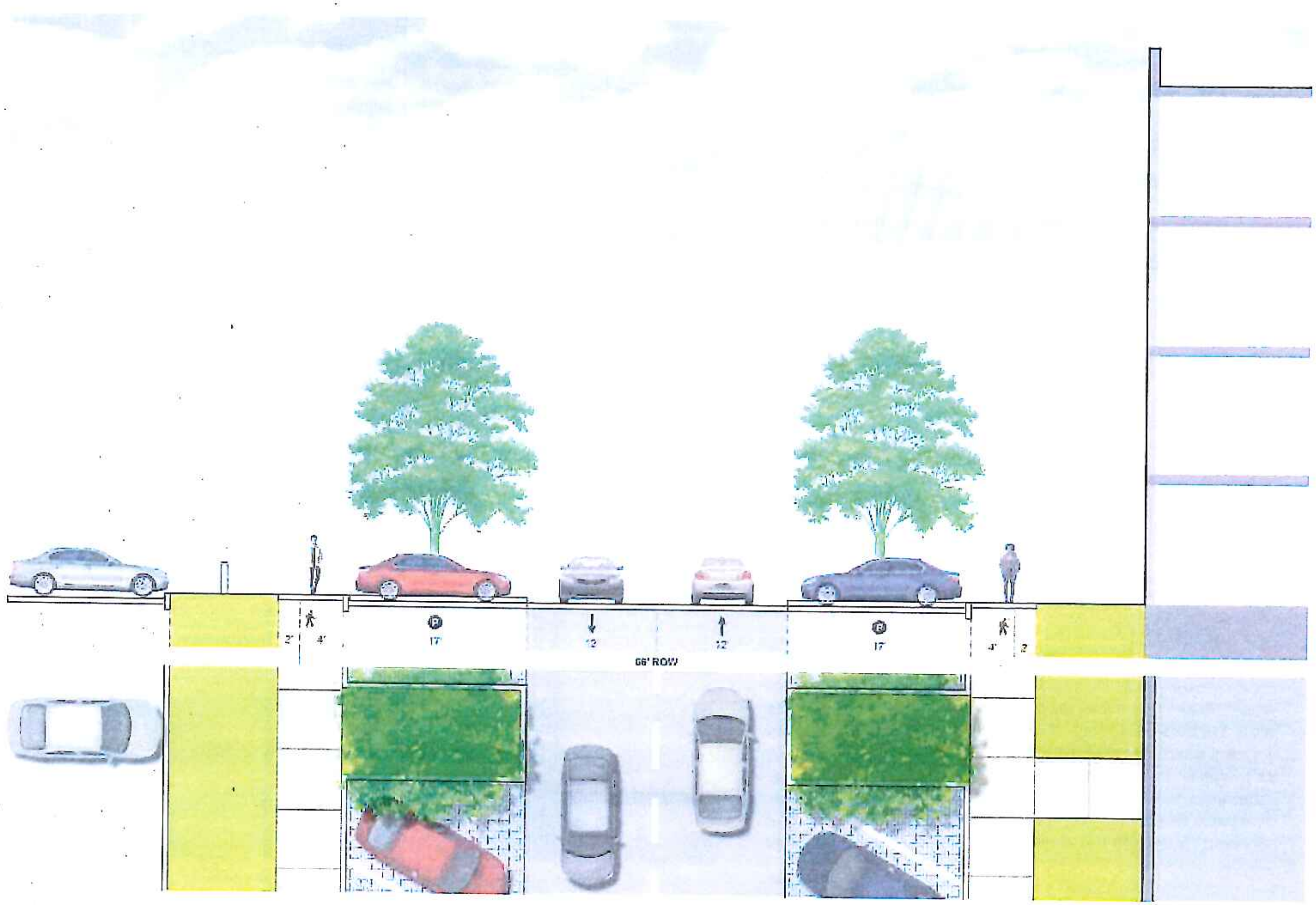
Multiple streets within the district will have a 60' ROW. These will include **A, B, and C Streets.** Within the ROW, these streets will contain a traffic lane in each direction, parking lanes, landscaped parkway strips, and sidewalks on each side of the street. A Streets will be more generous in their amenity package, with permeable pavers in the parking lanes, extensive landscaping along the parkway strips, and storm water planters. B and C Streets will have a diminishing gradient of amenities (permeable pavers, landscaping, street furniture, green infrastructure, etc.), with B Streets less generous than A Streets, and C Streets less generous than B Streets.



MOBILITY

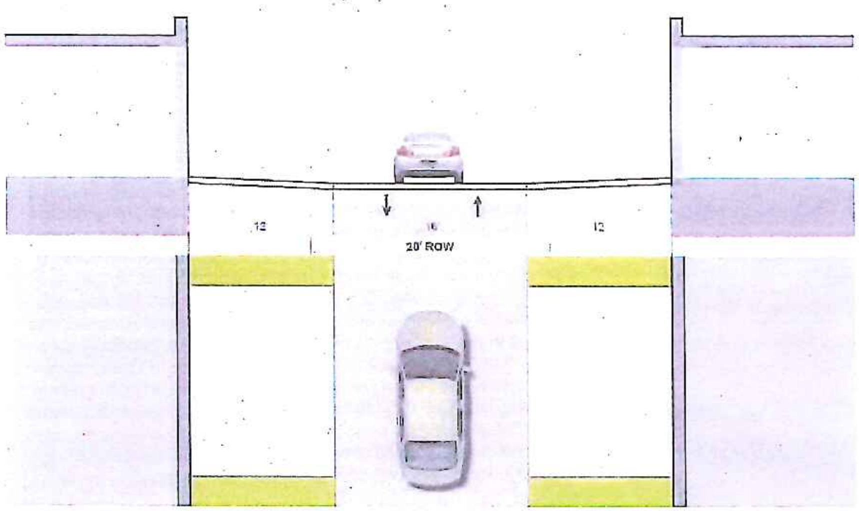
66' ROW: RACCOON STREET

Raccoon Street is a **C Street** with a 66' ROW. It has two primary functions – it is an overland path used to vacate storm water during heavy rainfall events, and it is a parking lot (designed as a street) to help accommodate parking on the adjacent under-sized development blocks. Within the ROW, it will contain a traffic lane in each direction, angled parking with permeable pavers, landscape islands, and 6' sidewalks. Due to the narrow ROW and the need to increase the parking yield through the use of angled parking, an additional 2' easement will be required on each side of the ROW so that parallel 6' sidewalks can be provided.

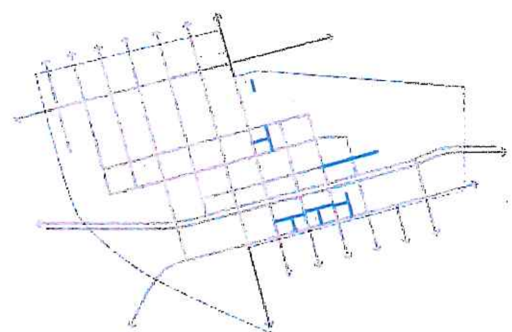


ALLEYS

In many cases, alleys will be required in order to service rear-loaded residential projects, such as townhomes. Where alleys are located, they will require a 30' ROW. Alley paving should be 16' wide (to allow "yield" passing when necessary). A minimum 12' parking apron (in front of the rear-loaded parking garages) should be provided in order to provide ease of turning movement into and out of the individual garages. The alley extending east along Raccoon Street will also provide access to the City's pump station.



Example of alley serviced rear-loaded townhomes



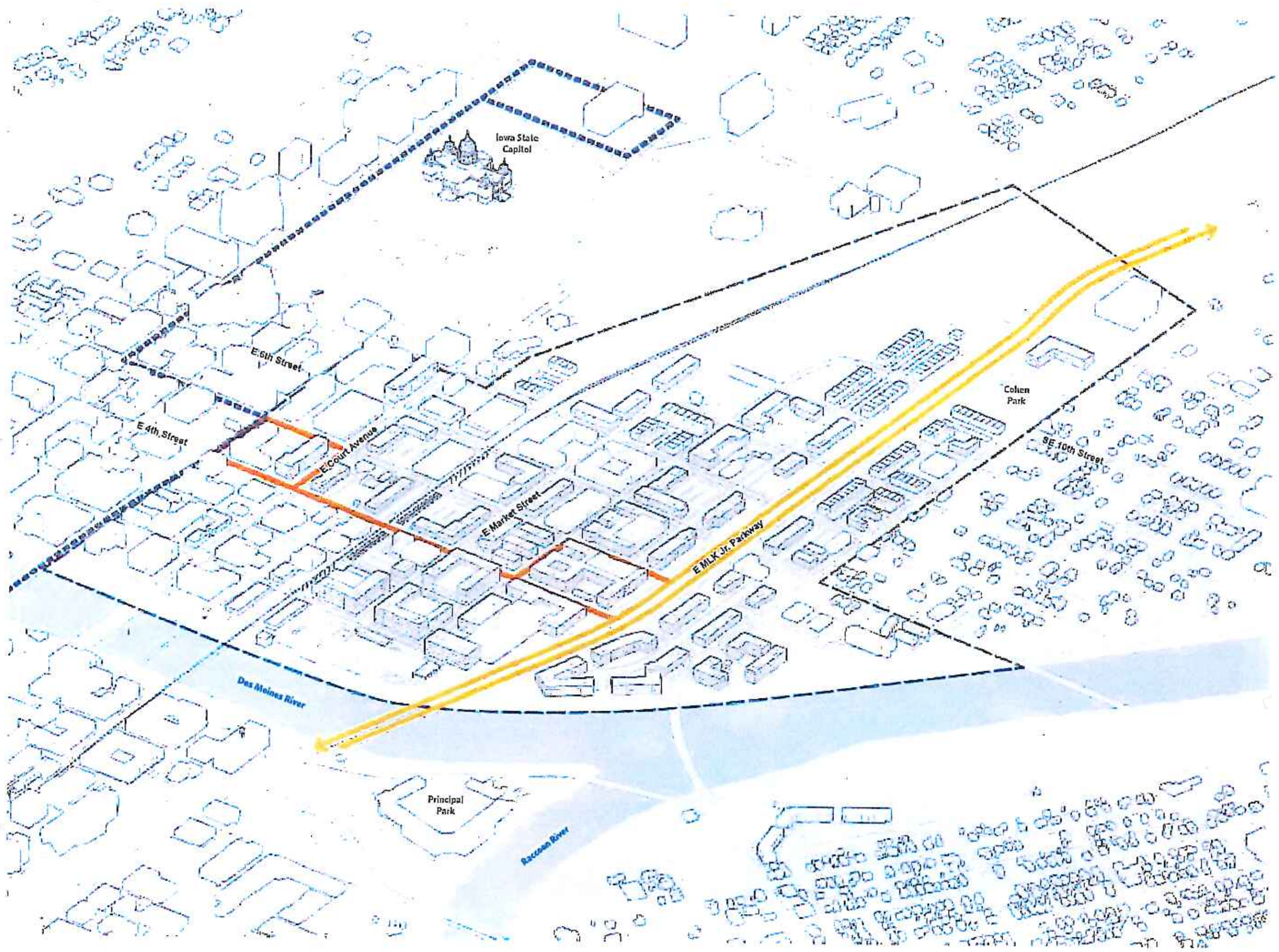
MOBILITY

TRANSIT

The Market District has significant potential to transition into a dense, vibrant, pedestrian-oriented urban neighborhood. In order for it to achieve its full potential, it will need to reduce its reliance on personal vehicles and the resulting need to park them, which ultimately encumbers valuable real estate and its associated development potential, and instead focus on developing around a multi-modal transportation framework. A key element of this framework is a viable transit system. Currently, only the extreme northern portion of the Study Area is served by transit. The free D-Line, which functions as a "walk extender," runs on Court Avenue on 10-minute headways, creating a loop that provides service from the East Village to the Western Gateway. The D-Line connects the Capitol Complex, Historic East Village, Downtown, and the Western Gateway.

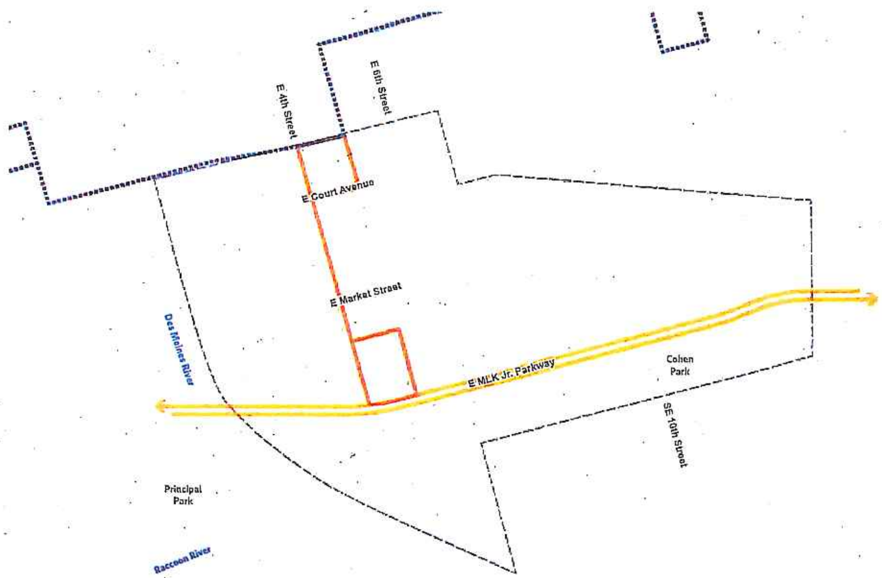
In the future, additional service will be necessary in order for the Market District to reach its full potential. The MLK Express, which will provide service along the MLK Jr. Parkway, will connect the metro's eastern suburbs with the DART Central Station in Downtown Des Moines. This express service will provide regional connectivity to DART's central mobility hub and, in essence, the entire metropolitan area.

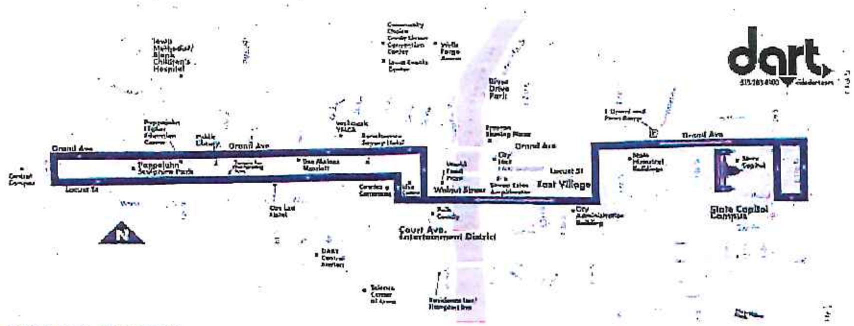
In order to fully serve the residents, employees, and visitors of the Market District, a new route should be initiated that connects the D-Line with the MLK Express through the heart of the Market District. This new service would run down E 4th Street, utilizing an enhanced bus vehicle or an autonomous shuttle. Providing local and regional transit connections, it would ideally run on 10-minute headways, and provide access to a variety of destinations, including the Historic East Village, Capitol Complex, Downtown, Western Gateway, DART Central Station, and the resulting remainder of the metro. This new service, with its inherently valuable local and regional connections, would greatly reduce dependence on personal vehicles within the district, thereby allowing it to develop at a much higher density than would otherwise be the case.



KEY:

- Market District Connector (Future)
- MLK Express (Future)
- D-Line (Existing)





Existing D-Line route

Example of an autonomous shuttle vehicle

Photo of existing D-Line vehicle

Example of proposed connector vehicle stop

BIKE + PEDESTRIAN NETWORK

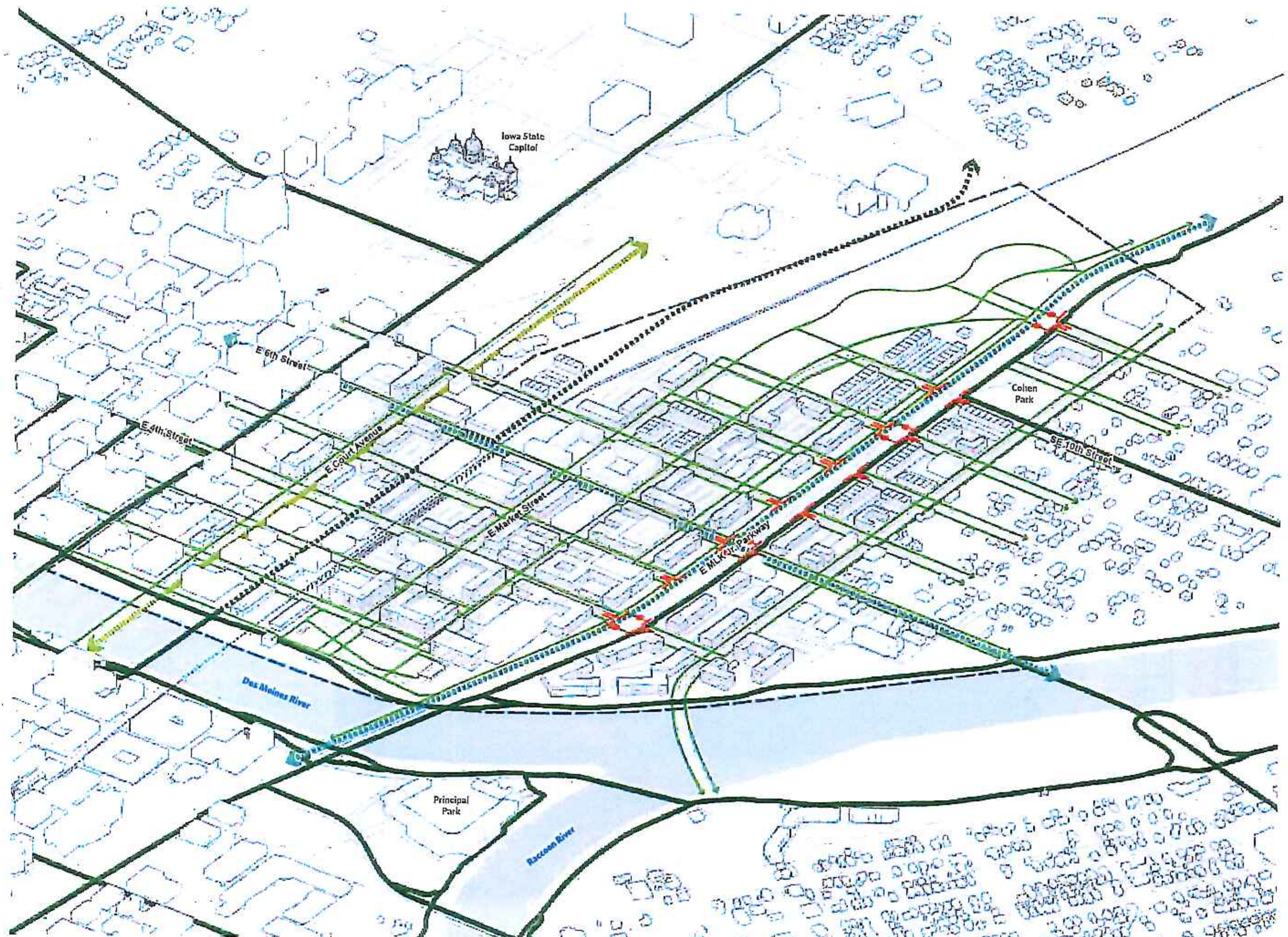
The Market District will contain a robust bicycle and pedestrian network. Every street within the neighborhood is lined by a 6' – 10' sidewalk in order to encourage walking. These sidewalks are typically placed a minimum of 8' behind the back of curb, allowing the parkway strips a sufficient width to accommodate street trees and landscape planters, and enough space for plowed snow to accumulate without collecting on the adjacent sidewalk. The entire network would be designed to be fully accessible and ADA compliant.

The neighborhood also contains an interconnected shared-use path network that interfaces with the existing trail routes along the riverfront and MLK Jr. Parkway. Special elements of the network include the East Village Promenade / Trail and the Court Avenue Cycle Track, which are each described in greater detail in this document. The neighborhood's bicycle and pedestrian network creates a variety of routes/loops useful for short, medium, and long walks/runs/rides, and allows for easy and direct connectivity to adjacent neighborhoods and downtown Des Moines. On-street bike lanes, outlined in the Connect Downtown study, are also recommended on 6th Street and E MLK Jr. Parkway.

In addition, two recommendations are made that would facilitate easer pedestrian crossings at key intersections. The first is the establishment of pedestrian refuge islands within the median of MLK Jr. Parkway. These enhancements, to be made at the signalized intersections, would provide mid-crossing safety enhancements, as well as amenities, for pedestrians unable to cross the entire width of the parkway during one signal cycle. This, combined with the reduction of the corner turning radii at all of the intersections along MLK Jr. Parkway, would calm traffic entering the Market district and make for a safer pedestrian environment.

KEY:

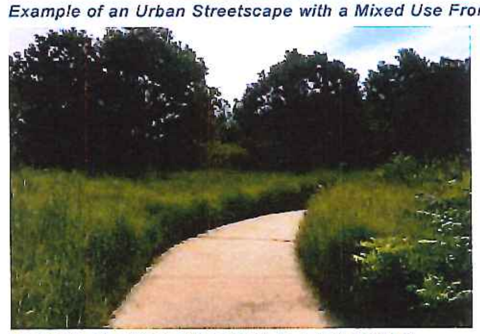
- Existing Shared Use Path
- Proposed Shared Use Path
- Court Ave. Cycle Track
- On-Street Bike Lanes (Connect DT Study)
- Sidewalks
- Pedestrian Refuge Islands
- Reduced Turning Radii



Example of an Urban Streetscape with a Mixed Use Frontage

Example of a Pedestrian Promenade in an Urban Setting

Example of a Sidewalk Retail Frontage



Example of a Shared Use Path in a Naturalized Setting

Example of a Pedestrian Refuge Island along a Parkway

KEY INFRASTRUCTURE

INTRODUCTION

The Market District of the East Village is an old industrial neighborhood that contains above- and below- ground infrastructure that is well beyond its useful life. While the majority of the existing public infrastructure will need to be either abandoned or reconstructed over an extended period of time, there are several key infrastructure improvements that are required in the short-term to provide the necessary services to existing and future private development projects and to act as a catalyst for additional redevelopment within the neighborhood. There is special emphasis placed on the maintenance of existing drainage patterns and providing proposed storm sewer improvements to address existing storm sewer capacity deficiencies within the neighborhood, which has resulted in five recommended projects within the Study Area. Detailed technical memorandums for each of these key elements, along with associated recommendations, are included in the Appendix.

PROPOSED SANITARY SEWER IMPROVEMENTS

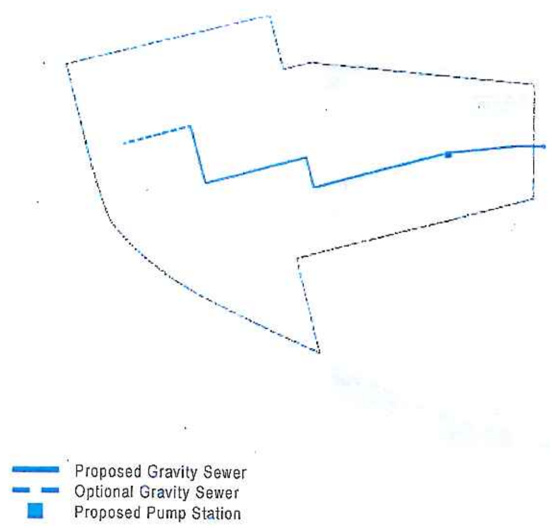
The recommended approach to meeting future sanitary sewer service demands is to construct a new pump station and force main to serve the northern portion of the Market District of the East Village. The recommended location of the pump station is at the east end of Raccoon Street, on property owned by the City. The proposed gravity trunk sewer would extend from the pump station along the alignment shown in **Figure 1**. This proposed sanitary sewer alignment maximizes opportunities to connect future services as redevelopment continues in the neighborhood.

PROPOSED STORM WATER CONVEYANCE IMPROVEMENTS

There are several locations within the Study Area that are experiencing storm sewer capacity issues during smaller storm events. To remedy these existing capacity issues, there are three recommended projects at various locations within the district, as shown on **Figure 2.**

- 200 Block of East 2nd Street Conveyance Improvements
- East Market Street Conveyance Improvements - SE 6th Street to East Detention Basin
- Capitol View South Storm Sewer Improvements
- SE 4th Street Conveyance Improvements
- Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)

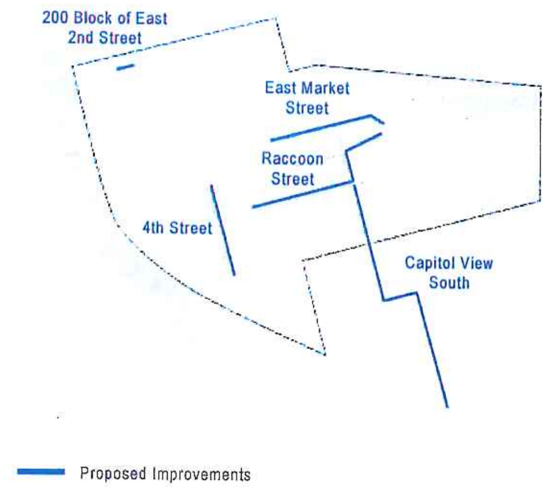
Figure 1: Proposed Sanitary Sewer Improvements



PROPOSED OVERLAND STORM WATER ROUTE

As the neighborhood continues to redevelop, and parcels are combined into larger project sites and the future street network is altered, it will be critical to maintain emergency overland storm water flow paths. To ensure this, it is recommended that the Raccoon Street overland storm water flow path be maintained within the existing public right-of-way width. The alternative to maintaining the existing overland storm water flow path would involve moving the Raccoon Street storm sewer and overland flow path south to a 60 foot wide drainage easement north of East Martin Luther King Jr. Parkway. These options are shown in **Figure 3.**

Figure 2: Proposed Storm water Conveyance Improvements



PROPOSED STORM WATER DETENTION AREAS

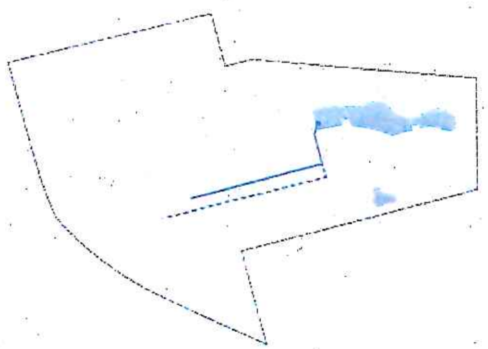
The Study Area has an existing storm water detention basin located at the east end of East Market Street. This basin is recommended for expansion in order to increase storage capacity to approximately 50 acre-feet. The benefit of expanding this detention basin is a reduction of the flooding risk to the Market District of the East Village neighborhood. The expansion project should include a more naturalized drainage basin aesthetic, native landscaping, and public amenities. **Figure 3** provides the location and general size requirement of this detention area, along with the one located in Cochran Park.

NEW STREETS

Findings from the traffic analysis support the planning efforts within the neighborhood to reconnect the street grid system to support new development. Scenarios modeled to review conditions after completion of the complete grid network confirm that the impact of additional street connections are positive.

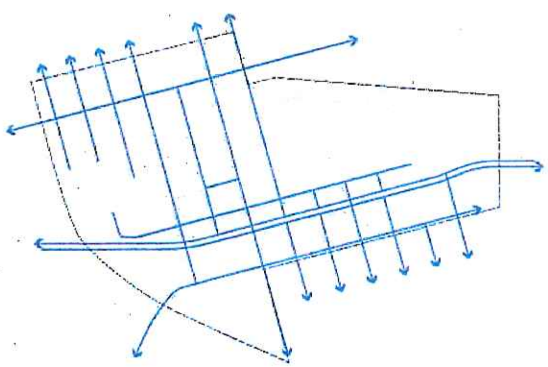
Traffic analysis considering both the before and after conditions of redevelopment within the Market District noted a slight drop in average speeds when adding new trips from new Market District land uses. The drop in average speeds was small relative to conditions before redevelopment, indicating that the proposed streets within the district can adequately handle the additional traffic. It is recommended that the City work with developers to complete the proposed street grid network as redevelopment occurs within the neighborhood. The before and after street grid improvements are shown in **Figure 4.**

Figure 3: Proposed Overland Storm water Flow Path and Detention Areas



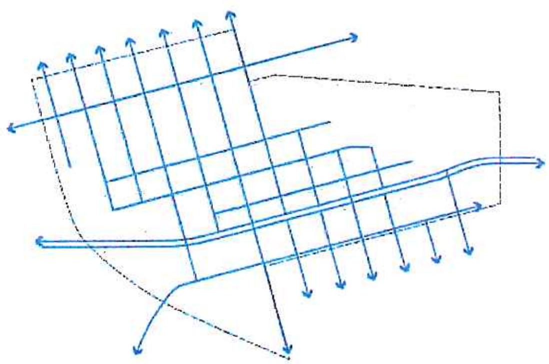
Proposed Overland Flow Path
Optional Overland Flow Path

Figure 4: Existing Street Network



Existing Streets

Figure 4: New Street Network



Proposed Streets

KEY INFRASTRUCTURE PRIORITY PROJECTS

Project	Description	Estimated Cost	Priority
Sanitary Sewer Improvements	New gravity 12" sanitary sewer main from E 4th Street at the Iowa Interstate Railroad tracks, south to Elm Street, east to SE 7th Street, south to Raccoon Street, east to a new sanitary sewer pump station, new sanitary sewer force main to vicinity of SE 20th Street.	$3.8M	1 – Project addresses current sanitary sewer capacity issues in the Market District neighborhood.
Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)	Replace storm sewer between SE 5th Street and SE 8th Street with 30-inch up to 42-inch RCP (pipe capacity ranges from 25 to 60 cfs). New 48-inch RCP along SE 8th Street from Raccoon Street to detention basin. Reconstruct Raccoon Street with a typical urban street section for a 66-foot wide public right-of-way.	$2.3M	2 – Project addresses current 5-year event sewer deficiencies.
SE 4th Street Conveyance Improvements	Replace storm sewer on SE 4th Street, between Raccoon Street and Scott Avenue, with 48-inch RCP (pipe capacity approximately 65 cfs)	$0.7M	3 – Project addresses current 5-year event sewer deficiencies.
E Market Street Detention Basin Capacity Improvements	Increase storage capacity of detention basin to approximately 42 acre-feet. Construct a new 18-inch RCP outlet from the detention basin.	$2.0M	4 – Project needs to be completed prior to E Market Street and Raccoon Street overland flow improvements to ensure there is adequate storage capacity.
Raccoon Street Overland Flow Improvements (SE 8th Street to SE 11th Street)	Lower Raccoon Street by 0.5 feet from SE 8th Street to SE 11th Street (cul-de-sac) and raise the ground elevation outside of the ROW by 2.0 feet. Construct a 48-inch RCP culvert through the railroad north of Raccoon Street to connect overland flow on Raccoon Street to the detention basin.	$1.5M	5 – Project addresses current and future 100-year event deficiencies.
E Market Street Conveyance Improvements between SE 6th Street and detention basin	Increase the conveyance capacity between the detention basin and E 6th Street to approximately 250 cfs and add a flap valve on the detention basin end of the pipe to prevent flow from leaving the basin.	$1.5M	6 – Project reduces flooding during the larger rainfall events throughout the North of E Market Street area.
E Walnut Street Conveyance Improvements	Realign the storm sewer to increase the capacity to 10 cfs in the alley south of E Walnut Street, between E 2nd Street and E 3rd Street. Connect 15-inch RCP storm sewer to E 3rd Street sewer.	$0.2M	7 – Project addresses a localized flooding issue and would likely be completed in combination with another project (i.e. street replacement)
Subtotal		$12.0M	
30' ROW Alley Improvements	Reconstruction of alley within public ROW. Project limits to be determined based on proposed private development.	$0.2M per Block - $1.4M total	Priority to be established by proposed private development.
66' ROW Street Improvements	Reconstruction of street and streetscaping within public ROW. Project limits to be determined based on proposed private development.	$0.5M per Block – $9.5M total	Priority to be established by proposed private development.
Raccoon Street Improvements	Reconstruction of 4 blocks of street and streetscaping within 66' wide public ROW. Front-end parking on both sides of street.	$2.4M	Priority to be established by proposed private development.
80' ROW Street Improvements	Reconstruction of street and streetscaping within public ROW. Project limits to be determined based on proposed private development.	$0.6M per Block - $11.4M total	Priority to be established by proposed private development.
East Market Street Improvements	Construction of 7 blocks of shared-space street and streetscaping within public ROW.	$5.6M	Priority to be established by proposed private development.
East 4th Street Improvements	Reconstruction of 7 blocks of street and streetscaping within 84' wide public ROW.	$4.2M	Priority to be established by Capital Improvement Program.
East Court Avenue Improvements	Reconstruction of 6 blocks of street and streetscaping within 100' wide public ROW.	$5.0M	Priority to be established by Capital Improvement Program.
Subtotal		$39.5M	
TOTAL		$51.5M	

Notes:

1. The storm water improvement projects that occur within existing pavement limits include improvements to restore the street to existing conditions. These projects do not include full street reconstruction and streetscaping enhancements. The exception is the reconstruction of Raccoon Street from SE 5th Street to SE 8th Street, which estimates cost to reconstruct entire street to the Market District Master Plan typical street section for 66-foot wide public right-of-way.
2. The individual street improvement project costs could be shared by public and private entities.
3. The individual street improvement projects for 30', 66', and 80' wide right-of-way widths have costs provided per city block because these projects will be defined and prioritized by future development phasing in the neighborhood.

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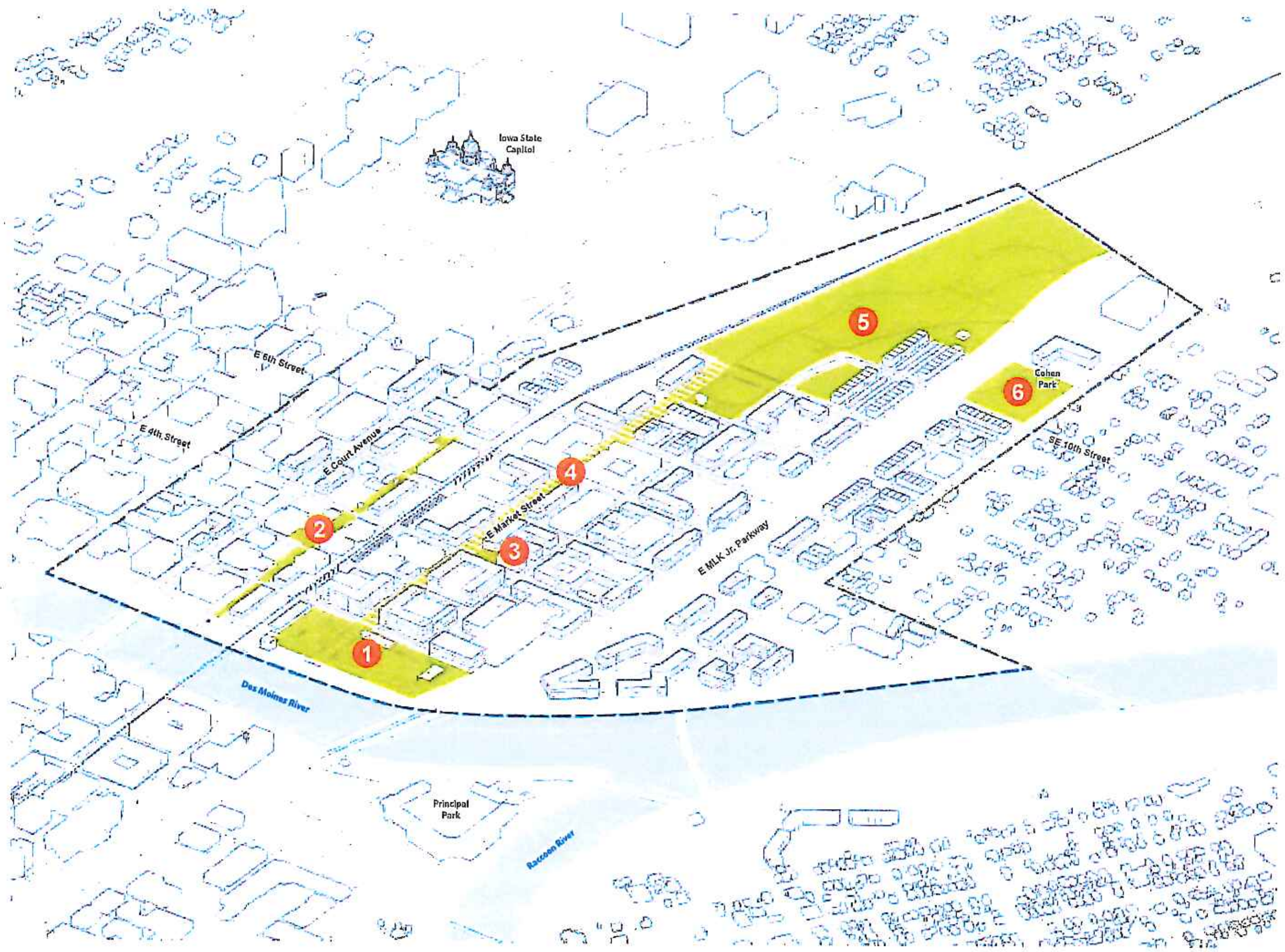
PARKS + OPEN SPACE SYSTEM

INTRO

The Park and Open Space System consists of different types of open spaces that respond to both community and environmental needs. The plan identifies key locations that provide opportunities for a variety of open space amenities, such as parks, public plazas, green streets, promenades, trails, and naturalized areas. Passive and naturalized areas are typically located along the river or are co-located with the detention basins, while public spaces ideal for programed activities are located at key focal points throughout the neighborhood.



KEY:

- Parks / Pedestrian Spaces
- 1 Destination Riverfront Park
- 2 East Village Promenade / Trail
- 3 Market Street Plaza
- 4 Shared Space / Green Street
- 5 Naturalized Park
- 6 Cohen Park Enhancements

Example of Programmable Urban Park

Example of Naturalized Storm water Park

Example of Urban Promenade and Trail

Example of Urban Plaza

PARKS + OPEN SPACE SYSTEM

Destination Playground

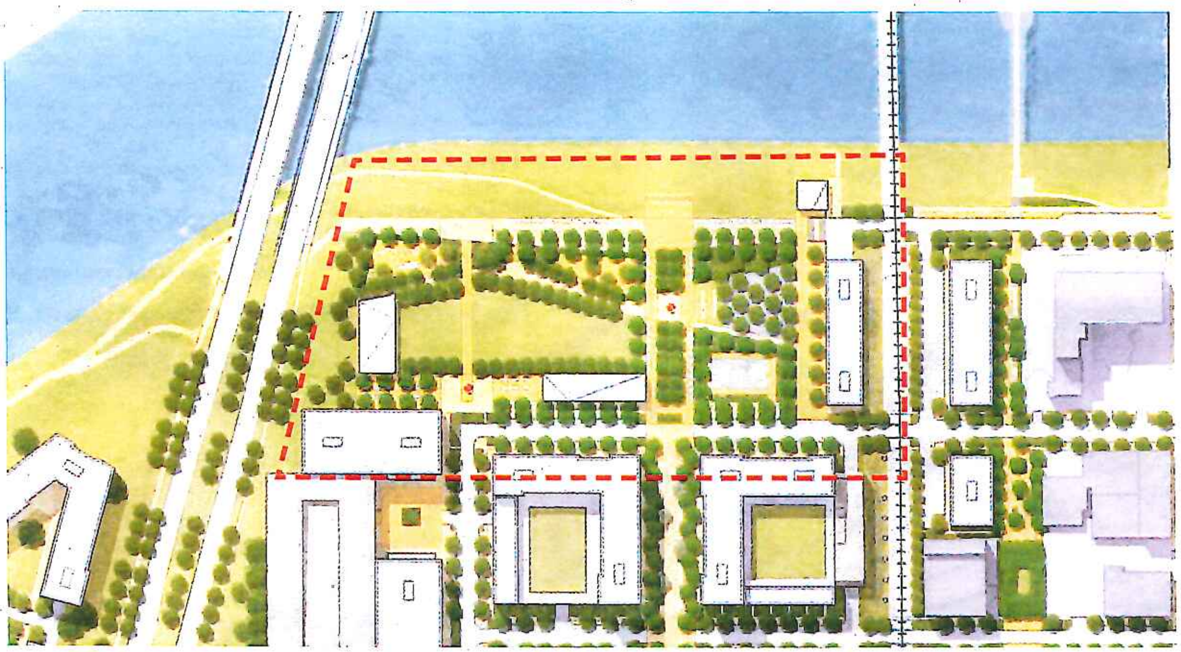
Putting Green

Outdoor Reading Room

DESTINATION RIVERFRONT PARK

The cornerstone of the park and open space system is the Destination Riverfront Park located on the MidAmerica Energy property overlooking the Des Moines River. This site, with documented environmental conditions, is ideal for a park and provides commanding views of both the river and downtown Des Moines skyline. Nationwide, destination parks have been transformative catalysts for their adjacent neighborhoods. Whether it's Klyde Warren Park in Dallas, Maggie Daly Park in Chicago, or Tongva Park in Santa Monica, these parks are highly programmed and activated with a variety of uses and activities. As a result, they have become destinations for not only their adjacent neighborhoods, but for their respective metro areas as well. Because of their drawing power, they are significant catalysts for new development on adjacent blocks, and lead to increased property values, lease rates, and sales tax revenue.

Destination parks are typically programmed with a variety of uses. This prominent riverfront site would be ideal for a number of features, including programmable open spaces for concerts, outdoor movies, and other activities; performance pavilions/stages; destination playgrounds; dog parks; restaurants; food truck plazas; outdoor dining groves; sports courts; gardens; public art; restrooms; water trail access; scenic river overlooks; and promenades specifically designed to accommodate vendor kiosks, stalls, and tents for farmers markets, art shows, and other similar events. As plans for the park evolve, on-going dialogue and coordination with MidAmerican Energy, the City of Des Moines, and community stakeholders will be necessary.



Outdoor Game Room

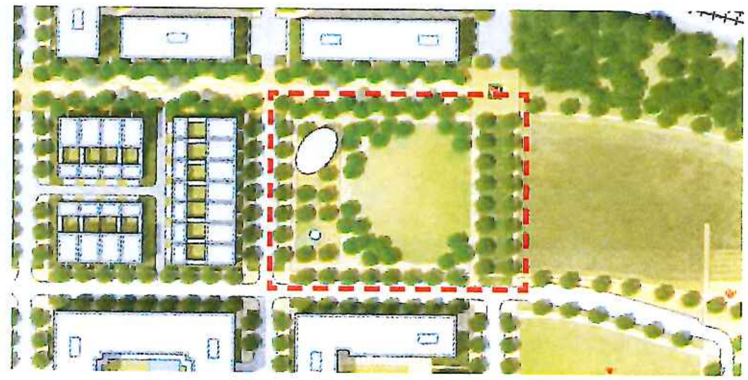
Children's Play

Art in the Park

Adult Play

Dog Park

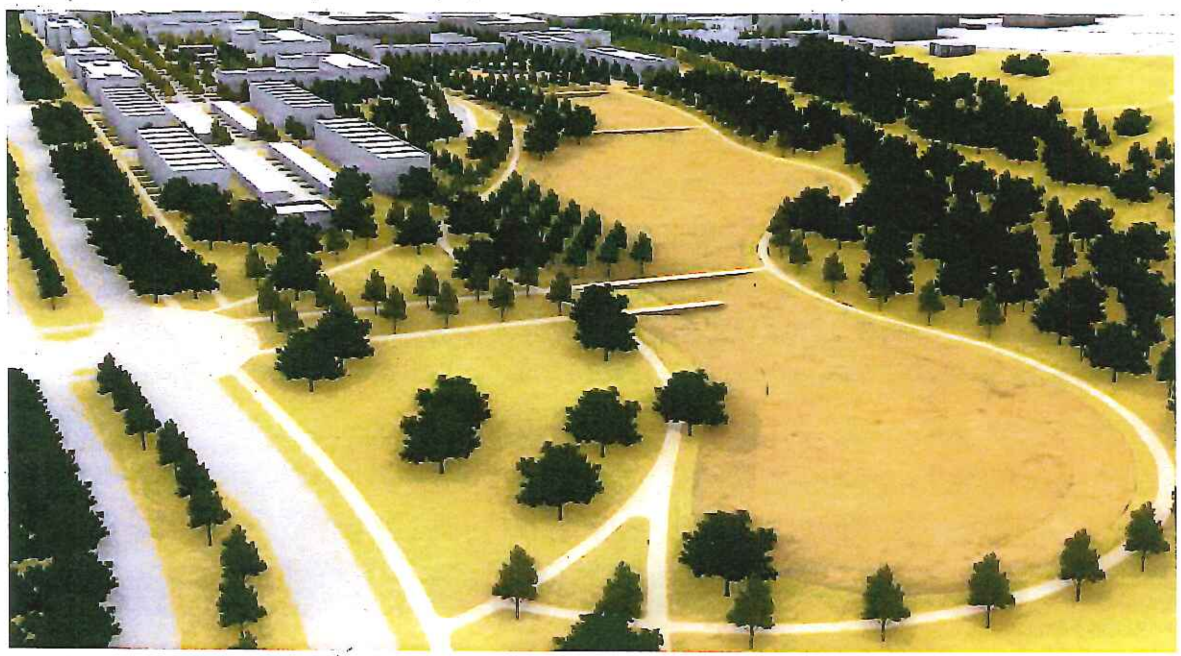
PARKS + OPEN SPACE SYSTEM

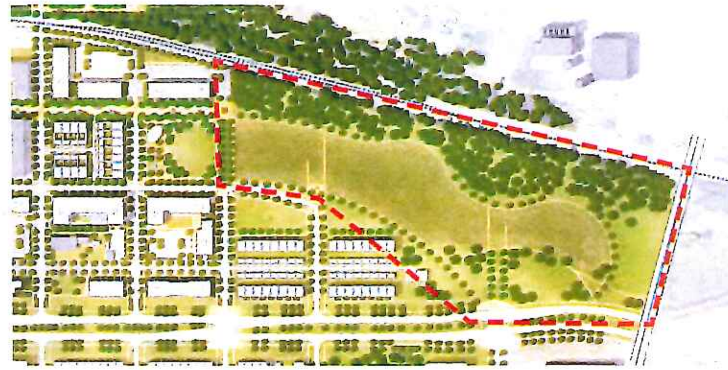


NATURALIZED PARK - WEST

A large naturalized park should be constructed on the east edge of the Market District. This park will be a passive counter-point to the highly programmed and activated riverfront park proposed for the west side of the district. The passive park's primary responsibility is to detain and treat storm water from within the district. The western portion of the passive park will be more structured in nature. and act as a "town square" for the adjacent residential units. The square should contain a large passive lawn /detention area, a pavilion and/or restroom structure, a children's playground, and other neighborhood recreational amenities. Storm water from the previously discussed overland flow path will enter this portion of the park near the intersection of Elm Street and SE 8th Street. During heavy rainfall events, storm water will fill the passive lawn "bowl" and then outflow under SE 9th Street and into the more naturalized east side of the park.

Neighborhood "Square" & Storm Water Detention





NATURALIZED PARK - EAST

The eastern portion of the park should be much more passive than the western portion. A majority of the site will contain the storm water detention basin. The basin should be designed so that it looks natural, not like a man-made storm water facility. Instead, it should look more like a subtle depression within a large field of native grasses and wildflowers. Native and regionally appropriate plants should be utilized throughout the site, helping replicate the habitat that once existed in the area. The basin itself should be enclosed by a curated collection of trees, such as oaks, hickories, and other native varieties. The goal is to create a natural environment, within walking distance of Downtown Des Moines, that fosters significant biodiversity and a sustainable population of native flora and fauna. Functionally, the basin should be designed so that it initially holds, and then slowly releases, storm water following heavy rain events. Boardwalks should be constructed across the basin at strategic locations, and a shared-use path should encircle the basin. This combination will allow for a variety of loop distances for those walking, running, and / or bicycling through the park. Additionally, the path should provide seating areas at key locations, and have frequent connections with adjacent streets and development sites.

Constructed Wetland / Detention Basin

PARKS + OPEN SPACE SYSTEM

Rendering Location Key

Examples of Naturalized Urban Parks with Storm Water Detention Basins

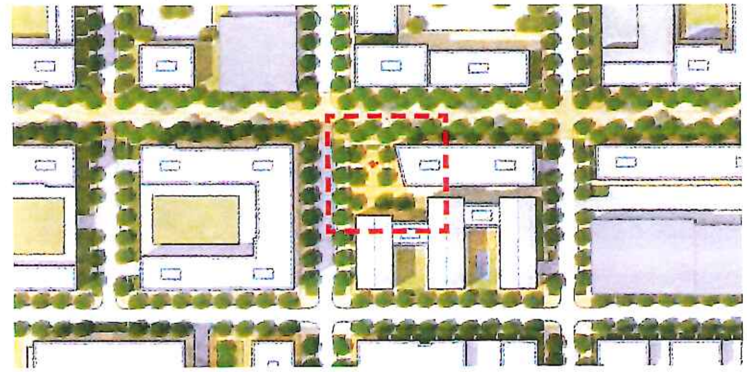
Future Naturalized Park - West "Neighborhood Square"

PARKS + OPEN SPACE SYSTEM

SHARED SPACE / GREEN STREET (MARKET STREET)

East Market Street provides a direct connection between the Destination Riverfront Park on the west edge of the Market District and the Naturalized Park on the east edge of the district. As such, it should be designed as a shared space / green street, and serve as a continuous, functional, park-like link between the neighborhood's two primary open spaces. Its design should accommodate pedestrians, bicyclists, and vehicles equally. Its profile should include a curbless cross-section, with bollards and paver colors / textures demarcating travel lanes, parking areas, and pedestrian zones. Generous areas for outdoor dining and other programmed activities, such as festivals, markets, and pop-ups should be provided along its length. Street trees, storm water planters, lighting, and other furnishings should be designed to set this special street apart from the others.

Examples of Curbless Shared-Space / Green Streets

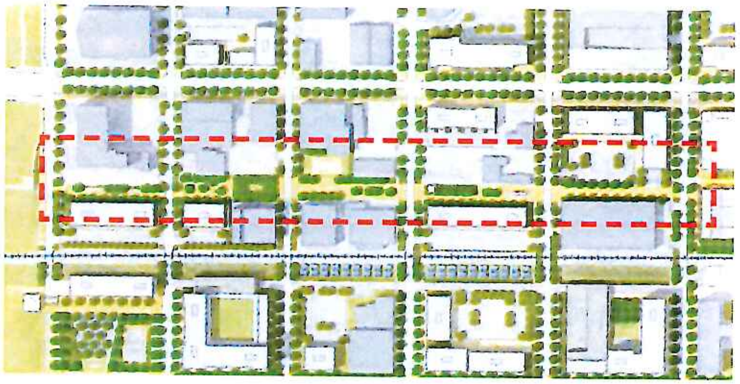


MARKET STREET PLAZA

The Market Street Plaza is proposed for the southeast corner of the intersection of E. Market Street and E. 4th Street. This strategic location provides a small amount of programmable open space at the intersection of two "A" streets and is located in the most dense portion of the Market District. This plaza should be urban in nature, with a paver surface, landscape beds, shade trees, movable tables and chairs, public art, and an interactive water feature. The buildings that front onto the plaza should contain ground-level active uses, such as restaurants, cafes, pubs and/or small retailers. Activities, including small performances, pop-up retailers, and other activity generating uses should be programmed on a regular basis.

Examples of Plazas with Ground-Level Active Uses

PARKS + OPEN SPACE SYSTEM



Examples of Neighborhood Promenades

EAST VILLAGE PROMENADE / TRAIL

The East Village Promenade / Trail is proposed for the former Norfolk Southern Railroad right-of-way located mid-way between Court Avenue and E. Market Street. The promenade portion will extend east from the Red Bridge over the Des Moines River to E. 7th Street, and then up the hill as a shared-use path to the Capitol Complex. This bicycle / pedestrian-only corridor should be activated with amenities such as food truck stalls, community gardens and courts for sand volleyball, pickleball, bocce ball, and basketball. In addition, the corridor should be adorned with native landscaping, seating areas, fire pits, and festival lighting. Green infrastructure, including permeable paving, storm water planters, and rain cisterns should be incorporated along its length. New buildings should be designed so that outdoor patios and secondary entrances open up and/or front onto the promenade, helping activate it throughout the day and creating a unique amenity that functions as a neighborhood gathering spot and functional corridor that connects downtown with neighborhoods to the east.

COHEN PARK ENHANCEMENTS

Cohen Park is an existing neighborhood park serving the neighborhood south of MLK Jr. Parkway. The park contains a small manicured landscaped area and an historic 1906 water trough/fountain. Future plans include adding a storm water detention basin to this park in order to address regional storm water quantity/quality issues. As with the detention basin in the larger naturalized park to the north, this basin should be designed to look as natural as possible, and landscaped with native and regionally appropriate trees, forbs, and grasses. Because parks add value to adjacent properties, future enhancements should consider adjacent development sites and their views into the park. Enhancements should be designed to act as forecourts for these projects, and offer amenities for their future residents. In return, future development projects should be designed so that they front onto and help activate the park.

Examples of "Naturalized Neighborhood Parks

OVERVIEW

Throughout the course of the master planning process for the Market District, participants, including the City of Des Moines, key stakeholders, and the general public, brought up their desire for the district to become one of the most sustainable neighborhoods within the State of Iowa. Words such as "green" and "sustainable" were used to describe the district's future condition on a regular basis. Accordingly, the master plan establishes a framework to help ensure that this becomes a reality.

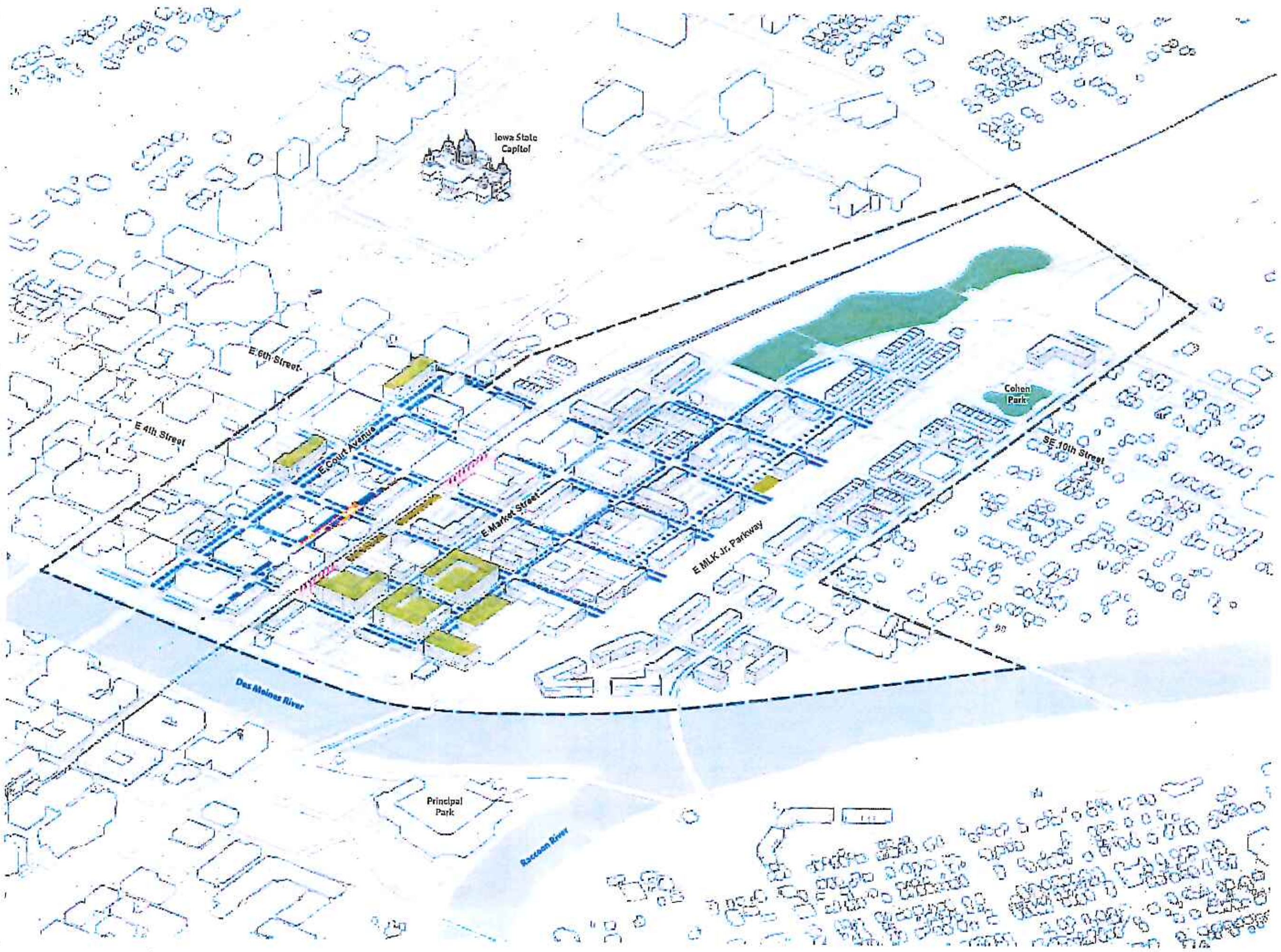
At its most basic level, the Market District will be a pedestrian-oriented, mixed-use district built upon a tight grid of streets. This walkable urban neighborhood will contain a variety of uses, including residential, retail, hospitality, and office. These uses will be mixed vertically and horizontally, and will be interconnected by a multi-modal network that equally accommodates pedestrians, bicyclists, transit users, and personal vehicles. This will allow flexibility in how one moves throughout the district, and the mix of uses should help capture trips that would normally require one to leave the district. In essence, the Market District will be designed in a manner that most of our great cities were before the advent of the personal automobile, in which most of one's daily needs were within walking distance or a short ride on transit.

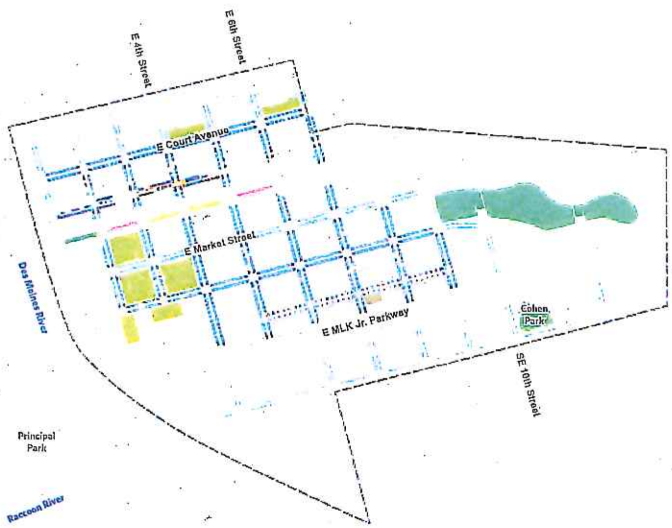
With the most basic, but often overlooked, sustainability framework elements in place, additional green initiatives can then be layered in for increased impact. These include the following, and will be addressed in greater detail later in this chapter:

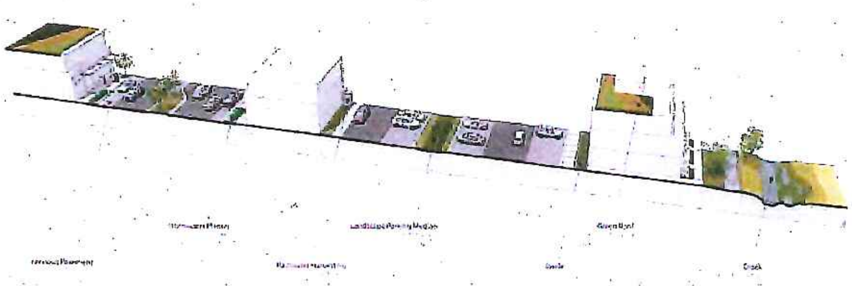
- Storm water Detention Facilities
- Storm water Planters
- Permeable Pavers
- Geothermal Energy loop
- Solar Energy
- Wind Energy
- Green Roofs
- Community Gardens
- Dark Skies
- Parking Structure Retrofit

KEY:

- Storm water Detention Facilities
- Storm water Planters
- Permeable Pavers
- Geothermal Energy Loop
- Solar Energy
- Wind Energy
- Green Roofs
- Community Gardens







Transect of Green Infrastructure Options

These green initiatives have significant individual benefits, and combined their overall impact is substantial. With the walkable design framework in place, if only one or two of the green initiatives are implemented, the positive impacts would exceed that of most development projects occurring within the State. If all of the green initiatives are implemented, which is the goal, the Market District would become not only the most environmentally friendly neighborhood within the State, but would be near the top of the projects occurring throughout the country.

To encourage the on-going implementation of the above green initiatives, the City should consider selecting a community sustainability rating system for use within the Market District. An overview of potential rating systems to consider is highlighted, below. Prior to development, or as soon as possible, community/stakeholder discussions will be necessary in order to select a preferred rating system for the district.

OPERATIONS/MAINTENANCE-RELATED CREDITS IN SEVERAL COMMUNITY-LEVEL SUSTAINABILITY RATING SYSTEMS

WELL COMMUNITY STANDARD

The WELL Community Standard offers 100 features (called credits in other rating systems) worth one point each, plus up to 40 additional points for innovation and buildings with health/wellness or green certifications. 55 of the total 100 base features/points are related to operations and maintenance (e.g. landscaping and pesticide use policies) or require ongoing documentation (e.g. annual air quality results). A few features included in the 55 could be interpreted either way, like indoor and outdoor smoking bans. See below for a list of features with operations-related credits marked.

LEED ND

Only 2 out of 110 possible points might be considered operational: Long-Term Conservation Management of Habitat or Wetlands and Water Bodies, which requires a management plan, and Solid Waste Management. There are no ongoing documentation requirements for any credits.

ECODISTRICTS

There is no set list of credits for EcoDistrict certification. Instead, there are set imperatives (equity, resilience, and climate protection) and priorities (place, prosperity, health + wellbeing, connectivity, living infrastructure, resource regeneration). Districts develop road maps with performance targets and implementation strategies to achieve the imperatives and priorities. As part of the road map, a district must develop a set of indicators to measure and track performance towards each imperative and priority. EcoDistricts offers a list of suggested illustrative indicators that districts can choose to use or modify, or districts can develop their own. Examples include average life expectancy, number of intersections per square mile, and gallons of water used daily per capita. These indicators don't have set achievement thresholds, like credits in more prescriptive rating systems like LEED. Instead, districts designate their own goals for achievement and set their own horizon year. Since the EcoDistricts certification system is built around districts developing their own goals and achievement levels, it is not possible to estimate the number of "credits" associated with operations and maintenance, as opposed to neighborhood design.

ENVISION (NOT COMMUNITY-SPECIFIC; INFRASTRUCTURE FOCUSED)

Envision is a framework that includes 64 sustainability and resilience indicators, called 'credits', organized into five categories: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Resilience. These collectively address areas of human wellbeing, mobility, community development, collaboration, planning, economy, materials, energy, water, siting, conservation, ecology, emissions, and resilience. These indicators collectively become the foundation of what constitutes sustainability in infrastructure. Of the 64 credits, six credits are focused on operations (two for water and energy monitoring: one for operational energy; one for operational water use; and one for operational waste; and one for monitoring and maintenance).

SUSTAINABILITY

STORM WATER DETENTION

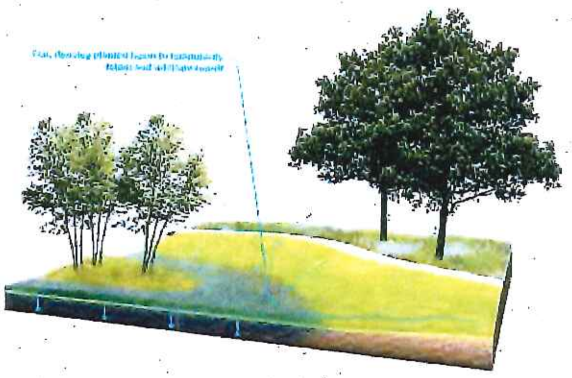
Storm water detention basins provide a full range of ecological services for polluted runoff, including retention, infiltration, and treatment. In addition, they provide both educational opportunities and aesthetic benefits for surrounding communities, and reduce reliance on pipes and other underground infrastructure. When done correctly, these man-made facilities replicate natural systems by enhancing water quality and providing flood storage. Depending on the size of their catchment area, they are typically large in scale to provide enough area for storm water storage, vegetative cover, and wildlife habitat. Vegetation should consist of a variety of native species well-suited for both wet and dry soil conditions. The main priority is the creation of a large detention basin in the 'Naturalized Park' to handle excess runoff

STORM WATER PLANTERS

Landscape planters placed along the street provide opportunities for retention, infiltration, and/or treatment of water during storm events. Instead of transporting polluted water downstream, these facilities are designed with a wide variety of vegetation to slow down and treat storm water near its source. Curb-cuts are designed to divert storm flows into the planters. Lower growing plants should be utilized at intersections to help maintain street site distances. When used liberally, as proposed in the master plan, this form of green infrastructure helps to provide both an aesthetic and ecological function to the street. Priorities include incorporating storm water planters in new streetscape projects.

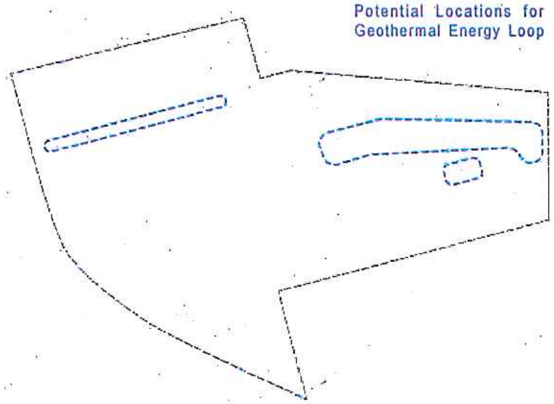
PERMEABLE PAVERS

Combined with other forms of green infrastructure, previous pavement helps to slow down and infiltrate polluted water into a sub-layer of aggregate before leaving a site. Pervious pavement can be used on-street in parking lanes or in parking bays in surface parking lots, but should be avoided in high traffic areas. Several types of pervious pavement exist, including modular porous pavement systems, pervious concrete, porous asphalt, and reinforced grass pavers. Pervious pavement helps to filter sediment from runoff and should be placed near the source of the treatment network. Permeable clay pavers are recommended for use within the right-of-way. Other types of pervious pavement can be utilized elsewhere within the Market District. Priorities include incorporating permeable pavers in new streetscape projects, and open space projects.



GEOTHERMAL ENERGY LOOP

Geothermal energy is heat from the Earth that is both clean and sustainable. Nearly everywhere, the upper 10 feet of the Earth's surface maintains a nearly constant temperature between 50 – 60 degrees Fahrenheit. Geothermal heat pumps can tap into this resource to heat and cool buildings. In the winter, the earth is used as a heat source, and in the winter it is used as a heat sink. A geothermal energy system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger – a system of pipes buried in the shallow ground near the buildings to be heated and cooled. Large open spaces, such as the ones identified in the diagram, below, are ideal locations for the placement of the geothermal heat exchanger, and should be further studied for use as a district energy loop. Priorities: Assess near-term development opportunities for geothermal w/ design of storm water park. Convene owners adjoining linear promenade park to determine feasibility of geothermal in this location.



SOLAR ENERGY

Solar energy is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, and solar architecture. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. Depending on the interest and ability of participants to fully integrate solar into the Study Area infrastructure, off-setting 30 – 50% of energy use through rooftop or on-site ground mounted solar appears to be a viable alternative. However, discussion with the local utility should occur in order to better understand how a large, behind-the-meter facility will impact demand and energy charges for each building location. Priorities include encouraging solar panels on new developments, and utilizing vacant land adjacent to the Railroad ROW as an opportunity site for solar.

WIND ENERGY

Wind power is the use of air flow through wind turbines to provide the mechanical power to turn electric generators. Wind power is renewable, clean, and uses little land. There are a number of wind turbine types that are appropriate for urban settings such as the Market District. A cursory analysis shows that building small-scale wind energy may be of potential value if done in open park land or other spaces where small-scale turbines could be installed away from buildings and other structural interferences. That said, winds at the lower elevations in Des Moines are generally seen as insufficient for economic wind generation in the investigated scenarios, and should be used be used instead to supplement other energy sources. As such, wind is not a priority for the district but may be incorporated on a project basis if desired.

SUSTAINABILITY

GREEN ROOFS

In urban areas, building roofs account for a significant amount of impervious surface. Many of these roofs can be planted with vegetation to help treat and retain storm water. Green roofs require structural improvements to support soils, vegetation, and loads associated with rainfall and snowfall. Benefits include providing habitat for plants, animals, and insects; reducing the heat island effect; and providing a development tool to create green space in otherwise under-utilized space. Vegetation should ideally be native species that are drought tolerant. Priorities include encouraging green roofs on sites west of E. 4th Street to reduce storm water runoff to the Des Moines River.

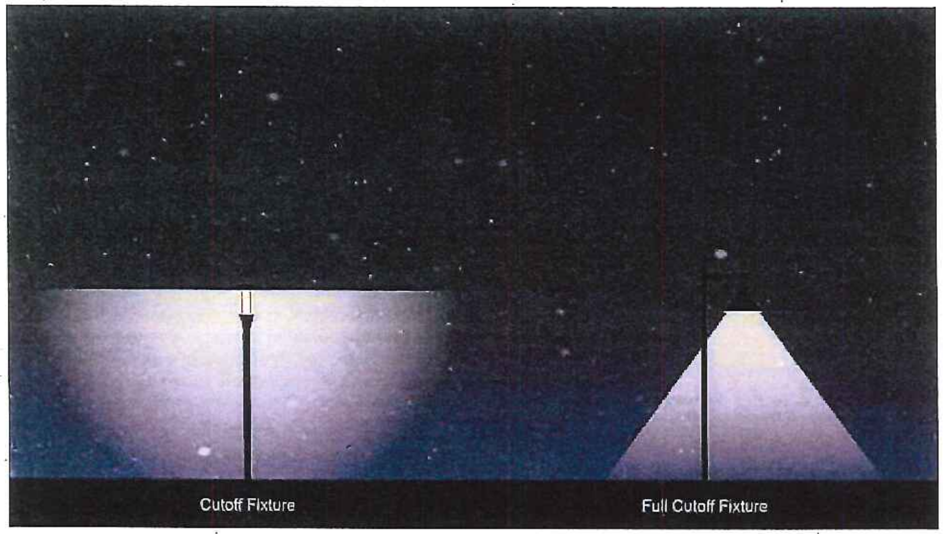
COMMUNITY GARDENS

Community gardens should be encouraged throughout the neighborhood. Community gardens are typically small parcels of land gardened by a group of people utilizing either individual or shared plots. These plots can be located on private or public land, and provide fresh produce and plants to those who work them. Community gardens are typically publicly functioning in terms of ownership, access, and management, and are often owned in trust by local governments or not-for-profit associations. Priorities include new community gardens along the promenade park and in new private developments. Private development has been recognizing that tenants value community garden space and often include them as amenities. Benefits of community gardens are many, including:

- They provide a sense of community to those who participate in the gardening activity
- Participants can keep or give away the fruit and produce they grow
- The fruit and produce grown can be used to stock local farmer's markets and co ops
- They can be used to alleviate the food desert effect in certain neighborhoods, ensuring residents' access to healthy and affordable food
- They can break down isolation by creating social opportunities/community.

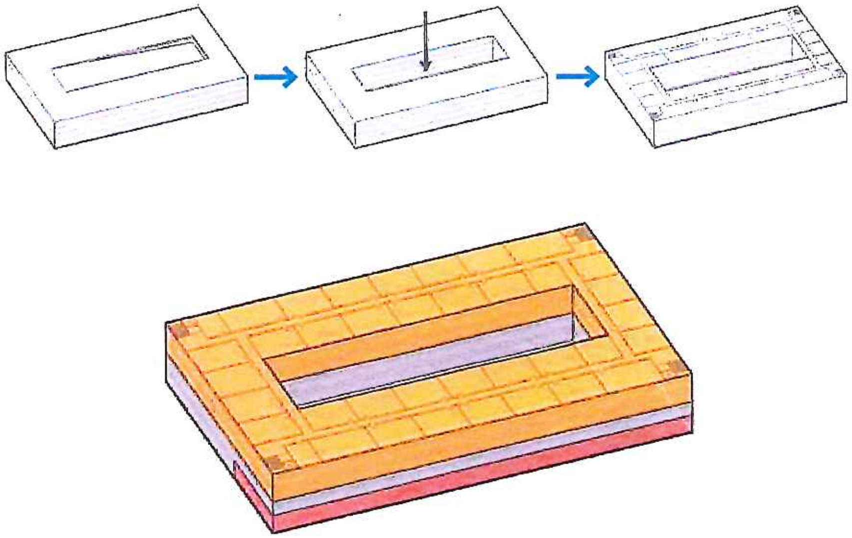
DARK SKIES

Light pollution is the unwanted and excessive casting of light by exterior fixtures. Examples include glare from nearby lights, light trespass into windows of adjacent buildings, and sky glow, which is commonly seen over heavily populated areas. Manufacturers now create special fixtures to more directly focus light on an intended area. In addition to increasing energy consumption, light pollution can disrupt delicate ecosystem balances that rely on the natural day and night cycle, such as migratory patterns of birds. Excessive nighttime light has even been shown to affect the sleep patterns in humans, making it harder to sleep at night. Lighting in the Market District should use either Cutoff Fixtures or Full Cutoff Fixtures. Light fixtures with no cutoff kits or semi cutoff fixtures should be allowed.



PARKING STRUCTURE RETROFIT

Prevailing thought is that autonomous transit and autonomous vehicles will significantly change the way people move around cities in the not so distant future. As a result, it is predicted that demand for parking stalls will decrease significantly. This will allow surface parking lots to quickly redevelop as new, mixed-use projects, thus benefiting walkable urban neighborhoods. However, parking structures are a different story. To ensure that the parking structures that are needed today do not become impediments to development in the future, care must be made to design them so that they can easily be retrofit into future uses, such as office space and/or residential units. Parking structure design in the Market District should encourage exteriors that will function physically and aesthetically in the future as habitable buildings; provide flat parking levels that can be easily converted to usable space; be designed with column spacing that works in standardized increments for office and/or residential applications; and have ramps that are strategically placed so they can be removed/altered and their space be used for interior core functions, such as circulation, or as atriums for future interior light and air.



URBAN FORM

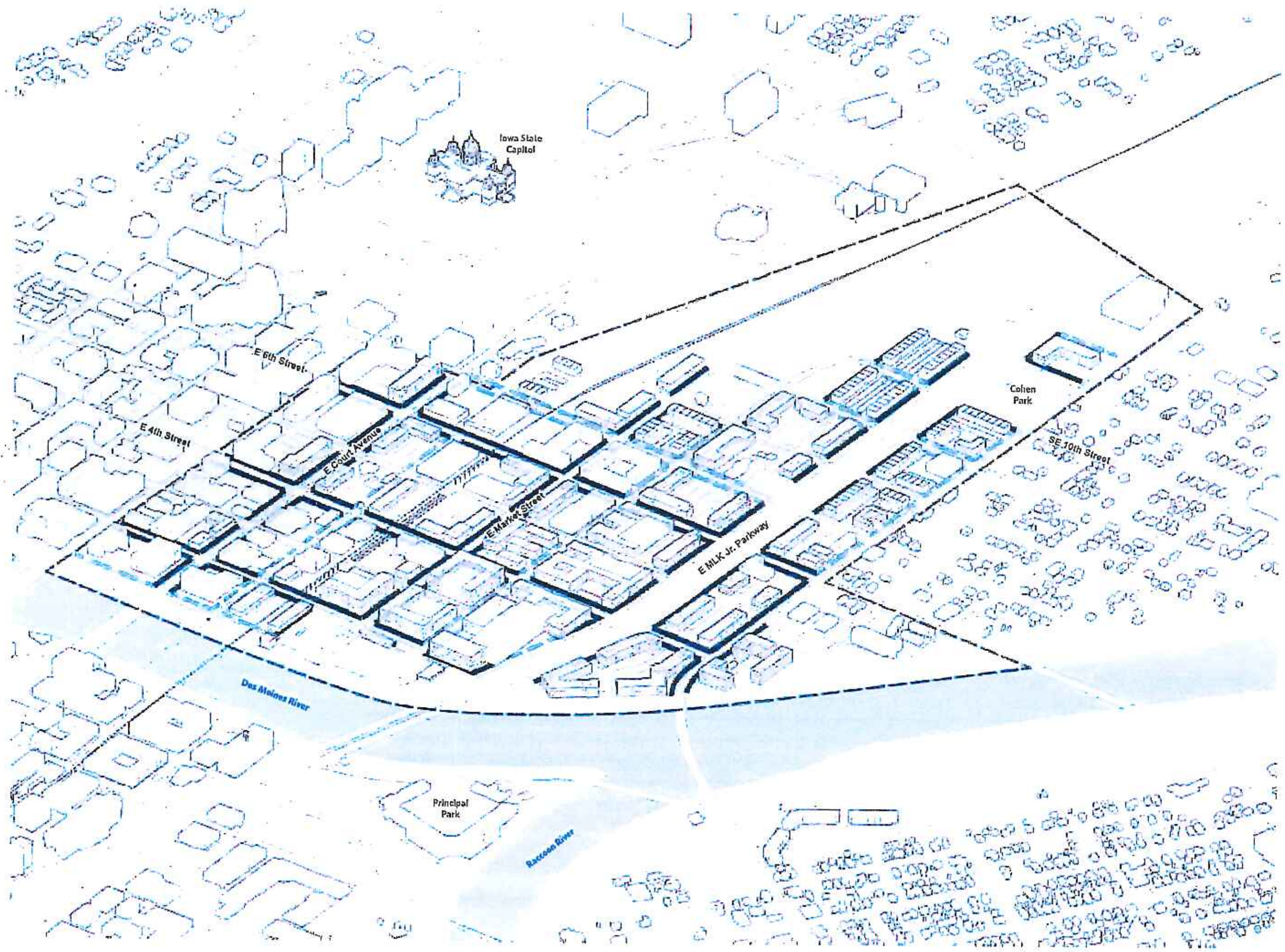
FRONTAGE REQUIREMENTS

A key goal of the Market District Master Plan is to create a walkable, urban neighborhood. To help achieve this, new buildings will have frontage requirements that are tied to their respective street hierarchy. As such, **A Streets** will have **required urban frontage** and **B Streets** will have **recommended urban frontage.**

A Streets are the primary streets within the Market District and must be lined by mixed-use buildings that front onto, and address, the street. Buildings fronting onto A Streets often have street level active uses, including retailers and restaurants. Blank walls must be avoided. Parking is provided on-street, or in surface parking lots or parking structures that are located on the interior of their respective blocks. Buildings should have primary front doors accessed from the primary street, and convenience doors accessed from secondary streets and rear parking areas. Streetscape enhancements on A Streets are significantly more robust than those on other street hierarchies. As a result, A Streets are typically sought after addresses due to their special character and high level of street-level activity.

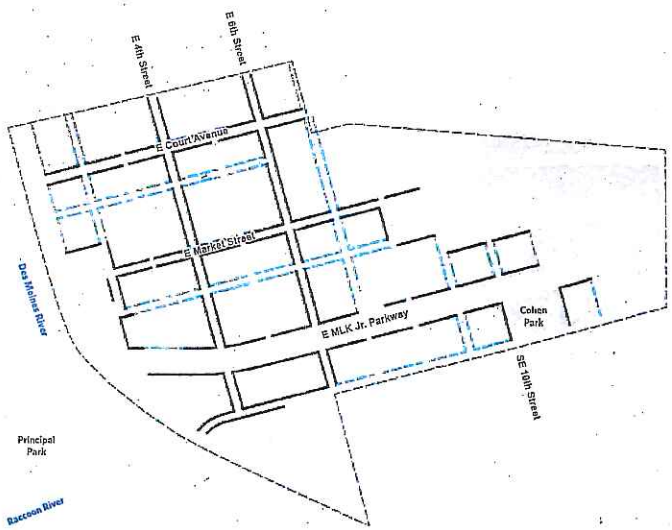
B Streets are not as restrictive as A Streets. B Streets are secondary streets within the Market District and should be lined by mixed-use buildings that front onto, and address, the street. Exceptions can be made if applicants show that viable design alternatives do not exist. Buildings fronting onto B Streets are not required to have active street-level uses; however, blank walls are to be avoided. If parking structures, lots, service courts, or docks front onto the street, they must be buffered by low screen walls and extensive landscaping. Streetscape enhancements are not as robust as those for A Streets, but are greater than those required for C Streets.

C Streets function as service and access streets, and are often lined by surface parking lots, entrances to parking structures and lots, and service courts and loading docks for adjacent buildings. Building frontage is optional, but encouraged. As a result, pedestrian activity on C Streets is typically limited. Because of this, streetscape enhancements are provided, but to a lesser degree than either A or B Streets.



KEY:

Required Urban Frontage
Recommended Urban Frontage



Urban Grocery Store Street Frontage

Office Building with Street-Level Active Uses

Active Use Frontage

URBAN FORM

REQUIRED GROUND FLOOR ENTRANCES

In tight, urban settings, it is not uncommon to see multi-family units stacked on top of a ground floor or more of podium parking, often resulting in blank walls along the street and significantly reduced street-level activity. Some buildings in the district will be mixed-use with residential units over ground floor commercial, adding vibrancy to street life. While this may be the easiest way to add housing units while accommodating market-driven parking ratios on urban sites, this building typology does little, if anything, to enhance the urban fabric. Studies have shown that the benefits accrued by increased unit counts are offset by the negative impact of blank street walls on neighborhood street life. To encourage street-level activity, all new multi-family buildings within the Market District will be required to have ground floor, street-facing entrances to residential units. The associated photos on pages 78 and 79 show examples of how this can be accomplished.

Examples of Buildings with Ground-Floor, Street-Facing, Entrances & Residential Uses

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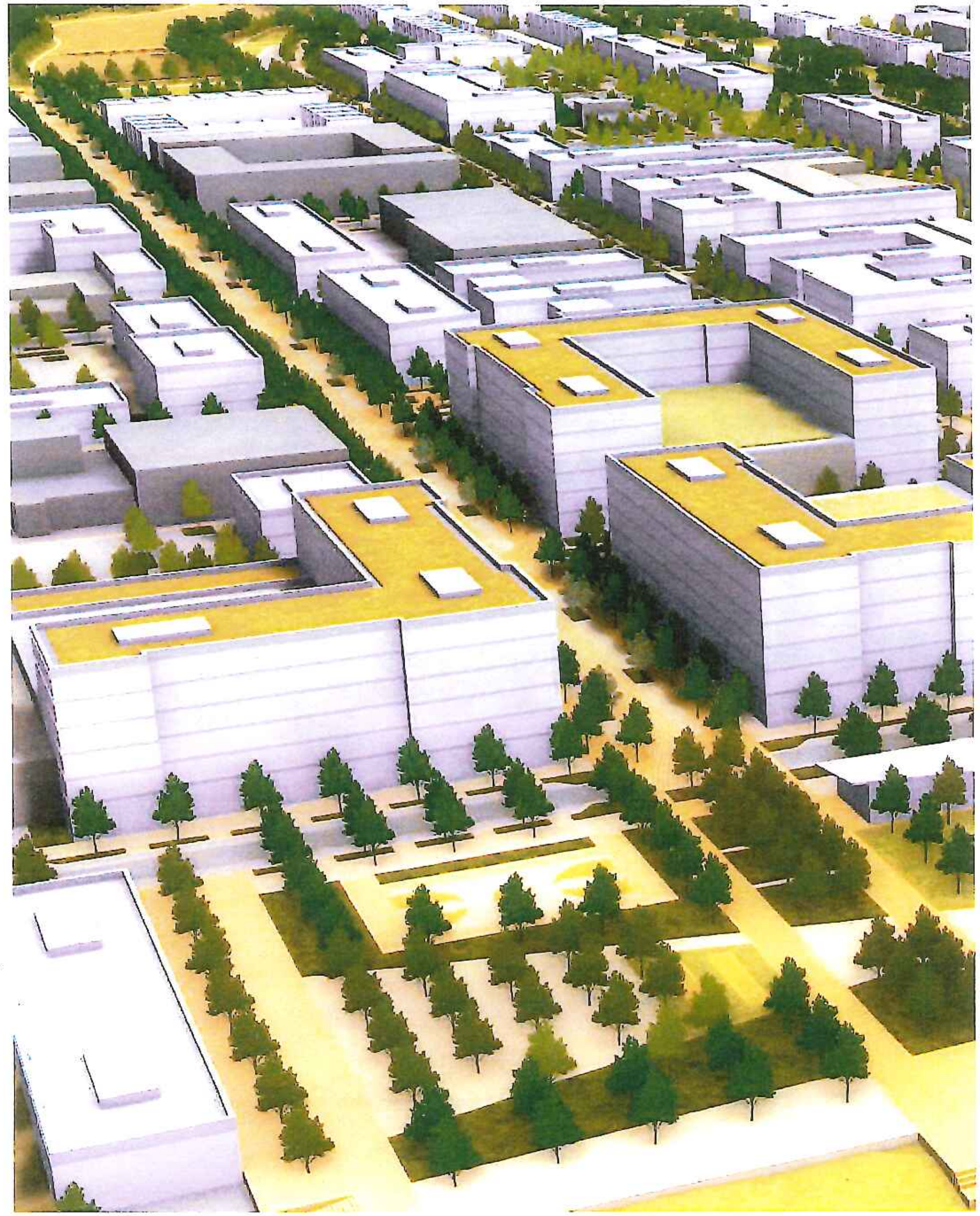
DEVELOPMENT OPPORTUNITIES

Restored / Preserved Buildings
Office / Hospitality Uses
Retail Uses
Residential Uses
District Parking
Yield Analysis

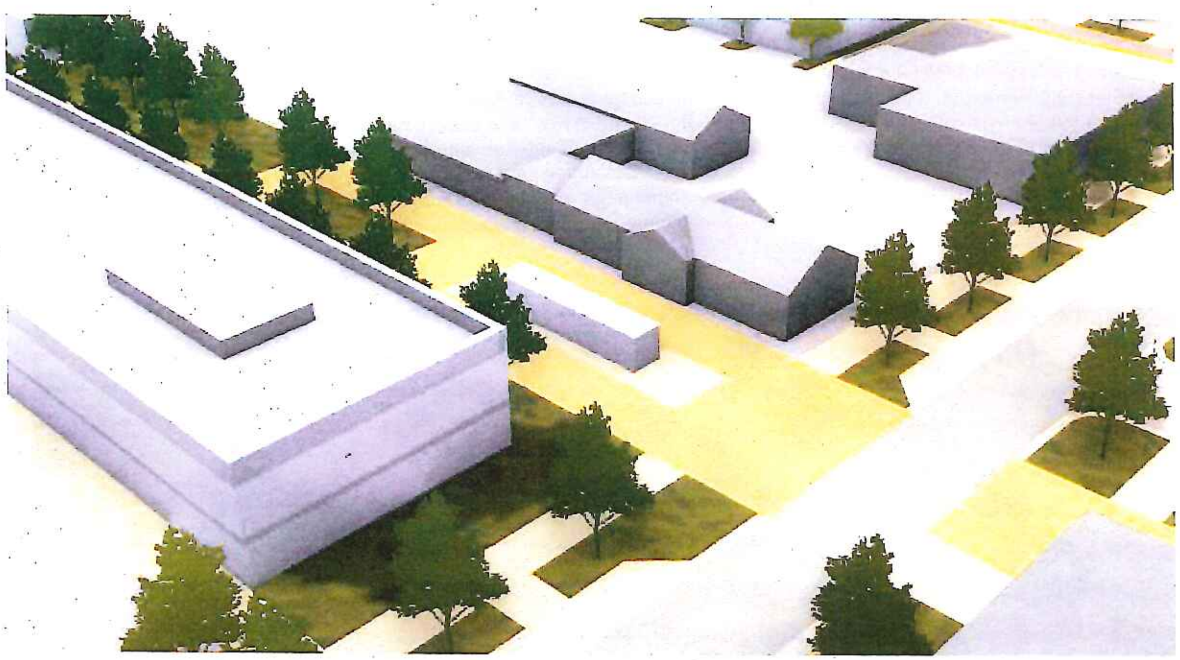


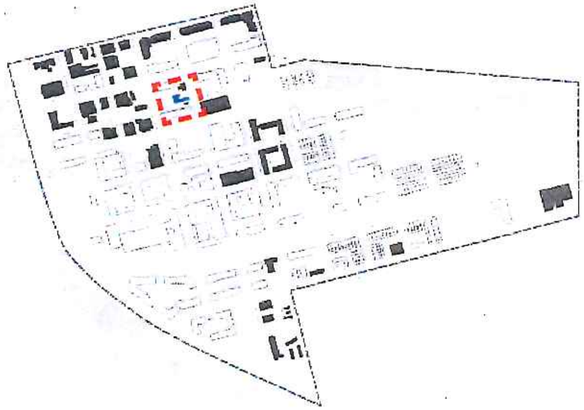
DEVELOPMENT OPPORTUNITIES

INTRO

A key element of the Market District Master Plan is the identification of future Development Opportunities. These opportunities emerged from conversations with City, key stakeholders, and real estate professionals, were tested during the Design Charrette, and further advanced and vetted during the refinement period following the Charrette. They are based on local market conditions and have been developed to the level of detail possible in a conceptual master plan. **It bears emphasizing – the Development Opportunities identified on the following pages are conceptual in nature. Their value is to identify visions and ideas for specific areas of the neighborhood. Successful visions will endure, but details will change and evolve as projects are implemented.** The plan is simply a vision, highlighting certain potential development projects. The Development Opportunities are listed with brief descriptions of each project or intervention. Following the discussion on Development Opportunities is a brief Yield Analysis. This analysis summarizes the Development Opportunities and includes building types, unit totals, square footages, and

RESTORED / PRESERVED BUILDINGS



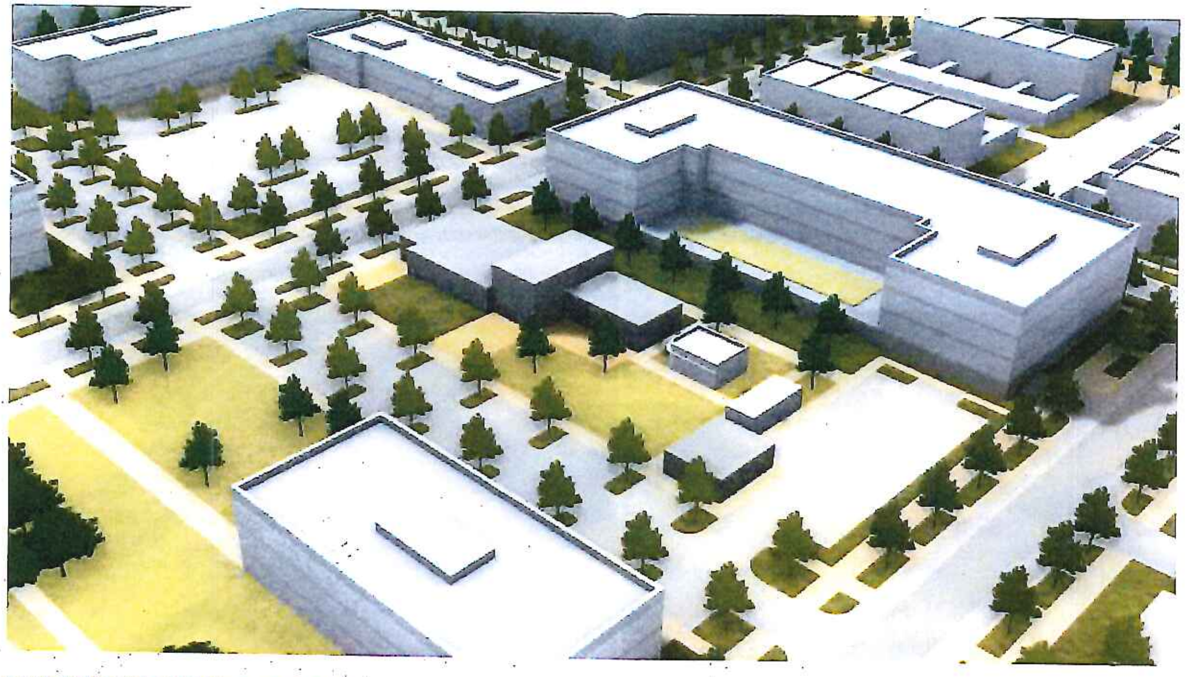


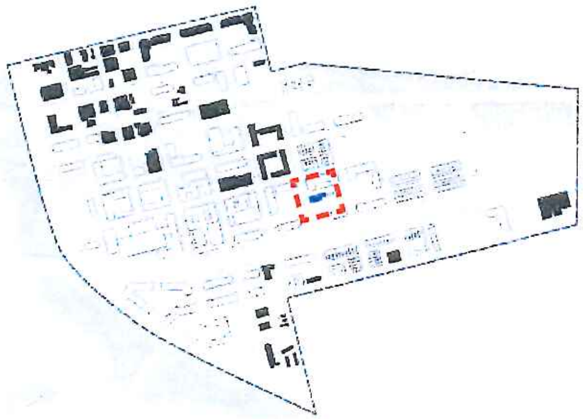
DEPOT / HISTORIC STREETCAR

The historic East Des Moines Union Depot, built in 1907, was purchased by the Des Moines Heritage Trust to save it from demolition. The former depot should be preserved and re-purposed as a museum to showcase Des Moines' history. Current thoughts include constructing a new event center to the West of the depot, to be used for weddings, corporate meetings, and other public events. This re-purposing is ideal for the Market District, and would significantly help activate the East Village Promenade / Trail in this location. In addition, the plaza proposed for the south side of the depot would provide an ideal location for the historic Des Moines streetcar that has been dis-assembled and put into storage. The restored streetcar, placed in this plaza, would help enhance the ambiance of the depot and act as an additional draw for the district.

Des Moines Heritage Trust Concept by BNIM

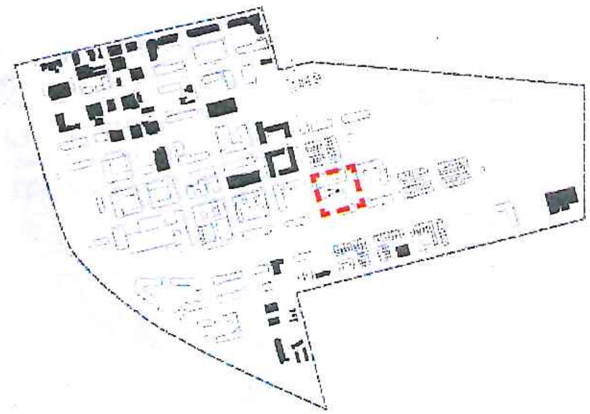
RESTORED / PRESERVED BUILDINGS





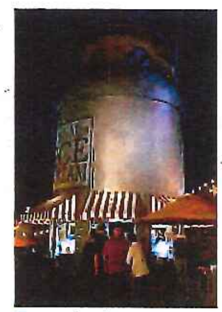
STANDARD OIL BUILDING / GARAGE

The Standard Oil Building and adjacent garage contain some of the most unique architecture within the Market District. As the district evolves from an industrial district to a walkable urban neighborhood, existing industrial uses will likely desire better-suited surroundings. If this occurs and the site becomes available, these two buildings should be preserved and redeveloped with uses more compatible with the emerging neighborhood. The site could be transitioned into a "Standard Oil Commons" in which the main building houses one or two destination restaurants, and one or both wings of the building and the garage house pop-up retailers, vendor kiosks, and/or market stalls. Additional small historic out-buildings could be relocated to the site for vendor use, as demand warrants. Views to the primary facade of the building from MLK Jr. Parkway should be kept open and framed, and the "commons" should be surfaced in grass and pavers, providing a small common open space for the site. Pads and hook-ups for food trucks should also be provided.



ART MODERNE BUILDING

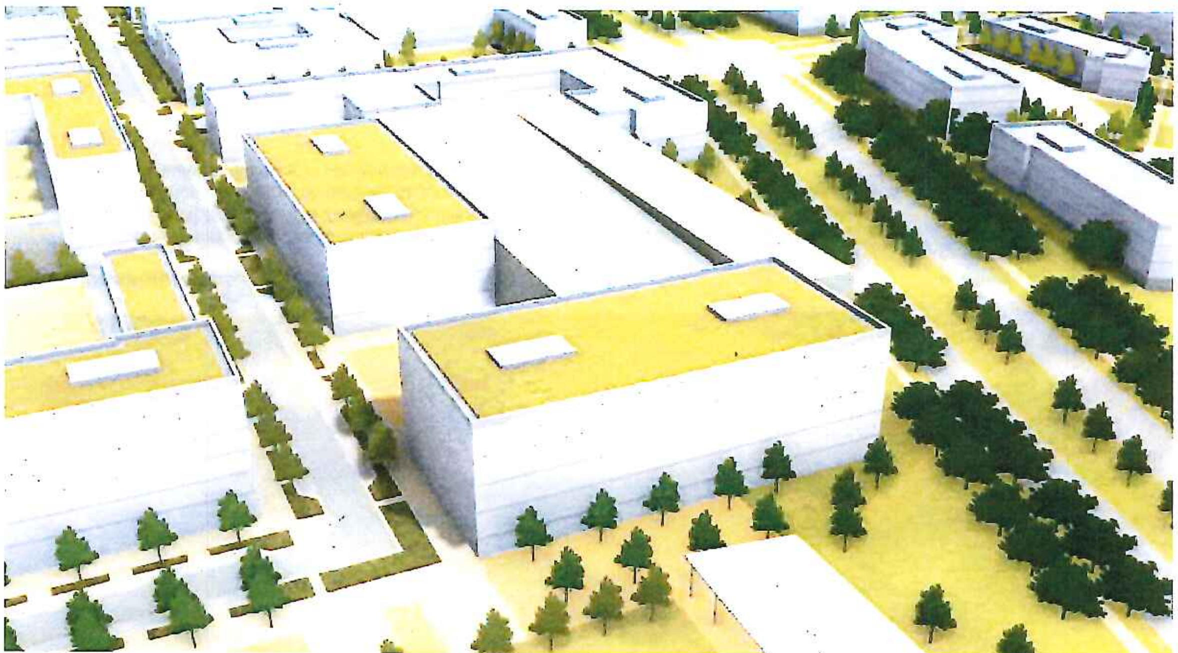
A small Art Moderne building functions as an office at the City of Des Moines yard facility at the NE corner of E. 6th Street and E. Market Street. When the City relocates its yard facilities in the future, this small building will be in jeopardy and reuse should be considered. It could be moved to the "Standard Oil Commons" site and restored for use as a pavilion housing a small restaurant, retailer, vendors, or pop-up use.

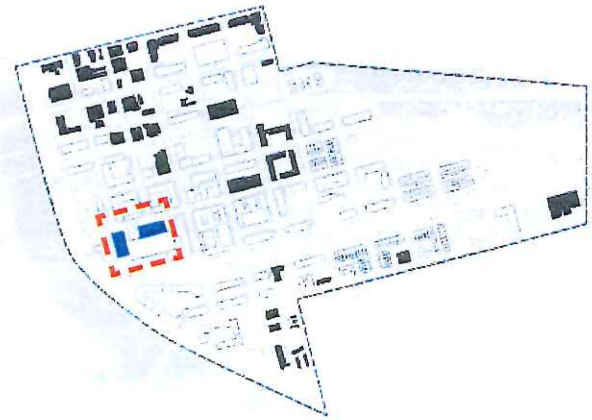


Example of a Small Retailer

Existing Art Moderne Building

OFFICE / HOSPITALITY USES



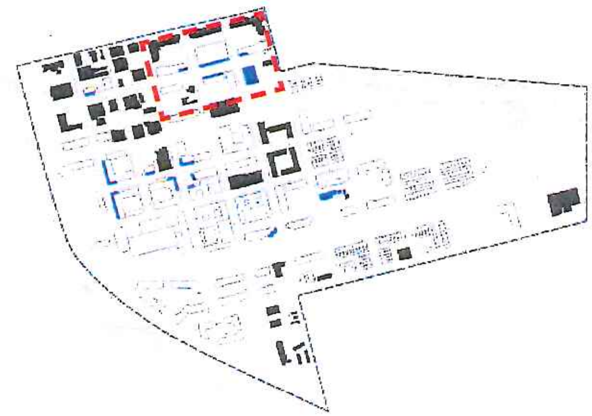


Example of Urban Office Buildings

OFFICE / HOSPITALITY USES

A major portion of the Market District is projected to be developed with residential units. However, the district also offers opportunities for large single or multi-tenant office use and/or hotel. The priority location is in the southwestern quadrant of the district, south of Elm Street, west of E 4th Street, and north of MLK Jr. Parkway. This location is preferred for a number of reasons. The large block size allows for ideal office floor-plates of 20,000 - 25,000 sq. ft. In addition, access to the site is ideal, with both E. 4th Street and MLK Jr. Parkway bordering the site. Visibility is very high, with views of the site from the proposed park, Downtown Des Moines, and MLK Jr. Parkway. Views from the site are just as commanding, with one-of-a-kind views of Downtown, the Des Moines River, and the future destination riverfront park. Parking could be provided in one large "district" parking structure, creating opportunities to share it with park-goers and the general public during the evening and on the weekends. Perhaps most importantly, no other site within the City has the potential to front onto a destination riverfront park that could be activated throughout the year. This is no small benefit when considering the value amenities like this bring to companies who are competing to attract the best and the brightest. Sites throughout the district should provide the setting for small, medium, and large office uses that are attractive to businesses seeking a mixed-use district. While this plan shows multi-family housing as the dominant use, most parcels can be interchangeable to include office uses, and the district can maintain it's mixed-use nature while supporting many places of business and employment.

RETAIL USES

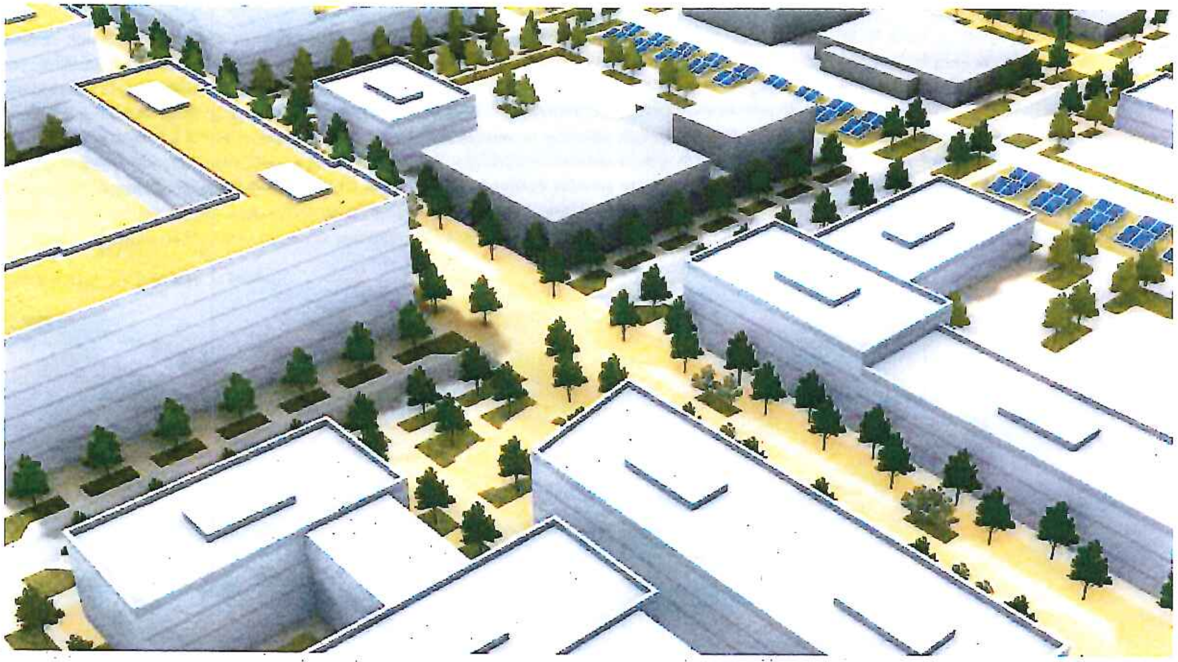


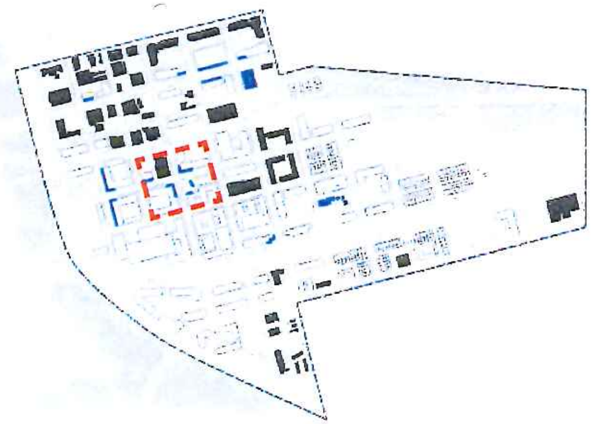
COURT AVENUE RETAIL USES

As the Market District develops with new residential projects, the "rooftops" generated will create a need for a small amount of neighborhood-serving retail uses. Because retail depends on foot and vehicular traffic for survival, its location on higher volume streets is critical. As such, new development projects along Court Avenue should be designed to accommodate retail uses, as well as professional and medical offices. In particular, larger residential projects should be designed with ground-level retail bays that front onto Court Avenue. This retail frontage will activate the corridor and help integrate the Market District with East Village. If a district parking structure is developed on the north side of Court Avenue, as shown in the conceptual master plan, it should also incorporate ground-level retail uses so that its block-long frontage is activated. Perhaps the most significant opportunity is to develop a small neighborhood grocery at the southeast corner of the intersection of Court Avenue and E 6th Street. If an urban vestibule format is utilized, this small grocery could have entrances at the primary corner and fronting on the small surface parking lot serving the grocery. The block could accommodate a grocery store in the 15,000 – 20,000 sq. ft. range.

Example of Urban Grocery Store

RETAIL USES

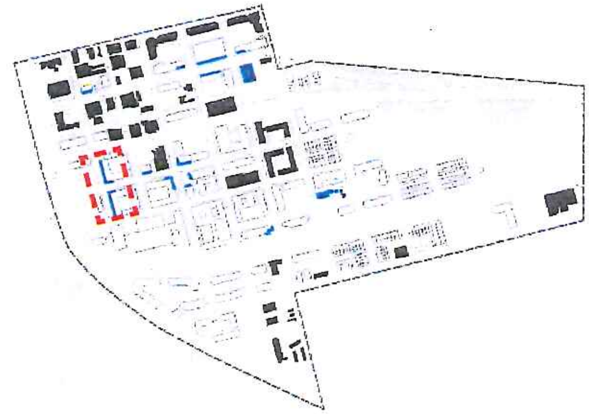




MARKET STREET PLAZA RETAIL

Another preferred location for neighborhood-serving retail is at the intersection of Market Street and East 4th Street. The Market Street Plaza, to be designed as an attached plaza, will be located at the southeast corner of this important and ceremonial intersection. Retail uses should be provided on the ground floors of the buildings that open directly to the plaza, as well as the buildings across both Market Street and E. 4th Street that will front onto the plaza. The retail uses in this location should be neighborhood-oriented, i.e. small restaurants, pubs, convenience consumer goods, and professional services such as dentists, accountants, etc. The plaza and associated retail uses will help create a small, active focal point within easy walking distance of the majority of the neighborhood, and calm traffic that moves through the neighborhood.

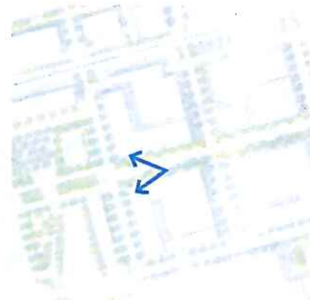
Example of Neighborhood-Oriented retail / commercial uses



PARK FRONTAGE RETAIL USES

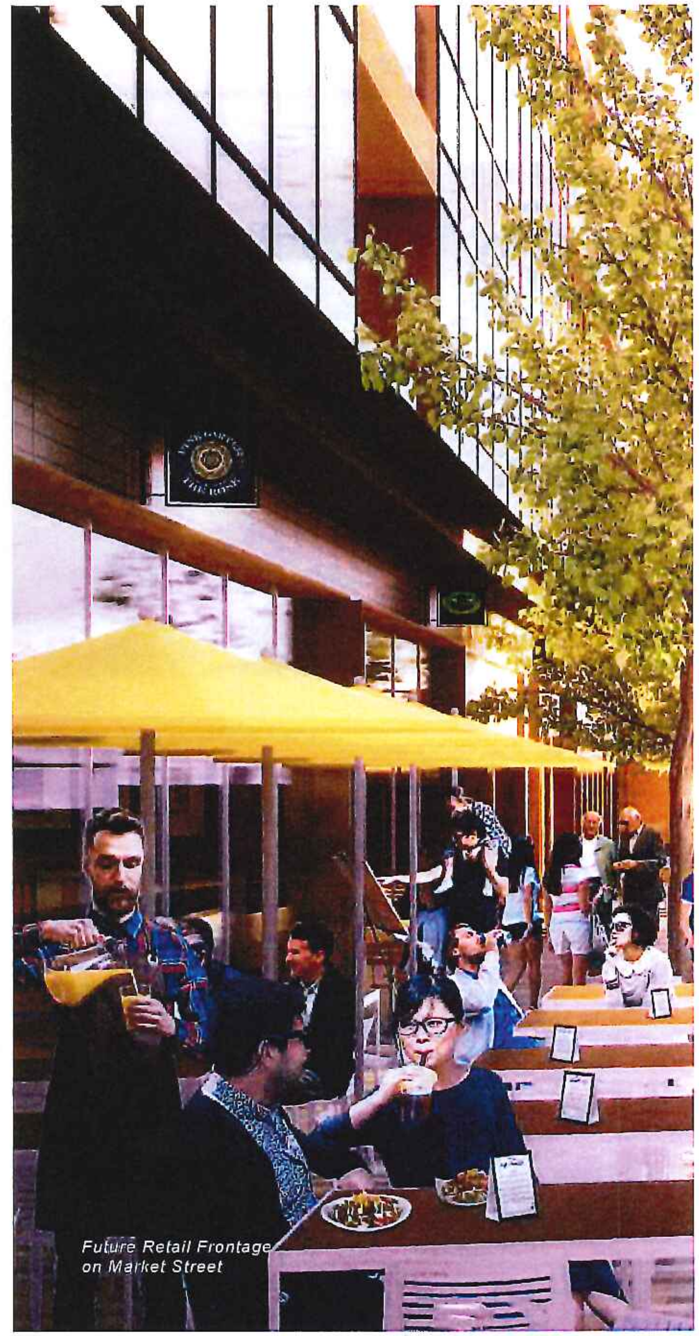
The ground level floors of the new buildings that front onto E. 2nd Street / the Destination Riverfront Park should also contain retail uses. These retail uses will likely be more regional in nature / destination-oriented than those retail uses along Market Street and Court Avenue. The goal is to create synergy between the retailers and the activities occurring within the park. Sidewalk cafes, roll-up / sliding doors, and outdoor patios are all appropriate. Uses that generate a higher level of activity, such as destination restaurants, pubs, microbreweries, and regional-oriented retailers are encouraged. Activities that flow from the fronting uses to the park, and back, should be encouraged. The combination of Riverfront Park and adjacent retail uses should act as a draw and catalyst for residents and visitors from throughout the region.

DEVELOPMENT OPPORTUNITIES

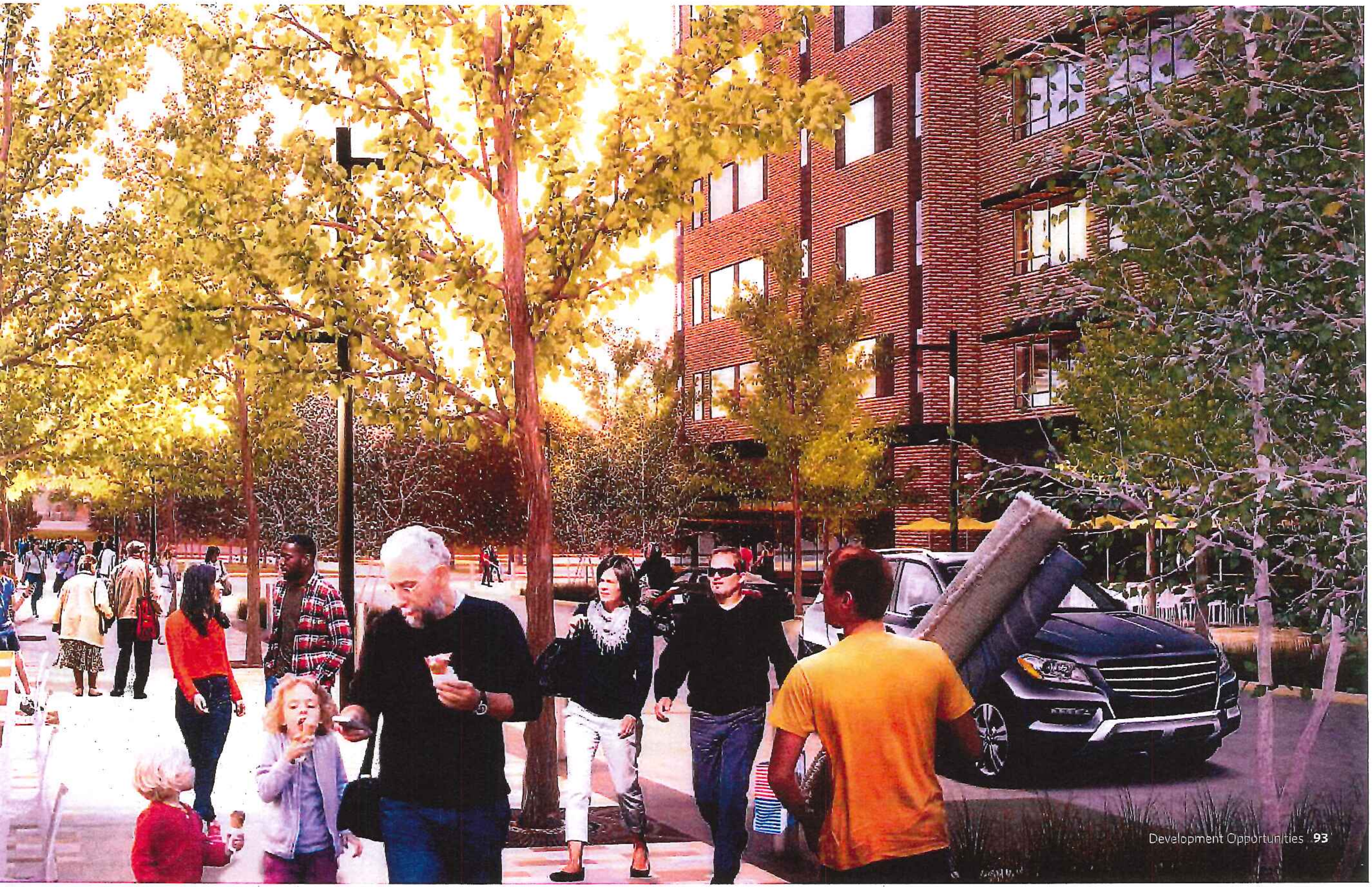


Rendering Location Key

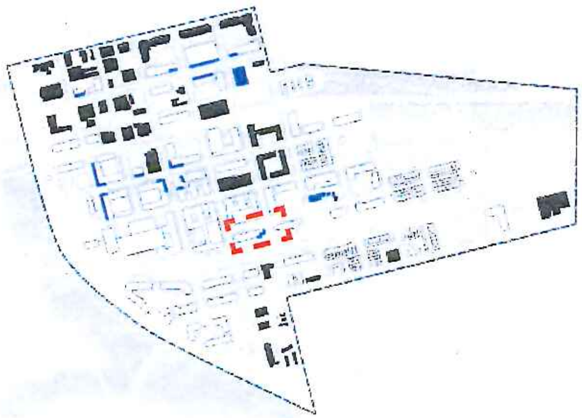
Examples of Desired Street-Level Retail Uses



Future Retail Frontage on Market Street



RETAIL USES

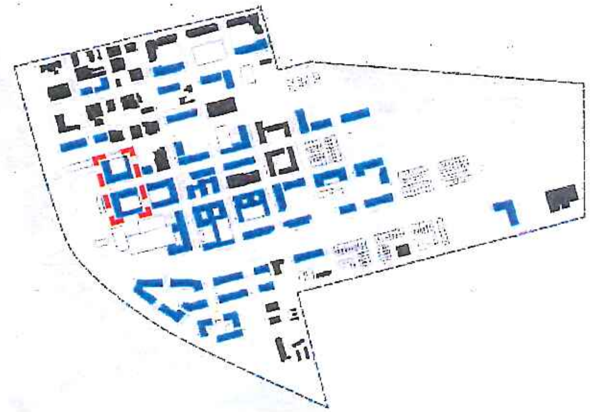


DRUG STORE

The market assessment prepared for the Market District study identified the potential need for a drug store to serve the new neighborhood. Ideally, this new drug store would be located along key commuter routes and within easy walking distance of most of the neighborhood. As such, a location at either the northwest corner or the northeast corner of the intersection of E. 6th Street and MLK Jr. Parkway would be preferred. This is a signalized intersection of two key commuter routes, and would allow easy vehicular and pedestrian access. The drug store should be constructed as part of a mixed-use development project, with the drug store on the ground level and residential units on the upper levels. Parking should be provided in a number of ways, including structured parking, on-street parking, or with a very limited amount of surface convenience parking. Additionally, this easily accessible and visible location could host a small grocery store, medical clinic, or other high profile retailer.

Example of Urban Drug Store Typology

RESIDENTIAL USES

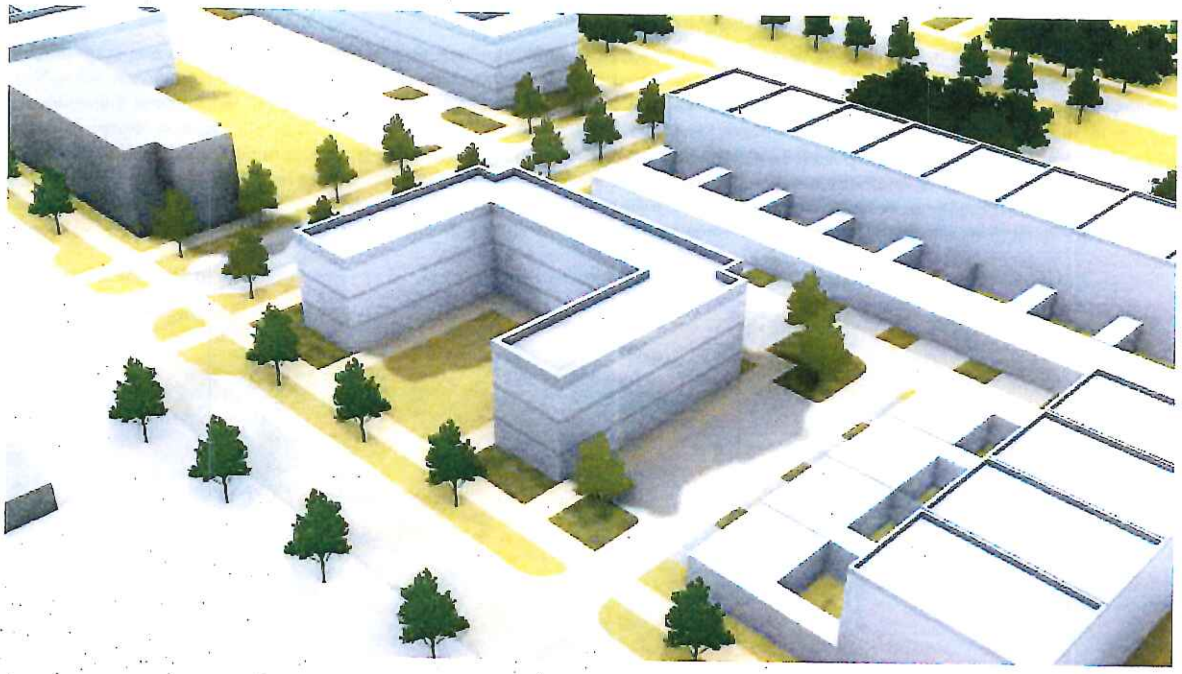


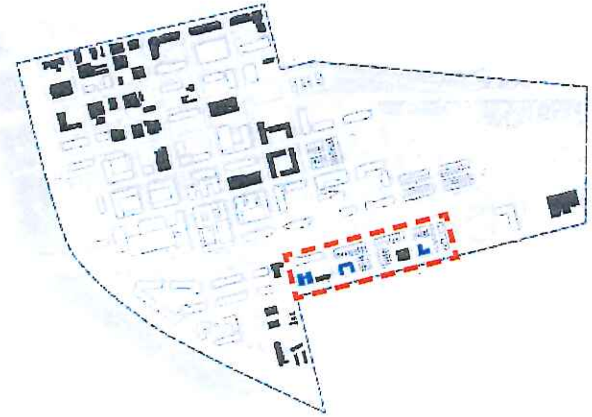
MULTI-FAMILY HOUSING

A majority of the Market District will be developed with multi-family units. These units can be either rental or owner-occupied, and will add density and critical mass to the neighborhood. The structures will generally be three to six stories in height, with parking provided on-street, or in surface parking lots or parking structures that are embedded on the interior of their respective blocks or on adjoining blocks. Buildings should have primary front doors accessed from the primary street, and convenience doors accessed from secondary streets and rear parking areas. In order to encourage street-level activity, all new multi-family buildings within the Market District will be required to have ground floor, street-facing entrances to residential units, if not over commercial uses. Units will generally have one-, two-, or three-bedrooms. For every 10 market rate residential units two should be affordable, with one unit being 60% AMI and the other 80% AMI, at a minimum.

Example of Large Multi-Family Building Typology

RESIDENTIAL USES

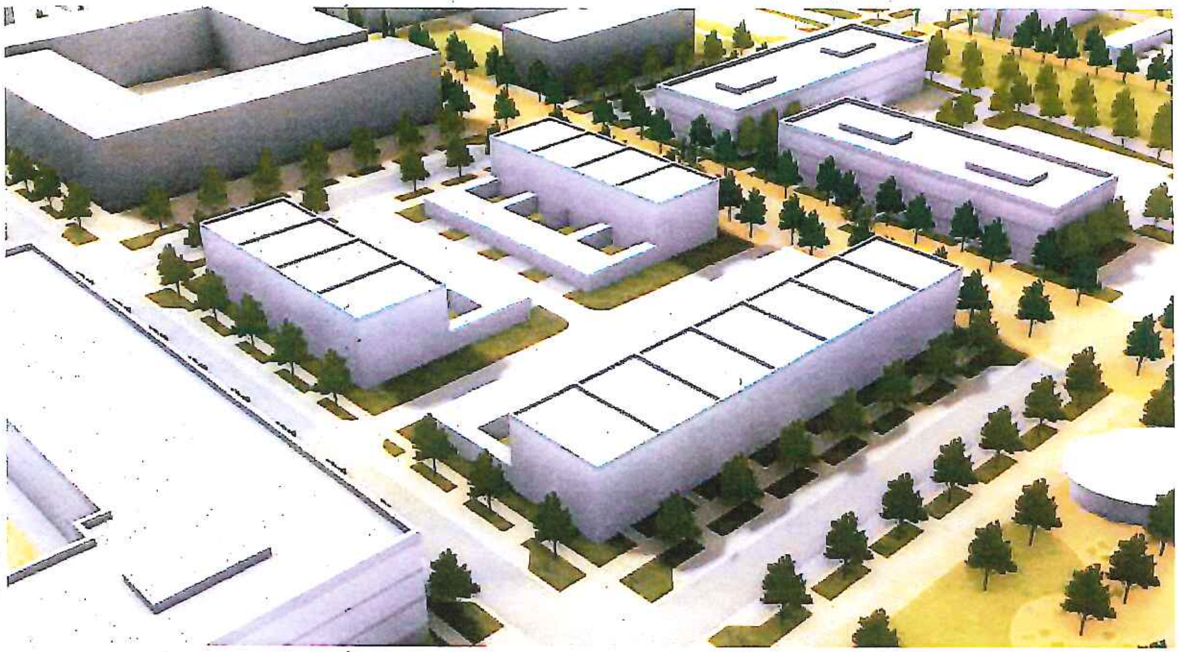


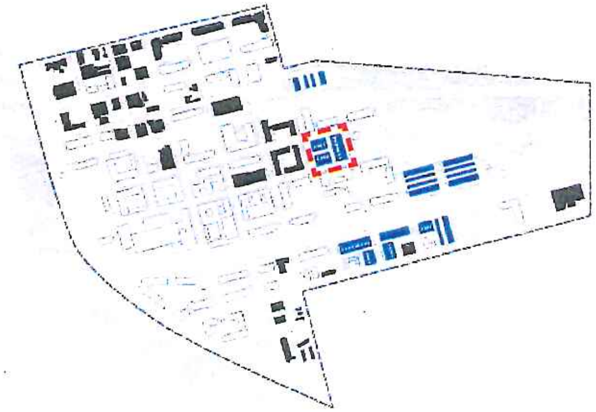


MISSING MIDDLE HOUSING

New development fronting onto MLK Jr. Parkway will generally consist of higher density building types, such as apartment buildings. Because the neighborhood to the south is predominantly single-family in nature, there should be a gradient of scale between the two differing building typologies. This presents a prime opportunity to introduce a variety of Missing Middle building types. The Missing Middle consist of building types that used to be widely used in our cities, but gradually fell out of favor by our large production home builders. This includes duplexes, 4-plexes, 8-plexes, and 12-plexes, in a number of configurations. With changing demographics and markets, these once-popular unit types are back in demand, and should be included in the new housing mix serving the Market District. Like multi-family housing, for every 10 market rate residential units two should be affordable, with one unit being 60% AMI and the other 80% AMI, at a minimum.

Examples of "Missing Middle" Housing Typologies



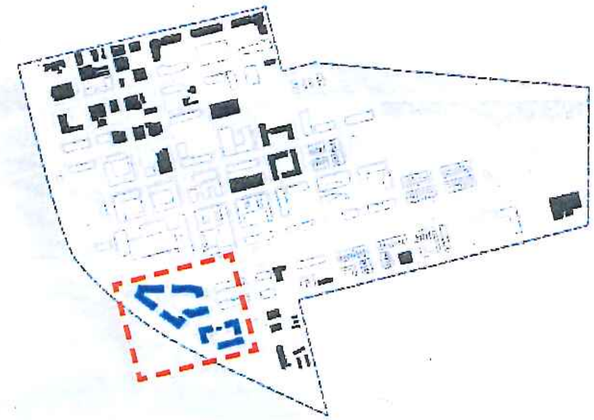


TOWNHOMES

Townhomes and row houses are sited to front onto parks and parkway frontages, where increased density and activity is desired. These single-family attached homes (owner- or renter-occupied) are higher in density, typically two or three stories in height, and have common party walls, front stoops, and parking accessed through rear alleys. Parking can be in a number of configurations, including tuck-under, attached, or detached. This frees up the front of the units for façade enhancements, including generous front stoops and porches, which allows residents and passing pedestrians the opportunity to interact.

Examples of Townhome Typologies

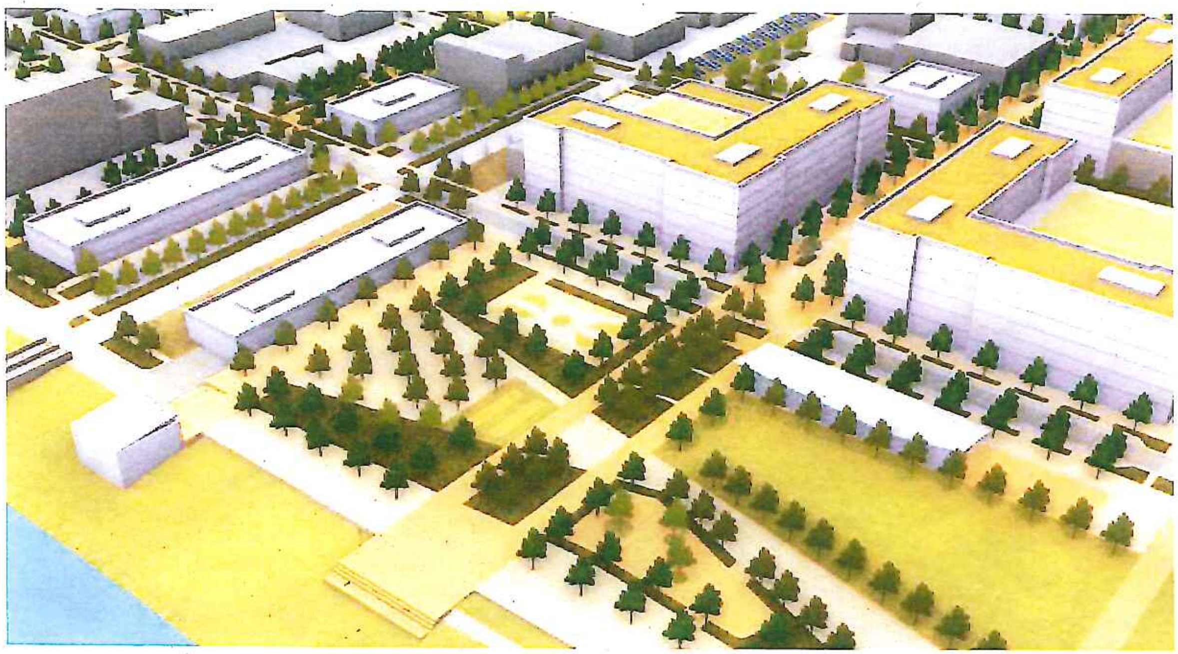
SPECIAL USES

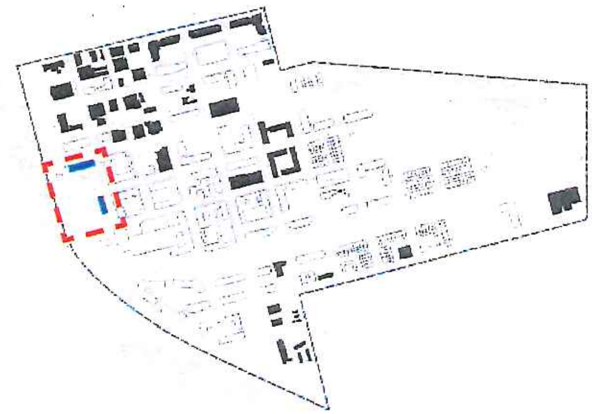


SOUTH RIVERFRONT SITE

The development blocks directly to the south of MLK Jr. Parkway and East of the river should consist of higher density building types. Because of it's important location along the river these sites should have an important use, such as a large scale multi-family housing project, Class A office space, or Public/Cultural amenity space. The Architecture fronting the river and MLK should be of a higher quality, as it helps frame a key entrance into the district.

Example of the type of Multi-Family housing expected to be developed.





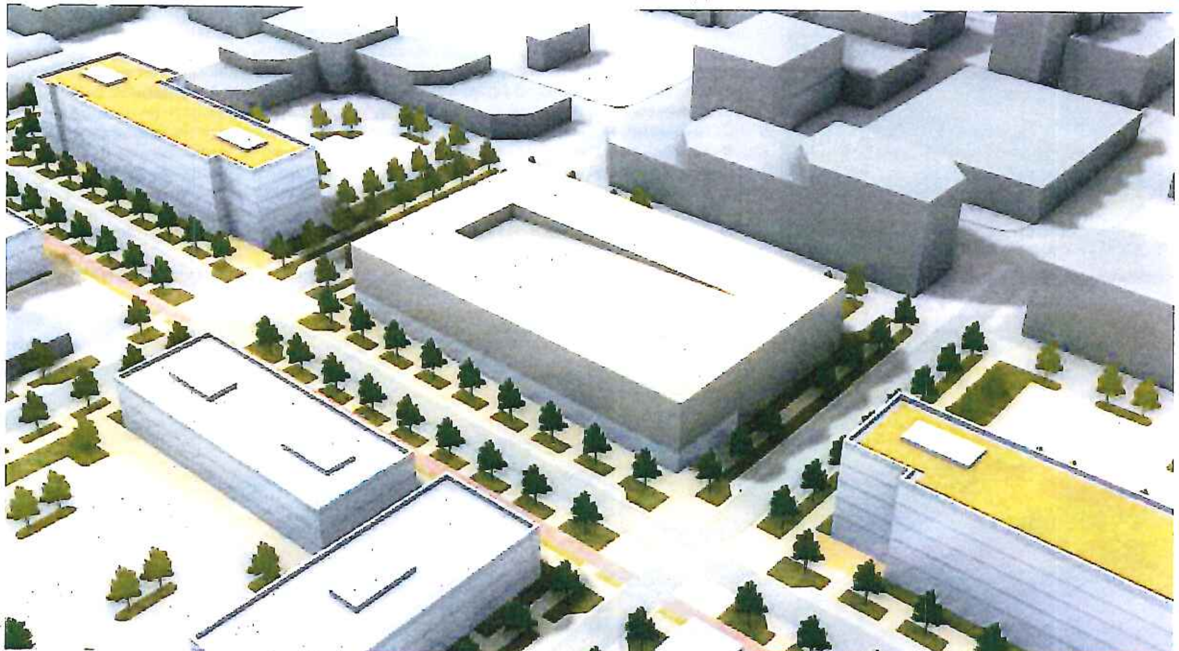
PARK BUILDINGS

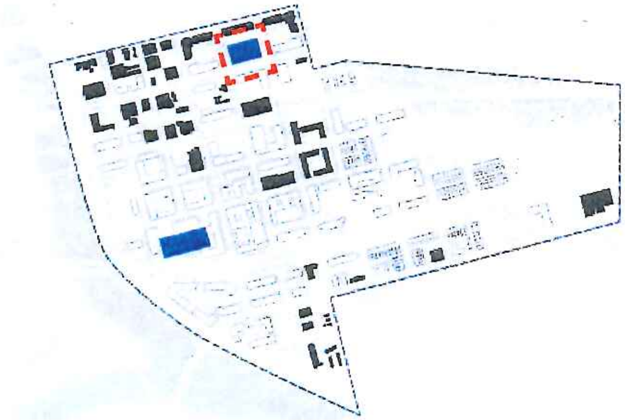
There are two special buildings associated with the Destination Riverfront Park. The first is the **Park Pavilion** building. This building is located at the north end of the park, between the river and E. 2nd Street, just south of the rail tracks. This building should be designed for, and house, a variety of functions that will help draw people to the park and neighborhood. These include, but are not limited to, a programmable rental space for community events, wedding parties, reunions, etc.; a multi-vendor food hall that opens up to the park; and an incubator space that could be programmed yearly with upstart businesses and / or restaurants, or a new cultural use. The second special building is the **Park Restaurant** building located on the east side of the park, between Market Street and Elm Street. This multi-functioning building could house an upper-end white tablecloth restaurant, a lower price-point burger joint, and a pub or craft cocktail bar, in addition to park restroom facilities. Both buildings should be designed to function synergistically with each other and the park. Further study is needed to determine whether environmental conditions on the capped site for the park would allow construction of new buildings.

Example of Park Restaurant Building

Example of Park Pavilion Building

DISTRICT PARKING





Example of District Parking Structure

DISTRICT PARKING STRUCTURES

In order to achieve the desired density within the Market District, and until the neighborhood is served by transit, it will be necessary to construct parking structures. Most development projects, and in particular residential uses, will have their own parking/structures. However, there are two opportunities for District Parking Structures. The first is located between Market Street and MLK Jr. Parkway, between E. 2nd Street and E. 4th Street. This parking structure could serve a variety of uses, including the corporate office, hospitality, retail, and residential units located on this large block. At night and on weekends, when office tenants are gone, the parking structure would be well situated to provide public parking for visitors to the riverfront, the destination riverfront park, and the various activities that will be programmed in the neighborhood. The second potential District Parking Structure is located on the north side of Court Avenue, between E. 5th Street and E. 6th Street. This parking structure would replace an existing surface parking lot. The additional stalls provided by the parking structure would serve the existing office tenants on the adjacent blocks, as well as allow for additional infill uses along Court Avenue, including new multi-family residential buildings and retail uses. The ground level of the new parking structure should also include retail uses in order to help activate the Court Avenue frontage. Because parking in each of these structures is shared among office, retail, and residential uses, it should create efficiencies that will reduce the overall number of stalls that would be required if each of these projects were parked independently, thereby making the District Parking Structures more efficient and cost effective than would otherwise be the case.

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YIELD ANALYSIS

YIELD ANALYSIS

The Market District is a pedestrian-oriented, mixed-use neighborhood that contains a variety of uses and amenities in an environmentally-friendly design. Based on the Conceptual Master Plan and the uses it identifies, the neighborhood will provide a variety of housing typologies and other uses. The overall neighborhood yields over 3,400 housing units, with 3,300+ multi-family units and 100+ townhomes. The mixed-use structures contain approximately 210,000+ square feet of office space and 135,000+ square feet of retail space. Over 7,500 parking stalls are provided in a number of configurations, including on-street parking, surface parking lots, and parking structures. Details of the development yield are included in the Yield Analysis Summary on the following page.

	Yield					Parking						
Block ID	Multi Family Sq. Ft.	Townhomes	# of Units	Retail Sq. Ft.	Office Sq Ft.	Surface Parking	Garage Parking	On-Street Parking	Demand	Total Stalls	Net	Notes:
1	31,980	0	33	2,000	0	19	0	18	59	37	22	
2	101,000	0	103	4,000	42,000	60	229	47	327	336	9	Shared garage between blocks 2 3 & 4, Office is existing, replace 456 surface parking stalls total between 3 blocks
3	0	0	0	17,200	66,000	34	230	45	238	309	71	Shared garage between blocks 2 3 & 4, Office is existing, replace 456 surface parking stalls total between 3 blocks
4	106,000	0	109	4,000	42,000	53	229	47	335	329	6	Shared garage between blocks 2 3 & 4, Office is existing, replace 456 surface parking stalls total between 3 blocks
5	34,000	0	35	0	0	25	0	22	52	47	5	
6	16,800	0	17	0	0	10	0	25	26	35	9	
7	0	0	0	0	0	0	0	30	0	30	30	No new development
8	87,300	0	89	0	0	87	12	30	134	129	5	
9	76,000	0	78	3,000	0	68	0	30	132	98	34	Retail parking shared with garage on block 3
10	26,640	0	27	18,700	0	0	200	24	134	224	90	Grocery Store
11	0	8	8	0	0	0	8	10	12	18	6	
12	0	0	0	0	0	0	0	19	0	19	19	Incubator Building
13	113,200	0	116	20,000	0	0	306	25	274	331	57	Extra public parking for riverside park
14	12,600	0	13	6,300	0	64	0	25	51	89	38	
15	65,200	0	67	8,400	0	66	0	26	142	92	50	Utilize extra garage spaces on Block 16
16	116,900	0	120	0	0	0	225	26	180	251	71	
17								26	0	26	26	Rowal Site Vacancy
18	140,100	0	143	0	0	178	0	24	215	202	13	
19	126,400	0	129	21,000	0	0	354	22	299	376	77	Extra public parking for riverside park
20	178,700	0	183	6,000	0	0	354	32	305	386	81	
21	124,200	0	127	8,400	0	0	180	34	233	214	19	
22	53,400	0	55	0	0	30	0	36	82	66	16	
23								40	0	40	40	District @ 6th Lofts
24	0	15	15	0	0	0	15	30	23	45	23	
25	188,440	0	193	0	211,200	0	1,151	31	1134	1182	48	Office Parking used as event parking for riverside park
26	259,053	0	265	0	0	0	368	42	398	410	12	
27	239,800	0	246	10,000	0	46	370	44	418	460	42	
28	141,500	0	145	0	0	159	0	42	217	201	16	
29	114,000	0	117	7,000	0	72	100	40	210	212	2	
30	139,400	0	143	0	0	102	27	42	214	171	43	
31	0	16	16	0	0	0	16	42	24	58	34	
32	0	16	16	0	0	0	16	13	24	29	5	
33	253,500	0	260	0	0	187	195	22	389	404	15	
34	138,500	0	142	0	0	107	75	36	213	218	5	
35	27,000	9	37	0	0	14	9	28	55	51	4	
36	24,000	13	38	0	0	23	13	26	56	62	6	
37	18,810	13	32	0	0	0	13	24	48	37	11	
38	0	12	12	0	0	20	12	27	18	59	41	
39	73,500	0	75	0	0	30	70	23	113	123	10	
40	154,000	0	158	0	0	102	108	29	237	239	2	
Totals:	3,181,923	102	3,361	136,000	361,200	1,556	4,885	1,204	7,022	7,645	623	

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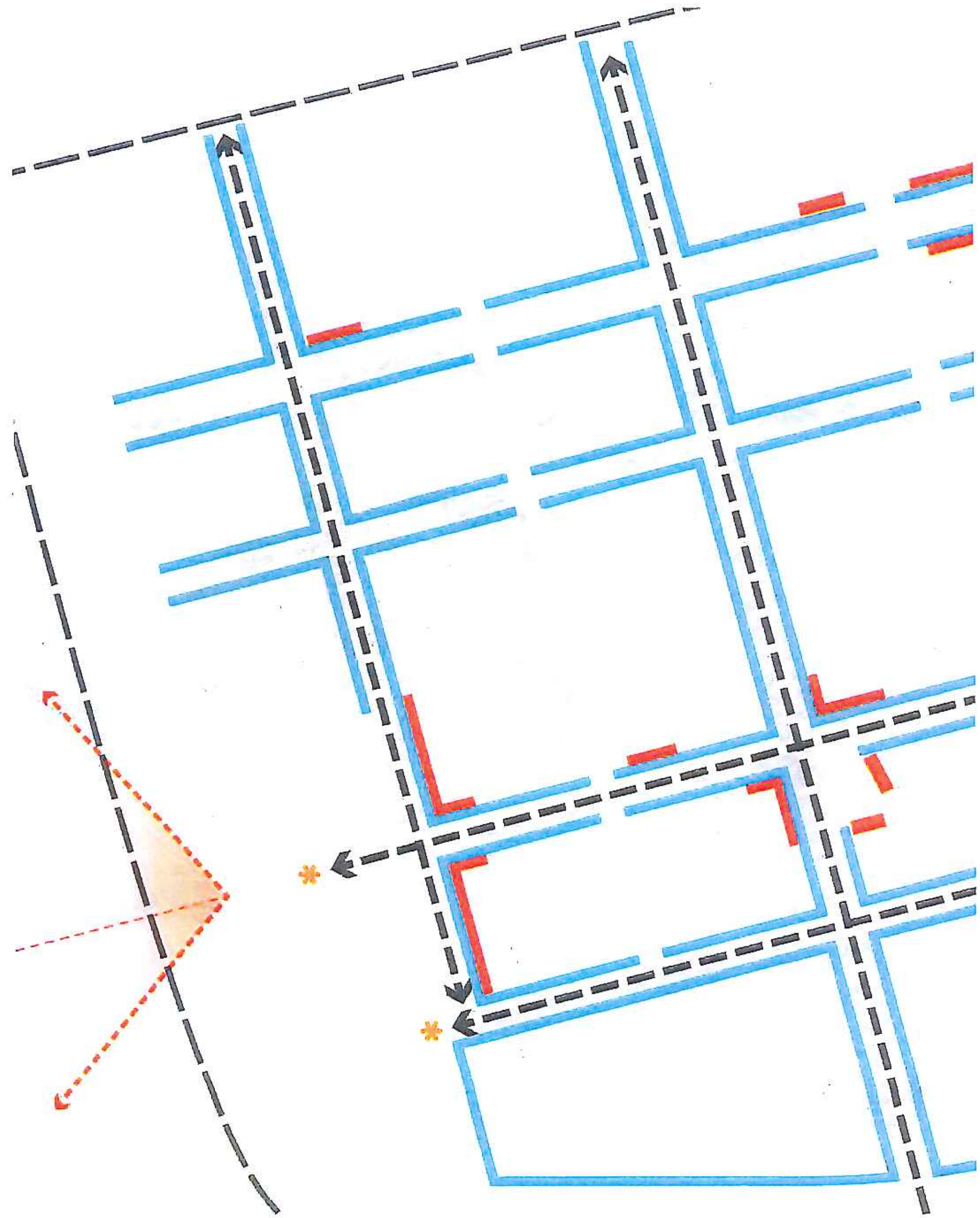
DESIGN GUIDELINES

Land Use
Building Heights / Capital View Shed
Building Setbacks
Parking and Access
Special Requirements



DESIGN GUIDELINES

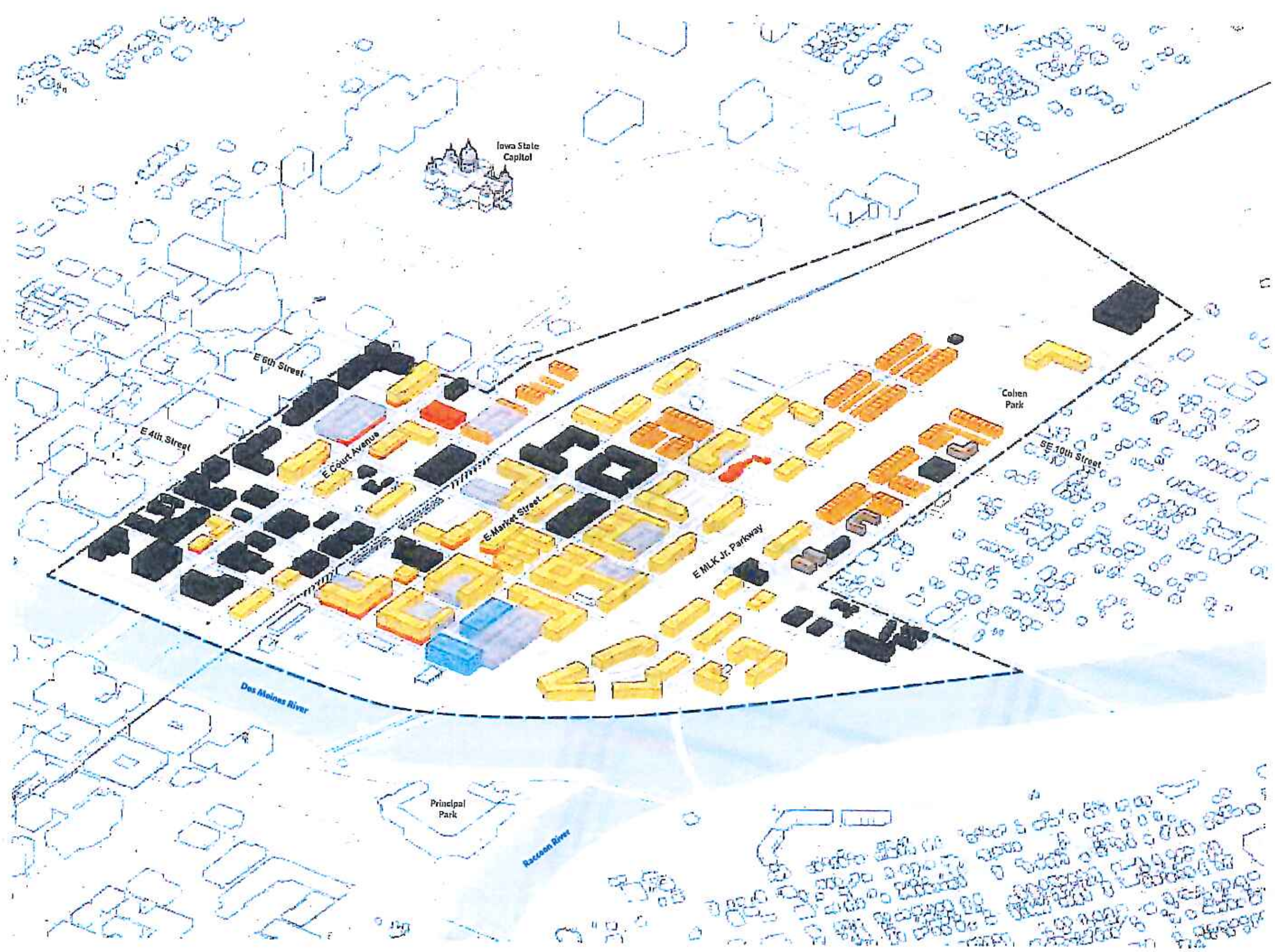
LAND USE

In order to create a true pedestrian-oriented, mixed-use neighborhood, the study area must be able to accommodate a number of land uses in order to achieve the vision of becoming a walkable urban neighborhood. This idea goes against the conventional planning ideals of the last half-century where uses were separated from each other into their own individual districts, but coincides with recent planning and successful urban districts throughout the country. The Market District aims to encourage the development of a diversity of uses that will be integrated not only horizontally, but vertically within the same structure. In particular, office retail and restaurant uses are key components to bringing vitality to the neighborhood.

A considerable portion of the neighborhood is planned for residential uses, including multi-family structures (owner and renter occupied), missing middle typologies (4-plex, 6-plex, 8-plex, and 12-plex), and townhouses. This variety of housing allows residents to age in-place and move up or down the scale of housing based on what their life, family, and financial needs dictate. This allows for a variety of household types to be accommodated within the neighborhood, promoting a diverse community with a stable population of long-term residents of all incomes and ages rather than focusing only on a market for a single demographic group. Millennials, young professionals, newlyweds, young families, empty nesters, retirees, and seniors will all have housing options that will be suitable for their lifestyle. Multi-family buildings are distributed evenly throughout the district. Missing Middle residential typologies are concentrated south of MLK Jr. Parkway and east of E. 6th Street, and townhomes are concentrated east of E. 7th Street. and typically front onto parks and open spaces.

KEY:

- Multi-Family
- Townhomes
- Missing Middle
- Office / Hospitality
- Retail / Restaurant
- Parking Garages
- Existing Uses



Retail uses are focused in three areas, and will support the daily needs of those living and working in the neighborhood. Court Avenue contains a number of infill sites and is the interface with the East Village District located to the north. Ground level retail will be scattered up and down the corridor, with a concentration located between E. 5th Street and E. 6th Street. A second concentration of street-level retail occurs along the buildings fronting on the Market Street Plaza, located at the intersection of E. 4th Street and Market Street. The third concentration of street-level retail occurs along the buildings fronting on the Destination Riverfront Park. This retail will likely be more regional in nature compared to the previous two neighborhood service concentrations. Office and/or hospitality uses should be located on the block immediately to the south and east of the riverfront park, but may also be located throughout the neighborhood.


Apartments


Hospitality


Office


Retail

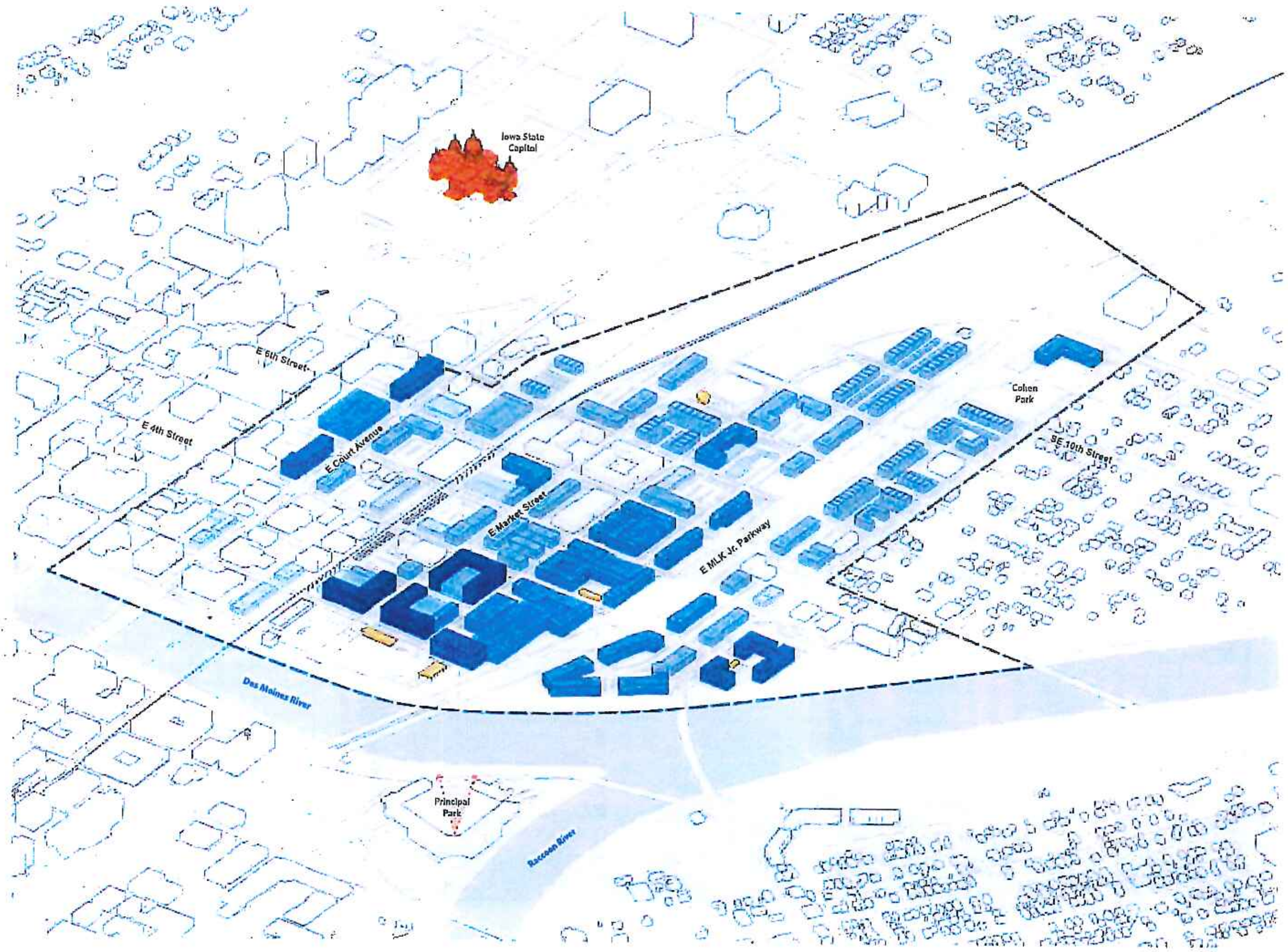

Townhomes


Missing Middle

DESIGN GUIDELINES

BUILDING HEIGHTS / CAPITOL VIEWSHED

The building heights within the Market District are based on the desired urban form and density of the neighborhood balanced with the capacity of each respective development parcel/block to be parked. If the neighborhood receives more robust transit service in the future, and less land needs to be devoted to parking vehicles, building heights/density can increase. The tallest and most dense development within the district occurs on the blocks adjacent to the destination riverfront park and along Court Avenue. The mixed-use buildings in these locations are generally 5 and 6 stories in height. Multi-family buildings throughout the district are typically 3 – 4 stories in height. Townhomes on the eastern edge of the neighborhood and fronting on MLK Jr. Parkway are 3 stories in height. Pavilions in the parks are typically one story, but future programming and a detailed design process will determine their actual height. The Capitol Dominance Overlay District currently limits heights of commercial buildings to 55 ft. and residential buildings to 75 ft. It is intended to protect the view of the entire building. The view corridor from Principal Park to the Capitol is protected by this zoning overlay. To realize the development potential and vibrancy of this district while preserving this important viewshed, further detailed study of height limits is needed.



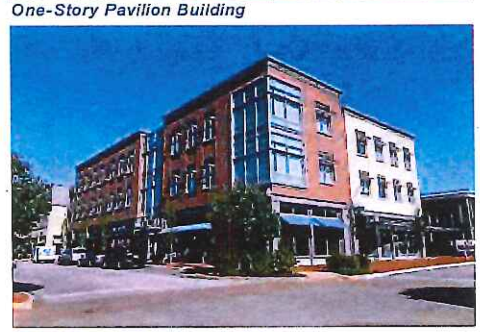
KEY:

- 6 Stories
- 5 Stories
- 4 Stories
- 3 Stories
- 2-3 Stories
- Pavilions

Capitol Viewshed from Principal Park

One-Story Pavilion Building

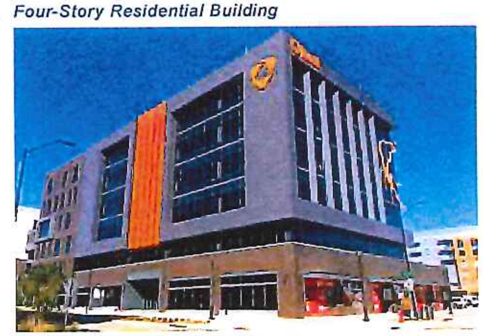
Two-Story Mixed-Use Building



Three-Story Mixed-Use Building

Four-Story Residential Building

Five-Story Mixed-Use Building

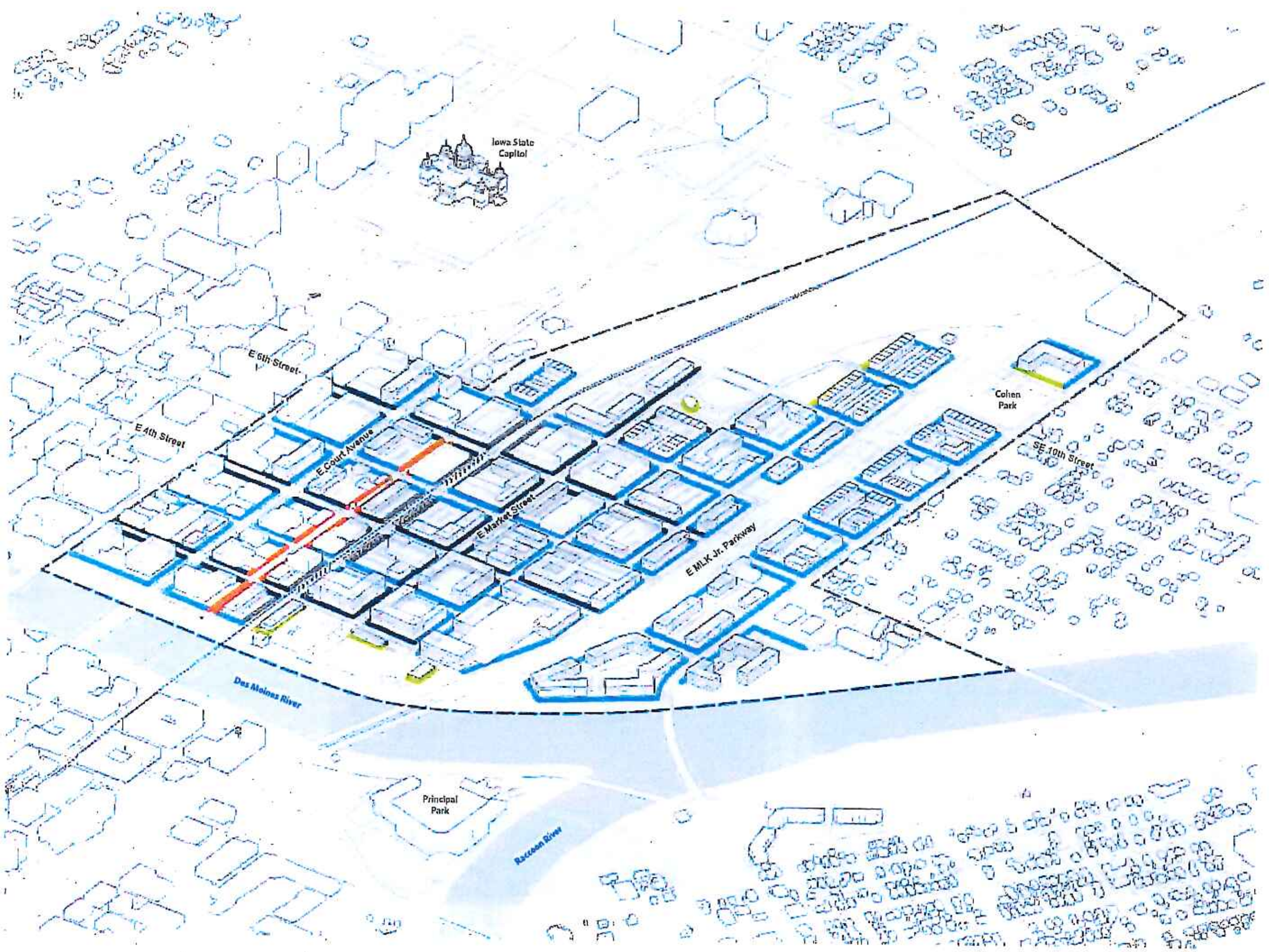


Six-Story Mixed-Use Building

DESIGN GUIDELINES

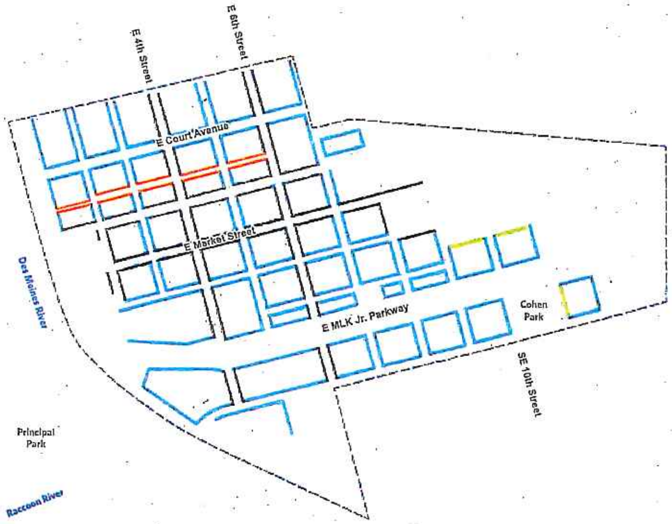
BUILDING SETBACKS

Guidelines for building setbacks help guarantee the appropriate placement of buildings within the public realm. This helps to ensure that the interface between the buildings, sidewalk, and street are detailed appropriately. Most of the buildings within the district will have urban frontages and should address the street. Standard setbacks will range from 0' – 15'. Buildings built tight to the property line will have a 0' setback, while those requiring canopy/balcony overhangs, stoops, and small landscape buffers can be set back accordingly, or may seek additional air rights over the right-of-way. Maximum setbacks for most buildings are based according to the street they front onto, and can be 5', 10', and 15' respectively. This uniformity, by street, helps to ensure consistent street walls and streetscape enhancements. Buildings that front onto MLK Jr. Parkway will have deeper 15' landscaped setbacks. This depth will keep building frontages away from the higher speed street, and will help to ensure that the original parkway aesthetic of the street is maintained. Buildings that front onto the East Village Promenade / Trail will have setbacks of varying depths. This is intentional, and will help create a fine grain of unique spaces suitable for sitting, landscape features, and activation along the length of the promenade.



KEY:

- 0'-5'
- 0'-15'
- Park Frontage
- Varies
- Railroad Frontage




Example of a building with a small Setback


Example of a building with a small Setback


Example of a building with a medium Setback


Example of a building with a medium Setback


Example of a building with no Setback


Example of a building with no Setback

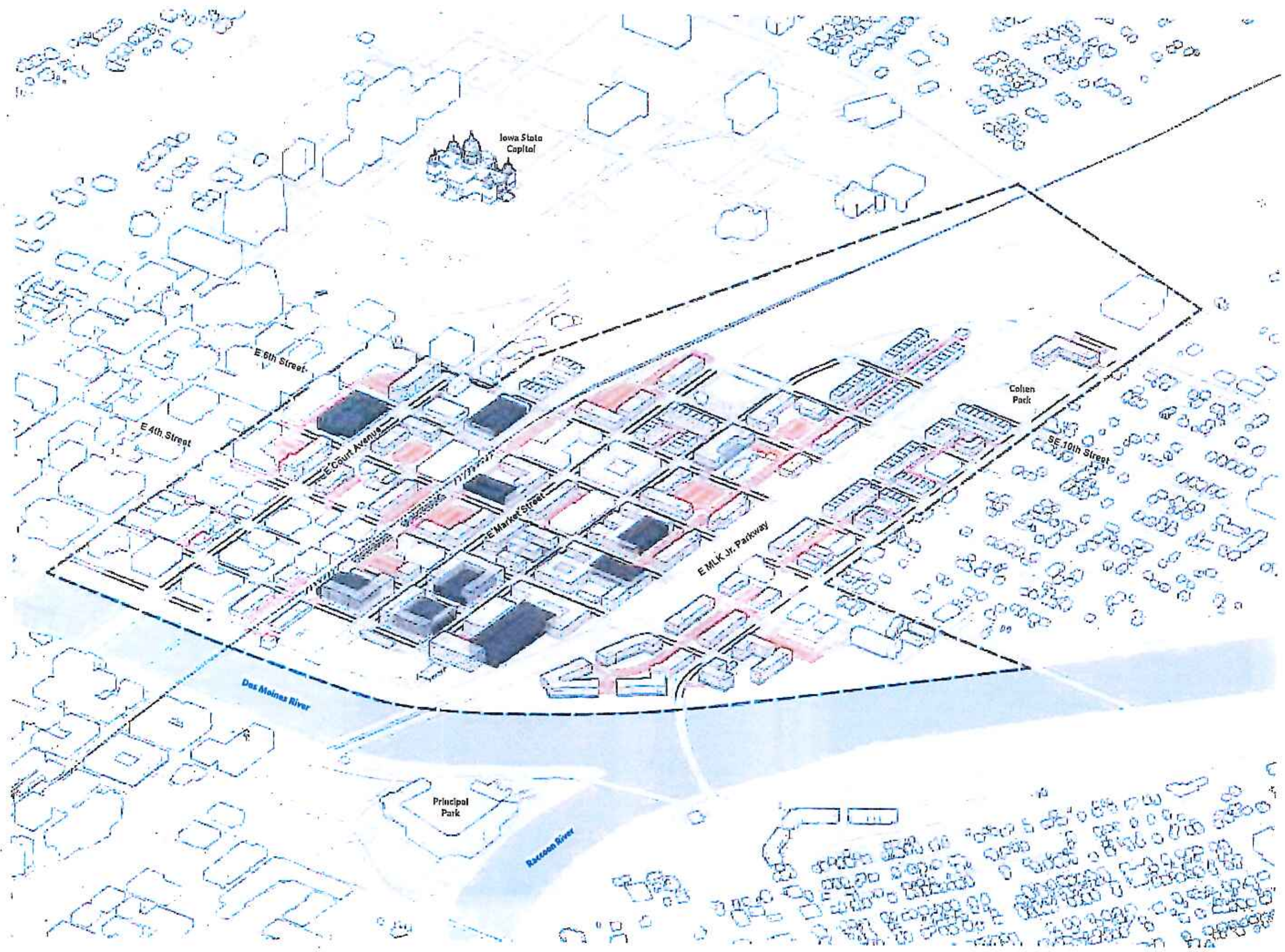

Example of a building with a large Setback


Example of a building with a large Setback

DESIGN GUIDELINES

PARKING AND ACCESS

The type of parking, and how it is accessed, is critical to the proper development and success of the Market District. Entries into off-street parking areas should be limited from the street (see section on Street Hierarchies) in order to promote a comfortable and safe pedestrian-oriented environment. The more curb-cuts that are allowed, the more unsafe and inconvenient the area becomes for pedestrians. Parking areas (both structures and lots) should always be located to the rear of their respective buildings and accessed by alleys in order to shield them from view and to improve the aesthetics of the neighborhood. On-street parking should be provided whenever possible to activate the street, provide convenient parking for retail users, and provide a safety buffer for pedestrians walking along sidewalks. The intent of the Market District Master Plan is to provide enough parking within each development block to accommodate its adjoining uses. The number of parking spaces is determined by the density of development, with higher density blocks requiring structured and shared parking solutions.



KEY:

- Structured Parking
- Podium Parking
- Surface Lots / Alleys
- On-Street Parking

Interior Parking Structure

Interior Parking Lot

On-street Parking

On-street Parking

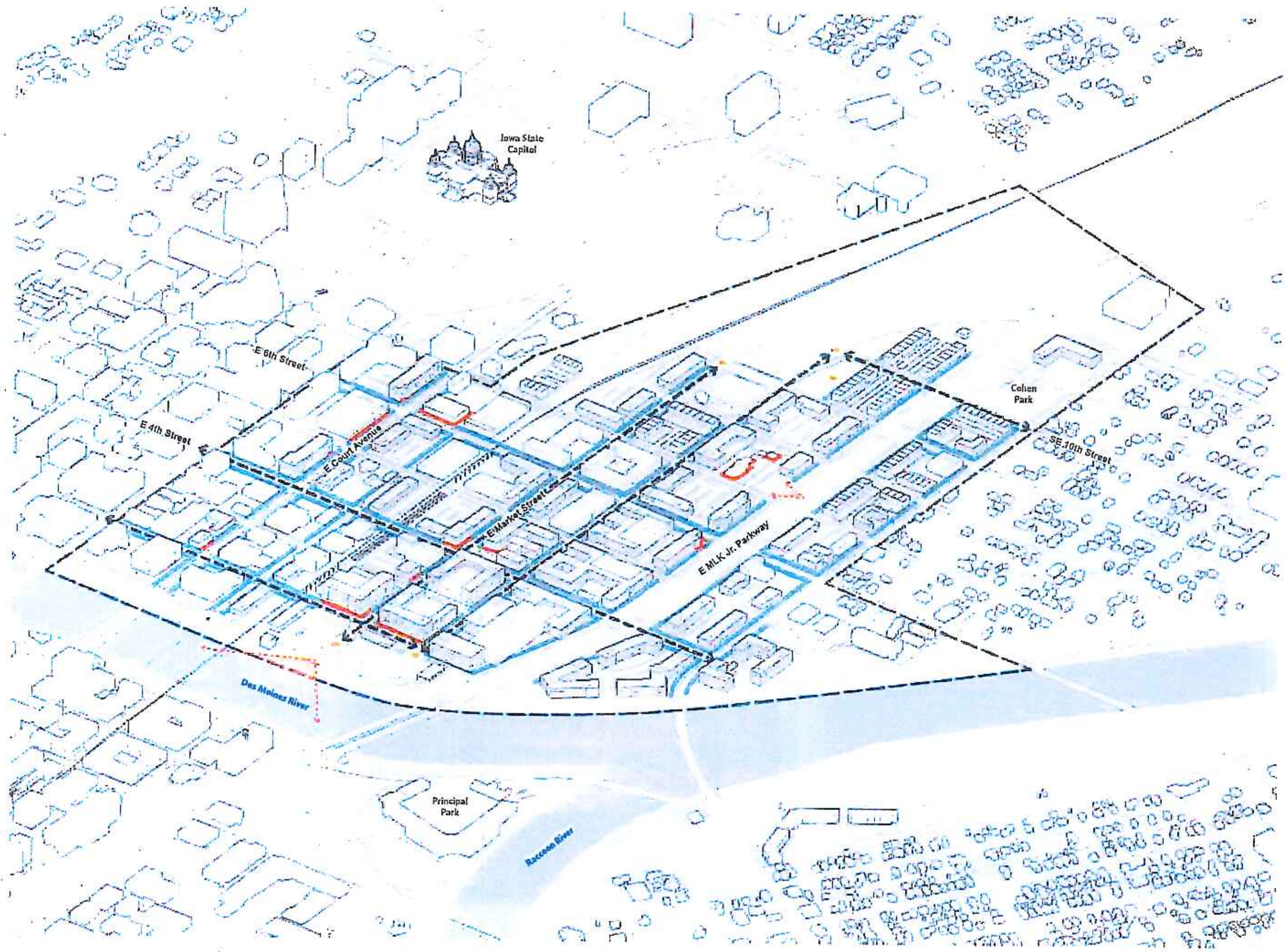
Alley accessed parking

Alley accessed parking

DESIGN GUIDELINES

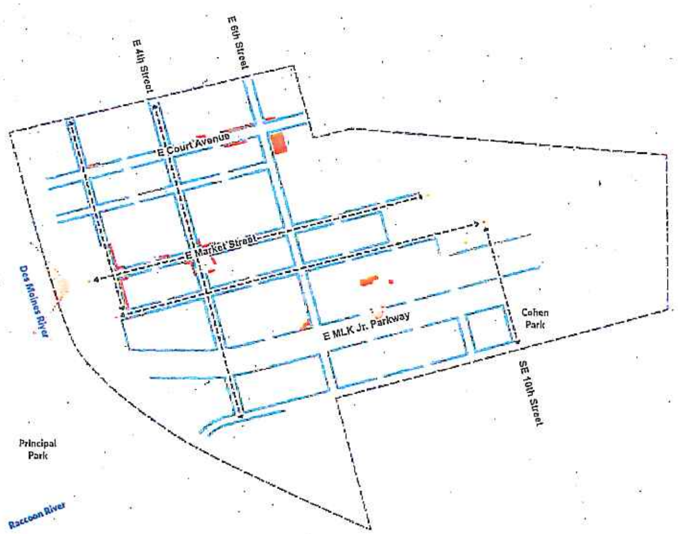
SPECIAL REQUIREMENTS

The Market District Master Plan is designed to maximize the pedestrian experience and visually articulate relationships between important buildings and public open spaces through axial views, terminated vistas, and enhanced facades. The relationship between terminated vistas and axial views is direct, whereby each axial view corridor is terminated by a vertical element. These elements can include architectural elements, statues, fountains, and public art. To create a more compelling public realm, visually significant building facades shall be designed to respond to functional and aesthetic cues. Important corners, as well as facades facing onto public open spaces, should receive special architectural recognition, and include elements that distinguish them from other buildings within the plan. The required storefronts / retail frontages require that the buildings provide a storefront at sidewalk level along the length of the facade shown. These storefronts should be substantially glazed in clear glass, and shaded with a canopy overhanging the sidewalk. All street-facing buildings should be required to have a minimum level of architectural treatment; however, higher design standards should be placed on buildings that front onto key public spaces and along key streets and corners, such as the buildings fronting onto the Destination Riverfront Park.



KEY:

- Required Storefront / Retail Frontages
- Enhanced Facades
- Axial Views / Terminated Vistas
- Public Art
- View Corridors



Enhanced Facade

Enhanced Facade

Maintained Viewshed

Maintained Viewshed

Required Storefront / Retail Frontage

Required Storefront / Retail Frontage

Axial View / Terminated Vista and Public Art

Axial View / Terminated Vista and Public Art

APPENDIX

Infrastructure Technical Memorandums

- Storm water Analysis
- Sanitary Sewer Analysis
- Water Distribution System Evaluation
- Streets and Traffic Analysis
- Parking Analysis
- Cultural Resources Review
- Hazardous Materials Review
- Alternative Energy Feasibility
- Geothermal Heating and Cooling Feasibility

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Stormwater Study

Market District Master Plan

CITY OF DES MOINES

August 22, 2019

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Summary

As part of the City of Des Moines Market District planning study, the City of Des Moines (City) has evaluated the effect the future development would have on the storm sewer system, and has developed recommendations and projects to address future stormwater needs related to the redevelopment of the Market District. The primary tool used to assess the future conditions requirements was a one-dimensional and two-dimensional (1D-2D) stormwater model. Existing and future conditions results were compared to city stormwater criteria and deficiencies documented. Projects addressing the system deficiencies were developed and evaluated by the model.

Six projects were identified that address the future stormwater needs of the Market District. The six identified projects include four conveyance improvement projects and two detention projects (shown in Table 1). With these improvements, certain areas may still experience shallow localized flooding. Given the current model limitations, these areas of potential shallow flooding should be confirmed through more detailed hydraulic modeling during preliminary and final design efforts for street improvements and developments. Flood risk to private properties can be reduced through future street designs and new development site plans that provide adequate elevation difference to maintain 100-yr design storm inundation limits within the existing public rights-of-way. Building practices that elevate the main floor of buildings and maintain positive drainage to the street curb and gutter should be adhered to. These recommendations integrate community planning and infrastructure planning for developing a resilient and functional downtown district.

Each project was prioritized based on current deficiencies and future expected development needs. The prioritization for the six recommended improvements is shown in Table 1 (with 1 being highest priority and 6 being lowest priority).

Table 1. Recommended Projects and Cost

Project	Description	Cost	Priority
Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)	Replace storm sewer between SE 5th Street and SE 8th Street with 30-inch up to 42-inch RCP (pipe capacity ranges from 25 to 60 cfs). New 48-inch RCP along SE 8th Street from Raccoon Street to detention basin. Reconstruct Raccoon Street to street section that has the capacity to covey up to 110 cfs during the 100-year event.	$2,236,000	**1**, Addresses current 5-year event sewer deficiencies.
SE 4th Street Conveyance Improvements	Replace storm sewer on SE 4th Street, between Raccoon Street and Scott Avenue, with 48-inch RCP (pipe capacity approximately 65 cfs)	$709,000	**2**, Addresses current 5-year event sewer deficiencies.
E Market Street Detention Basin Capacity Improvements	Increase storage capacity of detention basin to approximately 42 acre-feet. Construct a new 18-inch RCP outlet from the detention basin.	$1,933,000	**3**, Improvement needs to be completed prior to E Market Street and Raccoon Street overland flow improvements to ensure there is adequate storage capacity.
Raccoon Street Overland Flow Improvements (SE 8th Street to SE 11th Street)	Construct a 48-inch RCP culvert through the railroad north of Raccoon Street to connect overland flow on Raccoon Street to the detention basin. Reconstruct Raccoon Street from SE 8th Street to SE 11th Street (cul-de-sac) to a street section that has the capacity to convey up to 130 cfs during the 100-year event.	$1,497,000	**4**, Addresses current and future 100-year event deficiencies
E Market Street Conveyance Improvements between SE 6th Street and detention basin	Increase the conveyance capacity between the detention basin and E 6th Street to approximately 250 cfs and add a flap valve on the detention basin end of the pipe to prevent flow from leaving the basin.	$1,476,000	**5**, Reduces flooding during the larger rainfall events throughout the North of E Market Street area
E Walnut Street Conveyance Improvements	Realign the storm sewer to increase the capacity to 10 cfs in the alley south of E Walnut Street, between E 2nd Street and E 3rd Street. Connect 15-inch RCP storm sewer to E 3rd Street sewer.	$111,000	**6**, Localized flooding issue and would likely be completed in combination with another project (i.e. street replacement)
Total		$7,962,000	

Objective

The City is planning for development and infrastructure needs in the Market District of East Village. As part of the infrastructure assessment, the City has evaluated which components of the stormwater management system need to be enhanced, added, or replaced. The objective of this study is to identify and recommend projects that will meet the Market District's future stormwater management needs. To complete this evaluation, a 1D-2D stormwater model was developed to simulate the storm sewer system for six design storms (1.25-inch – 100-year event). Existing system deficiencies were identified. Future development plans were incorporated in to the model to determine recommended projects that meet future stormwater management needs.

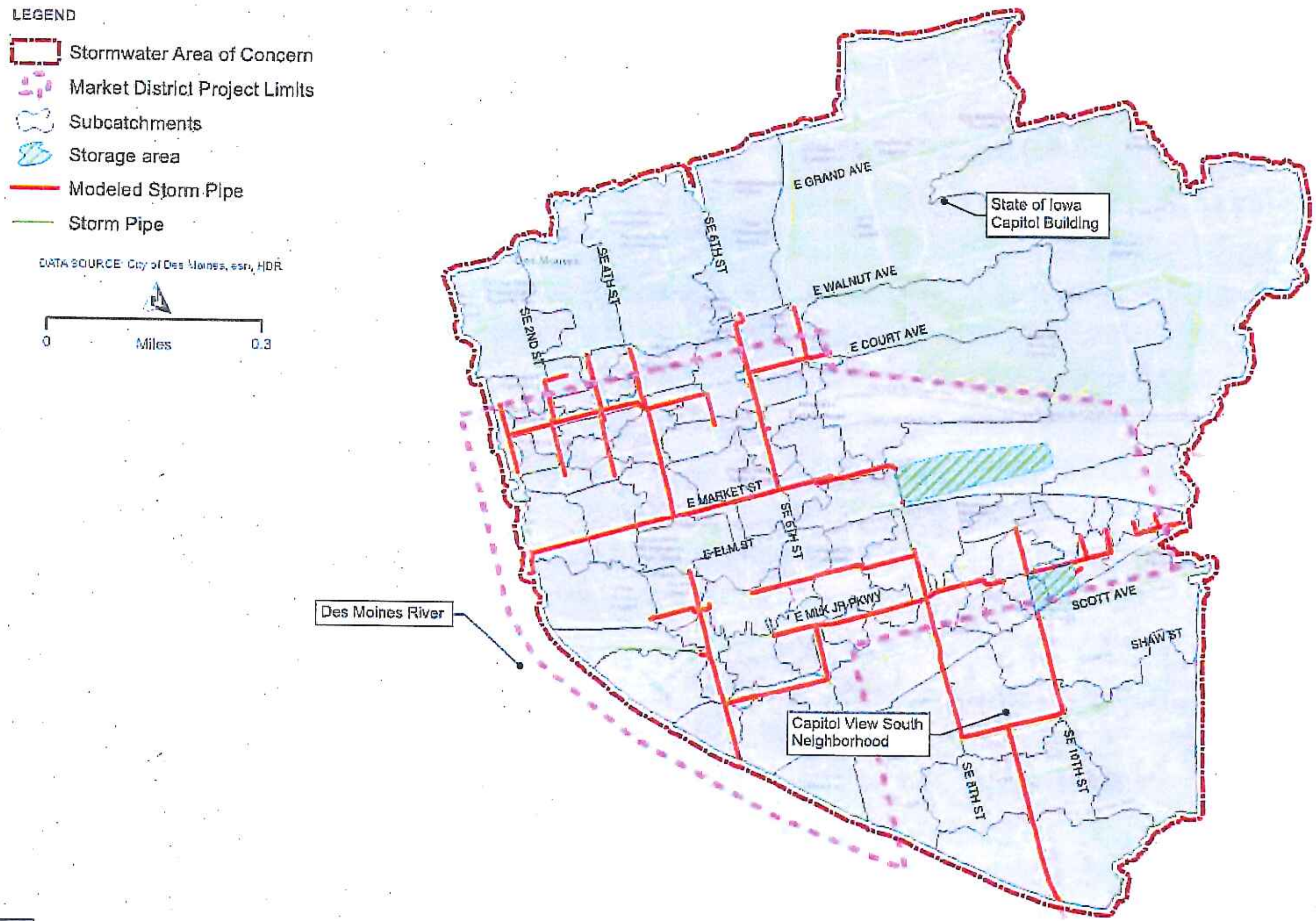
The City's goal is to use the Market District as an example of how downtown redevelopment can integrate community planning and infrastructure planning to make a vital, resilient, and functional downtown district. The Market District's future stormwater system would need to address existing and future storm sewer capacity issues and manage overland flow up to the City's standard. Several areas within the District have been identified as planned green stormwater infrastructure (GSI) corridors. The future conditions 1D-2D model incorporated reductions in runoff from these areas to demonstrate the benefit of including GSI into the stormwater system. Suitability maps have been produced to guide the placement of categories of GSI technologies.

Model Development

Modeling Approach

Hydrology Development

Eighty-five subcatchments within the Market District stormwater study area were delineated. Each of these subcatchments, shown in Figure 1, were used to estimate runoff from a portion of the study area. Runoff volumes were estimated using the SCS curve number method outlined in Technical Reference (TR) 55 (Natural Resources Conservation Service [NRCS] 1986). Composite curve numbers for each subcatchment, shown in Figure 2, were developed based on soil type (Soil Survey Staff 2016) and on land use, which was derived from City planimetric data and confirmed from recent aerial photography. Times of concentration were determined based on Light Detection and Ranging (LiDAR) data using the methods outlined in TR-55. A 24-hour nested frequency storm, derived from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (Perica 2013) were developed for the 2-, 5-, 10-, 25-, 50-, 100-year return interval storms. A constant 1.25-inch, 1-hour intensity storm was also evaluated to represent the water quality volume storm.



MARKET DISTRICT OVERVIEW

Figure 1. Market District Overview

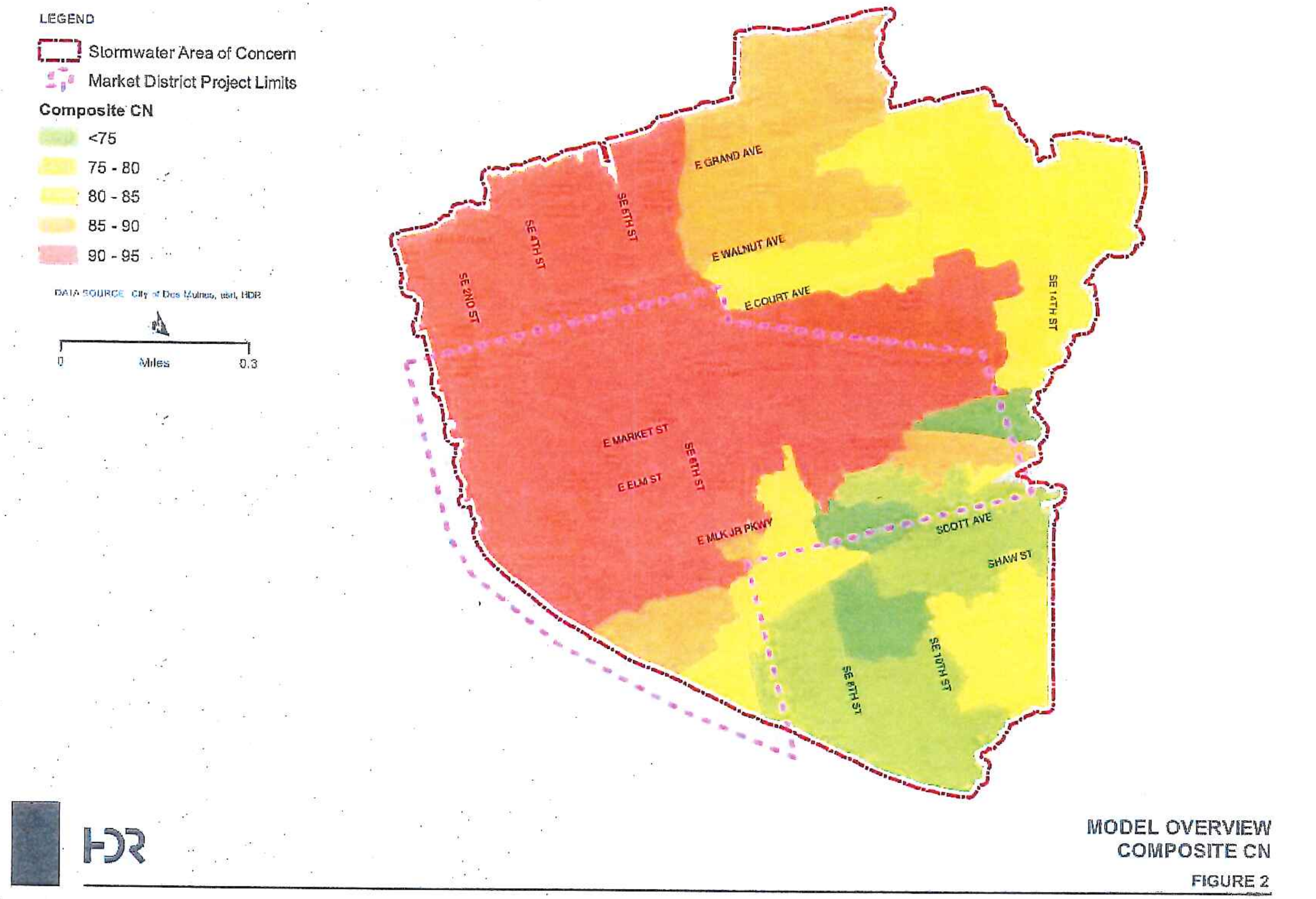


Figure 2. Model Overview Composite CN

1D Model Development

Water from each subcatchment is loaded to a node in the 1D model, which represents the storm sewer system. The 1D model includes most storm pipes in the Market District study area with a diameter greater than 15 inches. A grouped inlet approach was used to aggregate the runoff estimate contributing to all the storm inlets within an area—for example, an intersection or city block. This estimate reduces the need to represent every storm pipe in the system and prevents larger capacity issues from being muted by inadequate inlet or collector pipe capacity.

The 1D pipe network model was developed based on City-provided geographic information system (GIS) files. Not all pipe sizes and inverts are included in the City's GIS storm pipe database. In cases where size and depth of the pipe were not available, these data were inferred from properties of upstream and downstream pipe sections.

Flow is loaded at nodes defined in the 1D pipe network model. The software routes flow in the 1D pipe network, estimating the capacity for the storm sewer system to convey runoff during rainfall events.

2D Model Development

When flow to a specific section of the 1D pipe network model exceeds the pipe capacity and the hydraulic grade line is above the ground surface, the model contributes surcharged flow to the 2D surface flow area at the associated node. Flow and ponding is represented using the 2D flow area. Surface flow reenters the 1D model at nodes when pipe capacity allows. Elevations for the 2D flow area were developed using Iowa Department of Natural Resources statewide LiDAR data, and refined with City-provided CAD files from the MLK Jr. Drive Expansion Project to create a mesh representing the existing ground surface. Building footprints in the study area were removed from the model domain to prevent flow through the area occupied by the building. Approximately 42,000 triangular mesh cells were used to discretize flow on the surface. Cells were refined within and fitted to the edges of roads in the area to improve the estimate of conveyance and depth of ponding present in the roadway.

Model Limitations

Uncertainty in model inputs, including LiDAR terrain and roughness, can affect model results. Additionally, simplified components of the system, such as roadway sections without a curb and gutter can affect depths by up to 0.5 feet. The overall uncertainty of the modeled flow depths is roughly 1.0 foot. The model was developed to facilitate planning-level evaluations in the Market District study area, and were prepared with adequate detail to meet the study objectives. The depth plots in Appendix A show the maximum depth of water over the entire simulation. An area with the lightest color contour (white) has at least 0.1 feet of water average over a 1-minute duration in the simulation. This depth is within the accuracy of the model. Areas with less than 1.0 feet of depth may or may not experience flooding, based on local elevations and roadway flow conditions. Further modeling effort is recommended during design phase of projects to confirm flow depths with updated model inputs that include field survey and street and site design elements.

Model Analysis

There are two main branches in the Market District stormwater system. One main branch is north of E Market Street and the other main branch is south of Raccoon Street and E MLK Jr. Parkway; these areas are shown in Figure 3. Some storm sewers in the Capitol View South Neighborhood are included in the model so pipe capacity limitations in the Market District area can be accurately identified.

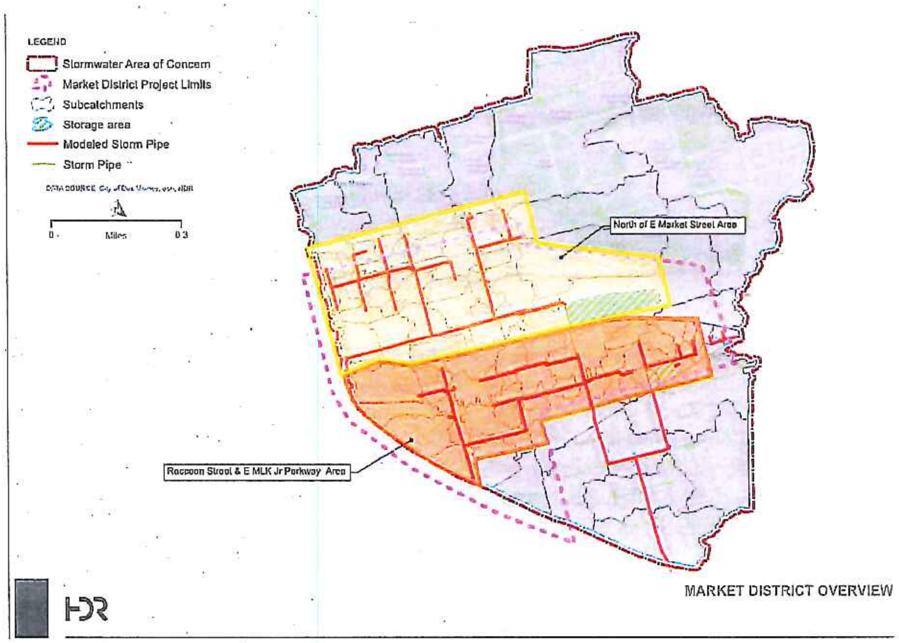


Figure 3. Model Overview

Six design storms (1.25-inch, 2-, 5-, 10-, 50-, and 100-year) were used to simulate to stormwater system in the Market District study area. The performance of the stormwater system was evaluated against the 5-year and 100-year rainfall event standards that are outlined in the *Statewide Urban Design and Specifications* (SUDAS) (2018) manual. The City adopted the SUDAS standards in 2018.

- SUDAS standards for new design indicate that the minor stormwater drainage system (which consists of underground piping and other required conveyance) should be designed against the 5-year event. Evaluation of the 5-year event was focused on areas where sewer surcharging occurs.
- SUDAS standards for new design indicate that the major stormwater drainage system (which consists overland flow pathways) should be designed to prevent major damages or loss-of-life from runoff from the 100-year event. Evaluation of the 100-year event was

focused on areas where surface flow and ponding beyond the City right-of-way (ROW) occurs.

Projects that address the future conditions stormwater needs were identified for each area, and the model results, benefits, and cost for each project are discussed in this report. Model results for the 1.25-inch, 2-, 5-, 10-, 50-, and 100-year rainfall events are shown in Appendix A.

Existing Conditions Model Results

North of E Market Street

The area north of E Market Street in the Market District Stormwater Study includes the contributing areas from Des Moines Street to E Market Street and from the Des Moines River to the State of Iowa Capitol Building, shown in Figure 3. The storm sewers in the area north of E Market Street generally flow south to E Market Street, then west to the Des Moines River. The storm sewer sizes ranges from 15-inch diameter reinforced concrete pipe (RCP) to 84-inch diameter RCP. The surface runoff in this area generally flows east-southeast, away from the Des Moines River, and toward a detention basin near E Market Street and SE 8th Street. The detention basin has an estimated volume of 32 acre-feet.

Model results indicate storm sewer capacity limitations lead to street and alley flooding between E 2nd Street and E 3rd Street, south of E Walnut Street during the 5-year rainfall event. Model results indicate other areas north of E Market Street that may experience street flooding during the 5-year rainfall event, which are the following areas: the intersection of E Court Avenue and E 7th Street, along SE 5th Street, and the intersection of E Walnut Avenue and E 4th Street. Additionally, not all storm sewers in these areas are incorporated into the model because of size (small); it is possible that model results underestimate the full capacity of the storm sewer system.

The storage volume used in the detention basin ranges from 6 acre-feet during the 2-year event up to 32 acre-feet during the 100-year event. The detention basin collects runoff from the area north of E Market Street and from the area north of the railroad. The detention basin also fills with backflow from the E Market Street storm sewer.

Raccoon Street and E MLK Jr Parkway

The Raccoon Street and E MLK Jr. Parkway area includes contributing areas from Elm Street to E MLK Jr Parkway and from the Des Moines River to SE 14th Street, shown in Figure 3. The storm sewer near SE 2nd Street and SE 11th Street generally flows south on SE 4th Street and SE 8th Street from Elm Street to E MLK Jr Parkway, additional storm sewer on Raccoon Street and E MLK Jr Parkway carries flow east toward SE 8th Street. South of E MLK Jr Parkway, storm sewer generally flows south, through the Capitol View South Neighborhood, to the Des Moines River. East of SE 11th Street, the storm sewer flows east past SE 14th Street. Surface runoff in this area generally flows south across E MLK Jr Parkway toward the Des Moines River.

Model results indicate storm sewer capacity limitations result in flooding along Raccoon Street with potential building flooding during the 2-year through 100-year rainfall events. Model results indicate that street flooding from Raccoon Street and E Allen Street flows over E MLK Jr

Parkway during the 100-year rainfall event. The model results indicate flood depths on E MLK Jr Parkway, near SE 9th Street are in excess of 1.0 foot, which may prevent the ability for vehicles to travel on E MLK Parkway. Additional survey of E MLK Jr Parkway and surrounding streets would be required to validate the model result depths in this area. Model results indicate that the 100-year overland flow rate on Raccoon Street is approximately 150 cfs near SE 4th Street and increases to more than 260 cfs at SE 9th Street.

Future Conditions

Development Planning

Future development and land use changes were identified as part of the Market District of East Village Study. The changes include commercial and high-density residential property redevelopment. Green space would be incorporated on both the east and west end of E Market Street. Additionally, a bioswale in the abandoned railroad ROW south of E Court Avenue and green infrastructure best management practices (BMPs) throughout the study area were identified as amenities. The future development plan, shown in Figure 4, was incorporated into the model by modifying hydrologic curve number and time of concentration for each subcatchment to reflect the future conditions. Future development also includes vacating Raccoon Street and building across the ROW matching the elevations of the surrounding blocks. This was incorporated into the model by raising the elevations along Raccoon Street in the mesh.

Figure 4. Future Development Plan

Stormwater Concerns

NORTH OF E MARKET STREET

The future conditions stormwater system would have similar flooding issues as the existing system. Model results indicate storm sewer capacity limitations may result in street and alley flooding issues between E 2nd Street and E 3rd Street, south of E Walnut Street for storms equal to or greater than the 5-year rainfall event.

RACCOON STREET AND E MLK JR PARKWAY

The future conditions stormwater system would have similar flooding issues as the existing system for the 5-year event. Model results indicate storm sewer capacity limitation would result in street flooding, potentially including adjacent buildings along existing Raccoon Street. Model results indicate that vacating the Raccoon Street and developing across the ROW would cause widespread flooding between Elm Street and E MLK Jr. Parkway.

Future Conditions Improvements and Constraints

Recommended improvements were identified for areas where model results show more than 0.5 feet of surface ponding. The 0.5 feet of surface ponding threshold was selected for proposed improvements because curb and gutter, which are not reflected in the model, is traditionally 0.5 feet so it is assumed that flooding less than 0.5 feet would stay in the street.

The following constraints were identified in the Market District study area by HDR and City staff. These constraints may limit the feasibility and effectiveness of potential projects.

- SE 9th Street Pump Station Capacity: Blocked gravity events and pump stations were not incorporated in this model. However, the City noted that the SE 9th Street pump station is under reconstruction and that proposed projects in the Market District area cannot increase peak flows to the pump station during the 5-year event.
- Raccoon Street Flow Path: Raccoon Street is the primary overland flow path for runoff between 4th Street and 10th Street. Vacating the Raccoon Street ROW would cause widespread flooding between Elm Street and E MLK Jr. Parkway; and therefore is not recommended.

The identified storm water improvement projects include regional detention, conveyance improvements, and green infrastructure retrofits. Projects were incorporated into the model to determine feasibility and effectiveness.

NORTH OF E MARKET STREET

There are three storm sewer improvement projects located in the area north of E Market Street, two storm sewer conveyance improvement projects and one regional detention project. Table 2 shows the proposed projects, location, and benefits.

Table 2. North of E Market Street: Recommended Projects and Benefits

Project Name	Existing Conditions	Proposed Project Description	Benefits
E Walnut Street Conveyance Improvements	15-inch reinforced concrete pipe (RCP) in the alley south of E Walnut Street, between E 2nd Street and E 3rd Street (pipe capacity is approximately 4.5 cubic feet per second [cfs])	Realign the storm sewer to increase the capacity to 10 cfs in the alley south of E Walnut Street, between E 2nd Street and E 3rd Street. Connect 15-inch RCP storm sewer to E 3rd Street sewer.	Reduces potential flooding in the alley, E 2nd Street, and E 3rd Street.
E Market Street Conveyance Improvements between SE 6th Street and detention basin	54-inch RCP on E Market Street (pipe capacity approximately 110 cfs)	Increase the conveyance capacity between the detention basin and E 6th Street to approximately 250 cfs (replace existing 54-inch RCP with 78-inch RCP or add 60-inch RCP) and add a flap valve on the detention basin end of the pipe to prevent flow from leaving the basin.	Reduces flooding in the area north of E Market Street by lowering the hydraulic grade line in the storm sewer network.
E Market Street Detention Basin Capacity Improvements	Detention basin with 32 acre-feet storage capacity	Increase storage capacity of detention basin to approximately 42 acre-feet. Construct a new 18-inch RCP outlet from the detention basin.	Reduces flooding in the Market District study area

RACCOON STREET AND E MLK JR. PARKWAY

The storm water improvement projects in the Raccoon Street and E MLK Jr. Parkway area are related to the flooding issues on Raccoon Street. Five alternatives were evaluated to determine the recommended and proposed projects. Three alternatives assume the existing surface flow path (storm sewer and overland flow) would remain on Raccoon Street. The other two alternatives assume Raccoon Street corridor is raised and developed, moving the primary surface flow path to an easement north of E MLK Jr. Parkway. The five alternatives are discussed in Table 3.

Table 3. Raccoon Street and E MLK JR. Parkway: Potential Projects

Option Number	Project Name	Project Description	Results	Pros	Cons
1	60-foot right-of-way (ROW) on Raccoon St Standard Street	Replace storm sewer under Raccoon Street to have 5-year capacity. Reconstruct Raccoon Street to have a standard street cross section.	100-year Flood depth is approximately 1.1 feet deep above street centerline.	Provides overland flow route from 4th St along Raccoon St to the detention basin. Preserves current street grade and flow path. This may be important for drainage laws.	Flat slopes prevent complete compliance with Statewide Urban Design and Specifications (SUDAS) criteria which would require a variance. Finish floor elevations would need to be above flow depths. It divides the redevelopment block.
2	30-foot ROW on Raccoon St Open Channel	Replace storm sewer under Raccoon Street to have 5-year capacity. Replace Raccoon Street with a vegetated open channel. The channel would be 30 feet wide, have a 10 ft bottom width and 4.5:1 side slopes.	100-year Flood depth is approximately 2.3 feet deep above channel invert.	Would be a smaller easement on Raccoon St (compared to Option 1) Provides overland flow route from 4th St along Raccoon St to the detention basin. Satisfies SUDAS criteria for zero surcharge at ROW line.	Not drivable or walkable Swale invert would be at curb elevation on cross streets Finish floor elevations would need to be above flow depths.
3	60-foot Drainage Easement on north MLK Jr. Parkway – Swale with Shared Use Pathway	Abandon storm sewer under Raccoon Street, replace with new storm sewer in easement north of E MLK Jr. Parkway. Extend ROW north of E MLK Jr. Parkway and construct a 60-foot-wide swale with 4 percent side slopes, and have a shared use pathway. Reconstruct cross-streets.	100-year Flood depth is approximately 1.8 feet above swale invert.	Provides overland flow route from 4th St along Raccoon St to the East Side detention basin Satisfies SUDAS criteria for zero surcharge at ROW line.	Requires major regrade of every intersection along north approach of MLK Requires redirection of adjacent surface flows to the proposed drainage easement. Flatter street slopes for all streets from Elm St to MLK Jr. Parkway would result in poor drainage on north-south streets. Would require culverts under cross-streets to meet cross-street depth criteria. The culverts would require maintenance to prevent debris buildup.
4	Increase ROW width on Raccoon Street	Same as Option 1, but have a wider street so that all SUDAS criteria are met.	100-year flood depth is approximately 0.5 feet above street centerline (not modeled, design to meet SUDAS).	Provides overland flow route from 4th St along Raccoon St to the detention basin. Preserves current street grade and flow path – This may be important for drainage laws.	Greater flow depth resulting from additional width would require variance for street centerline depth criteria. Requires additional ROW along Raccoon St, which effects developable area.
5	Increase conduit capacity under Raccoon Street	Replace storm sewer under Raccoon Street with capacity to convey the flow that causes limited surcharge during 100-year event.	100-year flood depth is approximately 0.3 feet above street centerline (not modeled, confirm in design).	Meets SUDAS criteria for overland flow within current ROW. Reduces overland flow as conduit capacity increase.	Increases peak flows to Capital View South neighborhood.

The recommended option is allowing surface flow to stay on Raccoon Street. The benefits to the recommended options is that Raccoon Street is the existing flow path, would not require reconstruction of the cross-streets, and does not increase flood risk in the Market District. The Raccoon Street flow path option should provide a proposed street cross section that is either the 66' ROW: Raccoon Street option in the Market District Master Plan or the SUDAS urban street cross-section (Option 1) because either maintains the drivability and walkability along the corridor, increases storm sewer and overland flow capacity, reduces flood risk and reduces future operation and maintenance activities. The surface flow easement could be a standard street cross-section. The standard street cross-section would require a variance from SUDAS standard due to flow depths at the ROW line. The recommended projects included in Option 1 for the Raccoon Street and E MLK Jr. Parkway area are shown in Table 4

Table 4. Raccoon Street and E MLK JR. Parkway: Recommended Projects and Benefits

Project Name	Existing Conditions	Proposed Project Description	Benefits
Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)	15-inch reinforced concrete pipe (RCP) at SE 5th Street up to a 36-inch RCP at SE 8th Street. (pipe capacity ranges from 5 to 25 cfs)	Replace storm sewer between SE 5th Street and SE 8th Street with 30-inch up to 42-inch RCP (pipe capacity ranges from 25 to 60 cfs). New 48-inch RCP along SE 8th Street from Raccoon Street to detention basin. Reconstruct Raccoon Street to street section that has the capacity to covey up to 110 cfs during the 100-year event.	Reduces flooding on Raccoon Street Street reconstruction would keep overland flow within the ROW during the 100-year event
Raccoon Street Overland Flow Improvements (SE 8th Street to SE 11th Street)	Rural street section with surrounding private property having a lower elevation than Raccoon Street	Construct a 48-inch RCP culvert through the railroad north of Raccoon Street to connect overland flow on Raccoon Street to the detention basin. Reconstruct Raccoon Street from SE 8th Street to SE 11th Street (cul-de-sac) to a street section that has the capacity to convey up to 130 cfs during the 100-year event.	Prevents flow from escaping the Raccoon Street ROW and reduces flow overtopping E MLK Jr Parkway
SE 4th Street Conveyance Improvements	36-inch RCP on SE 4th Street (pipe capacity approximately 30 cfs)	Replace storm sewer on SE 4th Street, between Raccoon Street and Scott Avenue, with 48-inch RCP (pipe capacity approximately 65 cfs).	Reduces flooding on Raccoon Street

CAPITOL VIEW SOUTH NEIGHBORHOOD

The proposed upstream improvements for the 5-year event in the Raccoon Street and E MLK Jr. Parkway area do not increase the peak flow to the SE 9th Street pump station. Therefore, no improvements in the Capitol View South Neighborhood would be required as a result of the Market District redevelopment.

ADDITIONAL CONSIDERATIONS FOR RECOMMENDED PROJECTS

Raccoon Street Reconstruction

Preliminary calculations for the Raccoon Street reconstruction projects were completed to estimate the required flow width (street width) and flow depth (curb height) for the 100-year overland flow rate. Assumptions used in the preliminary calculations include a longitudinal street slope of 0.002 ft/ft, which is the estimated existing street slope; a Manning's n-value of 0.013 (smooth concrete or asphalt); and a 0 percent (flat) street cross slope, which simplifies the calculation but is not representative of how the street would be actually designed.

Two flow width and flow depth combinations were evaluated and the results are as follows:

1. Using a 24 feet flow width (two 12 feet wide driving lanes) the required flow depth would be 1.1 feet. This results is a flow rate of approximately 135 cfs.
2. Using a 58 feet flow width (two 12 feet driving lanes and two 17 feet parking lanes) the required flow depth would be 0.7 feet. This results is a flow rate of approximately 160 cfs.

The required flow width and flow depth may change after assumptions are confirmed during the project design phase.

E Market Street Detention Basin

The bottom elevation of the detention basin is limited by the elevation of the existing storm sewer (54-inch RCP on E Market Street) that outlets to the detention basin. The E Market Street Conveyance Improvements projects recommends increasing the capacity of the storm sewer on E Market Street to approximately 250 cfs. This conveyance improvement can be achieved by constructing a parallel 60-inch RCP at the same grade as the existing 54-inch RCP or by removing and replacing the 54-inch RCP with a new pipe that has 250 cfs capacity. If a new pipe is the preferred option, the bottom elevation of the detention basin could be lowered. Lowering the detention basin bottom elevation would allow the proposed Raccoon Street storm sewer to have more slope which could potentially reduce the size of the storm sewer needed under Raccoon Street and SE 8th Street. Additional evaluation should be completed during the design phase to quantify the benefits of lowering the detention basin bottom elevation and determine the preferred option.

Summary of Recommended Projects

The recommended improvements for the Market District are outlined below. The recommended projects are shown spatially in Figure 5.

- E Walnut Street Conveyance Improvements (See Project Description in Table 2)
- E Market Street Conveyance Improvements between SE 6th Street and detention basin (See Project Description in Table 2)
- E Market Street Detention Basin Capacity Improvements (See Project Description in Table 2)
- Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street) (See Project Description in Table 4)
- Raccoon Street Overland Flow Improvements (See Project Description in Table 4)
- SE 4th Street Conveyance Improvements (See Project Description in Table 4)

Model Results

The recommended projects, outlined below, were incorporated into the model and proposed conditions model results are included in Appendix A.

NORTH OF E MARKET STREET

In proposed conditions, flooding in the area north of E Market Street is eliminated for most areas for the 2-year and 5-year events. The areas that continue to show flooding during the 2-year and 5-year are less than 0.5 feet and ponding may or may not occur. There is a significant reduction in flood extent and depth for the 10-, 50- and 100-year events. Flood depth in most areas for larger events is less than 0.5 feet and would likely stay within the ROW if curb and gutter exists.

RACCOON STREET AND E MLK JR. PARKWAY

In proposed conditions, the Raccoon Street flooding is reduced by 90-100 percent for the 5-year event. In areas where the model results show some ponding on Raccoon Street, the ponding depth is less than 0.5 feet and may or may not occur. Minimal flooding may occur in other areas of the Raccoon Street and E MLK Jr. Parkway area during the 10-year event, but model results show that flood depth is less than 1.0 foot.

For the 50- and 100-year events, flooding may occur in the existing Raccoon Street ROW. The maximum modeled flood depth between SE 4th Street and SE 6th Street is less than 1.5 feet. East of SE 7th Street, the 100-year event maximum modeled flood depth is approximately 1.7 feet. However, the modeled ground elevation in the areas surrounding Raccoon Street in proposed conditions is the same as existing condition. The future ground elevation of Raccoon Street and the new developments may change during final design. Therefore the depths shown in the model results may not be accurate for future conditions. A further modeling effort should be completed during final design to determine future estimated flood depths along Raccoon Street. Model results indicate that the 100-year overland flow rate on Raccoon Street is approximately 100 cfs near SE 4th Street and increases to approximately 130 cfs at SE 9th Street. In proposed conditions, the overland flow rate on Raccoon Street is reduced by 33 percent and 50 percent from existing conditions at SE 4th Street and SE 9th Street, respectively.

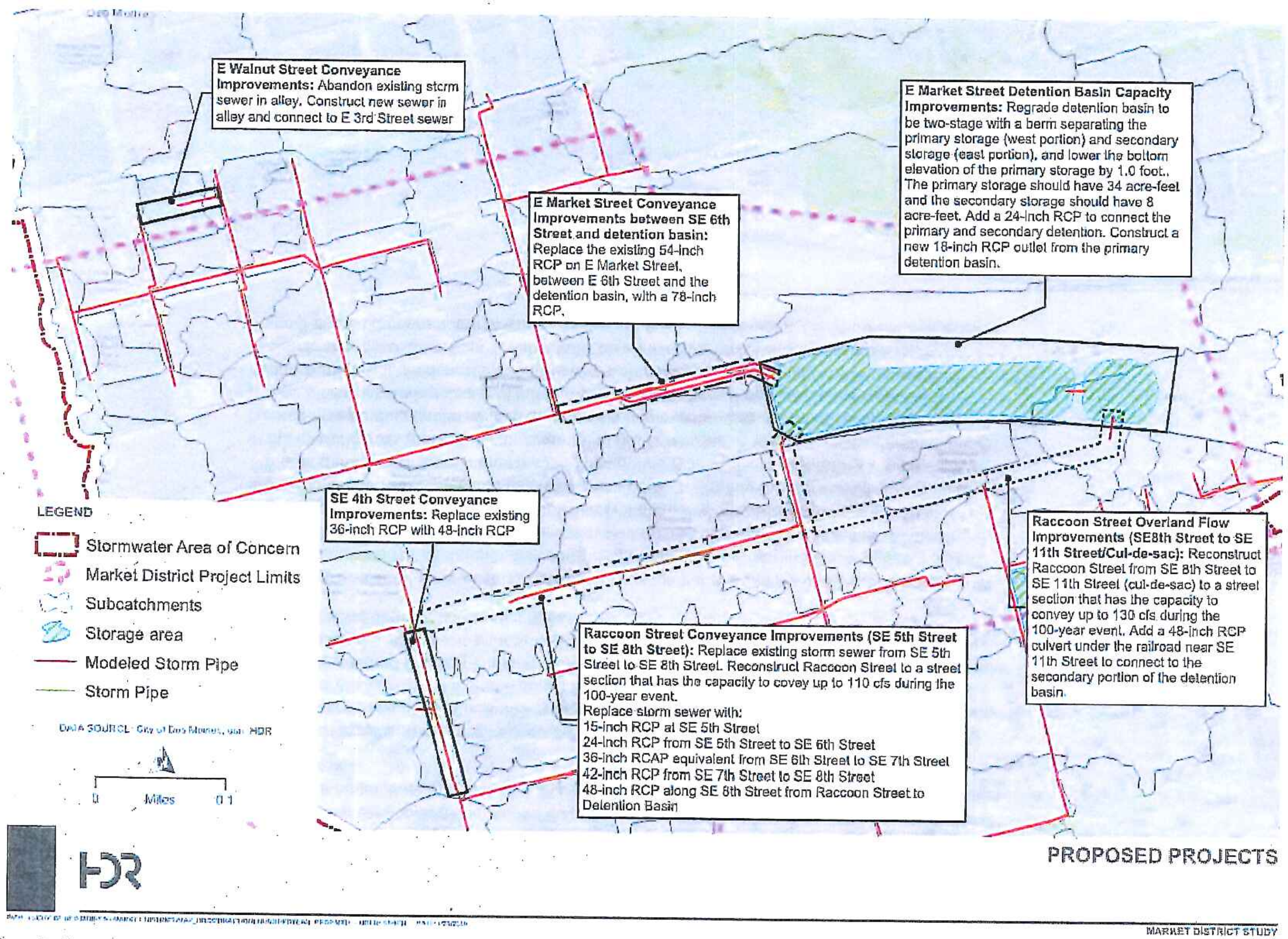


Figure 5. Proposed Projects

Project Cost Estimates for Recommended Projects

The itemized costs for projects are included in Appendix C.

Conveyance Improvements

Costs estimates were developed for increasing the capacity in these four areas. Costs include estimates for storm sewer removal and installation, pavement removal and replacement, earthwork, new inlets, and manhole modifications. Storm sewer conveyance improvement project costs are shown in Table 5.

Table 5. Storm Sewer Conveyance Improvement Project Costs

Project	Cost
E Walnut Street Conveyance Improvements	$111,000
Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)	$2,236,000
Raccoon Street Overland Flow Improvements (SE8th Street to SE 11th Street/Cul-de-sac)	$1,454,000
SE 4th Street Conveyance Improvements	$709,000

Stormwater Detention Improvements

Model results indicate that flood risk in the Market District can be reduced if stormwater storage is maximized. Project recommendations include expansion of an existing detention basin and storm sewer improvements to increase detention the Market District. Cost estimates include earthwork, storm sewer installation, flow control structures, and seeding. Stormwater detention costs are summarized in Table 6.

Table 6. Stormwater Detention Costs

Project	Cost
E Market Street Conveyance Improvements between SE 6th Street and detention basin	$1,476,000
E Market Street Detention Basin Capacity Improvements	$1,933,000

Project Prioritization

The recommended stormwater projects were prioritized based on existing stormwater deficiencies and future expected growth needs. The highest priority projects address existing deficiencies for the 5-year rainfall event. Lower priority projects address local issues and deficiencies for the 100-year event. The projects in order of priority are shown in Table 7.

Table 6. Recommended Projects Prioritization

Priority	Project	Details
1	Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)	This project addresses current 5-year event storm sewer deficiencies. No other projects need to be completed prior to this improvement; however, surface flooding on Raccoon Street may not be fully addressed until SE 4th Street Conveyance Improvements are completed.
2	SE 4th Street Conveyance Improvements	This project addresses current 5-year event storm sewer deficiencies and no other projects need to be completed prior to this improvement.
3	E Market Street Detention Basin Capacity Improvements	This project is needs to be completed prior to the Raccoon Street Overland Flow Improvements and E Market Street Conveyance Improvements projects because additional storage volume is required before additional flow from those two projects can be added to the detention basin.
4	Raccoon Street Overland Flow Improvements (SE8th Street to SE 11th Street/Cul-de-sac)	The project must be completed after the E Market Street Detention Basin Capacity Improvements. It is prioritized before the E Market Street Conveyance Improvements because this project reduces flow overtopping E MLK Jr. Parkway.
5	E Market Street Conveyance Improvements between SE 6th Street and detention basin	This project must be completed after the E Market Street Detention Basin Capacity Improvements.
6	E Walnut Street Conveyance Improvements	This project is a local drainage issue and is considered lowest priority. This project would likely be completed in combination with another City project (i.e. street pavement replacement project)

Green Stormwater Infrastructure Suitability

GSI suitability was evaluated and documented to identify the locations where various categories of BMPs could be located. Four types of GSI were addressed: bioretention, green roofs, porous pavement, and storage such as cisterns and rain barrels. These four categories of green stormwater infrastructure were selected to represent the broader categories of GSI that can be used to improve stormwater management in urban areas.

This suitability screening is based on a desktop analysis of existing soils, land uses, building locations, and pervious areas. Conditions should be reevaluated during development and design to confirm the suitability for different GSI technologies. The GSI locations identified on the maps in Appendix B are potentially viable locations, not as a specific site recommendation.

Bioretention

Bioretention GSI technologies reduce runoff volume by creating an area where water is collected at shallow depths. Water infiltrates at these locations, reducing the runoff and pollutant load to the system. Non-compact pervious soils are required for bioretention to ensure infiltration can occur. Bioretention technologies can include bioswales, roadside planters, and vegetated infiltration basins. Deeply rooted native grasses and other vegetation are often used in these technologies to improve infiltration, increase water and nutrient uptake, and provide aesthetic benefits.

This screening identified suitable areas for bioretention began with identifying potential spaces in the ROW adjacent to streetways. These areas were then compared to the soil types in those locations for preferred infiltration soils (A and B). The areas with preferred infiltration soil were rated Tier 1. At Tier 2 locations, the available soil data indicate that the soils are either too compact or are not adequately pervious to support infiltration. Soil amendments may be required in these areas and they still potentially viable bioretention locations if soil amendment occurs.

In general, the Market District is built on compacted urban fill. Compacted soils are not conducive to increasing infiltration unless the underlying soil is either amended or disturbed to increase void spaces. Tree-root systems, such as Silva Cells, could also be used in these areas to encourage tree growth and maintain uncompact soils that would allow for long-term infiltration to occur. Some of the areas near MLK Jr Parkway may have more suitable soils. These areas, indicated in Appendix B, Figure B1 as Tier 1 areas, should be prioritized for bioretention and infiltration practices.

Green Roofs and Other Roof Interception

In addition to streetside bioretention locations, green roofs are able to reduce runoff and increase vegetation. Existing buildings and roof footprints were identified on the map for potential retrofit to become green roofs. These locations could be retrofitted as gray roofs. These systems store rainfall excess on the roof in open-air cells or bins and release this water to the storm sewer system at a reduced flow rate. Both technologies would increase the loading on the building's structure. Therefore, retrofitting an existing building may require structural modifications. In addition to retrofits, new buildings could be designed with roof rainfall interception. This may be more efficient and effective than targeting existing buildings for retrofitting.

The screening results in Appendix B, Figure B2 show that the largest buildings in the Market District are north of Raccoon, south of Walnut Street, and west of the Capitol building. These locations have the most potential for a significant stormwater benefit by incorporating roof rainfall interception. Residential areas that intersect with the Market District and its contributing areas do not have large roofs. Many more residences would have to construct these practices to achieve the same benefit as one large downtown building. Therefore, roof interception technologies like green roofs and grey roofs should be prioritized in commercial areas with large building footprints.

Porous Pavement

Pavement systems can create large spans of impermeable surface. Porous pavements instead provide permeable surfaces to allow stormwater to infiltration into the subsoil. This GSI is best suited for paved locations with limited turning movement and heavy truck traffic to limit raveling and heavy point loads. They should be installed after surfaces are stabilized to limit clogging of the critical voids that allow for infiltration. Debris caught in the voids should be regularly vacuumed or flushed to maintain effective infiltration. To sustain effective infiltration between maintenance services, porous pavement is best suited for pedestrian walkways and parking lots. Similar to bioretention GSI, Tier 1 locations are surface parking lots found with improved infiltration soil (A and B). Tier 2 locations will require soil amendment.

There are several large spans of paved areas within the Market District where porous pavement systems could reduce runoff. However, many of these areas were constructed on compacted urban fill, which likely has marginal or poor infiltration rates. Soil amendments over these large spans is likely not economically justifiable. These systems could be designed to have porous fill beneath the pavement. The porous pavement system would be designed to temporarily store water in the void spaces in the fill material beneath the pavement, and released at a reduced flow rate.

Rain Barrel and Cisterns

Rain barrels and cisterns allow runoff volume to be stored for later gray water use. These BMPs reduce runoff until the container is full. Once full, flow bypasses the container and contributes directly to the stormwater system. The screening for this GSI involved filtering for rooftops (elevated impermeable surfaces) in the LiDAR data. Each possible rooftop is shown with an adjacent red marker.

The largest density of suitable rain barrel locations are in the residential neighborhoods to the north, east, and south of the Market District. The high density of potential locations suggests that neighborhood-based rain barrel programs, targeted in these areas, could improve stormwater management in the Market District. In the commercial areas of the District, there are few opportunities to incorporate rain barrels. The larger roofs in these areas would require larger cisterns that would take up more space and may not be visually appealing. Therefore, the adjacent residential areas should be prioritized for implementing a rain barrel program.

Conclusions

The Market District's existing stormwater management system has some deficiencies that do not meet SUDAS criteria (Adopted by the City in 2018). Development in the Market District will increase and change the stormwater management needs. The following recommended improvements to the stormwater conveyance and detention will address the existing and future drainage issues. These projects have been prioritized based on current deficiencies and future expected development needs.

- Priority 1: Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)
- Priority 2: SE 4th Street Conveyance Improvements
- Priority 3: E Market Street Detention Basin Capacity Improvements
- Priority 4: Raccoon Street Overland Flow Improvements (SE8th Street to SE 11th Street/Cul-de-sac)
- Priority 5: E Market Street Conveyance Improvements between SE 6th Street and detention basin
- Priority 6: E Walnut Street Conveyance Improvements

With these improvements, certain areas may still experience shallow localized flooding. Given the current model limitations, these areas of potential shallow flooding should be confirmed through more detailed hydraulic modeling during preliminary and final design efforts for street improvements and developments. Flood risk to private properties can be reduced through future street designs and new development site plans that convey overland design flows within the existing ROW. Building practices that elevate the main floor of buildings and maintain positive drainage to the street curb and gutter should be adhered to. These recommendations integrate community planning and infrastructure planning for developing a resilient and functional downtown district.

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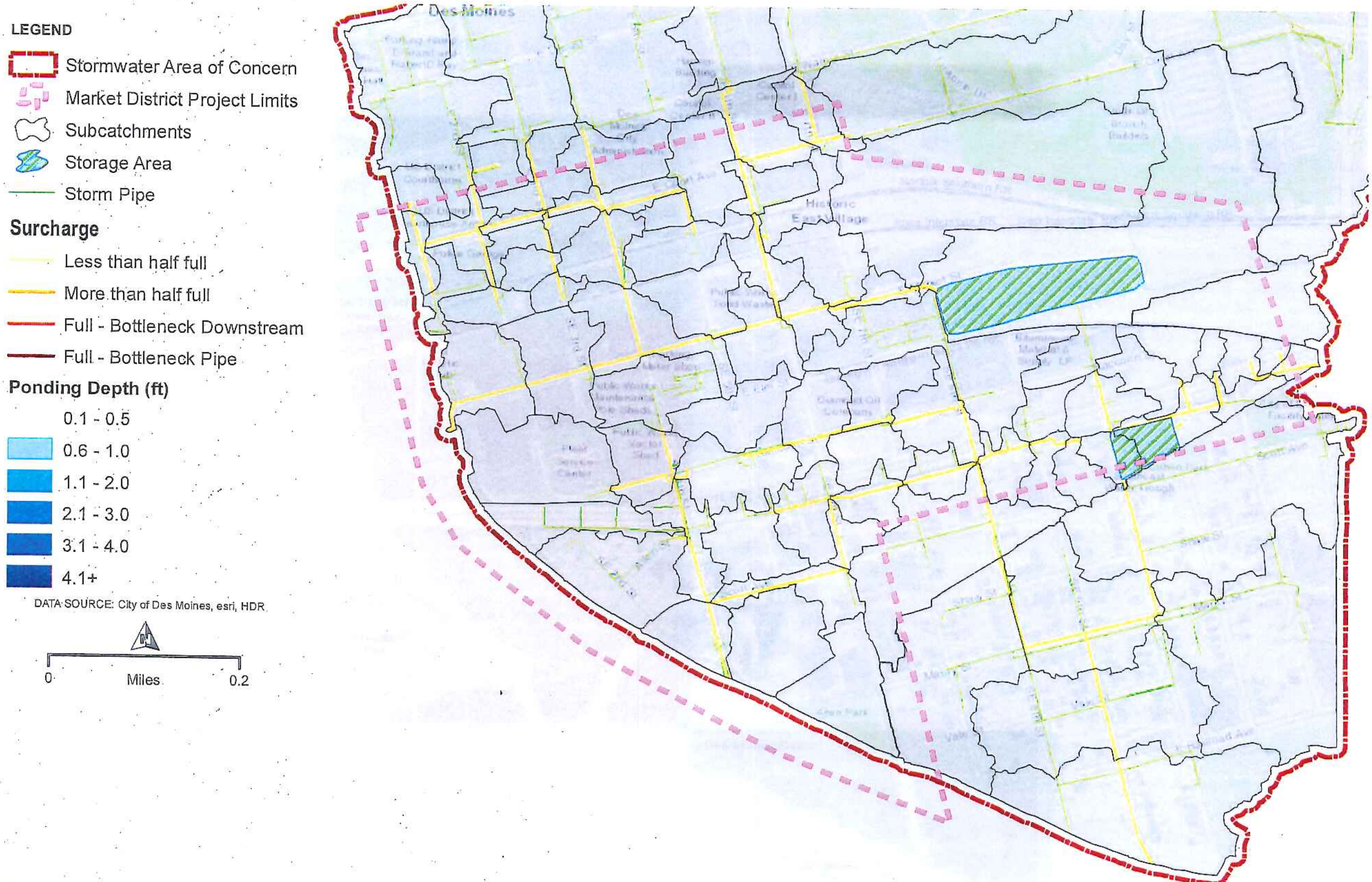
A

Model Results



HDR

1.25" EVENT RESULTS
EXISTING CONDITIONS

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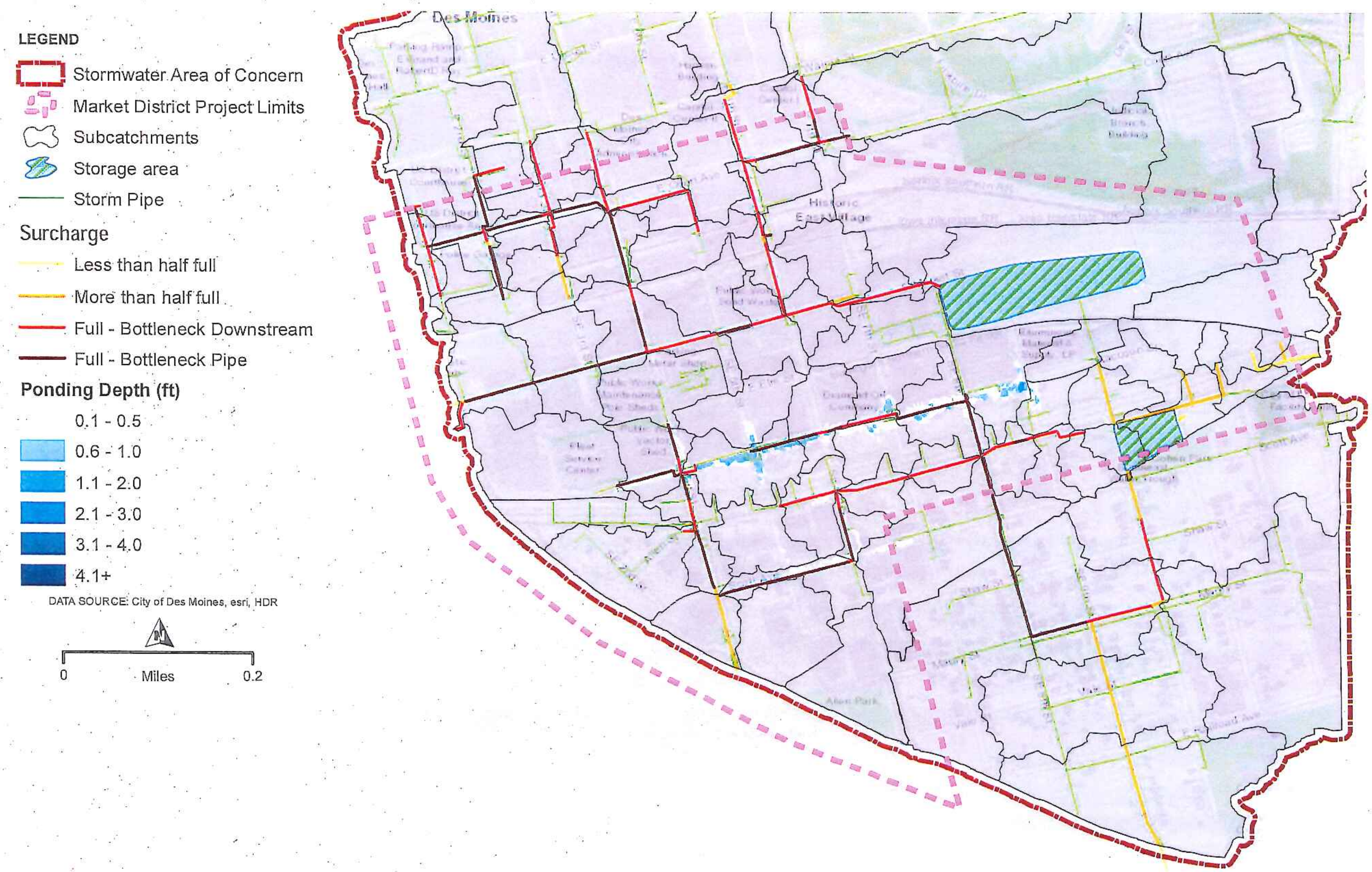

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2-YEAR EVENT RESULTS
EXISTING CONDITIONS

LEGEND

Stormwater Area of Concern

Market District Project Limits

Subcatchments

Storage area

Storm Pipe

Surcharge

Less than half full

More than half full

Full - Bottleneck Downstream

Full - Bottleneck Pipe

Ponding Depth (ft)

0.1 - 0.5

0.6 - 1.0

1.1 - 2.0

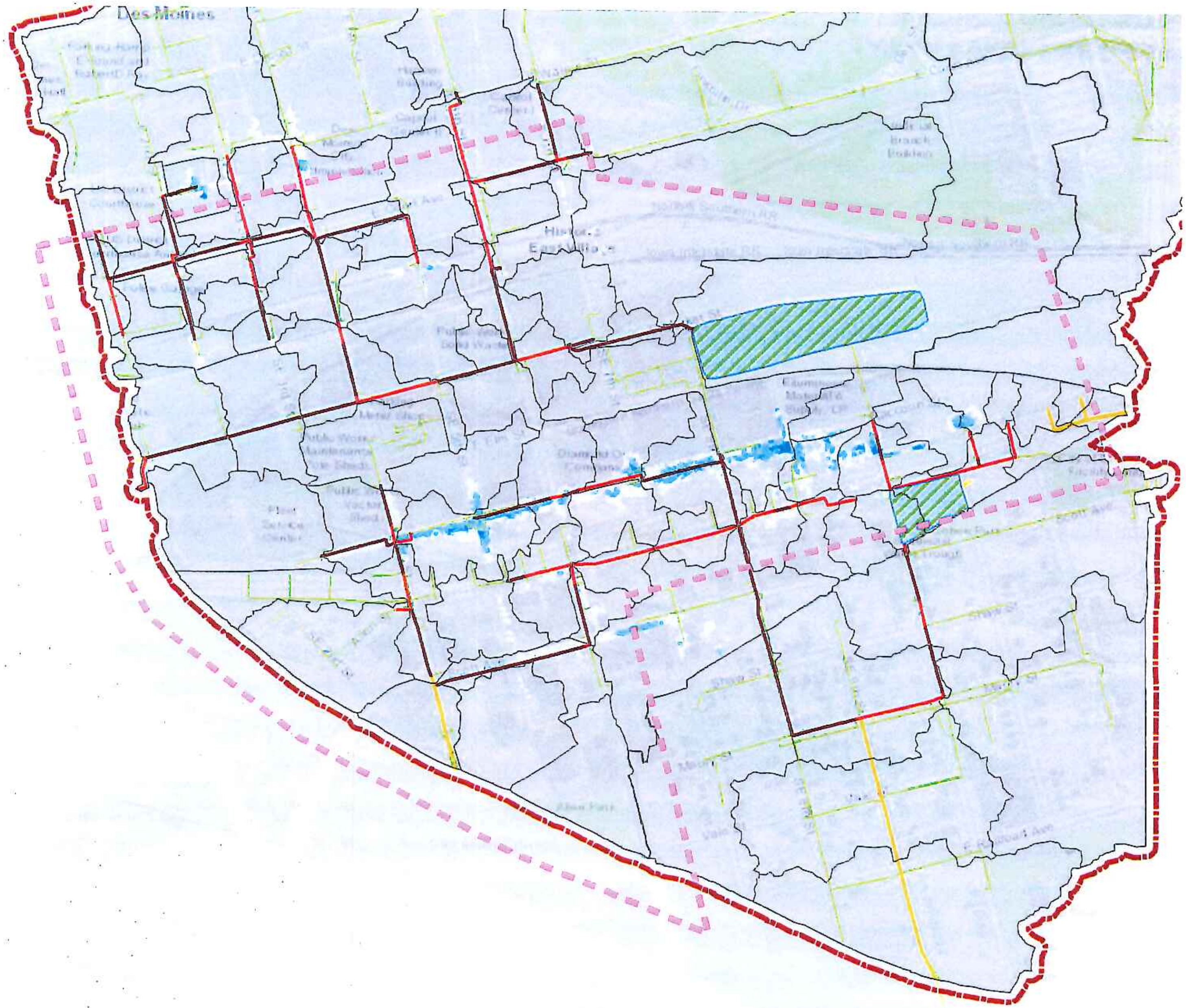
2.1 - 3.0

3.1 - 4.0

4.1+

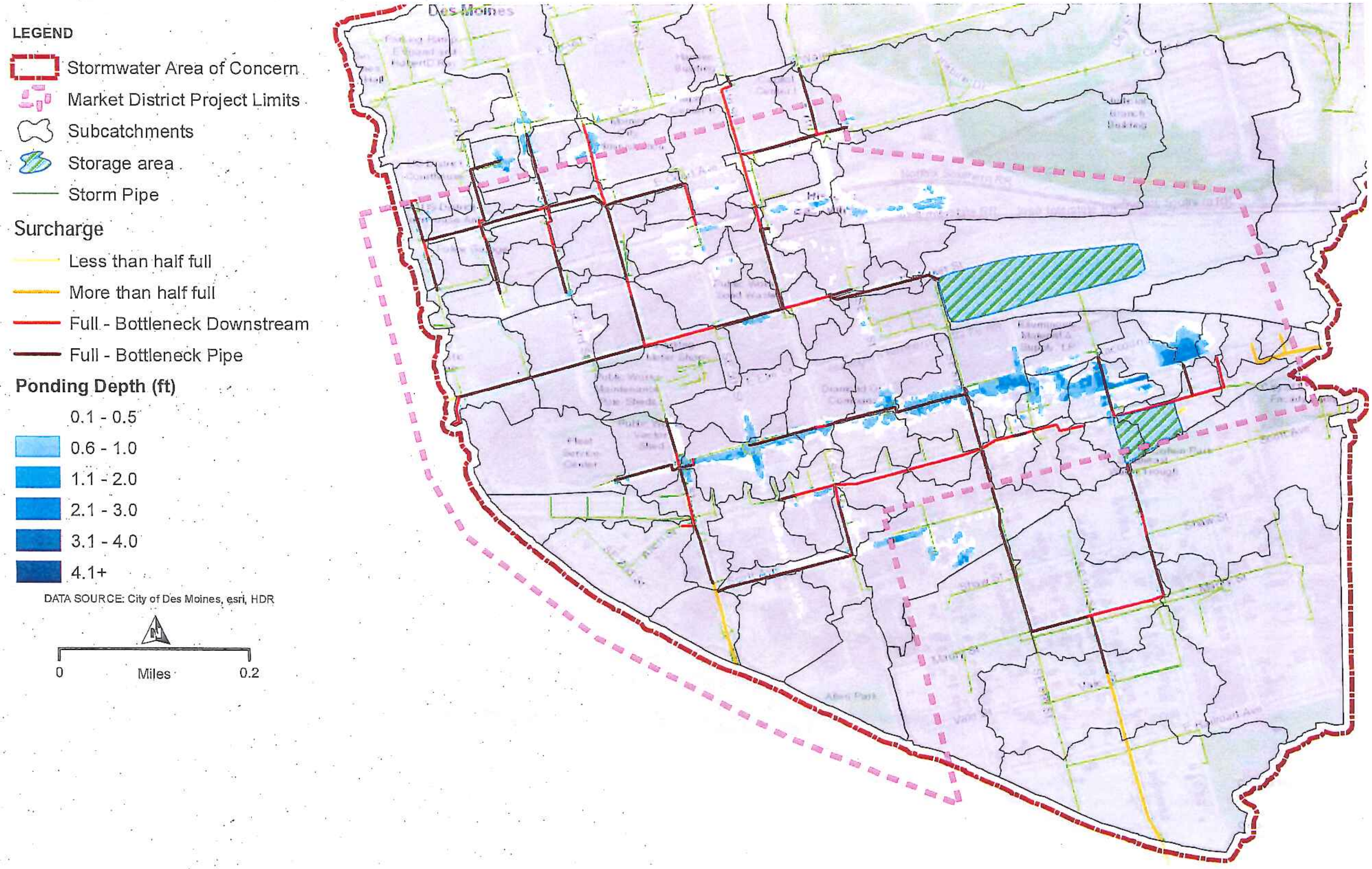
DATA SOURCE: City of Des Moines, esri, HDR

0 Miles 0.2



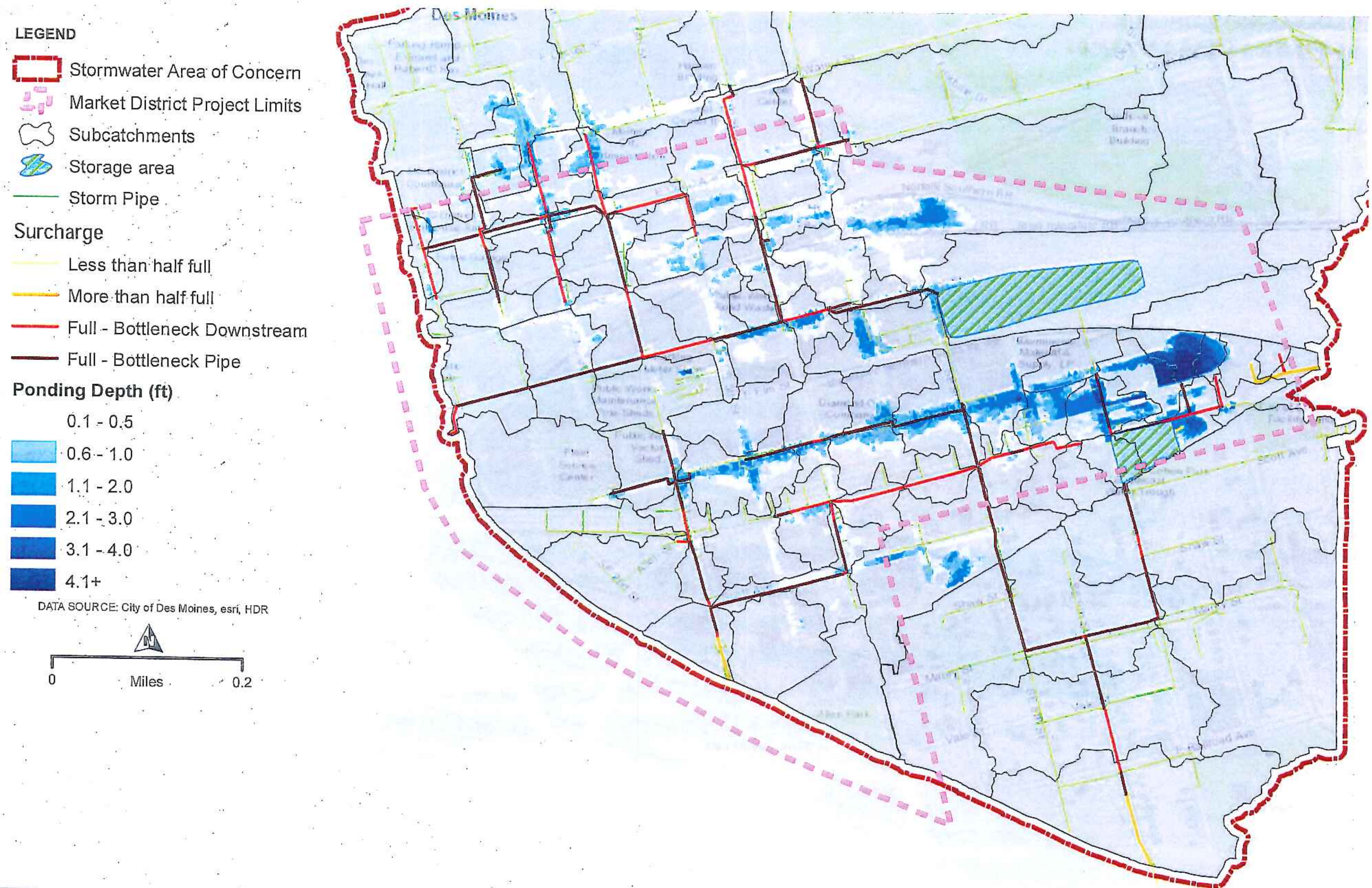
HDR

5-YEAR EVENT RESULTS
EXISTING CONDITIONS



HDR

10-YEAR EVENT RESULTS
EXISTING CONDITIONS



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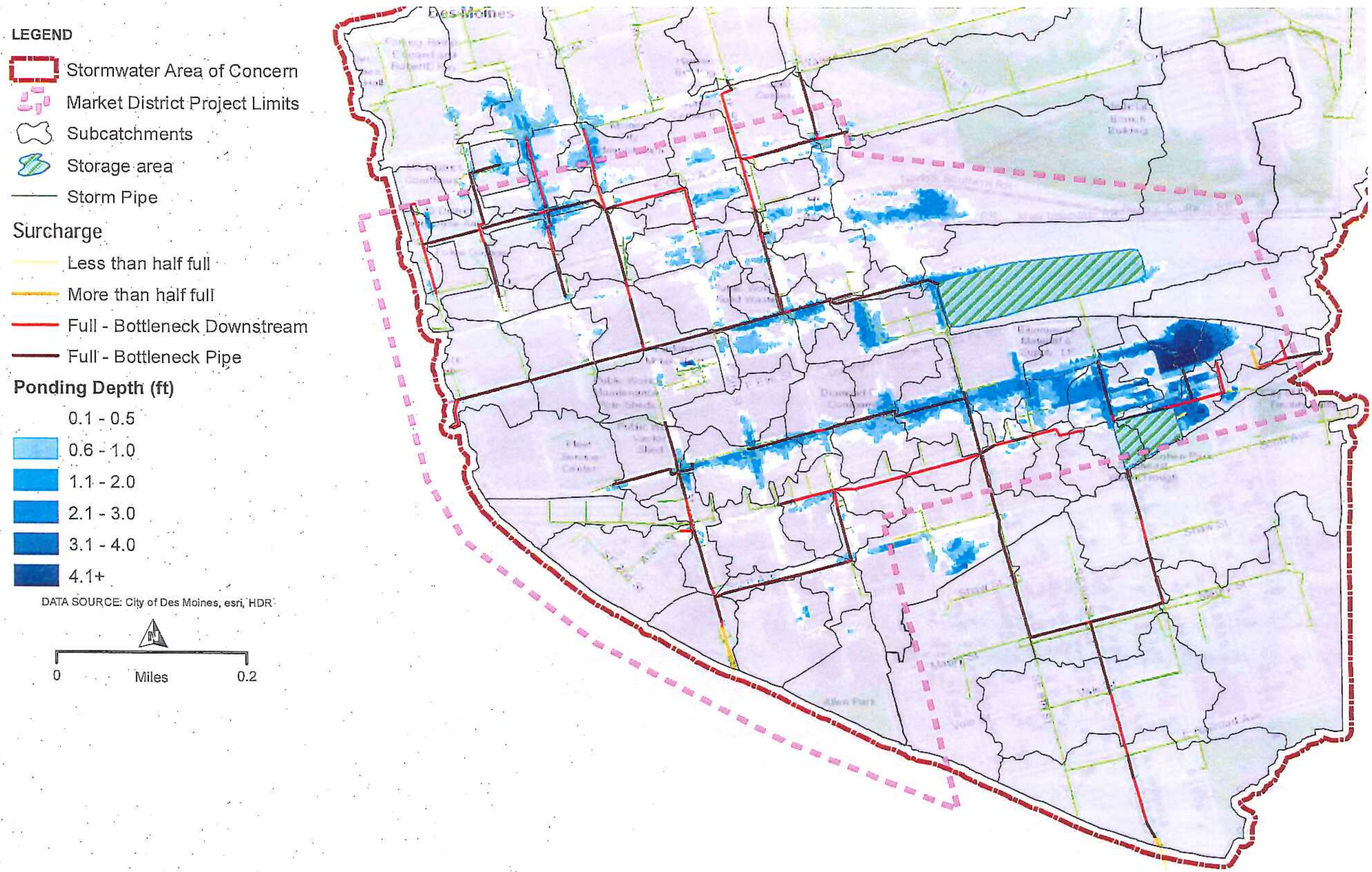
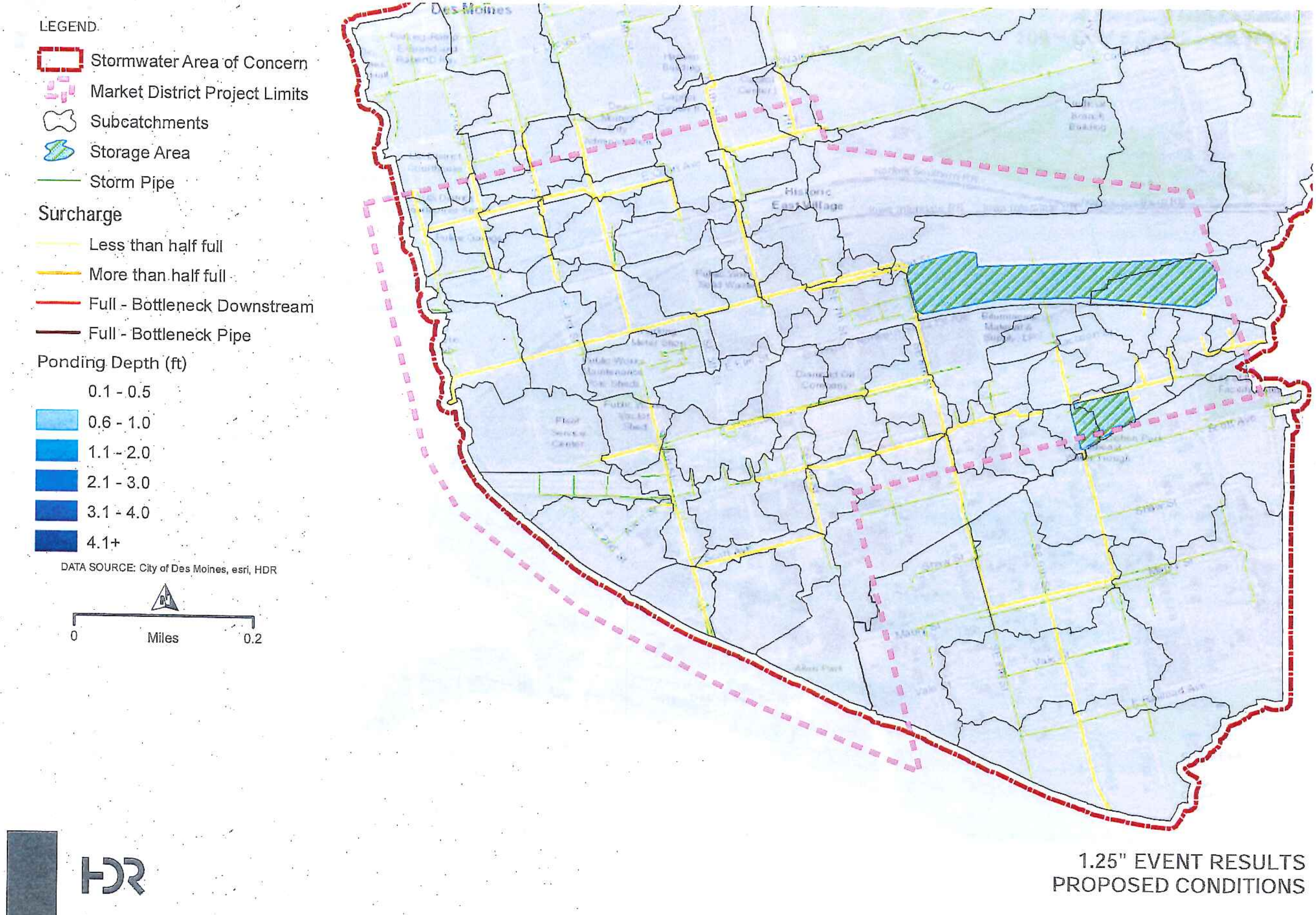
50-YEAR EVENT RESULTS
EXISTING CONDITIONS



HDR

100-YEAR EVENT RESULTS
EXISTING CONDITIONS



1.25" EVENT RESULTS PROPOSED CONDITIONS

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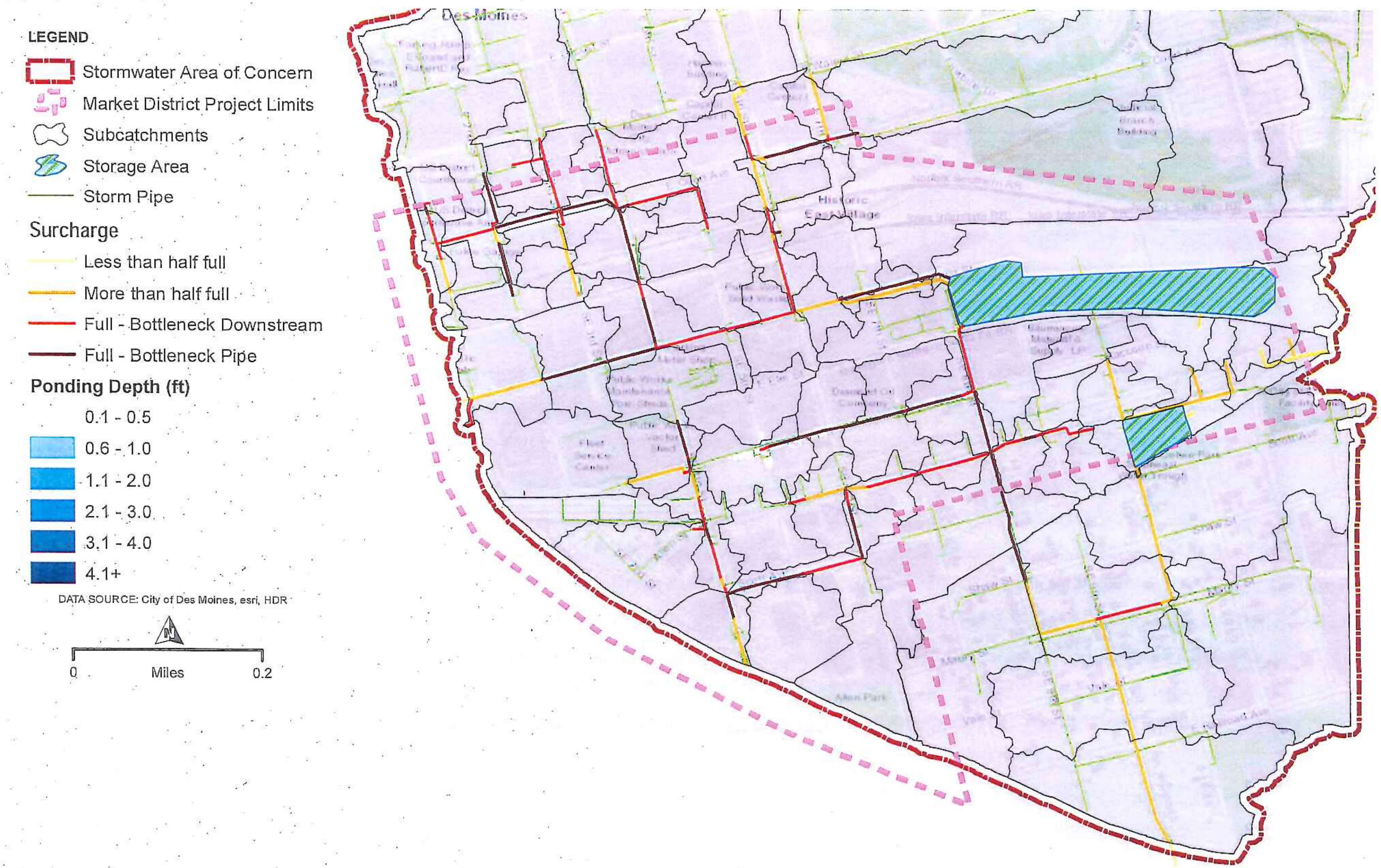


HDR

2-YEAR EVENT RESULTS
PROPOSED CONDITIONS

LEGEND

Stormwater Area of Concern

Market District Project Limits

Subcatchments

Storage area

Storm Pipe

Surcharge

Less than half full

More than half full

Full - Bottleneck Downstream

Full - Bottleneck Pipe

Ponding Depth (ft)

0.1 - 0.5

0.6 - 1.0

1.1 - 2.0

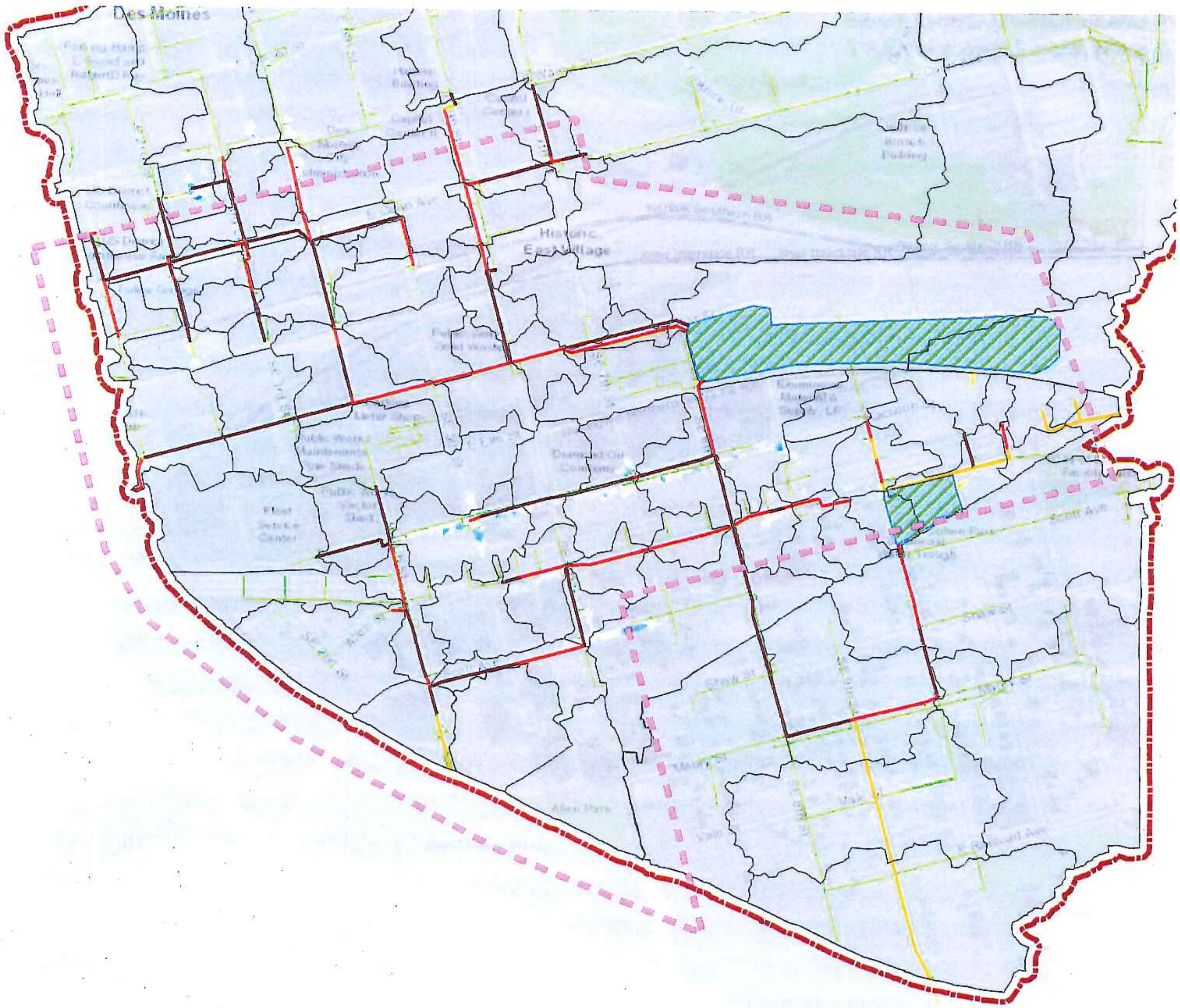
2.1 - 3.0

3.1 - 4.0

4.1+

DATA SOURCE: City of Des Moines, esri, HDR

0 Miles 0.2



HDR

5-YEAR EVENT RESULTS
PROPOSED CONDITIONS

LEGEND

Stormwater Area of Concern

Market District Project Limits

Subcatchments

Storage Area

Surcharge

Less than half full

More than half full

Full - Bottleneck Downstream

Full - Bottleneck Pipe

Storm Pipe

Ponding Depth (ft)

0.1 - 0.5

0.6 - 1.0

1.1 - 2.0

2.1 - 3.0

3.1 - 4.0

4.1+

DATA SOURCE: City of Des Moines, esri, HDR

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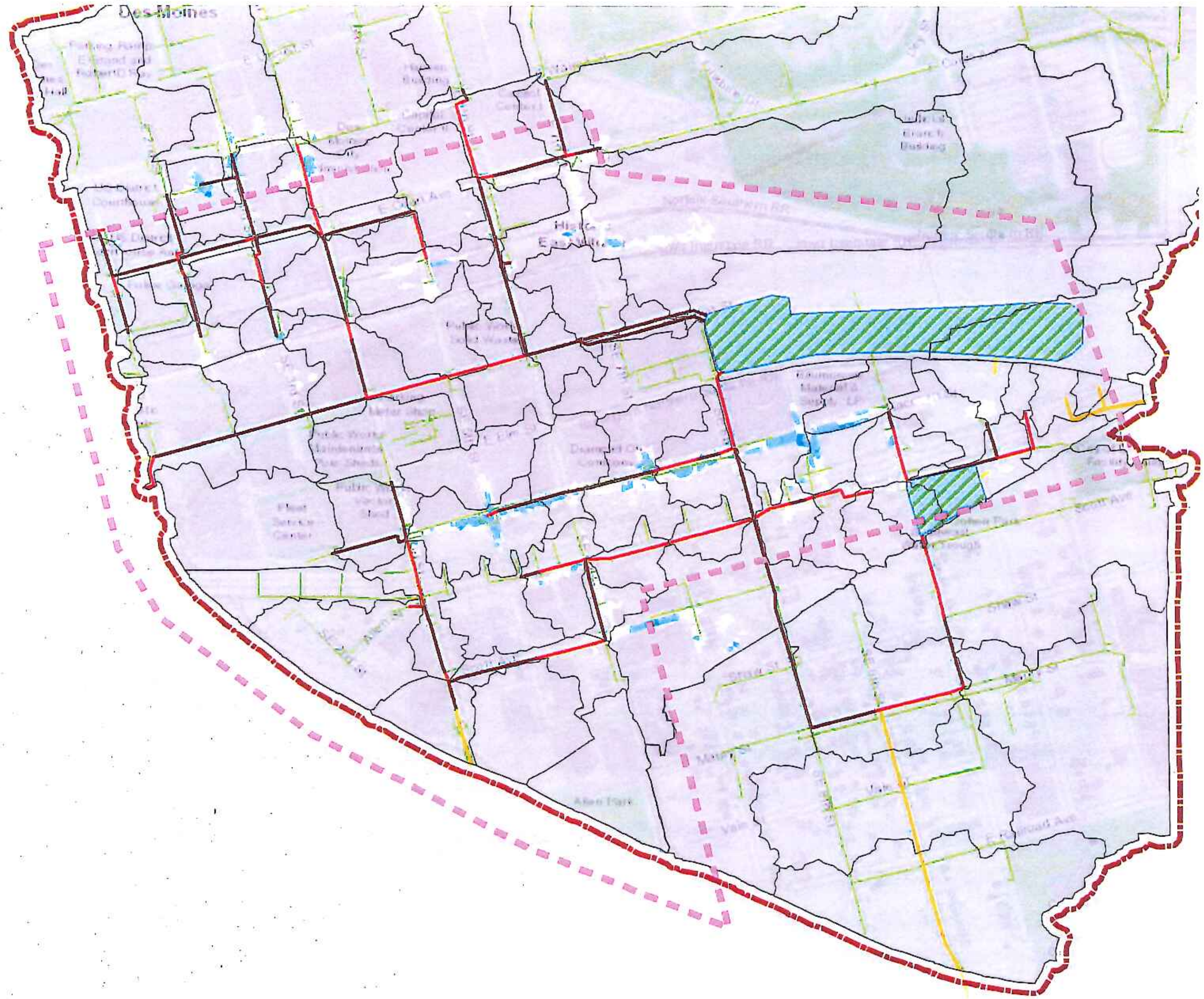

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10-YEAR EVENT RESULTS
PROPOSED CONDITIONS

LEGEND

- Stormwater Area of Concern
- Market District Project Limits
- Subcatchments
- Storage area
- Storm Pipe

Surcharge

- Less than half full
- More than half full
- Full - Bottleneck Downstream
- Full - Bottleneck Pipe

Ponding Depth (ft)

- 0.1 - 0.5
- 0.6 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1+

DATA SOURCE: City of Des Moines, esri, HDR

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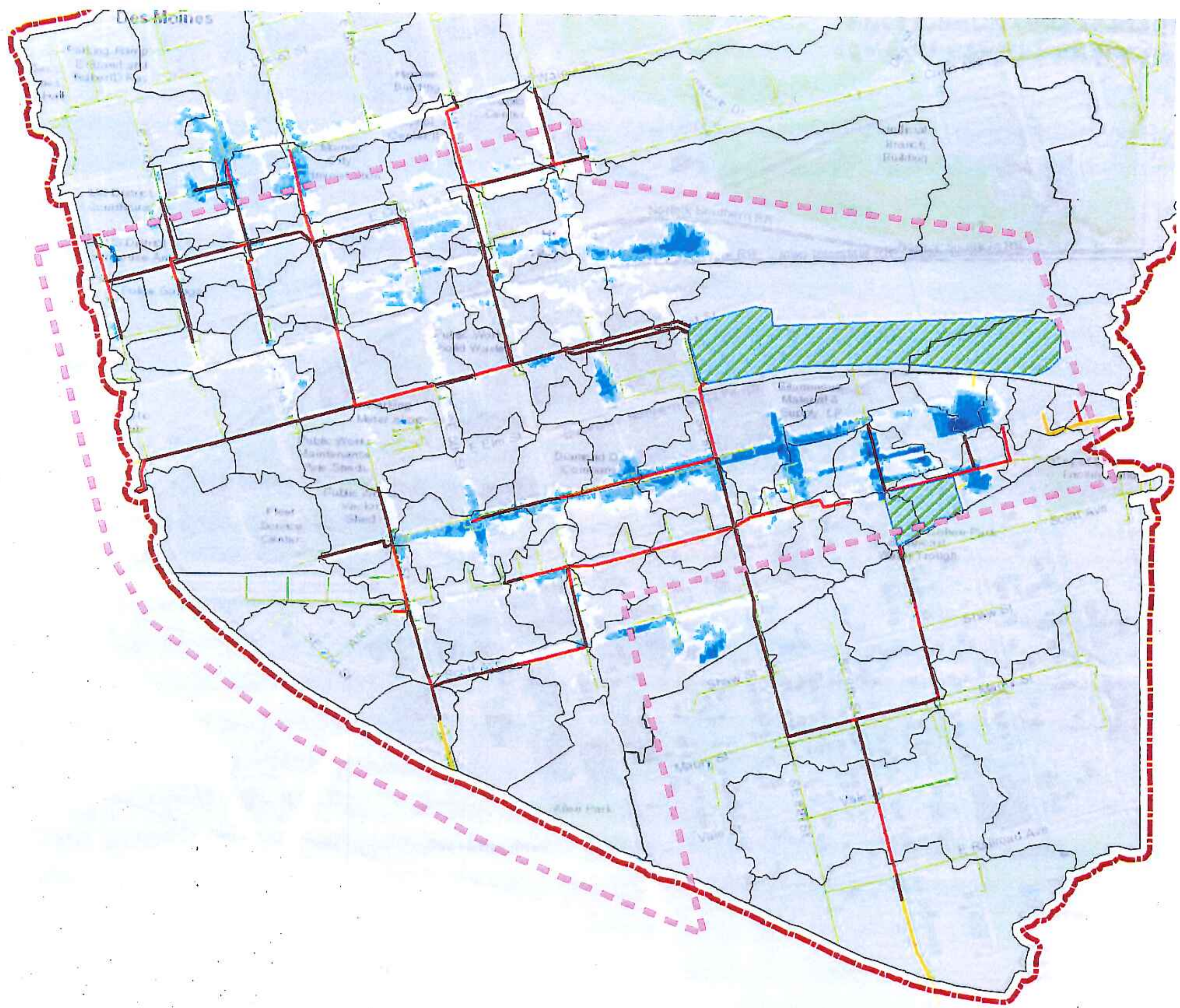

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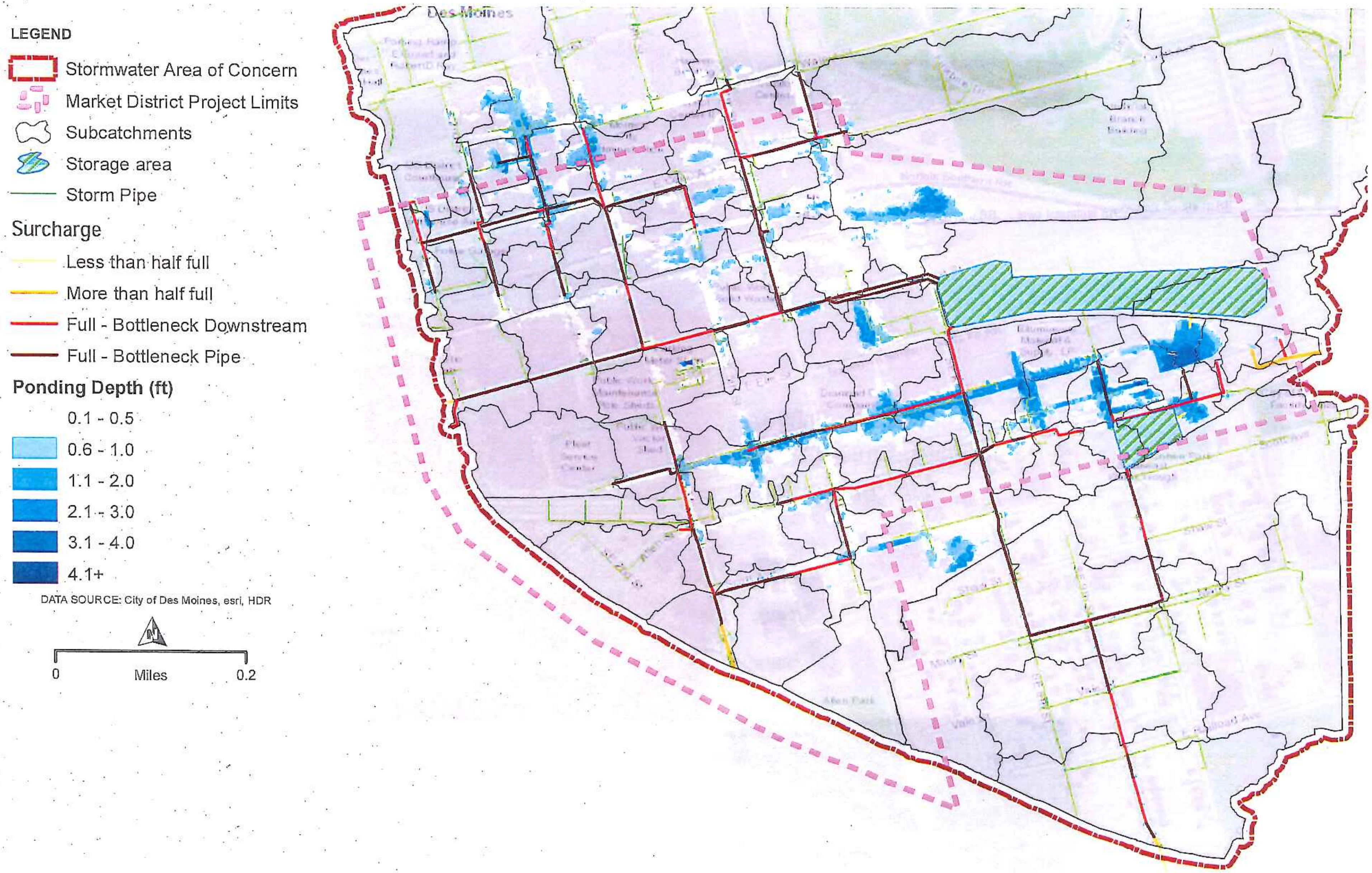
50-YEAR EVENT RESULTS
PROPOSED CONDITIONS



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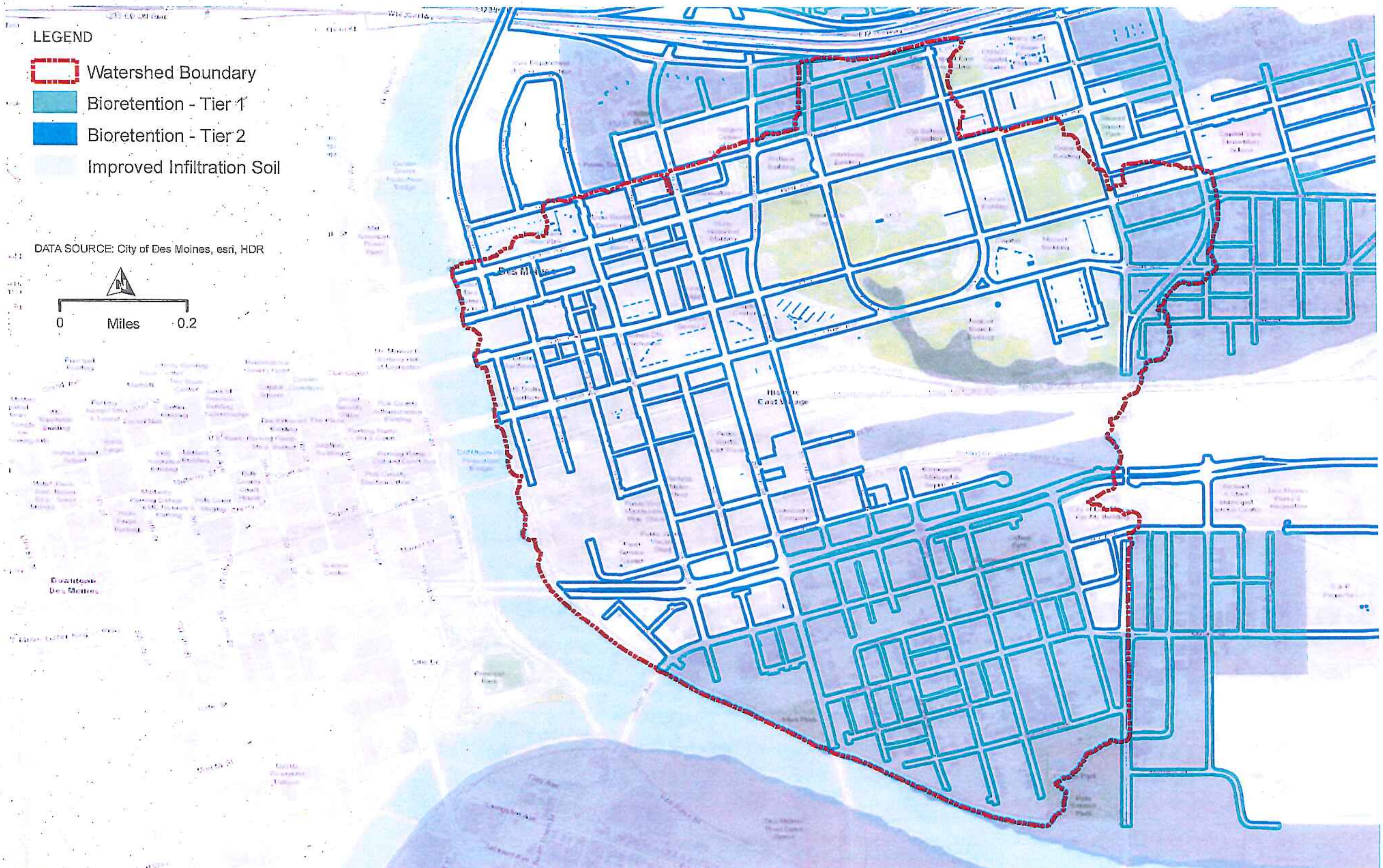
100-YEAR EVENT RESULTS
PROPOSED CONDITIONS

B

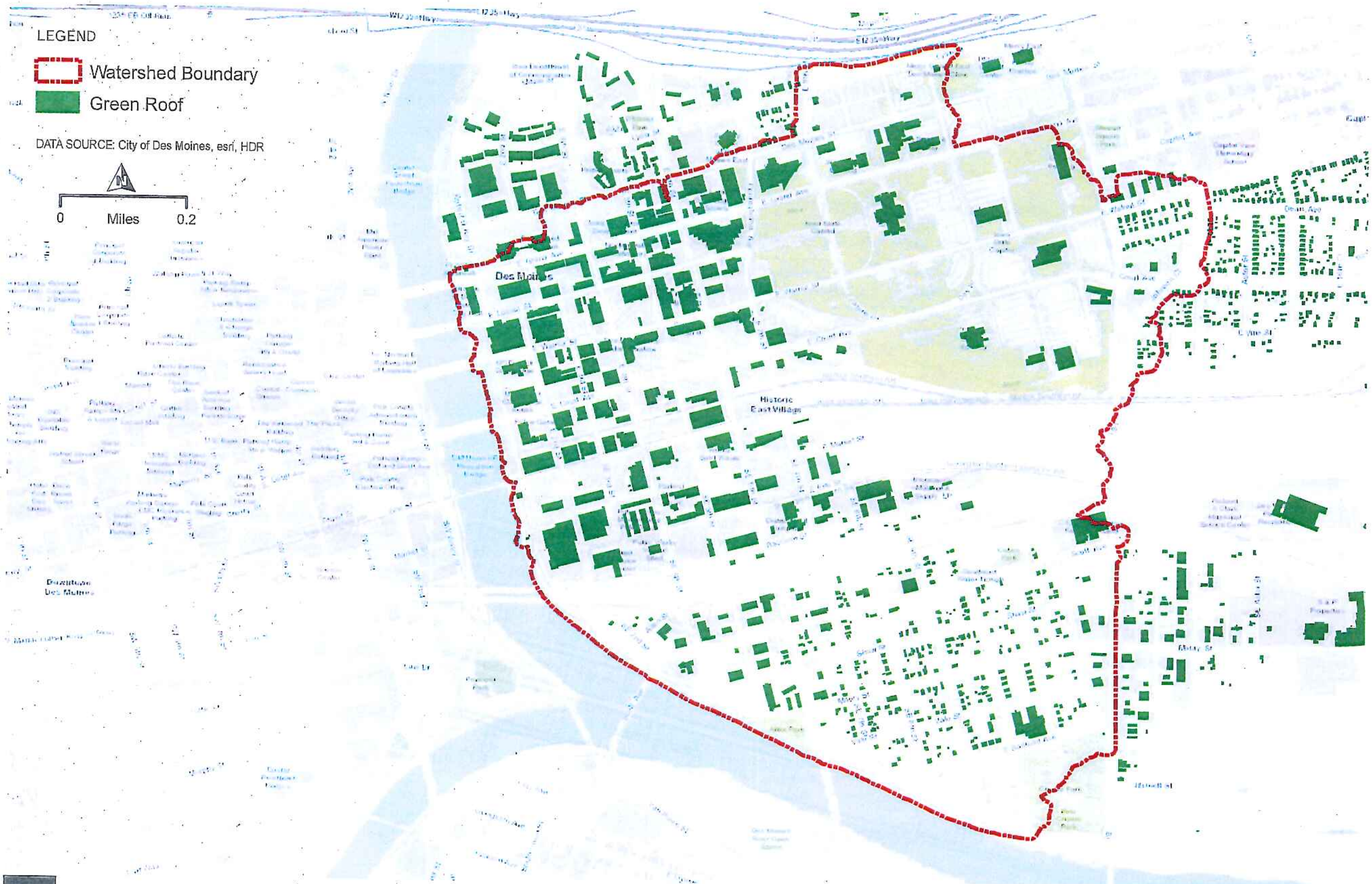
Green Stormwater Infrastructure Suitability Results



BIORETENTION POTENTIAL LOCATIONS

GREEN INFRASTRUCTURE

FIGURE B1



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GREEN ROOF POTENTIAL LOCATIONS

GREEN INFRASTRUCTURE

FIGURE B2

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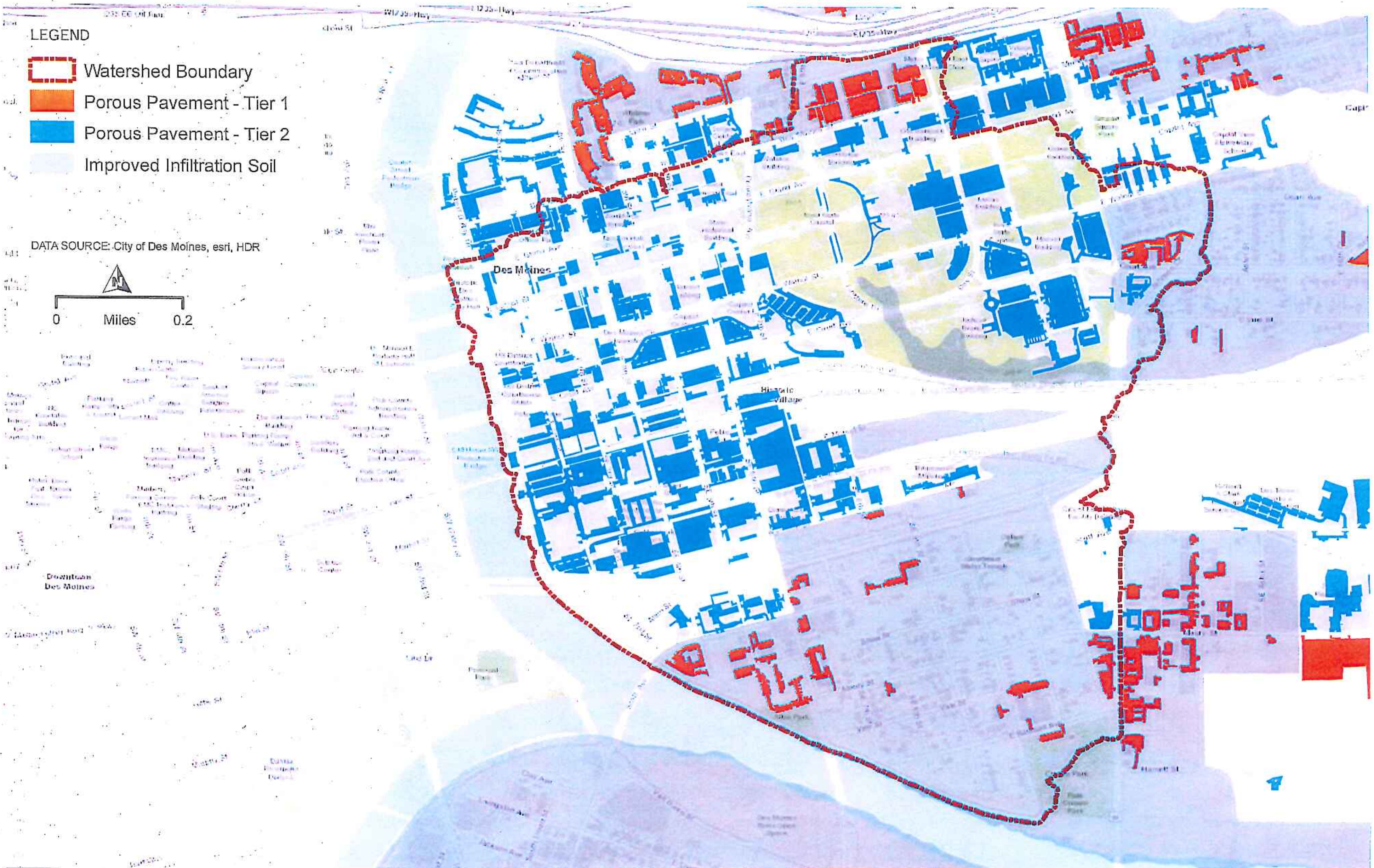
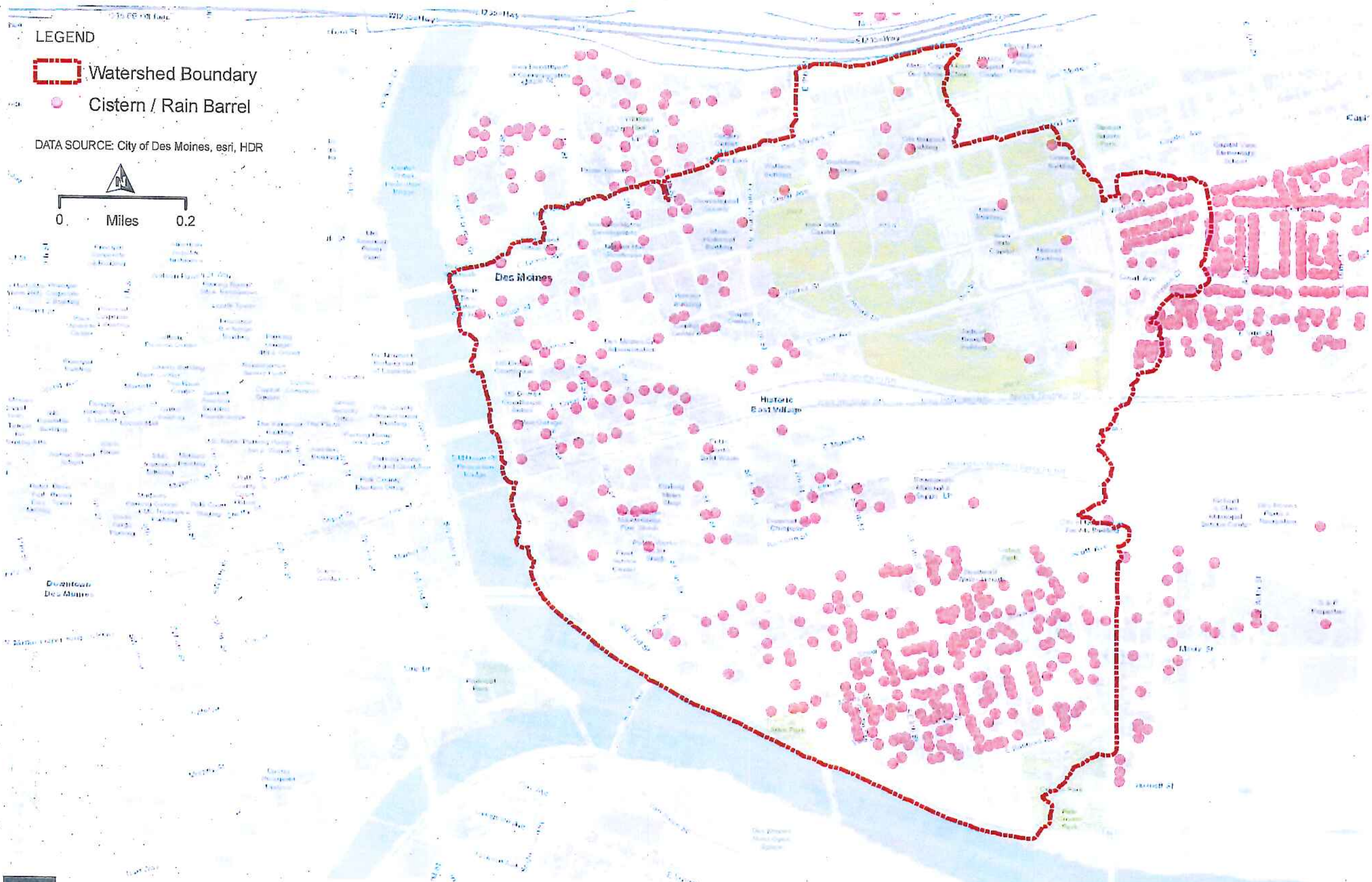


POROUS PAVEMENT POTENTIAL LOCATIONS

GREEN INFRASTRUCTURE

FIGURE B3



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CISTERN AND RAIN BARREL POTENTIAL LOCATIONS

GREEN INFRASTRUCTURE

FIGURE B4

C

Cost Estimates

This Appendix provides the details for project concepts and their associated costs, including project descriptions and assumptions. This appendix also provides a planning-level summary of the costs and utility conflicts associated with each project. Cost estimates are developed using RS Means unit rates and quantities estimated from the model. Standard percentage markups for contractor overhead, contractor fees, insurance and bonds, construction contingency, construction observation, geotechnical analysis, and engineering are included where applicable.

Because this is planning-level study, HDR did not conduct site-specific surveys to locate utilities or other potential design constraints. Planning level design was based on observations and City-provided data. Utility conflicts were not included in cost estimates for each project.

E Walnut Street Conveyance Improvements Project

The conveyance improvement project includes increasing the storm sewer capacity in the Alley south of E Walnut Street, between E 2nd Street and E 3rd Street to 10 cubic feet per second (cfs). The itemized cost estimate is shown in Table 1.

Table 1. E Walnut Street Conveyance Improvements Concept Level Costs

Item	Size (in)	Unit	Quantity		Cost
Pavement Removal	--	SY	460	$	6,000
Pavement Replacement	--	SY	460	$	28,000
New Pipe - RCP	15	LF	170	$	8,000
Manholes	--	EA	1	$	4,000
Inlets		EA	2	$	4,000
Manhole Modification	--	EA	2	$	4,000
Pipe Removal - RCP	15	LF	170	$	5,000
			Total Cost:	$	59,000
Construction Total (includes overhead)			15%	$	68,000
Contractor fee			10%	$	7,000
Insurance and bonds			2%	$	1,000
Construction Contingency			25%	$	17,000
Construction Observation			10%	$	7,000
Geotechnical			5%	$	3,000
Engineering			12%	$	8,000
			ESTIMATED TOTAL	*$*	***111,000***

E Market Street Conveyance Improvements between SE 6^{th} Street and Detention Basin

This conveyance improvement project includes increasing the conveyance capacity between the east side detention basin and E 6^{th} Street to 330 cfs, and add a flap valve on the end of each pipe at the detention basin to prevent back flow. The itemized cost estimate is shown in Table 2.

Table 2. E Market Street Conveyance Improvements Concept Level Costs

Item	Size (in)	Unit	Quantity	Cost
Pavement Removal		SY	2,660	$ 32,000
Pavement Replacement		SY	2,660	$ 160,000
Pipe Installation - RCP	78	LF	930	$ 527,000
Manholes		EA	9	$ 36,000
Flap Gate		EA	1	$ 13,500
Water Control Structure		EA	2	$ 20,000
Erosion Protection		EA	3	$ 15,000
Seeding		SY	9	$ 30
Manhole Modification		EA	2	$ 4,000
			Total Cost	$ 782,530
Construction Total (includes overhead)			15%	$ 900,000
Contractor fee			10%	$ 90,000
Insurance and bonds			2%	$ 18,000
Construction Contingency			25%	$ 225,000
Construction Observation			10%	$ 90,000
Geotechnical			5%	$ 45,000
Engineering			12%	$ 108,000
			ESTIMATED TOTAL	***$ 1,476,000***

E Market Street Detention Basin Capacity Improvements

This detention basin project includes increasing the storage capacity of the detention basin to approximately 42 acre-feet and construct a new 18-inch reinforced concrete pipe (RCP) outlet on Market Street. This estimate does not include any costs related to the shared use pathway around the basin as proposed in the future development plan. The itemized cost estimate is shown in Table 3.

Table 3. E Market Street Detention Basin Capacity Improvements Concept Level Costs

Item	Size (in)	Unit	Quantity	Cost
Earthwork - Excavation		CY	61,300	$ 368,000
Earthwork - Hauling		CY	61,300	$ 337,000
Pipe Installation - RCP	18	LF	675	$ 38,000
Pipe Installation - RCP	24	LF	45	$ 3,000
Manholes		EA	2	$ 8,000
Erosion Protection		EA	1	$ 5,000
Outlet		EA	2	$ 20,000
Seeding		SY	40,920	$ 158,000
Clear and Grub		AC	8	$ 87,200
			Total Cost	$ 1,024,200
Construction Total (includes overhead)			15%	$ 1,178,000
Contractor fee			10%	$ 118,000
Insurance and bonds			2%	$ 24,000
Construction Contingency			25%	$ 295,000
Construction Observation			10%	$ 118,000
Geotechnical			5%	$ 59,000
Engineering			12%	$ 141,000
ESTIMATED TOTAL				***$ 1,933,000***

Raccoon Street Conveyance Improvements (SE 5th Street to SE 8th Street)

This project includes increasing the conveyance capacity between 4th Street and 8th Street to 25-60 cfs. It also requires a complete reconstruction of Raccoon Street to have a standard street profile. The itemized cost estimate is shown in Table 4.

Table 4. Raccoon Street Standard Street Profile Concept Level Costs

Item	Size (in)	Unit	Quantity	Cost
Pavement Removal		SY	6,000	$ 72,000
Pavement Replacement		SY	11,130	$ 668,000
New Pipe - RCP	30	LF	447	$ 49,000
New Pipe - RCP	36	LF	385	$ 59,000
New Pipe - RCP	42	LF	332	$ 64,000
New Pipe - RCP	48	LF	415	$ 94,000
Manholes		EA	7	$ 28,000
Inlets		EA	20	$ 40,000
Pipe Removal - RCP	18	LF	960	$ 36,000
Pipe Removal - RCP	36	LF	745	$ 76,000
			Total Cost	$ 1,186,000
Construction Total (includes overhead)			15%	$ 1,364,000
Contractor fee			10%	$ 136,000
Insurance and bonds			2%	$ 27,000
Construction Contingency			25%	$ 341,000
Construction Observation			10%	$ 136,000
Geotechnical			5%	$ 68,000
Engineering			12%	$ 164,000
			ESTIMATED TOTAL	***$ 2,236,000***

Raccoon Street Overland Flow Improvements (SE 8th Street to SE 11th Street)

This project includes a complete reconstruction of Raccoon Street to lower the elevation by 0.5 feet from existing conditions and to have a standard street profile. It also includes construction a 48-inch RCP culvert through the railroad north of Raccoon Street to connect overland flow on Raccoon Street to the detention basin. The itemized cost estimate is shown in Table 5.

Table 5. Raccoon Street Overland Flow Path with Standard Street Profile Concept Level Costs

Item	Size (in)	Unit	Quantity	Cost
Pavement Removal		SY	6,000	$ 72,000
Pavement Replacement		SY	11,130	$ 668,000
New Pipe - RCP	48	LF	130	$ 30,000
Headwall/Endwall		EA	2	$ 24,000
			Total Cost	$ 794,000
Construction Total (includes overhead)			15%	$ 913,000
Contractor fee			10%	$ 91,000
Insurance and bonds			2%	$ 18,000
Construction Contingency			25%	$ 228,000
Construction Observation			10%	$ 91,000
Geotechnical			5%	$ 46,000
Engineering			12%	$ 110,000
			ESTIMATED TOTAL	***$ 1,497,000***

SE 4th Street Conveyance Improvements

This project includes increasing the conveyance capacity between on SE 4th Street between Raccoon Street and Scott Avenue by replacing the existing 36-inch RCP with a 48-inch RCP. The itemized cost estimate is shown in Table 6.

Table 6. Raccoon Street Standard Street Profile Concept Level Costs

Item	Size (in)	Unit	Quantity	Cost
Pavement Removal		SY	1,933	$ 72,000
Pavement Replacement		SY	24,675	$ 668,000
New Pipe - RCP	48	LF	447	$ 49,000
Manholes		EA	11	$ 59,000
Inlets		EA	11	$ 64,000
Pipe Removal - RCP	36	LF	675	$ 94,000
			Total Cost	$ 1,741,000
Construction Total (includes overhead)			15%	$ 2,002,000
Contractor fee			10%	$ 200,000
Insurance and bonds			2%	$ 40,000
Construction Contingency			25%	$ 501,000
Construction Observation			10%	$ 200,000
Geotechnical			5%	$ 100,000
Engineering			12%	$ 240,000
			ESTIMATED TOTAL	***$ 3,283,000***

HDR

Draft Sanitary Sewer Technical Memorandum

Date: Friday, December 28, 2018

Project: Des Moines Market District Master Plan

To: City of Des Moines

From: HDR Engineering, Inc.

Subject: Sanitary Sewer Service Analysis

HDR previously completed a desktop review of the sanitary sewer collection system within the Market District of East Village (Study) neighborhood. The purpose of the review was to provide preliminary recommendations for addressing the sanitary sewer collection system within the Study area.

The existing collection system generally flows from north to south. The northern portion of the service area is approximately mid-block between East Court Avenue and Iowa Interstate (IAIS) Railroad. The east boundary of the service area is Southeast 14th Street and the west and southern boundary is the Des Moines River. The majority of the collection system is currently served by the Hawthorne Pump Station located near Southeast 14th Street and East Railroad Avenue. A portion of the service area is served by a combined sewer on vacated right-of-way along the former East Vine Street.

A meeting was held with City of Des Moines and Water Reclamation Authority (WRA) personnel on January 25, 2018 to discuss the current system condition and limitations. The Hawthorne Pump Station is a duplex station with a 10 IN force main that extends to the wastewater treatment plant. High water alarms are reported at the station during rain events. The events have not resulted in backups or an overflow.

The majority of the sewer in the collection system is 12 IN clay pipe that was installed at minimal grade. The 12 IN sewer on Southeast 12th Street between Shaw Street and Scott Avenue is known to have been installed essentially flat. A 12 IN sewer in the area of Southeast 6th Street and Maury Street is also known to have a flat slope.

At least one storm sewer inlet is known to be connected to the sanitary sewer collection system in the intersection of Southeast 5th and Shaw Streets. Two additional connections exist to serve water quality basins.

A combined sewer is located along the former East Vine Street that conveys flow to the combined sewer located on Southeast 1st Street. The shallow grades of the sanitary sewer on Southeast 5th Street do not allow for a sanitary sewer to be extended to this sub-basin and eliminate the combined sewer. WRA personnel stated their intent is not to increase the flow in the combined sewer.

The capacity of the Hawthorne Pump Station and force main is 1,000 gpm, based on available information. The estimated dry weather flow to the station is approximately 300 gpm based on the influent flow calculations. However, metered discharge flow from the station was approximately 70 gpm for the period of February 1 – 8, 2018. As stated previously, the station does reach a high water condition during larger rain events.

WRA personnel expressed concern that additional flow to the station would result in sewer backups along the 12 IN sewer on Southeast 12th Street. Backflow valves would likely have to be installed in the laterals of the residences along this sewer.

Future land uses in the service area will substantially increase the volume of sanitary sewer flow to the Hawthorne Pump Station. With the exception of the sub-basin served by the combined sewer, the area north of East Elm Street is currently served by a single 12 IN sewer that conveys flow to the pump station. This area is currently lightly utilized. Several developments are planned or under construction in this area that will substantially increase the volume of sanitary sewer flows from the area. The estimated increase in flow is approximately 200 – 300 gpm. This additional flow would reduce the peaking factor for the station to a less than recommended level.

Options considered:

1. Upgrade the Hawthorne Pump Station to accommodate the additional flow. This option is not recommended because upgrades to the collection system will be necessary to convey the additional flow to the station due to the flat and minimal grade sewers. In addition, a parallel force main would be necessary to accommodate the additional flow. The shallow sewers would necessitate maintaining a portion of the area as a combined sewer and increasing the amount of flow into the combined system as development continues.
2. Construct a new pump station and force main that will serve the northern portion of the Study area. The proposed force main could be routed east along the north side of East Martin Luther King Jr. (MLK) Parkway. A crossing of the abandoned railroad tracks would occur just west of Southeast 14th Street. The proposed force main would connect to the interceptor sewer located in the vicinity of Southeast 20th Street.

It was also recommend the City evaluate options to eliminate the storm water connections to the collection system upstream of the Hawthorne Pump Station. Based on the data provided, the station does have adequate capacity for the service area but the high level alarm is activated during some rain events. Coupled with the elimination of the storm water connections, the proposed pump station will also reduce the loading on the Hawthorne Pump Station. The Hawthorne Pump Station should have the necessary capacity for future development south of East MLK Parkway.

Trunk Sewer Evaluation

Based on the previous desktop review of the existing sanitary sewer collection system and review of the proposed future development plan of the area, an evaluation was completed to determine routing and estimated sizing for a new gravity trunk sewer. Estimated sewer flows were calculated based on the proposed areas of residential, office and mixed use spaces identified in the proposed development plan. Ground surface elevations from GIS were also reviewed to determine approximate slopes and depths of the new trunk sewer.

Based on the desktop review, the recommended approach is to construct a new pump station and force main to serve the northern portion of the Study area. The recommended location of the pump station is at the east end of Raccoon Street, on property owned by the City. The site is currently served by three phase power at the east end of Raccoon Street. The boundary of the proposed area that would be served by the new pump station is shown in yellow in Figure 1. The area is approximately 100 acres. The pump station is estimated to have a capacity of approximately 600 – 800 gpm and utilize an 8 IN diameter force main. The sizing of the pump station and force main will be determined during final design.

The proposed gravity trunk sewer would extend from the pump station south to the north right of way of East MLK Parkway and then continue west along the right of way to Southeast 7th Street. The sewer would turn north along Southeast 7th Street to Elm Street and then west along Elm Street to Southeast 4th Street to serve the northern portion of the Study area. Locating the sewer along East MLK Parkway and within the Elm Street right of way would allow the existing sewer in Raccoon Street to be abandoned and removed. Removal of the existing sanitary sewer and relocation of other utilities within the Raccoon Street right of way would open this area to future larger scale development. Existing sanitary service connections located along Raccoon Street would need to be relocated, depending on what existing facilities stay in place. Existing north/south sanitary sewers located in 5th Street and 7th through 9th Streets could be utilized to reestablish service connections.

As shown in Figure 1, the existing sanitary sewer located in Southeast 5th Street could be connected to the proposed trunk sewer at Elm Street to pick up existing flows from the north and reduce flow to the Hawthorne Pump Station. The proposed gravity trunk sewer would continue along Elm Street to Southeast 4th Street to provide a connection point for the possible future Federal Court House or other developments at this location.

The gravity trunk sewer would then be extended north on Southeast 4th Street and west along City-owned property south of IAIS Railroad. This routing would allow connections of the sanitary services between Southeast 1st and 4th Streets to the new sanitary sewer and reduce the amount of flow to the existing combined sewer located in Southeast 1st Street.

To determine the required sizing and estimated depth for the proposed trunk sewer, an initial depth of 10 FT was established at the upstream end, near the intersection of Southeast 2nd Street and Vine. (The initial depth could be raised if it is determined future development would not require any sewer service connections to be this deep.) A minimum slope of 0.5% was used for the entire length of the new trunk sewer. Utilizing this minimum slope keeps the sewer above the minimums required for sanitary sewer design, for pipes 8 IN in diameter and larger, and helps minimize the final depth at the proposed pump station. In addition, based on existing GIS ground elevations, the trunk sewer would be able to maintain at least the 10 FT starting depth.

Based on the estimated flows from future development, an 8 IN diameter trunk sewer at 0.5% slope should provide sufficient capacity from the upstream end east to the Southeast 5th and Elm Street intersection. From this intersection to the proposed pump station, a 12 IN diameter sewer is recommended. Approximate invert depths of the sewer would range between 10 FT to 15 FT deep. The final sizing of the gravity sewer will be determined during final design.

Public Grease Interceptor Evaluation

An evaluation was completed to review the feasibility of shared or public grease interceptors located within the study area. Grease interceptors are intended to treat kitchen wastewater from food service establishments and other similar facilities with large volumes of wastewater. When fats, oils and grease (FOG) enter the sewer and start to cool they separate from the wastewater flow and can create problems such as sewer blockages and spills. Grease interceptors prevent accumulated FOG from clogging sewer lines.

Grease interceptors are designed to slow the wastewater flow and allow sufficient time for FOG to separate. Accumulated FOG is removed from the interceptor on a regular maintenance schedule. Typical placement of grease interceptors is as close as possible to the facility's fixture(s) being served. Wastewater from toilets, restroom sinks and other similar fixtures is not piped through the grease interceptor. Variations in discharge levels from these other fixtures can disrupt the design intent of the grease interceptor, causing it to not function as intended and FOG to be discharged downstream into the public sewer.

In evaluating the use of a shared or public grease interceptor, the distance from the point source is a major consideration. The further the interceptor is located away from the source(s), the longer amount of time allowed for the FOG to cool and possibly collect in sewer lines before reaching the shared interceptor. Typically, shared grease interceptors are only designed where multiple food service facilities occupy portions of a single or connected commercial structure or constitute a combined food court within a single structure. If future development includes structures with multiple food service facilities located within the same structure, a shared grease interceptor may be beneficial. However, a public grease interceptor option is not recommended due to concerns with proximity to the multiple FOG point sources. There is a higher risk of material cooling in the collection system and producing clogs prior to entering the public interceptor, increasing the level of maintenance required of the collection system.

Draft Water Distribution Technical Memorandum

Date: Friday, December 28, 2018

Project: Des Moines Market District Master Plan

To: City of Des Moines

From: HDR Engineering, Inc.

Subject: Water Distribution System Evaluation

Objective

The Market District Master Plan (Study) has established the recommended future land use plan for the Study area. With this updated information the distribution system network was reviewed to identify if deficiencies occurred related to pressure and fire flow. The distribution network outside of the study area was assumed to operate as normal. The adjustments made to the model only reflect changes in demand to reflect the anticipated change in land use.

Des Moines Water Works (DMWW) completed a Long Range Plan in 2017 in which the existing system and anticipated future system were evaluated for deficiencies. The final DMWW capital improvement plan (CIP) has been developed through 2020. DMWW continues to update and refine improvement plans. At the time of the Long Range Plan, the Historic East Village neighborhood had already been identified as an Urban Renewal Growth Area. Special attention to increased demands were shown in future modeling scenarios. For the purpose of this study, the current system was evaluated. While planned improvements may occur in the future that enhance system performance, the most conservative simulation is to assume all planned future growth were to occur immediately with the current system.

The existing system is presented first, followed by the proposed system with the updated land use plan. Evaluation for deficiencies include pressure and available fire flow.

Existing System

In the Long Range Plan, demands were assigned by separating the top 2,000 users in the system and assigning demand based on historical use at that account. This allows for an accurate spatial distribution of experienced high demands. The remaining demand was assigned based on Land Use type. None of the top 2,000 users is included within the study area. The unit demands presented in Table 0-1 use the assigned land use and the area of the parcel to assign an average day demand.

Table 0-1 Unit Average Day Demands by Land Use Type

Land Use Type	Unit Average Day Demand (gpd/acre)
Agriculture	100
Commercial	500
Exempt	150
Government	150
Industrial	600
Multi-Family	1,000
Park/Open Space	15
Residential - High Density	600
Residential – Medium Density	400
Residential - Low Density	100
Residential - Rural	50
Right-of-Way/Vacant	0
School	150
Utility	350

The peaking factor of maximum day demand (MDD) to average day demand (ADD) is 2.0.
MDD scenario was used to evaluate system performance for low pressure areas. Within the study area all pressures remain above 60 psi as shown in Figure 0-1.

The fire flow standards set by the Insurance Services Office (ISO) require a minimum residual water pressure of 20 psi during a fire. Residual pressure, in this instance, is defined as the pressure inside the pipeline system near the points at which hydrant flows are taking place. From a fire fighting perspective, the principal reason for a required minimum residual pressure of 20 psi is that this pressure is sufficient to overcome the friction losses in the hydrant branch, hydrant, and suction hose with some pressure remaining at the fire pump. From a water quality perspective, the 20 psi residual is consistent with American Water Works Association (AWWA) requirements for minimum system pressure to prevent backflow contamination. The Distribution System Requirements for Fire Protection manual (AWWA M31) indicates that the system should be capable of supplying the required fire flow during the MDD condition. The fire flow availability compared to fire flow demand was determined by the hydraulic model for all model nodes with the constraint of maintaining a residual pressure of 20 psi at every other location in the system that serves customers. Available fire flow is shown in Figure 0-2. Flow may not be the only significant parameter of system performance needed. For instance, a sprinkler system can reduce the actual fire flow needed and requires an operating pressure of 40 psi, an industrial parcel may not contain a heavy industry, or the MDD peaking factor may be unrealistic for an industrial area with high fire flow requirements.

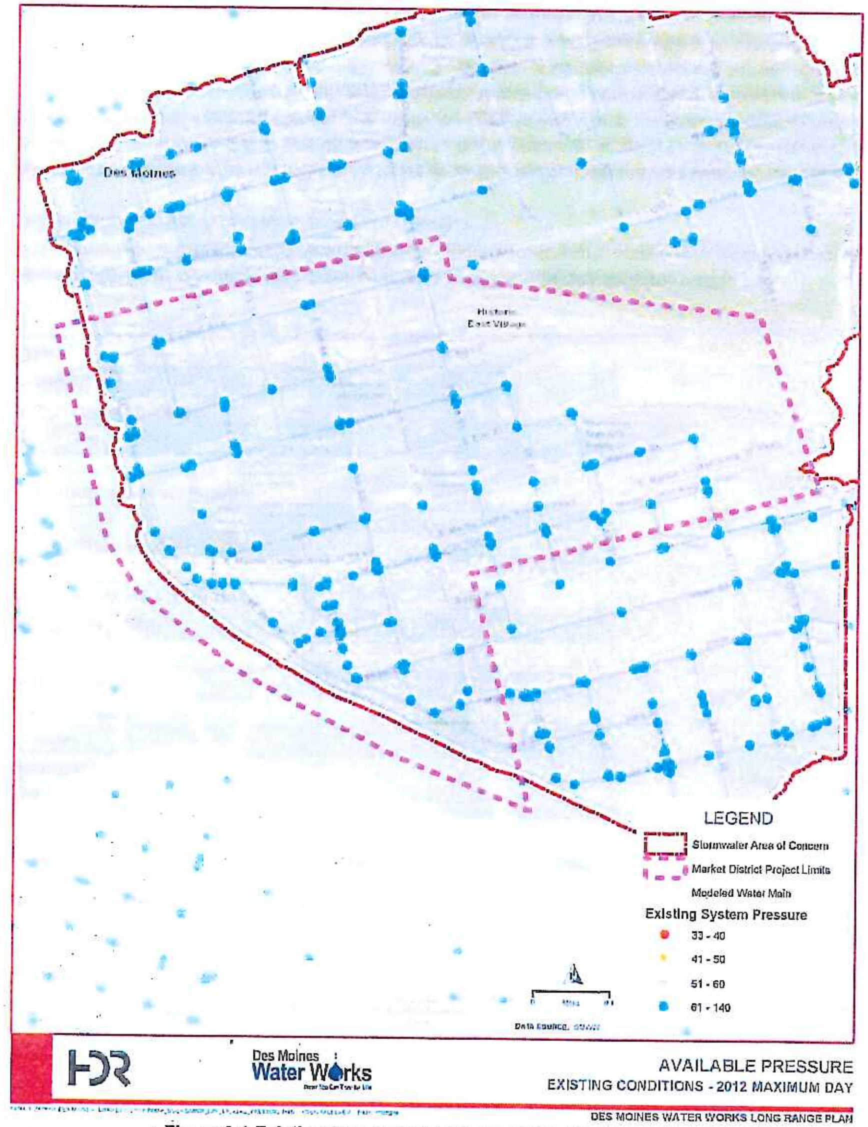


Figure 0-1 Existing System Available Pressure (Maximum Day Demand)

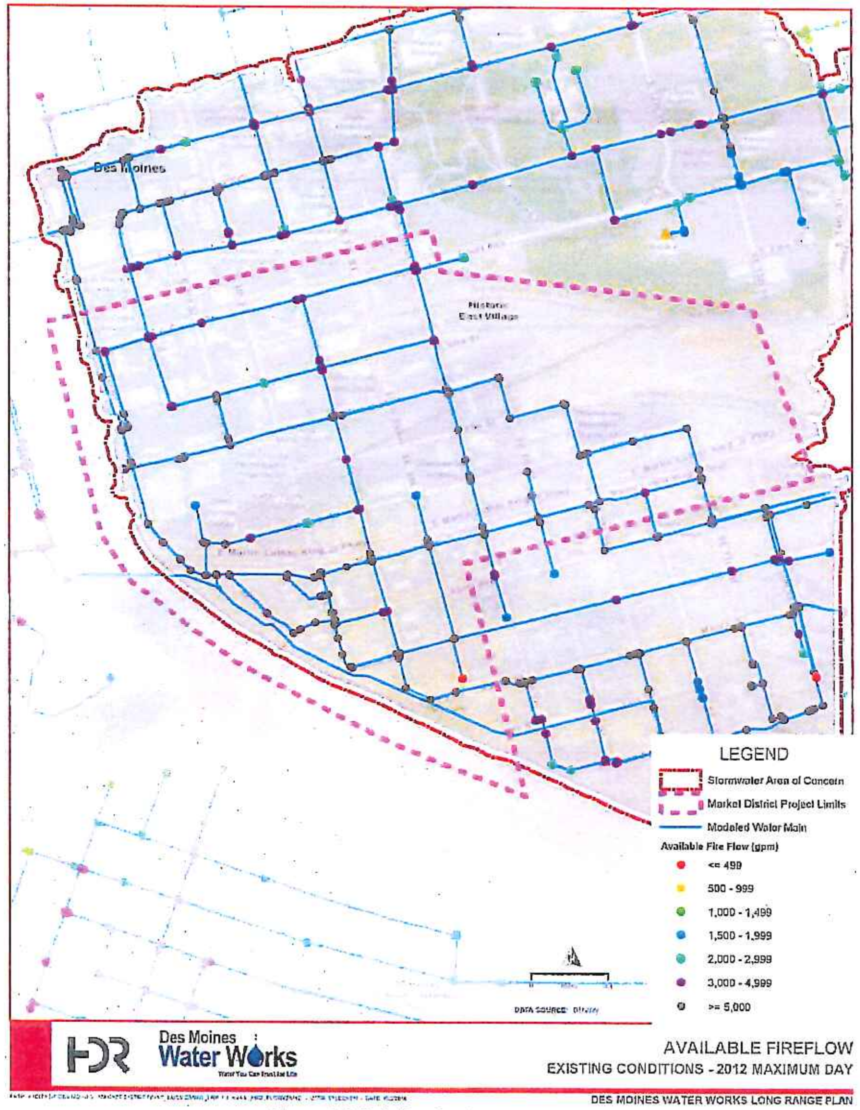


Figure 0-2 Existing System – Available Fireflow

A fire flow of 1,500 gpm is regularly used to evaluate residential areas. With the exception of dead-end nodes, the service area has greater than 1,500 gpm available fire flow. The dead-end nodes are in close proximity to larger mains and available fire flows, so it is not recommended to upsize mains or extend a redundant line.

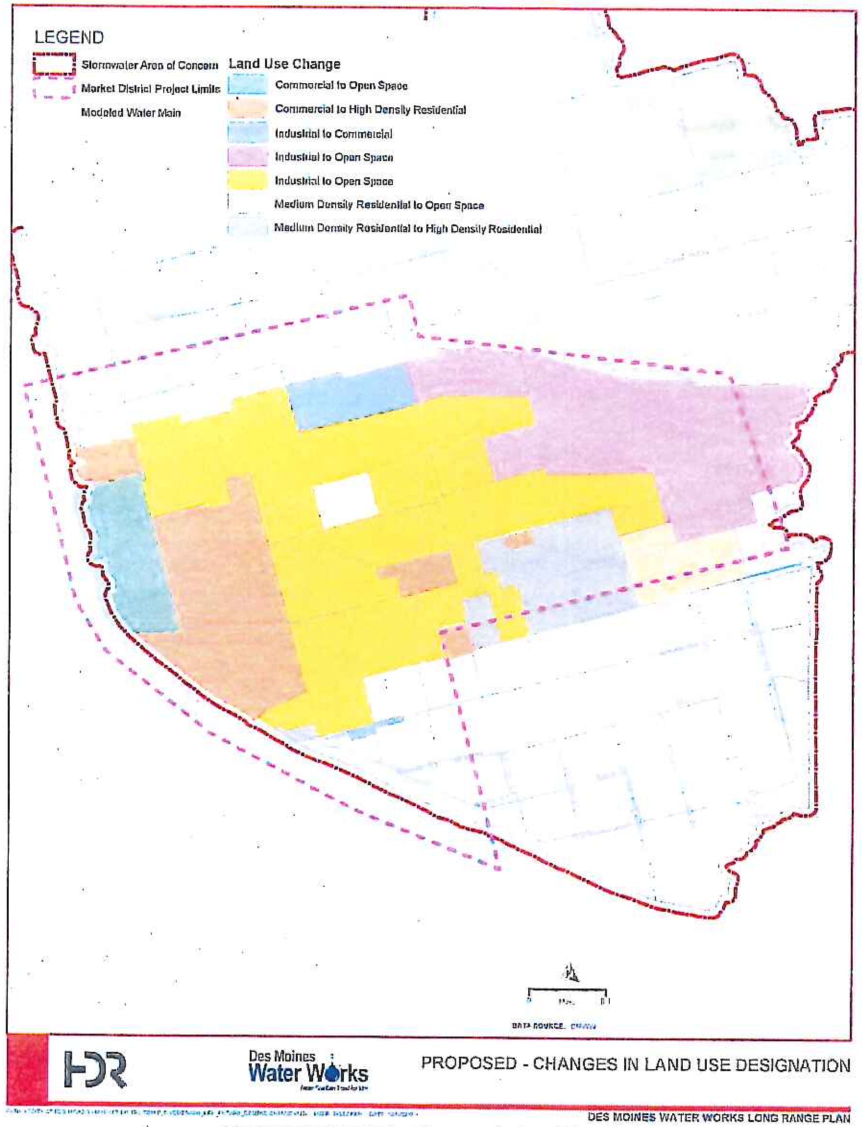


Figure 0-3 Proposed – Changes in Land Use Designation

Figure 0-3 shows the changes in land use designation from the existing land use plan to the proposed land use plan. The demands within the polygons were updated to reflect the unit demands presented in Table 0-1 Unit Average Day Demands by Land Use Type.

Results

The model did not identify any new deficiencies due to increased density and demand. The results have minor changes, but none that have exceeded the service targets of maintaining greater than 60 psi pressure and 1,500 gpm fire flow. The results of the proposed land use plan meet the same standards presented in the existing system, as shown in Figure 0-4 Proposed – Available Pressure and Figure 0-5 Proposed – Available Fire Flow.

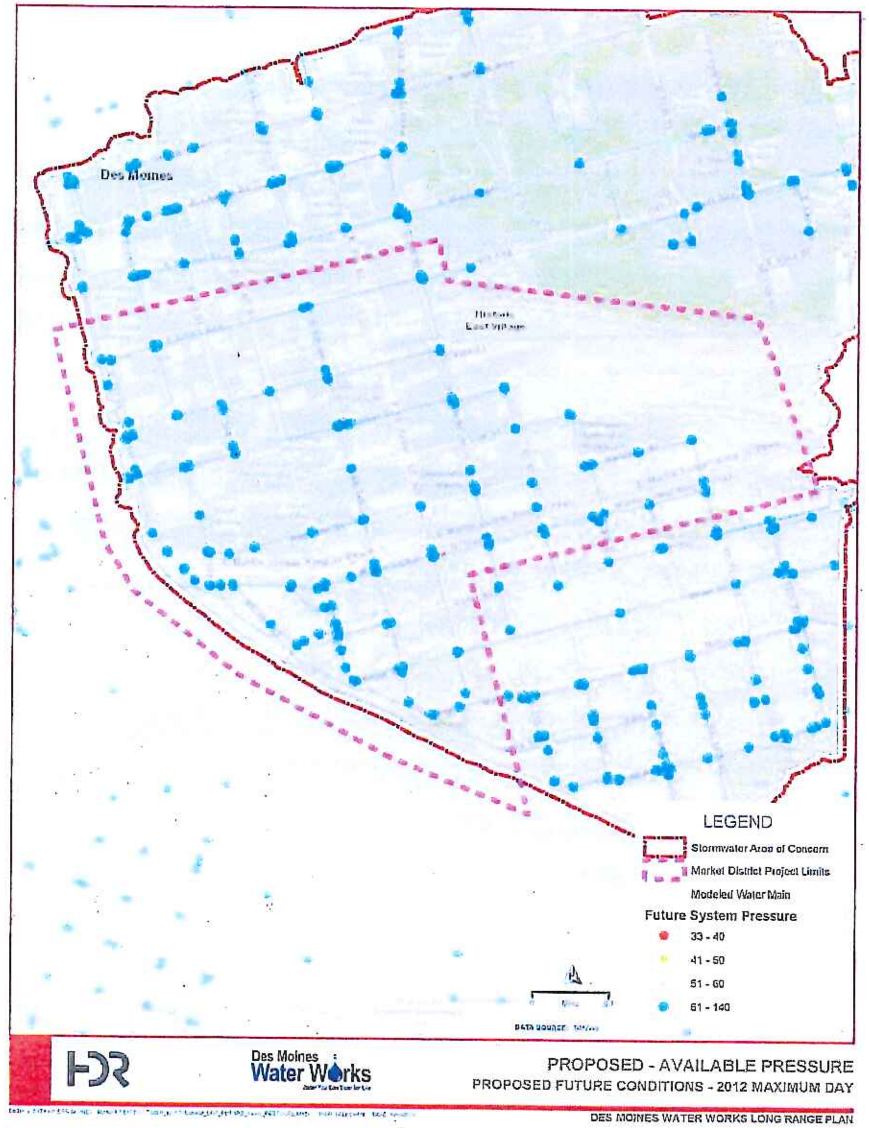


Figure 0-4 Proposed – Available Pressure

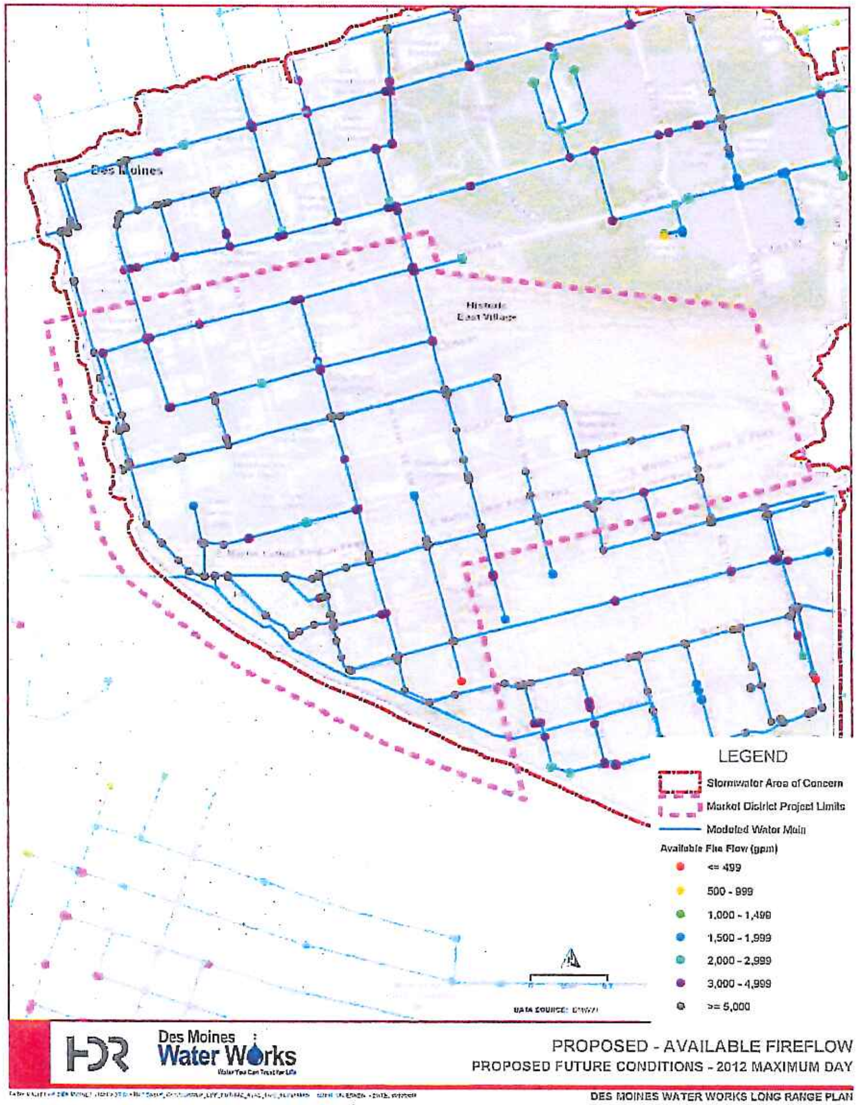


Figure 0-5 Proposed – Available Fire Flow

Potential Improvements

In addition to the DMWW CIP developed as part of the Long Range Plan, a study was completed at the same time titled Water Main Replacement Analysis. The study evaluated the unique mains in the system and assigned a risk score comprised of a likelihood of failure and consequence of failure. Figure 0-6 shows the relative risk scores for the Study area.

While there were no issues identified related to pressure or fire flow, there remains a potential to address concerns with high risk pipe while upgrading other infrastructure in the area.

The recommended sanitary sewer improvement areas are shown in a highlighted orange color. This project overlaps with a high risk pipe on Raccoon St between SE 9th St and SE 11th St. These mains could be replaced and coordinated during the same project schedule.

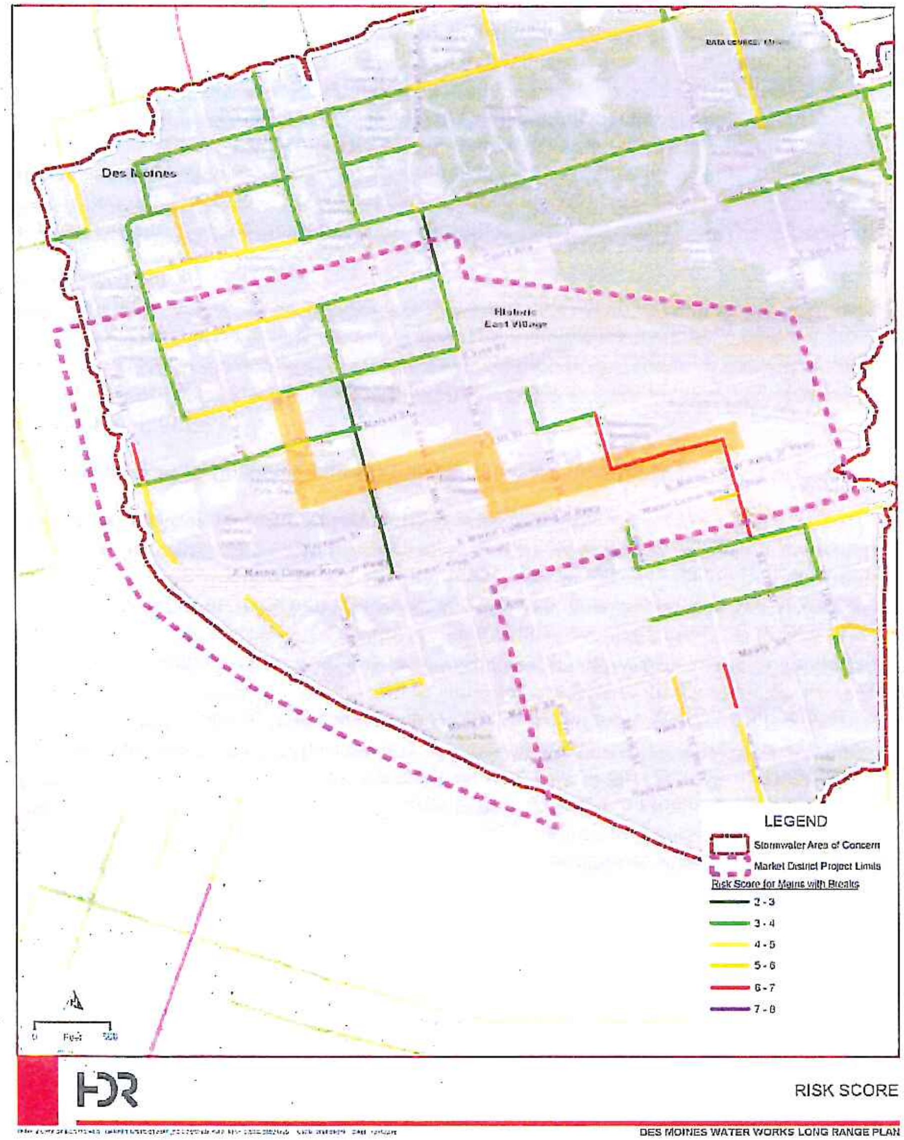


Figure 0-6 Existing System – Risk Score

Draft Streets and Traffic Technical Memorandum

Date: Friday, December 28, 2018

Project: Des Moines Market District Master Plan

To: City of Des Moines

From: HDR Engineering, Inc.

Subject: Streets and Traffic Analysis

Executive Summary

The Market District Master Plan represents the potential for thousands of additional trips to occur on busy streets near Downtown Des Moines. The traffic analysis developed a methodology to determine the level of current trip making in the area and the number of future trips to be anticipated on the street system based on master plan land uses. Through the master plan process and coordination with the City of Des Moines traffic staff, multiple scenarios emerged to allow for the traffic analysis to support a determination of 1) the importance of street improvements to complete the grid system in the Market District, 2) the need for additional intersection or corridor improvements to support redevelopment volumes, and 3) the potential benefit of transit operating in the district. The traffic analysis utilized the City of Des Moines existing downtown area multi-modal simulation model and developed within that model a series of eight scenarios. For each scenario, performance measures were captured from the model to determine if the Market District area improved as a whole and how individual key intersections were operating with regard to vehicular level of service (LOS).

The following statements represent key findings of the traffic analysis.

Key Traffic Findings

Complete Grid Network Reduces Congestion - Findings support the planning efforts within the Market District to reconnect the grid system to support development. Scenarios modeled to review conditions after completion of the complete grid network confirm by average speed the impact of additional roadway connections is positive, though there are some spot increases in intersection delay.

Market District Redevelopment Traffic Satisfied with Grid – Traffic analysis considering the before and after conditions of redevelopment within the Market District noted a slight drop in average speeds when adding new trips from new Market District land uses. The drop in average speeds was small relative to conditions before redevelopment, indicating that the proposed roadways within the community can adequately handle the additional traffic. Further, intersection level analysis confirmed that while some new land uses led to decreases in intersection LOS for autos, the worst-case LOS at each location within the Market District was LOS D or better, indicating limited value in additional intersection improvements.

Transit Represents a Community Benefit without Gridlock – Transit service to the Market District would provide new and current residents to the community linkages to downtown, the capitol, and new retail and recreational spaces. Those benefits to transit are not considered in a multimodal simulation, which typically looks at the impact modes have on each other. The introduction of transit on SE 4th Street and MLK Jr Parkway add to the intersection delay at some intersections near transit stops, but transit provides relief to the network as a whole by removing some trips from vehicles on busy streets. The traffic model does not indicate any intersections with a vehicle LOS beyond LOS D and thus the analysis does not recommend further intersection improvements to mitigate vehicle LOS.

RECOMMENDATIONS FOR THE CITY OF DES MOINES TRAFFIC ENGINEERING DEPARTMENT

The project traffic analysis supports the master plan recommendations to the City of Des Moines to: 1) work with developers to complete the Market District grid network, 2) work with the Des Moines Area Rapid Transit Agency (DART) to provide circulator and frequent radial transit service to and within the Market District, and 3) review developments and street reconstruction projects to provide appropriate multimodal amenities to support transit users, bicyclists, and pedestrians. The traffic analysis did not identify any additional vehicular-based roadway needs to be developed as future projects by the City of Des Moines.

Introduction

This 2018 study is to determine the impacts to traffic operations as a result of the proposed redevelopment to the Des Moines Market District. Determining these impacts allows for the identification of City of Des Moines improvements needed in response to redevelopment focusing on traffic performance. The Des Moines Market District is a region in Des Moines, Iowa with the following general bounds. The western limit is established by the Des Moines River. To the north, the Market District is bounded by East Court Avenue. The eastern limit is established by SE 14th Street north of Scott Avenue and SE 6th Street south of Scott Avenue. Detailed limits are shown in **Figure 1**. For the purposes of this study, existing conditions are matched to 2018 current conditions. The redevelopment of areas outside the market district proposed by PlanDSM is considered to gradually occur over a span of approximately 20 years. The Market District master plan established a vision for redevelopment that includes most new land uses replacing existing land use patterns by year 2030 and the remaining redevelopment of sites within the Market District occurring by 2040. The time interval for this study is 2018 to 2040. The end year 2040 is chosen for convenience based on available data.

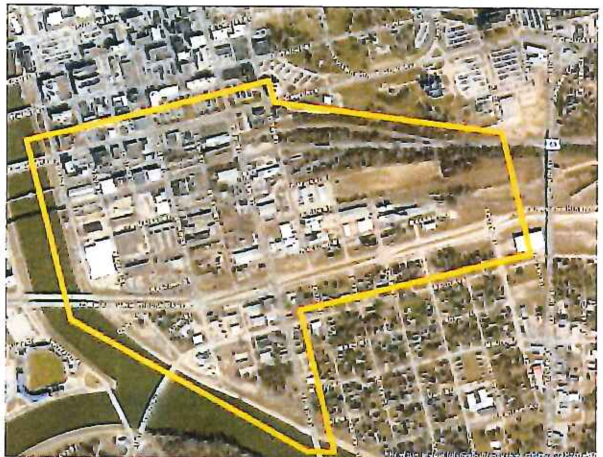


Figure 1 Des Moines Market District Limits

Scenarios

In analyzing the traffic operations of the Market District development indicated by the Master Plan, eight scenarios are analyzed to determine the likely effects of said development. These scenarios are spread across three time horizons; the first: existing conditions (year 2018), the second: interim conditions (year 2030), and the third: future conditions (year 2040). These scenarios are further delineated by varying Market District conditions: no development, partial development, and full development; and the roadway network: base road network, complete grid network, and complete grid network with transit. **Table 1** shows the breakdown of the eight scenarios by year, development, and roadway network.

Table 1 Scenario Breakdown

Year of Analysis	Market District	Base Road Network	Complete Grid Network	Complete Grid + Transit
2018	No Development / Includes Regional Growth	X		
2030			X	
2040		X	X	
2030	Partial Development		X	X
2040	Full Development		X	X

HDR

EXISTING CONDITIONS – EXISTING ROADWAY NETWORK, EXISTING TRAFFIC VOLUMES

This scenario resembles current operating conditions for the Market District. The roadway network matches current conditions, and the traffic volumes are extrapolated from 2016 turning movement counts. Traffic volumes assigned a total of 21,092 trips for all modes. The mode split for the traffic is between automobile trips and bicycle/pedestrian trips. In accordance with information supplied via MoveDSM, 3.2% of trips are assigned to bicycle/pedestrian trip modes and 96.8% of trips are assigned to automobile modes. The results of this analysis scenario are useful in assessing the sensitivity of the TransModeler model and establishing a baseline against which the effects of changes in subsequent scenarios can be assessed.

FUTURE BASELINE CONDITIONS – EXISTING ROADWAY NETWORK, 2040 BASE VOLUMES

This scenario utilizes the existing roadway network from the previous scenario and 2040 background growth traffic volumes. Background growth volumes simply reflect the change in traffic volumes as affected by population growth irrespective of changes in patterns of development. Traffic volumes assigned a total of 27,039 trips (a 28% growth in traffic volume, or 1.1% per year in a mature neighborhood near downtown) for all modes. As with the previous scenario, the mode split for this scenario is also 3.2% bicycle/pedestrian trips and 96.8% automobile trips. This scenario approximates the traffic operations in the Market District in 2040 if no changes are made to the roadway network or development: also known as a "do nothing" scenario. Results of this analysis scenario are used as a baseline to determine the impact of changes to the roadway network and land-use in the future conditions.

INTERIM CONDITIONS – FULL-BUILD ROADWAY NETWORK, 2030 BASE VOLUMES

Under the assumption that the proposed roadway network will be fully built out by 2030, this interim condition scenario has the full-build roadway network and 2030 background growth traffic volumes. These background growth volumes are developed using the process detailed later under **Volume Development.** Traffic volumes assigned a total of 27,168 trips for all modes. The mode split for this scenario is approximated as halfway between the existing mode split from MoveDSM and the future condition mode split proposed by Des Moines Metropolitan Planning Organization. Thus, bicycle/pedestrian trips comprise 7% of total trips and automobile trips comprise 93% of total trips.

INTERIM CONDITIONS – FULL-BUILD ROADWAY NETWORK, 2030 BASE + PARTIAL BUILD VOLUMES

This scenario utilizes the full-build roadway network, 2030 background growth traffic volumes, and partial development specific volumes. There are three development area/zones that are identified as being undeveloped at the interim condition time horizon. Traffic volumes assigned a total of 29,140 trips for all modes. As with the previous scenario, 7% of trips are bicycle/pedestrian and 93% of trips are automobile-based.

INTERIM CONDITIONS – FULL-BUILD ROADWAY NETWORK, PARTIAL BUILD + TRANSIT VOLUMES

This scenario implements a small transit system into the previous scenario. The transit system is reflected through the addition of a bus-line running north and south along SE 4th Street from Walnut Street to MLK Jr Parkway. Two buses, staggered between northbound and southbound, run along the route at 10 minute intervals. The buses stop at most intersections. Traffic volumes assigned a total of 29,113 trips for all modes. The mode split caused by the addition of the transit system is 7% bicycle/pedestrian trips, 10% transit trips, and 83% automobile trips.

FUTURE CONDITIONS – FULL-BUILD ROADWAY NETWORK, 2040 BASE VOLUMES

This future condition uses the fully built out roadway network. The traffic volumes included in this scenario reflect background growth from year 2020 to year 2040. Traffic volumes assigned a total of 23,146 trips for all modes. In this future condition, the mode split is 10% bicycle/pedestrian trips and 90% automobile trips.

FUTURE CONDITIONS – FULL-BUILD ROADWAY NETWORK, 2040 BASE + FULL BUILD VOLUMES

On the fully built out roadway network, this scenario includes traffic volumes from both background growth and development specific traffic volumes. The development specific traffic volumes are from the full redevelopment plan proposed. Traffic volumes assigned a total of 25,213 trips for all modes. As with the previous scenario, the mode split for this scenario is 10% bicycle/pedestrian trips and 90% automobile trips.

FUTURE CONDITIONS – FULL-BUILD ROADWAY NETWORK, FULL BUILD + TRANSIT VOLUMES

A transit network is added to the previous scenario to create this scenario. The transit network includes two bus lines. The bus line along SE 4th Street from the interim transit scenario is included as well as a bus line running east and west along MLK Jr Parkway from 2nd Avenue to SE 12th Street. Two buses, staggered between eastbound and westbound, run along the route at 15 minute intervals. Traffic volumes assigned a total of 25,003 trips for all modes. The mode split caused by the addition of the transit system is 10% bicycle/pedestrian trips, 20% transit trips, and 70% automobile trips.

Volume Development

To perform the analysis, traffic volumes need to be developed for each scenario. There are two types of traffic volumes that need to be developed: background traffic and development specific traffic. Background traffic volumes are determined based on existing traffic counts and proposed growth independent of development. The City of Des Moines provided 2016 turning movement counts,[1] which are used as the base for developing traffic volumes.

Traffic volumes for 2040 are determined using the turning movement counts provided by the City and forecast daily volume data provided by the Des Moines Area Metropolitan Planning Organization. **Table 2** shows provided roadway daily volumes along key segments within the Market District.

Table 2 Key Roadway Daily Volumes

Segment Location	2018 Daily Volume	2040 Daily Volume
Court Ave, W of SE 4th St	2,700	4,200
Court Ave, between SE 4th St and SE 6th St	3,200	5,200
Court Ave, between SE 6th St and SE 7th St	3,900	4,600
Court Ave, E of SE 7th St	4,200	4,900
MLK Jr Pkwy, W of SE 4th St	10,250	16,250
MLK Jr Pkwy, between SE 4th St and SE 6th St	9,750	18,900
MLK Jr Pkwy, E of SE 7th St	0[2]	21,000
SE 4th St, between Court Ave and MLK Jr Pkwy	2,000	4,500
SE 6th St, between Court Ave and MLK Jr Pkwy	4,000	7,200
SE 7th St, between Court Ave and MLK Jr Pkwy	800	1,000

The project team reviewed the MPO's travel demand model daily volumes for future conditions with PlanDSM land uses (representing more concentration of activity in the downtown node) and future conditions without PlanDSM land uses compared to existing traffic volume levels. The travel model including Plan DSM land uses represented a more conservative estimate of future expected growth on arterial roadways than the alternative model which showed very limited growth. The project team elected to go with the future year model results with PlanDSM land uses as conservative and treated those model flows as representing 2040. Growth factors were estimated between the 2040 model volumes and base model year 2010 ADTs to be applied to existing conditions traffic count data.

Because the period of interest for the analysis is the PM peak hour, ten percent of the AADT growth is applied to the turning movement counts provided by the City.

Traffic volumes for the interim condition (2030) are determined using a straight-line regression from the 2040 volumes to the existing volumes. The since the interim condition is effectively halfway between the

[1] Source: All Traffic Data, 2016

[2] Data provided listed this volume as 0. Actual volume was interpolated from adjacent segments for volume development purposes. Included value corresponds to same segment as 2040 Daily Volume.

existing and 2040 conditions, half of the change in traffic volume between existing and 2040 is assumed to occur by the interim (2030) condition.

Site Traffic Generation

Estimates of vehicle trips generated by the proposed Market District master plan land uses during weekday AM and PM peak hours were determined using the following sources:

1. Market District Land Uses
2. ITE *Trip Generation Manual*
3. ITE *Trip Generation Handbook*[3]

For the full build-out by year 2040, the proposed developments are estimated to generate 2,168 new network trips in the study area during the AM peak hour and 2,259 new network trips in the study area during the PM peak hour.

To assist with developing trip generation estimates, the proposed master plan was broken down into zones based on the types of the proposed land use and the proposed locations of the future roadway network. **Figure 2** illustrates the trip generation zones for the master plan area. The mix of development included in each zone and trip generation details for full build-out of each zone are provided in the **Appendix.**

At this master plan stage, no adjustments were made to remove trips as pass-by and removal of trips as internal capture was undesirable because most trips will require travel to other zones and the entire network circulation is via public roadways and alleys.

TransModeler utilized these zone level entering and existing trips in constructing the master plan development trip table. The trips between zones were balanced between origin and destination zones using iterative factoring. Once the ultimate year master plan development trip table was complete, the interim trip table was generated by assuming all trips occur by 2030 except those to and from zones: 71, 72, 74, 75, 82, 83, 85, 86.

[3] ITE's *Trip Generation Handbook, 2nd Edition*

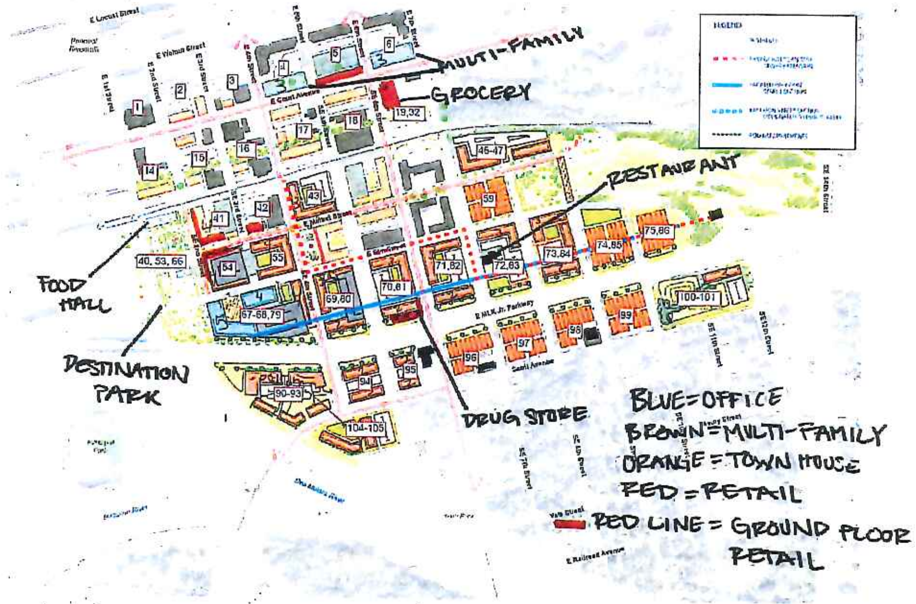


Figure 2. Site Map for Trip Generation

After the baseline growth and site trips were determined, the volumes for city streets in each scenario were generated by TransModeler by selecting the appropriate trip tables and then allowing the model to develop equilibrium routes using Dynamic Traffic Assignment (DTA), discussed later in **Model Development.**

Traffic Analysis

Traffic analysis is the process of determining the operating performance for vehicles on a given road or roadway network. By comparing differing scenarios for the roadway network, traffic analysis determined the impact of changes to the network on traffic operations for the network. Parameters often assessed in traffic analysis include delay and level-of-service, average speed, and traffic flow. For this project, traffic analysis is performed using the modeling software TransModeler. A microscopic traffic simulation model, TransModeler simulates and analyzes traffic at an individual vehicle level. TransModeler allows the user to create a street network, specify roadway classifications and speeds, dictate traffic control for intersections, and add off-network points for vehicles to access the streets to create a roadway network. Once the network is created, there are a number of ways in which traffic volumes can be added to the model for simulation. For this project, traffic volumes were added either by using turning movement counts at each intersection or by using an origin-destination matrix.

Model Development
Modeling the network traffic operations is performed using TransModeler. The City of Des Moines recently developed a TransModeler model of the areas surrounding downtown for use as an analysis tool, with the limits shown below in **Figure 3**. The black lines in **Figure 3** represent the streets being modeled and the limits to which those streets extend within the model.

Figure 3. Model Limits in TransModeler

This study uses the existing conditions version of that model as the base network. The base network is only used in simulation scenarios 1 and 2: existing conditions and future baseline conditions. For the all scenarios aside from baseline conditions, the assumption is made that the street system enhancements proposed in the Market District Master Plan will be implemented by the interim condition time horizon (by 2030). Thus, the base model network needs to be updated to reflect the expanded street network condition, updates to traffic control / traffic signal operations, and updates to the transit network.

STREET NETWORK
The change in the street network modeled is shown in **Figure 4** and **Figure 5**. **Figure 4** shows the street network modeled for the scenarios with the base road network condition. **Figure 5** shows the street network modeled for all scenarios with the complete grid network condition.

Figure 4. Existing Street Network Modeled in TransModeler

Figure 5. Full Build Street Network Modeled in TransModeler

TRAFFIC CONTROL / TRAFFIC SIGNAL TIMINGS

Intersections created as part of the expanded street network are all treated as two-way stop-control intersections. Stop signs are added to the approaches belonging to the minor street (based on traffic levels). To better reflect the impacts of development and street network configuration adjustments, traffic signal optimization was performed within TransModeler using the corridor toolbox. Traffic signal optimization was performed for the signals along SE 4th Street between Grand Avenue and MLK Jr Parkway as well as the signals along SE 6th Street between Grand Avenue and Scott Avenue.

TRANSIT

Adding transit routes to the network is accomplished by adding a new route system. The transit route is drawn into the model and then stops are assigned to the transit system. Once the transit route and stops are drawn into the model, a transit schedule is created to assign transit fleet vehicles to the route. For this project, the only transit vehicle used is a bus vehicle type.

TRAFFIC VOLUME INPUT

Adding traffic volumes to the models is a multi-step process. Initially, traffic volumes are input as turning movement counts to match the data provided by the City of Des Moines[1]. These turning movement counts account for traffic volumes at intersections of interest, however there are numerous intersections throughout the Market District, for which turning movement counts are not provided. For the intersections without provided turning movement counts, turning movement volumes must be estimated based upon known entering and exiting flows as well as the characteristics of surrounding land-use. **Figure 6** and **Figure 7** show the locations of turning movement counts. Green intersections indicate a location for which traffic counts are provided. Yellow intersections indicate a location for which traffic counts must be estimated. The base road network is shown in **Figure 6** and the complete grid network is shown in **Figure 7**.

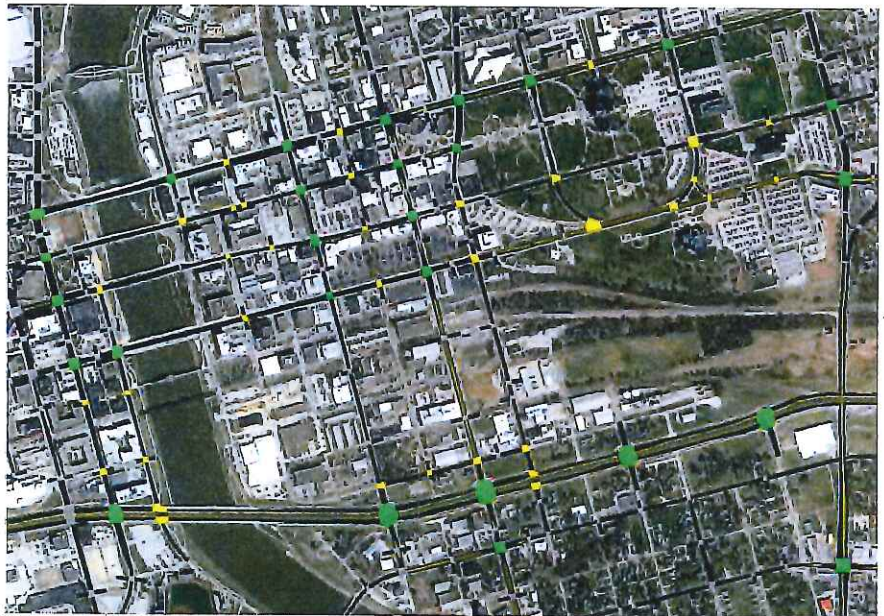


Figure 6 Count Coverage and Estimated Counts for Base Road Network

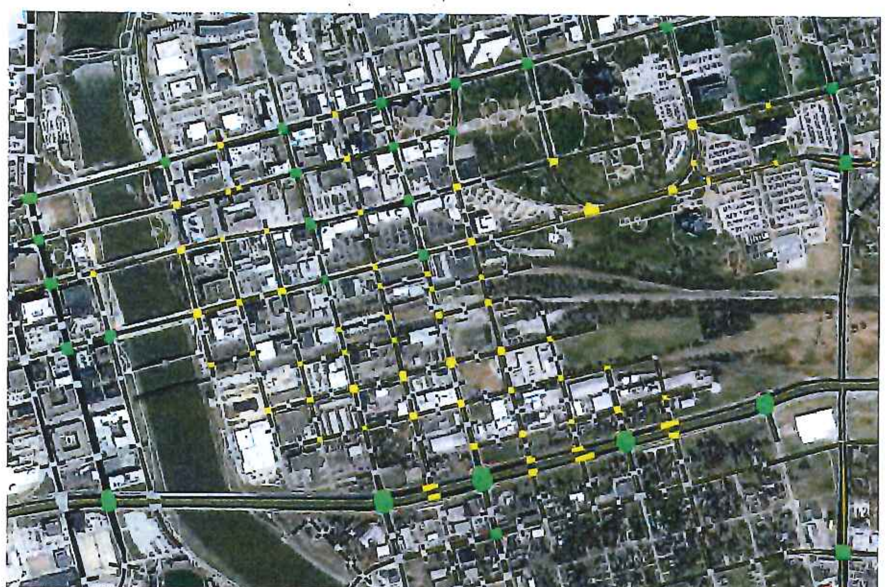


Figure 7 Count Coverage and Estimated Counts for Complete Streets Network

Once turning movement volumes have been established for the entire network, a single simulation is run. TransModeler can then use the output volumes to create an origin-destination matrix for the traffic volumes in the network. This origin-destination matrix assigns traffic to the network based upon the points of the network at which vehicles enter and exit the network. The origin-destination matrix is then copied and modified to create separate matrices for each mode of transportation (bicycle and automobile). Using matrices, TransModeler can simulate traffic operations using Dynamic Traffic Analysis (DTA), a process that iteratively changes traffic paths to decrease the travel time individual vehicles in the model. DTA continues until simulated traffic condition reach an equilibrium in overall system travel times. For the project model, DTA was run for a sufficient number of iterations to satisfy the equilibrium criteria for each scenario.

Here, it is important to note that individual trips being assigned for bicycle and automobile modes are treated as one trip even when shifting modes. Thus, the trips for bicycle and automobile modes can be treated as both vehicle-trips and person-trips. This is important when transit is added to the network. With the addition of transit to the network, trips entering and exiting the network along the transit route must be split between bicycle, automobile, and transit modes. Since automobile trips can be treated as person-trips, trips tied to zones adjacent to the transit route can be split up between automobile and transit trips by percentage with no additional conversion necessary. In these transit route-adjacent zones, person-trips are assigned to transit modes based upon the mode-split percentages presented by MoveDSM and the City of Des Moines. Therefore, zones adjacent to transit routes see mode-splits with three modes (bicycle, automobile, and transit) in accordance with those presented by MoveDSM and the City of Des Moines, whereas zones which are removed from the transit routes only see mode-splits between two modes: bicycle and automobile. Comparing the original automobile-trip matrix with the transit-adjusted automobile-trip matrix, the number of person-trips choosing the transit mode is calculated. These person trips are then assigned across the transit stops and the simulation time period to determine the arriving and alighting rates.

Traffic Analysis Results

EXISTING – FUTURE BASELINE

The following are the results of the analysis for each simulation scenario. For the existing conditions scenario with the existing roadway network and existing traffic volumes, average delay across the whole network is 25.3 seconds per vehicle and average speed across the whole network is 19.6 miles per hour. For the future baseline conditions scenario with the existing roadway network and 2040 base volumes, average delay across the whole network is 22.8 seconds per vehicle and average speed across the whole network is 18.4 miles per hour. Between the former and latter scenarios, average delay and average speed decreased. This comparison of the future no-build condition to existing conditions indicates that the background growth in traffic in the future year was observed to route along streets with lower volumes based on DTA. The use of less congested streets lowers average delay, but also yields lower network average speeds as trip lengths increase.

FUTURE COMPLETE GRID NETWORK – WITH & WITHOUT MARKET DISTRICT REDEVELOPMENT

For the future conditions scenario with the full-build roadway network and 2040 base volumes, the average delay across the whole network is 29.9 seconds per vehicle and average speed across the whole network is 19.6 miles per hour. For the future conditions scenario with the full-build roadway network and full-build volumes, the average delay across the whole network is 27.1 seconds per vehicle and average speed across the whole network is 19.3 miles per hour. As before, the average delay and average speed decreased between these two future conditions scenarios. Again, this indicates that the traffic added to the network between scenarios routes through lower volume streets with lower free-flow speeds, simultaneously lowering average delay and average speed. From this comparison, it can be concluded that the site trips overall travel along routes that lack congestion, which is a benefit of a grid system.

FUTURE BASELINE NETWORK – FUTURE COMPLETE GRID NETWORK (NO REDEVELOPMENT)

Comparing the results for the future baseline conditions scenario with the existing roadway network and 2040 base volumes with the results for the future conditions scenario with the full-build roadway network and 2040 base volumes both average delay and average speed increase from 22.8 seconds per vehicle to 29.9 seconds per vehicle and 18.4 miles per hour to 19.6 miles per hour respectively. This increase in delay and speed indicates that more vehicles are choosing to use one or two of the same higher speed facilities. This increases the average speed, and the increased demand at intersections causes the increase in average delay.

In fact, looking at a comparison of the control delay for the north-south corridors between the two scenarios reveals that this is indeed the case. **Table 3** shows the comparison of control delay at the intersections along 2nd Avenue, Water Street, SE 4th Street, and SE 6th Street between the two scenarios. It is shown that the average delay decreases along 2nd Avenue and Water Street while increasing along SE 4th Street and SE 6th Street. The speeds along SE 4th Street and SE 6th Street are higher than the speeds along Water Street and comparable to the speeds along 2nd Avenue. However, the shift in traffic from 2nd Avenue and Water Street to SE 4th Street and SE 6th Street is not primarily due to corridor speeds, but more likely is due to the increased connectivity along SE 4th Street and SE 6th Street caused by the more complete street network. The increased connectivity along SE 4th Street and SE 6th Street creates more routing options along those corridors, thereby increasing the overall traffic demand for those corridors.

Table 3 Average Control Delay for North-South Corridors

Intersection	Existing Roadway Network, 2040 Base Volumes	Full-Build Roadway Network, 2040 Base Volumes
2nd Avenue & Grand Avenue	9.1	9.5
2nd Avenue & Locust Street	12.5	11.0
2nd Avenue & Walnut Street	13.3	11.5
2nd Avenue & Court Avenue	12.0	10.9
2nd Avenue & MLK Jr Parkway	33.1	23.9
Water Street & Walnut Street	2.2	2.0
Water Street & Court Avenue	12.2	10.0
Water Street & MLK Jr Parkway	4.0	2.6
SE 4th Street & Grand Avenue	12.2	22.2
SE 4th Street & Locust Street	8.1	19.0

SE 4th Street & Walnut Street	15.0	14.1
SE 4th Street & Court Avenue	8.5	32.7
SE 4th Street & MLK Jr Parkway	31.4	36.5
SE 6th Street & Grand Avenue	16.0	11.5
SE 6th Street & Locust Street	22.1	8.1
SE 6th Street & Walnut Street	15.4	19.0
SE 6th Street & Court Avenue	11.9	32.4
SE 6th Street & MLK Jr Parkway	29.1	22.3
SE 6th Street & Scott Avenue	18.3	13.1

Average speeds in a travel model are a good indication of lower levels of delay. The proposed complete streets network to be developed in conjunction with the Market District redevelopment is likely to lead to lower delays for travelers on average. However, providing enhanced connections within the Market District led travelers that were formerly without options except to attempt to access major roads like Court Street from a stop-condition to navigate within the grid to a more major crossing, like SE 4th Street and SE 6th Street. As this new traffic builds up on SE 4th Street and SE 6th Street, the roadways generally continue to operate at reasonable levels of control delay, but the intersections of SE 4th Street & Court Avenue, SE 4th Street and MLK Jr Parkway, and SE 6th Street & Court Avenue begin to approach unsatisfactory levels of service (LOS) for the auto mode according to the HCM. As the intersection level of service does not exceed LOS D, no additional mitigation is recommended.

FUTURE MARKET DISTRICT REDEVELOPMENT + COMPLETE STREETS + TRANSIT

For the future conditions scenario with the full-build roadway network and full-build plus transit volumes, average delay across the network is 31.0 seconds per vehicle and average speed is 19.4 miles per hour. Given that the bus schedule for SE 4th Street is 1 bus in each direction every 10 minutes and the bus schedule for MLK Jr Parkway is 1 bus in each direction every 15 minutes, the number of stops each bus makes and the position of stops in the outer travel lanes accounts for the increase in average delay from other future conditions scenarios. Especially on SE 4th Street, where there is only one lane in each direction, each stop made by a bus slows or stops traffic generating more delay. As the transit routes increase delay along their respective corridors, some other vehicles will opt to utilize non-transit streets with higher free-flow speeds, thereby increasing the average speed across the network as well.

The addition of transit leads to added delays at the intersection level, but again, across a network travel model the metric of average speed is a better indicator of whether conditions improve or exhibit negative impacts. The movement of some vehicle traffic to transit appears to have a limited positive impact to congestion in the Market District as a whole, with a few spot locations seeing growth in intersection delay. No intersections within the Market District exhibit a LOS worse than LOS D, so additional mitigation measures are recommended.

INTERIM CONDITIONS

The interim conditions included three scenarios to test incrementally the impact of the increase in traffic due to redevelopment and then the benefit of transit. The base these two scenarios are compared against is the 2030 baseline growth modeled on the complete streets network. For the interim conditions scenario with the full-build roadway network and 2030 base volumes, average delay across the network is 30.5 seconds per vehicle and average speed is 18.2 miles per hour. For the interim conditions scenario with the full-build roadway network and partial build volumes, average delay across the network is 44.2 seconds per vehicle and average speed is 16.3 miles per hour. For the interim conditions scenario with the full-build roadway network and partial built plus transit volumes, average delay across the network is 38.7 seconds per vehicle and average speed is 16.2 miles per hour.

The interim conditions represent a counterintuitive trend. Network average speeds for these three scenarios are lower than all three scenarios for 2040. The amount of added traffic due to redevelopment is a vast majority of the trips added in the full redevelopment scenario, but upon adding these trips in the interim condition the network average speeds slow at a much greater percentage of the base. Network performance in these scenarios

The compiled results for all scenarios are shown below in **Table 4**.

Table 4 Traffic Analysis Results by Scenario – Worst-Case Peak Hour

Scenario	Total Vehicles	Total Delay (sec)	Average Delay (sec/veh)	Average Speed (mph)
Existing Roadway Network, Existing Traffic Volumes	21,092	533,537.8	25.3	19.6194
Existing Roadway Network, 2040 Base Volumes	23,146	528,784.0	22.8	18.3721
Full-Build Roadway Network, 2030 Base Volumes	22,119	674,002.9	30.5	18.2086
Full-Build Roadway Network, 2030 Base + Partial Build Volumes	24,091	1,064,952.9	44.2	16.3058
Full-Build Roadway Network, Partial Build + Transit Volumes	24,073	930,467.8	38.7	16.2215
Full-Build Roadway Network, 2040 Base Volumes	23,146	692,618.4	29.9	19.6399
Full-Build Roadway Network, 2040 Base + Full-Build Volumes	25,213	682,091.7	27.1	19.2902
Full-Build Roadway Network, Full-Build + Transit Volumes	25,003	774,119.4	31.0	19.4279

Conclusions

Analysis of the traffic operations for the Market District development indicated by the Master Plan, was performed for eight scenarios to determine the likely effects of the development. These scenarios are spread across three time horizons: 2018, 2030, and 2040; three Market District development conditions: no development, partial development, and full development; and three roadway network conditions: base road network, complete grid network, and complete grid network with transit.

All scenarios were modeled in TransModeler for traffic analysis. TransModeler analysis accounts for proposed changes in the street network, traffic control for each intersection, number of trips by mode in the network, and impact of transit. TransModeler allows Dynamic Traffic Assignment (DTA) to be performed to create an equilibrium condition for traffic routing based on individual vehicular travel times simplifying the need to develop input traffic analysis volumes for each scenario and intrinsically accounting for transportation improvements to draw traffic from parallel roadways and modes.

Key Traffic Findings

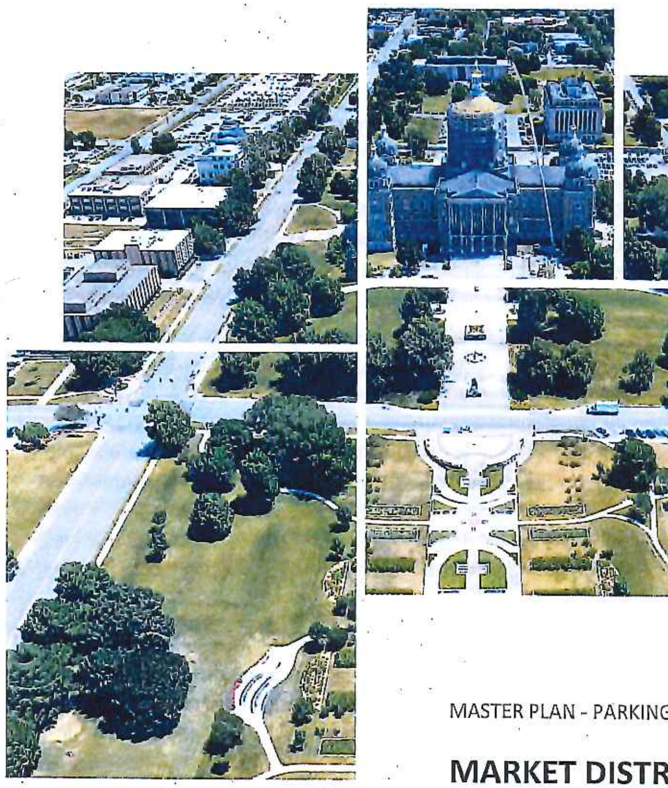
Complete Grid Network Reduces Congestion - Traffic analysis of baseline growth in the Market District in the absence of redevelopment shows that average speeds will decrease as surrounding areas and corridors experience traffic growth. This finding supports the planning efforts within the Market District to reconnect the grid system to support development. Scenarios run to review conditions after completion of the complete streets network confirm by average speed the impact of additional roadway connections is positive, though there are some spot increases in intersection delay.

Market District Redevelopment Traffic Satisfied with Grid – Traffic analysis considering the before and after conditions of redevelopment within the Market District noted a slight drop in average speeds when adding new trips from new Market District land uses. The drop in average speeds was small relative to conditions before redevelopment, indicating that the roadways within in the community can adequately handle the additional traffic. Further, intersection level analysis confirmed that while some new land uses led to decreases in intersection LOS for autos, the worst-case LOS at each location within the Market District was LOS D or better, indicating limited value in additional intersection improvements.

Transit Represents a Community Benefit without Gridlock – Transit service to the Market District would provide new and current residents to the community linkages to downtown, the capitol, and new retail and recreational spaces. Those benefits to transit are not considered in a multimodal simulation, which typically looks at the impact modes have on each other. The introduction of transit on SE 4th Street and MLK Jr Parkway add to the intersection delay at some intersections near transit stops, but overall provide relief to the network as a whole by removing some trips from vehicles on busy streets. The traffic model does not indicate any intersections with a vehicle LOS beyond LOS D and thus the analysis does not recommend further intersection improvements to mitigate vehicle LOS.

RECOMMENDATIONS FOR THE CITY OF DES MOINES TRAFFIC ENGINEERING DEPARTMENT

The project traffic analysis supports the master plan recommendations to the City of Des Moines to: 1) work with developers to complete the Market District grid network, 2) work with the Des Moines Area Rapid Transit Agency (DART) to provide circulator and frequent radial transit service within the Market District, and 3) review developments and street reconstruction projects to provide appropriate multimodal amenities to support transit users, bicyclists, and pedestrians. The traffic analysis did not identify any additional vehicular-based roadway needs to be developed as projects by the City of Des Moines.



BUILDING ENVELOPE

CONSULTING

FORENSIC RESTORATION

PARKING DESIGN

PLANNING

MASTER PLAN - PARKING NEEDS ANALYSIS

MARKET DISTRICT – DES MOINES, IOWA

HDR ENGINEERING, INC.

December 11, 2018

WALKER CONSULTANTS

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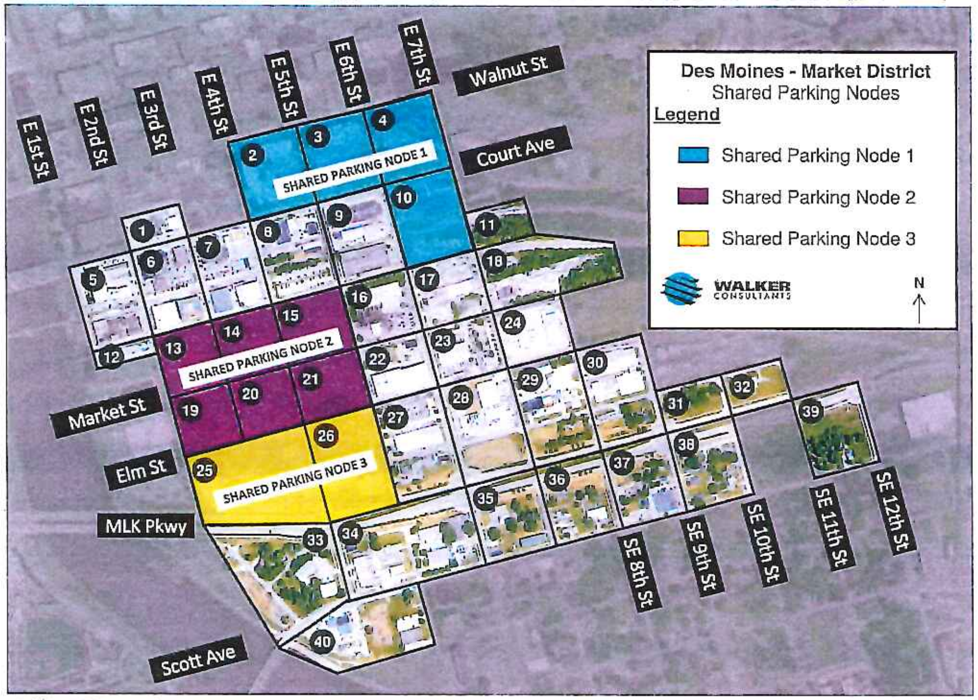
EXECUTIVE SUMMARY

HDR Engineering, Inc. (HDR) engaged Walker Consultants (Walker) to assist with the parking portion of the Master Plan for the Market District in Des Moines, Iowa. Walker was tasked to work with HDR to develop an opinion of parking needs once development projects in the Market District have been completed, to develop plans for parking supply volume and location, and to discuss the impacts of transportation alternatives on the area.

Walker utilized Google Earth images to estimate current parking supply and demand, and added the relevant supply and demand of proposed developments and infill opportunities to derive projected future supply and demand. Future proposed parking supply information was provided by HDR, and Walker estimated future demand based upon proposed development project information, also provided by HDR. Shared parking methodology was utilized by Walker to estimate future demand, using assumptions shaped by the Urban Land Institute (ULI) and Institute of Traffic Engineers (ITE). The model is designed to provide a reasonable recommendation of parking capacity to meet the parking needs of a mixed-use development during typical busy times. The shared parking model assumed driving ratios, captive market ratios, and presence factors applied to ULI and ITE-based, industry standard parking demand ratios, specific to each node.

Walker identified three nodes or influence areas which would have opportunities to share parking, based upon proposed development projects. Blocks which were assumed to not utilized shared parking included mostly residential projects, and as such, it was assumed that the majority of off-street spaces on these blocks would be used privately by residents. The three nodes are presented in the following map, and the remaining blocks were assumed to not share parking.

Study Area and Shared Parking Nodes



Source: Walker Consultants

The following table presents the shared parking assumptions and resulting estimated future adequacy across nodes, and in the Market District as a whole. As the table indicates, Walker estimates that, as a whole, the proposed parking supply in the Market District would be adequate to support demand, with a surplus of approximately 1,155 spaces. However, much of the surplus is estimated to be concentrated in Nodes 1 and 3, and parking supply may be slightly inadequate among the blocks with unshared parking (the blocks not included in the three nodes) by approximately a 140-space deficit. HDR may wish to consider reducing the parking supply in Nodes 1 and 3, and redistributing parking supply from Nodes 1 and 3 to the unshared parking blocks.

Estimated Future Adequacy

	Quantity	Base Ratio		Drive Ratio	Non-Captive Ratio	Peak Hour Factor	Demand
Node 1: 2:00 PM Weekday Demand Peak							
Retail Shopping	7,310	2.90	/ ksf GLA	90%	60%	100%	11
Fine Dining	3,655	15.25	/ ksf GLA	90%	60%	65%	20
Casual Dining	3,655	12.75	/ ksf GLA	90%	60%	90%	23
Retail / Restaurant Employees	14,620	1.60	/ ksf GLA	86%	100%	95%	19
Residential	176	1.63	/ Unit	95%	100%	70%	191
Office	127,500	3.15	/ ksf GLA	86%	95%	100%	326
Existing Demand						100%	15
Subtotal Demand							605
Subtotal Effective Supply							1,027
Subtotal Adequacy							422
Node 2: 7:00 PM Weekday Demand Peak							
Retail Shopping	29,793	2.90	/ ksf GLA	90%	30%	75%	17
Fine Dining	14,896	15.25	/ ksf GLA	90%	30%	100%	61
Casual Dining	14,896	12.75	/ ksf GLA	90%	30%	80%	41
Retail / Restaurant Employees	59,585	1.60	/ ksf GLA	86%	100%	95%	77
Residential	635	1.63	/ Unit	95%	100%	97%	954
Existing Demand						50%	69
Subtotal Demand							1,220
Subtotal Effective Supply							1,488
Subtotal Adequacy							268
Node 3: 10:00 AM Weekday Demand Peak							
Residential	420	1.63	/ Unit	95%	100%	75%	488
Office	179,520	3.15	/ ksf GLA	86%	95%	100%	459
Existing Demand						100%	12
Subtotal Demand							959
Subtotal Effective Supply							1,563
Subtotal Adequacy							604
Unshared Parking Demand							
Remaining Residential	1,860	1.63	/ Unit	95%	100%	100%	2,880
Misc. Retail	4,760	2.90	/ ksf GLA	90%	60%	100%	7
Misc. Fine Dining	2,380	15.25	/ ksf GLA	90%	60%	100%	20
Misc. Casual Dining	2,380	12.75	/ ksf GLA	90%	60%	100%	16
Misc. Retail / Rest. Employees	9,520	1.60	/ ksf GLA	86%	100%	100%	13
Existing Demand						100%	400
Subtotal Demand							3,337
Subtotal Effective Supply							3,197
Subtotal Adequacy							(140)
Total Demand							**6,120**
Total Effective Supply							**7,275**
Total Adequacy							**1,155**

Source: Walker Consultants

The general cost of building and maintaining parking should also be considered. Walker generally estimates that surface parking costs approximately $4,000 - $5,000 per space and that at- and above-grade structured parking costs at least $15,000 - $20,000 per space (but can be more, depending on factors like the façade), not including land costs. Soft costs, including financing, engineering fees, etc. are typically about 25 percent of capital costs.

Parking, particularly parking garages, also include operating costs which includes maintenance, cleaning, staffing, supplies, insurance, etc. The following table presents estimated breakeven monthly, per-space costs for structured parking. As the table indicates, on the lowest end of the cost spectrum, the monthly per-space breakeven cost is $135, and on the highest end it is $204.

Breakeven Monthly Per-Space Cost of Structured Parking*

Project Cost	Annual Operating Cost Per Space					
Per Space	$150	$200	$250	$300	$350	$400
$ 18,000	$135	$140	$144	$148	$152	$156
$ 19,000	$142	$146	$151	$155	$159	$163
$ 20,000	$149	$153	$157	$162	$166	$170
$ 21,000	$156	$160	$164	$168	$173	$177
$ 22,000	$163	$167	$171	$175	$179	$184
$ 23,000	$170	$174	$178	$182	$186	$190
$ 24,000	$176	$181	$185	$189	$193	$197
$ 25,000	$183	$187	$192	$196	$200	$204

Monthly Revenue Per Space Needed

Rate: 6.50% Amortized Period: 25 Years

*Assumes at- and above-grade parking developed on a site geometrically suitable for an efficient parking structure.

Source: Walker Consultants

Transportation demand management (TDM) could also lessen demand for parking in the Market District, among other structural and social benefits. TDM is a collection of complimentary strategies and behavioral incentives that emphasize the movement of people and goods rather than the motor vehicle. It focuses on assisting people to make transportation decisions that include transit, ridesharing, shuttles, walking, biking, and other solutions or improvements and to reduce single-occupancy vehicle (SOV) trips and the parking infrastructure required to accommodate those trips.

Based on years of research, some of the most effective TDM strategies are related to Parking Pricing/ Policy, Commute Trips, and Land Use/Location. Limiting the parking supply typically results in a 5% to 12.5% reduction in vehicle miles traveled (VMT); unbundling parking results in a 3% to 13% reduction in VMT. Mandatory commute-trip reductions can result in a VMT reduction of 21%, and pricing workplace parking can reduce VMT by 20%. When a site provides a mix of land uses, good transit accessibility, and increased density, VMT reductions can reach 30%.

INTRODUCTION

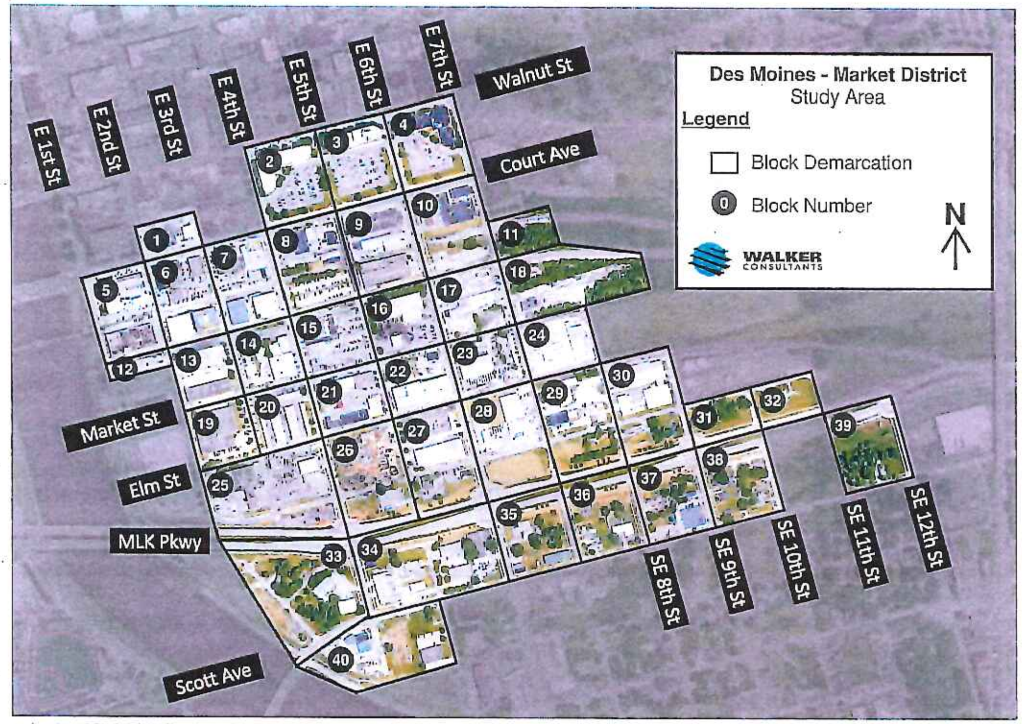
The purpose of this study was to provide an evaluation of the existing parking adequacy and to provide insight on how parking adequacy will change given forthcoming development projects in the Market District in Des Moines, IA. Walker estimated current parking supply using Google Earth images taken on June 15, 2017, and estimated future adequacy using data provided by HDR.

STUDY AREA

The study area was defined for the purpose of this analysis by the client as the geographical area generally bounded by Walnut Street to the north, East 1st Street to the west, Scott Avenue to the south, and extends beyond East 7th Street to the east, into currently under-developed areas. The boundaries of the defined study area included in this analysis are presented in the following figure. The area was broken into "blocks", for the purposes of the parking study, although not every block included in the map below is bounded by four streets.

There are restaurants and offices and other businesses along Court Avenue, and north of Court Avenue. The area south of Market Street has more warehouse and industrial businesses. Much of the parking available in the area is north of Market Street, and some blocks, particularly those south of Market Street and in the eastern area of the map, do not currently have any parking spaces.

Figure 1: Market District Study Area



Source: Walker Consultants

CURRENT CONDITIONS

PARKING INVENTORY AND OCCUPANCY

Parking inventory and occupancy were estimated using Google Earth images from Tuesday, June 15, 2017, and the images appear to have been taken during midday. When estimating parking adequacy, it is important to use typical peak parking demand conditions. The study area contains mostly workplaces, with a modest number of restaurants, and other retail businesses, relative to other areas near downtown Des Moines. Since the majority of parking demand in the area is likely generated by employee parking, it is reasonable to assume that the Google Earth images, which were taken on a weekday, represent approximately typical weekly peak parking demand.

When using satellite images to estimate inventory and occupancy, it is important to consider obstructions of parking in the area. The only discernable major obstructions of visibility were two covered parking facilities. One is a parking structure, on the corner of Elm Street and East 5th Street (Block 22 of the study area map), and the other is a covered parking lot between Market Street and Court Avenue, along East 3rd Street (Block 7). Because the parking spaces were not visible, neither parking facility was included in this analysis.

Walker estimated that the area contains approximately 235 on-street spaces, most of which are located in the northern area of the study area, and approximately 2,121 off-street spaces.

Table 1 presents on- and off-street parking estimated inventory and occupancy. The percent occupancy is highlighted with colors indicated the level of occupancy. The colors indicate the following levels:

- Green: 0 – 49% occupancy
- Yellow: 50 – 69% occupancy
- Orange: 70 – 84% occupancy
- Red: 85%+ occupancy

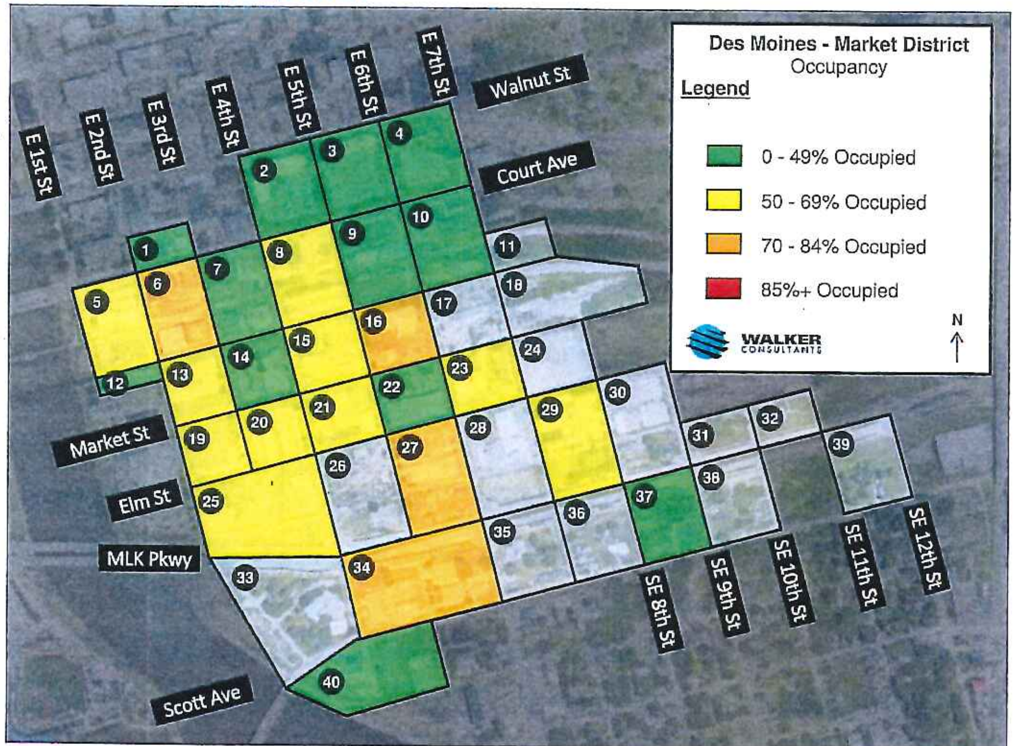
As Table 1 indicates, the total occupancy for the entire area observed using the Google Earth images was approximately 46 percent, which is an indication that, overall, parking in the Market District is generally available to meet demand. No blocks indicated a parking occupancy of 85 percent or greater, and only four blocks indicated parking occupancy of greater than or equal to 70 percent.

Table 1: Estimated Parking Inventory and Occupancy

	On-Street			Off-Street			Total
Block	Inventory	Occupancy	% Occ.	Inventory	Occupancy	% Occ.	% Occ.
1	19	5	26%	71	34	48%	43%
2	33	12	36%	184	87	47%	46%
3	17	7	41%	185	88	48%	47%
4	19	12	63%	116	27	23%	29%
5	46	26	57%				57%
6	22	9	41%	75	59	79%	70%
7	12	4	33%	73	31	42%	41%
8	14	9	64%	140	75	54%	55%
9	11	5	45%	151	30	20%	22%
10				161	21	13%	13%
12				61	20	33%	33%
13				144	74	51%	51%
14	6	0	0%	109	55	50%	48%
15	6	4	67%	57	36	63%	63%
16	3	3	100%	40	30	75%	77%
19				89	60	67%	67%
20				20	12	60%	60%
21	7	4	57%	20	12	60%	59%
22				87	35	40%	40%
23				67	34	51%	51%
25	20	12		92	52	57%	57%
27				15	11	73%	73%
29				20	11	55%	55%
34				72	56	78%	78%
37				37	15	41%	41%
40				35	15	43%	43%
Total	235	112	48%	2,121	980	46%	46%

Source: Walker Consultants, Google Earth

Figure 2: Estimated Parking Occupancy Map



Source: Walker Consultants

PARKING ADEQUACY

Parking adequacy is the difference between the number of available spaces and the number of spaces occupied by a vehicle. Walker evaluates demand within a parking system by applying an effective supply factor (ESF) to that supply's inventory, to include a buffer in the number of spaces available to account for spaces needing repair, maintenance to a parking facility, and misparked and oversized vehicles occupying more than one space. The determination of the effective supply factors for a parking system are informed by Walker's experiences with similar areas and the observations of field staff who collect the data. More spread out parking areas, like on-street parking, are typically assumed to have smaller effective supply since available spaces are not as easily recognized as in more condensed parking areas, like parking structures.

In this case, Walker assigned the following effective supply factors:

- 85 percent for all on-street parking spaces, and
- 90 percent for off-street parking facilities.

The following table presents the on- and off-street parking space inventory, the effective supply factor applied, and the parking adequacy based upon the difference between the effective supply and occupancy. As the table indicates, the estimated current parking adequacy of the study area was estimated as a surplus of approximately 1,017 spaces.

Table 2: Current Parking Adequacy

	Inventory	Effective Supply Factor	Effective Supply	Occupancy / Demand	Adequacy
On-Street	235	0.85	200	112	88
Off-Street	2,121	0.90	1,909	980	929
Total	2,356		2,109	1,092	1,017

Source: Walker Consultants

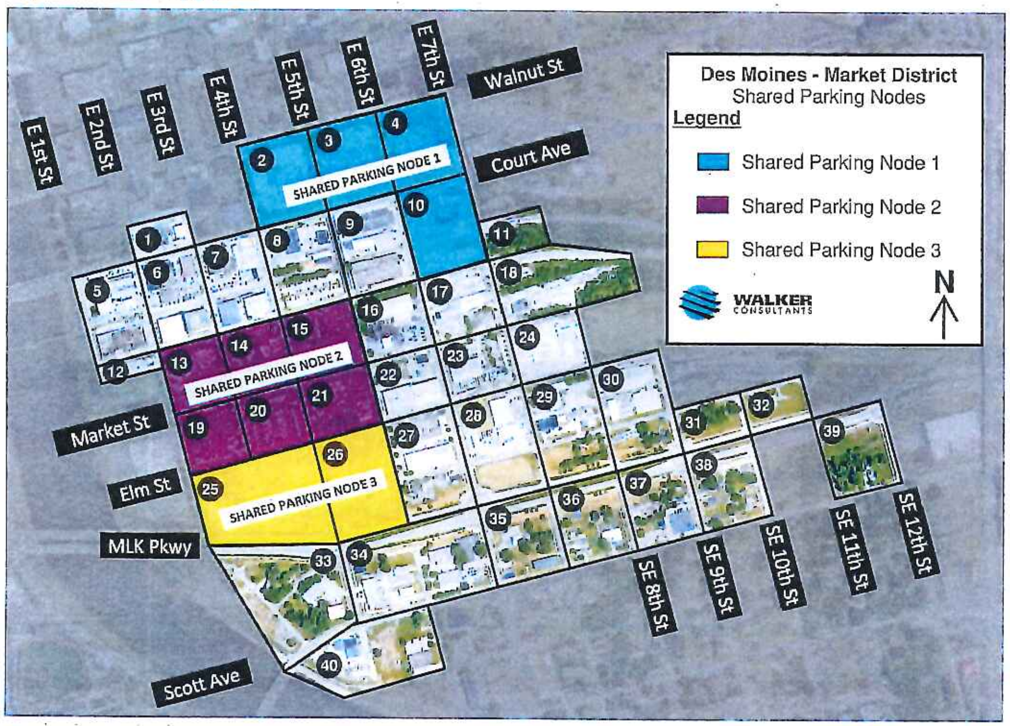
FUTURE CONDITIONS

Walker employed shared parking methodology, as well as base parking demand ratios from the Urban Land Institute (ULI) to estimate future demand, generated by the proposed developments in the Market District. The demand as discussed under Current Conditions was added to future demand generated by the developments to estimate future, overall demand for the Market District area.

Walker identified three areas where the proposed developments would be conducive to shared parking. These nodes included a mix of residential and/or office and retail/restaurant spaces, and were small enough areas for people to walk from one land use to another. The remaining residential and small amounts of retail/restaurant demand outside of these nodes was assumed to be unshared with other land uses.

Node 1 includes Blocks 2, 3, 4, and 10, Node 2 includes Blocks 13 through 15 and 19 through 21, and Node 3 includes Blocks 25 and 26. The three nodes are presented in the following map.

Figure 3: Shared Parking Nodes



Source: Walker Consultants

SHARED PARKING

Shared parking is the use of a parking space generated by more than one land use. Walker's model was developed and updated with data from our previous mixed-use development experience and surveys, along with data from the Urban Land Institute (ULI), the Institute of Traffic Engineers (ITE), and client-provided data. The model is designed to provide a reasonable recommended parking capacity to meet the parking needs of a mixed-use development during typical busy times.

To calculate the impact of shared parking, Walker modified the base demand ratios by several factors including a driving ratio, a non-captive factor, and presence factor. These factors were adjusted specifically for this project based upon local factors and past mixed-use research experience. A shared parking model generates 456 parking demand computations as follows:

- 19 hours during a day, beginning at 6 a.m. and concluding at 1 a.m.
- 2 days per week, a weekday and a weekend day
- 12 months of the year
- 19 x 2 x 12 = 456 different calculations

The recommended parking capacity is derived based on the highest figure generated from these 456 computations. Therefore, the intent is to design for the busiest hour of the year, busiest day of the year, and busiest month of the year, at an 85th percentile level relative to similar properties.

A shared parking analysis begins first by taking the land use quantities of the mixed-use project, e.g., number of hotel rooms, and multiplying by a base parking demand ratio and monthly and hourly adjustment factors. All base ratios and hourly and monthly adjustments are industry standards that are based on thousands of parking occupancy studies, vetted by leading parking consultants and real estate professionals, and documented within the Second Edition of ULI/ICSC's *Shared Parking*.

Walker, as the analyst for this particular study and in accordance with standard shared-parking methodology, applies two additional adjustments to the base parking demand ratios, one to reflect an estimate of the local transportation modal split (called the driving ratio) and another to account for the best estimate of captive market effects (called the non-captive ratio).

LAND USES

Walker utilized land use information provided by HDR. It is Walker's understanding that, with the exception of the office space in Blocks 2, 3, and 4, the land use numbers presented by HDR include only future additional buildings. To capture existing demand generated by land uses that are not included in HDR's land use figures, Walker added estimated current demand from current occupancy, which is described in the Current Conditions section.

The shared parking model uses gross leasable area (GLA) as opposed to gross floor area (GFA), which accounts for spaces like storage, restrooms, stairs, etc., in a building. Walker assumed a factor of 85 percent, to estimate GLA.

The residential units are planned to be, on average, about 1,000 square feet, so Walker assumed that half will be 1-bedroom units, and half will be 2-bedroom units. Of the "retail" space planned, Walker also assumed that half will be shopping retail spaces, and that half will be restaurant spaces.

The resulting land use assumptions utilized in the shared parking model are presented in the following table.

Table 3: Land Use Quantities

Land Use	Quantity	Unit
Node 1		
Retail Shopping	7,310	sf GLA
Fine Dining	3,655	sf GLA
Casual Dining	3,655	sf GLA
1-bedroom Residential	88	Units
2-bedroom Residential	88	Units
Office	127,500	sf GLA
Node 2		
Retail Shopping	29,793	sf GLA
Fine Dining	14,896	sf GLA
Casual Dining	14,896	sf GLA
1-bedroom Residential	318	Units
2-bedroom Residential	318	Units
Node 3		
1-bedroom Residential	210	Units
2-bedroom Residential	210	Units
Office	179,520	sf GLA
Unshared Parking Areas		
1-bedroom Residential	930	Units
2-bedroom Residential	930	Units
Misc. Retail	4,760	sf GLA
Misc. Fine Dining	2,380	sf GLA
Misc. Casual Dining	2,380	sf GLA

Source: Walker Consultants and HDR

BASE DEMAND RATIOS

Simply put, the base parking demand ratios represent how many spaces should be supplied to each use if the spaces are unshared, and the project is located in a suburban context where the driving ratio is at or near 100 percent. The base parking generation rates employed are rates taken verbatim from the Second Edition of ULI *Shared Parking*, and informed by thousands of field parking occupancy studies performed by dozens of parking and transportation professionals over decades. These ratios have been vetted by a team of consultants who specialize in parking demand analyses and who mutually agreed upon the use of these ratios prior to the publication of the Second Edition of *Shared Parking*.

The base demand ratios employed are presented below. The residential ratio represents a proportionally blended ratio of one- and two-bedroom units, as does the retail/restaurant employees ratio.

Table 4: Base Demand Ratios

Land Use	Base Ratio	
Retail Shopping	2.90	/ ksf GLA
Fine Dining	15.25	/ ksf GLA
Casual Dining	12.75	/ ksf GLA
Retail / Restaurant Employees	1.60	/ ksf GLA
Residential	1.63	/ Unit
Office	3.15	/ ksf GLA

Source: Walker Consultants

PRESENCE FACTORS

After the Project's land uses have been quantified and standard base parking generation ratios have been applied to these land use quantities, adjustments are made to account for parking demand variability by hour of day and month of year. This is referred to as a "presence" adjustment. Presence is expressed as a percentage of peak potential demand modified for both time of day and month of the year. The fact that parking demand for each component may peak at different times generally means that fewer parking spaces are needed for the project than would be required if each component were a freestanding development.

In this case, each of the three nodes resulted in a peak demand at different times of the day. Node 2 peaked in the evening hours. As it was discussed in the Current Conditions section, Walker estimates that the current demand in the area likely peaks during the daytime, when people have driven to the area for work. Therefore, adding 100 percent of current demand in Node 2 would likely not be the most accurate method, since many of the vehicles counted during the daytime would not be parked in the area in the after-work hours. As such, Walker added 50 percent of demand from the Node 2 blocks to the overall future demand for the area.

Since the other modes peaked during typical working hours, the remaining blocks were assumed to be unshared, 100 percent of current demand was added to the overall future demand in these areas.

DRIVING RATIO ADJUSTMENT

The driving ratio adjustment is the percentage of total visitors and employees that are projected to arrive to the mixed-use development by a personal vehicle, expressed as a ratio. This ratio excludes visitors arriving using means other than a single-occupancy vehicle, like a shuttle bus, charter bus, walking, biking, and carpooling.

Walker's employee driving ratio was based upon US Census data for Des Moines.[1] The data, from 2016, reports that 80.3 percent of employees drove alone to work in Des Moines, and that 10.4 percent carpooled. Assuming two individuals per carpooling vehicle, Walker assumed an employee drive ratio of 85.5 percent.

For retail/restaurant patrons and residents, Walker assumed higher drive ratios than the employee drive ratios. This assumption was shaped by the "walk score" for Des Moines.[2] The walk score "measure walkability on a scale from 0 – 100 based on walking routes to destinations such as grocery stores, schools, parks, and restaurants." While some areas in Des Moines have a higher walk score, like the CBD area west of the Market

[1] https://datausa.io/profile/geo/des-moines-ia/
[2] https://www.walkscore.com/IA/Des_Moines

District area which has a score in the 70 – 89 range in which "most errands can be accomplished on foot," the Market District area's walk score is currently in the 0 – 49 range in which "almost all" or "most" errands require a car, and walk scores are particularly low in the areas south of Court Avenue. While the Market District area will be more walkable once the developments are completed, the overall city of Des Moines walkability is scored as 45, so residential drive ratios were assumed to be higher than retail and restaurant patrons. Walker assumed a residential drive ratio of 95 percent, and a retail and restaurant patron drive ratio of 90 percent.

NON-CAPTIVE RATIO ADJUSTMENT

A shared parking analysis recognizes that people often visit two or more land uses housed within the same development site, without increasing their on-site parking use. For example, an office employee who dines at an on-site restaurant, and arrived by automobile creates parking demand for one, not two parking spaces. A non-captive ratio allows for an adjustment to the parking needs analysis by taking into account the portion of on-site visitors who are already accounted for as primary land use demand and are therefore not creating additional parking demand.

Non-captive ratios can vary from one property to the next and from one function to the next within the same property. The non-captive ratios included herein are intended to be reasonable and appropriate adjustments.

Residents were assumed to be 100 percent captive to the residential land uses, and service employees were also assumed to be 100 percent captive. Ordinarily, office employees would be considered as 100 percent captive as well, but since over 3,000 new residential units are planned to be added to the Market District area, it was assumed that 5 percent of office employees would reside in these units, so the non-captive ratio assumed for office employees was 95 percent.

The non-captive ratio for retail and restaurant uses were assumed to be lower, since a portion of patrons would come from their homes and offices to visit these uses. During day time hours, it was assumed that 60 percent of retail and restaurant patrons would be captive, meaning that 40 percent of their business was assumed to come from employees and residents, since the bulk of demand in the area would be from residents and office employees. In the evening hours, when residents would be home for the evening, it was assumed that 30 percent of retail and restaurant patrons would be captive.

FUTURE ADEQUACY

Walker estimated future parking supply using the future development plans presented by HDR and adding in the existing lots that will remain. Similarly, future demand was estimated using the methods described above, while existing demand, generated by buildings that are planned to remain, was added to the future demand.

HDR has plans to add surface parking, garage parking, and on-street spaces to the Market District area. There are some existing surface lots which were not included in HDR's total parking space plans because the buildings associated with the lots are not planned to change. Walker identified these lots and counted the inventory and added the figure (374 spaces) to HDR's planned parking spaces to estimate the total future supply. The future supply, across the three nodes and the unshared parking blocks is presented in the following table. In total, the planned supply would be approximately 7,274 spaces.

Table 5: Future Proposed Supply

Area	Supply*
Node 1	
Garage Spaces	540
Surface Lot Spaces	323
On-Street Spaces	163
Total	1,026
Node 2	
Garage Spaces	1,194
Surface Lot Spaces	130
On-Street Spaces	164
Total	1,488
Node 3	
Garage Spaces	1,490
Surface Lot Spaces	-
On-Street Spaces	73
Total	1,563
Unshared Spaces	
Garage Spaces	989
Surface Lot Spaces	1,411
On-Street Spaces	797
Total	3,197
Total Spaces	7,274

***Supply includes a total of 374 existing surface lot spaces not included in HDR's plans.**

Source: Walker Consultants

The following table presents a summary of the shared parking assumptions and the estimated future parking adequacy both in aggregate and across the three nodes and the unshared parking blocks. The shared parking models for the three nodes all estimate that parking demand will peak at different times on a weekday. Existing demand, represented by observed occupancy of on- and off-street spaces, was added to estimated future demand (based upon the estimated occupancy of buildings to remain), but since Node 2 peaks at 7:00 PM on a weekday, only 50 percent of existing demand was added since the area likely sees peak demand during the daytime, working hours currently.

Table 6: Estimated Future Adequacy

	Quantity	Base Ratio	Drive Ratio	Non-Captive Ratio	Peak Hour Factor	Demand
Node 1: 2:00 PM Weekday Demand Peak						
Retail Shopping	7,310	2.90 / ksf GLA	90%	60%	100%	11
Fine Dining	3,655	15.25 / ksf GLA	90%	60%	65%	20
Casual Dining	3,655	12.75 / ksf GLA	90%	60%	90%	23
Retail / Restaurant Employees	14,620	1.60 / ksf GLA	86%	100%	95%	19
Residential	176	1.63 / Unit	95%	100%	70%	191
Office	127,500	3.15 / ksf GLA	86%	95%	100%	326
Existing Demand					100%	15
Subtotal Demand						605
Subtotal Effective Supply						1,027
Subtotal Adequacy						422
Node 2: 7:00 PM Weekday Demand Peak						
Retail Shopping	29,793	2.90 / ksf GLA	90%	30%	75%	17
Fine Dining	14,896	15.25 / ksf GLA	90%	30%	100%	61
Casual Dining	14,896	12.75 / ksf GLA	90%	30%	80%	41
Retail / Restaurant Employees	59,585	1.60 / ksf GLA	86%	100%	95%	77
Residential	635	1.63 / Unit	95%	100%	97%	954
Existing Demand					50%	69
Subtotal Demand						1,220
Subtotal Effective Supply						1,488
Subtotal Adequacy						268
Node 3: 10:00 AM Weekday Demand Peak						
Residential	420	1.63 / Unit	95%	100%	75%	488
Office	179,520	3.15 / ksf GLA	86%	95%	100%	459
Existing Demand					100%	12
Subtotal Demand						959
Subtotal Effective Supply						1,563
Subtotal Adequacy						604
Unshared Parking Demand						
Remaining Residential	1,860	1.63 / Unit	95%	100%	100%	2,880
Misc. Retail	4,760	2.90 / ksf GLA	90%	60%	100%	7
Misc. Fine Dining	2,380	15.25 / ksf GLA	90%	60%	100%	20
Misc. Casual Dining	2,380	12.75 / ksf GLA	90%	60%	100%	16
Misc. Retail / Rest. Employees	9,520	1.60 / ksf GLA	86%	100%	100%	13
Existing Demand					100%	400
Subtotal Demand						3,337
Subtotal Effective Supply						3,197
Subtotal Adequacy						(140)
Total Demand						6,120
Total Effective Supply						7,275
Total Adequacy						1,155

Source: Walker Consultants

The table indicates that the total Market District area, based on the assumptions described throughout this report, would experience a parking surplus of approximately 1,155 spaces. However, much of the surplus is centered around the Node 3 area (a surplus of approximately 604 spaces), which includes blocks 25 and 26, while the unshared areas would experience a parking deficit of approximately 140 spaces. HDR may wish to consider both reducing the planned parking supply in Nodes 1 and 3 and increasing parking supply in the unshared parking blocks, especially to accommodate existing demand.

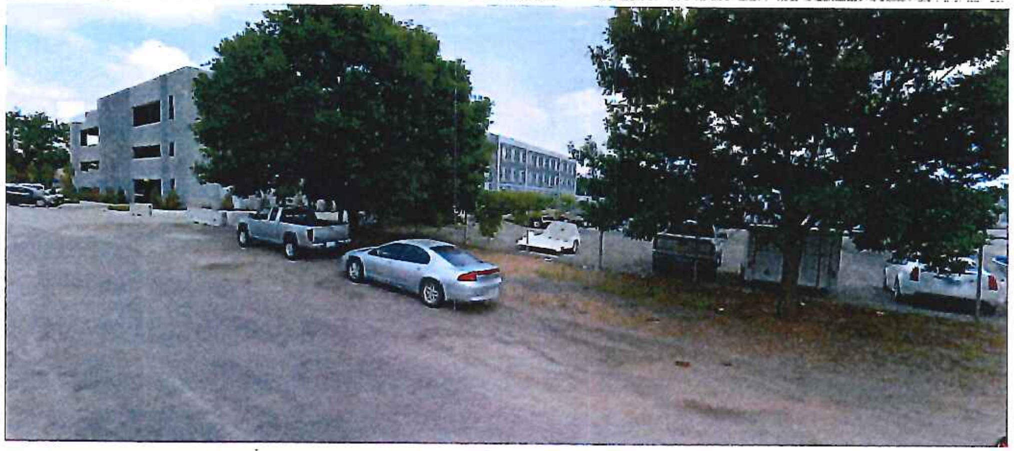
PARKING ALTERNATIVES

Walker and HDR worked to develop the planned parking for the Market District area. HDR's plans include structured parking, surface parking, and on-street parking.

PROPOSED PARKING SUPPLY

HDR has planned to build out on-street parking spaces on every block. Many blocks do not currently have designated on-street parking spaces. Vehicles park on the sides of wide streets, but in some areas there is not a clear curb, and there is no signage or paint visually designating on-street parking.

Figure 4: Current On-Street Parking

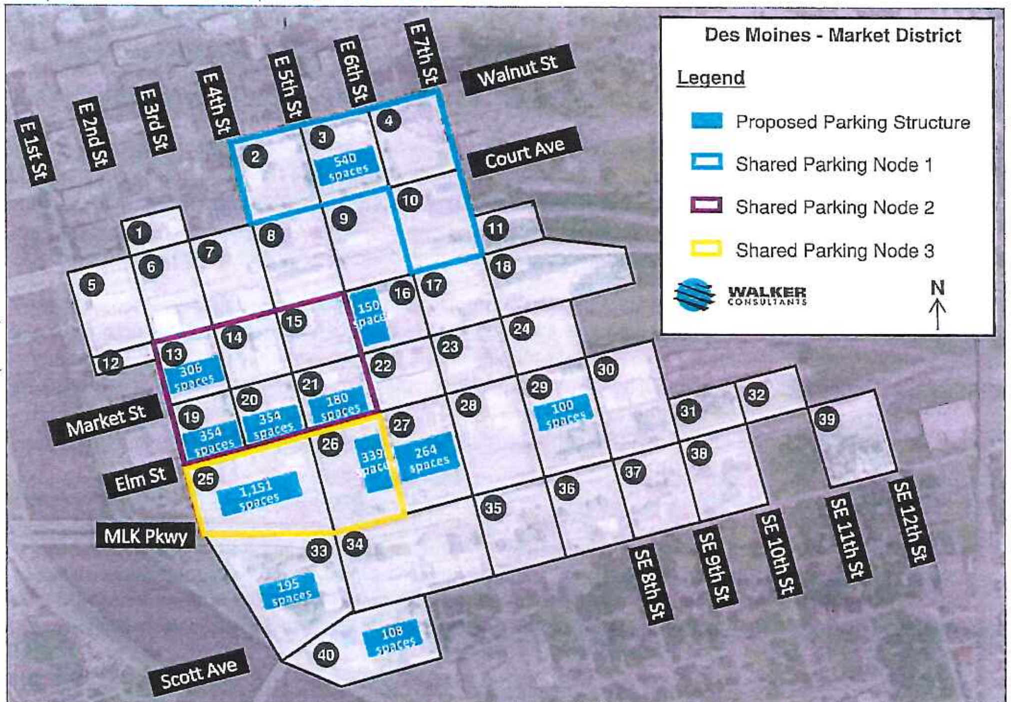


Source: Google Earth, 2018 (Near the corner of 5th St. and Racoon St.)

The addition of designated on-street parking in the area will increase the parking supply and serve as a buffer for pedestrians from street traffic. In total, Walker counted approximately 235 on-street spaces, currently. HDR's plans include a total of 1,197 on-street parking spaces in the area.

HDR has planned to include structured parking on 23 of the Market District area blocks. The locations of parking structures with capacities of at least 100 spaces are included in the following map. In total, including parking structures with smaller capacities, HDR has proposed adding 4,213 structured spaces to the area.

Figure 5: Proposed Parking Structures (With at least 100 spaces)



Source: Walker Consultants and HDR

As the map shows, many of the larger parking structures are centered in or near the three shared parking nodes. Based upon the future demand projections discussed earlier in Table 6, HDR may wish to consider reducing proposed supply, particularly in nodes 1 and 3, and increasing supply in the unshared parking areas with a large number of proposed residential units, and smaller quantities of proposed parking, like Blocks 28, 30, and 34. Similarly, Blocks 5 through 9 totaled approximately 235 occupied spaces, currently, that will impact future demand, and are blocks with proposed additional residential units.

COST OF PARKING

Walker generally estimates that surface parking costs approximately $4,000 - $5,000 per space and that at- and above-grade structured parking costs at least $15,000 - $20,000 per space (but can be more, depending on factors like the façade), not including land costs. Soft costs, including financing, engineering fees, etc. are typically about 25 percent of capital costs.

Parking, particularly parking garages, also include operating costs which includes maintenance, cleaning, staffing, supplies, insurance, etc. The following table presents estimated breakeven monthly, per-space costs for structured parking. As the table indicates, on the lowest end of the cost spectrum, the monthly per-space breakeven cost is $135, and on the highest end it is $204.

Table 7: Breakeven Monthly Per-Space Cost of Structured Parking*

Project Cost Per Space	Annual Operating Cost Per Space $150	$200	$250	$300	$350	$400
$ 18,000	$135	$140	$144	$148	$152	$156
$ 19,000	$142	$146	$151	$155	$159	$163
$ 20,000	$149	$153	$157	$162	$166	$170
$ 21,000	$156	$160	$164	$168	$173	$177
$ 22,000	$163	$167	$171	$175	$179	$184
$ 23,000	$170	$174	$178	$182	$186	$190
$ 24,000	$176	$181	$185	$189	$193	$197
$ 25,000	$183	$187	$192	$196	$200	$204

Monthly Revenue Per Space Needed

Rate: 6.50% Amortized Period: 25 Years

*Assumes at- and above-grade parking developed on a site geometrically suitable for an efficient parking structure.
Source: Walker Consultants

Even the best designed and constructed parking structures require maintenance and repairs throughout the life of the structure. Different structure types require different levels of maintenance throughout the life of the structure. For example, precast structures require significantly more sealant repair/replacement over the expected service life of the structure compared to a similarly-maintained cast-in-place structure. Expansion joints and sealants have limited life spans and need to be replaced periodically to prevent moisture intrusion within the structure.

The lack of maintenance and timely repair can significantly impact the service life and maintenance cost of the structure. Poorly maintained structures result in costly repairs as compared to a well-maintained structure. Many property owners tend to grossly underestimate the structural maintenance cost and do not budget adequately for, or implement corrective actions in a timely manner to cost-effectively extend the service life of the structure. The cost of regularly scheduled maintenance is relatively small considering the comparatively high expenditures associated with the failure to perform proper maintenance on a timely basis.

To maximize the life of a parking structure and to minimize total life-cycle costs, Walker highly recommends that sufficient funds be set-aside on a regular basis to cover structural maintenance and repairs. We recommend that a minimum of one percent of initial capital costs be reserved annually and adjusted each year to cover inflationary costs, and be placed in a sinking fund. Once a sinking fund is established, contributions to this fund can accumulate over time, and be made available to cover maintenance and structural repairs, as required.

In general, Walker recommends charging for parking, and to be especially aware of the rate when structured parking is part of the system. Many owners do not recover the true cost of parking in revenues, and as is often the case, owners charge for on-street and surface lot parking to help recover some of the costs of structured parking.

TRANSPORTATION ALTERNATIVES

As the Market District development projects come to fruition, it will continue to grow in popularity and become more and more of a destination and neighborhood for employees and residents in the surrounding community.

This chapter introduces the concept of transportation demand management (TDM), identifies how TDM is successful, and outlines the benefits of TDM. The TDM strategies aim to accommodate the proposed changes occurring within the Market District area, minimize the demand for on-site parking, and enhance the transportation experience of all users.

TRANSPORTATION DEMAND MANAGEMENT (TDM)

TDM is a collection of complimentary strategies and behavioral incentives that emphasize the movement of people and goods rather than the motor vehicle. It focuses on assisting people to make transportation decisions that include transit, ridesharing, shuttles, walking, biking, and other solutions or improvements and to reduce single-occupancy vehicle (SOV) trips and the parking infrastructure required to accommodate those trips. TDMs focus is on the people that will be accessing the site and the alternative ways in which they could do so. Often, substantial subsidies, in the form of free/available parking and federal and local investments in roadways, allow driving to be the most convenient option. TDM strategies propose a range of possible transportation incentives for the Market District that could optimize several different modes and counterbalance subsidies. This methodology is intended to create a more balanced transportation system that provides the best access and mobility for all users.

Simply providing options within the transportation system is the start of the TDM process; developing a desire by travelers to use the services is the logical next step to managing traffic. TDM is a much more cost-effective strategy than trying to build a system to meet peak travel or parking demands, and it creates significantly fewer community and environmental impacts. TDM strategies often require some tradeoffs between personal travel freedom and greater network efficiency or utilization.



BENEFITS OF TDM

There are many important, interrelated benefits of reducing the number of cars on the roadway and the number of vehicle miles traveled (VMT). There are transportation system benefits, social benefits, environmental benefits, health and safety benefits, and financial benefits.

Transportation System Benefits

- Reduced congestion and resultant time savings
- Multiple options for getting around

Social Benefits

- Enhanced quality of life in walkable, bikeable communities with many transportation options
- Reduced community fragmentation caused by wide, high-speed roads

Environmental Benefits

- Allow for and promote the revitalization and redevelopment of historical buildings
- Improved air quality
- Reduced greenhouse gas emissions
- Improved water quality

Health and Safety Benefits

- Fitness benefits of active transportation (biking and walking)
- Health benefits of improved air quality
- Stress reduction

Financial Benefits

- Reduced costs of car ownership and maintenance
- Reduced cost of parking for both developers and tenants

TDM provides a multitude of options for users to access a site and promotes a mode shift away from the SOV. In providing these options, roadways can be used more efficiently, and impacts to these networks can be lessened. TDM strategies that offer transportation choices are often considered a site amenity by users and visitors. Walkability, proximity to transit, bicycle facilities, and bikeshare/ carshare enhance convenience and provide several transportation options to those that do not have to drive.

HOW TDM WORKS

TDM is most effective when supported and implemented by both the public and private sector through a coordinated effort to reduce vehicle trips to a specific area such as the Market District. A shift from automobile trips to other transportation modes may result in the reduction of VMT by employees, visitors, and residents. TDM is also most effective when multiple strategies are implemented together as part of a package of transportation options for end users.

Ongoing monitoring is also a key element in the success of a TDM plan. The TDM Plan can be focused to encourage lower VMT, reduce greenhouse gas emissions, lower rates of SOVs, and reduce parking demand depending upon the goals of the project.

TDM strategies are often classified into six different categories:

- **Land Use/Location** - sites located in urban environments with higher densities and a mix of uses (see examples on the left), with grid roadway systems, in proximity to local attractions, and with access to transit are more successful when implementing TDM programs.
- **Neighborhood Site Enhancements** – physical and/or programmatic improvements can enhance pedestrian, bicyclist, and carshare experiences.
- **Parking Pricing** – use of management strategies that correlate parking supply and cost.
- **Transit System** – improvements can increase accessibility of transit: expansion, frequency, and proximity.
- **Commute Trips** – incentives offered by employers may reduce SOV commute trips: transit fare subsidies, alternative work schedules, employer-sponsored vanpools/shuttles, and ride-share programs.
- **Marketing/Promotions** – education provides real-time information regarding transportation options.

Depending on the project, a TDM plan can incorporate elements from one, several, or all of these categories. Most of the strategies are considered incentives rather than disincentives, and the responsibility for implementation is often a collaboration between the private and public sectors.

TDM IMPACTS

TDM has been proven to reduce the impacts on the physical transportation infrastructure, air quality, energy use, and travel costs, while still preserving mobility. There is extensive peer-reviewed research related to TDM strategies. The California Air Pollution Control Officers Association Quantifying Greenhouse Gas Mitigation Measures[3] report provides a comprehensive overview of most of the available literature and identifies TDM strategies and their effectiveness in VMT reduction.

Based on years of research, some of the most effective TDM strategies are related to Parking Pricing/ Policy, Commute Trips, and Land Use/Location. Limiting the parking supply typically results in a 5% to 12.5% reduction in VMT; unbundling parking results in a 3% to 13% reduction in VMT. Mandatory commute-trip reductions can result in a VMT reduction of 21%, and pricing workplace parking can reduce VMT by 20%. When a site provides a mix of land uses, good transit accessibility, and increased density, VMT reductions can reach 30%.

[3] http://www.aqmd.gov/docs/default-source/ceqa/handbook/capcoa-quantifying-greenhouse-gas-mitigation-measures.pdf

In addition, several cities and large projects in the United States have implemented successful TDM programs with measurable success.

Aspen, Colorado – Aspen implemented transit as a TDM strategy in the 1970s and launched a more formal program with paid parking in the mid-1990s. Traffic volumes across the Cripple Creek Bridge into town have remained below 1998 volumes, largely due to the city's TDM program. This is true even during the multiple events throughout the year that draw hundreds of out-of-town visitors. New development projects in Aspen are required to implement TDM strategies that result in zero net new vehicle trips.

Barclays Center, Brooklyn, New York – In 2012, the Barclays Center, both an active year-round event center and home to the Brooklyn Nets, implemented a holistic TDM program. This program reduced overall auto mode share by 8% and resulted in a 20% reduction in peak hour auto trips. Initiatives included enhanced transit service on New York City Transit (NYCT) and the Long Island Rail Road (LIRR), preferred parking for carpools, parking supply limits, and targeted marketing programs.

Boulder, Colorado – The City of Boulder requires a TDM plan be completed and implemented for every development within the city. The City currently realizes approximately 20-percent fewer vehicle trips due to their TDM program and the multimodal transportation options available. Increases in the demand for transit and an increase in transit service create a positive-feedback loop.

CenturyLink Field, Seattle, Washington – Home to the Seattle Seahawks, the CenturyLink Field complex also serves as a concert and multipurpose event venue. In 2002, the complex implemented a Transportation Management Program (TMP) that ultimately reduced auto mode share from over 80% to 57%. Interventions included hiring a transportation manager to implement TMP strategies, a shuttle program to park-and-ride lots, and improvements to pedestrian and bicycle amenities.

Prudential Center, Newark, New Jersey – The Prudential Center in Newark hosts about 200 events per year and is also home to the New Jersey Devils. After years of car-centric transportation planning, the Center implemented a TDM program in 2010 which doubled transit ridership. Interventions included dedicated transit ambassadors, special discounts and passes for event attendees and signage and wayfinding to park-and-ride locations.

In summary, the aforementioned strategies can help manage demand on the transportation network, and be designed to make it easier for new residents, tenants, employees, and visitors to get around by sustainable travel modes such as public transit, walking, and biking, by implementing and supporting TDM strategies. Without TDM strategies, mobility options would be limited, a less efficient transportation system would be realized, and the demand for parking in the Market District would be higher.

Some key points to maintain as TDM takeaways are listed below:

- TDM policies are proven to be generally effective in encouraging multi-modal transportation choices in other cities across the country.
- The cost to implement moderate TDM policies is much lower than the cost to develop and operate a comparable amount of on-site parking and access infrastructure.
- TDM programs encourage a range of transportation options, many of which are well positioned to respond to changes in demand as the transportation industry evolves. Major industry disruptors such as the impact of TNCs (e.g., Uber and Lyft) and possible future changes due to autonomous vehicles are two possible factors to consider.
- Though not an option for all patrons, multi-model options are likely appealing to some percentage of residents and visitors.

APPENDIX I – STATEMENT OF LIMITING CONDITIONS

This report is subject to the following limiting conditions:

1. This report is based on assumptions outside the control of Walker Parking Consultants/Engineers, Inc. ("Walker") and/or our client. Therefore, Walker cannot guarantee the results.
2. The results and conclusions presented in this report may be dependent on assumptions regarding the future local, national, or international economy. These assumptions and resultant conclusions may be invalid in the event of war, terrorism, economic recession, rationing, or other events that may cause a significant change in economic conditions.
3. Walker assumes no responsibility for any events or circumstances that take place or change subsequent to the date of this report.
4. Walker is not qualified to detect hazardous substances or environmental matter, has not considered such, and therefore urges the client to retain an expert in this field, if relevant to this study.
5. Sketches, photographs, maps and other exhibits included herein may not be of engineering quality or to a consistent scale, and should not be relied upon as such.
6. All information, estimates, and opinions obtained from parties not employed by Walker, are assumed to be accurate. We assume no liability resulting from information presented by the client or client's representatives, or received from any third-party sources.
7. All mortgages, liens, encumbrances, leases, and servitudes have been disregarded unless specified otherwise. Unless noted, we assume that there are no encroachments, zoning violations, or building violations affecting the subject properties.
8. This report is to be used in whole and not in part. None of the contents of this report may be reproduced or disseminated in any form for external use by anyone other than our client without our written permission.
9. The projections presented in the analysis assume responsible ownership and competent management. Any departure from this assumption may have a negative impact on the conclusions.

Draft Cultural Resources Technical Memorandum

Date: Friday, December 28, 2018

Project: Des Moines Market District Master Plan

To: City of Des Moines

From: HDR Engineering, Inc.

Subject: Cultural Resources Review

Information regarding cultural resources in the Des Moines Market District Master Plan (Study) area were collected from the I-Sites Database of the Iowa Office of the State Archaeologist Geographic Information Services. The database includes geospatial and metadata information on previously identified archaeological sites and historic building and structures. Information from the I-Sites database was retrieved and compiled into tabular and geospatial formats. Metadata information contained site numbers, site type or name, addresses, National Register of Historic Places (NRHP) eligibility or listing status, and geospatial data. Due to federal regulations regarding confidentiality of archaeological site locational information, archaeological sites are not displayed in publicly available documents, including the maps in this Study. Data regarding NRHP eligibility status in I-Sites is not always updated and many of the sites and resources in the Study area are listed as unevaluated. Attempts were made to determine the official status of those resources through confirmation of the associated survey report and/or site forms and the Iowa SHPO database which records the official determinations of eligibility. If inventory forms in the SHPO database contained a SHPO determination it was updated, otherwise the status was left as Unevaluated. Additionally, information on locally designated resources was provided by the Des Moines Planning and Urban Design Division of the Community Development Department.

The following sections include a summary of the previously identified archaeological sites and architectural resources in the Study area, along with information and recommendations regarding the consideration of cultural resources for planning and future redevelopment in the Study area.

Archaeological Resources

Six previously identified archaeological sites were found in the Study area and are summarized below in Table 1.

Table 1. Archaeological Sites in the Study Area.

Site Number	Site Type/Name	NRHP Status
13PK860	Historic Dump-Urban Fill	Not Eligible
13PK861	Historic Gas Production Plant	Not Eligible

13PK917	Historic Farm/Residence	Unevaluated
13PK944	Historic Chicago, St. Paul and Kansas City Railway Bridge	Unevaluated
13PK990	Historic Dump	Unevaluated
13PK1051	Historic Scatter	Unevaluated

Of the unevaluated sites, 13PK917 is located where a parking lot is presently and is assumed to be destroyed; 13PK944, the Chicago, St. Paul and Kansas City Railway Bridge is not extant; 13PK990 was evaluated by the Office of State Archaeologist in 2013 and recommended Not Eligible; and 13PK1051 was evaluated in 2017 by Quality Services, Inc. and recommended Not Eligible.

Architectural Resources

Sixty-four (64) architectural or built resources were found in the I-Sites database. The Study area also includes two historic districts—the Civic Center Historic District's east boundary extends into the west side of the survey area and the Des Moines Industrial Historic District is located at the north end of the Study area. Of the 64 resources, seven (7) are in the Civic Center District boundary, thirty-five (35) are in the Industrial District boundary, and two (2) are in both district boundaries. Of the remaining 20 resources, 7 are Eligible for or Listed in the NRHP or designated a local landmark, 7 are Not Eligible, and 6 are Unevaluated. Table 2 includes the two NRHP-listed historic districts, NRHP-listed properties that are not bridges or railroads, and NRHP-Eligible properties that are not bridges or railroads. A full list of architectural resources, including those contributing or non-contributing to either of the historic Districts is found in the Appendix.

Table 2. National Register Eligible or Listed Properties in the Study Area.

Property Number	Property Name/Type	Address	NRHP Status
77-01703	Civic Center Historic District	District	Listed
	East Des Moines Industrial Historic District	District	Listed
77-03117	House	400 SE 6th St	Eligible
77-03249	International Harvester Company of America Building	217 E 7th St	Eligible
77-07376	Sun Oil Company	710 Raccoon St	Eligible
77-07484	Roadside Settlement House	620 Scott Ave	Eligible
77-10422	Gas Station	601 SE 6th St	Eligible
77-03794	Southeast Water Trough	SE 10th St	Local Landmark
77-06076	Des Moines Western Railway Freight House	625 E Court Ave	Listed

Conclusions and Recommendations

The National Register of Historic Places (NRHP) is the official list of the Nation's historic properties deemed significant and worthy of preservation. NRHP listing for individual properties and those within a historic district is largely an honorary designation. However, projects with federal agency involvement (funding, permits, etc.) would require the federal agency to comply with Section 106 of the National Historic Preservation Act to consider the effects to historic properties (archaeological sites, buildings, structures, objects, or districts eligible for or listed in the NRHP). Individually listed properties and properties contributing to a NRHP-listed historic district are also eligible for a federal historic preservation tax credit of 20% of qualified expenses. To qualify for the tax credit, the property must be NRHP-listed (individually or contributing to a district), an income-producing property, and the rehabilitation work must meet the Secretary of the Interior's Standards for Rehabilitation.

Iowa has a state tax credit of 25% for rehabilitation of historic properties through the Historic Preservation and Cultural and Entertainment District Tax Credit Program, administered by the Iowa Economic Development Authority (IEDA). The state tax credit follows the federal tax credit parameters, but with a few important differences. Qualifying properties must be listed in the NRHP as an individual property or contributing to a district or must be determined Eligible for listing in the NRHP by the Iowa State Historic Preservation Office. Other qualifying properties include those designated as local landmarks by city or county ordinance or a barn either listed in or eligible for listing in the NRHP or constructed before 1937. Commercial or non-commercial properties both qualify for the tax credit, but the rehabilitation must be "substantial" (rehabilitation expenses must be greater or equal to $50,000 or 50% of building value for commercial, $25,000 or 25% for non-commercial). The state credit is only available to an eligible taxpayer, the fee simple owner of the property or an entity with a long-term lease.

While NRHP eligibility or listing places no restrictions on a property (beyond those summarized above for federal agencies), Des Moines does have a local ordinance for designating local landmarks and historic districts. The Des Moines Historic Preservation Commission is responsible for making recommendations to City Council on proposals for designation of historic districts and amendments to existing districts. Within locally designated districts, the Commission reviews applications for Certificates of Appropriateness for development or rehabilitations. Presently, there are no locally designated districts within the Study area.

Other properties in the Study area may be identified as significant for history or architecture through survey and inventory and deemed eligible for listing in the NRHP or as a local landmark or district.

APPENDIX

Property Number	Property Name/Type	Historic District	Address	NRHP Status	UTM Easting	UTM Northing	Notes
77-01703	Civic Center Historic District	Civic Center	Des Moines River, Center St Dam to Scott Ave Dam, Incl. Both Banks	Listed			need polygon sketched
77-01813	Sioux Planting Company	East Des Moines Industrial	309 E Walnut St	Contributing	448914	4604221	23C
77-01817	Building	East Des Moines Industrial	223 E Walnut St	Contributing	448856	4604209	21C
77-01818	Hawkeye Tire Company	East Des Moines Industrial	215 E 3rd St	Contributing	448896	4604164	08C
77-01819	Pitt Carriage Works	East Des Moines Industrial	212 E 3rd St	Contributing	448862	4604141	07C
77-01820	Globe Hoist Manufacturing Company	East Des Moines Industrial	215 E 2nd St	Contributing	448797	4604141	04C
77-01822	Eagle Iron Works	East Des Moines Industrial	301 E Court Ave	Contributing	448930	4604065	28C
77-02634	River Walls	Civic Center	n/a	Listed	448645	4604027	
77-02635	West Riverfront Park and East Riverfront Park	Civic Center	n/a	Listed	448648	4604112	
77-02729	House		467 SE 2nd St	Unevaluated	449026	4603504	
77-02771	Advance-Rumley Thresher Company Warehouse	East Des Moines Industrial	130 E 3rd St	Contributing	448911	4603958	06C
77-02873	Commercial Building		SE 4th St	Unevaluated	449182	4603524	
77-02874	Commercial Building		SE 4th St	Unevaluated	449198	4603500	
77-02876	Central Oil Works	East Des Moines Industrial	118 SE Fourth St	Contributing	449047	4603877	13C
77-02962	Railroad Depot	East Des Moines Industrial	120 E 5th St	Contributing	449122	4604056	14C
77-02970	Sanico Ornamental Iron Company		401 SE 5th St	Unevaluated	449259	4603667	
77-03117	House		400 SE 6th St	Eligible	449348	4603690	
77-03119	Building		511 SE 6th St	Unevaluated	449410	4603580	
77-03249	International Harvester Company of America Building		217 E 7th St	Eligible	449378	4604241	
77-03390	House		400 SE 8th St	Unevaluated	449581	4603753	
77-03537	House		403 SE 9th St	Unevaluated	449738	4603785	
77-03538	House		406 SE 9th St	Unevaluated	449694	4603766	
77-03539	House		410 SE 9th St	Unevaluated	449696	4603755	
77-03794	Southeast Water Trough		SE 10th St	Listed	449904	4603640	Local
77-06061	River Embankment	Civic Center	Court Ave	Unevaluated	448665	4603994	
77-06064	Court Avenue Bridge	Civic Center	Court Ave	Listed	448591	4604002	
77-06076	Des Moines Western Railway Freight House		625 E Court Ave	Listed	449340	4604173	
77-06078	Building	East Des Moines Industrial	208 E Court Ave	Unevaluated	448839	4604042	15C
77-06079	National Biscuit Company Warehouse and Office	East Des Moines Industrial	219 E Court Ave	Contributing	448866	4604059	27C
77-06080	Iowa Boiler and Iron Works/Capitol Boilder and Iron Works	East Des Moines Industrial	306 E Court Ave	Contributing	448912	4604111	29C
77-06082	Building		601 E Court Ave	Unevaluated	449278	4604152	
77-07376	Sun Oil Company		710 Raccoon St	Eligible	449385	4603738	
77-07483	Scott Avenue Bridge & Dam	Civic Center	Scott Ave	Listed	449020	4603293	
77-07484	Roadside Settlement House		620 Scott Ave	Eligible	449508	4603545	
77-07705	Chicago,-Rock Island & Pacific Railroad Bridge	Civic Center/East Des Moines Industrial	Vine St	Listed	448638	4603850	37C
77-07781	United States Courthouse	Civic Center	123 E Walnut St	Listed	448724	4604162	
77-07782	Commercial Building	East Des Moines Industrial	205 E Walnut St	Contributing	448792	4604198	19C
77-07784	Commercial Building	East Des Moines Industrial	215 E Walnut St	Contributing	448833	4604206	20C
77-07785	Auto Finance and Sales Company	East Des Moines Industrial	301 E Walnut St	Contributing	448890	4604217	22C
77-07788	Northwestern Hotel	East Des Moines Industrial	321 E Walnut St	Listed	448953	4604227	24C
77-07791	Marquis Electric		416 E Walnut St	Unevaluated	449041	4604278	
77-09377	Municipal Court and Public Safety Building	Civic Center	25 E 1st St	Listed	448742	4604012	
77-09378	Des Moines Union Railway Company Bridge	Civic Center/East Des Moines Industrial	Crosses the Des Moines River between Court Ave and Vine St	Eligible	448627	4603905	36C
77-10407	Sun Tool, Inc.		300 Allen St	Unevaluated	449066	4603521	
77-10422	Gas Station		601 SE 6th St	Eligible	449451	4603479	
77-11232	Paul J. Johnson House		454 SE 2nd St	Unevaluated	448982	4603516	
EDMIHD-01		East Des Moines Industrial	106 SE First St	Contributing	448731	4603839	01C
EDMIHD-03		East Des Moines Industrial	101 E Second St	Noncontributing	448860	4603942	03NC
EDMIHD-05		East Des Moines Industrial	111 E Third St	Noncontributing	448959	4603968	05NC
EDMIHD-09		East Des Moines Industrial	220 E Third St	Contributing	448856	4604152	09C
EDMIHD-10		East Des Moines Industrial	108 SE Fourth St	Contributing	448860	4604138	10C
EDMIHD-11		East Des Moines Industrial	101 SE Fourth St	Contributing	449066	4603935	11C
EDMIHD-12		East Des Moines Industrial	112 SE Fourth St	Contributing	449037	4603913	12C
EDMIHD-15		East Des Moines Industrial	108 SE Fifth St	Noncontributing	449079	4603914	15NC
EDMIHD-16		East Des Moines Industrial	216 SE Fifth St	Contributing	449144	4603821	16C
EDMIHD-17		East Des Moines Industrial	106 E Sixth St	Contributing	449190	4604033	17C
EDMIHD-18	Hilltop Tire Service	East Des Moines Industrial	201 E Walnut St	Contributing	448780	4604197	18C
EDMIHD-26		East Des Moines Industrial	216 E Court Ave	Noncontributing	448876	4604103	26NC
EDMIHD-30		East Des Moines Industrial	317 E Court Ave	Noncontributing	448985	4604062	30NC
EDMIHD-31		East Des Moines Industrial	322 E Court Ave	Noncontributing	448970	4604123	31NC
EDMIHD-32	Wabash/Des Moines Union Railway Segment	East Des Moines Industrial	SE 1st to SE 6th	Contributing	create	line	32C
EDMIHD-33	Chicago, Rock Island & Pacific Railway	East Des Moines Industrial	E. Vine St	Contributing	create	line	33C
EDMIHD-34	Des Moines Western Railway	East Des Moines Industrial	E 2nd to E 3rd	Contributing	create	line	34C
EDMIHD-35	Chicago & NW Railway	East Des Moines Industrial	E 4th/SE 4th, E Walnut to E Market	Contributing	create	line	35C
	East Des Moines Industrial Historic District	East Des Moines Industrial		Listed			need polygon sketched
			702 Racoon St	Potential	449512	4603783	

Draft Hazardous Materials Technical Memorandum

Date: Friday, December 28, 2018

Project: Des Moines Market District Master Plan

To: City of Des Moines

From: HDR Engineering, Inc.

Subject: Hazardous Materials Review

As part of the Des Moines Market District Master Plan (Study), HDR provided a desktop-level review of hazardous materials in the Market District of the East Village (Market District) neighborhood. The following are sites contained within the Market District neighborhood. The search area was a standard ASTM search radius. Sites found on the opposite side of the Des Moines River were not further evaluated for impact to the Market District neighborhood at this time. A number of triangles are located on the figure, this indicates a former site that has most likely received a No Further Action or a No Action Required designation from IDNR; however, contamination may remain in soil or groundwater.

Former Manufactured Gas Plants (FMGP):

- Des Moines Gas Company – 101-123 SE 1st Street
- Des Moines Southeast – Market Street and Des Moines River
- Des Moines Gas Company – 100 E Raccoon
- Des Moines Gaslight – 201 SE 1st Street
- Des Moines Gaslight – SEC E Elm and SE 2nd
- Des Moines Two Rivers MGP – SE 2nd Street and East Market Street
- Des Moines 2nd Avenue and Market Street Coal Gas – Market Street Between 2nd And 3rd Ave
- Des Moines SE Connector (south of facility beneath MLK)

It appears that these sites are at the same location in Des Moines with different names. There are several different Iowa Contaminated Sites numbers associated with these sites and several have been closed out (Active Site IDs 368, 1188, and 38).

Information Required: Several borings have been completed for the pump station. Are there additional borings or investigations that are not included in the City or IDNR Contaminated Sites files? Mid-American Energy may have additional information such as the location of the former gas holders?

Contaminated Sites/Brownfield:

- Iowa Muffler and Brakes – 216 East Court (SVOCs in soil and groundwater)
- Newbury Living – 401 SE 6th Street (Fuel and lead contamination) also listed as a Brownfield
- Parker Oil – 399 SE 7th Street (Fuel contamination – GW)
- 7th Street Lead Site – 7th Street (Lead Removal of 14,000 cy)

Information Required: There are some files located in the IDNR Contaminated Sites database. These will be further evaluated to determine if enough site coverage is available. The 7th Street Lead Site has been cleaned up and remediated; however, there is no report that shows where soils were excavated from the former salvage yard.

Leaking Underground Storage Tanks

- Former Station – 501 E Court Avenue (LST 9LTF54) Expanding plume
- DSM City Garage – 101-123 SE 1st Street (LST 7LTC32) No free product remaining
- Capital DX – 107 E 6th (LST 7LTO81) Rec'd Pre-Remediation Groundwater Sampling documents
- Two Rivers Service Center – 201 SE 1st Street (LST 8LTU41) Free product

Information Required: Several sites had files that ended in 2006, but no additional information has been provided. Updated information will need to be requested from IDNR.

Miscellaneous Sites

- Bitucote Products Co. -900 SE Raccoon Street (files in microfiche, not available)
- Des Moines Traffic & Transportation – 511 SE 6th Street (solvent contamination)
- Historic Auto and Historic Cleaner Sites (prior to mid-1980's) No documentation – see map

Information Required: The Bitucote property has all of the files on microfiche and will need to be requested for review. The Des Moines Traffic property was last sampled in 2000. This may be a NFA site, but additional information is needed. The historic Auto and Cleaner Sites is a database developed by EDR. EDR used City Directories to find companies that a former drycleaner or automotive facility. In some cases, these sites overlap with other EDR sites; however, a number do not. There is no available information on these properties.

Contamination Issues

Raccoon Street Corridor – Sewer Line install (estimated 10-12 feet below ground surface)

Site	Address	Contaminants	Potential Depth
FMGP	SE 1st to SE 2nd and Raccoon to Market	Coal Tars, PAHs, cyanides, heavy metals	Below fill to groundwater
Lots 9 and 10 Block 44	404 SE 5th Street	Heavy Metals	Est. 0-2' bgs - unknown
Diamond Oil Co.	600 SE Raccoon St	Fuels/Oils	Tank depth to groundwater
SE 6th Street UST Site	SE 6th Street And Raccoon Street	Fuels	Tank depth to groundwater
Parker Oil	399 SE 7th Street	Fuels/Oils	Tank depth to groundwater
Scrap Processors Inc.	306 SE 5th St	Fuels and Heavy Metals	Fuels 0-gw; metals 0-2'
Waste Management	1800 SE Elm	Fuels	Tank depth to groundwater – was high risk site in '97
Des Moines City Garage	212 SE Raccoon	Fuels	Tank depth to groundwater – Free product through 2010
DL & V	Lots 3, 4, 5 of Block 43 SE 5th & Allen	VOCs	PCE and daughters > MCL
Bitucote	900 SE Raccoon ST	Asphalt	Tank depth to groundwater

Des Moines SE Connector	MLK and Des Moines River	Coal Tars, PAHs, cyanides, heavy metals	Below fill to groundwater
SE Connector	1101 Raccoon ST	Fuels - UST	No release
7th Street Lead Site	7th Street SE and Raccoon	Lead – Battery cracking	Remediated, residual
Unknown Fuel Sites	TBD	Fuels	Tank depth to groundwater
Unknown Solvent Sites	TBD	Solvents (TCE, carbon tetrachloride, etc.	Fill to groundwater
Heavy Metal Sites	TBD	Lead, arsenic, etc.	Surface to 2′ bgs

Draft Alternative Energy Technical Memo

Date:	Friday, December 28, 2018
Project:	Des Moines Market District Master Plan
To:	City of Des Moines
From:	HDR Engineering, Inc.
Subject:	Alternative Energy Feasibility Study

Introduction & Purpose

As part of an energy evaluation for the Market District Master Plan (Study), HDR was requested to evaluate the feasibility of including renewable energy elements to increase project value. The following information was requested for review:

- Evaluate the use of wind, solar, energy storage and geothermal on site.
- Evaluate the economic feasibility for alternative energy on site.
- Provide conceptual layouts, preliminary production estimates and Return on Investment (ROI) calculations.

The purpose of this technical memo is to provide methodology and results of a conceptual level analysis based upon requested scope for Study information.

Energy estimates and installation costs were estimated from current marketplace and bid information available to HDR regarding renewable installations in the regional area.

Payback period was estimated without the use of incentives.

Assumptions

Due to the stage of planning, a 10% conceptual design effort and cost estimate was completed at the time of writing this memo. Estimated electrical loads for each building were ignored and alternative energy production estimates were completed strictly based upon potential, rather than an appropriate level of installation. As such, production results may be greater than could be integrated into each building. A building by building analysis with balancing of energy use versus alternative energy production was not part of the requested scope and could be completed at a future date if determined to be of value for future planning efforts.

System Equipment & Production Analysis Assumptions

To develop the nameplate capacity or facility size for estimating purposes, assumptions were made regarding factors to determine production estimates for the wind and solar facilities. Detailed energy modeling was not completed for this work as a selected site for facility location is required and existing meteorological data for wind speeds and solar irradiance are required respectively. Rather, generalized information based upon NREL data was utilized for energy estimates. These values tend to be conservative relative to detailed estimates; however, they should be further evaluated prior to purchase decisions being made regarding a facility.

Wind

A turbine's physical location, blade swept area and tower height have significant impact on the production that can be generated for a wind turbine. As the power generated is a function of the cube of the velocity at the turbine height, placing turbines in locations with consistent, high wind speeds is important to maximizing return on investment.

A review of NREL wind maps at 30m (98.5 FT) for the study area indicates that wind speeds of 4.5-5 m/s are prevalent on average annually. This low speed is not generally conducive to wind generation which will yield a return of investment that is economically viable without significant incentives. There is also a limited number of turbines which could be used in the study area due to low wind or gusty wind and inconsistent wind due to impacts from surrounding buildings. As such, no detailed evaluation was completed for wind production in the study area.

Solar

Due to the stage of planning, solar facility sizing for each building was evaluated strictly based upon available rooftop space using HelioScope, a solar PV estimation program. Balancing of potential production with energy use at each building was not analyzed as part of this scope of work.

Facility location, physical size & layout, equipment to be installed, interconnection type, and other information is needed to accurately model the solar generation system via HelioScope or PVSYST, a PC software package for the study, sizing, simulation and data analysis of complete PV systems.

The study team was able to make certain assumptions during analysis to generate reasonable estimates for the study area. They are:

- Solar facility would be located on rooftops in the study area. No off site community solar or large scale ground mount solar system was evaluated.
- Solar irradiance data for Des Moines, Iowa to be used.
- HelioScope PC software package was used to estimate facility size and production.
- Panels will be installed roof tops (fixed rack).
- Panels will be standard efficiency panels.
- Inverters will be string inverters.
- PV systems will tie into each individual building and be metered separately at building level.

Energy Storage

In order to increase overall use of renewable energy in the study area, energy storage could be integrated into each building where solar panels area also installed. This would allow for each building to generate more energy than it can use at any given time and increase overall sustainable return on investment.

The ROI for battery storage was not evaluated as part of this study at the current phase as the economic assumptions associated with a ROI calculation requires coordination with the Utility for specific interconnection terms. Generally, the cost of adding energy storage to a building integrated solar project does not generate a return on investment less than 10 years at the current time. However, within the next five years, technology advancements are expected to increase and costs to decline sufficiently that plan implementation should analyze for battery storage as part of the overall alternative energy mix.

Economic Assumptions

A key assumption throughout this analysis is the assumption of electrical rates in Des Moines. Current rates or final application of any interconnection tariffs, net metering or impacts on demand charges have not been determined by this memo. As these items can significantly impact the return on investment and justification for any behind the meter installation, detailed discussion with the utility company who will off take any energy production or provide any back up generation to determine final life cycle cost implications would be required for future analysis.

In order to evaluate the actual cost savings to be anticipated, discussion should occur with the Utility to better understand how Demand Charges, Use Charges, Meter Fees, any tariffs or other fees would occur with the addition of a renewables component to the facility to offset grid purchased energy or in the event the facility was able to sell excess power onto open market. Detailed cost evaluation for interconnection and market conditions is beyond the scope of this memo but could be looked at in the future once a selection is made on facility type and size.

Economic assumptions generally remain the same for both wind and solar. They are:

- Rate paid for electricity (2015): $0.11/kW-hr
- Escalation for electrical rates: 3%/year
- Return Period: 20 years
- No escalation for O&M services
- Assumes no replacement of major equipment over 20 year life

Specific assumptions for solar:

- CAPEX Solar: $2.20 per watt nameplate
- OPEX Solar: $0.002 /KWhr production
- Solar energy production diminishes by 1% per year

Results

The following summarizes estimated electricity generation for solar alternatives including estimated capital costs and rate of return for a maximum production potential scenario. Conceptual layouts and ROI calculations are included in the Appendix to this Memo.

A conceptual layout using fixed rooftop solar with standard efficiency solar panels with string inverters yielded a study area potential capacity of 5,820 KW or a year one production benefit of 8,884,000 KWhrs. With the assumptions for electric pricing and CAPEX/OPEX, the ROI is estimated to payback in Year 12.

Depending upon the interest and ability to fully integrate solar into the study area infrastructure, offsetting 30-50% of energy use through rooftop or on site ground mounted solar appears to be a viable alternative. However, discussion with the local utility should occur to better understand how a large behind the meter facility will impact demand and energy charges for each building location.

Building small scale wind energy may be of potential value in open parkland areas where small scale turbines could be installed away from building interferences. However, the winds at lower elevations in Des Moines are generally insufficient for economic wind generation in the investigated scenarios.

Energy storage is potentially a viable alternative for integration into buildings along with solar PV. However, without discussions with the local Utility for current limitations and contractual requirements, the study team was not able to determine current ROI. Future work should include energy storage options in a renewable energy scenario to accommodate potential changes to the study area grid such as changes due to electrification and electric vehicle charging growth in the area.

Design 1 Des Moines, 600 E Locust St, Des Moines, IA 50319

Report

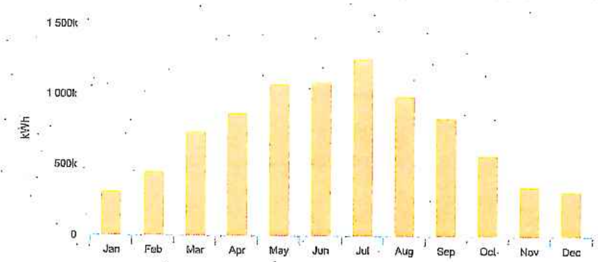
Project Name	Des Moines
Project Address	600 E Locust St, Des Moines, IA 50319
Prepared By	Quinn Knudsen quinn.knudsen@hdrinc.com

System Metrics

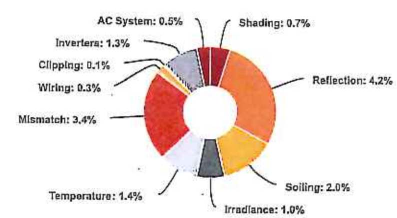
Design	Design 1
Module DC Nameplate	7.20 MW
Inverter AC Nameplate	5.82 MW Load Ratio: 1.24
Annual Production	8.884 GWh
Performance Ratio	86.0%
kWh/kWp	1,233.3
Weather Dataset	TMY, 10km Grid (41.55,-93.65), NREL (prospector)
Simulator Version	883bdd9168-2561898dd0-2b8c6f3164-96e2f62ef9

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,478.8	
	POA Irradiance	1,434.9	-3.0%
	Shaded Irradiance	1,424.4	-0.7%
	Irradiance after Reflection	1,364.3	-4.2%
	Irradiance after Soiling	1,337.0	-2.0%
	Total Collector Irradiance	**1,337.0**	**0.0%**
Energy (kWh)	Nameplate	9,636,482.1	
	Output at Irradiance Levels	9,537,669.5	-1.0%
	Output at Cell Temperature Derate	9,401,061.4	-1.4%
	Output After Mismatch	9,084,342.6	-3.4%
	Optimal DC Output	9,054,193.7	-0.3%
	Constrained DC Output	9,046,834.0	-0.1%
	Inverter Output	8,929,130.0	-1.3%
	Energy to Grid	**8,884,480.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		12.5 °C
	Avg. Operating Cell Temp		19.0 °C
Simulation Metrics			
	Operating Hours		4676
	Solved Hours		4676

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km Grid (41.55,-93.65), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model
Temperature Model Parameters	Rack Type / a / b / Temperature Delta Fixed Tilt / -3.56 / -0.075 / 3°C Flush Mount / -2.81 / -0.0455 / 0°C
Soiling (%)	J F M A M J J A S O N D 2 2 2 2 2 2 2 2 2 2 2 2
Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%
Module Characterizations	Module: TSM-PD14 320 (May16) (Trina Solar) Characterization: Spec Sheet Characterization, PAN
Component Characterizations	Device: SUN2000-60KTL-M0 (480) (Huawei) Characterization: Spec Sheet

Components

Component	Name	Count
Inverters	SUN2000-60KTL-M0 (480) (Huawei)	97 (5.82 MW)
Strings	10 AWG (Copper)	1,164 (426,329.8 ft)
Module	Trina Solar, TSM-PD14 320 (May16) (320W)	22,512 (7.20 MW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	6-20	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Portrait (Vertical)	10°	0.273101°	2.0 ft	1x1	490	490	156.8 kW
Field Segment 2	Fixed Tilt	Portrait (Vertical)	10°	270°	2.0 ft	1x1	375	375	120.0 kW
Field Segment 3	Fixed Tilt	Portrait (Vertical)	10°	125.011°	2.0 ft	1x1	509	509	162.9 kW
Field Segment 4	Fixed Tilt	Portrait (Vertical)	10°	255.018°	2.0 ft	1x1	320	320	102.4 kW
Field Segment 5	Fixed Tilt	Portrait (Vertical)	10°	254.678°	2.0 ft	1x1	474	474	151.7 kW
Field Segment 6	Fixed Tilt	Portrait (Vertical)	10°	254.678°	2.0 ft	1x1	456	456	145.9 kW
Field Segment 7	Fixed Tilt	Portrait (Vertical)	10°	254.678°	2.0 ft	1x1	224	224	71.7 kW
Field Segment 7 (copy)	Fixed Tilt	Portrait (Vertical)	10°	254.678°	2.0 ft	1x1	209	209	66.9 kW
Field Segment 9	Fixed Tilt	Portrait (Vertical)	10°	114.814°	2.0 ft	1x1	282	282	90.2 kW
Field Segment 10	Fixed Tilt	Portrait (Vertical)	10°	74.859°	2.0 ft	1x1	271	271	86.7 kW
Field Segment 11	Fixed Tilt	Portrait (Vertical)	10°	164.501°	2.0 ft	1x1	272	272	87.0 kW
Field Segment 12	Fixed Tilt	Portrait (Vertical)	10°	164.501°	2.0 ft	1x1	582	582	186.2 kW
Field Segment 13	Fixed Tilt	Portrait (Vertical)	10°	164.501°	2.0 ft	1x1	538	538	172.2 kW
Field Segment 14	Fixed Tilt	Portrait (Vertical)	10°	164.501°	2.0 ft	1x1	288	288	92.2 kW
Field Segment 15	Fixed Tilt	Portrait (Vertical)	10°	255.579°	2.0 ft	1x1	465	465	148.8 kW
Field Segment 16	Fixed Tilt	Portrait (Vertical)	10°	255.579°	2.0 ft	1x1	583	583	186.6 kW
Field Segment 17	Fixed Tilt	Portrait (Vertical)	10°	255.579°	2.0 ft	1x1	302	302	96.6 kW
Field Segment 18	Fixed Tilt	Portrait (Vertical)	10°	343.918°	2.0 ft	1x1	440	440	140.8 kW
Field Segment 19	Fixed Tilt	Portrait (Vertical)	10°	344.762°	2.0 ft	1x1	472	472	151.0 kW
Field Segment 20	Fixed Tilt	Portrait (Vertical)	10°	344.943°	2.0 ft	1x1	294	294	94.1 kW
Field Segment 21	Fixed Tilt	Portrait (Vertical)	10°	344.943°	2.0 ft	1x1	448	448	143.4 kW
Field Segment 22	Fixed Tilt	Portrait (Vertical)	10°	165.046°	2.0 ft	1x1	471	471	150.7 kW
Field Segment 23	Fixed Tilt	Portrait (Vertical)	10°	165.046°	2.0 ft	1x1	366	366	117.1 kW
Field Segment 24	Fixed Tilt	Portrait (Vertical)	10°	165.046°	2.0 ft	1x1	276	276	88.3 kW
Field Segment 25	Fixed Tilt	Portrait (Vertical)	10°	165.046°	2.0 ft	1x1	366	366	117.1 kW
Field Segment 26	Fixed Tilt	Portrait (Vertical)	10°	165.046°	2.0 ft	1x1	493	493	157.8 kW
Field Segment 27	Fixed Tilt	Portrait (Vertical)	10°	180.51°	2.0 ft	1x1	916	916	293.1 kW
Field Segment 28	Fixed Tilt	Portrait (Vertical)	10°	254.801°	2.0 ft	1x1	755	755	241.6 kW
Field Segment 29	Fixed Tilt	Portrait (Vertical)	10°	75.0861°	2.0 ft	1x1	456	456	145.9 kW
Field Segment 30	Fixed Tilt	Portrait (Vertical)	10°	345.122°	2.0 ft	1x1	512	512	163.8 kW
Field Segment 31	Fixed Tilt	Portrait (Vertical)	10°	345.122°	2.0 ft	1x1	1,040	1,040	332.8 kW
Field Segment 32	Fixed Tilt	Portrait (Vertical)	10°	345.122°	2.0 ft	1x1	822	822	263.0 kW
Field Segment 33	Fixed Tilt	Portrait (Vertical)	10°	345.122°	2.0 ft	1x1	391	391	125.1 kW
Field Segment 34	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	420	420	134.4 kW
Field Segment 35	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	290	290	92.8 kW
Field Segment 36	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	566	566	181.1 kW
Field Segment 37	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	317	317	101.4 kW
Field Segment 38	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	391	391	125.1 kW
Field Segment 39	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	183	183	58.6 kW
Field Segment 40	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	127	127	40.6 kW
Field Segment 41	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	368	368	117.8 kW
Field Segment 42	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	297	297	95.0 kW
Field Segment 43	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	612	612	195.8 kW
Field Segment 44	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	353	353	113.0 kW
Field Segment 45	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	391	391	125.1 kW

Field Segment 46	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	476	476	152.3 kW
Field Segment 47	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	780	780	249.6 kW
Field Segment 48	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	391	391	125.1 kW
Field Segment 49	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	236	236	75.5 kW
Field Segment 50	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	790	790	252.8 kW
Field Segment 51	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	210	210	67.2 kW
Field Segment 52	Fixed Tilt	Portrait (Vertical)	10°	344.793°	2.0 ft	1x1	156	156	49.9 kW

Detailed Layout

DES MOINES EAST
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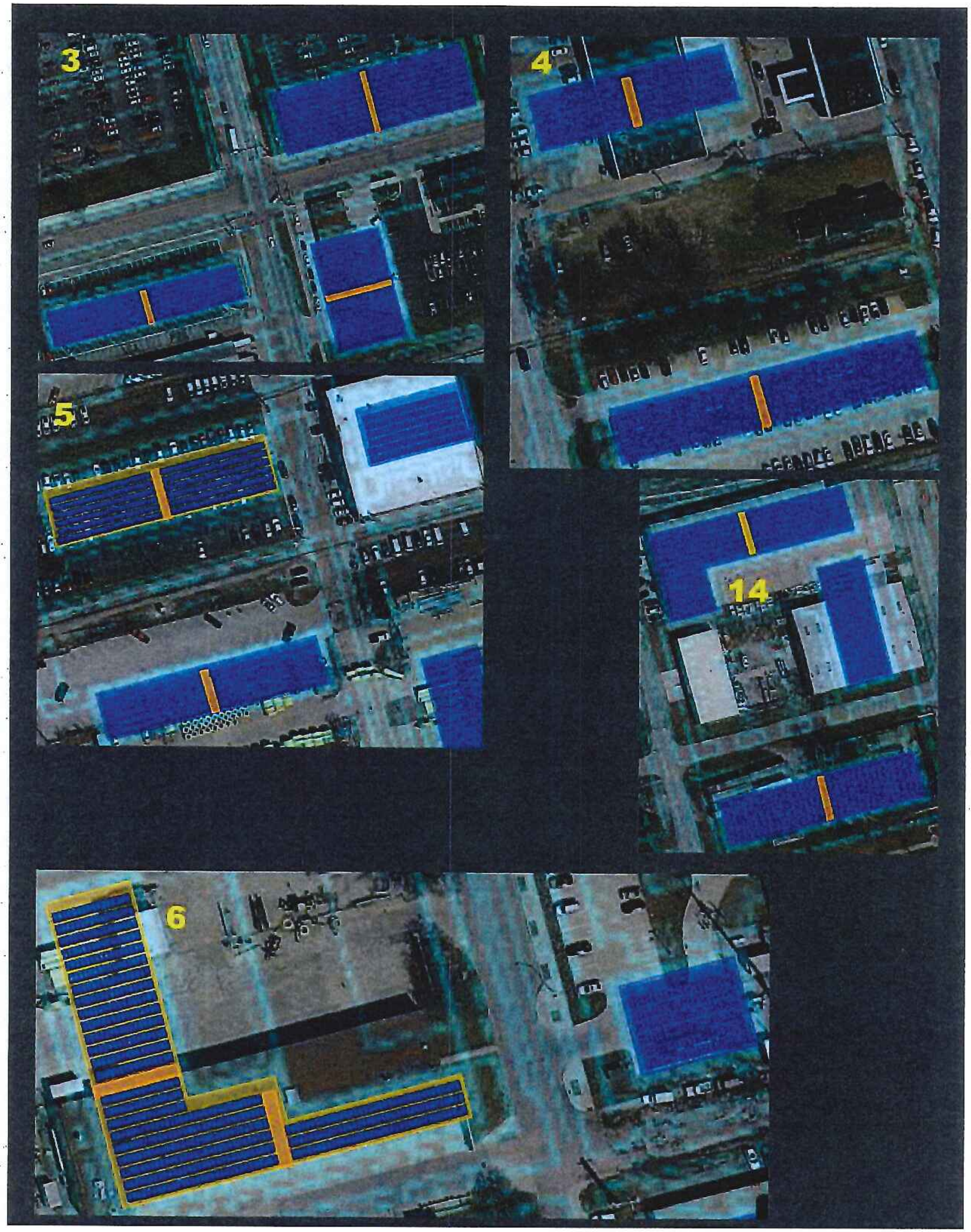

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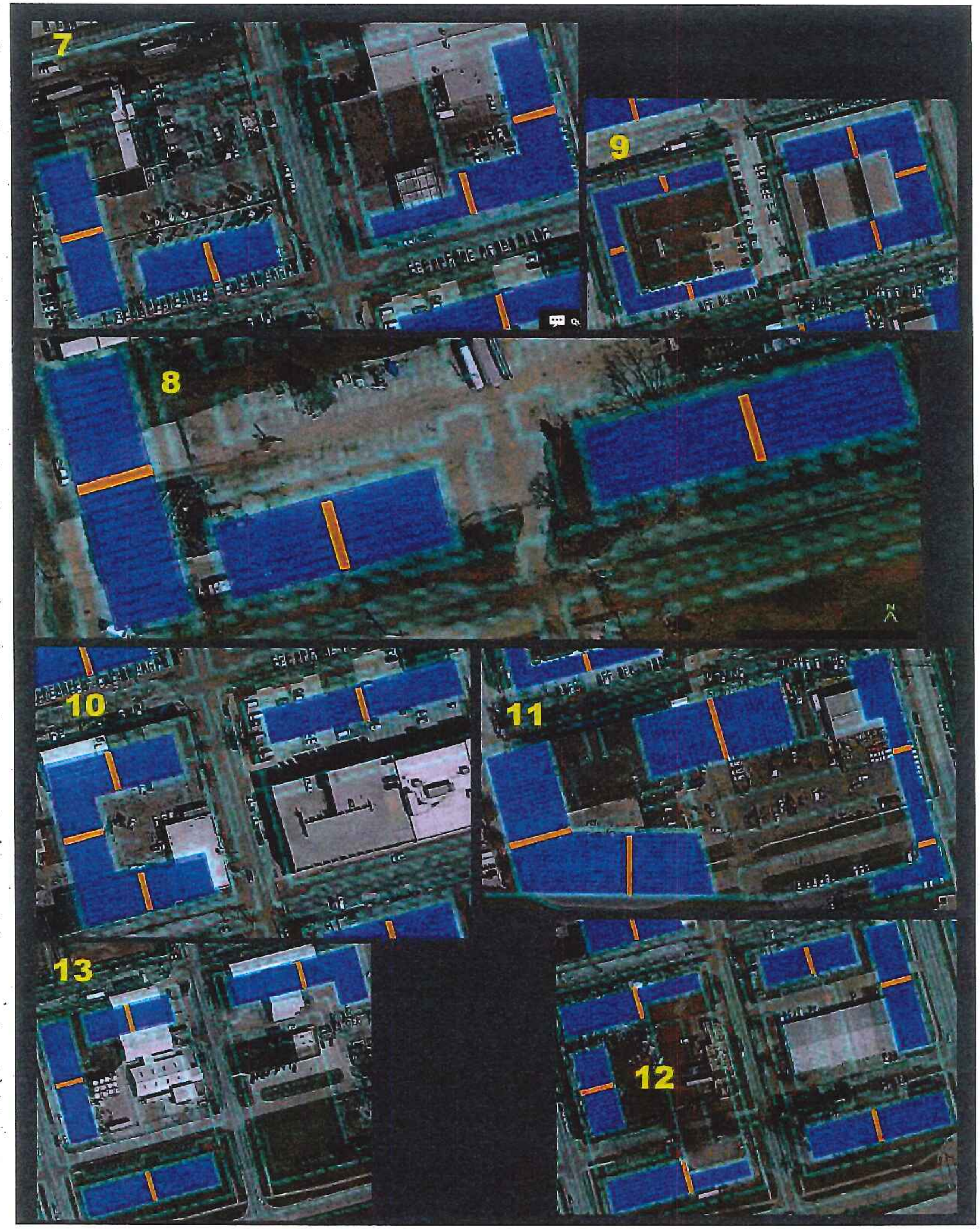
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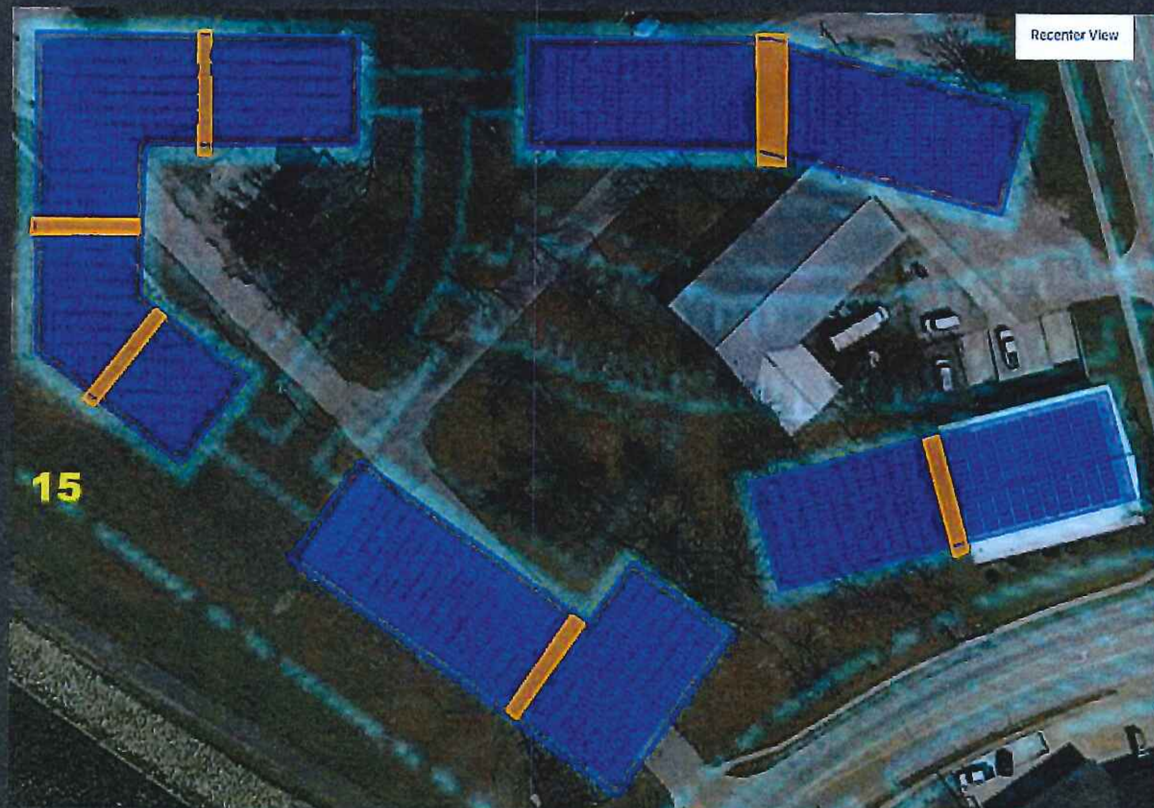
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Job No.		No.	
Project		Computed GLD	Date 8/23/2018
Subject	Des Moines Solar Feasibility	Checked	Date
Task	Prduction and Cost Analysis	Sheet 1	Of 54

A. Production Analysis Assumptions

Tank Tops

1. Panels will be mounted with unirac or similar racking system with minimal rise on roof. (20 degree assumed angle=rack+roof slope)
2. No roof plan has been completed at the time of analysis so 80% of the area was assumed to be usable
3. Electrical connection at building will be a 480 V connection.
4. Inverter will be located outside the building at ground level near the location of the inside electrical equipment to minimize cable run
5. Standard efficiency panels will be used for installation
6. Helioscope software used to estimate panel locations and equipment. (See printout for analysis)

B. Cost & ROI Analysis Assumptions

Rate paid for electricity (2014)	$ 0.11	kWhr
Escalation for electrical rates	3%	per year
Return Period	20	years
No escalation for O&M services		
O&M costs	$ 0.0020	per watt production
Assumes no replacement of major equipment over 20 year life		
Capital Installation Cost	$ 2.20	per watt
Energy production diminishes by 1% per year		

Job No.		No.	
Project	2	Computed	GLD
Date	1/2/1900		
Subject	Solar Feasibility	Checked	
Date			
Task	Prduction and Cost Analysis	Sheet	2
of	54		

C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 12,804,000	$ 17,768.00	8,884,000	$ 0.11	$ 977,240	$ 12,821,768	$ 977,240	$ 12,821,768	$ 977,240	0.08
	2	0	$ 17,590.32	8,795,160	0.113	$ 996,492	$ 17,590	$ 996,492	$ 12,839,358	$ 1,973,732	0.15
5820	3	0	$ 17,414.42	8,707,208	0.117	$ 1,016,123	$ 17,414	$ 1,016,123	$ 12,856,773	$ 2,989,854	0.23
KW	4	0	$ 17,240.27	8,620,136	0.120	$ 1,036,140	$ 17,240	$ 1,036,140	$ 12,874,013	$ 4,025,994	0.31
Nameplate	5	0	$ 17,067.87	8,533,935	0.124	$ 1,056,552	$ 17,068	$ 1,056,552	$ 12,891,081	$ 5,082,546	0.39
	6	0	$ 16,897.19	8,448,596	0.128	$ 1,077,366	$ 16,897	$ 1,077,366	$ 12,907,978	$ 6,159,913	0.48
	7	0	$ 16,728.22	8,364,110	0.131	$ 1,098,590	$ 16,728	$ 1,098,590	$ 12,924,706	$ 7,258,503	0.56
	8	0	$ 16,560.94	8,280,469	0.135	$ 1,120,233	$ 16,561	$ 1,120,233	$ 12,941,267	$ 8,378,735	0.65
	9	0	$ 16,395.33	8,197,664	0.139	$ 1,142,301	$ 16,395	$ 1,142,301	$ 12,957,663	$ 9,521,036	0.73
	10	0	$ 16,231.37	8,115,687	0.144	$ 1,164,804	$ 16,231	$ 1,164,804	$ 12,973,894	$ 10,685,841	0.82
	11	0	$ 16,069.06	8,034,530	0.148	$ 1,187,751	$ 16,069	$ 1,187,751	$ 12,989,963	$ 11,873,592	0.91
	12	0	$ 15,908.37	7,954,185	0.152	$ 1,211,150	$ 15,908	$ 1,211,150	$ 13,005,871	$ 13,084,742	1.01
	13	0	$ 15,749.29	7,874,643	0.157	$ 1,235,009	$ 15,749	$ 1,235,009	$ 13,021,621	$ 14,319,751	1.10
	14	0	$ 15,591.79	7,795,897	0.162	$ 1,259,339	$ 15,592	$ 1,259,339	$ 13,037,212	$ 15,579,090	1.19
	15	0	$ 15,435.88	7,717,938	0.166	$ 1,284,148	$ 15,436	$ 1,284,148	$ 13,052,648	$ 16,863,238	1.29
	16	0	$ 15,281.52	7,640,758	0.171	$ 1,309,446	$ 15,282	$ 1,309,446	$ 13,067,930	$ 18,172,684	1.39
	17	0	$ 15,128.70	7,564,351	0.177	$ 1,335,242	$ 15,129	$ 1,335,242	$ 13,083,059	$ 19,507,926	1.49
	18	0	$ 14,977.41	7,488,707	0.182	$ 1,361,546	$ 14,977	$ 1,361,546	$ 13,098,036	$ 20,869,472	1.59
	19	0	$ 14,827.84	7,413,820	0.187	$ 1,388,369	$ 14,828	$ 1,388,369	$ 13,112,864	$ 22,257,841	1.70
	20	0	$ 14,679.36	7,339,682	0.193	$ 1,415,719	$ 14,679	$ 1,415,719	$ 13,127,543	$ 23,673,560	1.80
			TOTALS	161,771,477					$ 13,127,543	$ 23,673,560	
			ANNUAL AVERAGE	8,088,574						$ 1,183,678	

*Initial production estimate in year 1 from Helioscope model run

HDR

Job No.		No.	
Project	2	Computed	GLD
Date	1/2/1900		
Subject	Solar Feasibility	Checked	
Date			
Task	Prducion and Cost Analysis	Sheet	3
Of	54		

C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 344,960	$ 478.70	239,349	$ 0.11	$ 26,328	$ 345,439	$ 26,328	$ 345,439	$ 26,328	0.08
	2	0	$ 473.91	236,956	0.113	$ 26,847	$ 474	$ 26,847	$ 345,913	$ 53,175	0.15
156.8	3	0	$ 469.17	234,586	0.117	$ 27,376	$ 469	$ 27,376	$ 346,382	$ 80,551	0.23
KW	4	0	$ 464.48	232,240	0.120	$ 27,915	$ 464	$ 27,915	$ 346,846	$ 108,467	0.31
Nameplate	5	0	$ 459.84	229,918	0.124	$ 28,465	$ 460	$ 28,465	$ 347,306	$ 136,932	0.39
	6	0	$ 455.24	227,619	0.128	$ 29,026	$ 455	$ 29,026	$ 347,761	$ 165,958	0.48
	7	0	$ 450.68	225,342	0.131	$ 29,598	$ 451	$ 29,598	$ 348,212	$ 195,556	0.56
	8	0	$ 446.18	223,089	0.135	$ 30,181	$ 446	$ 30,181	$ 348,658	$ 225,736	0.65
	9	0	$ 441.72	220,858	0.139	$ 30,775	$ 442	$ 30,775	$ 349,100	$ 256,512	0.73
	10	0	$ 437.30	218,649	0.144	$ 31,382	$ 437	$ 31,382	$ 349,537	$ 287,893	0.82
	11	0	$ 432.93	216,463	0.148	$ 32,000	$ 433	$ 32,000	$ 349,970	$ 319,893	0.91
	12	0	$ 428.60	214,298	0.152	$ 32,630	$ 429	$ 32,630	$ 350,399	$ 352,524	1.01
	13	0	$ 424.31	212,155	0.157	$ 33,273	$ 424	$ 33,273	$ 350,823	$ 385,797	1.10
	14	0	$ 420.07	210,034	0.162	$ 33,929	$ 420	$ 33,929	$ 351,243	$ 419,725	1.19
	15	0	$ 415.87	207,933	0.166	$ 34,597	$ 416	$ 34,597	$ 351,659	$ 454,322	1.29
	16	0	$ 411.71	205,854	0.171	$ 35,279	$ 412	$ 35,279	$ 352,071	$ 489,601	1.39
	17	0	$ 407.59	203,796	0.177	$ 35,974	$ 408	$ 35,974	$ 352,478	$ 525,574	1.49
	18	0	$ 403.52	201,758	0.182	$ 36,682	$ 404	$ 36,682	$ 352,882	$ 562,257	1.59
	19	0	$ 399.48	199,740	0.187	$ 37,405	$ 399	$ 37,405	$ 353,281	$ 599,661	1.70
	20	0	$ 395.49	197,743	0.193	$ 38,142	$ 395	$ 38,142	$ 353,677	$ 637,803	1.80
			TOTALS	4,358,379					$ 353,677	$ 637,803	
			ANNUAL AVERAGE	217,919						$ 31,890	

*Initial production estimate in year 1 from Helioscope model run

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Project	2	Computed	GLD
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 264,000	$ 366.35	183,175	$ 0.11	$ 20,149	$ 264,366	$ 20,149	$ 264,366	$ 20,149	0.08
	2	0	$ 362.69	181,344	0.113	$ 20,546	$ 363	$ 20,546	$ 264,729	$ 40,695	0.15
120	3	0	$ 359.06	179,530	0.117	$ 20,951	$ 359	$ 20,951	$ 265,088	$ 61,646	0.23
KW	4	0.	$ 355.47	177,735	0.120	$ 21,364	$ 355	$ 21,364	$ 265,444	$ 83,010	0.31
Nameplate	5	0	$ 351.91	175,957	0.124	$ 21,785	$ 352	$ 21,785	$ 265,795	$ 104,795	0.39
	6	0	$ 348.40	174,198	0.128	$ 22,214	$ 348	$ 22,214	$ 266,144	$ 127,009	0.48
	7	0	$ 344.91	172,456	0.131	$ 22,651	$ 345	$ 22,651	$ 266,489	$ 149,660	0.56
	8	0	$ 341.46	170,731	0.135	$ 23,098	$ 341	$ 23,098	$ 266,830	$ 172,757	0.65
	9	0	$ 338.05	169,024	0.139	$ 23,553	$ 338	$ 23,553	$ 267,168	$ 196,310	0.73
	10	0	$ 334.67	167,334	0.144	$ 24,017	$ 335	$ 24,017	$ 267,503	$ 220,327	0.82
	11	0	$ 331.32	165,660	0.148	$ 24,490	$ 331	$ 24,490	$ 267,834	$ 244,816	0.91
	12	0	$ 328.01	164,004	0.152	$ 24,972	$ 328	$ 24,972	$ 268,162	$ 269,788	1.01
	13	0	$ 324.73	162,364	0.157	$ 25,464	$ 325	$ 25,464	$ 268,487	$ 295,253	1.10
	14	0	$ 321.48	160,740	0.162	$ 25,966	$ 321	$ 25,966	$ 268,809	$ 321,218	1.19
	15	0	$ 318.27	159,133	0.166	$ 26,477	$ 318	$ 26,477	$ 269,127	$ 347,696	1.29
	16	0	$ 315.08	157,541	0.171	$ 26,999	$ 315	$ 26,999	$ 269,442	$ 374,695	1.39
	17	0	$ 311.93	155,966	0.177	$ 27,531	$ 312	$ 27,531	$ 269,754	$ 402,225	1.49
	18	0	$ 308.81	154,406	0.182	$ 28,073	$ 309	$ 28,073	$ 270,063	$ 430,298	1.59
	19	0	$ 305.72	152,862	0.187	$ 28,626	$ 306	$ 28,626	$ 270,368	$ 458,925	1.70
	20	0	$ 302.67	151,334	0.193	$ 29,190	$ 303	$ 29,190	$ 270,671	$ 488,115	1.80
			TOTALS	3,335,494					$ 270,671	$ 488,115	
			ANNUAL AVERAGE	166,775						$ 24,406	

*Initial production estimate in year 1 from Helioscope model run

HDR		Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 358,380	$ 497.32	248,660	$ 0.11	$ 27,353	$ 358,877	$ 27,353	$ 358,877	$ 27,353	0.08
	2	0	$ 492.35	246,174	0.113	$ 27,891	$ 492	$ 27,891	$ 359,370	$ 55,244	0.15
162.9	3	0	$ 487.42	243,712	0.117	$ 28,441	$ 487	$ 28,441	$ 359,857	$ 83,685	0.23
KW	4	0	$ 482.55	241,275	0.120	$ 29,001	$ 483	$ 29,001	$ 360,340	$ 112,686	0.31
Nameplate	5	0	$ 477.72	238,862	0.124	$ 29,573	$ 478	$ 29,573	$ 360,817	$ 142,259	0.39
	6	0	$ 472.95	236,474	0.128	$ 30,155	$ 473	$ 30,155	$ 361,290	$ 172,414	0.48
	7	0	$ 468.22	234,109	0.131	$ 30,749	$ 468	$ 30,749	$ 361,759	$ 203,163	0.56
	8	0	$ 463.54	231,768	0.135	$ 31,355	$ 464	$ 31,355	$ 362,222	$ 234,518	0.65
	9	0	$ 458.90	229,450	0.139	$ 31,973	$ 459	$ 31,973	$ 362,681	$ 266,491	0.73
	10	0	$ 454.31	227,156	0.144	$ 32,603	$ 454	$ 32,603	$ 363,135	$ 299,093	0.82
	11	0	$ 449.77	224,884	0.148	$ 33,245	$ 450	$ 33,245	$ 363,585	$ 332,338	0.91
	12	0	$ 445.27	222,635	0.152	$ 33,900	$ 445	$ 33,900	$ 364,030	$ 366,238	1.01
	13	0	$ 440.82	220,409	0.157	$ 34,568	$ 441	$ 34,568	$ 364,471	$ 400,805	1.10
	14	0	$ 436.41	218,205	0.162	$ 35,249	$ 436	$ 35,249	$ 364,908	$ 436,054	1.19
	15	0	$ 432.05	216,023	0.166	$ 35,943	$ 432	$ 35,943	$ 365,340	$ 471,997	1.29
	16	0	$ 427.72	213,862	0.171	$ 36,651	$ 428	$ 36,651	$ 365,767	$ 508,648	1.39
	17	0	$ 423.45	211,724	0.177	$ 37,373	$ 423	$ 37,373	$ 366,191	$ 546,021	1.49
	18	0	$ 419.21	209,607	0.182	$ 38,109	$ 419	$ 38,109	$ 366,610	$ 584,130	1.59
	19	0	$ 415.02	207,511	0.187	$ 38,860	$ 415	$ 38,860	$ 367,025	$ 622,990	1.70
	20	0	$ 410.87	205,435	0.193	$ 39,626	$ 411	$ 39,626	$ 367,436	$ 662,616	1.80
			TOTALS	4,527,934					$ 367,436	$ 662,616	
			ANNUAL AVERAGE	226,397						$ 33,131	

*Initial production estimate in year 1 from Helioscope model run

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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 225,280	$ 312.62	156,310	$ 0.11	$ 17,194	$ 225,593	$ 17,194	$ 225,593	$ 17,194	0.08
	2	0	$ 309.49	154,746	0.113	$ 17,533	$ 309	$ 17,533	$ 225,902	$ 34,727	0.15
102.4	3	0	$ 306.40	153,199	0.117	$ 17,878	$ 306	$ 17,878	$ 226,209	$ 52,605	0.23
KW	4	0	$ 303.33	151,667	0.120	$ 18,230	$ 303	$ 18,230	$ 226,512	$ 70,835	0.31
Nameplate	5	0	$ 300.30	150,150	0.124	$ 18,590	$ 300	$ 18,590	$ 226,812	$ 89,425	0.39
	6	0	$ 297.30	148,649	0.128	$ 18,956	$ 297	$ 18,956	$ 227,108	$ 108,381	0.48
	7	0	$ 294.32	147,162	0.131	$ 19,329	$ 294	$ 19,329	$ 227,404	$ 127,710	0.56
	8	0	$ 291.38	145,691	0.135	$ 19,710	$ 291	$ 19,710	$ 227,695	$ 147,420	0.65
	9	0	$ 288.47	144,234	0.139	$ 20,098	$ 288	$ 20,098	$ 227,984	$ 167,518	0.73
	10	0	$ 285.58	142,791	0.144	$ 20,494	$ 286	$ 20,494	$ 228,269	$ 188,012	0.82
	11	0	$ 282.73	141,364	0.148	$ 20,898	$ 283	$ 20,898	$ 228,552	$ 208,910	0.91
	12	0	$ 279.90	139,950	0.152	$ 21,310	$ 280	$ 21,310	$ 228,832	$ 230,220	1.01
	13	0	$ 277.10	138,550	0.157	$ 21,729	$ 277	$ 21,729	$ 229,109	$ 251,949	1.10
	14	0	$ 274.33	137,165	0.162	$ 22,157	$ 274	$ 22,157	$ 229,383	$ 274,106	1.19
	15	0	$ 271.59	135,793	0.166	$ 22,594	$ 272	$ 22,594	$ 229,655	$ 296,700	1.29
	16	0	$ 268.87	134,435	0.171	$ 23,039	$ 269	$ 23,039	$ 229,924	$ 319,739	1.39
	17	0	$ 266.18	133,091	0.177	$ 23,493	$ 266	$ 23,493	$ 230,190	$ 343,232	1.49
	18	0	$ 263.52	131,760	0.182	$ 23,956	$ 264	$ 23,956	$ 230,453	$ 367,188	1.59
	19	0	$ 260.88	130,442	0.187	$ 24,428	$ 261	$ 24,428	$ 230,714	$ 391,616	1.70
	20	0	$ 258.28	129,138	0.193	$ 24,909	$ 258	$ 24,909	$ 230,973	$ 416,524	1.80
			TOTALS	2,846,289					$ 230,973	$ 416,524	
			ANNUAL AVERAGE	142,314						$ 20,826	

*Initial production estimate in year 1 from Helioscope model run

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Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 333,740	$ 463.13	231,564	$ 0.11	$ 25,472	$ 334,203	$ 25,472	$ 334,203	$ 25,472	0.08
	2	0	$ 458.50	229,248	0.113	$ 25,974	$ 458	$ 25,974	$ 334,662	$ 51,446	0.15
151.7	3	0	$ 453.91	226,956	0.117	$ 26,486	$ 454	$ 26,486	$ 335,116	$ 77,931	0.23
KW	4	0	$ 449.37	224,686	0.120	$ 27,007	$ 449	$ 27,007	$ 335,565	$ 104,939	0.31
Nameplate	5	0	$ 444.88	222,440	0.124	$ 27,539	$ 445	$ 27,539	$ 336,010	$ 132,478	0.39
	6	0	$ 440.43	220,215	0.128	$ 28,082	$ 440	$ 28,082	$ 336,450	$ 160,560	0.48
	7	0	$ 436.03	218,013	0.131	$ 28,635	$ 436	$ 28,635	$ 336,886	$ 189,195	0.56
	8	0	$ 431.67	215,833	0.135	$ 29,199	$ 432	$ 29,199	$ 337,318	$ 218,394	0.65
	9	0	$ 427.35	213,675	0.139	$ 29,774	$ 427	$ 29,774	$ 337,745	$ 248,169	0.73
	10	0	$ 423.08	211,538	0.144	$ 30,361	$ 423	$ 30,361	$ 338,168	$ 278,530	0.82
	11	0	$ 418.84	209,422	0.148	$ 30,959	$ 419	$ 30,959	$ 338,587	$ 309,489	0.91
	12	0	$ 414.66	207,328	0.152	$ 31,569	$ 415	$ 31,569	$ 339,002	$ 341,058	1.01
	13	0	$ 410.51	205,255	0.157	$ 32,191	$ 411	$ 32,191	$ 339,412	$ 373,248	1.10
	14	0	$ 406.40	203,202	0.162	$ 32,825	$ 406	$ 32,825	$ 339,819	$ 406,074	1.19
	15	0	$ 402.34	201,170	0.166	$ 33,472	$ 402	$ 33,472	$ 340,221	$ 439,545	1.29
	16	0	$ 398.32	199,159	0.171	$ 34,131	$ 398	$ 34,131	$ 340,619	$ 473,676	1.39
	17	0	$ 394.33	197,167	0.177	$ 34,803	$ 394	$ 34,803	$ 341,014	$ 508,480	1.49
	18	0	$ 390.39	195,195	0.182	$ 35,489	$ 390	$ 35,489	$ 341,404	$ 543,969	1.59
	19	0	$ 386.49	193,243	0.187	$ 36,188	$ 386	$ 36,188	$ 341,791	$ 580,157	1.70
	20	0	$ 382.62	191,311	0.193	$ 36,901	$ 383	$ 36,901	$ 342,173	$ 617,058	1.80
			TOTALS	4,216,621					$ 342,173	$ 617,058	
			ANNUAL AVERAGE	210,831						$ 30,853	

*Initial production estimate in year 1 from Helioscope model run

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Project	.2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 320,980	$ 445.42	222,711	$ 0.11	$ 24,498	$ 321,425	$ 24,498	$ 321,425	$ 24,498	0.08
	2	0	$ 440.97	220,483	0.113	$ 24,981	$ 441	$ 24,981	$ 321,866	$ 49,479	0.15
145.9	3	0	$ 436.56	218,279	0.117	$ 25,473	$ 437	$ 25,473	$ 322,303	$ 74,952	0.23
KW	4	0	$ 432.19	216,096	0.120	$ 25,975	$ 432	$ 25,975	$ 322,735	$ 100,927	0.31
Nameplate	5	0	$ 427.87	213,935	0.124	$ 26,486	$ 428	$ 26,486	$ 323,163	$ 127,413	0.39
	6	0	$ 423.59	211,796	0.128	$ 27,008	$ 424	$ 27,008	$ 323,587	$ 154,421	0.48
	7	0	$ 419.36	209,678	0.131	$ 27,540	$ 419	$ 27,540	$ 324,006	$ 181,961	0.56
	8	0	$ 415.16	207,581	0.135	$ 28,083	$ 415	$ 28,083	$ 324,421	$ 210,044	0.65
	9	0	$ 411.01	205,505	0.139	$ 28,636	$ 411	$ 28,636	$ 324,832	$ 238,680	0.73
	10	0	$ 406.90	203,450	0.144	$ 29,200	$ 407	$ 29,200	$ 325,239	$ 267,880	0.82
	11	0	$ 402.83	201,415	0.148	$ 29,775	$ 403	$ 29,775	$ 325,642	$ 297,656	0.91
	12	0	$ 398.80	199,401	0.152	$ 30,362	$ 399	$ 30,362	$ 326,041	$ 328,018	1.01
	13	0	$ 394.81	197,407	0.157	$ 30,960	$ 395	$ 30,960	$ 326,435	$ 358,978	1.10
	14	0	$ 390.87	195,433	0.162	$ 31,570	$ 391	$ 31,570	$ 326,826	$ 390,548	1.19
	15	0	$ 386.96	193,479	0.166	$ 32,192	$ 387	$ 32,192	$ 327,213	$ 422,740	1.29
	16	0	$ 383.09	191,544	0.171	$ 32,826	$ 383	$ 32,826	$ 327,596	$ 455,566	1.39
	17	0	$ 379.26	189,629	0.177	$ 33,473	$ 379	$ 33,473	$ 327,976	$ 489,039	1.49
	18	0	$ 375.46	187,732	0.182	$ 34,132	$ 375	$ 34,132	$ 328,351	$ 523,171	1.59
	19	0	$ 371.71	185,855	0.187	$ 34,805	$ 372	$ 34,805	$ 328,723	$ 557,976	1.70
	20	0	$ 367.99	183,996	0.193	$ 35,490	$ 368	$ 35,490	$ 329,091	$ 593,466	1.80
			TOTALS	4,055,405					$ 329,091	$ 593,466	
			ANNUAL AVERAGE	202,770						$ 29,673	

*Initial production estimate in year 1 from Helioscope model run

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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 157,740	$ 218.89	109,447	$ 0.11	$ 12,039	$ 157,959	$ 12,039	$ 157,959	$ 12,039	0.08
	2	0	$ 216.71	108,353	0.113	$ 12,276	$ 217	$ 12,276	$ 158,176	$ 24,316	0.15
71.7	3	0	$ 214.54	107,269	0.117	$ 12,518	$ 215	$ 12,518	$ 158,390	$ 36,834	0.23
KW	4	0	$ 212.39	106,197	0.120	$ 12,765	$ 212	$ 12,765	$ 158,603	$ 49,599	0.31
Nameplate	5	0	$ 210.27	105,135	0.124	$ 13,016	$ 210	$ 13,016	$ 158,813	$ 62,615	0.39
	6	0	$ 208.17	104,083	0.128	$ 13,273	$ 208	$ 13,273	$ 159,021	$ 75,888	0.48
	7	0	$ 206.08	103,042	0.131	$ 13,534	$ 206	$ 13,534	$ 159,227	$ 89,422	0.56
	8	0	$ 204.02	102,012	0.135	$ 13,801	$ 204	$ 13,801	$ 159,431	$ 103,223	0.65
	9	0	$ 201.98	100,992	0.139	$ 14,073	$ 202	$ 14,073	$ 159,633	$ 117,295	0.73
	10	0	$ 199.96	99,982	0.144	$ 14,350	$ 200	$ 14,350	$ 159,833	$ 131,645	0.82
	11	0	$ 197.96	98,982	0.148	$ 14,633	$ 198	$ 14,633	$ 160,031	$ 146,278	0.91
	12	0	$ 195.98	97,992	0.152	$ 14,921	$ 196	$ 14,921	$ 160,227	$ 161,199	1.01
	13	0	$ 194.02	97,012	0.157	$ 15,215	$ 194	$ 15,215	$ 160,421	$ 176,413	1.10
	14	0	$ 192.08	96,042	0.162	$ 15,515	$ 192	$ 15,515	$ 160,613	$ 191,928	1.19
	15	0	$ 190.16	95,082	0.166	$ 15,820	$ 190	$ 15,820	$ 160,803	$ 207,748	1.29
	16	0	$ 188.26	94,131	0.171	$ 16,132	$ 188	$ 16,132	$ 160,992	$ 223,880	1.39
	17	0	$ 186.38	93,190	0.177	$ 16,450	$ 186	$ 16,450	$ 161,178	$ 240,330	1.49
	18	0	$ 184.52	92,258	0.182	$ 16,774	$ 185	$ 16,774	$ 161,362	$ 257,103	1.59
	19	0	$ 182.67	91,335	0.187	$ 17,104	$ 183	$ 17,104	$ 161,545	$ 274,207	1.70
	20	0	$ 180.84	90,422	0.193	$ 17,441	$ 181	$ 17,441	$ 161,726	$ 291,648	1.80
			TOTALS	1,992,958					$ 161,726	$ 291,648	
			ANNUAL AVERAGE	99,648						$ 14,582	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 147,180	$ 204.24	102,120	$ 0.11	$ 11,233	$ 147,384	$ 11,233	$ 147,384	$ 11,233	0.08
	2	0	$ 202.20	101,099	0.113	$ 11,455	$ 202	$ 11,455	$ 147,586	$ 22,688	0.15
66.9	3	0	$ 200.18	100,088	0.117	$ 11,680	$ 200	$ 11,680	$ 147,787	$ 34,368	0.23
KW	4	0	$ 198.17	99,087	0.120	$ 11,910	$ 198	$ 11,910	$ 147,985	$ 46,278	0.31
Nameplate	5	0	$ 196.19	98,096	0.124	$ 12,145	$ 196	$ 12,145	$ 148,181	$ 58,423	0.39
	6	0	$ 194.23	97,115	0.128	$ 12,384	$ 194	$ 12,384	$ 148,375	$ 70,807	0.48
	7	0	$ 192.29	96,144	0.131	$ 12,628	$ 192	$ 12,628	$ 148,568	$ 83,435	0.56
	8	0	$ 190.37	95,183	0.135	$ 12,877	$ 190	$ 12,877	$ 148,758	$ 96,312	0.65
	9	0	$ 188.46	94,231	0.139	$ 13,131	$ 188	$ 13,131	$ 148,946	$ 109,443	0.73
	10	0	$ 186.58	93,289	0.144	$ 13,389	$ 187	$ 13,389	$ 149,133	$ 122,832	0.82
	11	0	$ 184.71	92,356	0.148	$ 13,653	$ 185	$ 13,653	$ 149,318	$ 136,485	0.91
	12	0	$ 182.86	91,432	0.152	$ 13,922	$ 183	$ 13,922	$ 149,500	$ 150,407	1.01
	13	0	$ 181.04	90,518	0.157	$ 14,196	$ 181	$ 14,196	$ 149,682	$ 164,603	1.10
	14	0	$ 179.23	89,613	0.162	$ 14,476	$ 179	$ 14,476	$ 149,861	$ 179,079	1.19
	15	0	$ 177.43	88,717	0.166	$ 14,761	$ 177	$ 14,761	$ 150,038	$ 193,840	1.29
	16	0	$ 175.66	87,829	0.171	$ 15,052	$ 176	$ 15,052	$ 150,214	$ 208,892	1.39
	17	0	$ 173.90	86,951	0.177	$ 15,348	$ 174	$ 15,348	$ 150,388	$ 224,241	1.49
	18	0	$ 172.16	86,082	0.182	$ 15,651	$ 172	$ 15,651	$ 150,560	$ 239,891	1.59
	19	0	$ 170.44	85,221	0.187	$ 15,959	$ 170	$ 15,959	$ 150,730	$ 255,850	1.70
	20	0	$ 168.74	84,369	0.193	$ 16,273	$ 169	$ 16,273	$ 150,899	$ 272,124	1.80
			TOTALS	1,859,538					$ 150,899	$ 272,124	
			ANNUAL AVERAGE	92,977						$ 13,606	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project	2	Computed	GLD
Date	1/2/1900		
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 198,440	$ 275.37	137,687	$ 0.11	$ 15,146	$ 198,715	$ 15,146	$ 198,715	$ 15,146	0.08
	2	0	$ 272.62	136,310	0.113	$ 15,444	$ 273	$ 15,444	$ 198,988	$ 30,589	0.15
90.2	3	0	$ 269.89	134,947	0.117	$ 15,748	$ 270	$ 15,748	$ 199,258	$ 46,338	0.23
KW	4	0	$ 267.19	133,597	0.120	$ 16,058	$ 267	$ 16,058	$ 199,525	$ 62,396	0.31
Nameplate	5	0	$ 264.52	132,261	0.124	$ 16,375	$ 265	$ 16,375	$ 199,790	$ 78,771	0.39
	6	0	$ 261.88	130,939	0.128	$ 16,697	$ 262	$ 16,697	$ 200,051	$ 95,468	0.48
	7	0	$ 259.26	129,629	0.131	$ 17,026	$ 259	$ 17,026	$ 200,311	$ 112,494	0.56
	8	0	$ 256.67	128,333	0.135	$ 17,362	$ 257	$ 17,362	$ 200,567	$ 129,856	0.65
	9	0	$ 254.10	127,050	0.139	$ 17,704	$ 254	$ 17,704	$ 200,822	$ 147,560	0.73
	10	0	$ 251.56	125,779	0.144	$ 18,052	$ 252	$ 18,052	$ 201,073	$ 165,612	0.82
	11	0	$ 249.04	124,521	0.148	$ 18,408	$ 249	$ 18,408	$ 201,322	$ 184,020	0.91
	12	0	$ 246.55	123,276	0.152	$ 18,771	$ 247	$ 18,771	$ 201,569	$ 202,791	1.01
	13	0	$ 244.09	122,043	0.157	$ 19,141	$ 244	$ 19,141	$ 201,813	$ 221,932	1.10
	14	0	$ 241.65	120,823	0.162	$ 19,518	$ 242	$ 19,518	$ 202,054	$ 241,449	1.19
	15	0	$ 239.23	119,615	0.166	$ 19,902	$ 239	$ 19,902	$ 202,294	$ 261,351	1.29
	16	0	$ 236.84	118,419	0.171	$ 20,294	$ 237	$ 20,294	$ 202,530	$ 281,645	1.39
	17	0	$ 234.47	117,234	0.177	$ 20,694	$ 234	$ 20,694	$ 202,765	$ 302,339	1.49
	18	0	$ 232.12	116,062	0.182	$ 21,102	$ 232	$ 21,102	$ 202,997	$ 323,441	1.59
	19	0	$ 229.80	114,901	0.187	$ 21,517	$ 230	$ 21,517	$ 203,227	$ 344,958	1.70
	20	0	$ 227.50	113,752	0.193	$ 21,941	$ 228	$ 21,941	$ 203,454	$ 366,900	1.80
			TOTALS	**2,507,180**					**$ 203,454**	**$ 366,900**	
			ANNUAL AVERAGE	**125,359**						**$ 18,345**	

*Initial production estimate in year 1 from Helioscope model run

	Job No.		No.
Project: 2	Computed: GLD		Date: 1/2/1900
Subject: Solar Feasibility	Checked		Date
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 190,740	$ 264.69	132,344	$ 0.11	$ 14,558	$ 191,005	$ 14,558	$ 191,005	$ 14,558	0.08
	2	0	$ 262.04	131,021	0.113	$ 14,845	$ 262	$ 14,845	$ 191,267	$ 29,402	0.15
86.7	3	0	$ 259.42	129,710	0.117	$ 15,137	$ 259	$ 15,137	$ 191,526	$ 44,540	0.23
KW	4	0	$ 256.83	128,413	0.120	$ 15,435	$ 257	$ 15,435	$ 191,783	$ 59,975	0.31
Nameplate	5	0	$ 254.26	127,129	0.124	$ 15,739	$ 254	$ 15,739	$ 192,037	$ 75,714	0.39
	6	0	$ 251.72	125,858	0.128	$ 16,049	$ 252	$ 16,049	$ 192,289	$ 91,764	0.48
	7	0	$ 249.20	124,599	0.131	$ 16,366	$ 249	$ 16,366	$ 192,538	$ 108,129	0.56
	8	0	$ 246.71	123,353	0.135	$ 16,688	$ 247	$ 16,688	$ 192,785	$ 124,817	0.65
	9	0	$ 244.24	122,120	0.139	$ 17,017	$ 244	$ 17,017	$ 193,029	$ 141,834	0.73
	10	0	$ 241.80	120,899	0.144	$ 17,352	$ 242	$ 17,352	$ 193,271	$ 159,186	0.82
	11	0	$ 239.38	119,690	0.148	$ 17,694	$ 239	$ 17,694	$ 193,510	$ 176,880	0.91
	12	0	$ 236.99	118,493	0.152	$ 18,042	$ 237	$ 18,042	$ 193,747	$ 194,922	1.01
	13	0	$ 234.62	117,308	0.157	$ 18,398	$ 235	$ 18,398	$ 193,982	$ 213,320	1.10
	14	0	$ 232.27	116,135	0.162	$ 18,760	$ 232	$ 18,760	$ 194,214	$ 232,080	1.19
	15	0	$ 229.95	114,973	0.166	$ 19,130	$ 230	$ 19,130	$ 194,444	$ 251,210	1.29
	16	0	$ 227.65	113,824	0.171	$ 19,507	$ 228	$ 19,507	$ 194,672	$ 270,717	1.39
	17	0	$ 225.37	112,685	0.177	$ 19,891	$ 225	$ 19,891	$ 194,897	$ 290,608	1.49
	18	0	$ 223.12	111,559	0.182	$ 20,283	$ 223	$ 20,283	$ 195,120	$ 310,891	1.59
	19	0	$ 220.89	110,443	0.187	$ 20,682	$ 221	$ 20,682	$ 195,341	$ 331,573	1.70
	20	0	$ 218.68	109,339	0.193	$ 21,090	$ 219	$ 21,090	$ 195,560	$ 352,663	1.80
			TOTALS	2,409,895					$ 195,560	$ 352,663	
			ANNUAL AVERAGE	120,495						$ 17,633	

*Initial production estimate in year 1 from Helioscope model run

HDR		Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 191,400	$ 265.60	132,802	$ 0.11	$ 14,608	$ 191,666	$ 14,608	$ 191,666	$ 14,608	0.08
	2	0	$ 262.95	131,474	0.113	$ 14,896	$ 263	$ 14,896	$ 191,929	$ 29,504	0.15
87	3	0	$ 260.32	130,159	0.117	$ 15,189	$ 260	$ 15,189	$ 192,189	$ 44,694	0.23
KW	4	0	$ 257.72	128,858	0.120	$ 15,489	$ 258	$ 15,489	$ 192,447	$ 60,182	0.31
Nameplate	5	0	$ 255.14	127,569	0.124	$ 15,794	$ 255	$ 15,794	$ 192,702	$ 75,976	0.39
	6	0	$ 252.59	126,293	0.128	$ 16,105	$ 253	$ 16,105	$ 192,954	$ 92,081	0.46
	7	0	$ 250.06	125,031	0.131	$ 16,422	$ 250	$ 16,422	$ 193,204	$ 108,503	0.56
	8	0	$ 247.56	123,780	0.135	$ 16,746	$ 248	$ 16,746	$ 193,452	$ 125,249	0.65
	9	0	$ 245.08	122,542	0.139	$ 17,076	$ 245	$ 17,076	$ 193,697	$ 142,325	0.73
	10	0	$ 242.63	121,317	0.144	$ 17,412	$ 243	$ 17,412	$ 193,940	$ 159,737	0.82
	11	0	$ 240.21	120,104	0.148	$ 17,755	$ 240	$ 17,755	$ 194,180	$ 177,492	0.91
	12	0	$ 237.81	118,903	0.152	$ 18,105	$ 238	$ 18,105	$ 194,418	$ 195,597	1.01
	13	0	$ 235.43	117,714	0.157	$ 18,461	$ 235	$ 18,461	$ 194,653	$ 214,058	1.10
	14	0	$ 233.07	116,537	0.162	$ 18,825	$ 233	$ 18,825	$ 194,886	$ 232,883	1.19
	15	0	$ 230.74	115,371	0.166	$ 19,196	$ 231	$ 19,196	$ 195,117	$ 252,079	1.29
	16	0	$ 228.44	114,218	0.171	$ 19,574	$ 228	$ 19,574	$ 195,345	$ 271,654	1.39
	17	0	$ 226.15	113,075	0.177	$ 19,960	$ 226	$ 19,960	$ 195,571	$ 291,613	1.49
	18	0	$ 223.89	111,945	0.182	$ 20,353	$ 224	$ 20,353	$ 195,795	$ 311,966	1.59
	19	0	$ 221.65	110,825	0.187	$ 20,754	$ 222	$ 20,754	$ 196,017	$ 332,720	1.70
	20	0	$ 219.43	109,717	0.193	$ 21,163	$ 219	$ 21,163	$ 196,236	$ 353,883	1.80
			TOTALS	2,418,233					$ 196,236	$ 353,883	
			ANNUAL AVERAGE	120,912						$ 17,694	

*Initial production estimate in year 1 from Helioscope model run

HDR

Job No.		No.	
Project 2	Computed GLD	Date	1/2/1900
Subject Solar Feasibility	Checked	Date	
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 409,640	$ 568.45	284,227	$ 0.11	$ 31,265	$ 410,208	$ 31,265	$ 410,208	$ 31,265	0.08
	2	0	$ 562.77	281,385	0.113	$ 31,881	$ 563	$ 31,881	$ 410,771	$ 63,146	0.15
186.2	3	0	$ 557.14	278,571	0.117	$ 32,509	$ 557	$ 32,509	$ 411,328	$ 95,655	0.23
KW	4	0	$ 551.57	275,785	0.120	$ 33,149	$ 552	$ 33,149	$ 411,880	$ 128,804	0.31
Nameplate	5	0	$ 546.05	273,027	0.124	$ 33,802	$ 546	$ 33,802	$ 412,426	$ 162,607	0.39
	6	0	$ 540.59	270,297	0.128	$ 34,468	$ 541	$ 34,468	$ 412,967	$ 197,075	0.48
	7	0	$ 535.19	267,594	0.131	$ 35,147	$ 535	$ 35,147	$ 413,502	$ 232,222	0.56
	8	0	$ 529.84	264,918	0.135	$ 35,840	$ 530	$ 35,840	$ 414,032	$ 268,062	0.65
	9	0	$ 524.54	262,269	0.139	$ 36,546	$ 525	$ 36,546	$ 414,556	$ 304,608	0.73
	10	0	$ 519.29	259,646	0.144	$ 37,266	$ 519	$ 37,266	$ 415,075	$ 341,873	0.82
	11	0	$ 514.10	257,050	0.148	$ 38,000	$ 514	$ 38,000	$ 415,590	$ 379,873	0.91
	12	0	$ 508.96	254,479	0.152	$ 38,748	$ 509	$ 38,748	$ 416,098	$ 418,622	1.01
	13	0	$ 503.87	251,934	0.157	$ 39,512	$ 504	$ 39,512	$ 416,602	$ 458,134	1.10
	14	0	$ 498.83	249,415	0.162	$ 40,290	$ 499	$ 40,290	$ 417,101	$ 498,424	1.19
	15	0	$ 493.84	246,921	0.166	$ 41,084	$ 494	$ 41,084	$ 417,595	$ 539,508	1.29
	16	0	$ 488.90	244,452	0.171	$ 41,893	$ 489	$ 41,893	$ 418,084	$ 581,401	1.39
	17	0	$ 484.01	242,007	0.177	$ 42,719	$ 484	$ 42,719	$ 418,568	$ 624,120	1.49
	18	0	$ 479.17	239,587	0.182	$ 43,560	$ 479	$ 43,560	$ 419,047	$ 667,680	1.59
	19	0	$ 474.38	237,191	0.187	$ 44,418	$ 474	$ 44,418	$ 419,522	$ 712,098	1.70
	20	0	$ 469.64	234,819	0.193	$ 45,293	$ 470	$ 45,293	$ 419,991	$ 757,391	1.80
			TOTALS	5,175,575					$ 419,991	$ 757,391	
			ANNUAL AVERAGE	258,779						$ 37,870	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project	2	Computed	GLD
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 378,840	$ 525.71	262,856	$ 0.11	$ 28,914	$ 379,366	$ 28,914	$ 379,366	$ 28,914	0.08
	2	0	$ 520.46	260,228	0.113	$ 29,484	$ 520	$ 29,484	$ 379,886	$ 58,398	0.15
172.2	3	0	$ 515.25	257,626	0.117	$ 30,065	$ 515	$ 30,065	$ 380,401	$ 88,463	0.23
KW	4	0	$ 510.10	255,049	0.120	$ 30,657	$ 510	$ 30,657	$ 380,912	$ 119,120	0.31
Nameplate	5	0	$ 505.00	252,499	0.124	$ 31,261	$ 505	$ 31,261	$ 381,417	$ 150,360	0.39
	6	0	$ 499.95	249,974	0.128	$ 31,877	$ 500	$ 31,877	$ 381,916	$ 182,257	0.48
	7	0	$ 494.95	247,474	0.131	$ 32,505	$ 495	$ 32,505	$ 382,411	$ 214,762	0.56
	8	0	$ 490.00	244,999	0.135	$ 33,145	$ 490	$ 33,145	$ 382,901	$ 247,907	0.65
	9	0	$ 485.10	242,549	0.139	$ 33,798	$ 485	$ 33,798	$ 383,387	$ 281,705	0.73
	10	0	$ 480.25	240,124	0.144	$ 34,464	$ 480	$ 34,464	$ 383,867	$ 316,169	0.82
	11	0	$ 475.45	237,723	0.148	$ 35,143	$ 475	$ 35,143	$ 384,342	$ 351,311	0.91
	12	0	$ 470.69	235,345	0.152	$ 35,835	$ 471	$ 35,835	$ 384,813	$ 387,146	1.01
	13	0	$ 465.98	232,992	0.157	$ 36,541	$ 466	$ 36,541	$ 385,279	$ 423,687	1.10
	14	0	$ 461.32	230,662	0.162	$ 37,261	$ 461	$ 37,261	$ 385,740	$ 460,948	1.19
	15	0	$ 456.71	228,355	0.166	$ 37,995	$ 457	$ 37,995	$ 386,197	$ 498,943	1.29
	16	0	$ 452.14	226,072	0.171	$ 38,743	$ 452	$ 38,743	$ 386,649	$ 537,687	1.39
	17	0	$ 447.62	223,811	0.177	$ 39,507	$ 448	$ 39,507	$ 387,097	$ 577,193	1.49
	18	0	$ 443.15	221,573	0.182	$ 40,285	$ 443	$ 40,285	$ 387,540	$ 617,478	1.59
	19	0	$ 438.71	219,357	0.187	$ 41,079	$ 439	$ 41,079	$ 387,979	$ 658,557	1.70
	20	0	$ 434.33	217,164	0.193	$ 41,888	$ 434	$ 41,888	$ 388,413	$ 700,445	1.80
			TOTALS	4,786,434					$ 388,413	$ 700,445	
			ANNUAL AVERAGE	239,322						$ 35,022	

*Initial production estimate in year 1 from Helioscope model run

Job No.				No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 202,840	$ 281.48	140,740	$ 0.11	$ 15,481	$ 203,121	$ 15,481	$ 203,121	$ 15,481	0.08
	2	0	$ 278.66	139,332	0.113	$ 15,786	$ 279	$ 15,786	$ 203,400	$ 31,268	0.15
92.2	3	0	$ 275.88	137,939	0.117	$ 16,097	$ 276	$ 16,097	$ 203,676	$ 47,365	0.23
KW	4	0	$ 273.12	136,560	0.120	$ 16,414	$ 273	$ 16,414	$ 203,949	$ 63,779	0.31
Nameplate	5	0	$ 270.39	135,194	0.124	$ 16,738	$ 270	$ 16,738	$ 204,220	$ 80,517	0.39
	6	0	$ 267.68	133,842	0.128	$ 17,068	$ 268	$ 17,068	$ 204,487	$ 97,585	0.48
	7	0	$ 265.01	132,504	0.131	$ 17,404	$ 265	$ 17,404	$ 204,752	$ 114,989	0.56
	8	0	$ 262.36	131,179	0.135	$ 17,747	$ 262	$ 17,747	$ 205,015	$ 132,735	0.65
	9	0	$ 259.73	129,867	0.139	$ 18,096	$ 260	$ 18,096	$ 205,274	$ 150,832	0.73
	10	0	$ 257.14	128,568	0.144	$ 18,453	$ 257	$ 18,453	$ 205,531	$ 169,284	0.82
	11	0	$ 254.56	127,282	0.148	$ 18,816	$ 255	$ 18,816	$ 205,786	$ 188,101	0.91
	12	0	$ 252.02	126,010	0.152	$ 19,187	$ 252	$ 19,187	$ 206,038	$ 207,287	1.01
	13	0	$ 249.50	124,750	0.157	$ 19,565	$ 249	$ 19,565	$ 206,288	$ 226,852	1.10
	14	0	$ 247.00	123,502	0.162	$ 19,950	$ 247	$ 19,950	$ 206,535	$ 246,803	1.19
	15	0	$ 244.53	122,267	0.166	$ 20,343	$ 245	$ 20,343	$ 206,779	$ 267,146	1.29
	16	0	$ 242.09	121,044	0.171	$ 20,744	$ 242	$ 20,744	$ 207,021	$ 287,890	1.39
	17	0	$ 239.67	119,834	0.177	$ 21,153	$ 240	$ 21,153	$ 207,261	$ 309,043	1.49
	18	0	$ 237.27	118,636	0.182	$ 21,570	$ 237	$ 21,570	$ 207,498	$ 330,613	1.59
	19	0	$ 234.90	117,449	0.187	$ 21,994	$ 235	$ 21,994	$ 207,733	$ 352,607	1.70
	20	0	$ 232.55	116,275	0.193	$ 22,428	$ 233	$ 22,428	$ 207,966	$ 375,035	1.80
			TOTALS	2,562,772					$ 207,966	$ 375,035	
			ANNUAL AVERAGE	128,139						$ 18,752	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project 2	Computed GLD	Date	1/2/1900
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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 327,360	$ 454.27	227,137	$ 0.11	$ 24,985	$ 327,814	$ 24,985	$ 327,814	$ 24,985	0.08
	2	0	$ 449.73	224,866	0.113	$ 25,477	$ 450	$ 25,477	$ 328,264	$ 50,462	0.15
148.6	3	0	$ 445.23	222,617	0.117	$ 25,979	$ 445	$ 25,979	$ 328,709	$ 76,442	0.23
KW	4	0	$ 440.78	220,391	0.120	$ 26,491	$ 441	$ 26,491	$ 329,150	$ 102,933	0.31
Nameplate	5	0	$ 436.37	218,187	0.124	$ 27,013	$ 436	$ 27,013	$ 329,586	$ 129,946	0.39
	6	0	$ 432.01	216,005	0.128	$ 27,545	$ 432	$ 27,545	$ 330,018	$ 157,491	0.48
	7	0	$ 427.69	213,845	0.131	$ 28,088	$ 428	$ 28,088	$ 330,446	$ 185,578	0.56
	8	0	$ 423.41	211,707	0.135	$ 28,641	$ 423	$ 28,641	$ 330,870	$ 214,219	0.65
	9	0	$ 419.18	209,590	0.139	$ 29,205	$ 419	$ 29,205	$ 331,289	$ 243,424	0.73
	10	0	$ 414.99	207,494	0.144	$ 29,781	$ 415	$ 29,781	$ 331,704	$ 273,205	0.82
	11	0	$ 410.84	205,419	0.148	$ 30,367	$ 411	$ 30,367	$ 332,115	$ 303,572	0.91
	12	0	$ 406.73	203,365	0.152	$ 30,965	$ 407	$ 30,965	$ 332,521	$ 334,538	1.01
	13	0	$ 402.66	201,331	0.157	$ 31,575	$ 403	$ 31,575	$ 332,924	$ 366,113	1.10
	14	0	$ 398.64	199,318	0.162	$ 32,198	$ 399	$ 32,198	$ 333,323	$ 398,311	1.19
	15	0	$ 394.65	197,325	0.166	$ 32,832	$ 395	$ 32,832	$ 333,717	$ 431,143	1.29
	16	0	$ 390.70	195,351	0.171	$ 33,479	$ 391	$ 33,479	$ 334,108	$ 464,621	1.39
	17	0	$ 386.80	193,398	0.177	$ 34,138	$ 387	$ 34,138	$ 334,495	$ 498,759	1.49
	18	0	$ 382.93	191,464	0.182	$ 34,811	$ 383	$ 34,811	$ 334,878	$ 533,570	1.59
	19	0	$ 379.10	189,549	0.187	$ 35,496	$ 379	$ 35,496	$ 335,257	$ 569,066	1.70
	20	0	$ 375.31	187,654	0.193	$ 36,196	$ 375	$ 36,196	$ 335,632	$ 605,262	1.80
		TOTALS		4,136,013					$ 335,632	$ 605,262	
			ANNUAL AVERAGE	206,801						$ 30,263	

*Initial production estimate in year 1 from Helioscope model run

HDR

Job No.				No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 410,520	$ 569.68	284,838	$ 0.11	$ 31,332	$ 411,090	$ 31,332	$ 411,090	$ 31,332	0.08
	2	0	$ 563.98	281,989	0.113	$ 31,949	$ 564	$ 31,949	$ 411,654	$ 63,281	0.15
186.6	3	0	$ 558.34	279,169	0.117	$ 32,579	$ 558	$ 32,579	$ 412,212	$ 95,860	0.23
KW	4	0	$ 552.76	276,378	0.120	$ 33,221	$ 553	$ 33,221	$ 412,765	$ 129,081	0.31
Nameplate	5	0	$ 547.23	273,614	0.124	$ 33,875	$ 547	$ 33,875	$ 413,312	$ 162,956	0.39
	6	0	$ 541.76	270,878	0.128	$ 34,542	$ 542	$ 34,542	$ 413,854	$ 197,498	0.48
	7	0	$ 536.34	268,169	0.131	$ 35,223	$ 536	$ 35,223	$ 414,390	$ 232,721	0.56
	8	0	$ 530.97	265,487	0.135	$ 35,917	$ 531	$ 35,917	$ 414,921	$ 268,638	0.65
	9	0	$ 525.66	262,832	0.139	$ 36,624	$ 526	$ 36,624	$ 415,447	$ 305,262	0.73
	10	0	$ 520.41	260,204	0.144	$ 37,346	$ 520	$ 37,346	$ 415,967	$ 342,608	0.82
	11	0	$ 515.20	257,602	0.148	$ 38,082	$ 515	$ 38,082	$ 416,482	$ 380,689	0.91
	12	0	$ 510.05	255,026	0.152	$ 38,832	$ 510	$ 38,832	$ 416,992	$ 419,521	1.01
	13	0	$ 504.95	252,476	0.157	$ 39,597	$ 505	$ 39,597	$ 417,497	$ 459,118	1.10
	14	0	$ 499.90	249,951	0.162	$ 40,377	$ 500	$ 40,377	$ 417,997	$ 499,495	1.19
	15	0	$ 494.90	247,451	0.166	$ 41,172	$ 495	$ 41,172	$ 418,492	$ 540,667	1.29
	16	0	$ 489.95	244,977	0.171	$ 41,983	$ 490	$ 41,983	$ 418,982	$ 582,650	1.39
	17	0	$ 485.05	242,527	0.177	$ 42,810	$ 485	$ 42,810	$ 419,467	$ 625,460	1.49
	18	0	$ 480.20	240,102	0.182	$ 43,654	$ 480	$ 43,654	$ 419,947	$ 669,114	1.59
	19	0	$ 475.40	237,701	0.187	$ 44,514	$ 475	$ 44,514	$ 420,423	$ 713,628	1.70
	20	0	$ 470.65	235,324	0.193	$ 45,391	$ 471	$ 45,391	$ 420,893	$ 759,018	1.80
		TOTALS		5,186,694					$ 420,893	$ 759,018	
		ANNUAL AVERAGE		259,335						$ 37,951	

*Initial production estimate in year 1 from Helioscope model run

HDR

Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 212,520	$ 294.91	147,456	$ 0.11	$ 16,220	$ 212,815	$ 16,220	$ 212,815	$ 16,220	0.08
	2	0	$ 291.96	145,982	0.113	$ 16,540	$ 292	$ 16,540	$ 213,107	$ 32,760	0.15
96.6	3	0	$ 289.04	144,522	0.117	$ 16,866	$ 289	$ 16,866	$ 213,396	$ 49,625	0.23
KW	4	0	$ 286.15	143,076	0.120	$ 17,198	$ 286	$ 17,198	$ 213,682	$ 66,823	0.31
Nameplate	5	0	$ 283.29	141,646	0.124	$ 17,537	$ 283	$ 17,537	$ 213,965	$ 84,360	0.39
	6	0	$ 280.46	140,229	0.128	$ 17,882	$ 280	$ 17,882	$ 214,246	$ 102,242	0.48
	7	0	$ 277.65	138,827	0.131	$ 18,234	$ 278	$ 18,234	$ 214,523	$ 120,476	0.56
	8	0	$ 274.88	137,439	0.135	$ 18,594	$ 275	$ 18,594	$ 214,798	$ 139,070	0.65
	9	0	$ 272.13	136,064	0.139	$ 18,960	$ 272	$ 18,960	$ 215,070	$ 158,030	0.73
	10	0	$ 269.41	134,704	0.144	$ 19,333	$ 269	$ 19,333	$ 215,340	$ 177,363	0.82
	11	0	$ 266.71	133,357	0.148	$ 19,714	$ 267	$ 19,714	$ 215,607	$ 197,077	0.91
	12	0	$ 264.05	132,023	0.152	$ 20,103	$ 264	$ 20,103	$ 215,871	$ 217,180	1.01
	13	0	$ 261.41	130,703	0.157	$ 20,499	$ 261	$ 20,499	$ 216,132	$ 237,678	1.10
	14	0	$ 258.79	129,396	0.162	$ 20,902	$ 259	$ 20,902	$ 216,391	$ 258,581	1.19
	15	0	$ 256.20	128,102	0.166	$ 21,314	$ 256	$ 21,314	$ 216,647	$ 279,895	1.29
	16	0	$ 253.64	126,821	0.171	$ 21,734	$ 254	$ 21,734	$ 216,901	$ 301,629	1.39
	17	0	$ 251.11	125,553	0.177	$ 22,162	$ 251	$ 22,162	$ 217,152	$ 323,791	1.49
	18	0	$ 248.59	124,297	0.182	$ 22,599	$ 249	$ 22,599	$ 217,400	$ 346,390	1.59
	19	0	$ 246.11	123,054	0.187	$ 23,044	$ 246	$ 23,044	$ 217,646	$ 369,434	1.70
	20	0	$ 243.65	121,824	0.193	$ 23,498	$ 244	$ 23,498	$ 217,890	$ 392,932	1.80
			TOTALS	2,685,073					$ 217,890	$ 392,932	
			ANNUAL AVERAGE	134,254						$ 19,647	

*Initial production estimate in year 1 from Helioscope model run

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Project	2	Computed	GLD
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 309,760	$ 429.85	214,926	$ 0.11	$ 23,642	$ 310,190	$ 23,642	$ 310,190	$ 23,642	0.08
	2	0	$ 425.55	212,776	0.113	$ 24,108	$ 426	$ 24,108	$ 310,615	$ 47,749	0.15
140.8	3	0	$ 421.30	210,649	0.117	$ 24,582	$ 421	$ 24,582	$ 311,037	$ 72,332	0.23
KW	4	0	$ 417.08	208,542	0.120	$ 25,067	$ 417	$ 25,067	$ 311,454	$ 97,399	0.31
Nameplate	5	0	$ 412.91	206,457	0.124	$ 25,561	$ 413	$ 25,561	$ 311,867	$ 122,959	0.39
	6	0	$ 408.78	204,392	0.128	$ 26,064	$ 409	$ 26,064	$ 312,275	$ 149,023	0.48
	7	0	$ 404.70	202,346	0.131	$ 26,578	$ 405	$ 26,578	$ 312,680	$ 175,601	0.56
	8	0	$ 400.65	200,325	0.135	$ 27,101	$ 401	$ 27,101	$ 313,081	$ 202,702	0.65
	9	0	$ 396.64	198,321	0.139	$ 27,635	$ 397	$ 27,635	$ 313,477	$ 230,337	0.73
	10	0	$ 392.68	196,338	0.144	$ 28,179	$ 393	$ 28,179	$ 313,870	$ 258,517	0.82
	11	0	$ 388.75	194,375	0.148	$ 28,735	$ 389	$ 28,735	$ 314,259	$ 287,251	0.91
	12	0	$ 384.86	192,431	0.152	$ 29,301	$ 385	$ 29,301	$ 314,644	$ 316,552	1.01
	13	0	$ 381.01	190,507	0.157	$ 29,878	$ 381	$ 29,878	$ 315,025	$ 346,430	1.10
	14	0	$ 377.20	188,602	0.162	$ 30,466	$ 377	$ 30,466	$ 315,402	$ 376,896	1.19
	15	0	$ 373.43	186,716	0.166	$ 31,067	$ 373	$ 31,067	$ 315,775	$ 407,963	1.29
	16	0	$ 369.70	184,849	0.171	$ 31,679	$ 370	$ 31,679	$ 316,145	$ 439,642	1.39
	17	0	$ 366.00	183,000	0.177	$ 32,303	$ 366	$ 32,303	$ 316,511	$ 471,944	1.49
	18	0	$ 362.34	181,170	0.182	$ 32,939	$ 362	$ 32,939	$ 316,873	$ 504,883	1.59
	19	0	$ 358.72	179,358	0.187	$ 33,588	$ 359	$ 33,588	$ 317,232	$ 538,471	1.70
	20	0	$ 355.13	177,565	0.193	$ 34,250	$ 355	$ 34,250	$ 317,587	$ 572,721	1.80
			TOTALS	3,913,647					$ 317,587	$ 572,721	
			ANNUAL AVERAGE	195,682						$ 28,636	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 332,200	$ 460.99	230,496	$ 0.11	$ 25,355	$ 332,661	$ 25,355	$ 332,661	$ 25,355	0.08
	2	0	$ 456.38	228,191	0.113	$ 25,854	$ 456	$ 25,854	$ 333,117	$ 51,209	0.15
151	3	0	$ 451.82	225,909	0.117	$ 26,363	$ 452	$ 26,363	$ 333,569	$ 77,572	0.23
KW	4	0	$ 447.30	223,650	0.120	$ 26,883	$ 447	$ 26,883	$ 334,016	$ 104,454	0.31
Nameplate	5	0	$ 442.83	221,413	0.124	$ 27,412	$ 443	$ 27,412	$ 334,459	$ 131,867	0.39
	6	0	$ 438.40	219,199	0.128	$ 27,952	$ 438	$ 27,952	$ 334,898	$ 159,819	0.48
	7	0	$ 434.01	217,007	0.131	$ 28,503	$ 434	$ 28,503	$ 335,332	$ 188,322	0.56
	8	0	$ 429.67	214,837	0.135	$ 29,064	$ 430	$ 29,064	$ 335,761	$ 217,386	0.65
	9	0	$ 425.38	212,689	0.139	$ 29,637	$ 425	$ 29,637	$ 336,187	$ 247,023	0.73
	10	0	$ 421.12	210,562	0.144	$ 30,221	$ 421	$ 30,221	$ 336,608	$ 277,244	0.82
	11	0	$ 416.91	208,456	0.148	$ 30,816	$ 417	$ 30,816	$ 337,025	$ 308,061	0.91
	12	0	$ 412.74	206,371	0.152	$ 31,423	$ 413	$ 31,423	$ 337,438	$ 339,484	1.01
	13	0	$ 408.62	204,308	0.157	$ 32,042	$ 409	$ 32,042	$ 337,846	$ 371,526	1.10
	14	0	$ 404.53	202,265	0.162	$ 32,674	$ 405	$ 32,674	$ 338,251	$ 404,200	1.19
	15	0	$ 400.48	200,242	0.166	$ 33,317	$ 400	$ 33,317	$ 338,651	$ 437,517	1.29
	16	0	$ 396.48	198,240	0.171	$ 33,974	$ 396	$ 33,974	$ 339,048	$ 471,491	1.39
	17	0	$ 392.51	196,257	0.177	$ 34,643	$ 393	$ 34,643	$ 339,440	$ 506,133	1.49
	18	0	$ 388.59	194,295	0.182	$ 35,325	$ 389	$ 35,325	$ 339,829	$ 541,459	1.59
	19	0	$ 384.70	192,352	0.187	$ 36,021	$ 385	$ 36,021	$ 340,213	$ 577,480	1.70
	20	0	$ 380.86	190,428	0.193	$ 36,731	$ 381	$ 36,731	$ 340,594	$ 614,211	1.80
			TOTALS	4,197,164					$ 340,594	$ 614,211	
			ANNUAL AVERAGE	209,858						$ 30,711	

*Initial production estimate in year 1 from Helioscope model run

Project	2	Computed	GLD	Date	1/2/1900
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Job No. No.

C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 207,020	$ 287.28	143,640	$ 0.11	$ 15,800	$ 207,307	$ 15,800	$ 207,307	$ 15,800	0.08
	2	0	$ 284.41	142,204	0.113	$ 16,112	$ 284	$ 16,112	$ 207,592	$ 31,912	0.15
94.1	3	0	$ 281.56	140,781	0.117	$ 16,429	$ 282	$ 16,429	$ 207,873	$ 48,341	0.23
KW	4	0	$ 278.75	139,374	0.120	$ 16,753	$ 279	$ 16,753	$ 208,152	$ 65,094	0.31
Nameplate	5	0	$ 275.96	137,980	0.124	$ 17,083	$ 276	$ 17,083	$ 208,428	$ 82,177	0.39
	6	0	$ 273.20	136,600	0.128	$ 17,419	$ 273	$ 17,419	$ 208,701	$ 99,596	0.48
	7	0	$ 270.47	135,234	0.131	$ 17,762	$ 270	$ 17,762	$ 208,972	$ 117,358	0.56
	8	0	$ 267.76	133,882	0.135	$ 18,112	$ 268	$ 18,112	$ 209,239	$ 135,471	0.65
	9	0	$ 265.09	132,543	0.139	$ 18,469	$ 265	$ 18,469	$ 209,504	$ 153,940	0.73
	10	0	$ 262.44	131,218	0.144	$ 18,833	$ 262	$ 18,833	$ 209,767	$ 172,773	0.82
	11	0	$ 259.81	129,905	0.148	$ 19,204	$ 260	$ 19,204	$ 210,027	$ 191,977	0.91
	12	0	$ 257.21	128,606	0.152	$ 19,582	$ 257	$ 19,582	$ 210,284	$ 211,559	1.01
	13	0	$ 254.64	127,320	0.157	$ 19,968	$ 255	$ 19,968	$ 210,539	$ 231,527	1.10
	14	0	$ 252.09	126,047	0.162	$ 20,361	$ 252	$ 20,361	$ 210,791	$ 251,889	1.19
	15	0	$ 249.57	124,787	0.166	$ 20,763	$ 250	$ 20,763	$ 211,040	$ 272,651	1.29
	16	0	$ 247.08	123,539	0.171	$ 21,172	$ 247	$ 21,172	$ 211,287	$ 293,823	1.39
	17	0	$ 244.61	122,303	0.177	$ 21,589	$ 245	$ 21,589	$ 211,532	$ 315,412	1.49
	18	0	$ 242.16	121,080	0.182	$ 22,014	$ 242	$ 22,014	$ 211,774	$ 337,426	1.59
	19	0	$ 239.74	119,869	0.187	$ 22,448	$ 240	$ 22,448	$ 212,014	$ 359,873	1.70
	20	0	$ 237.34	118,671	0.193	$ 22,890	$ 237	$ 22,890	$ 212,251	$ 382,763	1.80
			TOTALS	2,615,583					$ 212,251	$ 382,763	
			ANNUAL AVERAGE	130,779						$ 19,138	

*Initial production estimate in year 1 from Helioscope model run

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Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 315,480	$ 437.79	218,894	$ 0.11	$ 24,078	$ 315,918	$ 24,078	$ 315,918	$ 24,078	0.08
	2	0	$ 433.41	216,705	0.113	$ 24,553	$ 433	$ 24,553	$ 316,351	$ 48,631	0.15
143.4	3	0	$ 429.08	214,538	0.117	$ 25,036	$ 429	$ 25,036	$ 316,780	$ 73,668	0.23
KW	4	0	$ 424.79	212,393	0.120	$ 25,530	$ 425	$ 25,530	$ 317,205	$ 99,197	0.31
Nameplate	5	0	$ 420.54	210,269	0.124	$ 26,033	$ 421	$ 26,033	$ 317,626	$ 125,230	0.39
	6	0	$ 416.33	208,166	0.128	$ 26,545	$ 416	$ 26,545	$ 318,042	$ 151,775	0.48
	7	0	$ 412.17	206,085	0.131	$ 27,068	$ 412	$ 27,068	$ 318,454	$ 178,844	0.56
	8	0	$ 408.05	204,024	0.135	$ 27,602	$ 408	$ 27,602	$ 318,862	$ 206,445	0.65
	9	0	$ 403.97	201,984	0.139	$ 28,145	$ 404	$ 28,145	$ 319,266	$ 234,590	0.73
	10	0	$ 399.93	199,964	0.144	$ 28,700	$ 400	$ 28,700	$ 319,666	$ 263,290	0.82
	11	0	$ 395.93	197,964	0.148	$ 29,265	$ 396	$ 29,265	$ 320,062	$ 292,556	0.91
	12	0	$ 391.97	195,985	0.152	$ 29,842	$ 392	$ 29,842	$ 320,454	$ 322,397	1.01
	13	0	$ 388.05	194,025	0.157	$ 30,430	$ 388	$ 30,430	$ 320,842	$ 352,827	1.10
	14	0	$ 384.17	192,084	0.162	$ 31,029	$ 384	$ 31,029	$ 321,226	$ 383,856	1.19
	15	0	$ 380.33	190,164	0.166	$ 31,640	$ 380	$ 31,640	$ 321,606	$ 415,496	1.29
	16	0	$ 376.52	188,262	0.171	$ 32,264	$ 377	$ 32,264	$ 321,983	$ 447,760	1.39
	17	0	$ 372.76	186,379	0.177	$ 32,899	$ 373	$ 32,899	$ 322,356	$ 480,659	1.49
	18	0	$ 369.03	184,516	0.182	$ 33,547	$ 369	$ 33,547	$ 322,725	$ 514,207	1.59
	19	0	$ 365.34	182,670	0.187	$ 34,208	$ 365	$ 34,208	$ 323,090	$ 548,415	1.70
	20	0	$ 361.69	180,844	0.193	$ 34,882	$ 362	$ 34,882	$ 323,452	$ 583,297	1.80
			TOTALS	3,985,916					$ 323,452	$ 583,297	
			ANNUAL AVERAGE	199,296						$ 29,165	

*Initial production estimate in year 1 from Helioscope model run

C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 331,540	$ 460.08	230,038	$ 0.11	$ 25,304	$ 332,000	$ 25,304	$ 332,000	$ 25,304	0.08
	2	0	$ 455.47	227,737	0.113	$ 25,803	$ 455	$ 25,803	$ 332,456	$ 51,107	0.15
150.7	3	0	$ 450.92	225,460	0.117	$ 26,311	$ 451	$ 26,311	$ 332,906	$ 77,418	0.23
KW	4	0	$ 446.41	223,205	0.120	$ 26,829	$ 446	$ 26,829	$ 333,353	$ 104,247	0.31
Nameplate	5	0	$ 441.95	220,973	0.124	$ 27,358	$ 442	$ 27,358	$ 333,795	$ 131,605	0.39
	6	0	$ 437.53	218,763	0.128	$ 27,897	$ 438	$ 27,897	$ 334,232	$ 159,502	0.48
	7	0	$ 433.15	216,576	0.131	$ 28,446	$ 433	$ 28,446	$ 334,666	$ 187,948	0.56
	8	0	$ 428.82	214,410	0.135	$ 29,007	$ 429	$ 29,007	$ 335,094	$ 216,955	0.65
	9	0	$ 424.53	212,266	0.139	$ 29,578	$ 425	$ 29,578	$ 335,519	$ 246,533	0.73
	10	0	$ 420.29	210,143	0.144	$ 30,161	$ 420	$ 30,161	$ 335,939	$ 276,694	0.82
	11	0	$ 416.08	208,042	0.148	$ 30,755	$ 416	$ 30,755	$ 336,355	$ 307,449	0.91
	12	0	$ 411.92	205,961	0.152	$ 31,361	$ 412	$ 31,361	$ 336,767	$ 338,809	1.01
	13	0	$ 407.80	203,902	0.157	$ 31,979	$ 408	$ 31,979	$ 337,175	$ 370,788	1.10
	14	0	$ 403.73	201,863	0.162	$ 32,609	$ 404	$ 32,609	$ 337,579	$ 403,397	1.19
	15	0	$ 399.69	199,844	0.166	$ 33,251	$ 400	$ 33,251	$ 337,978	$ 436,648	1.29
	16	0	$ 395.69	197,846	0.171	$ 33,906	$ 396	$ 33,906	$ 338,374	$ 470,554	1.39
	17	0	$ 391.73	195,867	0.177	$ 34,574	$ 392	$ 34,574	$ 338,766	$ 505,128	1.49
	18	0	$ 387.82	193,909	0.182	$ 35,255	$ 388	$ 35,255	$ 339,154	$ 540,383	1.59
	19	0	$ 383.94	191,970	0.187	$ 35,950	$ 384	$ 35,950	$ 339,538	$ 576,333	1.70
	20	0	$ 380.10	190,050	0.193	$ 36,658	$ 380	$ 36,658	$ 339,918	$ 612,991	1.80
		TOTALS		4,188,825					$ 339,918	$ 612,991	
			ANNUAL AVERAGE	209,441						$ 30,650	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 257,620	$ 357.50	178,749	$ 0.11	$ 19,662	$ 257,977	$ 19,662	$ 257,977	$ 19,662	0.08
	2	0	$ 353.92	176,961	0.113	$ 20,050	$ 354	$ 20,050	$ 258,331	$ 39,712	0.15
117.1	3	0	$ 350.38	175,191	0.117	$ 20,445	$ 350	$ 20,445	$ 258,682	$ 60,157	0.23
KW	4	0	$ 346.88	173,440	0.120	$ 20,847	$ 347	$ 20,847	$ 259,029	$ 81,004	0.31
Nameplate	5	0	$ 343.41	171,705	0.124	$ 21,258	$ 343	$ 21,258	$ 259,372	$ 102,262	0.39
	6	0	$ 339.98	169,988	0.128	$ 21,677	$ 340	$ 21,677	$ 259,712	$ 123,939	0.48
	7	0	$ 336.58	168,288	0.131	$ 22,104	$ 337	$ 22,104	$ 260,049	$ 146,043	0.56
	8	0	$ 333.21	166,605	0.135	$ 22,539	$ 333	$ 22,539	$ 260,382	$ 168,582	0.65
	9	0	$ 329.88	164,939	0.139	$ 22,983	$ 330	$ 22,983	$ 260,712	$ 191,566	0.73
	10	0	$ 326.58	163,290	0.144	$ 23,436	$ 327	$ 23,436	$ 261,038	$ 215,002	0.82
	11	0	$ 323.31	161,657	0.148	$ 23,898	$ 323	$ 23,898	$ 261,362	$ 238,900	0.91
	12	0	$ 320.08	160,040	0.152	$ 24,369	$ 320	$ 24,369	$ 261,682	$ 263,269	1.01
	13	0	$ 316.88	158,440	0.157	$ 24,849	$ 317	$ 24,849	$ 261,999	$ 288,117	1.10
	14	0	$ 313.71	156,856	0.162	$ 25,338	$ 314	$ 25,338	$ 262,312	$ 313,456	1.19
	15	0	$ 310.57	155,287	0.166	$ 25,837	$ 311	$ 25,837	$ 262,623	$ 339,293	1.29
	16	0	$ 307.47	153,734	0.171	$ 26,346	$ 307	$ 26,346	$ 262,930	$ 365,639	1.39
	17	0	$ 304.39	152,197	0.177	$ 26,865	$ 304	$ 26,865	$ 263,235	$ 392,505	1.49
	18	0	$ 301.35	150,675	0.182	$ 27,395	$ 301	$ 27,395	$ 263,536	$ 419,900	1.59
	19	0	$ 298.34	149,168	0.187	$ 27,934	$ 298	$ 27,934	$ 263,834	$ 447,834	1.70
	20	0	$ 295.35	147,676	0.193	$ 28,485	$ 295	$ 28,485	$ 264,130	$ 476,319	1.80
			TOTALS	3,254,887					$ 264,130	$ 476,319	
			ANNUAL AVERAGE	162,744						$ 23,816	

*Initial production estimate in year 1 from Helioscope model run

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Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
Subject	Solar Feasbility	Checked		Date	
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 194,260	$ 269.57	134,786	$ 0.11	$ 14,827	$ 194,530	$ 14,827	$ 194,530	$ 14,827	0.08
	2	0	$ 266.88	133,439	0.113	$ 15,119	$ 267	$ 15,119	$ 194,796	$ 29,945	0.15
88.3	3	0	$ 264.21	132,104	0.117	$ 15,416	$ 264	$ 15,416	$ 195,061	$ 45,362	0.23
KW	4	0	$ 261.57	130,783	0.120	$ 15,720	$ 262	$ 15,720	$ 195,322	$ 61,082	0.31
Nameplate	5	0	$ 258.95	129,475	0.124	$ 16,030	$ 259	$ 16,030	$ 195,581	$ 77,111	0.39
	6	0	$ 256.36	128,181	0.128	$ 16,346	$ 256	$ 16,346	$ 195,838	$ 93,457	0.48
	7	0	$ 253.80	126,899	0.131	$ 16,668	$ 254	$ 16,668	$ 196,091	$ 110,125	0.56
	8	0	$ 251.26	125,630	0.135	$ 16,996	$ 251	$ 16,996	$ 196,343	$ 127,121	0.65
	9	0	$ 248.75	124,373	0.139	$ 17,331	$ 249	$ 17,331	$ 196,591	$ 144,451	0.73
	10	0	$ 246.26	123,130	0.144	$ 17,672	$ 246	$ 17,672	$ 196,838	$ 162,124	0.82
	11	0	$ 243.80	121,898	0.148	$ 18,020	$ 244	$ 18,020	$ 197,081	$ 180,144	0.91
	12	0	$ 241.36	120,679	0.152	$ 18,375	$ 241	$ 18,375	$ 197,323	$ 198,519	1.01
	13	0	$ 238.95	119,473	0.157	$ 18,737	$ 239	$ 18,737	$ 197,562	$ 217,257	1.10
	14	0	$ 236.56	118,278	0.162	$ 19,106	$ 237	$ 19,106	$ 197,798	$ 236,363	1.19
	15	0	$ 234.19	117,095	0.166	$ 19,483	$ 234	$ 19,483	$ 198,032	$ 255,846	1.29
	16	0	$ 231.85	115,924	0.171	$ 19,867	$ 232	$ 19,867	$ 198,264	$ 275,713	1.39
	17	0	$ 229.53	114,765	0.177	$ 20,258	$ 230	$ 20,258	$ 198,494	$ 295,971	1.49
	18	0	$ 227.23	113,617	0.182	$ 20,657	$ 227	$ 20,657	$ 198,721	$ 316,628	1.59
	19	0	$ 224.96	112,481	0.187	$ 21,064	$ 225	$ 21,064	$ 198,946	$ 337,692	1.70
	20	0	$ 222.71	111,356	0.193	$ 21,479	$ 223	$ 21,479	$ 199,169	$ 359,171	1.80
			TOTALS	2,454,368					$ 199,169	$ 359,171	
			ANNUAL AVERAGE	122,718						$ 17,959	

*Initial production estimate in year 1 from Helioscope model run

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Job No.		No.	
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 257,620	$ 357.50	178,749	$ 0.11	$ 19,662	$ 257,977	$ 19,662	$ 257,977	$ 19,662	0.08
	2	0	$ 353.92	176,961	0.113	$ 20,050	$ 354	$ 20,050	$ 258,331	$ 39,712	0.15
117.1	3	0	$ 350.38	175,191	0.117	$ 20,445	$ 350	$ 20,445	$ 258,682	$ 60,157	0.23
KW	4	0	$ 346.88	173,440	0.120	$ 20,847	$ 347	$ 20,847	$ 259,029	$ 81,004	0.31
Nameplate	5	0	$ 343.41	171,705	0.124	$ 21,258	$ 343	$ 21,258	$ 259,372	$ 102,262	0.39
	6	0	$ 339.98	169,988	0.128	$ 21,677	$ 340	$ 21,677	$ 259,712	$ 123,939	0.48
	7	0	$ 336.58	168,288	0.131	$ 22,104	$ 337	$ 22,104	$ 260,049	$ 146,043	0.56
	8	0	$ 333.21	166,605	0.135	$ 22,539	$ 333	$ 22,539	$ 260,382	$ 168,582	0.65
	9	0	$ 329.88	164,939	0.139	$ 22,983	$ 330	$ 22,983	$ 260,712	$ 191,566	0.73
	10	0	$ 326.58	163,290	0.144	$ 23,436	$ 327	$ 23,436	$ 261,038	$ 215,002	0.82
	11	0	$ 323.31	161,657	0.148	$ 23,898	$ 323	$ 23,898	$ 261,362	$ 238,900	0.91
	12	0	$ 320.08	160,040	0.152	$ 24,369	$ 320	$ 24,369	$ 261,682	$ 263,269	1.01
	13	0	$ 316.88	158,440	0.157	$ 24,849	$ 317	$ 24,849	$ 261,999	$ 288,117	1.10
	14	0	$ 313.71	156,856	0.162	$ 25,338	$ 314	$ 25,338	$ 262,312	$ 313,456	1.19
	15	0	$ 310.57	155,287	0.166	$ 25,837	$ 311	$ 25,837	$ 262,623	$ 339,293	1.29
	16	0	$ 307.47	153,734	0.171	$ 26,346	$ 307	$ 26,346	$ 262,930	$ 365,639	1.39
	17	0	$ 304.39	152,197	0.177	$ 26,865	$ 304	$ 26,865	$ 263,235	$ 392,505	1.49
	18	0	$ 301.35	150,675	0.182	$ 27,395	$ 301	$ 27,395	$ 263,536	$ 419,900	1.59
	19	0	$ 298.34	149,168	0.187	$ 27,934	$ 298	$ 27,934	$ 263,834	$ 447,834	1.70
	20	0	$ 295.35	147,676	0.193	$ 28,485	$ 295	$ 28,485	$ 264,130	$ 476,319	1.80
			TOTALS	3,254,887					$ 264,130	$ 476,319	
			ANNUAL AVERAGE	162,744						$ 23,816	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project 2	Computed GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 347,160	$ 481.75	240,675	$ 0.11	$ 26,496	$ 347,642	$ 26,496	$ 347,642	$ 26,496	0.08
	2	0	$ 476.93	238,467	0.113	$ 27,018	$ 477	$ 27,018	$ 348,119	$ 53,515	0.15
157.8	3	0	$ 472.16	236,082	0.117	$ 27,551	$ 472	$ 27,551	$ 348,591	$ 81,065	0.23
KW	4	0	$ 467.44	233,721	0.120	$ 28,093	$ 467	$ 28,093	$ 349,058	$ 109,158	0.31
Nameplate	5	0	$ 462.77	231,384	0.124	$ 28,647	$ 463	$ 28,647	$ 349,521	$ 137,805	0.39
	6	0	$ 458.14	229,070	0.128	$ 29,211	$ 458	$ 29,211	$ 349,979	$ 167,016	0.48
	7	0	$ 453.56	226,779	0.131	$ 29,787	$ 454	$ 29,787	$ 350,433	$ 196,803	0.56
	8	0	$ 449.02	224,512	0.135	$ 30,373	$ 449	$ 30,373	$ 350,882	$ 227,176	0.65
	9	0	$ 444.53	222,267	0.139	$ 30,972	$ 445	$ 30,972	$ 351,326	$ 258,148	0.73
	10	0	$ 440.09	220,044	0.144	$ 31,582	$ 440	$ 31,582	$ 351,766	$ 289,729	0.82
	11	0	$ 435.69	217,843	0.148	$ 32,204	$ 436	$ 32,204	$ 352,202	$ 321,933	0.91
	12	0	$ 431.33	215,665	0.152	$ 32,838	$ 431	$ 32,838	$ 352,633	$ 354,772	1.01
	13	0	$ 427.02	213,508	0.157	$ 33,485	$ 427	$ 33,485	$ 353,060	$ 388,257	1.10
	14	0	$ 422.75	211,373	0.162	$ 34,145	$ 423	$ 34,145	$ 353,483	$ 422,402	1.19
	15	0	$ 418.52	209,260	0.166	$ 34,818	$ 419	$ 34,818	$ 353,902	$ 457,220	1.29
	16	0	$ 414.33	207,167	0.171	$ 35,504	$ 414	$ 35,504	$ 354,316	$ 492,723	1.39
	17	0	$ 410.19	205,095	0.177	$ 36,203	$ 410	$ 36,203	$ 354,726	$ 528,926	1.49
	18	0	$ 406.09	203,044	0.182	$ 36,916	$ 406	$ 36,916	$ 355,132	$ 565,842	1.59
	19	0	$ 402.03	201,014	0.187	$ 37,643	$ 402	$ 37,643	$ 355,534	$ 603,486	1.70
	20	0	$ 398.01	199,004	0.193	$ 38,385	$ 398	$ 38,385	$ 355,932	$ 641,871	1.80
			TOTALS	4,386,175					$ 355,932	$ 641,871	
			ANNUAL AVERAGE	219,309						$ 32,094	

*Initial production estimate in year 1 from Helioscope model run

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Project	2	Computed GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 644,820	$ 894.81	447,406	$ 0.11	$ 49,215	$ 645,715	$ 49,215	$ 645,715	$ 49,215	0.08
	2	0	$ 885.86	442,932	0.113	$ 50,184	$ 886	$ 50,184	$ 646,601	$ 99,399	0.15
293.1	3	0	$ 877.00	438,502	0.117	$ 51,173	$ 877	$ 51,173	$ 647,478	$ 150,572	0.23
KW	4	0	$ 868.23	434,117	0.120	$ 52,181	$ 868	$ 52,181	$ 648,346	$ 202,752	0.31
Nameplate	5	0	$ 859.55	429,776	0.124	$ 53,209	$ 860	$ 53,209	$ 649,205	$ 255,961	0.39
	6	0	$ 850.96	425,478	0.128	$ 54,257	$ 851	$ 54,257	$ 650,056	$ 310,218	0.48
	7	0	$ 842.45	421,223	0.131	$ 55,326	$ 842	$ 55,326	$ 650,899	$ 365,544	0.56
	8	0	$ 834.02	417,011	0.135	$ 56,416	$ 834	$ 56,416	$ 651,733	$ 421,960	0.65
	9	0	$ 825.68	412,841	0.139	$ 57,527	$ 826	$ 57,527	$ 652,559	$ 479,487	0.73
	10	0	$ 817.43	408,713	0.144	$ 58,661	$ 817	$ 58,661	$ 653,376	$ 538,148	0.82
	11	0	$ 809.25	404,626	0.148	$ 59,816	$ 809	$ 59,816	$ 654,185	$ 597,964	0.91
	12	0	$ 801.16	400,579	0.152	$ 60,995	$ 801	$ 60,995	$ 654,986	$ 658,958	1.01
	13	0	$ 793.15	396,574	0.157	$ 62,196	$ 793	$ 62,196	$ 655,780	$ 721,154	1.10
	14	0	$ 785.22	392,608	0.162	$ 63,421	$ 785	$ 63,421	$ 656,565	$ 784,576	1.19
	15	0	$ 777.36	388,682	0.166	$ 64,671	$ 777	$ 64,671	$ 657,342	$ 849,247	1.29
	16	0	$ 769.59	384,795	0.171	$ 65,945	$ 770	$ 65,945	$ 658,112	$ 915,191	1.39
	17	0	$ 761.89	380,947	0.177	$ 67,244	$ 762	$ 67,244	$ 658,874	$ 982,435	1.49
	18	0	$ 754.27	377,137	0.182	$ 68,569	$ 754	$ 68,569	$ 659,628	$ 1,051,004	1.59
	19	0	$ 746.73	373,366	0.187	$ 69,919	$ 747	$ 69,919	$ 660,375	$ 1,120,923	1.70
	20	0	$ 739.26	369,632	0.193	$ 71,297	$ 739	$ 71,297	$ 661,114	$ 1,192,220	1.80
			TOTALS	8,146,945					$ 661,114	$ 1,192,220	
			ANNUAL AVERAGE	407,347						$ 59,611	

*Initial production estimate in year 1 from Helioscope model run

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Job No.		No.	
Project	2	Computed	GLD
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 531,520	$ 737.59	368,793	$ 0.11	$ 40,567	$ 532,258	$ 40,567	$ 532,258	$ 40,567	0.08
	2	0	$ 730.21	365,105	0.113	$ 41,366	$ 730	$ 41,366	$ 532,988	$ 81,934	0.15
241.6	3	0	$ 722.91	361,454	0.117	$ 42,181	$ 723	$ 42,181	$ 533,711	$ 124,115	0.23
KW	4	0	$ 715.68	357,839	0.120	$ 43,012	$ 716	$ 43,012	$ 534,426	$ 167,127	0.31
Nameplate	5	0	$ 708.52	354,261	0.124	$ 43,860	$ 709	$ 43,860	$ 535,135	$ 210,987	0.39
	6	0	$ 701.44	350,718	0.128	$ 44,724	$ 701	$ 44,724	$ 535,836	$ 255,710	0.48
	7	0	$ 694.42	347,211	0.131	$ 45,605	$ 694	$ 45,605	$ 536,531	$ 301,315	0.56
	8	0	$ 687.48	343,739	0.135	$ 46,503	$ 687	$ 46,503	$ 537,218	$ 347,818	0.65
	9	0	$ 680.60	340,302	0.139	$ 47,419	$ 681	$ 47,419	$ 537,899	$ 395,238	0.73
	10	0	$ 673.80	336,899	0.144	$ 48,353	$ 674	$ 48,353	$ 538,573	$ 443,591	0.82
	11	0	$ 667.06	333,530	0.148	$ 49,306	$ 667	$ 49,306	$ 539,240	$ 492,897	0.91
	12	0	$ 660.39	330,194	0.152	$ 50,277	$ 660	$ 50,277	$ 539,900	$ 543,174	1.01
	13	0	$ 653.78	326,892	0.157	$ 51,268	$ 654	$ 51,268	$ 540,554	$ 594,442	1.10
	14	0	$ 647.25	323,623	0.162	$ 52,278	$ 647	$ 52,278	$ 541,201	$ 646,720	1.19
	15	0	$ 640.77	320,387	0.166	$ 53,308	$ 641	$ 53,308	$ 541,842	$ 700,027	1.29
	16	0	$ 634.37	317,183	0.171	$ 54,358	$ 634	$ 54,358	$ 542,476	$ 754,385	1.39
	17	0	$ 628.02	314,012	0.177	$ 55,429	$ 628	$ 55,429	$ 543,104	$ 809,814	1.49
	18	0	$ 621.74	310,871	0.182	$ 56,521	$ 622	$ 56,521	$ 543,726	$ 866,334	1.59
	19	0	$ 615.53	307,763	0.187	$ 57,634	$ 616	$ 57,634	$ 544,342	$ 923,968	1.70
	20	0	$ 609.37	304,685	0.193	$ 58,769	$ 609	$ 58,769	$ 544,951	$ 982,737	1.80
			TOTALS	6,715,462					$ 544,951	$ 982,737	
			ANNUAL AVERAGE	335,773						$ 49,137	

*Initial production estimate in year 1 from Helioscope model run

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Job No.		No.	
Project	2	Computed	GLD
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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 320,960	$ 445.42	222,711	$ 0.11	$ 24,498	$ 321,425	$ 24,498	$ 321,425	$ 24,498	0.08
	2	0	$ 440.97	220,483	0.113	$ 24,981	$ 441	$ 24,981	$ 321,866	$ 49,479	0.15
145.9	3	0	$ 436.56	218,279	0.117	$ 25,473	$ 437	$ 25,473	$ 322,303	$ 74,952	0.23
KW	4	0	$ 432.19	216,096	0.120	$ 25,975	$ 432	$ 25,975	$ 322,735	$ 100,927	0.31
Nameplate	5	0	$ 427.87	213,935	0.124	$ 26,486	$ 428	$ 26,486	$ 323,163	$ 127,413	0.39
	6	0	$ 423.59	211,796	0.128	$ 27,008	$ 424	$ 27,008	$ 323,587	$ 154,421	0.48
	7	0	$ 419.36	209,678	0.131	$ 27,540	$ 419	$ 27,540	$ 324,006	$ 181,961	0.56
	8	0	$ 415.16	207,581	0.135	$ 28,083	$ 415	$ 28,083	$ 324,421	$ 210,044	0.65
	9	0	$ 411.01	205,505	0.139	$ 28,636	$ 411	$ 28,636	$ 324,832	$ 238,680	0.73
	10	0	$ 406.90	203,450	0.144	$ 29,200	$ 407	$ 29,200	$ 325,239	$ 267,880	0.82
	11	0	$ 402.83	201,415	0.148	$ 29,775	$ 403	$ 29,775	$ 325,642	$ 297,656	0.91
	12	0	$ 398.80	199,401	0.152	$ 30,362	$ 399	$ 30,362	$ 326,041	$ 328,018	1.01
	13	0	$ 394.81	197,407	0.157	$ 30,960	$ 395	$ 30,960	$ 326,435	$ 358,978	1.10
	14	0	$ 390.87	195,433	0.162	$ 31,570	$ 391	$ 31,570	$ 326,826	$ 390,548	1.19
	15	0	$ 386.96	193,479	0.166	$ 32,192	$ 387	$ 32,192	$ 327,213	$ 422,740	1.29
	16	0	$ 383.09	191,544	0.171	$ 32,826	$ 383	$ 32,826	$ 327,596	$ 455,566	1.39
	17	0	$ 379.26	189,629	0.177	$ 33,473	$ 379	$ 33,473	$ 327,976	$ 489,039	1.49
	18	0	$ 375.46	187,732	0.182	$ 34,132	$ 375	$ 34,132	$ 328,351	$ 523,171	1.59
	19	0	$ 371.71	185,855	0.187	$ 34,805	$ 372	$ 34,805	$ 328,723	$ 557,976	1.70
	20	0	$ 367.99	183,996	0.193	$ 35,490	$ 368	$ 35,490	$ 329,091	$ 593,466	1.80
			TOTALS	4,055,405					$ 329,091	$ 593,466	
			ANNUAL AVERAGE	202,770						$ 29,673	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 360,360	$ 500.07	250,034	$ 0.11	$ 27,504	$ 360,860	$ 27,504	$ 360,860	$ 27,504	0.08
	2	0	$ 495.07	247,534	0.113	$ 28,046	$ 495	$ 28,046	$ 361,355	$ 55,549	0.15
163.8	3	0	$ 490.12	245,059	0.117	$ 28,598	$ 490	$ 28,598	$ 361,845	$ 84,147	0.23
KW	4	0	$ 485.22	242,608	0.120	$ 29,161	$ 485	$ 29,161	$ 362,330	$ 113,309	0.31
Nameplate	5	0	$ 480.36	240,182	0.124	$ 29,736	$ 480	$ 29,736	$ 362,811	$ 143,045	0.39
	6	0	$ 475.56	237,780	0.128	$ 30,322	$ 476	$ 30,322	$ 363,286	$ 173,367	0.48
	7	0	$ 470.80	235,402	0.131	$ 30,919	$ 471	$ 30,919	$ 363,757	$ 204,286	0.56
	8	0	$ 466.10	233,048	0.135	$ 31,528	$ 466	$ 31,528	$ 364,223	$ 235,814	0.65
	9	0	$ 461.44	230,718	0.139	$ 32,149	$ 461	$ 32,149	$ 364,685	$ 267,963	0.73
	10	0	$ 456.82	228,411	0.144	$ 32,783	$ 457	$ 32,783	$ 365,142	$ 300,746	0.82
	11	0	$ 452.25	226,126	0.148	$ 33,428	$ 452	$ 33,428	$ 365,594	$ 334,174	0.91
	12	0	$ 447.73	223,865	0.152	$ 34,087	$ 448	$ 34,087	$ 366,042	$ 368,261	1.01
	13	0	$ 443.25	221,627	0.157	$ 34,759	$ 443	$ 34,759	$ 366,485	$ 403,020	1.10
	14	0	$ 438.82	219,410	0.162	$ 35,443	$ 439	$ 35,443	$ 366,924	$ 438,463	1.19
	15	0	$ 434.43	217,216	0.166	$ 36,141	$ 434	$ 36,141	$ 367,358	$ 474,605	1.29
	16	0	$ 430.09	215,044	0.171	$ 36,853	$ 430	$ 36,853	$ 367,788	$ 511,458	1.39
	17	0	$ 425.79	212,894	0.177	$ 37,579	$ 426	$ 37,579	$ 368,214	$ 549,038	1.49
	18	0	$ 421.53	210,765	0.182	$ 38,320	$ 422	$ 38,320	$ 368,635	$ 587,357	1.59
	19	0	$ 417.31	208,657	0.187	$ 39,075	$ 417	$ 39,075	$ 369,053	$ 626,432	1.70
	20	0	$ 413.14	206,570	0.193	$ 39,844	$ 413	$ 39,844	$ 369,466	$ 666,276	1.80
			TOTALS	4,552,950					$ 369,466	$ 666,276	
			ANNUAL AVERAGE	227,647						$ 33,314	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 732,160	$ 1,016.01	508,006	$ 0.11	$ 55,881	$ 733,176	$ 55,881	$ 733,176	$ 55,881	0.08
	2	0	$ 1,005.85	502,926	0.113	$ 56,982	$ 1,006	$ 56,982	$ 734,182	$ 112,862	0.15
332.8	3	0	$ 995.79	497,897	0.117	$ 58,104	$ 996	$ 58,104	$ 735,178	$ 170,966	0.23
KW	4	0	$ 985.84	492,918	0.120	$ 59,249	$ 986	$ 59,249	$ 736,163	$ 230,215	0.31
Nameplate	5	0	$ 975.98	487,989	0.124	$ 60,416	$ 976	$ 60,416	$ 737,139	$ 290,631	0.39
	6	0	$ 966.22	483,109	0.128	$ 61,606	$ 966	$ 61,606	$ 738,106	$ 352,237	0.48
	7	0	$ 956.56	478,278	0.131	$ 62,820	$ 957	$ 62,820	$ 739,062	$ 415,057	0.56
	8	0	$ 946.99	473,495	0.135	$ 64,057	$ 947	$ 64,057	$ 740,009	$ 479,114	0.65
	9	0	$ 937.52	468,760	0.139	$ 65,319	$ 938	$ 65,319	$ 740,947	$ 544,433	0.73
	10	0	$ 928.14	464,072	0.144	$ 66,606	$ 928	$ 66,606	$ 741,875	$ 611,039	0.82
	11	0	$ 918.86	459,432	0.148	$ 67,918	$ 919	$ 67,918	$ 742,794	$ 678,957	0.91
	12	0	$ 909.67	454,837	0.152	$ 69,256	$ 910	$ 69,256	$ 743,703	$ 748,213	1.01
	13	0	$ 900.58	450,289	0.157	$ 70,620	$ 901	$ 70,620	$ 744,604	$ 818,834	1.10
	14	0	$ 891.57	445,786	0.162	$ 72,012	$ 892	$ 72,012	$ 745,496	$ 890,846	1.19
	15	0	$ 882.66	441,328	0.166	$ 73,430	$ 883	$ 73,430	$ 746,378	$ 964,276	1.29
	16	0	$ 873.83	436,915	0.171	$ 74,877	$ 874	$ 74,877	$ 747,252	$ 1,039,153	1.39
	17	0	$ 865.09	432,546	0.177	$ 76,352	$ 865	$ 76,352	$ 748,117	$ 1,115,505	1.49
	18	0	$ 856.44	428,220	0.182	$ 77,856	$ 856	$ 77,856	$ 748,974	$ 1,193,361	1.59
	19	0	$ 847.88	423,938	0.187	$ 79,390	$ 848	$ 79,390	$ 749,821	$ 1,272,751	1.70
	20	0	$ 839.40	419,699	0.193	$ 80,954	$ 839	$ 80,954	$ 750,661	$ 1,353,705	1.80
		TOTALS		9,250,438					$ 750,661	$ 1,353,705	
		ANNUAL AVERAGE		462,522						$ 67,685	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 578,600	$ 802.92	401,459	$ 0.11	$ 44,161	$ 579,403	$ 44,161	$ 579,403	$ 44,161	0.08
	2	0	$ 794.89	397,445	0.113	$ 45,030	$ 795	$ 45,030	$ 580,198	$ 89,191	0.15
263	3	0	$ 786.94	393,470	0.117	$ 45,918	$ 787	$ 45,918	$ 580,985	$ 135,109	0.23
KW	4	0	$ 779.07	389,535	0.120	$ 46,822	$ 779	$ 46,822	$ 581,764	$ 181,931	0.31
Nameplate	5	0	$ 771.28	385,640	0.124	$ 47,745	$ 771	$ 47,745	$ 582,535	$ 229,675	0.39
	6	0	$ 763.57	381,784	0.128	$ 48,685	$ 764	$ 48,685	$ 583,299	$ 278,360	0.48
	7	0	$ 755.93	377,966	0.131	$ 49,644	$ 756	$ 49,644	$ 584,055	$ 328,005	0.56
	8	0	$ 748.37	374,186	0.135	$ 50,622	$ 748	$ 50,622	$ 584,803	$ 378,627	0.65
	9	0	$ 740.89	370,444	0.139	$ 51,619	$ 741	$ 51,619	$ 585,544	$ 430,246	0.73
	10	0	$ 733.48	366,740	0.144	$ 52,636	$ 733	$ 52,636	$ 586,277	$ 482,882	0.82
	11	0	$ 726.14	363,072	0.148	$ 53,673	$ 726	$ 53,673	$ 587,003	$ 536,556	0.91
	12	0	$ 718.88	359,442	0.152	$ 54,731	$ 719	$ 54,731	$ 587,722	$ 591,286	1.01
	13	0	$ 711.69	355,847	0.157	$ 55,809	$ 712	$ 55,809	$ 588,434	$ 647,095	1.10
	14	0	$ 704.58	352,289	0.162	$ 56,908	$ 705	$ 56,908	$ 589,139	$ 704,004	1.19
	15	0	$ 697.53	348,766	0.166	$ 58,029	$ 698	$ 58,029	$ 589,836	$ 762,033	1.29
	16	0	$ 690.56	345,278	0.171	$ 59,173	$ 691	$ 59,173	$ 590,527	$ 821,205	1.39
	17	0	$ 683.65	341,825	0.177	$ 60,338	$ 684	$ 60,338	$ 591,210	$ 881,544	1.49
	18	0	$ 676.81	338,407	0.182	$ 61,527	$ 677	$ 61,527	$ 591,887	$ 943,071	1.59
	19	0	$ 670.05	335,023	0.187	$ 62,739	$ 670	$ 62,739	$ 592,557	$ 1,005,810	1.70
	20	0	$ 663.35	331,673	0.193	$ 63,975	$ 663	$ 63,975	$ 593,221	$ 1,069,785	1.80
			TOTALS	7,310,292					$ 593,221	$ 1,069,785	
			ANNUAL AVERAGE	365,515						$ 53,489	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 275,220	$ 381.92	190,960	$ 0.11	$ 21,006	$ 275,602	$ 21,006	$ 275,602	$ 21,006	0.08
	2	0	$ 378.10	189,051	0.113	$ 21,419	$ 378	$ 21,419	$ 275,980	$ 42,425	0.15
125.1	3	0	$ 374.32	187,160	0.117	$ 21,841	$ 374	$ 21,841	$ 276,354	$ 64,266	0.23
KW	4	0	$ 370.58	185,288	0.120	$ 22,272	$ 371	$ 22,272	$ 276,725	$ 86,538	0.31
Nameplate	5	0	$ 366.87	183,436	0.124	$ 22,710	$ 367	$ 22,710	$ 277,092	$ 109,249	0.39
	6	0	$ 363.20	181,601	0.128	$ 23,158	$ 363	$ 23,158	$ 277,455	$ 132,406	0.48
	7	0	$ 359.57	179,785	0.131	$ 23,614	$ 360	$ 23,614	$ 277,815	$ 156,020	0.56
	8	0	$ 355.97	177,987	0.135	$ 24,079	$ 356	$ 24,079	$ 278,171	$ 180,100	0.65
	9	0	$ 352.42	176,208	0.139	$ 24,554	$ 352	$ 24,554	$ 278,523	$ 204,653	0.73
	10	0	$ 348.89	174,445	0.144	$ 25,037	$ 349	$ 25,037	$ 278,872	$ 229,690	0.82
	11	0	$ 345.40	172,701	0.148	$ 25,531	$ 345	$ 25,531	$ 279,217	$ 255,221	0.91
	12	0	$ 341.95	170,974	0.152	$ 26,033	$ 342	$ 26,033	$ 279,559	$ 281,254	1.01
	13	0	$ 338.53	169,264	0.157	$ 26,546	$ 339	$ 26,546	$ 279,898	$ 307,801	1.10
	14	0	$ 335.14	167,572	0.162	$ 27,069	$ 335	$ 27,069	$ 280,233	$ 334,870	1.19
	15	0	$ 331.79	165,896	0.166	$ 27,603	$ 332	$ 27,603	$ 280,565	$ 362,473	1.29
	16	0	$ 328.47	164,237	0.171	$ 28,146	$ 328	$ 28,146	$ 280,893	$ 390,619	1.39
	17	0	$ 325.19	162,595	0.177	$ 28,701	$ 325	$ 28,701	$ 281,218	$ 419,320	1.49
	18	0	$ 321.94	160,969	0.182	$ 29,266	$ 322	$ 29,266	$ 281,540	$ 448,586	1.59
	19	0	$ 318.72	159,359	0.187	$ 29,843	$ 319	$ 29,843	$ 281,859	$ 478,429	1.70
	20	0	$ 315.53	157,765	0.193	$ 30,431	$ 316	$ 30,431	$ 282,175	$ 508,860	1.80
		TOTALS		3,477,253					$ 282,175	$ 508,860	
		ANNUAL AVERAGE		173,863						$ 25,443	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 295,680	$ 410.31	205,156	$ 0.11	$ 22,567	$ 296,090	$ 22,567	$ 296,090	$ 22,567	0.08
	2	0	$ 406.21	203,105	0.113	$ 23,012	$ 406	$ 23,012	$ 296,497	$ 45,579	0.15
134.4	3	0	$ 402.15	201,074	0.117	$ 23,465	$ 402	$ 23,465	$ 296,899	$ 69,044	0.23
KW	4	0	$ 398.13	199,063	0.120	$ 23,927	$ 398	$ 23,927	$ 297,297	$ 92,971	0.31
Nameplate	5	0	$ 394.14	197,072	0.124	$ 24,399	$ 394	$ 24,399	$ 297,691	$ 117,370	0.39
	6	0	$ 390.20	195,102	0.128	$ 24,879	$ 390	$ 24,879	$ 298,081	$ 142,250	0.48
	7	0	$ 386.30	193,151	0.131	$ 25,370	$ 386	$ 25,370	$ 298,467	$ 167,619	0.56
	8	0	$ 382.44	191,219	0.135	$ 25,869	$ 382	$ 25,869	$ 298,850	$ 193,488	0.65
	9	0	$ 378.61	189,307	0.139	$ 26,379	$ 379	$ 26,379	$ 299,228	$ 219,867	0.73
	10	0	$ 374.83	187,414	0.144	$ 26,899	$ 375	$ 26,899	$ 299,603	$ 246,766	0.82
	11	0	$ 371.08	185,540	0.148	$ 27,428	$ 371	$ 27,428	$ 299,974	$ 274,194	0.91
	12	0	$ 367.37	183,684	0.152	$ 27,969	$ 367	$ 27,969	$ 300,342	$ 302,163	1.01
	13	0	$ 363.69	181,847	0.157	$ 28,520	$ 364	$ 28,520	$ 300,705	$ 330,683	1.10
	14	0	$ 360.06	180,029	0.162	$ 29,082	$ 360	$ 29,082	$ 301,066	$ 359,765	1.19
	15	0	$ 356.46	178,229	0.166	$ 29,655	$ 356	$ 29,655	$ 301,422	$ 389,419	1.29
	16	0	$ 352.89	176,446	0.171	$ 30,239	$ 353	$ 30,239	$ 301,775	$ 419,658	1.39
	17	0	$ 349.36	174,682	0.177	$ 30,834	$ 349	$ 30,834	$ 302,124	$ 450,492	1.49
	18	0	$ 345.87	172,935	0.182	$ 31,442	$ 346	$ 31,442	$ 302,470	$ 481,934	1.59
	19	0	$ 342.41	171,206	0.187	$ 32,061	$ 342	$ 32,061	$ 302,813	$ 513,995	1.70
	20	0	$ 338.99	169,494	0.193	$ 32,693	$ 339	$ 32,693	$ 303,152	$ 546,688	1.80
			TOTALS	3,735,754					$ 303,152	$ 546,688	
			ANNUAL AVERAGE	186,788						$ 27,334	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 204,160	$ 283.31	141,656	$ 0.11	$ 15,582	$ 204,443	$ 15,582	$ 204,443	$ 15,582	0.08
	2	0	$ 280.48	140,239	0.113	$ 15,889	$ 280	$ 15,889	$ 204,724	$ 31,471	0.15
92.8	3	0	$ 277.67	138,837	0.117	$ 16,202	$ 278	$ 16,202	$ 205,001	$ 47,673	0.23
KW	4	0	$ 274.90	137,448	0.120	$ 16,521	$ 275	$ 16,521	$ 205,276	$ 64,195	0.31
Nameplate	5	0	$ 272.15	136,074	0.124	$ 16,847	$ 272	$ 16,847	$ 205,549	$ 81,041	0.39
	6	0	$ 269.43	134,713	0.128	$ 17,179	$ 269	$ 17,179	$ 205,818	$ 98,220	0.48
	7	0	$ 266.73	133,366	0.131	$ 17,517	$ 267	$ 17,517	$ 206,085	$ 115,737	0.56
	8	0	$ 264.06	132,032	0.135	$ 17,862	$ 264	$ 17,862	$ 206,349	$ 133,599	0.65
	9	0	$ 261.42	130,712	0.139	$ 18,214	$ 261	$ 18,214	$ 206,610	$ 151,813	0.73
	10	0	$ 258.81	129,405	0.144	$ 18,573	$ 259	$ 18,573	$ 206,869	$ 170,386	0.82
	11	0	$ 256.22	128,111	0.148	$ 18,939	$ 256	$ 18,939	$ 207,125	$ 189,325	0.91
	12	0	$ 253.66	126,830	0.152	$ 19,312	$ 254	$ 19,312	$ 207,379	$ 208,636	1.01
	13	0	$ 251.12	125,561	0.157	$ 19,692	$ 251	$ 19,692	$ 207,630	$ 228,329	1.10
	14	0	$ 248.61	124,306	0.162	$ 20,080	$ 249	$ 20,080	$ 207,879	$ 248,409	1.19
	15	0	$ 246.13	123,063	0.166	$ 20,476	$ 246	$ 20,476	$ 208,125	$ 268,885	1.29
	16	0	$ 243.66	121,832	0.171	$ 20,879	$ 244	$ 20,879	$ 208,368	$ 289,764	1.39
	17	0	$ 241.23	120,614	0.177	$ 21,290	$ 241	$ 21,290	$ 208,610	$ 311,054	1.49
	18	0	$ 238.82	119,408	0.182	$ 21,710	$ 239	$ 21,710	$ 208,848	$ 332,764	1.59
	19	0	$ 236.43	118,213	0.187	$ 22,138	$ 236	$ 22,138	$ 209,085	$ 354,902	1.70
	20	0	$ 234.06	117,031	0.193	$ 22,574	$ 234	$ 22,574	$ 209,319	$ 377,475	1.80
			TOTALS	2,579,449					$ 209,319	$ 377,475	
			ANNUAL AVERAGE	128,972						$ 18,874	

*Initial production estimate in year 1 from Helioscope model run

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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 398,420	$ 552.88	276,442	$ 0.11	$ 30,409	$ 398,973	$ 30,409	$ 398,973	$ 30,409	0.08
	2	0	$ 547.36	273,678	0.113	$ 31,008	$ 547	$ 31,008	$ 399,520	$ 61,416	0.15
181.1	3	0	$ 541.88	270,941	0.117	$ 31,619	$ 542	$ 31,619	$ 400,062	$ 93,035	0.23
KW	4	0	$ 536.46	268,231	0.120	$ 32,241	$ 536	$ 32,241	$ 400,599	$ 125,276	0.31
Nameplate	5	0	$ 531.10	265,549	0.124	$ 32,877	$ 531	$ 32,877	$ 401,130	$ 158,153	0.39
	6	0	$ 525.79	262,894	0.128	$ 33,524	$ 526	$ 33,524	$ 401,655	$ 191,677	0.48
	7	0	$ 520.53	260,265	0.131	$ 34,185	$ 521	$ 34,185	$ 402,176	$ 225,862	0.56
	8	0	$ 515.32	257,662	0.135	$ 34,858	$ 515	$ 34,858	$ 402,691	$ 260,720	0.65
	9	0	$ 510.17	255,085	0.139	$ 35,545	$ 510	$ 35,545	$ 403,201	$ 296,265	0.73
	10	0	$ 505.07	252,535	0.144	$ 36,245	$ 505	$ 36,245	$ 403,707	$ 332,510	0.82
	11	0	$ 500.02	250,009	0.148	$ 36,959	$ 500	$ 36,959	$ 404,207	$ 369,469	0.91
	12	0	$ 495.02	247,509	0.152	$ 37,687	$ 495	$ 37,687	$ 404,702	$ 407,156	1.01
	13	0	$ 490.07	245,034	0.157	$ 38,430	$ 490	$ 38,430	$ 405,192	$ 445,585	1.10
	14	0	$ 485.17	242,584	0.162	$ 39,187	$ 485	$ 39,187	$ 405,677	$ 484,772	1.19
	15	0	$ 480.32	240,158	0.166	$ 39,959	$ 480	$ 39,959	$ 406,157	$ 524,731	1.29
	16	0	$ 475.51	237,756	0.171	$ 40,746	$ 476	$ 40,746	$ 406,633	$ 565,476	1.39
	17	0	$ 470.76	235,379	0.177	$ 41,549	$ 471	$ 41,549	$ 407,103	$ 607,025	1.49
	18	0	$ 466.05	233,025	0.182	$ 42,367	$ 466	$ 42,367	$ 407,569	$ 649,392	1.59
	19	0	$ 461.39	230,695	0.187	$ 43,202	$ 461	$ 43,202	$ 408,031	$ 692,594	1.70
	20	0	$ 456.78	228,388	0.193	$ 44,053	$ 457	$ 44,053	$ 408,488	$ 736,646	1.80
			TOTALS	5,033,817					$ 408,488	$ 736,646	
			ANNUAL AVERAGE	251,691						$ 36,832	

*Initial production estimate in year 1 from Helioscope model run

Job.No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1.	$ 223,080	$ 309.57	154,763	$ 0.11	$ 17,026	$ 223,390	$ 17,026	$ 223,390	$ 17,026	0.08
	2	0	$ 306.47	153,235	0.113	$ 17,362	$ 306	$ 17,362	$ 223,696	$ 34,388	0.15
101.4	3	0	$ 303.41	151,703	0.117	$ 17,704	$ 303	$ 17,704	$ 223,999	$ 52,091	0.23
KW	4	0	$ 300.37	150,186	0.120	$ 18,052	$ 300	$ 18,052	$ 224,300	$ 70,144	0.31
Nameplate	5	0	$ 297.37	148,684	0.124	$ 18,406	$ 297	$ 18,406	$ 224,597	$ 88,552	0.39
	6	0	$ 294.39	147,197	0.128	$ 18,771	$ 294	$ 18,771	$ 224,892	$ 107,322	0.48
	7	0	$ 291.45	145,725	0.131	$ 19,140	$ 291	$ 19,140	$ 225,183	$ 126,463	0.56
	8	0	$ 288.54	144,268	0.135	$ 19,517	$ 289	$ 19,517	$ 225,472	$ 145,980	0.65
	9	0	$ 285.65	142,825	0.139	$ 19,902	$ 286	$ 19,902	$ 225,757	$ 165,882	0.73
	10	0	$ 282.79	141,397	0.144	$ 20,294	$ 283	$ 20,294	$ 226,040	$ 186,176	0.82
	11	0	$ 279.97	139,983	0.148	$ 20,694	$ 280	$ 20,694	$ 226,320	$ 206,870	0.91
	12	0	$ 277.17	138,583	0.152	$ 21,101	$ 277	$ 21,101	$ 226,597	$ 227,971	1.01
	13	0	$ 274.39	137,197	0.157	$ 21,517	$ 274	$ 21,517	$ 226,872	$ 249,488	1.10
	14	0	$ 271.65	135,825	0.162	$ 21,941	$ 272	$ 21,941	$ 227,143	$ 271,430	1.19
	15	0	$ 268.93	134,467	0.166	$ 22,373	$ 269	$ 22,373	$ 227,412	$ 293,803	1.29
	16	0	$ 266.24	133,122	0.171	$ 22,814	$ 266	$ 22,814	$ 227,678	$ 316,617	1.39
	17	0	$ 263.58	131,791	0.177	$ 23,263	$ 264	$ 23,263	$ 227,942	$ 339,880	1.49
	18	0	$ 260.95	130,473	0.182	$ 23,722	$ 261	$ 23,722	$ 228,203	$ 363,602	1.59
	19	0	$ 258.34	129,169	0.187	$ 24,189	$ 258	$ 24,189	$ 228,461	$ 387,791	1.70
	20	0	$ 255.75	127,877	0.193	$ 24,666	$ 256	$ 24,666	$ 228,717	$ 412,457	1.80
			TOTALS	2,818,493					$ 228,717	$ 412,457	
			ANNUAL AVERAGE	140,925						$ 20,623	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 275,220	$ 381.92	190,960	$ 0.11	$ 21,006	$ 275,602	$ 21,006	$ 275,602	$ 21,006	0.08
	2	0	$ 378.10	189,051	0.113	$ 21,419	$ 378	$ 21,419	$ 275,980	$ 42,425	0.15
125.1	3	0	$ 374.32	187,160	0.117	$ 21,841	$ 374	$ 21,841	$ 276,354	$ 64,266	0.23
KW	4	0	$ 370.58	185,288	0.120	$ 22,272	$ 371	$ 22,272	$ 276,725	$ 86,538	0.31
Nameplate	5	0	$ 366.87	183,436	0.124	$ 22,710	$ 367	$ 22,710	$ 277,092	$ 109,249	0.39
	6	0	$ 363.20	181,601	0.128	$ 23,158	$ 363	$ 23,158	$ 277,455	$ 132,406	0.48
	7	0	$ 359.57	179,785	0.131	$ 23,614	$ 360	$ 23,614	$ 277,815	$ 156,020	0.56
	8	0	$ 355.97	177,987	0.135	$ 24,079	$ 356	$ 24,079	$ 278,171	$ 180,100	0.65
	9	0	$ 352.42	176,208	0.139	$ 24,554	$ 352	$ 24,554	$ 278,523	$ 204,653	0.73
	10	0	$ 348.89	174,445	0.144	$ 25,037	$ 349	$ 25,037	$ 278,872	$ 229,690	0.82
	11	0	$ 345.40	172,701	0.148	$ 25,531	$ 345	$ 25,531	$ 279,217	$ 255,221	0.91
	12	0	$ 341.95	170,974	0.152	$ 26,033	$ 342	$ 26,033	$ 279,559	$ 281,254	1.01
	13	0	$ 338.53	169,264	0.157	$ 26,546	$ 339	$ 26,546	$ 279,898	$ 307,801	1.10
	14	0	$ 335.14	167,572	0.162	$ 27,069	$ 335	$ 27,069	$ 280,233	$ 334,870	1.19
	15	0	$ 331.79	165,896	0.166	$ 27,603	$ 332	$ 27,603	$ 280,565	$ 362,473	1.29
	16	0	$ 328.47	164,237	0.171	$ 28,146	$ 328	$ 28,146	$ 280,893	$ 390,619	1.39
	17	0	$ 325.19	162,595	0.177	$ 28,701	$ 325	$ 28,701	$ 281,218	$ 419,320	1.49
	18	0	$ 321.94	160,969	0.182	$ 29,266	$ 322	$ 29,266	$ 281,540	$ 448,586	1.59
	19	0	$ 318.72	159,359	0.187	$ 29,843	$ 319	$ 29,843	$ 281,859	$ 478,429	1.70
	20	0	$ 315.53	157,765	0.193	$ 30,431	$ 316	$ 30,431	$ 282,175	$ 508,860	1.80
			TOTALS	3,477,253					$ 282,175	$ 508,860	
			ANNUAL AVERAGE	173,863						$ 25,443	

*Initial production estimate in year 1 from Helioscope model run

HDR

Job No.		No.	
Project: 2	Computed: GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 128,920	$ 178.90	89,451	$ 0.11	$ 9,840	$ 129,099	$ 9,840	$ 129,099	$ 9,840	0.08
	2	0	$ 177.11	88,556	0.113	$ 10,033	$ 177	$ 10,033	$ 129,276	$ 19,873	0.15
58.6	3	0	$ 175.34	87,671	0.117	$ 10,231	$ 175	$ 10,231	$ 129,451	$ 30,104	0.23
KW	4	0	$ 173.59	86,794	0.120	$ 10,433	$ 174	$ 10,433	$ 129,625	$ 40,537	0.31
Nameplate	5	0	$ 171.85	85,926	0.124	$ 10,638	$ 172	$ 10,638	$ 129,797	$ 51,175	0.39
	6	0	$ 170.13	85,067	0.128	$ 10,848	$ 170	$ 10,848	$ 129,967	$ 62,022	0.48
	7	0	$ 168.43	84,216	0.131	$ 11,061	$ 168	$ 11,061	$ 130,135	$ 73,084	0.56
	8	0	$ 166.75	83,374	0.135	$ 11,279	$ 167	$ 11,279	$ 130,302	$ 84,363	0.65
	9	0	$ 165.08	82,540	0.139	$ 11,502	$ 165	$ 11,502	$ 130,467	$ 95,865	0.73
	10	0	$ 163.43	81,715	0.144	$ 11,728	$ 163	$ 11,728	$ 130,631	$ 107,593	0.82
	11	0	$ 161.80	80,898	0.148	$ 11,959	$ 162	$ 11,959	$ 130,792	$ 119,552	0.91
	12	0	$ 160.18	80,089	0.152	$ 12,195	$ 160	$ 12,195	$ 130,953	$ 131,747	1.01
	13	0	$ 158.58	79,288	0.157	$ 12,435	$ 159	$ 12,435	$ 131,111	$ 144,182	1.10
	14	0	$ 156.99	78,495	0.162	$ 12,680	$ 157	$ 12,680	$ 131,268	$ 156,862	1.19
	15	0	$ 155.42	77,710	0.166	$ 12,930	$ 155	$ 12,930	$ 131,424	$ 169,791	1.29
	16	0	$ 153.87	76,933	0.171	$ 13,184	$ 154	$ 13,184	$ 131,577	$ 182,976	1.39
	17	0	$ 152.33	76,163	0.177	$ 13,444	$ 152	$ 13,444	$ 131,730	$ 196,420	1.49
	18	0	$ 150.80	75,402	0.182	$ 13,709	$ 151	$ 13,709	$ 131,881	$ 210,129	1.59
	19	0	$ 149.30	74,648	0.187	$ 13,979	$ 149	$ 13,979	$ 132,030	$ 224,108	1.70
	20	0	$ 147.80	73,901	0.193	$ 14,254	$ 148	$ 14,254	$ 132,178	$ 238,363	1.80
			TOTALS	1,628,833					$ 132,178	$ 238,363	
			ANNUAL AVERAGE	81,442						$ 11,918	

*Initial production estimate in year 1 from Helioscope model run

C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 89,320	$ 123.95	61,974	$ 0.11	$ 6,817	$ 89,444	$ 6,817	$ 89,444	$ 6,817	0.08
	2	0	$ 122.71	61,355	0.113	$ 6,951	$ 123	$ 6,951	$ 89,567	$ 13,769	0.15
40.6	3	0	$ 121.48	60,741	0.117	$ 7,088	$ 121	$ 7,088	$ 89,688	$ 20,857	0.23
KW	4	0	$ 120.27	60,134	0.120	$ 7,228	$ 120	$ 7,228	$ 89,808	$ 28,085	0.31
Nameplate	5	0	$ 119.06	59,532	0.124	$ 7,370	$ 119	$ 7,370	$ 89,927	$ 35,456	0.39
	6	0	$ 117.87	58,937	0.128	$ 7,516	$ 118	$ 7,516	$ 90,045	$ 42,971	0.48
	7	0	$ 116.70	58,348	0.131	$ 7,664	$ 117	$ 7,664	$ 90,162	$ 50,635	0.56
	8	0	$ 115.53	57,764	0.135	$ 7,815	$ 116	$ 7,815	$ 90,278	$ 58,450	0.65
	9	0	$ 114.37	57,186	0.139	$ 7,969	$ 114	$ 7,969	$ 90,392	$ 66,418	0.73
	10	0	$ 113.23	56,615	0.144	$ 8,126	$ 113	$ 8,126	$ 90,505	$ 74,544	0.82
	11	0	$ 112.10	56,048	0.148	$ 8,286	$ 112	$ 8,286	$ 90,617	$ 82,830	0.91
	12	0	$ 110.98	55,488	0.152	$ 8,449	$ 111	$ 8,449	$ 90,728	$ 91,278	1.01
	13	0	$ 109.87	54,933	0.157	$ 8,615	$ 110	$ 8,615	$ 90,838	$ 99,894	1.10
	14	0	$ 108.77	54,384	0.162	$ 8,785	$ 109	$ 8,785	$ 90,947	$ 108,679	1.19
	15	0	$ 107.68	53,840	0.166	$ 8,958	$ 108	$ 8,958	$ 91,055	$ 117,637	1.29
	16	0	$ 106.60	53,302	0.171	$ 9,135	$ 107	$ 9,135	$ 91,161	$ 126,772	1.39
	17	0	$ 105.54	52,768	0.177	$ 9,315	$ 106	$ 9,315	$ 91,267	$ 136,086	1.49
	18	0	$ 104.48	52,241	0.182	$ 9,498	$ 104	$ 9,498	$ 91,371	$ 145,584	1.59
	19	0	$ 103.44	51,718	0.187	$ 9,685	$ 103	$ 9,685	$ 91,475	$ 155,269	1.70
	20	0	$ 102.40	51,201	0.193	$ 9,876	$ 102	$ 9,876	$ 91,577	$ 165,145	1.80
			TOTALS	1,128,509					$ 91,577	$ 165,145	
			ANNUAL AVERAGE	56,425						$ 8,257	

*Initial production estimate in year 1 from Helioscope model run

HDR		Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 259,160	$ 359.63	179,817	$ 0.11	$ 19,780	$ 259,520	$ 19,780	$ 259,520	$ 19,780	0.08
	2	0	$ 356.04	178,019	0.113	$ 20,170	$ 356	$ 20,170	$ 259,876	$ 39,949	0.15
117.8	3	0	$ 352.48	176,239	0.117	$ 20,567	$ 352	$ 20,567	$ 260,228	$ 60,516	0.23
KW	4	0	$ 348.95	174,476	0.120	$ 20,972	$ 349	$ 20,972	$ 260,577	$ 81,488	0.31
Nameplate	5	0	$ 345.46	172,732	0.124	$ 21,385	$ 345	$ 21,385	$ 260,923	$ 102,874	0.39
	6	0	$ 342.01	171,004	0.128	$ 21,806	$ 342	$ 21,806	$ 261,265	$ 124,680	0.48
	7	0	$ 338.59	169,294	0.131	$ 22,236	$ 339	$ 22,236	$ 261,603	$ 146,916	0.56
	8	0	$ 335.20	167,601	0.135	$ 22,674	$ 335	$ 22,674	$ 261,938	$ 169,590	0.65
	9	0	$ 331.85	165,925	0.139	$ 23,121	$ 332	$ 23,121	$ 262,270	$ 192,711	0.73
	10	0	$ 328.53	164,266	0.144	$ 23,576	$ 329	$ 23,576	$ 262,599	$ 216,287	0.82
	11	0	$ 325.25	162,623	0.148	$ 24,041	$ 325	$ 24,041	$ 262,924	$ 240,328	0.91
	12	0	$ 321.99	160,997	0.152	$ 24,514	$ 322	$ 24,514	$ 263,246	$ 264,842	1.01
	13	0	$ 318.77	159,387	0.157	$ 24,997	$ 319	$ 24,997	$ 263,565	$ 289,840	1.10
	14	0	$ 315.59	157,793	0.162	$ 25,490	$ 316	$ 25,490	$ 263,880	$ 315,329	1.19
	15	0	$ 312.43	156,215	0.166	$ 25,992	$ 312	$ 25,992	$ 264,193	$ 341,321	1.29
	16	0	$ 309.31	154,653	0.171	$ 26,504	$ 309	$ 26,504	$ 264,502	$ 367,825	1.39
	17	0	$ 306.21	153,107	0.177	$ 27,026	$ 306	$ 27,026	$ 264,808	$ 394,851	1.49
	18	0	$ 303.15	151,576	0.182	$ 27,558	$ 303	$ 27,558	$ 265,111	$ 422,410	1.59
	19	0	$ 300.12	150,060	0.187	$ 28,101	$ 300	$ 28,101	$ 265,412	$ 450,511	1.70
	20	0	$ 297.12	148,559	0.193	$ 28,655	$ 297	$ 28,655	$ 265,709	$ 479,166	1.80
		TOTALS		3,274,344					$ 265,709	$ 479,166	
			ANNUAL AVERAGE	163,717						$ 23,958	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	

Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 209,000	$ 290.03	145,014	$ 0.11	$ 15,952	$ 209,290	$ 15,952	$ 209,290	$ 15,952	0.08
	2	0	$ 287.13	143,564	0.113	$ 16,266	$ 287	$ 16,266	$ 209,577	$ 32,217	0.15
95	3	0	$ 284.26	142,128	0.117	$ 16,586	$ 284	$ 16,586	$ 209,861	$ 48,803	0.23
KW	4	0	$ 281.41	140,707	0.120	$ 16,913	$ 281	$ 16,913	$ 210,143	$ 65,716	0.31
Nameplate	5	0	$ 278.60	139,300	0.124	$ 17,246	$ 279	$ 17,246	$ 210,421	$ 82,963	0.39
	6	0	$ 275.81	137,907	0.128	$ 17,586	$ 276	$ 17,586	$ 210,697	$ 100,548	0.48
	7	0	$ 273.06	136,528	0.131	$ 17,932	$ 273	$ 17,932	$ 210,970	$ 118,481	0.56
	8	0	$ 270.32	135,162	0.135	$ 18,286	$ 270	$ 18,286	$ 211,241	$ 136,766	0.65
	9	0	$ 267.62	133,811	0.139	$ 18,646	$ 268	$ 18,646	$ 211,508	$ 155,412	0.73
	10	0	$ 264.95	132,473	0.144	$ 19,013	$ 265	$ 19,013	$ 211,773	$ 174,425	0.82
	11	0	$ 262.30	131,148	0.148	$ 19,388	$ 262	$ 19,388	$ 212,035	$ 193,813	0.91
	12	0	$ 259.67	129,836	0.152	$ 19,770	$ 260	$ 19,770	$ 212,295	$ 213,583	1.01
	13	0	$ 257.08	128,538	0.157	$ 20,159	$ 257	$ 20,159	$ 212,552	$ 233,742	1.10
	14	0	$ 254.51	127,253	0.162	$ 20,556	$ 255	$ 20,556	$ 212,807	$ 254,298	1.19
	15	0	$ 251.96	125,980	0.166	$ 20,961	$ 252	$ 20,961	$ 213,059	$ 275,259	1.29
	16	0	$ 249.44	124,720	0.171	$ 21,374	$ 249	$ 21,374	$ 213,308	$ 296,633	1.39
	17	0	$ 246.95	123,473	0.177	$ 21,795	$ 247	$ 21,795	$ 213,555	$ 318,428	1.49
	18	0	$ 244.48	122,238	0.182	$ 22,225	$ 244	$ 22,225	$ 213,800	$ 340,653	1.59
	19	0	$ 242.03	121,016	0.187	$ 22,662	$ 242	$ 22,662	$ 214,042	$ 363,315	1.70
	20	0	$ 239.61	119,806	0.193	$ 23,109	$ 240	$ 23,109	$ 214,281	$ 386,424	1.80
			TOTALS	2,640,600					$ 214,281	$ 386,424	
			ANNUAL AVERAGE	132,030						$ 19,321	

*Initial production estimate in year 1 from Helioscope model run

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Project	2	Computed	GLD
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Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 430,760	$ 597.76	298,881	$ 0.11	$ 32,877	$ 431,358	$ 32,877	$ 431,358	$ 32,877	0.08
	2	0	$ 591.78	295,892	0.113	$ 33,525	$ 592	$ 33,525	$ 431,950	$ 66,401	0.15
195.8	3	0	$ 585.87	292,933	0.117	$ 34,185	$ 586	$ 34,185	$ 432,535	$ 100,587	0.23
KW	4	0	$ 580.01	290,004	0.120	$ 34,858	$ 580	$ 34,858	$ 433,115	$ 135,445	0.31
Nameplate	5	0	$ 574.21	287,104	0.124	$ 35,545	$ 574	$ 35,545	$ 433,690	$ 170,990	0.39
	6	0	$ 568.47	284,233	0.128	$ 36,245	$ 568	$ 36,245	$ 434,258	$ 207,236	0.48
	7	0	$ 562.78	281,390	0.131	$ 36,959	$ 563	$ 36,959	$ 434,821	$ 244,195	0.56
	8	0	$ 557.15	278,577	0.135	$ 37,688	$ 557	$ 37,688	$ 435,378	$ 281,883	0.65
	9	0	$ 551.58	275,791	0.139	$ 38,430	$ 552	$ 38,430	$ 435,930	$ 320,313	0.73
	10	0	$ 546.07	273,033	0.144	$ 39,187	$ 546	$ 39,187	$ 436,476	$ 359,500	0.82
	11	0	$ 540.61	270,303	0.148	$ 39,959	$ 541	$ 39,959	$ 437,016	$ 399,459	0.91
	12	0	$ 535.20	267,600	0.152	$ 40,746	$ 535	$ 40,746	$ 437,551	$ 440,205	1.01
	13	0	$ 529.85	264,924	0.157	$ 41,549	$ 530	$ 41,549	$ 438,081	$ 481,754	1.10
	14	0	$ 524.55	262,274	0.162	$ 42,367	$ 525	$ 42,367	$ 438,606	$ 524,121	1.19
	15	0	$ 519.30	259,652	0.166	$ 43,202	$ 519	$ 43,202	$ 439,125	$ 567,323	1.29
	16	0	$ 514.11	257,055	0.171	$ 44,053	$ 514	$ 44,053	$ 439,639	$ 611,377	1.39
	17	0	$ 508.97	254,485	0.177	$ 44,921	$ 509	$ 44,921	$ 440,148	$ 656,298	1.49
	18	0	$ 503.88	251,940	0.182	$ 45,806	$ 504	$ 45,806	$ 440,652	$ 702,104	1.59
	19	0	$ 498.84	249,420	0.187	$ 46,708	$ 499	$ 46,708	$ 441,151	$ 748,812	1.70
	20	0	$ 493.85	246,926	0.193	$ 47,629	$ 494	$ 47,629	$ 441,645	$ 796,440	1.80
			TOTALS	5,442,415					$ 441,645	$ 796,440	
			ANNUAL AVERAGE	272,121						$ 39,822	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project 2	Computed GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 248,600	$ 344.98	172,490	$ 0.11	$ 18,974	$ 248,945	$ 18,974	$ 248,945	$ 18,974	0.08
	2	0	$ 341.53	170,765	0.113	$ 19,348	$ 342	$ 19,348	$ 249,287	$ 38,322	0.15
113	3	0	$ 338.11	169,057	0.117	$ 19,729	$ 338	$ 19,729	$ 249,625	$ 58,050	0.23
KW	4	0	$ 334.73	167,367	0.120	$ 20,117	$ 335	$ 20,117	$ 249,959	$ 78,168	0.31
Nameplate	5	0	$ 331.39	165,693	0.124	$ 20,514	$ 331	$ 20,514	$ 250,291	$ 98,682	0.39
	6	0	$ 328.07	164,036	0.128	$ 20,918	$ 328	$ 20,918	$ 250,619	$ 119,600	0.48
	7	0	$ 324.79	162,396	0.131	$ 21,330	$ 325	$ 21,330	$ 250,944	$ 140,930	0.56
	8	0	$ 321.54	160,772	0.135	$ 21,750	$ 322	$ 21,750	$ 251,265	$ 162,680	0.65
	9	0	$ 318.33	159,164	0.139	$ 22,179	$ 318	$ 22,179	$ 251,583	$ 184,859	0.73
	10	0	$ 315.15	157,573	0.144	$ 22,616	$ 315	$ 22,616	$ 251,899	$ 207,474	0.82
	11	0	$ 311.99	155,997	0.148	$ 23,061	$ 312	$ 23,061	$ 252,211	$ 230,535	0.91
	12	0	$ 308.87	154,437	0.152	$ 23,515	$ 309	$ 23,515	$ 252,519	$ 254,051	1.01
	13	0	$ 305.79	152,893	0.157	$ 23,979	$ 306	$ 23,979	$ 252,825	$ 278,030	1.10
	14	0	$ 302.73	151,364	0.162	$ 24,451	$ 303	$ 24,451	$ 253,128	$ 302,481	1.19
	15	0	$ 299.70	149,850	0.166	$ 24,933	$ 300	$ 24,933	$ 253,428	$ 327,413	1.29
	16	0	$ 296.70	148,351	0.171	$ 25,424	$ 297	$ 25,424	$ 253,724	$ 352,837	1.39
	17	0	$ 293.74	146,868	0.177	$ 25,925	$ 294	$ 25,925	$ 254,018	$ 378,762	1.49
	18	0	$ 290.80	145,399	0.182	$ 26,436	$ 291	$ 26,436	$ 254,309	$ 405,198	1.59
	19	0	$ 287.89	143,945	0.187	$ 26,956	$ 288	$ 26,956	$ 254,597	$ 432,154	1.70
	20	0	$ 285.01	142,506	0.193	$ 27,487	$ 285	$ 27,487	$ 254,882	$ 459,641	1.80
			TOTALS	3,140,924					$ 254,882	$ 459,641	
			ANNUAL AVERAGE	157,046						$ 22,982	

*Initial production estimate in year 1 from Helioscope model run

HDR

Job No.		No.	
Project	2	Computed	GLD
Date	1/2/1900		
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 275,220	$ 381.92	190,960	$ 0.11	$ 21,006	$ 275,602	$ 21,006	$ 275,602	$ 21,006	0.08
	2	0	$ 378.10	189,051	0.113	$ 21,419	$ 378	$ 21,419	$ 275,980	$ 42,425	0.15
125.1	3	0	$ 374.32	187,160	0.117	$ 21,841	$ 374	$ 21,841	$ 276,354	$ 64,266	0.23
KW	4	0	$ 370.58	185,288	0.120	$ 22,272	$ 371	$ 22,272	$ 276,725	$ 86,538	0.31
Nameplate	5	0	$ 366.87	183,436	0.124	$ 22,710	$ 367	$ 22,710	$ 277,092	$ 109,249	0.39
	6	0	$ 363.20	181,601	0.128	$ 23,158	$ 363	$ 23,158	$ 277,455	$ 132,406	0.48
	7	0	$ 359.57	179,785	0.131	$ 23,614	$ 360	$ 23,614	$ 277,815	$ 156,020	0.56
	8	0	$ 355.97	177,987	0.135	$ 24,079	$ 356	$ 24,079	$ 278,171	$ 180,100	0.65
	9	0	$ 352.42	176,208	0.139	$ 24,554	$ 352	$ 24,554	$ 278,523	$ 204,653	0.73
	10	0	$ 348.89	174,445	0.144	$ 25,037	$ 349	$ 25,037	$ 278,872	$ 229,690	0.82
	11	0	$ 345.40	172,701	0.148	$ 25,531	$ 345	$ 25,531	$ 279,217	$ 255,221	0.91
	12	0	$ 341.95	170,974	0.152	$ 26,033	$ 342	$ 26,033	$ 279,559	$ 281,254	1.01
	13	0	$ 338.53	169,264	0.157	$ 26,546	$ 339	$ 26,546	$ 279,898	$ 307,801	1.10
	14	0	$ 335.14	167,572	0.162	$ 27,069	$ 335	$ 27,069	$ 280,233	$ 334,870	1.19
	15	0	$ 331.79	165,896	0.166	$ 27,603	$ 332	$ 27,603	$ 280,565	$ 362,473	1.29
	16	0	$ 328.47	164,237	0.171	$ 28,146	$ 328	$ 28,146	$ 280,893	$ 390,619	1.39
	17	0	$ 325.19	162,595	0.177	$ 28,701	$ 325	$ 28,701	$ 281,218	$ 419,320	1.49
	18	0	$ 321.94	160,969	0.182	$ 29,266	$ 322	$ 29,266	$ 281,540	$ 448,586	1.59
	19	0	$ 318.72	159,359	0.187	$ 29,843	$ 319	$ 29,843	$ 281,859	$ 478,429	1.70
	20	0	$ 315.53	157,765	0.193	$ 30,431	$ 316	$ 30,431	$ 282,175	$ 508,860	1.80
			TOTALS	3,477,253					$ 282,175	$ 508,860	
			ANNUAL AVERAGE	173,863						$ 25,443	

*Initial production estimate in year 1 from Helioscope model run

HDR		Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 335,060	$ 464.96	232,460	$ 0.11	$ 25,573	$ 335,525	$ 25,573	$ 335,525	$ 25,573	0.08
	2	0	$ 460.31	230,155	0.113	$ 26,077	$ 460	$ 26,077	$ 335,985	$ 51,649	0.15
152.3	3	0	$ 455.71	227,854	0.117	$ 26,590	$ 456	$ 26,590	$ 336,441	$ 78,240	0.23
KW	4	0	$ 451.15	225,575	0.120	$ 27,114	$ 451	$ 27,114	$ 336,892	$ 105,354	0.31
Nameplate	5	0	$ 446.64	223,319	0.124	$ 27,648	$ 447	$ 27,648	$ 337,339	$ 133,002	0.39
	6	0	$ 442.17	221,086	0.128	$ 28,193	$ 442	$ 28,193	$ 337,781	$ 161,195	0.48
	7	0	$ 437.75	218,875	0.131	$ 28,748	$ 438	$ 28,748	$ 338,219	$ 189,943	0.56
	8	0	$ 433.37	216,686	0.135	$ 29,315	$ 433	$ 29,315	$ 338,652	$ 219,258	0.65
	9	0	$ 429.04	214,520	0.139	$ 29,892	$ 429	$ 29,892	$ 339,081	$ 249,150	0.73
	10	0	$ 424.75	212,374	0.144	$ 30,481	$ 425	$ 30,481	$ 339,506	$ 279,631	0.82
	11	0	$ 420.50	210,251	0.148	$ 31,082	$ 421	$ 31,082	$ 339,926	$ 310,713	0.91
	12	0	$ 416.30	208,148	0.152	$ 31,694	$ 416	$ 31,694	$ 340,343	$ 342,407	1.01
	13	0	$ 412.13	206,067	0.157	$ 32,318	$ 412	$ 32,318	$ 340,755	$ 374,725	1.10
	14	0	$ 408.01	204,006	0.162	$ 32,955	$ 408	$ 32,955	$ 341,163	$ 407,680	1.19
	15	0	$ 403.93	201,966	0.166	$ 33,604	$ 404	$ 33,604	$ 341,567	$ 441,284	1.29
	16	0	$ 399.89	199,946	0.171	$ 34,266	$ 400	$ 34,266	$ 341,967	$ 475,550	1.39
	17	0	$ 395.89	197,947	0.177	$ 34,941	$ 396	$ 34,941	$ 342,363	$ 510,491	1.49
	18	0	$ 391.93	195,967	0.182	$ 35,629	$ 392	$ 35,629	$ 342,754	$ 546,120	1.59
	19	0	$ 388.02	194,008	0.187	$ 36,331	$ 388	$ 36,331	$ 343,142	$ 582,452	1.70
	20	0	$ 384.14	192,068	0.193	$ 37,047	$ 384	$ 37,047	$ 343,527	$ 619,499	1.80
			TOTALS	4,233,298					$ 343,527	$ 619,499	
			ANNUAL AVERAGE	211,665						$ 30,975	

*Initial production estimate in year 1 from Helioscope model run

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Job No.		No.	
Project	2	Computed	GLD
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 549,120	$ 762.01	381,005	$ 0.11	$ 41,910	$ 549,882	$ 41,910	$ 549,882	$ 41,910	0.08
	2	0	$ 754.39	377,194	0.113	$ 42,736	$ 754	$ 42,736	$ 550,636	$ 84,647	0.15
249.6	3	0	$ 746.85	373,423	0.117	$ 43,578	$ 747	$ 43,578	$ 551,383	$ 128,225	0.23
KW	4	0	$ 739.38	369,688	0.120	$ 44,437	$ 739	$ 44,437	$ 552,123	$ 172,661	0.31
Nameplate	5	0	$ 731.98	365,991	0.124	$ 45,312	$ 732	$ 45,312	$ 552,855	$ 217,973	0.39
	6	0	$ 724.66	362,332	0.128	$ 46,205	$ 725	$ 46,205	$ 553,579	$ 264,178	0.48
	7	0	$ 717.42	358,708	0.131	$ 47,115	$ 717	$ 47,115	$ 554,297	$ 311,292	0.56
	8	0	$ 710.24	355,121	0.135	$ 48,043	$ 710	$ 48,043	$ 555,007	$ 359,335	0.65
	9	0	$ 703.14	351,570	0.139	$ 48,989	$ 703	$ 48,989	$ 555,710	$ 408,325	0.73
	10	0	$ 696.11	348,054	0.144	$ 49,954	$ 696	$ 49,954	$ 556,406	$ 458,279	0.82
	11	0	$ 689.15	344,574	0.148	$ 50,939	$ 689	$ 50,939	$ 557,095	$ 509,218	0.91
	12	0	$ 682.26	341,128	0.152	$ 51,942	$ 682	$ 51,942	$ 557,778	$ 561,160	1.01
	13	0	$ 675.43	337,717	0.157	$ 52,965	$ 675	$ 52,965	$ 558,453	$ 614,125	1.10
	14	0	$ 668.68	334,339	0.162	$ 54,009	$ 669	$ 54,009	$ 559,122	$ 668,134	1.19
	15	0	$ 661.99	330,996	0.166	$ 55,073	$ 662	$ 55,073	$ 559,784	$ 723,207	1.29
	16	0	$ 655.37	327,686	0.171	$ 56,158	$ 655	$ 56,158	$ 560,439	$ 779,365	1.39
	17	0	$ 648.82	324,409	0.177	$ 57,264	$ 649	$ 57,264	$ 561,088	$ 836,629	1.49
	18	0	$ 642.33	321,165	0.182	$ 58,392	$ 642	$ 58,392	$ 561,730	$ 895,021	1.59
	19	0	$ 635.91	317,954	0.187	$ 59,542	$ 636	$ 59,542	$ 562,366	$ 954,563	1.70
	20	0	$ 629.55	314,774	0.193	$ 60,715	$ 630	$ 60,715	$ 562,996	$ 1,015,278	1.80
			TOTALS	6,937,828					$ 562,996	$ 1,015,278	
			ANNUAL AVERAGE	346,891						$ 50,764	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project	2	Computed	GLD	Date	1/2/1900
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 275,220	$ 381.92	190,960	$ 0.11	$ 21,006	$ 275,602	$ 21,006	$ 275,602	$ 21,006	0.08
	2	0	$ 378.10	189,051	0.113	$ 21,419	$ 378	$ 21,419	$ 275,980	$ 42,425	0.15
125.1	3	0	$ 374.32	187,160	0.117	$ 21,841	$ 374	$ 21,841	$ 276,354	$ 64,266	0.23
KW	4	0	$ 370.58	185,288	0.120	$ 22,272	$ 371	$ 22,272	$ 276,725	$ 86,538	0.31
Nameplate	5	0	$ 366.87	183,436	0.124	$ 22,710	$ 367	$ 22,710	$ 277,092	$ 109,249	0.39
	6	0	$ 363.20	181,601	0.128	$ 23,158	$ 363	$ 23,158	$ 277,455	$ 132,406	0.48
	7	0	$ 359.57	179,785	0.131	$ 23,614	$ 360	$ 23,614	$ 277,815	$ 156,020	0.56
	8	0	$ 355.97	177,987	0.135	$ 24,079	$ 356	$ 24,079	$ 278,171	$ 180,100	0.65
	9	0	$ 352.42	176,208	0.139	$ 24,554	$ 352	$ 24,554	$ 278,523	$ 204,653	0.73
	10	0	$ 348.89	174,445	0.144	$ 25,037	$ 349	$ 25,037	$ 278,872	$ 229,690	0.82
	11	0	$ 345.40	172,701	0.148	$ 25,531	$ 345	$ 25,531	$ 279,217	$ 255,221	0.91
	12	0	$ 341.95	170,974	0.152	$ 26,033	$ 342	$ 26,033	$ 279,559	$ 281,254	1.01
	13	0	$ 338.53	169,264	0.157	$ 26,546	$ 339	$ 26,546	$ 279,898	$ 307,801	1.10
	14	0	$ 335.14	167,572	0.162	$ 27,069	$ 335	$ 27,069	$ 280,233	$ 334,870	1.19
	15	0	$ 331.79	165,896	0.166	$ 27,603	$ 332	$ 27,603	$ 280,565	$ 362,473	1.29
	16	0	$ 328.47	164,237	0.171	$ 28,146	$ 328	$ 28,146	$ 280,893	$ 390,619	1.39
	17	0	$ 325.19	162,595	0.177	$ 28,701	$ 325	$ 28,701	$ 281,218	$ 419,320	1.49
	18	0	$ 321.94	160,969	0.182	$ 29,266	$ 322	$ 29,266	$ 281,540	$ 448,586	1.59
	19	0	$ 318.72	159,359	0.187	$ 29,843	$ 319	$ 29,843	$ 281,859	$ 478,429	1.70
	20	0	$ 315.53	157,765	0.193	$ 30,431	$ 316	$ 30,431	$ 282,175	$ 508,860	1.80
			TOTALS	3,477,253					$ 282,175	$ 508,860	
			ANNUAL AVERAGE	173,863						$ 25,443	

*Initial production estimate in year 1 from Helioscope model run

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Job No.		No.	
Project	2	Computed	GLD
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 166,100	$ 230.50	115,248	$ 0.11	$ 12,677	$ 166,330	$ 12,677	$ 166,330	$ 12,677	0.08
	2	0	$ 228.19	114,095	0.113	$ 12,927	$ 228	$ 12,927	$ 166,559	$ 25,604	0.15
75.5	3	0	$ 225.91	112,954	0.117	$ 13,182	$ 226	$ 13,182	$ 166,785	$ 38,786	0.23
KW	4	0	$ 223.65	111,825	0.120	$ 13,441	$ 224	$ 13,441	$ 167,008	$ 52,227	0.31
Nameplate	5	0	$ 221.41	110,707	0.124	$ 13,706	$ 221	$ 13,706	$ 167,230	$ 65,933	0.39
	6	0	$ 219.20	109,599	0.128	$ 13,976	$ 219	$ 13,976	$ 167,449	$ 79,910	0.48
	7	0	$ 217.01	108,503	0.131	$ 14,251	$ 217	$ 14,251	$ 167,666	$ 94,161	0.56
	8	0	$ 214.84	107,418	0.135	$ 14,532	$ 215	$ 14,532	$ 167,881	$ 108,693	0.65
	9	0	$ 212.69	106,344	0.139	$ 14,819	$ 213	$ 14,819	$ 168,093	$ 123,512	0.73
	10	0	$ 210.56	105,281	0.144	$ 15,110	$ 211	$ 15,110	$ 168,304	$ 138,622	0.82
	11	0	$ 208.46	104,228	0.148	$ 15,408	$ 208	$ 15,408	$ 168,512	$ 154,030	0.91
	12	0	$ 206.37	103,186	0.152	$ 15,712	$ 206	$ 15,712	$ 168,719	$ 169,742	1.01
	13	0	$ 204.31	102,154	0.157	$ 16,021	$ 204	$ 16,021	$ 168,923	$ 185,763	1.10
	14	0	$ 202.26	101,132	0.162	$ 16,337	$ 202	$ 16,337	$ 169,125	$ 202,100	1.19
	15	0	$ 200.24	100,121	0.166	$ 16,659	$ 200	$ 16,659	$ 169,326	$ 218,759	1.29
	16	0	$ 198.24	99,120	0.171	$ 16,987	$ 198	$ 16,987	$ 169,524	$ 235,745	1.39
	17	0	$ 196.26	98,129	0.177	$ 17,321	$ 196	$ 17,321	$ 169,720	$ 253,067	1.49
	18	0	$ 194.29	97,147	0.182	$ 17,663	$ 194	$ 17,663	$ 169,914	$ 270,729	1.59
	19	0	$ 192.35	96,176	0.187	$ 18,011	$ 192	$ 18,011	$ 170,107	$ 288,740	1.70
	20	0	$ 190.43	95,214	0.193	$ 18,365	$ 190	$ 18,365	$ 170,297	$ 307,105	1.80
			TOTALS	2,098,582					$ 170,297	$ 307,105	
			ANNUAL AVERAGE	104,929						$ 15,355	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project	2	Computed	GLD
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Subject	Solar Feasibility	Checked	
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 556,160	$ 771.78	385,889	$ 0.11	$ 42,448	$ 556,932	$ 42,448	$ 556,932	$ 42,448	0.08
	2	0	$ 764.06	382,030	$ 0.113	$ 43,284	$ 764	$ 43,284	$ 557,696	$ 85,732	0.15
252.8	3	0	$ 756.42	378,210	$ 0.117	$ 44,137	$ 756	$ 44,137	$ 558,452	$ 129,869	0.23
KW	4	0	$ 748.86	374,428	$ 0.120	$ 45,006	$ 749	$ 45,006	$ 559,201	$ 174,875	0.31
Nameplate	5	0	$ 741.37	370,684	$ 0.124	$ 45,893	$ 741	$ 45,893	$ 559,942	$ 220,768	0.39
	6	0	$ 733.95	366,977	$ 0.128	$ 46,797	$ 734	$ 46,797	$ 560,676	$ 267,565	0.48
	7	0	$ 726.61	363,307	$ 0.131	$ 47,719	$ 727	$ 47,719	$ 561,403	$ 315,283	0.56
	8	0	$ 719.35	359,674	$ 0.135	$ 48,659	$ 719	$ 48,659	$ 562,122	$ 363,942	0.65
	9	0	$ 712.15	356,077	$ 0.139	$ 49,617	$ 712	$ 49,617	$ 562,835	$ 413,560	0.73
	10	0	$ 705.03	352,516	$ 0.144	$ 50,595	$ 705	$ 50,595	$ 563,540	$ 464,155	0.82
	11	0	$ 697.98	348,991	$ 0.148	$ 51,592	$ 698	$ 51,592	$ 564,238	$ 515,746	0.91
	12	0	$ 691.00	345,501	$ 0.152	$ 52,608	$ 691	$ 52,608	$ 564,929	$ 568,354	1.01
	13	0	$ 684.09	342,046	$ 0.157	$ 53,644	$ 684	$ 53,644	$ 565,613	$ 621,999	1.10
	14	0	$ 677.25	338,626	$ 0.162	$ 54,701	$ 677	$ 54,701	$ 566,290	$ 676,700	1.19
	15	0	$ 670.48	335,240	$ 0.166	$ 55,779	$ 670	$ 55,779	$ 566,960	$ 732,479	1.29
	16	0	$ 663.77	331,887	$ 0.171	$ 56,878	$ 664	$ 56,878	$ 567,624	$ 789,356	1.39
	17	0	$ 657.14	328,568	$ 0.177	$ 57,998	$ 657	$ 57,998	$ 568,281	$ 847,355	1.49
	18	0	$ 650.57	325,283	$ 0.182	$ 59,141	$ 651	$ 59,141	$ 568,932	$ 906,495	1.59
	19	0	$ 644.06	322,030	$ 0.187	$ 60,306	$ 644	$ 60,306	$ 569,576	$ 966,801	1.70
	20	0	$ 637.62	318,810	$ 0.193	$ 61,494	$ 638	$ 61,494	$ 570,214	$ 1,028,295	1.80
			TOTALS	7,026,775					$ 570,214	$ 1,028,295	
			ANNUAL AVERAGE	351,339						$ 51,415	

*Initial production estimate in year 1 from Helioscope model run

Job No.		No.	
Project	2	Computed	GLD
Subject	Solar Feasibility	Checked	
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Date	
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C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 147,840	$ 205.16	102,578	$ 0.11	$ 11,284	$ 146,045	$ 11,284	$ 148,045	$ 11,284	0.08
	2	0	$ 203.10	101,552	0.113	$ 11,506	$ 203	$ 11,506	$ 148,248	$ 22,789	0.15
67.2	3	0	$ 201.07	100,537	0.117	$ 11,733	$ 201	$ 11,733	$ 148,449	$ 34,522	0.23
KW	4	0	$ 199.06	99,531	0.120	$ 11,964	$ 199	$ 11,964	$ 148,648	$ 46,486	0.31
Nameplate	5	0	$ 197.07	98,536	0.124	$ 12,199	$ 197	$ 12,199	$ 148,845	$ 58,685	0.39
	6	0	$ 195.10	97,551	0.128	$ 12,440	$ 195	$ 12,440	$ 149,041	$ 71,125	0.48
	7	0	$ 193.15	96,575	0.131	$ 12,685	$ 193	$ 12,685	$ 149,234	$ 83,810	0.56
	8	0	$ 191.22	95,610	0.135	$ 12,935	$ 191	$ 12,935	$ 149,425	$ 96,744	0.65
	9	0	$ 189.31	94,653	0.139	$ 13,189	$ 189	$ 13,189	$ 149,614	$ 109,934	0.73
	10	0	$ 187.41	93,707	0.144	$ 13,449	$ 187	$ 13,449	$ 149,802	$ 123,383	0.82
	11	0	$ 185.54	92,770	0.148	$ 13,714	$ 186	$ 13,714	$ 149,987	$ 137,097	0.91
	12	0	$ 183.68	91,842	0.152	$ 13,984	$ 184	$ 13,984	$ 150,171	$ 151,082	1.01
	13	0	$ 181.85	90,924	0.157	$ 14,260	$ 182	$ 14,260	$ 150,353	$ 165,341	1.10
	14	0	$ 180.03	90,014	0.162	$ 14,541	$ 180	$ 14,541	$ 150,533	$ 179,882	1.19
	15	0	$ 178.23	89,114	0.166	$ 14,827	$ 178	$ 14,827	$ 150,711	$ 194,710	1.29
	16	0	$ 176.45	88,223	0.171	$ 15,119	$ 176	$ 15,119	$ 150,887	$ 209,829	1.39
	17	0	$ 174.68	87,341	0.177	$ 15,417	$ 175	$ 15,417	$ 151,062	$ 225,246	1.49
	18	0	$ 172.94	86,468	0.182	$ 15,721	$ 173	$ 15,721	$ 151,235	$ 240,967	1.59
	19	0	$ 171.21	85,603	0.187	$ 16,031	$ 171	$ 16,031	$ 151,406	$ 256,998	1.70
	20	0	$ 169.49	84,747	0.193	$ 16,346	$ 169	$ 16,346	$ 151,576	$ 273,344	1.80
			TOTALS	1,867,877					$ 151,576	$ 273,344	
			ANNUAL AVERAGE	93,394						$ 13,667	

*Initial production estimate in year 1 from Helioscope model run

HDR

Job No.		No.	
Project 2	Computed GLD	Date	1/2/1900
Subject Solar Feasibility	Checked	Date	
Task Prduction and Cost Analysis	Sheet 54	Of	54

C. ROI

Location	Year	Capital Cost	O&M Cost	Annual Production (kWhr)*	Electricity Escalation	Electricity Savings ($)	Annual Total Costs	Total Savings	Costs to Date	Savings to date	IRR based upon total costs
Tanks	1	$ 109,780	$ 152.34	76,170	$ 0.11	$ 8,379	$ 109,932	$ 8,379	$ 109,932	$ 8,379	0.08
	2	0	$ 150.82	75,409	0.113	$ 8,544	$ 151	$ 8,544	$ 110,083	$ 16,923	0.15
49.9	3	0	$ 149.31	74,655	0.117	$ 8,712	$ 149	$ 8,712	$ 110,232	$ 25,635	0.23
KW	4	0	$ 147.82	73,908	0.120	$ 8,884	$ 148	$ 8,884	$ 110,380	$ 34,518	0.31
Nameplate	5	0	$ 146.34	73,169	0.124	$ 9,059	$ 146	$ 9,059	$ 110,527	$ 43,577	0.39
	6	0	$ 144.87	72,437	0.128	$ 9,237	$ 145	$ 9,237	$ 110,671	$ 52,814	0.48
	7	0	$ 143.43	71,713	0.131	$ 9,419	$ 143	$ 9,419	$ 110,815	$ 62,234	0.56
	8	0	$ 141.99	70,996	0.135	$ 9,605	$ 142	$ 9,605	$ 110,957	$ 71,838	0.65
	9	0	$ 140.57	70,286	0.139	$ 9,794	$ 141	$ 9,794	$ 111,097	$ 81,632	0.73
	10	0	$ 139.17	69,583	0.144	$ 9,987	$ 139	$ 9,987	$ 111,237	$ 91,619	0.82
	11	0	$ 137.77	68,887	0.148	$ 10,184	$ 138	$ 10,184	$ 111,374	$ 101,803	0.91
	12	0	$ 136.40	68,198	0.152	$ 10,384	$ 136	$ 10,384	$ 111,511	$ 112,187	1.01
	13	0	$ 135.03	67,516	0.157	$ 10,589	$ 135	$ 10,589	$ 111,646	$ 122,776	1.10
	14	0	$ 133.68	66,841	0.162	$ 10,797	$ 134	$ 10,797	$ 111,780	$ 133,573	1.19
	15	0	$ 132.35	66,173	0.166	$ 11,010	$ 132	$ 11,010	$ 111,912	$ 144,583	1.29
	16	0	$ 131.02	65,511	0.171	$ 11,227	$ 131	$ 11,227	$ 112,043	$ 155,810	1.39
	17	0	$ 129.71	64,856	0.177	$ 11,448	$ 130	$ 11,448	$ 112,173	$ 167,259	1.49
	18	0	$ 128.41	64,207	0.182	$ 11,674	$ 128	$ 11,674	$ 112,301	$ 178,932	1.59
	19	0	$ 127.13	63,565	0.187	$ 11,904	$ 127	$ 11,904	$ 112,428	$ 190,836	1.70
	20	0	$ 125.86	62,930	0.193	$ 12,138	$ 126	$ 12,138	$ 112,554	$ 202,974	1.80
			TOTALS	1,387,010					$ 112,554	$ 202,974	
			ANNUAL AVERAGE	69,350						$ 10,149	

*Initial production estimate in year 1 from Helioscope model run

Draft Geothermal Heating/Cooling Technical Memorandum

Date: Friday, December 28, 2018

Project: Des Moines Market District Master Plan

To: City of Des Moines

From: HDR Engineering, Inc.

Subject: Geothermal Heating/Cooling Feasibility Study

Introduction & Purpose

Geothermal Heating/Cooling System

As part of an energy evaluation for the Market District Master Plan (Study), HDR was requested to evaluate the feasibility of including renewable energy elements to increase project value.

The purpose of this technical memo is to provide methodology and results of a conceptual analysis for a geothermal energy system.

What is a Geothermal Heating/Cooling System?

A geothermal heating and cooling system uses the earth as a heat source (in the winter) and a heat sink (in the summer). In the winter heat is extracted from the earth, while in the summer heat is put into the earth. It is important to have a relative balance between heating and cooling requirements within the buildings being served; without this balance ground temperatures can change which could affect the long term capacity of the system. In climates where cooling or heating is required for the majority of the year, geothermal systems are not a good choice.

There are several types of geothermal systems including vertical, horizontal, slinky coil, ground water and surface water to name a few. For the purposes of this evaluation, information contained is based on a vertical closed loop geothermal system, also referred to as a ground coupled heat pump (GCHP) system; the system will be referred to as such in this technical memorandum.

A vertical GCHP system is installed as a series of vertical bores drilled into the earth in depths ranging from 50 to 600 feet depending on drilling conditions and equipment available. This area sees installations ranging from 200 to 400 feet with 300 foot depths being very common. Bores are installed in a grid pattern and are separated in each direction by 15 -20 feet.

An individual bore consists of a 5-6 inch diameter hole to the required depth (300' in this case). Two small diameter high-density polyethylene tubes fused together with a u-bend at the bottom are placed in the bore hole. Each bore is completely filled with a sand/grout mixture to provide the thermal contact with the earth. A common misconception is that water is being pumped out of the ground; in a closed loop system all water is contained in the piping system and no water is pumped out of the ground.

Each bore is connected to a header system which is then connected to the main piping system. The main piping system would enter a pump house which would include pumps, accessories and chemical treatment, etc., to distribute the fluid in the system to the required areas in the district. The liquid contained in the system is a mixture of water and environmentally safe glycol (anti-freeze). The glycol is added to the system for buildings that may have heating, ventilation and air conditioning (HVAC) equipment located on the roof (more common for office and retail spaces).

The mixture of water and glycol is generally referred to as condenser water. The temperature range of the condenser water for a geothermal system is typically between 44°F and 95°F. HVAC equipment suitable for geothermal system use is able to extract heat from the condenser loop even at the lower temperature and is able to reject heat at the higher temperature. Several HVAC system types are available for use with a geothermal condenser water system; these HVAC systems are not discussed as part of this technical memorandum. This HVAC equipment would be part of the building owner's system.

Assumptions

The following assumptions were used in determining the future potential heating and cooling loads of the district.

1 Ton = 12,000 BTU

Tons/300' Bore = 1.5 Tons (Can vary based on actual soil conditions)

Area Required/Bore = 225 Sq.Ft. (Based on 15' grid spacing)

Areas of possible geothermal well locations where determined by aerial view of the preferred concept master plan.

Cooling loads are based on industry averages (square foot/ton) for this climate and will vary from detailed design calculations.

For purposes of this analysis, building load requirements are based on cooling. For this region the cooling load is generally greater than the heating load requirements. If a system is designed to meet the cooling load it will have enough capacity to meet the heating load requirements.

BUILDING/GEOTHERMAL REQUIREMENTS						
Building Type	Building Area (Sq.Ft.)	Sq.Ft./Ton of Cooling	Tons Required	# of Bores	Required Land Area (Sq.Ft.)	Required Land Area (Acres)
Residential – Multi-Family	3,155,283	450	7,012	4,674	1,051,761	24.1
Retail	136,000	200	680	453	102,000	2.3
Office	211,200	350	603	402	90,514	2.1
Total	3,502,483	434	8,295	5,530	1,244,275	28.6

POTENTIAL GEOTHERMAL SITE LOCATIONS/CAPACITY			
Area Available	Sq.Ft. of Area Available	# of Bores Possible	% of Load Served
Former Railroad Tracks	105,000	467	8.44
East Area	44,610	198	3.59
Storm Detention	517,550	2,300	41.59
Total	667,160	2,965	53.62

If the geothermal system is installed under the storm detention areas there would be some environmental impacts. These impacts would include a requirement to provide a bentonite cap to seal the top of the geothermal installation which prevent surface water for penetrating into the geothermal zone. Capping the system could make any future modifications to the storm detention cost prohibitive. Along with the bentonite cap the geothermal piping requires approximately 5 feet of soil coverage which would limit the options to deepen the detention area after the geothermal system is installed.

Cost Information

Costs for installation of geothermal systems will vary depending on drilling conditions, site constraints, special environmental requirements, availability of drilling contractors, etc. Costs in the State of Iowa can range from $3,000 to $5,000/bore. The following is based on $4,000/bore:

Borefield:

Cost to install the full amount of bores required: 5,530 bores x $4,000 = $22,120,000.

Cost to install the amount of bores based on potential land areas: 2,965 bores x $4,000 = $11,860,000.

Pump House:

Estimated cost of the pump house to be completed during remaining study.

System Distribution Piping:

Distribution piping for the district to be completed during remaining study.

A system simple payback analysis with estimated consumer rates will be completed during the remaining study.

Acknowledgements

ASHRAE

HVAC Equations, Data and Rules of Thumb

Iowa Geothermal Association

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