Memo

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To: Mayor and Council

From: John Dunn

Date: April 12, 2013

Subject: Flood Mitigation Study Workshop

HRD Engineers, the firm that conducted the City's community-wide flood mitigation study, has just presented its final update to the public, and will now give that same presentation to the City Council. At the April 16, 2013 Council workshop, HDR will provide Council with a brief overview of the scope of the study, a description of the extensive public involvement efforts, and a summary of the public input and feedback received. The majority of the presentation will focus on the results of the mitigation alternatives that were evaluated.

The presentation portion of the workshop is expected to take about an hour. Following that, staff and the consulting team will welcome questions and discussion with Council. There will not be public input at this workshop, and Council will not be asked to make any final decisions.

Throughout the progress of the study, staff members from Iowa State University, Story County and the Iowa Department of Transportation actively participated and provided key input. Because many of the alternatives would involve these neighboring bodies, invitations have been extended to senior leaders from each of these three organizations to attend the April 16 workshop.

To aid in your preparation for the workshop, a copy of the presentation materials is attached. Materials from the various public meetings, including the most recent meetings on April 10, are available on a website hosted by the consulting team. These can be reached by clicking the Flood Study link in the upper right corner of the City's home page.

Following Tuesday's workshop, HDR will finalize the written report, incorporating any additional feedback or direction from Council. The draft report is anticipated to be ready for staff review by mid-May, with the final report brought to Council in late June for acceptance. Staff will then look for guidance from Council at some point this summer or fall regarding follow up actions. This could include projects Council desires to consider as part of the next Capital Improvements Plan, any changes in floodplain regulations that Council may wish to consider, or any other types of actions to mitigate flooding in the future.

Water and Pollution Control Department
Administrative Division

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www.CityofAmes.org/Water

Council Workshop 3

City of Ames

Flood Mitigation Study

April 16, 2013

Welcome

The purpose of this update is to:

- Present the detailed screening evaluation of flood mitigation alternatives and strategies for the Ames Community to the City Council
- Present feedback on the strategies to the City Council.

The Study

Method

Collect public input, develop and analyze alternatives and strategies, summarize impacts.

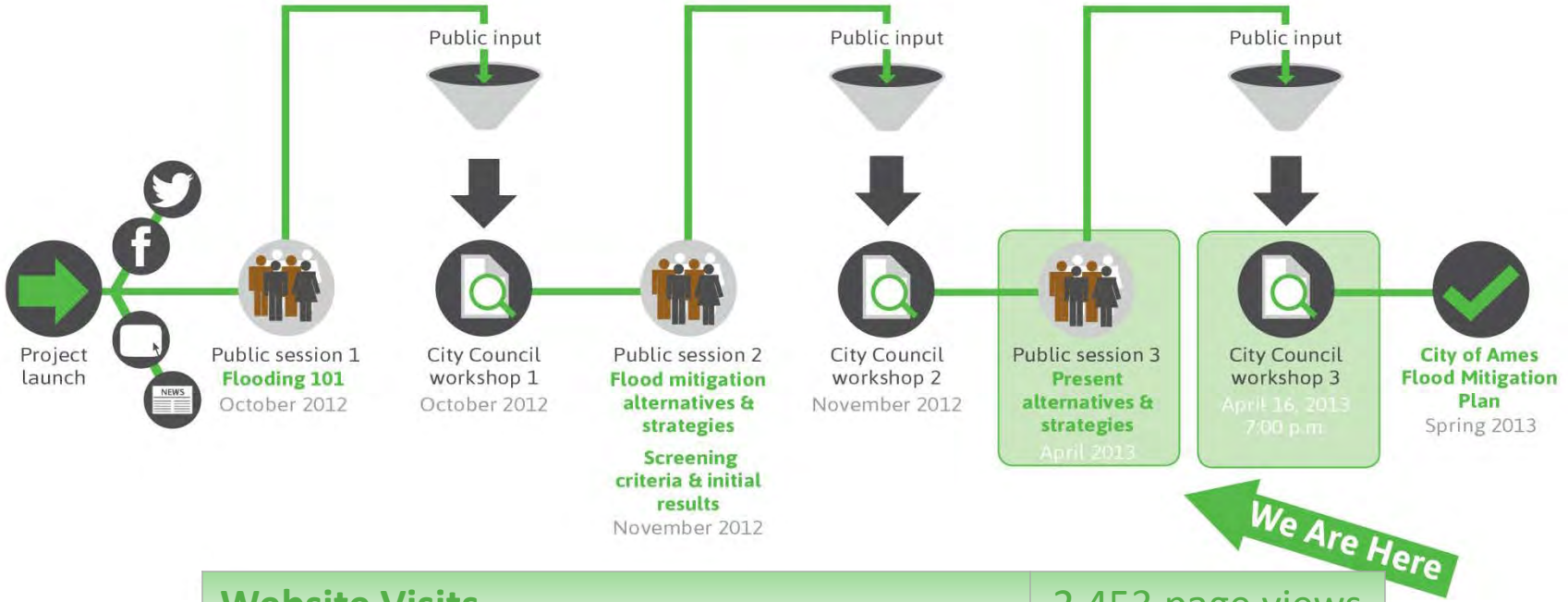
Focus

Determine impacts – positive and negative – of flood mitigation alternatives and strategies.

Goal

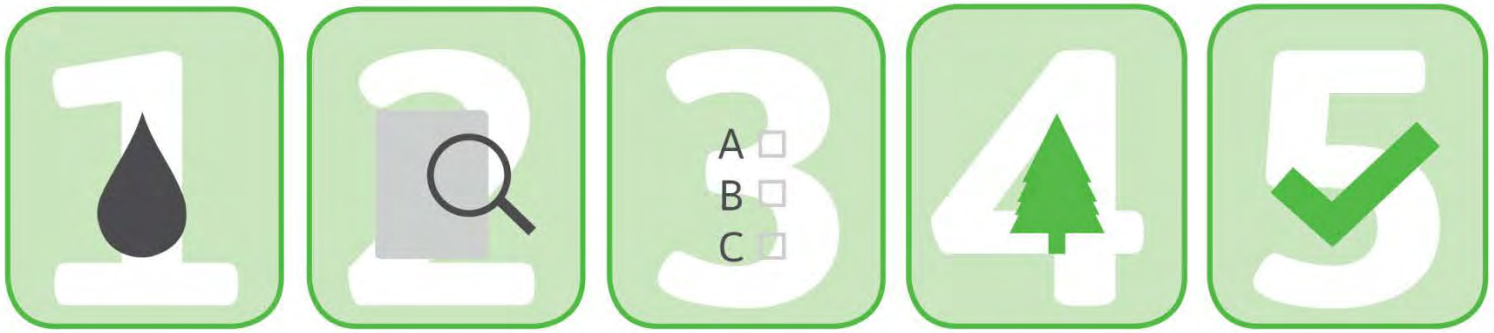
Present the best alternatives and strategies to City Council.

Community Involvement



Website Visits	2,453 page views
Online Meeting Participation	645 page views
Public Session 1 Meeting Attendance	98 attendees
Public Session 2 Meeting Attendance	58 attendees
Public Session 3 Meeting Attendance	112 attendees
Comments Received	181 comments

Evaluation Process



Since we last met in November, we conducted the Detailed Screening Process of Flood Mitigation Alternatives and Strategies. Criteria included:

- Level of Protection Provided
- Project Cost
- Environmental Impacts
- Benefit Cost Analysis

Flood Hydrology

The study team updated flood magnitudes and frequencies by engineering and statistical calculations and reviewed and updated flood maps.

USGS Gage	Source	Annual flood-probability discharge (cfs)			
		10-percent	2-percent	1-percent	0.2-percent
South Skunk River near Ames, IA	Updated FFA	6,800	10,200	11,600	14,900
	FEMA Effective Flows	6,280	9,000	10,100	12,600
Squaw Creek at Ames, IA	Updated FFA	8,260	15,800	20,000	32,600
	FEMA Effective Flows	7,570	13,700	17,000	26,300
South Skunk River below Squaw Creek near Ames, IA	Updated FFA	14,500	24,100	28,900	41,800
	FEMA Effective Flows	12,700	19,700	23,000	31,400

Transposed Rainstorms

- **Upper Iowa River, Iowa, June 7-8, 2008**
  10.5 inches in 30 hours
- **Ames, Iowa, August 8-11, 2010**
  10 inches
- **Lake Delhi, Iowa, Dam Failure Event, July 24, 2010**
  13 inches in 48 hours
- **Ames, Iowa, August 8-11, 2010**
  with transposed 2nd Night of Rainfall
  20% more rainfall
- **Dubuque, Iowa (Galena, Illinois), July 27-28, 2011**
  11+ inches of rain in 13 hours, 0.1% annual chance rainfall (1,000 year rainfall)

Upper Iowa
(77,000 acre-ft of runoff)

Ames
(69,000 acre-ft of runoff)

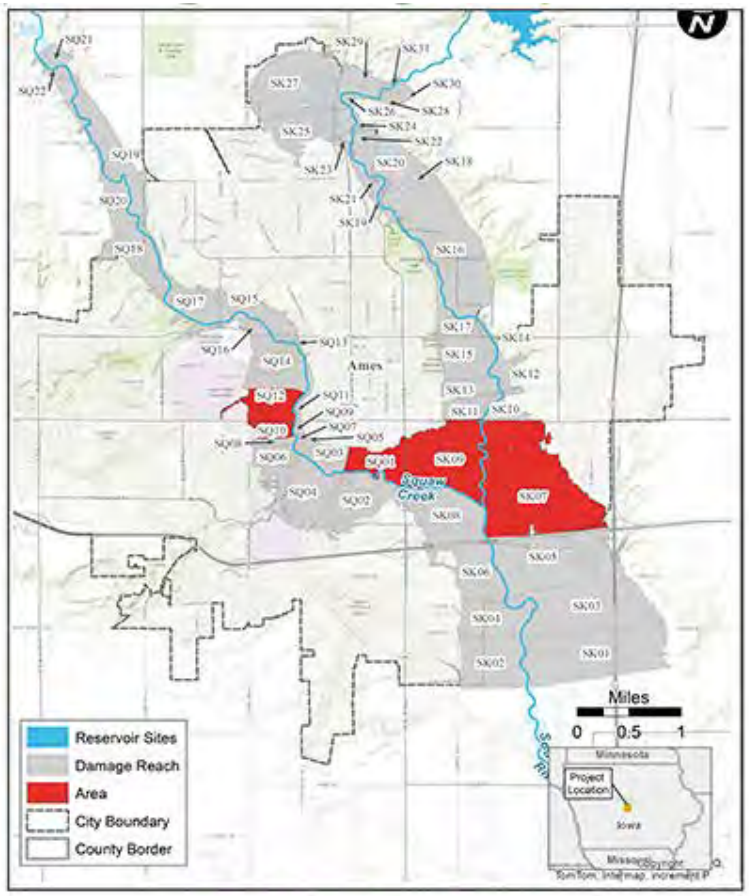
Lake Delhi Storm
(120,000 acre-ft of runoff)

Ames – Transposed
(187,000 acre-ft of runoff)

Dubuque
(103,000 acre-ft of runoff)

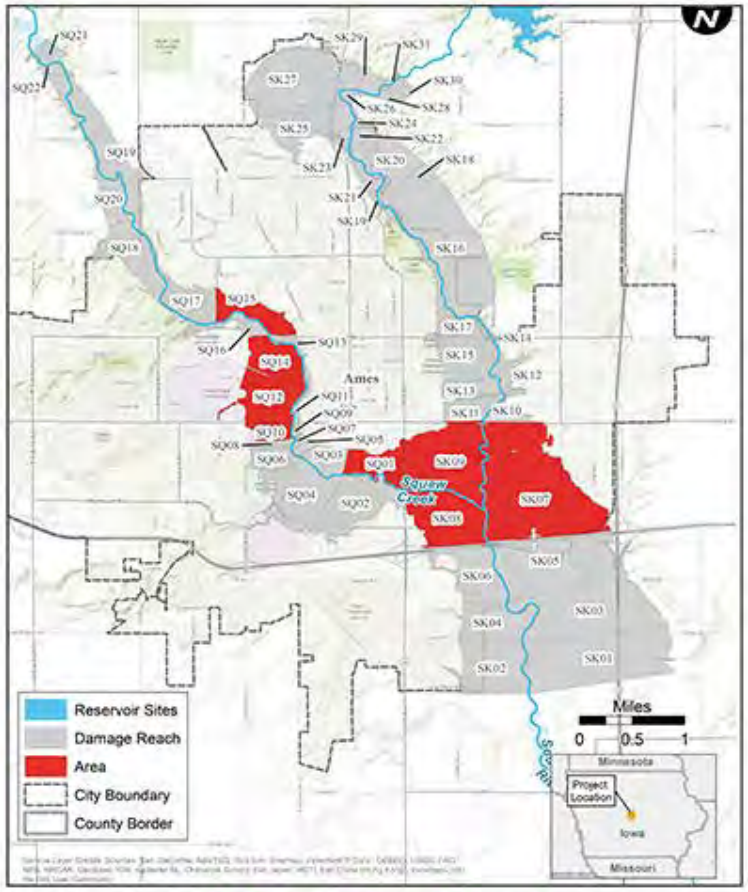
Flood Damage Areas

(Red = High $ Damage Area)



100-Year Flood Event

40% of total Structures and 99% of total Property Value



500-Year Flood Event

60% of total Structures and 99% of total Property Value

Flood Mitigation Alternatives & Strategies

Storage	Protection	Non-Structural
• Centralized Flood Storage • Regional Flood Storage • Floodplain Storage • Conservation Measures in Watershed	• Flood Water Diversion • Conveyance Improvements • Levee along Skunk River • Levee along Squaw Creek	• Do Nothing • Property Buyouts • Flood Plain Ordinance Modification

Flood Mitigation Alternatives & Strategies

Floodwall

Levee with Roadway

Floodwall

Levee with Roadway

Diversion

Dry Reservoir

Wetlands Restoration

Reservoir

Screening Criteria

The following criteria were used to evaluate flood mitigation alternatives and strategies.

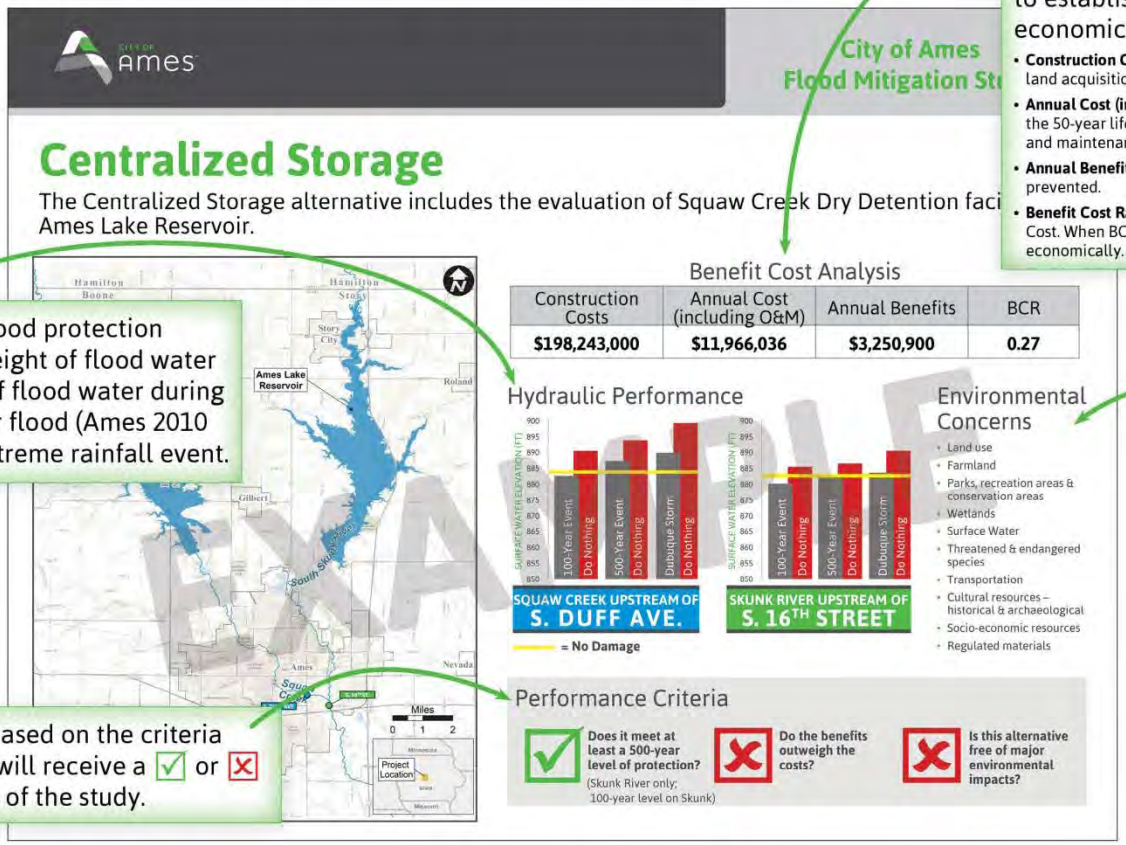
Benefit Cost Analysis – Estimates and totals the equivalent dollar value of the benefits and costs to the community to establish whether projects are economically worthwhile.

- **Construction Costs** – Final project cost including construction, land acquisition, and transportation relocations.
- **Annual Cost (including O&M)**– Annual cost of the project over the 50-year life of the project including capital costs, operation and maintenance costs.
- **Annual Benefits** – Annual dollar value of property damage prevented.
- **Benefit Cost Ratio (BCR)** – Annual Benefits divided by Annual Cost. When BCR is greater than 1, the project is justified economically.

Hydraulic Performance – Flood protection achieved by lowering the height of flood water and reducing the quantity of flood water during the 100-year flood, 500-year flood (Ames 2010 Flood), and the Dubuque extreme rainfall event.

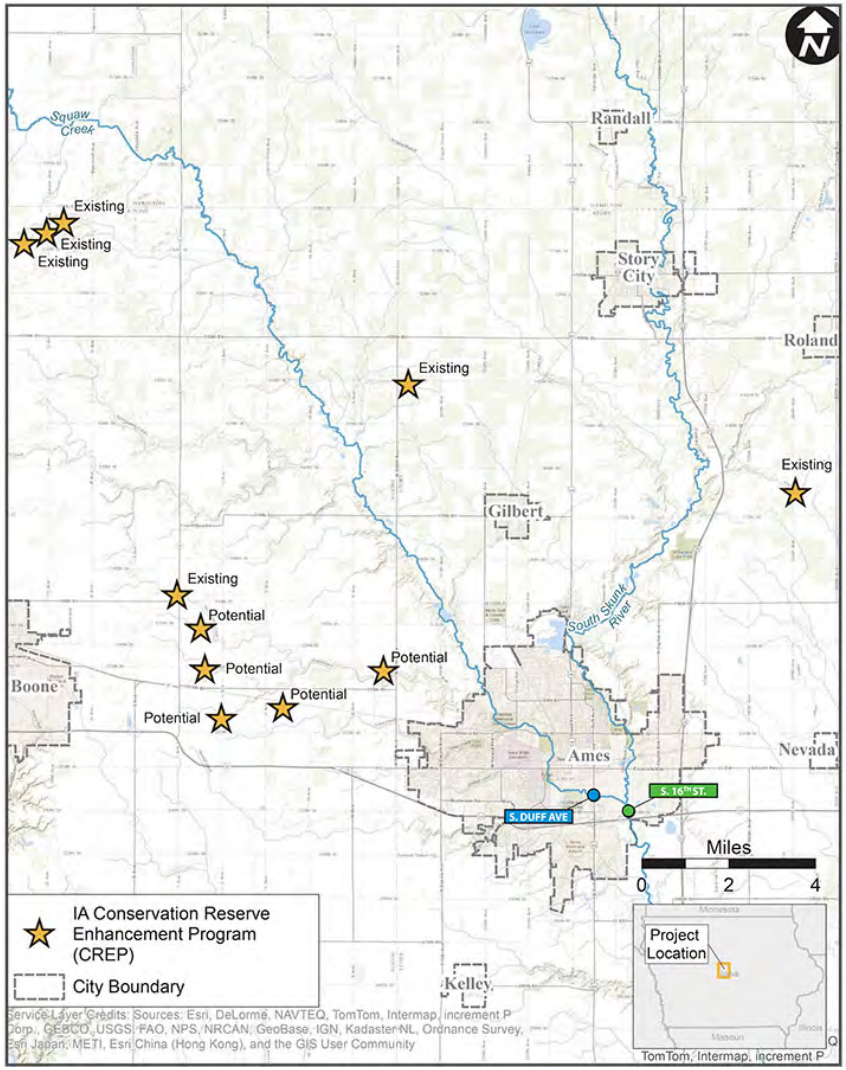
Performance Criteria – Based on the criteria above, each alternative will receive a ☑ or ☒ if it meets the objectives of the study.

Environmental Concerns – Identifies the main environmental impacts of each alternative or strategy.



Conservation Measures in Watershed

The Conservation Measures in the Watershed alternative evaluates small detention sites that could contribute to flood reduction, and the construction of wetlands administered under the Iowa Department of Agriculture and Land Stewardship Conservation Reserve Enhancement Program.



Benefit Cost Analysis

Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$2,025,000	**$122,230**	**$0**	**0.00**

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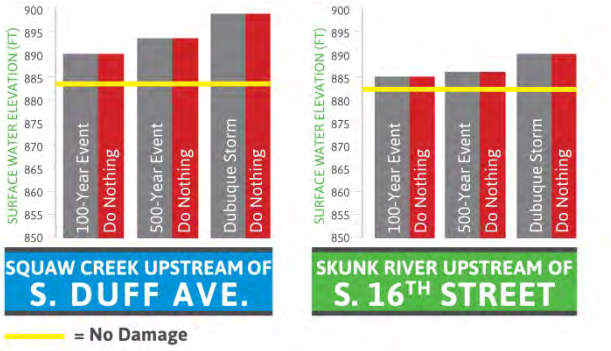
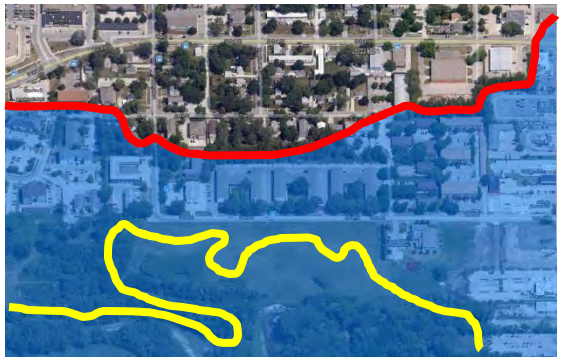
Hydraulic Performance



500-Year Event

100-Year Event

Dubuque Storm



Environmental Concerns

Land Use	Impacts to Agricultural land. (1,326 acres)		
Farmland	Impacted.		
Parks, Recreation & Conservation Areas	No impact.		
Wetlands	Would increase existing wetland conservation areas in partnership with the Iowa Department of Agriculture and Land Stewardship.		
Surface Water	No impact.		
Threatened & Endangered Species	No impact.		
Cultural Resources – Historical & Archaeological	No impact.		
Socio-Economic Resources	No impact.		
Environmental Justice	No impact.		
Transportation	No impact.		
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.		
Regulated Materials	No impact.		
Air Quality	No impact.		
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (Provide no flood level of reduction.)	Do the benefits outweigh the costs? ☒	Is this alternative free of major environmental impacts? ☑

Conservation Measures in Watershed

Limited Flood Protection Value for the City of Ames

Limited number of sites available

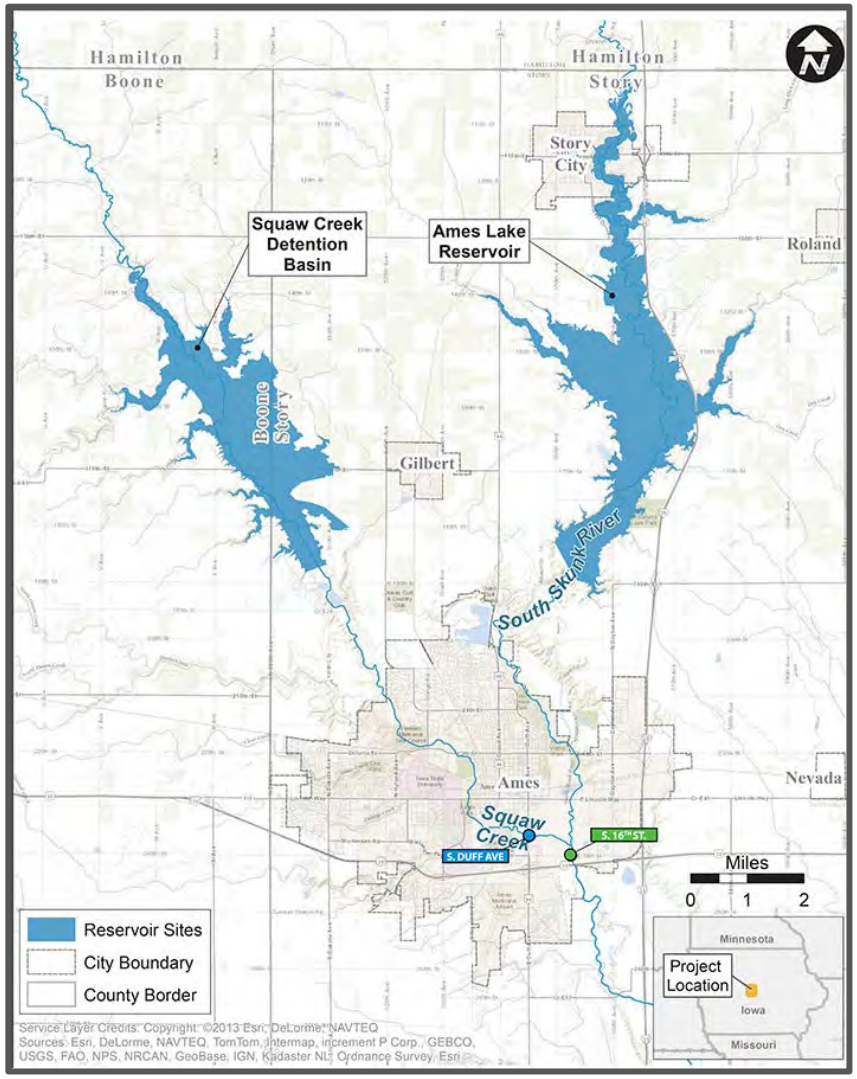
Partnering opportunities with State of Iowa and Counties in Watershed

Centralized Storage

The Centralized Storage alternative includes the evaluation of Squaw Creek Dry Detention facility and Ames Lake Reservoir.

Benefit Cost Analysis

Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$198,243,000	**$11,966,036**	**$3,250,900**	**0.27**



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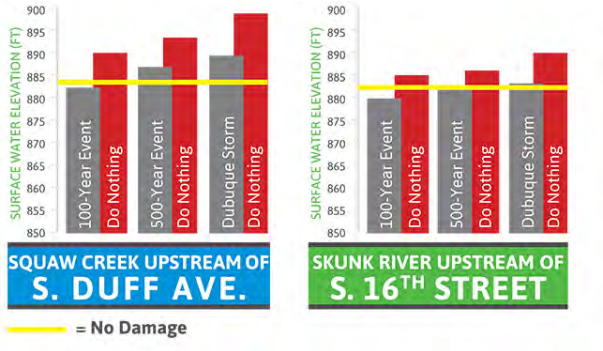
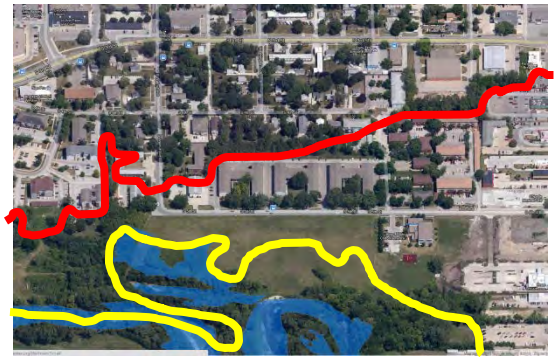
Hydraulic Performance



500-Year Event

100-Year Event



Dubuque Storm

Environmental Concerns

Land Use	Impacts to residential & agricultural land uses NW of Ames. Residential, agricultural and Public Lands NE of Ames & Story City. Housing developments in Western Story County and Eastern Boone County. Scattered farm residences in both counties. (10,660 acres)
Farmland	Impacted.
Parks, Recreation & Conservation Areas	Impacts to Story City Park, River Bend Municipal Golf Course, 12 conservation and recreation areas between Ames and Story City.
Wetlands	Impacts to approximately 840 acres.
Surface Water	Impacts to approximately 15 miles of Skunk River and approximately 7.5 miles of Squaw Creek.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 93 archaeological sites and 17 historic structures with the construction of SR-1, and 17 archaeological sites and 46 historical structures with the construction of SC-1.
Socio-Economic Resources	Impacts to approximately 150 residences from construction of SR-1 and 75 residences from construction of SC-1. Construction of SR-1 and SC-1 would preclude further development in and near affected areas. Construction of SR-1 would also affect Story City's wastewater treatment plant, a school and associated athletic facilities, and 2-3 businesses in Story City.
Environmental Justice	Impacts to minorities, low-income, elderly and LEP populations.
Transportation	Impacts to US 69, Broad Street in Story City, 130th, 150th, 170th, 180th, and 190th Streets, as well as local roads with the construction of SR-1. Construction of SC-1 would affect 140th, 150th, 160th, 170th, and 180th Streets. Potential impacts to airspace at the Ames Municipal Airport.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	15 leaking UST's within 1 mile of SR-1. 1 leaking UST is within the proposed footprint of SR-1.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☑ (Skunk River only; 100 –year level on Squaw.)	Do the benefits outweigh the costs? ☒	Is this alternative free of major environmental impacts? ☒

Centralized Storage

Not free of major environmental impacts

Cost prohibitive

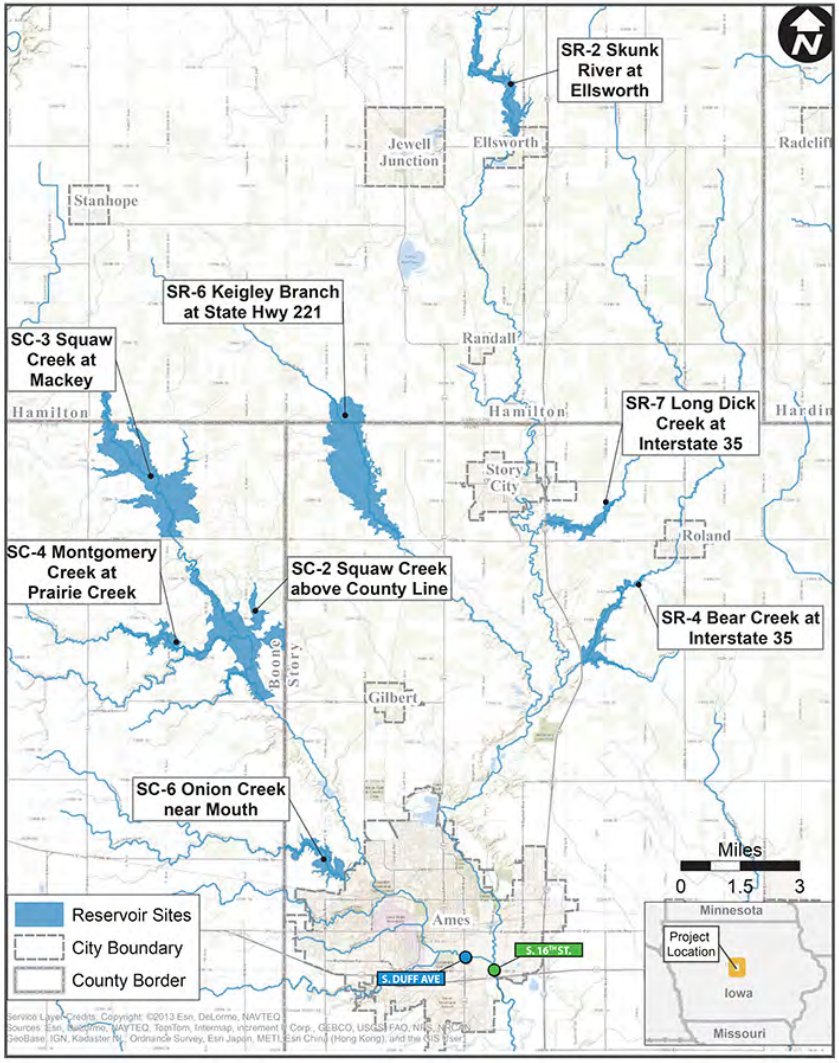
Does provide 450-year level of flood protection on both skunk river and squaw creek

Regional Flood Storage

The Regional Flood Storage alternative includes the evaluation of 14 storage sites.

Benefit Cost Analysis

Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$145,339,000	**$8,772,727**	**$3,217,700**	**0.37**



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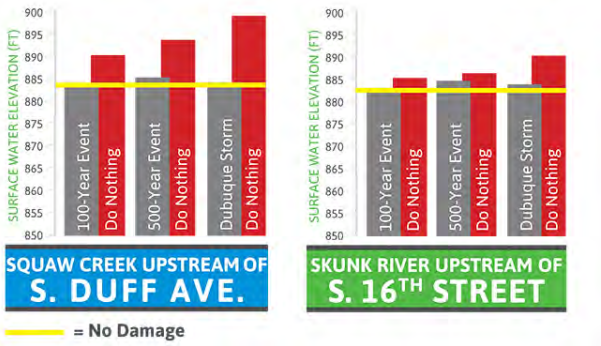
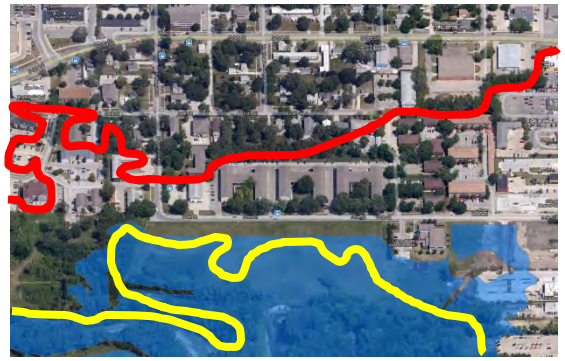
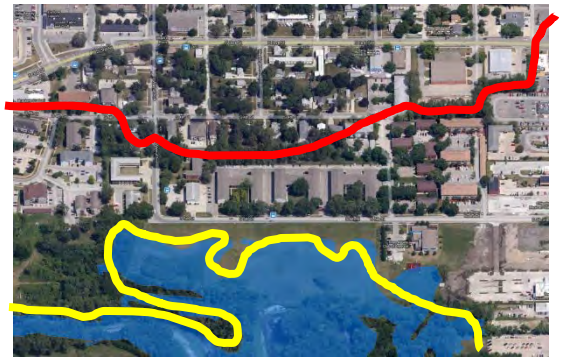


500-Year Event



100-Year Event

Dubuque Storm



Environmental Concerns

Land Use	Impacts to residential developments, cemeteries, and agricultural land. (7,355 acres)
Farmland	Impacted.
Parks, Recreation & Conservation Areas	Impacts to the Bob Pyle Marsh WMA.
Wetlands	Impacts to approximately 800 acres.
Surface Water	Impacts to approximately 5.5 miles of Skunk River; approximately 5.3 miles of the Keigley Branch of the Skunk River; approximately 3.0 miles of Bear Creek, and approximately 2.8 miles of Long Dick Creek. This alternative would also flood approximately 10.5 miles of Squaw Creek, approximately 2.7 miles of Montgomery Creek, and approximately 2.6 miles of Onion Creek.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 18 archaeological sites and 22 historic structures.
Socio-Economic Resources	Impacts to approximately 110 residences, farms, and acreages.
Environmental Justice	No impacts.
Transportation	Impacts to 100th, 110th, 120th, 130th, 140th, 150th, and 160th Streets, as well as local roads. Potential impacts to airspace at the Ames Municipal Airport.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	15 leaking UST's, 1 Iowa contaminated site and 1 non-NPL Superfund site.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (100-year level on Squaw; 100-year level on Skunk) Do the benefits outweigh the costs? ☒ Is this alternative free of major environmental impacts? ☒

Regional Flood Storage

Not free of major environmental impacts

Cost prohibitive

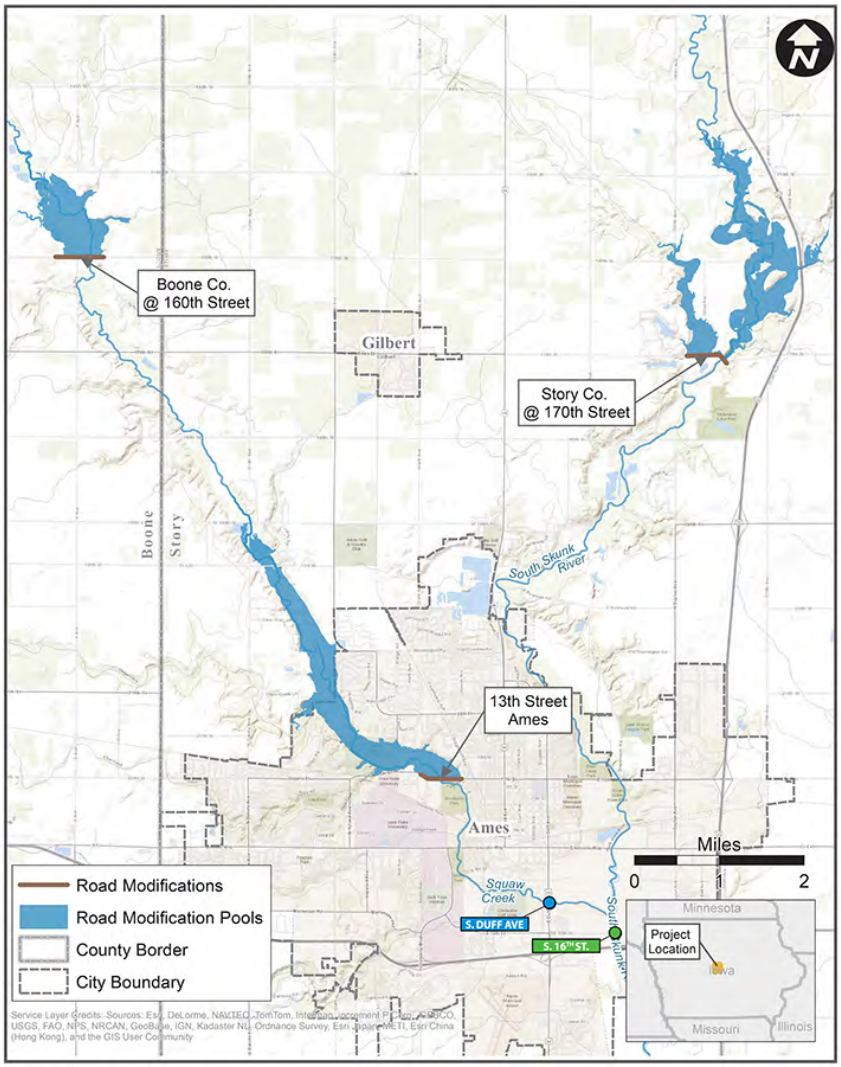
It does provide 450-year level of flood protection on both skunk river and squaw creek

Floodplain Storage

The Floodplain Storage alternative achieves additional floodplain storage by raising 3 roads by 5 feet, and modifying 3 bridges/culverts.

Benefit Cost Analysis

Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$41,000,000	**$2,474,778**	**$2,786,900**	**1.13**



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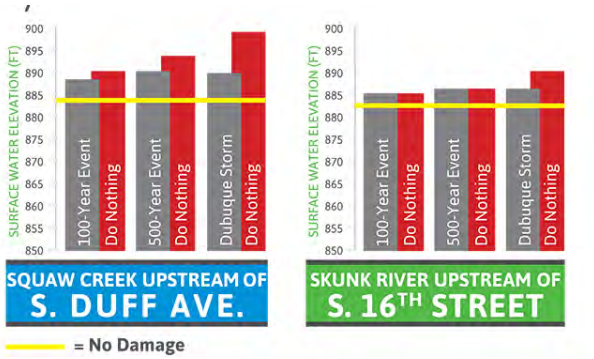
Hydraulic Performance



500-Year Event

100-Year Event

Dubuque Storm

Environmental Concerns

Land Use	Impacts to residential area (ISU housing), recreation land, parks and conservation land, and agricultural land uses. (709 acres)
Farmland	Impacted.
Parks, Recreation & Conservation Areas	Impacts to Skunk River Greenbelt WMA, Crooked Bend WMA, Bear Creek Area, and Soper's Mill County Park, Veenker Memorial Golf Course, part of the Ames High Prairie State Preserve, the Furman Aquatic Park in Ames, and the ISU Stable Run Disc Golf Course.
Wetlands	Impacts to approximately 540 acres.
Surface Water	Impacts to approximately 6.5 miles of Squaw Creek and approximately 2.5 miles of Skunk River.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 66 archaeological sites and 5 historic structures.
Socio-Economic Resources	Impacts to part of the ISU housing area, approximately 25 residences, 2 businesses, a golf course, and a water park.
Environmental Justice	Impacts to minorities, low-income, elderly and LEP populations.
Transportation	Impacts to 150th, 160th, 170th, and 190th Streets. Would also require raising the following roads 5 feet and modifying bridges/culverts at these locations: Boone County Road 160 at Squaw Creek, Story County Road 170 at the Skunk River, and 13th Street in Ames at Squaw Creek. Potential impacts to airspace at the Ames Municipal Airport.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	10 leaking UST sites, 1 non-NPL Superfund site, and 1 Iowa contaminated site within 1 mile of the 13th Avenue site in Ames.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (Reduced 100-year flood height of 2-ft on Squaw.) Do the benefits outweigh the costs? ☑ Is this alternative free of major environmental impacts? ☒

Floodplain Storage

Positive Cost Benefit Ratio

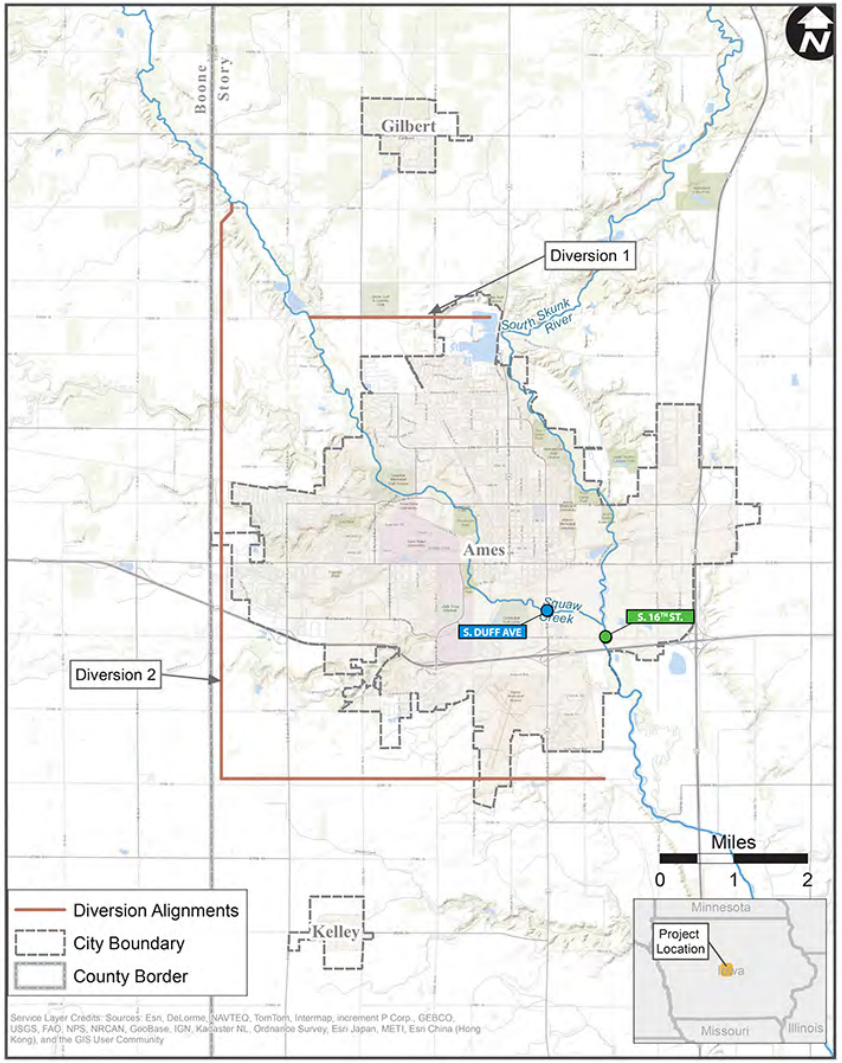
Would require coordination with the county

Not free of major environmental impacts

Reduces the flood levels at the 100-year flood 2-ft on Squaw Creek

Diversion 1

The Diversion 1 alternative includes diverting flood waters around Ames by diverting Squaw Creek at Cameron School Road to the Skunk River via the Ada Hayden Reservoir.



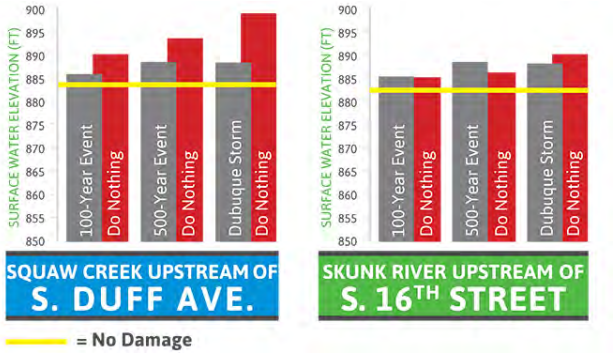
Benefit Cost Analysis

Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$49,243,000	**$2,972,329**	**$3,042,700**	**1.02**

Diversion 1

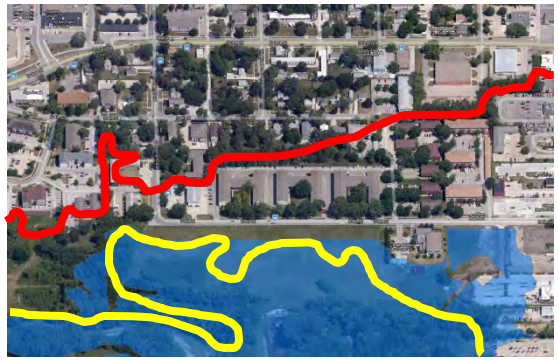
The Diversion 1 alternative includes diverting flood waters around Ames by diverting Squaw Creek at Cameron School Road to the Skunk River via the Ada Hayden Reservoir.

Hydraulic Performance



500-Year Event

100-Year Event



Dubuque Storm

Environmental Concerns

Land Use	Impacts to small areas of residential and commercial, southern edge of Ames Municipal Airport, recreation, conservation, and agricultural land. (1,370 acres)
Farmland	Impacted.
Parks, Recreation & Conservation Areas	Would divide the Ames Golf and Country Club and the Ada Hayden Heritage Park by creating a channel through these areas.
Wetlands	Impacts to approximately 10 acres.
Surface Water	No impacts to existing streams; however construction of these diversions would create a total of 17 miles of new stream channel. Construction of these diversions would affect flow in both the Skunk River and Squaw Creek.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 9 archaeological sites and 7 historic structures.
Socio-Economic Resources	Impacts to approximately 60 residences, a 25-residence trailer park, approximately 5 businesses, and the approach lighting in the clear zone of the Ames Municipal Airport.
Environmental Justice	Impacts to minorities, low-income, elderly and LEP populations.
Transportation	Would cut across several roads in Ames, including US 30, Lincoln Way, South Duff Avenue, George Washington Carver Avenue, 180th Street, 520th Avenue, and 530th Avenue. Bridges would need to be constructed, or in some cases, reconstructed. Potential impacts to the UPRR tracks and airspace at the Ames Municipal Airport.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	5 leaking USTs within 1 mile.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (Reduced 100-year flood height of 5-ft on Squaw.) Do the benefits outweigh the costs? ☑ Is this alternative free of major environmental impacts? ☒

Diversion 1

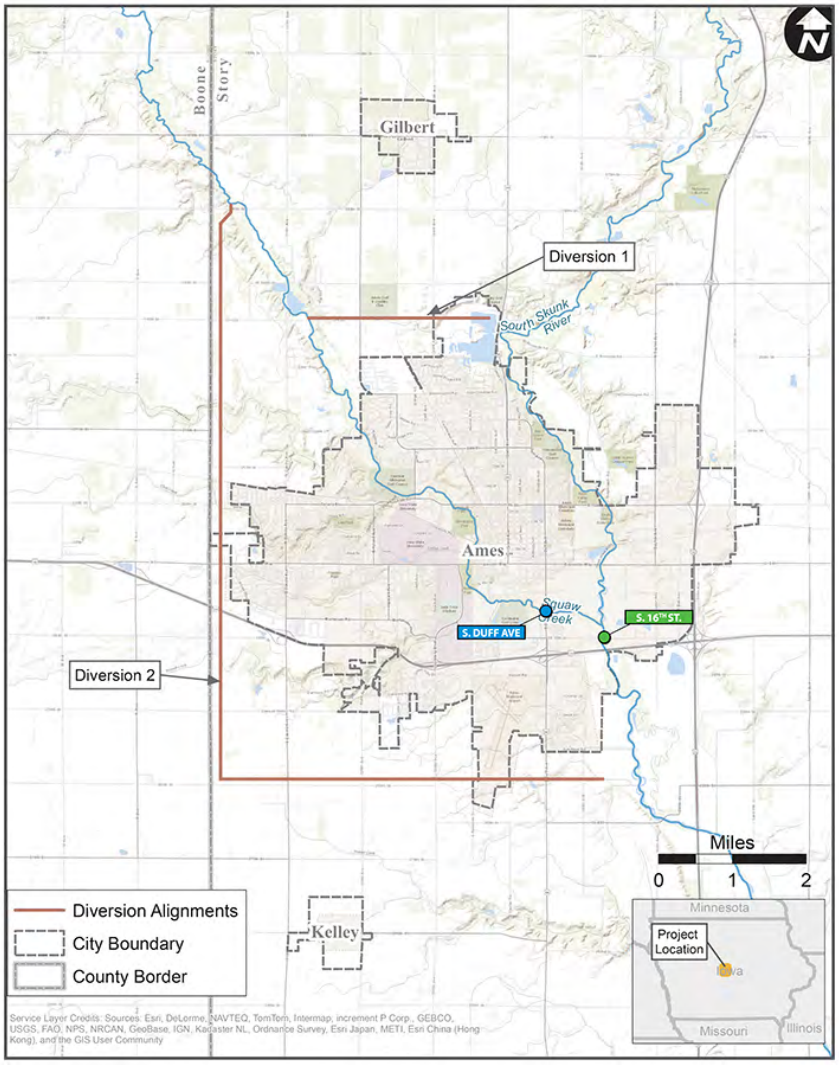
Reduces 100-year flood 5-ft on squaw creek

Benefits outweigh the costs

Not free of major environmental impacts

Diversion 2

The Diversion 2 alternative includes diverting flood waters around Ames by diverting Squaw Creek upstream from Cameron School Road, to the Skunk River downstream from the Ames Municipal Airport.



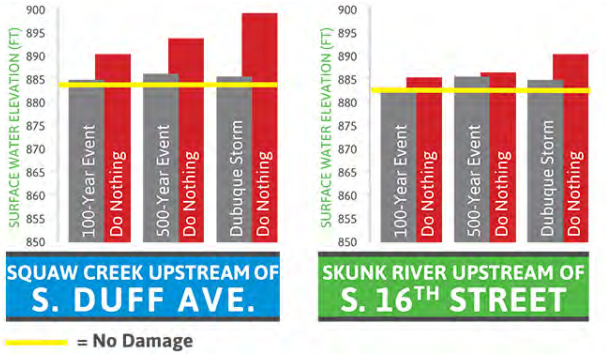
Benefit Cost Analysis

Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$1,095,000,000	$66,094,687	$3,192,300	0.05

Diversion 2

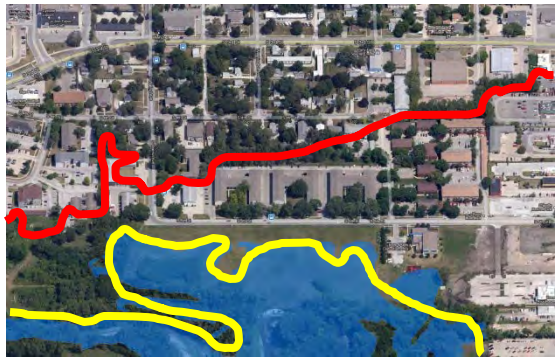
The Diversion 2 alternative includes diverting flood waters around Ames by diverting Squaw Creek upstream from Cameron School Road, to the Skunk River downstream from the Ames Municipal Airport.

Hydraulic Performance



500-Year Event

100-Year Event



Dubuque Storm

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Surface Water	No impacts to existing streams; however construction of these diversions would create a total of 17 miles of new stream channel. Construction of these diversions would affect flow in both the Skunk River and Squaw Creek.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 9 archaeological sites and 7 historic structures.
Socio-Economic Resources	Impacts to approximately 60 residences, a 25-residence trailer park, approximately 5 businesses, and the approach lighting in the clear zone of the Ames Municipal Airport.
Environmental Justice	Impacts to minorities, low-income, elderly and LEP populations.
Transportation	Would cut across several roads in Ames, including US 30, Lincoln Way, South Duff Avenue, George Washington Carver Avenue, 180th Street, 520th Avenue, and 530th Avenue. Bridges would need to be constructed, or in some cases, reconstructed. Potential impacts to the UPRR tracks and airspace at the Ames Municipal Airport.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	5 leaking USTs within 1 mile.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (Reduced 100-year flood height of 5-ft on Squaw; 100-year protection on Skunk.) / Do the benefits outweigh the costs? ☒ / Is this alternative free of major environmental impacts? ☑

Diversion 2

Reduces 100-year flood 5-ft on squaw creek

Cost Prohibitive

Not free of major environmental impacts

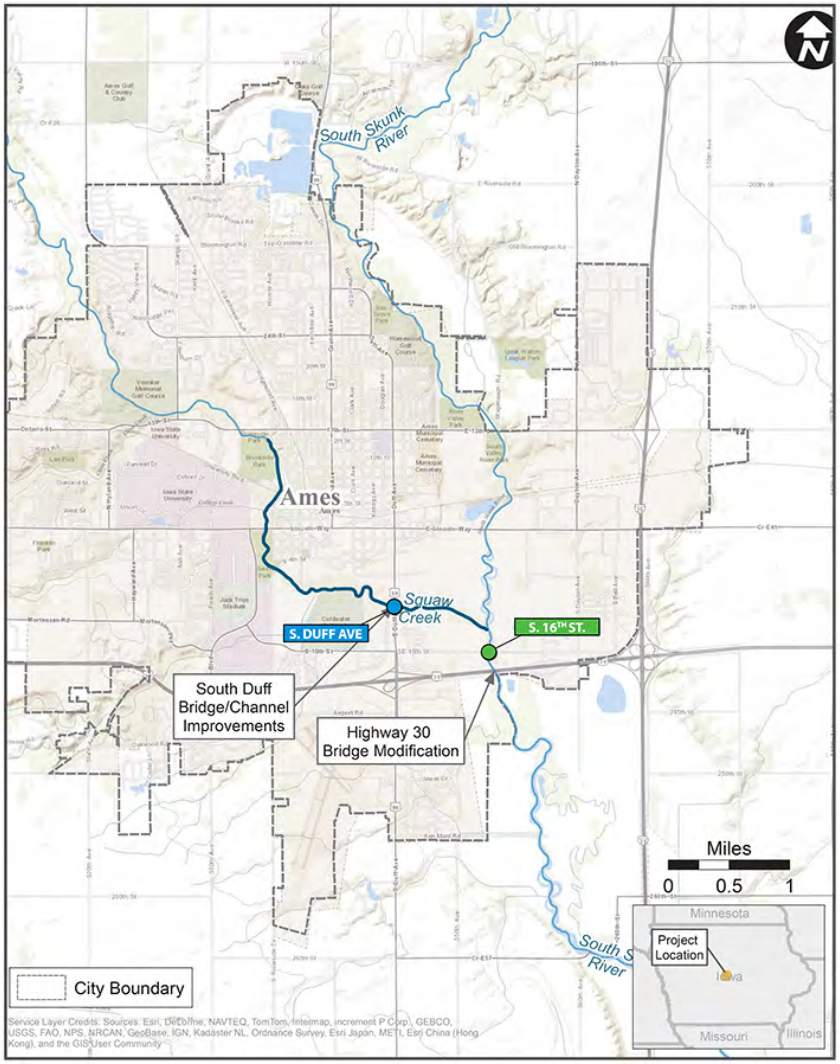
Conveyance Improvements

(Clear Channel)

The Conveyance Improvements alternative involves the clearing or excavating of river channel improvements and/or the removal of bridge obstructions.

Benefit Cost Analysis

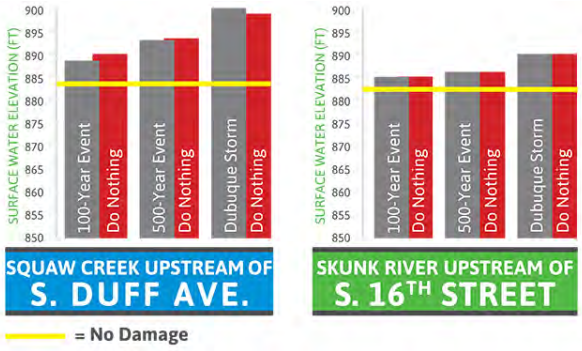
Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$2,943,000	**$177,641**	**$2,436,700**	**13.72**



Conveyance Improvements (Clear Channel)

The Conveyance Improvements alternative involves the clearing or excavating of river channel improvements and/or the removal of bridge obstructions.

Hydraulic Performance



500-Year Event

100-Year Event

Dubuque Storm

Environmental Concerns

Land Use	Impacts to small areas of commercial land adjacent to South Duff Road Bridge, open space, agricultural land adjacent to US 30 bridge. (70 acres)
Farmland	Impacted.
Parks, Recreation & Conservation Areas	No impact.
Wetlands	No impact.
Surface Water	Impacts to short stretches of stream channel near the South Duff Bridge and the Highway 30 Bridge during construction.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 3 archaeological sites and 2 historic structures.
Socio-Economic Resources	Impacts to businesses adjacent to the South Duff Road bridge and open space and agricultural land adjacent to the US 30 bridge.
Environmental Justice	No impact.
Transportation	Temporary impacts to roads within the Project Area. Would also require the lengthening of Hwy 30 Bridge over the Skunk River and the South Duff Bridge over Squaw Creek. Impacts to the approach lighting at the southern end of the runway at Ames Municipal Airport and potential impacts to the airspace.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	31 leaking UST sites, 2 non-NPL Superfund site, and 6 no leaking USTs within the proposed footprints are within 1 mile.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (Reduced 100-year flood height of 1-ft on Squaw.) Do the benefits outweigh the costs? ☑ Is this alternative free of major environmental impacts? ☒

Conveyance Improvements (Clear Channel)

Reduces 100-year flood 1-ft on squaw creek

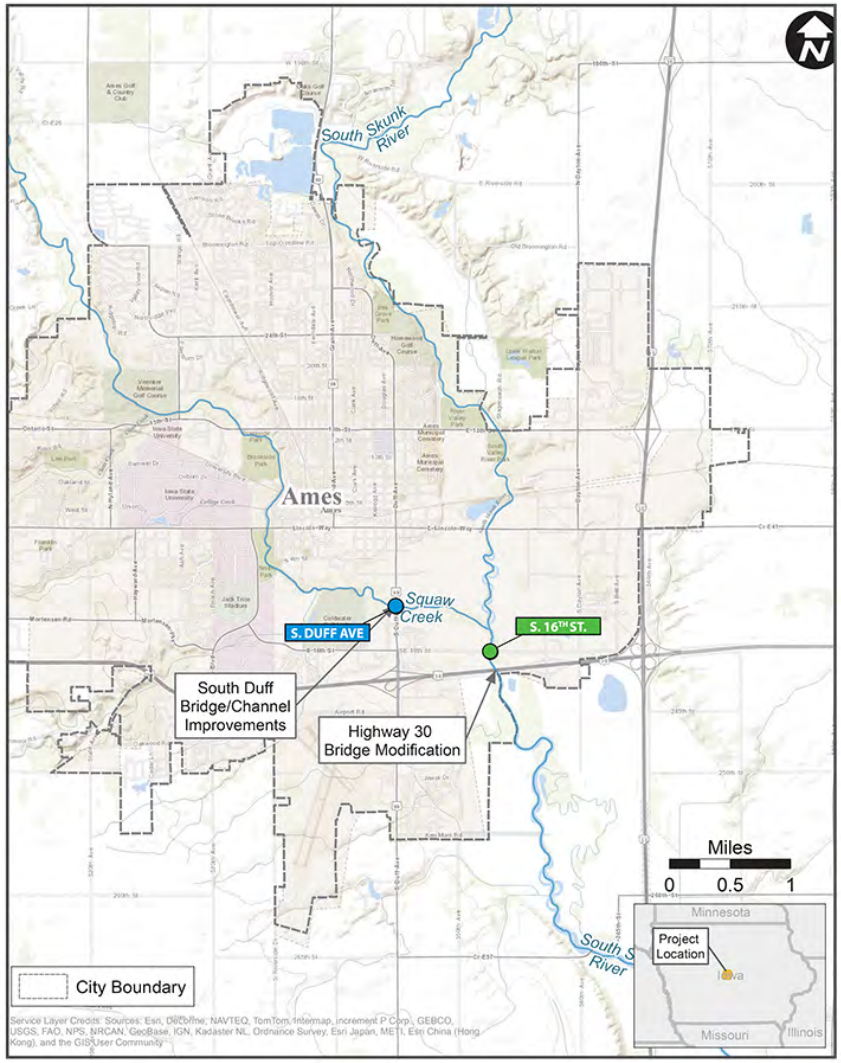
Benefits outweigh Costs

Not free of major environmental impacts

Conveyance Improvements

(US Hwy 30 Bridge Improvement)

The Conveyance Improvements alternative involves the clearing or excavating of river channel improvements and/or the removal of bridge obstructions.



Benefit Cost Analysis

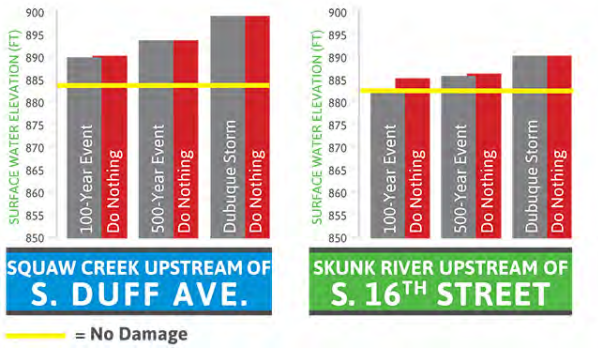
Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$7,740,000	**$467,190**	**$2,097,300**	**4.49**

Conveyance Improvements

(US Hwy 30 Bridge Improvement)

The Conveyance Improvements alternative involves the clearing or excavating of river channel improvements and/or the removal of bridge obstructions.

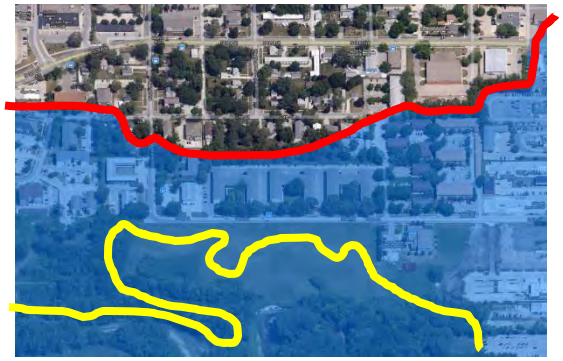
Hydraulic Performance



500-Year Event

100-Year Event

Dubuque Storm



Environmental Concerns

Land Use	Impacts to small areas of commercial land adjacent to South Duff Road Bridge, open space, agricultural land adjacent to US 30 bridge. (70 acres)
Farmland	Impacted.
Parks, Recreation & Conservation Areas	No impact.
Wetlands	No impact.
Surface Water	Impacts to short stretches of stream channel near the South Duff Bridge and the Highway 30 Bridge during construction.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 3 archaeological sites and 2 historic structures.
Socio-Economic Resources	Impacts to businesses adjacent to the South Duff Road bridge and open space and agricultural land adjacent to the US 30 bridge.
Environmental Justice	No impact.
Transportation	Temporary impacts to roads within the Project Area. Would also require the lengthening of Hwy 30 Bridge over the Skunk River and the South Duff Bridge over Squaw Creek. Impacts to the approach lighting at the southern end of the runway at Ames Municipal Airport and potential impacts to the airspace.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	31 leaking UST sites, 2 non-NPL Superfund site, and 6 no leaking USTs within the proposed footprints are within 1 mile.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (Reduced 100-year flood height of 2.5-ft on Skunk.) Do the benefits outweigh the costs? ☑ Is this alternative free of major environmental impacts? ☑

Conveyance Improvements (US Hwy 30 Bridge Improvement)

Reduces 100-year flood 2.5-ft on skunk river

Benefits outweigh Costs

Free of major environmental impacts

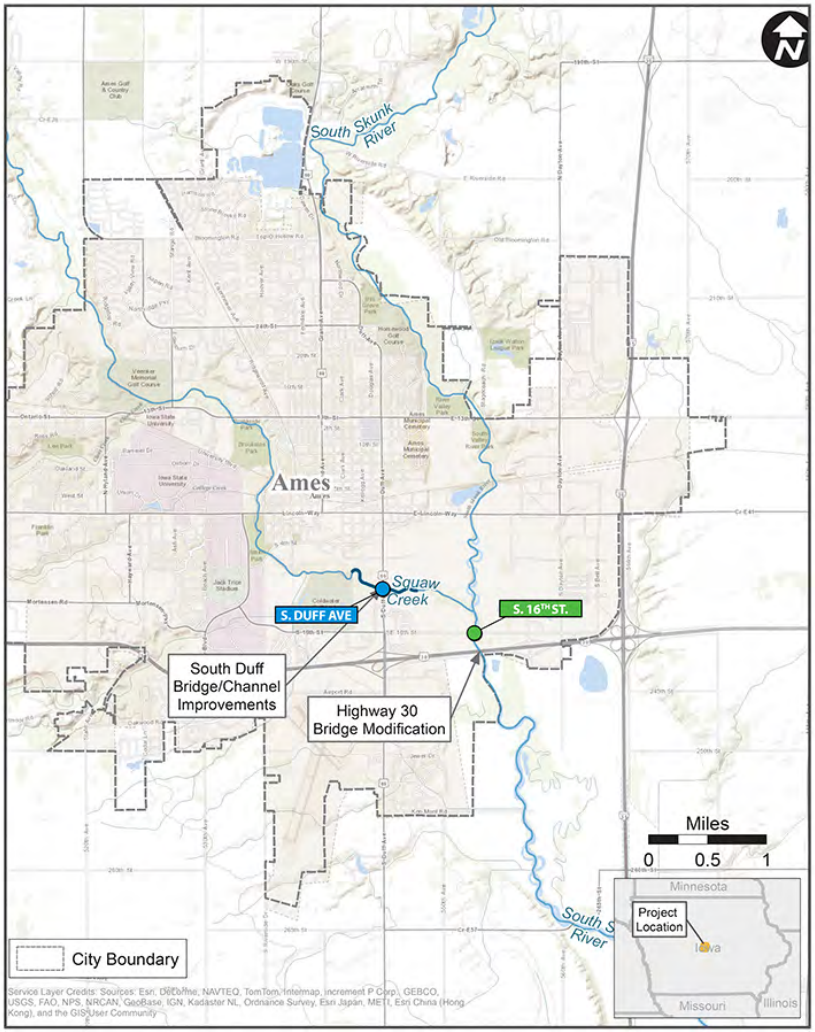
Conveyance Improvements

(South Duff Bridge Improvement & Clear Channel)

The Conveyance Improvements alternative involves the clearing or excavating of river channel improvements and/or the removal of bridge obstructions.

Benefit Cost Analysis

Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
$4,715,000	**$284,599**	**$2,086,900**	**7.33**

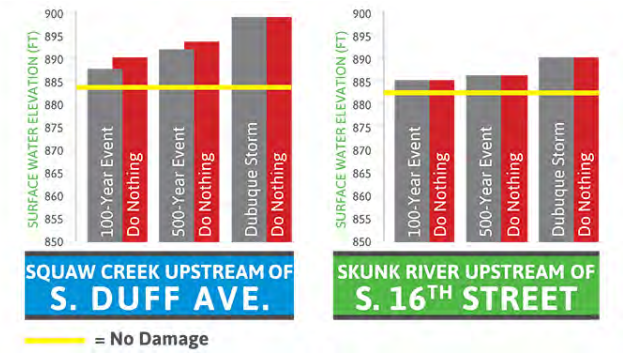


Conveyance Improvements

(South Duff Bridge Improvement & Clear Channel)

The Conveyance Improvements alternative involves the clearing or excavating of river channel improvements and/or the removal of bridge obstructions.

Hydraulic Performance



500-Year Event

100-Year Event

Dubuque Storm

Environmental Concerns

Land Use	Impacts to small areas of commercial land adjacent to South Duff Road Bridge, open space, agricultural land adjacent to US 30 bridge. (70 acres)
Farmland	Impacted.
Parks, Recreation & Conservation Areas	No impact.
Wetlands	No impact.
Surface Water	Impacts to short stretches of stream channel near the South Duff Bridge and the Highway 30 Bridge during construction.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 3 archaeological sites and 2 historic structures.
Socio-Economic Resources	Impacts to businesses adjacent to the South Duff Road bridge and open space and agricultural land adjacent to the US 30 bridge.
Environmental Justice	No impact.
Transportation	Temporary impacts to roads within the Project Area. Would also require the lengthening of Hwy 30 Bridge over the Skunk River and the South Duff Bridge over Squaw Creek. Impacts to the approach lighting at the southern end of the runway at Ames Municipal Airport and potential impacts to the airspace.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	31 leaking UST sites, 2 non-NPL Superfund site, and 6 no leaking USTs within the proposed footprints are within 1 mile.
Air Quality	Would generate minor amounts of emissions from construction equipment and fugitive dust from soil disturbance.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (Reduced 100-year flood height of 2-ft on Squaw.) Do the benefits outweigh the costs? ☑ Is this alternative free of major environmental impacts? ☑

Conveyance Improvements (US Hwy 30 Bridge Improvement)

Reduces 100-year flood 2-ft on squaw creek

Benefits outweigh Costs

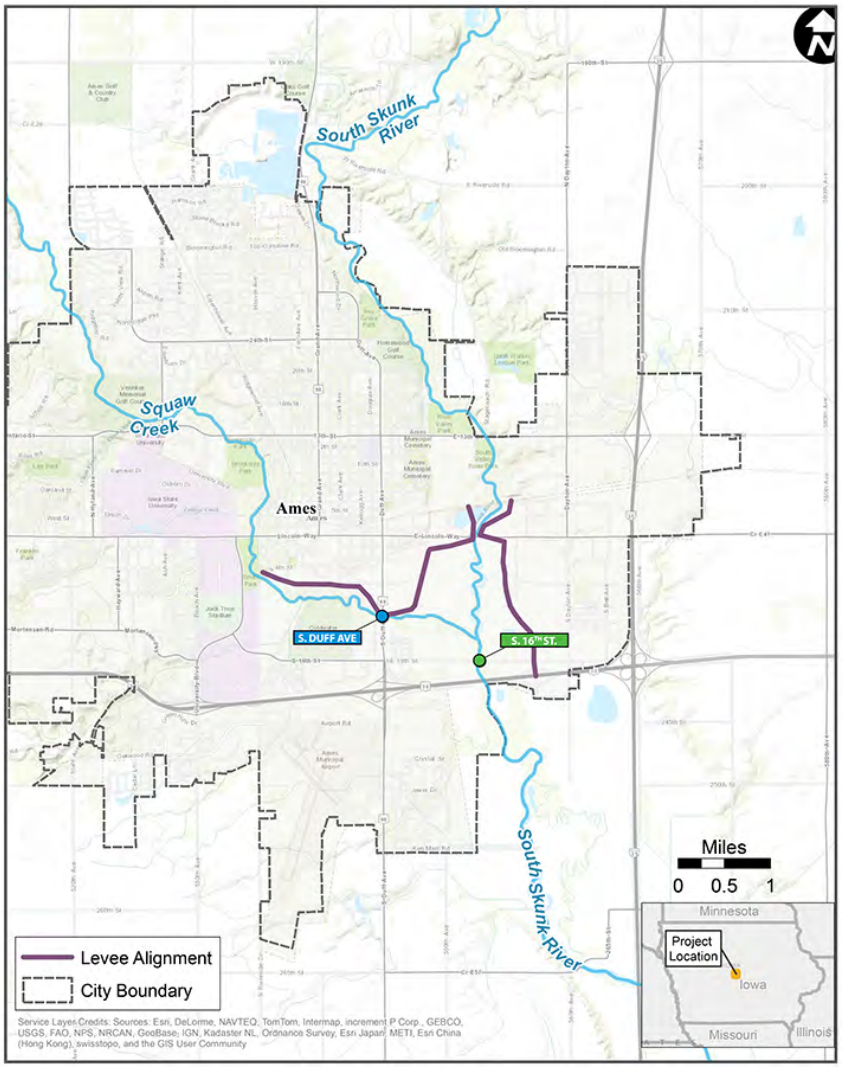
Free of major environmental impacts

Levee Protection to 100-Year

The Levees alternatives evaluates protection to the 100-year flood level protecting property areas along Skunk River and Squaw Creek by constructing a levee (berm/floodwall) combination.

Benefit Cost Analysis

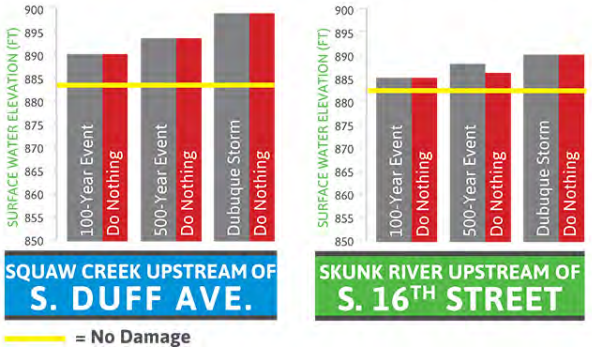
Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
Skunk River $4,818,000	**Skunk River $290,817**	**Skunk River $121,400**	**Skunk River 0.42**
Squaw Creek $6,079,000	**Squaw Creek $366,931**	**Squaw Creek $174,600**	**Squaw Creek 0.48**



Levee Protection to 100-Year

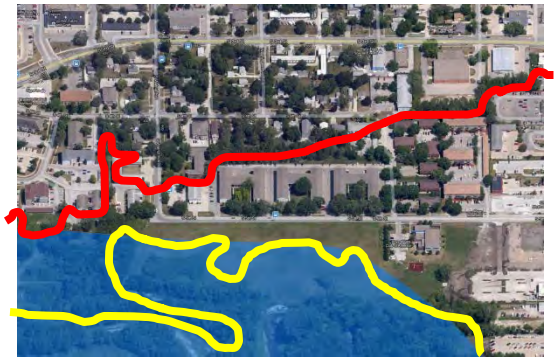
The Levees alternatives evaluates protection to the 100-year flood level protecting property areas along Skunk River and Squaw Creek by constructing a levee (berm/floodwall) combination.

Hydraulic Performance

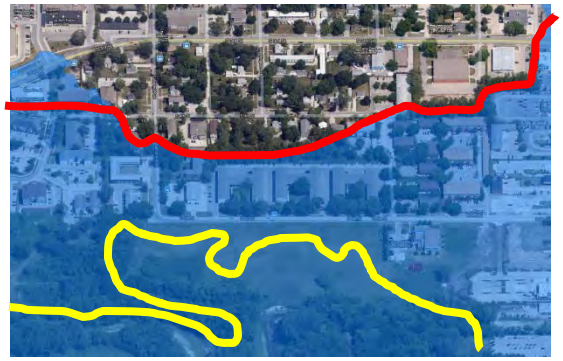


500-Year Event

100-Year Event



Dubuque Storm



Environmental Concerns

Land Use	Impacts to commercial and agricultural land. (10 acres)
Farmland	No impact.
Parks, Recreation & Conservation Areas	No impact.
Wetlands	No impact.
Surface Water	No impact.
Threatened & Endangered Species	Potential impacts.
Cultural Resources – Historical & Archaeological	Impacts to 3 archaeological sites and 24 historic structures.
Socio-Economic Resources	Impacts to approximately 10 to 15 businesses.
Environmental Justice	Impacts to minorities, low-income, elderly and LEP populations.
Transportation	Temporary impacts to roads within the Project Area. Potential impacts to the UPRR tracks and airspace at the Ames Municipal Airport.
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.
Regulated Materials	45 leaking UST sites, 6 non-NPL Superfund sites, and 6 Iowa contaminated sites are within 1 mile. 1 leaking UST is located within the footprint of the Squaw Creek levee.
Air Quality	No impacts.
Performance Criteria	Does it meet at least a 500-year level of protection? ☒ (The alternative meets the 100-year protection on Squaw & Skunk.)
	Do the benefits outweigh the costs? ☒
	Is this alternative free of major environmental impacts? ☑

Levee Protection to 100-Year

Protects to 100-year level

Benefits do not outweigh costs

Free of major environmental impacts

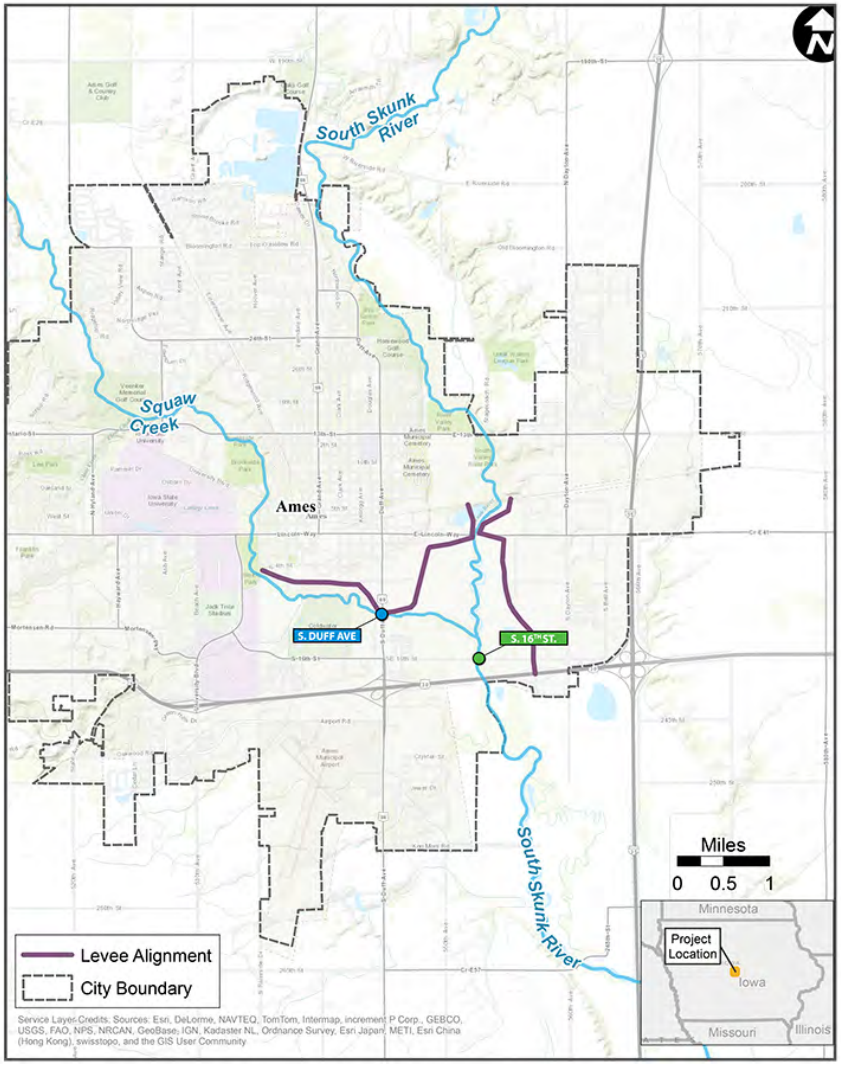
Opportunities for combination with conveyance improvements

Levee Protection to 500-Year

The Levees alternatives evaluates protection to the 500-year flood level protecting property areas along Skunk River and Squaw Creek by constructing a levee (berm/floodwall) combination.

Benefit Cost Analysis

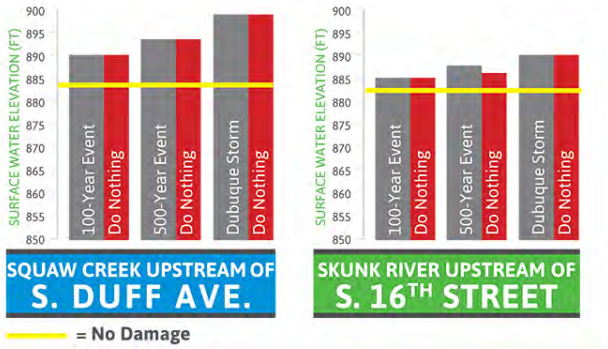
Construction Costs	Annual Cost (including O&M)	Annual Benefits	BCR
Skunk River $5,333,000	**Skunk River $321,902**	**Skunk River $198,100**	**Skunk River 0.62**
Squaw Creek $7,688,000	**Squaw Creek $462,844**	**Squaw Creek $174,600**	**Squaw Creek 0.38**



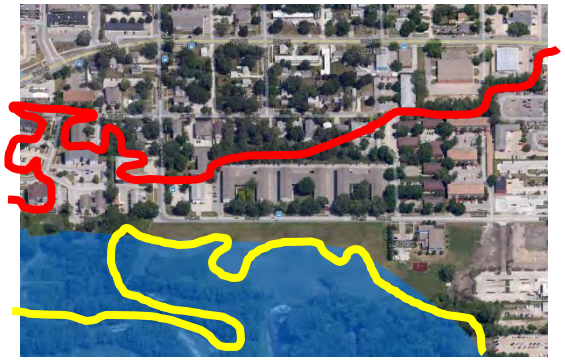
Levee Protection to 500-Year

The Levees alternatives evaluates protection to the 500-year flood level protecting property areas along Skunk River and Squaw Creek by constructing a levee (berm/floodwall) combination.

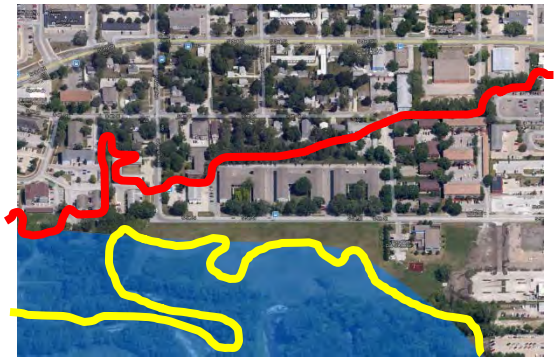
Hydraulic Performance



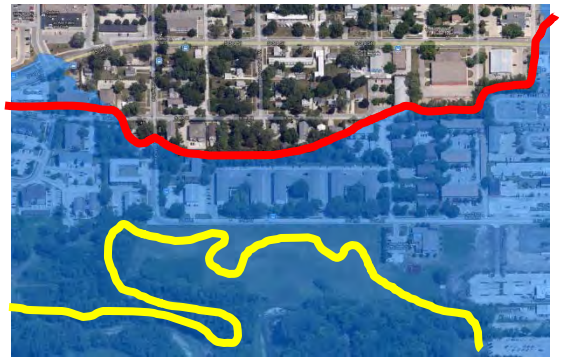
500-Year Event



100-Year Event



Dubuque Storm



Environmental Concerns

Land Use	Impacts to commercial and agricultural land. (10 acres)		
Farmland	No impact.		
Parks, Recreation & Conservation Areas	No impact.		
Wetlands	No impact.		
Surface Water	No impact.		
Threatened & Endangered Species	Potential impacts.		
Cultural Resources – Historical & Archaeological	Impacts to 3 archaeological sites and 24 historic structures.		
Socio-Economic Resources	Impacts to approximately 10 to 15 businesses.		
Environmental Justice	Impacts to minorities, low-income, elderly and LEP populations.		
Transportation	Temporary impacts to roads within the Project Area. Potential impacts to the UPRR tracks and airspace at the Ames Municipal Airport.		
Noise	Construction of any alternative selected would be temporary and intermittent. It is not anticipated that any acceptable noise levels would be generated by construction of the selected alternatives.		
Regulated Materials	45 leaking UST sites, 6 non-NPL Superfund sites, and 6 Iowa contaminated sites are within 1 mile. 1 leaking UST is located within the footprint of the Squaw Creek levee.		
Air Quality	No impacts.		
Performance Criteria	Does it meet at least a 500-year level of protection? ☑	Do the benefits outweigh the costs? ☒	Is this alternative free of major environmental impacts? ☑

Levee Protection to 500-Year

Protects to 500-year level

Benefits do not outweigh costs

Free of major environmental impacts

Three Questions – Three Answers

Question 1. Could rain barrels prevent the flooding in Ames? If every citizen of Ames had two 50 gallon rain barrels, wouldn't it prevent flooding on the Skunk and Squaw?

Answer 1. No it would not. This is the equivalent of 30 seconds of flow at the South Skunk River at Highway 30.

Question 2. Do the bridges cause the flooding in Ames?

Answer 2. No. If every single bridge and embankment was removed through the City of Ames, it would only result in water surface elevations at South Duff that are 0.5-ft lower during 100-year event and 1.7-ft lower during the 500-year event.

Question 3. Does continued development in floodplain cause the flooding in Ames?

Answer 3. If every piece of land in the floodway fringe was developed it leads to 1-ft higher water surface elevations (100-year) and 3-ft higher water surface elevations (500-year). That is what is behind Ames floodplain policy.

Next Steps and Path Forward

Combination of three alternatives:

- Channel Improvements near South Duff, Hwy 30 Improvements, and Levees along Squaw Creek and Skunk River
- Lower water surface elevations reduce levee height, material from channel used in levee or interior drainage storage area (2-3-ft on sq.; 0.8-ft on sk; 100-year)
- Stand Alone – Annual Benefits ($4.5 million), Annual Costs ($1.5 million)
- Phasing – HWY 30 Improvements 5-10 Years
  - 100-year levee -> ~200-year
  - 500-year levee -> ~700-year

Next Steps and Path Forward

Modification of Floodplain Ordinance:

- At South Duff the FEMA 100-year water surface elevation is 888.5 ft. Development must be built to 3-ft above, or 891.5 ft. The FEMA 500-year water surface elevation is 891.0-ft, or less than the development standard.
- Consider adopting a 2D hydraulic model for quantifying impacts of development beyond the scope of this study (the impact of removal of a single building on flood plain water surface elevations)