WALNUT CREEK WATERSHED

master plan

PLAN IN PROGRESS

January 8, 2015

Executive Summary

Os es pos suntion eatiae doluptaquis dusam et hitam, sin et, sinverro verum nimpor simil inullat ulparum fuga. Ur? Quiatiis sitat. Aximolu ptatiat doluptati non et explaborit, non nonesedis sant maximpor re platqui veliquia est, tecta platemqui aut la doluptatem sa possit prat ma quianis maio odias siminimus aliciis et rest audis autatemqui cust, que por atis nemporatio. Itatest, num veriore rspitecta ab is rem fuga. Fic tem ipicil iuntotatum quas ma illore quo officiis re ilici tem. Namendio voluptas quidenime preiciatium quam veribearcid quos moditio nseque pra voluptatquas sitis venisi con net, core, quisqui anienda eperfere volupta tendae. Ga. Ut aligend ipicto et pe explita acepudis dolor sitibus aria quametur aliberum quatior eseque volum ipsae as pa sequi solenihitet aliquate poria ducimi, volorro dis aut aribus ate vendes imus destio blabor arum exped quatur?

Suntis sum, nobis eum corectiae si ad quam voluptistem quid eratecto et enti alit aut occabo. Sunt magnist alia parum re inciis re nectasp itaqui omni dem nostrumqui odi untem harita di omnihiliquo con cum qui vellaut et utatur si ommodictem fuga. Nam, culpa ducia delectatus aliquos a volorib uscium es acepe quam di ducipid ebitiorem nitio bla adipsam quaturem inciunt doluptat qui venectat que nimus diaturectus unt accatia nis vent eossitatum rem rat volorerae occum fugit velesequam sum re necupti iscipsam quis milicit laut dolore porit hitaspe rchicilit fuga. Idem fugiati te voluptas il ma serspero is eriae et quam, nonsequi officiendae. Fuga. Ipsa conecae sequam dolut qui consed et eos ex es dolum fugiam, iligendia commodi tataspid quodi doloreicium repudant pratur, consequ atemperunt autatumOrios ea sequis coratur? Quiatur, con con num quo blabo. Ellatus. Solorest occaero quam qui non cuptia doluptate dolum quissit facest ut eos ullupti usanit laccat. Cesed modis in pedi

DES MOINES AREA MPO
METROPOLITAN PLANNING ORGANIZATION

RDG PLANNING ● DESIGN

Forward

Os es pos suntion eatiae doluptaquis dusam et hitam, sin et, sinverro verum nimpor simil inullat ulparum fuga. Ur? Quiatiis sitat. Aximolu ptatiat doluptati non et explaborit, non nonesedis sant maximpor re platqui veliquia est, tecta platemqui aut la doluptatem sa possit prat ma quianis maio odias siminimus aliciis et rest audis autatemqui cust, que por atis nemporatio. Itatest, num veriore rspitecta ab is rem fuga. Fic tem ipicil iuntotatum quas ma illore quo officiis re ilici tem. Namendio voluptas quidenime preiciatium quam veribearcid quos moditio nseque pra voluptatquas sitis venisi con net, core, quisqui anienda eperfere volupta tendae. Ga. Ut aligend ipicto et pe explita acepudis dolor sitibus aria quametur aliberum quatior eseque volum ipsae as pa sequi solenihitet aliquate poria ducimi, volorro dis aut aribus ate vendes imus destio blabor arum exped quatur?

Suntis sum, nobis eum corectiae si ad quam voluptistem quid eratecto et enti alit aut occabo. Sunt magnist alia parum re inciis re nectasp itaqui omni dem nostrumqui odi untem harita di omnihiliquo con cum qui vellaut et utatur si ommodictem fuga. Nam, culpa ducia delectatus aliquos a volorib uscium es acepe quam di ducipid ebitiorem nitio bla adipsam quaturem inciunt doluptat qui venectat que nimus diaturectus unt accatia nis vent eossitatum rem rat volorerae occum fugit velesequam sum re necupti iscipsam quis milicit laut dolore porit hitaspe rchicilit fuga. Idem fugiati te voluptas il ma serspero is eriae et quam, nonsequi officiendae. Fuga. Ipsa conecae sequam dolut qui consed et eos ex es dolum fugiam, iligendia commodi tataspid quodi doloreicium repudant pratur, consequ atemperunt autatumOrios ea sequis coratur? Quiatur, con con num quo blabo. Ellatus. Solorest occaero quam qui non cuptia doluptate dolum quissit facest ut eos ullupti usanit laccat. Cesed modis in pedigentiam, cus, vendici licipsam, nos et accum idus maximiliquis et endebis aut eariorum assi tes sunt. Xerate mo berum ditiae esecus idel illandus. Ipsant occuptat quam qui sum alissus. Bus et quo inumquate exeruptur sum comnimp erempe etur sinullu ptiatibusam ea ium il il maximet as que conesequas earum ut et Os es pos suntion eatiae doluptaquis dusam et hitam, sin et, sinverro verum nimpor simil inullat ulparum fuga. Ur? Quiatiis sitat. Aximolu ptatiat doluptati non et explaborit, non nonesedis sant maximpor re platqui veliquia est, tecta platemqui aut la doluptatem sa possit prat ma quianis maio odias siminimus al

Table of Contents

Chapter 1.....alkdfjldj
Chapter 2.....alkdfjldj
Chapter 3.....alkdfjldj
Chapter 4.....alkdfjldj
Chapter 5.....alkdfjldj
Chapter 6.....alkdfjldj
Chapter 7.....alkdfjldj
Chapter 8.....alkdfjldj
Chapter 9.....alkdfjldj
Chapter 10.....alkdfjldj
Chapter 11.....alkdfjldj
Chapter 12.....alkdfjldj
Chapter 13.....alkdfjldj
Chapter 14.....alkdfjldj
Chapter 15.....alkdfjldj

“Onsequi vero dit, sequunt accab ium qui con res plibus, nonse laut alibus. Pudigeniat. Officab oreium la voluptur, teceritet ut asit aut exped es mo es sae nos dent, ut que doloreseni dolupit autamet exerio et” exero quaspe.

“Onsequi vero dit, sequunt accab ium qui con res plibus, nonse laut alibus. Pudigeniat. Officab oreium la voluptur, teceritet ut asit aut exped es mo es sae nos dent, ut que doloreseni dolupit autamet exerio et” exero quaspe

ONE

PLAN IN PROGRESS

January 8, 2015

Process Overview

Walnut Creek WMA

- Board Meetings
- Executive Committee

Public Interaction

- Open House Events
- Stakeholder Meetings
- Individual Discussions

Plan Development

- Windshield Survey
- Stream Assessment Walks
- Quadcopter Video Collection
- Water Quality Monitoring

Boots on the Ground

- GIS Analysis
- Computer Modeling & Simulation

Desktop Assessments

PLAN IN PROGRESS

January 8, 2015

Watershed Geography

Plan Understanding

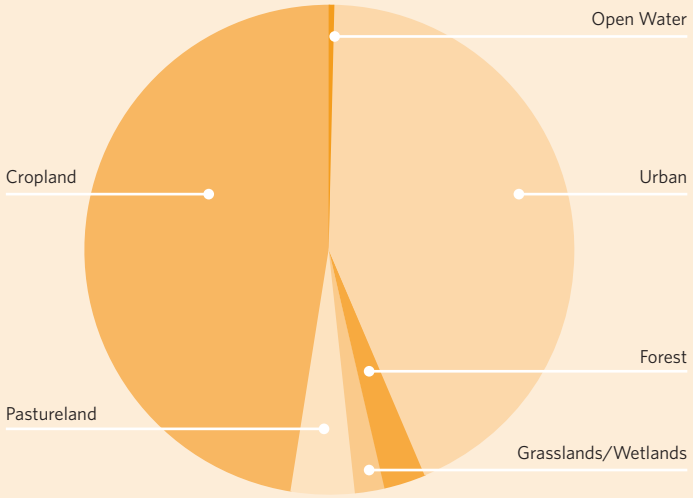
Local Topography & Terrain

82.8 square miles drains through Walnut Creek and its tributaries to the Raccoon River.

Past & Current Land Uses

During a recent 10-year period, 6.7 square miles were developed into urban land use.

Currently, the watershed is nearly evenly split between urban and agricultural land uses.



Soil Conditions

The slopes of soils, their ability to absorb water and their resistance to erosion are key features to consider in watershed planning.

Location and Geography

A watershed is an area of land which drains to a common point. The Walnut Creek watershed covers approximately 53,000 acres (82.8 square miles) across eastern Dallas and western Polk Counties. Its most western source falls within the community of Dallas Center. The footprint of the watershed extends across eight communities and other unincorporated areas within each county. Walnut Creek drains generally from northwest to southeast, meeting the Raccoon River northwest of Water Works Park in Des Moines, upstream of the water intake to the Des Moines Water Works plant.

The Raccoon River drains into the Des Moines River in downtown Des Moines. The Des Moines River then flows generally southeast, first through Red Rock Lake in Marion County, then on to the Mississippi River at Keokuk. The Mississippi River flows south, ultimately reaching the Gulf of Mexico in Louisiana.

In 2010, Iowa lawmakers authorized forming Watershed Management Authorities. A Watershed Management Authority (WMA) is a mechanism for cities, counties, Soil and Water Conservation Districts (SWCDs) and stakeholders to cooperatively engage in watershed planning and management.

What is a WMA?
The WMA is formed by an agreement (Chapter 28E) between two or more eligible political subdivisions within a specific watershed. A board of directors governs the WMA. WMAs may:

- Assess and reduce flood risk
- Assess and improve water quality
- Monitor federal flood risk planning and activities
- Educate residents of the watershed regarding flood risks and water quality
- Allocate moneys made available to the WMA for water quality and flood mitigation

Requirements of a WMA include:
per Iowa Code Chapter 466B Subchapter II

- All cities, counties and SWCDs of the watershed must be invited to participate in the WMA
- A Chapter 28E agreement that includes a map of the watershed must be filed with the Secretary of State
- Must be governed by a Board of Directors
- WMAs may not acquire land through eminent domain and do not have taxing authority

Benefits of forming a WMA:

- To conduct planning on a watershed scale, which has greater benefits for water quality improvement and flood risk reduction
- To foster partnerships and cooperation
- To leverage resources such as funding and technical expertise
- To facilitate stakeholder involvement in watershed management

Information about forming a WMA:
Available on the Iowa Department of Natural Resources website at http://www.iowadnr.gov/Environment/WaterQuality/WatershedManagementAuthorities.aspx.
This website includes:

- A complete listing of existing WMAs in Iowa
- Example agreements and by-laws
- More information on setting up a WMA
- Contacts for technical assistance

Overall Watershed

Lower Walnut Creek - Stable

Lower Walnut Creek - Unstable

The Tributaries of Walnut Creek

Dozens of smaller streams and three major tributaries feed into Walnut Creek. North Walnut Creek runs generally from north to south, draining parts of Grimes, Johnston, Urbandale, Des Moines, Clive and Windsor Heights. South Walnut Creek is more commonly known as the stream which passes through Country Club Lake in Clive. This stream drains primarily southwest to northeast, collecting runoff from portions of West Des Moines and Waukee in addition to Clive. Little Walnut Creek generally flows from west to east, beginning in rural Dallas County and flowing through rapidly developing portions of Waukee, Clive and Urbandale.

Topography and Terrain

There are two distinct types of land forms within this watershed. The upland parts of the watershed are generally flat, featuring meandering flow paths and low spots. These features are what remains of the prairie pothole wetlands formed by the Des Moines Lobe of the Wisconsin Glacier(1). These pothole wetlands were drained after pioneer settlement to improve agricultural production. This was accomplished through installation of subsurface tile drains and engineered ditches during the last half of the 1800s and the early 1900s. Many of the smaller streams which exist today did not exist before this landscape was altered.

The topography in the lower parts of the watershed becomes steeper, with many more hills and valleys. The surface of these areas were shaped by large scale erosion

Subwatershed Name	Number	Area (acres)*	Area (square miles)
Lower Walnut Creek	100	4240	6.6
Walnut Creek	200	10830	16.9
Upper Walnut Creek	300	3170	5.0
Eastern Headwaters Walnut Creek	400	8330	13.0
North Walnut Creek	500	9150	14.3
Little Walnut Creek	600	8630	13.5
Western Headwaters Walnut Creek	700	8480	13.3
Total		**52830**	**82.5**

*Rounded to nearest 10 acres

Lower Walnut Creek - Stable

Upper Walnut Creek - Stable

Lower Walnut Creek - Unstable

Upper Walnut Creek - Unstable

North Walnut Creek - Stable

Little Walnut Creek - Stable

North Walnut Creek - Unstable

Little Walnut Creek - Unstable

LIdar Topography DEM

Photo courtesy of sweetlightgallery.com, Flint Hills Tallgrass Prairie Preserve, Kansas

caused by the melting of the Wisconsin glacier. Surface slopes in excess of 5% are typical, with slopes greater than 9% scattered throughout this part of the watershed. These areas are also within the historical footprint of the Des Moines Lobe. Its southern edge fell just north of where Walnut Creek flows into the Raccoon River.

The Native Landscape

The Walnut Creek watershed was a much different place when initial land surveys were performed in the mid-1800s. Much of the landscape was covered by tallgrass prairie. Grasses and wildflowers, reaching eight feet in height, would have stretched to the horizon in every direction with deep roots, some up to 15 feet below the surface. These plants combined with worms and burrowing animals to create several feet of the loose, fertile, porous black topsoil that Iowa is known for. These soils allowed nearly all of the rainfall that fell on the landscape to soak into the ground through infiltration. Most streams were formed from natural groundwater outflows or springs. Prairie lands were kept largely clear of trees and shrubs by regularly occurring grass fires, limiting the opportunity for less fire tolerant species to flourish.

The prairie pothole landscape featured a largely flat surface with depressed areas. These pothole areas usually featured wetlands fed by natural springs. Runoff from very large storms would collect in these areas until it either evaporated, infiltrated or overflowed into an adjacent depressed area or receiving stream.

Savannas would have covered the remainder of the landscape, usually along the larger streams and hills in the southeastern part of the watershed. These forests would have also been quite different from those that are familiar to us today. Savannas lacked much of the understory brush and invasive species that currently make many of our forested lands difficult to walk through. Many of the current invasive species did not arrive within the watershed until the early 20th century, brought over from Europe and Asia. The lack of understory growth allowed more sunlight in to the floor of the forest, supporting shade tolerant native plants. The presence of these deeper rooted plants would have made the surface below the canopy significantly more resistant to erosion than what exists today.

Pioneer Settlement and Agriculture

The deep, fertile soils created by the prairie supported agricultural development. During the late 1800s and early 1900s, drainage projects installed tiles and ditches allowing the pothole wetlands to be dried out and farmed. The draining of wetlands, removal of vegetation and soil compaction by tilling and harvesting reduces infiltration and increases runoff volume. As a result, a larger volume of rainfall is transported to streams by surface or tile flow. Installation of tiles, culverts and ditches allows this larger volume of water to flow downstream more quickly. Water rushes downstream, with larger portions arriving at given points downstream at nearly the same time. This makes the rate of runoff increase even more dramatically than the runoff volume.

Today, virtually all native prairie is gone from the watershed. Absent fire, grass swales and buffers need maintenance through controlled burns, mowing or grazing to keep out tree growth. Over time, forested areas along waterways and ravines have become crowded with invasive species and underbrush. They often lack good erosion resistant ground cover. Many of these areas have experienced significant soil erosion from surfaces and stream channels.

Soils

There are many properties of soils that have a significant impact on the quality and quantity of stormwater runoff. Three of the key properties are hydrologic soil group, hydric conditions and soil erodibility. These properties are catalogued in various GIS layers that are available for review and use.

Hydrologic Soil Group

The ability of water to move into and through the ground is different with every soil. Soils with more clay tend to be less permeable. Very little water can enter the surface of a clayey soil, and the water that does enter takes a long time to move through that soil. In contrast, sandy soils allow water to enter and move very freely. Different soils are classified into different hydrologic soil groups, on a scale from "A" to "D". Group "A" soils allow water to infiltrate into the soil and percolate through the soil very easily. These soils have a higher sand content and will absorb more rainfall, causing less runoff to be developed. Group "D" soils include clays and other soils that inhibit the free movement of water.

These measures of soil group are used in many different models and calculations for determining rates and volumes of stormwater runoff.

Hydric Soils

Hydric soils formed in areas that were frequently wet or saturated. Their presence implies possible past or present existence of wetlands – possibly in need of protection or highlighting opportunities to restore such features if they have been lost through agricultural or urban land use changes. A stricter definition of "hydric soils" comes from the NRCS: a hydric soil is one that formed under the conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Soil Erosion Coefficient

The erosion potential for soils has been classified by use of a coefficient which can be input into the Revised Universal Soil Loss Equation (RUSLE). This equation was developed by the USDA to predict erosion rates from landscapes (not including streambank or gully erosion). Erodibility changes with soil type and surface slope. Steeper slopes are more prone to erosion than flatter surfaces. This coefficient is a decimal value between 0 and 1 which is a series of factors that goes into the RUSLE equation to determine how much soil would be expected to be washed off the surface of a given area. The RUSLE formula also includes factors that vary based on the length and steepness of a given slope.

Slopes

The change in surface elevation over a given length has many impacts. Longer and steeper slopes have greater potential for erosion. Steeper slopes also lend to faster runoff velocities. This decreases the time it takes for water to reach a receiving stream, resulting in a larger pulse of water (or peak flow rate) reaching a given point.

As runoff rates increase, steeper streams may be vulnerable to incision, or downcutting of the stream bottom. In such cases, the stream will flatten and widen until a point is reached where the stream can convey the larger runoff volumes and rates at a velocity that causes less erosion. Tall streambanks or other steep slope areas can also become unstable, sloughing or sliding – especially during extended periods of wet weather.

	Hydrologic Soil Group Properties			
	A	B	C	D
	Most Porous			Least Porous
Infiltration Rate (inches/hr)	> 2	0.5 - 2.0	0.14 - 0.5	<0.14

Hydric Soils

Soil Group

Slope Map

Recent Land Use Change

This watershed includes some of the most rapidly growing urban areas in the state. Aerial photos from the 1930s and 50s show a watershed with limited urban growth primarily within the far eastern (downstream) parts of the watershed. Shortly thereafter, development of the interstate system including I-235 and I-35/80 facilitated westward expansion of the metro area.

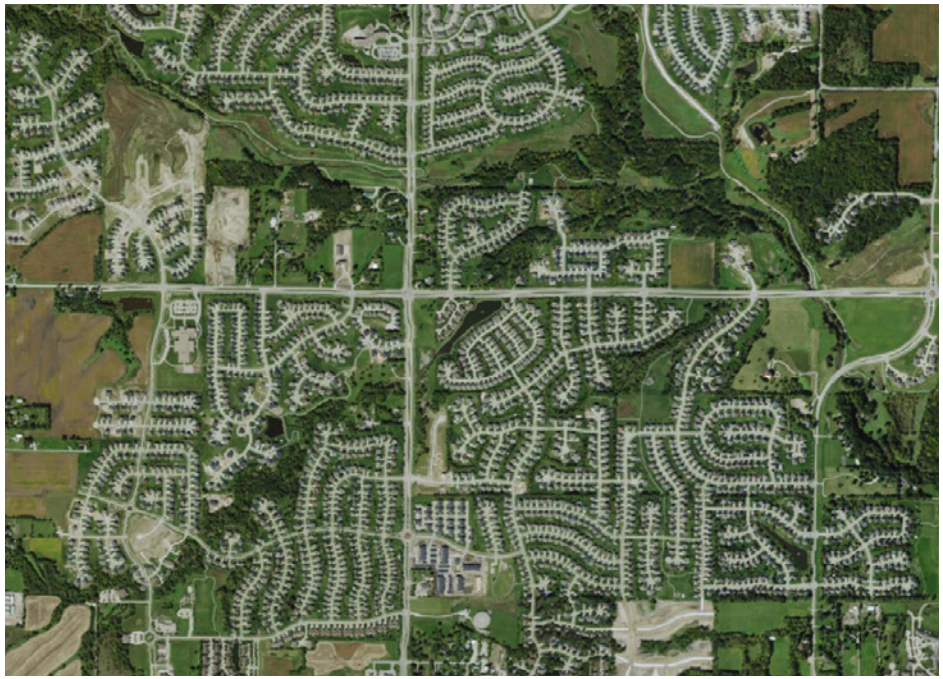
During the 1990s urban growth began to significantly push past the I-35/80 corridor. Over the following decades the communities of West Des Moines, Clive, Urbandale and Waukee saw significant growth in the western part of the watershed. More recently the communities of Grimes and Johnston have seen more rapid growth in the North Walnut Creek basin.

During the period between 2001 and 2011, eight percent of the watershed developed into urban land uses. This included nearly 4,300 acres of land, or about 6.7 square miles. An annual rate of urban growth of 430 acres occurred during this period, which included both times of intense economic growth as well as the major recession period late in the first decade of the 21st century. As of 2011, urban land uses covered 43% of the Walnut Creek watershed.

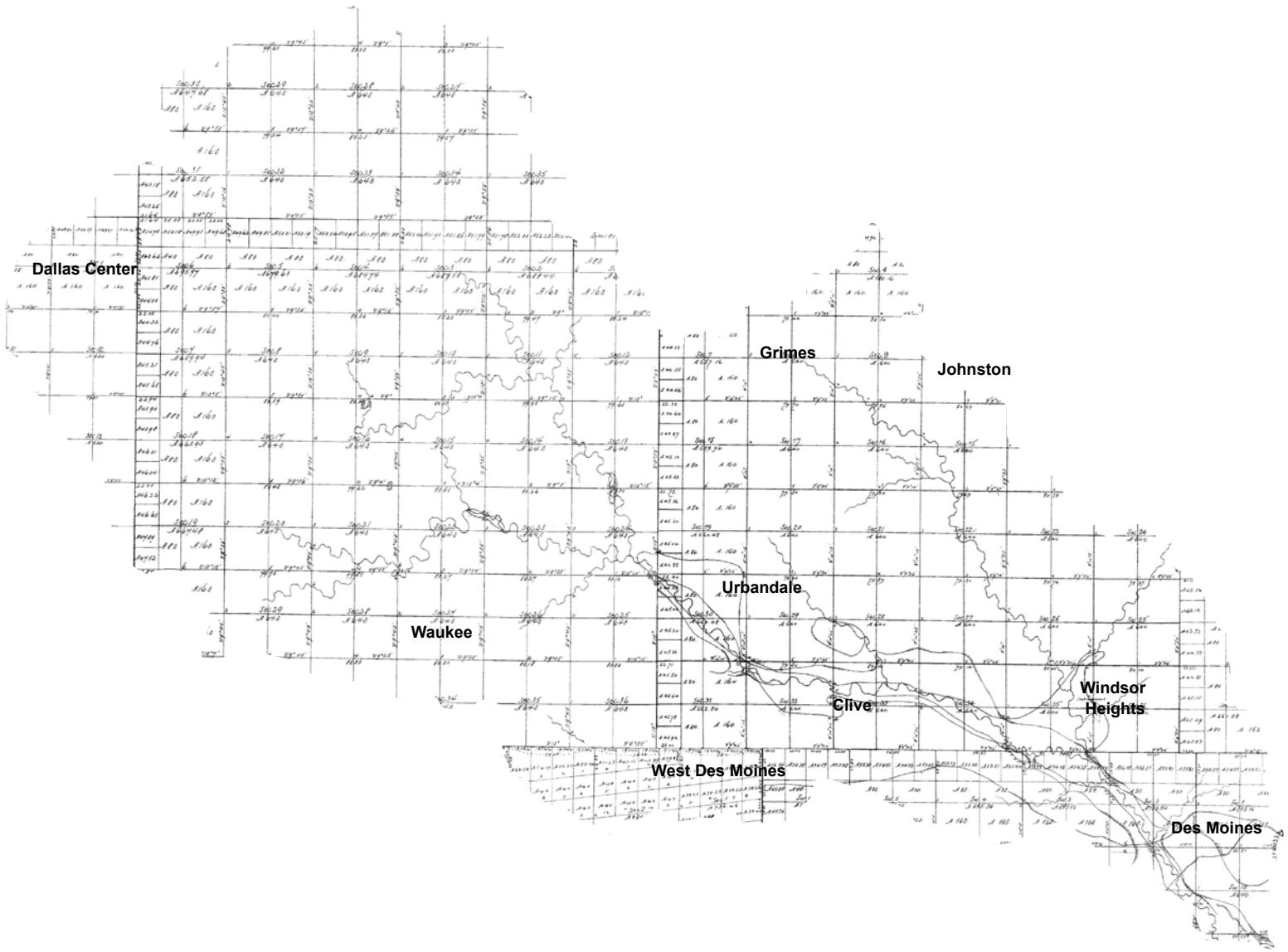
Land Use	2001		2011		2001-11
	area (in acres)	% of watershed	area (in acres)	% of watershed	% change
Open Water	146	0.3%	147	0.3%	0.0%
Urban	18663	35.3%	22936	43.4%	8.1%
Forest	1650	3.1%	1446	2.7%	-0.4%
Grasslands /Wetlands	1209	2.3%	1135	2.1%	-0.1%
Pastureland	3530	6.7%	2147	4.1%	-2.6%
Cropland	27626	52.3%	25013	47.4%	-4.9%
Total	**52825**		**52825**		

2002 CIR Aerial

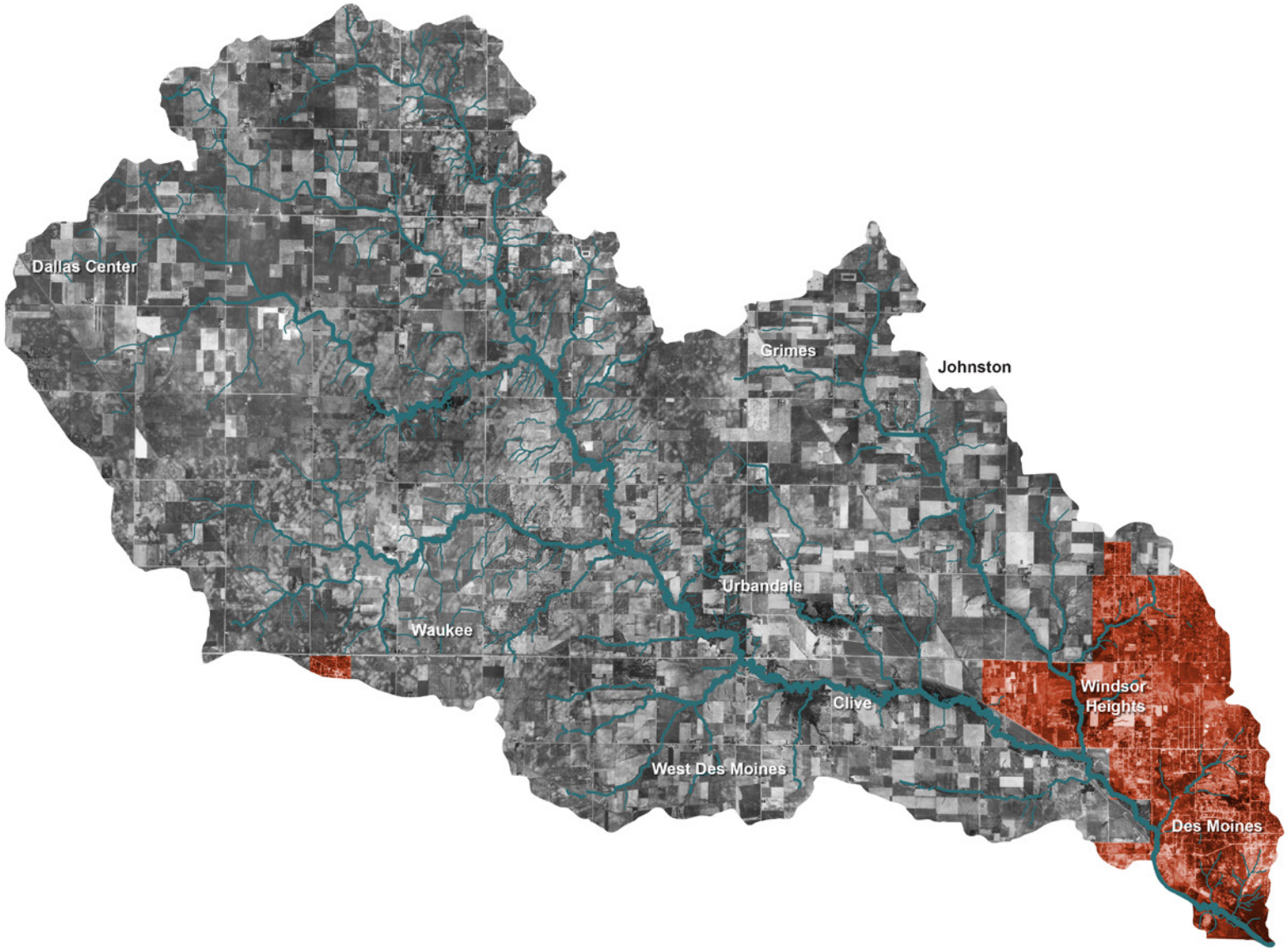
2014 CIR Aerial



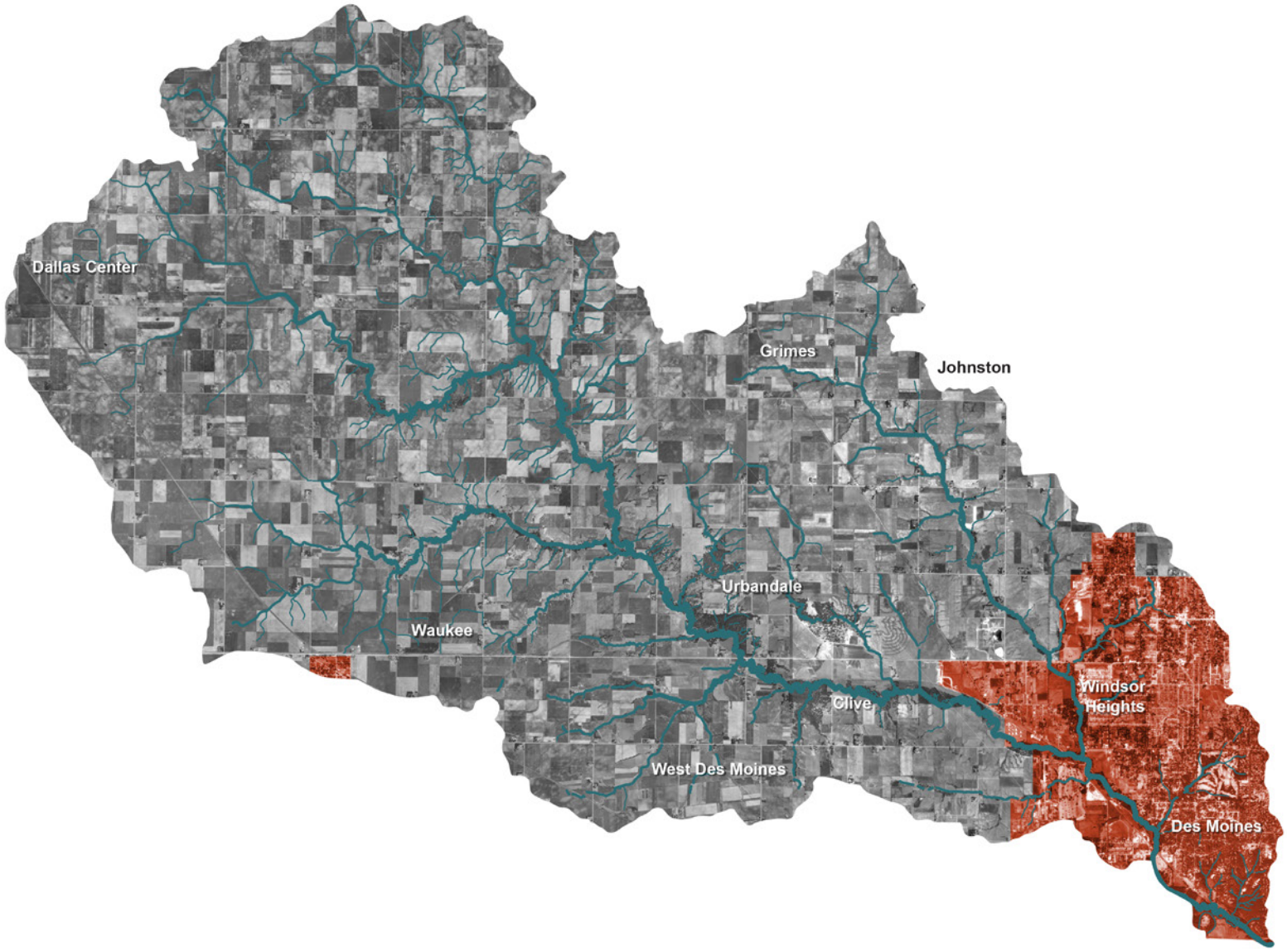
	2001							2011						
Subwatershed ID	Open Water	Urban	Forest	Grassland/ Wetlands	Pastureland	Cropland	TOTAL	Open Water	Urban	Forest	Grassland/ Wetlands	Pastureland	Cropland	TOTAL
101	0.0	956.7	272.0	151.0	57.6	43.4	1480.6	3.1	966.0	264.0	177.5	49.4	20.6	1480.6
102	0.0	537.5	8.2	10.9	8.2	0.0	564.9	0.0	555.8	8.0	1.1	0.0	0.0	564.9
111	0.0	1196.2	26.7	3.1	0.0	0.0	1226.0	0.0	1201.5	21.3	3.1	0.0	0.0	1226.0
112	0.0	956.8	6.9	0.0	0.2	0.0	963.9	0.0	961.3	2.7	0.0	0.0	0.0	963.9
201	0.0	1180.7	36.6	94.5	10.0	0.0	1321.8	0.0	1196.9	30.6	88.9	5.3	0.0	1321.8
202	20.9	1455.3	84.0	145.1	243.6	102.0	2050.9	14.4	1625.3	57.2	132.8	152.4	68.8	2050.9
203	5.8	435.3	258.2	98.6	288.5	241.4	1327.8	5.8	832.5	213.4	93.0	144.5	38.7	1327.8
211	0.0	678.8	0.0	0.0	11.0	0.0	689.7	0.0	688.8	0.0	0.0	0.9	0.0	689.7
212	1.6	691.4	102.7	14.4	301.5	796.3	1907.9	3.1	1062.8	95.1	10.2	166.8	569.8	1907.9
213	63.1	1936.7	67.9	37.9	349.9	413.3	2868.8	60.2	2582.9	46.1	32.3	73.7	73.5	2868.8
214	1.3	81.1	136.7	5.7	41.0	401.8	667.6	1.3	171.7	130.9	5.7	35.9	322.1	667.6
301	5.1	126.2	125.4	140.5	440.7	1168.8	2006.7	4.2	608.4	106.7	100.3	264.8	922.3	2006.7
311	0.0	16.6	5.3	4.0	23.6	426.4	476.0	0.0	17.5	5.3	6.7	20.9	425.5	476.0
312	0.0	37.8	8.7	6.9	51.6	580.7	685.7	0.0	37.8	8.7	6.9	51.6	580.7	685.7
401	0.0	17.3	3.8	11.1	113.9	252.0	398.1	0.0	17.3	3.8	13.8	111.9	251.4	398.1
402	0.0	171.1	9.1	74.2	145.4	3382.0	3781.9	0.0	171.1	9.1	74.2	145.4	3382.0	3781.9
411	4.0	219.7	4.9	70.1	151.5	3701.8	4151.9	4.0	219.7	4.9	72.5	137.9	3712.9	4151.9
501	0.0	771.4	24.5	0.0	0.0	0.0	795.9	0.0	771.4	24.5	0.0	0.0	0.0	795.9
502	2.7	1117.5	12.0	18.2	0.0	0.0	1150.5	2.7	1117.5	12.0	18.2	0.0	0.0	1150.5
503	11.6	1475.9	34.9	46.7	145.4	527.7	2242.3	10.7	1762.7	28.9	42.3	54.1	343.6	2242.3
504	0.0	372.6	2.7	0.0	134.3	973.5	1483.0	6.0	662.9	2.7	0.0	67.8	743.6	1483.0
511	0.0	1333.4	0.0	0.0	2.9	0.0	1336.2	0.0	1333.4	0.0	0.0	2.9	0.0	1336.2
512	4.2	949.5	4.7	0.0	10.7	0.0	969.0	4.2	955.3	0.2	4.0	5.3	0.0	969.0
513	2.0	160.3	0.0	0.0	17.1	990.7	1170.1	4.7	497.6	0.0	0.0	0.7	667.2	1170.1
601	10.7	207.2	145.2	101.5	407.0	1601.9	2473.6	10.7	738.9	124.9	84.2	249.2	1265.8	2473.6
602	0.0	89.2	3.8	7.3	59.3	1542.1	1701.8	0.0	89.2	3.8	7.3	59.3	1542.1	1701.8
611	2.4	241.7	51.9	32.0	185.3	603.3	1116.6	1.1	727.6	28.9	14.0	61.3	283.8	1116.6
612	3.1	503.0	8.0	7.3	44.0	212.6	778.0	3.1	583.5	7.3	7.3	10.9	165.8	778.0
613	0.0	161.3	10.0	16.0	11.1	1511.4	1709.8	0.0	161.3	10.0	20.0	11.1	1507.4	1709.8
614	0.0	43.4	0.0	4.7	0.4	802.5	851.0	0.0	43.4	0.0	4.7	0.4	802.5	851.0
701	1.6	109.8	192.1	36.2	198.1	1988.2	2525.9	1.6	109.8	192.1	36.2	188.9	1997.3	2525.9
702	6.2	333.2	0.0	62.8	66.7	3511.6	3980.5	6.2	364.3	0.0	65.0	64.1	3480.9	3980.5
711	0.0	98.7	3.3	8.2	9.7	1850.3	1970.3	0.0	100.0	3.3	12.4	9.7	1844.7	1970.3
Totals	**146.2**	**18663.4**	**1649.9**	**1209.2**	**3530.3**	**27625.8**	**52824.8**	**147.1**	**22936.2**	**1446.4**	**1134.7**	**2147.3**	**25013.2**	**52824.8**
Change (in acres)								0.9	4272.8	-203.6	-74.5	-1383.0	-2612.6	
Change (% of watershed)								0.0%	8.1%	-0.4%	-0.1%	-2.6%	-4.9%	



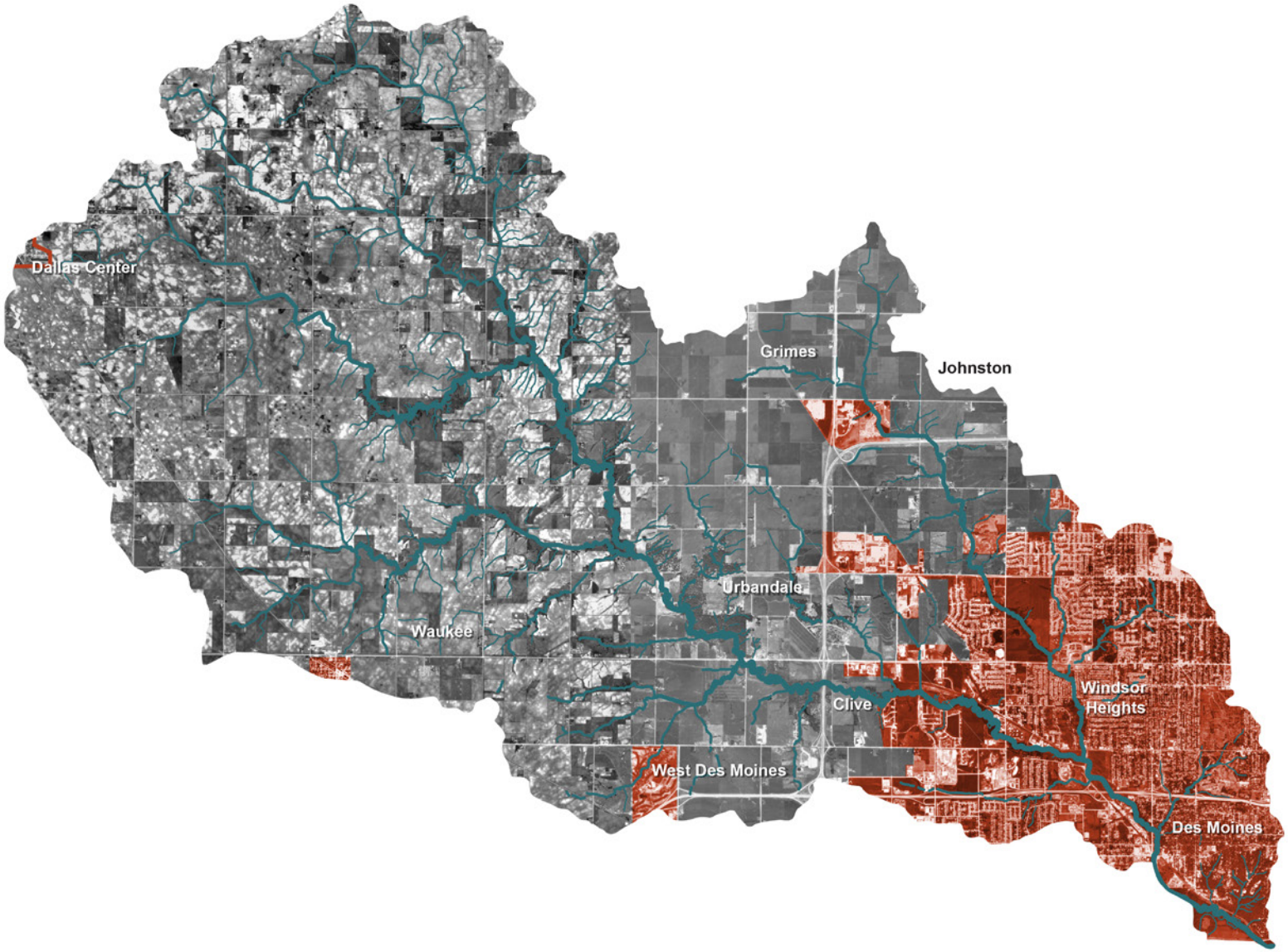
Landscape Change



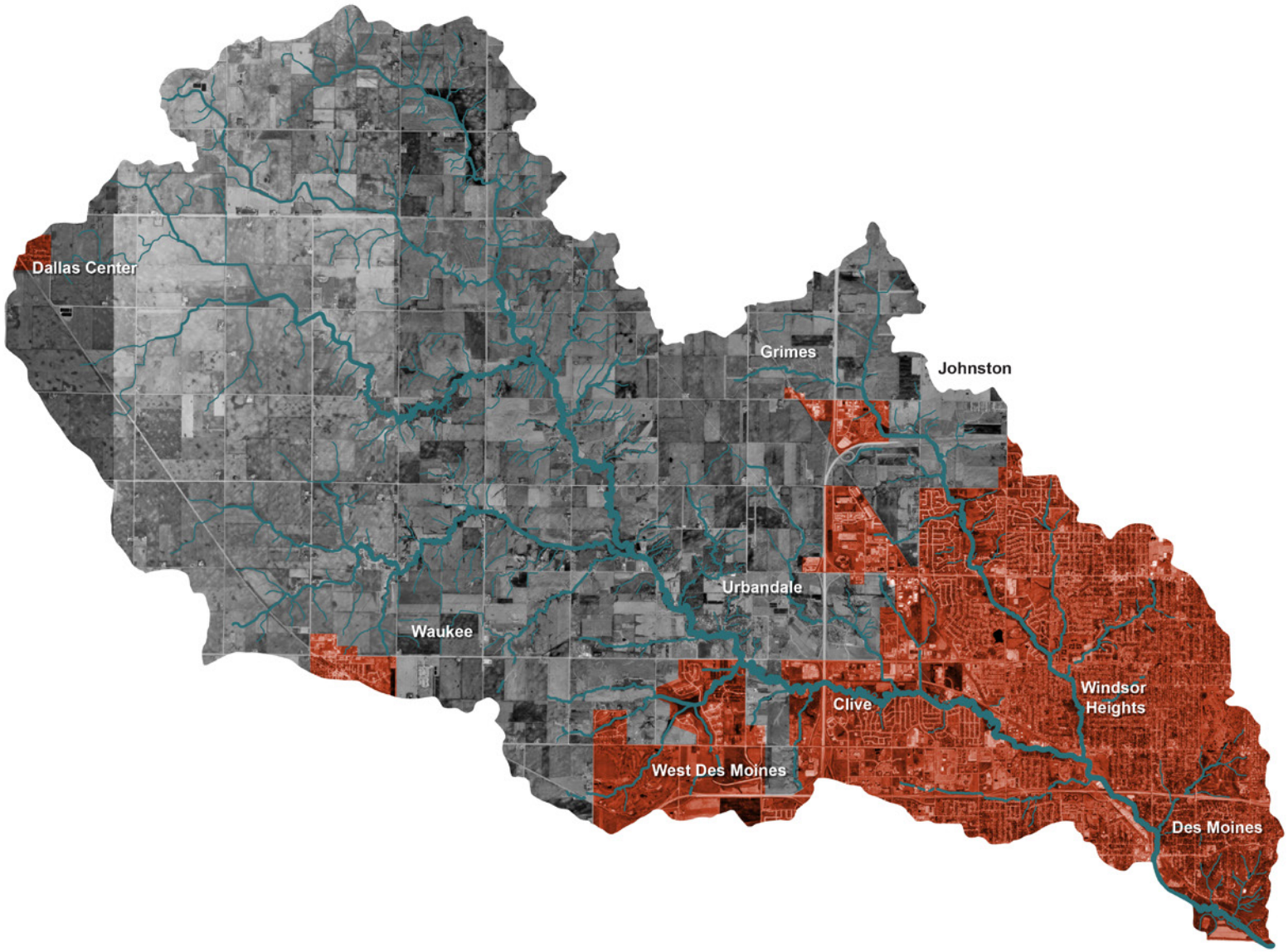
Landscape Change



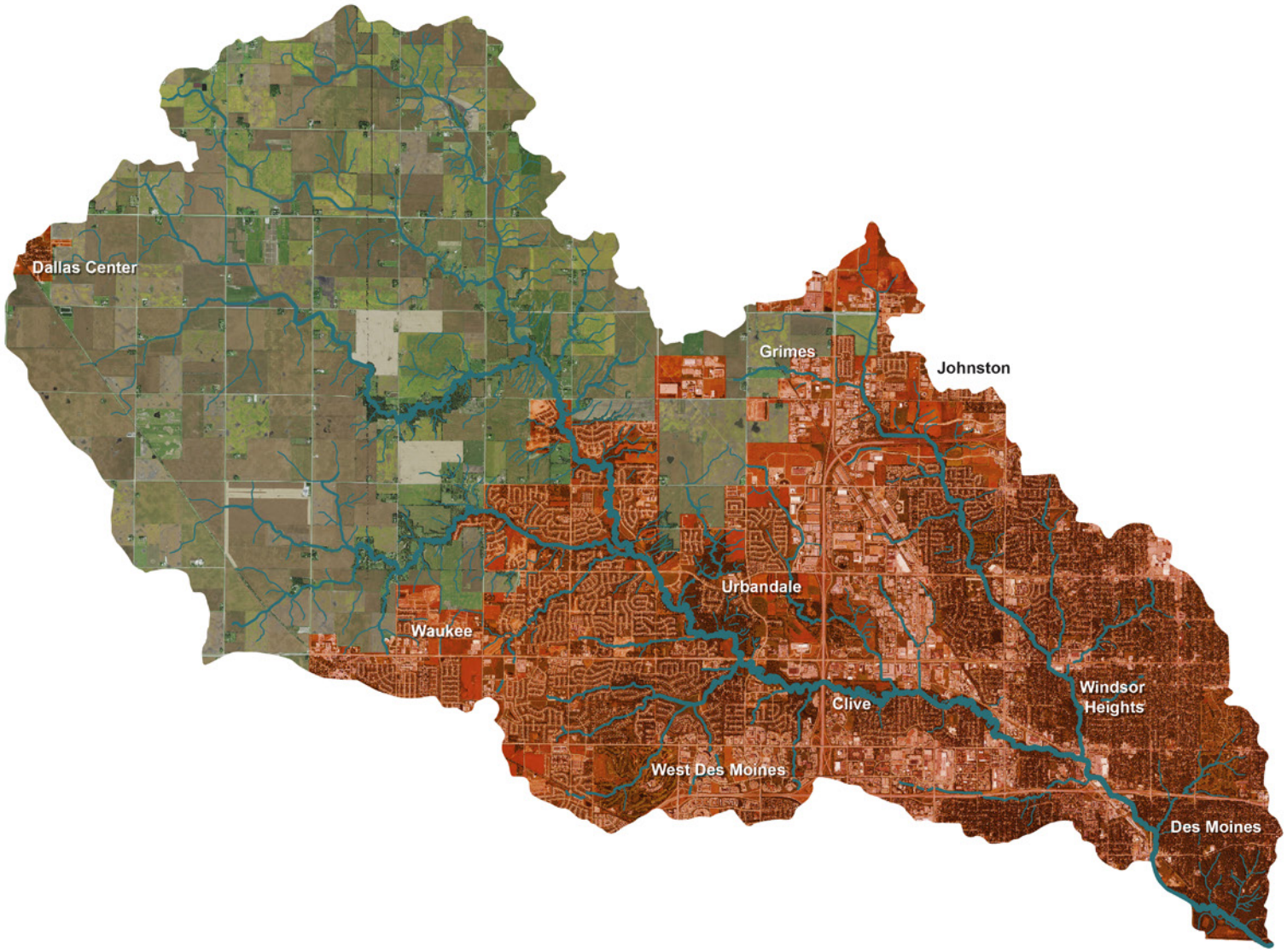
Landscape Change



Landscape Change



Landscape Change



Current Land Use

Climate patterns vary from season to season and year to year. Variations in temperature and precipitation have great influence in flow patterns and pollutant loadings within Walnut Creek. Reviewing historic data related to climate and streamflow can help identify patterns that relate to observed changes in water quality and quantity. A better understanding of these effects can help in the development of more accurate computational models to explain the sources of pollution throughout the watershed.

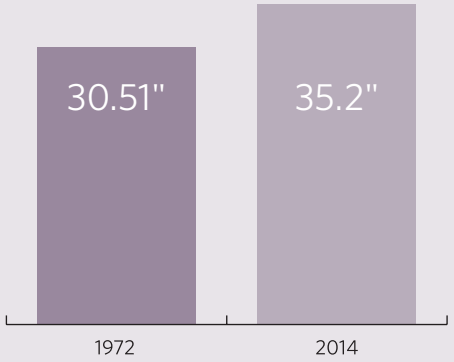
thrett

PLAN IN PROGRESS
January 8, 2015

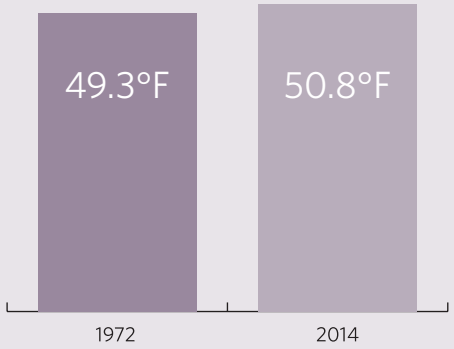
Climate and Streamflow

Climate - Recent Trends

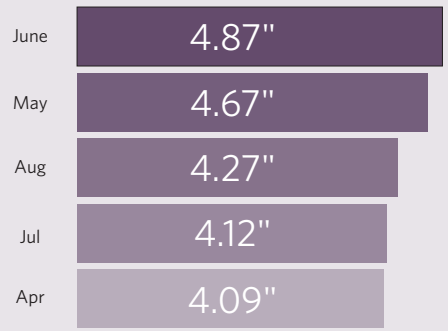
Normal Annual Precipitation



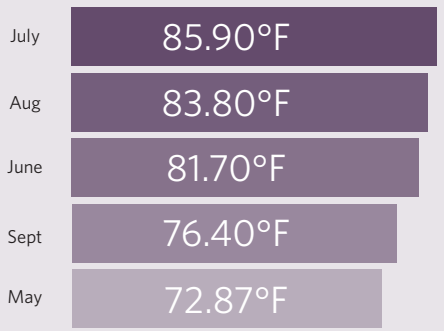
Normal Annual Temperature



Highest Monthly Precipitation*



Highest Monthly Temperatures*

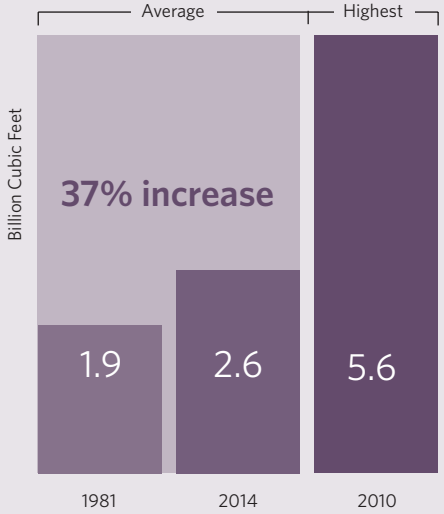


90% of all rainfall events in central Iowa are less than 1.25 inches in depth.

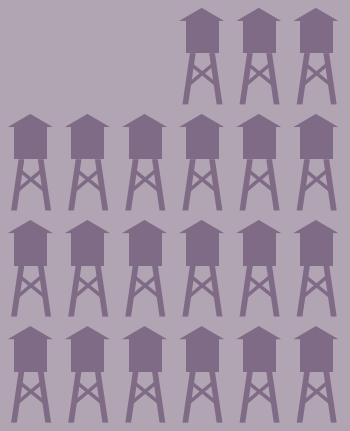
*1985-2014

Streamflow - Recent Trends

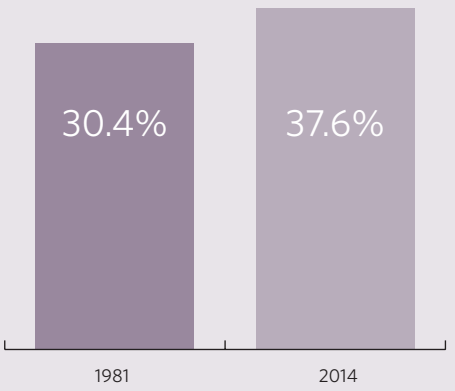
Annual Flow



5.6 billion cubic feet of water would fill 21,000 water towers

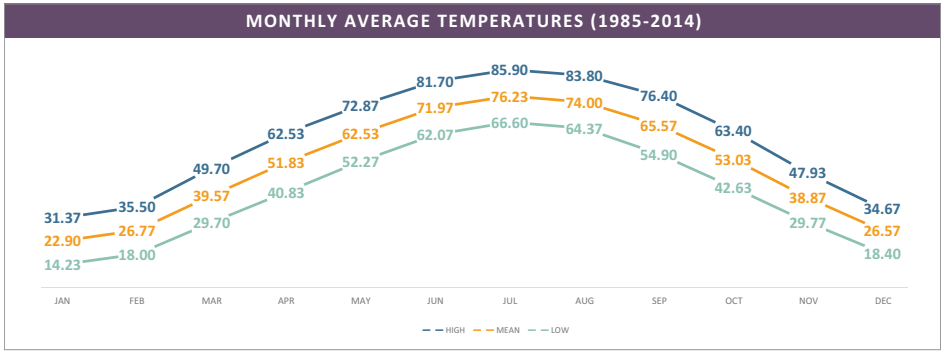


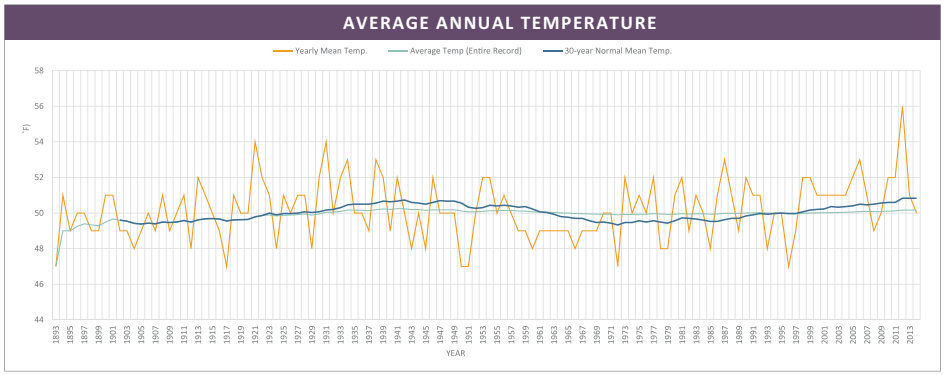
The portion of rainfall converted to runoff has increased recently.

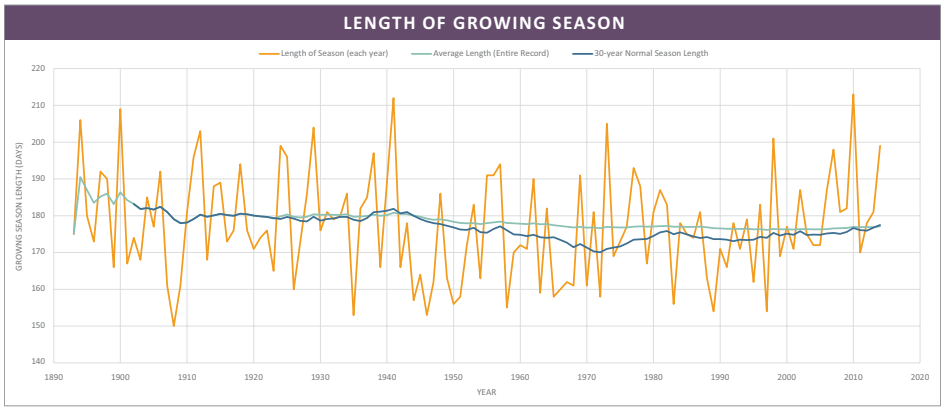


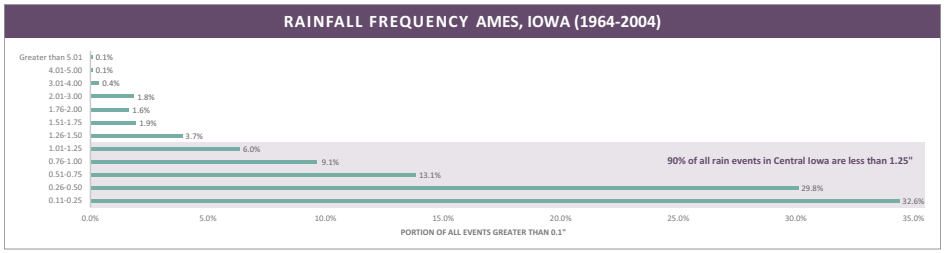
Highest flows typically from May - June

2mil gal x 21,000









Annual Temperature

Historic climate data was obtained through the Iowa Environmental Mesonet (IEM) website, housed by Iowa State University. Since no weather stations fall directly within the footprint of the Walnut Creek watershed, data from the station located at the Des Moines International Airport (IA2203) was used. This site is located approximately 2 miles southwest of the boundary of the watershed. Its historic record extends from January 1, 1893 to the present.

Records were used to review cycles and trends in average annual temperature. A normal annual mean temperature was calculated using the average annual temperature readings over the previous 30 years for any given date through the period of record (1893-present). These normal annual temperature readings generally increased between 1893 and 1942 (30-year annual average increased from 49.87˚F in 1922 to 50.73˚F in 1942). Over the following 30 years, this normal annual temperature value fell 1.40˚F to 49.33˚F in 1972 following a period that included several colder than average years during the 1940s, 50s and 60s. Since that point, this value has risen 1.50˚F to a high value of 50.83˚F in 2014.

Seasonal Temperature

Between 1985 and 2014, January has generally been the coldest month of the year, with a mean temperature of 22.90˚F (14.23˚F LO / 31.37˚F HI). July has typically been the warmest month of the year, with a mean temperature of 76.23˚F (66.60˚F LO / 85.90˚F HI). The highest temperature recorded at the Des Moines Airport was 110˚F on July 25, 1936 and August 4, 1918. The minimum temperature reading of -29˚F was registered on January 12, 1912.

Growing Season

A similar analysis was performed using data for the length of the growing season for each year over the period of record. A normal growing season length was computed using the average length of season over the previous 30 years through the period of record. Even though normal annual temperatures increased until 1942, the normal growing season length generally decreased from the beginning of records until 1972 (183.2 days in 1922 to 170.1 days in 1972). Since that date, the average growing season has generally been on the rise, although a downtrend did occur between 1982

and 1992. The normal growing season length in 2014 was calculated to be 177.5 days (based on period form 1985-2014).

Annual Precipitation

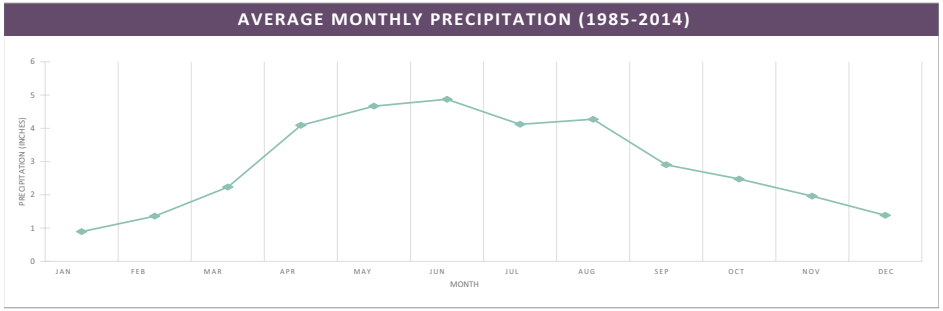
Precipitation data was reviewed in a manner similar to temperature information. Annual precipitation totals observed at the Des Moines Airport over the period of record range from 17.08" (1956) to 55.89" (1993), with an average of 32.14" over the entire period of record. A normal annual precipitation depth was computed using the annual precipitation over the most recent 30 years through the period of record. Up until 1982, the annual normal precipitation generally remained within 0.5" of the average of the overall period of record. But since that time, annual rainfall has been trending upward. Normal precipitation values peaked in 2011 at 36.15". The normal value dropped slightly through 2014 to 35.23", as the three consecutive wet years of 1982-1984 dropped out of the computation of the 30-year normal. Even so, the normal annual precipitation remains more than three inches above the longer term average. There appears to be a clear local trend of increased precipitation over the past three decades. Six of the top eight wettest years on record have occurred since 1982, while none of the driest years on record have occurred during that same period.

Top/Bottom Precipitation Years

	HIGH		LOW	
Rank	Year	Precipitation (in inches)	Year	Precipitation (in inches)
1	1993	55.89	1956	17.08
2	2010	51.78	1910	18.25
3	2008	49.43	1930	19.58
4	1973	45.19	1933	19.68
5	1982	44.81	1901	19.78
6	1990	43.94	1953	20.01
7	1961	42.88	1894	20.07
8	1986	42.59	1967	21.83
9	1947	42.08	1966	21.86
10	1902	42.02	1955	21.99

Monthly Precipitation

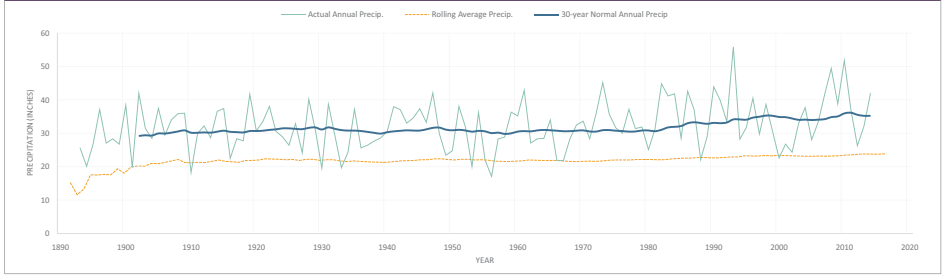
Normal precipitation levels are lowest in January, rising through the spring to highest levels during the month of June. Precipitation levels remain elevated through July and August, falling off significantly through the fall months.



Short Term Precipitation

Engineers use published studies on local rainfall rates in the design of storm sewers, culverts and storm water management practices. In the past, local design standards have used information from Technical Paper 40 (1961) and Bulletin 71 (1992) rainfall depths and rates for short-term events (time periods ranging from a few minutes to up to 10 days). Recently, NOAA issued their Atlas 14 rainfall data set, which included more recent precipitation data to establish these rates. SUDAS (Statewide Urban Design Standards and Specifications) and ISWMM (Iowa Stormwater Management Manual) have adopted these values for use in design. Values listed in Atlas 14 are generally similar to or higher than those listed in previous studies, meaning that storm water facilities now are expected to be designed to handle runoff generated by more rainfall than expected in the past.

ANNUAL PRECIPITATION



Rainfall Depths (in inches) for Various Storm Event Durations – 1-Year Return Period Storm				
		TP-40	Bulletin 71	Atlas 14
Issue Date		1961	1992	2013
Storm Event Duration	30 minutes	1.1	0.88	0.99
	1 hour	1.3	1.12	1.29
	6 hours	2.0	1.79	2.05
	12 hours	2.3	2.07	2.34
	24 hours	2.7	2.38	2.67

Rainfall Depths (in inches) for Various Storm Event Durations – 10-Year Return Period Storm				
		TP-40	Bulletin 71	Atlas 14
Issue Date		1961	1992	2013
Storm Event Duration	30 minutes	1.9	1.58	1.70
	1 hour	2.4	2.01	2.23
	6 hours	3.6	3.20	3.61
	12 hours	4.2	3.71	4.07
	24 hours	4.7	4.27	4.46

Rainfall Depths (in inches) for Various Storm Event Durations – 100-Year Return Period Storm				
		TP-40	Bulletin 71	Atlas 14
Issue Date ->		1961	1992	2013
Storm Event Duration	30 minutes	2.7	2.45	2.63
	1 hour	3.4	3.11	3.55
	6 hours	5.1	4.96	5.98
	12 hours	6.0	5.75	6.62
	24 hours	6.7	6.61	7.12

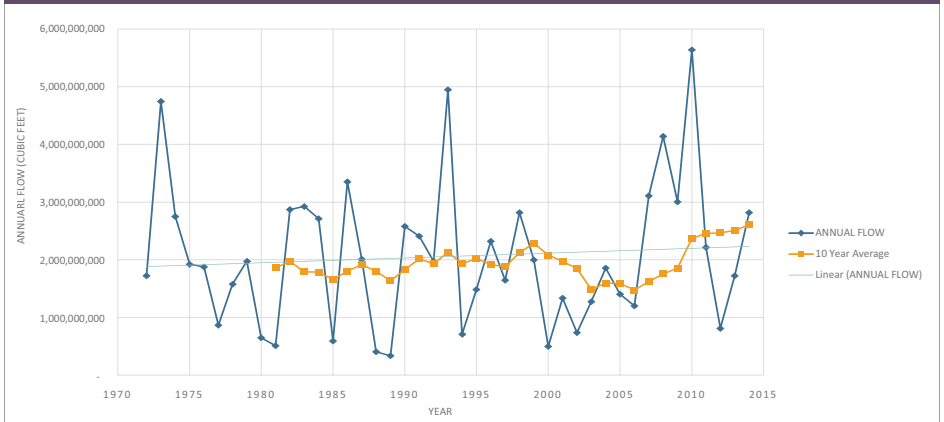
Available Streamflow Gage Data

Stream flow data has been collected at a USGS gaging station located near the 63rd Street Bridge on the border between Des Moines and West Des Moines (USGS 05484800). Data collection began in October of 1971 and continues through the present day. At this location, Walnut Creek is collecting runoff from an area of 78.3 square miles (95% of its entire watershed).

Annual Flows

As would be expected, stream flow varies greatly from year to year, based on precipitation. Since 1972, annual flow volumes have ranged from 334 million cubic feet in 1989 to 5.64 billion cubic feet in 2010. To put that in perspective, the annual volume of flow from 2010 would be enough to fill 21,000 large water towers (assuming each tower could hold 2 million gallons) compared to XX water towers in 1989. A general upward trend can be observed in runoff volume. The value of annual flow based on an average over the previous 10-years has increased from 1.85 billion cubic feet in 1981 to a high value of 2.6 billion cubic feet in 2014.

ANNUAL RUNOFF (1972-2014)



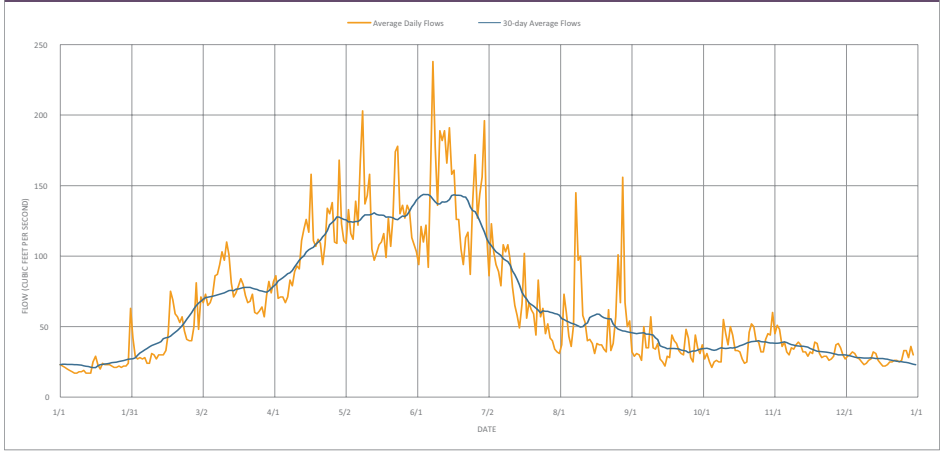
Sources: **Values for TP-40 interpreted from rainfall map data.**
Technical Paper No. 40 – Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years; Hershfield, David M.; US Department of Agriculture, May 1961.
Rainfall Frequency Atlas of the Midwest; Huff,Floyd A. and Angel, James R.; Midwest Climate Center – NOAA, 1992.
Values for Atlas 14 taken from Iowa SUDAS Design Manual, interpreted from Atlas 14 map data.
NOAA Atlas 14, Precipitation-Frequency Atlas of the United States (Volume 8, Version 2.0); Perica, Sanja, et al; US Department of Commerce, NOAA and NWS, 2013.

Gaging Station Location

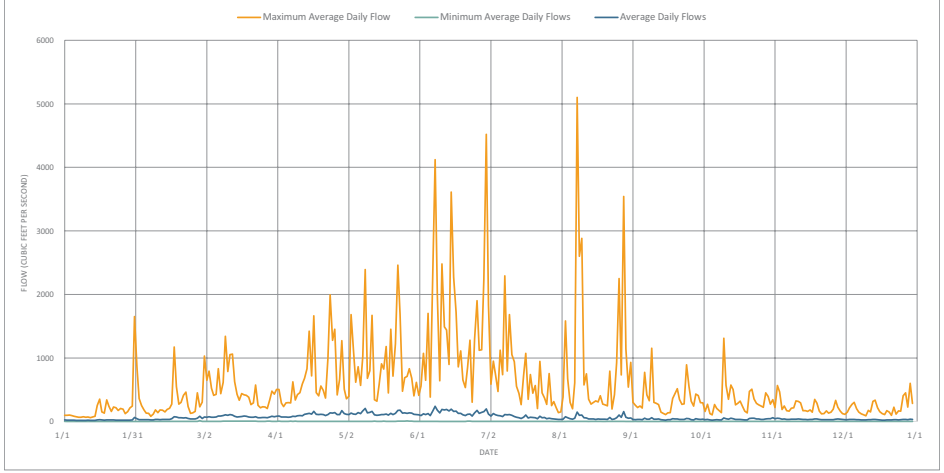
Flow Variation

Daily average flow rates in Walnut Creek have ranged from essentially no flow to 5,100 cubic feet per second on August 9, 2010. The total flow on that single day of 441 million cubic feet would have exceeded the flow for the entire year of 1989, and would have been equal in volume to more than 1,600 large water towers. However, such large flows are uncommon. Average daily flow rates have exceeded 1,000 cubic feet per second for only 67 days over a period of more than 43 years (less than 0.5% of all days). The average daily flow rate over the entire period of record is 26 cubic feet per second, or a daily volume of 2.3 million cubic feet (8 large water towers).

AVERAGE DAILY FLOWS (1971 - 2015)



RANGE OF AVERAGE DAILY FLOWS (1971 - 2015)



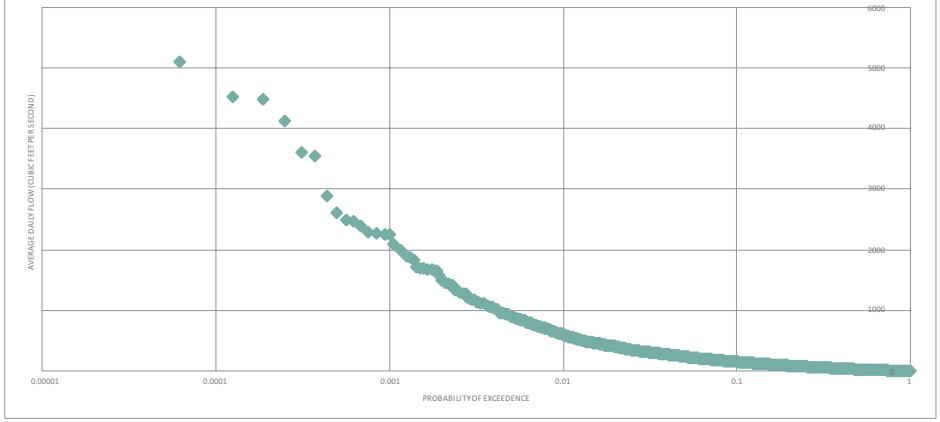
Seasonal Variation

A typical flow curve for Walnut Creek has been constructed by reviewing average daily flow data collected from October 1, 1971 to August 5, 2015. Over this period, highest flows are most often observed between late April and the end of June. Flows typically decline through July, although higher flows have sometimes occurred during periods in early and late August. The typical flow curve is constructed by using a 30-day average (looking 15 days before and after a given date). This has the effect of smoothing out the high and low values into a more regular pattern over the course of an "average" year.

Conversion of Precipitation to Streamflow

The amount of precipitation which is converted to streamflow has varied greatly. Comparing precipitation observed at the Des Moines Airport and data from the stream gage at Walnut Creek, we can find that in 1989, annual stream flow volume was only 7% of the volume of that year's precipitation. Contrast that with 2010, when stream flow equaled nearly equaled 60% of annual precipitation.

OBSERVED AVERAGE DAILY FLOWS (OCTOBER 1971 - AUGUST 2015)

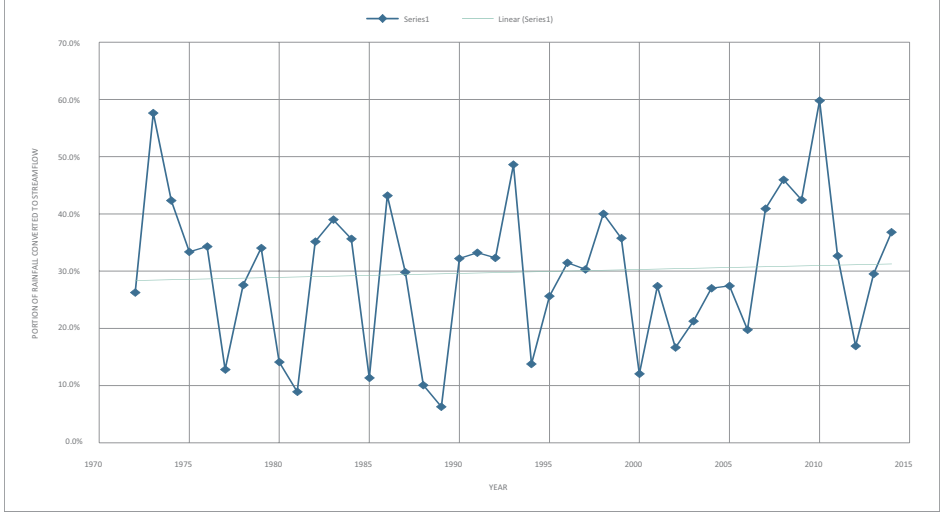


GRAPHIC

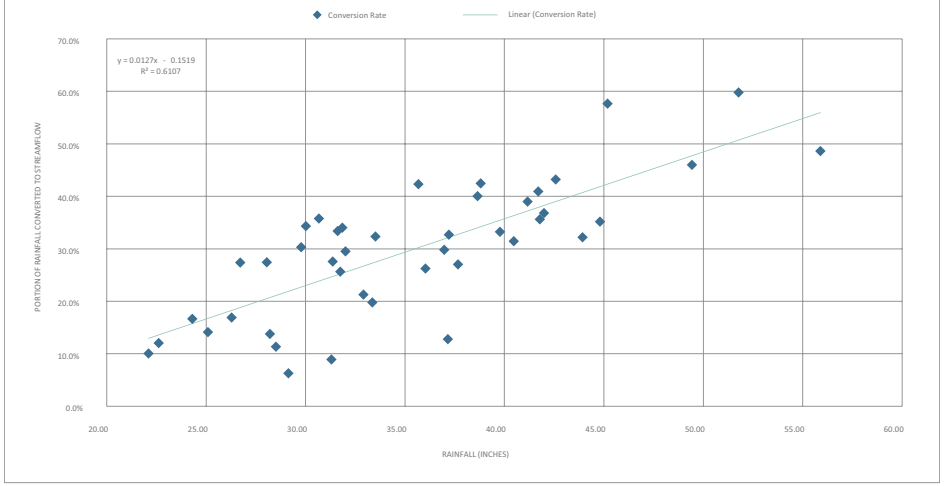
Many factors appear to influence this value which are hard to separate at this level of study:

- Was that year more wet or dry? Streamflow percentages are higher in wet years than dry years.
- Was the previous year wet or dry? A previous dry year may have lowered groundwater and surface moisture levels, resulting in less runoff.
- Did precipitation come in large storm events or more steady over time? A higher percentage of runoff is expected during heavier rainfall.
- Continuing development throughout the watershed. Development activities install impervious surfaces (hard/solid surfaces that won't slow or hold water like rooftops and driveways) and development compacts remaining open spaces through mass grading. These factors lead to higher levels of runoff.

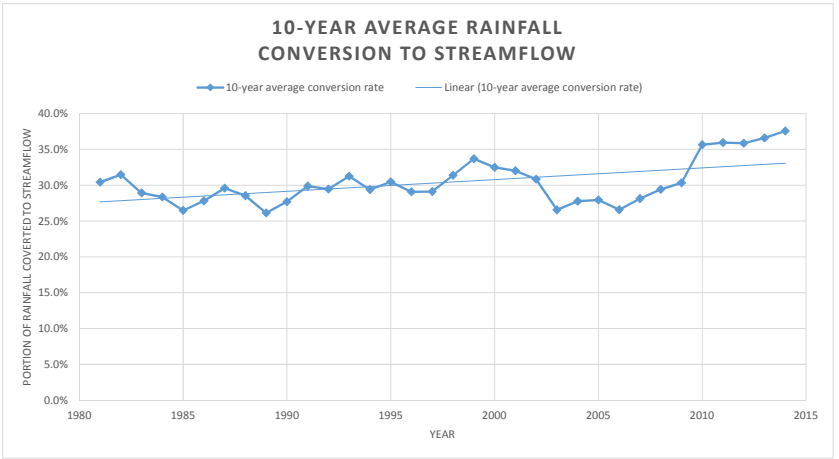
PORTION OF PRECIPITATION TO STREAMFLOW (1972-2014)



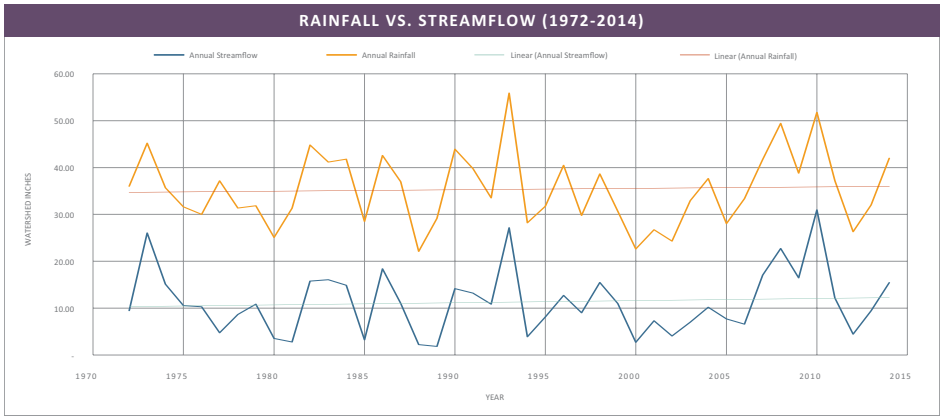
CONVERSION OF RAINFALL TO STREAMFLOW (1972-2014)



10-YEAR AVERAGE RAINFALL CONVERSION TO STREAMFLOW



RAINFALL VS. STREAMFLOW (1972-2014)



PHOTOS HERE

With the information that is available, it is difficult to draw conclusions on how each of the items above influences in the percentage of precipitation that is converted into streamflow. From the information on hand, we can derive these conclusions:

1. The portion of streamflow that is converted to runoff increases with annual rainfall volume.
2. Reviewing averages over the previous 10-years from a given date, the proportion of precipitation converted to runoff has increased from an average of 30.4% in 1981 to 37.6% in 2014.
3. Normal annual precipitation has risen from 30.61 inches in 1981 to 35.23 inches in 2014 (based on the average precipitation of the previous 30 years from the given date).
4. From 2001 to 2011, urban land cover within the watershed increased from 35% to 43% of the total watershed area (a change of 4,300 acres).

Flood Risk Potential

Flooding is a key concern within this watershed. This was a key topic discussed at board meetings and open houses. A flood event which occurred during the planning process intensified the focus on this issue. Flooding occurred during the morning hours of June 25, 2015. This event occurred when more than five inches of rain fell over portions of the watershed beginning late in the evening of June 24. Most of the rain fell over a three to five hour period, depending on location.

Urban development has occurred within many flood prone areas. In some cases, structures have been located in areas where they are frequently flooded including residential, commercial, industrial and public buildings.

Flood risks in this area have been evaluated multiple times. Studies of flooding are developed into maps which demonstrate different levels of expected risk along major stream corridors.

These maps typically identify key features of a flood plain:

- Base Flood Elevations – Detailed studies may identify expected high water elevations caused by a 1% annual recurrence chance flood. This is a flood

event, expected to have a 1% chance of occurring in any given year, or over very long periods of time would be expected to happen once every 100 years on average. This has commonly been referred to as a "100-year flood event", although the phrase "1% annual recurrence chance" is now the preferred terminology.

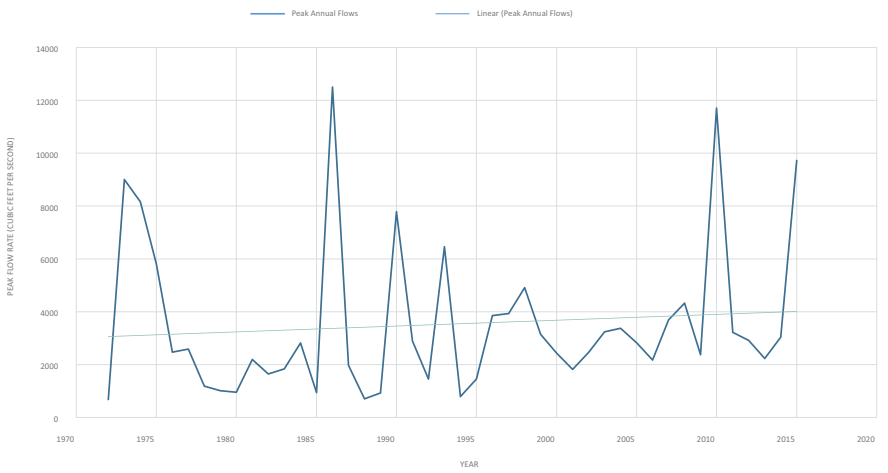
- Floodway – A zone where grading or structure construction is most limited. This zone is intended to be kept clear of obstructions. In theory, the flood plain could be completely filled on either side of this zone and the expected result would be a one foot rise in base flood elevations. Not all maps identify the floodway for a given stream, but they are usually identified on larger streams or in areas where more detailed studies have been completed.
- Flood Fringe – Maps often identify areas outside of the floodway which show areas expected to be covered by the 1% or 0.2% annual recurrence chance flood events. The 0.2% chance event has commonly been called the "500-year flood event".

In some areas, these maps are associated with studies that provide detailed cross-sectional information of the flood plain. Such studies may include expected flood elevation profiles for other more commonly occurring storm events (i.e. 2%, 10% recurrence intervals, etc.). It is important to understand that localized flash flooding can occur outside of areas with mapped flood risk. This can be caused by clogged inlets or storm sewers and culverts; overloaded storm sewer systems, blocked overflow paths and urban small stream flooding.

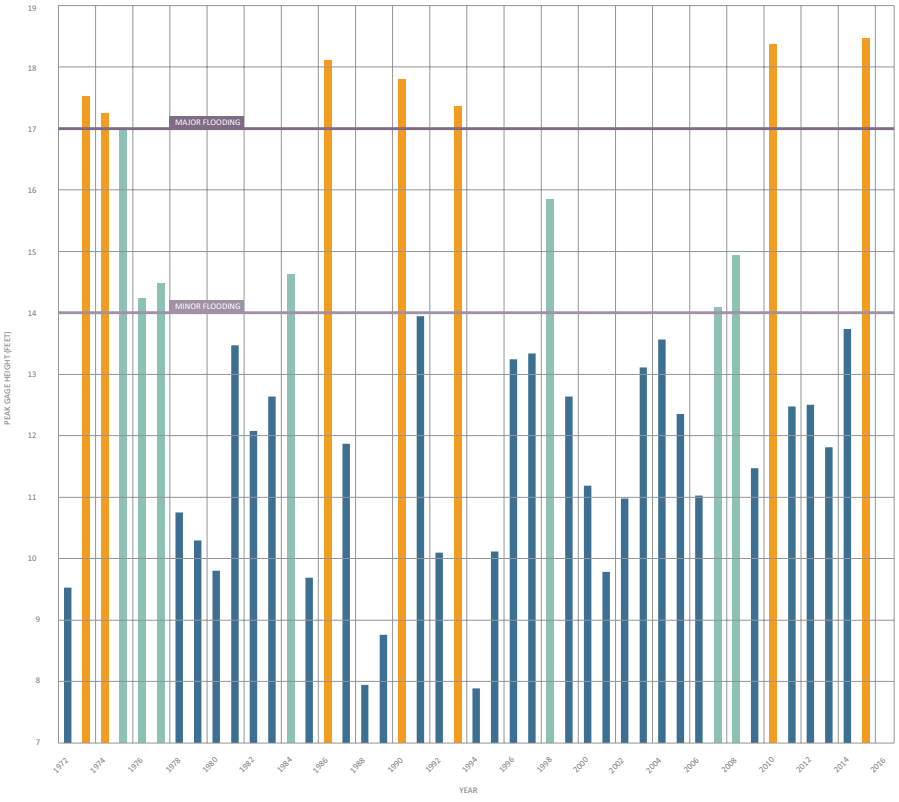
Flood History

At the gaging station at the 63rd Street Bridge, minor flooding impacts are expected at a gage height of 14 feet. At this location, major impacts due to flooding are expected when water exceeds a gage height of 17 feet. Gage height data has been collected every year since 1972. Over that 44 year period, there have been 14 years (31.8%) where a gage height above 14 was recorded. Water levels have exceeded a gage height of 17 feet in eight (18.1%) of the years on record. This indicates that a flooding to a gage height of 17 feet may be expected once every five years on average.

PEAK ANNUAL FLOWS (1972-2015)



PEAK GAGE HEIGHT (1972-2015)



Hydraulic Modeling and Flood Inundation Mapping

To begin the hydraulic and floodplain mapping investigation for the Walnut Creek Watershed Management Plan, data and models from three previous studies were reviewed. These previous studies included hydraulic and hydrologic analyses for the North Walnut Creek watershed, hydraulic and hydrologic analyses for the Walnut Creek watershed, and updated FEMA floodplain mapping for North Walnut Creek and Walnut Creek. These studies and models were produced using rainfall data published in 1992 in Bulletin 71 - Rainfall Frequency Atlas of the Midwest. Bulletin 71 rainfall data was the most recent rainfall data available at the time these studies were completed. These studies were eventually incorporated into a FEMA floodplain mapping update that went preliminary in June 2015. They are scheduled to become effective in the winter of 2016.

This study further updates hydrologic and hydraulic models as well as inundation mapping for Walnut Creek and North Walnut Creek using more recent rainfall estimates. This plan uses NOAA Atlas 14 data. The Atlas 14 rainfall estimates take into account a longer period of statistical data than Bulletin 71 and include rainfall data through the 2013 water year. In general, in Iowa, the rainfall estimates for NOAA Atlas 14 have increased when compared to Bulletin 71. This is also the case for the Walnut Creek and North Walnut Creek watersheds. This increase in rainfall estimates, in turn, increased the peak flow estimates, water surface elevations, and floodplain extents.

The results of the analyses using the Bulletin 71 estimates and the NOAA Atlas 14 estimates were compared. Points of interest are outlined for each flooding source below.

Walnut Creek 1% Annual Chance:

- 73 acres greater floodplain area for the Atlas 14 based mapping over 18 miles of stream length
- An average of 34 feet wider than the preliminary mapping or 17 feet on either side of the stream
- Smaller in some areas due to some of the additional area being within backwater fingers

North Walnut Creek 1% Annual Chance:

- 16 acres greater floodplain area for the Atlas 14 based mapping
- An average of 24 feet wider than the preliminary mapping or 12 feet on either side of the stream
- Smaller in some areas due to some of the additional area being within backwater fingers

The differences highlighted above are obviously a direct result of increased rainfall estimates with the updated statistical data. However, as land use and management changes within the watershed, these increases in peak flow estimates could worsen over time. Since we cannot predict meteorological changes, to mitigate risk and future losses, watershed and floodplain management becomes paramount.

Flow Increases			
	Effective Flows (CFS)	Preliminary Flows (CFS)	Atlas 14 Flows (CFS)
	1% Annual Chance Flows		
Above RT Bank Tributary	5,480	5,415	6,137
Above Little Walnut Creek	10,280	10,875	12,368
At NW 142nd Street	14,410	14,715	16,734
At NW 100th Street	14,950	16,570	18,858

Flood Risk

Past studies have been completed that broaden the understanding of Walnut Creek and where it fits within larger watersheds. The designated uses of the stream influence the maximum allowable concentrations of certain pollutants. This influences if the stream is considered to be impaired, and the required reductions in pollutants that are needed in order to fully support the stream's desired public uses.

four
PLAN IN PROGRESS
January 8, 2015
Background

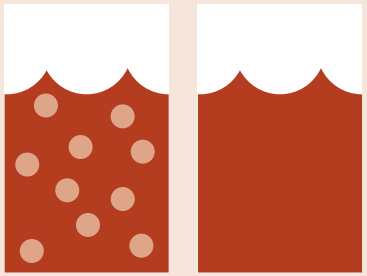
Downstream waterbodies are:

1. Des Moines River
2. Lake Red Rock
3. Mississippi River
4. Gulf of Mexico

Elevated levels of nutrients such as nitrogen and phosphorus have created a 5,840 square mile **dead zone** in the Gulf of Mexico (10% of the size of the entire State of Iowa)

Walnut Creek

- Currently considered an impaired waterbody due to high levels of bacteria.
- Flows into the Raccoon River which is impaired due to high levels of bacteria and nitrate.



Des Moines Water Works collects water from the Raccoon River for drinking water use. This water must be disinfected and nitrates removed through a special process when concentrations are above a certain level.

Iowa's Nutrient Reduction Strategy

Created to reduce the amount of nutrient load sent from Iowa to the Gulf of Mexico.

Designated Uses

Streams have specific designation classifications based on their use. Uses such as swimming, fishing, drinking water or maintaining aquatic life fall into different classifications. Each class has a series of rules that applies to it, known as the IDNR water quality standards. The listed designated uses for Walnut Creek (Waterbody ID Code: IA 04-RAC-0020_1) are below:

- Class A1 (Primary contact recreational use): The recreation uses involve full body immersion with prolonged and direct contact with the water.
- Class B (WW-2): Typically smaller, perennially flowing streams capable of supporting and maintaining a resident aquatic community, but lacking the flow and habitat necessary to fully support and sustain game fish populations.

Sources: IDNR website **"What does "Designated Use" mean?"**

http://www.iowadnr.gov/InsideDNR/RegulatoryWater/WaterQualityStandards/DesignatedUses.aspx

Iowa Surface Water Classifications (567 Iowa Administrative Code 61.3).

Impaired Waters Status

The lowest 7.6 miles of Walnut Creek are listed on the State of Iowa's 305(b) list as an impaired waterway. Streams are added to the impaired waters list if conditions exist that have a negative impact on one or more of the streams designated uses. For each stream studied, each use is categorized as fully, partially or not supported. Portions of Walnut Creek are listed as Category 4a , meaning that it is impaired or a downward water quality trend is evident, and a TMDL has been prepared.

Primary contact recreation uses are listed as "not supported" based on data from Iowa Geological Survey snapshot monitoring from 2004 through 2008. The levels of indicator bacteria (E.coli) at multiple sampling points were far in excess of the water quality criterion established by the State of Iowa. (These criteria for E.coli are a geometric mean for all samples of 126 organisms per 100 milliliters (mL) and a single sample maximum of 235 orgs/100 mL)

Aquatic life support is listed as "fully supported" based on data collected in the 1998 IDNR/UHL stream biocriteria project. Overall use support is listed as "not supporting ". A TMDL is not considered needed for this stream segment as it was considered and included within the TMDL report prepared by the IDNR for the Raccoon River, which was approved by the EPA in June 2008.

The lower Raccoon River (Waterbody ID Code: IA 04-RAC-0010_1) is listed as impaired by bacteria and nitrate. Elevated bacteria levels are the reason it is listed as "not supporting" primary contact recreation. In addition to the uses established for Walnut Creek, the Raccoon River has the following designated uses:

- Class C (Drinking water supply): Water is used as a raw water sources of potable water supply.
- Class HH (Human health): Waters where fish are routinely harvested for human consumption or where water is used a drinking water supply and where fish are routinely harvested for consumption.

The river is also listed as a high quality resource, or a water "of substantial recreational or ecological significance which possess unusual, outstanding or unique physical, chemical or biological characteristics". The Raccoon River is listed as "fully supporting" fish consumption. However, nitrate levels frequently exceeded the maximum contaminate level for nitrate of 10 mg/L, leading to this stream segment being categorized as "not supporting" for drinking water use.

Source – IDNR 305(b) Water Quality Assessment Database https://programs.iowadnr.gov/adbnet/assessment.aspx?aid=12318

Applicable Water Quality Standards

The TMDL established for the Raccoon River set maximum contaminant levels (MCLs) for both nitrate and bacteria. The MCL for nitrate for single samples was established to be 9.5 mg/L, which includes a 0.5 mg/L factor of safety below the acceptable limit established by the EPA (10.0 mg/L). The MCL for bacteria for single samples was established to be 200 organisms / 100 mL, which includes a 35 org./100mL factor of safety below the established EPA standard (235 org./100mL). These standards are to be applied to major tributaries of the river (such as Walnut Creek) which have been designated as impaired by these pollutants of concern.

Previous Studies

Water Quality Improvement Plan for Raccoon River (TMDL) - 2008

The Federal Clean Water Act required the Iowa Department of Natural Resources (IDNR) to develop a Watershed Improvement Plan, also known as a Total Maximum Daily Load (TMDL), for waters that have been identified on the state's 303(d) list as impaired by a pollutant. Three segments of the Raccoon River have been identified

as impaired by nitrate and five segments by the pathogen indicator (E.coli) bacteria (TMDL, p.12). The segment of Walnut Creek in Polk County, downstream of I-80/35 is one of several Class A1 streams within the Raccoon River watershed where a TMDL has been determined and included within the report prepared for the overall Raccoon River TMDL.

Surface water from the Raccoon River is used as a drinking water source for the Cities of Des Moines and Panora. Because of this, the Class C water quality standard applies to the Raccoon River at these two locations. The maximum contaminant level (MCL) set by the US Environmental Protection Agency (USEPA) is 10 mg/L. Between 1996 and 2005, nitrate concentrations at the Des Moines Water Works (DMWW) exceeded this value 24.0% of the time. Higher concentrations were observed during April, May and June as well as November and December. Nitrate concentrations were highest during higher flows, with an average concentration of 10.0 mg/L when flow rates were in the upper 25% (TMDL, p 12).

E. coli is used as the indicator bacterium for Class A waters (waters with a recreational use where human contact is likely to occur). Sampling data suggests that all Class A1 waters in the Raccoon River watershed could be considered as "not supporting" their designated uses. Therefore, the conclusion of the Raccoon River TMDL report was to assign a maximum contaminate level (MCL) to all of these streams within the watershed which had not been previously classified (TMDL, p 14).

Highest concentrations were observed during May, June and July, although concentrations above 10,000 CFU/100 mL were observed at DMWW in all months except February and December. Highest concentrations were observed when flows were highest, with the median concentration being 665 CFU/100mL in the upper 25% range (TMDL, p 14). Non-point sources were expected to contribute up to 99% of the total loading, on days when observed concentrations were higher than the established standards (TMDL, p 15).

The TMDL report projects that reductions of nitrate loading of 48% would be required to meet established maximum concentration levels for all storm events. Loading of E.coli is projected to require more than 95% reduction to meet the water quality standard for all ranges of flow, with more than 99% reductions required when flows are in the upper 70% of observed levels.

Five load reduction strategies were analyzed by computer modeling as part of the TMDL report:

1. Reducing the rate of ammonia fertilizer application in the watershed from 170 kg/ha to levels of 150 kg/ha, 100 kg/ha and 50 kg/ha. (1 kg = 2.20 lbs) (1 ha = 2.47 acres)
2. Remove all cattle from the streams.
3. Remove all human waste from the watershed.
4. Convert all row crop lands located on slopes greater than C slopes to CRP grassland.
5. Convert all row crop lands located on floodplain alluvial soils to CRP.

Several other strategies were also listed to address nitrate and bacteria pollution:

- Strategically sited wetlands near tile outlets.
- Implement urban stormwater best management practices (BMPs).
- Changing fall applications of fertilizer to spring.
- Changing fertilizer application method.
- Use nitrification inhibitors.
- Improved manure management.
- Adopt comprehensive farm nutrient management plans using NRCS Conservation Practice Standard 590.
- Adopt conservation tillage.
- Contour planting and terracing.
- Use cover crops.

For a more detailed summary about the TMDL report for the Raccoon River, refer to the technical memo on this topic included in the appendix of this management plan.

Raccoon River Watershed Water Quality Master Plan - 2011

This plan was prepared by Agren, Inc., funded by a grant from the Iowa Department of Natural Resources (DNR) to the Missouri and Mississippi Divide RC & D. The plan states that it "does not define specific outcome targets for water quality, nor does it prescribe a specific vision of what constitutes an environmentally and economically prosperous Raccoon River basin. Rather, [it] focuses on common needs that have been identified by, and are broadly supported by, multi-disciplinary experts and watershed stakeholders." (p 3-4)

The plan organized identified priorities into nine recommendations (p 5):

1. Develop a regional planning organization to guide implementation of the Raccoon River Watershed Water Quality Master Plan.
2. Conduct public education to improve awareness of water quality and instill a personal commitment to water quality improvement among all watershed residents.
3. Focus outreach and education efforts to farm operators and agricultural landowners on nutrient and drainage management strategies.
4. Aggressively pursue opportunities to facilitate private-sector conservation planning services.
5. Take full advantage of emerging technologies and LiDAR elevation data to identify areas of concern and target practices based on landscape characteristics at the field level.
6. Target implementation of agricultural best management practices to priority subwatersheds and priority impairments.
7. Enhance effectiveness of nutrient control and removal practices by encouraging a "stacked" approach to nutrient management such as reduce, trap, and treat.
8. Monitor water quality at the subwatershed scale to characterize existing conditions and evaluate effectiveness of watershed projects and conservation practices.
9. Continue to assess long-term water quality status and trends in the Raccoon River and enhance these efforts as resources allow.

The plan discussed the topic of subsurface tile drainage. "Although subsurface tile decreases runoff from the surface of a field, subsurface flow and leaching losses of nitrate are increased. This is due mostly to an increase in flow volume and the "short-circuiting" of subsurface flow, but also in part to the increased mineralization and formation of nitrate in the soil profile (Randall, Goss, and Fausey 2010). Subsurface tile drainage provides a direct channel from farm fields into adjacent surface water streams." (page 21)

Other findings listed were as follows:

- An organization is needed to carry out a strategic mission for the entire Raccoon River watershed, however to be effective, projects would need to target smaller geographic areas (p 25).
- The Iowa Stormwater Management Manual was identified as an under-used resource for educating communities on the issue of stormwater management and low-impact development (p 31).
- Recent surveys identified a lack of awareness among agricultural landowners regarding the impact of row crop production in tile drained landscapes (p 33).
- Proper messaging regarding the priority problem and the need for action needs to be developed. The absentee landowner needs to be successfully engaged (p 36).
- Creating an effective payment or incentive program to engage agronomists is important (p 41).
- A table of agricultural best management practices that were evaluated is included (p 50).
- The Walnut Creek watershed was listed as very low priority for nitrate reduction (p 55).
- The plan also listed the Walnut Creek watershed as very low priority for pathogen reduction (p 59). (This seems to be contradicted by available monitoring data which shows extremely high pathogen levels, especially in the urbanized area of the watershed).
- Phosphorus reduction was listed as a higher priority in areas outside the Walnut Creek watershed (p 64).
- Sediment reduction within the Walnut Creek watershed was listed as a medium priority (p 66).

A nutrient reduction strategy is described on page 73 of the Raccoon River plan, stating "adequate control of nutrients will require a combination of best management practices that 1) reduce the source of nutrients; 2) trap nutrients before they enter water sources; and 3) treat tile drainage water or surface runoff to reduce nutrients." A table of nutrient BMPs categorized by source reduction, trapping and treatment is included on that same page.

Iowa Nutrient Reduction Strategy – Updated 2014

The subtitle of this report is "a science and technology based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico." It was prepared by the Iowa Department of Agriculture and Land Stewardship (IDALS) along with the IDNR and Iowa State University's College of Agriculture and Life Sciences.

It was developed following the creation of the 2008 Gulf Hypoxia Action Plan that calls for states to create strategies to reduce pollutant loadings to the Gulf of Mexico. The Action Plan set a goal of at least 45% reduction in total nitrogen and total phosphorus loads. The Iowa Nutrient Reduction Strategy outlines steps to prioritize watersheds and resources, improve current state programs and increase voluntary efforts to reduce nutrient loadings (Executive Summary).

The Nutrient Strategy assigns pollutant loadings to both point and non-point sources. It assumes that a 4% reduction in nitrogen and 16% reduction in phosphorus can be accomplished by point source reductions. The remaining 41% of nitrogen and 29% of phosphorus reductions are identified as being accomplished through non-point source reductions (page 3).

The Strategy expects that N losses are a greater concern in tile drained landscapes. The largest losses are expected to occur with sustained flows occurring in the spring and a time with little evapotranspiration and nutrient uptake. In steeper, hilly areas, phosphorus losses can be greater. Surface runoff and transported sediment are common carriers of phosphorus. The largest losses can occur after rainfall events (page 9). Streambank erosion is also identified as potentially significant source of phosphorus loading (page 10).

The Strategy includes the Iowa Nonpoint Source Nutrient Reduction Science Assessment. This is based on peer-reviewed studies of in-field, edge-of-field and watershed scale practices and treatments to determine potential reductions in total nitrogen and phosphorus.

The framework for the Nutrient Reduction Strategy includes several major points (pages 18-26). Key items relatable to the Walnut Creek watershed are underlined.

1. Prioritization of Watersheds. In 2013, the Water Resources Coordinating Council (WRCC) selected nine priority watersheds to focus targeted conservation and water quality efforts. The North Raccoon River was listed as one of these nine priority watersheds.
2. Determine Watershed Goals. The WRCC is tasked with coordination of indicators to provide stakeholders with information to establish baselines and report progress.
3. Ensure Effectiveness of Point Source Permits. The goal is to have major Publicly Owned Treatment Works (POTWs) install improvements to reduce nutrient outflow. Permitted animal feeding operations will continue to be monitored. Iowa point sources, IDNR, IDALS and WRCC will work to develop a nutrient trading credit program, based on 2003 EPA guidance.
4. Agricultural Areas. Setting priorities includes a focus on conservation, in- and off-field practices, pilot projects and implementation of nutrient trading. Research and Technology will continue to identify new technologies and solutions, develop private and public support for more research and continue to gain a better understanding of the Gulf Hypoxia Zone. An approach to improved outreach, education and collaboration is outlined. Programs for farmer recognition and a statewide education and marketing campaign is identified as a need. Sources of potential funding are briefly described.
5. Storm Water, Septic Systems, Minor POTWs and Source Water Protection. No specific nutrient reductions are identified for urban stormwater runoff. However, a focus is given to infiltration of the water quality volume (runoff from a 1.25" rainfall event). By managing this volume, reductions of 80-85% of annual runoff volumes could be achieved. Septic systems are proposed to be addressed through time of sale inspections to identify and correct leaky systems. The Iowa Source Water Protection Program educates the public and

local officials on the importance of protecting groundwater drinking water resources. A link to potential funding sources is provided.

6. Accountability and Verification Measures. A technical work group will define the process for providing a regular nutrient load estimate. The IDNR will track progress of implementing the reduction strategy for permitted point sources. A system for tracking non-point sources and improvements is outlined.
7. Public Reporting. WRCC will develop public annual reports. Watershed management plans are expected to include strategies to assess and demonstrate progress in achieving load reductions.
8. Nutrient Criteria Development. IDNR continues to review and assess water quality, with development of a suitable nutrient criteria as a long-term goal.

Section 2 of the Nutrient Reduction Strategy contains the science assessment. Some key findings of note, as related to the development of a plan for the Walnut Creek watershed:

- Key practices for nitrogen removal:
  - Nitrogen management practices, cover crops and living mulches.
  - Land use changes to energy crops, perennial vegetation or extended rotations.
  - Wetlands, buffers and bioreactors are edge-of-field practices with greatest potential for nitrogen reduction.
- Key practices for phosphorus removal:
  - Reducing tillage and cover crops can significantly reduce phosphorus loss.
  - Land use changes to energy crops, perennial vegetation or extended rotations.
  - Edge of field practices that settle sediment such as ponds and stream buffers.
- The Science Team will publish an updated practice list as an addendum to the Reduction Strategy,
- Table 2 (p 6) and Table 3 (pa 7) have details on expected load reductions for N and P for various practices and their expected impact on corn yield.

As part of the development of this plan, 239 miles of stream length have been assessed using desktop technologies. GIS maps have been created using information from aerial photographs, LiDAR topography and other sources of information. From this analysis, we can identify were the stream is changing vertically, moving horizontally and if a given reach has adequate buffers.

five

PLAN IN PROGRESS
January 8, 2015

Character of Streams

57%
of all field assessed streams had moderate to severe erosion

4-10x
how much wider streams are now than they were prior to pioneer settlement

239
miles of streams reviewed as part of the development of this plan

48%
of smaller streams (0 or 1st order) have no stream buffer or have a buffer that is less than 50 feet in total width

71%
of streams (1st order and above) are incised or deeply incised meaning they have downcut or become lower over time

What is a buffer? Buffers slow and filter runoff before it enters the stream.

Zero Order

First Order

Second Order

Third Order

Stream Order

Stream order is an important concept to understand in watershed planning. Streams of different sizes often have different challenges and opportunities for improvements. The IDNR has created maps of streams throughout the state. They group these streams into classes by stream order using the Strahler method. The headwaters of a given stream, where perennial flow is first observed are defined as first order steams. When two first order streams meet, they join to form a second order stream. When two second order streams meet, they join to form a third order stream. Two streams of the same order must meet in order to move up to the next order. For example, at the confluence of a first and second order stream, the downstream segment remains classified as a second order stream. The second order stream does not become a third order stream, until it meets another second order stream.

The Walnut Creek watershed includes first, second and third order streams. Most of the perennial streams in the watershed are of the first order. Lower sections of the Little Walnut, South Walnut and North Walnut Creek are second order streams. Walnut Creek is a third order stream downstream of its confluence with Little Walnut Creek.

Throughout the watershed, there are many swales, ditches, depressions and small streams that drain significant areas, yet are not classified as first order streams. These drainage paths are clearly visible on LiDAR topographic imaging available through the State of Iowa. To better understand the properties of key flow paths throughout the watershed, many of these features have been mapped as "zero order" streams. As part of this effort, they were studied in similar detail to the more defined stream segments within the watershed.

Sources: State University of New York; http://www.fgmorph.com/fg_4_8.php

USGS website; http://usgs-mrs.cr.usgs.gov/NHDHelp/WebHelp/NHD_Help/Introduction_to_the_NHD/Feature_Attribution/Stream_Order.htm

Stream Order	Length Within Watershed (miles)	Proportion of All Streams
0	143	60%
1	58	24%
2	21	9%
3	17	7%

Stream Order

Vertical Stream Character

These basic categories were used to describe the general types of stream cross-sections that have been observed during field assessments and desktop GIS information review. They are used to evaluate the relationship of a stream to the surrounding areas and the severity of past erosion.

Vertical Stream Character by Stream Order								
Stream Order	P	U	D	I	DI	R	G	V
0	3%	11%	55%	9%	8%	10%	2%	2%
1	8%	2%	28%	11%	45%	6%	0%	0%
2	4%	0%	2%	14%	73%	2%	5%	0%
3	0%	0%	0%	0%	100%	0%	0%	0%

Undefined

Defined

Pond

Incised

Deeply Incised

Ravine

Gorge

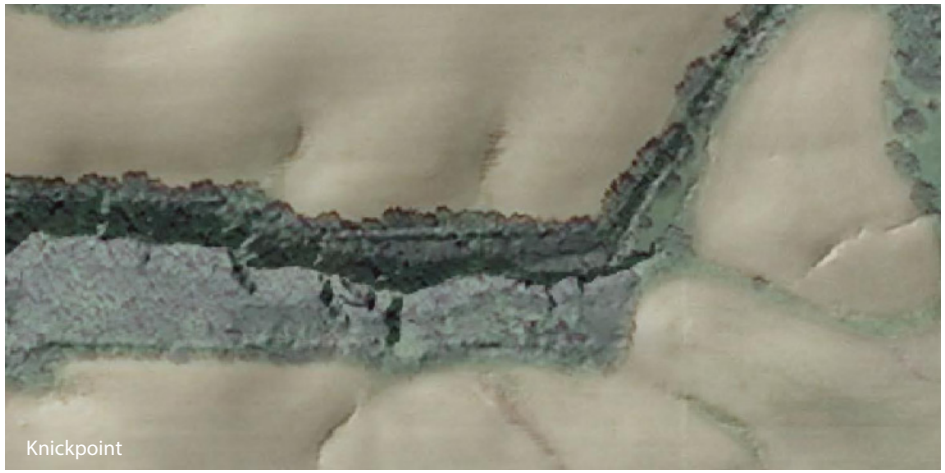
Vertical Stream Characteristics		
Buffer Type		**Description**
P	**Pond**	Wet ponds, usually located on zero to second order streams and usually created by an artificial dam.
U	**Undefined**	These are parts of zero and first order streams in agricultural lands in the flat, upper areas of the watershed. Paths of concentrated flow are difficult to discern from topographic information. Sometimes these paths can be determined by wet areas observed in aerial photographs. There is little or no daily flow observed between rainfall events.
D	**Defined**	Sections of zero to second order streams where the flow path can be seen using LiDAR topographic maps. Road ditches, swales and more concentrated flow paths in farm fields fall into this category.
I	**Incised**	Erosion is visible on some portions of zero to second order streams where the stream is beginning to downcut into the soil. This "incision" usually begins on streams with moderate to higher slopes with a narrow cut of one to five feet in width and one to two feet in depth. In this condition, normal stream flow is beginning to be separated from the rest of the natural flood plain.
DI	**Deeply Incised**	Where downcutting has progressed past a small incision, erosion can range from three to fifteen feet (or more) in depth, at widths from 5 to more than 50 feet. The cross-section of the stream is actively deepening and/or widening to convey additional flow. Most of the higher order stream segments within the watershed fall into this category. At this stage, normal stream flow is disconnected from the surrounding flood plain.
R	**Ravine**	Ravines (or gullies) were considered to be smaller order stream segments, usually with steeper slopes. Active downcutting is often visible in these segments. The rate of erosion is moderate, with the stream channel cross-section forming a "V" shape with a narrow bottom and steep sides. The top of the ravine is usually 20 to 100 feet wide.
G	**Gorge**	Similar to a ravine, but with more rapid erosion. The channel cross-section has a wider bottom, forming a shape more similar to a "U". Depths of erosion can exceed 20 feet and the top of the gorge can be 40 to 60 feet in width.
V	**Valley**	Similar to a ravine, but with more gentle side slopes and with minimal active erosion. Flow passes through a narrow point. The top of the valley is most often more than 100 feet wide.

Horizontal Stream Character

These basic categories were used to describe the general types of stream alignments that have been observed during field assessments and desktop GIS information review. They are used to evaluate the relationship of a stream to the surrounding areas and the severity of past erosion.

Meandering

Oxbow


Knickpoint

Straightened

Straightened Aerial

Tiled

Horizontal Stream Characteristics		
Buffer Type		**Description**
B	**Braided**	This is where the stream is divided into multiple paths, separated by islands or where multiple points of erosion have occurred.
M	**Meandering**	The stream weaves back and forth through a series of tight curves.
O	**Oxbow**	These are remnants of past channel locations. As the stream moves and meanders, low spots are left in the landscape where the stream channel used to be. They are often filled with sediment during large flood events, becoming much more subtle features over time. Since these are no longer the primary path of flow of the stream, they were catalogued as "zero order" streams, even though they usually were found near higher order streams.
K	**Knickpoint**	These are segments where a sudden drop or waterfall occurs. Below the drop, the stream is actively incising (downcutting). These knickpoints tend to work their way upstream over time, as erosion grows more significant. The downstream channel is left wider and flatter than before, able to convey larger flows at lower velocities than the stream above. These are usually located on smaller order streams. Often, the downstream alignment follows a straightened path. The knickpoint is usually at a defined point, but for the purpose of this analysis, longer segments were defined as this feature type when the knickpoint existed within them.
S	**Straightened**	Almost all segments have been altered, straightened or restricted from movement in the past. For this analysis, the stream was defined as straightened if it was a stream with constant flow where the alignment and general character of the original drainage ditch construction was clearly evident.
N/A	**No Definition**	The location and character of most of these segments have been significantly altered by human activity, but they don't clearly fall within any of the definitions above.

Horizontal Stream Character by Stream Order						
Stream Order	**B**	**M**	**O**	**K**	**S**	**N/A**
0	<0.1%	3%	3%	6%	7%	81%
1	0%	30%	0%	1%	28%	42%
2	0%	61%	0%	0%	30%	9%
3	0%	70%	0%	0%	25%	5%

Horizontal Stream Characteristics

Vertical Stream Characteristics

Stream Evolution

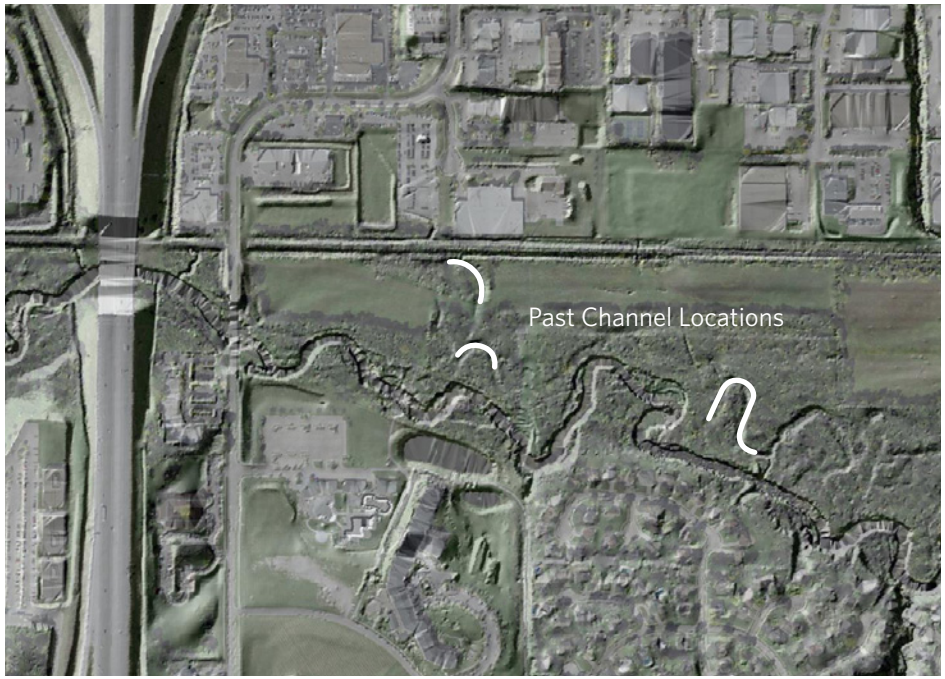
The study of stream evolution is called fluvial geomorphology. One method of stream path change involves sediment settling out of flow in areas where velocity is reduced (i.e. inside curve of stream bends, downstream of obstructions like downed trees or debris piles). As sediment collects, it piles up and can change the normal path of flow, often forcing it toward the outer banks of the stream. As this happens, stream velocity increases along the edges of the stream, leading to more streambank erosion. The sediment lost from the streambank is carried downstream by flows to points where velocities drop to a point where it can settle out. This is a cycle of erosion and deposition which repeats over time. The stream meanders, and flow paths form and disappear. In some areas along Walnut Creek, there is evidence of past meanders that are more than 500 feet from the current stream.

Changes in land use can magnify this effect to levels not seen within the native landscape. Increases in the rate and volume of runoff result in faster and deeper streamflows. These effects increase the erosive force on the bed and banks of the stream. This shear force cuts against stream banks, widening the stream. The bed of the stream begins to be incised, or downcut.

Sources of increased sediment loads, such as cropland, gullies and construction sites with insufficient controls can accelerate the cycle of stream evolution. Over a long period of time, a wider and flatter stream is created, capable of conveying higher flow volumes. The new channel is often several feet lower than the natural stream bed. This results in a stream that is disconnected from the flood plain above.

Caption Area

Caption Area



Streambank Stability Analyses

Two separate stability studies were reviewed as part of development of this plan. The first was completed within the scope of this planning process by staff from the Polk County Soil and Water Conservation District. Their efforts completed a RASCAL (Rapid Assessment of Stream Conditions Along Length) assessment of more than 28 miles of streams, primarily in the rural areas of this watershed. This assessment was completed in the field during the summer months of 2015, walking along each segment using a GPS data collector equipped with the RASCAL software to gather information about a variety of characteristics of the stream.

The second was the 2014 Clive Stream Assessment Report Update. This study reviewed the stability conditions of streambanks of more than 13 miles of streams within the City of Clive. Most of these assessments were completed within the publicly owned Clive Greenbelt. This report was an update to assessments completed in 2009, which was conducted using the RASCAL protocol.

Collectively, these two studies evaluated streambank stability for nearly 42 stream miles within this watershed. This represents a current evaluation of 44% of the total length of first through third order streams in this area. Other studies have also been completed in the past by other cities, which were reviewed as part of development of this plan. In some cases, specific GIS data from these other studies was not available for analysis. In other cases, the data provided was from before 2014, so it was not considered a current evaluation of stream conditions and was not included in the statistical analysis for this plan.

	2015 RASCAL Survey		2014 Clive Assessment		Combined	
Bank Stability	**miles**		**miles**		**miles**	
Stable	5.89	20.8%	0.10	0.7%	5.99	14.4%
Minor Erosion	7.72	27.3%	4.24	31.6%	11.97	28.7%
Moderate Erosion	7.41	26.2%	5.83	43.4%	13.24	31.7%
Severe Erosion	7.26	25.7%	3.26	24.3%	10.52	25.2%
Total	28.29		13.43		41.72	

These assessments generally grouped streambank conditions into four categories:

- Stable – Banks were protected by natural vegetation and were not showing signs of lateral erosion.
- Minor erosion (or moderately stable) – Banks were mostly protected by natural vegetation, but the banks were showing signs of minor erosion.
- Moderate erosion (or moderately unstable) – Natural vegetation was not protecting major portions of the stream. Outer banks were often showing signs of erosion. Often there were some signs of trees and/or other vegetation falling into the stream within these segments.
- Severe erosion (or unstable) – Some straight reaches and inside bends were actively eroding, as well as the outer bends. Trees and vegetation were frequently falling into the stream. Little or no natural vegetation was protecting the banks of the stream.

Definitions above were adapted from IDNR RASCAL protocol instructions.

What is notable from these studies is that streambanks appear to be more unstable in urban areas. Less than 1% of streams in urban areas were categorized as "stable", while nearly 21% were seen in this condition in the rural assessments. Moderate erosion is also much more noticeable in urban areas than in rural areas.

To calculate sediment loads generated by streambank erosion, erosion rates were established for each of these four conditions. To account for loadings where streams were not assessed, the ratios above were applied to all streams which were noted as having a vertical condition as "incised" or "deeply incised", as described earlier within this plan. Ratios from the 2015 RASCAL survey were applied to non-assessed streams in rural areas. Ratios from the 2014 Clive Assessment were applied those streams in urban areas. Using these assumptions, it is estimated that 11,300 tons of sediment loading per year may be caused by streambank erosion. Primary sources of this erosion are the 88.7 miles of stream segments that were categorized as "incised" or "deeply incised". The methods of water quality modeling that generated these estimates are explained in greater detail in Chapter 6 and in the Appendices of this plan.

Rascal Streambank Stability

Stream Width

Streams throughout the watershed have changed significantly since pioneer settlement. The early surveyors measured the width of streams as they surveyed each section line (or the edge of each square mile of land). They would measure the width of streams by the numbers of links on their surveyor chains. Each chain had 100 links and the chain was 66 feet long. So each link in the chain was eight inches in length. By reviewing the original survey maps of this area, we can determine the width of the stream in their time (mid 1800s) and compare it today's conditions.

Two conclusions can be reached:

1. Fewer streams existed prior to settlement. The surveyors recorded streams as small as one foot in width. Many of the "zero" and some of the first order streams that exist today were not drawn on their survey maps and no measurement for stream width was recorded. As agricultural and urban uses have increased the portion of precipitation that is converted to surface runoff, new streams have been created.
2. The streams that did exist prior to settlement were much narrower than those we see today. The table below notes changes in stream width between what was recorded by the original surveyors and what can be measured from the LiDAR survey of the state that was completed in 2007-2008.

ID #	Location	Microwatershed	Stream Width		Change	% Change
			Presettlement	Recent (LiDAR)		
0	Tributary to Little Walnut at Douglas Avenue	611.01	3	35	32	1067%
1	Tributary to Little Walnut at 156th Street	611.01	3	20	17	567%
2	Living History Creek at Projection of 114th Street	212.01	4	20	16	400%
3	Living History Creek at Douglas Avenue	212.01	4	40	36	900%
4	North Walnut Creek at 100th Street (Just North of I-35/80)	503.02	3	45	42	1400%
5	Tributary to North Walnut at Projection of 100th (S of Brookview)	503.22	1	30	29	2900%
6	Small Tributary to N. Walnut at Projection of 100th (N of Oakwood)	503.23	1	20	19	1900%
7	North Walnut Creek at Meredith Drive	503.01	3	45	42	1400%
8	North Walnut Creek at Douglas Avenue	502.02	4	55	51	1275%
9	North Walnut Creek at 86th Street	502.02	4	45	41	1025%
10	Rocklyn Creek at Hickman Avenue	511.01	4	40	36	900%
11	Rocklyn Creek at Douglas Avenue	511.03	1	40	39	3900%
12	Walnut Creek at Projection of 55th Street (DSM)	101.02	12	80	68	567%
13	Walnut Creek at 86th Street	201.01	10	65	55	550%
14	Walnut Creek at 100th Street	201.01	8	65	57	713%
15	Walnut Creek at 114th Street	202.01	10	45	35	350%
16	Walnut Creek at Old Alignment of 128th Street	202.02	10	60	50	500%
17	Walnut Creek at Hickman Road	203.01	10	70	60	600%
18	Walnut Creek at Douglas Avenue	203.03	8	60	52	650%
19	Little Walnut Creek at 156th Street	601.02	7	35	28	400%
20	Small Tributary to Little Walnut Creek at Meredith Dr.	601.31	4	6	2	50%
21	Little Walnut Creek at Warrior Lane	601.03	4	30	26	650%
22	Little Walnut Creek at U Avenue	602.01	3	30	27	900%
23	Tributary to Little Walnut at U Avenue	613.01	4	6	2	50%
24	Tributary to Walnut Creek at Projection of 260th (East)	701.01	7	30	23	329%
25	Tributary to Walnut Creek at V Avenue	701.01	4	40	36	900%
26	Tributary to Walnut Creek at Projection of 260th (West)	701.01	3	40	37	1233%
27	Walnut Creek at 250th Street	401.01	7	40	33	471%
28	Tributary to Walnut Creek at W Avenue	411.01	2	35	33	1650%
29	Walnut Creek at 260th Street	301.02	7	45	38	543%
30	Tributary to Walnut Creek at W Avenue	701.01	7	45	38	543%

Stream Width

Stream Buffers

Variety of Buffer Types

Stream conditions throughout the watershed were observed and were grouped into seven general buffer descriptions. The length of each type of buffer for each stream order for the entire watershed was calculated.

These buffers were grouped into the following categories:

Several observations can be made from this analysis.

- Nearly 50% of all "zero order" streams pass through agricultural and urban landscapes without any significant buffer.
- Grass buffers were most common on smaller first order streams.
- Buffers along larger streams are more likely to include overstory trees, either from historically forested areas or locations where grass buffers have been allowed to evolve into a young forest.

Current Stream Buffer Widths

Existing buffers can generally be grouped into grass and tree buffers. Knowing the width of these buffers is important in understanding how effective each buffer will be in filtering runoff and providing important habitat. Buffer width for this study is defined as the total width measured across both sides of the stream.

Developing Overstory Aerial

Where they exist, grass buffers are often wider than 50 feet. However, 33% of "zero order" streams are less than this width. Combining these lengths with those sections that were observed to have no buffer, means that 57% of all "zero order" streams in the watershed have either no buffer or grass buffers which are less than 50 feet in width. Grass buffers can be very effective in smaller order streams in capturing sediments, reducing pollutant loads and slowing runoff velocities. Their notable absence in large portions of the watershed is a concern.

Most treed buffers exceed 100 feet in width. These buffers tend to get wider along larger streams. Many of these higher order streams pass through urban areas. Their larger drainage areas lead to wider floodplains, limiting other development opportunities. Over time, many of these open spaces have developed into wider buffers of overstory trees.

Stream Buffer Maintenance

Develop text for this section.

Grass Swale

Range

Overstory Aerial

Tilled

Partial Over Aerial

Urban

Generic Buffer Descriptions			
	Buffer Type		Description
No Buffer	T	Tilled	Water flows directly through row crop agricultural lands without any type of buffer.
	R	Range	Streams pass through pastures used to support livestock operations, where they have direct access to the stream and no fencing or other buffer is present.
	U	Urban	Streams pass adjacent to residential, commercial or other urban land uses without a discernable buffer between the land use and the stream. Manicured lawns, paved surfaces or even structures are located directly adjacent to the top of bank of the steam.
	G	Grass	A buffer of tall grasses or native vegetation (primarily without trees or shrubs) or located along the stream.
Trees	D	Developing Overstory	Overstory trees are starting to establish within what was previously a grass buffer.
	P	Partial Overstory	The canopy cover of trees within the buffer is generally between 40 and 70%.
	O	Overstory	The buffer along the stream is more than 70% covered by a tree canopy.

Generic Buffer Types by Stream Order							
Stream Order	T	R	U	G	D	P	O
0	42%	2%	5%	17%	4%	4%	26%
1	6%	1%	15%	35%	2%	7%	33%
2	0%	8%	6%	12%	5%	11%	58%
3	0%	0%	0%	4%	15%	26%	55%

Grass Buffers					
	Buffer Width (feet)				
Stream Order	< 10	11-49	50-99	100-199	> 200
0	7%	26%	48%	15%	4%
1	0%	14%	16%	43%	27%
2	0%	0%	32%	12%	56%
3	0%	0%	0%	31%	69%

Treed Buffers					
	Buffer Width (feet)				
Stream Order	< 10	11-49	50-99	100-199	> 200
0	0%	3%	20%	44%	33%
1	0%	1%	22%	36%	41%
2	0%	0%	12%	14%	74%
3	0%	0%	0%	15%	85%

Stream Buffer Types

Stream Buffer Widths

Available monitoring data within the Walnut Creek watershed was reviewed to aid in the identification of pollutants of concern, potential sources of pollution and to help inform and calibrate watershed water quality models. Several sources of information were reviewed.

SIX

PLAN IN PROGRESS
January 8, 2015

Key Pollutants and Sources

Water Quality Monitoring Samples

- Collected by Iowa Soybean Association/Clean Water Alliance and IOWATER volunteers
- Collected at two sites along Walnut Creek, every other week, throughout spring and summer
- IOWATER completed sampling at over 30 locations within the watershed, but more infrequently

Pollutant Sources By Land Use				
	N	**P**	**BOD**	**Sediment**
Urban	13.61%	26.14%	51.51%	6.89%
Cropland	80.59%	49.12%	33.76%	10.24%
Pastureland	1.91%	2.02%	5.09%	0.29%
Forest	0.14%	0.66%	0.25%	0.44%
Grasslands	0.04%	0.16%	0.06%	0.03%
Gully	0.81%	4.79%	2.05%	18.97%
Streambank	1.63%	9.58%	4.10%	37.95%
Construction Site	1.27%	7.53%	3.20%	25.19%

Key Pollutants of Concern

- Nitrogen
- Phosphorus
- Sediment
- Pathogens (bacteria and viruses)
- Runoff rates and volumes

8 loading reduction goals are outlined within this chapter.

Nitrates

Highest measured concentration

22.9 mg/L

More than twice the Raccoon River Total Maximum Daily Load (TMDL) standard of 9.5 mg/L.

Agricultural Areas

Nitrogen and phosphorus compounds have been measured higher levels.

Urban Areas

Levels of bacteria have been at higher concentrations.

77,010 MPN/ 100mL

was observed to be the maximum level of E.coli (indicator bacteria), which is more than 330 times the state's allowable average concentration of 235 MPN/100mL.

Overview of Available Monitoring Data

Iowa Soybean Association / Clean Water Alliance (ISA/CWA)

The Iowa Soybean Association in collaboration with Agriculture's Clean Water Alliance and the Des Moines Water Works has collected data at four separate locations along the main stem of Walnut Creek. Regular sampling at these sites offers the ability to evaluate conditions during a variety of flow conditions through most of the year. The limitations of this data are the small number of sites (no more than two for each year) and a lack of data during the winter, early spring and fall months of the year.

Site 40 – Located near Valley Drive Bridge over Walnut Creek (Des Moines)

Data collection at this site began in April 1999 with weekly sampling through mid-November of that year. Beginning in 2000, sampling was usually conducted every other week from April through August. Data through 2014 was reviewed with the development of this plan.

This location is located less than one mile downstream of an USGS gaging station. Walnut Creek has received runoff from over 98% of its watershed at this location. The combination of these two factors makes this location valuable in estimating overall watershed loading and watershed scale model calibration.

Note: Water Quality data provided by the Iowa Soybean Association, the Agriculture's Clean Water Alliance and the Des Moines Water Works, supported by various grants and contracts assisting watershed management implementation in Iowa. For more information contact Roger Wolf, Director of Environmental Programs; Executive Director, Agriculture's Clean Water Alliance; Iowa Soybean Association; 1255 SW Prairie Trail Parkway; Ankeny, Iowa 50023; Tel: 515-251-8640 Fax: 515-251-8657

Information about eleven parameters was collected at this location. Not all parameters were measured during each sampling.

- Chloride
- Discharge
- Ecoli
- pH
- Fluoride
- Nitrate as N
- Nitrite as N
- Turbidity
- Orthophosphate as P
- Sulfate
- Total Coliform

Site 70.0 – Located near 156th Street Bridge over Walnut Creek (Urbandale)

Data collection at this site began in April 2005 with sampling occurring every other week. Sampling ended each year in late July, August or early September. Data through 2014 was reviewed with the development of this plan.

This location, in concert with sites 70.1 and 70.2 provide valuable information about water quality as the stream leaves the agricultural landscape in rural Dallas County and enters the developing urban area.

Information about ten parameters was collected at this location. Not all parameters were measured during each sampling.

- Chloride
- Nitrate as N
- Nitrite as N
- Turbidity
- Fluoride
- Sulfate
- Total Coliform
- Orthophosphate as P
- Ecoli
- pH

Site 70.1 – Located near Douglas Parkway Bridge over Walnut Creek (Urbandale)

Data collection at this site began in April 2002 with sampling occurring every other week through August of 2003. Both years, sampling ended in late August.

Information about nine parameters was collected at this location. Not all parameters were measured during each sampling.

- Chloride
- Nitrate as N
- Total Phosporus
- Fluoride
- Sulfate
- Conductivity
- Orthophosphate as P
- Nitrite as N
- Turbidity

Site 70.2 – Located near Meredith Drive Bridge over Walnut Creek (Urbandale)

Data collection at this site began in April 2004 with sampling occurring every other week through August of that same year.

Information about four parameters was collected at this location. Not all parameters were measured during each sampling.

- Chloride
- Nitrite as N
- Nitrate as N
- Orthophosphate as P

Snapshot Monitoring Data

Water quality data was collected at 31 sites across the Walnut Creek watershed through the Polk County, Raccoon River Watershed and Walnut Creek snapshot monitoring events. These events were typically conducted twice each year (a spring and fall date each year) by volunteers using IDNR IOWATER field test kits. These kits contain test strips and other measurement methods of making a quick evaluation of water quality conditions in the field. During these events, some samples were also taken for laboratory testing. Data collected and reviewed as part of this study extends from June 2004 through October 2014.

Data gathered using field test kits included the following parameters:

- Chloride
- Dissolved Oxygen
- Nitrate as N
- Nitrite as N
- pH
- Phosphate
- Water Temperature
- Transparency
- Secchi Depth

Laboratory analysis included the following parameters:

- Bromide
- Chloride
- Chlorophyll
- E. Coli
- Fluoride
- Nitrate
- Nitrate + Nitrite
- Nitrite
- Nitrogen, Ammonia
- Nitrogen, Kjeldahl
- Orthophosphate
- Solids, Dissolved
- Solids, Total Suspended (TSS)
- Soilds, Total Volatile Susp. (TVSS)
- Specific Conductance
- Sulfate
- Total Coliform
- Turbidity

Data was not collected at every site during each snapshot event. When data was collected, not all of the parameters above were analyzed for each sample collected. Since sampling was conducted less frequently, this data is less effective at measuring the patterns of pollutant loading on a monthly or seasonal basis. It is also more difficult to evaluate the effects of different flow conditions on these pollutant levels. However, where this data is most beneficial, is that it has been collected over a broader area than that collected by the Iowa Soybean Association, with a greater number of pollutants measured. More data was also collected in the later months of the year than at the ISA sites. Using this information with that collected by ISA/CWA, allows a broader evaluation into the possible sources of certain types of pollution. This provides opportunities to validate outcomes from water quality modeling at a subwatershed level.

USGS Water Quality Data

Water quality data was collected at USGS gaging station 05484800 located near the 1st Street / 63rd Street Bridge over Walnut Creek on the border between Des Moines and West Des Moines. Data was collected on roughly a monthly basis through between December 1971 and August 1975; October 1983 and January 2002.

Over these periods, data on the following parameters was collected:

- Discharge
- Gage Height
- Temperature, Water
- Suspended Sediment Discharge
- Suspended Sediment Conc.
- Specific Conductance
- pH
- Temperature, Air

Des Moines Water Works

Des Moines Water Works collects nearly continuous water quality information from their intake site on the Raccoon River. This site is located less than one mile downstream of the confluence of Walnut Creek with the Raccoon River. The continuous nature of the data available makes it a valuable resource to review. However at the point of measurement, streamflow from Walnut Creek has mixed with flow from the much larger Raccoon River watershed. Given the other data sources available, it can be difficult to separate out the influence of the Walnut Creek watershed from water samples collected at this location.

Pollutants of Concern

Key pollutants of concern within the Walnut Creek watershed have been defined by considering the following information gathered through development of this plan: Review of past studies, including the Water Quality Improvement Plan for the Raccoon River (TMDL), the Raccoon River Water Quality Master Plan and Iowa's Nutrient Reduction Strategy.

1. Review of past local and municipal watershed assessments and storm water infrastructure studies.
2. Collection of stakeholder input at WMA meetings, open houses and individual conversations.
3. An overview of the available water quality monitoring information collected from sites within the watershed.

Potential Impacts of the Identified Pollutants of Concern

This document identifies key sources of pollution and determines methods to reduce their impacts, both in this watershed and the downstream receiving waters. Reducing pollutant loads will require policy changes and implementation of practices requiring significant investment. To understand why such investments are necessary, it is important to realize the impact these pollutants have on health, the environment and local economic interests.

Source 1 - http://www2.epa.gov/nutrientpollution/problem

Nutrients (Nitrogen and Phosphorus)

Nutrients like nitrogen and phosphorus exist in both surface and ground water under natural conditions. Their presence supports the growth of algae and aquatic plants, providing food and habitat for fish and other aquatic life within streams and lakes. Excessive algal growth can occur when the levels of these nutrients are too high. Algal blooms can block sunlight below the surface, clog fish gills, reduce habitat quality and diminish habitat. The death and decay of algae can lead to diminished oxygen levels, known as hypoxia. Oxygen levels can fall to a range where fish and other wildlife may be sickened or killed. As of 2013, there were 166 of these hypoxic "dead zones" that had been identified in and around the United States. The largest of these areas was a 5,840 square mile area (approximately 10% of the size of the entire state of Iowa) in the Gulf of Mexico, largely attributed to nutrient polluted runoff received from the Mississippi River watershed.

Excessive algal growth can also increase growth of bacteria and other human pathogens. In some cases, toxic algae can form which can cause rashes, stomach/liver illness, respiratory and neurological effects in humans. Direct exposure to this algae affects fish and other wildlife, with the toxic impacts being carried up the food chain if they are consumed by other animals. If toxic algae enter into the water supply stream, they can be converted into dioxins through the use of chemical disinfectants in the water treatment process. Risks to human health from dioxins include cancers, reproductive and developmental issues.

Pollutant of Concern	Reasons
Nitrate (Nitrogen)	• The Raccoon River is listed as impaired by high nitrate levels, one of the reasons for development of the Raccoon River TMDL. • Nitrogen is one of the two key pollutants of concern listed within Iowa's Nutrient Reduction Strategy. • Levels of nitrate have routinely been observed at monitoring sites within the watershed above the State's water quality standard for the streams intended uses and above those levels established within the Raccoon River TMDL.
Phosphorus	• Phosphorus is one of the two key pollutants of concern listed within Iowa's Nutrient Reduction Strategy. • Levels of phosphorus have occasionally been observed at monitoring sites within the watershed above the State's water quality standard for the streams intended uses and above those levels established within the Raccoon River TMDL.
Sediment	• Improper construction site erosion control has been observed to be a significant source of sediment loading in certain locations. • Significant sediment deposition has been observed within channel areas of Walnut Creek and its tributaries. • Sediment loading has impacted the water quality and storage capacity of many ponds and lakes throughout the watershed, including Country Club Lake and Southfork Pond. • Depositing sediment has deflected and narrowed low flow paths, accelerating the horizontal movement of streams. This is leading to more significant streambank erosion, leading to higher sediment loads.
Pathogens	• The Raccoon River and lower Walnut Creek are listed as impaired by high bacteria levels, one of the reasons for development of the Raccoon River TMDL. • Levels of indicator bacteria at monitoring sites within the watershed have almost always been observed above the State's water quality standard for the streams intended uses and above those levels established within the Raccoon River TMDL. In many cases, these levels have been well above the established standards, indicating a potential risk to public health.
Stormwater Quantity (Runoff Volume)	• While not considered a pollutant directly, volumes and rates of stormwater runoff are observed to be well above those which would have been expected prior to agricultural and urban development. These changes to the hydrology of the watershed increase the risk of flooding, streambank erosion and act as a carrier for larger pollutant loads being delivered through and out of the watershed.

Possible Sources of Nutrient Pollution	
Wastewater Treatment Plant	Dallas Center's wastewater treatment facility is located within this watershed. Point sources such as these are permitted through the Iowa Department of Natural Resources and are required to provide treatment of wastewater to lower pollutant loads to acceptable levels.
Leaking Sanitary Sewer Systems	Untreated wastewater can exfiltrate, or leak out from gaps or cracks in sanitary sewer mains, structures and connection points. This most commonly occurs in older systems, if they are not regularly inspected or maintained. Communities often have a program of regular inspections to address this issue.
Septic Systems	System failures related to improper design, age or lack of maintenance can lead to overflows or leakage into shallow groundwater layers.
Confined Animal Feeding Operations	Considered point sources and require operation permits by the State. Usually include collection of wastewater in lagoons and application of manure in the surrounding area following a manure management plan.
Pastures	Loading can be higher where livestock has direct access to streams, or there is little buffer between the pastureland and the stream.
Fertilizer and Manure Applications	Pollutant loadings can be affected by application rates, season, timing of rainfall events and application close to streams where adequate buffers are absent.
Legume Fixation	Process where crops such as soybeans convert nitrogen in the atmosphere to nitrogen compounds. A portion of the amount converted often remains in the soil and can be transported into groundwater or tile drainage.
Tile Drainage	More efficiently drains shallow groundwater from agricultural fields. This groundwater often contains elevated levels of nutrients.
Lawn Fertilizer Applications	Nutrient content, irrigation, overspray onto paved surfaces or streams and rainfall events following application can influence the amount of nutrient loading from this source.
Pet and Yard Waste	Fecal matter from pets and decomposing yard waste such as lawn clippings, leaves and garden waste. These materials are sometimes not collected appropriately, or in some cases are dumped directly into the storm sewer system or streams.
Wildlife	Sources include fecal matter from ducks, geese, other birds, deer, raccoons, other rodents, feral cats and dogs.
Car wash detergents	Car wash detergents contain high levels of phosphates. Most commercial car washes have systems which collect polluted wash water, however washing of vehicles in parking lots and driveways could allow these detergents to be washed into the storm sewer system.
Atmospheric deposition	Nitrogen gas is the most common compound in our atmosphere. Deposition of nitrogen can be increased by elevated levels of air pollution, usually attributed to the burning of fossil fuels.

Nitrates are nitrogen based compounds that have been observed at elevated levels in stream flows within the Walnut Creek watershed. Des Moines Water Works main intake point for surface water from the Raccoon River is located just downstream of where Walnut Creek flows into that river. Nitrates have been known to cause illness and death of human infants when at high levels. For this reason, Water Works employs a state of the art nitrate removal system, which is used when elevated levels of are nitrate are detected in the source water. This system is expensive to operate and maintain, costing $7,000 per day to operate. From December 2014 to July of 2015, DMWW spent more than $1,500,000 to remove nitrate from the water. The cost of this operation is being transferred to residents and local businesses through annual water use rate increases.

Source 2 – "Pathogens in Urban Stormwater Systems", Urban Water Resources Research Council, August 2014

Pathogens

Pathogens are the most common cause for water quality impairment in the United States, with nearly 11,000 waterbodies listed as impaired for this cause on state lists in 2014. Pathogens are microscopic organisms which can cause disease in humans or animals. These include viruses, bacteria, protozoa and parasitic worms. The likely presence of pathogens is typically identified by measuring levels of fecal indicator bacteria (FIB) such as Escherichia coli (E. coli) or fecal coliform. Elevated levels of these indicator species demonstrate that conditions are favorable for pathogens at a level which could impact human health when exposures occur.

The primary concern is incidental human ingestion during recreational contact, resulting in illness. In addition, respiratory, skin, ear and eye infections are also possible. Those most at risk are the very young, those with compromised immune systems and those with no prior exposure to the pathogen. The level of exposure required to cause illness varies with each type of pathogen.

Pathogen	Symptoms
Viruses	Main symptoms from most common viruses may include diarrhea, vomiting, headache, fever and abdominal cramps.
Bacteria Salmonella	May cause diarrhea in humans.
Bacteria Campylobacter	Known to cause diarrhea, abdominal cramping, pain, fever nausea and vomiting.
Bacteria E. coli	Most strains are harmless. A few specific strains can result in hemorrhagic colitis. Approximately 10% of cases of this disease lead to hemolytic uremic syndrome, a leading cause of kidney failure in children.
Bacteria Others	Other water related bacterial diseases include pneumonia, kidney infections and skin / wound infections.
Protozoa Cryptosporidium	This is one of the most significant causes of waterborne illness today, able to persist in the environment for months at a time in some cases. The dose required to cause infection is small. The disease is usually self-limiting, however it can be chronic and life threatening for those with compromised immune systems.
Protozoa Giardia	The dose required to cause infection is small. The disease is usually self-limiting, however it can be chronic and debilitating for those with compromised immune systems.

Possible Sources of Pathogens	
Wastewater Treatment Plant	Dallas Center's wastewater treatment facility is located within this watershed. Point sources such as this, are permitted through the Iowa Department of Natural Resources and are required to provide treatment of wastewater to lower pollutant loads to acceptable levels.
Leaking Sanitary Sewer Systems	Untreated wastewater can exfiltrate, or leak out from gaps or cracks in sanitary sewer mains, structures and connection points. This most commonly occurs in older systems, if they are not regularly inspected or maintained. Communities often have a program of regular inspections to address this issue.
Septic Systems	System failures related to improper design, age or lack of maintenance can lead to overflows or leakage into shallow groundwater layers.
Confined Animal Feeding Operations	Considered point sources and require operation permits by the State. Usually include collection of wastewater in lagoons and application of manure in the surrounding area following a manure management plan.
Pastures	Loading can be higher where livestock has direct access to streams, or there is little buffer between the pastureland and the stream.
Manure Applications	Pollutant loadings can be affected by application rates, season, timing of rainfall events and application close to streams where adequate buffers are absent.
Pet and Yard Waste	Fecal matter from pets and decomposing yard waste such as lawn clippings, leaves and garden waste. These materials are sometimes not collected appropriately, or in some cases are dumped directly into the storm sewer system or streams.
Wildlife	Sources include fecal matter from ducks, geese, other birds, deer, raccoons, other rodents, feral cats and dogs.

Sediment

Sediment is naturally present and transported in streams. However, the excessive loadings observed within this watershed can have significant impacts on water quality and stream structure.

Hydrology is the study of how water moves through and over the landscape. Stormwater runoff caused by rain and snowmelt and groundwater movement are the main ways that pollutants are carried from the landscape to receiving waters. As volumes of surface and subsurface runoff increase, a larger load of nutrients, pathogens and sediments are likely to be driven to the stream. Understanding the activities that increase the rates and flows of runoff can help us identify potential sources of such increases to address.

Activities that reduce the soil's ability to soak up water (infiltration) or restrict its ability to move through the soil (percolation) lead to increases in stormwater runoff volume. Both infiltration and percolation are decreased when soils are compacted. In rural areas, compaction can occur when large equipment is driven over or through the soil during agricultural activities. Tilling, fertilizing, harvesting and tile installations are all activities which can compact soils. In urban areas, soil compaction primarily occurs by use of heavy equipment during grading and construction operations as part of land development. Installation of impervious surfaces such as roofs, driveways, parking lots and streets also increases runoff volume.

Source - "Handbook for Developing Watershed Plans to Restore and Protect Our Waters", US EPA, March 2008

Problem	Effect
Habitat Loss	• In stream structures such as pools and gravel beds which are important habitat for fish and other aquatic life can be lost when filled with sediment. • Sediment laden waters can keep fish from finding food and can interrupt spawning.
Deposition	• Sediment is more quickly deposited in lower velocity flow zones, such as inside bends of streams or near bridge columns. As sediment builds up in these areas, it can push more water outward in higher velocity zones toward banks of the stream, accelerating bank erosion and creating even higher sediment loads. • In some locations sediment deposition can reduce channel flood plain storage and clog stormwater infrastructure such as inlets, pipes and culverts. • Deposited sediment can fill wetlands, ponds and lakes; diminishing their storage depth, affecting habitat and impacting water quality within and downstream of these waterbodies.
Other Pollutants	• Sediment particles act as transport vehicles for certain pollutants, such as phosphorus and metals. • Sediments can provide refuge for pathogens from sunlight and predators, extending their lifespan and in some cases creating a medium for their reproduction.
Drinking Water	• Taste and odor problems can be developed in drinking water sources.

Possible Sources of Sediment	
Tilled Agricultural Landscapes	During periods of heavy rain, wind or during the spring freeze thaw cycle, soils can be eroded from the surface of the land and transported to streams.
Paved Surfaces	Untreated wastewater can exfiltrate, or leak out from gaps or cracks in sanitary sewer mains, structures and connection points. This most commonly occurs in older systems, if they are not regularly inspected or maintained. Communities often have a program of regular inspections to address this issue.
Construction Sites	Surfaces that are disturbed by construction can be significant sources of sediment loading, with erosion rates commonly ranging from 35-45 tons per exposed acre. Effectively installed and maintained erosion and sediment controls are necessary to prevent the movement of soil particles or to trap displaced sediment particles if erosion does occur.
Gully and Ravine Formation	Erosion rates can be dramatic within steep, narrow stream corridors. Rates of erosion can be most dramatic where the surface has little erosion resistant vegetation or where flow rates or volumes have been altered by land development activities.
Streambank Erosion	When stream channels widen, downcut or move the soil eroded from the bottom or the bank of the stream is directly input into the flow of the stream.
Wind Erosion	Wind erosion can remove soil from various landscapes and deposit it in other surfaces where it can be washed away during rainfall events .

Runoff Volume

Runoff volume is also increased when native plants, trees and other vegetation are removed. Plants use water in photosynthesis, changing air and water into sugars for growth. They also distribute water to their leaves and release it back into the atmosphere using a process called transpiration. Their root structures dig deep into the soil, helping to keep it loose and porous. They provide habitat for worms, insects and burrowing animals which also increase void spaces within the soil.

As landscapes are developed, many changes also effect the speed at which runoff is funneled to streams. This decreases the time of concentration, or the longest time it takes for runoff to reach the most downstream point from the extents of a given area. In agricultural areas, many ditches and tiles were constructed to drain wetlands and low lying areas. In some areas, the alignments of larger streams were straightened. Roads were installed with ditches and culverts. In urban areas, impervious areas collect runoff and quickly funnel it into gutters and storm sewers. The pipe network very quickly routes this runoff to the nearest pond or stream.

The combination of these effects results in a system which has been significantly altered from natural conditions. By modeling a case study of a developing area, the effects of these changes can be seen. Runoff volumes in both the agricultural watershed and suburban environments are likely to be several times higher than pre-settlement conditions. The proportion of increases are highest during the smaller, most frequently occurring storms. It should be noted that this comparison is based on suburban conditions (primarily single-family with some commercial growth, with a total of 40-45% impervious cover). More intense development scenarios would be expected to generate even higher runoff volumes.

Shortened time of concentrations magnify the effects of increased runoff volume. In rural areas, peak rates of flow may be nearly 20 times higher than pre-settlement levels during the most frequently occurring storms. In the suburban environment, peak rates for these events are expected to be 20-45 times more than the natural conditions. These drastic changes demonstrate storm events of less than three inches of rain can cause rapid rises in stream levels and flash flooding. These effects are likely most dramatic in smaller streams in urban developed areas. These quick bounces account for a significant amount of streambank erosion on an annual basis, leaving the streambanks weakened and vulnerable for more significant impacts from the more rarely occurring larger events.

Average Unit Peak Rates of Flow in Case Study Area (cfs per 100 acres drained)			
Storm Return Period	**Pre-settlement**	**Agriculture**	**Suburban Developed**
1-year	4	79	173
10-year	42	227	359
100-year	142	480	638

Increase in Peak Rates of Flow from Pre-settlement Levels			
Storm Return Period	**Pre-settlement**	**Agriculture**	**Suburban Developed**
1-year		1912%	4332%
10-year		442%	759%
100-year		238%	349%

Runoff Volume Generated in Inches				
Storm Return Period	**Rainfall**	**Runoff**		
		Pre-settlement	**Agriculture**	**Suburban Developed**
1-year	2.67	0.18	0.75	1.46
10-year	4.46	0.89	2.02	3.07
100-year	7.12	2.49	4.27	5.61

Conversion of Rainfall to Runoff				
Storm Return Period	**Rainfall**	**Pre-settlement**	**Agriculture**	**Suburban Developed**
1-year	2.67	6.6%	28.2%	54.7%
10-year	4.46	19.9%	45.4%	68.8%
100-year	7.12	35.0%	59.9%	78.7%

Increase in Runoff Volume from Pre-settlement Levels				
Storm Return Period	**Rainfall**	**Pre-settlement**	**Agriculture**	**Suburban Developed**
1-year	2.67		327%	727%
10-year	4.46		129%	247%
100-year	7.12		71%	125%

Review of Existing Monitoring Data for Key Pollutants

Now that we have identified the key pollutants of concern, it is important to review the available monitoring data for these pollutants in greater detail.

Data collected by the Iowa Soybean Association / Clean Water Alliance offers the highest number of samples, typically collected every other week. Site 40 is also located just downstream of a USGS gaging station, and is less than two miles from the weather station located at the Des Moines Airport. Collectively, this information offers opportunities to understand how pollutant concentrations vary with time, streamflow and climate patterns.

IOWATER data collection does not have as many samples at each site, but has more sites distributed throughout the watershed. This data can be used in determining where higher pollutant concentrations are most likely located.

Nitrate (Nitrogen)

Iowa Soybean Association / Clean Water Alliance Monitoring

A total of 168 samples were collected and analyzed for nitrate from the ISA/CWA site 40 between 1999and 2014. At sites 70.0, 70.1 and 70.2; a total of 131 samples were collected between 2002 and 2014. The overall average concentration for all samples at site 40 was 5.83 mg/L, with 26% of the samples being above the water quality criterion of 10.0 mg/L. The average concentration for samples collected at site 70 locations was 9.95 mg/L, or 78% higher than the average of those taken at site 40. At site 70, 49% of all samples exceeded the water quality criterion. This indicates that nitrate concentrations appear to be significantly higher in streams within the rural landscapes. (The site 70 locations were positioned in a primarily rural watershed, whereas site 40 received runoff from both urban and rural sources.) It appears that nitrate concentrations in urban runoff is lower, diluting nitrate concentrations as those flows enter the stream.

At both sites, concentrations were highest during the months of April through July,with peak levels occurring in May and June. This trend seems to follow the times after spring fertilization has occurred and when rainfall patterns are near their highest levels. It should be noted that concentration levels were noted to drop significantly in August, although average precipitation remains high during this month. Concentrations remained low from September to November, although very few samples were collected during each of these months (only 5 total samples were collected in the months of Sept-Oct-Nov at site 40, and only 2 samples during those months at site 70).

At site 40, nitrate concentrations appear to be lowest during low flows, noticeablyso when streamflows are in the lowest 20% of observed flow rates (above 80% exceedance probability). They appear highest when flows are in the highest 10 – 50% of observed flowrates. In extremely high flows (within the highest 10%) concentrations appear to drop off, likely due to dilution of pollutants within such high flows. However, with flowrates being so high for these events, the total loading is likely highest during these types of events. This distribution pattern indicates that nitrate loading is most likely from non-point sources, being moved off the landscape or out of tile flows primarily during and after measurable rainfall events. In contrast, if concentrations remained high at low flow, or had spikes that appeared outside of larger rainfall events, that would indicate that the source of the pollutant was from one or more point sources.

Snapshot Monitoring

IOWATER has collected data from 31 separate sampling sites in the Walnut Creek watershed. Nitrate was measured by 521 IOWATER kit samples and 233 laboratory samples from these sites. Laboratory samples were also collected for Nitrate + Nitrite, with 189 collected for that parameter (nitrite levels when measured alone were typically low, so nitrate + nitrate may still be a good measure to approximate and compare nitrate levels).

Since significant seasonal patterns were seen at the ISA/CWA sites, analysis of IOWATER samples has been divided into three periods: spring (April-June), summer (July-August) and fall (September-November). The sites with the highest average levels of nitrates are listed below.

Since there are fewer data points at each site, it is difficult to draw specific conclusions about each location. However, this data seems to follow the pattern of the ISA/CWA monitoring, indicating elevated levels of nitrate in the spring months, especially where runoff is being received from rural landscapes.

The IOWATER data does seem to lend some support to possibilities of spikes in nitrate concentrations in the fall. Some higher concentrations were noted on a few dates. In reviewing USGS streamflow data, it appears that these elevated values may coincide with above average flow rates. Regularly occurring late season monitoring would be needed to determine if elevated nitrate levels in the fall are a normal pattern or caused by more unique sets of circumstances.

IOWATER kits use test strips that read nitrate levels by changes in color. This means that readings are estimates of concentration within a given range around that number. Of the 521 samples taken, no reading above 20 mg/L was recorded. This measurement is intended to represent a range between 20 and 50 mg/L. The table above notes the different locations and dates where readings of 20 were recorded. Most of these dates coincide with elevated flow volumes measured at the USGS gaging station within the Walnut Creek watershed.

	Site 40	Site 70
Average Nitrate Concentration	5.83 mg/L	9.95 mg/L
Maximum Recorded Level	17.6 mg/L	22.9 mg/L
Date of Maximum Recorded Level	5/20/2004	5/16/2013

Average Nitrate Concentrations (Laboratory)

SPRING			SUMMER			FALL		
SITE	COUNT	AVG	SITE	COUNT	AVG	SITE	COUNT	AVG
	#	mg/L		#	mg/L		#	mg/L
LWC1A*	5	14.9	-	-	-	LWC1A*	4	5.6
WC1	3	13.1	-	-	-	WCTrib*	4	4.7
WCTrib*	6	11.3	-	-	-	WC1	5	4.5
WC8*	6	11.0	-	-	-	WC8*	4	3.9
WC3	3	10.7	-	-	-	WC5	5	3.3

* No Nitrate + Nitrite laboratory samples taken at this site during this season

Average Nitrate+Nitrite Concentration (Laboratory)

SPRING			SUMMER			FALL		
SITE	COUNT	AVG	SITE	COUNT	AVG	SITE	COUNT	AVG
	#	mg/L		#	mg/L		#	mg/L
LWC2*	2	17.5	NWC1*	2	2.9	LWC2	1	11.0
WCTrib2*	2	14.0	D11*	2	2.2	LWC1	1	7.1
LWC1*	2	13.5	POL2*	2	1.0	WCTrib2	1	6.3
WC1	6	13.1	WAVE*	2	0.5	WCTrib1	1	5.7
D11*	2	12.5	-	-	-	WC7	1	5.4

* No Nitrate laboratory samples taken at this site during this season
** Only eight total samples taken in summer months throughout the entire watershed

Average Nitrate Concentrations (IOWATER test kits)

SPRING			SUMMER			FALL		
SITE	COUNT	AVG	SITE	COUNT	AVG	SITE	COUNT	AVG
	#	mg/L		#	mg/L		#	mg/L
LWC1A	6	11.2	WC4	4	7.5	LWC1	3	5.3
D11	6	8.7	D11	4	7.3	WCTrib2	2	5.0
WCTrib	6	8.7	NWC6	6	4.8	LWC2	3	3.3
WC8	6	8.7	NWC2	2	3.5	WCTrib	5	2.4
WC1	13	8.4	WC3	2	3.5	WC7	3	2.3

Maximum Nitrate Concentrations (Laboratory)								
SPRING			SUMMER			FALL		
SITE	DATE	MAX	SITE	DATE	MAX	SITE	DATE	MAX
		mg/L			mg/L			mg/L
LWC1A*	5/8/13	31.8	-	-	-	LWC1	-	14.3
WC8*	5/8/13	21.0	-	-	-	WCTrib	-	9.8
WCTrib*	5/8/13	18.9	-	-	-	WC8	-	9.4
WC2	5/8/13	17.4	-	-	-	WC2	-	8.4
WC1	5/23/07	16.2	-	-	-	WC1	-	7.9
* No Nitrate + Nitrite laboratory samples taken at this site during this season								

Maximum Nitrate+Nitrite Concentration (Laboratory)								
SPRING			SUMMER			FALL		
SITE	DATE	MAX	SITE	DATE	MAX	SITE	DATE	MAX
		mg/L			mg/L			mg/L
LWC2*	4/28/07	20.0	NWC1*	7/21/07	3.9	LWC2*	9/22/07	11.0
WC1	6/2/04	18.0	D11*	7/21/07	2.3	WC1	10/16/07	8.4
NWC1	6/2/04	17.0	D11*	7/22/06	2.0	WC2	10/16/07	7.7
WC2	6/2/04	17.0	NWC1*	7/22/06	1.9	WC3	10/16/07	7.6
LWC1*	4/28/07	17.0	POL2*	7/21/07	1.8	WC4	10/16/07	7.5
* No Nitrate laboratory samples taken at this site during this season ** Only eight total samples taken in summer months throughout the entire watershed								

Maximum Nitrate Concentrations (IOWATER test kits)								
SPRING			SUMMER			FALL		
SITE	DATE	MAX	SITE	DATE	MAX	SITE	DATE	MAX
		mg/L			mg/L			mg/L
NWC1	5/8/13	20	WC4	5/8/13	20	WC8	5/8/13	20
NWC2	5/8/13	20	WC4	5/24/13	20	LWC1A	5/8/13	20
WC1	6/2/04	20	WC5	5/8/13	20	LWC1A	5/7/14	20
WC1	5/8/13	20	WC6	6/2/04	20	D11	7/4/08	20
WC2	6/2/04	20	WC6	5/9/12	20	NWC6	7/8/13	20
WC2	5/8/13	20	WC6	5/8/13	20	WC4	7/8/13	20
WC3	5/8/13	20	WCTrib	5/8/13	20			

Phosphorus

Iowa Soybean Association / Clean Water Alliance Monitoring

A total of 136 samples were collected and analyzed for phosphorus from the ISA/CWA site 40 between 2001 and 2014. At sites 70.0, 70.1 and 70.2; a total of 127 samples were collected between 2002 and 2014. The overall average concentration for all samples at site 40 was 0.083 mg/L. The average concentration for samples collected at site 70 locations was 0.134 mg/L, or 61% higher than those taken at site 40. This indicates that phosphorus concentrations may be higher in streams within the rural landscapes.

At site 70, average concentrations were elevated above 0.12 mg/L during all months sampled, except for August, with peak levels occurring in May and June. At site 40, highest concentrations were observed in April, with concentrations wavering after that. Seasonal trendlines are present, but do not appear as strong as those seen for nitrate concentrations. Also in contrast to nitrate levels, there appears to be much less correlation between high flow levels and elevated phosphorus concentrations. This appears to indicate that phosphorus concentrations may be more influenced by individual site actions, such as fertilizer applied soon before a storm event, which could lead to a sudden spike in phosphorus concentrations.

Snapshot Monitoring

IOWATER has collected data from 31 separate sampling sites in the Walnut Creek watershed. Phosphorus was measured by 136 laboratory samples from these sites. Laboratory samples were also collected for Orthophospate, with 217 collected for that parameter.

Since there are fewer data points at each site, it is difficult to draw specific conclusions about each location. However, this data seems to indicate elevated levels of phosphorus may be present at various locations in both rural and urban areas. It is also possible that Waveland Golf Course could be a source of elevated phosphorus loading, however this would need to be verified with additional monitoring data collection.

	Site 40	Site 70
Average Phosphorus Concentration	0.083 mg/L	0.134 mg/L
Maximum Recorded Level	1.5 mg/L	0.68 mg/L
Date of Maximum Recorded Level	4/17/2004	4/18/2013

At Site 40, 110 samples were below the concentration levels which could be detected by the test. At site 70, 73 samples were below this threshold. To calculate average concentrations, tests that indicated concentrations were below the detection limit were assumed to have a value of one half of the detection limit.

Average Phosphorus and Phosphate Concentrations (Laboratory)

PHOSPHORUS			ORTHOPHOSPHATE		
SITE	**COUNT**	**AVG**	**SITE**	**COUNT**	**AVG**
	#	mg/L		#	mg/L
WAVELAND GC	2	0.45	LWC1(A)	9	0.16
WC1	8	0.45	WAVELAND	7	0.14
D11	1	0.36	WCTrib	10	0.14
WCTrib1	1	0.36	WC8	10	0.12
WAVELAND	9	0.36	WAVELAND GC	3	0.11

Maximum Phosphorus and Phosphate Concentrations (Laboratory)

PHOSPHORUS			ORTHOPHOSPHATE		
SITE	**DATE**	**MAX**	**SITE**	**DATE**	**MAX**
		mg/L			mg/L
WC1	5/18/05	2.5	NWC1	10/15/14	0.69
WAVELAND	5/18/05	1.0	WCTrib	10/15/14	0.66
WAVELAND	10/12/05	1.0	WAVELAND	10/12/05	0.64
WAVELAND GC	5/24/06	0.68	LWC1	10/15/14	0.57
WAVELAND	5/14/06	0.54	LWC1	5/8/13	0.52

A review of maximum phosphorus concentrations also seems to indicate that the areas near Waveland Golf Course may have significant spikes in loadings. Perhaps these are associated with fertilization coinciding with certain rainfall events. It is also worthy of note, that certain dates resulted in maximum values at multiple sites. This indicates that runoff or streamflow patterns likely do influence concentrations, but it is difficult to interpret how much with the limited data available.

Bacteria (E. coli)

Iowa Soybean Association / Clean Water Alliance Monitoring

A total of 62 samples were collected and analyzed for E. coli at the ISA/CWA site 40 between 2005 and 2011. At site 70.0, a total of 46 samples were collected between 2006 and 2011. The overall average concentration for all samples at site 40 was 3126 MPN (most probable number of organisms)/100 mL, with 73% exceeding the State of Iowa's single sample water quality criterion of 235 MPN/100mL. The average concentration for samples collected at site 70 locations was 1333 MPN/100mL, with 66% of the samples exceeding the single sample criterion. Average values at site 40 were 135% higher than those observed at site 70. This indicates pathogens may be much more present in streams which receive more urban runoff.

At both sites, average concentrations over this period peaked in June, with average levels during that month at 8,122 MPN/100mL at site 40 and 1,602 at site 70. Average values showed a very high peak in June at site 40, where values were more consistent through all months at site 70.

At site 40, there appears to be a connection between high flow levels and elevated bacteria concentrations. Most of the highest concentrations were observed during the highest 30% of all flow conditions. At site 70, this connection was much less defined.

This data provides strong evidence that there is a connection between high runoff events from urban environments and high concentrations of indicator bacteria. Other seasonal factors, such as elevated temperatures may provide better environments for these bacteria and allow them to survive and multiply.

Snapshot Monitoring

IOWATER has collected data from 31 separate sampling sites in the Walnut Creek watershed. E. coli was measured by 298 laboratory samples from these sites. Since there are fewer data points at each site, it is difficult to draw specific conclusions about each location. However, this data seems to follow the pattern of the ISA/CWA monitoring, indicating elevated levels of indicator bacteria where runoff is being received from urbanized areas.

Highest concentrations appear to be in the older developed areas, lying east of I-35/80. Highest concentrations often appear in tributary streams, however high averages and maximums were noted at sites NWC5A (North Walnut Creek) and WC6 (Walnut Creek). Samples at both of these sites were collected from second or third order stream channel.

	Site 40	Site 70
Average Phosphorus Concentration	3,126 MPN/100mL	1,333 MPN/100mL
Maximum Recorded Level	54,700 MPN/100mL	14,670 MPN/100mL
Date of Maximum Recorded Level	6/26/2008	7/24/2008

Average and Maximum E. coli Concentrations (Laboratory)					
AVERAGE			MAXIMUM		
SITE	COUNT	AVG	SITE	DATE	AVG
	#	MPN/100ML			mg/L
NWCTrib1	12	9,165	NWCTrib1	10/12/2005	77,010
WC3Trib	2	7,875	WC6	5/8/2005	61,310
NWC5A	2	8,585	WAVELAND	10/12/2005	30,760
WAVELAND	10	8,585	NWCTrib2	10/18/2006	30,760
WC6	19	5,332	NWC5A	10/18/2006	16,070

Nitrogen Monitoring

Phosphorus Monitoring

Bacteria Monitoring

Watershed Loading – Key Pollutants

Water quality modeling was completed to determine the most likely sources of the key pollutants of concern. A more detailed description of this modeling effort is included as an appendix to this plan. Available GIS land use dataset information was used to determine the amount of different land uses in each of 33 subwatershed areas within the Walnut Creek watershed. The model accounts for other factors including local rainfall patterns, soil types, terrain, farm animals, wildlife and management practices. Gully and streambank stability characteristics are also input into the modeling. The modeling software used did not account for construction site runoff. To account for this, separate calculations were completed to determine the amount of development that occurred on an annual basis over a recent ten year period. Modeling results were developed for each subarea, considering scenarios with and without this construction site loading.

Estimated Average Watershed Loading		
Pollutant	**Total Load (pounds)**	**Total Load (tons)**
Nitrogen	941,600	471
Phosphorus	61,500	31
Sediment	59,360,000	29,700

Pollutant Sources By Land Use				
	N	**P**	**BOD**	**Sediment**
Urban	13.61%	26.14%	51.51%	6.89%
Cropland	80.59%	49.12%	33.76%	10.24%
Pastureland	1.91%	2.02%	5.09%	0.29%
Forest	0.14%	0.66%	0.25%	0.44%
Grasslands	0.04%	0.16%	0.06%	0.03%
Gully	0.81%	4.79%	2.05%	18.97%
Streambank	1.63%	9.58%	4.10%	37.95%
Construction Site	1.27%	7.53%	3.20%	25.19%

Existing monitoring data at Iowa Soybean Association Site 40 and streamflow data from the USGS gage located nearby were used to evaluate preliminary results. The monitoring and streamflow data was used to calculate approximations of loading rates based on the data available. The water quality model was then calibrated using this information, to bring it into better agreement with real world observations.

Expected Pollutant Sources by Land Use

Modeling results demonstrate that cropland is likely the largest source of nitrogen and phosphorus loadings. This is consistent with observations from monitoring sites, which demonstrated higher phosphorus and much higher nitrate concentrations in rural areas. Urban landscapes are expected to be the largest source of biological oxygen demand (BOD) and pathogens. Over 80% of the sediment loading in the watershed is expected from three sources – streambank, construction site and gully erosion.

Pollutant Sources by Subarea

The water quality modeling completed identifies potential sources of key pollutants at a subwatershed level. For each of these areas, the expected annual load of nitrogen, phosphorus, BOD and sediment has been calculated. These loading rates were divided by the acres of land within each subwatershed to determine the annual loading rate per acre, in order to compare loading rates of subwatershed that are different in size.

Loading rates have been calculated both with and without the expected effects of construction site sediment loads. Construction site loadings were calculated based on land development patterns that occurred between 2001 and 2011. The modeling provides a good estimate of average annual construction site loadings from each subarea which would have occurred during that period of time. As development patterns change over time, the location of these sources will be different in the years ahead. Therefore, the maps included within this chapter show the expected loading rates without construction site effects. This allows non-construction site sources to be evaluated and targeted separately. Construction site sources are best addressed with site level management techniques.

Nitrogen

Sources of nitrogen are expected to be highest in the agricultural lands that make up the headwaters of Walnut Creek. Areas west of Waukee and those between Dallas Center and Grimes appear to be the largest sources for nitrogen on a per acre basis. Elevated levels are also indicated to be present in the upper reaches of the North Walnut Creek subwatershed. These results appear to be consistent with available monitoring data.

Phosphorus

Like nitrogen, sources of phosphorus are expected to be highest in the agricultural lands in the upland areas of the watershed. However, there is less variation in phosphorus loading between the various subareas. Twenty-eight of the thirty-three subwatersheds are expected to have loading rates between 0.8-1.3 pounds per acre per year. Levels are expected to be below this range in two subwatersheds and above this range in three others. These results appear to be in agreement with available monitoring data.

BOD and Pathogens

This modeling software did not include detailed modeling of bacteria sources. Bacteria loading can be difficult to estimate, as they are driven by a variety of factors such as animal sources, temperature, precipitation, growth and lifespan. This software did evaluate general sources of biological oxygen demand. Results of this modeling show that sources of BOD are likely highest within the urban landscapes, especially those in the older development areas, located east of Interstates 35 and 80. These results appear to parallel available monitoring data for indicator bacteria, where levels were most elevated in the urban environment.

Sediment

Source loadings of sediment are expected to be highest in areas of steeper slopes and where more streambank and gully erosion has been observed. Highest levels are expected along lower Little Walnut Creek and along Walnut Creek upstream of its confluence with South Walnut Creek. There are many ravines, gullies and streams with significant slope in these areas. Please remember construction site loadings are not reflected in the maps included within this chapter.

Average Loading per Acre by Subwatershed Without Construction Site Runoff

	N lb/ac/yr	P lb/ac/yr	BOD lb/ac/yr	Sediment lb/ac/yr
101	4.8	0.7	10.8	967.2
102	6.1	0.9	19.5	895.3
111	5.1	0.6	11.7	489.1
112	6.0	0.9	18.5	729.5
201	6.1	1.0	20.7	1034.2
202	6.7	0.9	17.6	911.9
203	6.7	1.1	15.3	2198.1
211	6.4	0.9	22.2	761.7
212	13.3	0.9	15.8	737.5
213	6.3	0.8	14.9	919.7
214	17.3	1.1	11.4	1810.8
301	17.7	1.2	13.3	1923.3
311	28.3	1.3	11.1	1862.8
312	27.0	1.2	11.0	1513.8
401	24.0	1.8	16.1	3823.2
402	27.4	1.0	9.4	568.4
411	28.7	1.9	15.2	520.7
501	5.5	0.8	14.7	855.7
502	5.8	0.9	16.1	1081.4
503	9.8	1.0	17.4	1001.6
504	18.0	0.9	14.8	335.7
511	6.0	0.8	18.1	799.4
512	5.5	0.8	15.6	605.6
513	19.3	0.8	12.7	201.0
601	18.6	1.1	12.8	1311.7
602	27.4	0.8	8.7	195.6
611	12.3	1.0	15.9	1051.1
612	10.8	0.8	15.6	389.6
613	26.7	0.8	8.9	254.3
614	28.2	0.8	8.3	182.5
701	25.5	1.2	10.8	1757.9
702	29.5	1.8	13.3	153.8
711	28.0	0.8	8.4	184.2
Watershed Total	**17.6**	**1.1**	**13.7**	**840.8**

Nitrogen Loading

Phosphorus Loading

BOD Loading

Sediment Loading

Reduction Goals

The reduction goals within this section are intended to be long-term goals which will likely take many decades to achieve. The Watershed Action Plan and Implementation Plan included within this document will identify how these long-term goals can be addressed over a shorter period of time.

Iowa's Nutrient Reduction Strategy calls for reductions in nutrient loading from non-point sources in agricultural areas. These loading reductions are 41% for nitrogen and 29% for phosphorus. Using past monitoring data from the ISA/CWA sites, loading reductions of this amount for nitrogen would be expected to limit violations of the Raccoon River watershed TMDL standard for nitrate to less than 1% of all samples collected at site 40. Many management practices which target phosphorus are also effective at reducing erosion or trapping sediment loads. Based on this, it seems reasonable to expect that sediment loadings from the agricultural areas could be reduced by a similar amount by implementing practices which aim to reduce phosphorus loading.

Loading Reduction Goal #1:

Reduce nitrogen loading from non-point sources within rural areas by 41%.

Loading Reduction Goal #2:

Reduce phosphorus loading from non-point sources within rural areas by 29%.

Loading Reduction Goal #3:

Reduce sediment loading from non-point sources within rural areas by 29%.

The Nutrient Reduction Strategy does not establish reduction goals for nutrients within urban areas. The analysis within this plan identifies that pathogens, sediment loadings and water quantity are more critical pollutants to address within the urban environment.

The Raccoon River TMDL established a target single sample maximum concentration of E.coli bacteria at 200 MPN/100mL. Based on monitoring sites, load reductions of more than 99% would be necessary to meet this criterion. This appears to be an impractical goal, given the level of existing urban development throughout the watershed and the amount of retrofits that would be necessary to meet this standard. For this reason, the following load reduction goals are proposed:

Loading Reduction Goal #4:

In newly developing areas, employ best management practices (BMPs) to capture and treat runoff from the 1.25" rainfall event (Water Quality event). Select practices such as bioretention, wet detention ponds and constructed wetlands which have been demonstrated to remove 60% or more of bacteria loading. Refer to the International Stormwater BMP Database (bmpdatabase.org) for updated information.

Loading Reduction Goal #5:

In existing developed areas, develop a program to employ stormwater retrofits where practical to reduce pathogen loading to the maximum extent possible.

There is no established criteria governing sediment loadings or water quantity volumes. This plan has identified that these items have a significant impact related to both water quality and stream corridor stability. **Therefore, the following goals related to sediment and runoff water quantity are proposed:**

Sediment

Loading Reduction Goal #6:

Employ effective construction site pollution prevention management practices in developing areas. Controls should reduce total suspended solids (TSS) from site runoff by 80% (as compared to no controls) and limit overall site loadings to less than three tons per acre per year.

Loading Reduction Goal #7:

Complete streambank stabilization and restoration projects as needed to reduce sediment loading attributed to streambank erosion by 25% by 2040.

Runoff Water Quantity

Loading Reduction Goal #8:

In developing areas, provide stormwater management practices which achieve the following:

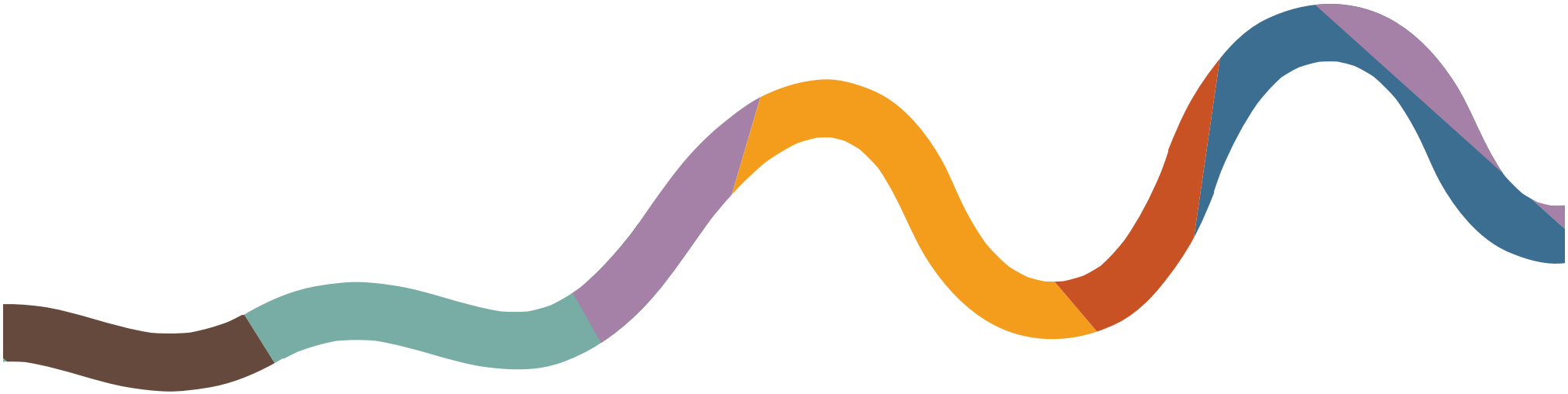
- Capture and treat runoff from the Water Quality Event (treat 100% of runoff from precipitation events of less than 1.25 inches).
- Provide extended detention of the 24-year, 1-year return period event; with slow release over a period of not less than 24 hours. This should reduce peak runoff rates from newly developing areas by more than 95% for these types of storm events.
- Limit runoff rates for events equal to or smaller than the 24-hour, 1% annual chance event (100-year return period storm) to levels similar to pre-settlement conditions.

Loading Reduction Goal #9:

In developed areas, evaluate opportunities and implement practices to reduce runoff rates and volumes by the maximum extent possible.

VISION: Engaged residents working across political and property boundaries to create and sustain a healthy watershed.

MISSION: Through collaboration, education and research, implement science-based policies and practices for flood mitigation, water quality improvements, natural resources protection, and improved recreation while maintaining economic health.



seven

PLAN IN PROGRESS
January 8, 2015

Strategic Framework

ONE

Reduce flooding through improved stormwater management and soil health.

TWO

Improve water quality, with an emphasis on sediment, nitrate, phosphorous and e-coli reductions.

THREE

Enhance recreation and public health through improved water quality, habitat restoration, stream accesses, improved connectivity to parks/trails and cultural opportunities.

FOUR

Deliver enriched conservation education and programming with emphasis on water quality/ quantity management, wildlife/habitat, urban and agricultural needs within the watershed.

FIVE

Support community vitality and maintain economic health through implementing multi-purpose projects producing benefits in public, natural resources and economic health that can be documented.

SIX

Develop ongoing means for collaboration and implementation of effective policies and practices, taking a consistent watershed and/or regional scale approach as much as practical.

GOALS

1. Reduce flooding through improved stormwater management and soil health.
   a. Implement urban and rural best management practices (BMPs) to: (See BMPs Matrix)
      i. Mitigate increases in runoff volumes and peak rates of flow caused by man-made alterations to the landscape
      ii. Reconnect Walnut Creek and tributaries with their adjacent flood plains
      iii. Reduce streambank and channel erosion.
      iv. Improve physical habitat within the stream and adjacent flood plains and stream buffers
      v. Reduce flood damage overall and protect municipal infrastructure
   b. Promote policies and practices which lead to soil quality restoration on both urban and rural landscapes
      i.

2. Improve water quality, with an emphasis on sediment, nitrate, phosphorous and e-coli reductions.
   a. Improve effectiveness and consistency of enforcement of Stormwater Pollution Protection Plans
   b. Develop and implement a monitoring program to measure results and identify additional pollutants of concern
   c. Implement urban and rural BMPs to meet water quality standards, reduce sediment and allow water contact recreation (see BMPs matrix)

3. Enhance recreation and public health through improved water quality, habitat restoration, stream accesses, improved connectivity to parks/trails and cultural opportunities.
   a. Phase improved stream accesses to coordinate with water quality and safety improvements
   b. Improve watershed-wide volunteer coordination/opportunities for habitat improvement projects
   c. Incorporate purposeful community arts initiatives for improved public engagement and education, as well as enhanced aesthetics
   d. Enhance/improve greenway development within the watershed (e.g., See upcoming Clive Greenbelt Master Plan for example)
   e. Use buffering to expand the watershed's greenways network and connectivity of waterways and trails
   f. Implement BMPs to: (See BMPs Matrix)
      i. Restore wetlands/natural areas
      ii. Expand native landscape cover and riparian areas
      iii. Improve wildlife habitat and remove invasive species
      iv. Promote healthy soils

4. Deliver enriched conservation education and programming with emphasis on water quality/quantity management, wildlife/habitat, urban and agricultural needs within the watershed.
   a. Implement the Education and Collaboration Plan included within this Watershed Plan

5. Support community vitality and maintain economic health through implementing multi-purpose projects producing benefits in public, natural resources and economic health that can be documented.
   a. Establish metrics for projects that identify appropriate scales to measure social, economic, and environmental costs and benefits for projects
   b. Identify BMPs with multiple benefits through use of this Watershed Plan's BMP Matrix, particularly employing use of the Community Section where multi-purpose projects, citizen awareness and regional connections are emphasized

6. Develop ongoing means for collaboration and implementation of effective policies and practices, taking a consistent watershed and/or regional scale approach as much as practical. (Also see Collaboration and Education Plan and Chapter 9: Policy Recommendations).
   a. Priority policies for watershed-wide (and/or metro-wide) adoption include:
      i. Unified sizing criteria as described within the Iowa Stormwater Management Manual
      ii. Protected stream buffers, following the State of Minnesota's lead
      iii. Construction site pollution prevention improvements (see Goal 2a

above) to address both erosion and sediment control practices that are currently falling short

iv. Ordinances to protect or restore healthy soils, particularly in light of the state's recent removal of the 4" top soil preservation requirement, and

v. Flood plain protection standards designed to reduce structural/property losses, maintain flood storage capacity, identify areas of active stream movement (for preservation) and provide flood "head room" (an additional foot of separation between expected flooding levels and protection requirements).

b. Advocate for expanded regional/watershed resources for planning and practice implementation at the county, state and federal level

c. Collectively pursue resources for plan implementation, recognizing projects often have benefits beyond the jurisdiction/property boundaries in which they are implemented

d. Recognizing upstream partner costs and downstream partner benefits, explore creative funding options (e.g., a water fund, whereby downstream partners support upstream practices)

e. Similarly, pursue incorporation of regional-scale practices with associated cost-benefits, e.g., wetland mitigation banks

PLAN IN PROGRESS
January 8, 2015

Case Study: Subwatershed Strategic Plan

Show case study location map - not sure where this is located???

Smaller subwatersheds are being used as case studies to:

- Target improvements within smaller areas where changes can be more quickly observed.
- Results can be reviewed and lessons learned applied to other areas.
- These smaller areas can be studied and modeled in greater detail than the whole watershed.

Key Lessons Learned

Rural (411)

- Cropland is expected to be the largest source of nitrogen and phosphorus loads.
- Gully and streambank erosion is expected to be a large source of sediment load.

Urban (213)

From 2001-2011, construction sites made up 2-3% of this subwatershed. This small portion of this landscape is estimated to contribute:

- 61% Sediment load
- 17% Nitrogen
- 26% Phosphorus

25%

Construction sites likely contribute more than 25% of the total sediment load.

Developing (602)

7x Runoff volume increase in suburban residential areas compared to pre-settlement conditions during a one-year storm event (2.67" in 24 hrs)

43x Rate of flow increase for same conditions

97% Reduction in peak outflow rates from developing areas for the one-year event, using new stormwater design methods outlined in the Iowa Stormwater Management Manual (compared to current methods)

1/2 Restoring healthy topsoil layers to open space areas can reduce stormwater runoff by 1/2.

Modifying key pond outlet structures to manage small storms could reduce:

- One-year outflow rates for the area served by more than 40%
- Phosphorus and sediment loads downstream by 10%

Subwatershed Case Studies

The Walnut Creek watershed covers an area of nearly 83 square miles.

It would take significant investments within an area of this scale to notice measurable improvements in water quality. This is the primary reason that certain subwatersheds have been selected for more intense study. Focusing efforts in these case study areas allows monitoring to better measure changes in water quality that result from localized improvements. This provides the opportunity to review results and make strategic adjustments which can be applied to improvements in other subwatershed areas. A secondary benefit of this approach, is more precise modeling of the subject area, using information about land use, streambank conditions, gully formation and existing management practices at a higher level of detail than is practical to collect at the larger watershed scale.

One subwatershed was selected to represent a typical rural setting, another in a developed area and one in an area which is expected to experience rapid urban growth in the next few years. Four candidate subareas of each of these types were presented to the Walnut Creek WMA board for review, to establish a consensus on which ones should be designated as case study subwatersheds. For each selected subwatershed, a specific plan has been developed to target expected sources of key pollutants.

A more detailed review of each case study is included within an appendix to this plan.

Average Loading per Acre by Microwatershed

Microwatershed		Area	N	P	BOD	Sediment
		(acres)	lb/ac/yr	lb/ac/yr	lb/ac/yr	lb/ac/yr
411.01	W1	138.1	17.8	2.5	24.8	4884
411.02	W2	165.5	15.0	1.1	10.5	1111
411.03	W3	32.4	14.6	1.4	20.8	375
411.04	W4	102.7	31.5	2.6	19.8	2079
411.05	W5	1116.3	27.7	1.9	15.6	624
411.06	W6	297.9	32.2	2.1	16.0	322
411.11	W7	224.7	22.7	1.8	16.7	1463
411.12	W8	257.8	31.4	2.1	16.2	423
411.21	W9	174.7	27.5	1.8	15.6	348
411.31	W10	222.1	29.8	1.8	14.1	392
411.32	W11	151.2	29.3	1.9	17.0	338
411.33	W12	202.6	31.5	2.0	15.4	361
411.41	W13	39.0	27.9	2.0	19.3	454
411.42	W14	299.8	30.8	2.1	15.7	472
411.51	W15	72.8	27.6	1.5	13.7	370
411.52	W16	299.1	30.6	1.9	14.8	389
411.61	W17	157.1	32.5	2.2	15.2	546
411.71	W18	198.1	30.5	2.1	16.3	574

Rural Case Study – Subwatershed 411

Location

This area is located in the headwaters of Walnut Creek. This 6.5 square mile area is generally located between Dallas Center and Grimes, with Highway 44 running east-west through the center of the area. This subwatershed has been divided into 18 smaller areas, or microwatersheds, for analysis.

Pollutant Sources

More than 80% of this subwatershed is used for row-crop agricultural production. Over the past two years, these areas were primarily farmed either in a rotation of corn and soybeans, or planted as corn in each year. Modeling results indicate that cropland areas are the most significant sources of nutrient loadings. Row crop areas also produce the majority of the sediment loading from this subwatershed, although streambank and gully erosion are also significant contributors of this pollutant. There are several areas within this subwatershed with pollutant loadings that are expected to be much higher than the Walnut Creek Watershed averages, based on completed modeling.

Current Land Uses – Subwatershed 411		
	Area (acres)	**%**
Urban	376.0	9.1%
Cropland	3422.9	82.4%
Pastureland	69.0	1.7%
Forest	6.7	0.2%
Grasslands	277.3	6.7%
Total	**4151.9**	

Estimated Pollutant Sources – Subwatershed 411			
	N	**P**	**Sediment**
Urban	3.1%	7.1%	5.2%
Cropland	95.4%	87.2%	53.0%
Pastureland	0.6%	0.8%	1.3%
Forest	0.0%	0.0%	0.0%
Grasslands	0.1%	0.5%	0.4%
Gully	0.3%	1.4%	10.6%
Streambank	0.5%	3.0%	29.5%
Construction Site	0.0%	0.0%	0.0%

Estimated Pollutant Loading – Subwatershed 411*			
	N	**P**	**Sediment**
	tn/yr	tn/yr	tn/yr
All Sources	59	4	1,540

* Note that pollutant loading is the estimated pollutant load delivery to the outlet point from this subwatershed area.

Strategy		
Location	Completion Date	Cost

Water Quality Improvement Plan

The following strategies are recommended to improve water quality within this subwatershed area and develop and evaluate a template for future action within other rural agricultural areas.

Strategy #1 - Employ best management practices (BMPs) which are identified in the Nutrient Reduction Strategy document or other resources, with a goal of reducing nutrient loads from this subwatershed area. Loading reduction targets are 41% for nitrogen and 29% for phosphorus by 2025.

- This plan outlines a "model plan", which is one possible set of improvements that collectively would reach these goals. Many other combinations are possible.
- Staff and resources from local and regional groups such as the Heartland Co-op, County Soil and Water Conservation Districts (SWCDs), IDNR, NRCS and Iowa Soybean Association should work with local farmers and landowners to expand knowledge about these practices and find the right fit for practices throughout the landscape.

Model Plan				
Portion of Subwatershed to be Applied	Acres to be Applied	Practice	Expected Load Reduction (Where Applied)	
			Nitrogen	Phosphorus
10%	415	Extended Crop Rotations	42%	NA
20%	830	Split Seasonal N Applications	5%	NA
25%	1,040	Cover Crops	28%	29%
25%	1,040	Increased Use of Nitrification Inhibitors	9%	NA
35%	1,455	Increased Use of "No-Till" Practices	NA	90%
50%	2,075	Adjust N Application Rates	10%	NA

The model plan focuses on several key practices to meet the desired load reductions. Brief descriptions of these practices are included in Chapter 15 of this plan. Six of these practices were projected to be applied broadly across this subwatershed area. Expected load reductions are typically based on values from the 2014 edition of the Nutrient Reduction Strategy.

The "model plan" has other practices were projected to be installed within certain smaller microwatershed areas.

- Land Retirement to CRP – Convert some steep slope (slopes > 5%) cropland areas to grasslands through use of CRP or by dedication to permanent conservation easements. The model assumes that 5% of the cropland in area 411.01, 2% of the cropland in 411.04 and 1% of the cropland in 411.05 would be converted in this way. (The Raccoon River Water Quality Improvement Plan identified this as a strategy to address nutrient losses on steeper, more erodible lands.)
  - Total land affected = 20 acres.
  - Expected reductions of 85% nitrogen and 75% phosphorus loading from groundwater and surface runoff from the affected areas.

- Saturated Buffers and Drainage Water Management – Intercept tile drainage systems and divert most subsurface drainage through a saturated buffer strip adjacent to the stream. The model included 50% of the land area within subarea 411.04 and 35% of the land area within subarea 411.05 being managed using this method.
  - Total land area treated = 442 acres.
  - Expected reduction of 33% nitrogen loading from groundwater from the treated area.

- Bioreactors – Intercept tile drainage systems for smaller areas (less than 100 acres) and divert most subsurface drainage through a bioreactor system. The model included 30% of the land area within subareas 411.02, 411.03, 411.11, 411.31, 411.32, 411.33 and 411.41 being treated in this manner.
  - Total land area treated = 311 acres.
  - Expected reduction of 43% nitrogen loading from groundwater from the treated area.

- Grass waterways – Create or enhance grass waterways to maintain a minimum 33 foot width, or wider as dictated by current design guidelines. The model included installing such waterways (where they don't yet exist) along 90% of the "zero order" streams mapped as part of this plan located within subareas 411.12, 411.21, 411.32, 411.33, 411.42, 411.51, 411.52, 411.61 and 411.71. Installing such waterways would impact 25 acres of cropland area.
  - Total land area treated = 1,632 acres.
  - Expected reduction of 50% phosphorus loading from surface runoff from the treated area.

- Wetlands – Construct wetland features in areas where productivity is most commonly lost to due standing water. Flow paths immediately upstream

Microwatershed

Pollutant Sources

Practice Locations

of road crossings are also good candidate locations. Wetlands should be designed with multi-stage outlet structures to maximize reduction of peak flow rates from small and moderate storm events. (Provide drawdown of a 1-year return period storm over a period of 24-48 hours). Such outlet modifications would allow the wetlands to serve multiple purposes: nutrient reduction and stormwater peak flow reduction for storms of approximately 3" or less. For this model, it is assumed that wetlands could intercept runoff from 30% of subarea 411.05 and 100% of subarea 411.06. Total wetland new area expected to be 30 acres in size.

- Total land area treated = 633 acres.
- Expected reduction of 52% phosphorus loading from surface runoff from the treated area.

- Two Stage Ditch – Although these features have not been included in the Nutrient Reduction Strategy, several studies have demonstrated that these features have been very effective at removing nitrogen and phosphorus from streams with larger drainage areas. They are best implemented in areas without adequate buffer widths, where the stream is narrow or where the streambanks or channel bottom are unstable. This practice allows for expansion of the channel cross-section, slowing flow velocities and allowing for increased filtration of runoff. One key section of channel extending through parts of subarea 411.04 and 411.05 appears best suited for this practice. It would treat not only runoff from this subarea, but all areas located upstream. Installation of this practices would likely affect only 2 acres of current row-crop production.
  - Total land area treated = 2,244 acres.
  - Expected reduction of 10% nitrogen and 15% of phosphorus loading from both surface and groundwater runoff from the upstream treated area.

This chapter includes two maps of potential best management practices within this case study subwatershed. The first shows the improvements that are included in the "model plan" described within this chapter. The second identifies other possible improvements which could be considered, but that were not included in the "model plan" developed to project potential pollutant load reductions.

Current Land Uses – Subwatershed 213		
	Land Use	%
Urban*	2643.1	92.1%
Cropland	73.5	2.6%
Pastureland	0.0	0.0%
Forest	46.1	1.6%
Grasslands	106.1	3.7%
Total	2868.8	

* Includes Des Moines Golf and Country Club (470 acres)

Estimated Pollutant Sources (Without Construction Site Runoff) – Subwatershed 213			
	N	**P**	**Sediment**
Urban	82.0%	72.0%	18.8%
Cropland	13.5%	7.1%	6.0%
Pastureland	0.0%	0.0%	0.0%
Forest	0.1%	0.4%	0.1%
Grasslands	1.2%	5.8%	9.1%
Gully	0.2%	1.2%	5.2%
Streambank	2.9%	13.5%	60.9%
Construction Site	0.0%	0.0%	0.0%

Estimated Pollutant Sources (Including Construction Site Runoff) – Subwatershed 213			
	N	P	Sediment
Urban	67.8%	53.6%	7.3%
Cropland	11.2%	5.3%	2.3%
Pastureland	0.0%	0.0%	0.0%
Forest	0.1%	0.3%	0.0%
Grasslands	1.0%	4.3%	3.5%
Gully	0.2%	0.9%	2.0%
Streambank	2.4%	10.1%	23.7%
Construction Site	17.3%	25.5%	61.0%

Estimated Pollutant Loading – Subwatershed 213			
	N	P	Sediment
	tn/yr	tn/yr	tn/yr
All Sources Except Construction Sites	8.2	0.7	580
All Sources	10.0	0.9	1,490

* Note that pollutant loading is the estimated pollutant load delivery to the outlet point from this subwatershed area.

Average Loading per Acre by Microwatershed (w/o Construction Site Loads)						
		Area	N	P	BOD	Sediment
Microwatershed		(acres)	lb/ac/yr	lb/ac/yr	lb/ac/yr	lb/ac/yr
213.01	W1	181.0	5.5	1.2	12.4	2827
213.02	W2	869.6	5.1	0.4	3.0	97
213.03	W3	208.2	5.5	0.3	2.7	83
213.11	W4	190.9	5.3	0.7	14.1	599
213.21	W5	43.8	3.7	0.3	2.3	91
213.22	W6	298.5	4.9	0.5	4.1	602
213.31	W7	402.7	8.5	0.4	3.2	335
213.32	W8	219.2	5.3	0.3	3.0	180
213.41	W9	285.8	5.3	0.3	2.6	87
213.51	W10	169.1	6.9	0.5	3.4	306

Projected Pollutant Loading – Subwatershed 411*			
	N	P	Sediment
	tn/yr	tn/yr	tn/yr
All Sources	33	2	582
Model Plan Projected Reductions	42%	62%	65%

* Note that pollutant loading is the estimated pollutant load delivery to the outlet point from this subwatershed area.

Strategy #2 - Address key areas of gully and streambank erosion.

- Streambank stabilization and restoration – Target efforts to a one mile stretch of stream within subarea 411.01 and a half mile segment within subarea 411.02. These improvements have the potential to reduce the annual rate of erosion by 265 tons.

- Two stage ditch – Conversion of a section of stream within parts of subareas 411.04 and 411.05 to a two-stage ditch would also reduce the annual rate of erosion by up to 52 tons.

The "model plan" includes the two improvements listed above. There is also some other gully areas in subareas 411.01 and 411.11 which could be addressed which could reduce annual erosion rates by up to 170 tons. Such repairs have not been included in the model calculations.

Strategy #3 - Look for opportunities to reduce the peak rates of flow caused by small to moderate storm events.

Where practices are constructed that pond water (i.e. wetlands, sediment basins, ponds, etc.) use multi-stage outlet designs that provide temporary stormwater storage for extended detention of small and moderate storm events. A 1-year return period, 24-hour storm event in this area is 2.67" of rainfall. This could reduce runoff peak rates from the area managed by the practice by over 90%, compared to existing conditions. The multi-stage design would not necessarily be designed to fully detain runoff from larger storms, however the first 40% of the flow volume of a 100-year return period event would be captured and slowly released by managing runoff from the more commonly occurring smaller storms. Therefore, such outlet structures would provide downstream benefits during both small and large storm events.

Expected Load Reductions

The projected load reductions included in this table is based only on the practices and strategies listed previously as included in the "model plan" for this case study area. The simulation indicates that this plan meets the goal for nitrogen loading reduction, and exceeds the goals for phosphorus and sediment loading reductions.

Urban Case Study – Subwatershed 213

Location

This subwatershed includes areas tributary to South Walnut Creek, which flows into Walnut Creek just south of Hickman Road, west of 128th Street in Clive. Most of this area drains through Country Club Lake in Clive. This 4.5 square mile area is almost completely developed at this point.

Pollutant Sources

More than 80% of this subwatershed is now developed into suburban land uses, and as such modeling indicates that a majority of nutrient loadings are expected to be sourced from these land uses. Cropland makes up less than 3% of the watershed, but is expected to be the source of over 13% of nitrogen and 7% of phosphorus loading. As these areas continue to be developed, the loading attributed to cropland is expected to decrease. Overall, nutrient loading from this subarea is expected to be generally lower than the Walnut Creek Watershed averages. However, within this subwatershed there are several areas with pollutant loadings that are expected to be much higher than the watershed average, based on completed modeling.

GRAPHIC

- {multistage outlet graphic from October Open House Boards}

These modeling results represent pollutant loads measured at the downstream end of this subwatershed, where it enters Walnut Creek. Loadings of phosphorus and sediment might be significantly higher if they were measured upstream of one of the many wet ponds located in this area. Many of these ponds are expected to trap about half of the sediment and phosphorus loadings that pass through them, based on their current design. Identifying opportunities to address these pollutants throughout the watershed would likely result in water quality improvements within the ponds themselves.

Sediment loading from the subwatershed over the recent past is expected to be primarily attributed to construction site and streambank erosion. Between 2001 and 2011, about 650 acres within this area was converted from agricultural to suburban land uses. If each construction site takes one to two years to construct (from initial construction to final home site development), then at any given time between 65 to 130 acres of land may have been in some stage of site construction. From modeling results, these sites, making up only 2-5% of the area within this subwatershed, may have generated more than 60% of the sediment load. Streambank erosion is the next largest generator at nearly 24% of the expected load. A large share of loading due to steambank erosion is expected to come from microwatershed 213.01. This area is located downstream of Country Club Lake and features a heavily eroded segment of South Walnut Creek. This area bypasses all the ponds and other features within the subwatershed, so there is little opportunity to capture generated sediment before it enters Walnut Creek.

Water Quality Improvement Plan - Subwatershed 213

The following strategies are recommended to improve water quality within this subwatershed area and develop and evaluate a template for future action within other urban developed areas.

Strategy #1 - Review opportunities to modify outlets of existing ponds or entrances to existing culverts to provide better management of small storm events. Primary and secondary opportunities for these improvements are noted on the improvement plan map for this subwatershed. Other locations for such modifications may need to be evaluated.

- Perform a more detailed study of selected candidate locations to determine

Microwatershed

Pollutant Sources by Microshed

Practice Locations

if modifications can be made that result in significant reduction in the peak outflow rate for the 1-year return period, 24-hour storm event. The study should evaluate the improvements potential impact on high water levels for storm events up to the 100-year return period, 24-hour storm event, to make sure that such changes will not have a negative impact on surrounding buildings or other infrastructure.

- Complete such improvements where they are determined to be feasible.

Other sections of this plan have demonstrated how land use changes have altered the volumes and flow rates of stormwater runoff. These changes have intensified streambank and gully erosion. Much of this erosion is caused by the types of events that occur most frequently. Ponds designed primarily to prevent flooding during large storms often lack controls to slow runoff from smaller events. Modifying outlets to include multiple stages can limit peak rates of flow during small events, while still managing the risk of local flooding during larger storms.

Strategy #2 – Complete streambank stabilization and restoration projects in key identified areas, as identified on the improvement plan map for this subwatershed.

- Perform a more detailed study of selected candidate locations to better define potential scope of work and project costs.
- Complete final design and construction of improvements.
- Perform short-term maintenance to establish desired vegetation and address minor erosion repairs which are most likely to occur before vegetation is well established.
- Schedule and perform long-term maintenance and repairs as needed to prevent re-emergence of invasive species, support desired vegetation and prevent larger erosion issues from developing.

These improvements are proposed primarily on publicly owned land, but similar projects may be completed within privately owned common spaces or within private properties where easements are provided by the owner.

Strategy #3 – For developing and redeveloping areas, require compliance with policy initiatives as identified within Chapter 9 of this plan.

Iowa's Nutrient Reduction Strategy does not assign reductions of nitrogen or phosphorus to urban landscapes. Modeling results and monitoring data indicate that concentrations of nutrients within this subwatershed is likely lower than allowable water quality standards. However, addressing nutrient loadings would likely benefit the water quality within the individual ponds and water features within the interior of this subwatershed. Adoption of these policies would result in additional reductions of nitrogen and phosphorus loadings.

Expected Load Reductions

Modeling simulations have been completed to evaluate the effectiveness of the proposed strategies for this subwatershed. **These calculations are based on the following assumptions:**

1. Complete Strategy #1 (modify outlets) at the following primary locations:
   - West Lakes Office Park Plat 3, Outlot Z
   - 6400 Westown Parkway
   - South of 1801 68th Street

2. Complete Strategy #1 (modify outlets) at the following secondary locations:
   - Largest Pond within Southfork Development (upstream of Southfork Drive)
   - Country Club Lake
   - Ponds within Des Moines Golf and Country Club, immediately downstream of the South Maple Grove and Country Club Ridge developments

3. Complete Strategy #2 (streambank stabilization/restoration) at the following locations:
   - Microshed – 213.01: South Walnut Creek between Country Club Lake and Walnut Creek.
   - Microshed – 213.22: Between 156th Street and recreational trail crossing located 1,100 feet downstream in Clive.

Storm Event Return Period (24-hour duration)	Temporary Water Level Rise
1-year	2 feet
10-year	3 feet
100-year	5 feet

Other strategy applications listed within Chapter 12 of this plan have not been included within modeling calculations.

Estimated Pollutant Loading (Without Construction Site Runoff) – Subwatershed 213			
	N	P	Sediment
	lb/yr	lb/yr	tn/yr
Current	16,500	1,370	580
Future	16,100	1,140	330
Rate Reduction	400	230	250
% Reduction	2%	17%	43%

Developing Case Study – Subwatershed 601

Location

This area is located within the watershed of Little Walnut Creek and is expected to see rapid urban growth over the next decade. This 960 square mile area is generally located on both sides of Little Walnut Creek between Warrior Lane and NW 170th Street. This subwatershed has been divided into 12 smaller microsheds for analysis.

Purpose

This case study is different from the rural and urban subwatersheds, in that the land uses of concern do not yet exist. The purpose of this analysis is to evaluate stormwater management techniques to prepare a plan for management which mitigates the impact to receiving streams caused by increased runoff rates and volumes as land uses change within this area. Nutrient, pathogen and sediment loading reductions are expected to be complementary benefits to this approach.

Expected Outcomes

To establish management strategies and to better explain their reasoning, the following outcomes need to be achieved by this study:

1. Understand predicted runoff volumes and rates within this area for four conditions:
    a. Pre-settlement conditions: Primarily tallgrass prairie prior to pioneer settlement.

Volume Generated in Inches					
		Runoff Volume (inches x watershed area)			
Storm Return Period	Rainfall	Pre-settlement	Existing	Future w/no SQR	Future w/ SQR
1-year	2.67	0.18	0.75	1.46	0.81
10-year	4.46	0.89	2.02	3.07	2.11
100-year	7.12	2.49	4.27	5.61	4.38

Conversion of Rainfall to Runoff					
Storm Return Period	Rainfall	Pre-settlement	Existing	Future w/no SQR	Future w/ SQR
1-year	2.67	6.6%	28.2%	54.7%	30.3%
10-year	4.46	19.9%	45.4%	68.8%	47.4%
100-year	7.12	35.0%	59.9%	78.7%	61.6%

Increase in Runoff Volume from Pre-settlement Levels					
Storm Return Period	Rainfall	Pre-settlement	Existing	Future w/no SQR	Future w/ SQR
1-year	2.67		327%	727%	358%
10-year	4.46		129%	247%	138%
100-year	7.12		71%	125%	76%

Average Unit Peak Rates of Flow for 12 Microwatersheds in Area 601 (cfs per 100 acres drained)				
Storm Return Period	Pre-settlement	Existing	Future w/no SQR	Future w/ SQR
1-year	4	79	173	91
10-year	42	227	359	250
100-year	142	480	638	518

Increase in Peak Rates of Flow from Pre-settlement Level				
Storm Return Period	Pre-settlement	Existing	Future w/no SQR	Future w/ SQR
1-year		1912%	4332%	2216%
10-year		442%	459%	498%
100-year		230%	349%	265%

SQR = Soil Quality Restoration techniques applied to restore healthy topsoil layers to open spaces.

b. **Existing conditions:** Primarily agricultural row-crop uses with some areas reserved within a flood plain buffer.
c. **Future conditions:** Mainly low to medium residential growth with some commercial development. This case assumes that normal mass grading practices are used for development construction and minimal topsoil is replaced on the disturbed landscape.
d. **Future condition with soil quality restoration:** Similar to the conditions described in "c", except that it is assumed that techniques such as topsoil respreads or soil amendments are used to create a healthy layer of topsoil on the disturbed landscape.

2. Locate and size potential "regional" stormwater management practices (wet detention ponds). Determine the storage volume and outflow rates for these systems for the following conditions:
   a. Traditional stormwater management, with principal focus on management of larger storm events (5-year storms or larger).
   b. Use of the Unified Sizing Criteria from the Iowa Stormwater Management Manual to manage both small and large storm events. For this case, assume no soil quality restoration is completed.
   c. Use the Unified Sizing Criteria and implement soil quality restoration throughout this area.
3. Predict pollutant loads under existing and future conditions.
4. Determine expected load reductions that could be provided by regional stormwater management practices for conditions listed under "2a" through "2c" above.

Average Expected Unit Peak Release Rates of Flow for 12 Microwatersheds in Area 601 (cfs per 100 acreas)			
Storm Return Period	**Traditional**	**Unified Sizing Criteria**	**Reduction**
1-year	126	4	4
10-year	158	43	32
100-year	186	144	131

Rate Reduction vs. Traditional			
Storm Return Period	**Traditional**	**Unified Sizing Criteria**	**Unified Sizing Criteria w/SQR**
1-year		97%	97%
10-year		73%	80%
100-year		23%	29%

Summary of Methods

An area within subwatershed 601 was defined where smaller microwatersheds exist that are largely free of urban development. Boundaries of twelve microwatersheds were drawn based on available LiDAR topographic information. Ten of these areas have separate outlet points, draining either to Little Walnut Creek, or to storm sewers, culverts or ditches which also drain to that stream. The other two areas drain in a series with one common outlet point to the creek.

For this study, it is assumed that each of these microsheds will include one stormwater management area, likely a wet pond or other large "regional" basin for detention and retention of stormwater. These ponds would provide retention of water by holding a permanent pool. They provide detention by temporarily holding runoff from storm events in the additional storage created as water levels rise above the normal pool. For consistency of comparison, it was decided that the basin footprints would be adjusted as needed so that the water level rise caused by various storms would be as follows:

Projected Detention Footprint Area of 100-year High Water Elevation (as % of watershed area drained)			
Storm Return Period	**Traditional**	**Unified Sizing Criteria**	**Unified Sizing Criteria w/SQR**
100-year	4.61%	6.41%	4.60%

SQR = Soil Quality Restoration techniques applied to restore healthy topsoil layers to open spaces

Runoff rates and volumes were calculated for each microshed for each of the conditions listed under item 1 of the "Expected Outcomes" listed on the previous page. Methods listed within the Iowa Stormwater Management Manual were used to develop a preliminary sizing of the storage required for each basin, based on each condition listed under item 2 of "Expected Outcomes". A more refined design was developed by creating stage-storage relationships and an initial outlet design for each pond. Calculated stormwater flows were then routed through each basin and the outflow rates were reviewed based on meeting the requirements for each scenario. The results were reviewed and the basin designs were adjusted to attempt to design a basin with the smallest footprint which restricts flow for each storm event below the required limits.

Overview of Results

Stormwater Runoff Volume from Land Uses

Changes in land uses have fundamentally altered the way runoff is generated by rainfall events. These effects are expected to be most dramatic in the most commonly occurring storms, such as those that are less intense than the 1-year return period storm (2.67" in a 24-hour period). Volume increases of over 700% may be expected during the most commonly occurring events. Conversion ratios of rainfall to runoff during these common events may change from under 7% for pre-development conditions to above 50% for developed suburban conditions (assuming that little or no topsoil is placed uniformly over the landscape). Runoff volume increases for larger storms are less dramatic by proportion, but represent a larger change in total volume.

Projected Loading from Developing Case Study Area to Walnut Creek (in tons per year)			
Pollutant	**Traditional**	**Unified Sizing Criteria**	**Reduction**
Particulate Solids	28	8	71%
Total Solids	86	64	24%
Phosphorus	0.21	0.14	34%
Nitrate	0.30	0.30	0.2%

Stormwater Runoff Rates from Land Uses

Stormwater runoff rate increases are more dramatic than those for volume. As runoff is funneled quickly down roofs, driveways, gutters and storm sewers; a larger portion of runoff arrives at nearly the same time. This multiplies the effects of additional runoff volume. Again, these changes are largest in proportion during the more commonly occurring events. During the 1-year return period storm, runoff rates for fully developed conditions are likely 2000 – 4000% higher than pre-settlement conditions. Lower increases are expected if sufficient topsoil is placed back on the landscape after development to absorb rainfall and support healthy vegetation.

Comparing Basin Design Using Traditional Methods vs. ISWMM's Unified Sizing Criteria

In recent years, stormwater management has primarily been provided by installing detention basins, either as a regional practice or at an individual development scale. Typically, these facilities have been designed to prevent local flooding caused by large storm events. A common standard has been to design the basin to limit runoff from under developed conditions from very large events (such as the 100-year return period storm), to a rate similar to a smaller event under existing agricultural

conditions (often the peak rate generated by the 5-year return period under condition existing immediately prior to development).

The analysis completed as part of this plan indicates that if applied properly, traditional methods may provide adequate management of very large storm events. However, basins that are solely designed to manage runoff rates from large storm events may lack effective controls to adequately reduce runoff rates from the more frequently occurring storm events. Modeling results indicated these "traditional" basins may reduce peak flows from the 1-year return period event by less than 35%.

The Iowa Stormwater Management Manual (ISWMM) offers a different approach, which includes a tiered structure to manage both small and large storm events. This structure is called the Unified Sizing Criteria.

It divides management of storms into four categories:

- **Water Quality Volume** – Reduce pollutant loads by capturing and treating

Comparison of Values (With and Without Soil Quality Restoration)				
Unit	**Value**	**Without SQR**	**With SQR**	**Reduction with SQR**
Watershed Inches	1-year Runoff Volume	1.46	0.81	45%
	10-year Runoff Volume	3.07	2.11	31%
	100-year Runoff Volume	5.61	4.38	22%
Cubic Feet per Second	1-year Peak Inflow Rate	173	91	48%
	10-year Peak Inflow Rate	359	250	30%
	100-year Peak Inflow Rate	638	518	19%
Cubic Feet per Acre Drained	1-year Required Storage	3899	1806	54%
	10-year Required Storage	6579	3979	40%
	100-year Required Storage	11160	7502	33%

Drawdown Comparision – 1-year return storm event (average of basin results)				
	With SQR	**Without SQR**	**Increase Due to Increased Volume Without SQR**	
	Time (in hours)		**(in hours)**	**(by %)**
Time from peak of rain event to high water level	5.8	8.3	2.6	45.0%
Drawdown time from high water to 1' above normal pool	8.9	24.0	15.1	169.0%

Microwatershed with Land Use

Potential Practice Locations

Projected Sizes and Locations of Regional Stormwater Management Practices in the Developing Case Study Subwatershed								
		Storm Event Return Period						
		1-year		10-year		100-year		
Microshed	Area (acres)	Storage (cubic feet)	Peak Release Rate (cubic feet per sec.)	Storage (cubic feet)	Peak Release Rate (cubic feet per sec.)	Storage (cubic feet)	Peak Release Rate (cubic feet per sec.)	Surface Area* (acres)
601.41.01	259	510,000	6.3	1,082,000	51	2,075,000	210	10.6
601.31.02	168	301,000	5.5	677,000	41	1,325,000	158	7.2
601.31.01	92	225,000	7.5	404,000	57	684,000	267	4.1
601.21.11	52	102,000	1.3	215,000	12	412,000	52	2.5
601.21.01	103	202,000	2.5	464,000	15	863,000	69	4.6
601.02.71	18	26,000	1.1	66,000	8	118,000	41	0.9
601.02.61	7	10,000	0.5	22,000	6	43,000	17	0.3
601.02.51	47	82,000	1.5	185,000	13	358,000	54	2.3
601.02.41	45	70,000	2.0	161,000	18	309,000	81	1.9
601.02.31	45	70,000	2.0	170,000	14	330,000	57	2.0
601.02.21	71	127,000	2.3	286,000	18	550,000	77	3.3
601.02.11	52	108,000	1.7	229,000	14	424,000	66	2.5

Results shown assume that soil quality restoration has been applied to open spaces within these microwatersheds
* Surface area assumes that temporary storage depth of the 100-year return storm event does not exceed 5 feet above normal pool
Outflow from basin 601.31.02 drains into basin 601.31.01

Assessments completed as part of this planning effort have identified how many activities have great influence on the quality and quantity of water flowing through Walnut Creek and the impact that water has on property and infrastructure.

nine

PLAN IN PROGRESS
January 8, 2015

Policy Recommendations

Concerns

- Elevated pollutant concentrations
- Long-term cost to repair eroded stream corridors ($2-3 million/mile)
- 25% of sediment load to Walnut Creek may be attributed to construction site runoff
- Flood damage to buildings and structures
- Lack of access for maintenanceor repairs
- Damage to habitat and loss of resources

Policies

- Use new stormwater management guidelines in developing areas
- Reserve open spaces for flood plains and stream buffers
- Make improvements on points of emphasis for sediment and erosion control practices
- Protect or restore healthy topsoil layers on open spaces in developing areas
- Rural management strategies

Outcomes

- Where implemented runoff is captured, filitered and reduced for more than 90% of all storm events
- Reduction in rapid bounce in water levels in small tributaries
- Establish a more natural pattern of flow in developing areas
- Lower the potential for costly stream bank and channel erosion
- Sediment loading related to construction sites and streambank erosion minimized
- Reserved spaces for access and improvements
- Limit placement of new structures or restrictions within the flood plain

Introduction

To address identified concerns, changes are necessary to methods of stormwater management, flood plain and stream buffer protection, construction site pollution prevention and soil quality management / restoration. Within these areas, it is unlikely that required changes can be fully implemented on a voluntary basis. This chapter outlines policies and ordinances which are recommended to be enforced in order to achieve the desired results.

Policies for Urban Areas

Stormwater Management

Modeling of the urban and developing priority subwatersheds has demonstrated that traditional stormwater detention practices have limited ability to control runoff for the most commonly occurring, small storm events. Rainfalls of 2.5" or less make up more than 98% of the precipitation volume in Central Iowa. Most streambank erosion occurs during the rapid rise and fall of streams during these types of events. To stabilize flowrates in urban tributaries, adopting policies that address these events is critical. Therefore, this plan recommends all communities within the watershed adopt the Unified Sizing Criteria, as described within the Iowa Stormwater Management Manual (ISWMM).

This standard would provide for the following:

- Water Quality Volume: Capture and treat runoff expected to be generated by a 24-hour, 1.25" event. Over 90% of all precipitation in Central Iowa can be attributed to these types of events.
- Channel Protection Volume: Provide extended detention of the 1-year return period storm, with slow release over a period of between 24 and 48 hours.
- Overbank Flood Protection: Limit peak runoff rates for the 2-, 5- and 10-year return period events to pre-settlement levels. Pre-settlement levels should be determined by calculating the time of concentration (use the NRCS lag equation based on pre-settlement conditions) and selecting Curve Numbers (use a CN of 58 based on meadow in good condition) in order to model such conditions. Refer to the ISWMM manual for additional information.
- Extreme Flood Protection: Limit peak runoff rates for the 25-, 50- and 100-year return period events to the lesser of pre-settlement values for the same storm event OR the values calculated for the 5-year return period event under existing (agricultural) conditions (calculate time of concentration and CN based on current conditions).

Application

This plan recommends ordinance and policies be implemented to apply these standards to all new developments. Each community should identify how these standards will be applied to redevelopment sites, allowing past calculation methods to be amended to reflect redevelopment changes where new impervious areas are below a set threshold (perhaps 10,000 SF of new impervious area). Above such a threshold, stormwater management practices would be required to meet the new recommended standards .

Expected Impacts

- Little or no direct surface runoff during rainfall events that are equal to or less than 1.25" in depth.
- Over 95% reduction in peak flow rates for the 1-year return period storm event (less flashy streams).
- Approximately 70% reduction in peak flow rates for the 10-year return period storm event.
- Approximately 20% reduction in peak flow rates for the 100-year return period storm event.
- If topsoil or soil quality restoration policies are not implemented, total area devoted to stormwater detention features may increase approximately 1.8 acres per 100 acres developed.
- Measureable reductions in nutrient, pathogen and sediment pollution are expected.
- Streambank and gully erosion rates should be reduced due to lower stream flow rates and velocities.
- Can be implemented either regionally, or within each individual development. However, regional basins may require less total area dedication and provide for more certain execution of long-term maintenance .

One Page of Graphics and Charts to Support this Policy

- Multistage Outlet Graphic
- 601.41.01 (Comparison Graph)

Flood Plain Protection

Local policies and ordinances should be adopted or amended to protect flood plains in the following ways:

- Reduce structural and property losses during major flood events by preventing construction of new privately owned structures within the limits of the 100-year flood plain.
- Maintain flood storage capacity by limiting grading or placement of fill materials within the flood plain.
- Identify areas of active stream movement and reserve areas as open space where future stream movement or flood plain inundation is expected.
- When establishing flood protection elevations, provide at least an additional foot of vertical separation between regulatory 100-year flood elevations and required building protection elevations to account for flow increases predicted by use of NOAA Atlas 14 data.

Application

This plan recommends implementing ordinance and policies to apply these standards to all new developments and where land subdivisions are planned to occur adjacent to streams.. Existing structures which fall within these protection zones should be identified. Past known damages to such structures may be reason to pursue opportunities to acquire and remove such structures to avoid recurrent damages.

Expected Impacts

- Reduced potential for damages to buildings, property and other infrastructure during flood events .
- Maximized capacity for storage and conveyance of large flood events.
- Reduced risk of higher velocity flows or reduced travel times being created due to narrowing of the flood plain.
- DEVELOP TEXT FOR THIS SECTION

One Page of Graphics and Charts to Support this Policy

Stream Buffer Protection

Stream buffers should be established, either by public land acquisition or through reservation as permanent easements as public or private open space. These buffers should be created along all first, second and third order streams, as well as any existing or created open drainage course with a drainage area that is larger than 40 acres. Local policies and ordinances should be adopted or amended to establish protected stream buffers.

Stream buffers should be wide enough to serve the following functions:

- Include the entirety of the regulatory 100-year (1% annual recurrence) flood plain OR where regulatory flood plains do not exist, include areas expected to be inundated by a 24-hour, 100-year return period storm event (flows calculated using the NRCS TR-55 method for fully developed conditions). Consider inclusion of the regulatory 500-year (0.2% annual recurrence) flood plain within the protected buffer.
- Allow for expected stream migration, based on recent movement patterns or historic stream channel locations.
- Provide enough width for future streambank improvements. This plan recommends setting a line based on the existing streambank toe locations, or a line that accounts for expected future movement of the streambank toe. From that line, the buffer should include all land which falls between the stream and a projected slope line from the established toe baseline to the surface of the surrounding area. The slope line should not be steeper than a rate of 4 (horizontal) to 1 (vertical).
- Allow width within the stream buffer for a minimum 15' cleared maintenance path on at least one side of the stream, with a cross slope not to exceed 5%, to allow for access by trucks, tractors and other maintenance equipment. Along streams of first order or higher, these maintenance paths should be provided on both sides of the stream. These paths may be either undeveloped paths, kept clear of trees and brush by annual mowing or paths which are surfaced with pavement or gravel.
- Provide a minimum five foot setback outside of the maintenance path to the edge of the reserved buffer, on the side opposite the stream from the path.
- For engineered channels in developing areas, construct channels as bioswales where feasible to improved volume reduction and water quality treatment. Refer to the ISWMM for feasibility review and design procedures.
- Program annual maintenance to remove invasive species and improve establishment of erosion resistant surface vegetation within protected buffer zones.
- In all cases, provide a minimum 50 foot building setback from the existing top of bank for a first order stream. Provide a minimum 100 foot building setback from the existing top of bank for second and third order streams.

Application

This plan recommends applying these standards to all new developments and where land subdivisions are planned to occur adjacent to streams subject to these provisions. Existing structures which fall within these protection zones should be identified. Past known damages to such structures may be reason to pursue opportunities to acquire and remove such structures to avoid recurrent damages.

Expected Impacts

- Reduced potential for damages to buildings, property and other infrastructure during flood events.
- Maximized capacity for storage and conveyance of large flood events.
- Improved access for maintenance and ability to complete any necessary repairs.
- Improved filtration of stormwater runoff through properly designed channels.
- DEVELOP TEXT FOR THIS SECTION

One Page of Graphics and Charts to Support this Policy

Develop a Cross-Sectional Graphic of a Stream Buffer

Construction Site Pollution Prevention

Construction site runoff has been identified as one of the largest sources of sediment loading within the urban environment. Many strides have been made over the past two decades in the development and implementation of stormwater pollution prevention plans (SWPPPs). While most sites are applying for required permits and preparing SWPPPs, there appears to be room for improvement in installation and maintenance of adequate erosion and sediment best management practices (BMPs). Erosion control practices protect the surface of the ground from being displaced by the force of falling precipitation or flowing water. Sediment control practices are intended to collect polluted runoff for a period of time, allowing suspended pollutants to settle out of runoff before it is allowed to leave a construction site.

Improvements are recommended in implementation of erosion control practices:

- Consider stormwater management early in the site design process. Look for ways to minimize the footprint of disturbed areas, lessen grading volumes and reduce impervious surfaces.
- Develop and implement a Soil Management Plan (SMP), with the goal of providing healthy soils across all open space areas on developed landscapes before construction has been completed.
- Where upstream areas drain through a construction site, stage construction to avoid disturbance to the flow path or provide stabilized methods to divert stormwater around or through site construction.
- Increase the use of temporary seeding and mulches. Use of adequate temporary mulch has been shown to reduce surface erosion by up to 98% compared to sites with no erosion controls. State law currently requires that disturbed areas where grading activities cease for a period of longer than 21 days shall have temporary stabilization (such as mulch with seed) applied within 14 days after the last grading activity. Many sites are currently not providing adequate temporary stabilization measures to comply with this requirement.
- On steeper slope areas or in areas of concentrated flow, increase the use of

rolled erosion control products (RECPs) and turf reinforcement mats (TRMs) where temporary mulch may be insufficient to prevent erosion.

Recommended improvements for sediment control practices:

- Prior to commencing land disturbing activities, install perimeter site controls (such as silt fences , filter socks, wattles and sediment basins), stabilized construction entrances, trash collection areas and temporary sanitary facilities for site workers.
- Install interior site controls as soon as allowed by grading or utility construction.
- Don't overload controls. Refer to design guidelines for sizing and design. For example, provide at least 100 feet of silt fence length for each quarter acre drained.
- Silt fences should feature "J-hooks" or other methods to increase their storage capacity and prevent concentrated flow from larger areas being directed to a single low point in a long fence. Silt fences often fail when they "blow out" when they have collected too much runoff or sediment, because the area they collect runoff from is too large. Silt fences should have these features placed at intervals of no greater than 200 feet.
- Use soil logs or wattles to break up the length of steeper slopes. Reducing the flow length along steep slopes can significantly reduce surface erosion.
- State law requires sediment basins to be installed where runoff from more than 10 disturbed acres is routed to a common outlet. These basins are to be designed with floating outlets or devices that collect water from the surface of ponded water. As pollutants settle out by gravity, the surface of the ponded water tends to be less polluted than that discharged from the bottom of the basin. Few of these types of outlets are being utilized currently. Also, as properly sized basins are often most effective at removal of suspended sediment from constructed runoff, it is recommended that new local policies be implemented to require their use in smaller disturbed areas.

- All site controls should be checked on a weekly basis and before rainfall is expected to make sure they are in good working order. Controls should be maintained and repaired promptly as needed. Trash and sanitary collection facilities need to be emptied routinely and collected materials disposed of properly. Stabilized entrances may need new surface aggregate provided is they are failing to prevent off-site tracking from occurring.
- When dewatering excavations, divert discharge to a sediment basin or other collection area on-site. Do not directly discharge such water to the storm sewer system without treatment. Avoid releasing concentrated flows at the top of steep slopes where gully erosion may be caused.
- Immediately following full establishment of permanent vegetation, all temporary controls such as silt fences, soil logs, inlet protection devices should be removed. Accumulated sediment should be properly disposed.

Recommended improvements to SWPPPs:

- The plan should be a "living document". The plan should be amended in some fashion so that the site map reflects current site conditions. Inspection records and changes to the sequence of construction events should be made part of the SWPPP document.
- The SWPPP and all site controls are to be maintained as necessary until full establishment of vegetation across all disturbed areas. Site inspections and maintenance of controls should continue until all areas are stabilized with permanent vegetation and the Notice of Discontinuation (NOD) has been filed with the Iowa Department of Natural Resources.

Recommended improvements to municipal inspections:

- Routinely check sites to assure that construction sites are in compliance with state and local standards.
- Respond promptly when polluted site runoff or off-site tracking is observed, or citizen complaints are received.
- When necessary, use "stop work orders" and other methods to bring sites back into compliance before work on other construction items can proceed.

Application

The plan recommends ordinance and policies be implemented that would apply these standards to all sites requiring either a local grading permit or authorization under the State of Iowa's NPDES General Permit No.2 (construction sites or common plans of development which will disturb at least one acre).

Expected Impacts

- Successful implementation of these policies could reduce sediment loadings from construction sites by 80%.
- Modeling indicates that such an improvement may reduce total annual sediment loadings within the Walnut Creek watershed by 20%.

One Page of Graphics and Charts to Support
Recommended Improvements

Soil Quality Management and Restoration

Recently, requirements within the State of Iowa's NPDES General Permit #2 for construction sites were amended. These changes removed a requirement to restore four inches of topsoil across disturbed open spaces. The permit now requires that topsoil be preserved on site where feasible, but does not specify where and how that topsoil is to be placed or preserved. During the discussions leading up to these changes, many concerns were raised by the development and real estate interests about the cost and timing of restoring topsoil, especially on finished lawn spaces within single-family land developments. Given that discussion, it can be assumed that with the changes in permit language, topsoil will likely be preserved within berms or other confined areas and will not be placed uniformly across the landscape. This means that many open spaces will lack the healthy soil material needed to support the growth of lawns and landscaping. Should this occur, the soil will have limited ability to absorb runoff during rainfall events (runoff volumes may be increased by more than 80% during the most commonly occurring storm events). Higher levels of watering and fertilization will be necessary to support desired plant materials. All of these factors have the potential to increase stormwater runoff volume and pollutant loads.

For this reason, it is recommended that communities implement local ordinances to protect or restore healthy soils in open space areas. The Iowa Stormwater Management Manual has an entire chapter devoted to the topic of maintaining and restoring healthy soil profiles. Options include limiting the footprint of land disturbance, topsoil stripping / replacing and using soil amendments like compost and sand to rebuild a healthy surface topsoil layer.

To fully realize the benefits of soil quality restoration, the methods within ISWMM manual list various ways to maintain or create eight inches of a healthy soil profile across the surface. Requirements to achieve this standard can be incorporated into other ordinances, or implemented as a stand-alone ordinance.

Such requirements should include the following elements:

- All construction sites which are subject to local grading permit or State NPDES permit requirements should develop and maintain a Soil Management Plan (SMP) which becomes a part of the SWPPP document when one is created for a given site.
- The SMP shall review soils information from county maps, geotechnical studies or other sources to identify where higher quality soils may exist. When possible, the organic content of onsite topsoil material should be determined by testing.
- To the extent possible, site improvements should be oriented to minimize disturbance of high quality soils. Site grading should be planned to avoid compacting, filling or tilling under the drip line of trees which are identified as being intended to be preserved through construction.
- Identify where topsoil will be stripped, stockpiled and replaced. The quantity of stockpiled material should be estimated.
- Where grading is necessary, show the location and type of method of Soil Quality Restoration (SQR) to be applied (reference ISWMM chapter to see the available methods and how they are achieved).
- In some locations, it is possible to use SQR techniques to partially or totally address the Unified Sizing Criteria requirements to manage the Water Quality Volume. If this is proposed, identify locations where SQR techniques are intended to be used to meet such requirements. Include relevant calculations to demonstrate compliance with requirements listed in the ISWMM manual within a stormwater management report submitted to the local jurisdiction for review.
- If SQR techniques are not proposed, or not applied, appropriate adjustments to runoff coefficients and curve numbers within stormwater design calculations should be made to account for the effects of soil compaction and poor establishment of vegetation. The ISWMM manual includes recommendations on how to account for these effects.

Soil Quality Restoration Graphics

Application

It is recommended that ordinance and policies be implemented that would apply these standards to all sites requiring either a local grading permit or authorization under the State of Iowa's NPDES General Permit No.2 (construction sites or common plans of development which will disturb at least one acre).

Expected Impacts

- It is expected that successful implementation of these policies could reduce runoff volumes from suburban development areas by approximately 45% during a 1-year return period storm event (2.67" in 24-hours). This would be a volume reduction of 17,600 gallons per acre drained for that event.
- Runoff reduction from areas developed using these policies during the 100-year return period storm event (7.12" in 24-hours) would be expected to be approximately 20%, compared to sites without soil quality restoration. This would be a volume reduction of 33,400 gallons per acre drained for that event.
- Total pollutant loading would be expected to be reduced by an amount similar to runoff volume reductions.
- Stormwater detention areas and other management practices can be reduced in storage volume and footprint area. Modeling results from the developing case study area indicate that stormwater management areas in areas without soil quality restoration would need to have 48% more volume and be 40% larger in area to limit runoff rates to desired levels.

Policies for Rural Areas

Rural Policy Recommendations

Over the next decade, it is expected that most water quality improvements will rely on voluntary actions taken by individual farmers and landowners. To support and accelerate the implementation of this plan, a series of policies and action items has been identified.

1. New sources of financial support are needed to support water quality improvements in rural areas. Many practices known to be effective at reducing pollutant loads and/or runoff volumes, but several of these have costs associated with their installation or the lost potential for agricultural production. There are many economic factors which may make it more difficult for farmers and land owners to commit to investing in these practices. Low crop prices may leave little room above the "bottom line" to devote to water quality initiatives. With higher prices, there is incentive to maximize productive land, potentially reducing available for buffers and other practices. Federal, state and local resources can be used to bridge this gap and provide water quality and quantity benefits that are important to the entire watershed.

Some alternatives for funding are listed below:

- Iowa Department of Agriculture and Land Stewardship provides grant opportunities for practices that support the Water Quality Initiative (WQI) Nutrient Reduction Strategy Practice Implementation and Demonstration Program. At the time of this plan's writing, Polk Soil and Water Conservation District received a grant from this source of nearly $200,000 to help implement best practices within the watershed.
- The Iowa Soybean Association has recently proposed a series of tax credits for farmers who install selected best management practices. Within the last year, these credits were included in House Study Bill 251 which would place emphasis on practices that are expected to provide multiple benefits and yield the highest levels of nutrient reduction.
- The Natural Resources and Outdoor Recreation Trust Fund (which was authorized by voters in 2010, but has not been funded as of this date) could be used to fund a variety of urban and rural water quality improvement. By law, money placed in the fund must be spent on a variety of conservation practices and improvements, many of which would have a direct benefit to water quality.
- The Iowa League of Cities has been working on a water quality offset exchange which would allow public water utilities or other municipalities to develop water quality projects in upstream areas that would have quantifiable nutrient reduction benefits. This or some other nutrient trading system could be used in the Walnut Creek watershed to develop rural-urban partnerships to creatively fund practices which address water quality and/or quantity.
- There are several other grants and cost sharing programs that are in place, some of which have funds targeted for use in the Walnut Creek watershed. However, with the projected cost to implement improvements broadly within

this area, there is a need for additional programs to be implemented.

2. Develop private and public partnerships to develop precision business planning for agricultural areas, targeting those areas which currently farmed on an annual basis, but are routinely not profitable to the producer. These lands could potentially be set aside for water quality practices such as conservation easements, wetlands, buffers, etc.

3. Additional educational materials are needed that better explain the best management practices that are included in the nutrient reduction strategy: what they are, where they are best applied, how they work, their benefits and liabilities, and where interested groups can seek out more information for funding or constructing such practices. The need for such materials extends beyond the boundaries of this watershed.

4. More information on existing research needs to be accessible to explain to producers and landowners what would be considered "natural" levels of nutrient loadings and how current agricultural practices have been shown to impact these levels.

5. Develop a stream buffer policy for voluntary implementation of stream buffers and grass waterway improvements throughout the watershed. It would be recommended to provide a minimum 50 foot buffer on either side of all streams which are first order or larger, or any stream noted as "zero order" within this plan which has a perennial flow. Also, it is recommended that grass waterways or other buffers be provided along the remaining "zero order" streams so that they are protected for a width of one rod (16.5 feet) on either side of the stream.

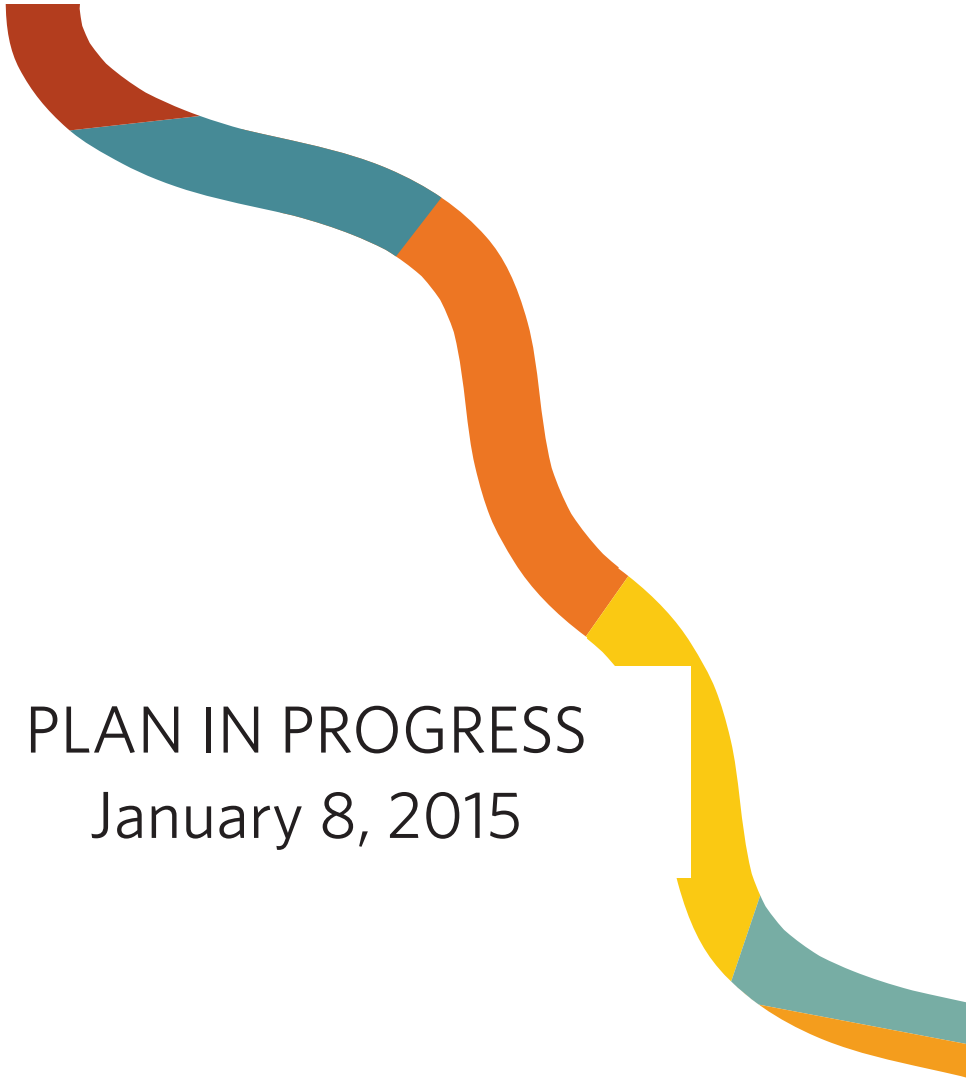
6. Practices that improve soil health and address water management have benefits beyond water quality and quantity improvements that should be pursued.
   - Maintaining and improving the structure and organic material within the upper soil profile is key to sustaining agricultural production into the foreseeable future. Practices such as extended crop rotations may cause short term reductions in yield when fields are used for alfalfa production, but long-term benefits in soil depth and quality are likely to be realized.
   - Saturated buffers and other methods of subsurface water control also can offer reduce risk of crop losses. It has been identified that over the past sixty years, significant crop losses can be attributed to either excess or insufficient moisture. In the past, field moisture management has often been focused on drying fields out during wet years. The importance of having the ability to retain moisture during drought conditions should not be overlooked. Drought has historically been a larger cause of crop losses than either excess moisture or flooding.

Portion of All Crop Losses Reported that are Related to Drought, Excess Moisture or Flooding

Cause of Crop Loss	Iowa Corn (1948-2010)	Iowa Soy (1995-2010)
Drought	40%	28%
Excess Moisture	27%	27%
Flooding	6%	6%

Source: "Managing Risk in Agriculture"; Chad Hart; Presented at Ag Credit School; Ames, Iowa; June 2013.

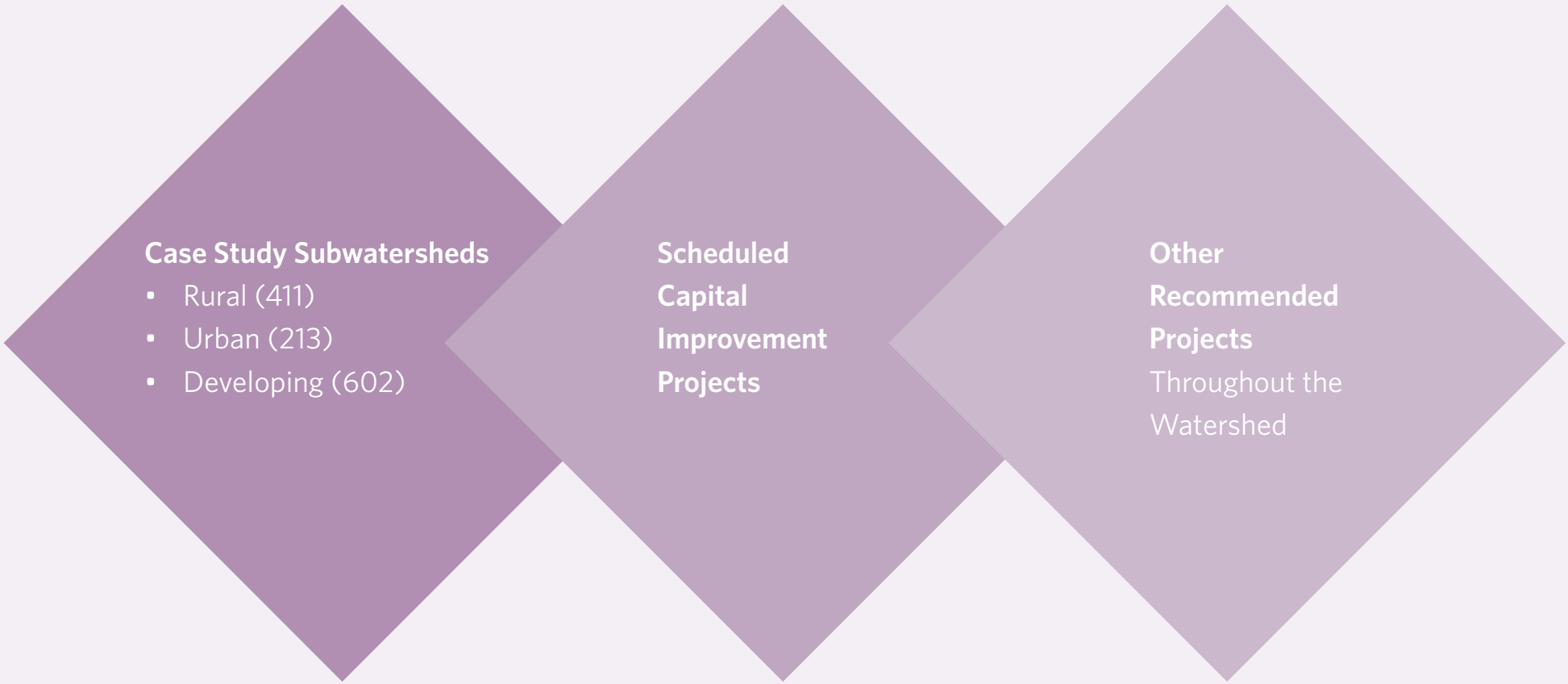
This chapter briefly outlines key improvement needs that have been recommended to meet the goals of this plan. Many of these projects have been identified during the development of this plan. Some of the listed projects have already been included within the Capital Improvement Plan (CIP) budgets of the various communities within the watershed. It is intended that most or all of these projects would need to be completed within the next ten years (prior to the end of 2025), in order to achieve the desired water quality improvements within case study watersheds as well as make progress toward water quality goals within the Walnut Creek Watershed as a whole.



PLAN IN PROGRESS
January 8, 2015

Projects and Priorities

10-Year Implementation Plan



Location Map of Case Study Subwatershed
Not sure where this is located?

Rural Case Study – Subwatershed 411

The following table lists practices that are included in the "model plan", one method to achieve the desired water quality improvements, as measured at the outlet point from this case study subwatershed. The cost of these practices includes the sum of all annual costs (including lost crop yields and the cost of implementing the practices) over the next ten year period (2016-2025). Note that negative cost values indicate that the practice would produce an overall cost savings if implemented.

Rural Case Study – Subwatershed Scale Practices			
Portion of Subwatershed to be Applied	**Acres to be Applied**	**Practice**	**Cost**
10%	415	Extended crop rotations (include alfalfa in 2 years of a 5 year rotation)	$70,000
20%	830	Split seasonal N apllications	-$40,000
25%	1,040	Cover crops (winter rye or oats)	$260,000
25%	1,040	Increased use of nitrification inhibitors	-$15,000
35%	1,455	Increased us of "no-till" practices	$100,000
50%	2,075	Adjust nitrogen application rates	-$20,000
		Subtotal	**$835,000**

Rural Case Study – Microwatershed Scale Practices		
Microwatersheds	**Project Description**	**Cost**
411.01, 411.04, 411.05	Convert 20 acres of steeper slope cropland into CRP or permanent conservation easement.	$55,000
411.04, 411.05	Install saturated buffers to treat runoff received from 442 acres of upslope areas.	$60,000
411.02, 411.03, 411.11, 411.31, 411.32, 411.33, 411.41	Install bioreactors to treat subsurface drainage received from 311 acres of upstream land area.	$140,000
411.12, 411.21, 411.32, 411.33, 411.42, 411.51, 411.52, 411.61, 411.71	Install grass waterways along 90% of the "zero order" streams within these areas. Estimated length required = 34,200 feet (6.5 miles)	$400,000
411.05, 411.06	Construct water quality wetlands to treat runoff from 633 acres of upstream land areas.	$180,000
	Subtotal	**$835,000**

Rural Case Study – Project Priorities			
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Project Description**	**Cost (2015)**
		COMPLETE TABLE AFTER MEETING WITH LOCAL LANDOWNERS	

Rural Case Study – Other Recommended Practices		
Microwatersheds	**Project Description**	**Cost**
411.04, 411.05	Modify an existing engineered stream channel to a two-stage ditch design to treat runoff along stream corrider receiving runoff from 2, 244 acres of land.	$250,000
411.01, 411.02	Targeted streambank stabilization and restoration practices along a 1-1/2 mile of stretch of stream.	$950,000
All subwatershed areas	Install or modify outlets to include multi-stage design to more effectively manage the more commonly occurring rainfall events.	$225,000
	Subtotal	**$1,425,000**

Practice Location

Urban Case Study – Subwatershed 213

The following table lists structural improvements that are recommended to achieve the desired water quality improvements, as measured at the outlet point from this case study subwatershed. Other site level water quality retrofits could help achieve the desired load reductions, however the cost of such improvements to private landowners may limit their implementation. Such practices should be encouraged, but are not relied upon for implementation of this plan.

Urban Case Study – Project Priorities			
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Project Description**	**Cost (2015)**
1	213.41 1-78-26 West Des Moines	Complete concept plan or more refined preliminary design for three pond outlet / culvert entrance modifications discussed in case study modeling.	$15,000
2	213.41 1-78-26 West Des Moines	Modify pond outlet at West Lakes Office Park Plat 3, Outlot Z to feature multi-stage design for better management of 1-year return period storm event.	$40,000
3	213.41 1-78-26 West Des Moines	Modify pond outlet at 6400 Westown Parkway to feature multi-stage design for better management of 1-year return period storm event.	$40,000
4	213.41 1-78-26 West Des Moines	Modify culvert inlet south of 1801 68th Street to feature multi-stage design. Add storage volume upstream of amended structure through grading.	$200,000
5	213 -- Clive / Waukee / WDM	Complete more detailed study identifying additional opportunities for outlet structure amendments and checking for impacts on large storm water levels.	$30,000
6	213.01 31-79-25 Clive	Complete channel restoration and repair of South Walnut Creek, downstream of Country Club Lake within Clive Greenbelt. (5,300 feet)	$2,500,000
7	213.22 36-79-26 Clive	Complete urban small tributary channel restoration and repair from NW 156th Street to trail crossing 1,100 feet downstream.	$300,000
8	213 -- Clive / Waukee / WDM	Implement pond outlet and culvert inlet modifications at sites identified by study (project #5). May be multi-phase implementation.	$750,000
9	213.31 36-79-26 Waukee	Complete urban small tributary channel restoration and repair downstream of Southfork Pond to Brentwood Drive. (600 feet)	$350,000
10	213.22 / 213.21 36-79-26 Clive	Complete urban small tributary channel restoration and repair between NW 149th Street and Lakeview Drive. (3,000 feet)	$1,350,000

Practice Location

Developing Case Study – Subwatershed 601

The following table lists the expected cost of stormwater management practices, as preliminarily designed to meet the ISWMM Unified Sizing Criteria.

Developing Case Study – Project Priorities			
Project #	Microwatershed Section-Township-Range Jurisdiction	Project Description	Cost (2015)
		DEVELOP	

Practice Location

Other Recommended Projects

The following table lists other key projects required to protect infrastructure or to address critical areas related to erosion reduction, streambank stability or water quality improvements.

Urban Case Study – Project Priorities			
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Project Description**	**Cost (2015)**
1	612.01 28-79-26 Waukee	Repairs and channel improvements to address severe erosion downstream of the dam for a private pond. Tributary to Little Walnut Creek, just west of Warrior Lane.	$350,000
2	611.21 26-79-26 Waukee / Clive	Channel repairs and restoration to address severe bank erosion and downcutting close to sanitary lift station. Located west of Berkshire Parkway.	$750,000
3	201.01 34-79-25 Clive	Channel repairs and restoration along outer bend of Walnut Creek east of north end of NW 90th Court. (Downstream of 2015 improvements).	$200,000
4	212.01 33-79-25 Clive	Channel repairs and improvements along Living History Creek, specifically along segment which parallels sanitary sewer alignment along north side of abandoned railroad grade.	$500,000
5	511.03 25-79-25 Urbandale	Study to review potential to construct water quality ponds to reduce bacteria and sediment loading along Rocklyn Creek on upstream side of 70th and 72nd Streets.	$30,000
6	601.02 22-79-26 Clive	Streambank restoration and improvements within the Clive Greenbelt corridor along Little Walnut Creek between Warrior Lane and NW 170th Street.	$1,750,000
7	511.03 25-79-25 Urbandale	Construct water quality pond along Rocklyn Creek on upstream side of 70TH Street (if feasible).	$750,000
8	2511.03 25-79-25 Urbandale	Construct water quality pond along Rocklyn Creek on upstream side of 72ND Street (if feasible).	$750,000
9	502.02 26-79-25 Urbandale	Streambank restoration and improvements to address streambank erosion and incision within the greenbelt corridor along North Walnut Creek between 86th Street and Hickman Road.	$2,000,000

Practice Location

Current Capital Improvement Projects

This table includes projects which have already been included by various communities within their Capital Improvement Plans. These projects are expected to be implemented over the next five to ten years and offer benefits related to the stated goals of this plan.

Watershed Level - Current Capital Improvement Plan Projects			
Project #	Microwatershed Section-Township-Range Jurisdiction	Project Description	Cost (2015)
		DEVELOP	

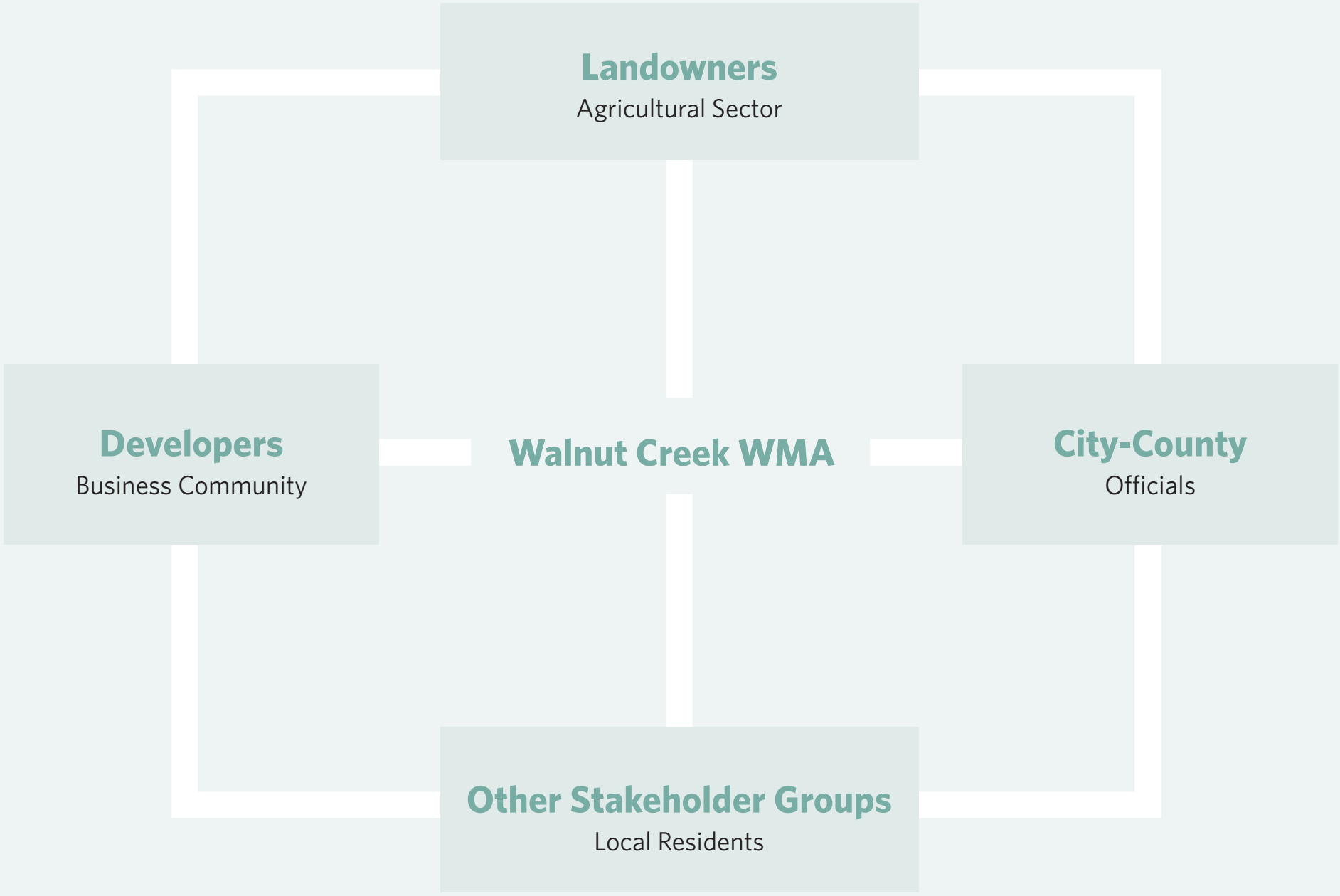
Practice Location

The following education and collaboration plan looks at four audiences with farmers, developers, and policy-makers (primarily council members, county supervisors, and SWCD commissioners) as the priority audiences. The "general public" is a catch-all for Walnut Creek watershed residents and business owners. Due to recent flooding, increasing erosion, and news accounts of water quality problems in Iowa, a subset of residents and business owners will likely be particularly responsive to learning more about their role in the Walnut Creek watershed.

PLAN IN PROGRESS
January 8, 2015

eleven

Education and Collaberation Plan


Landowners
Agricultural Sector
Developers
Business Community
Walnut Creek WMA
City-County
Officials
Other Stakeholder Groups
Local Residents

We do not yet know what the future will bring in terms of staff support for the various WMAs forming in Central Iowa.

This portion of the plan assumes some "watershed coordinator" staff time will be available to the Walnut Creek WMA (at a minimum, in partnership with other WMAs) to execute education tactics such as:

1. Work Sessions
2. Field Days
3. "Speed Dating" Sessions with Farmer, Elected Official, Developers, etc.
4. Developing Support from/through Current Staff
5. Incentives to Try Practices on Their Own
6. Local Television/Media
7. Panel of Experts

More general communications methods, and more specific "plan launch tactics" are described below for the primary audiences.

Landowners/Agricultural Sector

The education plan for agriculture and rural land identifies the following key messages for this audience:

1. Resources – There are extensive existing informational and teaching resources to ensure that practices are implemented correctly. There are also existing financial resources that can be utilized to address cost concerns.
2. Concerns with Land – The strategies targeted in this watershed management plan will ensure that soil and nutrients will remain in the upper watershed. This supports sustainable land use practices and agricultural yield potentials in the near term and for the following generations.
3. Partnerships & Collaboration – Partnerships with other producers or land owners allows cost sharing and efficiency for the implementation of certain practices. Additionally, landowners in this watershed have asked for bus tours/information exchanges (urban/rural) and a seat at the research development and analysis table. This plan hopes to assist.
4. Range of Solutions – There are a range of solutions available to mitigate certain concerns. A "one size fits all" approach does not apply. Given a range of potentially effective options, each land owner can find and decide upon which practice(s) they are most comfortable with for implementation. Information currently "buried" in the nutrient reduction strategy that pairs BMPs and their anticipated N/P reductions should be delivered to each landowner in the watershed. (See Tactics below).
5. Why to Care – What is the legacy you are leaving for the future generation of producers?
6. Opportunities for Partnership Using Existing Entities – Agencies and trade groups, such as the NRCS or the Iowa Soybean Association, already have the infrastructure for building partnerships with individuals or groups of producers.

Plan Launch Tactics

Early tactics for information distribution and primary information sources:

- A follow-up meeting at the Heartland Co-op to share the preliminary results of the plan and the early strategies for increased monitoring to get direct input into that aspect of the plan (thus providing the research "seat at the table"). Execute this in partnership with ISA, Heartland Co-op, Polk/Dallas SWCD. Begin with sharing "emerging themes" from the landowner meeting.
- Through ISA/Co-op or other means, directly distribute highlighted pages of the Nutrient Reduction Strategy that feature BMPs and associated N/P reductions. Present at meeting described above. Secure permission and post on-line. Distribute directly, by mail or other method as recommended by commodity group partners.
- Secure slot on Farm Bureau county meeting agenda(s) to present plan results.
- In partnership with ISA, Dallas/Polk SWCD, and the Heartland Co-op, identify a communications "task force" to develop (minimally) an annual bus tour.
- Identify (minimally) 3-5 area conservation farmers/landowners with best practices in place, and encourage their participation as watershed-educators through presentations, field days, and dialogue in their commodity group organizations. Research the viability of contracting with landowner-educators to secure ongoing participation.
- Additionally research the viability of partnership through Iowa Flood Center, ISU and other entities to bring researchers to the watershed for interactive presentations about research methods and encourage mutual exchange.

- Work in partnership with the Greater Des Moines Partnership's planned landowner dialogues to bring the Walnut Creek farm community to that table.

Additional methods of ongoing communication include:

1. Direct Mail
2. Informational Meetings
3. Focus Groups
4. Outreach via Agricultural Retail – USDA, SWCD, etc.
5. Field Days
6. Surveys
7. Website/Social Media
8. Workshops
9. Speaker Series
10. On Farm Learning Network

Developers and Business Community

Brief descriptions of the education elements applicable to this group are presented below. In this instance, these elements present a mix of key messages and long term strategies. These elements will assist in establishing greater consistency in the ordinances/guidelines throughout the WMA jurisdictions.

1. Resources – There is extensive informational and teaching resources to ensure that practices are implemented correctly. Additionally, once consistency in implementation throughout the watershed is achieved, developers will enjoy an increased efficiency when navigating standards and submittals.
2. Potential to Streamline the Review Process – Consistent standards will assist with streamlining the review process.
3. Review of Current Policies – Reviewing current policies while getting the business community involved will educate this group, as well as give ownership and involvement to the overall process.
4. Public Health – Making a connection between the health of the waterways and overall public health will help make a connection to the public, which builds advocacy. The developer and business community will have this information to take into consideration as they move forward with developments.
5. Why Regulations Exist – Educate regarding the negative effects that would result if regulations did not exist. Visual representations will be the strongest with this group.
6. Demonstration Opportunities – If practices are implemented within the property, it allows the owner to demonstrate their practice and get recognition throughout the community.
7. Previous Studies – Educate regarding the positive outcomes of previous studies performed with certain practices.
8. Partnership Opportunities and Outreach to Clients – This will allow partnerships between businesses for shared costs and provide another avenue to connect with potential clients and customers.
9. Triple Bottom Line – The triple bottom line consists of three P's: profit, people and planet. Education on effective watershed management practices aims to demonstrate that the financial, social and environmental performance of the corporation can improve over a period of time.

Plan Launch Tactics

Early tactics for information distribution and primary information sources:

- In partnership with other jurisdiction(s)/organizations, or as a stand-alone task force, convene Walnut Creek area developers for a special interactive presentation on the existing conditions findings and results of the Walnut Creek Watershed Plan.

  As part of this presentation/summit or short term education series:

  - Include data on development growth and degradation in water management over time. Emphasize the necessity of new developments needing to achieve new results in stormwater management for prevention of additional flood damages and water quality degradation.
  - Encourage developer participation in bus tour and other landowner/farmer/policy maker interactions (see above).
  - Provide education on strengths and challenges of Storm Water Protection Plans (SWPPPs) and provide case studies of successful SWPPP applications and where SWPPPs have commonly "gone wrong." Acknowledge the ongoing concerns that have surfaced as part of

this planning process related to potentially compliant, but perhaps ineffective, SWPPPs.
    - Present the vision of a healthy Walnut Creek watershed and the resulting growth in property values and desirability for residential and business/commercial interests.
- Encourage developer participation in bus tour and other landowner/farmer/policy maker interactions (see above).
- Work in partnership with the Greater Des Moines Partnership's planned landowner dialogues to bring the developer community to that table as well.

Additional methods of ongoing communication parallel those listed above under landowner/agricultural sector.

Decision/Policy-Makers - City and County Officials

This group consists of city council members, county board members, and other civic and/or agency officials with a particular emphasis on elected officials.

Brief descriptions of the education messages for delivery to this group are presented below:

1. Cost Savings with Potential Return on Investment – If policy changes, or even dollar investments on certain practices, are made now, the cost of future losses, maintenance, and repairs can be mitigated.
2. Impacts on Other Community Systems – Recognition and mitigation of flood and water quality issues can reduce the resource commitment required to address impacts to utility systems, transportation systems, and public health.
3. Community Collaboration Opportunities – Some practices provide opportunities for collaboration among different departments within a jurisdiction to ensure the most benefit for the community and its residents. There is also the possibility for talent collaboration with other jurisdictions on joint projects.
4. What is in the Water = Public Health – If the concentrations of contaminants entering Walnut Creek are reduced, the public health of users of the creek and greenway system will be enhanced.
5. Cost Sharing and Grants – Projects that may span multiple jurisdictions or are located at the border of more than one jurisdiction, provide opportunities for cost sharing and to implement a practice that may not otherwise be executed.
6. WMA Education – Educate these individuals on what a WMA is and what it is not, how the WMA process works, and how it will ultimately benefit their community.

Plan Launch Tactics

Early tactics for information distribution and primary information sources are based on a roll-out plan for securing final input and approval of this watershed plan.

These include:

Upcoming Public Engagement Event

- Prior to next WMA Meeting, craft a one-page update on plan results so far and overall progress report for distribution to WMA members, including hard-copy and/or e-versions for distribution to member-councils; post on MPO website and/or appropriate Facebook pages; include brief description of upcoming October 7 events (In the lead: RDG Team)
- Prepare news release(s)/brief descriptions of upcoming event for distribution to member community PR officials for additional publicity/inclusion in community newsletters; further distribute to media (In the lead: MPO)
- Additional publicity for October 7 Public Engagement Event (conducted in partnership with Healthiest State Initiative (HIS) and City of Clive/Clive Greenbelt Master Plan); this will be a heavily publicized event through HSI (In the lead: RDG/Clive/HSI team)

Take Draft Plan to Decision Makers

- Post-event; plan drafts will be completed by mid-to-late October. Create first draft of the plan's "executive summary" for web-posting and associated feedback. Before posting, develop accompanying power point and FAQ. Take presentation, DRAFT summary and FAQ to policy makers. WMA members will be encouraged to make these presentations and/or enlist help of MPO and/or consulting team members. Presentations slated for early-to-mid-November. (In the lead: RDG Team)
- Once these presentations are on agendas, push the draft plan out via media and stakeholders who have been engaged to allow for on-line feedback. (In the lead: MPO)

Gain Approval of Final Plan

- Based on feedback from those interactions with public, decision makers, executive team and overall WMA, produce one last set of changes to the plan and executive summary. Develop one-page handout outlining these responsive changes. Craft a council/board resolution for plan approval. Update the power point if necessary. WMA members take update/changes summary and resolution to their various jurisdictions for approval. (In the lead: RDG Team)
- Publicize and post executive summary, final plan, and a check-list of early implementation steps including responsible parties and timelines as much as practical. (In the lead: MPO)
- Work in partnership with the Greater Des Moines Partnership's planned landowner dialogues to bring the public decision-maker community to that table as well.

TO BE DEVELOPED -

General Public Strategy

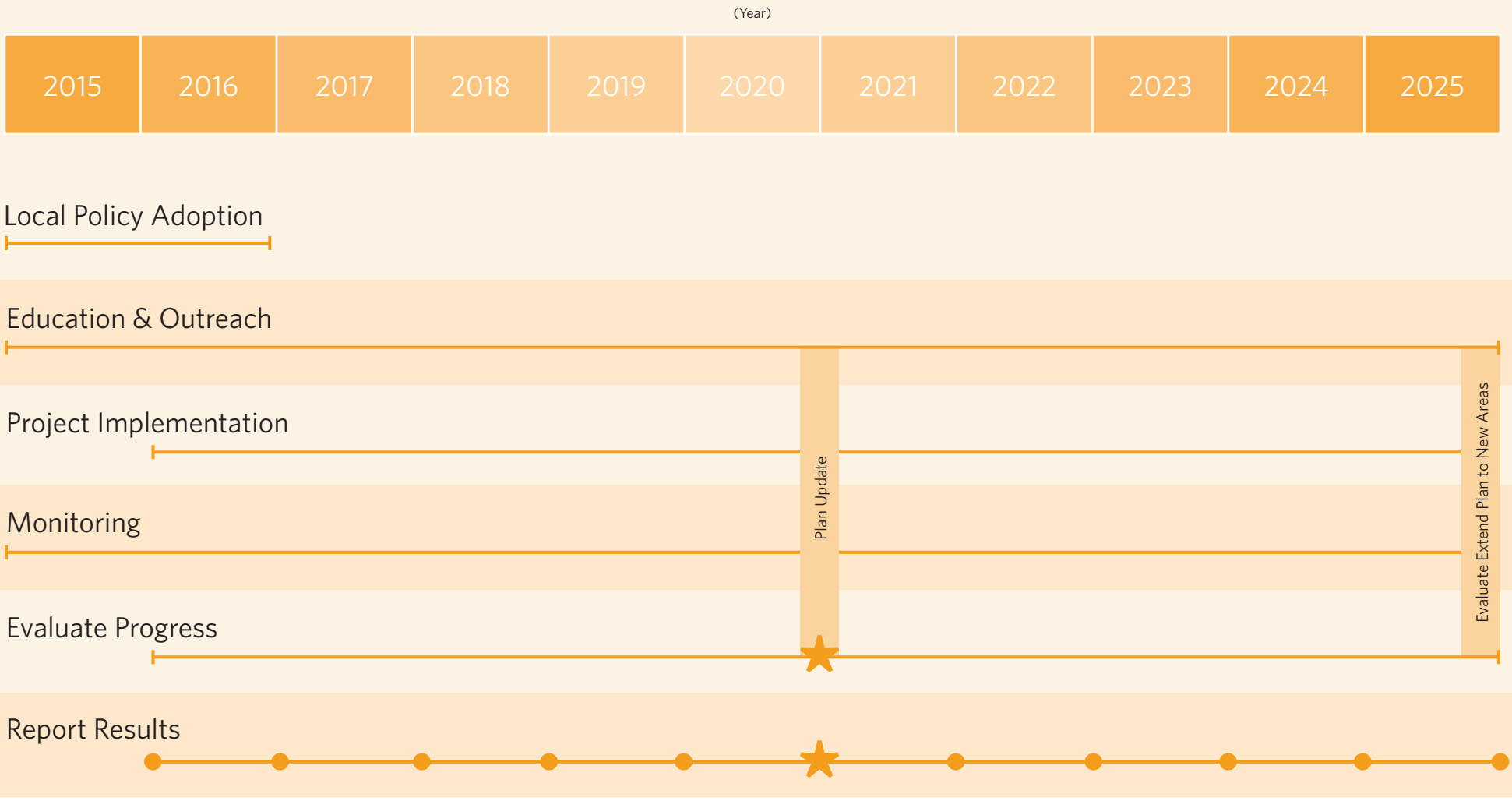
This chapter outlines the schedule for plan implementation and key milestones to evaluate progress. Included within is a plan for monitoring water quality and a list of criteria to evaluate if the plan is being successful at achieving water quality improvements.

twelve

PLAN IN PROGRESS
January 8, 2015

Measures and Milestones

Timeline


(Year)
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Local Policy Adoption
Education & Outreach
Project Implementation
Monitoring
Evaluate Progress
Report Results
Plan Update
Evaluate Extend Plan to New Areas
Key Benchmark

Schedule

The following is a plan for the first ten years of implementation of policies, improvements within case study subwatersheds and other key improvements throughout the watershed.

Urban Policy Adoption

Changes in local ordinances and policies often requires extended interaction with the general public, local stakeholders and elected officials. Such changes often have an impact on costs at various stages of development and how private land can be altered for more intense uses. These factors often result in a resistance to change.

This plan has documented how aspects of erosion and sediment control, stormwater management and development within the flood plain have had a negative influence on water quality and stream corridor stability. It cannot be expected to see improved watershed conditions without alterations to the way policies are enacted and enforced. The potential impacts and benefits of these policies was outlined in previous chapters.

The timeline below may be seen by some to be too rapid of a pace to make these changes. However, this study has identified that in an average year more than 400 acres are developed into urban land uses. As time passes, significant opportunities to reduce impacts related to stormwater runoff increases and pollutant loads will be lost. Also, uniform adoption of such policies will assure more widespread benefits throughout the watershed and reduce the perceptions that one community or municipality has standards which are more adverse towards development than the others. Such coordination and collaboration to set consistent policies across borders within the watershed has to be one of the key purposes of the existence of the Walnut Creek Watershed Management Authority.

Implementation of Recommended Policies		
Policy	**Community**	**Adopt by End of Year**
Review existing construction site erosion control ordinances. Implement changes in enforcement to achieve the desired results as outlined in Chapter 9 of this plan. Amend ordinances as required to support such enforcement. Coordinate with IDNR storm water coordinator as necessary prior to amending ordinances.	All communities	2016
Adopt or amend flood plain protection ordinances which include outlined recommendations as described in Chapter 9 of this plan.	All communities	2016
Adopt or amend stormwater management ordinances which reference ISWMM Unified Sizing Criteria as described in Chapter 9 of this plan.	All communities	2017
Adopt ordinances related to soil quality management and restoration or amend other ordinances to include requirements as described in Chapter 9 of this plan.	All communities	2017
Adopt or amend stream buffer protection ordinances which include outlined recommendations as described in Chapter 9 of this plan.	All communities	2017

Urban Case Study – Subwatershed 213

The following studies or infrastructure improvements are recommended to achieve the water quality improvements as outlined within Chapter 8 of this plan.

Urban Case Study - Project Priorities			
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Project Description**	**Complete by End of Year**
1	213.41 1-78-26 West Des Moines	Complete concept plan or more refined preliminary design for three pond outlet / culvert entrance modifications discussed in case study modeling.	2016
2	213.41 1-78-26 West Des Moines	Modify pond outlet at West Lakes Office Park Plat 3, Outlot Z to feature multi-stage design for better management of 1-year return period storm event.	2017
3	213.41 1-78-26 West Des Moines	Modify pond outlet at 6400 Westown Parkway to feature multi-stage design for better management of 1-year return period storm event.	2017
4	213.41 1-78-26 West Des Moines	Modify culvert inlet south of 1801 68th Street to feature multi-stage design. Add storage volume upstream of amended structure through grading.	2018
5	213 -- Clive / Waukee / WDM	Complete more detailed study identifying additional opportunities for outlet structure amendments and checking for impacts on large storm water levels.	2017
6	213.01 31-79-25 Clive	Complete channel restoration and repair of South Walnut Creek, downstream of Country Club Lake within Clive Greenbelt. (5,300 feet)	2018
7	213.22 36-79-26 Clive	Complete urban small tributary channel restoration and repair from NW 156th Street to trail crossing 1,100 feet downstream.	2020
8	213 -- Clive / Waukee / WDM	Implement pond outlet and culvert inlet modifications at sites identified by study (project #5). May be multi-phase implementation.	2025
9	213.31 36-79-26 Waukee	Complete urban small tributary channel restoration and repair downstream of Southfork Pond to Brentwood Drive. (600 feet)	2022
10	213.22 / 213.21 36-79-26 Clive	Complete urban small tributary channel restoration and repair between NW 149th Street and Lakeview Drive. (3,000 feet)	2025

Rural Case Study – Subwatershed 411

Develop Text for this Section – Save a page or two for text and table

{Table}

Developing Case Study – Subwatershed 601

Implementation of improvements within this case study subwatershed will depend on the pace of development within this area.

Watershed Level - Recommended Project Priorities			
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Project Description**	**Complete by End of Year**
1	612.01 28-79-26 Waukee	Repairs and channel improvements to address severe erosion downstream of the dam for a private pond. Tributary to Little Walnut Creek, just west of Warrior Lane.	2017
2	611.21 26-79-26 Waukee / Clive	Channel repairs and restoration along outer bend of Walnut Creek east of north end of NW 90th Court. (Downstream of 2015 improvements).	2018
3	201.01 34-79-25 Clive	Channel repairs and improvements along Living History Creek, specifically along segment which parallels sanitary sewer alignment along north side of abandoned railroad grade.	2018
4	212.01 33-79-25 Clive	Channel repairs and improvements along Living History Creek, specifically along segment which parallels sanitary sewer alignment along north side of abandoned railroad grade.	2020
5	511.03 25-79-25 Urbandale	Study to review potential to construct water quality ponds to reduce bacteria and sediment loading along Rocklyn Creek on upstream side of 70th and 72nd Streets.	2022
6	601.02 22-79-26 Clive	Streambank restoration and improvements within the Clive Greenbelt corridor along Little Walnut Creek between Warrior Lane and NW 170th Street.	2018
7	511.03 25-79-25 Urbandale	Construct water quality pond along Rocklyn Creek on upstream side of 72nd Street (if feasible).	2022
8	511.03 25-79-25 Urbandale	Construct water quality pond along Rocklyn Creek on upstream side of 70th Street (if feasible).	2023
9	502.02 26-79-25 Urbandale	Streambank restoration and improvements to address streambank erosion and incision within the greenbelt corridor along North Walnut Creek between 86th Street and Hickman Road.	2025

Other Recommended Watershed Improvements

The following studies or infrastructure improvements are recommended to protect infrastructure or address key sources of pollution or streambank erosion that have been identified as part of development of this plan.

Monitoring Plan

An expanded, ongoing monitoring program is required to better understand existing water quality conditions, better identify pollutant sources and evaluate the impact on installed practices on water quality. To more accurately define pollutant loadings, data needs to be collected more consistently from a broad number of locations and at dates spread throughout the year.

Data to be Collected

For each monitoring location that is maintained by the Walnut Creek WMA and its membership, data should be collected on at least these key chemical or environmental parameters:

- Air temperature
- pH
- Dissolved Oxygen
- Water Temperature
- Level of Flow
- Recent precipitation (from NWS records)
- Nitrate
- Phosphate
- E. coli (lab)
- Transparency, Turbidity or TSS
- Nitrite
- Chloride
- Conductance (lab)

At least once annually, at each location collect information on the following physical site characteristics:

- Stream width
- Local biological assessment
- Local stream stability
- Stream depth (from baseflow)

Recommended Implementation Strategies

Strategy #1 – Coordinate and Build upon Existing Monitoring Efforts

There are several ongoing programs that are collecting water quality information within the Walnut Creek watershed. The purpose of this plan is to support these efforts, rather than supplanting or competing with them.

- Iowa Soybean Association / Clean Water Alliance

  These organizations continue to collect data at two separate locations along the main channel of Walnut Creek. Their data collection has occurred every other week, typically from April through late August or early September. We would recommend that they expand upon this work, to include year round sampling. Late season spikes in nutrient levels have been reported at the Des Moines Water Works intake site on the Raccoon River. Such a spike has also been observed at some IOWATER testing sites within the Walnut Creek watershed. Year round testing could determine if such a spike commonly occurs within this watershed and provide a more accurate measurement of annual loadings of the pollutants of concern.

- Polk County Conservation

  This organization has just initiated a program to monitor select sites within the Fourmile, Beaver and Walnut Creek watershed inside Polk County. They have selected four collection sites within the watershed (three on Walnut Creek and one on North Walnut Creek). They plan to collect data during the first and third calendar weeks of each month, on a given day between the hours of 10am and 2pm. During each sample they will assess chemical and physical conditions. IOWATER test kits will be used to evaluate the following parameters:

  - Transparency
  - pH
  - Dissolved Oxygen
  - Nitrate
  - Nitrite
  - Phosphate
  - Chloride

- IOWATER volunteer monitoring

  Volunteer monitoring data has been recorded from a total of 32 sites throughout the Walnut Creek watershed since 2004. Of these sites, data has been actively been collected at 22 sites since 2012. At these ten sites, data has been collected twice each year (in May and October). Data has been collected both through the use of IOWATER test kits and by collection of samples for lab testing (lab testing completed at 10 of these sites since 2012). It is recommended that these volunteer efforts be continued and coordinated, so that data for the key parameters (noted under the heading "Data to be Collected" above) is collected at each site, either through IOWATER test kits or lab testing.

Recommended Real-Time Monitoring Station Locations		
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Location Description**
1	101.01 13-78-25 Des Moines	Downstream of railroad bridge, accessible by trail. Just upstream of mouth of Walnut Creek.
2	213.01 31-79-25 Clive	Just upstream of mouth of South Walnut Creek, accessible by trail. (Urban case study subwatershed monitoring station)
3	411.01 3-79-26 Dallas County	Upstream side of crossing at W Avenue along tributary to Walnut Creek. (Rural case study subwatershed monitoring station)
4	601.01 24-79-26 Urbandale	Upstream side of trail bridge, just upstream of mouth of Little Walnut Creek. (Developing case study subwatershed monitoring station)
5	501.01 3-78-25 Clive	Upstream side of trail bridge, just upstream of mouth of North Walnut Creek.
6	201.01 3-78-25 Clive	Station on Walnut Creek, just west of trail bridge over North Walnut Creek. Location nearby priority station 5.
7	301.02 11-79-26 Urbandale	Upstream side of bridge at 250th Street along Walnut Creek. (Monitor near current interface between rural and urban areas, downstream of where the three major headwater tributary streams converge)

Strategy #2 – Establish a Network of Real-Time Monitoring Stations within the Watershed

This plan has noted how different pollutants originate from different sources. Some of these sources are less frequently occurring and some are larger sources during storm events. There are some questions that cannot be answered without constant collection of data. Real time data collection allows more rarely occurring sources of pollution to be identified (a one-time fertilizer applications prior to a storm event, for example).

Ongoing data collection also makes it possible to understand how pollutant concentrations and loads are changing through the entire duration of a storm event. Higher concentrations are often observed during the "first flush" of storm events. It is challenging to grab samples during this period, as it would require collection of samples on random dates as rainfall occurs, samples would need to be collected within a short window after rainfall begins (often while it is still raining) and high flows could create dangerous conditions for sample collection.

For these reasons, a network of real-time monitoring stations is recommended as a key part of implementation of water quality improvements. As such stations come at an expense to install and maintain, this plan must be selective in the recommended initial locations for these stations. Over time, additional stations may be added to the network as dictated by the location of proposed improvements, changes in land use and available funding.

It is recommended that the initial network consist of seven stations located throughout the watershed. These locations have been selected to (1) help better define overall watershed pollutant loading rates, (2) differentiate pollutant concentrations and loadings within Walnut Creek and its principal tributaries, and (3) evaluate changes in conditions over time near the outlets of the case-study subwatershed areas.

The approximate cost for each station is expected to be $25,000 for the initial purchase of equipment and installation and average costs of $8,000 per year for ongoing operation and maintenance.

Strategy #3 – Establish Grab Sample Monitoring at Key Locations within the Case Study Subwatersheds

To determine the effects of water quality improvements within each case study area, a more frequent and distributed pattern of monitoring is required. Monitoring sites should be located so that changes in outcomes over time can be evaluated. These sites should be established as soon as possible, so that a time record of water quality conditions prior to any improvements can be established. Over time, this monitoring should determine if measureable changes in water quality parameters can be observed. Trends in data can be reviewed to determine if the proposed implementation program is working as expected or if the plan needs to be reviewed and amended to improve results.

It is recommended that sampling be conducted using a similar collection schedule as that which has been developed by Polk County Conservation (year round, 1st and 3rd week of each month, collection between 10am and 2pm). This will improve the quality of collected data by collecting it under more uniform conditions. IOWATER test kits could be used for an initial site screening, however it is recommended that samples be collected during each site visit for lab analysis of key pollutants and lab analysis will be necessary to evaluate levels of indicator bacteria present.

Recommended Grab Sample Monitoring Sites in the Rural Case Study Subwatershed (601)

Project #	Microwatershed Section-Township-Range Jurisdiction	Location Description
1	601.02 23-79-26 Urbandale	Upstream of crossing at NW 156th Street along Little Walnut Creek.
2	601.02 22-79-26 Clive	Upstream of crossing of NW 170th Street (Alice's Road) along Little Walnut Creek.
3	601.03 21-79-26 Waukee	Upstream of crossing of Warrior Lane along Little Walnut Creek.

* As development occurs, it is recommend to establish a sampling site at the inflow and outfall of each constructed detention facility.

Quality Control for Data Collection, Recording

The broad number of sites will likely require more than one person or party to complete the recommended sampling. Data needs to be collected in a consistent manner, to prevent results being influenced by how samples are collected or test kit results are interpreted at each site. The collected data needs to be collected and frequently uploaded into a database that is accessible to interested parties. For these reasons, the following methods are recommended by this plan:

1. Create a Quality Assurance Project Plan (QAPP) for all water quality monitoring activities. This document should be reviewed and approved by the Iowa Department of Natural Resources.
2. Maintain at least two databases of collected water quality data. Each database should be kept current with recorded results.
3. Collaborate with the ISA/CWA, Polk County Conservation and IOWATER at the end of each quarter year, to share all collected water quality data within the Walnut Creek watershed.
4. Pursue means to use online resources to make collected water quality data available for public review.

Recommended Grab Sample Monitoring Sites in the Rural Case Study Subwatershed (411)		
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Location Description**
1	411.03 4-79-26 Dallas County	Upstream side of crossing at V Avenue, approximately 600 feet south of Highway 44.
2	411.05 32-80-26 Dallas County	Upstream side of private farm crossing (north projection of U Avenue), approximately 1,100 feet north of Highway 44.
3	411.05 32-80-26 Dallas County	Tile drainage outlet on east side of T Avenue, approximately 3,900 feet north of Highway 44.
		CONSIDER OTHER SITES AS RURAL PLAN IS DEVELOPED

Recommended Grab Sample Monitoring Sites in the Urban Case Study Subwatershed (213)		
Project #	**Microwatershed** **Section-Township-Range** **Jurisdiction**	**Location Description**
1	213.01 31-79-25 Clive	Downstream of spillway from Country Club Lake, accessible by trail.
2	213.02 31-79-25 Clive	Storm sewer outlets from University Avenue to east branch of Country Club Lake. Site is located approximately 300 feet west of Country Club Boulevard.
3	213.02 31-79-25 Clive	Storm sewer outlets from University Avenue to central branch of Country Club Lake. Site is located approximately 400 feet east of NW 142nd Street.
4	213.02 31-79-25 Clive	Box culvert outlet from NW 142nd Street to west branch of Country Club Lake. Site is located approximately 300 north of South Shore Drive.
5	213.02 31-79-25 Clive	Box culvert outlet from Lake Point Drive into main body of Country Club Lake.
6	213.31 36-79-26 Clive	Sample from tributary, draining from the west from Brentwood Drive. Sampled to be collected just upstream of the confluence of this tributary with one that drains from the north from Lakeview Drive. This site is located just across NW 142nd Street from Urban Case Study Sampling Site #4.
7	213.21 36-79-26 Clive	Sample from tributary, draining from the north from Lakeview Drive. Sampled to be collected just upstream of the confluence of this tributary with one that drains from the west from Brentwood Drive. This is very close to Urban
8	213.22 36-79-26 Clive	Storm outlet from NW 149th Street, approximately 150 feet north of Woodcrest Drive.
9	213.41 1-78-26 West Des Moines	Storm sewer outlets from pond outlet structure at West Lakes Office Park Plat 3, Outlot Z. Site is located along the north side of Westown Parkway, approximately 400 feet northwest of Lake Drive.
10	213.41 1-78-26 West Des Moines	Sample at outlet structure from pond at 6400 Westown Parkway. Take sample from flow entering outlet structure.

Monitoring Site Location

Reporting Progress toward Water Quality Standards

An annual monitoring report should be prepared and presented to the Walnut Creek WMA board, then made available for public review. The report should include the following information:

1. An overall map of the watershed showing monitoring locations, including those maintained by the Walnut Creek WMA (and its membership), ISA/CWA, Polk County Conservation and IOWATER.
2. The average, maximum and minimum levels of each parameter at each monitoring location for the given year. Note the date when maximum and minimum levels were observed.
3. For each parameter, review changes in levels for each parameter on a month by month basis throughout the given calendar year.
4. Review data related to items #2 and #3 above for prior years, and provide a cumulative analysis for each that includes data collected for all calendar years to date.
5. Provide a brief review data from items #2-#4 above and determine if trends support that appropriate progress is being made toward established water quality goals.

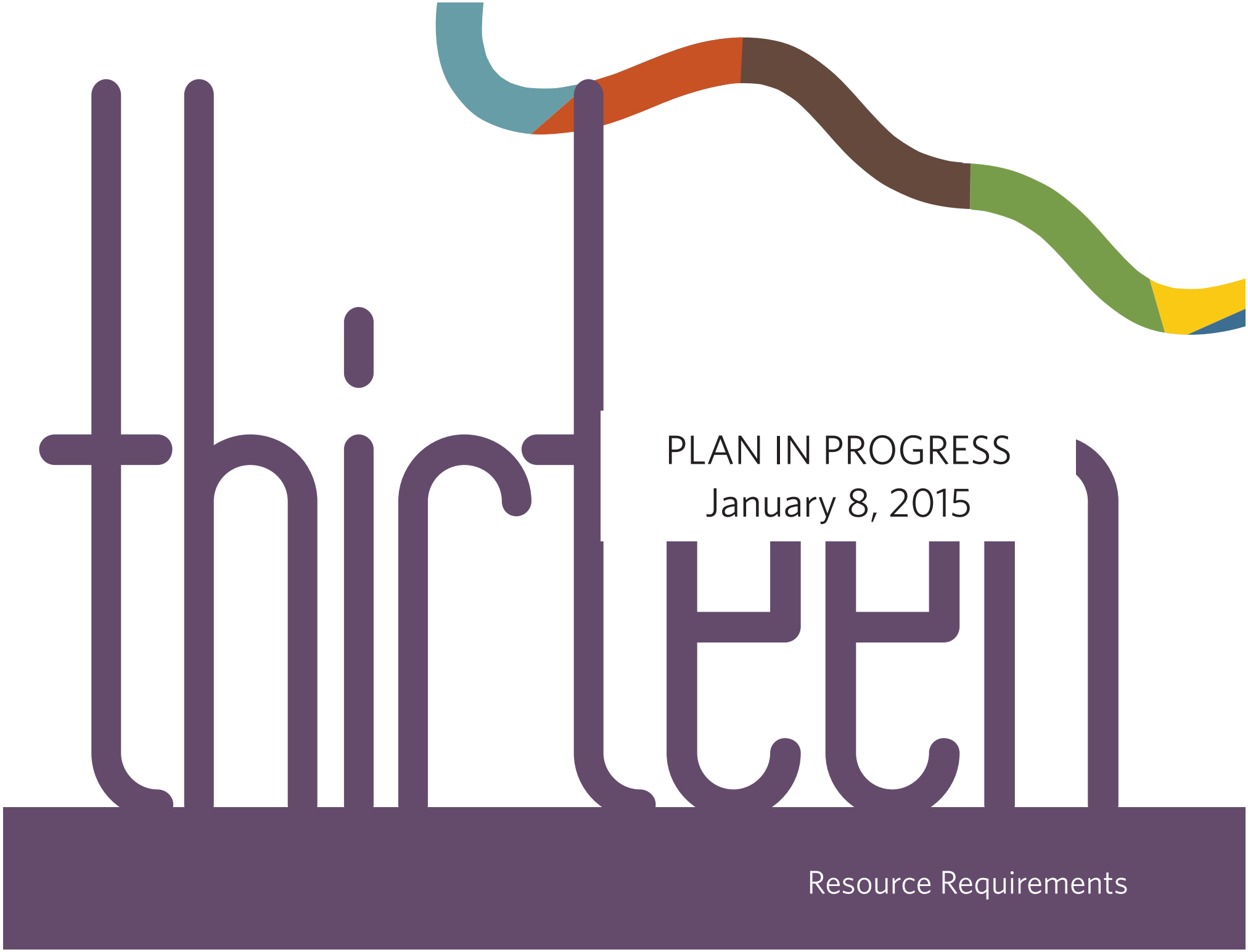
Milestones - Criteria for Measuring Success

At the end of each year, progress towards meeting the goals of this plan need to be evaluated. These key milestones represent ways to measure if implementation of this plan is on schedule and that the expected results are being observed.

1. Document when communities adopt and begin enforcement of the various recommended policies.
    - Goal: A review of ordinances and adoption of recommended amendments or new ordinances by the dates listed earlier in this chapter (staggered adoption in 2016 and 2017).
    - If not achieved by the desired dates, what are the obstacles to adoption?
2. Document improved compliance with erosion and sediment control recommendations through photographs, reductions in enforcement actions or other annual reports.
    - Are the concerns addressed in Chapter 9 being addressed?
    - What are some areas that remain in need of improvement?
3. Document when the recommended improvements are completed. Document any modifications to the implementation plan or additional practices which are constructed.
    - Review the schedule within this chapter and verify that this plan is on schedule.
    - If implementation is not on schedule, remark on expected changes to complete the overall project list by 2025.
    - Are there new challenges that have been identified that impede full completion of this list?
4. For the rural case study watershed, validate that desired pollutant loading reductions are being achieved by observing average annual (and seasonal) concentration reductions of 41% for nitrate+nitrite, 29% for phosphorus and 29% for TSS by the end of 2025.
    - By the end of 2020, be able to demonstrate at least a 25% reduction in these three parameters (10% nitrate+nitrite reduction, 7% phosphorus reduction and 7% TSS reduction).
5. For the urban case study watershed, validate that desired pollutant loading reductions are being achieved by observing average annual (and seasonal) concentration reductions of 2% for nitrate, 17% for phosphorus and 43% for TSS by the end of 2025.
    - By the end of 2020, be able to demonstrate at least a 25% reduction in these three parameters (0.5% nitrate+nitrite reduction, 4% phosphorus reduction and 11% TSS reduction).
6. For the developing case study watershed, document the number and size of each management facility constructed in urbanizing areas. Validate that each basin is designed and constructed to meet ISWMM's Unified Sizing Criteria.

Milestone Checklist

This chapter outlines the technical and financial resources that are expected to be required to implement this plan over the next ten year period (through 2025).



PLAN IN PROGRESS
January 8, 2015

Resource Requirements

Introduction

INTRODUCTION PARAGRAPH

Costs

Financial support will be key to successful implementation of this plan. Staff support activities, construction of improvements, monitoring water quality and maintenance activities cannot be completed without dedicated funding.

Staffing

Staff time will be required to monitor execution of the plan, review monitoring data, coordinate or complete grant applications, work with consultants and report results to the Walnut Creek WMA board and public. This can be achieved by using existing staff time from the various member communities or hiring a project coordinator (or additional staff) to be dedicated to directing execution of this plan on behalf of the WMA.

Improvements

This plan has detailed dozens of priority projects within the watershed that are intended to achieve a set of short-term water quality goals. The table below provides a summary of the overall infrastructure investments that have been recommended by this plan. For more specific information regarding these projects, refer to Chapter 10 of this plan.

Monitoring

Water quality monitoring will require resources to apply for grants and financial support, install monitoring stations, compensate for staff time and resources to collect samples and record results and pay for laboratory testing.

Maintenance

Several types of maintenance activities will be required to execute this plan and keep constructed improvements in good working order. Forested areas within stream buffers may need selective clearing of underbrush and invasive species to encourage establishment of more erosion resistant surface vegetation. Where new areas of native vegetation are established, short-term maintenance activities may include minor erosion repair and re-seeding, spot spraying of weeds. Long-term maintenance includes re-seeding, mowing and controlled burns. Streambank stabilization projects may require some repairs after major flood events. Other stormwater best management practices require removal of collected sediments, other debris and repairs to keep them operating as intended. These needed maintenance activities will likely not occur, if its cost is not identified and included in local budgets. Several types of maintenance activities will be required to execute this plan and keep constructed improvements in good working order. Forested areas within stream buffers may need selective clearing of underbrush and invasive species to encourage establishment of more erosion resistant surface vegetation. Where new areas of native vegetation are established, short-term maintenance activities may include minor erosion repair and re-seeding, spot spraying of weeds. Long-term maintenance includes re-seeding,

Category	Number of Projects	Projected Cost (2015 $)
Rural Case Study Subwatershed	##	###
Urban Case Study Subwatershed	10	$5,575,000
Developing Case Study Subwatershed		
Other Watershed Level Projects	9	$7,080,000
Current Capital Improvements Projects		

Year	Real-time Monitoring	Grab Sample Monitoring
2016	$ 5,000	
2017	$ 125,000	
2018	$ 90,000	
2019	$ 56,000	
2020	$ 56,000	
2021	$ 56,000	
2022	$ 56,000	
2023	$ 56,000	
2024	$ 56,000	
2025	$ 56,000	

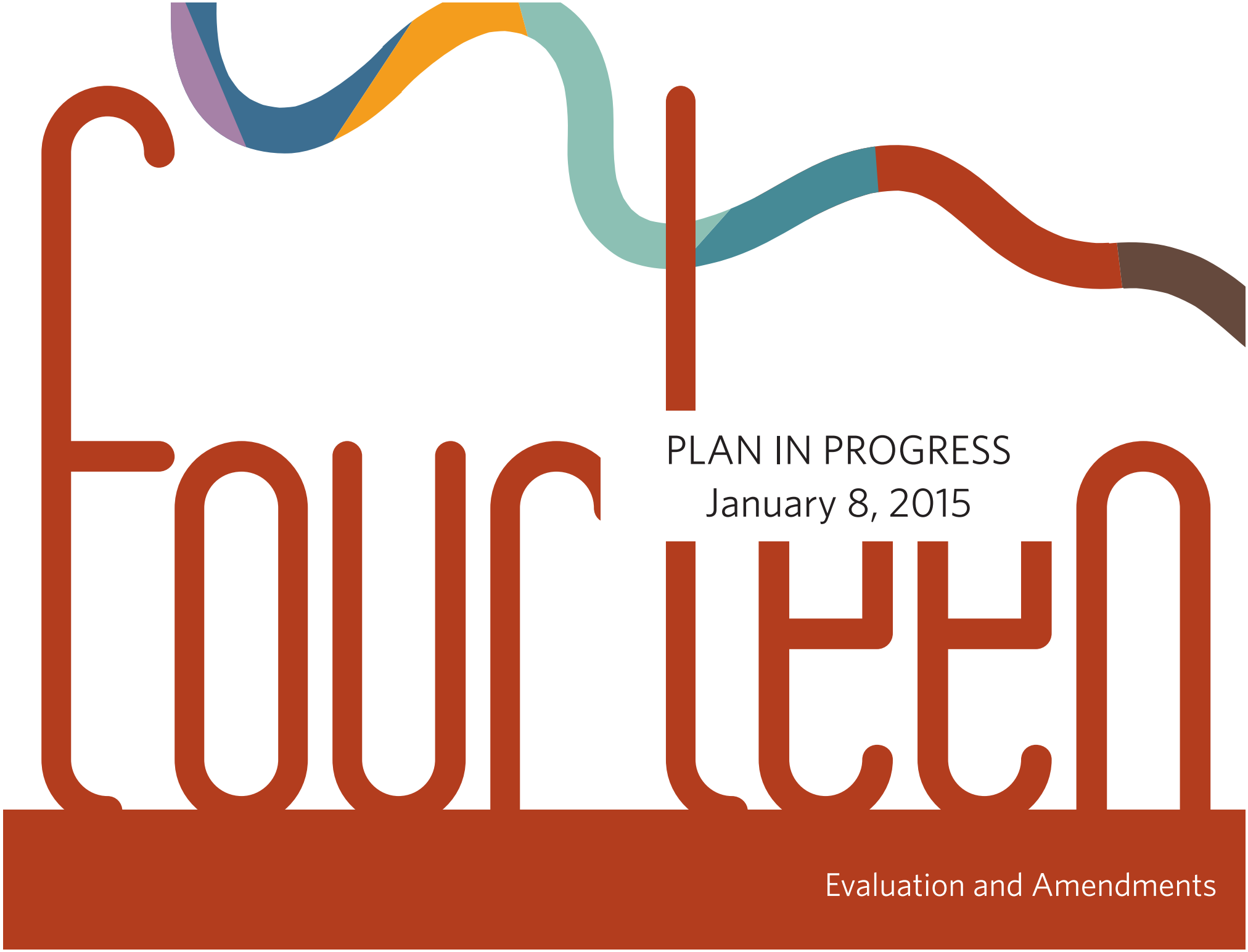
mowing and controlled burns. Streambank stabilization projects may require some repairs after major flood events. Other stormwater best management practices require removal of collected sediments, other debris and repairs to keep them operating as intended. These needed maintenance activities will likely not occur, if its cost is not identified and included in local budgets.

Sources of Financial Support / Technical Assistance

Develop Text for this Section

Responsible Authorities

Develop Text for this Section


fourteen
PLAN IN PROGRESS
January 8, 2015
Evaluation and Amendments

Introduction

INTRODUCTION PARAGRAPH

Continued WMA Structure

Develop Text for this Section

Evaluation Framework

Develop Text for this Section

Annually, complete a report which evaluates progress on the following issues:

- Document which communities have enacted new ordinances related to the recommendations listed in Chapter 9.
- Include a brief update from each community related to erosion and sediment control enforcement and compliance.
- Itemize completed improvements projects related to water quality within each community.
- A brief summary of monitoring results, including average, minimum and maximum pollutant concentrations and comparison of those values to those observed during Year 1 of the monitoring program.

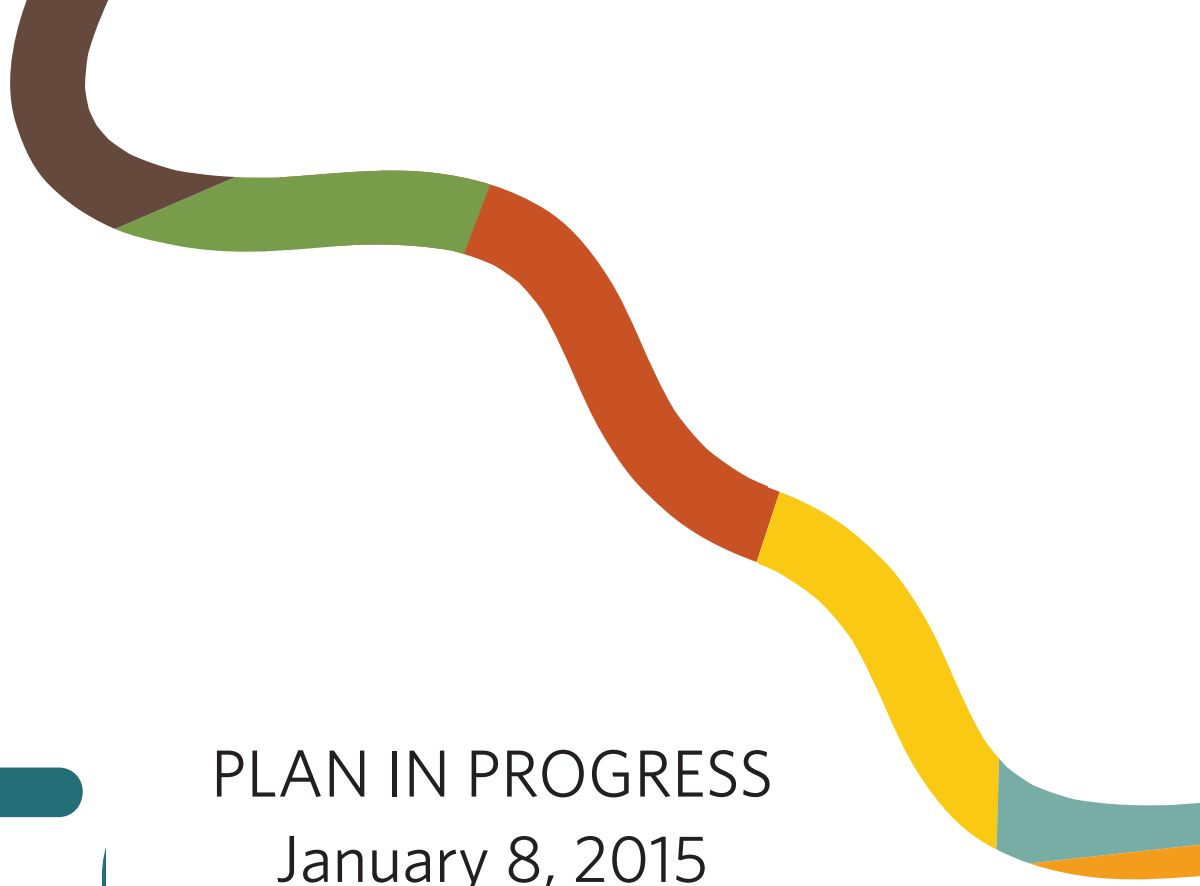
After Year 5 of monitoring, the annual report should include a more detailed review of monitoring results and determine if progress towards water quality goals (pollutant concentration reduction) is on pace, based on the level of improvements that has been implemented. If it is not, the implementation plan should be reviewed and adjustments made, informed by local observations and updated study related to management practices.

Process / Timeline to Amend the Plan

Develop Text for this Section

This study has detailed how rapidly conditions within this watershed are changing. Based on past growth rates, it could be expected that within the next ten years an additional six to eight square miles of the watershed may be developed. At that point, urban development may cover between 50 and 55% of the overall land area. Over a similar period of time, it would be expected that stream conditions may be much different and the need for improvements could shift.

Over a decade, the other improvements within the case study areas and throughout the watershed should be implemented. During Year 10 of the monitoring program, it is recommended to review and update many of the findings within this plan, and develop a new implementation and monitoring plan from those findings.



fifteen

PLAN IN PROGRESS
January 8, 2015

BMP Tool Kit