What, When, and Where in Studying the Best Management Practices in Grand Forks, ND

Yeo Howe Lim, Ph.D., Associate Professor
Abbie Beaudry, Graduate Student
Department of Civil Engineering,

UNIVERSITY OF NORTH DAKOTA

Overview

- Urban runoff, EPA Regulations and BMPs
- BMPs in Grand Forks , needs for effective assessment
- Rainstorm analysis, storm types and sampling plan
- Water quality parameters to be monitored in BMPs
- Selection of BMPs for baseline study
- Conclusion

- What
- What
- When
- What
- Where

Stormwater Pollutants

- Common stormwater pollutants/parameters in urban runoff to be monitored - EPA
  - turbidity, phosphorus, nitrates, temperature, conductivity, dissolved oxygen and biochemical oxygen demand
  - heavy metals and organic chemicals

- The stormwater pollution problem has two facets:
  - the concentration of pollutants in the runoff
  - the increased volume and rate of runoff from impervious surfaces

EPA Regulatory

- **CWA -The Clean Water Act**
  - passed by Congress in 1972, signed by the President
  - required the elimination of discharge of pollutants into the nation's waters

- **NPDES- Phase I (**National Pollutant Discharge Elimination System)
  - Permitting Program requires all point-source discharges be permitted
  - Cover medium or large MS4 (municipal separate storm sewer systems)

- **NPDES- Stormwater Phase II**
  - Small MS4 Program –not already covered by the Phase I

Small MS4s Requirements

Operators of regulated small MS4s are required to:

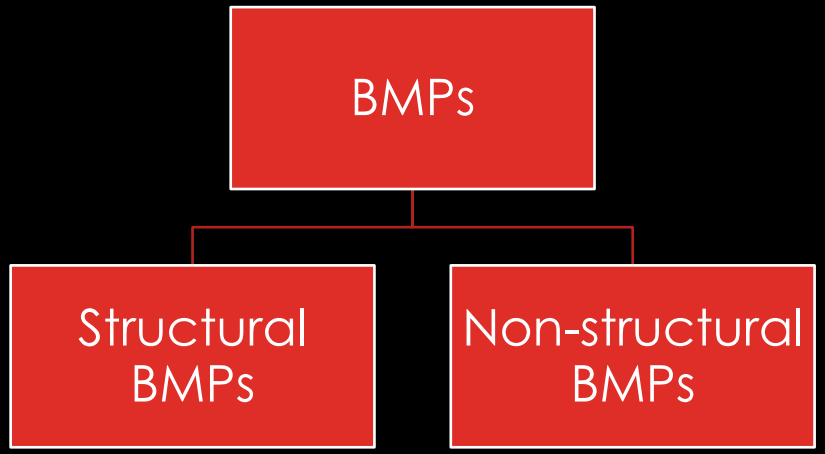
1. Apply for NPDES permit coverage (before 2003)
2. Develop a stormwater management program which includes six minimum control measures
3. Implement the stormwater management program using appropriate stormwater management controls, or best management practices (BMPs)
4. Develop measurable goals for the program
5. Evaluate the effectiveness of the program





BMPs in Stormwater Management

- **Best Management Practices (BMPs)** are control devices and systems to treat stormwater (structural), as well as operational or procedural practices (non-structural)



Phase II- Minimum Control Measures

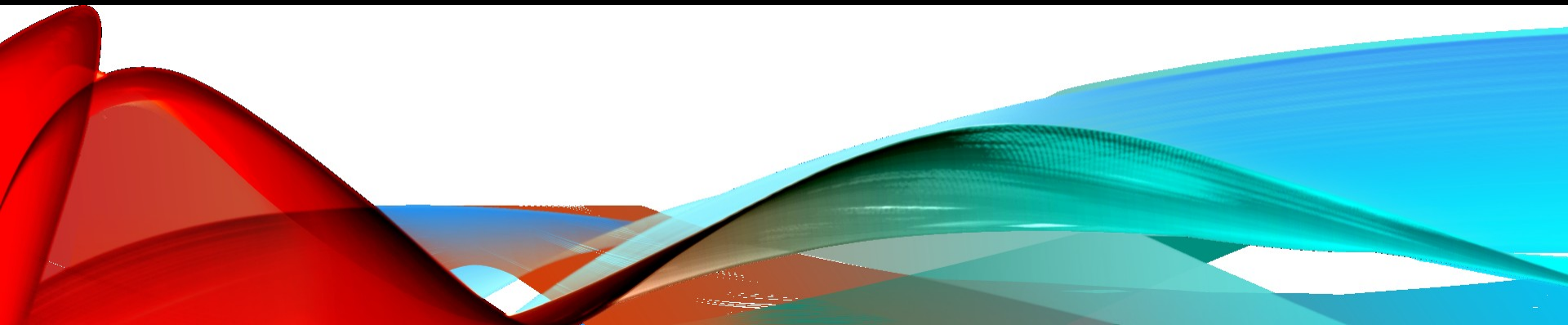
Stormwater Phase II Rules - 6 minimum control measures

1. Public Education - BMPs for MS4s to inform individuals and households about ways to reduce stormwater pollution.
2. Public Involvement - BMPs for MS4s to involve the public in the development, implementation, and review of an MS4's stormwater management program.
3. Illicit Discharge Detection & Elimination - BMPs for identifying and eliminating illicit discharges and spills to storm drain systems.
4. Construction - BMPs for MS4s and construction site operators to address stormwater runoff from active construction sites.
5. Post-construction - BMPs for MS4s, developers, and property owners to address stormwater runoff after construction activities have completed.
6. Pollution Prevention/Good Housekeeping - BMPs for MS4s to address stormwater runoff from their own facilities and activities.

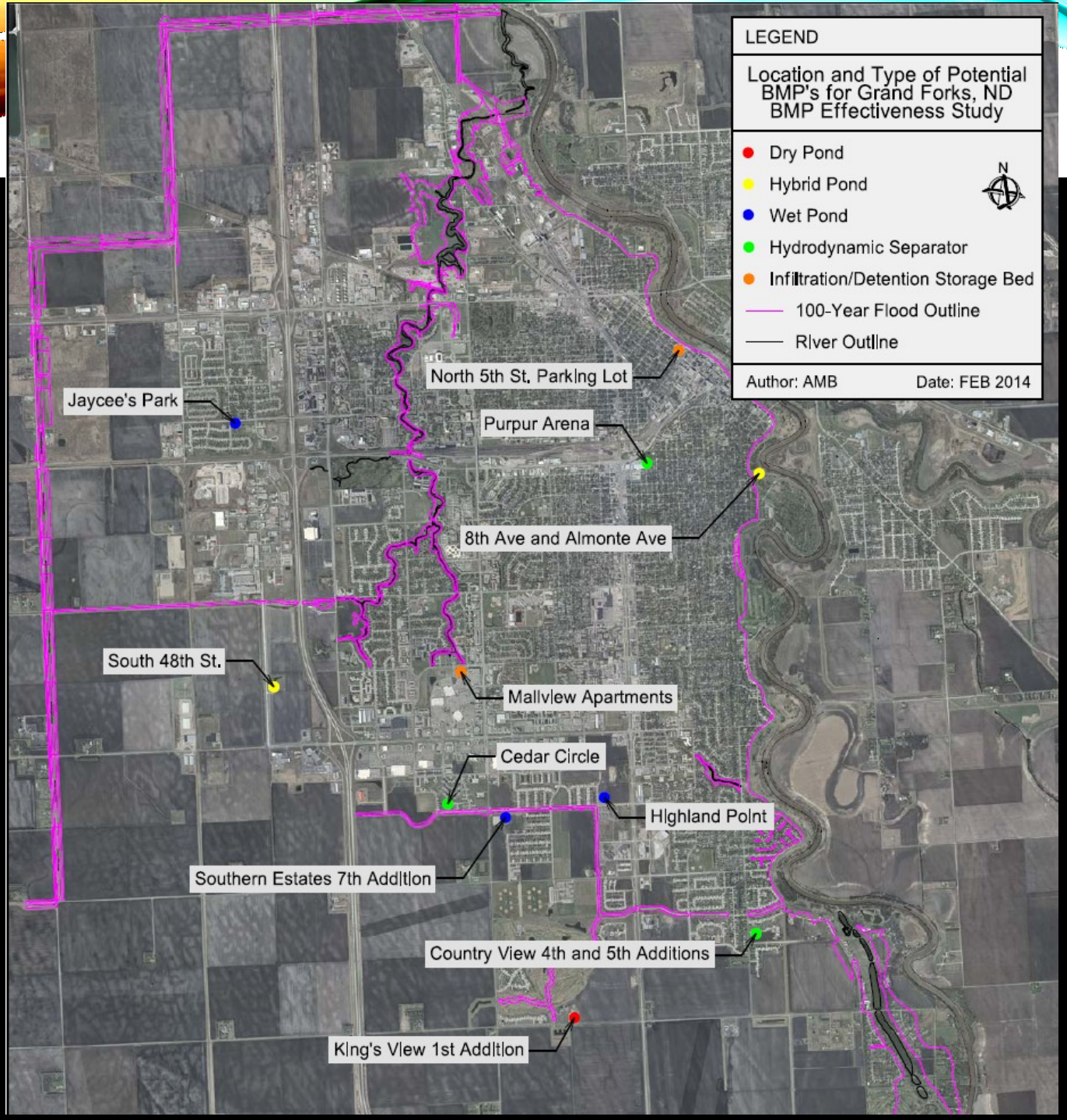
Communities have responded and implemented structural BMPs

--- > The main concern of this study --- the structural BMPs

BMPS IN GRAND FORKS



BMPs in Grand Forks



What are the BMPs?

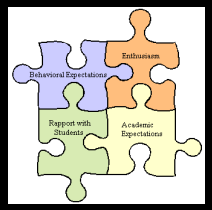
- Traditional and low impact BMP types, including
  - retention (wet) ponds
  - detention (dry) ponds
  - biofilters
  - grassed filter strips
  - porous pavement
  - wetlands
  - Others
    - hydrodynamic separators

Current Status of BMPs in Grand Forks

- Like most BMPs
  - Providing the services quietly; appear to be 'okay'
  - Occasionally there are some 'ups' and 'downs'

- A baseline study to allow effectiveness assessment of BMPs in the city – in progress

- Grand Forks City officers involved in stormwater
  - very supportive of the study



- Objectives in mind:
  - To develop a long term monitoring program
  - To re-examine design parameters for future BMPs

Selection of BMPs for Study: Where and When

- Many BMPs are potential sites for study

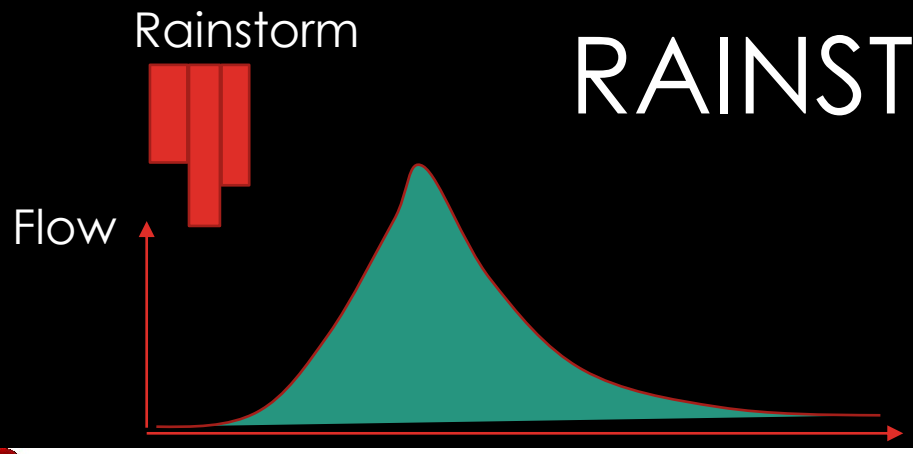
- Selection options:
  - Selecting all
    - Ruled out: time and budgetary constraint
  - Zoning and select representatives
    - Possible with a sizeable team
  - Selecting a few major BMPs and types
    - Cover all major type and inclusive of low impact developments

Hydrologic Characteristics & Implications

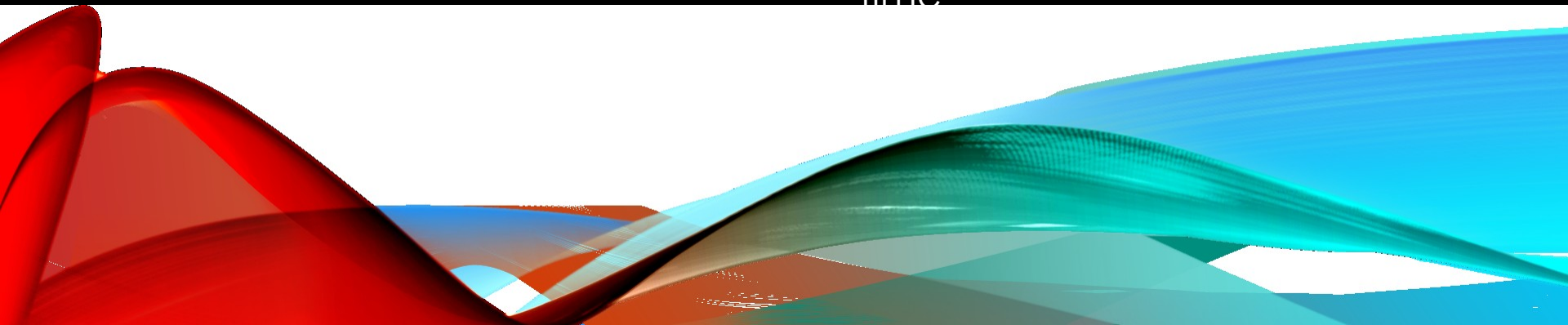
- Small urban watersheds connected to BMPs
  - Having very short concentration time (10 min to 60 min)
- North Dakota weather
  - BMPs only operational in summer-early-fall months (May to October)

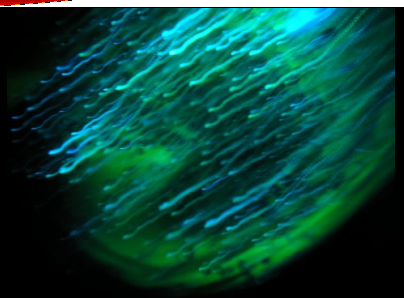
⇒Storm patterns in summer need to be examined so that the planning for taking water samples, flow measurements, in-situ measurements, etc. is statistically sound

⇒Effective Plan: One graduate student, and one summer: 2014 summer to complete the baseline study task



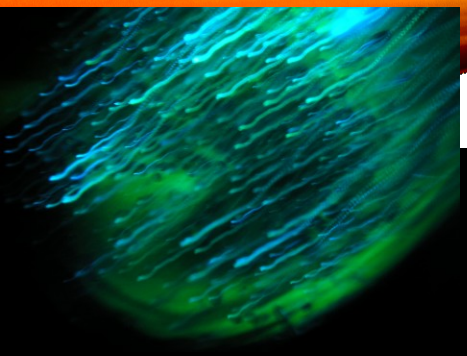
RAINSTORM ANALYSIS





>1.0 in. storm passing through the city?

- What is the chance of having an >1.0 in. event occurring over the 2014 study period ?
- How common are these storm event types ?
  - >0.1 in. and ≤ 0.5 in.
  - >0.5 in. and ≤1.0 in.
  - >1.0 in.
- Which event type has a greater impact on a certain type of BMP?



storm type recurring exactly twice in June ?

- More questions need to be answered before planning for each field trip.

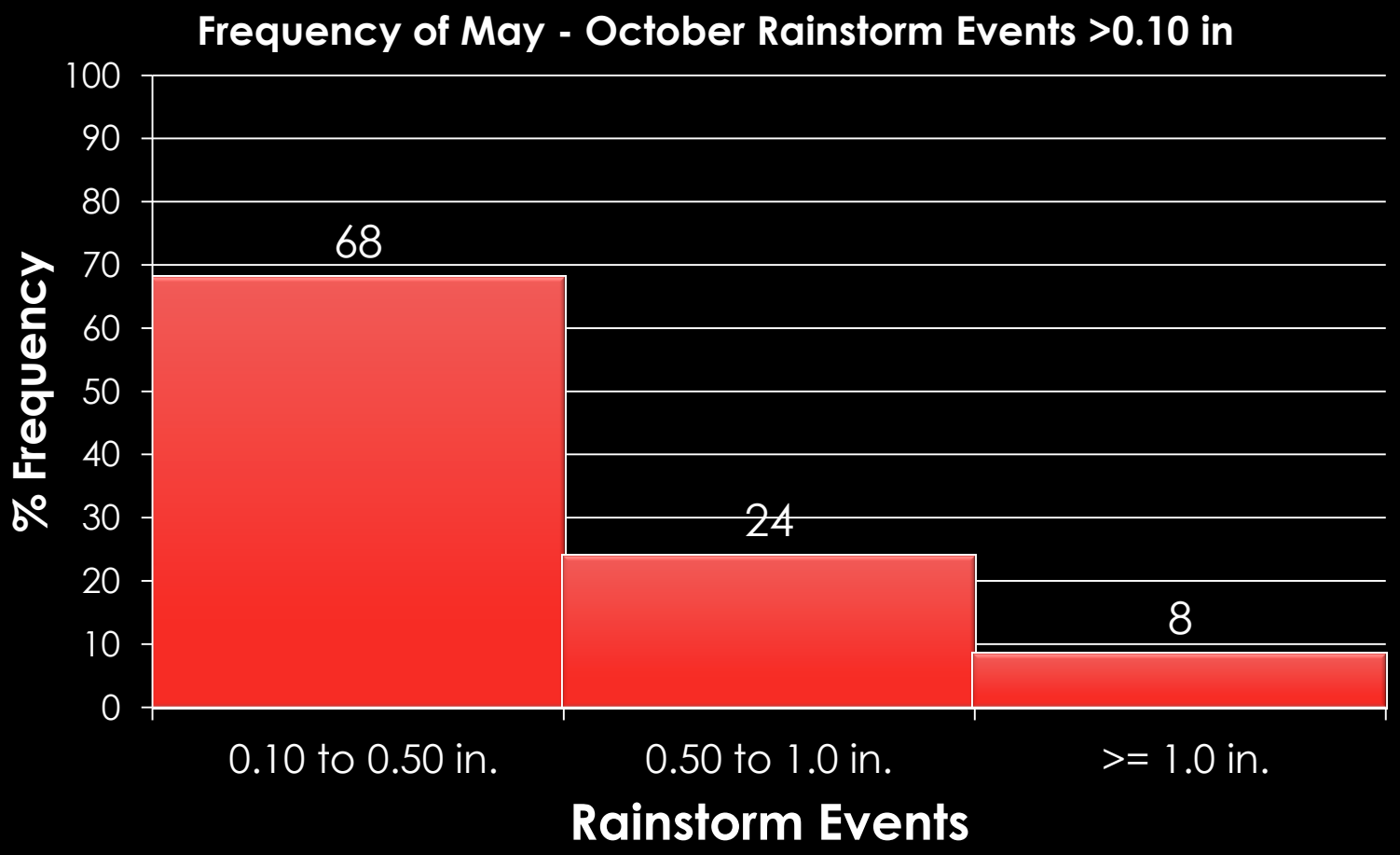
Example:

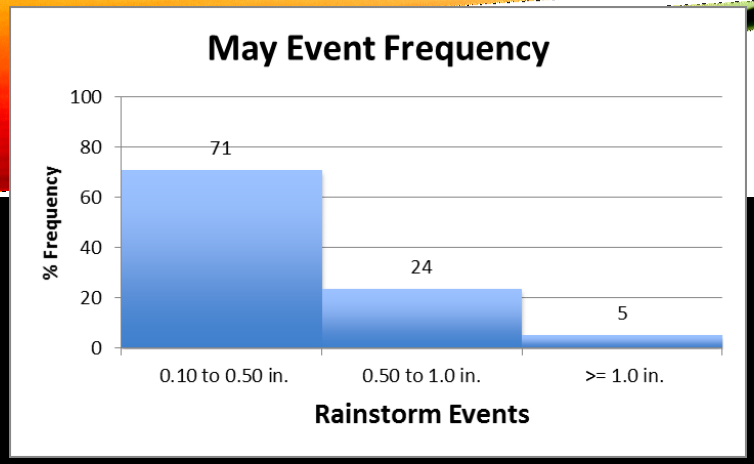
- Given that a weather forecast issued in June before the arrival of a significant storm, how likely is that there will be another (>0.5 in. and ≤ 1.0 in.) events in June ?

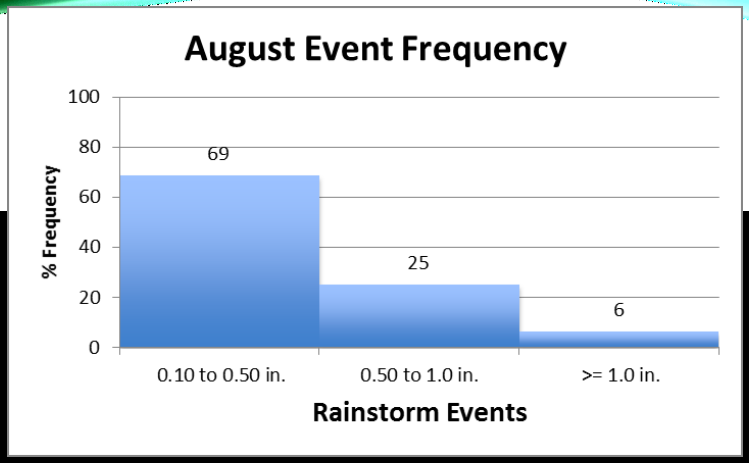
>> Need an analysis of the historical storm data

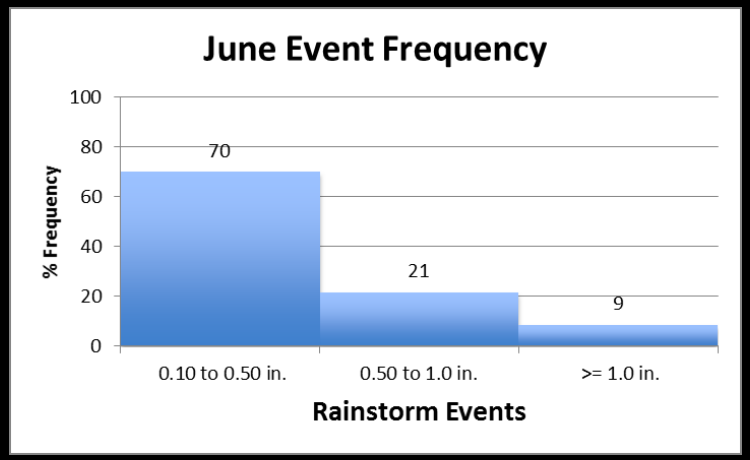
Rainstorm Events at Grand Forks

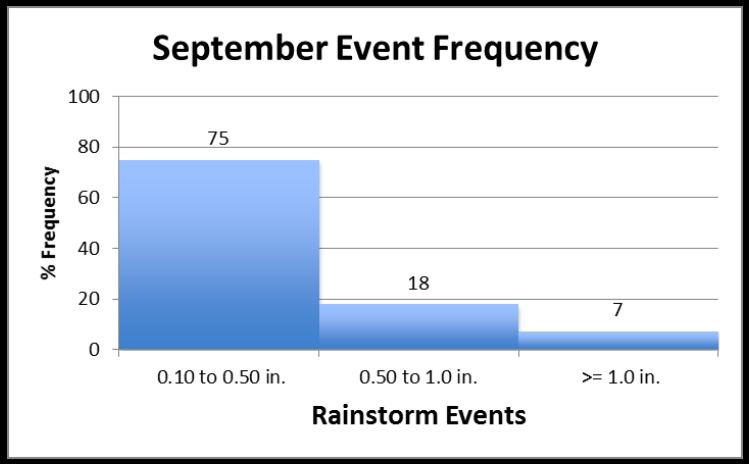
(Data 1994-2013)

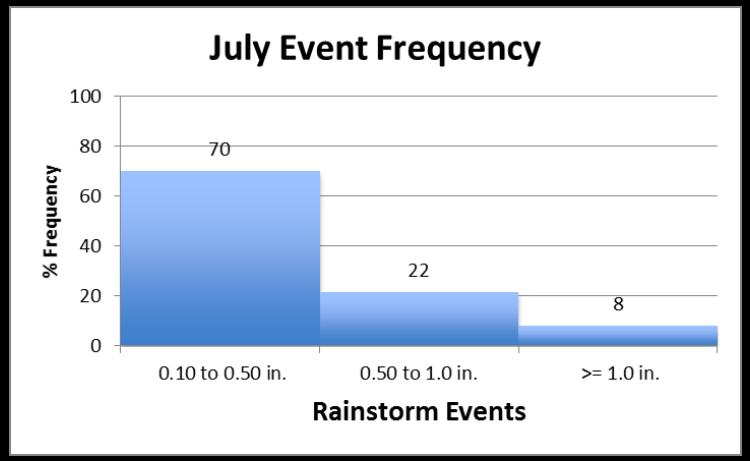


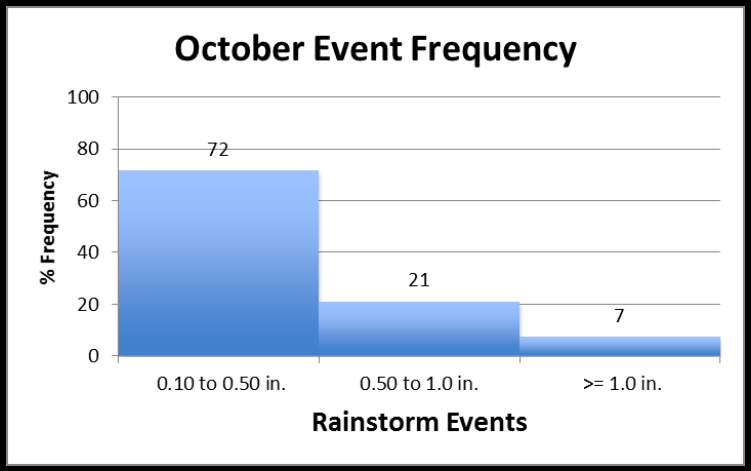

May Event Frequency
100
80
60
40
20
0
% Frequency
71
24
5
0.10 to 0.50 in.
0.50 to 1.0 in.
>= 1.0 in.
Rainstorm Events


August Event Frequency
100
80
60
40
20
0
% Frequency
69
25
6
0.10 to 0.50 in.
0.50 to 1.0 in.
>= 1.0 in.
Rainstorm Events

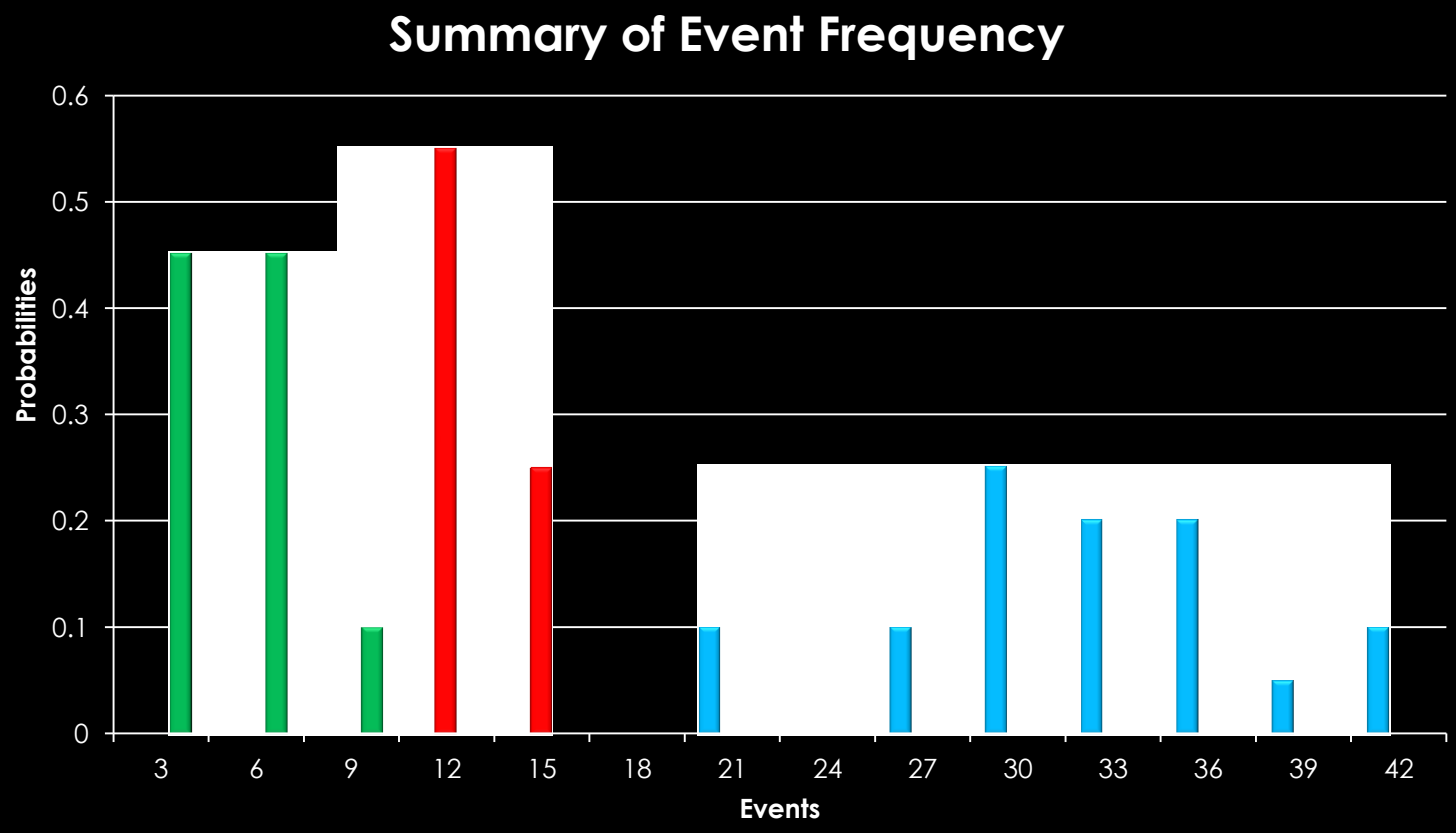

June Event Frequency
100
80
60
40
20
0
% Frequency
70
21
9
0.10 to 0.50 in.
0.50 to 1.0 in.
>= 1.0 in.
Rainstorm Events


September Event Frequency
100
80
60
40
20
0
% Frequency
75
18
7
0.10 to 0.50 in.
0.50 to 1.0 in.
>= 1.0 in.
Rainstorm Events

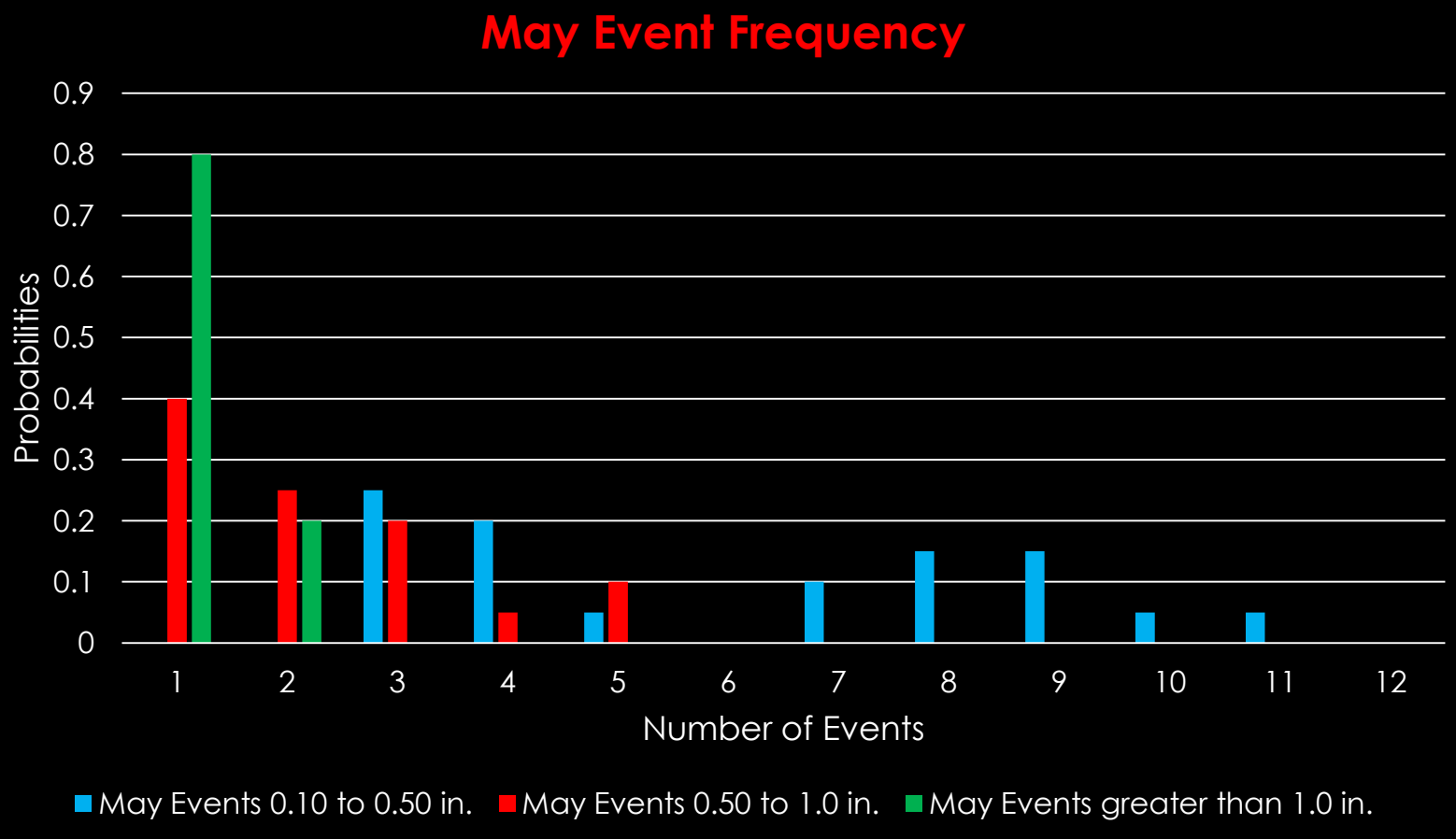

July Event Frequency
100
80
60
40
20
0
% Frequency
70
22
8
0.10 to 0.50 in.
0.50 to 1.0 in.
>= 1.0 in.
Rainstorm Events

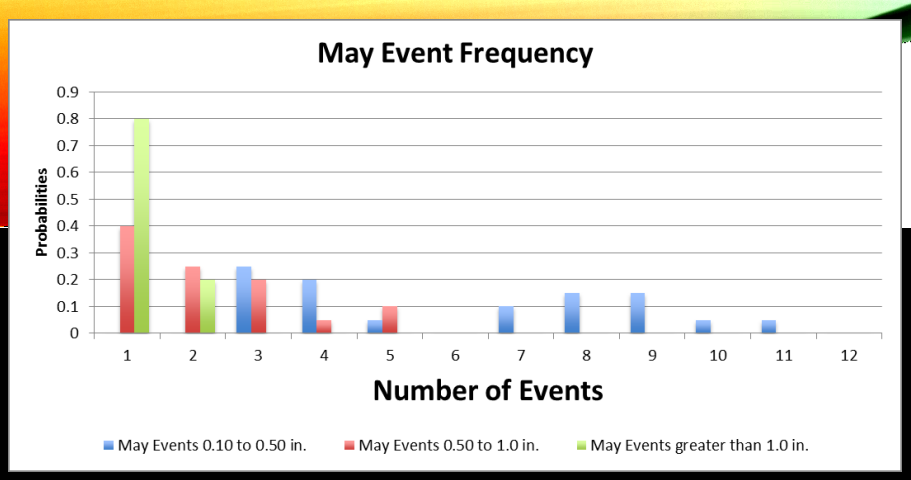

October Event Frequency
100
80
60
40
20
0
% Frequency
72
21
7
0.10 to 0.50 in.
0.50 to 1.0 in.
>= 1.0 in.
Rainstorm Events

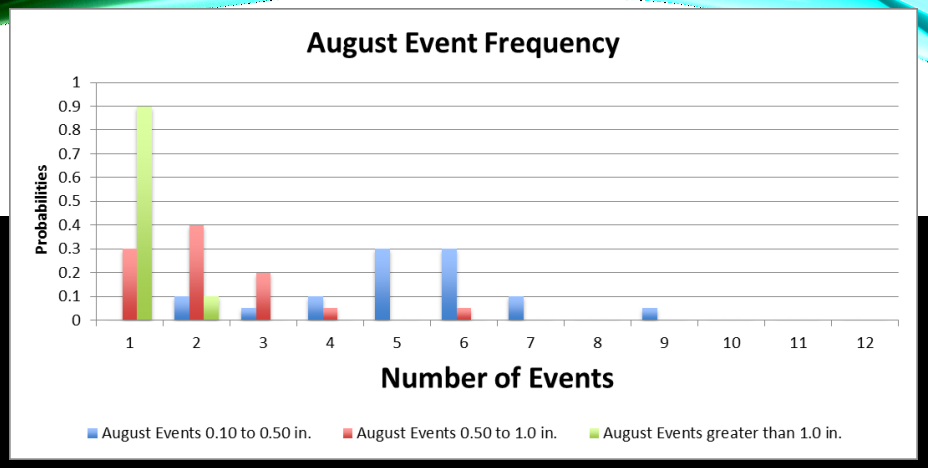
Number of an Event Type Occurring Over the May-October Period

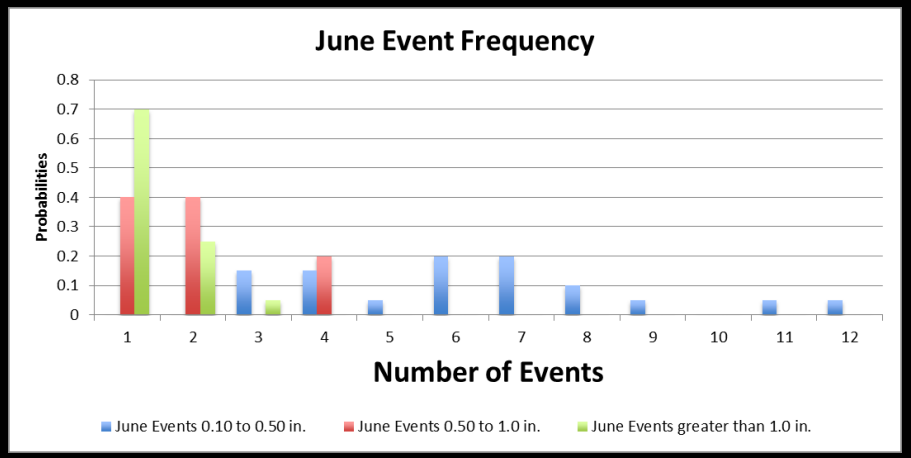


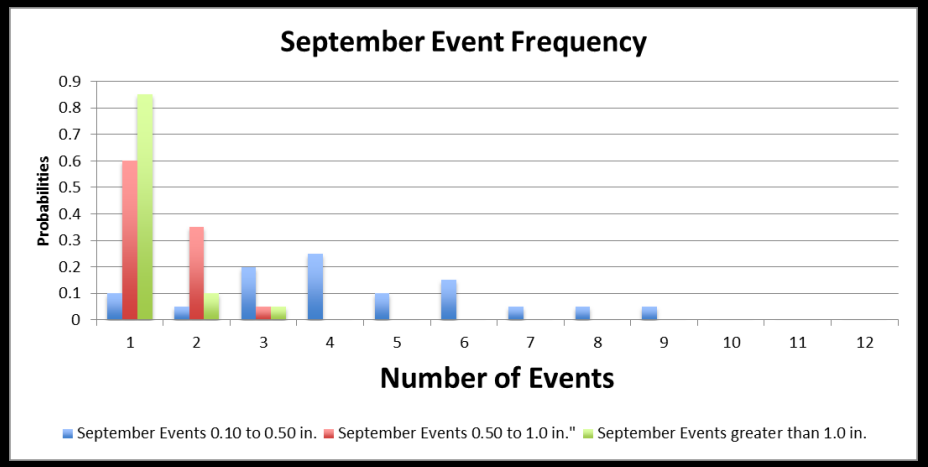
Probability of Having a Certain Number of an Event Type Occurring – by month

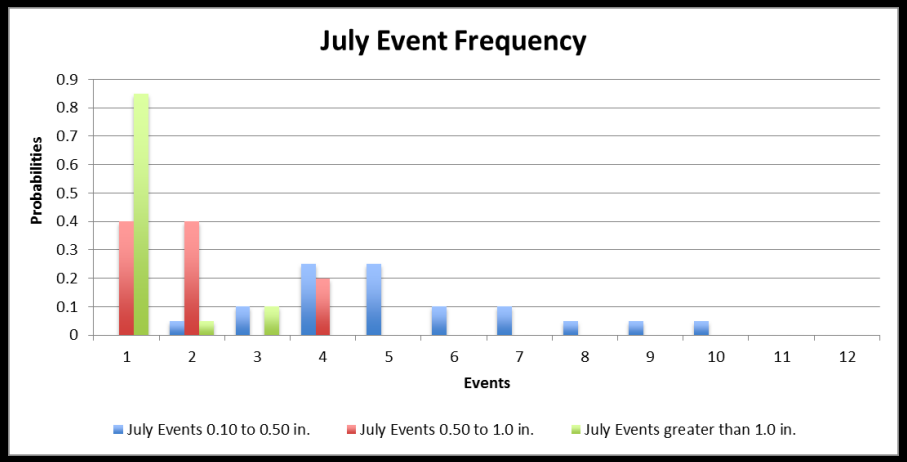


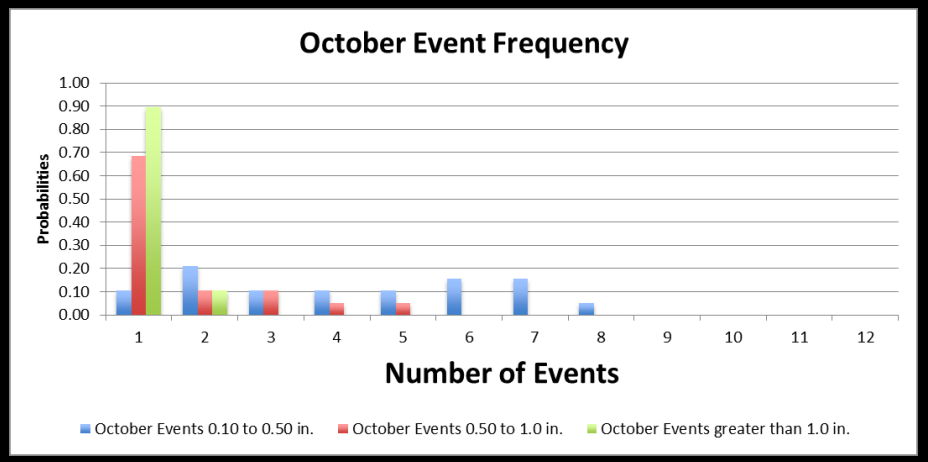

May Event Frequency
Probabilities
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12
Number of Events
May Events 0.10 to 0.50 in.
May Events 0.50 to 1.0 in.
May Events greater than 1.0 in.


August Event Frequency
Probabilities
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12
Number of Events
August Events 0.10 to 0.50 in.
August Events 0.50 to 1.0 in.
August Events greater than 1.0 in.


June Event Frequency
Probabilities
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12
Number of Events
June Events 0.10 to 0.50 in.
June Events 0.50 to 1.0 in.
June Events greater than 1.0 in.

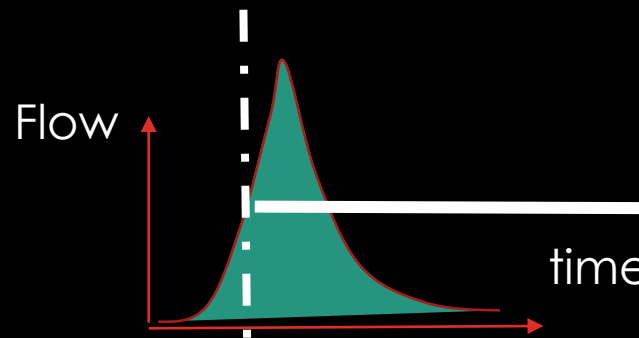

September Event Frequency
Probabilities
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12
Number of Events
September Events 0.10 to 0.50 in.
September Events 0.50 to 1.0 in."
September Events greater than 1.0 in.

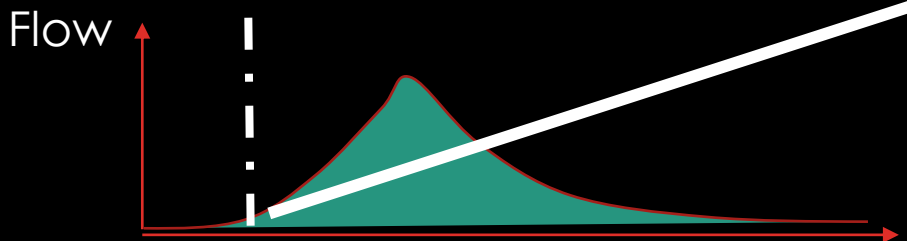

July Event Frequency
Probabilities
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12
Events
July Events 0.10 to 0.50 in.
July Events 0.50 to 1.0 in.
July Events greater than 1.0 in.


October Event Frequency
Probabilities
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 2 3 4 5 6 7 8 9 10 11 12
Number of Events
October Events 0.10 to 0.50 in.
October Events 0.50 to 1.0 in.
October Events greater than 1.0 in.

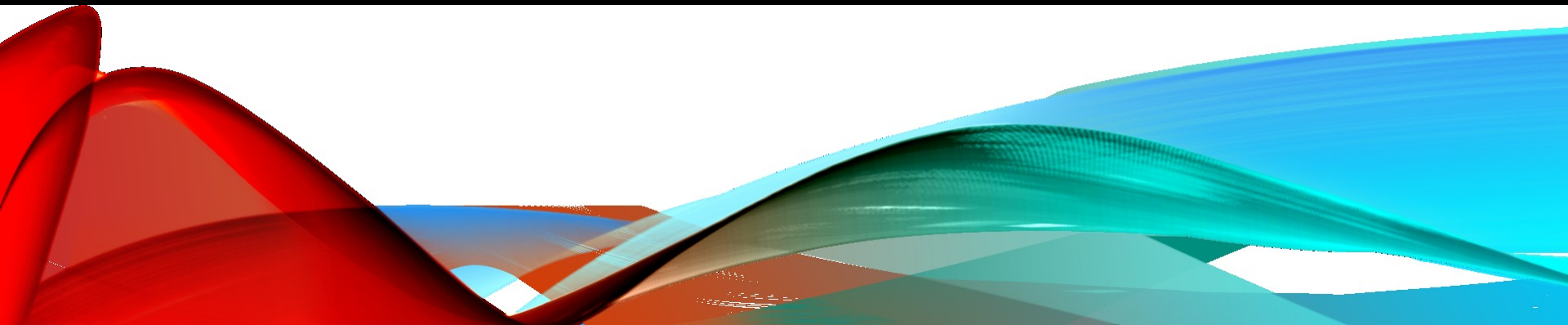
Field Sampling Plan

- With the rainstorm events frequency analysis, a much better schedule and plan for field sampling can be derived





WATER QUALITY PARAMETERS IN BMPS



General List for WQ Monitoring

- Turbidity
- Phosphorus
- Nitrates
- Temperature
- Conductivity
- Dissolved oxygen
- Biochemical oxygen demand
- Heavy metals
- Organic chemicals

WQ Monitoring For BMPs?

- Need to come up with a list that is appropriate for BMPs
- Consider:
  - Importance of the parameter
  - Sensitivity of the parameter
  - Eliminate one that is obviously not likely to be significance
  - Budgetary and time constraints

- Need a baseline study first

Full developed pa

States	Chlorophyll-a	Turbidity or Clarity (secchi depth)	Total Phosphorous	Inorganic Phosphates as P	Total Nitrogen	Total Inorganic Nitrogen	Nitrate as N	Nitrite	TKN
Alabama	x								
Arizona	x	x	x	x	x				x
California	x	x	x	x	x	x	x		x
Colorado	x								
Delaware		x		x		x			
Florida	x		x		x		x	x	
Georgia	x		x		x		x	x	
Hawaii	x	x	x	x	x	x	x	x	
Illinois			x						
Maryland	x	x							
Massachusetts			x		x				
Minnesota	x	x	x						
Missouri	x		x		x				
Montana	x		x		x				
Nebraska	x		x		x				
Nevada	x		x	x	x	x	x	x	
New Jersey			x				x		
New Mexico			x						
North Carolina	x	x							
Oklahoma	x		x						
Oregon	x		x						
Rhode Island			x						
South Carolina	x	x	x		x				
Tennessee	x								
Texas	x								
Vermont			x				x		
Virginia	x	x	x						
West Virginia	x		x						
Wisconsin			x						

Proposed List for Baseline Study
City of Grand Forks

Final parameters decided (for initial baseline study):

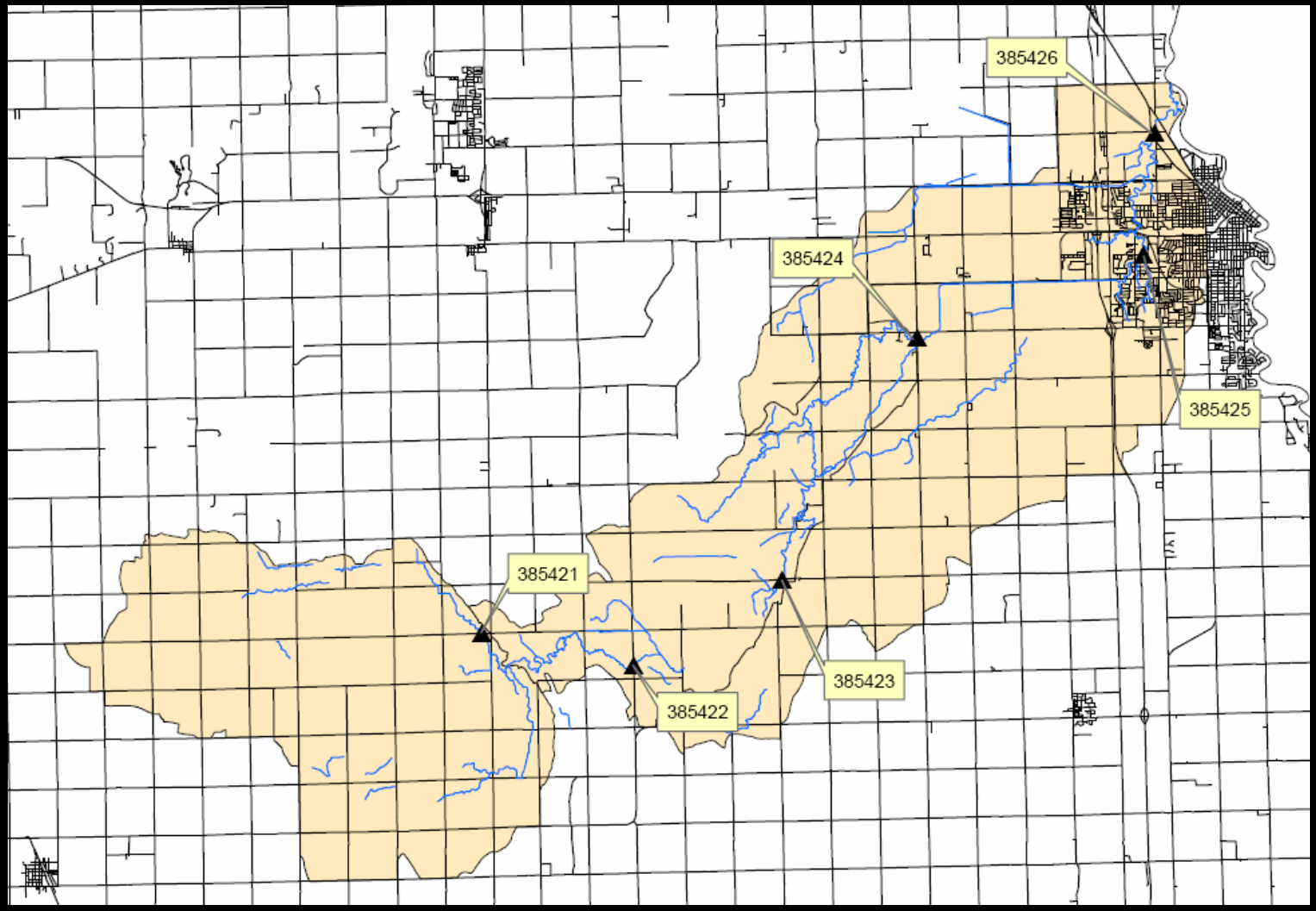
- TSS
- Conductivity
- D.O. (in field)
- pH (in field)
- Nitrates
- Phosphates
- TKN
- Phosphorus
- Heavy metals (Cu, Pb, Zn, Hg)

(may vary depending on BMP)

Expected Range of Parameters

- It is vital to know the expected range of values for various parameters
  - So that any testing kit to be acquired will be within the testing range
- Get guidance from previous studies
  - English Coulee WQ Study (2008-2009)

English Coulee WQ Study (2008-2009)



Details on English Coulee WQ Study Studied Parameters

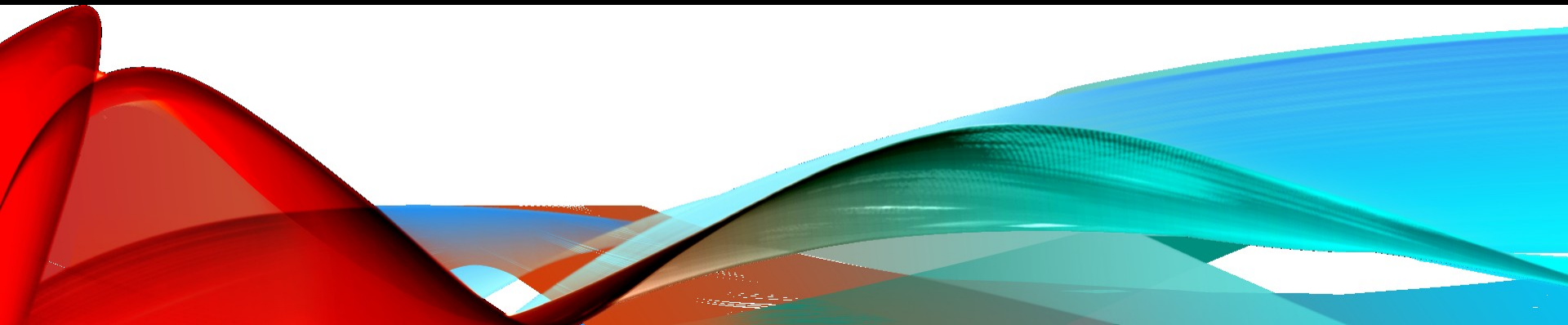
- Roughly 50 different parameters tested during the study
  - Data collected from April 2008 through October 2009
  - Sampling event count ranged from 68 to 77 between the six sample locations
- WQ parameters that overlap with typical urban runoff testing parameters
  - Copper, Lead, Nitrate + Nitrite (N), Nitrogen (TKN), Nitrogen (total), pH, Phosphorus (total), Total Suspended Solids, Zinc
- Use results to determine expected range of values for various parameters

Testing Parameter Values

Summary of Mean Results from English Coulee Sampling - Only Parameters Discussed thus far that were Tested (2008-2009)*

		Copper (Cu)	Lead (Pb)	Nitrate + Nitrite (N)	Nitrogen (TKN)	Nitrogen (Total)	pH	Phosphorus (Total)	Total Suspended Solids	Zinc (Zn)
Site ID	**Statistics**	(µg/L)	(µg/L)	(mg/L)	(mg/L)	(mg/L)		(mg/L)	(mg/L)	(µg/L)
385421	Minimum	0.5	0.5	0.015	0.1	0.694	6.74	0.007	2.5	0.5
	Maximum	5	5	11.7	11.1	12.3	8.04	2.38	76	54.9
	Median	2.75	2.75	5.857	5.6	6.497	7.39	1.194	39.25	27.7
	Mean	2.253	2.087	1.87	1.382	3.253	7.544	0.207	7.98	10.636
	Std. Deviation	1.105	1.256	2.645	1.422	2.899	0.334	0.336	13.925	10.253
	Count	75	75	74	74	74	74	74	74	75
385422	Minimum	0.5	0.5	0.015	0.599	0.711	7.12	0.004	2.5	0.5
	Maximum	5	5	5.12	1.34	5.94	8.55	0.332	45	259
	Median	2.75	2.75	2.567	0.97	3.326	7.835	0.168	23.75	129.75
	Mean	2.29	2.019	0.702	0.925	1.633	7.851	0.121	6.954	12.566
	Std. Deviation	1.001	1.276	1.337	0.194	1.284	0.295	0.08	7.465	31.48
	Count	77	77	76	76	76	76	76	76	77
385423	Minimum	0.5	0.5	0.015	0.765	0.795	6.71	0.025	2.5	1.41
	Maximum	5	5	1.23	4.99	5.21	8.42	0.969	46	45.5
	Median	2.75	2.75	0.622	2.878	3.002	7.565	0.497	24.25	23.455
	Mean	2.354	2.049	0.081	1.708	1.796	7.592	0.187	8.013	7.574
	Std. Deviation	0.979	1.267	0.18	0.777	0.793	0.404	0.183	9.244	8.419
	Count	77	77	76	76	76	76	76	76	77
385424	Minimum	1.25	0.5	0.015	0.789	0.823	6.68	0.025	2.5	0.5
	Maximum	40	9.6	8.47	4.24	11.5	8.42	0.713	338	78.2
	Median	20.625	5.05	4.243	2.515	6.162	7.55	0.369	170.25	39.35
	Mean	3.623	2.067	0.286	1.426	1.719	7.556	0.182	11.64	12.023
	Std. Deviation	4.55	1.466	1.191	0.595	1.488	0.316	0.163	41.971	15.638
	Count	76	76	75	75	75	75	75	75	76
385425	Minimum	1.8	0.5	0.015	0.36	0.617	6.43	0.023	2.5	0.5
	Maximum	16.4	5	3.32	3.51	4.23	8.08	0.391	72	129
	Median	9.1	2.75	1.668	1.935	2.424	7.255	0.207	37.25	64.75
	Mean	3.139	2.072	0.376	1.058	1.436	7.615	0.113	7.007	13.106
	Std. Deviation	1.893	1.191	0.597	0.466	0.682	0.422	0.079	11.466	17.055
	Count	76	76	75	75	75	75	75	75	76
385426	Minimum	0.5	0.5	0.015	0.488	0.607	6.49	0.045	2.5	0.5
	Maximum	7.02	5	1.87	1.9	3.03	8.8	0.852	38	87.3
	Median	3.76	2.75	0.943	1.194	1.818	7.645	0.449	20.25	43.9
	Mean	2.701	1.979	0.252	1.045	1.301	7.885	0.146	9.485	13.376
	Std. Deviation	1.031	1.205	0.339	0.265	0.424	0.469	0.137	8.074	14.486
	Count	69	69	68	68	68	68	68	67	69

SELECTION OF BMPS FOR STUDY

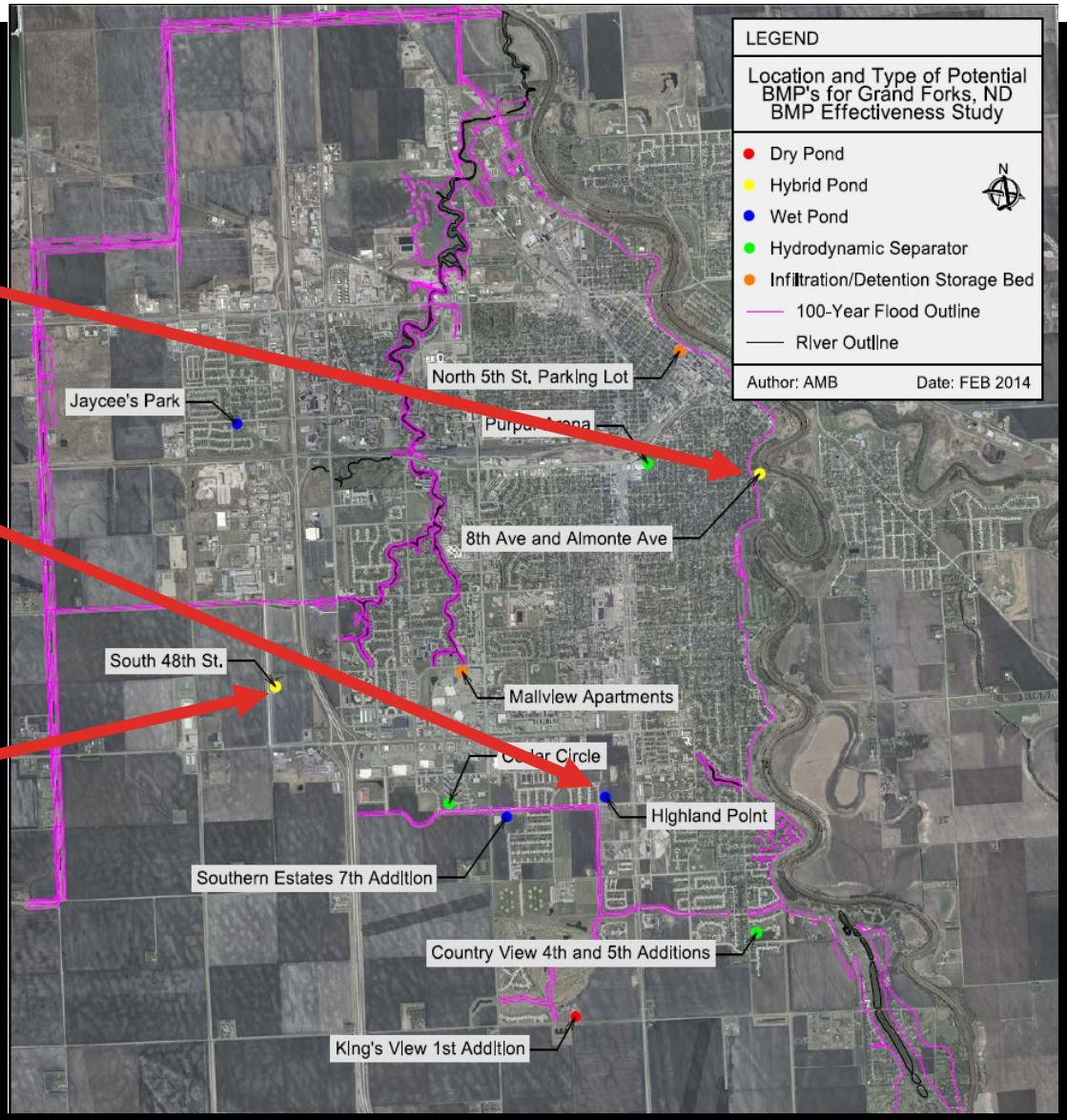


At Least 2 sites selected

- 8th Ave and Almonte Ave
  - designed by USACE
- Highland Point
  - designed by CPS, Ltd.

Other:

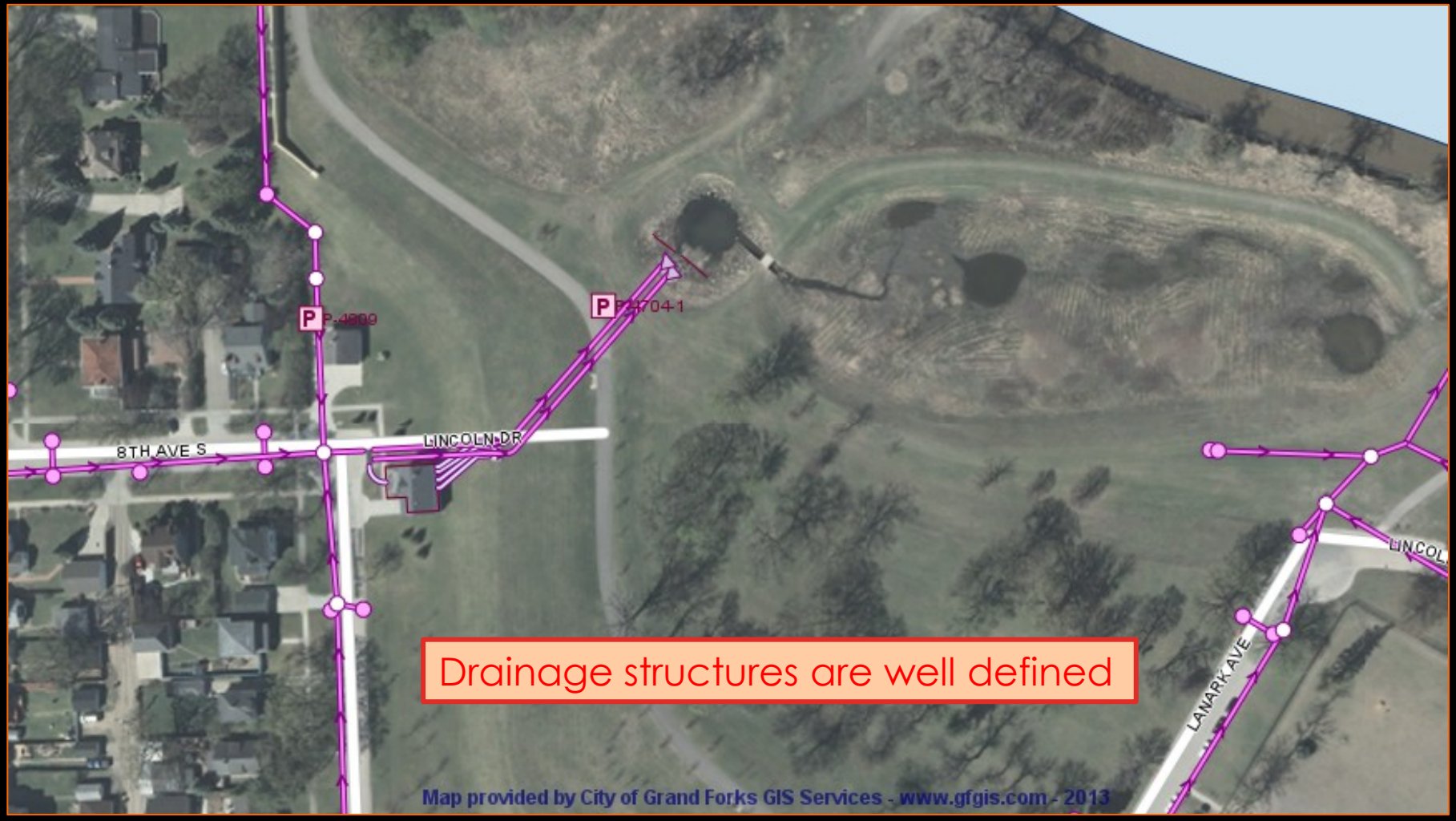
- S 48th St.



8th Ave and Almonte Ave


Minnesota
North Dakota
Accessibility for water sampling is good
A programmable rain gage was installed

8th and Almonte Storm Sewer System



Highland Point Drainage Pond

2011

Highland Point Drainage Area

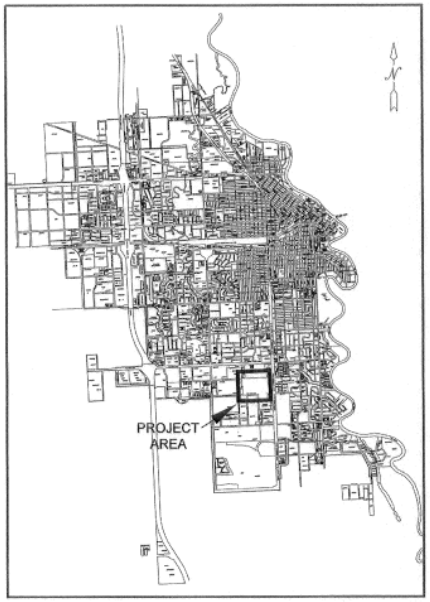
A PLACE OF EXCELLENCE
CITY OF GRAND FORKS

CITY PROJECT 6617, 6618, 6619

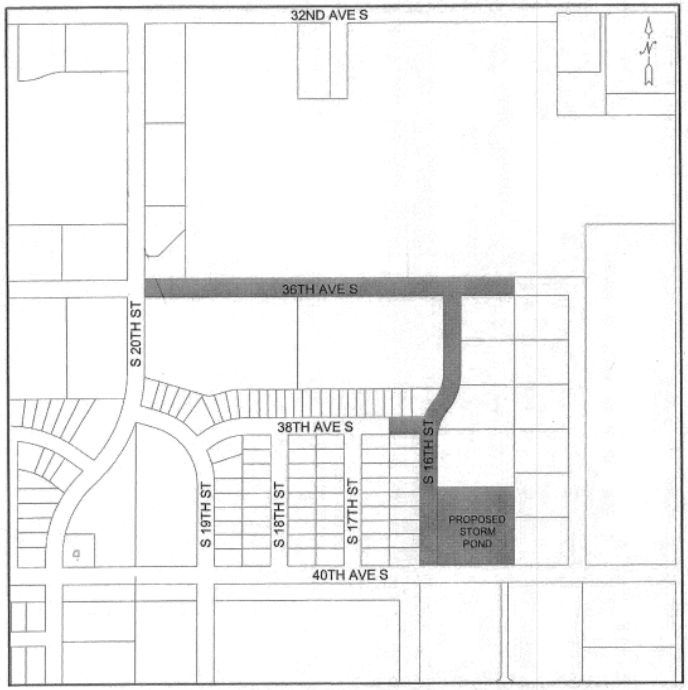
SANITARY SEWER, WATERMAIN & STORM SEWER
S 16th ST from 40th AVE S to 36th AVE S
36th AVE S from S 20th ST TO S 16th ST
HIGHLAND POINT 5TH RESUBDIVISION

CITY OF GRAND FORKS
ENGINEERING DEPARTMENT

CITY ENGINEER
ALLEN R. GRASSER



VICINITY MAP
SCALE: NTS



PROJECT AREA
SCALE: NTS

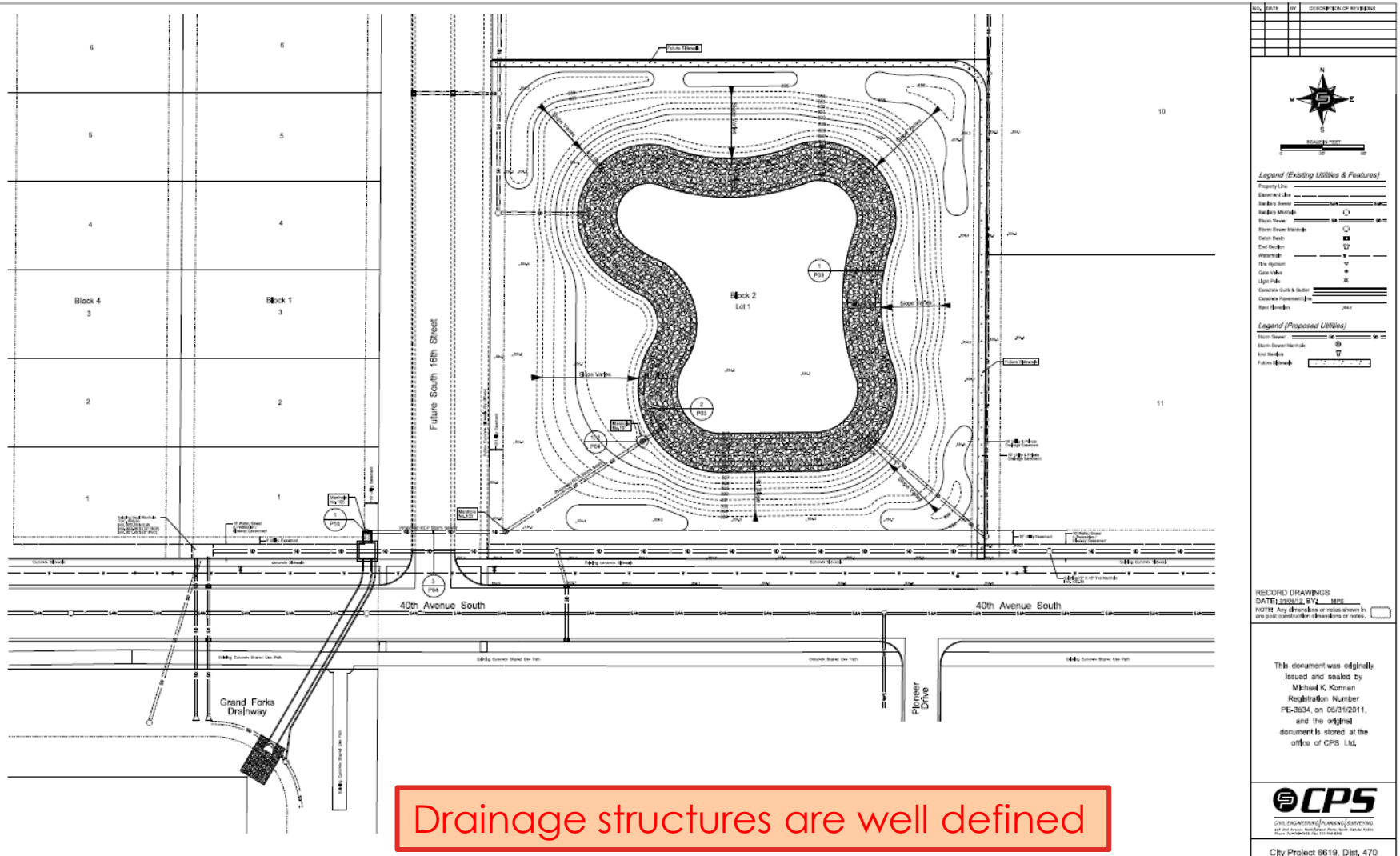
TABLE OF CONTENTS

LEGEND

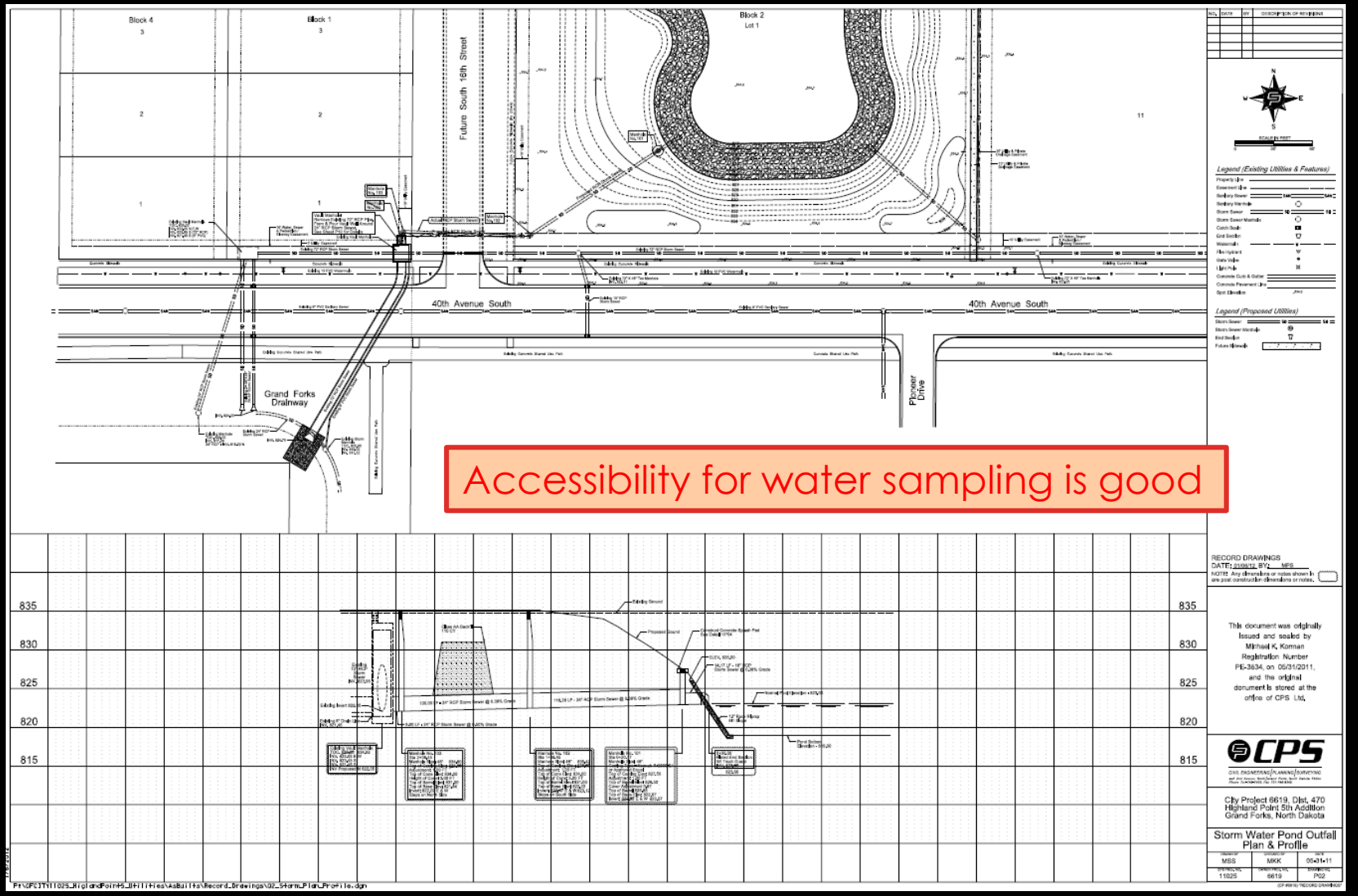
	PROPOSED	EXISTING
RIGHT-OF-WAY LINE		
PROPERTY LINE		
EASEMENT LINE		
SANITARY SEWER		
FORCEMAIN		
STORM SEWER		
WATER MAIN		
UNDERGROUND GAS		
UNDERGROUND ELECTRIC		
UNDERGROUND COMMUNICATIONS		
UNDERGROUND CABLE TV		
OVERHEAD ELECTRIC		
OVERHEAD COMMUNICATIONS		
OVERHEAD CABLE TV		
STORM & SANITARY MANHOLES		
FIRE HYDRANT		
FIRE HYDRANT & VALVE		
VALVE		
CATCH BASIN		

ALLEN R. GRASSER P.E. 2912

Drainage Area is well defined



Drainage structures are well defined


Block 4
Block 1
Block 2
Lot 1
Future South 16th Street
40th Avenue South
40th Avenue South
Grand Forks Dralnway
Pioneer Drive
Accessibility for water sampling is good
835
830
825
820
815
Legend (Existing Utilities & Features)
Legend (Proposed Utilities)
RECORD DRAWINGS
This document was originally issued and sealed by Michael K. Korman Registration Number PE-3634, on 05/31/2011, and the original document is stored at the office of CPS Ltd.
CPS
City Project 6619, Dist. 470
Highland Point 5th Addition
Grand Forks, North Dakota
Storm Water Pond Outfall
Plan & Profile
MSS
MKK
05-01-11
11025
6619
P02

Conclusions

1. Selection of sites for BMP study, need to be selective based on a number of factors:
   - BMP type – the potentially effective type
   - Location – proximity to available gauges
   - Accessibility – consider the short duration storms and crew respond time
   - Available construction plans – identify the designed drainage path and elevation details

2. Planning for field samplings need to take the probabilities of rainstorm types into account
   - Resolve the timing issues

Conclusions

3. Consider all possible pollutant measurements for an initial baseline study and provide guidance for a list of pollutants for future continuous monitoring

4. The study aims to contribute in these areas:
   - The performance of BMPs in the cold region
   - The cost-benefits for a certain type of BMPs
   - The design of BMPs

Acknowledgements

- City of Grand Forks
  - Rich Romness, Assistant City Engineer, P.E.
  - Hazel Sletten, Superintendent, Water Utility
  - Melanie Parvey, Environmental / Greenway Manager
  - Ken Stevenson, Stormwater, Public Works
  - Fred (John) Goetz, Water Treatment Plant
  - Andrew Job, Water Treatment Plant
  - Bill Sukalski, Wastewater Treatment Plant
- North Dakota Water Resources Research Institute
  - G. Padmanabhan, Professor of Civil Engineering
- CPS Inc.
  - Mike Korman, P.E.

Thank you

Howe Lim
howe.lim@engr.und.edu
Abbie Beaudry
Abbie.beaudry@my.und.edu

S 48th St