Sustainability: *Life, Liberty and the Pursuit of Negative Entropy*

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Entropy-based Resource Management:

"A simple Organizing Principle for developing sustainability strategies"

- Concept
- Examples
- Looking forward

Concept

1996-98 Salmon Creek Watershed Plan

"Instead of engineered facilities, why don't you use holistic, watershed-based methods that *"mimic natural processes?"*

Agree…….*but what exactly does that mean???*

“Mimic natural processes?”

- Natural processes always minimize energy loss and leave all resources in a *state of minimum entropy* afterwards
- The resource is always maintained in its highest, most ordered state, at the highest energy level possible

Try to create and maintain order, to *“create negative entropy”*, in all things, in all places, at all times

“Entropy-based watershed management; A holistic, watershed-based strategy that mimics natural processes”

Natural Examples

1. SNOWPACK

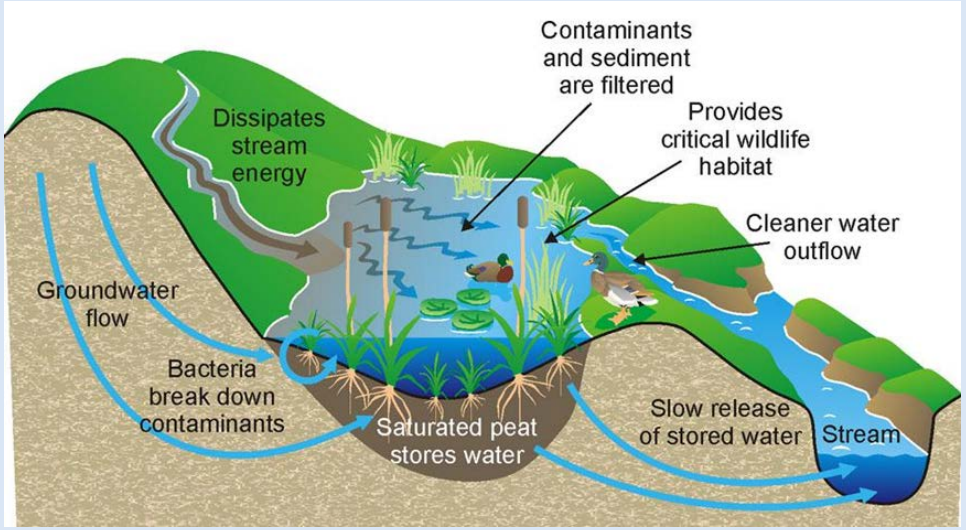
Water in solid phase at the highest potential energy possible.

….next best thing??

2. HIGH GROUNDWATER

Water in liquid phase at the highest potential energy possible.

"Pump up the groundwater as high as possible (then plant everything)"



The entropy-based resource management “organizing principle”……

Brings separate initiatives, covering multiple resources, together in a holistic sustainability strategy

Establishes order, not only on the molecular scale, but also in all other management, planning and regulatory operations.

……and does it quickly and cost effectively

“Top-down watershed management”

A tale of two whiskies….

Examples

Hydrologic Accounting and the 2008-2011 Stormwater CIP (SCIP)

"Hydrologic Accounting" was used to:

- Determine the cost-effectiveness of projects
- Select and prioritize capital projects
- Evaluate alternative designs

…….and quickly move projects forward into construction.

Hydrologic Accounting:
Project Effectiveness

Sub-basin Retrofit Plan

1. Use Watershed Sensitivity/Impact mapping to identify priority sub-basins

2. Use *"Top-down BMP selection"* to identify the most cost-effective infiltration BMP at every possible retrofit location

3. Use *Hydrologic Accounting* to select the most cost-effective combination of BMPs to form a *"Plan Alternative"*

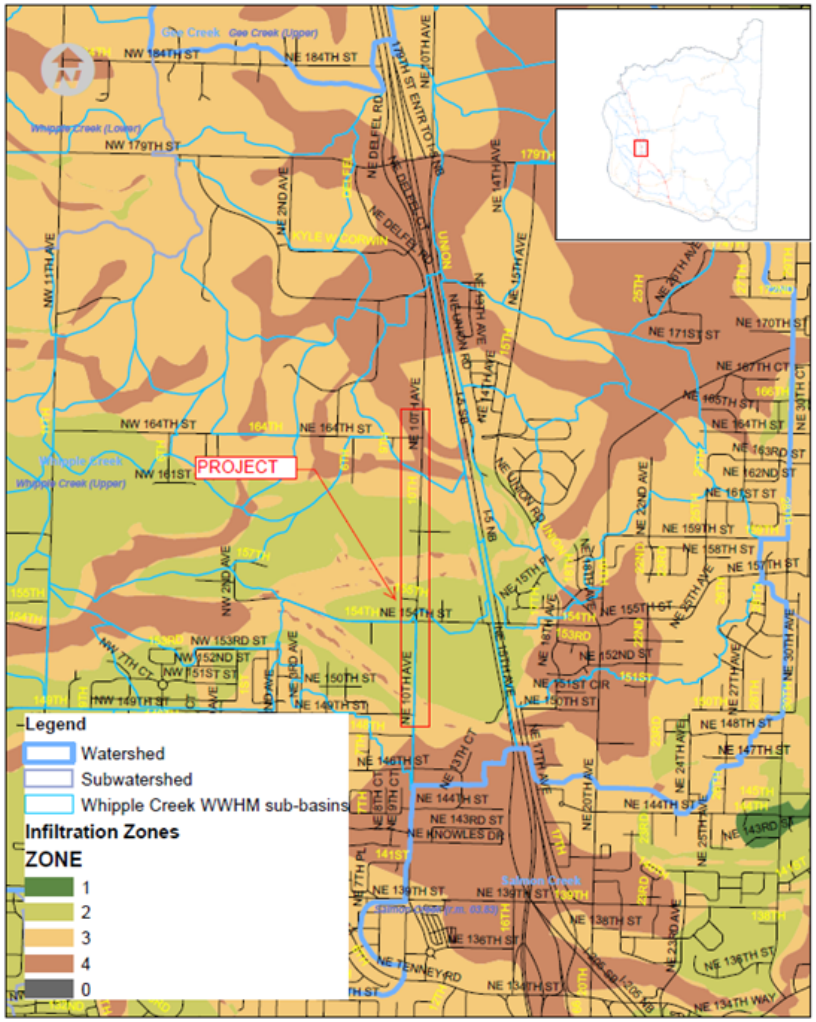
4. Use *Hydraulic Accounting* to confirm and adjust the selected Plan Alternative

5. Complete the final project design using standard hydrologic and hydraulic models

Sub-basin Retrofit Plan

Infiltration Zone Map and Matrix

NE 10th Avenue; NE 149th Street to NE 164th Street
Figure 8: Infiltration Zones



		Hydrologic Soil Groups			
		A*	B	C	D
Depth to GW	D >20 ft	ZONE 1	ZONE 2	ZONE 3	ZONE 3
	D=11 ft to 20 ft	ZONE 2	ZONE 2	ZONE 3	ZONE 3
	D=0 ft to 10 ft	ZONE 3	ZONE 3	ZONE 4	ZONE 4

The grid maps were combined to create an "Infiltration Zone Map" with four zones.

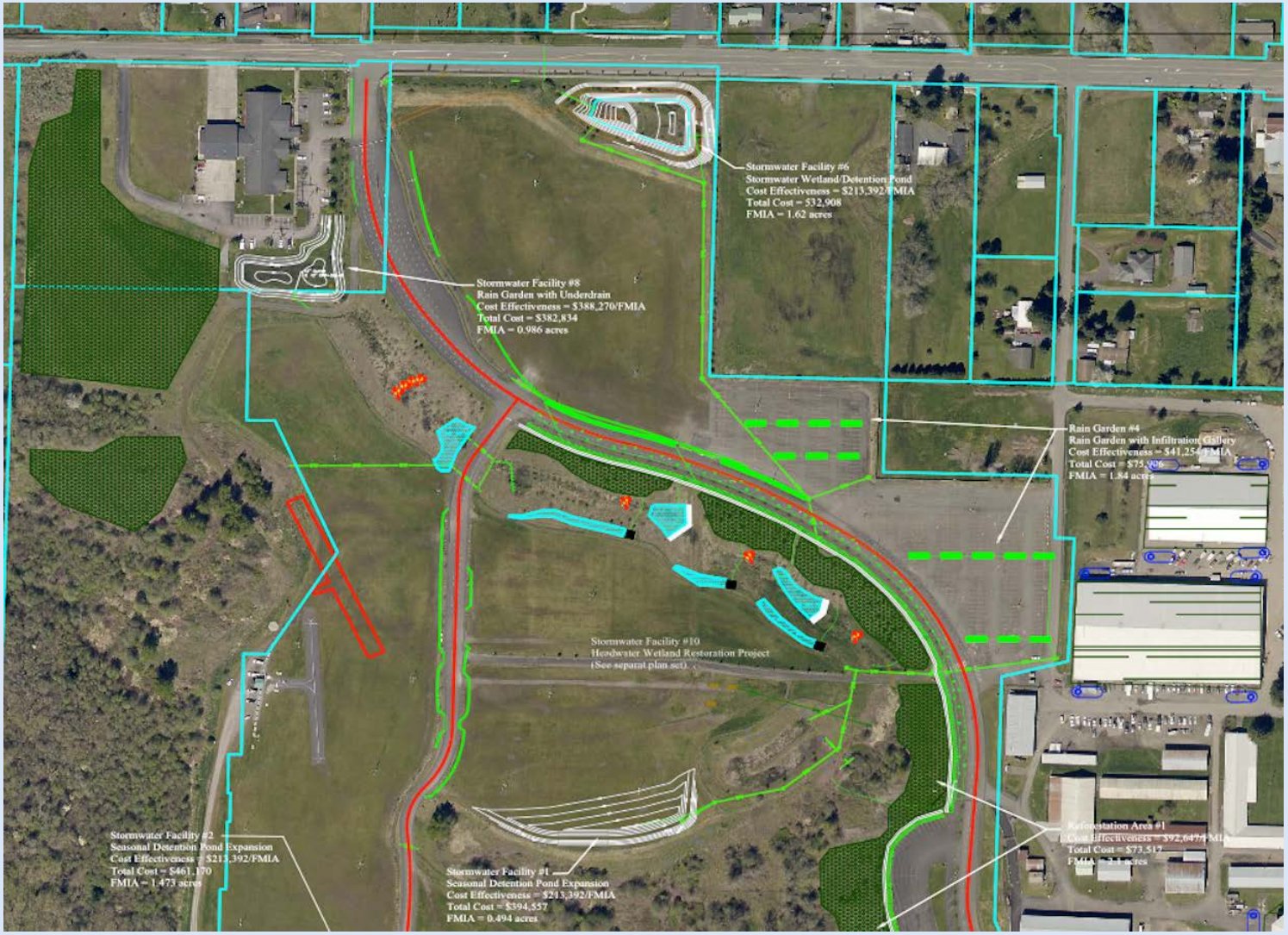
- Zone 1 – Good Infiltration Area
- Zone 2 – Potentially Good Infiltration Area (groundwater depth and soil investigation required)
- Zone 3 – Limited Potential Infiltration Area
- Zone 4 – Poor Potential Infiltration Area

BMP COST-EFFECTIVENESS
($/Fully-Mitigated Impervious Acre)

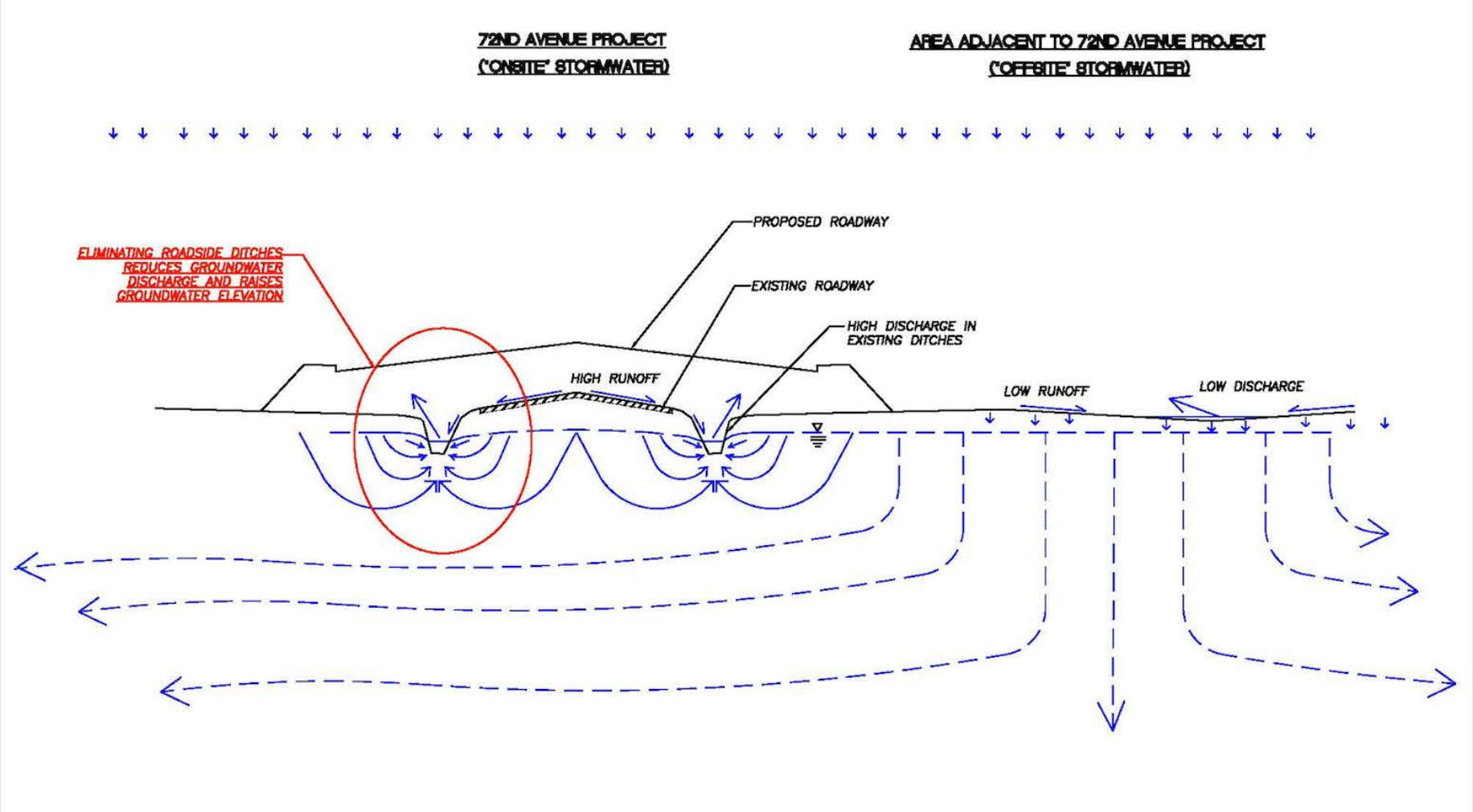
BMP	*INFILTRATION ZONE*			
	1	*2*	*3*	*4*
Detention Pond	*Don't Use*	*Don't Use*	*$317,559*	*$317,559*
Rain Garden (w/Inf. Gallery)	*$27,166*	*$56,878*	*Don't Use*	*Don't Use*
Rain Garden (w/Underdrain)	*Don't Use*	*$535,329*	*$535,329*	*$535,329*
Green Roof	*$7,920,000*	*$7,920,000*	*$7,920,000*	*$7,920,000*
Reforestation (of pasture)	*$135,821*	*$135,625*	*$92,647*	*$92,647*
Reforestation (R & R asphalt)	*$1,880,000*	*$1,880,000*	*$1,286,000*	*$1,286,000*
Roadside Rain Garden (w/Inf. Gallery)	*$47,811*	*$99,929*	*Don't Use*	*Don't Use*
Roadside Rain Garden (w/Underdrain)	*Don't Use*	*Don't Use*	*$917,538*	*$917,538*
Parking Lot Rain Garden (w/Inf. Gallery)	*$86,426*	*$181,856*	*Don't Use*	*Don't Use*
Parking Lot Rain Garden (w/Underdrain)	*Don't Use*	*Don't Use*	*$1,745,818*	*$1,745,818*

Sub-basin Retrofit Plan

Alternative #1: "Maximum Improvement"



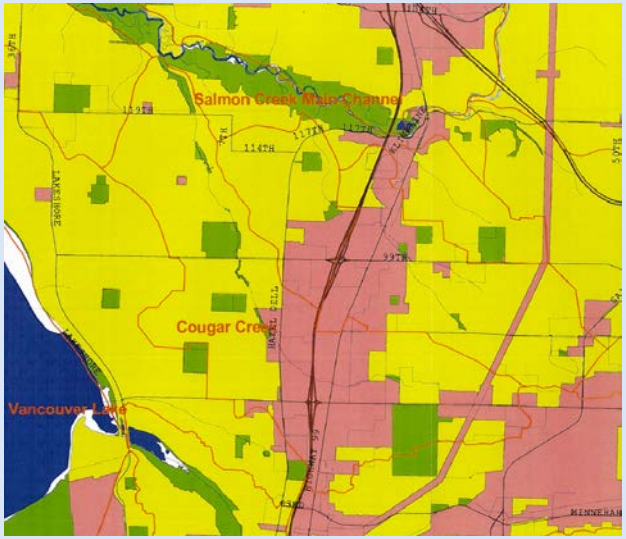
Groundwater Recharge *and Discharge*



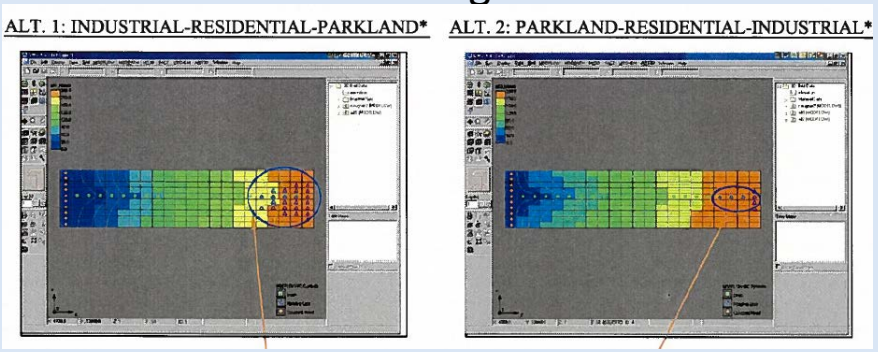
Looking forward

What is the most sustainable.....*land use plan?*

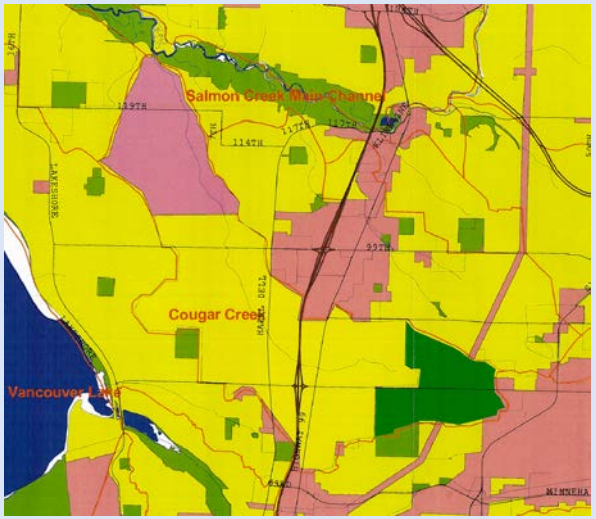
Current Land Use Plan



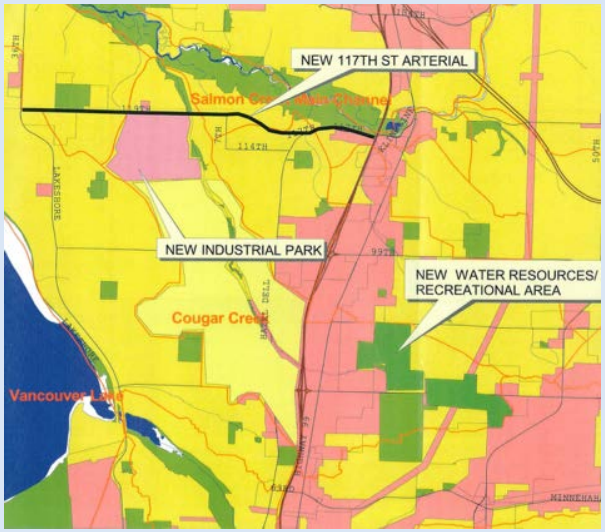
Use GW model to determine the optimal land use arrangement



Envirometric Land Use Plan

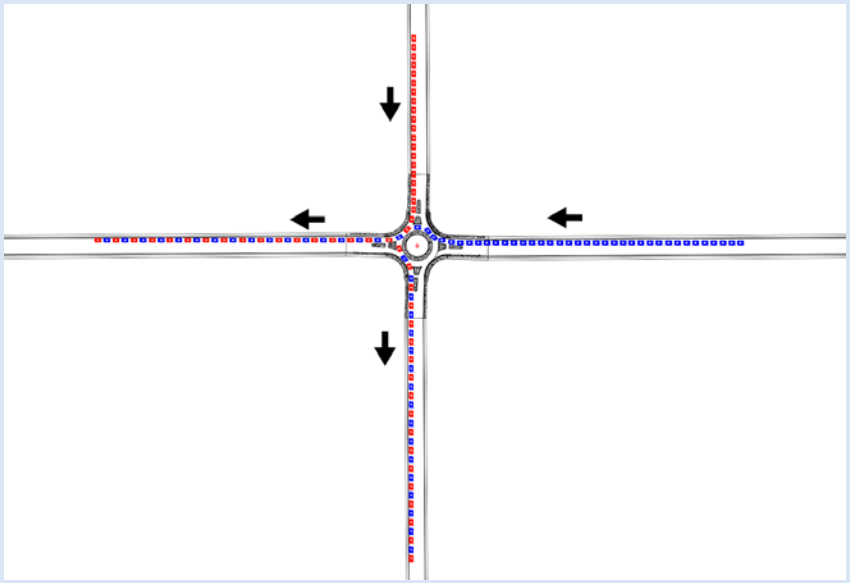


Sustainable Land Use Plan



What is the most sustainable....*roadway grid?*

Roundabout Corridor

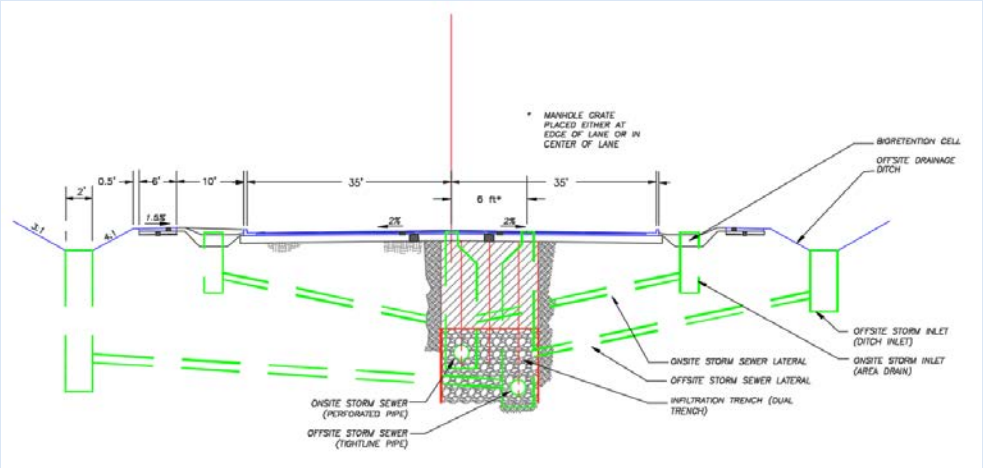


- No stoppages/less energy use
- Minimize entropy change from liquid/PE to gas/KE

Also:

- Less emissions

Green Street



- Infiltration of stormwater runoff
- Increased groundwater recharge
- Higher groundwater table
- Reduced stream erosion
- Less impervious area
- Less wetland impact

Watershed Management: New Focus

TRADITIONAL PROCESS

Comprehensive Plan

Watershed Plan

Capital improvement Projects

SUGGESTED PROCESS

Sustainable Land Use Plan

Sub-basin Retrofit Plan

Capital Improvement Projects

Causes for Optimism

- Increasing use of LID
- Stormwater capture and aquifer replenishment
- Increasing use of solar energy
- Wind energy linked to pumped storage
- Turbines inside gravity water supply lines
- Artificial photosynthesis for fuel

Create negative entropy!

"The ultimate purpose of life, mind, and human striving: to deploy energy and information to *fight back the tide of entropy and carve out refuges of beneficial order*"

- Steven Pinker

Sustainability???

"Just create a bit of negative entropy mate.....she'll be alright."

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