Fort Wayne Green Infrastructure Evaluation
Scorecard Approach and Description

1 Metrics for the Green Infrastructure Evaluation Process Scorecard

Specific metrics for the Green Infrastructure Evaluation Process were developed by the City of Fort Wayne (City) through a series of workshops and meetings and ultimately divided into the triple bottom line categories of cost, social and environmental impacts. These metrics were developed with the Long Term Control Plan (LTCP) as the driving reason; however it is the intent of the City to apply or evolve these metrics for other types of the City projects.

The three categories of metrics (i.e., cost, social and environmental) were organized in a scorecard spreadsheet to be used by the Engineer performing the alternatives analysis for a specific project. The first tab of the workbook is a summary tab of the alternatives analyzed and is linked to each subsequent tab for the specific alternative.

The score criteria for each metric is generally from 1 to 5, with a score of 5 having the highest benefit, lowest cost, lowest risk, etc. A score of zero is used when the metric is not applicable to the project. Typically, if a metric is deemed as "not applicable", the zero score would apply to each of the alternatives within the project (e.g., metric of downtown revitalization would be zero if the project area is not located downtown). Some metrics may have a negative score if the metric is actually worsened when considering the alternative (e.g., metric of streambank erosion control velocity would be "-3" if velocity in the stormwater outfall increases for a given alternative).

After the metrics were developed and defined, the City weighted each metric on its own merit based on City objectives such as the Consent Decree and Council initiatives. Weighting of metrics allows the City to apply its objectives into the evaluation process in a systematic defensible way. A metric scale of 1 to 3 was developed with 3 being of highest importance, 2 of higher importance, and 1 of high importance. The weightings may only be changed by the City as they continue to refine and improve this evaluation process.

The purpose of the scorecard is to provide a consistent evaluation process so the City's Project Manager can select a preferred alternative for detailed design. The scorecard provides the justification and documentation for each decision. It is not the intent that the scorecard be a rigid, inflexible tool that hinders creativity or common sense decisions, or that the alternative with the highest score is automatically the selected alternative; it is the intent that the scorecard be used as guidance to Engineers and the City in making good, sound decisions on their infrastructure solutions.

1.1 COST METRICS

Six cost metrics were developed for the evaluation process and are described in more detail in the sections below. In addition project specific cost metric could be developed and implemented based on the project location, objective, or other qualities of the project. The cost metrics include:

- Capital cost/gallon combined sewer overflow (CSO) reduction
- Lifecycle operations & maintenance (O&M) cost/gallon CSO reduction
- Other funding opportunities and/or shared resources
- Projected savings – Joint projects

- Use of existing assets
- Capital cost/pound total suspended solids (TSS) reduction

1.1.1 Capital Cost / Gallon CSO Reduction

The total capital cost includes design, construction, easements, City admin, legal, finance, and contingency costs associated with the alternative for the project area. The subbasin model, updated as part of the PER process, will be used to predict the alternative's annual overflow volume in a typical year. .The updated subbasin model will typically be integrated into the system wide interceptor model for this analysis, but can be used independently if the hydraulic impact of the interceptor system on subbasin response is confirmed as negligible.

Following analysis of existing conditions, the alternatives will be incorporated into the model such that the typical year simulation provides the alternatives annual overflow volume. Protocols for incorporating the alternatives (e.g. separation of subcatchments parameters between combined sewer and proposed storm sewer, reduction in impervious area) are discussed in the Modeling Guidelines that are currently being developed.

In Chapter 4 of the LTCP, the recommended plan for the LTCP component only is estimated to have a capital cost of $305.2M in 2005 dollars. The escalation rate was estimated to be a 16.5% increase using the Engineering News Record (ENR) Construction Cost index (CCI) from the 2005 average annual CCI to April 2010 CCI (i.e., 8677 / 7446). Based on this escalation rate, the recommended plan costs $355.5M in 2010 dollars. The recommended plan will reduce CSOs to between 1 to 4 activations with an annual overflow volume reduction of 962 MG (i.e. existing volume of 1,058 MG less remaining volume of 96 MG). Therefore, the recommended plan metric of capital cost divided by gallons of CSO reduction is $0.32/gallon in 2005 dollars and $0.37/gallon in 2010 dollars.

The scorecard criteria for this metric was developed assuming that the average capital cost per gallon overflow reduction for each CSO would be about $0.37/gallon in 2010 dollars. Therefore, if the alternative is close to that average, the score is a 3. If above the average (i.e., less beneficial for dollar spent), a lower score is assigned. If below the average (i.e., more beneficial for dollar spent), a higher score is assigned.

1.1.2 Lifecycle O&M Cost / Gallon CSO Reduction

For each alternative, the operations and maintenance (O&M) costs can include, but are not limited to, general maintenance of pipe (e.g. CCTV and cleaning of pipe at set frequency), routine inspections for pump stations, wet weather inspections for storage tanks and green facilities, maintenance of green infrastructure such as trash removal, sediment removal, invasive species removal, seeding and vegetation.

To assist in initial planning and budgeting of green infrastructure Table 1 provides green infrastructure type, typical ranges of standard O&M annual costs, and a reference to typical O&M requirements for green infrastructure and other stormwater BMPs.

O&M cost for new pipe could be assumed as the average annual cost for CCTV inspection and routine cleaning. From experience, other municipalities have determined this cost to be between $1.00/LF to $1.45/LF based on current CCTV contracts or historical CCTV and cleaning costs divided by the length of pipe maintained. Fort Wayne Sewer Maintenance reports an O&M cost of approximately $1.40/LF.

Table 1 Typical O&M Requirement References and Annual Cost for Green Infrastructure Practices.

Green Infra./ BMP Type [2]	Green Infrastructure/BMP Description	Green Infra./BMP Annual Maint. Cost/sqft-Low [1]	Green Infra./BMP Annual Maint. Cost/sqft-High [1]	Reference Green Infra./ BMP O&M Minimum Requirements [2]
Chapter 4.1: Green Roof	A green roof (vegetated roof/eco roof/roof garden) is a system consisting of waterproofing material, growing medium and vegetation. A green roof can be used in place of a traditional roof as a way to limit impervious site area and manage stormwater runoff.	$0.09	$2.00	Section 4.1.2 Green Roof O & M manual
Chapter 4.2: Permeable Pavement	Permeable Pavement provides the structural support of conventional pavement, but allows stormwater to drain directly through the surface into the underlying stone base and soils, thereby reducing stormwater runoff. There are permeable varieties of asphalt, concrete, and interlocking pavers.	$0.02	$0.04	Section 4.2.2 Permeable Pavement O & M manual
Chapter 4.3: Cisterns and Rain Barrels	Rain barrels, cisterns, and tanks are structures designed to intercept and store runoff from rooftops. Rain barrels are used on a small scale while cisterns and tanks may be larger.	N/A	$2.36	Section 4.3.2 Cistern and Rain Barrel O & M manual
Chapter 4.5: Bioretention (rain gardens)	Bioretention areas typically are landscaping features adapted to treat stormwater runoff. Bioretention systems are also known as, Rain Gardens, Infiltration Basins, Infiltration swales, bioretention basins, bioretention channels, tree box filters, planter boxes, or streetscapes, to name a few. Bioretention areas typically consist of a flow regulating structure, a pretreatment element, an engineered soil mix planting bed, vegetation, and an outflow regulating structure.	$0.49	$1.06	Section 4.5.2 Bioretention (rain garden) O & M manual
Chapter 4.7: Swales (vegetative)	A swale is a vegetated open channel, planted with a combination of grasses and other herbaceous plants, shrubs, or trees. A traditional swale reduces peak flow at the discharge point by increasing travel time and friction along the flow path	N/A	$0.58	Section 4.7.3 Swale O & M manual
Detention Basins	Detention basins provide storage by impoundment within a natural depression, or in an excavated area. Primarily used for water quantity control.	$0.25		Half of the Bioretention O&M cost based on detention not having as many plants, mulch and watering requirements.

Estimated O&M costs

In the LTCP, the O&M costs were derived as percentages of the capital costs. The percentage varies from 0.5% to 6.0% depending on the type of improvement included. For sewers and interceptors, 0.5% of the capital cost was assumed to be the annual O&M cost; and for satellite storage or disinfection 6.0% of the capital cost was used. For typical mixes of equipment, structure and pipe, 1.65 % was used. The use of percentage of capital cost as a way to estimate O&M costs is useful at the planning system-wide level. However, as projects become defined and detailed alternatives analysis are completed, a more detailed O&M cost estimate is more appropriate, as described in the paragraphs and table above.

Based on the frequency of each type of O&M and the associated annual or event cost for that activity, the lifecycle cost of O&M over a 25-year period with the assumed discount factor can be calculated for each alternative. The discount factor is the difference between the interest rate (assumed to be 2.5% which is less than the 5% used in the LTCP affordability analysis due to today's market conditions and City's current interest rate on new loans) and the inflation rate (assumed as 2.5% for O&M costs which is consistent with the LTCP affordability analysis). Therefore, the discount rate used in the lifecycle analysis will be 0%. In other words, the annual cost of O&M needed today multiplied by 25 years is the 25-yr lifecycle cost.

The interest rate and inflation rate may be updated by the City at any time based on current market conditions.

In Chapter 4 of the LTCP, the recommended plan for the LTCP component only is estimated to have an annual O&M cost of $4.93M in 2005 dollars. With a 2.5% inflation rate, the annual O&M costs for the recommended plan is $5.58M in 2010 dollars. The lifecycle cost over the next 25-years (2011 to 2035) for the recommended plan assuming that the infrastructure is operating today would be $139.4M in 2010 dollars. The recommended plan will reduce CSOs to between 1 to 4 activations with an annual overflow volume reduction of 962 MG (i.e., existing volume of 1,058 MG less remaining volume of 96 MG). Therefore, the recommended plan metric of O&M lifecycle cost divided by gallons of CSO reduction is $0.14/gallon in 2010 dollars.

The scorecard criteria for this metric was developed assuming that the average 25-year lifecycle O&M cost per gallon overflow reduction for each CSO would be about $0.14/gallon in today's (2010) dollars. Therefore, if the alternative is close to that average, the score is a 3. If above the average (i.e., less beneficial for O&M dollar spent), a lower score is assigned. If below the average (i.e., more beneficial for O&M dollar spent), a higher score is assigned.

1.1.3 Other Funding Opportunities and/or Shared Resources

The other funding opportunities and/or shared resources include a variety of project funding mechanisms that could be realized by the addition of green infrastructure to the existing project. Other funding opportunities could include low interest loans and/or grants for green infrastructure (e.g. State Revolving Fund (SRF) loans, Clean Water Act (CWA) Section 319 Grants, Community Action for a Renewed Environment (CARE), Community Development Block Grant Program, etc.). Shared resources include partnerships (e.g. businesses, churches, schools, etc. that wanted to partner with the City on sustainable projects).

The following equation is used to determine the percentage of the estimated total project cost that could be funded through other opportunities.

Calculate % funded by other opportunities:

$$\frac{(PGV + PPV + PLIS - AC)}{TotalCost} \times 100\% = \%Funded$$

PGV = Projected Grant Value
PPV = Projected Public/Private Partnership Value
PLIS = Projected Low Interest Loan Savings
AC = Estimate Cost to Administer Additional Funding Source
Total Cost = Estimated Total Project Cost

Federal grants are often time consuming in progress reports, forms, and measureable impacts of projects (pollution load reductions), complex invoicing consisting of documentation for tracking match and in-kind service and invoices, and usually require a lengthy final report. Philanthropic organization grants (e.g. American Water) require less administration time. Federal grants allow a maximum of 10% of the grant to cover administration costs.

For consistency in the analysis, the estimated cost to administer additional funding source should be based on the type of funding. As the City administers these funds and tracks costs, these assumptions can be revised:

- Federal grants: 10% of grant value
- SRF loans: 5% of loan value (Note: PLIS in the equation is "loan savings" not full loan value)
- Other grants: 2% of grant value
- Public/private partnerships: 2% of partnership value

Resources**:**
U.S. Environmental Protection Agency
Website: http://www.epa.gov/nps/cwact.html (accessed July 2010)
U.S. Environmental Protection Agency
Website: http://www.epa.gov/owm/cwfinance/cwsrf/ (accessed July 2010)
U.S. Environmental Protection Agency
Website: http://cfpub.epa.gov/npdes/greeninfrastructure/fundingopportunities.cfm (accessed July 2010)

1.1.4 Projected Savings - Joint Projects

Projected savings – Joint projects refers to the total cost savings to a project or alternative directly related to coordination with other projects or other departments. Example: The transportation department has plans and funding to repave a downtown street and the utility department has plans and funding to replace a sewer main under that same street. By coordinating efforts and funding, both projects could have cost savings. The transportation project may not have to include costs to mill or remove the old road surface (savings) and the utility department may not have to include costs to fine grade and place new pavement (savings). The value for this metric is estimated cost savings realized by an alternative or the savings provided to another project, as compared to the overall project cost.

$$\frac{EstimatedCostSavings}{TotalCost} \times 100\%$$

1.1.5 Use of Existing Assets

Use of existing assets metric is based on the percentage of total project savings from use of an existing asset. Note that this metric is important for alternatives that are reusing existing pipe. There are two different scenarios of existing asset use:

1. Reuse of An Existing Asset

An existing asset that would primarily serve the new capital project.

$$\frac{NewConstructionCost - AlternateCost - \left(replacementCost \times \left(1 - \frac{remainingLife}{designLife} \right) \right)}{NewConstructionCost} \times 100\%$$

Where:

New Construction Cost	Total cost of the construction of the project if existing assets were not used
Alternate Cost	Total cost of construction of the project if existing assets were used
Replacement Cost	Cost to replace the existing infrastructure
Remaining Life	Remaining life of the existing infrastructure should be based the structure' condition assessment ratings or grades
Design Life	Design life of existing infrastructure based on the material of construction

Example: An existing sewer does not have capacity to handle additional flows from a planned project. This pipe could be replaced with a new larger pipe, or a parallel pipe could be used in conjunction with the existing sewer. The total new construction cost, including installation of a larger sewer, is \$1.5M. The cost of a parallel sewer (Alternate Cost) is \$0.8M and the cost of replacing the existing sewer (Replacement Cost), at the end of its useful life, (like in-kind replacement) is \$1.0M.

New Construction Cost = \$1.5M
Alternate Cost = \$0.8M
Replacement Cost = \$1.0M
Remaining Life = 25yrs
Design Life = 50yrs

$$\frac{\$1.5M - \$0.8M - \left(\$1.0M \times \left(1 - \frac{25yrs}{50yrs} \right) \right)}{\$1.5M} \times 100\% = 13\%$$

2. Use of Underutilized Asset

An underutilized asset is in service for purposes unrelated to the new project, and has additional available capacity.

$$\frac{NewConstructionCost - AlternateCost}{NewConstructionCost} \times 100\%$$

Example: An existing storm sewer pipe serving an area near a planned project. The storm pipe was sized for future growth and has additional capacity to serve the new project needs. The new project could construct a new storm sewer pipe and new outfall at a cost of $0.8M or tie-in to the existing storm pipe and existing outfall at a cost of $0.4M. Regardless of which option is chosen for the new project, the City will continue to operate and maintain the existing storm sewer pipe. For this reason, the remaining life and replacement cost of the existing storm sewer pipe do not need to be included in the evaluation.

$$\frac{\$0.8M - \$0.4M}{\$0.8M} \times 100\% = 50\%$$

In both scenarios, the design life and remaining life for each asset should be consistently assessed for all alternatives by the engineer. For reference, the following design life is provided in Table 2. If special material or special circumstances exist, the asset design life can be adjusted from the table, so long as it is consistent for each alternative.

Table 2
Estimated Minimum Expected Design Life for Pipe Material

Material	Estimated Minimum Expected Design Life (year)
Pipe	
Brick	100
Cast Iron	50
Clay	50
Cured-in-Place Pipe	50
Ductile Iron	50
HDPE	50
PVC	50
RCP (High H2S)	10
RCP (medium H2S)	25
RCP (no H2S)	50
Structures	
Brick Manholes	50
Regulators	75
Concrete Manholes	50
Lift Station Structures	75
Pumps	
Pumps	20
Valves	25

Note: Pipe life should first be assessed by review of sewer video. If no video is available then use the table with engineering discernment.

1.1.6 Capital Cost / Pound TSS Reduction

The total capital cost includes design, construction, easements, City admin, legal, finance, and contingency costs associated with the alternative for the project area. The system-wide or subbasin model will be used to predict the existing conditions combined overflow volume. CSO total suspended solids concentration in conjunction with the existing overflow volumes will predict the existing annual pounds of TSS in a typical year coming from the CSO.

There is not a repository of CSO TSS concentrations; therefore the TSS concentration for CSO will be assumed from another similar city. Based on historic sampling in an Ohio city, the average TSS concentration is CSOs is 145 mg/L (+/-44 mg/L 95% confidence level) or 0.00121 lbs/gal.

For each alternative, the TSS reduction analysis should account for the changes in TSS in the discharges to the stream based on decrease in CSO overflow volume and potential increase in stormwater runoff. The National Urban Runoff Program (NURP) will be used to predict the annual pounds Total Suspended Solids (TSS) of stormwater runoff in a typical year. The NURP values are provided in Table 3.

Table 3 National Median Concentrations for Chemical Constituents in Stormwater

Constituent	Units	Urban Runoff	Units	Urban Runoff X 10^{-6}
TSS	mg/l	54.5	lb/gal	454.80
TP	mg/l	0.26	lb/gal	2.17
TN	mg/l	2	lb/gal	16.69
Cu	mg/l	11.1	lb/gal	92.63
Pb	mg/l	50.7	lb/gal	423.09
Zn	mg/l	129	lb/gal	1076.51
E Coli	mg/l	1.5	lb/gal	12.52

Source:
1. Pooled NURP/USGS (Smullen and Cave, 1998)
2. Schueler (1999)

Performance data from typical BMPs prior to stream discharge will be used to evaluate the alternative annual pounds TSS in a year. An excerpt from the City's Development Criteria/Standards Manual Unit II, Stormwater page 87 may be found on the following page.

An example calculation is provided below to estimate the TSS loading (pre BMP and post BMP) for a particular project.

	City Utilities Department Of Water Resources	Exhibit II-5-3 Page 1 of 1 Effectiveness of Management Practices for Runoff Control
		Created: 2005, 2007 Revised: January 23, 2008

Effectiveness of Management Practices for Runoff Control

Runoff Treatment or Control Practice Category or Type	Median Pollutant Removal (Percent)							
	No. of Studies	TSS	TP	OP	TN	NOx	Cu	Zn
Quality Control Pond	3	3	19	N/A	5	9	10	5
Dry Extended Detention Pond	6	61	20	N/A	31	-2	29	29
Wet Extended Detention Pond	14	**(50-90)**	**(30-90)**	69	35	63	44	**(40-50)**
Multiple-Pond System	1	91	76	N/A	N/A	87	N/A	N/A
Wet Ponds	43	80	51	65	33	43	57	66
Shallow Marsh	20	83	43	66	26	73	33	42
Extended Detention Wetland	4	**(67)**	**(49)**	59	**(28)**	35	**(41)**	**(45)**
Pond/Wetland System	10	71	56	37	19	40	58	56
Submerged Gravel Wetland	2	83	64	14	19	81	21	55
Organic Filter	7	88	61	30	41	-15	66	89
Perimeter Sand Filter	3	79	41	68	47	-53	25	69
Surface Sand Filter	7	87	59	N/A	31.5	-13	49	80
Vertical Sand Filter	2	**(70)**	**(33)**	21	**(21)**	-87	32	**(45)**
Bioretention	1	**(90)**	**(70-83)**	N/A	**(68-80)**	16	**(93-98)**	**(93-98)**
Infiltration Trench	3	**(90)**	**(60)**	100	**(60)**	82	**(90)**	**(90)**
Porous Pavement	3	95	65	10	83	N/A	N/A	99
Ditches [A]	9	31	-16	N/A	-9	24	14	0
Grass Channel	3	68	29	32	N/A	-25	42	45
Dry Swale	4	**(81)**	**(9)**	70	92	**(38)**	**(51)**	**(91)**
Wet Swale	2	74	28	-31	40	31	11	33
Oil-Grit Separator	1	**(40)**	**(5)**	40	**(5)**	47	-11	17

Notes to Table:

1. [A] Refers to open channel practices not designed for water quality.
2. The rate (percentage) for each practice in the Table shall be the accepted rate for use of that practice in the City of Fort Wayne. Where there is a range of rates, the lowest rate will be the accepted rate unless the person proposing a higher rate provides conclusive evidence supported by independent testing that the higher rate is the correct rate.
3. Cu=copper, OP=ortho-phosphorus, TN=total nitrogen, TP=total phosphorus, TSS=total suspended solids, NOx=nitrate and nitrite nitrogen, Zn=zinc.

Sources: USEPA, 2005; and the *Indiana Storm Water Quality Manual*, October 2007 (numbers in **bold**).

In Chapter 4 of the LTCP, the recommended plan for the LTCP component only is estimated to have a capital cost of $305.2M in 2005 dollars. The escalation rate was estimated to be a 16.5% increase using the Engineering News Record (ENR) Construction Cost index (CCI) from the 2005 average annual CCI to April 2010 CCI (i.e., 8677 / 7446). Based on this escalation rate, the recommended plan costs $305.5M in 2010 dollars. The recommended plan will reduce CSOs to between 1 to 4 activations with an annual overflow volume reduction of 962 MG (i.e. existing volume of 1,058 MG less remaining volume of 96 MG). The TSS overflow concentration (145 mg/L) was applied to the existing volume and the volume remaining to determine the net pollutant removal to be 81,200 lbs TSS. Therefore, the recommended plan metric of capital cost divided by gallons of CSO reduction is $3,800/lb in 2005 dollars and $4,400/lb in 2010 dollars. The analysis to estimate the scorecard criteria does not take into account the additional TSS that may be discharging into the stream and river based on increased stormwater runoff. That level of detail is being performed at the alternative level stage as described above and in the equation below.

The scorecard criteria for this metric was developed assuming that the average capital cost per pound TSS reduction for each CSO would be about $4,400/lb in today's (2010) dollars. Therefore, if the alternative is close to that average, the score is a 3. If above the average (i.e., less beneficial for dollar spent), a lower score is assigned. If below the average (i.e., more beneficial for dollar spent), a higher score is assigned.

Provided below is an example calculation:

Capital Cost/pound TSS Reduction Example:

Runoff Volume Calculation
This example utilizes the SCS Rainfall-Runoff method for calculating volume of runoff.

Ia = initial abstraction
S = retention
P = precipitation depth (inches)
Q = runoff depth (inches)
CN = curve number

(1) $S = (1000/CN) - 10$

(2) $Ia = 0.2S$

(3) $Q = (P - Ia)^2/(P+0.8S)$

Existing Conditions:
Drainage Area = 5 acres
Post-Development CN = 89
Percent Impervious = 64 %
P = 1 inch
Q = 0.285 inches
Existing condition volume generated from 1" of precipitation = 0.119 acre-ft

Existing TSS Loading Calculation:

Step 1: Estimate existing volume of storm water generated from the first flush (1 inch storm):

0.119 acre-ft

Step 2: Multiply Step 1 by 454.8 x 10^{-6} lb/gal = Initial lb TSS

0.119 acre-ft * 43560 ft^3/acre * 7.48 gal/ft^3 * 454.8x10^{-6} lb/gal = 17.63 lb TSS

TSS Loading from Proposed Condition Calculation:

Step 3: Estimate % removal of TSS from BMP selected (see Excerpt from City's manual) for volume of storm water generated.

BMP selected: Bioretention/Rain Garden = TSS removal efficiency = 90%

Step 4: Calculate TSS removed with proposed BMP providing storage for entire existing condition runoff volume from 1 inch of precipitation.

17.63 lb TSS * 0.90= 15.87 lb TSS

15.87 lb TSS removed

Step 5: Determine the reduction of TSS in the CSO reduction volume from the subbasin or system-wide model.

Step 6: Add the two TSS reductions to obtain total lbs TSS removed. Divide total project cost by the total lbs TSS removed.

$Total Project Cost / (15.87 + x) lb TSS = $/lb TSS

1.2 SOCIAL METRICS

Seven social metrics were developed for the evaluation process and are described in more detail in the sections below. In addition project specific cost metric could be developed and implemented based on the project location, objective, or other qualities of the project. The social metrics include:

- Downtown revitalization
- Percentage of CSO volume reduction
- Reduction in basement flooding
- Reduction in street flooding
- Job creation on capital projects
- Access to scenic feature and recreational areas
- Benefits of streetscape improvements

1.2.1 Downtown Revitalization

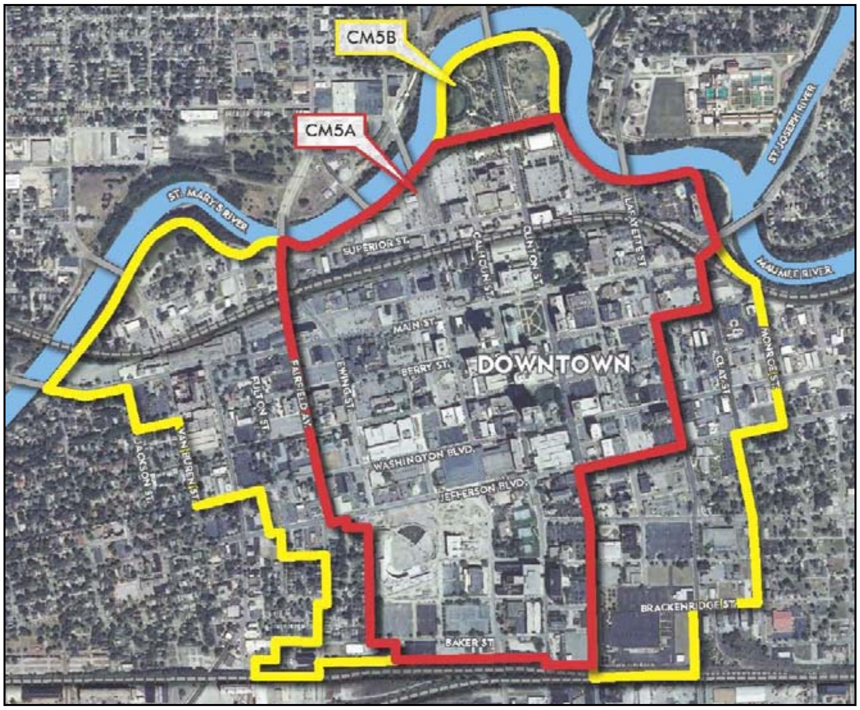
The City's goals for the downtown revitalization consists of improving the quality of life for the citizens that work, live, eat, shop, and play in the downtown area, encouraging high quality architecture and street scapes in its downtown development, and attracting regional activities for Fort Wayne and neighboring communities. Many initiatives are on-going to meet those goals such as the Downtown Design Manual and the Downtown Stormwater/Sewer Master Plan.

The score criterion for the downtown revitalization is qualitatively based on how consistent each alternative is with the City's goals of the downtown area. The downtown area is defined based on the zoning districts of CM5A (central) and CM5B (surrounding area) as shown in Figure 1. The

Downtown Design Manual (Final Draft April 2010) and the presentation from the City's Open House for the Downtown Design Standards dated February 11, 2010 provides a summary of elements (e.g. green infrastructure along sidewalks) that the City desires when looking at new or redevelopment. If the project alternative is not in the downtown zoning district then the metric should be scored as non applicable.

Reference:
http://www.cityoffortwayne.org/design-manual-project.html

Figure 1 Downtown Zoning Districts



1.2.2 Percentage of CSO Volume Reduction

The estimated reduction of CSO volume in typical year for each alternative will be compared to the existing conditions CSO volume in a typical year. Based on the LTCP, the percent of CSO volume reductions range from 0 to 100%. The 0% reduction reflects the CSOs that are already in compliance and the 100% reduction reflects the CSOs that will be eliminated. The City plans on addressing all the CSOs (except for a few that are in compliance of less than 4 activations in a typical year). A great majority of the CSOs will have a reduction above 50% with most at the 80% to 90% range. The reductions are based historic modeling results from the LTCP negotiations and were not summarize in the LTCP.

The scorecard criteria for this metric provides more resolution at the higher reductions to better differentiate between alternatives. A score of 5 is assigned if the CSO is eliminated (i.e., reduction of 100%), 4 corresponds to 86 to 99% reduction, 3 corresponds to 71 to 85% reduction, 2 corresponds to 36 to 70% reduction, and 1 for less than 35% reduction.

1.2.3 Reduction in Basement Flooding

Reduction in basement flooding is the estimated reduction in the number of basements that could be flooded in a given area, based on the number of homes/buildings that the alternative potentially protects. The metric value is calculated as the number of homes/ buildings that the alternative impacts. Basement elevations are assumed to be eight feet below grade elevation.

1.2.4 Reduction in Street Flooding

Reduction in street flooding is the estimated reduction in the number of streets that could be flooded in a given area, based on lowering the modeled amount of water spilled. This metric is estimated by running a design storm (allowing 4 overflows in the typical year) through a hydraulic model of the sewer system for that area. The metric value is calculated as the volume of water spilled, during the design storm. The amount of time each segment of the system experiences high levels is not a factored, as any amount of time with a HGL above the ground elevation would cause street flooding.

1.2.5 Job Creation on Capital Projects

The labor hours for construction of each alternative is calculated using a demonstrated process based on the following input:

- Alternatives are categorized by construction type – Sewer, sewer lining, pump station (storage) or treatment plant.
- An algorithm has been developed for each construction type to calculate the percent of construction related to craft labor.
- July 2010 prevailing rates from Allen County, IN are used to estimate the labor classification or crew associated with the work.

Project that contain green infrastructure are likely to site work and labor intensive similar to sewer projects. Currently green infrastructure projects are included under sewer projects, until such time information is gathered to delineate them separately.

Based on a typical sewershed size, a sewer separation project may cost $3.0 Million. Using the job creation spreadsheet, this equates to 30,000 hours of labor or 15 full time equivalent (FTE) jobs. Therefore, the scorecard criterion of 3 was based on this typical project size. If the FTE is greater, then a higher score is assigned. If the FTE is lesser, then a lower score is assigned.

1.2.6 Access to Scenic Features and Recreational Areas

This metric represents the social benefit of an increase in recreational areas, either by constructing new recreational areas or adding new/easier access to existing areas and features. This can include new parks, trails, sidewalks, and nature areas, or providing new methods to easier access existing features, such as schools, creeks, streams, and parks. This metric can also be used to show value added for an increase in overall area appeal, which would encourage more recreational use of an existing element.

The value of this metric is calculated based on 100% of the square footage of recreational space added, 50% of the square footage of recreational area improved, and 25% of the square footage of recreational area accessed. For example, if a 600 ft long trail, 8 ft wide was added to an area, a value of 4,800 would be calculated. If this trail also connected an existing community to a 45,000 square foot neighborhood park (no additional work completed at the park) a score of 16,050 would be calculated (4800 + 25%*45,000).

Example Metric Calculation:

$$\%\ CSO\ Reduction = \frac{Existing\ Condition\ Overflow\ Vouime - Alternative\ Overflow\ Volume}{Existing\ Condition\ Overflow\ Volume} * 100$$

1.2.7 Benefits of Street Scape Improvements

The benefits of street scape improvement include the economic benefits of improved landscaping through the addition of green infrastructure. Green infrastructure can improve the value of a community because of the increase in trees and plants associated with various green infrastructure practices. Such stormwater management practices include: rain gardens, bioswales, bioretention, and conservation of natural vegetation. These applications can be applied to street scapes making the landscape a part of the stormwater management system through use of bioretention bumpouts or roadside swales instead of the traditional use of curb, gutter, and pipe to manage stormwater. A number of case studies suggest that green infrastructure can increase surrounding property values. The economic benefits are many. Some benefits to property owners, businesses, and communities, according to studies, include:

- Trees and plantings enhance community economic stability by attracting business and tourism (Stormwater Manager's Resource Center 2006)
- Apartments and offices in wooded and vegetated areas rent more quickly and have higher occupancy rates (Stormwater Manager's Resource Center 2006)
- Property values of homes with trees and landscaping are 5% to 20% higher than equivalent properties without trees and landscaping. (Southeast Watershed Forum, p.1)
- Vacant land improvements in urban areas can lead to an increase in surrounding housing values by as much as 30%. (Philadelphia, USEPA Managing Wet Weather with Green Infrastructure)

The scorecard criteria for this metric was developed assuming the existing site condition as the baseline score. Therefore, if the alternative has the potential to decrease green space and /or beneficial existing vegetation causing a negative impact a score of -3 is given. If the alternative does not have the potential to change the existing landscape a score of 1 is given. If the alternative has the potential to improve the existing landscape then the following metrics are applied: 2-slight improvement, 3-moderate improvement, 4 or 5-high improvement.

Resources:

Southeast Watershed Forum. The Value of Community Forests.
Stormwater Manager's Resource Center. 2006. Land Conservation Fact Sheet: Urban Watershed Reforestation.
U.S. Environmental Protection Agency, Managing Wet Weather with Green Infrastructure, Website: http://cfpub.epa.gov/npdes/home.cfm?program_id=298 (accessed July 2010)

1.3 ENVIRONMENTAL METRICS

Nine environmental metrics were developed for the evaluation process and are described in more detail in the sections below. In addition project specific cost metric could be developed and implemented based on the project location, objective, or other qualities of the project. The environmental metrics include:

- Streambank erosion control: velocity
- Streambank erosion control: discharge volume
- Flood protection
- Local water quality (WQ): TSS

- Investment risk against new stormwater regulations
- Investment risk against mandates after consent decree
- Carbon footprint
- Biological diversity: quality of vegetation
- Biological diversity: area of vegetation

1.3.1 Streambank Erosion Control: Velocity

Stormwater or combined sewer and stormwater discharges often contribute to streambank erosion downstream of the outlets in natural or constructed open waterways.   The velocity of the discharge is one controlling factor in the amount of erosion on the stream banks. Conventional stormwater collection systems are designed to efficiently collect and move water with low resistance from streetscapes and parking area into pipes which eventually discharge to open waterways.

Green infrastructure can reduce the discharge velocity, thereby reducing downstream bank erosion by slowing down the velocity of the discharge. The velocity reduction is typically gained by creating resistance in the flow path including temporary storage, and surface roughness from vegetation, gravel, sand, or biosoil. The scoring for this metric is assigned by how well the alternative reduces the discharge velocity as compared to the City of Fort Wayne's maximum of 6 ft/s.

References regarding the effects of increased velocity on stream water quality and streambank erosion include:

Pitt, R. 2002. Receiving Water Impacts Associated with Urban Runoff. In: D. Hoffman, B. Rattner, J. Burton, B.S., and J. Cairns, J., editors. Handbook of Ecotoxicology, 2nd Edition. CRC Lewis, Boca Raton, FL.

Scheuler, T. 2000a. The importance of imperviousness. In: T. Scheuler and H. K. Holland, editors. The Practice of Watershed Protection. Center for Watershed Protection, Ellicott City, MD.

Impacts of Impervious Cover on Aquatic Systems   Published by the Center for Watershed Protection. 2003. Watershed Protection Research Monograph No. 1. Available for download through http://www.cwp.org

1.3.2 Streambank Erosion Control: Discharge Volume

Stormwater or combined sewer and stormwater discharges often contribute to streambank erosion downstream of the outlets in natural or constructed open waterways.   The severe fluctuation in the volume of the discharge is another controlling factor in the amount of erosion on the stream banks. Conventional stormwater collection systems are designed to effectively collect and move water quickly from streetscapes and parking area into pipes which eventually discharge to open waterways. This rapid rise in volume is typically followed by a rapid fall in volume after the storm. During the rapid drop off in volume is when most of the erosion is occurring because the saturated pore spaces in the soils are draining. The soil structure is at its weakest when saturated and offers little resistance to erosion when exposed to running water.

Green infrastructure can reduce the quick increase in volume discharge rates during and immediately following storm events, thereby reducing downstream bank erosion. The volume reduction is gained by temporary storage within the flow path, and infiltration into the ground water through gravel, sand, or biosoil, and uptake and evapotranspiration in vegetation.

Convey,store, and treat option. The scoring for this metric is assigned by modeling existing conditions versus proposed conditions using SWMM or similar hydrologic model of the stormwater outfall and/or CSO outfall depending on the project.

For references regarding runoff coefficients due to impervious surfaces see:
http://stormwaterbook.safl.umn.edu/content/impacts-urban-stormwater

For references regarding impervious surfaces and their affects on downstream erosion see:
Impacts of Impervious Cover on Aquatic Systems Published by the Center for Watershed Protection. 2003. Watershed Protection Research Monograph No. 1. Available for download through http://www.cwp.org

1.3.3 Flood Protection

Flood protection is the reduction in risk associated with naturally caused area flooding. This flooding could be caused by river intrusion, stream or pond overflow, or flooding due to overland flow. This metric is not intended to relate to sewer backups.

The value of this metric is a qualitative assessment of the flood protection impacts each alternative may have. Areas that have no flooding issues are scored as (0) Not Applicable. Alternatives should be scored as (-3) Negative Impact in cases where the alternative has a negative impact on flood protection such as an open storm drain to a nearby river, with no flap gate. Alternatives that have no change on the flood protection should be scored as a 1. Alternatives that provide some increase in flood protection, such as a retention pond to store overland flow, should be scored as Slight or Moderate Protection. Alternatives that provide a high level of protection, such as a local pump station, should be scored as (5) High Protection. Reviewers should analyze and score each alternative as consistently as possible. Each alternative should be scored based on its effect on flood protection, as compared to the other alternatives.

1.3.4 Local WQ: TSS

The Local WQ: TSS criteria evaluates if the alternative provides other stormwater benefits such as TSS removal BMPs. The City's *Water Resources Development Criteria/Standards Manual,UNIT II - Stormwater Sewer Design Standards* describes the removal efficiencies for BMPs.

The scorecard criterion for this metric was developed by evaluating if the alternative incorporates TSS removal BMPs: A score of 1 is given if no stormwater BMPs are present that could remove TSS. A score of 3 is given to an alternative that provides some level of control of stormwater TSS. A score of 5 is given to an alternative that incorporates BMP treatment into the LTCP project.

References:
City of Fort Wayne, *Water Resources Development Criteria/Standards Manual,UNIT II - Stormwater Sewer Design Standards* at:
http://www.cityoffortwayne.org/utilities/images/stories/docs/unitiii_toc.pdf

1.3.5 Investment risk against new stormwater regulations

The investment risk against new stormwater regulations evaluates existing regulations to possible new stormwater regulations. Stormwater regulations are created through the USEPA National Pollutant Discharge Elimination System (NPDES) permit. The city of Ft. Wayne has a NPDES

Ph II permit and has created a post construction stormwater quality control ordinance that requires the treatment of 80% Total Suspended Solids (TSS) from redevelopment and new development project that disturb ½ acre or more. In addition, NPDES storm water permits often have a requirement for existing capital water quantity projects to be retrofitted to meet current water quality regulations. There are many states and municipalities transitioning from a pollutant removal water quality requirement to a volume control water quality requirement. In addition the federal government also requires the use of green infrastructure for stormwater control on new projects.

The scorecard criteria for this metric were developed by using the existing stormwater quality requirement as the baseline and the various ways to meet this requirement were used to differentiate the regulation. Through using vegetated stormwater management and volumetric control design often the design alternatives will meet multiple water quality objectives (e.g. decreased flow, decreased e.coli, phosphorous, and TSS); thus reducing risk against future water quality regulations. The highest score would be obtained by meeting an example future regulation.

- Extremely high risk (-3): The alternative does not meet City of Ft. Wayne's current Water Quality Regulation of 80% TSS removal and does not include green infrastructure.
- Moderately high risk (-1): The alternative does not meet City of Ft. Wayne's current Water Quality Regulation of 80% TSS removal, but green infrastructure which could improve stormwater quality were used.
- High risk (1): The alternative meets City of Ft. Wayne's current Water Quality Regulation of 80% TSS removal through the use of manufactured BMPs or other structural controls (e.g. hydrodynamic separator, etc.).
- Moderate risk (2-3): The alternative meets City of Ft. Wayne's current Water Quality Regulation of 80% TSS removal through the use of green infrastructure or non structural BMPs (e.g. bioretention, rain gardens, vegetative swales, permeable pavement, etc.).
- Low risk (4-5): The alternative meets new federal requirement of using green infrastructure to the maximum extent practicable by designing, constructing and maintaining stormwater controls to achieve on-site retention of 1.2" volume of stormwater from a 24-hour storm.

References:
City of Ft. Wayne Stormwater Specification Manual
Permit for the District of Columbia MS4 Draft NPDES Permit No. DC0000221, April 22, 2010
Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act, December 4, 2009
Maryland Stormwater Management Act of 2007 and Maryland Stormwater Guidelines for State and Federal Projects, (updated April 15, 2010)

1.3.6 Investment Risk Against Mandates After CD

The City of Fort Wayne is currently entered into a Consent Decree with the US EPA to make sewer modifications to meet current regulations. Future changes to SSO regulations and others, may increase standards to a higher level. Although all alternatives should meet current CD requirements, some alternatives may provide additional treatment, storage, or control. Alternatives that meet a higher standard would reduce the risk of future costs to meet potential, future regulations. The value of this metric is a qualitative assessment of the reduction in risk against future mandates, due to an increase in the amount of treatment, storage, or control that each alternative has. Alternatives that provide no added control and are susceptible to future regulations, should be scored as (-3) Very High Risk or (1) High Risk. Alternatives, such as rain gardens or retention ponds, that provide additional treatment or storage above the current regulations should be scored as (2-3) Moderate Risk or (4-5) Low Risk. Reviewers should analyze and score each alternative as consistently as possible.

1.3.7 Carbon Footprint

The carbon footprint of each alternative will be evaluation and will include both direct and indirect sources of green house gases (GHG). This GHG emissions estimate uses the approaches and methodologies set forth by the Intergovernmental Panel on Climate Change (IPCC)[i] and the Greenhouse Gas Protocol Initiative[ii]. While a number of different gases contribute to the global warming and climate change, the most important anthropogenic greenhouse gases are the following:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Halocarbons (PFCs and HFCs)
- Sulfur Hexafluoride (SF_6)

The first three of these GHGs (CO_2, CH_4, and N2O) are emitted from wastewater treatment systems. CO_2 is considered to be of biogenic origin, while CH_4 and N_2O are of anthropogenic origin. PFCs, HFCs and SF6 are primarily produced for industrial purposes and are not considered to be significant emissions from wastewater processes. Accordingly, these last three groups of gases have not been evaluated as GHG emissions for this analysis.

As defined in the GHG Protocol[3], "direct GHG emissions are emissions from sources that are owned or controlled by the reporting entity", while "indirect GHG emissions are emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity." As applied specifically to this evaluation for the City of Fort Wayne, the three scopes are defined as follows:

- **Scope 1** emissions are defined as all direct GHG emissions – i.e., emissions from fossil fuels combusted at the alternative or by vehicles specifically assigned to the alternative; as well as emissions of GHGs from the CSO discharge into the receiving stream and any treatment processes at a plant (if building a new plant is an alternative).
- **Scope 2** emissions are defined as "indirect GHG emissions from the purchased electricity, heat or steam". Note that Scope 2 emissions physically occur at the outside electricity generating facility, but nonetheless are within the operational boundary since they occur because of the activities of the organization being evaluated.
- **Scope 3** emissions are defined as "other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g. T&D [transmission and distribution] losses) not covered in Scope 2, outsourced activities, waste disposal." Accounting for Scope 3 is optional, providing the owner discretion to focus on those activities that are most relevant to the business or evaluation goals and/or for which reliable information is available.

Following the GHG Protocol, it is appropriate for the purpose of this evaluation of the City's alternatives to consider only Scope 1 and Scope 2 emissions as shown in Table 4. Scope 3 emissions are difficult to quantify, and are commonly not included in organizational GHG inventory reporting. Accordingly, Scope 3 emissions are not included in this evaluation.

Table 4 GHG Emissions & Scope for Fort Wayne Evaluation Process

Scope	Emission Type	GHG Emission Sources of Alternatives
Scope 1	Direct: Combustion	– Stationary fossil fuel combustion (fuel oil for backup generator) – Mobile fossil fuel combustion (general purpose vehicles)
	Direct: Process	– Nitrous Oxide (N_2O) emissions resulting from overflow discharge to receiving waters
Scope 2	Indirect	– Purchased electricity
Scope 3	Indirect	– Scope 3 emissions not included

The global warming potential (GWP) factors are used to convert quantities of other GHG emissions to the reference gas **carbon dioxide equivalent** (CO_2e), thereby allowing for a summation of the total impacts of GHG emissions. CO_2e is the mass of carbon dioxide that would have the same contribution to global warming as the mixture of gases emitted.

The scorecard criterion for carbon footprint is based on the difference between the amount of CO_2e calculated for each alternative less the amount of CO_2e calculated for the baseline alternative. Assuming that an alternative is similar to the baseline calculated metric tons of CO_2e per year, then the alternative would receive a score of 3. If the GHG is greater for an alternative than the baseline, then a lower score is assigned. If the GHG is lesser for an alternative than the baseline, then a higher score is assigned.

To calculate this metric the Carbon Scope tabs within the score card should be filled out for the alternative then compared to the baseline condition to calculate the reduction. Basically if there is a new pump station being built the electric emissions, service vehicle and generator emissions need to be accounted for. For other typical alternatives maintenance vehicle emission and the reduction in emissions from the reduction in CSO volume need to be calculated.

References:
[1] Intergovernmental Panel on Climate Change.
Website: http://www.ipcc.ch/index.htm (accessed May 2010)
[2] The Greenhouse Gas Protocol Initiative.
Website: http://www.ghgprotocol.org/ (accessed May 2010)
[3] WRI (2004), *Greenhouse Gas Protocol*, A Corporate Accounting and Reporting Standard (Revised Edition), Bhatia P., Corbier L., Gage P., Oren K. and Schmitz S. Published: World Resources Institute and World Business Council for Sustainable Development, March 2004. http://www.ghgprotocol.org/files/ghg-protocol-revised.pdf (accessed May 2010)

1.3.8 Biological diversity: Quality of Vegetation

Urban landscapes are improved by incorporating vegetation to absorb radiant heat, provide oxygen, use carbon dioxide, and provide aesthetic improvements. A diversity of native plants provides a better aesthetic than a monoculture, and provides the opportunity for a greater diversity of insects (like butterflies), songbirds, and small mammals. An increase in the aforementioned wildlife often brings a greater interest and enjoyment of an area by people. Non-native invasive species (list below) may also be attractive or functional but typically do not support native wildlife and have no natural control mechanism.

Conventional stormwater collection systems typically do not include vegetation as a component of design. Green infrastructure systems may or may not incorporate vegetation depending upon whether an opportunity for surface treatment of stormwater exists. This metric scoring incorporates the assumption that if an opportunity to add vegetation exists then it is an added value to the project if more diversity of vegetation is incorporated or if non native species in the project area are removed.

A list of native plants can be viewed at the following websites as of August 2010:
http://www.inpaws.org/LandscapingPlants111708.pdf
http://www.indianawildlife.org/habitatPlants.htm,
http://www.dnr.state.mi.us/publications/pdfs/huntingwildlifehabitat/fqa_c_database.pdf
http://www.nativeplantsunlimited.com/docs/HHRC_raingarden_booklet.pdf
http://www.natureserve.org/library/indianasubset.pdf

A list of non-native invasive species present in Indiana as of August 2010 can be viewed at:
http://www.invasivespeciesinfo.gov/plants/main.shtml
http://www.in.gov/dnr/naturepreserve/4736.htm

1.3.9 Biological Diversity: Area of Vegetation

Urban landscapes are improved by incorporating vegetation to absorb radiant heat, provide oxygen, use carbon dioxide, and provide aesthetic improvements. Conventional stormwater collection systems typically do not include vegetation as a component of design. Green infrastructure systems may or may not incorporate vegetation depending upon whether an opportunity for surface treatment of stormwater exists. This metric assumes that the greater the areas of vegetation as a percentage of the watershed (sewershed), the greater the benefits. The scoring for this metric incorporates the assumption that if an opportunity to add vegetation exists then it is an added value.

Reference for infiltration and a reduction in pollutant loads based on vegetation within a watershed can be found within:
Impacts of Impervious Cover on Aquatic Systems 2003. Center for Watershed Protection. Watershed Protection Research Monograph No. 1 Available for download through http://www.cwp.org