the LINK

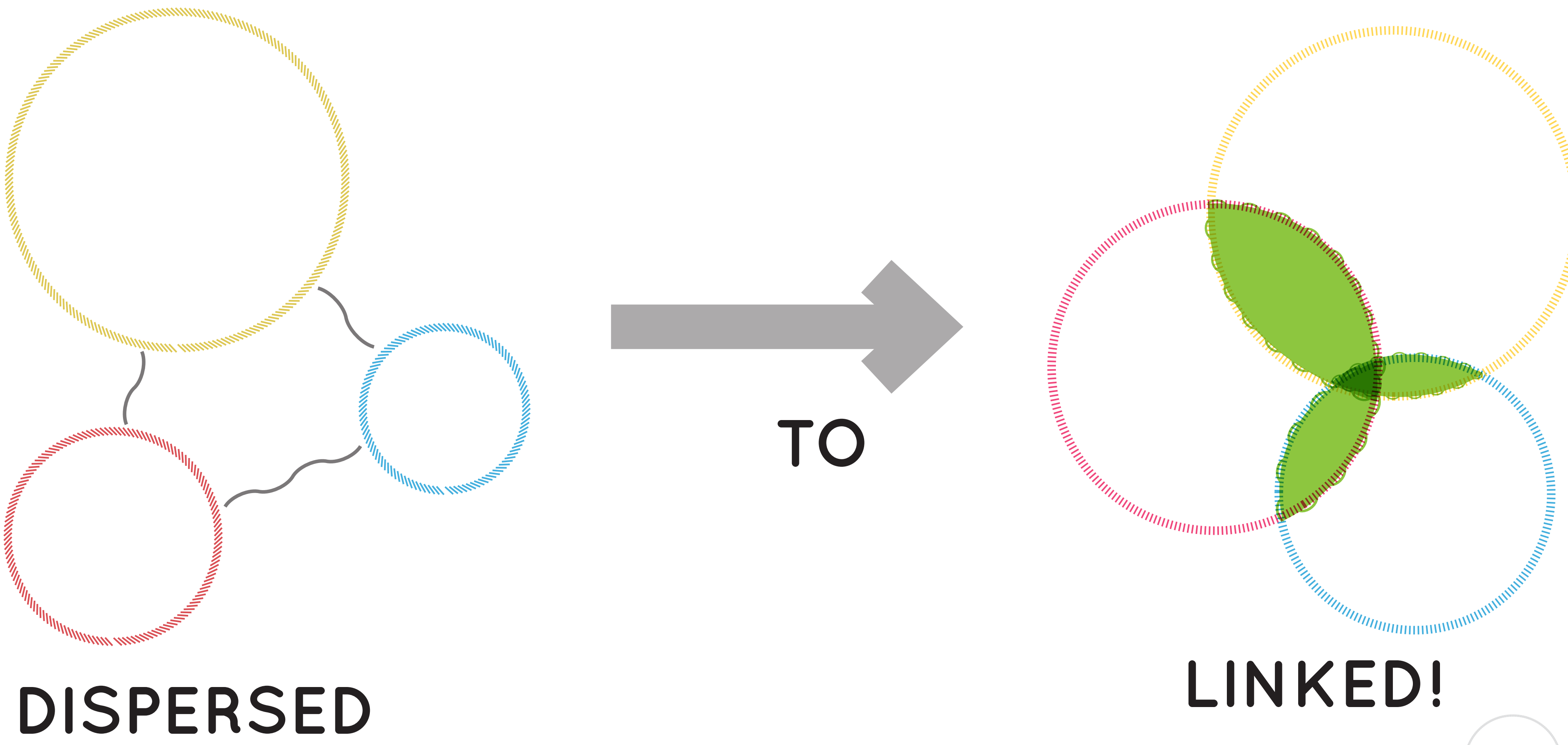
returning **nature** to the **neighborhood**
and **character** to the **community**

because every drop counts....
GREEN COUNTRY
SUSTAINABILITY FORUM

TEAM 01-02

the CHALLENGE

PRESENT A DESIGN THAT, THROUGH THE USE OF L.I.D. AND NEW URBANIST STRATEGIES, SETS A PRECEDENT FOR DENSE, MORE SUSTAINABLE COMMUNITIES IN BROKEN ARROW AND THE TULSA REGION.



GOALS

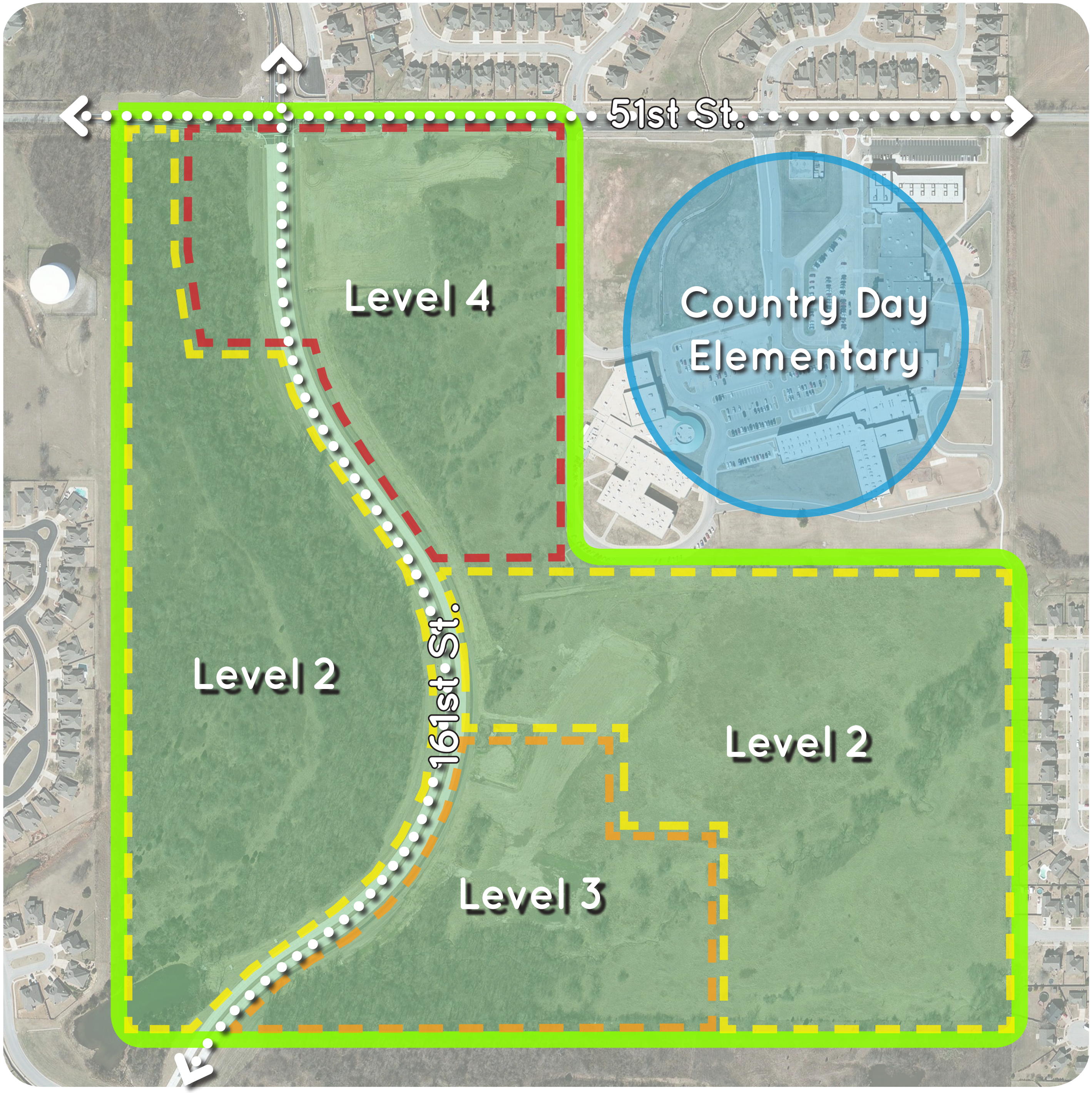
1 CREATE AN EXEMPLARY DEVELOPMENT THAT FOSTERS COMMUNITY AND ECONOMIC ACTIVITY

2 CAPITALIZE ON THE ABILITY OF LID STRATEGIES TO SUSTAINABLY MANAGE STORMWATER WHILE PROVIDING NEIGHBORHOOD AMENITIES

3 PROVIDE AN OPTION FOR WALKABLE, MIXED-USE LIVING TO BROKEN ARROW RESIDENTS

4 CONNECT USERS TO LOCAL AMENITIES

EXISTING CONDITIONS



LEVEL 2 Residential

LEVEL 3 Transitional

LEVEL 4 Commercial

As illustrated in this graphic, current zoning prohibits mixed-use development on the site.

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EXISTING CONDITIONS

SITE HYDROLOGY

The site is currently undeveloped. Stormwater follows its natural drainage pattern, running across the site from west to east and collecting in low areas on the north and east boundaries.

In addition, water from the site is currently adding to the load on adjacent properties. - in particular the school.

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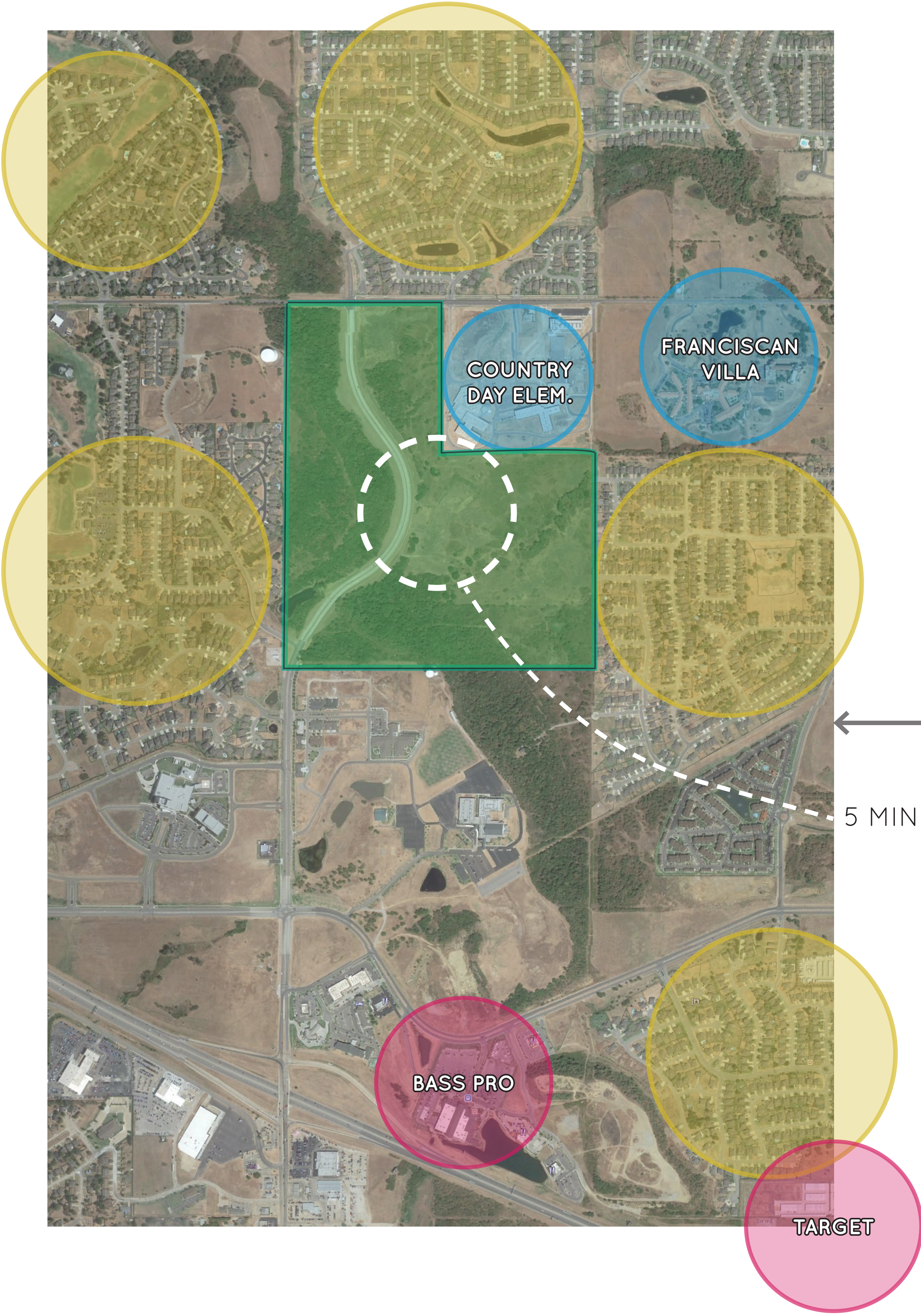
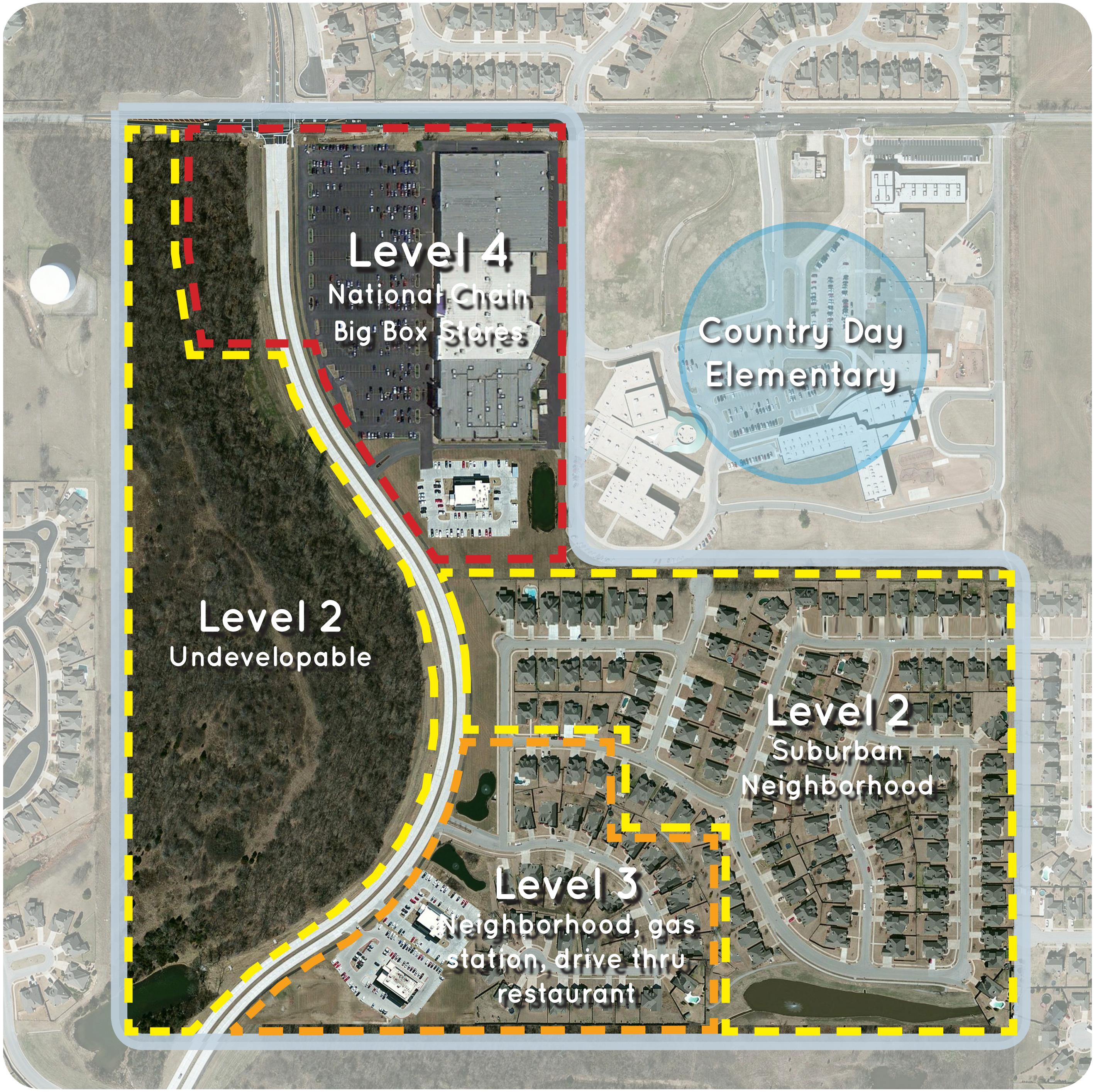


EXISTING CONDITIONS

OVERALL CONTEXT

The site is located near the intersection of 51st St and 161st St in Broken Arrow, Oklahoma. The area is maninly comprised of suburban neigborhoods. There are sparsley located institutional and commerical developments that are currently accessible only by car.

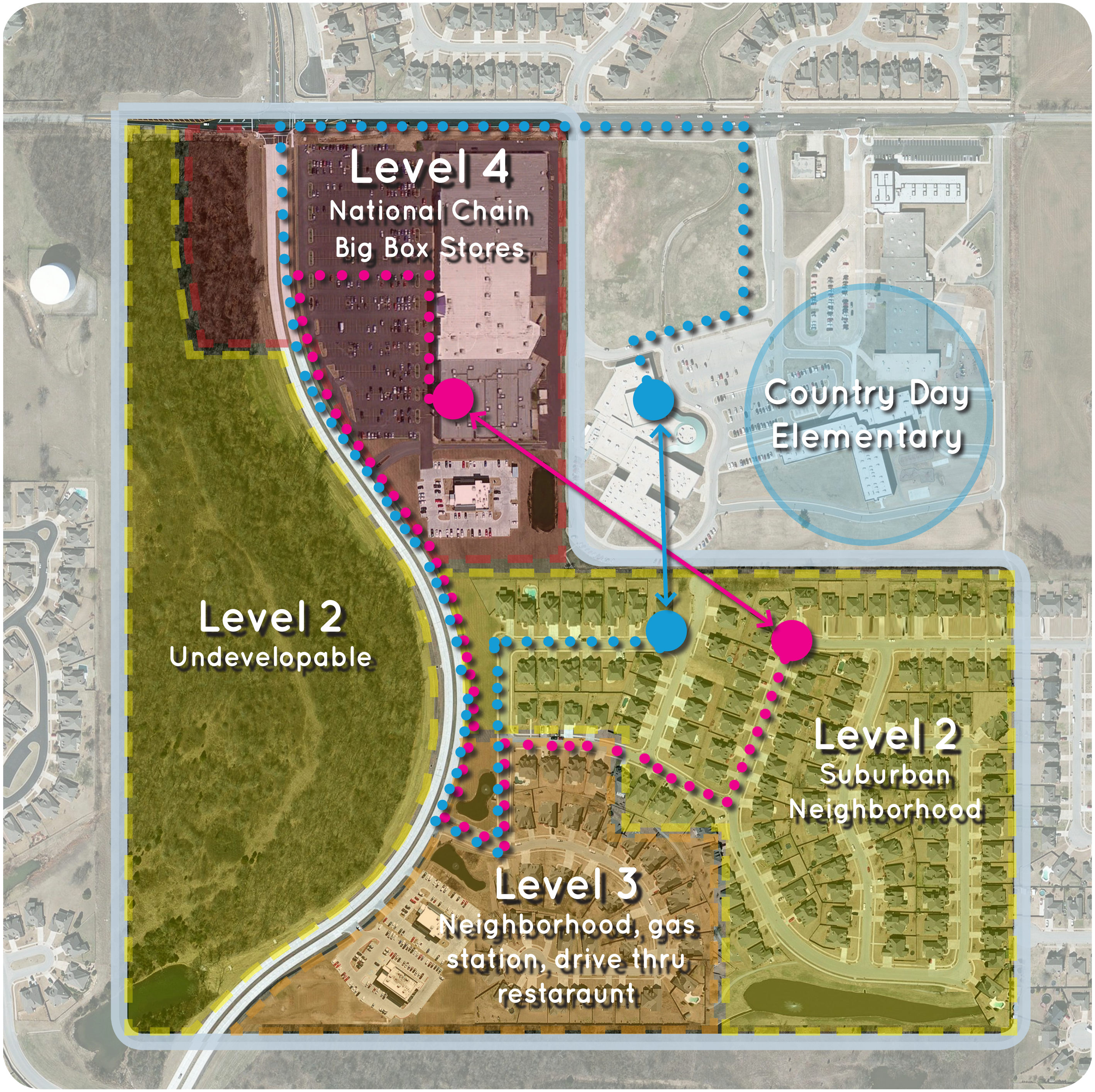


CONVENTIONAL DESIGN SOLUTION

EXISTING ZONING

This image illustrates the application of a conventional suburban development design strategy.

Similar developments can be found throughout the region and are consistent with local zoning and building codes.



CONVENTIONAL DESIGN SOLUTION

A LONG WAY TO GO

This image compares travel distances using conventional design strategies to those using new urbanist strategies.

Not only does the new urbanist approach result in shorter travel times, it allows users to select alternate methods of transportation for access to neighborhood amenities.

COMMUTE distance to COMMERCIAL = 5,090 FT (0.96 MI) (20 minutes)

ACTUAL distance to COMMERCIAL = 1,155 FT (0.22 MI) (4 minutes)

COMMUTE distance to SCHOOL = 6,090 FT (1.15 MI) (25 minutes)

ACTUAL distance to SCHOOL = 685 FT (0.13 MI) (2 minutes)

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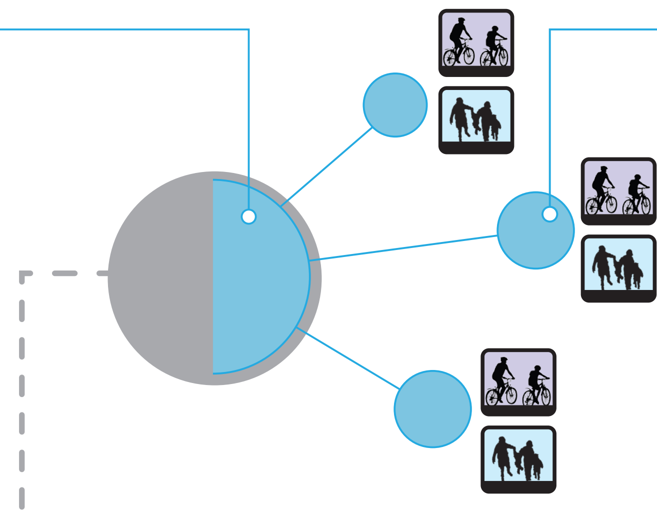
CONVENTIONAL DESIGN SOLUTION

AMOUNT OF STORMWATER DETENTION WITH LID PRINCIPLES

LESS RETENTION REQUIRED DUE TO VOLUME OF STORMWATER THAT IS INFILTRATED BY PERVIOUS SURFACES



DESIGNED TO CONSIDER WATER AS AN AMENITY AND DIVIDED THROUGHOUT THE DEVELOPMENT TO DISPERSE VALUE

DETENTION REQUIRED IN CONVENTIONAL DESIGN

TYPICALLY DESIGNED AS LARGE, MANMADE BASINS THAT TAKE UP SPACE AND ARE NOT CONSIDERED AN AMENITY

DETENTION STRATEGY

Detention ponds in conventional subdevelopments are large and isolated from the neighborhood.

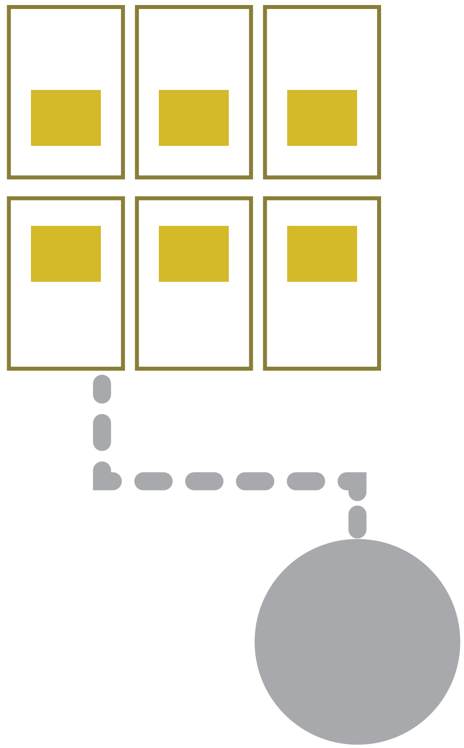
They are a solution to a problem - not an integrated design tactic.

"We must not build housing, we must build communities."
– Mike Burton, President, Urban Design Group

CONVENTIONAL DESIGN vs. LOW-IMPACT DESIGN

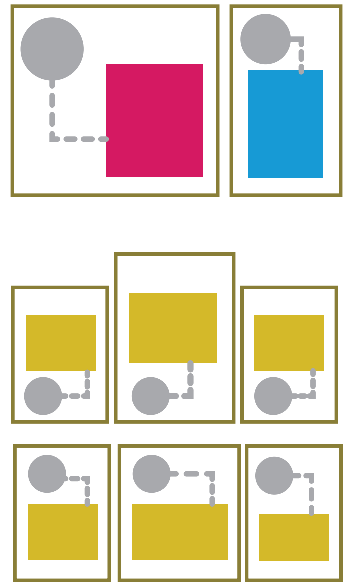
COMMON PRACTICES:

- treating stormwater as a problem on the site
- stormwater must be removed from the site as quickly as possible
- central management of stormwater
- natural ecosystem are not considered in design
- typical elements are
  - impervious roadways,
  - impearmeable surfaces on roofs,
  - gutters/downspouts,
  - curbs with inlets to main conveyance
  - impearmeable paved areas



WHICH YIELD:

- larger and more impervious surfaces
- decreased time of concentration
- higher speed and volume of runoff
- devastation of our natural watershed & ecosystems
- negative effect on water quality
- poor use of land



COMMON PRACTICES:

- treating stormwater as a resource
- collecting water as close to its source as possible
- localized management of stormwater
- emulation of predevelopment hydrology
- facilitation of natural ecosystem to thrive
- typical elements are
  - roadways draining to infiltration basins
  - greenroofs
  - rainwater collection on-site
  - curb cuts to infiltration basins
  - permeable paving

WHICH YIELD:

- more pervious surfaces to capture rainwater
- increased time of concentration on pervious surfaces
- lower speed and volume of runoff
- positive effects on stream stability and natural habitats
- positive effect on water quality

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SUBURBANISM vs. NEW URBANISM

Suburban sprawl is a multifaceted concept centered on the expansion of auto-oriented, low-density development.

The term urban sprawl generally has negative connotations due to the health, environmental and cultural issues asociated with the phrase.

- Characteristics of suburban developments include:
- single-use zoning
- low-density zoning
- car-dependent communities
- loss of agrictultural land
- large lot sizes
- centralized stormwater retention
- limited access

WHICH YIELDS:

- Low density
- Poor accessability
- Single use
- Lacking in context and character
- No feeling of community
- Inefficient use of land
- Results in poor stormwater runoff quality

Traditional Neighborhood Development (TND) refers to the development of a complete neighborhood or town using traditional town planning principles. TND often involves all-new construction on previously undeveloped land.

The following are commonly found in TND's:

- a range of housing types,
- narrow setbacks and narrower streets with crosswalks,
- buildings oriented to the street with parking behind
- compact, clustered, mixed-use development,
- higher density residential near commercial development, transit stops, parks and public facilities, and
- pedestrian and vehicular connectivity to schools, parks and activity centers.

WHICH YIELDS:

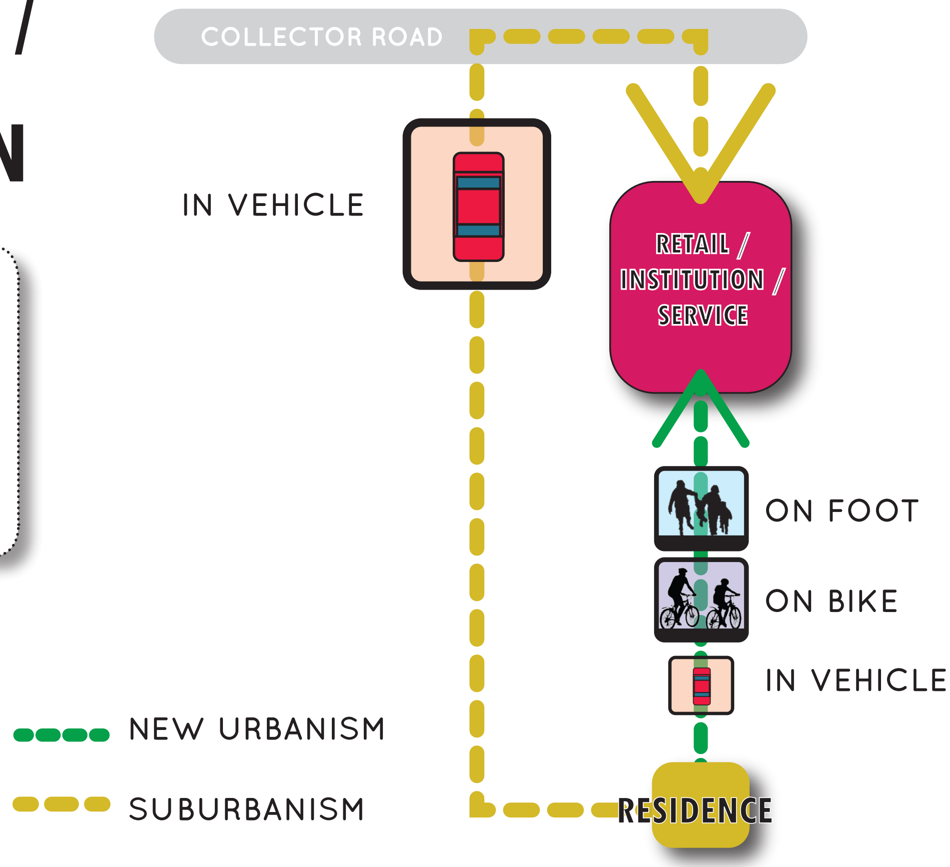
- Increased development densities
- A strong sense of place
- Diverse communities
- Increased open space
- Improved land and water conservation
- Transportation options
- Business opportunities

Not all suburbs are created equal

CONNECTIVITY / URBAN CLASSIFICATION

"Higher density housing offers an inferior lifestyle only when it is without a community as its setting."

– Andres Duany, Founder, Congress for the New Urbanism

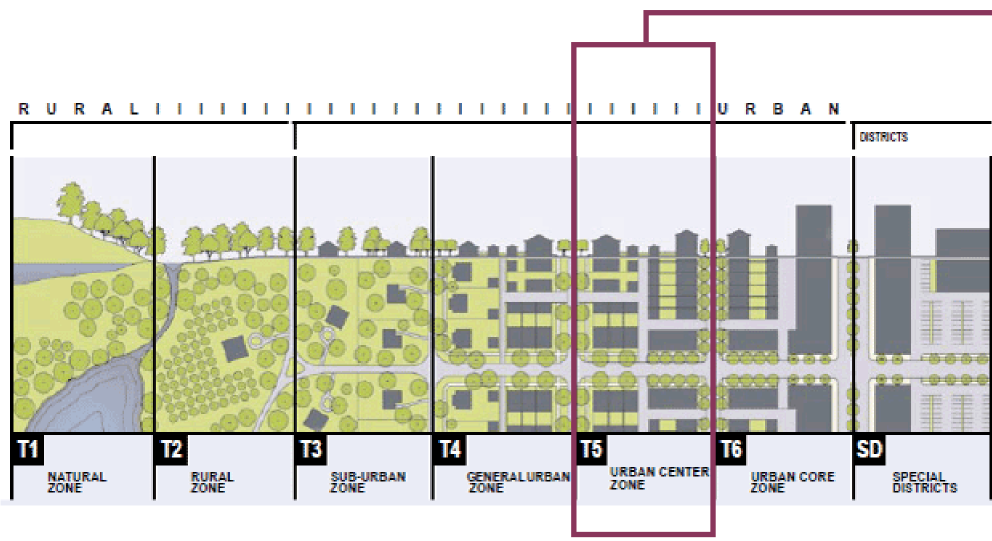


GETTING CONNECTED

In the **LINK,** residents have the option of traveling shorter distances using different modes of travel - eliminating the need for using their car every time they go somewhere.

New Urbanist Principles Emaphasize:

- efficiency
- walkability
- bikeability
- reduced traffic
- reduced infrastructure costs



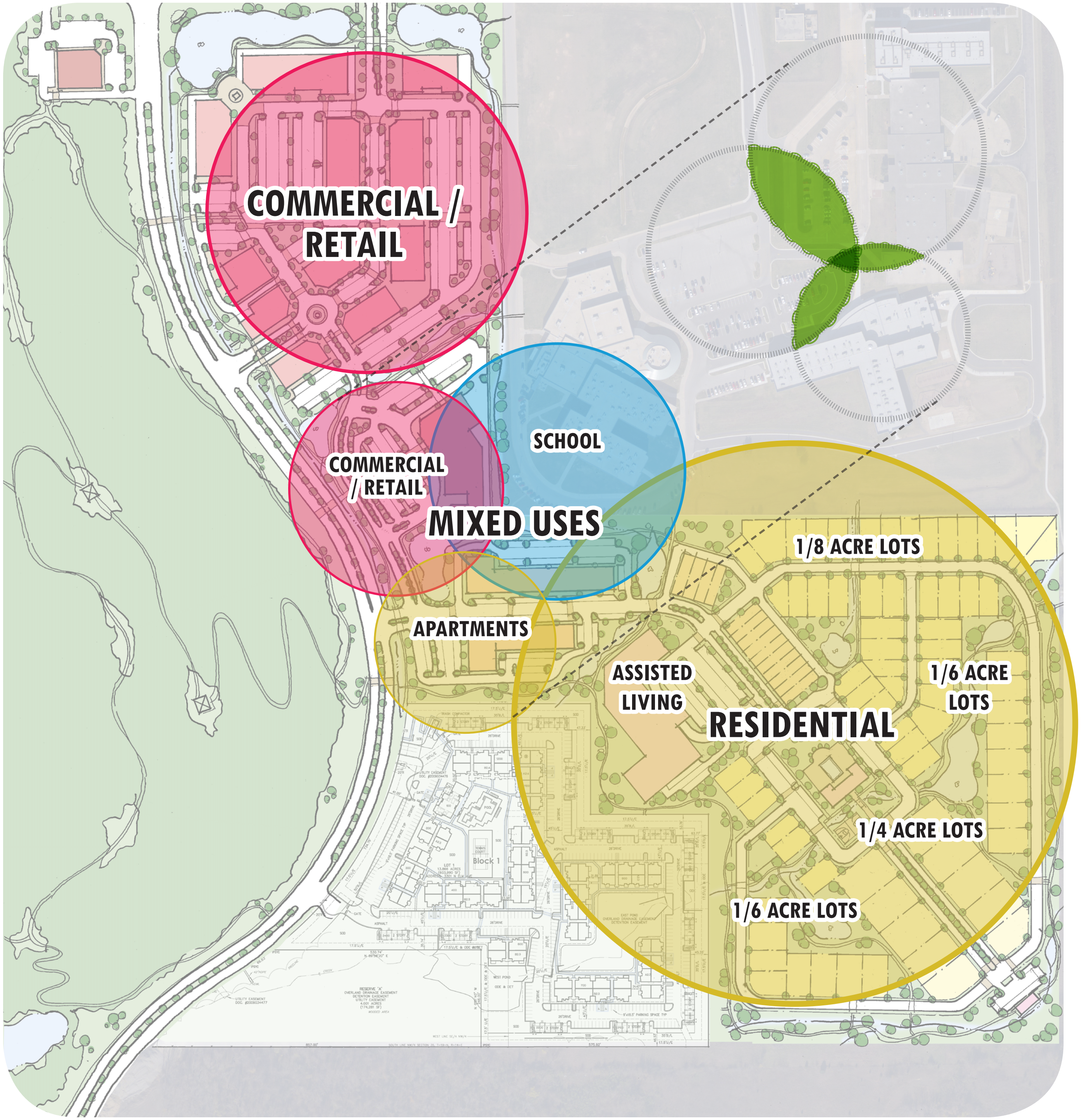
URBAN CLASSIFICATION

The transect diagram, developed by Duany Plater-Zyberk, is a tool to help classify areas of city development. The LINK is classified generally as a T5, which is characterized by mixed uses and urban living. Additionally, there would be single family homes in this area.

returning **nature** to the **neighborhood** and **character** to the **community**

Over the last fifty years, nature in new development has been an afterthought. Natural elements not only bring economic value, but also create community vibrance and improve quality of life. The LINK aims to create a community that is environmentally, socially, and economically sustainable.

PROPOSED DEVELOPMENT



re-LINKing

In LINK, we suggest PUD development in which different levels of programs are directly adjacent to one another. By overlappging programs the new development greater supports walkability and community.

PROPOSED DEVELOPMENT

MAINTAINING THE GREENWAY

The LINK has maintained the site's pre-development hydrology by building around existing drainage patterns. This eliminates the need to create artificial drainage paths, and enables the developer to beautify the natural swales as an amenity. The LINK Trail meanders along the waterways, enhancing the users experience and educating them on the history of the waterflow.

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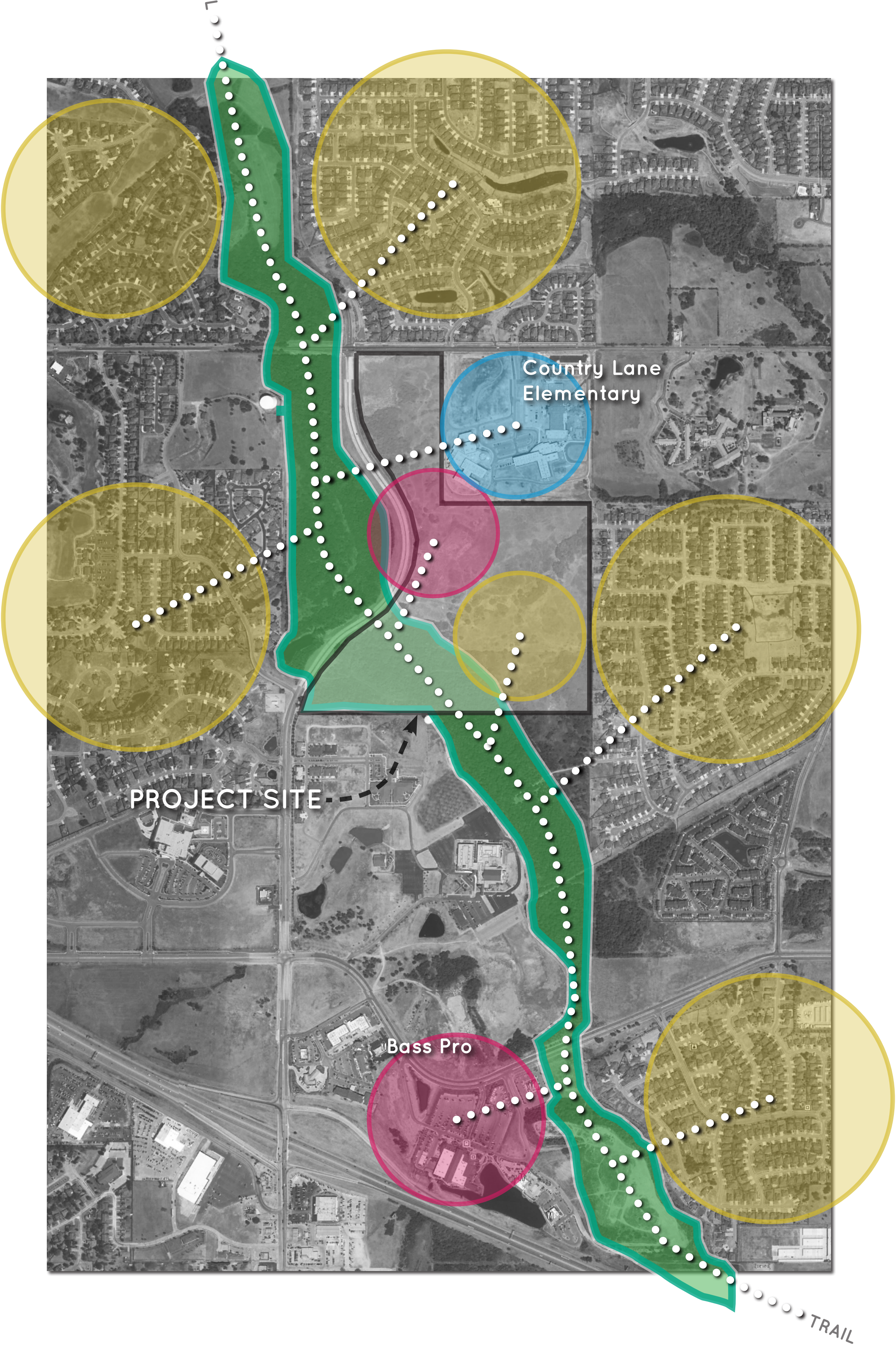

PROPOSED DEVELOPMENT

THE GREENBELT

This diagram illustrates how walking and biking trails connect to local amenities. Additionally, the greenbelt has the potential to expand beyond the site, and connect an even larger region.

NEIGHBORHOODS

to

SCHOOLS AND INSTITUTIONS

to

RETAIL & BUISNESSES

to

NEIGHBORHOODS

PROPOSED DEVELOPMENT

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RETURNING **NATURE** TO THE **NEIGHBORHOOD** AND **CHARACTER** TO THE COMMUNITY

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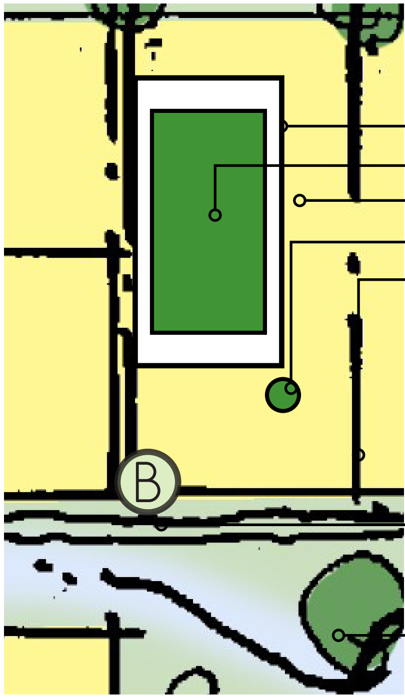
PROPOSED DEVELOPMENT

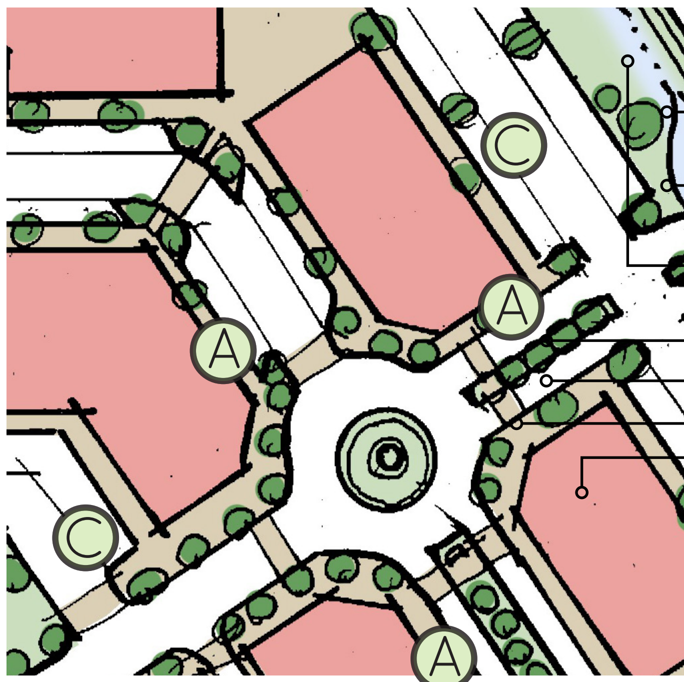
TYPICAL ENGLARGED PLANS



1'=50'

TYPICAL RESIDENTIAL LOT

1. residence
2. green roof
3. personal rain garden
4. cistern
5. the **LINK** trail connection to school (walk / bike)
6. bioswale adjacent to trail (pre-development drainage)
7. detention with native cleaning plants



1'=100'

TYPICAL COMMERCIAL BLOCK

1. the **LINK** trail connection to larger region (walk / bike)
2. bioswale adjacent to trail (pre-development drainage)
3. detention with native cleaning plants
4. street trees with bioswale curb cuts
5. narrow streets
6. permeable paving
7. green roofs

"The Beautiful is as useful as the useful...and perhaps more so."

– Victor Hugo, writer

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STORMWATER QUALITY NARRATIVE

As stormwater is collected through the site at bioswales and through plants, pollutants are removed through the soil. After the most of the water is infiltrated into the soil, the remaining cleaned water enters the main conveyance.

In conventional design, surface runoff contains pollutants from streets and buildings. This runoff is taken directly to the conveyance, and the polluted water enters the system without being cleaned.

TYPICAL FLOW THROUGH BIOSWALE CONDITION AT PARKING LOT

native plants that absorb runoff and pollutants 1
curb cut 2
curb and gutter 3
overflow control structure 4
soil mixture 5
gravel pipe bed 6
perforated pipe connecting to underground 7
storage / cistern / natural stream outlet

C

1 unit pavers, 1.5" sand setting bed, 4" compacted aggregate, compacted subgrade
2 6" concrete footing
3 steel gutter with filter gravel
4 storm water bridge beyond

A

TYPICAL INFILTRATIVE / FLOW THROUGH BIOSWALE CONDITION AT COMMERCIAL DEVELOPMENT

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B

TYPICAL FLOW THROUGH BIOSWALE CONDITION AT RESIDENCE

1 native plants that absorb runoff and pollutants
2 overflow control structure
3 soil mixture
4 gravel pipe bed perforated pipe connecting to underground storage / cistern / natural stream outlet

LET'S MAKE IT HAPPEN

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1. perform a feasibility study
2. define realistic goals for implementation (consider phasing)
3. update development / redevelopment standards and pass ordinances
4. educate stakeholders and get buy-in

PROPOSED DEVELOPMENT

STORMWATER QUALITY

As stormwater is collected through the site at bioswales and through plants, pollutants are removed through the soil. After the water has infiltrated into the soil, the remaining cleaned water enters the main conveyance.

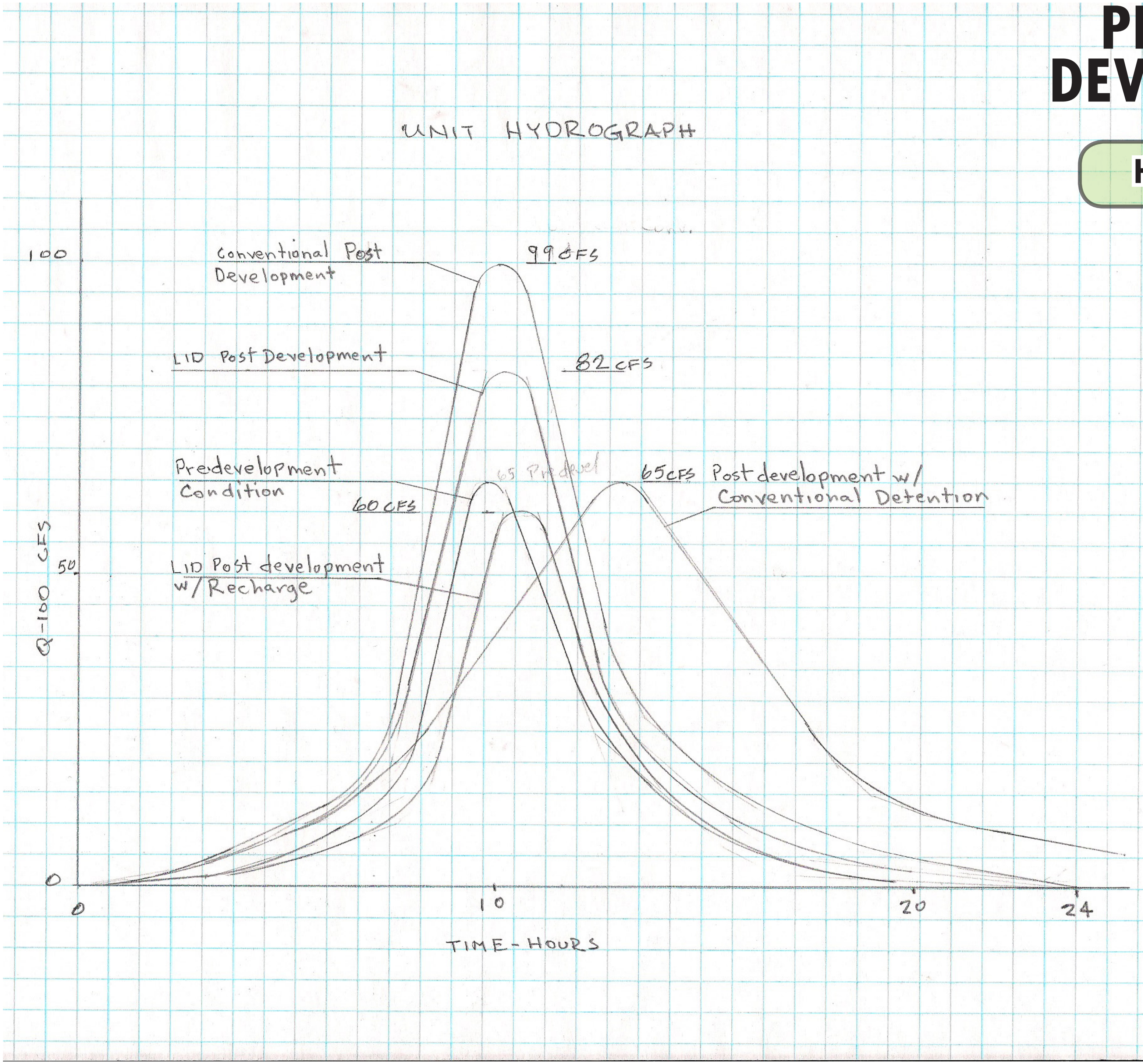
In conventional design, surface runoff contains pollutants from streets and buildings. This runoff is taken directly to the conveyance, and the polluted water enters the system without being cleaned.

STORMWATER QUANTITY

A conventional approach would greatly reduce permeable area and interrupt the natural drainage patterns, resulting in increased speed and quantity of stormwater runoff. This increased, untreated runoff would degrade the quality, potentially adversely affecting the Adams and Haikey Creek watersheds through the introduction of additional silt and pollutions. In addition, traditional methods of development could increase runoff onto neighboring properties if not handled correctly. Employing an LID approach would allow these issues to be addressed on site in a fashion that would greatly reduce, and possibly enhance, area watersheds while improving property values and community aesthetics.

PROPOSED DEVELOPMENT

HYDROGRAPH



PROPOSED DEVELOPMENT

RUN-OFF COMPARISON

Development Area	Land Area SF	Acres	Existing Condition slope	Velocity	Project Condition slope	Velocity	tc, min	I5	I100	LID w/Recharge tc, minutes
residential area	268,800	6.17	6%	2.0	4%	1.5	10.0	5.4	8.5	15.0
assisted living area	55,500	1.27	7%	1.4	2%	2.1	8.0	5.8	9.5	15.0
apartment area	52,900	1.21	7%	1.4	2%	3.0	8.0	5.8	9.5	15.0
grocery store area	52,800	1.21	6%	2.0	2%	3.0	8.0	5.8	9.5	15.0
commercial / retail area	410,400	9.42	6%	2.0	1%	2.9	12.0	5.2	8.3	20.0
	840,400	19.29								

	Existing Conditions Area, A	"C"	I-5	Q-5	I-100	Q-100	LID w/Recharge tc, minutes	I-100	Q-100
residential area	6.17	0.40	5.4	13.33	8.5	20.98	14.0	8.00	19.74
assisted living area	1.27	0.36	5.8	2.65	9.5	4.34	11.0	7.90	3.61
apartment area	1.21	0.36	5.8	2.53	9.5	4.14	10.0	7.80	3.40
grocery store area	1.21	0.40	5.8	2.81	9.5	4.60	10.0	8.00	3.87
commercial / retail area	9.42	0.40	5.2	19.59	8.3	31.27	16.0	7.80	29.39
				40.91		65.33			60.02

	Proposed Conditions - LID Area, A	"C"	I-5	Q-5	I-100	Q-100	
residential area	6.17	0.48	5.4	15.99	8.5	25.17	
assisted living area	1.27	0.44	5.8	3.24	9.5	5.31	
apartment area	1.21	0.48	5.8	3.37	9.5	5.52	
grocery store area	1.21	0.53	5.8	3.72	9.5	6.09	
commercial / retail area	9.42	0.52	5.2	25.47	8.3	40.66	
				51.79		82.75	
				27%		**27%**	Increase over existing

	Proposed Conditions - Conventional Area, A	"C"	I-5	Q-5	I-100	Q-100
residential area	6.17	0.56	5.4	18.66	8.5	29.37
assisted living area	1.27	0.52	5.8	3.83	9.5	6.27
apartment area	1.21	0.60	5.8	4.21	9.5	6.90
grocery store area	1.21	0.66	5.8	4.63	9.5	7.59
commercial / retail area	9.42	0.63	5.2	30.86	8.3	49.26

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LID METHODS

BIOSWALES

A bioswale is a shallow depression created in the earth to accept and convey stormwater runoff. A bioswale uses natural means, including vegetation and soil, to treat stormwater by filtering out contaminants being conveyed in the water.

- Natural water detention feature - water is absorbed into soil (LEVEL III: infiltrative)
- Reduces runoff reaching the subsurface infrastructure
- Cleanses water by removing pollutants
- Reduces the need for subsurface infrastructure

$ Costs vary greatly depending on size, plant material, and site considerations. Bioswales are generally less expensive when used in place of underground piping.

GREENROOFS

Greenroofs generate significant public and environmental benefits, as well as benefits to developers and building owners due to extended life compared to traditional roofs.

- Saves significant fossil-fuel energy use through insulation
- Reduces stormwater flow by 50% to 90%
- Increases water use efficiency through building storage for rain-water, and recycling of grey water
- Reduces air pollution
- Greatly reduces "heat island" effects in cities
- Reduces noise pollution from outside sources

$ Benefits to building owners were found to be significant, but they do not accrue until sometime after year 20. By year 40 the city estimated that the owner of a building with an ecoroof would save a total of $400,000

PERVIOUS PAVERS

Permeable paving provides a 100% pervious surface by runoff passing through small, aggregate-filled openings between solid high-strength durable concrete pavers.

- Infiltrates, filters and decreases stormwater runoff rate and reduces Total Maximum Daily Loads (TMDLs)
- Reduces or eliminates stormwater detention and retention ponds, storm sewers, drainage appurtenances and related costs
- Processes and reduces pollutants from vehicular oil drippings

$ Cost: $10-$15 per square foot

STREET TREES

Once seen as highly problematic for many reasons, street trees are proving to be a great value to people living, working, shopping, sharing, walking and motoring in and through urban places.

- Safer walking environment
- Businesses on treescaped streets show 12% higher income streams
- Absorb the first 30% of most precipitation through their leaf system reducing the amount of stormwater
- Improved air quality
- Mitigate urban heat island effect

$ Cost: $250-600
Return: $90,000 over the lifetime of the tree (not including aesthetic, social and natural)

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BARRIERS AND STRATEGIES

The following table lists a few of the limitations of current codes and regulations that prevent LID strategies from being implemented.

Identified Barriers	Conceptual Strategies
"Mixed messages" from different governmental departments about LID implementation (planning, public works, parks, engineering, City leaders, etc...)	Create an LID Manual that explains the installation procedure, maintenance requirements, and associated costs. Provide to all necessary to City Departments.
Americans with Disabilities Act considerations	Provide alternate surfaces for disabled access if there is potential for pervious surface to impede mobility.
Compatibility with existing developments that do not use LID practices	Involvement of Landscape Architects and Planners to better define "community identity and character."

Crown Street
Vancouver, Canada

CASE STUDY 1

Prairie Crossing Subdivision
Grayslake, Illinois

The Prairie Crossing subdivision is a conservation development on 678 acres, of which 470 acres is open space. The site was developed as a mixed-use community with 362 residential units and 73 acres of commercial property, along with schools, a community center, biking trails, a lakefront beach, and a farm. The site uses bioretention cells and vegetated swales to manage stormwater.

A cost analysis was performed to compare the actual construction costs of Prairie Crossing with the estimated costs of a conventional design on the site with the same layout. The total savings were estimated to be almost $1.4 million, or nearly $4,000 per lot.

Reduced road width	**$178,000**
Reduced stormwater management	**$210,000**
Decreased sidewalks	**$648,000**
Reduced curb and gutter	**$339,000**

CASE STUDY 2

Somerset Subdivision
Prince George's County, Maryland

The Somerset subdivision, outside Washington, D.C., is an 80-acre site consisting of nearly 200 homes. Approximately half of the development was built using LID techniques; the other half was conventionally built using curb-and-gutter design with detention ponds for stormwater management. Bioretention cells and vegetated swales were used in the LID portion of the site to replace conventional stormwater infrastructure. Sidewalks were also eliminated from the design.

In terms of environmental performance, the LID portion of the subdivision performed better than the conventional portion.

LID Cost	**$1,671,461**
Conventional Cost	**$2,456,843**
Additional Savings	**$ 785,382**

Somerset Subdivision
Prince George's County, Maryland

CASE STUDY 3

Laurel Springs Subdivision
Jackson, Wisconsin

LID Cost	**$1,149,552**
Conventional Cost	**$1,654,021**
Additional Savings	**$ 504,469**

The Laurel Springs subdivision is a residential subdivision that was developed as a conservation design community. The use of cluster design helped to preserve open space and minimize grading and paving. The use of bioretention and vegetated swales lowered the costs for stormwater management. In addition to preserving open space and reducing the overall amount of clearing and grading, the cluster design also reduced street lengths and widths, thereby lowering costs for paving and sidewalks.