

## ABSTRACT

Title of Thesis: SCHOOL DEVELOPMENT IN URBANIZING AREAS

Pranjali Rai, Master of Architecture 2016

Thesis Directed By: Prof. Emeritus, Ralph Bennett, Architecture

Good schools are essential for building thriving urban areas.<sup>1</sup> They are important for preparing the future human resource and directly contribute to social and economic development of a place. They not only act as magnets for prospective residents, but also are necessary for retaining current population.

As public infrastructure, schools mirror their neighborhood. “Their location, design and physical condition are important determinants of neighborhood quality, regional growth and change, and quality of life.”<sup>2</sup> They impact housing development and utility requirements among many things. Hence, planning for schools along with other infrastructure in an area is essential.

Schools are very challenging to plan, especially in urbanizing areas with changing demographic dynamics, where the development market and housing development can shift drastically a number of times. In such places projecting the

---

<sup>1</sup>McKoy, Deborah, Jeffrey M. Vincent, and Carrie Makarewicz. "Integrating infrastructure planning: The role of schools." *ACCESS Magazine* 1, no. 33 (2008)., Page 22

<sup>2</sup> McKoy, Deborah, Jeffrey M. Vincent, and Carrie Makarewicz. "Integrating infrastructure planning: The role of schools." *ACCESS Magazine* 1, no. 33 (2008)., Page 19

future school enrollments is very difficult and in case of large population influx, school development can be unable to catch up with population growth which results in overcrowding.

Typical is the case of Arlington County VA. In the past two decades the County has changed dramatically from a collection of bedroom communities in Washington DC Metro Region to a thriving urban area. Its metro accessible urban corridors are among most desired locations for development in the region. However, converting single family neighborhoods into high density areas has put a lot of pressure on its school facilities and has resulted in overcrowded schools. Its public school enrollment has grown by 19% from 2009 to 2014.<sup>3</sup> While the percentage of population under 5 years age has increased in last 10 years, those in the 5-19 age group have decreased<sup>4</sup>. Hence, there is more pressure on the elementary school facilities than others in the County.

Design-wise, elementary schools, due to their size, can be imagined as a community component. There are a number of strategies that can be used to develop elementary school in urbanizing areas as a part of the neighborhood. Experimenting with space planning and building on partnership and mixed-use opportunities can help produce better designs for new schools in future.

This thesis is an attempt to develop elementary school models for urbanizing areas of Arlington County. The school models will be designed keeping in mind the shifting

---

<sup>3</sup> Arlington Public Schools. Arlington School Board Adopted, FY 2015 – FY 2024 Capital Improvement Plan, <http://arlingtonva.s3.amazonaws.com/wp-content/uploads/sites/18/2014/09/9.-APS.pdf> (accessed October 15, 2015)

<sup>4</sup> Arlington Public Schools. Arlington School Board Adopted, FY 2015 – FY 2024 Capital Improvement Plan, <http://arlingtonva.s3.amazonaws.com/wp-content/uploads/sites/18/2014/09/9.-APS.pdf> (accessed October 15, 2015)

nature of population and resulting student enrollments in these areas. They will also aim to be efficient and sustainable, and lead to the next generation design for elementary school education. The overall purpose of the project is to address barriers to elementary school development in urbanizing areas through creative design and planning strategies.

To test above mentioned ideas for elementary schools, the Joint-Use School typology of housing +school design has been identified for elementary school development in urbanizing areas in this thesis project. The development is based the Arlington Public School's Program guidelines (catering to 600 students). The site selected for this project is Clarendon West (part of Red Top Cab Properties) in Clarendon, Arlington County VA.

SCHOOL DEVELOPMENT IN URBANIZING AREAS

by

Pranjali Rai

Thesis submitted to the Faculty of the Graduate School of the  
University of Maryland, College Park, in partial fulfillment  
of the requirements for the degree of  
Architecture  
2016

Advisory Committee:

Prof. Ralph Bennett, **Chair**, Professor Emeritus, Architecture Program

Prof. James Tilghman, Lecturer, Architecture Program

Prof. Brian Kelly, Professor and Director, Architecture Program

Dr. James Cohen, Professor and Director, Urban Studies & Planning Program

© Copyright by  
Pranjali Rai  
2016

## Dedication

To all the parents and their kids who had to leave cities and live in suburbs due to overcrowded schools in urban areas.

## Acknowledgements

I would like to thank my Thesis Committee, especially my Thesis Chair, Prof. Ralph Bennett for his support, patience, encouragement and guidance during the entire process. I thank Prof. James Tilghman for his valuable feedbacks, Prof. Brian Kelly and Dr. James Cohen for their assistance and encouragement in development of this thesis.

My special thanks to Mr. Andrew D'huyvetter, Urban Planner, Arlington County, Community Planning Housing and Development Department for the time he spent on discussing inspirational ideas related to the school situation in Arlington County and design proposal for this thesis. Also, I thank the Urban Design and Research Division at Arlington County CPHD Department for their time and feedback on this project.

I thank my peers in Architecture Thesis Cohort for critiquing ideas related to development and presentation of my thought process for this thesis. I would also like to thank my roommate Diane Bickel for emotional support.

Last but not the least, I thank my husband Abhishek for his endless patience and support throughout my masters education. I also thank my family for their encouragement, helping me to successfully culminate masters education at University of Maryland.

# Table of Contents

Dedication.....	ii
Acknowledgements.....	iii
Table of Contents.....	iv
List of Tables.....	v
List of Figures.....	vi
Chapter 1: Elementary Schools in Context.....	1
Elementary School – a community component.....	1
Elementary Schools in Urbanizing Contexts.....	1
Chapter 2: Elementary School Program.....	6
Elementary School Building Configuration- a Comparison by Context.....	6
Conclusions.....	9
Joint-Use School in Urbanizing Contexts.....	18
A Joint- Use school in Arlington, VA.....	22
Elementary School Program and Guideline Comparison.....	23
Chapter 3: Design Approach.....	30
Design Issues.....	30
<i>Issue 1- Daylighting</i> .....	31
<i>Issue 2- Connection to Outdoor Space</i> .....	36
<i>Issue 3- Multi-level</i> .....	39
Chapter 4: Site Analysis.....	44
Site Selection.....	44
<i>Arlington County: Regional Setting and Main Features:</i> .....	46
<i>Sites Considered:</i> .....	48
<i>A Transit Corridor Mixed- Use School in Arlington, VA:</i> .....	48
<i>Possible sites:</i> .....	50
Site Analysis.....	52
<i>Clarendon West- Site Attributes:</i> .....	52
<i>Clarendon West- Possible School Service Area:</i> .....	54
<i>Clarendon West- Existing Conditions:</i> .....	54
Chapter 5: Design Options.....	58
Zoning of School & Housing in Joint-School Development:.....	58
Chapter 6: Design Proposal.....	60
The Courtyard School Option:.....	60
Conclusion:.....	80
Appendices.....	81
Bibliography.....	84

## List of Tables

S.No	Topic	Page Number
Table 1	Project information as per context	9
Table 2	Mix of Uses for Spruce Street School	21
Table 3	Mix of Uses for Windward School	22
Table 4	Mix of Uses for Dock Street Dumbo School	22
Table 5	Mix of Uses for Riverside Center School	23
Table 6	School Program Comparision	26
Table 7	The School Program	76

## List of Figures

S.No	Topic	Page Number
Figure 1	Urban Transect	5
Figure 2	The Urban Transect perspectives	6
Figure 3	Characteristics of Elementary Schools	7
Figure 4	Redefining the Relocatable Classroom: Future Proofing Schools	7
Figure 5	Quantitative analysis of school projects in urbanizing contexts and schools in different urbanizing contexts	9
Figure 6	Scale Comparison	10
Figure 7	Multi-Level Schools	12
Figure 8	Shared Spaces with Community	13
Figure 9	Construction Phasing	14
Figure 10	Future Expansion	15
Figure 11	Flexible Zone	15
Figure 12	Green Building Strategies	15-16
Figure 13	Efficient Circulation	16
Figure 14	Separation of Grades	17
Figure 15	Access to Outdoor Spaces	18

Figure 16	Mixed Use Schools	19
Figure 17	Collaborative Learning Spaces	20
Figure 18	Daylighting	21
Figure 19	Windward Manhattan school campus	23
Figure 20	Dock Street Dumbo Project	24
Figure 21	Riverside School Section	25
Figure 22	Rule of Thumb for Window Configuration	33
Figure 23	Classroom Depth	33
Figure 24	The Linear Bay Scheme	35
Figure 25	The Perpendicular Bay Scheme	37
Figure 26	Common Core and Lobby Scheme	41
Figure 27	Common Core and Lobby with Shared Facilities	44
Figure 28	Appropriate Travel Path from Home to School	47
Figure 29	Arlington County Major Planning Corridors	49
Figure 30	Site Considered	51
Figure 31	Elementary School Capacity Utilization	52
Figure 32	Site Attribute Weightage	53
Figure 33	Site Ranking	54
Figure 34	Clarendon West- Site Attributes	55
Figure 35	Service Area Diagram	56

Figure 36	Site Aerial Image	57
Figure 37	Site Observations	57
Figure 38	Site Photos	57
Figure 39	Site Regulations	58
Figure 40	Site Section Existing	59
Figure 41	School & Housing Zoning Options	60-61
Figure 42	Base Case as per Regulations	62
Figure 43	Claiming Bonus Height Incentive	63
Figure 44	Commercial Block Preservation	63
Figure 45	Design Proposal- Site Plan	64
Figure 46	Design Proposal- Site Axon	65
Figure 47	View along 13 <sup>th</sup> St.	66
Figure 48	View from Clarendon Metro	66
Figure 49	Proposed Development Sectional Perspective	67
Figure 50	Floor Plans	68-70
Figure 51	View from the Community	71
Figure 52	G-1 level Access, Circulation & Shared Spaces	71
Figure 53	View from Clarendon Core	72
Figure 54	Drop-Off View	73
Figure 55	First Floor Access, Circulation & Shared Spaces	73

---

Figure 56	Courtyard View from Central Staircase	74
Figure 57	Courtyard View from Loggia	75
Figure 58	School Learning Space Program	78
Figure 59	Daylighting of Learning Spaces	78
Figure 60	N-E Classroom at 11 am	79
Figure 61	S-W Classroom at 2 pm	79
Figure 62	Collaboration Pods	80
Figure 63	Looking into Soccer Field from Housing	81
Figure 64	Flexible Classroom Space on 5 <sup>th</sup> floor	81

---

## Chapter 1: Elementary Schools in Context

### Elementary School – a community component

While high schools and middle schools are specialized buildings due to the nature of education, elementary schools can be imagined as community facilities. Elementary schools tend to serve smaller districts especially in dense areas due to high enrollment because of young families who tend to prefer living close to diverse work opportunities in these areas and enforced low capacity on these type of schools.

Therefore due to its smaller size and smaller service area, an elementary school can be imagined more like a neighborhood facility than, for example, a much larger high or middle school.

This unique nature of elementary school is an opportunity to develop different morphologies to best suit the neighborhood community. They can be imagined as not only educational buildings, but also as a common resource for the neighborhood.

They can exist in shared sites for schools and other public buildings. They can also exist in mixed-use environments in tandem with other structures in high density areas.

It is important to note that elementary schools are opportunities to build partnerships and to develop better living work and play environments for densely populated areas.

### Elementary Schools in Urbanizing Contexts

Architect Susana Torre – (Jury member New Schools for NY)- "A school can play an important role in forming a child's –especially an urban child's view of nature."<sup>5</sup>

---

<sup>5</sup> Architectural League of New York, Public Education Association of the City of New York, and Princeton Architectural Press. 1992. New Schools for New York. New York, N.Y.: Architectural League of New York. Pg 55

Urbanizing contexts chosen for this project are areas that are continuously densifying or are changing their development character. This shifting nature of urbanizing areas results in demographic shifts and population increase or loss. This leads to a fluctuating school enrollments. Planning and designing for this change is quite a challenge which will be addressed by this project.

To understand the implication on school buildings in changing contexts, The Urban Transect model from New Urbanism theory has been used (Fig1). An urbanizing context can look like anything from T4 to T6. Hence, developing strategies for these areas would be the goal for this project. Understanding the morphology of elementary schools found in these zones of The Transect will help in pinpointing the variables in design. Further study on the relationship of these variables with the context will help clarify the issues.

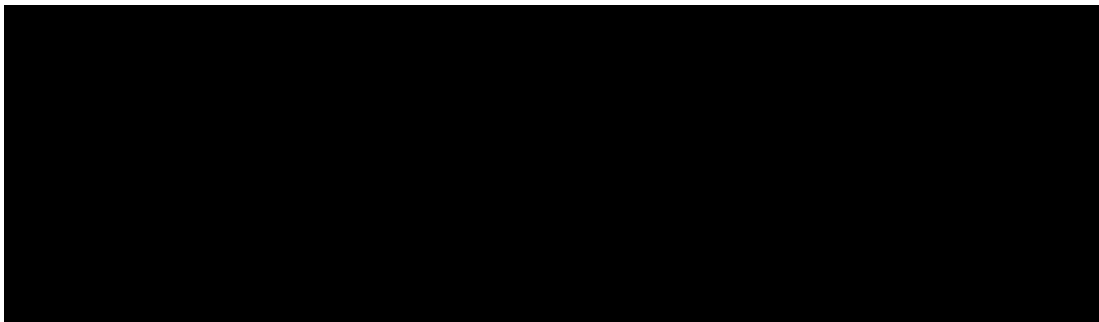
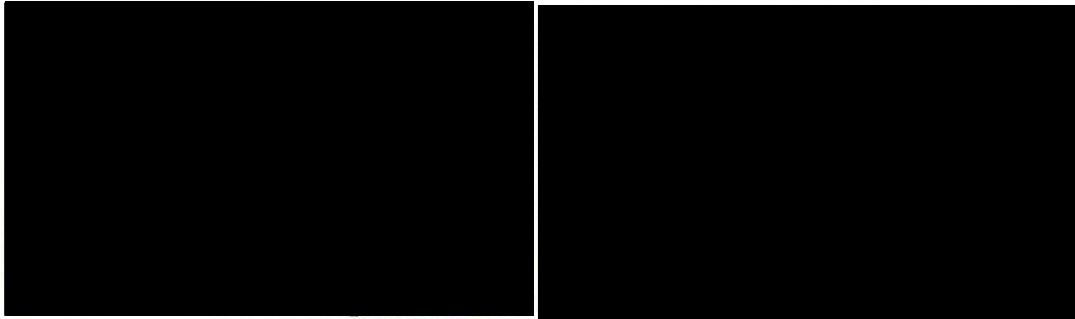


Figure 1 Urban Transect<sup>6</sup>

---

<sup>6</sup> Dino Marcantonio, Iconography and the Transect, <http://www.planetizen.com/node/89> (accessed October 2, 2015)



## URBANIZING CONTEXTS

The Urban Transect guides the development intensity from nature (T1) to the most urban (T6).  
<http://www.dpz.com/Initiatives/Transect>

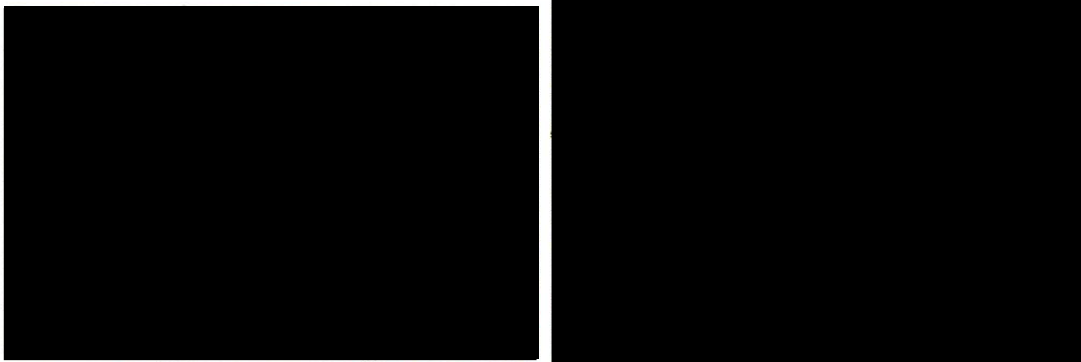
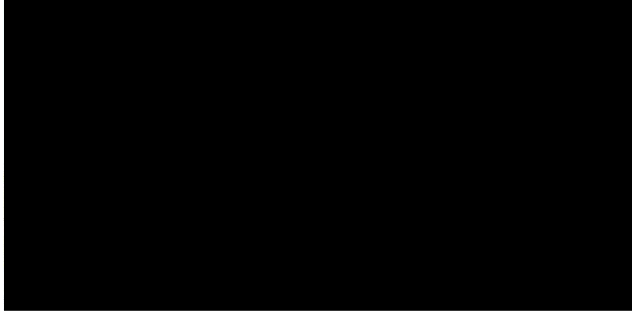
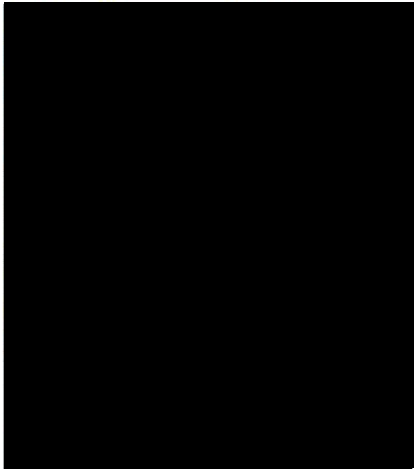


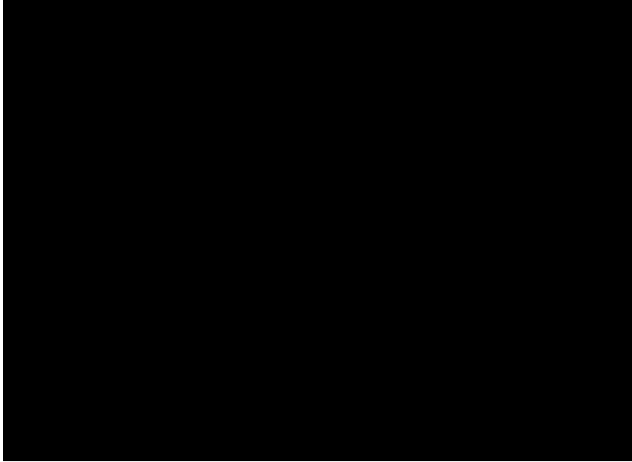
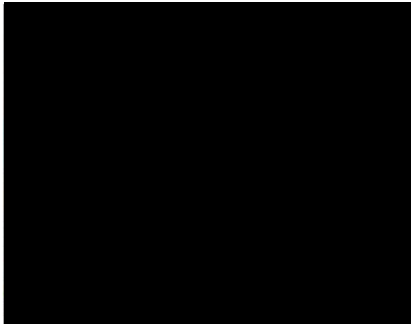
Figure 2: The Urban Transect perspectives <http://www.dpz.com/initiatives/Transect>

Another key difference to understand is in the requirements for elementary schools for each of these zones. The code requirements for development will be different in all zones. Determining how much is the change as a result of requirements in higher density construction can be a factor when developing school models for these zones.



**School as a Community Center:** In Emeryville, California, an enormous new school building will house the K-12 school, but also serve as a place for the entire community to gather and learn.  
<http://www.fastcoexist.com/1682549/this-is-what-it-looks-like-when-a-school-becomes-a-community-hub>

**Multilevel School:** Battery Park City School, NY- A 9 story in Battery Park city, Manhattan  
<http://www.dattner.com/portfolio/battery-park-city-school-psis-276/>



**School in Mixed-Use Building:** Spruce Street Public School in the first five floors of the Frank Gehry–designed rental tower at 8 Spruce Street.  
[http://therealdeal.com/issues\\_articles/new-york-gets-schooled/](http://therealdeal.com/issues_articles/new-york-gets-schooled/)

**School in Mixed-Use Building:** Maple Street School, a Prospect Lefferts Gardens preschool founded in 1978, is expanding. The school signed a 15-year lease for 5,500 square feet at 626 Flatbush, the 23-story mixed-use 80/20 tower Hudson Companies is building in the neighborhood  
<http://www.brownstoner.com/blog/category/schools/page/2/>

Figure 3 Characteristics of Elementary Schools.

Relocatable Classrooms –A stackable concept

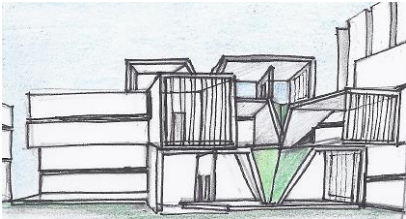
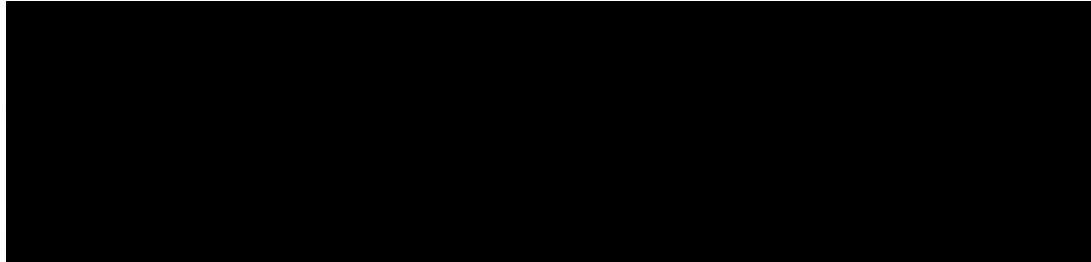


Figure 4 Redefining the Relocatable Classroom: Future Proofing Schools  
<http://www.australiandesignreview.com/event/redefining-the-relocatable-classroom>



One key difference is the value of land in different contexts. The development cost per acre in suburban areas is lower than per acre development cost in urban areas. The high development cost tends to result in smaller school sites in urban areas than suburban areas.<sup>7</sup> The limitation of land results in more floors in schools in urban areas. While the schools in suburban areas tend to be low especially for elementary schools. The smaller size of school sites in cities allow it to be more a part of the neighborhood than suburban schools where schools are more like a special zone on their own. This shows that the city context can be a great opportunity and a challenge for the architecture of schools.

In urbanizing areas belonging to T3-T5, planners and designers sometimes try to apply suburban school models, but such schools can cost a lot and therefore are not a good fit financially<sup>8</sup>. Such models usually face investment problems and therefore take a long time to get done.

The urbanizing areas of Arlington County are suffering from a similar problem. The schools are not able to keep up with the changing development around them. The increase in school enrollment has resulted in overcrowding. To accommodate new student population The Public School Board has proposed building above the existing suburban school models. On one hand, building above existing structure saves money, but on the other it is often not the most effective given the dynamic nature of population. The nature of problem requires further investigation of strategies for schools in such urbanizing areas, especially in its corridor developments.

---

<sup>7</sup> American Society of Planning Officials. New Physical Forms of the city School: The Urban Context, June 1968, <https://www.planning.org/pas/at60/pdf/report235.pdf>, (Accessed October 20, 2015)

<sup>8</sup> American Society of Planning Officials. New Physical Forms of the city School: The Urban Context, June 1968, <https://www.planning.org/pas/at60/pdf/report235.pdf>, (Accessed October 20, 2015)



## Chapter 2: Elementary School Program

### Elementary School Building Configuration- a Comparison by Context

The following elementary school projects belong to different contexts ranging from T2-T6. The difference in programming and space planning for these schools will showcase the variance in strategies for school development in different contexts. The key purpose of this exercise is to identify ideal elementary school programs using precedents and building codes when building in an urbanizing context. The precedent analysis will also help disclose the current trend and important strategies for elementary schools.

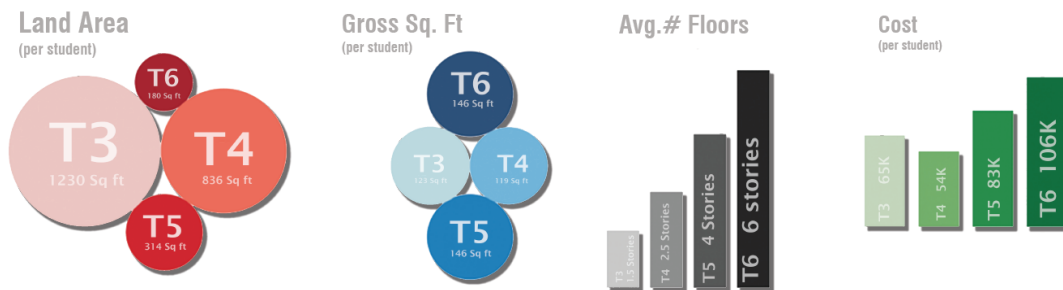


Figure 5 Quantitative analysis of school projects in urbanizing contexts (Authors Diagram)

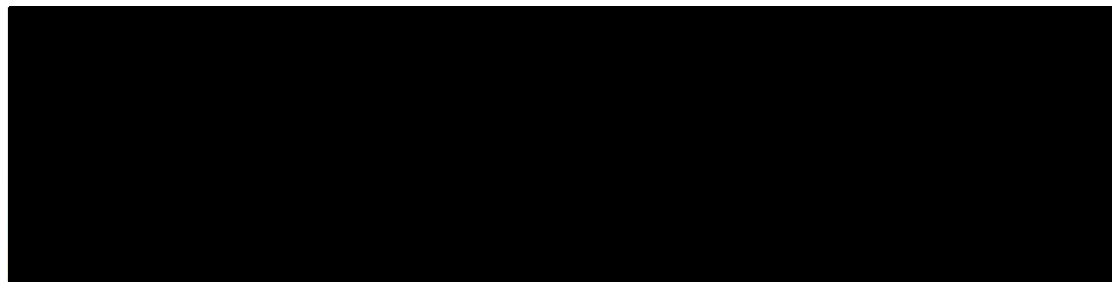


Figure 5 Schools in different urbanizing contexts (multiple sources)

Project information as per context (Table 1)(Full case study table refer Appendix 1)

PROJECT INFORMATION	T3	T4	T5	T6	
Avg. Project Area	60,097	79,656	76,046	99,232	Chesterton is an exception
Avg. Project Area/ student	123	119	146	146	no capacity for HM Elementary. Chesterton is an exception
Avg. Land Area	10.85	8.28	4.12	2.16	Chesterton is an exception
Avg. Land Area/ student	1230	836	314	180	no capacity for HM Elementary
Avg. Project Cost	\$41,330,000	\$39,725,667	\$43,149,000	\$69,966,667	Chesterton, London not included built in 1963, no cost avail for Patwin, Rogers, Boston Renn and Sandy Hook
Avg. Project Cost/ Student	\$65,603	\$54,066	\$83,067	\$106,745	Chesterton, London not included built in 1963, no capacity for HM Elementary, no cost avail for Patwin, Rogers, Boston Renn and Sandy Hook
Avg. No. of stories	1.5	2.5	4	5.7	Chesterton is an exception

*If in between two transect contexts, project is included in both contexts  
Avg. Value per child is calculated by averaging Value/ child for all cases*

Figure 6: Scale Comparison: (All images are at same scale)



Bailey Upper Elementary School, Falls Church, VA (T4-T5)



Horace Mann Elementary School, Washington DC (T5)



Battery Park City School, NY (T6)



Lafayette Elementary School, Washington DC (T4)



Boston Renaissance Charter Public School, Boston (T4)



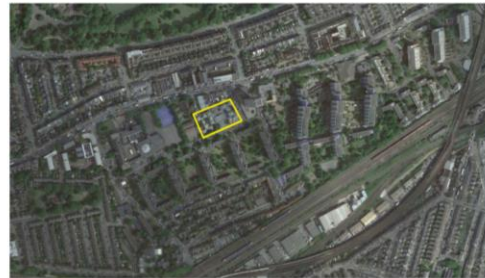
Marie Reed Elementary School, Washington DC (T6)



8 Spruce Street School, Beekman Tower, NY (T6)



Discovery Elementary School, Arlington VA (T3-T4)



Chesterton Primary School, London U.K. (T6)



Patwin Elementary School, Davis CA (T3-T4)



Rogers Elementary School, Victoria Canada (T3-T4)



New Sandy Hook School, Newton CT (T3)

### Conclusions

- Average \$/ student for projects in T3 and T4 contexts is about \$20,000-\$30,000 lower than T5 and T6 context
- Average built area Sq ft / student is more for T5 and T6 projects (by about 20 sq ft) than T3 and T4 projects,
- Average land area Sq.ft/ child decreases drastically from T4 projects to T5 projects (by about 500 sq.ft). Generally, it reduces from T3 projects to T6 projects.
- Average number of floors increase from T3 projects to T6 projects (by about 1-2 floors between contexts).
- Multilevel schools with more than 4 floors or underground functions were from T5 and T6 contexts

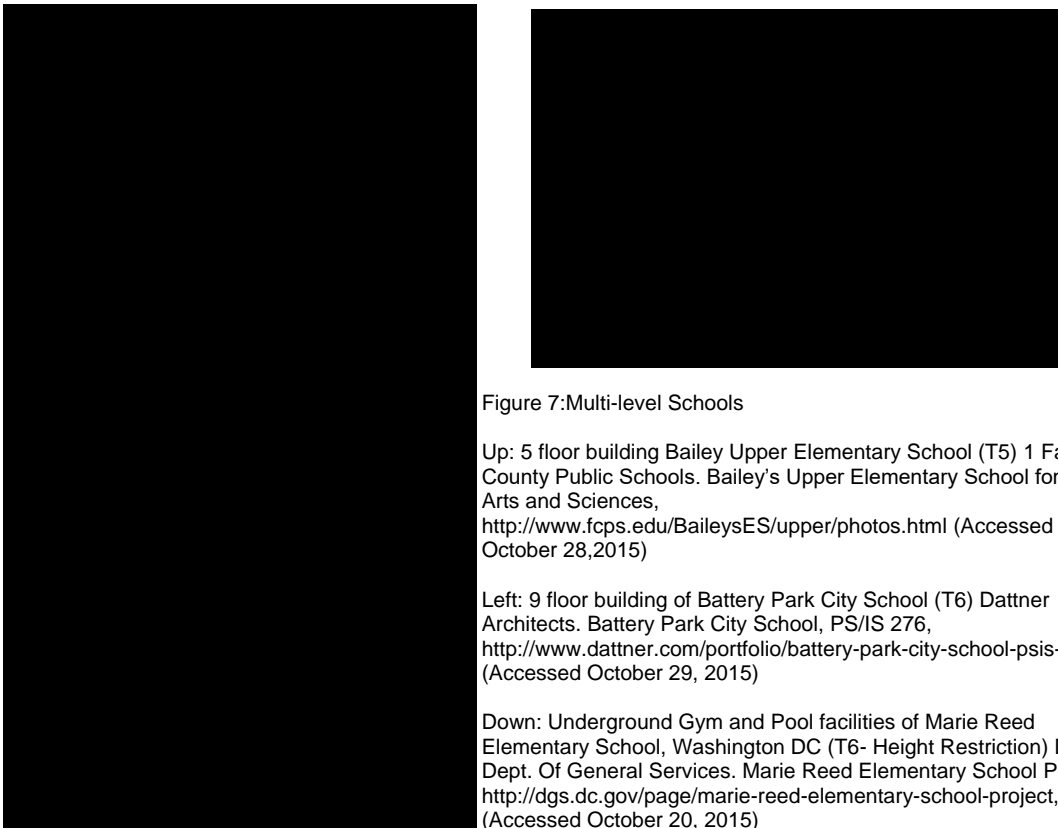


Figure 7: Multi-level Schools

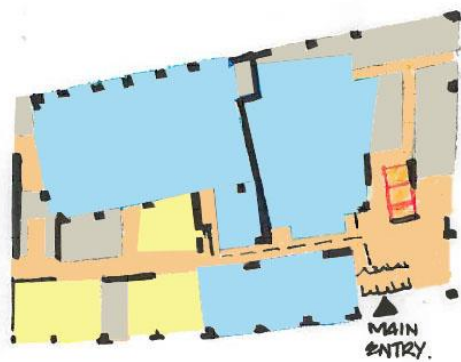
Up: 5 floor building Bailey Upper Elementary School (T5) 1 Fairfax County Public Schools. Bailey's Upper Elementary School for the Arts and Sciences,  
<http://www.fcps.edu/BaileysES/upper/photos.html> (Accessed October 28,2015)

Left: 9 floor building of Battery Park City School (T6) Dattner Architects. Battery Park City School, PS/IS 276,  
<http://www.dattner.com/portfolio/battery-park-city-school-psis-276/> (Accessed October 29, 2015)

Down: Underground Gym and Pool facilities of Marie Reed Elementary School, Washington DC (T6- Height Restriction) DC Dept. Of General Services. Marie Reed Elementary School Project,  
<http://dgs.dc.gov/page/marie-reed-elementary-school-project>, (Accessed October 20, 2015)



- In school projects for all contexts there is a tendency of sharing school gym, auditorium and sports facilities with the general community. Hence these facilities are generally located near main access points and parking.

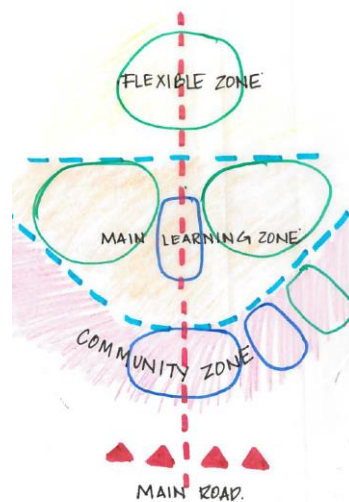
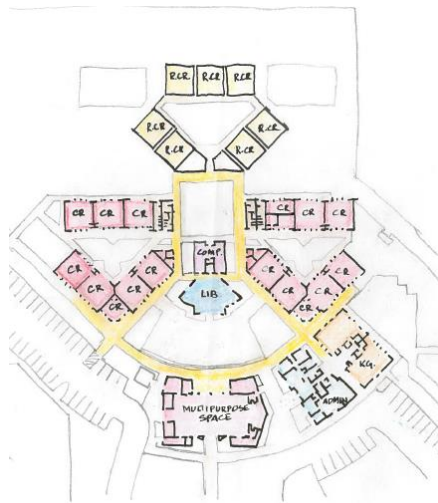


LEVEL 1

Figure 8: Shared Spaces with Community

Down: Community zone of Patwin Elementary School (T3-T4) containing multipurpose space, administration and kindergarten space is located close to parking near main road (Author's Diag)

Left: Ground floor of Battery Park City School (T6) with Gym and Auditorium (in light blue) located near main entry (Author's Diag)



- Most new urban (T4-T6) schools have land area constraints and require renovation or demolish of existing structure and expansion of current facility. In such cases class room relocations are built into the phasing of the project.



Figure 9: Construction Phasing  
Phasing of Lafayette Elementary School involved "Swing Space" planning since the design proposed demolishing a part of the old school DC Dept. Of General Services. Lafayette Elementary School Project <http://dgs.dc.gov/page/lafayette-elementary-school-project>, (Accessed October 20, 2015)

- Urban schools in T4-T6 contexts are more likely to include adaptive re-use and mixed use than suburban (T3-T4) schools.
- While suburban schools tend to allocate space for future expansion, urban schools don't.

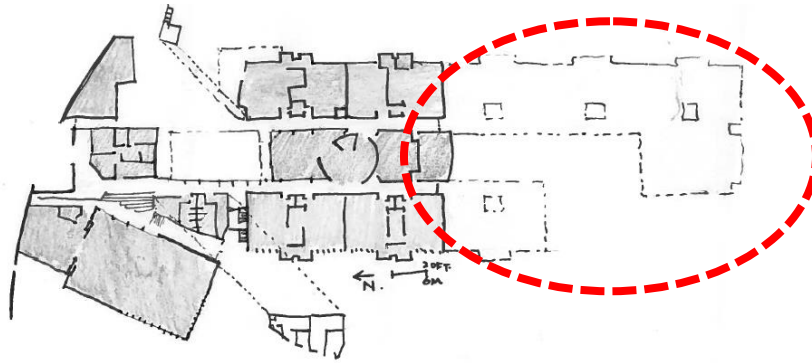


Figure 10: Future Expansion  
 Roger's Elementary School (T3-T4) was planned for a growing community and involves future expansion (Author's Diagram)

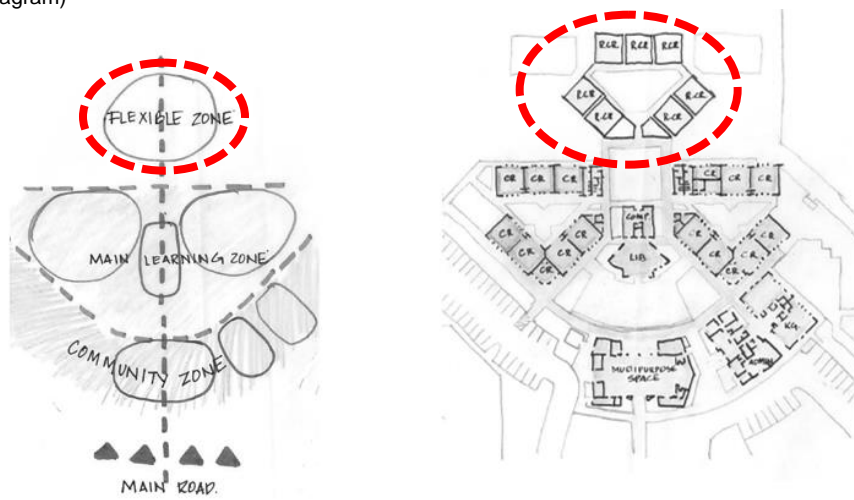


Figure 11: Flexible Zone  
 Patwin Elementary School (T3-T4) also has space assigned to relocatable classrooms in its Flexible Zone to accommodate excess enrollment (Author's Diagram)

- Most new elementary schools in all contexts involve green building strategies.

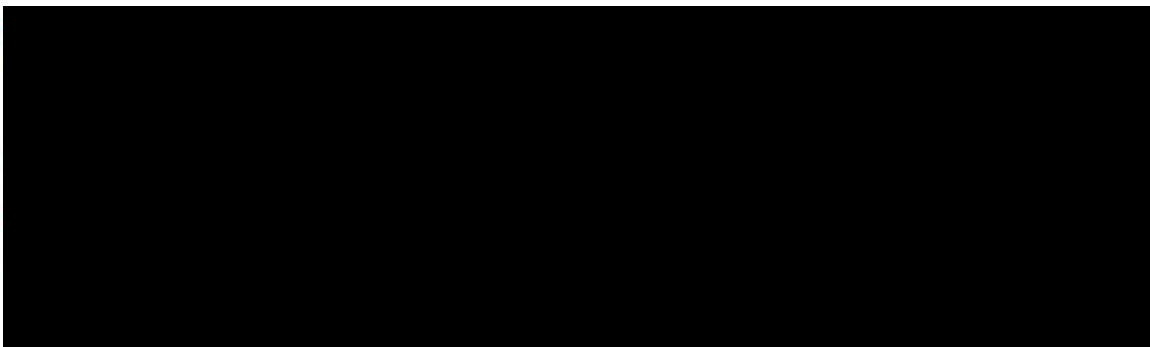


Figure 12: Green Building Strategies- Discovery Elementary School is a new Net Zero School in Arlington VA that uses roof mounted PV panels for generating power.



Figure 12: Green Building Strategies- Arlington Public Schools "Discovery Elementary School- a case study" <http://www.vmdo.com/project.php?ID=80> Accessed October 20, 2015

- Efficient circulation is an important design goal in all contexts, especially in urban (T4-T6) contexts.

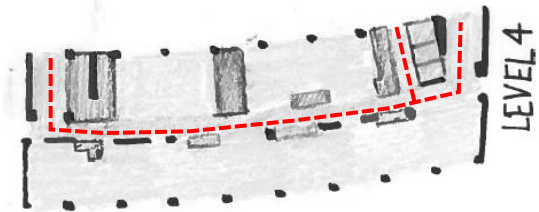


Figure 13: Circulation Battery Park City School (T6) (Author's Diagram)

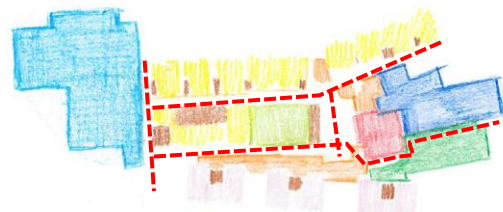


Figure 13: A simplified representation of circulation between private learning spaces in the center (green) and public spaces (blue) in the periphery of Discovery Elementary School (T3-T4) (Author's Diagram)

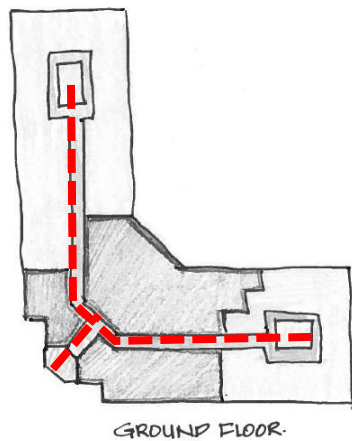
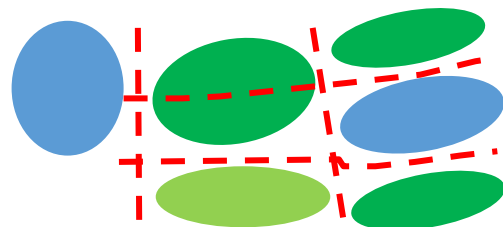


Figure 13: Circulation in Bailey Elementary School (T4-T5) (Author's Diagram)



- Separation of grades through design and space planning is an important feature in elementary schools in T3 to T4 contexts

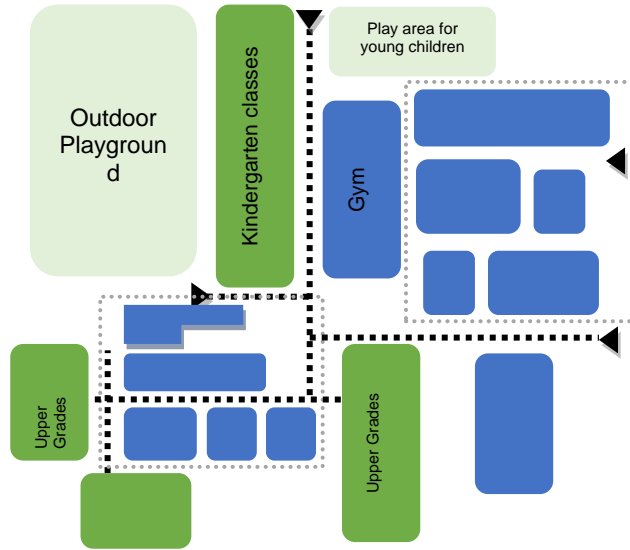


Figure 14: Separation of grades in Boston Renaissance Charter Public School (T4) (Author's Diagram)



Figure 14: Separation of Grades- The three courtyards of Patwin Elementary School (T3-T4) hold classrooms for different age group around them (Author's Diagram)

- Interaction with outdoor green spaces was found in mostly suburban schools (T3-T4) than Urban (T5-T6) schools. However, good designs and site opportunities make it possible even in urban schools (Eg: Horace Mann Elementary School, Washington DC)

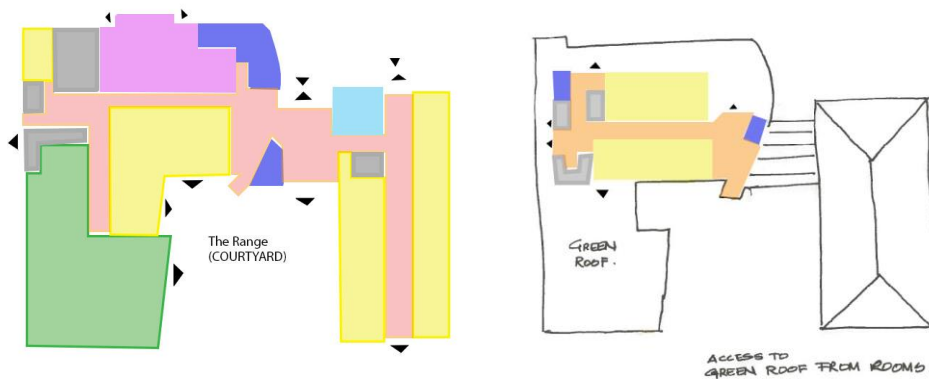
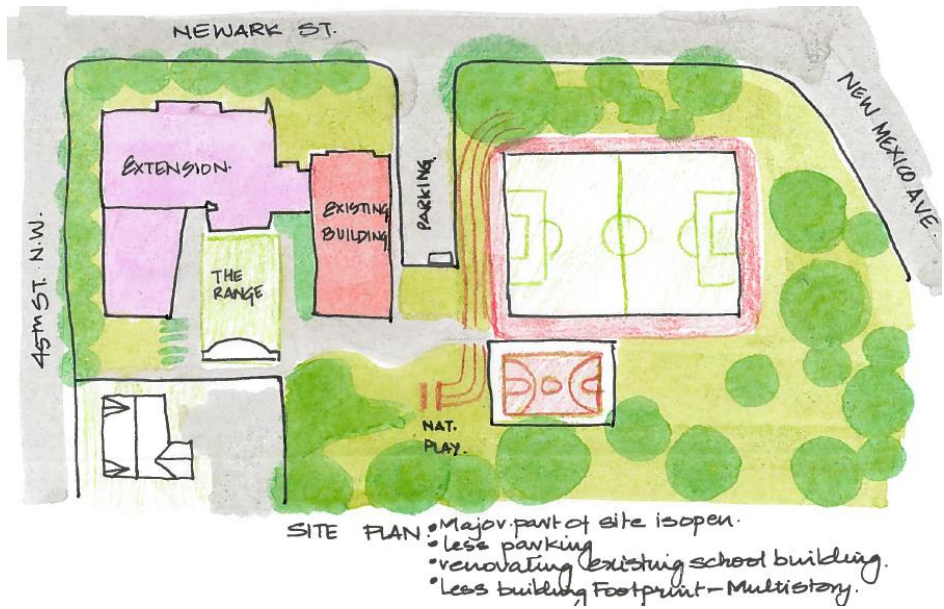


Figure 15: Access to outdoor space in Horace Mann Elementary School (T5) (Author's Diagram)

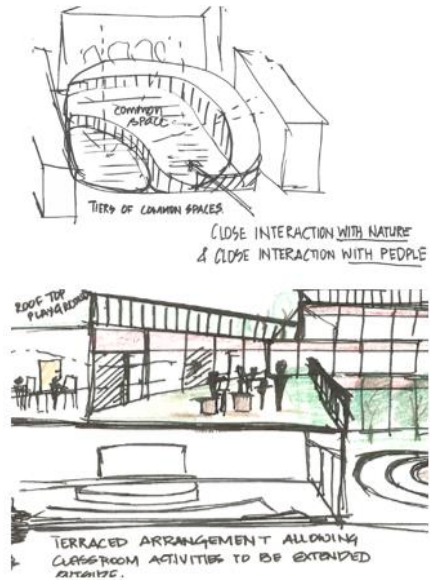
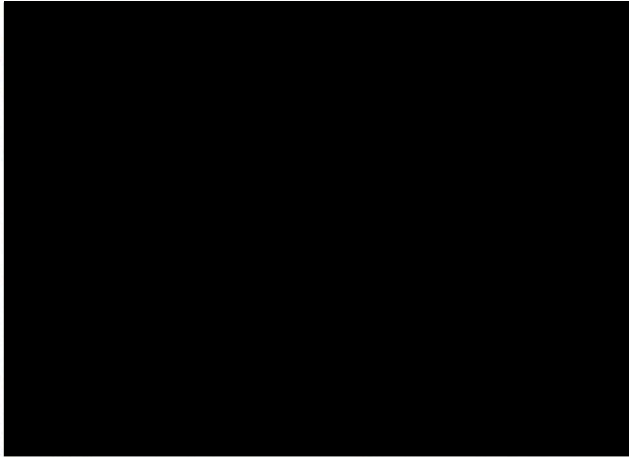


Figure 15: Access to Outdoor Spaces- A former Renault factory as a "living" school and gymnasium in the northern French city of Boulogne, by Chariter Dalix architects.

Figure 15: Access to Outdoor Spaces- Renault Factory School Observations (Author's Diagram)

- In mixed-use urban schools (T6) like Spruce Street School, separate identity for the school was achieved through massing, exterior finish and separate access.

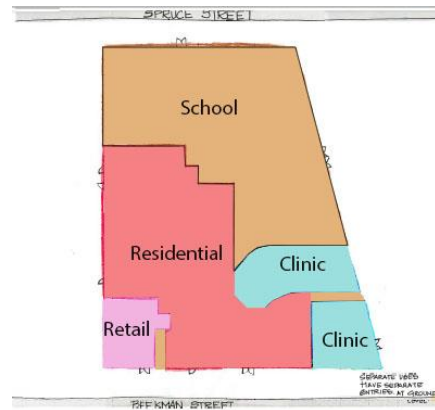
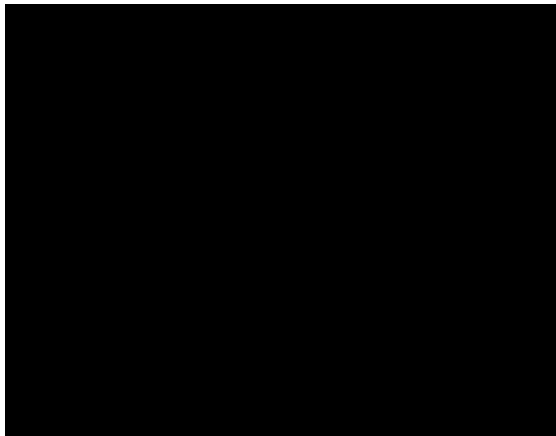


Figure 16: Mixed-Use Schools- Cody Lyon, "How building classrooms can help new condos get off the ground" The Real Deal News October 2012, Accessed October 2015, [http://therealdeal.com/issues\\_articles/new-york-gets-schooled/](http://therealdeal.com/issues_articles/new-york-gets-schooled/)

Figure 16: Mixed Use Schools- Plaza Level plan for Spruce Street Elementary School (T6) (Author's Diagram)

- Dedicated surface parking was common for suburban (T3-T4) contexts. Urban schools (T4-T6) did not have a lot of surface parking. Schools in T6 context had no surface parking at all.
- An effective classroom is an important module for elementary schools in all contexts since it holds the main function and is replicated in learning areas of the school. Some new elementary schools also indicate importance of collaborative learning spaces just outside the classrooms that are flexible in function. They occur in T3, T4 and some T5 projects but not in T6 projects. Chesterton Primary School in London was an exception and it was built in 1960s



Figure 17: Collaborative learning spaces in Discovery Elementary School (Author's Diagram)

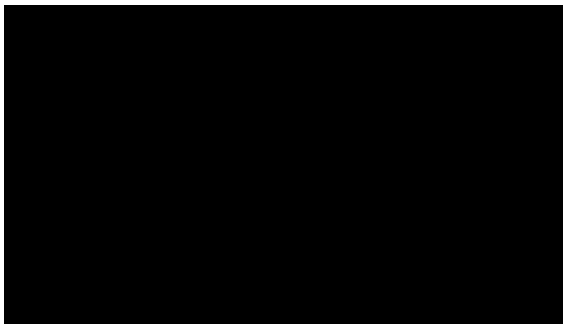


Figure 17: Collaboration Space at Richard J Lee School  
<https://vimeo.com/143136683>

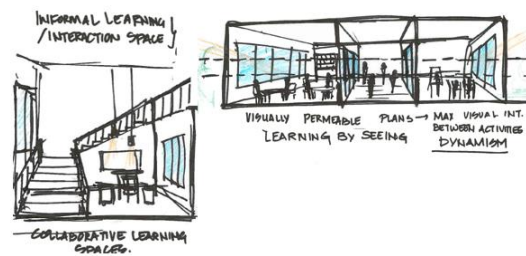


Figure 17: Collaboration Space (Author's Diagram)

- Depth of classrooms is important for proper interior daylighting. Shallow depths are required to achieve this.

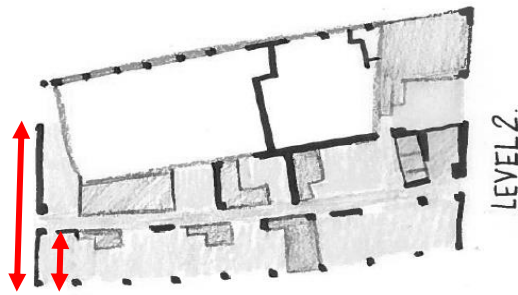


Figure 18: Daylighting- In Battery Park City School classrooms on the outer edge have proper daylight since they are less deep which might also be a result of or what lead to a narrow building mass. (Author's Diagram)

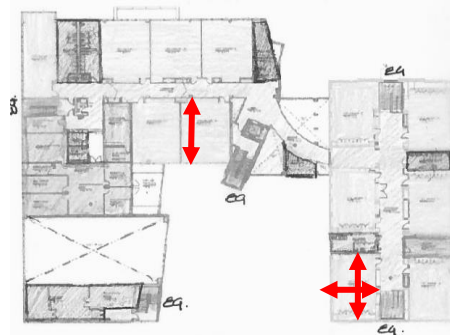


Figure 18: Daylighting- Different depths of classrooms in Horace Mann Elementary School might be due to orientation. The east west facing classrooms are shallower than south facing classrooms (Author's Diagram)

- In all projects kindergarten classrooms and daycare facilities are located near access points and drop-off areas on ground level. The kindergarten classes also have attached toilets.

### Joint-Use School<sup>9</sup> in Urbanizing Contexts

Mixed-use developments can prove to be the answer for overcrowding schools in urbanizing areas. In current economic scenario, public private partnership is the most viable funding solution. Also, integrating schools with other developments, especially residential, might create more opportunities to use the school as a community resource through shared spaces.

In New York a number of private developers are including schools in their developments. This has not only opened a number of City owned sites for private development but has also helped to resolve financial implications of developing new

<sup>9</sup> Joint Use School Partnerships in California: Strategies to Enhance Schools and Communities accessed May 17<sup>th</sup> 2016  
[http://citiesandschools.berkeley.edu/reports/CC&S\\_PHLIP\\_2008\\_joint\\_use\\_with\\_appendices.pdf](http://citiesandschools.berkeley.edu/reports/CC&S_PHLIP_2008_joint_use_with_appendices.pdf)

schools. Not surprisingly, a number of developers are using schools as tools for negotiating approvals from the city for their developments.

Following are some examples:

- **Spruce Street School, NY (Beekman Tower)**

Also discussed in previous section, the first five floors of this 76 story tower is dedicated to PS 397 also known as Spruce Street School. The development was a result of a partnership between the city’s School Construction Authority (SCA) of Department of Education and a private developer Forest City Ratner. The shell of the school was constructed by the private developer, while the interiors were done by SCA. In return the Forest City got \$ 190 million tax exempt bonds to also help finance the project.

The development has a number of 3 bed room apartments with children who attend school downstairs. There are no rent or enrollment implications of adding a school to this building.

Table 2: Mix of Uses for Spruce Street School-

<b>Function</b>	<b>Area</b>	<b>No. of Stories</b>
School	100, 000 sq ft (648 students)	5
Apartments	903 units (500-1000 sq ft each)	71
Hospital (ambulatory care)	25,000 sq ft	1-2
Retail	2,500 sq ft	Ground level
Public Space	22,000 sq ft	Ground Level
<b>TOTAL</b>	1,000,000 sq ft	76

- **Windward School, Manhattan**

The school is planned to be housed in the first five floors of a rental residential tower at 205 East 92nd Street. It is a private school dedicated to

language learning. The project did not receive any tax credits or incentives for this addition. The project is a partnership between Windward Private School and a private developer Related Companies.

Table 3: Mix of Uses for Windward School-

<b>Function</b>	<b>Area</b>	<b>No. of Stories</b>
School	60,000 sq ft (350 students)	5
Apartments	250 units	30
Open Space	12,000 sq ft	Ground Level
<b>TOTAL</b>	- sq ft	35



Figure 19: Windward Manhattan school campus, Tour the Manhattan Campus, Accessed Dec 11 2015 <http://www.thewindwardschool.org/windward-manhattan>

- **Dock Street Dumbo Project**

The Middle School is housed in the base of a condo building. This project was a partnership between NYC’s School Construction Authority (SCA) and a private developer Two Trees. The developer constructed the core and shell of the school building.

Table 4: Mix of Uses for Dock Street Dumbo School-

<b>Function</b>	<b>Area</b>	<b>No. of Stories</b>
School	50,000 sq ft (300 students)	4-5
Apartments	290 units	12
<b>TOTAL</b>	- sq ft	17

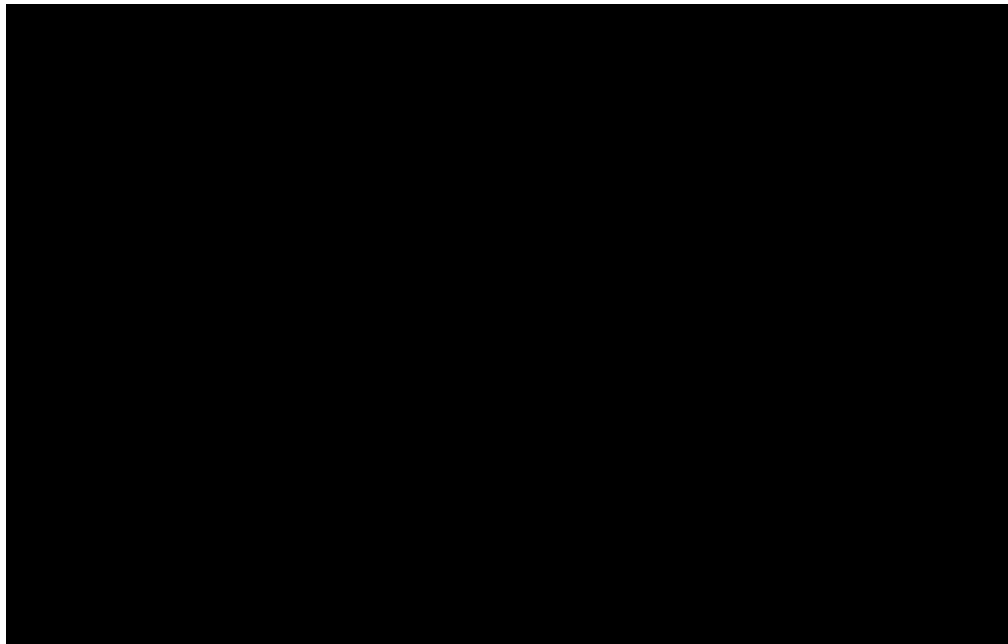


Figure 20: Dock Street Dumbo Project, Active Discussions, and Accessed Dec 11 2015, <http://ny.curbed.com/tags/dock-street-dumbo>

- **Riverside Center School**

The Pre K to 8<sup>th</sup> grade school is included in a new residential building in Upper West Side of NYC. The building is a part of a massive Riverside Center project. It is public school housed in Riverside Parcel 2 building. The whole center comprises of 5 residential buildings.

The project is a result of partnership between SCA and a private developer Extell. According to their agreement the developer is required to construct core and shell and install mechanical systems for the school while the SCA takes care of the interiors.

Table 5: Mix of Uses for Riverside Center School-

<b>Function</b>	<b>Area</b>	<b>No. of Stories</b>
School	100,000 sq ft (488 students)	4
Apartments	616 units	36
<b>TOTAL</b>	- sq ft	43

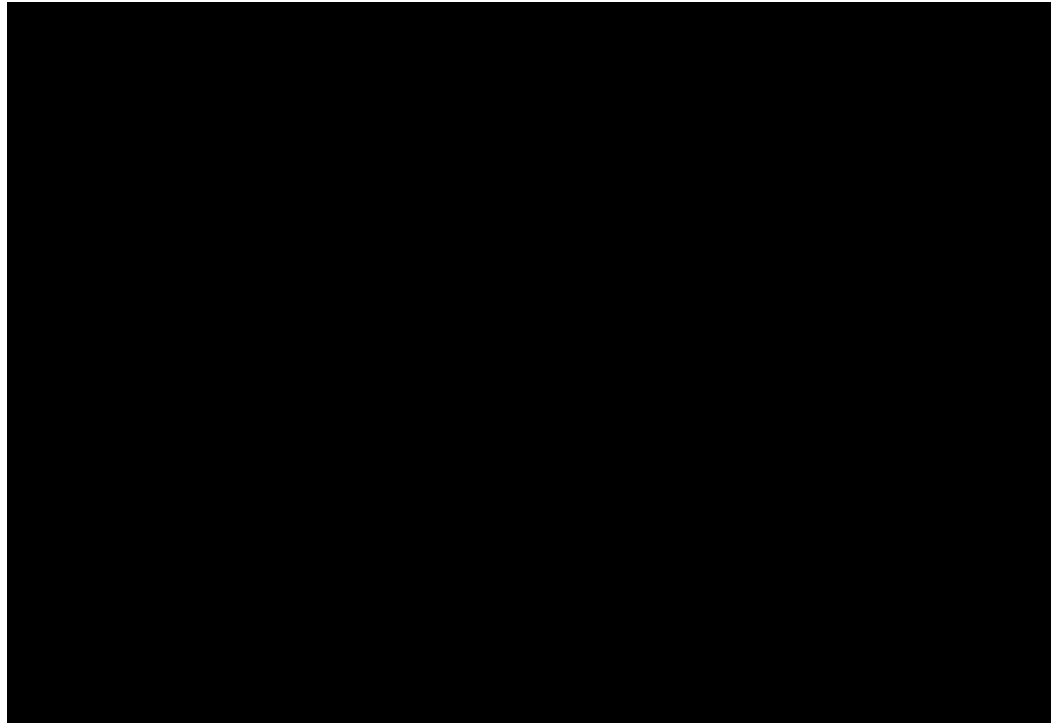


Figure 30: Riverside School Section, Datter Architects Educational Portfolio PS/IS Riverside Center School, Accessed Dec 11 2015, <http://www.dattner.com/portfolio/psis-342-riverside-center-school/>

### *A Joint- Use school in Arlington, VA*

A joint-use school development scenario can also be imagined for the upcoming and urbanizing parts of Arlington County, where the development market for housing can help finance schools for these areas. A developer could aim for density bonus or height and parking exceptions from zoning ordinance provided by the county for meeting certain conditions (that could include exceptions for incentivizing school development) for a Mixed-Use project.<sup>10</sup>

Currently, Arlington County doesn't have an impact fee on developers for development of new schools, also it doesn't include school development in its conditions for providing density bonus or height and parking exceptions from zoning

---

<sup>10</sup> Bonus Density and Height Exceptions, Land Use and Zoning Tools, Housing, Arlington, VA, accessed Dec 11 2015, <https://housing.arlingtonva.us/development/land-use-zoning-tools/>

ordinance. However, it does have a “Special Incentives” program that could be used to mobilize a mixed-use school projects in Arlington VA. The incentives can be negotiated between the county and private developers under “Special Exception” from zoning ordinance through their “Site Plan Review Process”<sup>11</sup>.

### *Elementary School Program and Guideline Comparison*

A general list of elementary school program was obtained from Virginia State Elementary School prototype and Arlington Public School guidelines. Following is the list of program spaces. The final square footage is exclusive of outdoor programs which have been mentioned separately.

In order to come up with an appropriate Elementary School Program the Virginia State, Arlington Public School and Montgomery County guidelines were compared. Later, the guidelines were also related with Discovery Elementary School program that uses APS guidelines<sup>12</sup>. This gave an idea of the level of implementation of APS guidelines, and the ways they could be customized.



---

<sup>11</sup> Private Development, Projects and Planning, accessed Dec 11 2016  
<http://projects.arlingtonva.us/private-development/>

<sup>12</sup> Arlington Public Schools – Elementary School Space Guidelines, accessed May 18<sup>th</sup>  
<http://www.apsva.us/cms/lib2/VA01000586/Centricity/Domain/105/Elementary%20School%20Guidelines%20Final%20SB.pdf>

Table 6: School Program Comparison

For the capacity of about 600 students						lesser than 600	
Space	Number	Area Provided	APS Requirements (2004)	Virginia State Guidelines (2013)	Discovery Elementary School Arlington (Based on APS Req.)	Mill Creek Public School Montgomery County Public Schools (1997)	
Pre-School+ in-built store & toilet	1	945	1040	975	1070	1300	
Montessori + in-built store & toilet	3	2835	3120	2925	1070	-	
Kindergarten + in-built store & toilet	4	3780	4180	3900	4280	3900	
First Grade + in-built store & toilet	4	3780	3480	3900	4160		
Second Grade	4	3780	3300	3200	3540		
Third Grade	4	3780	3300	3200	3440	12600	
Fourth Grade	3	2835	2475	2400	3440		
Fifth Grade	3	2835	2475	2400	3300		
Reading Classroom	1	-	420	-	855	650	
Reading Recovery/ Clinical	1	-	400	-	1075	-	
Flex Space Classroom	-	-	825	-	5125	-	
Art Classroom	1	1200	1730	1200	2810	1050	
Music Vocal Classroom+ Storage	1	945	1150	1000	1990	1050	
Music Instrumental Classroom+ Storage	1	945	1025	500	895		
Other resource Classroom+ Storage	1	945		500			








For the capacity of about 600 students							lesser than 600
Space	Number	Area Provided	APS Requirements (2004)	Virginia State Guidelines (2013)	Discovery Elementary School Arlington (Based on APS Req.)	Mill Creek Public School Montgomery County Public Schools (1997)	
Reading Room	1	1800	2800	1870	2475	2000	
Multi-use AV tech Area	1	420	300	120		250	
Computer class + Tech office	1	945	945	900	120	1000	
Library Admin+ Backrooms	1	540	300	300	335	500	
Conference Room	1	-	150	-	245		
Communications	1	-	150	-			
AV Storage	1	-	200	150	410	450	
Gymnasium	1	3150	4100	3150	6075	4750	
PE Toilet	1	300	150	300	100		
PE Office/ Toilet	1	250	100	250	110		
PE Storage	1	300	150	-	155		
Team room	4	1600	-	300			

For the capacity of about 600 students						lesser than 600	
Space	Number	Area Provided	APS Requirements (2004)	Virginia State Guidelines (2013)	Discovery Elementary School Arlington (Based on APS Req.)	Mill Creek Public School Montgomery County Public Schools (1997)	
Dining Area	1	2660	3500	2040	2860	-	
Kitchen + Food storage	1	1656	1200	1590	2020	1000	
Multipurpose Area	1	2400	-	-		2400	
Storage Furniture	1	1220.5	200	500	100	300	
Stage	1	1770	450	1700		450	

Concentrations and Gifted Students

ESOL	1		420			400	
HILT	1		825		1465		
Project Go	1	-	420	-			
Title 1	1		400			-	
Gifted Classroom	1		420		545		

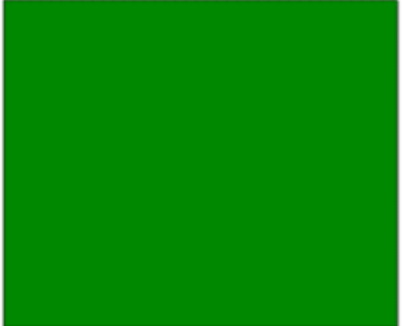
Special Education

For the capacity of about 600 students						lesser than 600	
Space	Number	Area Provided	APS Requirements (2004)	Virginia State Guidelines (2013)	Discovery Elementary School Arlington (Based on APS Req.)	Mill Creek Public School Montgomery County Public Schools (1997)	
Resource	1	420	420	2800	3855	500	
Pre School Disabled	1	825	825				
SC Small Classroom	1	500	500				
Interlude	1	825	825			4000	
Transitional	1	825	825				
SE Small Classroom	1	400	400				
Toilet	1	40	40				

Administration

For the capacity of about 600 students						lesser than 600
Space	Number	Area Provided	APS Requirements (2004)	Virginia State Guidelines (2013)	Discovery Elementary School Arlington (Based on APS Req.)	Mill Creek Public School Montgomery County Public Schools (1997)
Reception/ Clerical	1	2805	500	250	775	675
Principal's Office	1		200	200	195	250
Principal's Assistant	1		100	100	165	
Assistant Principal's Office	1		120	-	115	
Conference Room	1		250	200	245	300
Work Room	1		250	100	445	300
Book Storage	1		300	400		100
Record Storage	1		300	300	90	350
Clinic with Toilet	1		600	250	550	400
Staff toilets	2		65	100	55	
Speech	1		200	-	435	250
Social Worker/ Psychologist	1		120	-	240	250
Testing / Conference	1		150	200	205	150
Counselor	1		450	100	490	250
Occupational/ Physical Therapy	1		420	-	435	
Gifted/ Visiting Teachers	1		120	-		
Lounge with toilet	1		600	200	1115	850
Teacher work areas	1	300	250	335	150	
Storage Furniture	1	150	-			

Distributed on all levels and no fixed proportions

For the capacity of about 600 students						lesser than 600	
Space	Number	Area Provided	APS Requirements (2004)	Virginia State Guidelines (2013)	Discovery Elementary School Arlington (Based on APS Req.)	Mill Creek Public School Montgomery County Public Schools (1997)	
Extended Day (Storage/ office)	1	-			740	150	
	1	12000					
Playground							
Total Outdoor Play area	1		8000				
HVAC and circulation				16142	33893		
<b>Total (exclusive of outdoor spaces and circulation space)</b>		<b>54256.5</b>	<b>55130</b>	<b>44720</b>	<b>63810</b>	<b>42825</b>	

## Chapter 3: Design Approach

### Design Issues

The precedents and building guidelines revealed important issues that can define the design of a new age elementary school in urbanizing areas. While certain issues were radical others were more secondary, but had the ability to enhance the user experience of a school facility.

#### **Radical Issues**

- Efficient Circulation
- Future Expansion and Reuse
- Collaborative Learning
- Shared Community Facility
- Separation of Grades
- Small Footprint

#### **Critical Design Issues**

- Daylighting
- Connection to Outdoor Spaces
- Multiple Floors

The test program described in the previous chapter has been used to come up with a morphology of school buildings for densely populated contexts. Schemes have been developed keeping each of the secondary issues as the main idea. It is however understood that a school design can be a solution for more than one or even all these issues. In order to study the difference in form and space interactions, only one issue has been undertaken as the core design problem, but all schemes include the radical issues related to sustainable school design.

## Issue 1- Daylighting

A room depth of 30' has been followed throughout the school program to ensure proper daylighting from one side. Some classrooms also require exclusive storage and Bathrooms. These ancillary spaces have been used to increase daylight penetration and also cross-ventilation, if weather permits.



Figure 22: Rule of thumb for Window Configuration, AE Design, Accessed Dec 12 2015, <http://www.pages.drexel.edu/~st96dmn3/opt/mdl.htm>

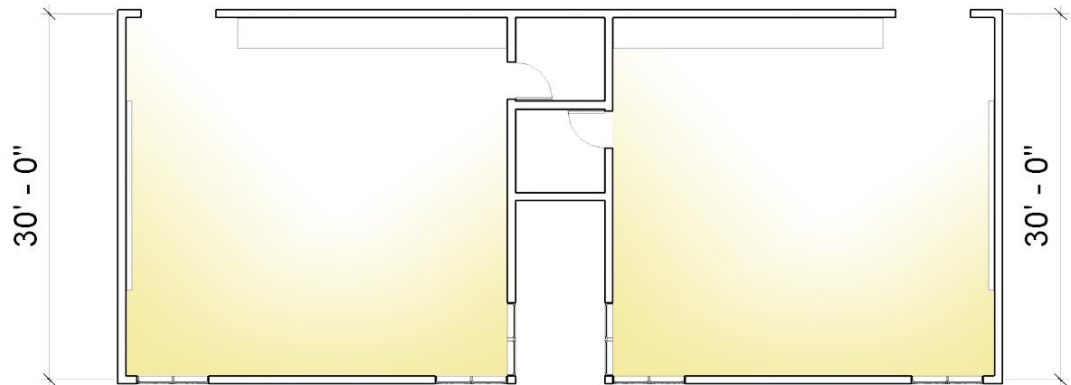
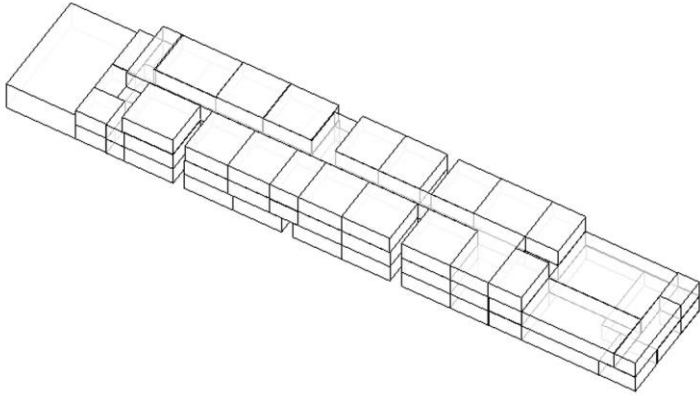
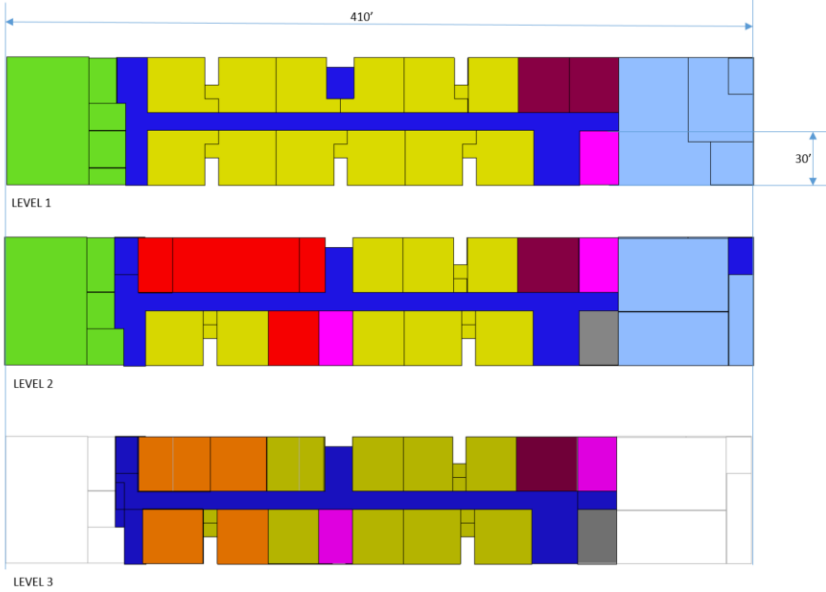


Figure 23: Classroom Depth- 30' depth considered for daylighting in classrooms and other learning areas. (Author's Diagram)

# Scheme 1.1 Linear Bay

- GYMNASIUM
- CLASSROOMS
- SPECIAL ED.
- CIRCULATION
- LIBRARY+  
MULTI MEDIA
- ADMINISTRATION+  
FACULTY
- DINING+  
MULTIPURPOSE
- SUPPORT



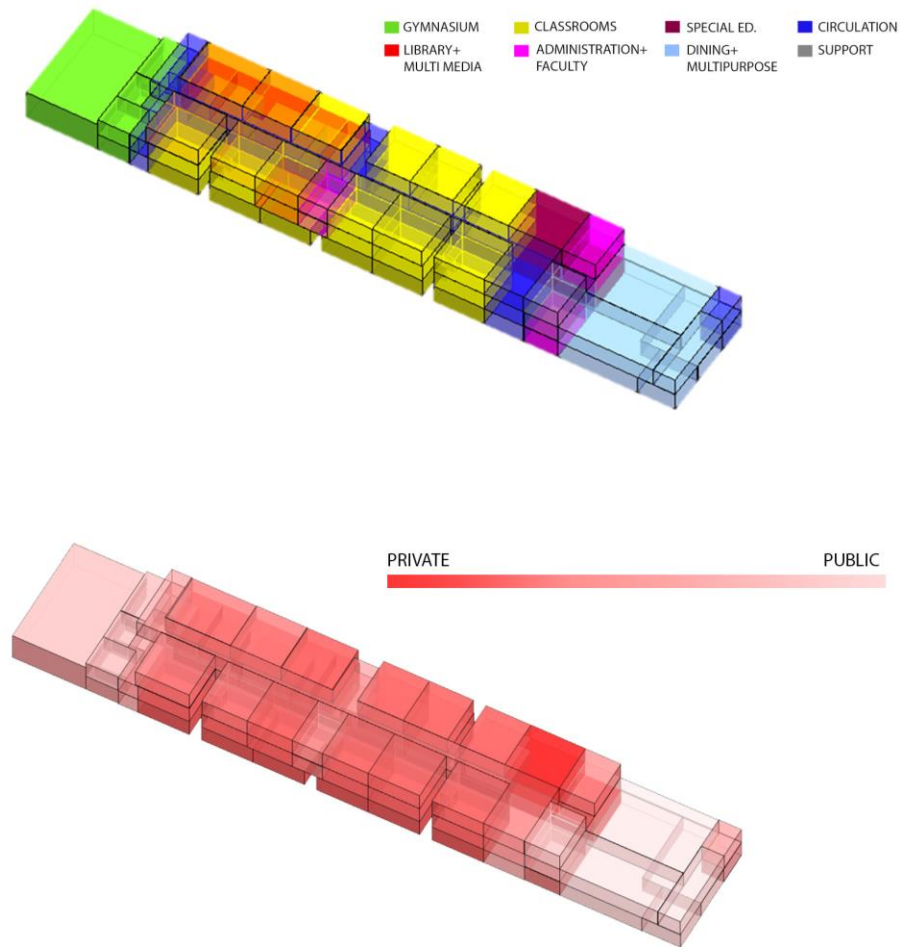


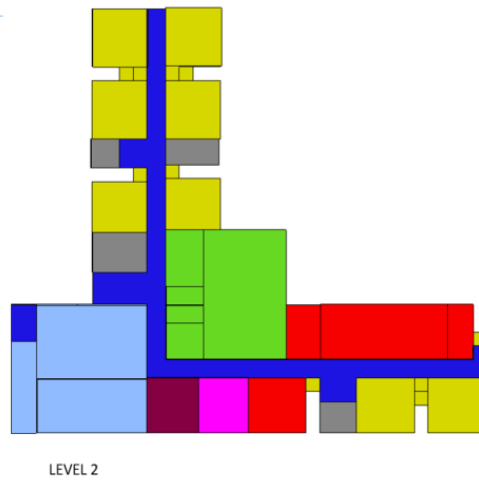
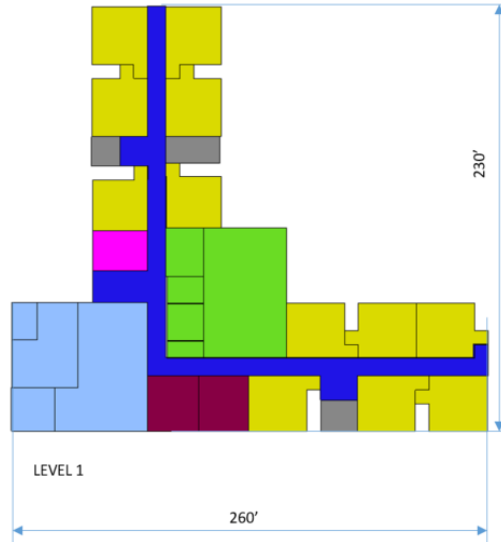
Figure 24: The Linear Bay Scheme (Author's Diagram)

Remarks:

- Linear design requires special large or linear parcels.
- The scheme has very efficient circulation.
- The shape is viable to have other programs for mixed use on top floors, but will require a different entrance lobby area
- Integrating functions in a structure adjoining this building will be tricky
- The programs are separated and the scheme has few opportunities for a vibrant common space that has different activities around it.
- The scheme allows separate access to public areas.

## Scheme 1.2 Perpendicular Bays

- |                                                            |                                                                   |                                                                  |                                                 |
|------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------|
| <span style="color: green;">■</span> GYMNASIUM             | <span style="color: yellow;">■</span> CLASSROOMS                  | <span style="color: maroon;">■</span> SPECIAL ED.                | <span style="color: blue;">■</span> CIRCULATION |
| <span style="color: red;">■</span> LIBRARY+<br>MULTI MEDIA | <span style="color: magenta;">■</span> ADMINISTRATION+<br>FACULTY | <span style="color: lightblue;">■</span> DINING+<br>MULTIPURPOSE | <span style="color: gray;">■</span> SUPPORT     |



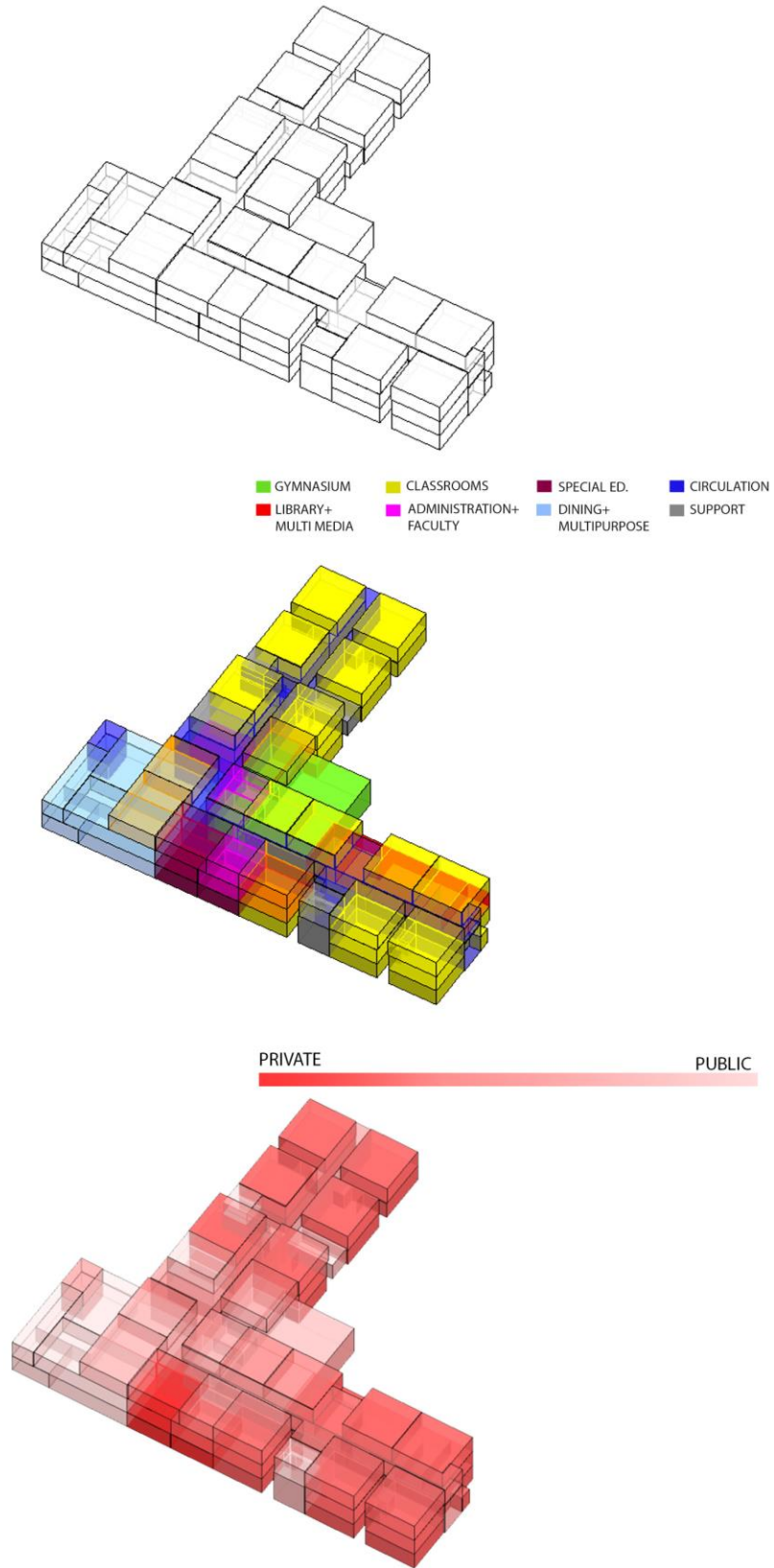


Figure 25: The Perpendicular Bay Scheme (Author's Diagram)

Remarks:

- The Perpendicular Bay shape can fit on most sites but requires more circulation space than linear scheme.
- A sloping site will allow multiple levels of exit discharge, allowing PK, K, 1 and special education to be arranged on multiple levels
- The shape is viable to have other programs for mixed use on top floors, but will require a different entrance lobby area
- Functions in a structure adjoining this building can be connected from dining facilities and Multi-function space area.
- Allows more mixing of programs
- The Public area can have same or separate access.
- The private learning spaces branch off from the public spaces.

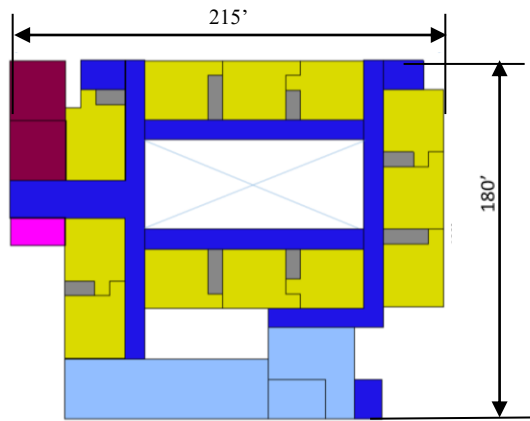
Issue 2- Connection to Outdoor Space

In precedent analysis schools with programs arranged around courts revealed greater opportunity of interaction with outdoor space. This is not only true for interaction with outdoor space at ground level but also at upper levels by using green roofs and terraces.

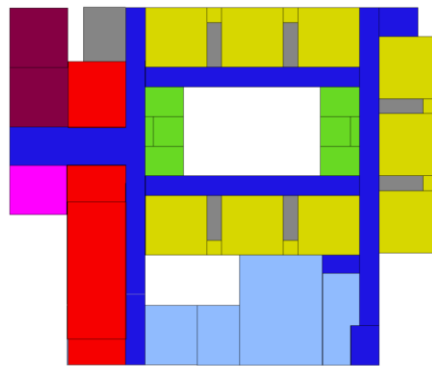
Scheme 2.1 Courtyard



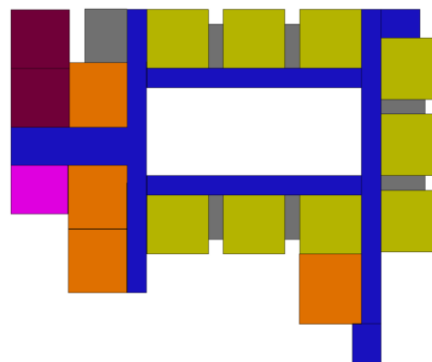
LEVEL G-1



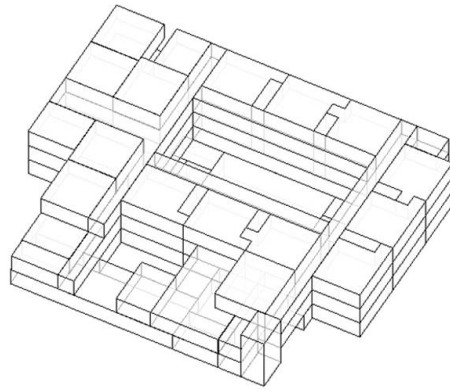
LEVEL 1



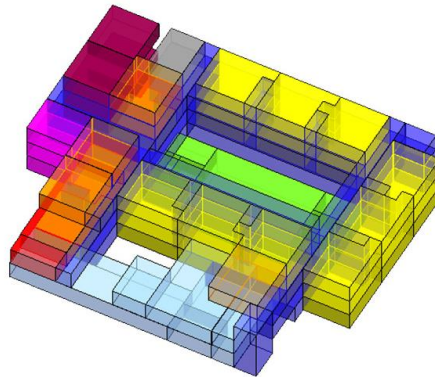
LEVEL 2



LEVEL 3



- |                                                            |                                                                   |                                                                  |                                                 |
|------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------|
| <span style="color: green;">■</span> GYMNASIUM             | <span style="color: yellow;">■</span> CLASSROOMS                  | <span style="color: maroon;">■</span> SPECIAL ED.                | <span style="color: blue;">■</span> CIRCULATION |
| <span style="color: red;">■</span> LIBRARY+<br>MULTI MEDIA | <span style="color: magenta;">■</span> ADMINISTRATION+<br>FACULTY | <span style="color: lightblue;">■</span> DINING+<br>MULTIPURPOSE | <span style="color: gray;">■</span> SUPPORT     |



PRIVATE  PUBLIC

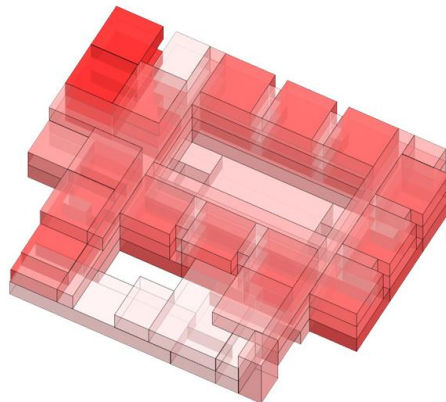


Figure 26: The Courtyard Scheme (Author's Diagram)

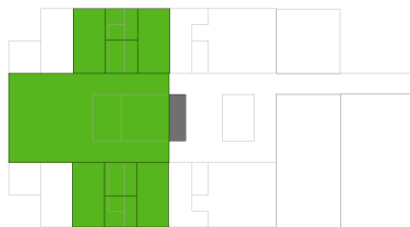
Remarks:

- More isolated programs but more interaction with outdoor play areas.
- Opportunity to expand programs on terraces
- Classrooms around the court create a unique environment.
- If the courtyard is covered it can be used in a mixed-use scenario but will require different entrance lobby space on ground floor
- The placement of courts results in different building proportion and may be decided as per the site.
- Both courts can have different level and nature of interaction depending on the type of activities around them.

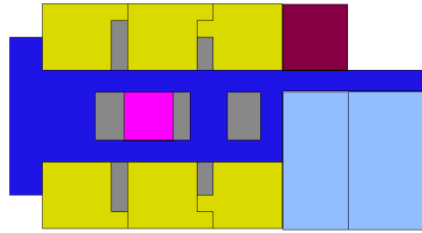
Issue 3- Multi-level

Most of the mixed-use school scenarios noted in precedent analysis have multi-level (more than 3 stories) schools that allows for ample open space even in relatively small urban sites. The following scheme is more compatible for mixed-use scenario and can have the same lobby and core.

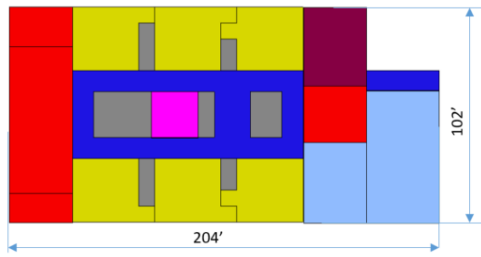
Scheme 3.1 Common Core and Lobby



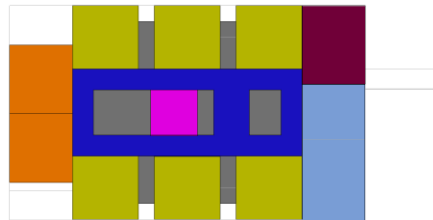
LEVEL G-1



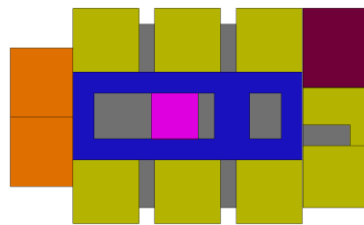
LEVEL 1



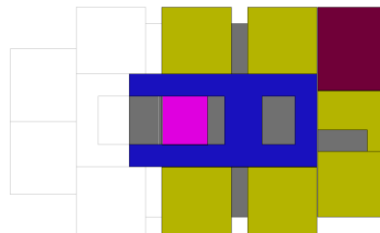
LEVEL 2



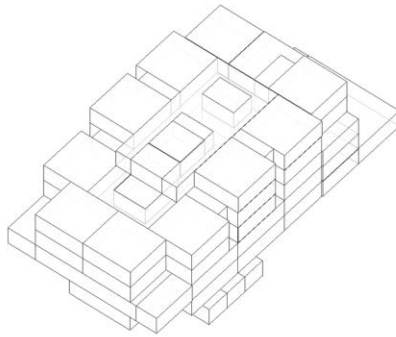
LEVEL 3



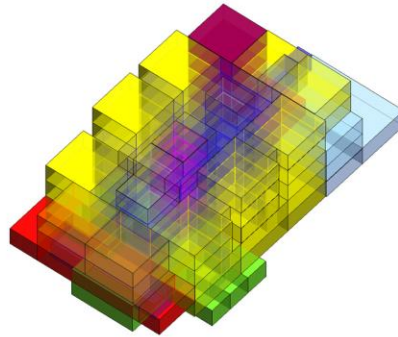
LEVEL 4



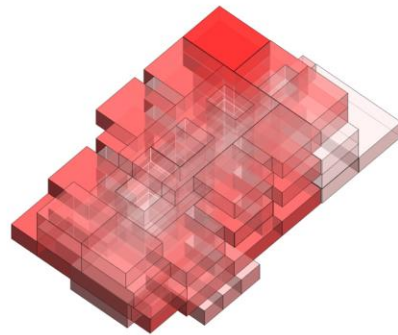
LEVEL 5

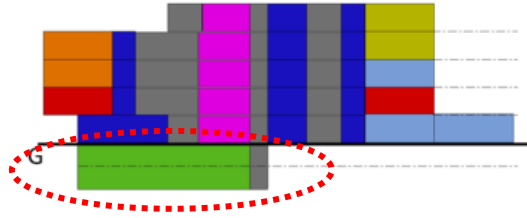


- GYMNASIUM
- CLASSROOMS
- SPECIAL ED.
- CIRCULATION
- LIBRARY+MULTI MEDIA
- ADMINISTRATION+FACULTY
- DINING+MULTIPURPOSE
- SUPPORT



PRIVATE PUBLIC





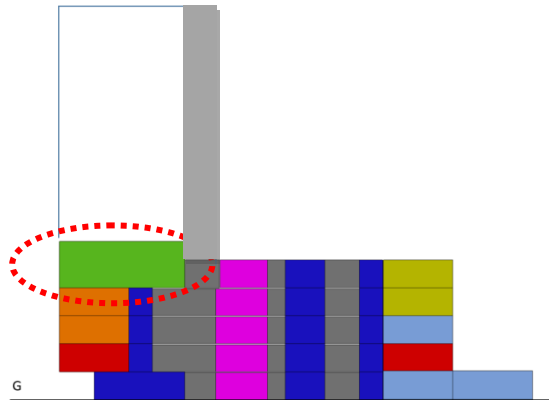
SECTION SCHEME 3.1

Figure 26: Common Core and Lobby Scheme (Author's Diagram)

Remarks:

- PK- 1 are housed on 2 levels resulting in smaller footprint
- Possibility of a central social space.
- roof (86' x 100') can be used for playground
- Small footprint
- Stacking of similar programs like Dining and Special Education can help have dedicated access in case these programs need to function independently

Scheme 3.2 Common Core and Lobby, and shared facilities



SECTION- SCHEME 3.2

Figure 27: Common Core and Lobby, with shared facilities (Author's Diagram)

Remarks:

This scheme has gymnasium on level 5 which will allow shared use with residential floors above the school in a mixed-use scenario. This option still allows for 86' x 100' playground on the roof

## Chapter 4: Site Analysis

### Site Selection

The site selection for schools is an important activity that has a great impact on the learning environment. Most school boards have certain site requirements for a project to qualify for school development. These requirements are usually related to lot sizes, accessibility, appropriate surrounding environment and other physical conditions<sup>13</sup>.

Following are the criteria for an appropriate school site:

- Lot Size: Usually the school boards prescribe a minimum lot size for school development. It is generally high for rural and suburban (T1-T3) contexts and low for urban (T5-T6) contexts. The lot size also varies as per expected enrollment and related future expansion plans. It also changes with the requirements for outdoor programs on school site.

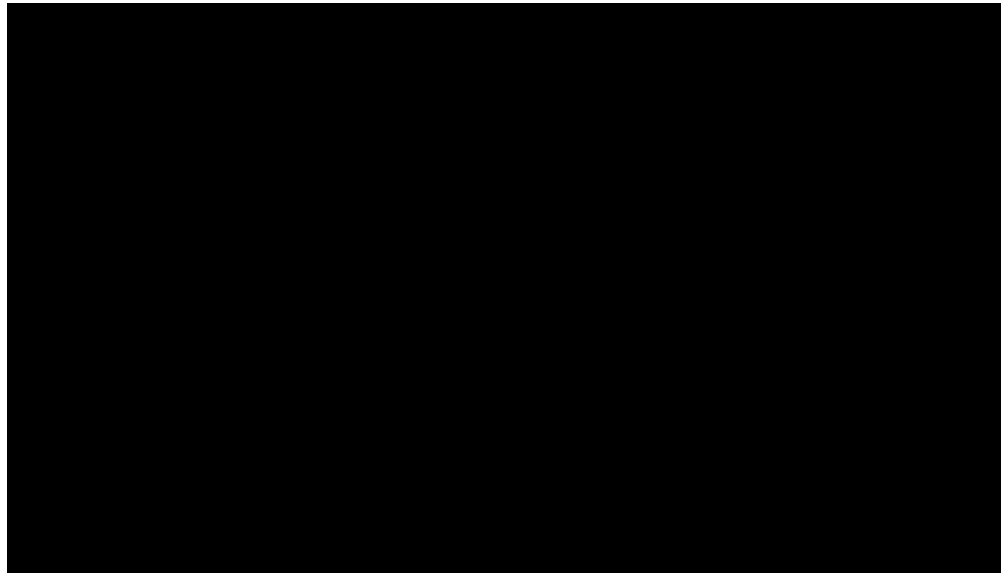
Arlington County considers a min. site area of 3.5 acre for school development.<sup>14</sup> Since this thesis is specifically looking at school development in urbanizing areas and emphasizes on shared facilities, determination of outdoor programs and the resulting lot size will depend on opportunities around the sites being considered. One of the main issues considered in previous sections is reduced building footprint which will also affect the required lot size.

---

<sup>13</sup> School Site Selection Historic PAS Report Series American Planning Association, accessed Dec 12 2015, <https://www.planning.org/pas/at60/report175.htm>

<sup>14</sup> Recommended sites for Schools, Public Land for Public Good, Projects and Planning, Arlington County VA, accessed Dec 12 2015, <http://projects.arlingtonva.us/plans-studies/land-use/public-land/>

- **Accessibility:** Walkability is an important variable for site selection of elementary schools. Most of the elementary schools have a service area of  $\frac{3}{4}$  to 1 mile around the school site. Also, a central location is usually preferred for school sites. School accessibility also depends on the travel time of students from home to school and the quality of their travel route. For elementary schools a travel time of less than 30 mins.<sup>15</sup> Is considered appropriate. Safe travel paths are an important consideration for selecting school sites.



Source: Candill, W. W., *Space for Teaching*.

Figure 28: Appropriate travel path from home to school, School Site Selection Historic PAS Report Series American Planning Association, accessed Dec12 2015, <https://www.planning.org/pas/at60/report175.htm>

- **Surrounding Environment and Site Physical Conditions:**

For an appropriate school site the surrounding environment conditions should be safe and pleasant. The site should not have any activities causing disturbance in the learning environment of the school. Usually zoning takes care of these

---

<sup>15</sup> School Site Selection Historic PAS Report Series American Planning Association, accessed Dec12 2015, <https://www.planning.org/pas/at60/report175.htm>

issues, but development sites considered in this thesis will go beyond zoning recommendations for school sites. Hence it is important to check for any disturbances that cannot be mitigated.

The site and its surrounding should not expose students to any toxic substances. Physical conditions like topography and soils have programming and financial implications on school projects. The school sites should allow proper drainage and preferably not be a part of flood plains. As discussed in previous section, a sloping site can have multiple levels of egress discharge, which will allow programming of lower elementary grade classrooms at 2 levels which will result in a smaller building footprint.

#### Arlington County: Regional Setting and Main Features:

Arlington County VA is located in Northern Virginia on the west bank of Potomac River. The county's planning is known for focusing high density development along its major transportation corridors while retaining lower density in its residential neighborhoods. There are three primary planning corridors in the county- The Rosslyn- Ballston corridor, The Jefferson- Davis Corridor and the Columbia Pike corridor<sup>16</sup>. Out of these the R-B and J-D corridors are along metro transit lines.

---

<sup>16</sup> Major Corridors Development, Projects and Planning, Arlington VA, <http://projects.arlingtonva.us/data-research/development/major-corridors/>

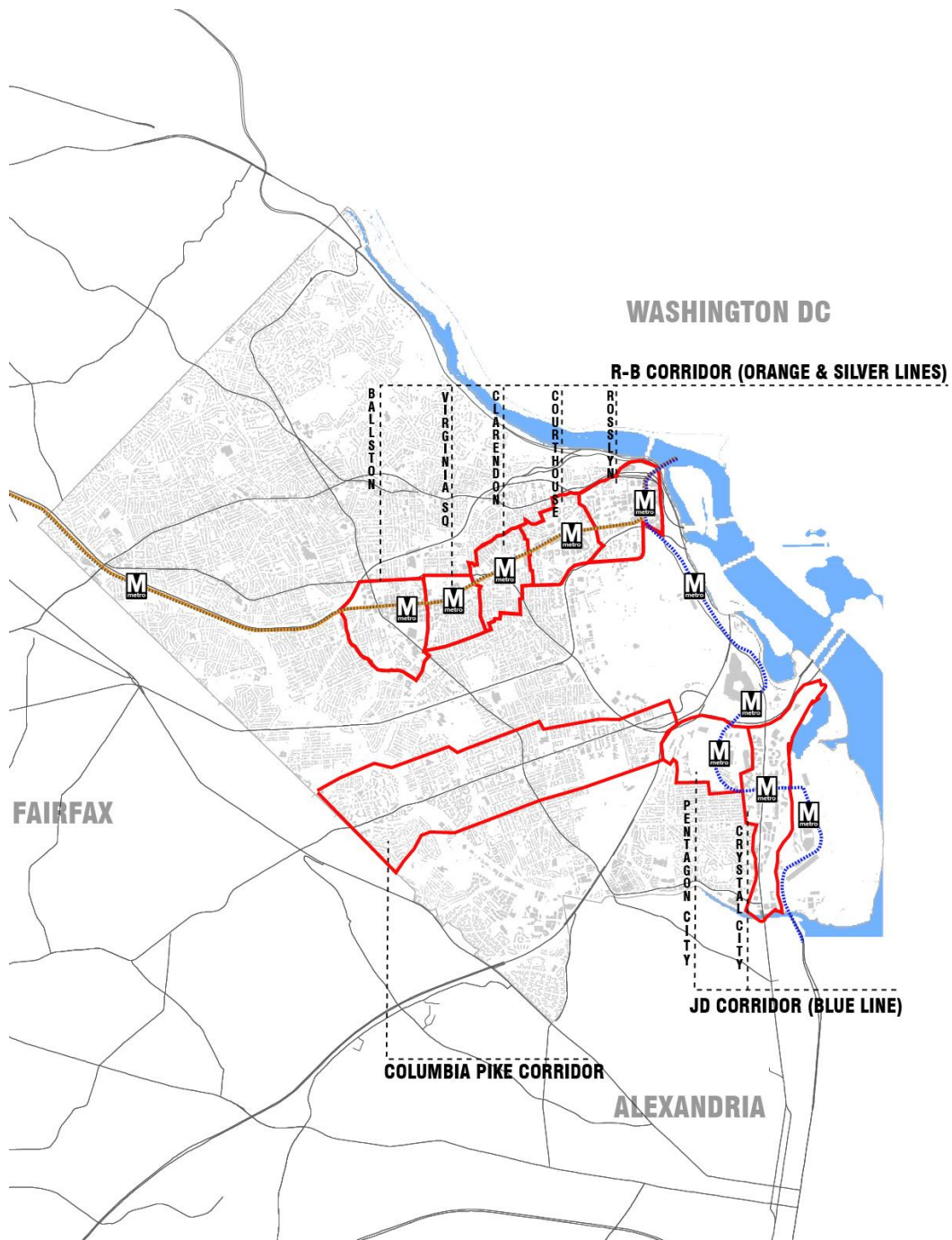


Figure 29: Arlington County Major Planning Corridors (Author's Diagram)

## Sites Considered:

Following attributes were used to come up with sites for elementary school development in urbanizing areas of Arlington County.

- Sites proposed for mixed use or housing development in Metro Corridors
- Sites considered for school development in Public Land for Public Good Study<sup>17</sup>
- Sites considered for affordable housing developments in Public Land for Public Good Study.<sup>18</sup>

## A Transit Corridor Mixed- Use School in Arlington, VA:

The sites being considered (refer figure 28) are in County's high density metro corridors . The county has been considering new schools in these areas, however no sites have been recommended yet.

Since these sites are closer to metro stations, it is possible to imagine a Transit Corridor School. The service area of this school could stretch along one of the metro corridors where, like in DC and New York, students could travel by metro rail. The travel time will be less than 30 minutes which is considered appropriate for elementary schools. The school itself can be supported with safe access to metro station. Along with metro rail, the sites considered are also served by Metro and ART buses.

---

<sup>17</sup> Recommended sites for Schools, Public Land for Public Good, Projects and Planning, Arlington County VA, accessed Dec 12 2015, <http://projects.arlingtonva.us/plans-studies/land-use/public-land/>

<sup>18</sup> Recommended Sites for Affordable Housing, Public Land for Public Good, Projects and Planning, Arlington County VA, accessed Dec 12 2015, <http://projects.arlingtonva.us/plans-studies/land-use/public-land/>



Figure 30: Sites Considered for a Mixed-Use Elementary School Project in Arlington County (Author's Diagram)

A corridor school along the R-B and J-D corridor can help relieve pressure on existing elementary schools serving these areas. It will have a significant impact on Oakridge, Ashlawn, Long Branch, Key and Glebe Elementary Schools that are projected to be at more than 110% capacity utilization by year 2024 (Fig. 29).

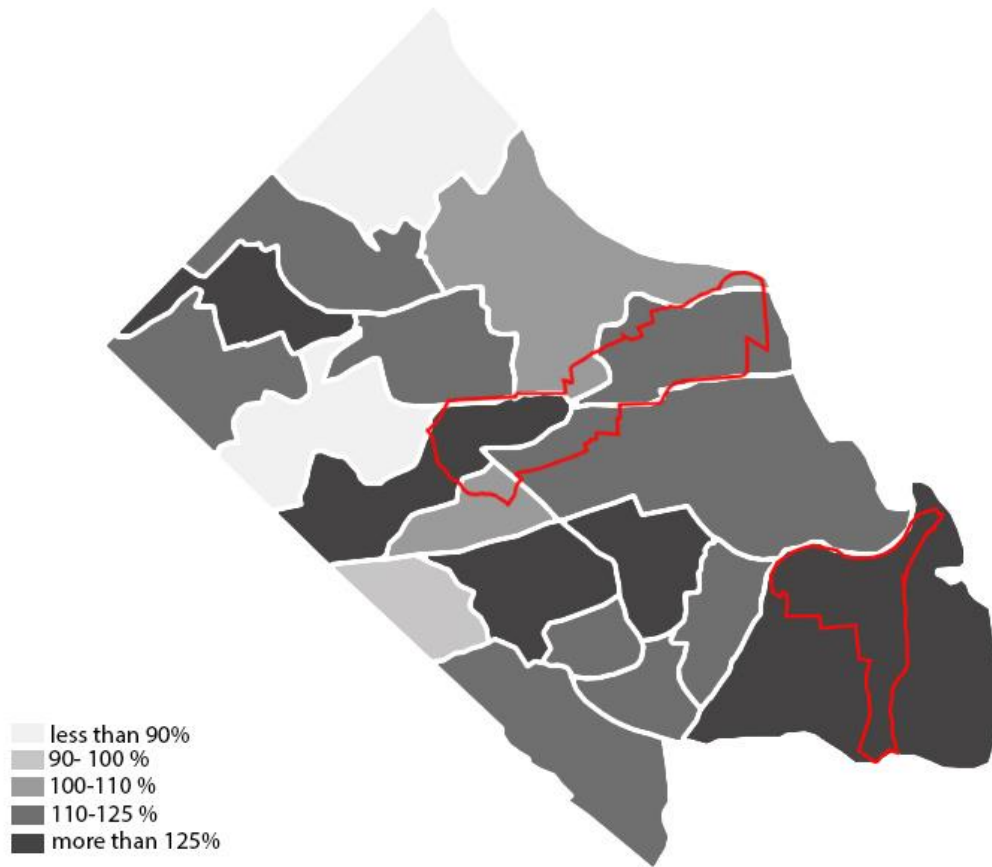


Figure 31: Elementary School Capacity Utilization projection for year 2024, (Author's Diagram, basemap CIP)

Possible sites:

In order to select the most appropriate site for a Transit Corridor Elementary School, all considered places discussed earlier were studied for the following desired attributes:

- Proper transit –ART or Metro bus and rail services for transportation
- Located centrally in the county
- Suitable for mixed-use school development.
- Safe access
- Possibility of having shared community facilities

- Proper site proportion- tested using the schemes generated in previous chapter
- Lot size not more than 3 acres, which was found feasible for schools in urban areas in precedent analysis. The min. lot size considered for schools by the county is 3.5 acres.
- Under consideration for future development.
- Preferably a sloping site allowing two levels of egress discharge.

To select a site for a Joint-Use school in Arlington County, the above listed attributes were weighted. The most desired attributes had higher weights than other attributes.

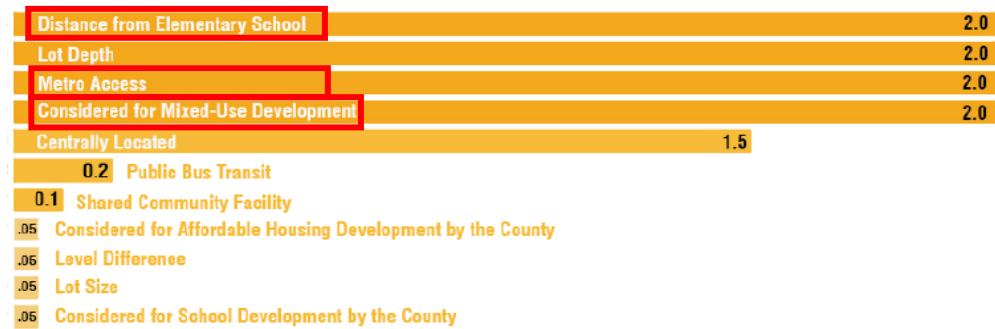


Figure 32: Site Attribute Weightage, (Author's Diagram)

The sites were ranked as per this weighting criteria to find the most suitable location for a joint- use school. Please refer Appendix 2 for the analysis.

Following sites ranked high in the analysis for site selection:

- Courthouse Sq
- Clarendon West
- Carpool Restaurant
- Mazda Site

The above listed sites are located in the R-B corridor. The Courthouse Sq site is very close to the existing Key elementary school. Hence, Clarendon West site was selected as the site for Joint-Use school development for this thesis.

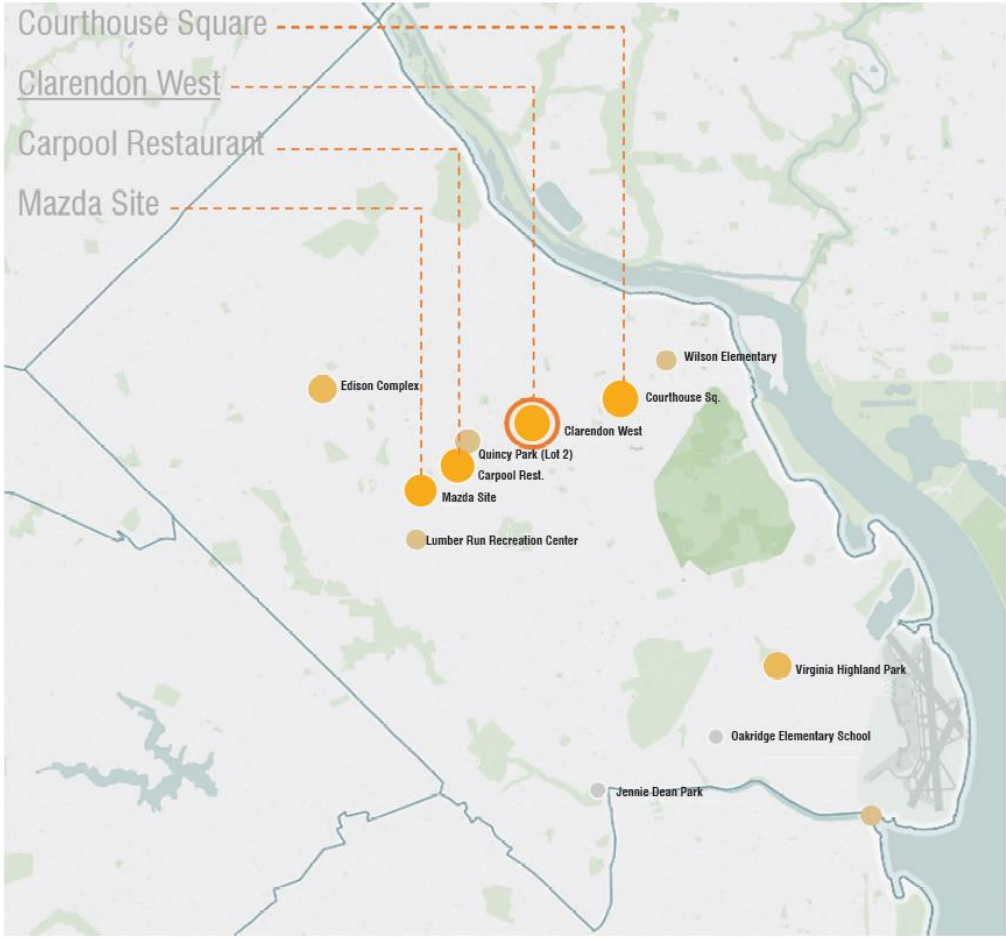


Figure 33: Site Ranking, (Author's Diagram, base map: Tableau Public)

Site Analysis

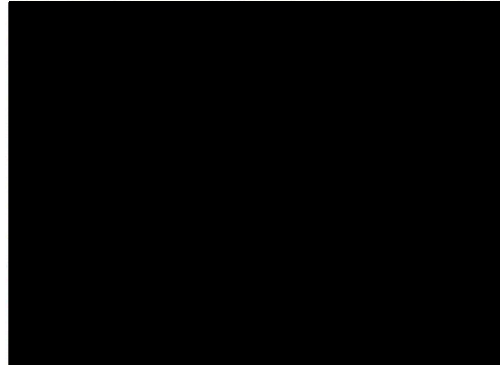
Clarendon West- Site Attributes:

The following images give a better idea of preferred characteristics on Clarendon West site:

Site Dimensions



Considered for Mixed -Use



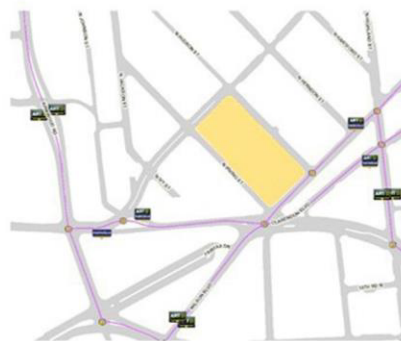
Topography



Distance from Metro



Bus Stops



Land Use

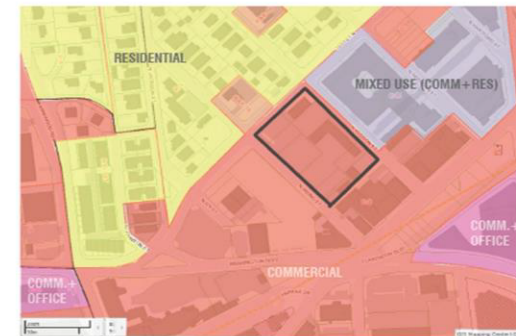


Figure 34: Clarendon West Site Attributes (Author's Diagram over base maps from Arlington GIS Center and Arlington County Projects and Planning Image Gallery, accessed May 15 2016 <http://projects.arlingtonva.us/projects/clarendon-west-red-top-cab/>)

### Clarendon West- Possible School Service Area:

A school on Clarendon West site will serve elementary school aged kids in ½ mile radius of the site<sup>19</sup>. The service area can also extend along the orange line metro till Ballston.



Figure 35: Service Area Diagram (Author's Diagram)

### Clarendon West- Existing Conditions:

The site is currently occupied as Red Top Cab parking area. It is also a part of a proposed commercial and housing development. A historic commercial block is located towards the Clarendon core. The site has housing and commercial developments, The Beacon and The Hudson, adjacent to it.

Towards N-W the site fronts the suburban community of Lyon Village. The

<sup>19</sup> Figure 26: Appropriate travel path from home to school, School Site Selection Historic PAS Report Series American Planning Association, accessed Dec12 2015, <https://www.planning.org/pas/at60/report175.htm>

context around the site drastically changes from a T6 Urban Core, Clarendon Core to T3 Suburban Lyon Village Community.



Figure 36: GIS Center Site Arial Image

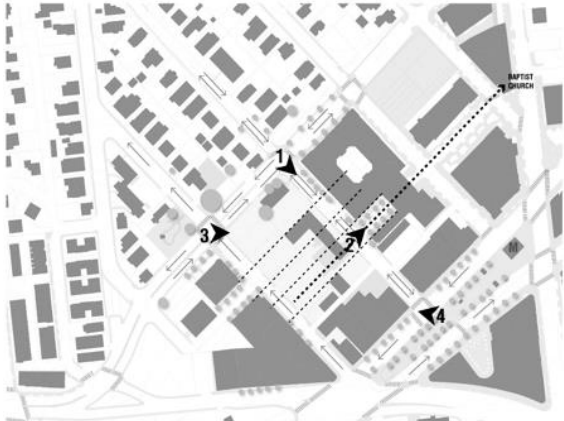


Figure 37: Site Observations (Author's Diag.)



Figure 38: Site Photos (Author's Photographs)

The site is an edge condition site with tapering height regulations ranging from 76' over the commercial block to 110' in the center and 55' towards the suburban Lyon Village community, as per the Clarendon Sector Plan<sup>20</sup>.

The site offered 2 options for subdivision based on extension of existing secondary streets serving the adjacent developments.

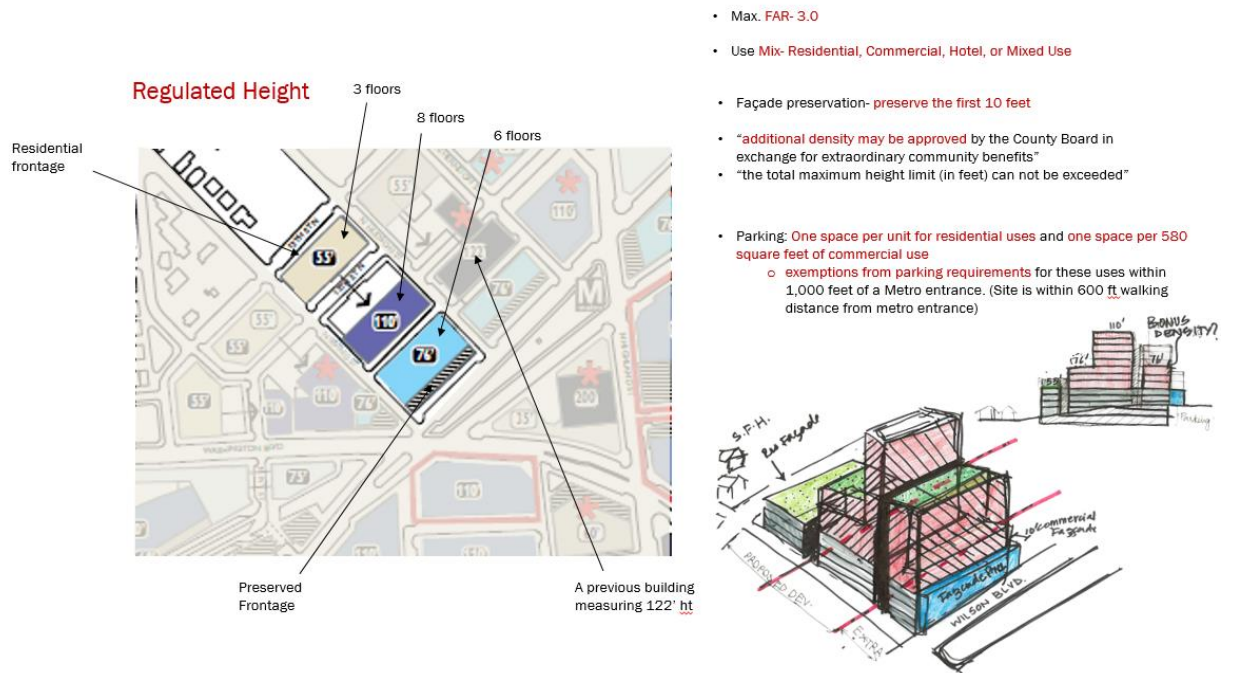


Figure 39: Site Regulations (Author's Diagram)

<sup>20</sup> Clarendon Sector Plan, accessed May 17 2016 <http://arlingtonva.s3.amazonaws.com/wp-content/uploads/sites/31/2014/03/Clarendon-SectorPlan06.pdf>



# Section Looking NW

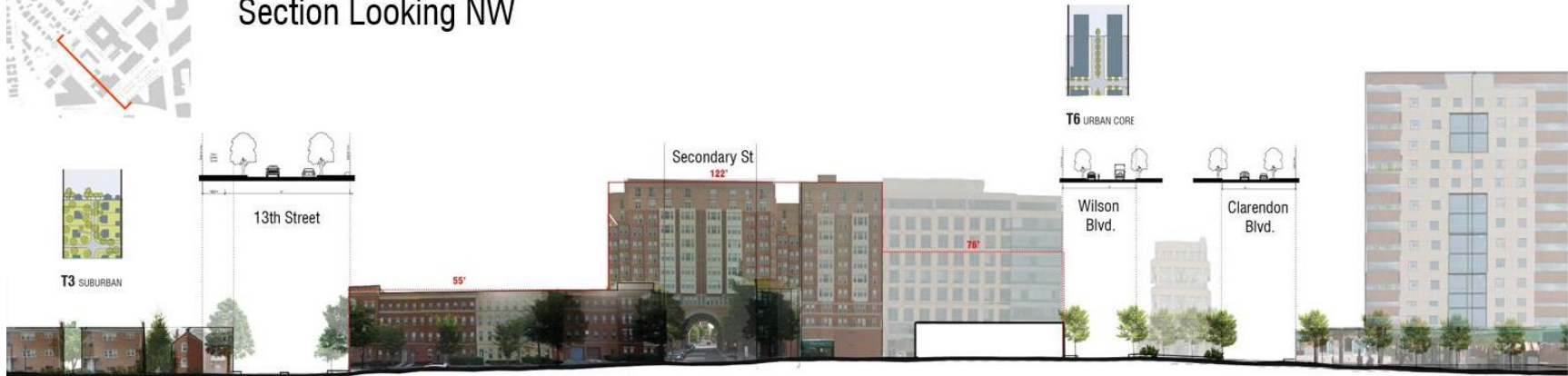


Figure 40: Site Section Existing (Author's Diagram)

## Chapter 5: Design Options

### Zoning of School & Housing in Joint-School Development:

The subdivision of the site and varying context on both sides allowed various options for zoning and massing of school and housing uses. Options were generated using The Design Issue studies (conducted in Chapter 3) and manipulating them for Clarendon West site. The options also consider different levels of school and housing use overlap.

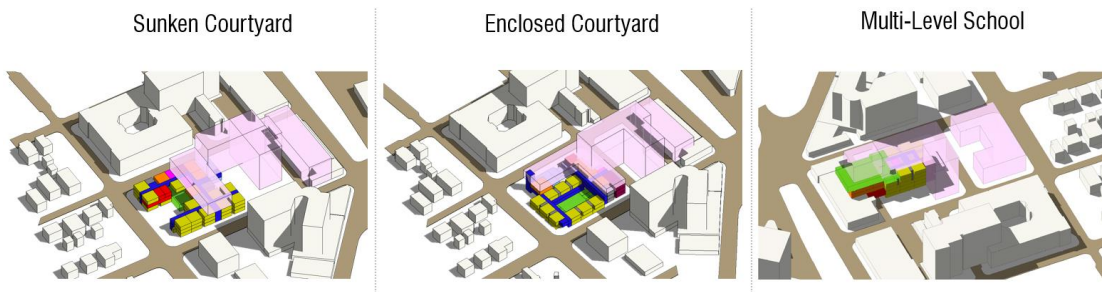


Figure 41: School & Housing Zoning Options (Author's Diagram)

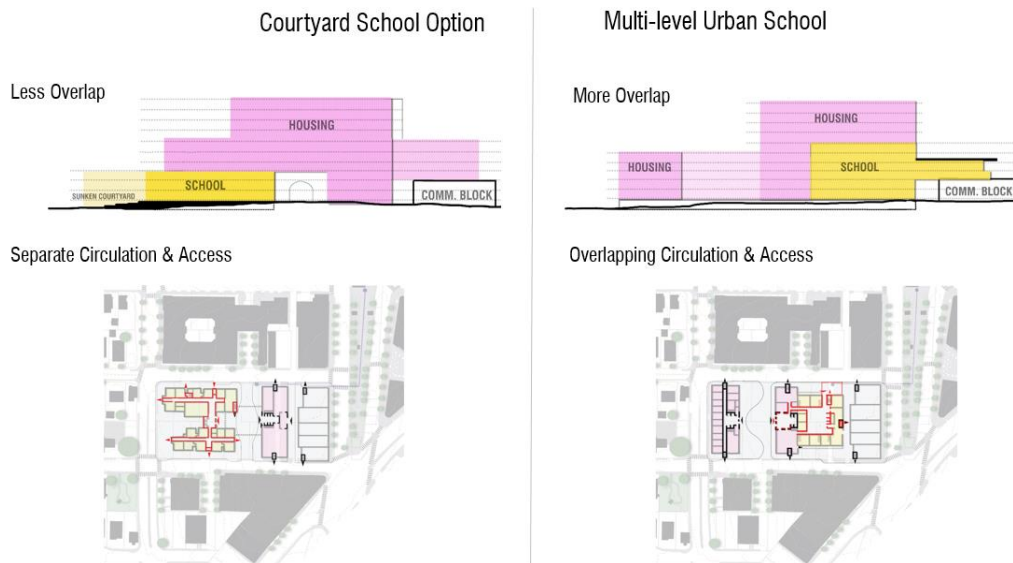


Figure 41: School & Housing Zoning Options (Author's Diagram)

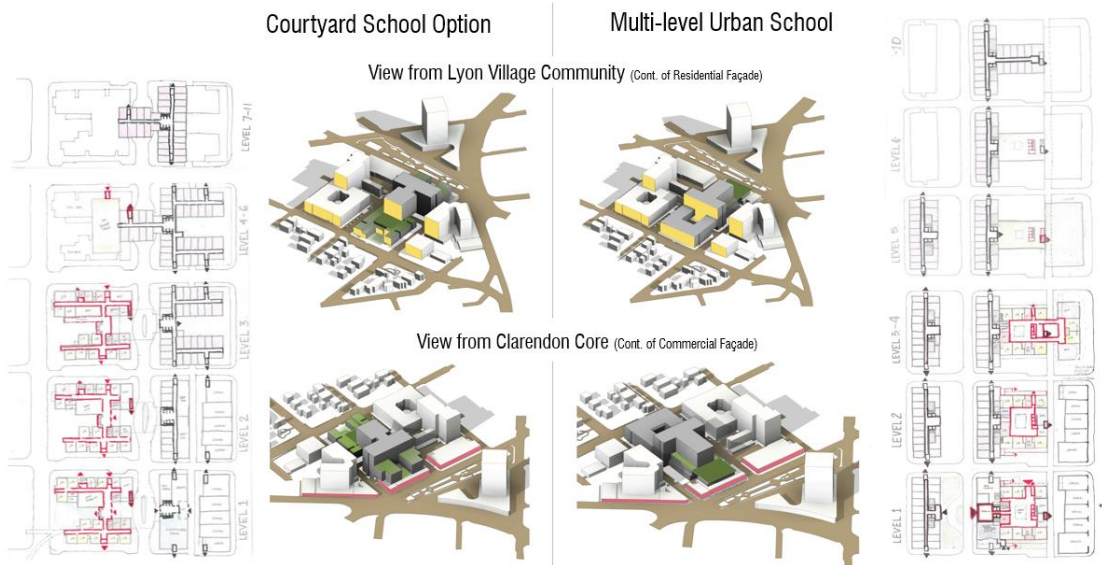


Figure 41: School & Housing Zoning Options (Author's Diagram)

The above described massing studies were also considered for separation and overlapping of school and housing circulation.

- The Courtyard School: The school is zoned facing the Lyon Village community. The housing and school uses have less overlap. Consequently, the circulations for school and housing is largely separated,
- The Multi-level Urban School: The school is zoned towards the Clarendon Core and over the existing historic commercial block. The housing and school uses overlap considerably. Consequently, the circulation for school and housing also overlap at a number of places.

## Chapter 6: Design Proposal

### The Courtyard School Option:

The design proposed in this thesis for Joint-Use school on Clarendon West site in Arlington VA is developed from The Courtyard School option discussed in the previous chapter.

The Courtyard School option offered better connection with the surrounding residential community. It had potential to address the critical design issues of daylighting and connection with open spaces in a better way. It also provided an option of fully conserving the existing historic commercial block.

The design proposal claims bonus height incentive for development of school on this site. Additional 5 floors have been added resulting in a height of 192'. This is approximately equal to the maximum height of 200' (Olmstead Building) in Clarendon Core.

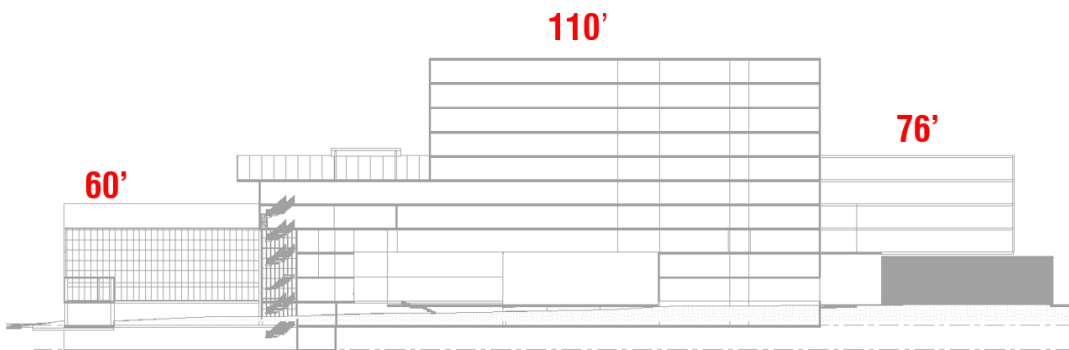


Figure 42: Base Case as per Regulations, (Author's Diagram)

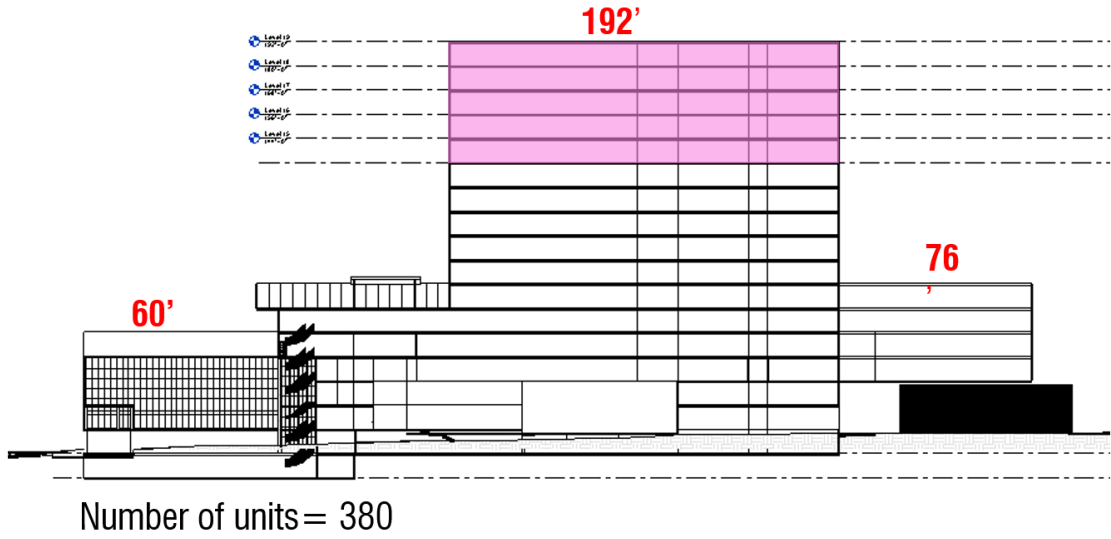


Figure 43: Claiming bonus height incentive, (Author's Diagram)

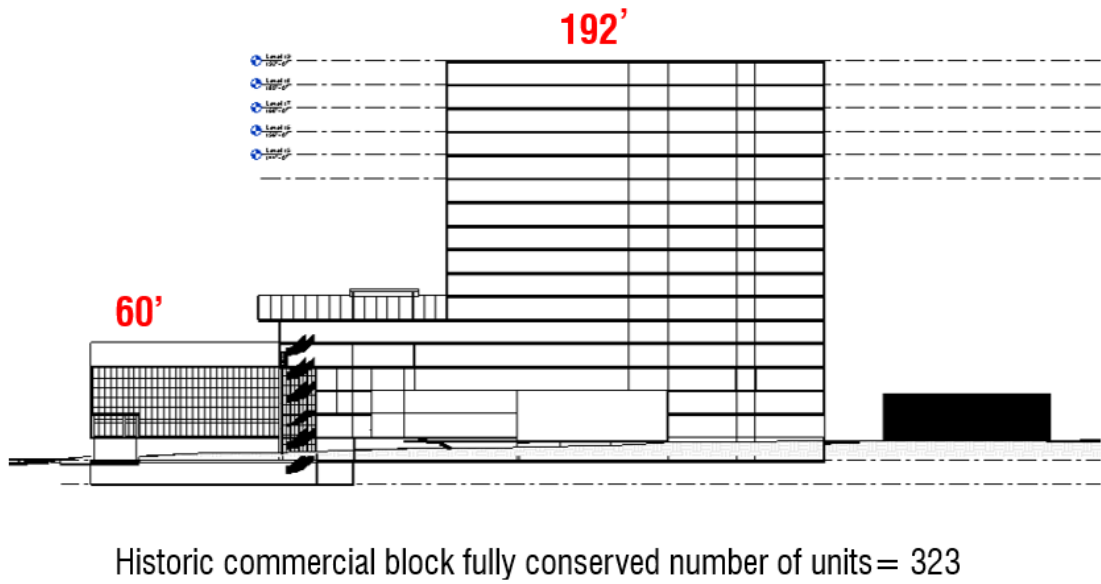


Figure 44: Commercial Block Preservation, (Author's Diagram)

Site Plan:

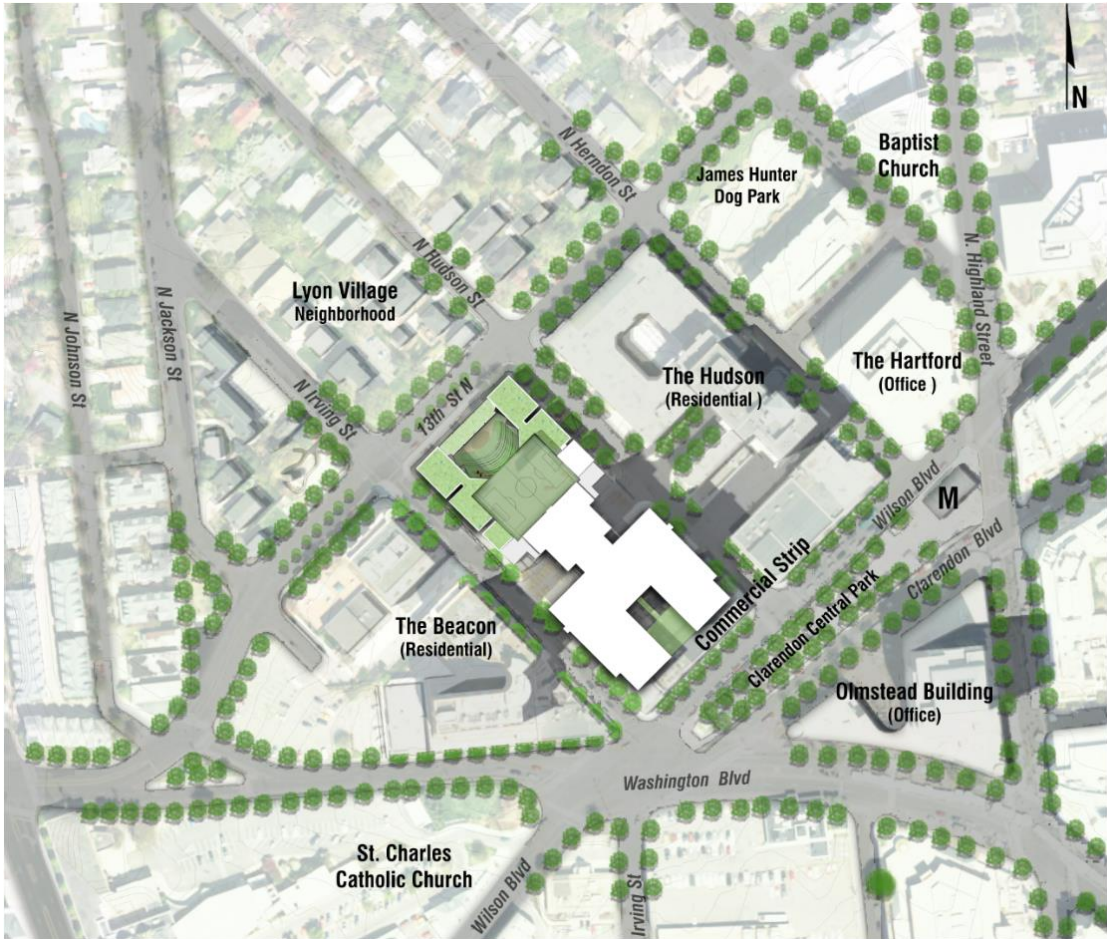


Figure 45: Site Plan (Author's Diagram)

Site Axon:

Height limit achieved by adding more stories for consistent street environment

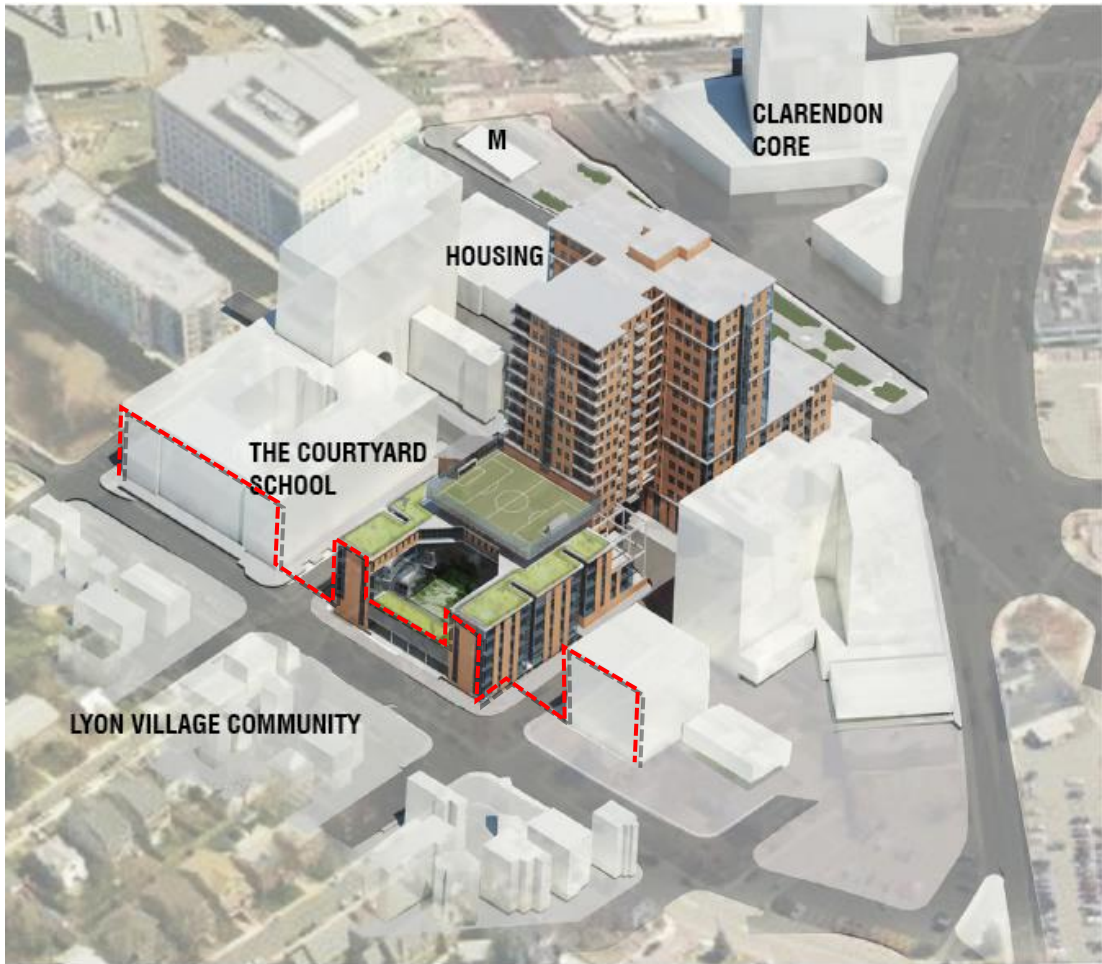


Figure 46: Site Axon (Author's Diagram)

View along 13<sup>th</sup> St:  
Relating to the Suburban Context



Figure 47: View along 13<sup>th</sup> Street (Author's Illustration)

View from the Clarendon Metro Station:  
Relating to the Urban Context



Figure 48: View from Clarendon Metro (Author's Illustration)

Sectional Perspective:

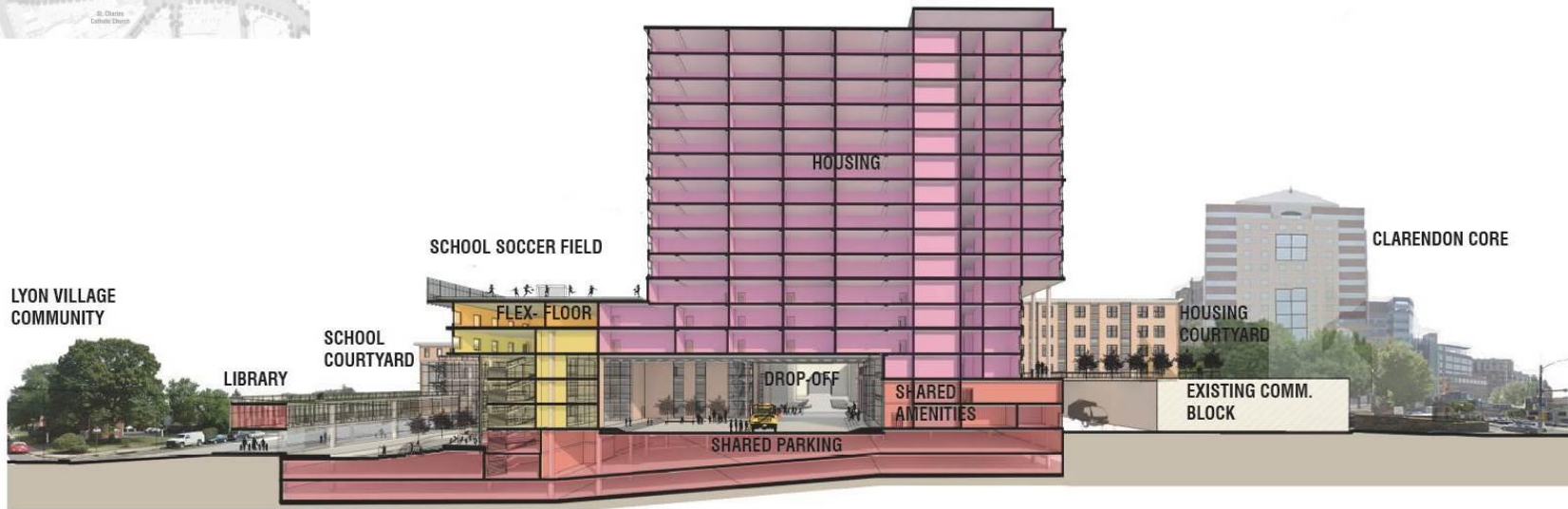


Figure 49: Proposed Development Sectional Perspective (Author's Diagram)

**Floor Plans:**

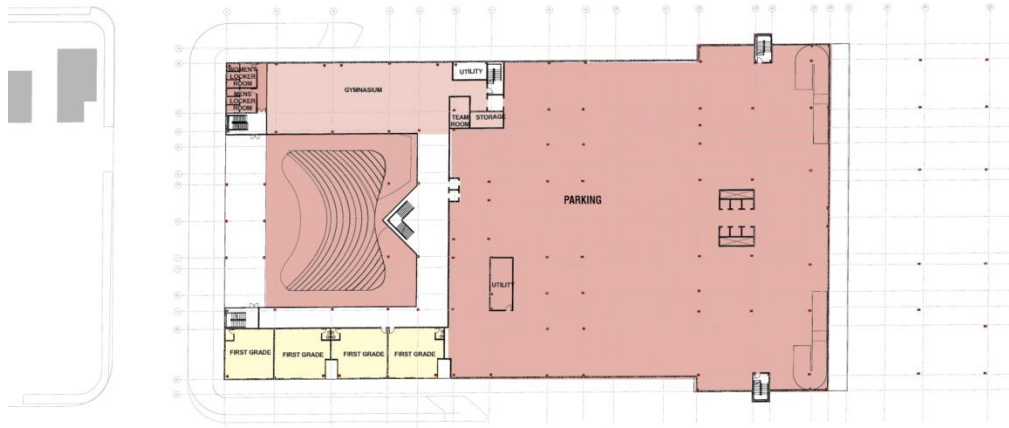


Figure 50: G-1 floor plan (Author's Diagram)



Figure 50: First (Ground) floor plan (Author's Diagram)

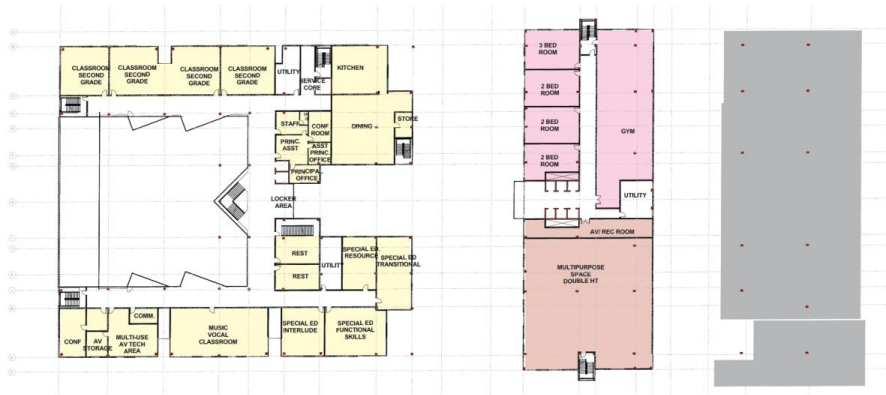


Figure 50: Second floor plan (Author's Diagram)



Figure 50 Third floor plan (Author's Diagram)



Figure 50 Fourth floor plan (Author's Diagram)



Figure 50 Fifth floor plan (Author's Diagram)

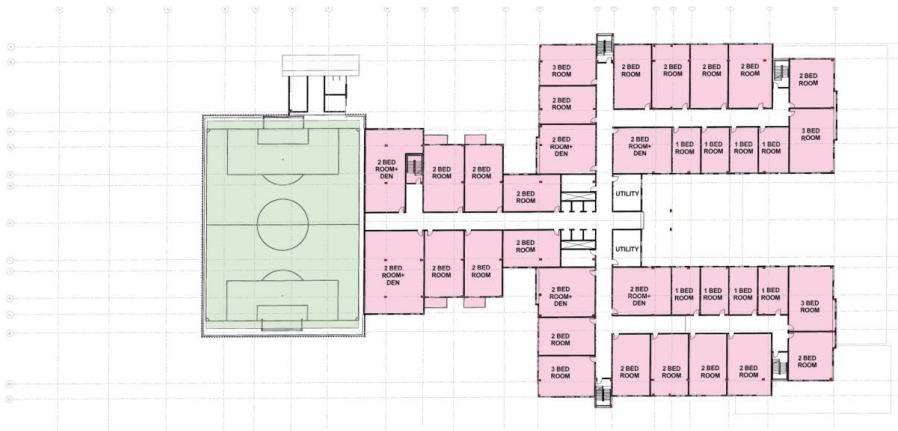


Figure 50 Sixth floor plan (Author's Diagram)



Figure 50 Seventh- Sixteenth floor plan (Author's Diagram)

# Approach View from Lyon Village Community: A Community Oriented School



Figure 51: View from Community (Author's Illustration)

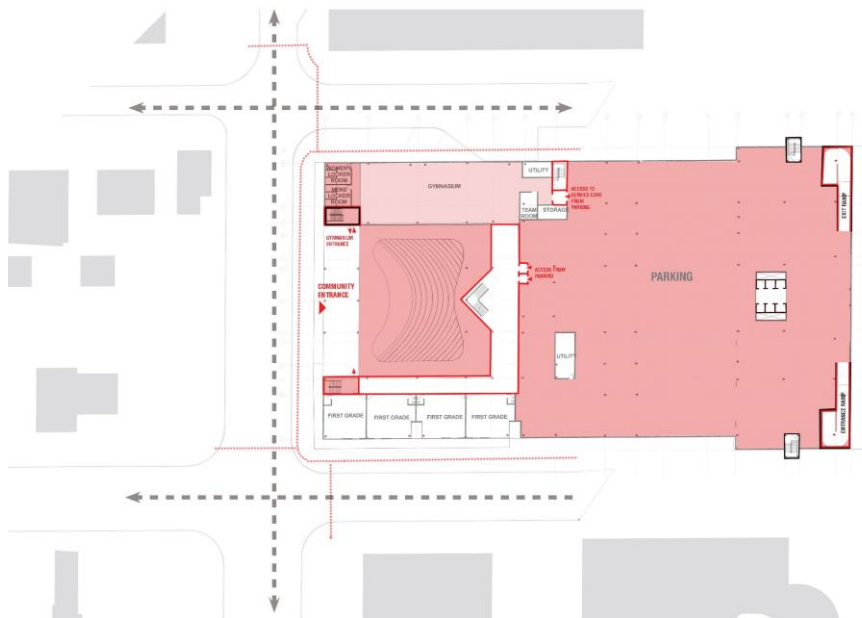


Figure 62: G-1 level Access, Circulation & Shared Spaces (Author's Diagram)

Approach View from Clarendon Central Park:  
Contributing to Pedestrian Oriented Clarendon Core.

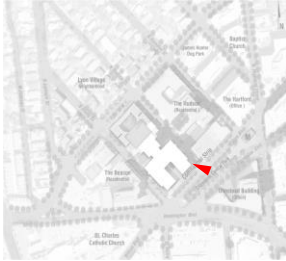


Figure 53: View from Clarendon Core (Author's Illustration)

Drop-Off View:  
Lively and Safe Environment

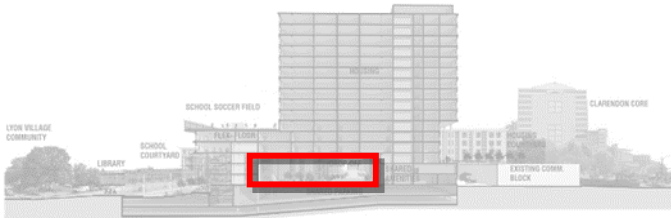


Figure 54: Drop-Off view (Author's Illustration)

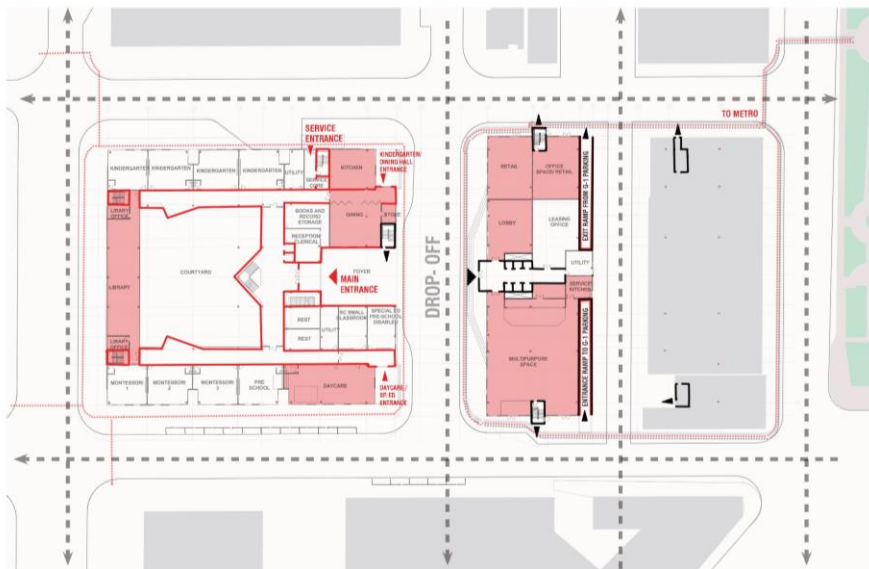
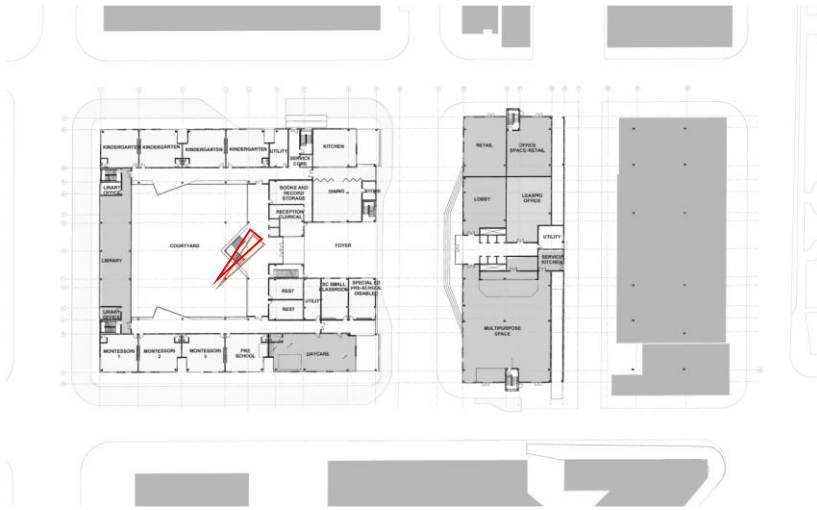


Figure 55: First Floor Access, Circulation & Shared Spaces (Author's Diagram)

The Courtyard:  
Interaction with outdoor green space and the center of life in school

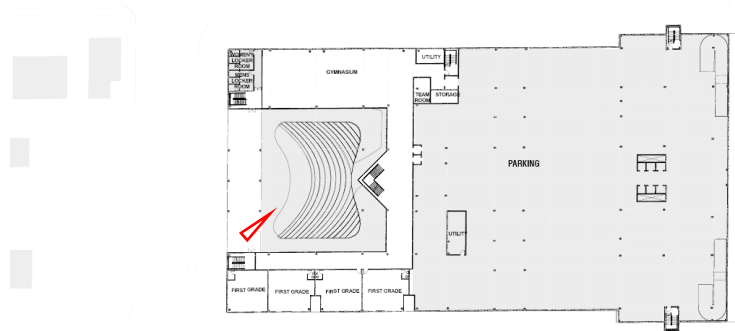


First Floor Plan (Author's Diag)



Figure 56: Courtyard View from Central Staircase (Author's Illustration)

The Courtyard:  
A Multipurpose Assembly Space for school and community



G-1 Floor Plan (Author's Diag)



Figure 57: Courtyard View from Loggia (Author's Illustration)

Table 7: The School Program: (Area in Sq Ft)

<b>Space</b>	<b>Number</b>	<b>Area provided final design</b>
Pre-School+ in-built store & toilet	1	930
Montessori + in-built store & toilet	3	2670
Kindergarten + in-built store & toilet	4	3605
First Grade + in-built store & toilet	4	3580
Second Grade	4	3385
Third Grade	4	3385
Fourth Grade	3	2550
Fifth Grade	3	2550
Reading Classroom	1	733
Reading Recovery/ Clinical	1	100
Flex Space Classroom	—	6788
Art Classroom	1	1700
Music Vocal Classroom+ Storage	1	1693
Music Instrumental Classroom+ Storage	1	1693
Other resource Classroom+ Storage	1	850
Reading Room	1	2326
Multi-use AV tech Area	1	690
Library Admin+ Backrooms	1	304
Computer class + Tech office	1	850
Conference Room	1	467
Communications	1	151
AV Storage	1	183
Dining Area	1	3038
Kitchen + Food storage	1	1300
Multipurpose Area	1	5300
Storage Furniture	1	522
Stage	1	370
Gymnasium	1	4629
PE Toilet	1	
PE Office/ Toilet	1	462
PE Storage	1	183
Team room	4	213
Resource	1	500
Pre School Disabled	1	817
SC Small Classroom	1	505
Interlude	1	850
Transitional	1	1067
SE Small Classroom	1	850
Toilet	1	

<b>Space</b>	<b>Number</b>	<b>Area provided final design</b>
ESOL	1	
HILT	1	
Project Go	1	
Title 1	1	
Gifted Classroom	1	
Reception/ Clerical	1	513
Principal's Office	1	260
Principal's Assistant+Circulation	1	253
Assistant Principal's Office	1	143
Conference Room	1	268
Work Room	1	150
Testing / Conference	1	262
Lounge with toilet	1	568
Teacher work areas	1	423
Book Storage	1	675
Record Storage	1	
Clinic with Toilet	1	1051.5
Occupational/ Physical Therapy	1	
Staff toilets	2	117
Speech	1	207
Social Worker/ Psychologist	1	80
Counselor	1	453
Gifted/ Visiting Teachers	1	-
Storage Furniture	1	
Extended Day (Storage/ office)	1	
Playground	1	12394
Total Outdoor Play area	1	21791
HVAC and circulation		
<b>Total (exclusive of outdoor spaces and circulation space)</b>		<b>67212.5</b>

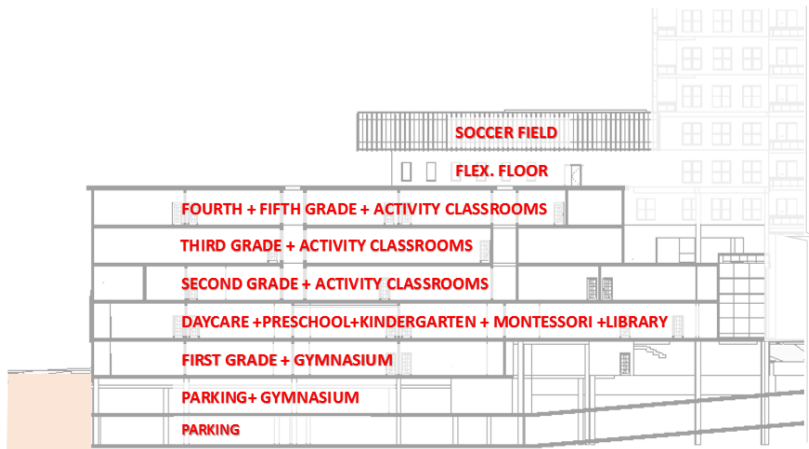


Figure 58: School Learning Space Program (Section looking N-W) (Author's Diagram)



Figure 58: School Learning Space Program (Author's Diagram)

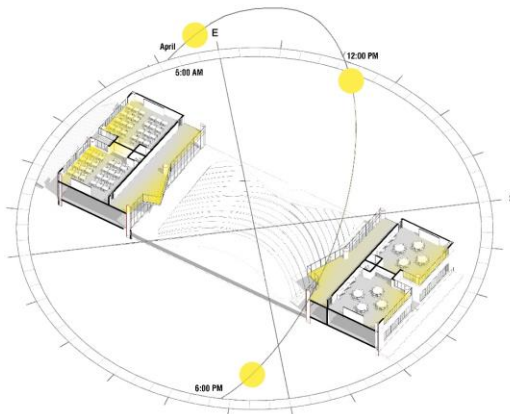


Figure 59: Daylighting of Learning Spaces (Author's Diagram)



Figure 60: N-E classrooms at 11 am (Author's Illustration)



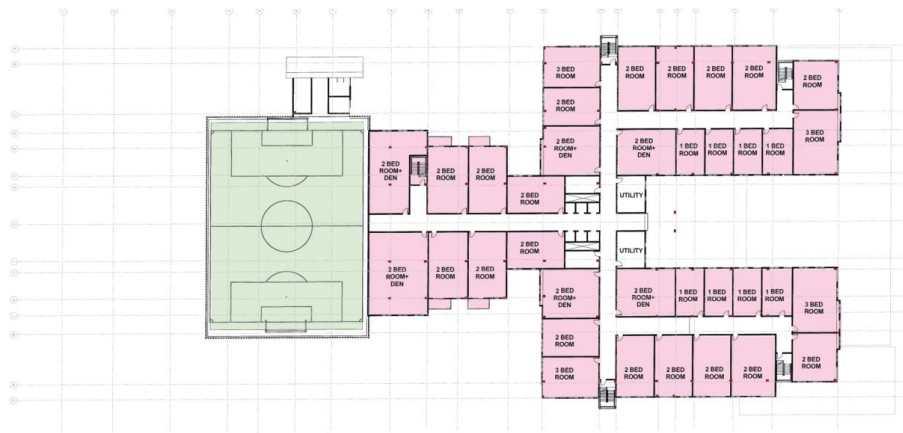
Figure 61: S-W classrooms at 2 pm (Author's Illustration)

## Collaboration Pods: Maximizing Interaction



Figure 62: Collaboration Pods (Author's Illustration)

## Soccer Field: Unique provisions for play areas and green spaces

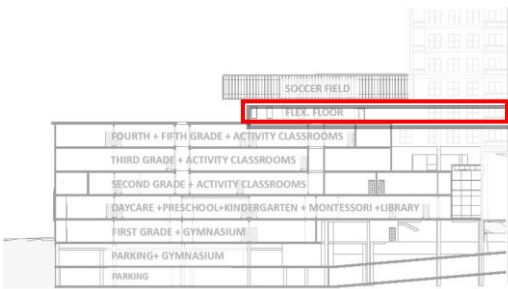


Sixth Floor Plan (Author's Diag)



Figure 63: Looking into Soccer Field from Housing (Author's Illustration)

### Flexible Classroom Space:



School Section Looking N-W (Author's Diag)



Figure 64: Flexible Classroom Space on Fifth Floor (Author's Diagram)

Conclusion:

The design proposal clearly shows that a Joint- Use School model can be successfully used to intensify and develop elementary schools in urbanizing areas of Arlington County VA. In case of Clarendon West, the regulations for edge sites of metro corridors played an important role in shaping the joint-use development.

Additionally this thesis demonstrates that it is possible to achieve effective learning environments even on constrained sites in high density areas. Both site selection and design have an important role to play in development of such sustainable school models for urbanizing areas.

## Appendices

### Appendix 1:

<b>Project Information</b>						
<b>Project title</b>	<b>Discovery Elementary School</b>	<b>Battery Park City School</b>	<b>8 Spruce Street School, Beekman Tower</b>	<b>Patwin Elementary School</b>	<b>Rogers Elementary School</b>	<b>Boston Renaissance Charter Public School</b>
<b>Location</b>	Arlington , VA	Manhattan, NY	Manhattan, NY	Davis, CA	Victoria, BC, Canada	Boston, MA
<b>Address</b>	5241 36th St N, Arlington, VA 22207	55 Battery Pl, New York, NY 10004	8 Spruce Street School Manhattan, New York City 10038	2222 Shasta Dr, Davis, CA 95616	765 Rogers Ave, Victoria, BC V8X 5K6	1415 Hyde Park Ave, Hyde Park, MA 02136
<b>Context</b>	T3-T4	T6	T6	T3-T4	T3-T4	T4
<b>Date Completed</b>	Opened Sept. 8th 2015	Built in 2010	Built in 2011	1990s	1990s	2010
<b>Status</b>	Complete	Complete	Complete	Complete	Complete	Complete
<b>Education Level</b>	PreK - 5	PreK - 8	PreK - 8	K-6	K-5	PreK-6
<b>Capacity</b>	630	950	648	438	250	885
<b>Project Area (GSF)</b>	97,588	124,861	94,046	33,000	23,000	105,000
<b>Project Area (GSF)/ student</b>	155	131	145	75	92	119
<b>Land Area (acres)</b>	15.5	0.6	0.71	5.78	15.5	5.54
<b>Land Area (acres)/ student</b>	1072	28	48	575	2701	273
<b>Project Cost</b>	\$41,330,000	\$72,000,000	\$76,400,000	-	-	-
<b>Project Cost(\$)/ student</b>	\$65,603	\$75,789	\$117,901	-	-	-
<b>No. of stories</b>	2	9	4	1	1	3
<b>Project title</b>	<b>New Sandy Hook School</b>	<b>Bailey Upper Elementary School</b>	<b>Horace Mann Elementary School</b>	<b>Lafayette Elementary School</b>	<b>Marie Reed Elementary School</b>	<b>Chesterton Primary School</b>
<b>Location</b>	Newton, CT	Falls Church, VA	Washington DC	Washington DC	Washington DC	London, UK
<b>Address</b>	12 Dickenson Dr, Newtown, CT 0648	6245 Leesburg Pike, Falls Church, VA 22044	4430 Newark St NW, Washington, DC 20016	5701 Broad Branch Rd NW, Washington, DC 20015	2201 18th St. NW, Washington, DC 20009	
<b>Context</b>	T3	T4-T5	T5	T4	T5-T6	T6
<b>Date Completed</b>	Planned to be completed by 2017	2014	2015	To be Completed Aug 2016	To be Completed Aug 2017	Completed
<b>Status</b>	Under Construction	Completed	Completed	Under Construction	In design Phase	
<b>Education Level</b>	Pre-K-4	Grade3-5	PK-5	PK-5	K-5	Primary School
<b>Capacity</b>	506	764	-	835	486	560
<b>Project Area (GSF)</b>	86,800	99,350	50,000	120,000	78,788	24,600
<b>Project Area (GSF)/ student</b>	172	130	-	144	162	44
<b>Land Area (acres)</b>	6.63	2.9	4.3	4.47	5.17	1.75
<b>Land Area (acres)/ student</b>	571	165	-	233	463	136
<b>Project Cost</b>	-	\$30,247,000	\$37,700,000	\$47,600,000	\$61,500,000	\$310,000
<b>Project Cost(\$)/ student</b>	-	\$39,590	-	\$57,006	\$126,543	\$554
<b>No. of stories</b>	2	5	3	3	4	1

## Appendix 2:

### Site Selection

Name of Site	Address	Zipcode	Latitude	Longitude	Considered for Mixed-Use Development	Weighted Mixed Use	Considered for School Development?	Weighted School Dev	Considered for Affordable Housing Development?	Weighted Housing Dev	Shared Community Facilities?	Weighted Shared Community
Wilson Elementary School	1601 Wilson Blvd	22209	38.894543	-77.077407	0	0	1	0.05	1	0.05	1	0.1
Courthouse Square	2041 15th St N	22201	38.890114	-77.084214	1	2	0	0	1	0.05	1	0.1
Clrendon West	1200 N Hudson St	22201	38.887158	-77.097378	1	2	0	0	0	0	0	0
Edison Complex	1801 N George Ma	22205	38.891189	-77.128336	0	0	1	0.05	1	0.05	0	0
Quincy Park (Lot 1)	1021 N Quincy St	22201	38.884981	-77.106750	0	0	0	0	1	0.05	1	0.1
Quincy Park (Lot 2)	1021 N Quincy St	22201	38.884981	-77.106750	0	0	0	0	1	0.05	1	0.1
Carpool Rest.	4000 Fairfax Dr	22203	38.882209	-77.108231	1	2	0	0	0	0	1	0.1
Mazda Site	750 N Glebe Rd	22203	38.879344	-77.113756	1	2	0	0	0	0	0	0
Lubber Run Recreation Center	300 N Park Dr	22203	38.873434	-77.114174	0	0	0	0	1	0.05	1	0.1
Virginia Highlands Park	1600 S Hayes St	22202	38.858419	-77.060755	0	0	0	0	1	0.05	1	0.1
Oakridge Elementary School	1414 24th St S	22202	38.850231	-77.070004	0	0	1	0.05	0	0	1	0.1
Jennie Dean Park	3630 27th St S	22206	38.844031	-77.087481	0	0	0	0	1	0.05	1	0.1

Name of Site	Access to Metro (Dist. In miles)	Metro Inv	Normalized Metro	Normalized Weighted Metro	Weighted Metro	Access to Public Bus Transit (Lines serving the site)	Normalized Public Bus Transit	Weighted Bus Transit	Lot Depth (depth in ft at the center)	Normalized Lot Depth	Weighted Lot Deph
Wilson Elementary School	0.3	3.3333333	0.15	0.30	0.60	3	0.2	0.04	350	0.68750	1.37500
Courthouse Square	0.05	20	1.00	2.00	4.00	7	1	0.2	185	0.17188	0.34375
Clrendon West	0.12	8.3333333	0.41	0.81	1.62	5	0.6	0.12	230	0.31250	0.62500
Edison Complex	1.3	0.7692308	0.02	0.04	0.08	2	0	0	450	1.00000	2.00000
Quincy Park (Lot 1)	0.4	2.5	0.11	0.22	0.43	5	0.6	0.12	130	0.00000	0.00000
Quincy Park (Lot 2)	0.4	2.5	0.11	0.22	0.43	5	0.6	0.12	130	0.00000	0.00000
Carpool Rest.	0.2	5	0.24	0.47	0.94	5	0.6	0.12	170	0.12500	0.25000
Mazda Site	0.3	3.3333333	0.15	0.30	0.60	5	0.6	0.12	240	0.34375	0.68750
Center	0.7	1.4285714	0.05	0.11	0.22	5	0.6	0.12	170	0.12500	0.25000
Virginia Highlands Park	0.2	5	0.24	0.47	0.94	3	0.2	0.04	330	0.62500	1.25000
Oakridge Elementary School	1.3	0.7692308	0.02	0.04	0.08	5	0.6	0.12	250	0.37500	0.75000
Jennie Dean Park	2.7	0.3703704	0.00	0.00	0.00	5	0.6	0.12	140	0.03125	0.06250

Name of Site	Level Difference of at least 10 ft?	Weighted Level Diff	Located Centrally?	Weighted Centrally located	Lot Size (acres)	Lot Size Inverse	Normalized Lot Size	Weighted Lot Size	Distance to nearest elementary school (miles)	Normalized Elementary School	Weighted Dist. From ES	Total w2
Wilson Elementary School	1	0.05	0	0	2.74	0.364964	0.205	0.010	0	0	0	2.279
Courthouse Square	0	0	0	0	0.92	1.086957	1.000	0.050	0.19	0.296875	0.59375	7.337
Clrendon West	1	0.05	1	1.5	1.85	0.540541	0.398	0.020	0.33	0.515625	1.03125	6.969
Edison Complex	1	0.05	1	1.5	5.58	0.179211	0.000	0.000	0.4	0.625	1.25	4.981
Quincy Park (Lot 1)	0	0	1	1.5	1.57	0.636943	0.504	0.025	0.4	0.625	1.25	3.479
Quincy Park (Lot 2)	0	0	1	1.5	1.24	0.806452	0.691	0.035	0.4	0.625	1.25	3.489
Carpool Rest.	0	0	1	1.5	1.87	0.534759	0.392	0.020	0.64	1	2	6.933
Mazda Site	0	0	1	1.5	2.78	0.359712	0.199	0.010	0.45	0.703125	1.40625	6.328
Center	0	0	1	1.5	1.4	0.714286	0.589	0.029	0	0	0	2.265
Virginia Highlands Park	1	0.05	0	0	3	0.333333	0.170	0.008	0.64	1	2	4.442
Oakridge Elementary School	1	0.05	0	0	5.4	0.185185	0.007	0.000	0	0	0	1.152
Jennie Dean Park	0	0	0	0	1.9	0.526316	0.382	0.019	0.3	0.46875	0.9375	1.289

Attribute	Weights (Good Metro, Mixed use, good depth& away from ES)
Metro Access	2
Public Bus Transit	0.2
Aff Housing Dev	0.05
Mixed-Use Dev	2
School Dev	0.05
Lot Size	0.05
Lot Depth	2
Centrally Located	1.5
Dist. From ES	2
Level Diff.	0.05
Shared Community Facility	0.1
	10

## Bibliography

- McKoy, Deborah, Jeffrey M. Vincent, and Carrie Makarewicz. "Integrating infrastructure planning: The role of schools." *ACCESS Magazine* 1, no. 33 (2008)
- Arlington Public Schools. Arlington School Board Adopted, FY 2015 – FY 2024 Capital Improvement Plan, accessed October 15, 2015, <http://arlingtonva.s3.amazonaws.com/wp-content/uploads/sites/18/2014/09/9.-APS.pdf>
- Architectural League of New York, Public Education Association of the City of New York, and Princeton Architectural Press. 1992. *New Schools for New York*. New York, N.Y.: Architectural League of New York
- Dino Marcantonio, *Iconography and the Transect*, accessed October 2, 2015 <http://www.planetizen.com/node/89>
- American Society of Planning Officials. *New Physical Forms of the city School: The Urban Context*, June 1968, accessed October 20, 2015 <https://www.planning.org/pas/at60/pdf/report235.pdf>,
- Joint Use School Partnerships in California: Strategies to Enhance Schools and Communities accessed May 17<sup>th</sup> 2016, [http://citiesandschools.berkeley.edu/reports/CC&S\\_PHLP\\_2008\\_joint\\_use\\_with\\_appe-ndices.pdf](http://citiesandschools.berkeley.edu/reports/CC&S_PHLP_2008_joint_use_with_appe-ndices.pdf)
- Bonus Density and Height Exceptions, Land Use and Zoning Tools, Housing, Arlington, VA, accessed Dec 11 2015, <https://housing.arlingtonva.us/development/land-use-zoning-tools/>
- Private Development, Projects and Planning, accessed Dec 11 2015 <http://projects.arlingtonva.us/private-development/>
- Arlington Public Schools – Elementary School Space Guidelines, accessed May 18<sup>th</sup> <http://www.apsva.us/cms/lib2/VA01000586/Centricity/Domain/105/Elementary%20School%20Guidelines%20Final%20SB.pdf>
- School Site Selection Historic PAS Report Series American Planning Association, accessed Dec 12 2015, <https://www.planning.org/pas/at60/report175.htm>

Recommended sites for Schools, Public Land for Public Good, Projects and Planning, Arlington County VA, accessed Dec 12 2015,  
<http://projects.arlingtonva.us/plans-studies/land-use/public-land/>

Major Corridors Development, Projects and Planning, Arlington VA,  
<http://projects.arlingtonva.us/data-research/development/major-corridors/>

Recommended Sites for Affordable Housing, Public Land for Public Good, Projects and Planning, Arlington County VA, accessed Dec 12 2015,  
<http://projects.arlingtonva.us/plans-studies/land-use/public-land/>

Clarendon Sector Plan, accessed May 17 2016,  
<http://arlingtonva.s3.amazonaws.com/wp-content/uploads/sites/31/2014/03/Clarendon-SectorPlan06.pdf>