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Brittny N. Wagner

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A Lack of Inclusive Playgrounds and How GIS Can Bridge the Gap: A Case Study in Metro Denver

Brittny N. Wagner
University of Denver
Department of Geography and the Environment
Capstone Project for
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Abstract

Inclusive and accessible playgrounds are a vital component to a sustainable and healthy community. These types of playgrounds encourage interactions between children of all abilities, which is a key component of social, emotional, and physical development. Playgrounds are often outdated or built without considering the needs of different types of community members. This is often due to lack of research about what it means to build an accessible playground and lack of awareness of the need for this type of play coming from city officials and park planners. Many parents and caregivers are left wondering where accessible playgrounds are located, or which playgrounds near them have at least some level of accessibility, like hard surfacing and ramps for wheelchair access. Spatial tools like GIS are the key to bridge the gap between what currently exists, and what can be built to create a brighter future of play for children in the community.

Introduction

While a playground or park can seem like such a simple aspect of a community, it is a benchmark in meeting the needs of a child's core development. Outdoor play is vital for a child's development for many reasons, including gross motor skills, problem solving abilities, self-expression, and social-emotional development through bonding with other children. A playground is supposed to help facilitate these developmental skills, and so much more. Many playgrounds seem appropriate to the outside viewer; they are typically dotted with slides, swings, climbing structures, and the occasional merry-go-round; however, therein lies the problem. Many people view these play areas as adequate to meet the needs of the average child, forgetting about children and caregivers with different ability levels, such as wheelchairs, canes, or walkers. Suddenly, when viewed through a different lens, these playgrounds and parks become transformed, with blaring gaps of accessible equipment and surfaces for these community members with different abilities. The term "differently abled" can take on many forms. While ADA accessibility mostly targets those using a wheelchair or walker, there are many other ability levels children and their caregivers can experience, and standard playgrounds often do not meet their needs. Vision impairment, deafness, autism spectrum, and sensory disorders are all examples of differently abled children who could also benefit from a more inclusive playground environment. Children who are vision impaired could benefit from hard surfacing to avoid tripping hazards while using their canes and could enjoy interactive aspects of a playground written in Braille, while children with sensory disorders could benefit from playground additions like musical instruments and a creative infrastructure. Not only do most playgrounds create a barrier for differently abled children, but also their parents or

caregivers who may find it difficult to interact with their children on traditional playground equipment or filler substances. For example, grandparents who have a cane or walker to assist in balance, and need a solid surface to walk on, are prevented from playing with their grandchildren on most playgrounds filled in with mulch, sand, and gravel.

This project will evaluate existing research done on the importance of outdoor play for children of all abilities, the design methods and standards for inclusive playgrounds including ADA compliance, what organizations exist to advocate for change, where inclusive playgrounds already exist around the Denver Metro, how GIS can connect parents and their children to what already exists in their communities, and how GIS can be used to push this type of innovation further. This project will analyze existing research, run statistical analysis on playground filler substances that may be creating a barrier, and GIS will be used to run an inventory on current playgrounds (traditional versus accessible) as well as to determine access to parks by the surrounding population through means of public transportation. Through these methods, this capstone project will answer the questions, “Why is inclusive play important for children and their families?”, “How can GIS be used to identify barriers to inclusive play?”, and “Where are current accessible playgrounds located and where can more be built in the future?”.

Background

In order to proceed with data analysis, it is vital to understand the foundational knowledge of why outdoor play is so important for a child’s development. Researchers Bento and Dias (2017) demonstrate this importance beginning at a very early age, showing evidence that outdoor play promotes self-esteem, bodily awareness, and creativity in many ways that a child cannot experience while indoors in a classroom through big loud movements, exposure to

nature, and social interactions with their peers (Bendo and Dias, 2017). Al-Maiyah and Parker (2021) recognize that the design elements of playgrounds can largely facilitate this development, especially through the encouragement of social interactions. Even though this research is highly recognized and developed across many different disciplines, it is apparent that children with disabilities are repeatedly left out of the equation, usually due to a partial or complete lack of design consideration to encourage play between children of all levels of abilities (Al-Maiyah and Parker, 2021); however, play between differently abled children is equally as important and vital for development, as well as exposure to the outdoors for children of different abilities.

Study Area

For the purpose of this capstone, the study area focuses on Denver, Colorado and surrounding adjacent cities containing existing accessible playgrounds including Arvada, Aurora, Broomfield, Castle Rock, Commerce City, Lakewood, Littleton, Lone Tree, Northglenn, Parker, Thornton, and Westminster. While accessible playgrounds exist in other Colorado cities, such as Boulder, Colorado Springs, Fort Collins, and Greely, those have been excluding from this study for purpose of scope, instead focusing on the Denver area.

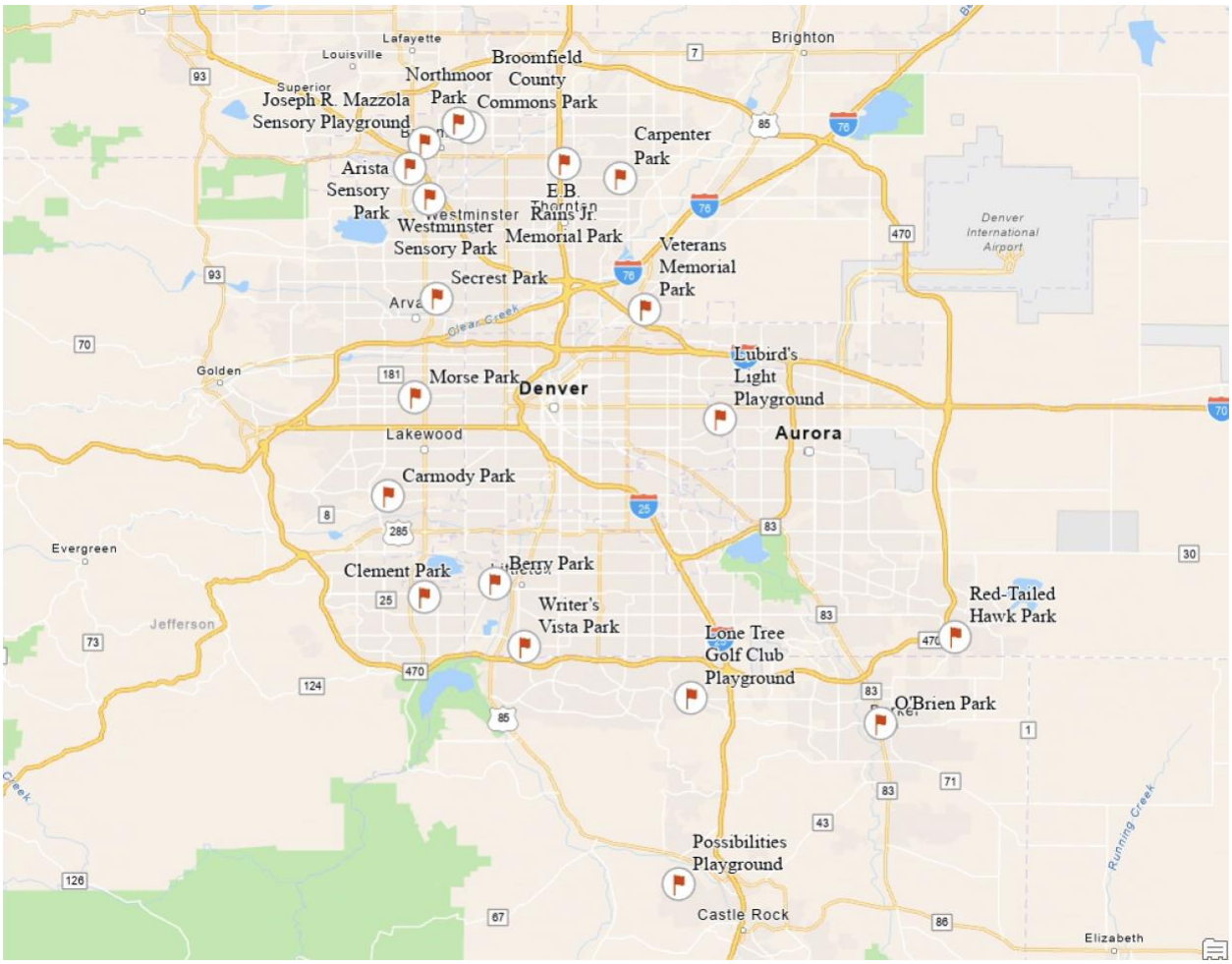


Figure 1: A map of the study area.

Standards

A playground is considered “inclusive” or “accessible” and meets the requirements to be included in this research if that playground has hard surfacing, such as rubber or poured in place substances, and an additional two accessible features. Those additional features can include ramps to and from the playground structure, sensory panels, auditory experiences and musical instruments, spinners, merry-go-rounds, handicapped swings, accessible water features, or other playground equipment to facilitate play between children of different ability levels. Each of the accessible playgrounds featured in this research meet those standards.

Playgrounds existing on public or private school property were not included in this research due to lack of available data and security reasons.

This capstone identifies possible barriers for community members to access these playgrounds through forms of transportation, such as by car or through forms of public transportation. Communities were defined by Colorado 2010 census tracts, and those areas were chosen based on the top three census tracts with the highest density of young children under the age of 10. A standard of greater than five miles was set to identify the census tracts with a high density of young children that were in excess of five miles from an existing accessible playground. The standard of five miles can be via car or public transportation methods. Those census tracts were then selected as candidates for potential future accessible playgrounds to be built or standard playgrounds to be retrofitted. When identifying public transportation access to the existing accessible playgrounds included in this research, all forms of RTD public services were included, such as bus routes, light rail lines, and Flexrides, which are services that provides additional rides to make public transportation connections in certain areas throughout the Denver Metro. Any private busing systems or ride share services were not included in this research.

Literature Review

Once a foundational knowledge is established of the importance of outdoor play, a literature review can be conducted to focus on the basic concepts of playground design, including the guidelines, standards, and governing bodies that dictate these practices. By understanding the choices community/city planners and playground designers make when constructing a playground, connections can be made between these design decisions and the

lack of inclusivity within the plans. According to Olson (2015), there is a planning framework that city planners and designers must consider, including management considerations, a planning committee, and planning steps. When including management considerations in the planning framework, it is vital to understand ADA compliance, safety guidelines, and proper installation procedures. A “planning committee” carefully considers who will be making major decisions involving the new addition to the community, and is best done with a small group of people versus just a single person. Planning steps lay the groundwork for the planning committee and management agencies, and include predesign, design, development, and evaluation (Olson, 2015). While these designers and committee members are key players in the process, they also must abide by the national standards and safety precautions set up by the governing bodies of that area. In the United States, those governing bodies include the U.S. Department of Justice, ASTM International, and the U.S. Consumer Product Safety Commission, and the ADA Americans with Disabilities Act (Olson, 2015). Even though these governing bodies and standards exist, there is still a major lack in accessible or inclusive playground equipment. Brown, et al., (2021) argues that while these standards and guidelines show progressive movement towards inclusive playground design, the lack of accessibility exists due to holes in these regulations that do not always ensure direct play between children of all ability types (Brown, et al., 2021). Unfortunately, many playground designers are focused on sales pitches, and to the “normative” narrative of the community, and their designs are continuously influenced by these means versus scientific research (Brown, et al., 2021). If a playground is designed around accessibility, many times this only includes small areas for wheelchair access, excluding design aspects that would engage a very large number of children with other types of

disabilities, such as sensory issues, deafness, or blindness (Brown, et al., 2021). While partial access is better than no access, researchers Stanton-Chapman and Schmidt (2017) argue that full, not partial, engagement between children of all abilities levels is absolutely vital for children with disabilities to better understand the world around them and aid into the transition to adulthood interactions (Stanton-Chapman and Schmidt, 2017). Stanton-Chapman and Schmidt also argue that the reason for the lack of interactions is not because the child is disabled, but because the surrounding environment is disabling the child from full participation. For example, most playgrounds in the United States use mulch, wood chips, and sand to fill in around playground equipment, instead of a flat surface like soft rubber. It is in fact this type of surfacing that prevents the differently abled child from using the equipment or playing with peers, not the wheelchair or walker (Stanton-Chapman and Schmidt, 2017). It also prevents parents or caregivers who may be differently abled from interacting with their children.

However, there are designers and architects that are trying to upgrade the way they think about play, whether that be through creating destination play spaces or considering the needs of the surrounding community members. An example of this type of design firm exists in the Denver Metro area and they are working towards putting the focus on people, community, public health and the environment when they create projects. Design Concepts has helped create a “sensory playground” in Northglenn, Colorado, where they worked side by side with parks and planning staff, as well as service providers that assist senior and disabled community members, to fully renovate an existing park into something new and innovative to better serve the people in this area. Northglenn Sensory Park is accessible for not only children with different abilities, but also their parents or grandparents who may be disabled, creating a

unique opportunity for multi-generational inclusive playtime (Design Concepts, 2021). According to the website, Northglenn Sensory Park is providing nearly 100% accessibility for people who need to use a wheelchair by incorporating hard, rubber surfaces versus mulch or gravel, as well as unique sensory-based experiences for children who may be blind, deaf, or be on the autism spectrum (Design Concepts, 2021). Design Concepts is breaking down the barriers that old, traditional playgrounds used to present, and creating a roadmap for future designers and park planners throughout the Denver Metro.

This literary review also shows research of how GIS is being used by parks and recreation departments in the United States, and how that technology can inspire future projects such as this one. Esri has rolled out a program called Smart Parks, where GIS will be used to help park management with planning, engineering, operational issues, and civic inclusion (Esri, 2021). This program applies to all parks in general, including trails and open spaces, and not to playgrounds specifically; however, it has huge potential to be utilized in other ways as it gains popularity over time. Kim (2020) observes how GIS tools like Smart Parks can help city and park planners modernize the way they manage parks moving forward, which can ultimately show them ways to better serve community members. One of the most valuable ways in which Smart Parks can assist park managers is through planning and engineering. Kim (2020) states that park managers can collect community driven data through tools like Esri's Survey 123 and apply that to future changes that need to be made to parks based upon the community's input and basic demographic data (Kim, 2020). Esri tools like Survey 123 can also be used to aid in this project, gaining community knowledge, opinion, and engagement in this way can identify the community's needs and assess which neighborhoods have the greatest

need for an accessible playground. There are other models in the United States that can serve as inspiration for how they are using GIS to transform parks and park management. One such project occurred in Three Rivers Park District in Minnesota, where the GIS team relied upon public participatory GIS and community engagement to shape the way land was being managed. By changing static maps to interactive ones, the public, along with volunteers, were able to engage with the GIS department to map areas of recreation around the park. This type of public engagement demonstrated how the park was being used through recreational activities that were most important to the community members, and aided GIS staff to better serve the community's needs through increased public safety and park management resources (Esri, 2018). This example shows the importance of public participatory GIS, and serves as a model for how it can be applied to bridge GIS with future accessible playground projects in the Denver Metro based on what community members need the most to facilitate inclusive play in their neighborhoods. These are the types of GIS tools that can help connect parents and caregivers to existing levels of accessibility in playgrounds across the Denver Metro. For example, combining Smart Parks with ArcGIS Pro to create a map of current playgrounds and the different accessible features like a handicapped ramp, surface material, special handicapped swings, or sensory features.

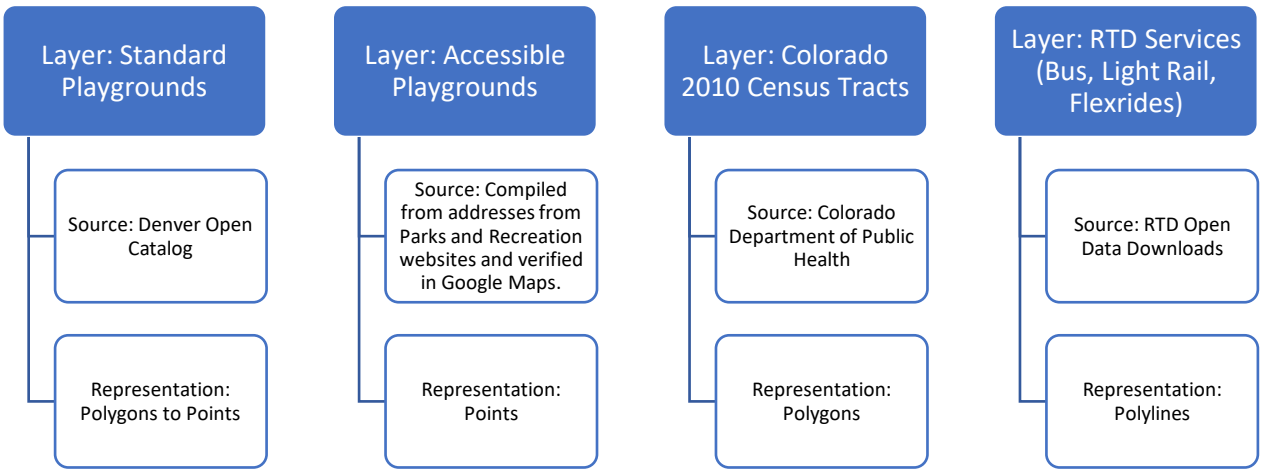
While this type of GIS tool doesn't yet exist in Colorado, there are companies using spatial thinking to push boundaries and make change. According to Dow (2015), a company called KaBOOM! has been researching playground inequities since 1996, and is using GIS technology to map areas that are child dense, and playground sparse (Dow, 2015). Through an initiative called Playful City USA, KaBOOM! is using mapping to identify areas where low income

children do not have access to a play space, park, or playground, and helping cities use this information to make changes (Dow, 2015). While this initiative isn't specifically targeting accessibility and inclusivity, it is laying the foundation for future research by showing how GIS and mapping tools can be used to solve social justice problems in communities. There are other organizations at the local level in the Denver Metro area that are advocating for direct change to the way we view interactive play among children. Lu Bird's Light Foundation, based out of Denver, is an organization that has already completed eight projects to either update existing playgrounds, donate accessible equipment, or build entirely new playgrounds from the ground up. Most recently, Lu Bird's Light Foundation has completed the Denver Metro's very first fully inclusive playground adjacent to the Stanley Marketplace in Aurora, Colorado (Lu Bird's Light Foundation, 2021). Fully inclusive and accessible means that every aspect of this playground can be used by any child, not matter their ability level. This 9,000 square foot play space is groundbreaking and can serve as a model for future playgrounds in other communities throughout the Denver area that are lacking in inclusive outdoor play spaces.

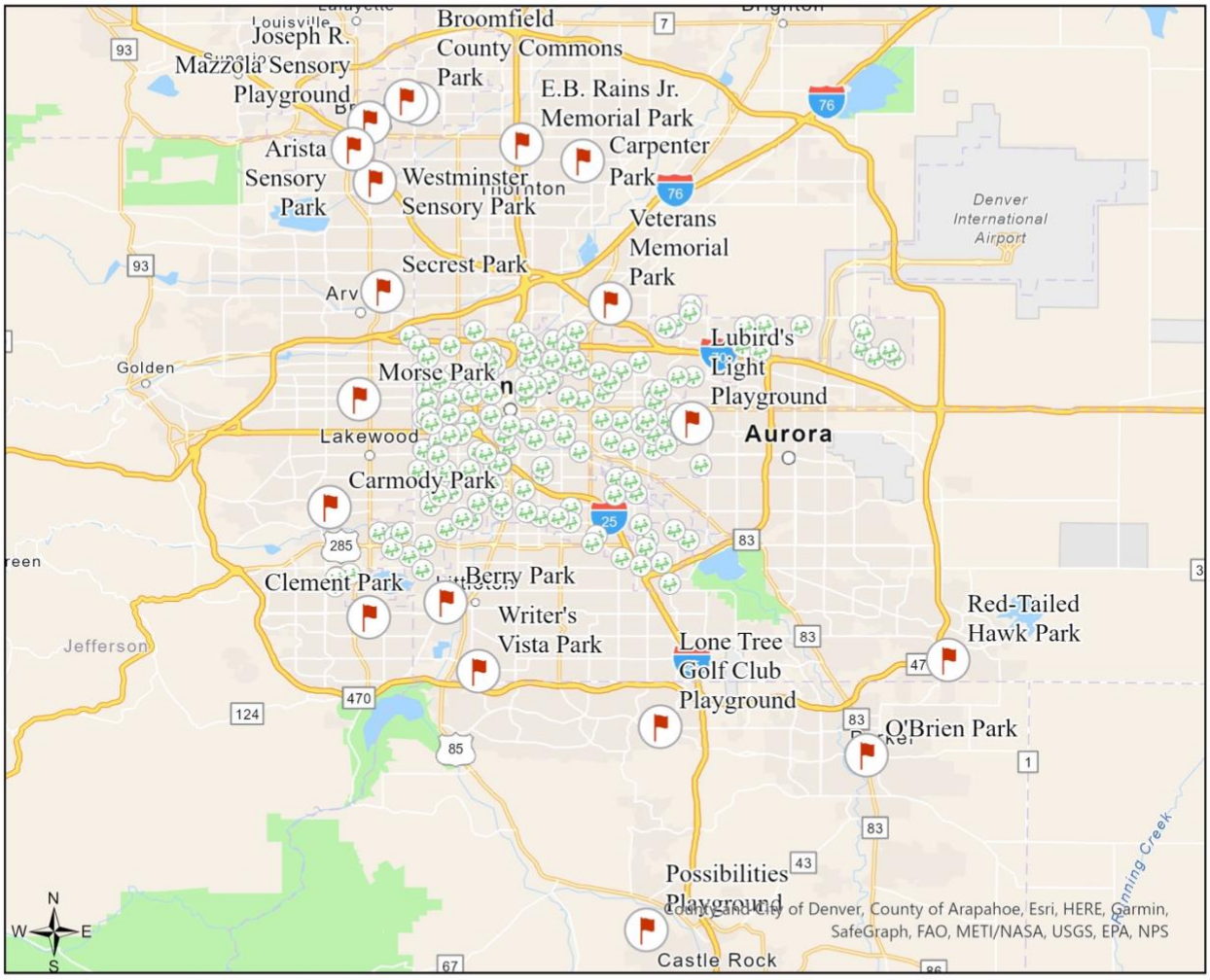
Design and Implementation

The first step in the design and implementation process was to collect and analyze GIS data from open sources. Data was collected from the Denver Open Data Catalog, the Colorado Department of Public Health, and the RTD's site for open data downloads. Statistical data on playground filler substances was collected using playground shapefile from the Denver Open Catalog. The playground shapefile was added to ArcGIS Pro, the attribute table was opened, and the attribute "Surface Type" was statistically analyzed to reveal the percentage of playgrounds with wood filler (mulch chips), pea gravel, sand, rubber surfacing, or poured in

place (concrete). This shapefile existed as polygons on the map, so the feature to point data management tool was used to convert the polygons to points on the map. There is no existing dataset identifying existing accessible or inclusive playgrounds, so this was created manually. The accessible playgrounds were identified based upon the standards set within this research and verified in the form of ground-truthing. While still using ArcGIS Pro and cross-checking Google Maps, a "Create Points" feature was used to add point features in the form of existing accessible/inclusive playgrounds around the Denver area. Once the point was created, the attributes for those points were added by filling in the park name and the description of the level of accessibility with included features. Once both standard playground points and accessible playground points were added to the map in ArcGIS Pro, the areas that were lacking accessible playgrounds could be identified.



Comparison of Inclusive Playgrounds Versus Standard Playgrounds in the Denver Metro, May 2023



This map shows the comparison between standard playgrounds and inclusive or accessible playgrounds in the Denver area. The accessible playgrounds have been identified based upon standards set within this research to offer partial or full levels of accessibility for children, parents, and caregivers of different ability levels, including wheelchair access. This map was created to show the high number of standard playgrounds versus accessible playgrounds, highlighting the disparity between the levels of play. Standard playground point data is currently on available for the city and county of Denver, Colorado. Accessible playground point data was created manually.

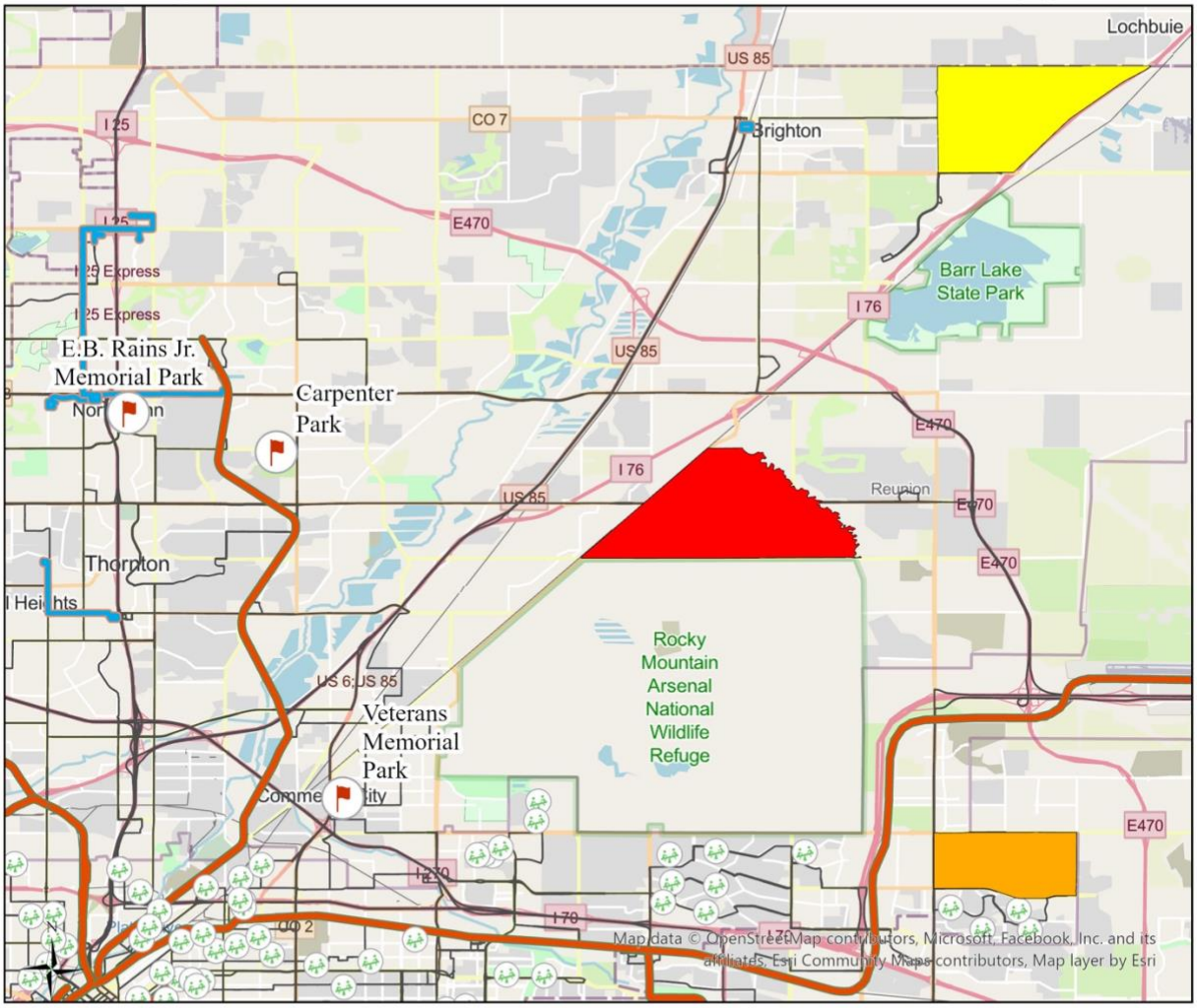
Author: Brittny N. Wagner
Produced on: May 3, 2023
University of Denver
Denver, Colorado

0 2.75 5.5 11 Miles

Accessible Playground
Standard Playground

Colorado census tracts from 2010 from the Colorado Department of Public Health were added to the map to identify the census tracts with the highest density of young children under age 10, with the farthest transportation route to the nearest accessible playground. This was done by reviewing the attribute table for Colorado 2010 Census Tracts and sorting the attributes in ascending order to identify the census tracts with the highest number of children under age 10. The “Select by Attributes” tool was used to select the top three census tracts with the highest density of young children. RTD polyline data was added to the map, and a “Select by Attribute” tool was used to create a new selection for bus routes, light rail lines, and Flexrides, in accordance with the transportation parameters set within this research. The “Measure” tool was used to measure the distance in miles along the centerline of roads and RTD routes, confirming each tract was more than five miles to the nearest accessible playground via a car or in the form of public transportation. A new layer was created from the selections to show those tracts on the map, ranked in order from most dense to least dense.

Colorado 2010 Census Tract Analysis between High Densities of Young Children and Distance to an Accessible Playground



This map represents an analysis of Colorado 2010 Census Tracts with a the highest densities of young children that have more than a 5 miles commute to the nearest accessible playground via a car or RTD public transportation routes such as busing, light rail, or Flexrides. The census tract highlighted in red has the highest density of children under age 10, the orange census tract has the second highest, and the yellow census tract has the third highest density of young children. The measure tool was used along transportation centerlines to measure the distance to the nearest accessible playground in miles. These census tracts would be recommended candidates for future potential accessible playgrounds to be built based upon these results.

Accessible Playground
Standard Playground
RTD Bus Routes
RTD Flexride
RTD Light Rail Lines
Recommended Tract 1
Recommended Tract 2
Recommended Tract 3

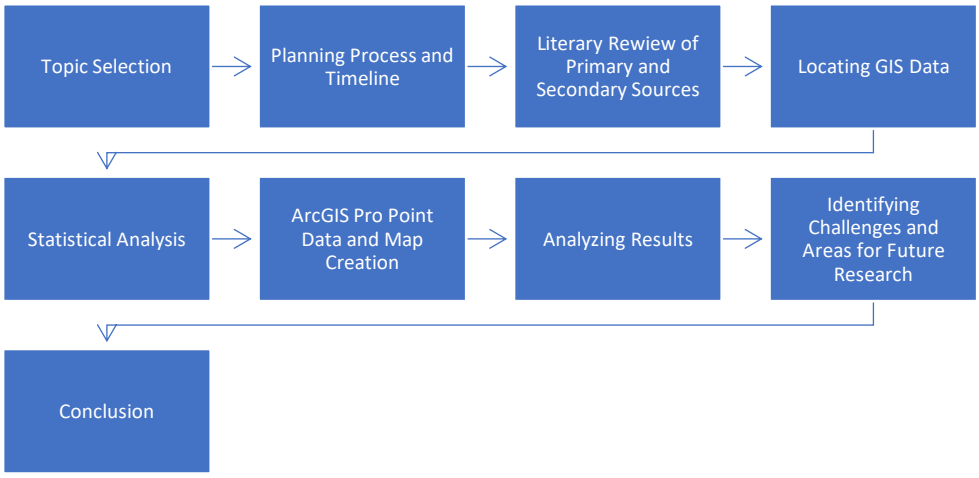
Author: Brittny N. Wagner
Produced on: May 4, 2023
University of Denver
Denver, Colorado

0 1 2 4 Miles

Challenges

Several challenges did arise during the research process. The first challenge occurred during the step of locating existing GIS data. While park and playground data were available within the city and county of Denver in the form of a shapefile, other cities and counties included in this research did not have playground point or polygon data available. This prevented a wider comparison between standard and accessible playgrounds within this capstone. There was also no pre-existing GIS data on accessible playgrounds anywhere in the State of Colorado, so this data had to be created manually through research, set standards, and ground-truthing, which was time consuming. A sample size of 19 accessible playgrounds were verified to meet the standards set within this research. Many park and recreation websites listed the general information of a park but offered little to no details on the accessible or inclusive features beyond a description such as “playground”, “picnic table”, or “gazebo”. With over 174 standard playgrounds in the city and county of Denver alone, there simply isn’t enough time to do ground-truthing and verify the accessibility level of each playground; however, that could be left open for future research or public participatory GIS methods.

Flowchart



Results

Upon reviewing the City and County of Denver's playground GIS data, it was discovered in the attribute table that the "surface type" of each playground was available for download. Out of 174 features, only one playground, I-70 Cover Park, was listed to have a hard rubberized surface. There were five playgrounds listed to have a surface type of "poured in place", meaning poured concrete surfacing. This means that out of the 174 playgrounds, only 3.4% have hard surfacing, which would be suitable for those needing this type of surfacing for mobility. The remaining playgrounds are filled with surfacing incompatible for differently children or their caregivers needing hard surfacing for mobility. There were 25 playgrounds with sand, one with pea gravel, two with turf, and 139 with "wood fiber" or mulch. The data also revealed that there are no fully accessible or inclusive playgrounds within Denver City and county boundaries. While some playgrounds in the City and County of Denver may have accessible or inclusive features, they did not meet the standards set within this research to have hard surfacing, plus the addition of two other accessible elements. All of the existing accessible playgrounds that meet the standards set within this research are located in the adjacent cities of Arvada, Aurora, Broomfield, Castle Rock, Commerce City, Lakewood, Littleton, Lone Tree, Northglenn, Parker, Thornton, and Westminster. A descriptive table can be seen below.

Arista Sensory Park	• Location: Broomfield, Colorado • Description: Part of Children's Hospital Therapy Clinic. Inclusive features such as ramps, sensory features, and swings.
Berry Park	• Location: Littleton, Colorado • Description: Some accessible features including rubber surfacing, sensory panels, and a swing.
Broomfield County Commons Park	• Location: Broomfield, Colorado • Description: PlayCore National Demonstration Site.; Some inclusive features such as some rubber surfacing and a swing.
Carmody Park	• Location: Lakewood, Colorado • Description: Innovative universal playground with hard rubber surfacing for wheelchair access.
Carpenter Park	• Location: Thornton, Colorado • Description: Inclusive elements like a swing and ramps to playground equipment. hard rubber surfacing for wheelchair access, accessible splahpad available in summer months.
Clement Park	• Location: Littleton, Colorado • Description: Accessible features such as a merry-g-round and swings, hard rubber surfacing, sensory elements like musical instruments.
E.B. Rains Jr. Memorial Park	• Location: Northglenn, Colorado • Description: Accessible playground with sensory features, Braille features, and an accessible water play area.
Joseph R. Mazzola Sensory Playground	• Location: Broomfield, Colorado • Description: Some accessible features available like a ramp leading to the playgroud eqipment and an accessible swing.
Lubird's Light Playground	• Location:Aurora, Colorado • Description: 100% accessible playground with smooth barrier- free surfacing, slides, swings, and spinners for all.
Lone Tree Golf Club Playground	• Location: Lone Tree • Description: Accessible playground with rubber surfacing and ramps leading onto playground equipment.
Morse Park	• Location: Lakewood, Colorado • Description: Some accessible features including rubber surfacing, a ramp to the play structure, and sensory panels.
Northmoor Park	• Location: Broomfield, Colorado • Description: Sensory playground with some rubber surfacing, ramps, and sensory panels.
O'Brien Park	• Location: Parker, Colorado • Description: Universal playground equipment and surfacing with some sensory elements.
Possibilities Playground	• Location: Castle Rock, Colorado • Description: Future site for a universal, sensory rich playground to open Summer 2023.
Red-Tailed Hawk Playground	• Location: Aurora, Colorado • Description: Accessible features include swing and spinner, sensory garden, and splash area.
Secrest Park	• Location: Arvada, Colorado • Description: Some accessible features including hard rubber surfacing, ramps, a swing, and a merry-go-round.
Veterans Memorial Park	• Location: Commerce City, Colorado • Description: Inclusive features like a swing and a merry-go-round, nature play area.
Westminster Sensory Park	• Location: Westminster, Colorado • Description: Special use sensory park with ramps and adaptive swings, sand pits, musical instruments, and a water area.
Writer's Vista Park	• Location: Littleton, Colorado • Description: Some accessible features including hard rubber surfacing, sensory panels, and a swing.

When performing analysis on the Colorado 2010 Census Tract data, census tracts with the highest density of young children were discovered by running statistics on the attribute "ageunder10", which means children under age 10. This attribute parameter was chosen because most playground equipment is designed for children two to five years old or five to nine years old depending on the size of the playground structure. While several other census tracts had even higher densities of children under age 10, those were not selected for this research because they did not meet the standard of being in excess of five miles to the nearest accessible playground. Each descending census tract was evaluated using the measure tool, until the top three census tracts were found and ranked in order from most dense to least dense. Census tract 008539, highlighted in red on the map, contains 1,867 children under age 10. It is located 5.60 miles by car from the nearest accessible playground of Carpenter Park, located in Thornton, Colorado, and 5.79 miles by RTD's public bus route. There is no light rail access or Flexride access from this census tract to Carpenter Park.

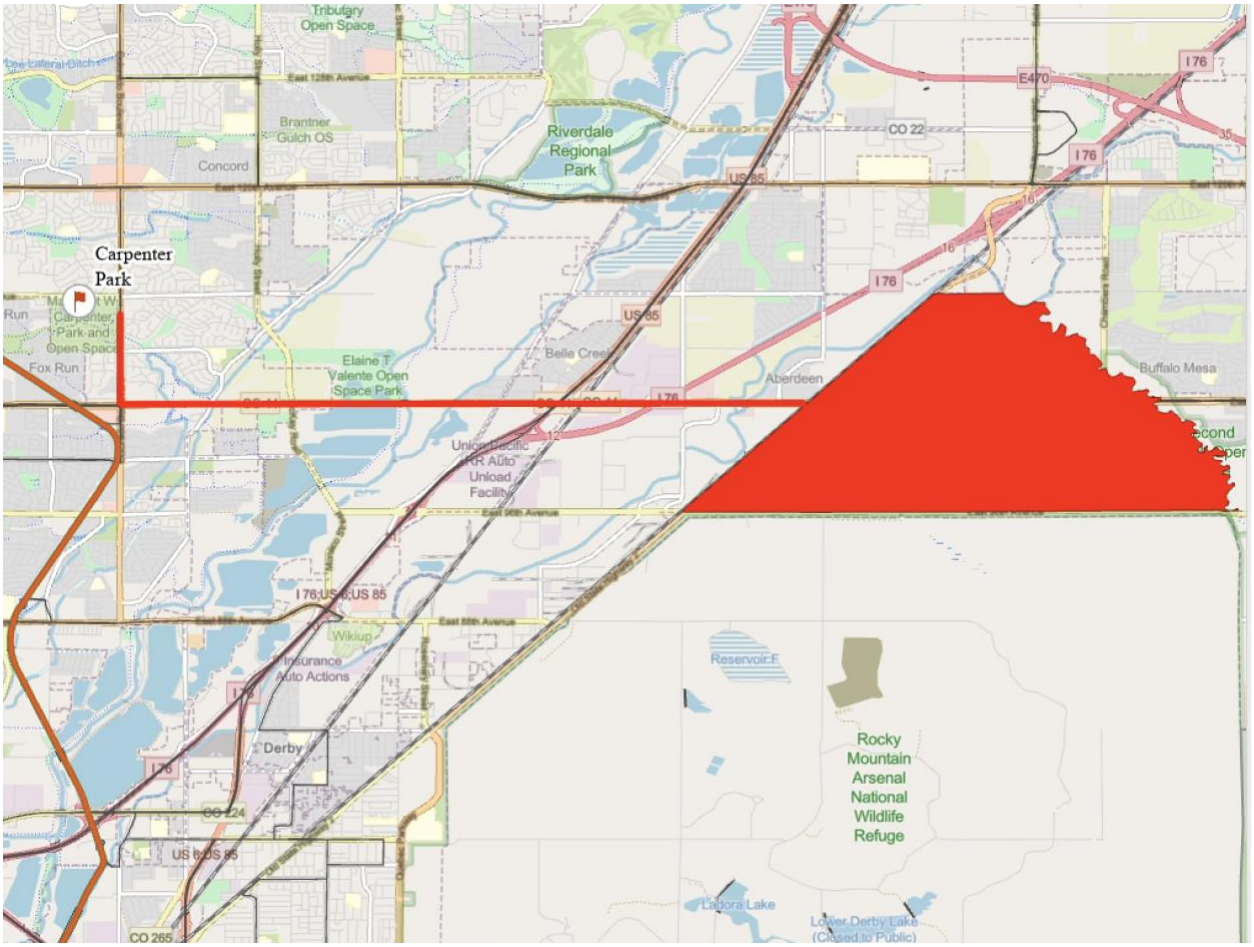


Figure 2: A map of Census Tract 008539 and the shortest route by vehicle from the edge of the Census tract polygon boundary to the nearest accessible playground of Carpenter Park, shown in red.

Census tract 008389, highlighted in orange on the map, contains 1,690 children under age 10. It is located 9.88 miles by car from the nearest accessible playground of Lubird's Light playground, located in Aurora, Colorado, and 9.50 miles by RTD's public bus route. While there is a light rail line nearby, there is no direct light rail or Flexride access from the census tract to Lubird's Light playground.

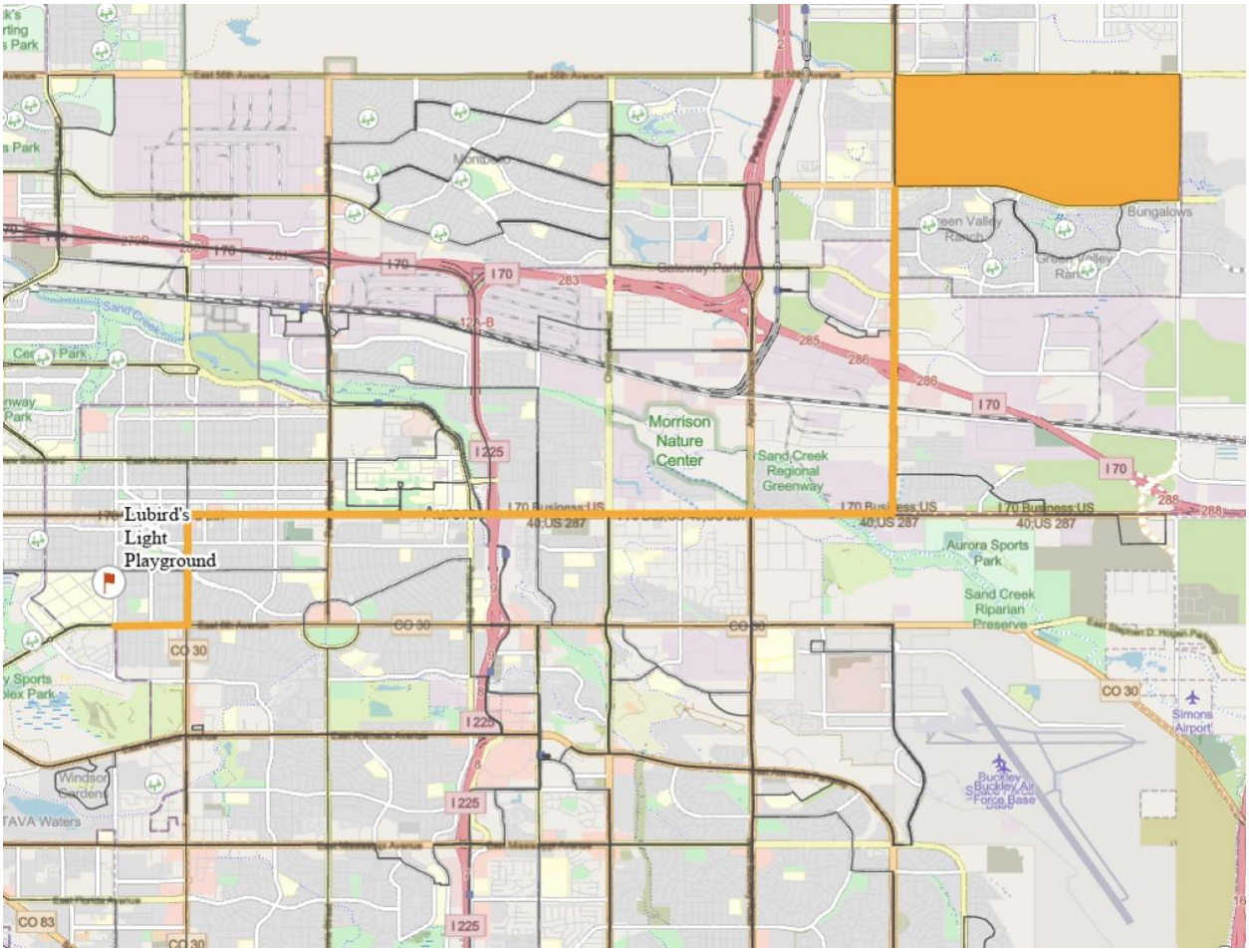


Figure 3: A map of Census tract 008389 and the shortest route by vehicle from the edge of the Census tract polygon boundary to the nearest accessible playground of Lubird's Light, shown in orange.

Census tract 008542, highlighted in yellow on the map, contains 1,545 children under age 10. It is located 14.23 miles by car from the nearest accessible playground of Carpenter Park, located in Thornton, Colorado, and 16.40 miles by RTD's public bus route. There is no light rail or Flexride access from this census tract to Carpenter Park.

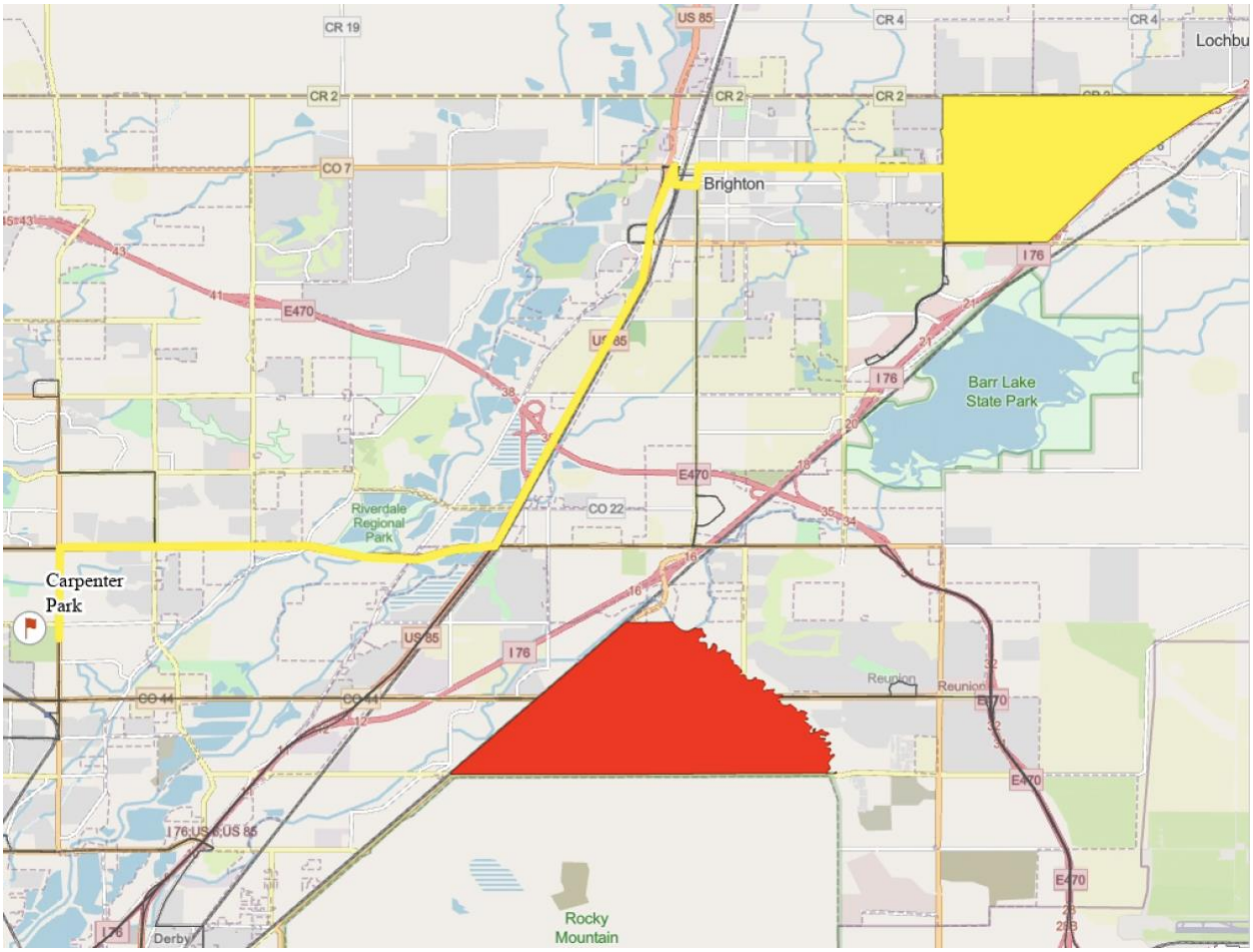


Figure 4: A map of Census Tract 008542 and the shortest route from the edge of the polygon boundary by vehicle to the nearest accessible playground of Carpenter Park, shown in yellow.

Discussion

The goal of this body of work is to contribute to the current and future efforts of social justice organizations, city planners, playground designers, and other community members who are advocating for changes in how playgrounds are designed and built. Based upon literary review, currently there is no research on how GIS can directly impact the future of accessible playground design, which is why this topic was chosen. This capstone project aims to bring GIS technology to the minds of city planners and park designers when considering future projects and renovations by showing the comparison between standard playgrounds and accessible

playgrounds in mapped format. Future site selection locations can be considered based upon demographic analysis founded on Colorado 2010 Census data and transportation analysis shown above. This project also adds value to the current research on the topic by giving parents and caregivers a mapping tool that didn't exist prior to this research to help locate current existing accessible playgrounds that meet their family's needs to foster a more inclusive play environment. While there are several websites that list some accessible playgrounds in and around Denver, these websites only provide partial lists with brief descriptions and written addresses, and none of the lists were comprehensive enough to include everything that currently exists. This project combined all existing accessible playgrounds into one cohesive list and displayed those playgrounds as points on a map that is easy to read and navigate.

Areas for Further Research

This capstone project created the framework for future research endeavors pertaining to planning and designing inclusive and accessible playgrounds. The maps created during this project are comprehensive for what currently exists today; however, new parks are being built and existing standard playgrounds are being renovated all year long. The maps created for this project are static, and therefore portray a glimpse in time. If this capstone project were to be taken further, it would be recommended to bridge GIS with IT to change the maps from static to active, in the form of an interactive downloadable app for iOS and Android users. Parents or caregivers could simply download the app to their smartphones and have mapping technology while on the go. While this app could show all existing accessible playgrounds and their features, it could also show standard parks and playgrounds. This mobile app could use technology like Esri's QuickCapture so that parents, caregivers, or community members who

have the app can update playground features in real-time. Parents and caregivers who visit standard parks or playgrounds could log into this application or website, locate the park on the map by using a search function, and either provide a description of what they see or drop a symbol representing the accessible feature. Not only could parents and caregivers update this information on the app on the fly, but they could also use this app as a tool to locate a specific accessible feature for their differently abled child, especially if there was not a fully inclusive playground near them. For example, if a parent of a differently abled child were visiting friends in an unfamiliar neighborhood and wanted to find a playground with an accessible swing for their child, they could simply log into the app and review the features available at all the nearby parks within a certain set radius of their choice. Filters like distance, bathroom availability, and number of handicapped parking spaces could also be applied when running a search. While this type of website or application could certainly assist parents and caregivers in finding accessible park features, it could also alert city planners or parks and recreation employees to playgrounds in need of repairs, upgrades, or renovations in a timely manner. This type of public participatory GIS could accelerate this research at a more rapid rate due to the extensive time it would take a single researcher or team or researchers to do all the ground-truthing for a large number of playgrounds within a city or county boundary.

Playgrounds are not only public spaces nestled in communities, but also a vital part of elementary schools' curriculum in the form of recess. This capstone project could also be applied to playgrounds on public and private school property, where existing playgrounds can be renovated or retrofitted to meet the needs of the differently abled children enrolled in that school. Further, ArcGIS tools could be used in this scenario, such as Survey123, where parents

and guardians of students are sent a survey to convey their child's ability level and their interest in seeing inclusive playground additions brought to that school. Teachers could also be sent a similar survey to assess their unique point of view, observing how these children interact together during outdoor play and recess. Schools that have the highest density of differently abled children and parent interest could get top priority for playground renovation or re-design within a county that has the budgetary means. Something as simple as a handicapped swing or merry-go-round could make all the difference to a child who typically doesn't get to engage with their peers in outdoor recess.

Conclusion

In conclusion, this project proposal employed a literary review, statistical analysis, and spatial analysis to answer why inclusive play is important for children and their families, where current accessible playgrounds are located, and where can more be built in the future. The disparity between standard playgrounds and accessible playgrounds in the Denver area were highlighted, and GIS was used to run a demographic analysis on surrounding Colorado 2010 Census Tracts with the highest density of young children. This was overlayed with RTD public transportation routes to show how those community members might locate the nearest accessible playground, which was in excess of five miles from the census tract boundary. These methods of analysis were used to identify possible barriers, such as playground surface type or lack of public transportation to and from the playground. This project proposal aimed to connect parents and caregivers of differently abled children to the accessible playgrounds nearest them, and contributed to the greater body of research knowledge by bridging the gap between accessibility through the power of GIS.

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