

LIVING SCHOOLYARDS AS STORMWATER INFRASTRUCTURE INSPIRING SCHOOL GROUNDS OF BERLIN

TECHNICAL TRAINING WORKSHOP AT THE SAN FRANCISCO PUBLIC UTILITIES COMMISSION
JANUARY 12, 2017

*This document is a summary of the two-part technical training workshop held on January 12, 2017 at the San Francisco Public Utilities Commission. Full-length video recordings of this program can be found online at the following links: Part #1: <http://bit.ly/LSY-SI-video> and Part #2: <http://bit.ly/LSY-SI-video2>
This summary was prepared by Sharon Danks, Green Schoolyards America.*

VISITING KEYNOTE SPEAKER:

Birgit Teichmann, Landscape Architect, Landscape Management Engineer, and Founder,
Teichmann LandschaftsArchitekten – Berlin, Germany

Birgit Teichmann, GmbH, is a landscape architect with a strong stormwater engineering background (Landscape Management Engineer, FH) and expertise that blends spatial planning with social work and youth engagement. She has been working in the landscape architecture field in Berlin, Germany for 25 years and is the founder of Teichmann LandschaftsArchitekten, a firm with extensive experience designing school grounds with integrated, child-friendly stormwater infrastructure.

OPENING SPEAKERS FROM THE SAN FRANCISCO BAY AREA:

Rosey Jencks, Program Manager, SFPUC Wastewater Enterprise
San Francisco Public Utilities Commission – San Francisco, California

Nik Kaestner, Director of Sustainability, San Francisco Unified School District – San Francisco, California

Sharon Danks, Executive Director, Green Schoolyards America – Berkeley, California

INTRODUCTION

Rosey Jencks, Program Manager, SFPUC Wastewater Enterprise

Video #1 – Time Clock – 0:00:00

Rosey Jencks gave the opening welcome as the host of the event. She explained that this half-day session is part of a new training and technical assistance program at the SFPUC that aims to articulate and lead a greener vision for the City. This technical training workshop is also intended to launch a public and interagency dialogue about how to implement comprehensive stormwater management on school grounds in San Francisco, in a way that benefits both children and the environment. This event is an opportunity to learn from Birgit Teichmann's expertise to understand how to use best practices from Berlin to catalyze stormwater schoolyard design in California.

This event brings three local organizations together to begin shaping a dialogue about the future of stormwater schoolyards in San Francisco. The organizations collaborating on this event are the San Francisco Public Utilities Commission, San Francisco Unified School District, and nonprofit Green Schoolyards America. The program for the half-day event included opening remarks from the three Bay Area organizations, followed by two in-depth presentations given by Birgit Teichmann describing best practices for stormwater schoolyard design in Berlin. The workshop closed with an interdisciplinary and interagency conversation among the audience members to brainstorm how best to move forward in this field in San Francisco.

Opening presentation #1

**SAN FRANCISCO'S URBAN WATERSHED MANAGEMENT PROGRAM:
STORMWATER MANAGEMENT, WATERSHED PLANNING AND SCHOOLS**

Rosey Jencks, Program Manager, SFPUC Wastewater Enterprise

Video #1 – Time Clock – 0:01:55

Rosey Jencks presented an overview of the San Francisco Public Utilities Commission's work and perspective. She explained how the SFPUC is integrating watershed management, green infrastructure and non-potable water reuse to help the City adapt to climate change, build resiliency, and better manage our natural resources. She also provided information about the SFPUC's school partnerships and the work the agency has done to date to develop stormwater management projects on San Francisco's school grounds.

The SFPUC is using green infrastructure to protect natural resources, promote natural processes, minimize San Francisco's carbon footprint, and maximize opportunities for multi-benefit projects on scarce urban land. Their Urban Watershed Management Program is focused specifically on using green infrastructure to:

- Protect water quality
- Slow and reduce stormwater entering the sewers and discharging to receiving waters
- Promote infiltration
- Promote the use of stormwater for non-potable purposes
- Reduce the amount of power and chemicals needed to manage stormwater
- Revitalize natural watershed functions
- Provide community benefits such as greening, traffic calming, urban habitat, and other multi-benefit outcomes

Why does the SFPUC care about schools? Schools are one of the largest land managers in San Francisco, and their grounds have highly impervious surfaces. SFUSD manages 118 schools on 406 acres, which is approximately 64% impervious. SFUSD schools consume 92 million gallons of water per year and produce more than 147 million gallons of stormwater runoff per year. San Francisco's school grounds are subject to stormwater regulations that the SFPUC oversees, and the Agency would like to ensure that complying with the regulations produces multi-benefit outcomes for stormwater, climate, and the community. In addition, SFPUC's ratepayer outreach identified schools as a key place to invest in green infrastructure. Engaging with schools also gives the SFPUC opportunities for education and outreach to future ratepayers.

The SFPUC has been working on a variety of green infrastructure and stormwater projects in recent years. Significant milestones include the Stormwater Management Ordinance, demonstration projects for the Sewer System Improvement Program, and Watershed Stewardship Grants. To date (January 2017), the Watershed Stewardship Grant program has invested \$650,000 in small grants to 32 schools in San Francisco, which seek to inspire the community to remove impervious ground surfaces and install rainwater-harvesting systems and drought tolerant plantings.

SFPUC and SFUSD are also collaborating on a project that started in 2014, to create a model stormwater schoolyard at Stevenson School in San Francisco. This school site covers 3.32 acres and is currently 87% impervious. The project is receiving \$680,000 in designated Add-Back funding from the City's Supervisors, and an additional \$150,000 from SFUSD's green schoolyard program. The design will include best practices inspired by Berlin and adapted for San Francisco.

The SFPUC is working to ensure that San Francisco's stormwater management practices are based on the highest industry standards. SFPUC programs include design training, construction and inspection training, and maintenance and monitoring training to support high quality work. The public can visit the SFPUC website to download training materials to learn about rainwater harvesting, greywater design, and stormwater management systems.

Opening presentation #2

THE FUTURE OF GREENING AT SFUSD

Nik Kaestner, Sustainability Director, San Francisco Unified School District

Video #1 – Time Clock – 0:16:00

Nik Kaestner explained that his role at SFUSD is to reduce energy use, water use, garbage production, and solo car trips in the school district. He is also working on green schoolyards because they have great educational value, are a terrific way to connect students to the environment, and they help foster connections that will lead to future sustainability.

Mr. Kaestner provided an overview of SFUSD's perspective and work related to stormwater management and green schoolyards. SFUSD's green schoolyard program has been funded by the Proposition A bond for more than a decade. The first modernization bond in 2003 included <1% for greening school grounds, but this was a lot of money due to the size of the overall bond. Since that time, the program has received 1% of 3 different bonds (passed in 2003, 2006, 2011), which total approximately \$14+ million for green schoolyards (as of January 2017). As a result, all of the elementary schools in SFUSD now have \$150,000 to green their grounds. Some middle and high schools are also engaging in green schoolyard projects, although these are generally at a smaller scale. Mr. Kaestner showed the audience some photographs of San Francisco's green schoolyards to illustrate their transformations and progress across the city.

From the beginning of the first bond, SFUSD's focus has been on outdoor education, particularly as it related to science and STEM education—where children and learn in a hands-on way. They also emphasized edible gardens to reflect the interests of the community and encourage students to have a healthy diet. SFUSD staff took a trip to Berlin several years ago and had the opportunity to see their school grounds first hand, which strongly influenced their perspective. In addition to outdoor education, they now prioritize nature play and stormwater management as key components of green schoolyards. SFUSD is very interested in Berlin's idea that school grounds should have visible water systems and zero stormwater discharge. SFUSD has another district wide initiative that seeks to make schools "zero energy", so the ideas of "zero stormwater discharge" and "zero energy" are powerful in combination.

The first Berlin-inspired schoolyard design in San Francisco was a project at Starr King Elementary School, designed by Sharon Danks and her colleagues at Bay Tree Design. The goal for this project was to go beyond an outdoor classroom to really transform the site for nature play and stormwater management. SFUSD has built the first phase of this plan now, although the building process was constrained by some technical issues encountered with the soil onsite. We learned a lot through this process and will apply our understanding at our next stormwater project at Stevenson School.

SFUSD is very interested in layering multiple uses onto our schoolyards so that they function as ball play spaces and outdoor classrooms, but also provide stormwater management and ecosystem services, and create a welcoming environment that kids who play in different ways can all enjoy and find their place onsite.

One of the people who helped us get to this place as a district is Sharon Danks, now the CEO of Green Schoolyards America. She will now tell us a little about how this work fits into the national and international context.

Opening presentation #3

GREEN SCHOOLYARDS IN CALIFORNIA AND AROUND THE WORLD

Sharon Danks, Executive Director, Green Schoolyards America

Video #1 – Time Clock – 0:21:50

Green Schoolyards America inspires and enables communities to enrich their school grounds and use them to improve children’s wellbeing, learning and play while contributing to the ecological health and resilience of their cities. Sharon Danks explained that her organization’s work includes research into best practices, partnerships with school districts and public agencies to build the field, and work to shift public policy to make green schoolyards the norm so every child will have access to nature every day. Ms. Danks’s presentation discussed the international context for green schoolyards and what our local and state efforts have accomplished to date.

Children’s access to their cities has been shrinking over the last 100 years, around the world, making school grounds the primary place where kids spend time outside. In most urban environments, this outdoor experience lacks access to nature. Most American school grounds were designed for 1940s educational objectives that aimed to produce good soldiers and factory workers. This paved environment is not a good fit for 21st Century curricula, which emphasizes hands-on experiential education, environmental literacy, and project-based learning. This is also an equity issue since low-income neighborhoods have the fewest trees and parks. There’s a growing movement around the world to improve children’s happiness and wellbeing by greening school grounds so that every child will have access to nature every day.

IMPACT: School districts are one of the largest land managers in every city and the choices they make shape the ecology of their cities. In California, public school districts manage approximately 130,000 acres of land for 10,300 schools. 6.2 million students inhabit that land every day—making it some of our most heavily used public space. With better design, this school ground land can help to support urban resilience in the face of climate change, and help to manage our water systems and green spaces for the health of the city, children, and communities.

INTERNATIONAL CONTEXT: There is a dynamic green schoolyard movement around the world, engaging in an ongoing dialogue, led in part by the nonprofit International School Grounds Alliance. Schools around the world are using their grounds for hands-on learning, to provide a wide range of play opportunities, to promote health and wellbeing, to demonstrate renewable energy, to mitigate climate change, manage stormwater, provide wildlife habitat, and demonstrate a wise use of building materials. Germany is a leader in stormwater schoolyard design, but there are also high quality examples in Sweden and Taiwan. (Danks showed examples from these places.)

CALIFORNIA CONTEXT: California is active in the green schoolyard movement. Thousands of schools have an edible garden, but most are on a small scale. We don’t have many infrastructure scale stormwater schoolyards yet, but smaller projects have been built. The field is at a turning point. More infrastructure scale projects that transform the whole school site are being built, and will act as outdoor learning labs and play environments for students.

The California state government is helping to build the green schoolyard field. They passed the *Living Schoolyard Resolution, ACR-128* (Ting) in June 2014. It declares the month of May to be Living Schoolyard Month every year and urges school districts to “prioritize the design and construction of student-accessible green space on school campuses and to integrate use of this space into the teaching of standards-based curriculum.” The California Dept. of Education also created a guiding document called the *Blueprint for Environmental Literacy* (Sept. 2015) that is shaping environmental education, including outdoors. Some California state funding has been used to build infrastructure scale stormwater schoolyards. This includes Proposition 84 (2006), which helped a few schools develop green schoolyards with green infrastructure for stormwater management. The DROPS Grants (2015) awarded \$30 million to schools across the state for multi-benefit stormwater management on school grounds. The Urban Greening Grant Program (March 2017), funded by the Cap and Trade, includes tree planting as a major objective, and schools are eligible to apply.

Creating healthy, ecologically resilient cities is no longer a technical issue. We know how to build them. What we need now is the collaboration, partnerships and consensus building to bring them about. Our work at this event is about imagining what those partnerships might look like and how we can work together to make green schoolyards a reality for all children in our region and beyond. [Sharon then introduced Birgit Teichmann.]

LIVING SCHOOLYARDS AS STORMWATER INFRASTRUCTURE: INSPIRING SCHOOL GROUNDS OF BERLIN TRAINING WORKSHOP PRESENTATION #1 – JANUARY 12, 2017

Birgit Teichmann, Landscape Architect, Landscape Management Engineer, and Founder,
Teichmann LandschaftsArchitekten, Berlin, Germany

Video #1 – Time Clock – 0:33:30

Birgit Teichmann's first presentation describes her work and includes information about Berlin's history and context for green schoolyards. She uses case studies to illustrate the benefits and impacts of green schoolyards on children and the environment, and also discusses the public policy, funding, and collaboration needed to make these projects a success.

HISTORY AND CONTEXT

Berlin was a divided city that had a wall between East and West Berlin from 1961 to 1989. The wall came down in 1989, and the differences between East and West Berlin's infrastructure was dramatic. East Berlin needed a lot of new infrastructure, including at its schools, and the government provided a lot of funding for urban environmental planning. This infrastructure investment, which started after about 1994, had positive outcomes for the City, and particularly for schools and streets.

In 2000, Germany funded a national program to reduce its environmental impact. This program is still in operation today. It is called the National Program to Reduce Environmental Impact (*Umweltentlastungsprogramm*)

The European Union Funding Program for Urban Revitalization in East and West Berlin (*Stadtumbau West und Ost*) was in operation from 2002-2017. This program helped to balance the investment between East and West Berlin. The initial investments in the 1990s went mostly to the East. More recently, the majority of the funding has been directed to West Berlin, since it is now time to refresh its infrastructure, too. The money always goes to the places that are least developed and have the most economic need.

The Economic Recovery Package (*Konjunkturpaket I und II*) began in 2009 and was underway until 2015. This funding package followed an economic downturn, and aimed to use the construction industry to help jump-start the economy, and also benefit children.

CLIMATE AND STORMWATER CONTEXT IN BERLIN

Berlin has distinct seasons, with warm summers that can reach more than 100°F and cold winters that drop below 0°F. Precipitation is year round, with snow in the winter and rain throughout the year. Berlin receives an average of 1.5" – 3" of rain per month. The City of Berlin also has a total of 224 miles of shoreline including five rivers and three lakes, and it also has 800 groundwater wells.

The groundwater and drinking water systems in Berlin are in good condition and are well managed. Berlin gets *all* of its drinking water from the groundwater within city limits, so the City is very careful with the way water is managed. To maintain this system, the City government tries to infiltrate as much stormwater as possible. The public utility/water company manages 800 wells that they use to access the groundwater. The municipal water supply companies provide a total of 38.8 million ft³ of drinking water daily from groundwater sources. Remarkably, the quality of the drinking water from Berlin's groundwater is better than bottled water, which is particularly impressive because bottled water standards are quite high in Germany.

BERLIN'S STORMWATER FEE

Every landowner in Berlin has to pay an annual stormwater fee. This fee is calculated using the amount of paved ground surface on the site, multiplied by the runoff coefficient, which varies by material. The base fee is \$1.90 (1,80€) per 11 square feet (1m²) of paved surface. This includes the footprint of the building. This stormwater fee is then applied to a calculation that uses the runoff coefficients for each material. The coefficients are weighted so that

fully unpaved areas (covered in vegetation and soil) have no fee, and fully impermeable areas (asphalt and concrete) are charged the full fee. For example, the coefficients for some common surface materials are as follows:

- Asphalt and concrete = 1.0
- Other types of pavement = 0.6
- Semi-permeable surfaces such as gravel = 0.3
- Green roofs = 0.3-0.5
- Vegetation and soil = 0.0

This policy encourages every landowner and municipal building owner to infiltrate stormwater, in order to save money. This includes creating green roofs to reduce the impact (and fee) of buildings. This also applies to public buildings and grounds.

CASE STUDIES

Video #1 – Time Clock – 0:43:30

In this section of the presentation, Birgit Teichmann showed examples from Berlin’s school grounds using before and after photographs. Berlin’s design standard is that 100% of rainfall should be infiltrated into the ground on each piece of property. The goal is to avoid all runoff to surrounding properties.

GALILEI GRUNDSCHULE, BERLIN, GERMANY

The case study example for Galilei Grundschule included before and after images of this school, and a stormwater design/plan that shows where stormwater is collected from the building rooftops and piped into areas elsewhere onsite to infiltrate. Teichmann also showed a master plan for the site, which was fully implemented.

Galilei Grundschule is an elementary school with more than 600 students. It is located in the urban heart of the City of Berlin. This school ground project was funded through a City program intended to reduce the impact of urban development on the environment.

Birgit Teichmann’s firm created the landscape design for Galilei Grundschule’s green schoolyard. Their plan is designed to infiltrate 100% of the stormwater that falls on the property, including all of the rooftop runoff from the school buildings. Before this design, the roof runoff was directed into the municipal stormwater system. The site design now uses permeable pavers, grading and planting as key elements of the green infrastructure system.

In the building’s courtyards and walkways, the ground surfaces are covered with permeable pavers with “green gaps”, which are suitable for wheelchairs. Most other areas onsite are planted for outdoor learning and play. The main playground space has a park-like feel with varied topography, dense plantings, and inviting meandering pathways that connect the key activity zones. The site includes many play structures for the children to climb that are primarily made from natural materials such as long lasting black locust logs (*Robinia spp.*) and boulders.

The overall strategy for this design was to disconnect *ALL* of the stormwater drainage pipes that used to direct rainwater to the municipal system in the streets. Instead, the design now uses an internal network of pipes to channel water from the building’s rooftops and any other hard surfaces onsite to the vegetated, contoured spaces in the playground where the stormwater can infiltrate into the ground.

The designers also added a stormwater detention tank that collects runoff from the school building’s rooftops and releases it slowly into the site through an outlet pipe. The outlet pipe discharges the water into a dry creek bed, reinforced with stones, and then it flows out into the unpaved, planted areas of the playground where it soaks into the ground. The detention tank was installed in the playground at-grade, and then the designers covered it up with soil to create a hill on top of it. The hill includes an amphitheater on one side and densely planted shrubs on the rest of the mound. The tank is completely hidden by the lushly planted hillside and the plantings have grown to cover the mound and stormwater infiltration areas. This hill now blends in with the rest of the playground and is part of the playscape for the children.

Stormwater that falls on the vegetated landscape at Galilei Grundschule is directed into the interior of the site using topography that was created for this purpose using cut and fill techniques that aimed for “mass-balance”. This means that they were able to balance the cut and fill onsite—and avoid exporting or importing soil to create the design. A series of hills and valleys were sculpted from the once flat terrain at the school in order to accomplish this goal. The site also uses trees, bushes and other plantings to keep the landforms in place, provide additional ecosystem services, and add play value for children.

DESIGN STRATEGIES USED AT GALILEI GRUNDSCHULE

Teichmann’s firm began the design process at Galilei Grundschule with the overall goal to create a green, park-like environment for children to use on a daily basis for all types of play and outdoor learning. To accomplish this, they used some key site design features that allow the school ground to feel like a park, but also stand up to the heavy foot traffic and play patterns produced by hundreds of children every day.

Pathways were one of the first elements placed in the design and determined the position of other elements. Their surfaces use a type of permeable terracotta brick with “green gaps”, which create an open grid pattern that allows plants to grow through each brick. The bricks reinforce the pathways and are very durable for foot traffic and for wheelchairs.

The school ground landscape includes topography that was built up between the pathways, and lush vegetation planted on top of the resulting mounds. The design includes short, sturdy walls around each of the mounds to reinforce the planting beds and help them survive the heavy use they receive every day from hundreds of children. The ground surfaces around the play structures’ fall zones are covered with a deep layer of sand to create a soft surface.

The play structures at this school include several site-specific installations made from natural materials, including: a tall stone retaining wall, made from massive sandstone blocks, that the children carved into a climbing wall with the help of a stonemason/artist; a set of 6 “social swings” that were built in a hexagon shape, so that the children can talk to one another while they swing; and other unique play elements.

The school also has a sports field that is more conventional. It has an asphalt surface that has been covered with a plastic coating that is supposed to be permeable, but it doesn’t work well in heavy rain. So, the designers added a drainage system with a French drain, along the side of the field. When the water enters the drain, it flows downhill into the detention tank in the main playground (mentioned above), where it eventually percolates into the ground in the nearby vegetation.

STORMWATER SCHOOLYARD BENEFITS

The stormwater schoolyard design at Galilei Grundschule was very cost effective, both in terms of the initial capital investment and for the long-term maintenance costs. The site cost approximately US\$700,000 to build (500,000€). Since the design used topography and plantings as the primary elements, it was cheaper than it would have cost to renovate the site using only hardscape. (Teichmann added that plant and topography-based designs are always cheaper than materials like concrete. The more green, the less expensive.) They also kept costs down by balancing cut and fill and avoided the need to import or export soil from the site. The resulting green infrastructure landscape can be maintained with simple park maintenance techniques, and does not require any technical maintenance since it doesn’t have any complex pump systems. It has also succeeded in totally eliminating the City’s stormwater fee for this site, which saves the school money every year.

Green schoolyards like this one have many benefits for the environment and for children. The environmental benefits include:

- *Reduced pavement and increased permeable surfaces.* This design choice not only increases stormwater infiltration, but also moderates the microclimate onsite. This is very important, not only for the environment, but also for the school itself. For example, greening the small courtyards at Galilei Grundschule has created a better microclimate for the adjacent classrooms.
- *Increased green spaces for the children,* which are very important because the schoolyard is the last green oasis in the city where children can play in protected environments, with nature.
- *Higher humidity levels,* which are helpful in a dry climate. The dust levels are also reduced when plantings and better ground surfaces are added.
- *Better use of materials.* Green schoolyards can reduce, reuse, and recycle building materials. The design at Galilei Grundschule (and our other projects) relies on reusing building materials such as concrete, which was harvested from the site itself during the renovation. Much of the old pavement was used to build the topography in the new design.
- *Making the most of the site's potential.* Green schoolyards make the most of the existing site and use key elements such as topography, trees, and shrubs, as the basis for the new design. Teichmann's firm tries to make the finished site look like it's always been there, so it doesn't look out of place or artificial. They believe that it should look like a real "piece of nature" that has been there for 20 years. Keeping the existing trees and other established vegetation helps with this goal.
- *Groundwater wells.* Sites like Galilei Grundschule are able to use groundwater wells to irrigate the plants in the dry season, after infiltrating water when it rains. In Berlin they need permits to create the wells, but this system is an efficient way to take care of the site.

Green schoolyards like Galilei Grundschule also generate benefits for children's wellbeing. The primary benefit is that they create spaces for outdoor learning and play that provide for the varied interests and needs of children as they grow up, and for children with a wide variety of different interests. Green schoolyards offer a range of different types of climbing and movement possibilities. They also create places for relaxation during school hours and after school. In Berlin, the school grounds are open to the public after hours.

Green schoolyards also generate benefits for children's social-emotional development and violence prevention. Teichmann's firm always includes the school community's participation in planning and construction to help them engage with the site. This process also helps to build collaboration and negotiation skills for the students as they discuss the plan and their desires and needs, and come to consensus about the direction the design should take. Students participate in workshops with Teichmann's firm to imagine what else their school environment could be if they work together. Because students and families are involved in all aspects of design and construction, they care more about their school grounds when the project is complete. This also translates to reduced vandalism during and after school, when the grounds are open to the public.

Green schoolyards like Galilei Grundschule also reduce violent behavior and bullying at recess and after school, because children have a wider range of activities to engage in and they are not bored. Also, this type of design creates different niches for each activity, which separates groups of children and gives them more space for their own activities—which also reduces conflict. Green schoolyards also provide places where children (and adults) can have some time to themselves to decompress.

MIERENDORFF GRUNDSCHULE, BERLIN, GERMANY

The case study presentation of Mierendorff Grundschule included a site plan, a master plan drawing, and before and after images of the school grounds, with emphasis on the items Teichmann explained in her description.

Teichmann LandschaftsArchitekten created the site design for Mierendorff Grundschule in Berlin. This school is part of a whole block in the middle of Berlin that is made up of public buildings including an elementary school, a preschool, and a high school. The City required 100% of the stormwater in this zone to infiltrate into the ground.

Teichmann's school ground master plan called for disconnecting all of the stormwater pipes and intakes in this whole area, so that none of the runoff from the public property would go into the municipal storm drains in the streets. After capturing rooftop runoff from the buildings, the stormwater flows are directed into an internal pipe system on the property that drains into subsurface detention basins. Outlets from those basins slowly release the water into the soil and it finds its way from there into the nearby river, over time.

Money for this project came from the City of Berlin's program to reduce environmental impact. When the project first started, the school site was almost entirely paved with concrete and asphalt. After construction, the ground surfaces were covered with many different materials, including a wide range of permeable pavers, vegetated areas and new topography. As at Galilei Grundschule, the firm also created raised planting beds surrounded by low walls to protect the vegetation from heavy foot traffic. The walls incorporate recycled materials and stones in the design.

In addition to shifting the stormwater flows onsite, this new design for Mierendorff Grundschule addressed problems the school was having with microclimates onsite that were too hot due to the thermal mass of all the pavement. When the paving was removed and green spaces with trees and plants were added, the microclimate shifted and became more moderate, which was greatly appreciated by students and teachers. This shift from a paved and lifeless landscape to one that is full of life and greenery also improved mental health in the school community, and made the school look more inviting and well cared for. It changed the children's wellbeing and behavior since the environment affects how people feel and how they act.

This school ground also includes some unique and beautiful stone features in the play areas. They are made of limestone and the children carved them themselves, under the direction of a local stone mason/artist. Teichmann noted that this type of stone carving is commonly done on Berlin's school grounds, but they don't let children make the carvings all alone. There is always instruction and supervision from an expert as the students create their masterpieces that will last for decades.

FUNDING AND COLLABORATION

Where does the money come from to create green infrastructure on school grounds in Berlin? Funding for green school ground renovations in Berlin comes from a variety of sources at different levels of government. That includes funding from the European Union, the national government in Germany, the state/county level, and from the city and neighborhood levels. (Berlin is both a city and a state, as San Francisco is both a city and a county.) All of these levels work together, as follows:

European Union: EU government offices play a management role and provide large funding sources.

Germany: Government at the country level provides some funding and helps with project management.

State Government: The state government is responsible for directing the funding process. Government offices at this level select the high need areas within their jurisdictions to receive increased funding, and aim to balance positive outcomes for everyone. They are in charge of achieving equity. In Berlin, a city agency within the government called Grün Macht Schule functions in manner that is similar to an NGO in other places. They have a small staff within the government and play a key coordination role to advise interested schools in their jurisdiction, and match them with the funding they need to accomplish their green schoolyard objectives.

City District Government: The central city government manages projects for individual city districts and the public works department. They also coordinate neighborhood groups, oversee funding and spending, and manage the bidding processes for individual projects.

Neighborhood Government: Local governmental representatives exist at the neighborhood level in Germany, and they coordinate action on local issues including school ground needs. They use local knowledge to make informed decisions. They facilitate access to higher levels of funding from larger governmental authorities, and know the lay of the land. They also coordinate with outside NGOs that want to work in a given area.

Each level of government is responsible for approving a different level of funding. The smallest levels of funding are available locally at the neighborhood level, and the largest amounts of funding are accessed at the country and EU levels, as follows:

Action funding, 1,500€ level: The neighborhood government has access to small amounts of funding at this level and can fund and approve projects that local residents would like that fall within this budget.

Project funding, 5,000€ level: Slightly larger projects that would like funding at this level begin by engaging their neighborhood representative. Then they also have to go one level up, to the city government, to gain access to funding at this level.

Construction funding, >500,000€ level: For larger levels of funding, individual projects also begin at the neighborhood level, but they need approval from higher levels of government at the state or country level. Projects receiving this level of funding may be able to accomplish infrastructure-scale shifts on school grounds.

European Union level projects: Projects that need significantly more funding can go to the highest level to the EU government, to arrange their funding.

This system means that larger projects take more approvals and oversight, but smaller projects can get approved with less bureaucracy at a much faster pace. This allows a high degree of local control and more integration with each neighborhood's needs. This system also increases the level of stewardship that local residents feel for their shared public lands.

[End of Presentation #1]

QUESTIONS FROM THE AUDIENCE

Video #1 – Time Clock – 1:05:00

- Q1: Are there municipal codes that require or encourage green schoolyards in Berlin?
- A1: Yes, there are environmental codes that relate to stormwater management, and also codes that come from the school district which is interested in having curriculum-based schoolyards. There are also regulations from the public works department at the state level, that relate to creating low maintenance spaces that they can manage. There are many different drivers for green schoolyards.
- Q2: I'm wondering if you have noticed in the last 10 years, as children have become more technologically savvy, if they interact in a different way in the schoolyards that you have designed?
- A2: We have a lot of discussions about this in Germany. Children are very interested in technology now. We find that they have less capability in their physical abilities and less coordination of their movement. This is really a problem because they are missing developmental milestones. When they sit in front of a computer all day long, they miss this part of their development, and it's not possible to gain this later in the way they would have when they were small. It's even more important to do this work now, because of this trend. It's not only about physical development, but it's also about sensory integration. They get enough of technology when they are in the classroom, and when they are outside we feel they need to learn through their other senses and get their hands in the dirt.
- Q3: I'm wondering if you know what the average size is for these projects in terms of square meters?
- A3: Berlin's schoolyards are all different sizes. We have some small ones in the center of the city that are too small for the number of children and they have to take their recess breaks in shifts. They might have about 2,000 m² of school grounds (approximately 0.5 acres). We also have large schoolyards on the perimeter of the city that are more like 10,000 m² (approximately 2.5 acres). Each school and schoolyard is unique, and we have to make the green schoolyard fit their situation.
- Q4: You talked about roof water being captured and directly fed into the green spaces onsite. In some of the examples you showed, children are then using roof runoff in their play areas as a temporary river or other play feature. Are there any public health concerns from this use of roof runoff water?
- A4: Yes, it depends on the material that is used on the roof. For example, copper is not a good roof material. We have regulations that describe which materials may be used in this way. Some of the materials used on older buildings isn't good, but the newer buildings usually have materials that are fine for this purpose, where the water runs off in an open system. We have restrictions for everything and this is tightly controlled.
- Q5: Could you speak a little bit about your process as a landscape architect, and when you get involved? Do you help to get the funding, or do you come in when the project is already funded? Are you involved with the children in the planning?
- A5: We always use community participation in our design process, with the students and the whole community. I think the whole process is about 2 years for each project. It starts with a school that has the idea that they want to change their grounds. It's very important that it comes from the school, itself. They have to want to change.

Then, the school approaches a state level institution called Grün Macht Schule to seek advice and understand which steps are needed in order to move forward with their project. Grün Macht Schule can help them match their project with the right funding source. Then, the school goes to the city district and they organize the project with all of the upper levels of funding and oversight they need. They might need to

get on a waiting list to receive the type of funding they would like. The funding is distributed to the schools in order of need.

Teichmann LandschaftsArchitekten comes in at the point where the school has received its funding. So, when we begin, we know the budget for the project. We then start the community participation process with the school and work with the children on their design ideas and models. We create a master plan for the project with the school, and negotiate it with the school and community so that it meets most of the needs. No project can ever meet all of the needs that are outlined and make everyone completely happy, but we come to consensus on the most important ones.

Then there is the construction process and bidding process, which we supervise. We then oversee the construction of the project, including building permits. We also make the technical plans in advance. Everything is very well planned and tightly controlled, even if the final landscape looks more “loose” and natural. The last step is including students in creating artwork on site. Sometimes this happens during the construction process, and sometimes afterwards. It can use a variety of materials, but often children work with stone. We are involved from the beginning and see the project through to the end.

Q6: I know that your presentation was about school grounds, but I’m wondering to what extent these ideas and design principles are also included in other aspects of the public realm in Berlin (e.g. parks and urban landscapes/neighborhoods)? Are the same types of practices included in those spaces?

A6: In 2016, Berlin created a new City Development Program that looks at how to meet the City’s needs for climate change and resilience. This program considers how to better address future needs for water, climate, heat, and other changes, as climate shifts. They have standards and best practices for different types of environments and contexts in the City. All designers and builders must follow these guidelines for the various parts of the city. There are some standards for schoolyards, but they also have them for areas with housing, public parks, public places, etc. They are for the whole city.

Q7: Is nature play a factor in city planning?

A7: Yes, there is a big new exciting project called the Nature Experience Room. There is going to be an exhibition next year at an international garden show. The first Nature Experience Room will be there for children to play in nature, without adult supervision. It is within the safety standards. We understand that this is necessary, but we know it’s hard to meet the safety standards, so we try to make it work.

LIVING SCHOOLYARDS AS STORMWATER INFRASTRUCTURE: INSPIRING SCHOOL GROUNDS OF BERLIN TRAINING WORKSHOP PRESENTATION #2 – JANUARY 12, 2017

Birgit Teichmann, Teichmann LandschaftsArchitekten, Berlin, Germany

Video #2 – Time Clock – 0:00:00

Birgit Teichmann's second presentation describes best practices for stormwater schoolyard design that have been gleaned from her work in Berlin over the past 25 years. This presentation delves more deeply into the technical side of school ground design and their connection to Berlin's wider city planning goals to create a green city.

DESIGN AND ENGINEERING CULTURE IN GERMANY

German landscape architects are trained in landscape design but are also usually engineers with a BS or a MS degree, so their landscape architecture understanding is strongly oriented toward science and technical expertise. Their standard training also includes completing coursework in child development, so that German landscape architects will be able to design well for both children and adults.

HISTORY OF STORMWATER MANAGEMENT ON SCHOOL GROUNDS

In the 20th century, landscape architects sought to drain the stormwater off of each site as efficiently as possible. This led to severe problems in that it harmed the surface water bodies, it caused the groundwater levels to sink, and it increased the threat of flooding since there was too much water in the municipal storm drain network. The City of Berlin has a separated sewer system with rainwater and wastewater in separate pipes.

As the City prepares for climate change adaptation, Berlin's government is requiring all new site designs to include climate change mitigation and stormwater planning. The standards require all sites to reduce urban heat islands and take steps to prevent urban flooding, since more extreme weather events will be occurring more frequently as time passes. There are many different sets of standards for each type of urban environment, including parks, housing areas, school grounds, etc. They are referred to as the "Sponge City" Goals.

For school grounds, this means setting a goal that all school grounds should be heat-adapted and water sensitive spaces. This type of planning creates what we call "Sponge School Grounds".

GOAL: SPONGE SCHOOL GROUNDS FOR ENVIRONMENTAL ADAPTATION AND RESILIENCE

Sponge School Ground strategies for reducing urban heat island effects, and cooling the grounds include:

- Ventilation, so school grounds receive enough fresh air circulation
- Shading
- Increased reflection
- Cooling through evaporation, from trees, vegetation and soil

Sponge School Ground strategies for water sensitive school grounds include:

- Infiltration
- Evaporation
- Storage
- Retention
- Drainage

When used together, these strategies provide relief for combined sewer networks and are beneficial for ponds and lakes. The overall goal is to infiltrate 100% of the stormwater onsite using an approach with the lowest level of technology possible.

On a school ground, this can be implemented in different ways when the opportunities arise with new projects or renovations that can address roof runoff or ground surfaces. Rooftop design strategies include temporary stormwater retention on rooftops and sports fields, “Blue/Green Roofs” on gymnasiums, and vegetated green roofs. Interventions at ground level include strategies such as directing surface water flows from paved areas into retention and detention areas on the landscape. The designs also increase the amount of shade on school grounds by planting more trees, greening building facades, and adding other vegetation. Surfaces that can’t be unpaved are addressed by increasing the solar reflectivity index using light colored materials (particularly for southern exposures). Design standards also aim to maintain gaps between buildings to allow for natural air circulation, which cools the green spaces further.

The most effective strategy to achieve many of these goals is to simply remove asphalt and concrete from as much of the land surface as possible, and replace it with vegetation and permeable paving that serve both ecology and children. This low-tech approach using open natural surfaces can achieve 100% infiltration.

In Berlin, stormwater infrastructure is designed to manage a 10-year storm event. The soil in the City is 75% sandy soil and 25% clay soil, which allows for infiltration in most places. In some places where the soil is not ideal, the design strategy is to use subsurface devices to detain the water underground so that it can soak in more slowly. In this case, there are drain inlets, but they are not connected to the City’s stormwater pipes; only to the subsurface infiltration devices. The inlets for these systems are much smaller than their counterparts in San Francisco, although the amount of annual rainfall is similar.

Teichmann LandschaftsArchitekten uses pavers—made from stone, granite, terracotta bricks and other materials—with living plants growing between the gaps. The firm designs ground surfaces so that a path can absorb some of the stormwater flow itself, and direct any remaining water into adjacent vegetation. This design strategy does not require any drainage pipes.

Teichmann’s firm also maximizes the colors and textures of the ground surfaces and pavers used in children’s environments. This adds interest, challenge and varied experiences for children when they are learning and playing, and when they are walking and riding bikes. The firm also sometimes engages students in adding additional texture and variation to the paving. Students can make their own designs as class projects and install paving in interesting patterns. Permeable pavers are used to create most paved surfaces on school grounds including wide areas for assembling groups of students or adults.

In addition to pavers, school ground site design incorporates sand or shredded wood in places where a soft fall zone is required. Wood chips are also used as mulch under plantings. Teichmann LandschaftsArchitekten shapes a site’s topography to manage stormwater and also uses these landforms to create different rooms, or spaces, within a schoolyard. Mounds, protected by low seat walls, also shelter vegetation from children’s feet. The planting mounds are placed in locations that are not in the midst of children’s pathway “desire lines”, so that the plants have a chance to get established and stay healthy. It’s important to select a plant pallet of robust natives that are adapted to local rainfall and will be resilient to heavy use. Schoolyards in Berlin often use plantings such as low growing willow to turn the once-barren school grounds into lush environments.

GOAL: OUTDOOR HANDS-ON CURRICULUM

The school and school grounds need to provide value across the curriculum. This is relevant to many different areas including body movement and health, social and cultural life at school, interpersonal communication skills, visual art and music activities, basic mathematical experiences, and basic experiences in natural sciences and technology.

Body Movement and Health

Children’s needs for body movement and health are addressed by building nature play environments that they can explore. For example, an image included in Teichmann’s presentation shows a slide that is built into a hillside. The

design includes challenging ways for the children to move up the hill to the slide along a series of rough logs that act as irregular stairs and also keep the hill from eroding.

The planted areas in Berlin's green schoolyards are intended as play spaces for the children, but the shrubs and trees need some time to get established before they can stand up to the high use they receive from hundreds of children each day. One helpful design strategy is to install wooden fences in the play areas to temporarily surround planted spaces. Wooden fences will naturally rot away after about 5-7 years, which is good timing for the plants to get established and outgrow their need for protection. The plantings will likely be strong enough to allow some access before the fences rot away, and will be fully established after five years.

Teichmann's firm also encourages children to explore body movement by climbing trees that are planted as part of the green schoolyard. They also build custom designed play structures that are intentionally challenging and are adapted to each site, rather than purchased from a standard catalogue. This helps the play structures fit into the site, no matter their size, rather than making the site fit the structures. The first thing Teichmann thinks about when she designs a school ground is where the best place to play will be for the children. Then, she designs a play structure to fit into that space. All of the play structures they design and build meet German safety standards. Teichmann's designs also include substantial sand and water play areas in all of their school grounds. The play pumps in the sand boxes usually use drinking water as the source, but they can also use the groundwater if it is tested once per year.

Social and Cultural Learning

The participatory design process Teichmann LandschaftsArchitekten used to create each green school ground allows children to learn social skills and practice collaboration and negotiation to reach consensus. There are also places in the design process, and out on the completed green schoolyard, where children can learn about math and counting, and also about science and technology.

Social Interaction

The site design for each schoolyard includes places for small and large groups to gather. This reinforces social interaction and provides places for conversations of all types to happen. Teichmann also ensures that there are places for all types of expression to occur outdoors at school. This includes places on the school grounds where shouting and screaming are allowed. Children can also express themselves through temporary or permanent artwork installed onsite, made from natural materials.

SITE PLANNING

Framework: Traditional schoolyards, before renovation, often reflect adult perspectives about "proper orderly settings" with things placed in neat and tidy rows. Children prefer more chaos. They are not happy with adults' orderly planning. Their firm tries to plan the "chaos" back into the site, in a way that works for both adults and children.

Path Analysis: When planning a site, the designer's first step is to begin with an analysis of the user patterns and desire lines on the site. They look to see where people are currently walking, and which pathways are the most heavily traveled when people want to go directly from Point A to Point B. They map these desire lines on a site plan, and talk about the user patterns they see with school personnel. Then, they use these use patterns as the organizing framework for site planning.

Spaces: After the pathways have been identified on the plan, spaces emerge between the pathways that allow room to add other features, nestled between the lines. The spaces between the pathways include green areas, play structures, gathering spaces, communication spaces and other uses. Next, they add greenery as a frame around each of the special niches that are created, and place plantings as buffers around the edges of the grounds to screen the school from the neighborhood and surrounding streets. A good green buffer is important to a successful green schoolyard.

Topography: After the overall structure of the site is determined, then they add the topography that shapes stormwater flows and children's experiences in each part of the grounds.

Master Plan: A master plan, developed with the students at the school, captures all of this adult-gathered site analysis and layers in children's needs and desires. The resulting plan is able to meet the needs of the children and function well for daily life at school.

TECHNICAL PLANNING

After the master plan is complete, Teichmann LandschaftsArchitekten creates a technical engineering plan that describes the details of the engineering required to accomplish the master plan. The technical plan (schematic design and construction drawings) includes some spot elevations and topographic contours. It also indicates the direction of stormwater flows and other engineering details. It takes into account the ways that the stormwater drains, and takes care to avoid creating areas that will freeze and become dangerous icy spots in the winter. This plan also includes details that help the builders to build the design precisely, so it will be within the safety standards.

MANAGEMENT AND MAINTENANCE

Traditional school ground play areas in Berlin, like the USA, are clean, expensive, technically perfect, and are planned by adults without children's participation. In contrast, the schoolyards that Teichmann LandschaftsArchitekten creates are totally different. Their school grounds use hardwood (*Robinia spp.*) to build play structures that last approximately 20 years, particularly if the wood is located in the sun. This material has a shorter lifespan, closer to 15 years, if it is placed in the shade. They also use robust, native plants (trees and shrubs) and consider the plantings centrally important. The firm doesn't use perennials at all on the schoolyards, since they get trampled and break, and don't last.

Teichmann LandschaftsArchitekten tries to use low-tech solutions, which are also low maintenance solutions. When they infiltrate all of the water on the site, then they don't have any drainage systems to maintain as time passes. They don't use pumps unless there is no other way to accomplish their goals. They seek to simplify the site design so that the school ground only needs simple, straightforward park-like maintenance.

Teichmann LandschaftsArchitekten seeks to meet children and nature's aesthetic, which is much different than a highly manicured "adult aesthetic". Adults might think that an area like this slide (shown) is not nice, but for children, it's much more important to provide adventure, challenge and interest than it is to provide a highly manicured visually clean adult-oriented landscape. Nettles are allowed to grow in their schoolyard environments. Tall grasses poke through.

They also include children's participation after the building process, in the stewardship of the site. The goal is to build ownership for the school ground and a sense of care, rather than to provide the maintenance for the grounds. Maintenance and reduced vandalism are nice side benefits of fostering stewardship and a sense of ownership for shared public space, but they are not the actual goals in and of themselves. Taking care of a site helps kids feel that they are responsible for their own living space and take part in managing shared space.

Students also participate in the construction process and add permanent artwork to the school grounds. In Berlin, this is often accomplished with hands-on stone carving that the children do under the direction of a stonemason. When children take part in the construction and stewardship processes, there is a lot less vandalism in the future and they take more pride in the overall outcome. Sometimes when children work on stone, it lasts several generations. A child can grow up and bring his own son to see what he did when he was young.

SAFETY INSPECTORS

Schools in Berlin have safety inspectors and they are always built within the safety standards. Safety inspectors come to visit each school on a regular basis and check to make sure that the standards are still being met over time, and that elements in the school grounds haven't broken. Things that wear out with hundreds of children using them everyday have to get replaced. We find that after 15-20 years the natural materials need to be fixed, redesigned, and replaced. This is also good because it gives a new group of students and adults a chance to participate in designing their school, and allows the site to change to match the current curriculum and other needs of the school community.

Teichmann LandschaftsArchitekten builds their school ground landscapes using techniques that are simple enough that students can repair some things on their own as they wear out. For example, their small landscape seat walls ("wild walls") are made of a wide variety of materials that can be easily replaced and patched. They don't need trained stonemasons to repair them.

LESSONS LEARNED

Birgit was asked to give the audience some things to think about that are transferable lessons for San Francisco's context. The list below is what she suggested:

- Set up precise standards from the government or the state to establish schoolyard design standards.
- If there are different authorities in charge of different parts of school ground oversight, they need to collaborate to make green schoolyards possible. This might include school district curriculum departments, facilities departments, maintenance departments, and city agencies. We need to get everyone on the same page to do things together.
- Provide good examples of solutions where all of the various actors worked together successfully. If they can do it, you can do it, too.
- Show the benefits of this design philosophy for children, water, and climate. Explain why this approach is needed.
- Specify the methods to be used to create the desired outcomes. Include a catalogue of directions that explains what needs to be done to achieve a top quality stormwater schoolyard that addresses the needs of children and the environment.

[End of Presentation #2]

QUESTIONS FROM THE AUDIENCE

Video #2 – Time Clock – 0:30:50

Q1: I would like to know how you irrigate in Berlin in the summer, because one thing I see that often fails here is the irrigation system. What is your approach?

A1: In Berlin, irrigation is only necessary when it gets really hot in the summer. For us, we don't put in complicated systems because it's too much to manage. We just have simple watering systems that we can use to soak each area that needs it, when it's too hot. We let the community take care of it, because these schools are their environments. It's only really 5 weeks a year when it's too hot and dry, so it's not bad to split it up and divide the responsibilities among the families at the school. Also, we select trees and shrubs that don't need much (if any) supplemental water once they are well established.

Q2: What is the main obstacle for the schools to adopt this type of approach in Berlin?

A2: It's mostly funding in Berlin. I also see that when there is a school that really wants to change the schoolyard, they will find the funding somewhere. If they are persistent, and specify their needs, it will work out. It might take some time, but it will work out. Also, sometimes it's not the whole schoolyard that will be done all at once. Sometimes only one part of it is implemented after a master plan is drawn to guide development.

Q3: How does children's participation work, exactly? How do you engage the children?

A3: We have children's participation in the design and planning process, and we lead that effort in coordination with the teachers at the school. During the building process, we have artists and other people who are experts in stone carving and other skills and they plan the individual project with the school and the kids, together, and then they build with the students. So the school always has a professional partner working with them, so it will be within their capabilities to do things well.

Q4: Is there any big project in the schoolyard that you can measure the outcomes for children's learning and ecological impacts?

A4: There is one insurance company for all of the schoolyards in Berlin. They made a study about the changes in safety on the schoolyards, and their findings indicate that there are fewer serious injuries on this type of a school ground than on traditional ones, and more small accidents like scrapes and splinters. So, this is better for children's overall health. The schools also say that the children come back after recess more relaxed after playing in a green schoolyard, and that there is less bullying and other types of violence between children since they are all engaged in things they enjoy and they have something to do. When there's just a flat concrete area they tend to fight with one another because there isn't anything else to do.

Q5: Can you please define what a "blue/green roof" is on school grounds? It was on one of the slides in your presentation.

A5: (Birgit held up a product sample for a green roof, with different layers) In a usual green roof, we install it with a system that includes different layers of materials for holding soil and plantings. In a green roof design, the materials aren't very thick, and water is not meant to be stored on the roof. Just enough water is absorbed and held by the materials to allow the plants to grow and to allow a small amount of evaporation.

In a blue/green roof, the layer that the water percolates into is deeper, so that more of the water is actually retained on the roof itself, temporarily. This water is more than the plants need to grow, so it's held below the soil level, in a separate layer. There is also an overflow mechanism that allows it to drain if it's too much.