Published in final edited form as:

Landsc Archit Front. 2022 February ; 10(1): 71–81.

Reducing Threats From Contamination and Flood Damage:Restoring the Brandywine Creek Edge in Wilmington, Delaware, USA

Galen Newman[1,*], **Cai Zhenhang**[1], **Jennifer Horney**[2], **Lyu Wuqi**[1]

[1]Department of Landscape Architecture and Urban Planning, Texas A&M University, College Station, TX 77843, USA

[2]Disaster Research Center, University of Delaware, Newark, DE 19716, USA

Abstract

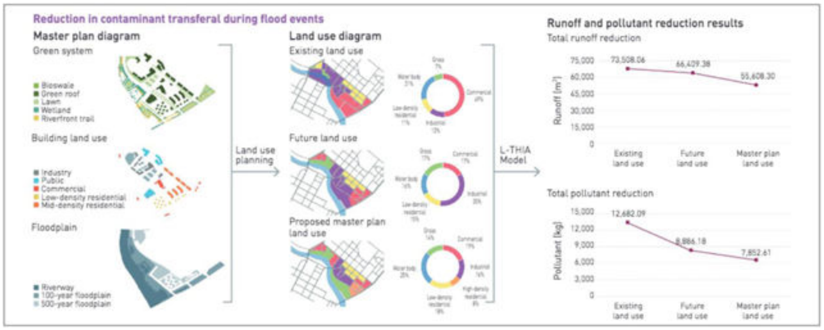
Located in Wilmington, Delaware, along the shoreline of the Brandywine Creek in the Greater Philadelphia/Delaware River Watershed, this project responds to a specific and critical need for the site as prioritized by multiple stakeholders. The project applies an innovative approach for quantifying increased flood resilience while simultaneously reducing contamination levels through the implementation of green infrastructure. To solve joint issues related to increased flood risk concurrent with higher potential for exposure to environmental contaminants transported in flood waters from adjacent industrial sites, brownfields, and combined sewer overflows, the research team develops a phased approach to decreasing stormwater runoff and pollutant loads on a 130-acre (52.6 hm2) site along the Brandywine Creek, applying the Long-Term Hydrologic Impact Assessment (L-THIA) model to quantify design impacts and performance of a master plan. Overall, the proposed master plan can reduce stormwater runoff and pollutant loads to levels significantly less than existing conditions or the current land use plan. Further, this research is unique in that it uses outputs from the L-THIA to compare existing conditions, effects of the current comprehensive plan, and impacts related to the proposed neighborhood-scaled master plan to evaluate the effectiveness between each scenario.

Graphical Abstract

---

[*] Corresponding Author: Galen Newman, Department of Landscape Architecture and Urban Planning, Texas A&M University, College Station, TX 77840, USA. gnewman@arch.tamu.edu.

PROJECT INFORMATION
LOCATION: Wilmington, Delaware, USA
AREA (SIZE): 130 acres (52.6 hm2)
CLIENT: National Fish and Wildlife Foundation, USA
LANDSCAPE DESIGN: Center for Housing & Urban Development, Texas A&M University
CHIEF DESIGNER: Galen Newman
PROJECT TEAM: Cai Zhenhang, Lyu Wuqi
COLLABORATOR: University of Delaware
DESIGN PERIOD: May, 2020 ~ May, 2021CONSTRUCTION PERIOD: In pre-approval
AWARDS: 2021Merit Award, American Society of Landscape Architects, DelawareChapter2021 Merit Award, American Society of Landscape Architects, Texas Chapter



Keywords

Green Infrastructure; Landscape Performance; Flood Resilience; Contamination; Stormwater; L-THIA; Master Plan Assessment

1 Background and Problems

The convergence of flood disasters and environmental contamination heightens the potential for mobility and transfer of toxic substances. Between 1990 and 2008, there were approximately 17,000 toxic material releases caused by natural disasters, 46% from flooding and hurricanes[1]. More recently, attention has been increasingly shifted toward public health issues and other risks associated with the convergence of these exposures. Yet, designers and planners have struggled to develop plans to effectively deal with such circumstances, or utilized appropriate quantitative approaches to project the probable impacts of such plans. The City of Wilmington, Delaware (DE) of USA has a population of more than 70,000, with a density of approximately 6,500 people per square mile[2]; this results in a relatively high demand for water use and treatment of wastewater and urban pollution[3].Northeast Wilmington, where the study site is located, consists of three densely populated census tracts that are designated as Opportunity Zones by the U.S. Department of Treasury to spur economic growth and job creation in low-income communities[4].Two catalytic brownfield sites are located along 1,800 linear feet(549 m) of Brandywine Creek shoreline, part of the Christina River Watershed and the larger Delaware River Basin (Fig. 1). The City's Central Business District is located in close proximity to the site, making live music, theater, and other entertainment and dining options accessible by foot, bicycle, automobile, and public transit. Although the Brandywine Creek is the primary source of drinking water for the City of Wilmington and much of the surrounding area (including New Castle County), it has been officially listed as an impaired waterway. As a result, fish consumption advisories are also in effect [5].Much of Northeast Wilmington is within the 100-year flood plain and the largest Combined Sewer Overflow (CSO) on the Brandy wine Creek is located in Northeast as well. This results in a combination of sewage and stormwater being released during heavy rains to keep runoff and wastewater from backing up into residences. The combined vulnerability of these low-lying neighborhoods and properties increase risks to flooding, sewer overflow events, and high tides/sea level rise (SLR) (Fig. 2), with decreasing water quality. Northeast Wilmington has historically suffered from industrial pollution that includes brownfield sites adjacent to the Brandywine shoreline, a variety of other former industrial sites, and vacant homes and parcels which raise concerns about the potential for flood events to transport and spread contaminants (Fig. 3). The population of Northeast Wilmington is among the most socially vulnerable in the Mid-Atlantic U.S.[6]. According to the U.S. Census (2010), 38% of households were living in poverty and nearly25% of the area's housing units were vacant. The prevalence of high blood pressure (39.8%), obesity (39.6%), and high cholesterol (31.9%) were also among the highest in the City of Wilmington or the State of Delaware [7] (Fig. 4). Other conditions such as asthma (12.1%), kidney disease (6.3%), and cancer (5.6%) which have been linked to increased exposure to industrial-related contaminants were also prevalent in the city. The synergistic detrimental health and quality of life impacts from exposure to industrial pollution and natural and anthropogenic hazards make Northeast Wilmington highly vulnerable, with a strong need for resilience planning and design to mitigate flooding and pollutant loads. Despite its heavily urbanized character, the Northeast Wilmington site is part of a much larger, and nearly contiguous, area of natural habitats and green infrastructure (GI)[8] (Fig. 5). It is the initial founding of Wilmington's current drive for applying urban greening as a solution to residents' concerns about flooding and exposure to environmental contaminants. The Brandywine Creek provides a critical habitat for a variety of fish and wildlife, including migratory fish and water-filtering shellfish. It is also a critical habitat for native freshwater mussel populations that provide data and opportunities for a regional freshwater mussel recovery program currently underway by Partnership for the Delaware Estuary[9].This research develops a master plan for the site suffering from both flood issues and significant contamination from brownfields and deindustrialization. Further, we apply an innovative performance model which assesses the probable impacts of both runoff and pollutant loads from the master plan. We then compare these outputs to existing conditions and the city's current comprehensive plan for the area. Building on existing and other ongoing projects, this project facilitates the use of GI to fill spatial gaps within this currently in contiguous areas of natural habitat, benefiting wildlife and improving public and environmental health in Northeast Wilmington by increasing resilience to flooding and reducing exposure to pollution.

2 Design Process

2.1 Study Area

This 130-acre (52.6-hectare) project site, adjacent to the Brandywine Creek and across the creek from the Center Business District of Wilmington, was heavily industrialized in the mid-20th century, occupying a series of built structures such as mills, transshipment centers, and factories. Currently, deindustrialization has led to a number of polluted and unused brownfields in various stages of remediation [10] which characterize the site's significant number of vacant parcels and structural abandonment. Simultaneously, due to its coastal proximity, flood risk remains high, with 27.4% of the site within the 100-year floodplain and high tides and SLR threatening a larger proportion of the site in the near future [11] (Fig. 6).

2.1 Design Goal and Assessment Method

The design targets two persistent issues identified as priorities by residents and stakeholders, a part of an ongoing set of planning and priority setting activities supported by Collaborate

Northeast and the City of Wilmington [4]: runoff reduction and pollutant removal. The goal of the design is to transform the existing brownfields into picturesque green spaces while promoting resilient new development that will 1) increase stormwater management efficiency and reduce flood vulnerability, and 2)reduce pollutant loads within current stormwater runoff, as well as transport of contaminants throughout the neighborhood [12].We utilize the Long-Term Hydrological Impact Assessment(L-THIA) model to assess the effects of parcel-level land use changes on runoff and contamination amounts. L-THIA is a spatial modeling tool that estimates changes in stormwater recharge, runoff, and nonpoint source pollution amounts (from 14 different contaminant sources) resulting from past or proposed development [13]~[15].Pollution sources measured in the model include Nitrogen, Phosphorous, Nickel, Chromium, Lead, Copper, Suspended Solids, COD, Cadmium, Zinc, Oil & Grease, BOD, Fecal Coliform, and Fecal Strep. L-THIA is a curve number (CN) and event mean concentration(EMC) based model. The CN method is one of the most widely accepted tools to predict daily surface runoff [16]. Unlike other EMC models which estimate totals based on a mean, L-THIA calculates pollutant loads and runoff during a simulated period [17] and can be used in areas with incomplete data (as long as land use data are available). One limitation, however, is that the model does not take into account factors such as slope or elevation[18]. Multiple studies globally have demonstrated the feasibility of L-THIA [19]~[21].After applying L-THIA to the current land use configuration, the future land use based on the designed master plan, and each of three phases of the master plan that was developed, are assessed to determine overall projected impacts per phase of implementation. (including coastal terracing, wetland reconstruction, barrier is land creation, and detention/retention facility repurposing) and non-nature-based (e.g. retaining walls, elevated trails, levee maintenance, and dredged harbors) programmatic elements. The overall master plan is accomplished through three phases.1) Topographic cultivation, which provides the foundation to the final two phases and sculpts the terrain as needed both to prevent a majority of intense flooding and to allow for more resilient parcels for future development.2) GI implementation, which concentrates on repurposing much of the newly contoured parcels with GI to help minimize the effects of frequent storms and assist in decontaminating runoff from obsoleteindustries.3) Pollutant removal, to bring a new industry which reuses and transforms wastewater into pigment for the instituted Artist Colony, bringing back the lost Brandywine picturesque style of landscape and artistry.

3.1 Phase 1: Topographic Cultivation

In the topographic cultivation stage, the project focuses on contour reshaping to reduce floodplain inundation and surface runoff through elevation cuts and strategic refilling, specifically along the Brandywine Creek and within the designated 100-year floodplain. To decrease flood vulnerability, the design 1) widens a portion of the Brandywine Creek to increase runoff volume through dredging,2) elevates a roadway to protect the site from extreme flooding, and3) transforms the existing concreate steep levee-based bank into a gentle vegetated and terraced slope to increase floodable area and access to the waterfront.

3.2 Phase 2: GI Implementation

In the GI implementation stage, the project focuses on runoff reduction and protection of properties. The design strategically implements GI within vacant lots and as a remediation method for the existing brownfields and residential areas. Specifically, the design1) applies a small number of green roofs for new, iconic buildings, 2) constructs a series of interconnected bioswales in residential areas, and 3) creates a living shoreline inform of a green corridor along the Brandywine Creek that is connected to large and small-scaled GI in higher elevation areas to collect runoff. The green roofs, due to large upfront construction costs, are limited to only the few lager-scaled and monument type buildings. They will collect and contain runoff from the top of these new large structures. The bioswales will be amended within existing open ditch systems to help reduce the volume of runoff and transfer rainwater into desired retention/ detention areas. Rights of ways with no open ditches or bioswales currently are converted, as needed, to connect the newly designed system. Finally, a trail system along the newly protected shoreline will be completed for recreational purposes. Elevated walkways, boardwalks, ground level surface paved with impervious materials are connected to create this trail system.

3.3 Phase 3: Pollutant Removal

In the pollutant removal stage, the project utilizes advanced industrial techniques to transform wastewater into a consumable commercial product. In particular, infrastructure and facilities are put in place to transform wastewater into artist pigment through element abstraction. As noted, the Brandywine Creek Watershed was once known for its artistic identity—it was the home of Brandywine Style for oil painting. We will reintroduce the Brandywine picturesque style back into the site, creating an artistic village for painters and other artists who require pigment to visualize their thoughts. The approach utilizes advanced industrial wastewater treatment technology where dye and pigment manufacturing alter industrial wastewater into useable products for consumers. This process creates local artist material, a new economic engine, and tourism opportunities for the neighborhood, all while reducing wastewater amounts and runoff. Primary programmatic elements include 1) a pigment lab that treats wastewater, 2) an artist colony near the creek front for pigment utility, and 3) a series of commercial venues related to the pigment creation process that can be used by residents and the public in general.

4 Discussion and Review

This project presents a unique approach to managing flood risk through design which also seeks to decrease hazardous substance transferal during flood events. Further, the innovative application of the L-THIA model to evaluate the design’s effectiveness should bean approach that other designers can take in the future on similar projects to aid in decision-making and better quantify the probable effects of designs. While much research has applied L-THIA to test such probable impacts, existing research on projecting the predicted impacts of conceptual (non-implemented) master plans at neighborhood scale is quite rare. Further, to our knowledge, no research has compared existing conditions, current comprehensive plans, and neighborhood-scaled master plans to evaluate the effectiveness between such differing approaches and scenarios. The approach presented in this paper both validates the master plan in its outputs by demonstrating that it is a better approach than what the current comprehensive plan calls for, at minimum, and shows that the comprehensive plan is also positively impactful for the city, when compared to existing conditions. To project the design's impacts on the goals of improved stormwater management and reduced pollutant loads, we input areas for different land uses (commercial, industrial, high-density residential, low-density residential, water, and grass) with their related soil types (A, B, C, or D) into the L-THIA model, which breaks down pollutant loads into14 different contaminants as noted. For the purposes of the final evaluation in this paper, we only include the results of top three contaminants reflected in the L-THIA outputs for the site (although all contaminants are projected to decrease with the design); these include suspended solids, BODs, and CODs. Wilmington's 2028 comprehensive plan—Wilmington 2028: A Comprehensive Plan for Our City and Communities [22]—includes proposed future land uses for the site and the Northeast overall. To evaluate the design impacts, we compare three potential future scenarios: the Existing Land Use (ELU), the City's 2028 Future Land Use Plan (CFLU), and the Master Plan's Land Use (MPLU) according to the presented design. It should be noted that CFLU was used as an initial basis for MPLU as we used the desires of growth for the city to serve as a foundation for the master plan's initial land use arrangement. However, some land uses eventually changed during the master planning process based on 1) needs and programs identified by engagement processes with the local organizations and residents and 2) findings from analyses related to flood risk and future flood risk changes. L-THIA model outputs show the CFLU—as well as the MPLU—will both decrease the amount of runoff and pollutants in the future on the site. MPLU is, however, more impactful. For example, regarding runoff reduction, compared with ELU, MPLU (24.35%) will reduce nearly 15% more than CFLU (9.66%). With regard to pollutant removal, MPLU will also perform better than CFLU, with an expected reduction of approximately 8.15% in contamination (Table 1). To evaluate the design impacts in each phase by comparing with the existing conditions. Results indicate that each phase will produce consistent improvement related to runoff reduction and pollutant removal (Table 2, Fig. 8): Phase 3 will reduce runoff by24.35%, while Phases 1 and 2 reduce runoff by 15.89% and 22.72%, respectively. Phase 3 is also effective regarding pollutant removal, with more than one-third (38.08%) of contaminants removed when compared with existing conditions; Phases 1 and 2 can reduce contaminants by 20.34% and 32.04%, respectively. Overall, the presented master plan using the L-THIA model can reduce stormwater runoff and pollutant loads to levels that are significantly less than the existing conditions or the city's current land use plan as part of its 2028 Comprehensive Plan Update Further, current flood risk will be reduced, and increases in future flood risk attributable to SLR will be ameliorated. Since risks are decreased in the master plan, the reductions in future flood damage will thereby be reduced. In addition to the primary goals of the master plan, housing typology diversity and population characteristic diversity will broaden and access/connections to the Brandywine Creek will be strengthened, both of which are in alignment with stakeholder and resident priorities [4]. When GI and nature-based solutions reducing runoff and contamination are mixed with strategic flood-proofed development approaches, cities—even urban industrial centers with contamination issues at risk from the impacts of natural and anthropogenic hazards—can create more vibrant communities with reduced flood risk and improved environmental and public health.

Acknowledgments

The findings and conclusions in this report are those of the authors and do notnecessarily represent the official position of National Fish and Wildlife Foundation.

REFERENCES

[1]. Sengul H, Santella N, Steinberg LJ, & Cruz AM (2012). Analysis of hazardous material releases due to natural hazards in the United States. Disasters, 36(4), 723–743. doi:10.1111/j.1467-7717.2012.01272.x [PubMed: 22329456]

[2]. World Population Review. (n.d.). Wilmington, Delaware population 2022(demographics, maps, graphs).

[3]. Aly NA, Casillas G, Luo Y-S, McDonald TJ, Wade TL, Zhu R, Newman G, Lloyd D, Wright FA, Chiu WA, & Rusyn I (2021).Environmental impacts of Hurricane Florence flooding in eastern North Carolina: Temporal analysis of contaminant distribution and potential human health risks. Journal of Exposure Science & Environmental Epidemiology, 31(5), 810–822.doi:10.1038/s41370-021-00325-5 [PubMed: 33895777]

[4]. Whitman, Requardt & Associates. (2019). Northeast Wilmington Community revitalization implementation plan.

[5]. Doyle MW, & Shields DF (2012). Compensatory mitigation for streams under the clean water act: Reassessing science and redirecting policy. Journal of the American Water Resources Association, 48(3), 494–509. doi:10.1111/j.1752-1688.2011.00631.x

[6]. U.S. Census Bureau. (2010). Quick facts: Wilmington City, Delaware.

[7]. State of Delaware. (n.d.). My Healthy Community: Delaware Environmental Public Health Tracking Network.

[8]. McMillan H (2011). Planning for sea level rise in the Northeast: Considerations for the implementation of tidal wetland habitat restoration projects (workshop report).

[9]. Partnership for the Delaware Estuary. (2017). Freshwater mussels.

[10]. Environmental Protection Agency. (2017). Brownfields 2017 area-wide planning grant fact sheet.

[11]. Perez VW, & Egan J (2016, September). Knowledge and concern for sea-level rise in an urban environmental justice community. Sociological Forum, (31),885–907. doi:10.1111/socf.12278

[12]. Fairbairn DJ, Karpuzcu ME, Arnold WA, Barber BL, Kaufenberg EF, Koskinen WC, Novak PJ, Rice PJ, & Swackhamer DL (2016).Sources and transport of contaminants of emerging concern: A two-year study of occurrence and spatiotemporal variation in a mixed land use watershed. Science of the Total Environment, (551–552), 605–613. doi:10.1016/j.scitotenv.2016.02.056

[13]. Zhu R, & Newman G (2021). The projected impacts of smart decline on urban runoff contamination levels. Computational Urban Science, 1(2), 1–20.doi:10.1007/s43762-021-00002-1

[14]. Newman G, Shi T, Yao Z, Li D, Sansom G, Kirsch K, Casillas G, &Horney J. (2020). Citizen science-informed community master planning: Land use and built environment changes to increase flood resilience and decrease contaminant exposure. International Journal of Environmental Research and Public Health, 17(2), 486.doi:10.3390/ijerph17020486 [PubMed: 31940904]

[15]. Hendricks MD, Newman G, Yu S, & Horney J (2018). Leveling thelandscape: Landscape performance as a green infrastructure evaluation toolfor service-learning products. Landscape Journal, 37(2), 19–39. doi:10.3368/lj.37.2.19 [PubMed: 32831452]

[16]. D'Asaro F, Grillone G, & Hawkins RH (2014). Curve number: Empiricalevaluation and comparison with curve number handbook tables in Sicily. Journalof Hydrologic Engineering, 19(12), 04014035. doi:10.1061/(ASCE)HE.1943-5584.0000997

[17]. Wang Y, Choi W, & Deal BM (2005). Long-term impacts of land-use changeon non-point source pollutant loads for the St. Louis Metropolitan Area, USA.Environmental Management, 35(2), 194–205. doi:10.1007/s00267-003-0315-8 [PubMed: 15902457]

[18]. Mirzaei M, Solgi E, & Salmanmahiny A (2016). Assessment of impactsof land use changes on surface water using L-THIA model (case study:Zayandehrud river basin). Environmental Monitoring and Assessment, 188(12),690. doi:10.1007/s10661-016-5705-5 [PubMed: 27885617]

[19]. Zhang J, Shen T, Liu M, Wan Y, Liu J, & Li J (2011). Research on non-point source pollution spatial distribution of Qingdao based on L-THIA model.Mathematical and Computer Modelling, 54(3–4), 1151–1159. doi:10.1016/j.mcm.2010.11.048

[20]. Engel BA, Ahiablame LM, & Leroy JD (2015). Modeling the impacts ofurbanization on lake water level using L-THIA. Urban Climate, (14), 578–585.doi:10.1016/j.uclim.2015.10.001

[21]. Zare M, Samani AAN, & Mohammady M (2016). The impact of land usechange on runoff generation in an urbanizing watershed in the north of Iran.Environmental Earth Sciences, 75(18), 1279. doi:10.1007/s12665-016-6058-7

[22]. Department of Planning and Development, City of Wilmington Delaware. (2019).Wilmington 2028: A comprehensive plan for our city and communities.

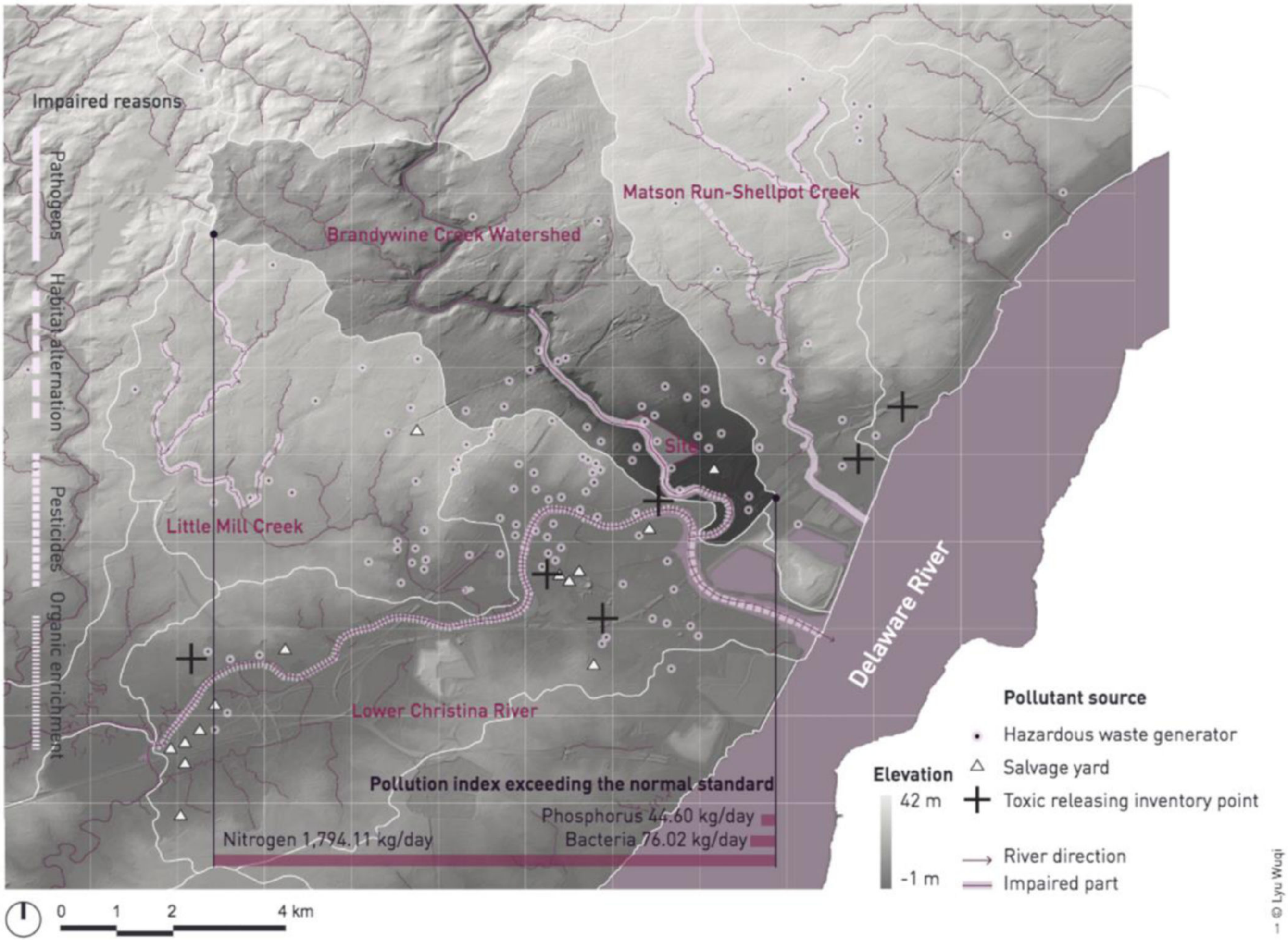


Figure 1.

Brandywine Creek impairment within larger watershed context. There are five watersheds in Wilmington. Total impaired length of the rivers is47.86 km; the river pollution is mainly caused by pesticides, pathogens, organic enrichment, and habitat alternation. There is 6.04 km of lower Brandywine Creek impaired, where Phosphorus, Nitrogen, and bacteria exceed normal amount.

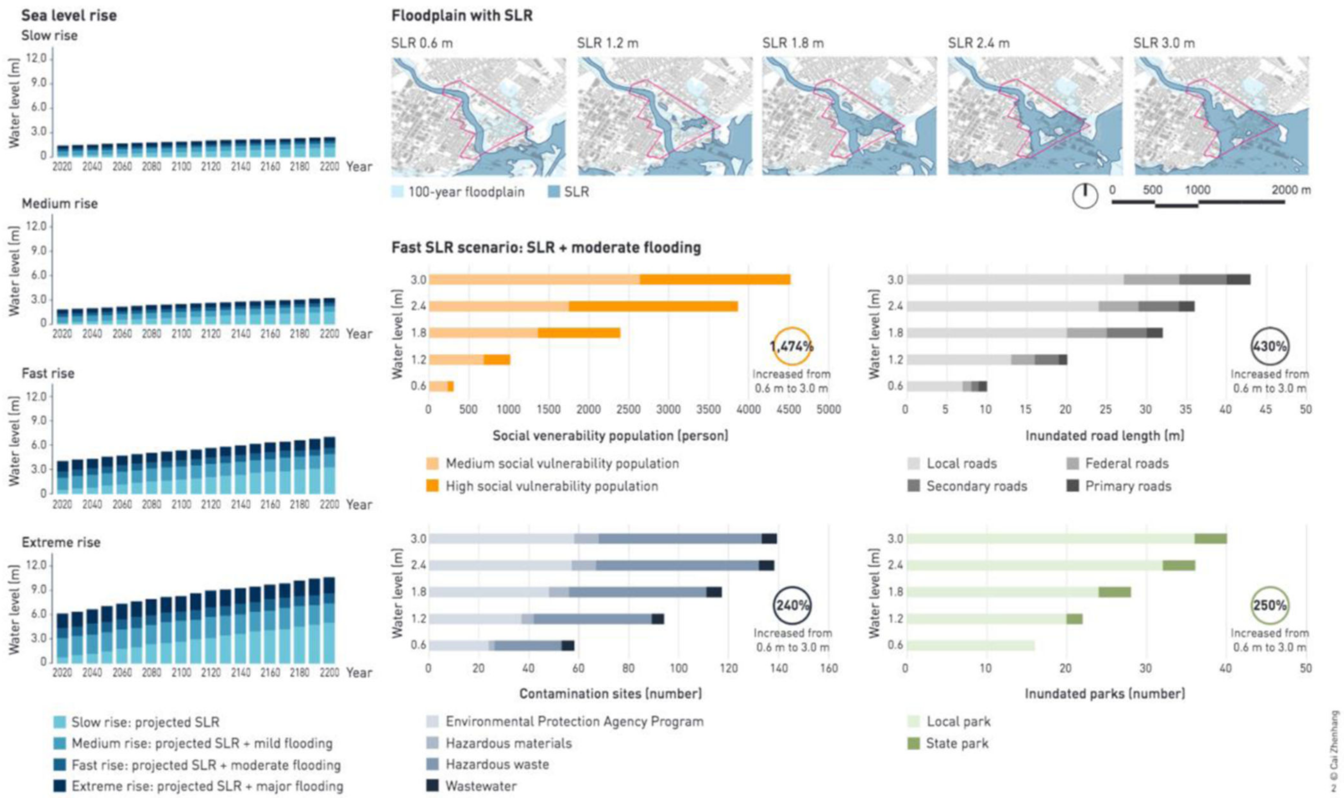


Figure 2.

SLR with floodplain predictions for the study area (Source: Sea Level Rise Viewer)

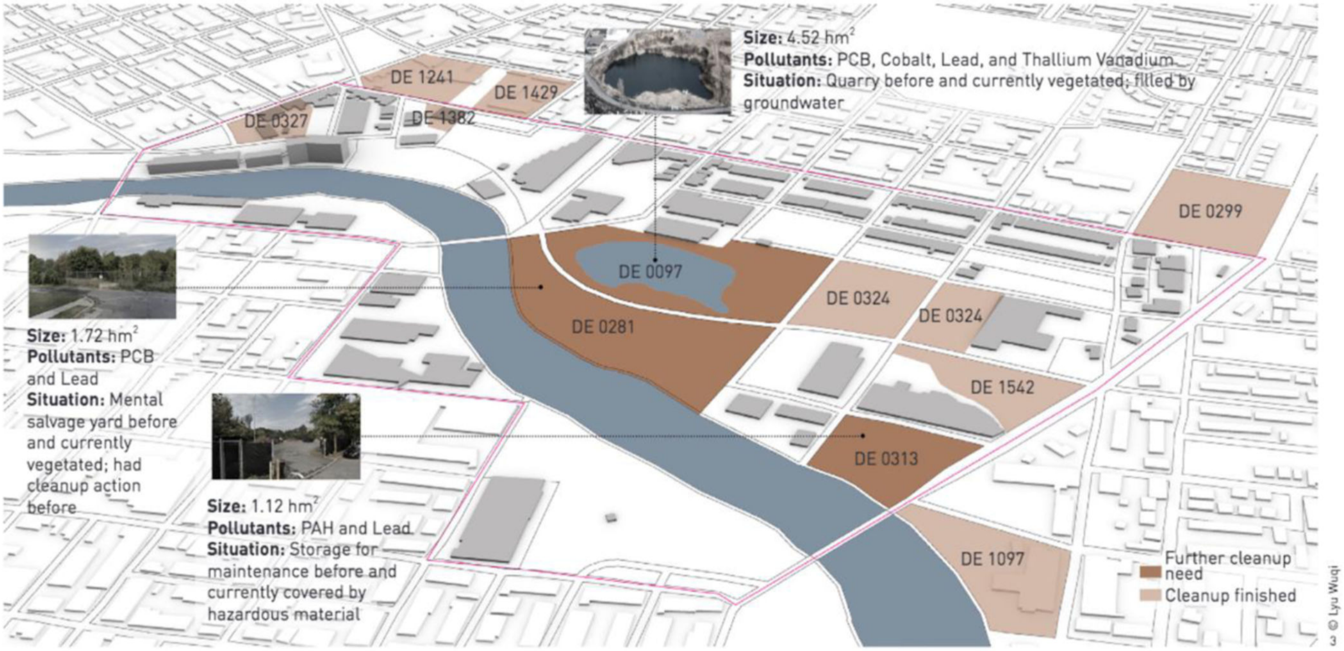


Figure 3.

Brownfield inventory within the design site (the letters and numbers for each brownfield, e.g. DE 0313, are the coding for brownfield sites for the Delaware list of brownfields)

4. Public health outcomes for the current population in Wilmington, DE (Source: PLACES: Local Data for Better Health From Centers for Disease Control and Prevention)

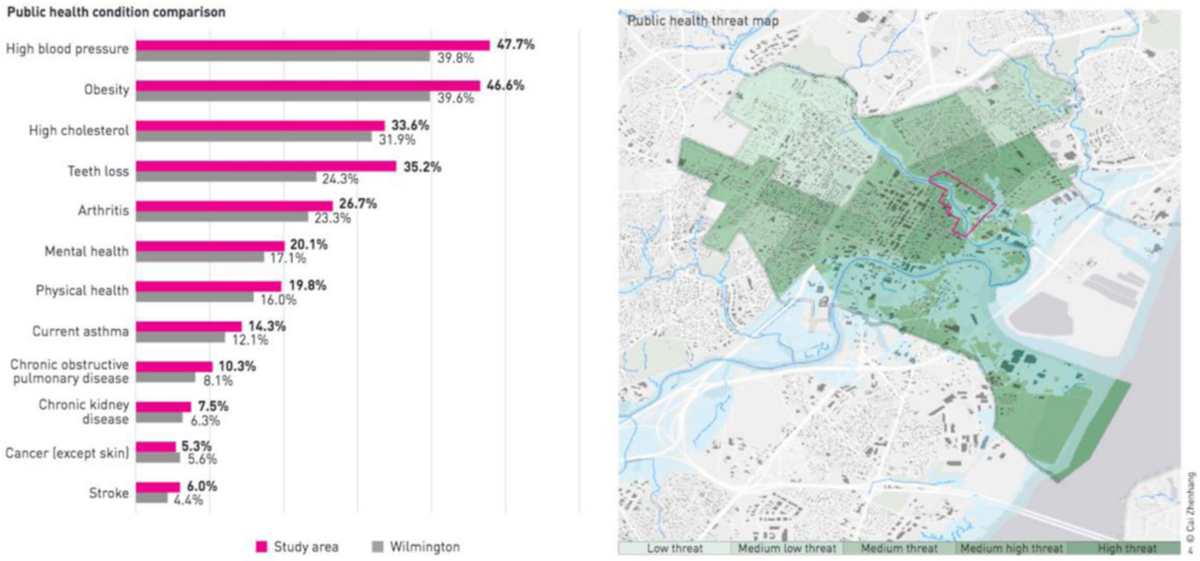


Figure 4.

Public health outcomes for the current population in Wilmington, DE (Source: PLACES: Local Data for Better Health From Centers for Disease Control and Prevention)

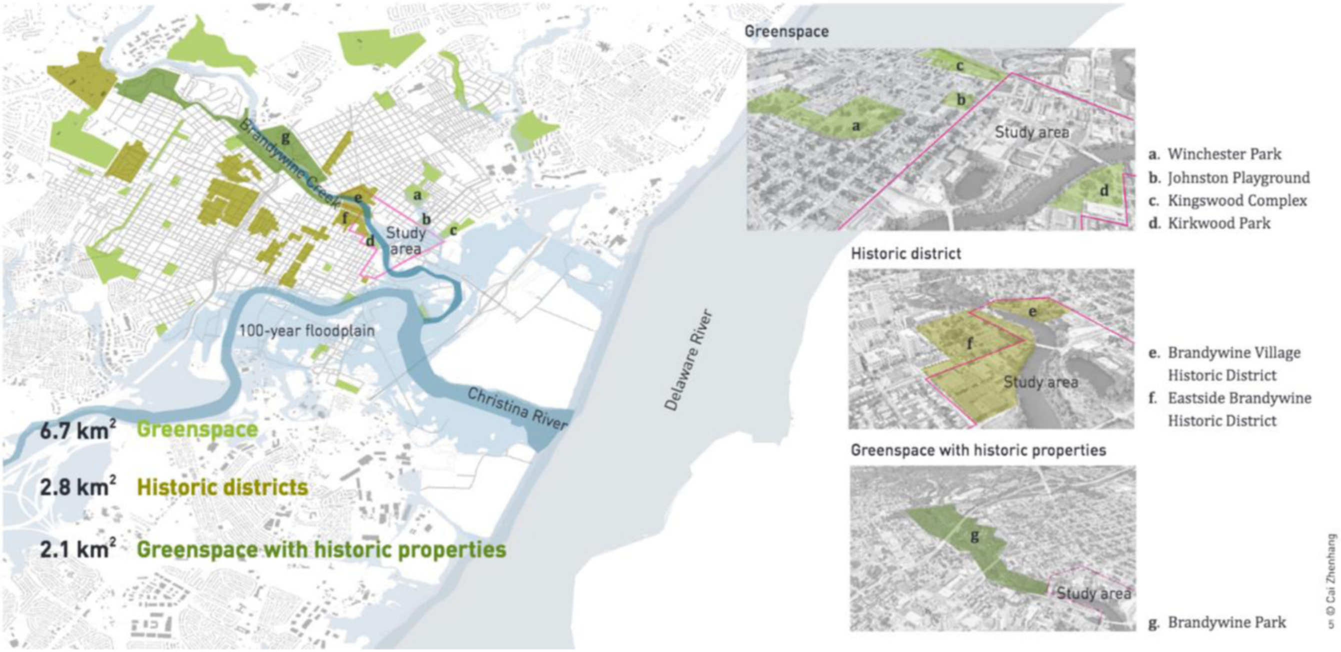


Figure 5.

Green space and historic districts in Wilmington, DE

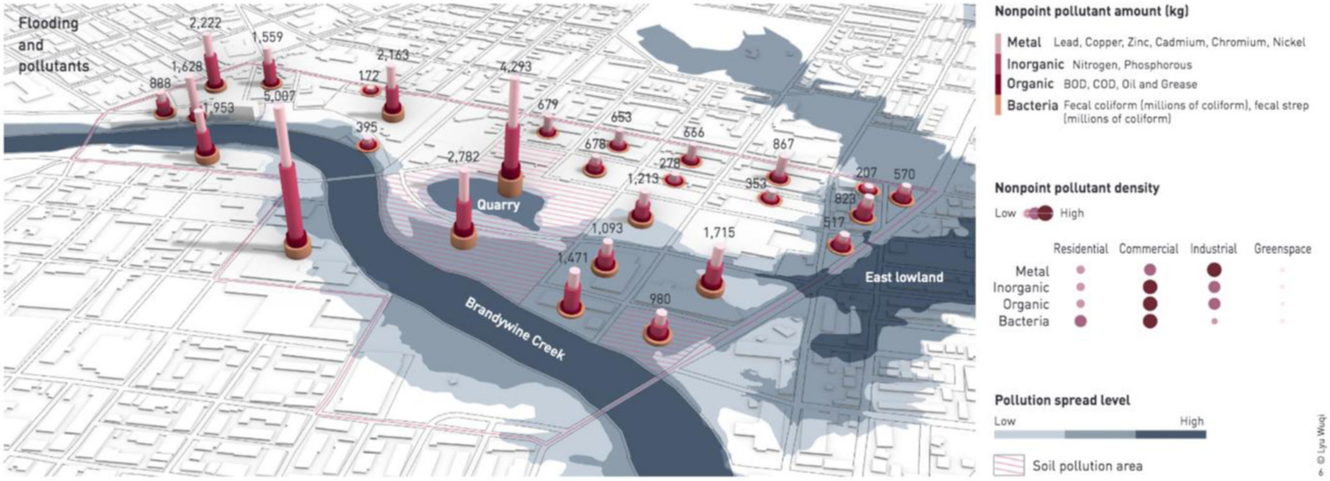


Figure 6.

Primary contamination sources within the 100-year floodplain of the study area

Figure 7.

Master plan of study area with green infrastructure, land use, and flood risk diagramming

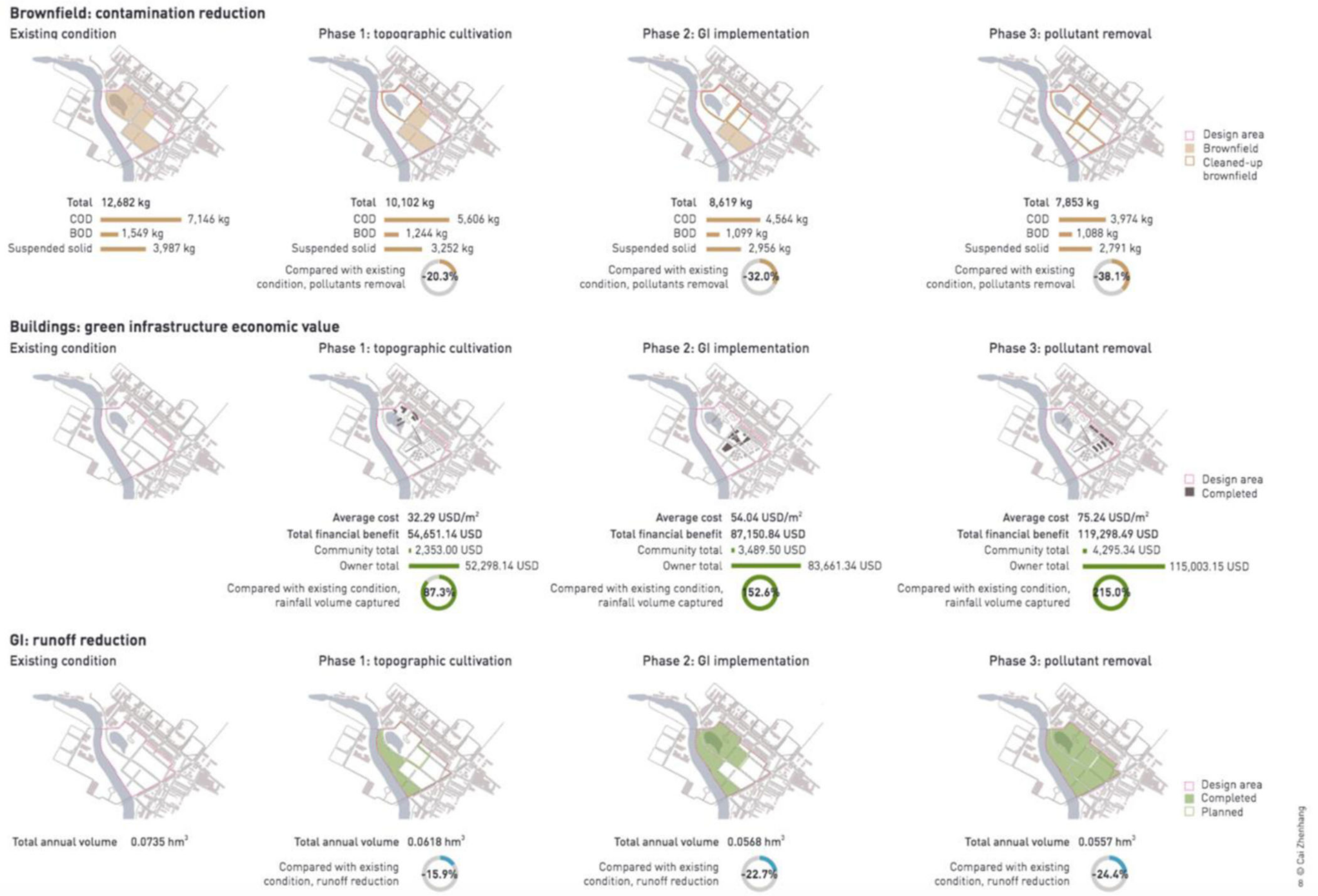


Figure 8.

Design impact overall and by phase for the study area based on the master plan

Table 1.

Comparison of the L-THIA model outputs comparing the ELU, CFLU, and MPLU.

	ELU			CFLU			MPLU		
	Area (hm2)	**Runoff(m3)**	**Pollutant (kg)**	**Area (hm2)**	**Runoff(m3)**	**Pollutant (kg)**	**Area (hm2)**	**Runoff(m3)**	**Pollutant (kg)**
Commercial	12.78	54,643.16	10,648.55	4.46	19,049.85	3,713.38	5.09	21,725.46	4,235.83
Industrial	3.11	12,625.92	1,517.91	9.19	37,347.57	4,491.16	4.12	16,719.48	2,010.88
High-density residential	0.00	0.00	0.00	0.00	0.00	0.00	2.06	6,818.49	792.74
Low-density residential	2.97	4,414.14	512.93	3.91	5,807.43	675.74	4.68	6,954.12	808.62
Water	5.48	0.00	0.00	4.30	0.00	0.00	6.76	0.00	0.00
Grass	1.91	1,824.84	2.72	4.39	4,204.53	5.90	3.55	3,390.75	4.54
Total	26.25	73,508.06	12,682.09	26.25	66,409.38	8,886.18	26.26.	55,608.30	7,852.61
Percentage decreased from ELU	——	——	——	——	9.66%	——	——	24.35%	38.08%

Table 2.

Comparison of design impact outputs from the L-THIA model by phase.

	Existing Condition			Phase 1			Phase 2			Phase 3		
	Area (hm2)	**Runoff(m3)**	**Pollutant (kg)**	**Area (hm2)**	**Runoff(m3)**	**Pollutant (kg)**	**Area (hm2)**	**Runoff(m3)**	**Pollutant (kg)**	**Area (hm2)**	**Runoff(m3)**	**Pollutant (kg)**
Commercial	12.78	54,643.16	10,648.53	9.68	41,391.81	8,067.57	6.95	29,727.63	5,795.01	5.09	21,725.46	4,235.83
Industrial	3.11	12,625.92	1,517.91	3.11	12,625.92	1,517.91	4.11	16,707.15	2,008.62	4.12	16,719.48	2,010.88
High-density residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.06	6,818.49	792.74
Low-density residential	2.97	4,414.14	512.93	2.97	4,414.14	512.93	4.69	6,978.78	810.88	4.68	6,954.12	808.62
Water	5.48	0.00	0.00	6.94	0.00	0.00	6.94	0.00	0.00	6.76	0.00	0.00
Grass	1.91	1,824.84	2.72	3.55	3,390.75	4.54	3.55	3,390.75	4.54	3.55	3,390.75	4.54
Total	26.25	73,508.06	12,682.09	26.25	61,822.62	10,102.95	26.24	56,804.31	8,619.05	26.26	55,608.30	7,852.61
Percentage decreased from ELU	——	——	——	——	15.89%	20.34%	——	22.72%	32.04%	——	24.35%	38.08%