OLF-8 HYBRID PLAN

GREEN INFRASTRUCTRUE IMPLEMENTATION

SUBMITTED TO

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EXECUTIVE SUMMARY

This document provides a summary for implementation of Green Infrastructure strategies for the OLF-8 project based on the Hybrid Plan developed by DPZ Codesign. The OLF-8 site provides an opportunity for a new development that is environmentally sustainable and resilient, compact, diverse, and well-connected. The overall approach for civil and environmental engineering is to protect resources and reduce construction and operating costs by using sustainable civil engineering practices that are coordinated with urban design.

This document provides selected Green Infrastructure strategies for the OLF-8 project based on the Hybrid Plan developed by DPZ Codesign in May 2021. Initial assessment of project site conditions and design considerations of the project site was conducted to determine potential constraints that may limit on-site retention of stormwater runoff and implementation of stormwater quality control measures. Six types of green infrastructure components are implemented.

For stormwater treatment a series of interconnected lakes and green areas are proposed (wet and dry ponds). The urban plan introduced 11 lakes (with a total area of 24 acres ranging between 0.3 and 4 acres in size) and additional dry ponds. The proposed wet and dry ponds are interconnected with overland and subsurface conveyances to distribute and treat water storage within the site. Based on the urban plan configuration, the stormwater system for the Hybrid Plan provides enough storage to attenuate post-development 100-year, 24-hour peak discharge rate to pre-development rates.

On a block and parcel scale, smaller green infrastructure components (with a total area of 32 acres ranging in size between 0.1 to 2 acres) are proposed, which include stormwater planters, rain gardens, stormwater trees and vegetated swales. To reduce the impact of introducing impervious roads, two strategies are proposed. Thoroughfare medians with total length of nearly 25,000 feet are used to provide stormwater storage runoff from the roads. Additionally, for semi-impervious road cover and medians are proposed for light vehicular and for pedestrian traffic.

For green building practices, either solar roofs or green roofs are proposed to cover the proposed 95 acre of building roofs. Using solar power has initial costly investment, however it has the potential to reduce the overall use of energy within the site. As an alternative to solar power, green roofs can be used to capture the runoff by a layer of vegetation and soil installed on top of a conventional flat or sloped roof. The rooftop vegetation allows evaporation and evapotranspiration processes to reduce the energy consumed by the building by estimated 33% and additional to reduce volume and discharge rate of stormwater runoff from the roofs. Geothermal Heat Pumps can be used to reduce the overall energy demand of the site and to reduce noise generated by air conditioning system. In Zones Z1 to Z4 Closed loop systems are recommended based on using a thermal fluid, (typically water), to circulate through underground pipes to a building’s heat exchange system. In the winter, the heat pump extracts heat from the ground to heat the building through space heating or to heat water.

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1 INTRODUCTION

The OLF-8 site provides an opportunity for a new development that is environmentally sustainable and resilient, compact, diverse, and well-connected. The overall approach for civil and environmental engineering is to protect resources and reduce construction and operating costs by using sustainable civil engineering practices that are coordinated with urban design. This document provides a series of Green Infrastructure strategies for the OLF-8 project based on the Hybrid Plan developed by DPZ Codesign, and presented to the Board of County Commissioners in May 2021.

Initial assessment of project site conditions and design considerations of the project site was conducted to determine potential constraints that may limit on-site retention of stormwater runoff and implementation of stormwater quality control measures. As part of this assessment, the project identified the physiographic, hydrologic, climatic, and regulatory conditions at the site and included:

- Site hydrology (topography, soils, current land use, wetlands, groundwater elevations, flood hazards).
- Predevelopment drainage patterns and area (acreage and location via project site map).
- Location of point(s) of stormwater runoff discharge (storm drain system or receiving water).
- Activities expected on-site.
- Regulatory requirements mainly which include Escambia County (Land Development and Municipal code) and Northwest Florida Water Management District.

The topography of the sites varies from 70 to 145 feet elevation in the North American Vertical Datum of 1988 (NAVD 88). Most of the site is primarily flat and approximately 85% of the area is at elevations above 100 feet NAVD 88. The site has favorable topography for a broad range of urban development. The areas with elevations lower than 100 ft NAVD 88 are primarily occupied by wetlands and considered undevelopable land, therefore a conservation zone was proposed to protect these areas from future development.

The pre-development drainage of rainfall that exceeds the infiltration capacity of soils results in surface runoff that is routed via natural land depressions and channels to the existing wetlands and perennial streams located at the southwest and southwest corners of the site and subsequently discharge into Eleven Mile Creek which is located approximately one mile southeast of OLF-8.

Flooding in Escambia County results primarily from tidal surges and the overflow of streams and swamps associated with rainfall-runoff. Major rainfall events occur because of hurricanes, tropical storms, and thundershowers associated with frontal systems. Some of the worst floods to occur in this area were the result of high-intensity rainfall during a hurricane (particularly in 2020, Hurricane Sally nearly 30" inches of rain were recorded within a few days and with maxim 3 -day rainfall (ref 3).

The project is located outside of FEMA-designated special flood hazard areas as per the FEMA Floor Insurance Rate Map (FIRM) Map No, 12033C0290G which is effective as of October 2019. The entire site is in zone X, designated for minimal flood hazard, and located outside the Special Flood Hazard Area with greater than the 0.2-percent-annual-chance flood (ref 1).

Based on the limited preliminary investigation by Terracon Inc (ref 11) the predominant soil type encountered on-site was silty to clayey fine-grained sand. The initial soil data obtained from (ref 2) indicates low infiltration rates in the north half of the site (soil hydro group C) where lakes would be more appropriate. For the south section of the project dry retention or natural preserves which rely on higher infiltration rates to disperse the accumulated water are recommended.

The project is a greenfield site and there are no areas with known groundwater pollution, therefore, infiltration and use of surface drainage features are not expected to mobilize groundwater contamination. Tests provided most recently, January 2019 (ref 11), showed no presence of organic pollution in groundwater. The depth to groundwater beneath the project site during the wet season indicates available storage for infiltration even though the infiltration rates could be slow.

The surficial aquifer is underlain by the sandy to clayey surficial horizons of the Citronelle Formation that are time-equivalent to the hydrogeologic Sand and Gravel Aquifer. The Sand and Gravel Aquifer is 275 to 300 feet thick and is the source of all domestic and municipal water in Pensacola. ECUA intends to build a public supply water well system within the northeast corner of the site for withdrawals from the Sand and Gravel aquifer which is not expected to impact the stormwater system because of the separation of surficial aquifer and surface water flows by the soil layer.

Delineation investigation completed by Wetland Sciences Inc in 2019 established that the existing wetlands are comprised of four distinct ecological communities, wetland bay gall, wetland shrub bog, wetland dome swamp, upland mesic hardwoods, and disturbed uplands. Previous wetland delineation studies from 2013 identified approximately 23.21 acres of palustrine wetlands (rooted in water but growing above the surface) along the northern, eastern, and southwestern borders of the site. Approximately 0.08 acres of emergent wetlands exist along the western border of the property. Upland and forested drainage channels are present, draining to the wetlands. Approved jurisdictional determination for 17.08 acres of the wetlands along the west, South, and Eastern boundaries was issued by the USACE in April of 2013 due to their drainage to Eleven Mile Creek, which is a tributary to traditionally navigable water. Wetlands along the northern border of the property are classified non- jurisdictional because these areas (6.05 acres) are isolated from, or not adjacent to traditional navigable water or other waters of the U.S. Upland buffers with a minimum width of 15-feet and an average width of 25-feet shall be provided abutting those wetlands under the regulatory jurisdiction of the State of Florida under 62-340. A 10-feet average upland buffer shall be required for development activities that avoid impacts to wetlands.

The proposed urban development will result in the addition of impervious and semi-impervious areas, which will reduce aquifer recharge and will increase stormwater surface runoff during rainfall events. The urban plan will introduce impervious and semi-impervious areas which are classified in the following categories based on their perviousness and accessibility:

i) Impervious surfaces mainly from building roof, roadways and sidewalks.
ii) Semi-impervious surfaces with public access, including light traffic roads, sidewalks, parking areas, and other public spaces.
iii) Pervious green infrastructure components designed to provide stormwater storage including green areas, parks, detention areas, stormwater trees (trees with the capacity to accommodate runoff)
iv) Pervious natural green areas, which are preserved in their native state and can be used for treatment of stormwater volumes peaks and water quality

The initial concept of the stormwater management system was developed in collaboration with the planners, and with the objective to meet the on-site retention and treatment requirements and regulatory compliance and reduce the overall costs by incorporating green infrastructure strategies. The configuration of the proposed stormwater system includes a series of interconnected storage ponds, conveyance and green infrastructure components which were sized to provide stormwater flow and water quality treatment (Figure 1).

Figure 1 Configuration of Green Infrastructure and Stormwater Management System

To ensure that the overall site hydrology is preserved, the urban plan uses multiple strategies to reduce the impacts of impervious areas such as:

i) Reduce impervious areas and reduce surface runoff and increase the aquifer recharge.
ii) Increase on-site storage to retain stormwater and maintain the pre-development drainage hydrology.

iii) Use native vegetation to increase evapotranspiration, reduce stormwater runoff velocities, and provided water quality treatment.

iv) Provide a series of inline cascading storage features (dry and wet retention ponds) to attenuate post-development peak runoff and provide water quality treatment, while providing park amenities.

Figure 1 provides the configuration of the stormwater system which preserves the pre-drainage flows and is comprised by conventional stormwater components (underground pipes and infrastructure). Retention-based stormwater quality control measures are more effective on leveled or gently sloped areas, therefore, the retention green infrastructure components were preferably placed in flatter areas.

The plan shown on Figure 1 was developed based on the Design Standards Manual of Escambia's Municipal Code (ref 8 and 9) considering that the stormwater management system (SMS) shall at minimum be designed to provide for the following for the total contributing runoff area:

- **Positive Discharge Outfall:** Provide attenuation of the runoff from a 100-year critical duration event, up to and including 24-hour duration, so that the post-development runoff rate does not exceed the pre-development runoff rate.
- **No Positive Discharge Outfall:** Provide retention up to and including 24-hour, 100-year frequency storm with no offsite discharge. The Municipal Codes states that these systems shall remain private and will not be accepted by the county for ownership and maintenance.

Furthermore, the stormwater management system (SMS) is designed to provide for the treatment of the first one-half inch of runoff which shall be recovered in 72 hours. The methods of water quality treatment are provided in the latest edition of the Environmental Resources Permit Applicants Handbook, Volume II (ref 5). The entire capacity of a dry pond shall be fully recovered within seven days for a pond with positive drainage outfall and ten days for a pond with no positive drainage outfall.

Designs requirements for dry and wet ponds are provided in the Environmental Resource Permitting Applicants Handbook, Volume II, Florida Department of Environmental Protection and Northwest Florida Water Management District and were taken into consideration in development of the plan shown on Figure 1.

The perimeter of all deep pool areas (four feet or greater in depth) are typically surrounded by two benches except when the pond side slopes are 6:1 or flatter. An aquatic bench that generally extends up to 15 feet inward from the normal shoreline should be included. Aquatic benches have an irregular configuration and have a maximum depth of 18 inches below the normal pool water surface elevation.

All ponds are required to slope at a subtle grade into the water as a safeguard against accidents, to encourage the growth of vegetation, allow for proper maintenance, and to allow alternate flooding and exposure of areas along the shore as water levels change. An additional benefit is to allow the pond to be well integrated into the open space network so that it is also used as a public amenity. The OLF-8 project will use unfenced dry and wet ponds with a slope of 6:1 horizontal to vertical, out to a depth of two feet below the control elevation for wet ponds.

The Design Manual requires stabilization of wet/dry ponds using solid sod above the permanent pool elevation; alternatively, stabilization can be obtained through incorporation of littoral plantings. The side slopes of dry ponds are required to be solid sod from the bottom to three feet beyond the top of bank. Unobstructed maintenance access is required with a minimum width of 15 feet for wet ponds and 12 feet for dry ponds to the wet/dry pond area constructed of graded aggregate a minimum 12 feet wide, no steeper than 6:1 (horizontal to vertical) at least five inches thick and underlain with pervious geotextile fabric. A summary of applicable standards for maintenance access include:

- A concrete driveway leading from the roadway meeting county standards. To reduce road impervious areas, semi-impervious materials are suggested (i.e. pervious concrete or pavers)
- Access gate with a minimum 14 feet wide, six feet tall double access gate at the pond parcel boundary line is required, however, an exception is proposed not to require this gate for the OLF-8 project
- Dry ponds are required to have a minimum 5-foot-wide access route around the pond perimeter with a cross slope no steeper than 6:1.
- Wet ponds are required to have a minimum 15-foot-wide access route around the top bank perimeter of the retention area perimeter with a cross slope no steeper than 6:1.

Overland Conveyance Systems: All conveyance systems are designed to convey the runoff from a 25-year critical duration event. Curb and gutter systems are designed to convey runoff without exceeding:

- For local residential roads, the maximum allowable spread shall not overtop the top of curb and the flow spread should not exceed to the crown of the roadway.
- For two lane collector roads, the maximum allowable spread shall not overtop the top of curb and the flow spread must leave one lane free of water in one direction.
- For arterial roads, the maximum allowable spread shall not overtop the top of curb and the flow spread must leave at least one lane free of water in both directions.

Roadside swales and ditches are designed for:

- Flow shall not extend over the property line, right-of-way line, or drainage/utility easement line
- Minimal longitudinal slope of 0.30 percent.
- Depth less than three feet.
- Minimum distance of six feet from the edge of the travel lane.
- Design velocity of unlined swale is less than three feet per second, and less than six feet per second for lined swale.
- Maximum side slope is flatter than 3:1 (horizontal to vertical).

The open channels in drainage rights-of-way or easements are designed to:

- All ditches or swales shall be stabilized.
- Bank slopes shall be 6:1 or flatter unless permanent stabilization is provided.
- Velocity of water shall not exceed three feet per second in grassed ditches or six feet per second in lined ditches.
- Maximum allowable design depth of water in ditches shall be three feet during a 25-year storm.
- Bottom of ditch or swale is two inches or more above the water table.
- Any ditches with grades of five percent or greater shall be lined or otherwise improved to eliminate erosion and sedimentation buildup in the lower elevations of the ditch, as approved by the county engineer.
- Adequate access for maintenance equipment (15 feet wide minimum) must be provided as needed for maintenance equipment access.
- Channels and culverts under all proposed roads, excluding conveyance systems diverting runoff to the ponds, shall be designed to convey the runoff from a 100-year critical duration event without overtopping the road.

- All proposed conveyance swales and open conveyance ditches are designed with minimum longitudinal slope of 0.30 percent.
- Design velocity of unlined swale is less than three feet per second, and less than six feet per second for lined swale.

Underground Conveyance Systems: All underground conveyance systems are designed with inlet/junction boxes spacing not to exceed 400 feet. The minimum pipe diameter is 18 inches and shall be equal to or larger than the adjoining upstream pipe diameter. Under proposed or existing paved roadways only reinforced concrete pipe (RCP) are acceptable. Drainage easements for underground conveyance systems are minimum width of 15 feet for when the proposed depth is equal to or less than five feet from pipe invert to proposed finished grade and 20 feet for greater depts. Under normal flood conditions county standard inlets are designed to accept the following flowrates, or alternatively, FDOT inlets may be used as a substitute for county standard inlets provided the inlet capacity is accommodated by the specified inlet type:

- Type "A" Inlet: 7—10 cfs
- Type "A-1" Inlet: 7—10 cfs
- Type Modified "A" Inlet: 14—20 cfs
- Double "A" Inlet: 14—20 cfs

The DSM requires a stormwater management plan (SMP) prepared by, signed, and sealed by a professional engineer registered in the State of Florida certifying that the intent of the land development code and this design standards section have been met.

2 PROJECT ZONING AND PHASING

The proposed zoning information was used to define the preferred green infrastructure components of the site. The proposed zoning map for the period 2021-2027 and the proposed stormwater infrastructure are depicted in Figure 2.

Figure 2 Proposed Zoning Map (2021-2027) and Stormwater Infrastructure

The zoning map was used to identify site-specific Green Infrastructure Components recommendations. The zoning of the site includes:

- **CZ: Conservation Zone:** Protected public open space and natural wildlife habitats, total of 143.84 acres three lakes with surface area 8.47 acres.
- **Z1: Neighborhood Core:** A high intensity mixed-use district, consisting of residential, commercial, and institutional uses, with total area 31.78 acres.
- **Z2: Neighborhood Center:** A medium intensity mixed-use district, consisting of residential, commercial, and institutional uses, covering 16.11 acres, stormwater storage is provided in CZ.
- **Z3: Commerce District:** A medium intensity commerce district, consisting of commercial and retail uses covering 72.69 acres and a lake with surface are of 0.74 acres. Additional stormwater storage is provided in Z4.
- **Z4: Light Industrial District:** A medium intensity district, consisting of light industrial and commercial/office uses covering 181.6 acres and 7 lakes with surface area of 14.67 acres.
- **Z5: Neighborhood General:** A medium intensity, predominantly residential district, consisting of single-family attached housing, multi-family housing and live-work units, stormwater storage is provided in CZ.

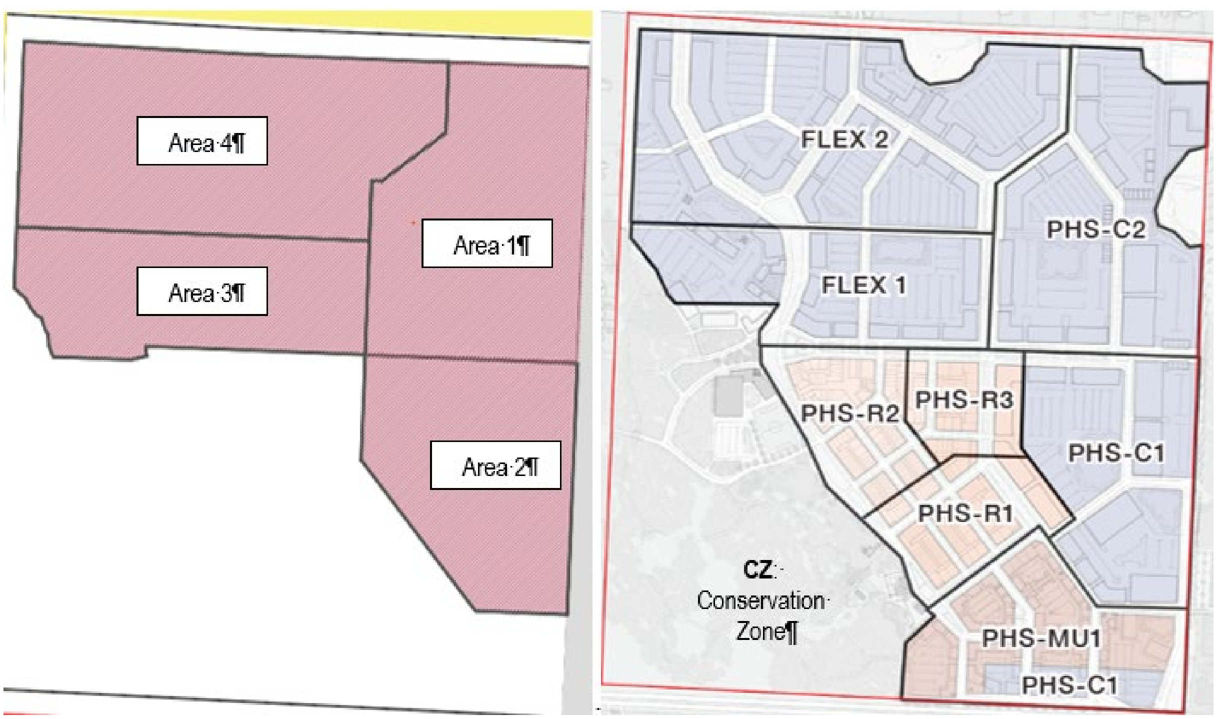


Figure 3 Phasing of Development Areas

The site infrastructure will be developed based on the urban phasing diagram shown on Figure 3. Areas 1 and 2, 3 and 4 will be developed sequentially starting with Area 1. The following recommendations are provided for infrastructure phasing:

- Infrastructure Phase 1 – Includes development of the infrastructure for Area 1 (PHS-C2), Area 2 (PHS-C1) and for the conservation zone will be developed. PHS-C1 of Area 1 and PHS-C2 of Area 2 will develop all civil infrastructure (stormwater, utilities, roads). The Conservation Zone will be developed initially considering that the entire zone is a set of parks which serves and provides amenities for the entire site, therefore early implementation is recommended.
- Infrastructure Phase 2 – Includes development of the infrastructure for Area 3 (FLEX 1), this area will also provide infrastructure for future development of Area 4.
- Infrastructure Phase 3 – Includes the development of the infrastructure for PHS-R1, PHS-R2, PHS-R3 and PHS-MU1. Considering that the land use type and zoning may change for some of the areas, the stormwater system and the utilities will be designed for medium intensity industrial (Z4, Z5 and Z6) or for high intensity neighborhood (Z1).

3 GREEN INFRASTRUCTURE IMPLEMENTATION

The project encourages the integration of Green Infrastructure strategies within all civil infrastructure components to provide the best environmental performance of the site and reduce the energy use and the costs of the civil infrastructure. Green infrastructure is a system of distributed and interconnected network of open spaces, natural areas and stormwater management components that preserve natural processes by engineering soils, topography, and vegetation in a way that maintains the pre-development hydrology and water quality of urban environments. The main design aspect of green infrastructure components is to minimize the impacts of development activities and impervious surfaces. This is accomplished mainly by maximizing stormwater storage, reducing impervious areas and increasing the use of vegetation (Figure 4):

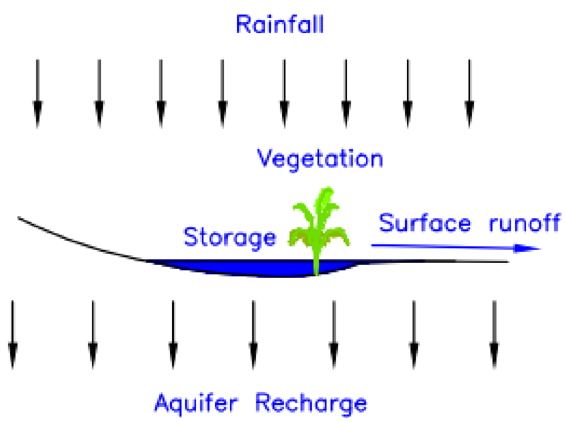


Figure 4 Principal Components of Hydrological and Green Infrastructure

The main aspect of Green Infrastructure Implementation is the preservation of the hydrological cycle (rainfall, runoff and evapotranspiration) which results in:

- Increase of on-site local storage of stormwater which proportionally reduce rainfall runoff volumes and provide longer contact times of surface runoff with soil to increase infiltration potential and aquifer recharge, preserve the physical integrity of receiving waters by managing stormwater runoff at or close to the source, and filter stormwater to improve water quality.
- Reduction of impervious areas which additionally reduce surface runoff volumes, peaks and velocities and improves distributed aquifer recharge.
- Increased use of native vegetation to reduce stormwater runoff velocities, correspondingly increase evapotranspiration, and improved water quality.

- Protect surface and ground water quality.
- Maintain the integrity of ecosystems.

Stormwater quality control measures are placed throughout the site in small, discrete units and distributed near the source of impacts.

The Green Infrastructure is designed to reduce and/or eliminate the altered areas of the post-development hydrograph, by reducing the peak discharge rate, volume, and duration of flow using site design and stormwater quality control measures. The benefits of reduced stormwater runoff volume include reduced pollutant loadings and increased groundwater recharge and evapotranspiration rates.

The main Green Infrastructure components include the use of bioretention/infiltration landscape areas, disconnected hydrologic flow paths, reduced impervious areas, functional landscaping, and grading to maintain natural hydrologic functions that existed prior to development, such as interception, shallow surface storage, infiltration, evapotranspiration, and groundwater recharge. The civil infrastructure will be designed as an integral part of the environment and to maintain the hydrologic functions through careful use of stormwater quality control measures.

All green open areas are designed to retain stormwater, increase infiltration, therefore reducing the overall stormwater runoff and providing water treatment by retaining the "first flush" water from semipervious and impervious surfaces. All open pervious areas contribute to the objective of the stormwater drainage system to retain and convey water during precipitation events. The Green Infrastructure system consist of a series of dry and wet ponds of various forms and sizes and strategically located to intercept stormwater runoff from adjacent upstream areas. The lakes additionally serve joint-use purposes such as parks and are be designed to improve the public areas. The integration of distributed Green Infrastructure on smaller scale that are distributed within the site will reduce the need for large-capacity retention systems and conveyance downstream.

Based on the hydrological properties of the site and the proposed zoning information, including site plan configuration, topography, soils and subsurface hydrology, a set of Green Infrastructure Components is proposed for best environmental performance and reduced energy use. The stormwater system consists of open green areas and conventional infrastructure (pipes, culverts, gutters, and structures) on neighborhood, block and parcel scale and include:

1. **Green Space Conservation** - Wetlands and forested areas below elevation of 100 ft NAVD 88 or slope greater than 15%.
2. **Natural Preserves (Dry Ponds) and Lakes (Wet Ponds)**
3. **Distributed Stormwater Control Components** - based on using stormwater retention areas, raingardens, bioswales, planters
4. **Urban Tree Canopy** - including stormwater trees, planters
5. **Thoroughfare Green Engineering Practices** –preferred use of semi-impervious materials for roadways and parking.
6. **Green Building Practices** –green roofs, geothermal energy for building heating and cooling.

3.1 Green Space Conservation

This project will provide protection of environmentally sensitive and valuable lands with unique topographic, hydrologic, and vegetative features at the southwest section of the site. These areas were included into a Conservation Zone (Figure 5) with total surface of 143.84 acres and includes three lakes with surface area 8.47 acres. The Conservation Zone will be protected from any activity that would alter their ecological integrity. The Conservation Zone includes all wetlands within the site limits, forested areas, flood plains, drainage ways, river or stream banks, and biological uniqueness.

The main function of the Conservation Zone is to protect wetlands, vegetation, slopes, soils, and the pre-development hydrology, including rainfall interception, infiltration, and evapotranspiration. Additionally, the conservation zone will include three lakes which will be used as stormwater treatment areas and will retain water for sufficient time to provide attenuate 100-year rainfall with duration of 24-hours and to provide water quality treatment. The proposed lakes will be constructed with a dual use as parks. The Conservation Zone includes the most sensitive areas, such as streams and their buffers, floodplains, wetlands, steep slopes, forested areas and highly permeable soils.

Within the conservation zone, the existing topography and drainage patterns will be preserved.

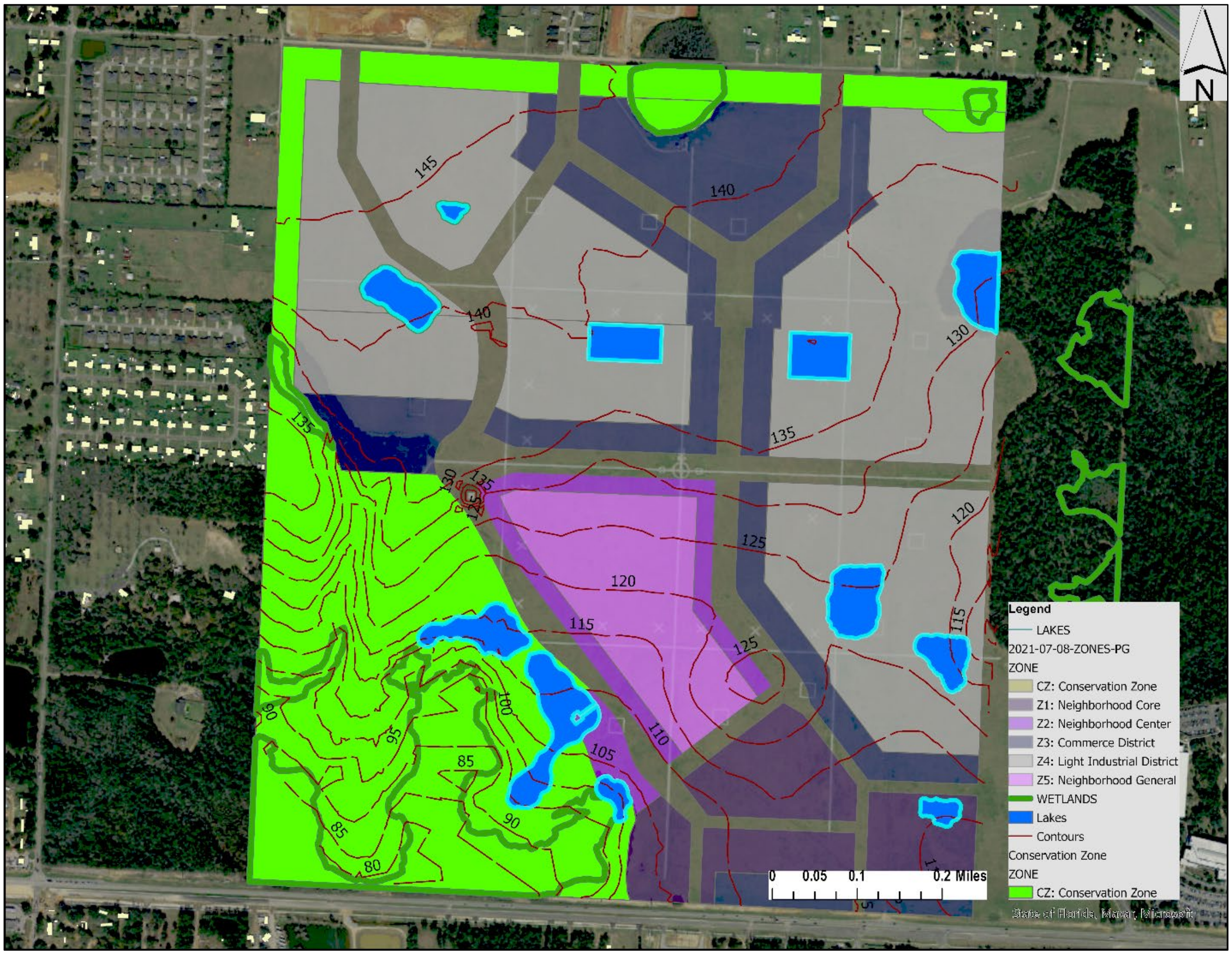


Figure 5 Conservation Zone

3.2 Natural Preserves and Lakes

The OLF-8 project will rely on a system of lakes (wet ponds) and natural preserves (dry ponds) to retain and treat stormwater on site for stormwater management and for attenuation of the 100-year rainfall. Dry and wet ponds are earthen depressions constructed with a substantial permanent water pool to provide both temporary and long-term storage of stormwater runoff, and they can be used to attenuate peak flows and provide Water Quality treatment through both pollutant removal and slow release. Ponds attenuate peak flows using an outlet control structure and provide storage capacity above the permanent pool, while water held within the system, including the permanent pool, is treated through natural physical, chemical, and biological processes. Typically, dry and wet ponds are designed within a watershed and have surface area greater than 0.5 acres.

Excess stormwater runoff from the developed areas will enter the lakes and the natural preserved areas directly or through natural and constructed channel systems. The lakes and the preserves are the two main Green Infrastructure components which will be used for stormwater storage and treatment.

The proposed plan relies on two main storage components for managing stormwater runoff and water quality:

- **Dry Ponds** (or Natural preserve) are stormwater facilities designed to temporarily hold a set amount of water while slowly draining to another location or infiltrate the ground (Figure 6). They are used for flood control when large amounts of rain could cause flash flooding. In general, higher conductivity of the subsurface layers is recommended in order to allow fast infiltration. Natural preserves have storage volumes which are equal to the surface area multiplied by the difference of the bottom elevation of the natural preserve and the freeboard.
- **Wet Ponds** (or Lakes) are bodies of water which are used for water retention (Figure 7). Lower conductivities of the underlying subsurface are preferable to maintain the lake water levels for extended period. Available lake storage during a stormwater event is defined based on the water level within the lake and the elevation of the freeboard.

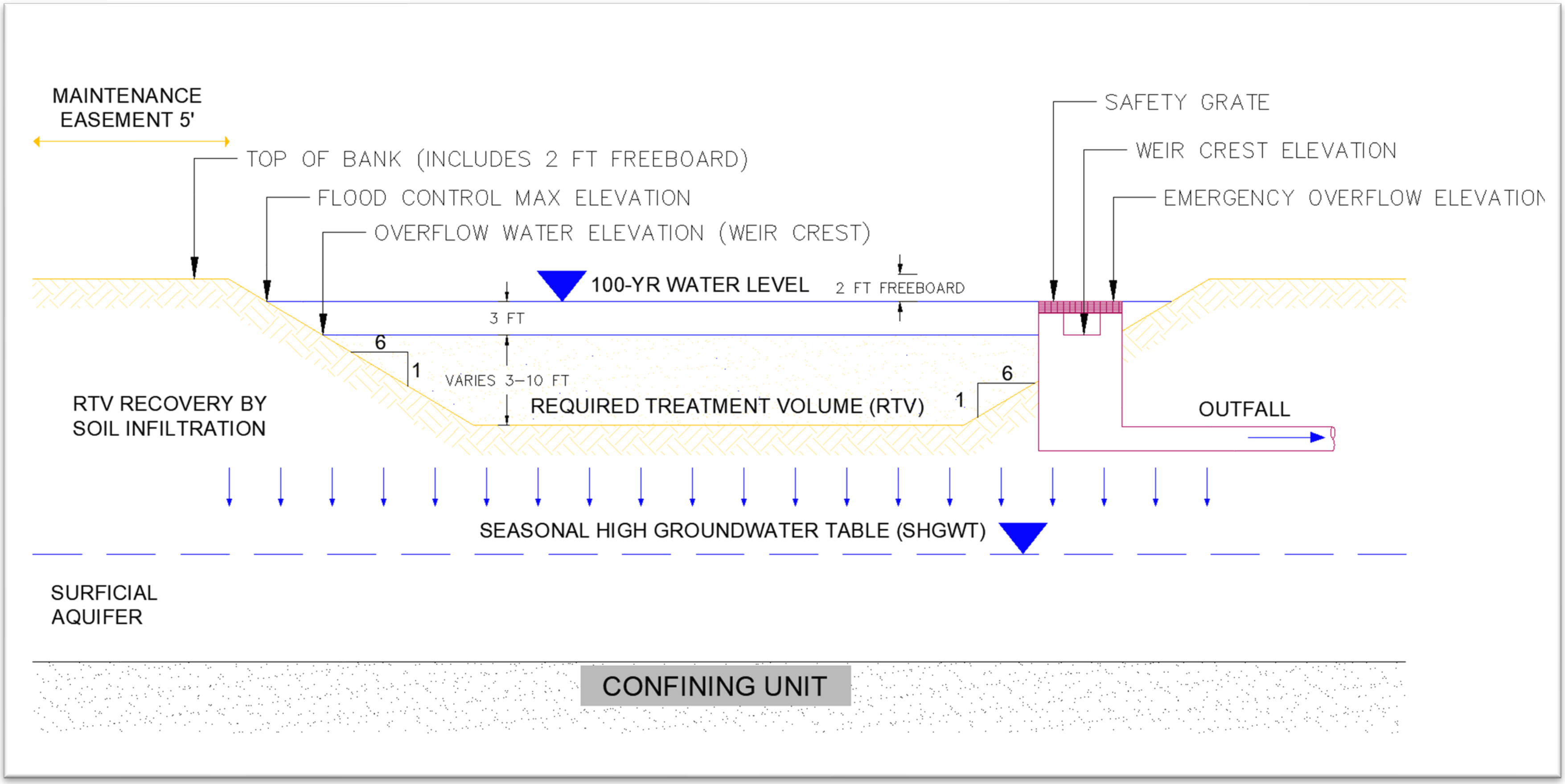


Figure 6 Typical Cross Section of Natural Preserve (Dry Pond)

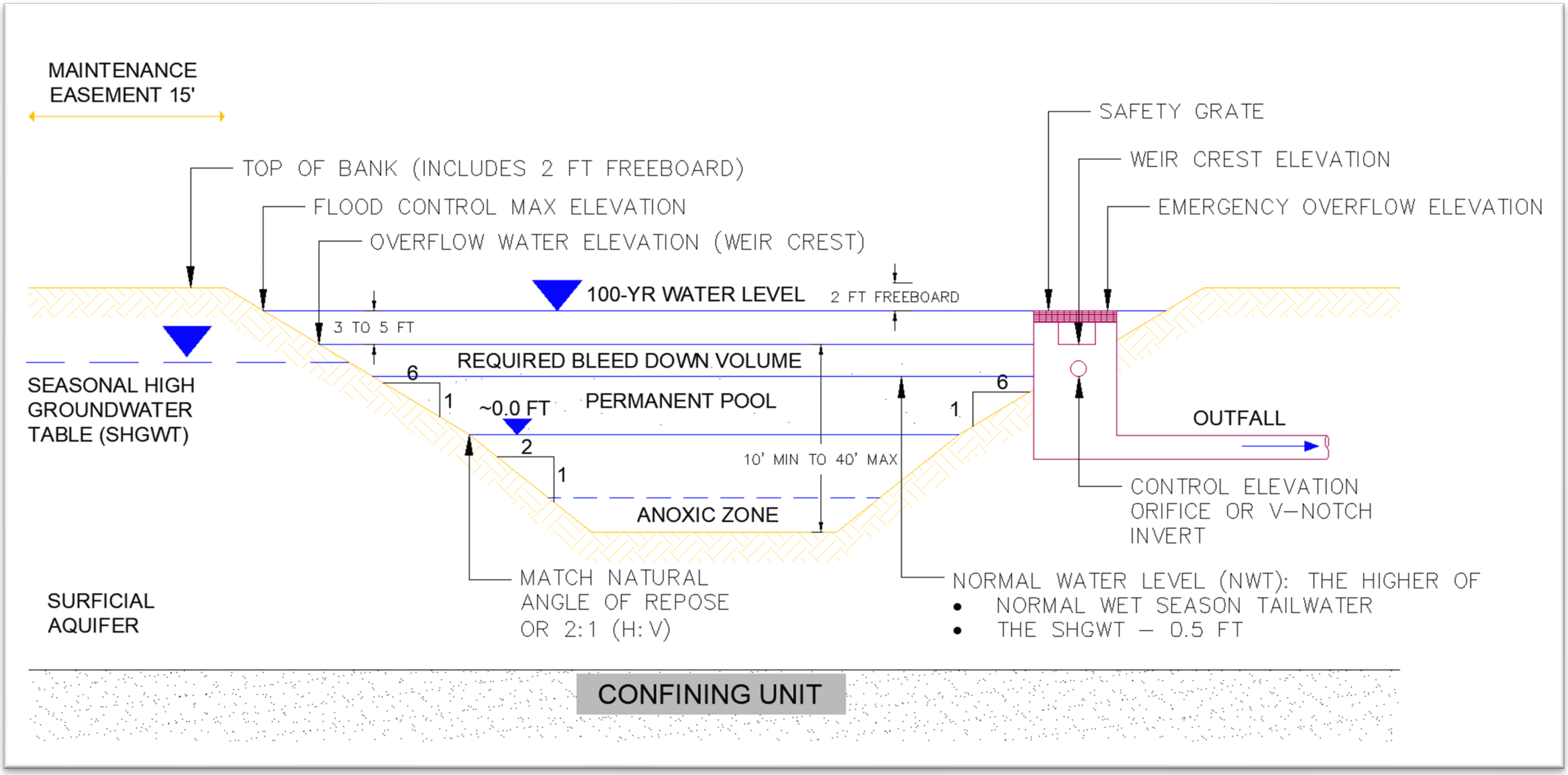


Figure 7 Typical Cross Section of Lake (Wet Pond)

The natural preserves and lakes have similar capacity in terms of stormwater storage. For natural preserves (dry ponds) the volume enclosed between ground level and the lower level of the freeboard is available for storage during stormwater events. Lakes provide storage between the lower level of the freeboard and the water level in the lake.

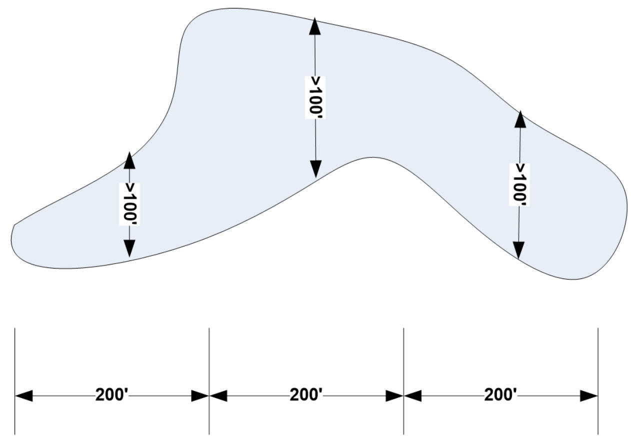
Based on the proposed master plan which provided conceptual location and sizing of green areas, lakes, and proposed buildings, a list of total areas of lakes and dry ponds per watershed are shown to provide stormwater management, distribution, and mitigation.

Table 1 Summary of Dry Ponds and Lakes

Watershed	Watershed Area (acre)	Total Area of Dry Ponds (acre)	Total Area of Lakes (acre)	Total Impervious Areas from Buildings (acre)**
Watershed 1	57.46	2.87	2.29	10.12
Watershed 2	47.71	3.59	0.30	9.55
Watershed 3	33.16	6.30		6.35
Watershed 4	32.37	0.63	2.27	5.29
Watershed 5	34.44	3.66	2.38	6.14
Watershed 6	47.66	3.00	2.60	10.04
Watershed 7	50.65	7.10	2.86	12.41
Watershed 8	42.09	1.67	3.01	9.85
Watershed 9	63.7	2.47	5.61	13.96
Watershed 10	48.27	1.14	2.55	11.20
Watershed 11*	77.05	0.99		
Total (acres)		**33.43**	**23.88**	**94.92**
* Watershed 11 covers the conservation area with no proposed development. ** The total building roof area is provided for reference				

General recommendations for constructing lakes and natural preserves:

- Recommended shape is irregular as demonstrated below



- **Average minimum width of 100 feet for each 200 foot reach**
- **Minimum surface area of 0.5 acres**

To provide final design, additional information should be taken into consideration:

- Soil borings should be obtained within the lake areas to determine the potential seepage rates. Hydraulic conductivity of 3 ft/d or less will ensure low seepage rates and the lakes will hold water. The soil within the site have conductivity and lakes will be the natural choices for these areas 62 2).
- For areas with conductivity greater than 3 ft/d, bentonite clay can be used for lining the lakes. Bentonite is common for pond building, however if vegetation grows into the bentonite from outside of the pond, it could cause a leak. Therefore, it will be preferable to build natural preserves (dry ponds) if higher conductivities of the underlying surface layers are present.
- The natural preserves can provide water quality improvement, downstream flood control, channel erosion control, and mitigation of post-development runoff to pre-development levels. The primary mechanism by which a dry extended detention facility improves runoff quality is through the gravitational settling of pollutants.
- The edges of the lakes and the natural preserves will be sodded to protect the bank slopes of the dry and wet ponds. Finished grade at the beginning of the slope downward to the property line is equal to street grade at the front of the lot.
- Solid sod is placed from the bulkhead to meet the sod on the property or a point 5 feet landward from the top of the slope.
- Bank slope or incline from the bulkhead outward into the water cannot be steeper than 1:6 to an elevation of the water surface.

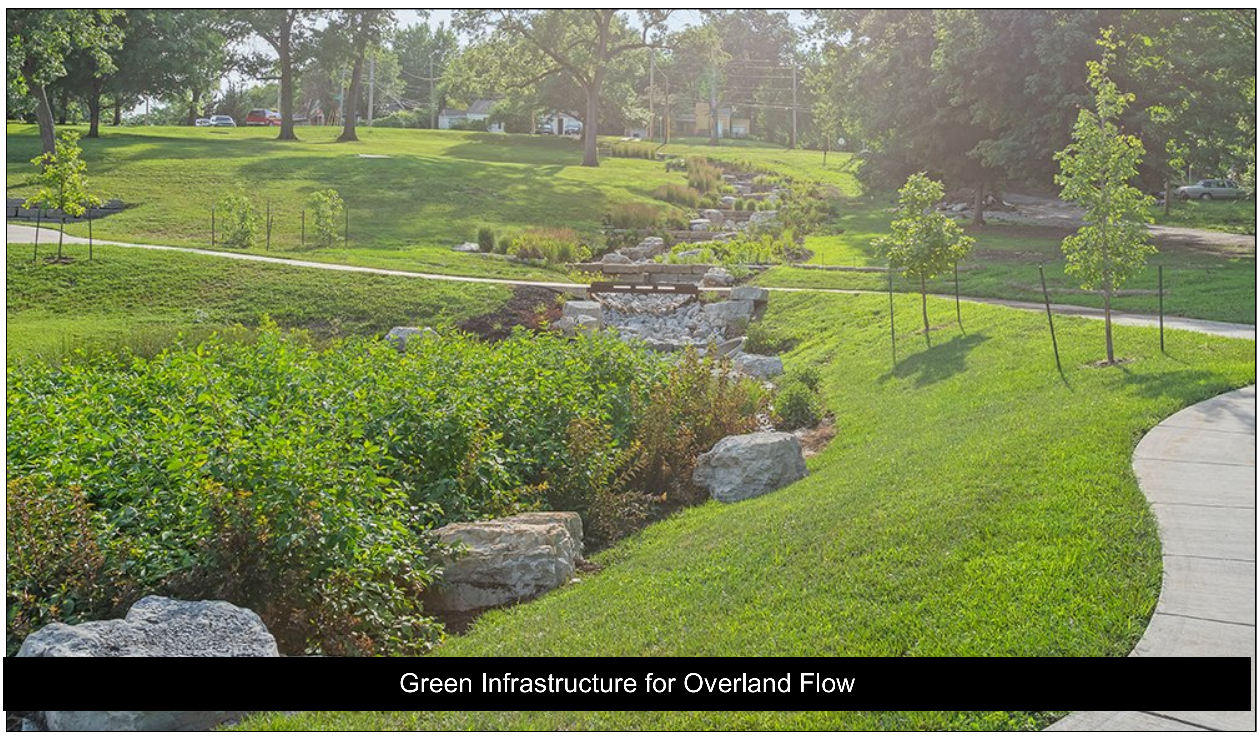
- If excavation below the water surface is in sound rock, the slope may be as nearly vertical as the rock will stand.
- Elevation of the top of the bulkhead is greater than one 1 foot above the control elevation
- Access boat ramps require slope of 20:1 (horizontal to vertical)
- A site plan is required for the construction of all dry and wet ponds following the Design Standards Manual of Escambia's Municipal Code (ref 8 and 9).
- The center portion of any man-made lake, pond, or waterway, other than a fish or wildlife facility, are typically excavated deep enough to maintain a water depth greater than 10 feet.
- Ponds are constructed at a distance at least fifty ft from an on-site, sanitary waste disposal system, and at least seventy-five feet from any existing or proposed residence, other structure or road right-of-way, at least twenty-five feet of any adjacent residential property line or at least two hundred feet of any agricultural property line.
- The perimeter of the man-made lake, pond, or waterway shall be landscaped and seeded within six months after completion of the excavation.
- All excavated material shall be moved from the site or shaped and spread to blend with the natural landforms in the area.
- Natural run-off and/or other waterway fed will be the only water sources allowed for the man-made lake, pond, or waterway
- The ground water table in the surrounding area and adjacent to the proposed man-made lake, pond, or waterway shall be protected.

Examples of typical lake configurations, of a dual function of stormwater lakes, including treatment and use as a park amenity, are shown for illustration.

Admiral Mason Park Pensacola Florida Stormwater Treatment Lake

Tavares Florida, 8-acre Stormwater Treatment Lake

Constructed wetlands (16 acre) as a multipurpose green infrastructure in Gorla Maggiore, Italy



Green Infrastructure for Overland Flow

3.3 Distributed Stormwater Control Components

For each watershed, the objective was to implement selected Green Infrastructure which will provide the most efficient reduction of runoff and water quality treatment. A system of distributed stormwater components is proposed to additionally reduce stormwater runoff and increase aquifer recharge on a block and parcel scale. A general description of the proposed infrastructure components is provided in this section.

A series of swales, planters and rain gardens is incorporated within the block and neighborhood to route stormwater downstream while simultaneously providing storage, retention, filtration and treatment and include:

- Vegetated Swales
- Raingardens
- Stormwater Planter
- Tree Canopy

The green infrastructure components are further refined based on the location within the urban zones are divided into two types:

- Stormwater infrastructure within median industrial, commercial, and high intensity urban areas (Z1, Z2 and Z3 zones).
- Stormwater infrastructure within medium or light industrial and commercial areas and medium intensity (Z4 and Z5) zones.

The stormwater system is individually designed for each block and integrates selected Green Infrastructure components that are evenly distributed within the site to provide a series of interconnected facilities for storage, filtration, and channeling within each catchment. The surface runoff from semi pervious and impervious surfaces is routed through surface channeling features (swales, and open channels), or optional subsurface piping system, to 88 Green Infrastructure components with average area of 24,000 square feet (min 400 and maximum 196,000 square feet). The total storage of all Green Infrastructure components is designed to exceed 66 ac-feet and contributes an additional 25% of storage to the wet and dry ponds.

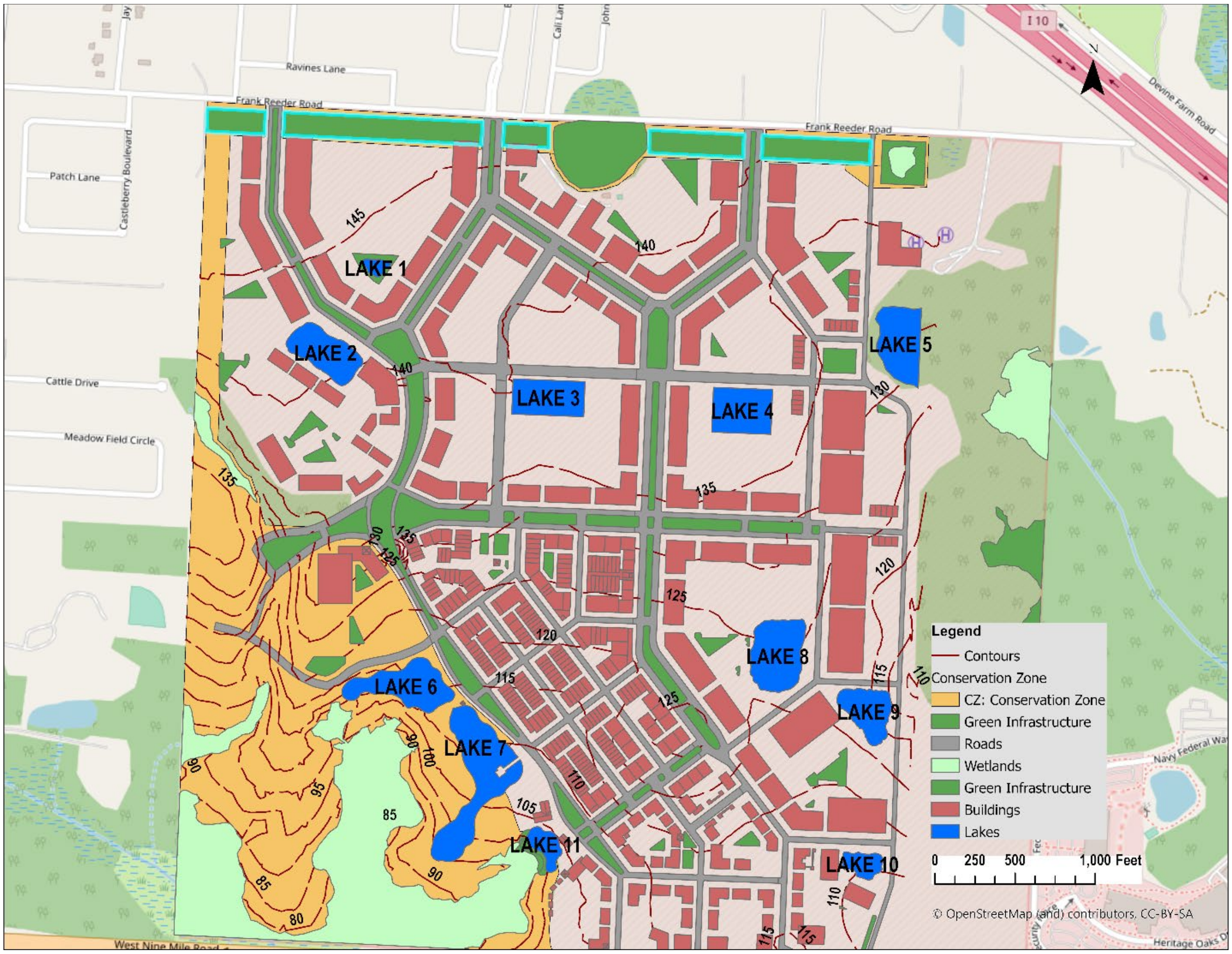


Figure 8 Map of Green Infrastructure Components within OLF-8

Each storage node connects downstream through a weir (an orifice is acceptable solution as well) which is designed to hold water according to the geometric properties of the storage node. During initial stages of rainfall, water flows to the storage node, and once the storage capacity of the node is exceeded, the water is routed downstream through the weir. Additionally, conventional stormwater infrastructure (system curbs, gutters, culverts, and pipes) will be used to drain the thoroughfares and public frontages within the urban zones (Z1, Z2 and Z3). Conventional infrastructure elements typically consist of the standard curb and gutter, and the pipes and culverts used as conduit, however, for low urban intensity, i.e. zones Z4 and Z5, drainage will be predominantly managed with green infrastructure which are designed to provide multiple functionality:

- **Conveyance** – Raingardens and swales provide conveyance and are positioned to take into consideration pedestrian movement and the fraction of impervious surface. The site implements multiple channeling functions within the variable median of the thoroughfares.
- **Storage** – All green infrastructure components provide storage and retention on-site to reduce the surface runoff and to provide sufficient time for water to infiltrate the subsurface. Public spaces with a storage functionality as the main component are preferably located in low areas to allow water to drain by gravity.
- **Filtration** - Maximizing the infiltration rates and capacities are important to increase aquifer recharge while reducing surface water run-off. All green infrastructure components improve infiltration to mimic the natural system and allow water to recharge the aquifer.

3.3.1 Stormwater Planters

Stormwater planters are small, landscaped stormwater treatment devices that can be designed as infiltration or filtering practices.

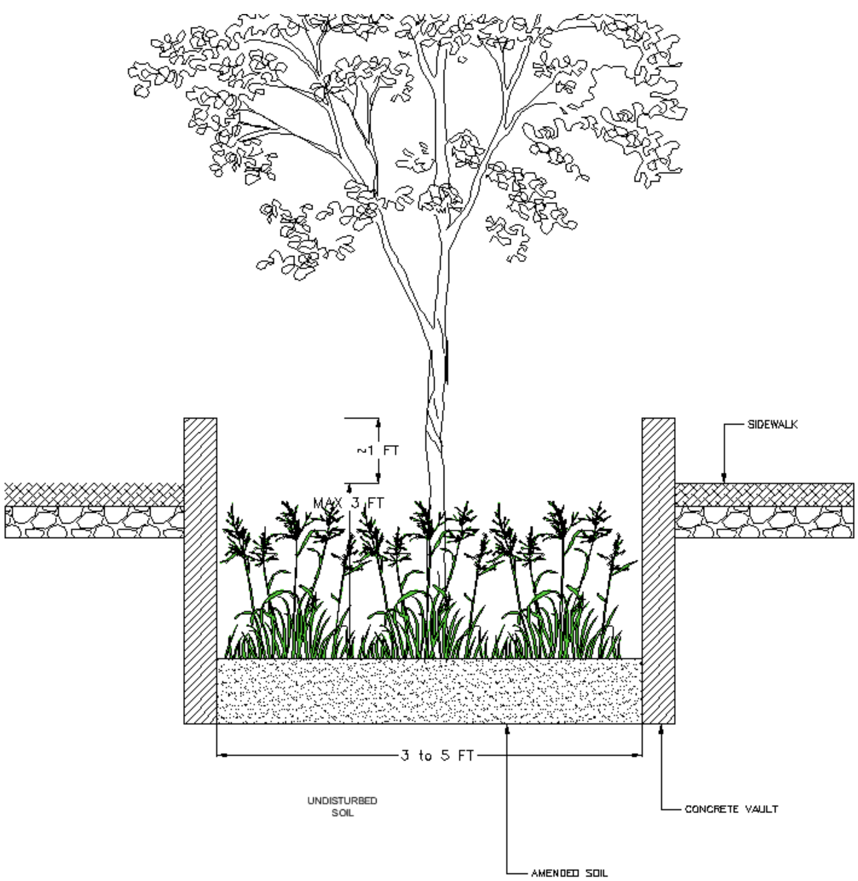


Figure 9 Stormwater Planter in Urban Settings (Z1, Z2, Z3)

Stormwater planters use soil infiltration and biogeochemical processes to decrease the stormwater quantity and improve water quality.

Green Infrastructure for Planters

Green Infrastructure Planters, Stockholm

Green Infrastructure Planters, Portland Oregon

3.3.2 Rain Garden

Rain gardens are used to manage and treat small volumes of stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. The rain garden is suitable for a townhouse, single-family residential, and in some institutional settings.

Figure 10 Rain garden, NYSDEC

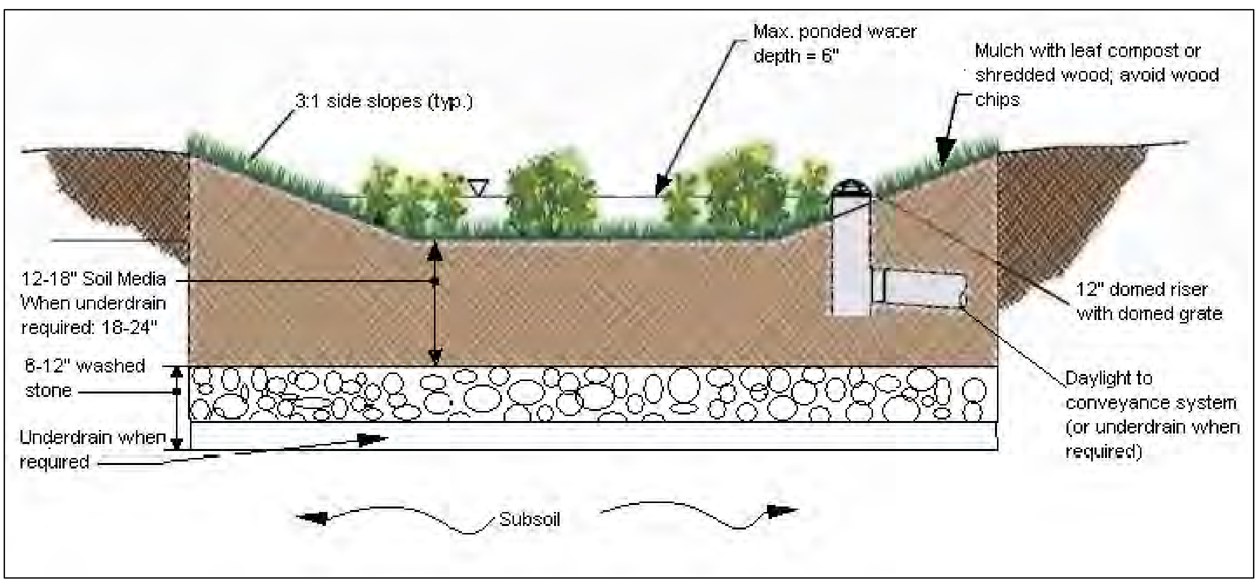


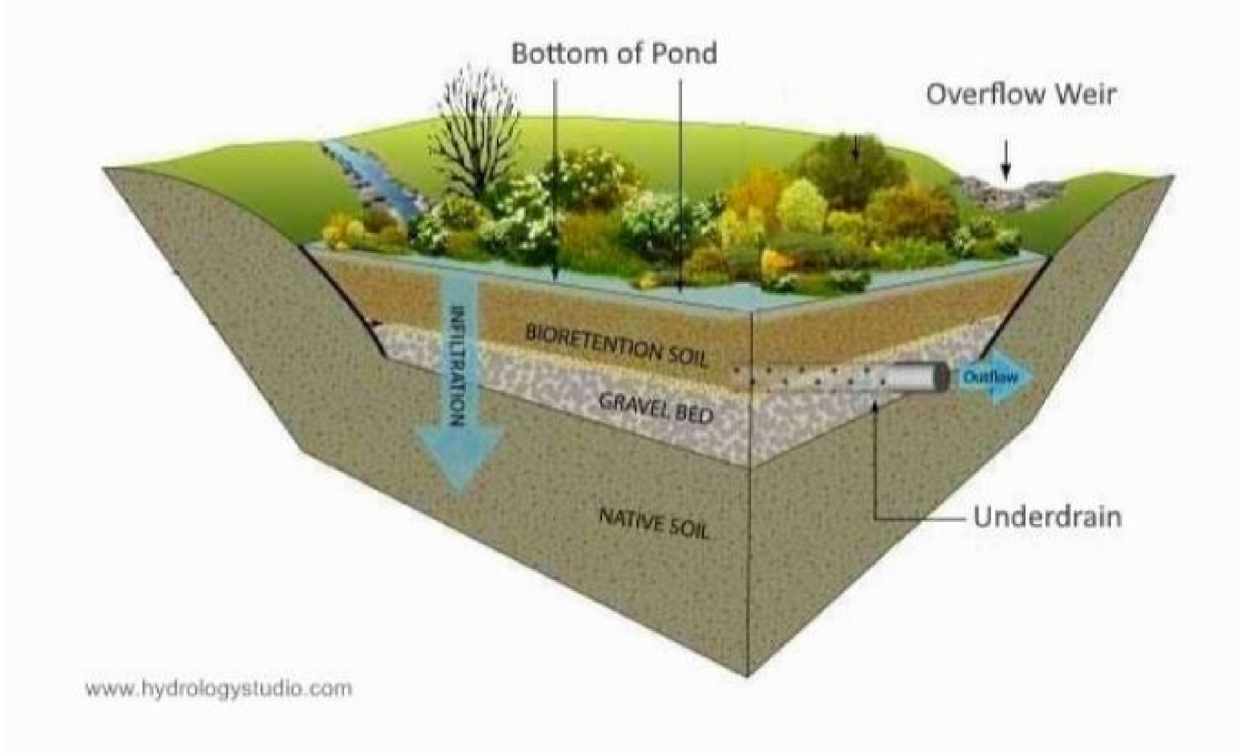
Figure 11 Profile of a typical rain garden, NYSDEC

https://stormwater.wef.org/2015/12/real-cost-green-infrastructure/

Figure 12 Vegetated Swale

https://currantdesign.wordpress.com/stormwater/

https://www.hedstromdesign.com/portfolio/streetscape-renovation/



https://www.ci.greenfield.wi.us/588/Green-Infrastructure

https://www.hazenandsawyer.com/work/services/green-infrastructure/

https://urbanresiliencehub.org/article/blue-green-infrastructure-for-climate-change-adaptation-in-peru/

3.3.3 Tree Canopy

In addition to documented social and economic benefits, planting and conserving trees reduce stormwater runoff, increase nutrient uptake, and provide bank stabilization. Trees can be used for applications such as landscaping, stormwater management practice areas, conservation areas, providing shade, and erosion and sediment control. Trees also provide additional space for storage and attenuation of stormwater runoff.

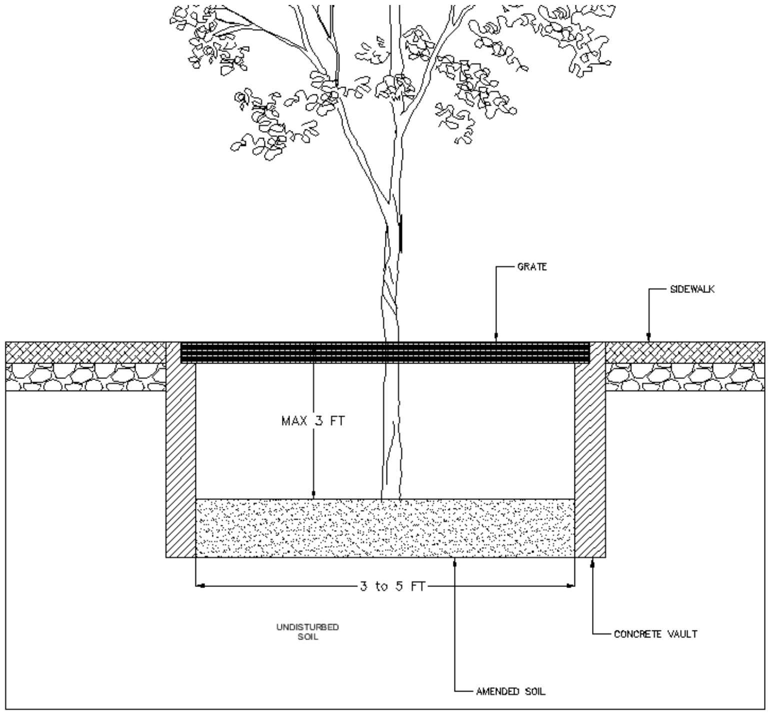


Figure 13 Stormwater Tree within Zones Z1, Z2 and Z3 (approximate storage 27-75 ft^3)

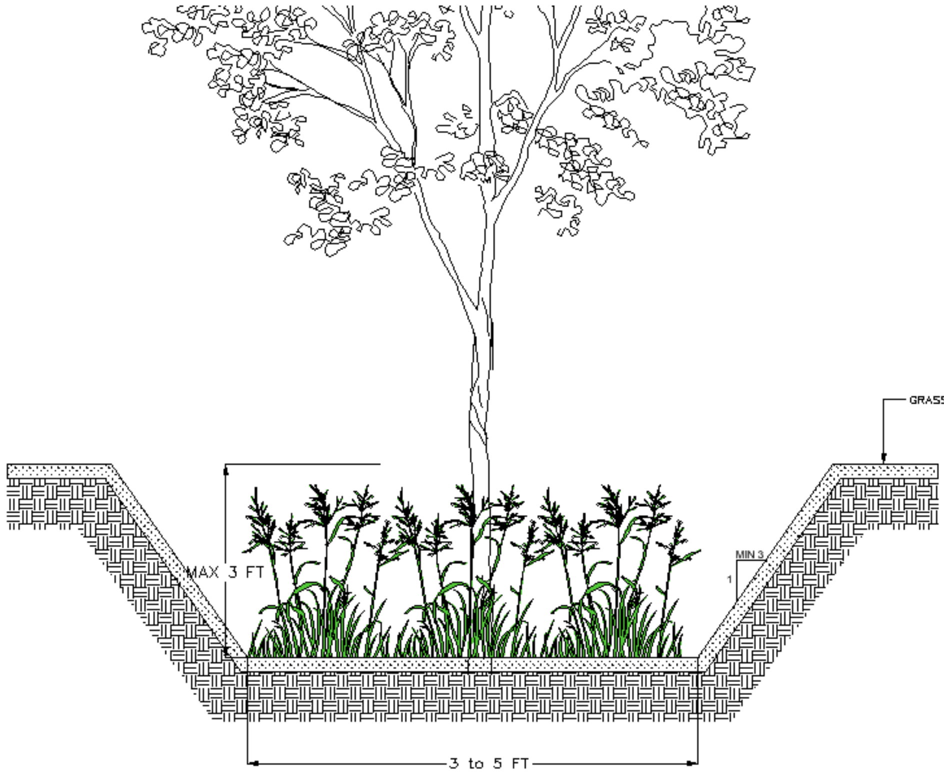


Figure 14 Stormwater Tree within Zones Z4 and Z5 (approximate retention 5-10 ft^3/ft)

The maximum side slope is flatter than 3:1 (horizontal to vertical). Minimal longitudinal slope of 0.30 percent. Depth is less than three feet. Minimum distance of six feet is provided from the edge of the travel lane. Design velocity of unlined swale is less than three feet per second, and less than six feet per second for lined swale.

3.3.4 Vegetated Swale

Rainwater is carried away from the thoroughfare by a system of swales. Swales are long, narrow open channels that infiltrate water and carry the excess water along the surface to a containment destination such as a detention or retention pond. Typically, all swales should be constructed to hold standing water for only a short time (approximately 70 to 80 hours) after a rainstorm. A minimum slope of 1 per cent should be maintained for proper drainage.

Vegetated Swale, City of Can Jose, CA

Shallow swales may run alongside a pedestrian pathway or bicycle trail on either side to accept the stormwater runoff from the gently crowned path. The maximum depth of swales is 3 ft. The natural drainage paths, or properly designed vegetated channels, can be used in zones Z4 and Z5 instead of constructing underground storm sewers or concrete open channels to increase the time of concentration, reduce the peak flow, and provide infiltration.

Example of Vegetated Swale with Erosion Control

Swales should be sodded and designed to look naturalistic and have a gradual maximum slope to prevent dangerous conditions to a nearby pedestrian.

Example of Vegetated Swale with Erosion Control

https://www.flowstobay.org/preventing-stormwater-pollution/in-my-community/green-infrastructure/

3.4 Thoroughfare Green Infrastructure

The potential for discharge of pollutants in stormwater runoff from roads increases as the percentage of the impervious areas within the project site increases. Pollutants deposited on impervious areas are easily mobilized and transported by stormwater runoff. Minimizing impervious areas through site design is an important method to reducing the pollutant load in stormwater runoff.

The following strategies for minimizing impervious areas through site design were applied:

- Use minimum allowable roadway and sidewalk cross-sections, driveway lengths, and parking stall sizes.
- Reduce building and parking lot footprints. Building footprints may be additionally reduced by building taller.

- Use pervious pavement material, such as modular paving blocks, turf blocks, porous concrete and asphalt, brick, and gravel or cobble, to accommodate overflow parking, if feasible.
- Cluster buildings and paved areas to maximize pervious area.
- Maximize tree preservation or tree planting.
- Use vegetated swales to convey stormwater runoff instead of paved gutters.
- Build compactly at redevelopment sites to avoid disturbing natural lands and to reduce per capita impacts.

3.4.1 Thoroughfare Medians

The plan incorporates medians along all major roads. Figure 15 shows the median along the major roads.

Figure 15 Vegetated Swale Along Frank Reader Road

The approximate length of all roadside swales is 25,000 feet, which provides significant attenuation of the stormwater runoff caused by road imperviousness. The medians provide an important benefit in intercepting stormwater runoff and reducing volumes and peaks downstream.

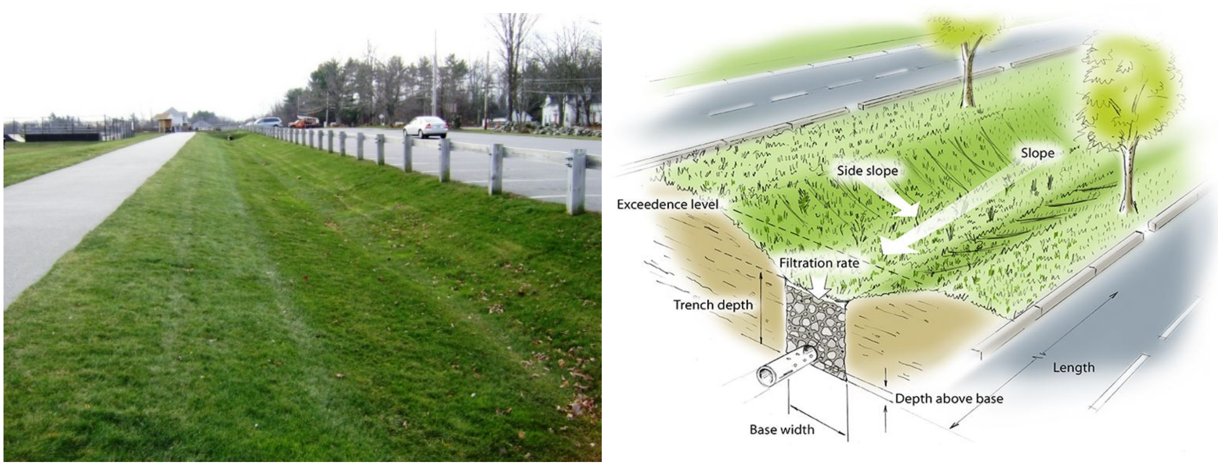


Figure 16 Typical Median Construction to Manage Stormwater Runoff

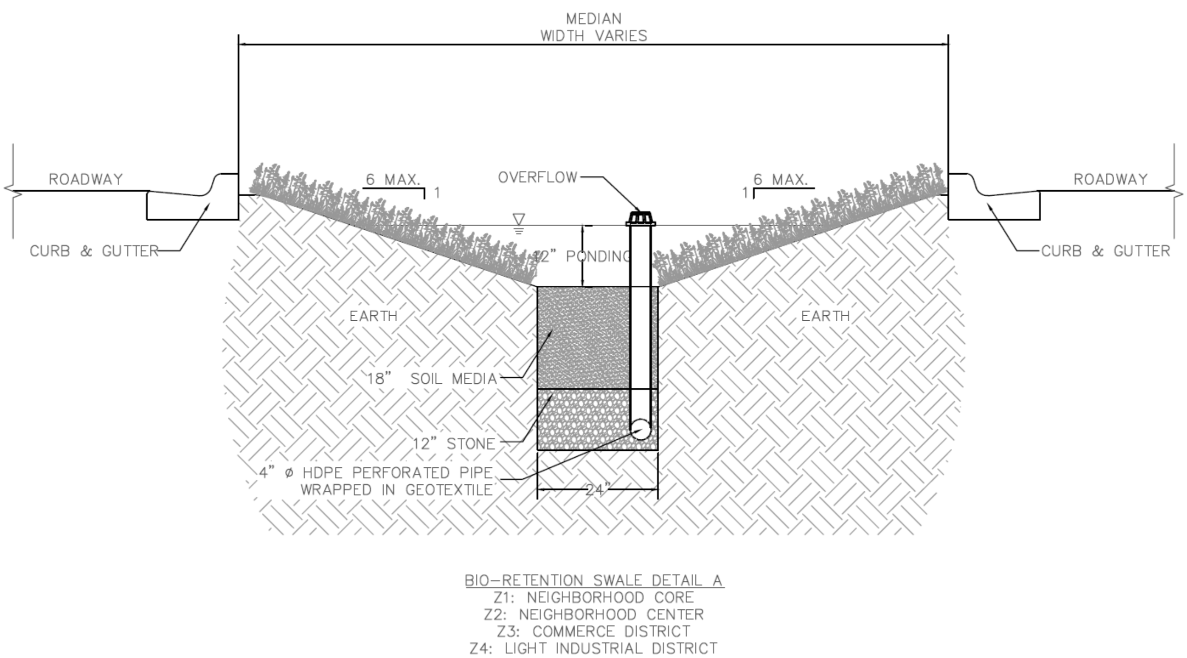


Figure 17 Typical Median in Zones Z1 to Z4

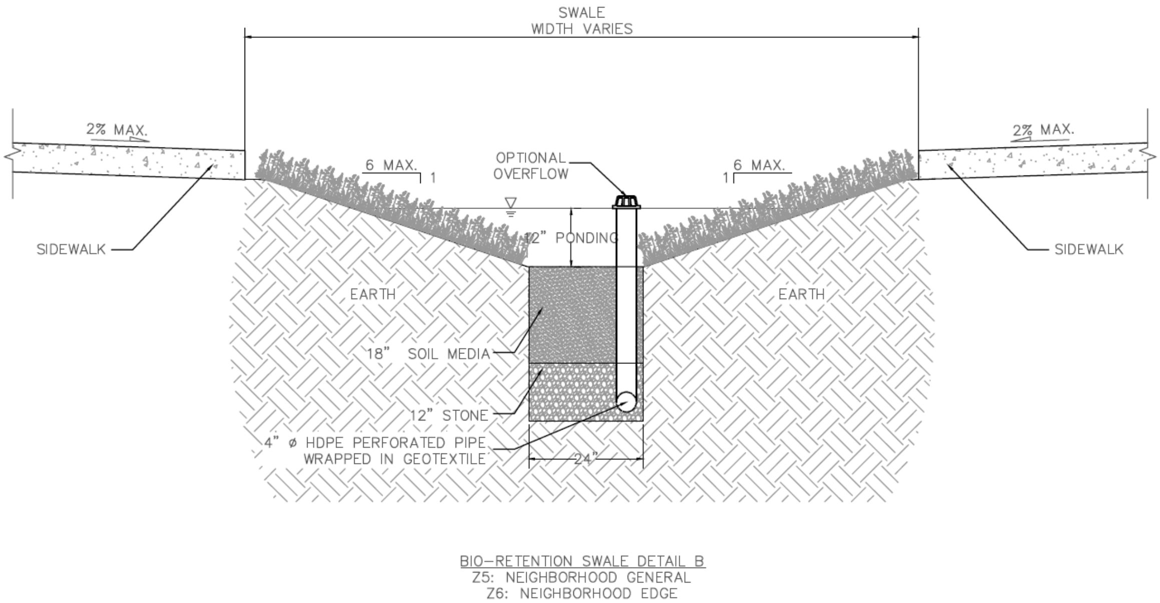


Figure 18 Typical Median in Zones Z5 and Z6, Overflow and Drainage Infrastructure are Optional

3.4.2 Semi-Impervious Pavement

Paving is a prominent feature in the landscape which provides vehicular and pedestrian access. It plays a large role in receiving, producing, and distributing stormwater runoff. Paving Green Engineering paving materials are based on various degrees of permeability. The best features of each paving tool were maximized by selection based on context, mode and volume of traffic and low maintenance requirements. For example, a very stable material that is less pervious will be used in the urban zones which will have larger amounts of commercial and vehicular traffic. Furthermore, areas with heavy traffic require low maintenance and sturdy paving material to keep repairs to a minimum. Less sturdy materials can be applied for light traffic volume and pedestrian areas. All low traffic thoroughfares should be based on using semi-impervious materials

Semipervious pavement, preferably gravel, should be considered for common parking areas which have low circulation, or are intended for daily parking. Pavement of alleys and low traffic volume roads should be preferably from gravel. Parking lots should not have curb and gutter and should be designed to be surrounded with raingardens with edges lower than the gravel pavement to promote drainage to the raingardens. For Z1 to Z4 zones, use of curb and gutter is allowed for the primary thoroughfares.

All streets and alleys in Zones Z5 to Z6 (Neighborhood General and Neighborhood Edge) residential areas should be from gravel or semipervious material, with no curbs. Road drainage should be directed to a roadside swale to attenuate stormwater runoff. For Z5 to Z6 zones, use of curb and gutter is not recommended.

To reduce the surface runoff, the project will use semipervious areas for light vehicular and for pedestrian traffic. Semi-impervious pavement is an important factor to reduce the overall runoff, as it reduces the surface flow between Directly Connected Impervious Areas (DCIA). Depending on the type of the construction material, the semipervious areas can provide limited infiltration and storage of stormwater. The semipervious surfaces will be shaped to provide conveyance to other stormwater components. Based on the above, all semipervious areas can be considered active components of the stormwater management system. The selection of semipervious areas is based on locally available materials and typically include:

- Cast or pressed concrete pavers
- Grassed cellular concrete
- Pervious asphalt

Porous pavement is a permeable asphalt or concrete surface that refers to a material composed of aggregate bound with a black solid or semisolid substance distilled from a petroleum byproduct. Pervious asphalt uses open-graded (uniformly sized) aggregate, as opposed to the finely graded (various size) aggregate used in standard asphalt. Using open-graded aggregate leaves voids between the aggregate that allow water to flow through. Also, pervious asphalt uses less asphalt binder to ensure that many of the voids between pieces of aggregate are not clogged. Pervious asphalt is laid over an aggregate base that retains stormwater until it can filter through to be absorbed by the subsurface.

Porous pavements provide an alternative to conventional paved surfaces, designed to infiltrate rainfall through the surface, thereby reducing stormwater runoff from a site and providing some pollutant uptake in the underlying soils. Permeable paving has three main design components: surface, storage, and outflow. The surface types of paving can be broken into two basic design variations: porous pavement and permeable pavers (ref 22 or Figure 19?).

Figure 19 Typical pervious concrete pavement cross section.

Pavement cross-section treatments are designated by Context and Public Frontage type. Surface finish materials can be selected from the range of acceptable materials commonly used in the locally calibrated context and shall employ commonly used pavement section design procedures. Pervious pavers, porous asphalt and concrete, Macadam, and other ecological materials are encouraged.

Figure 20 Pervious Pavers, Seaside, FL

Pervious pavers consist of cast or pressed concrete pavers that are solid blocks set on a surface with joints that leave open spaces between each unit. The joints may be filled with loose aggregate or pervious material such as pea gravel, sand, or soil. Another option is to plant grass in the joints. Concrete pavers may be dyed during the manufacturing process. Additionally, the blocks can be pressed with a pattern that simulates other more expensive materials such as brick, stone, or wood.

Example of Semi-impervious Pavement

Pervious pavements provide multiple benefits to reduce stormwater runoff, however the infiltration capacity is reduced over time. Suspended solids substrate breaks down, sand and clay fines infiltrate the pore spaces and some of the wet areas grow moss. Without routine maintenance (sweeping, vacuum treatment or pressure washing) the infiltration rates can continue to decline over time. The expected service life of pervious pavement is 6-20 years depending on maintenance and use. For comparison, typical asphalt pavement in Florida can lasts up to 25 years with proper maintenance. For high traffic use, the pervious concrete requires reinforcement and routine maintenance.

3.5 Green Building Practices

Selected green building strategies include solar, or green roofs, and geothermal heating and cooling

3.5.1 Solar Energy and Green Roof

The OLF-8 project will include approximately 95 acres of building roofs. A typical solar panel system? has a surface of 21.45 sq.ft and approximately 2030 panels are required to cover one acre with expected output of 1MW per 5-6 acre or approximately 16 MW as a conservative estimate if roofs with surface greater than 500 square feet, are covered with solar panels (cost of $500,000/acre, or $48M to install solar panels for the entire site).

Figure 21 Building Footprint within OLF-8 Site

Alternatively, the rooftop can be used as a green roof and can be covered with vegetation. There are multiple benefits of using the rooftop as a vegetation including mitigation of stormwater pollutants, reduction of stormwater runoff, and reduced energy use.

The primary function of implementing green roofs is to mitigate stormwater runoff and reduce energy use. Additionally, removal of pollutants from the atmosphere via rain deposition is also a beneficial function, could be a potential benefit. Previous studies observed that the effect of green roofs in reducing energy use can be impactful and is approximately 33%. Some of the challenges in implementing green roofs include need for irrigation, restrictive storage for rain events (0.5-20 inches) and the shallow media (approximately 4") which can complicate irrigation (ref 10).

3.5.2 Blue and Green Roofs

Green roofs capture runoff by a layer of vegetation and soil installed on top of a conventional flat or sloped roof. The rooftop vegetation allows evaporation and evapotranspiration processes to reduce the volume and discharge rate of runoff entering the conveyance system.

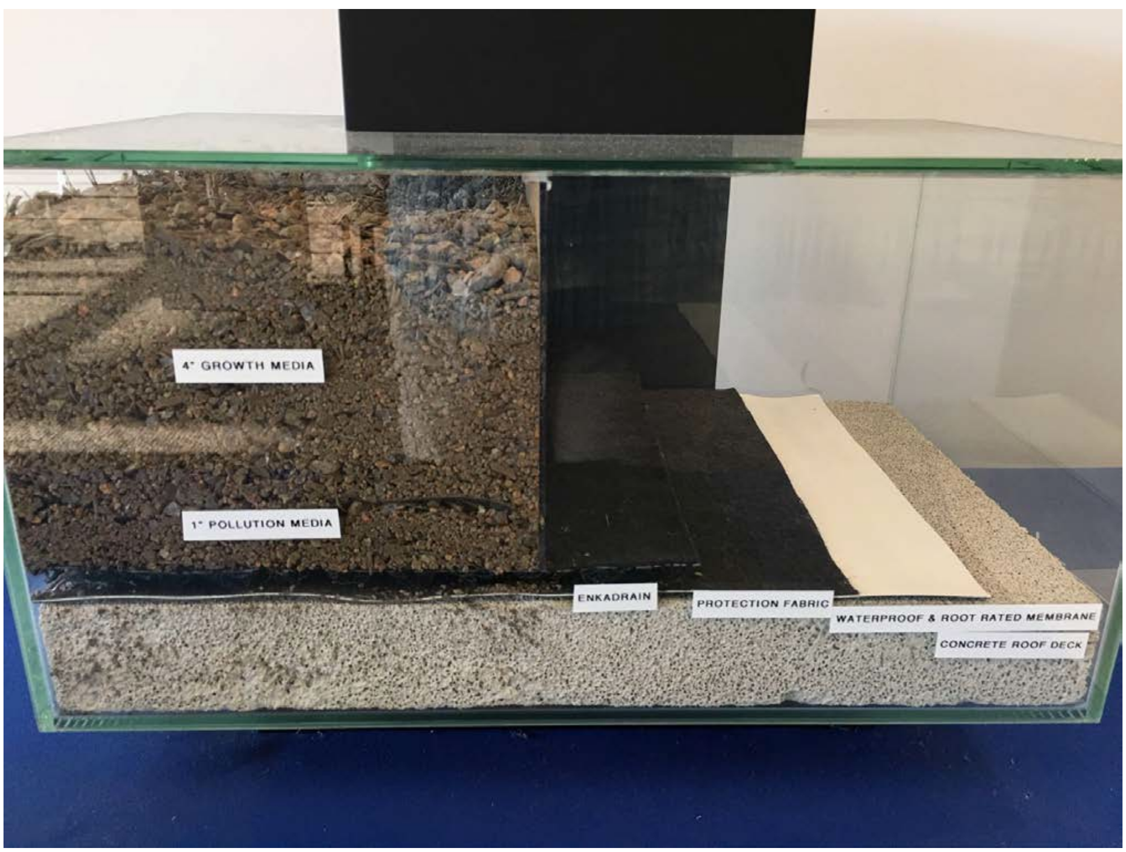
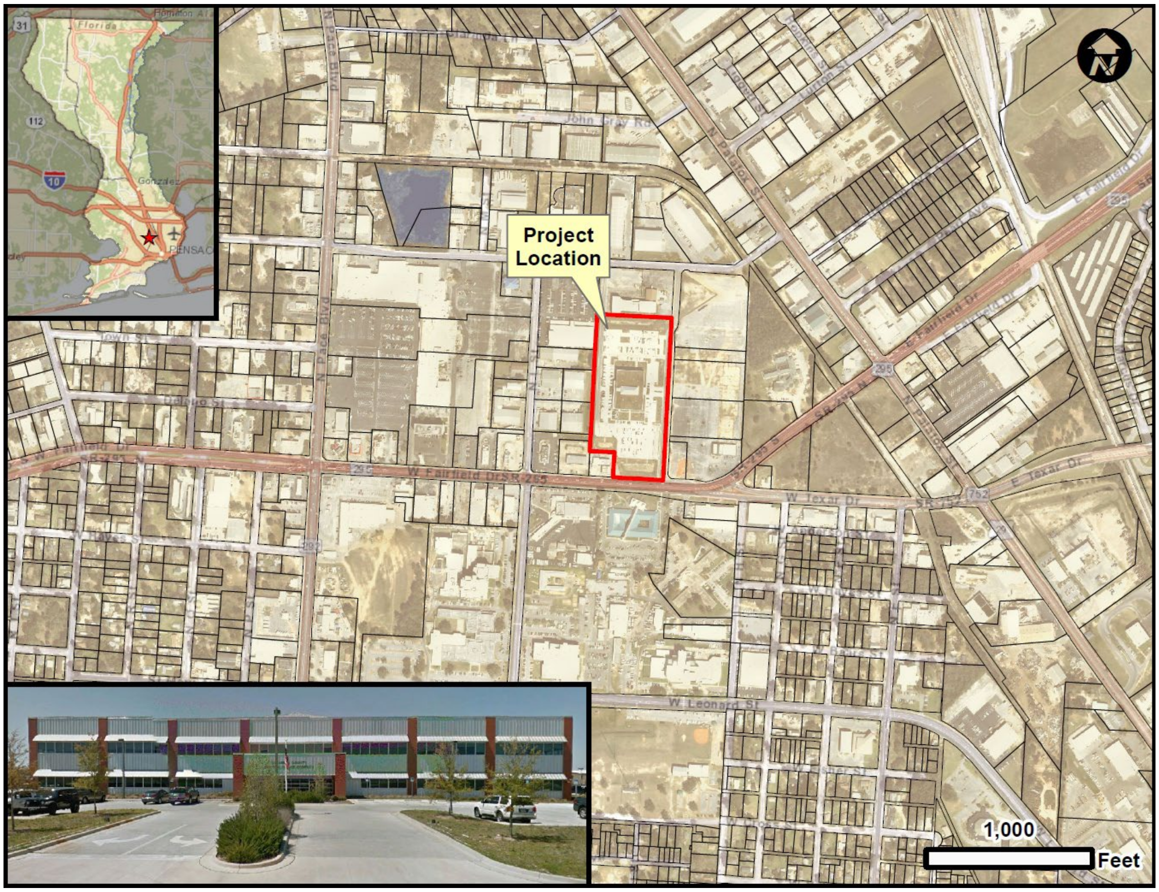


Figure 22 Typical Cross Section of Green Roof layers, Central Office Complex, Escambia County



Example of Green Building Roof, Central Office Complex Escambia County

3.5.3 Rain Barrels and Cisterns

Rain barrels and cisterns capture and store stormwater runoff to be used for irrigation systems or filtered and reused for non-contact activities. Rain Barrels and cisterns may be constructed of any water-retaining material; their size varies from hundreds of gallons for residential uses to tens of thousands of gallons for commercial and/or industrial uses. The storage systems may be located either above or below ground and may be constructed of on-site material or pre-manufactured.

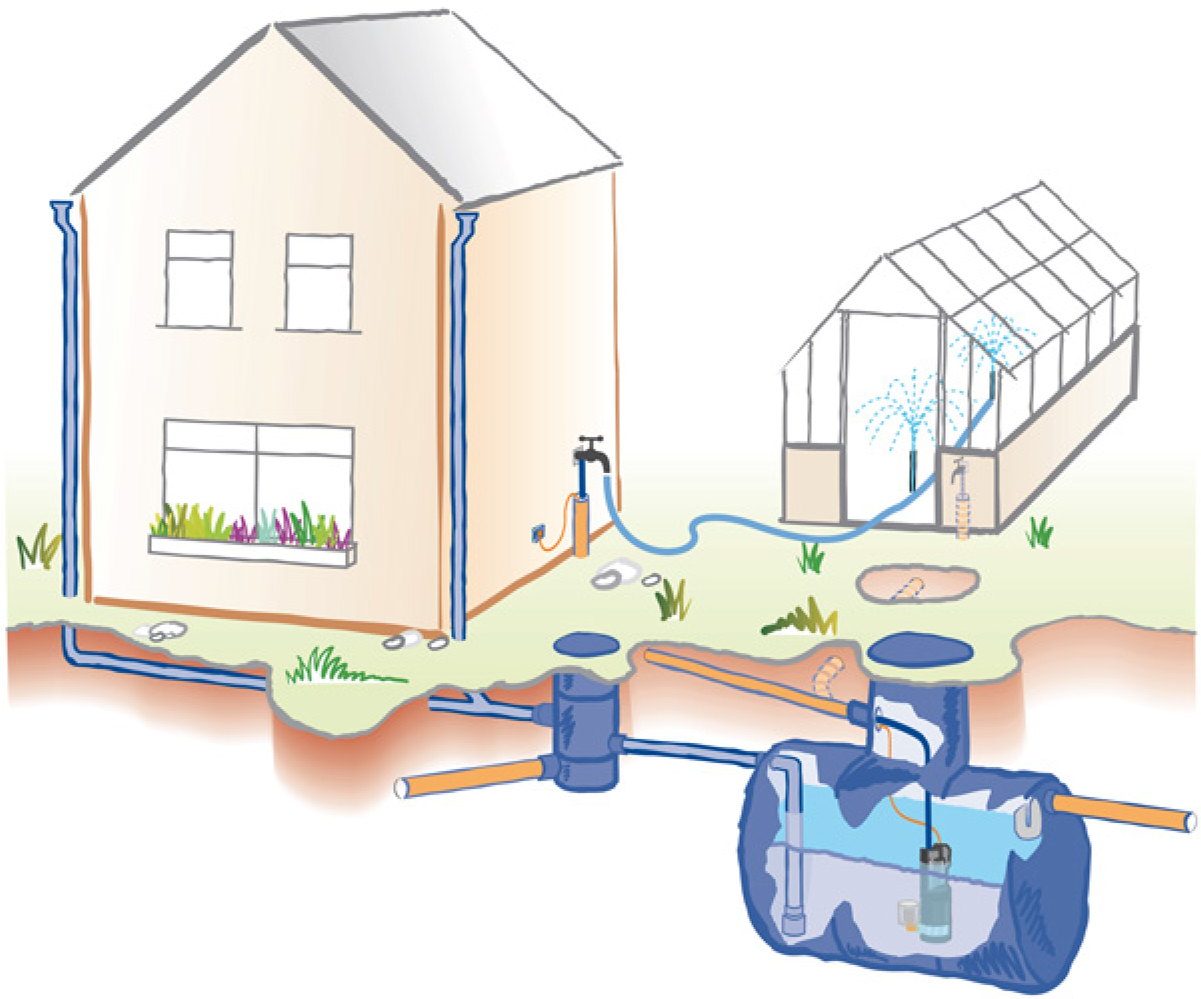
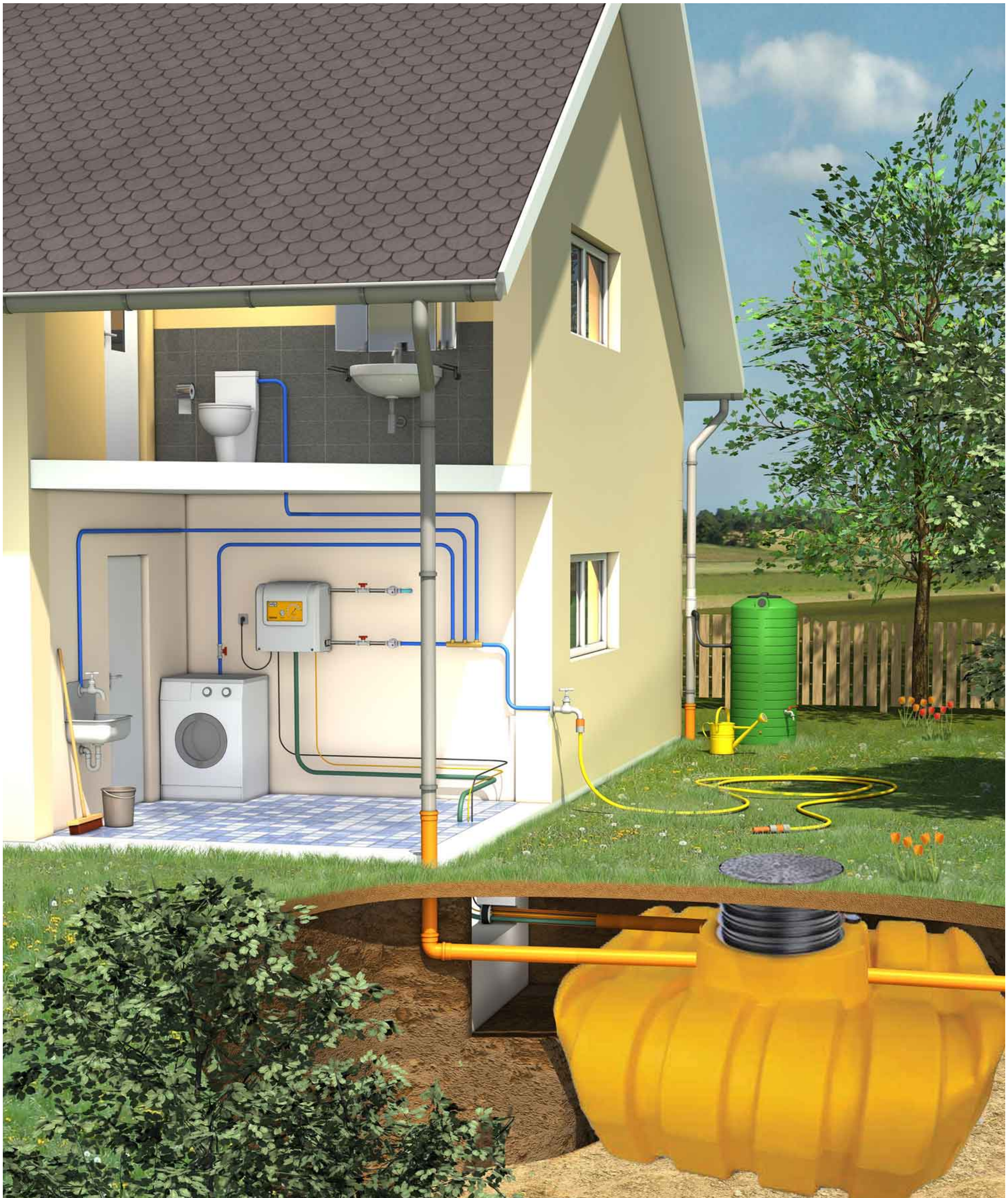


Figure 23 Rainwater collection system

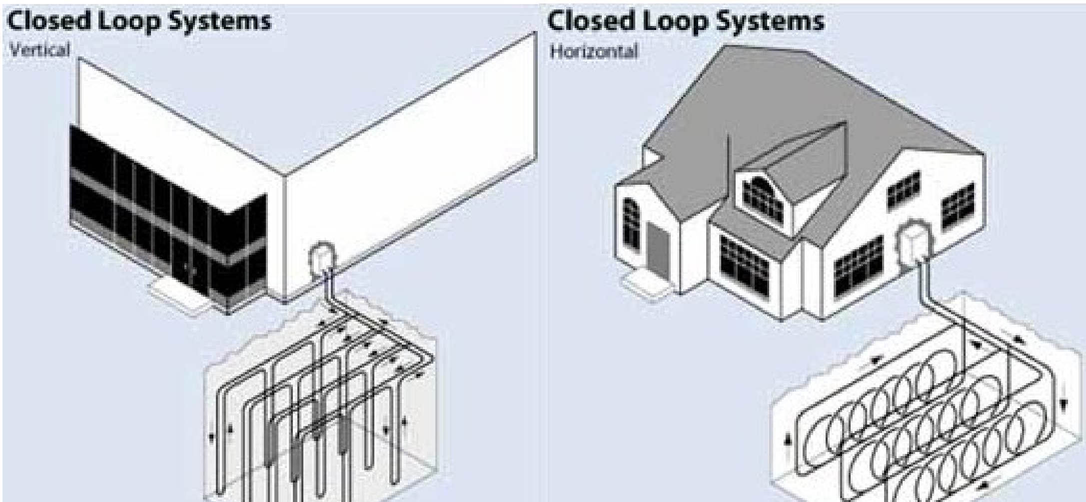


Example of Rainwater Harvesting System, SigmaE

Figure 24 Rainwater collection system

3.5.4 Geothermal Heating and Cooling

Geothermal Heat Pumps can be used to reduce the overall energy demand of the site and to reduce noise generated by air conditioning system. I



Vertical and Horizontal Closed Loop Geothermal Heat Pump

In Zones Z1 to Z6 closed loop systems are recommended based on using a thermal fluid, (typically water), to circulate through underground pipes to a building's heat exchange system. In the winter, the heat pump extracts heat from the ground to heat the building through space heating or to heat water.

4 INFRASTRUCTURE COSTS

The main cost reduction of the Hybrid Plan is based on the combined effect of:

i) Development of an urban plan which increases the connectivity while minimizing road infrastructure expressed by vehicular thoroughfare per capita,
ii) Eliminating or significantly reducing the subsurface conveyance (pipes and other stormwater infrastructure.

Most of the tools provide multiple functionalities, e.g., rain gardens may provide storage and filtration, while also performing conveyance features. The range of reduction can be in the range of 30 to 50% when the following main principles are followed.

- Maximizing pervious surfaces (green areas which are completely pervious):
- Private - includes privately accessible green areas
- Public - includes public open space, parks, green alleys.
- Substituting impervious surfaces with semi-impervious surfaces where possible
- Private - include privately accessible alleys.
- Public - include thoroughfare for light and pedestrian traffic.
- Reducing the impervious surfaces to building roofs only and roads with heavy vehicular traffic
- Building's footprints are completely impervious and cause stormwater runoff
- Roads for heavy vehicular traffic, which may be from concrete blocks, or from asphalt, which are mainly impervious.

An engineering estimate of probable costs for civil infrastructure within the right of way was developed. The costs assume 20% contingencies based on the uncertainty of the initial plans. Calculation of quantities is based on generalized information and assumption for each plan. The information is preliminary and additional optimization for reduction of the infrastructure under consideration.

Table 2 Engineer's Opinion of Probable Cost - Hybrid Plan

NO.	ITEM	UNIT	QUANTITY	QUANTITY	UNIT COST	EXTENDED AMOUNT
1	CONCRETE CURB & GUTTER, TYPE F	LF		13,040	$ 25	$ 320,393
2	TYPE B STABILIZATION	SY		181,050	$ 7	$ 1,336,149
3	BASE	SY		181,050	$ 27	$ 4,814,120
4	SUPERPAVE ASPHALTIC CONCRETE	TN		10,980	$ 109	$ 1,199,455
5	ASPHALT CONCRETE FRICTION COURSE	TN		21,950	$ 116	$ 2,548,615
6	DRAINAGE MANHOLE	EA		100	$ 8,362	$ 836,200
7	CURB INLET	EA		170	$ 6,851	$ 1,164,670
8	PIPE CULVERT 15"	LF		9,800	$ 90	$ 882,000
9	PIPE CULVERT 18"	LF		8,750	$ 98	$ 855,138
10	PIPE CULVERT 24"	LF		7,350	$ 114	$ 837,533
11	PIPE CULVERT 30"	LF		5,420	$ 166	$ 901,346
12	PIPE CULVERT 36"	LF		2,370	$ 196	$ 463,667
13	PIPE CULVERT 42"	LF		560	$ 225	$ 125,720
14	MITERED END SECTION 24"	EA		2	$ 2,353	$ 4,706
15	MITERED END SECTION 30"	EA		11	$ 3,162	$ 34,782
16	MITERED END SECTION 36"	EA		2	$ 4,216	$ 8,432
17	MITERED END SECTION 42""	EA		11	$ 5,270	$ 57,970
18	WATER MAIN, 8", FITTINGS, AND VALVES	LF		29,410	$ 125	$ 3,670,368
19	WATER SERVICE CONNECTIONS, 2" DOMESTIC	EA		200	$ 4,500	$ 900,000
20	WATER SERVICE CONNECTIONS, 2", FIRE	EA		200	$ 9,400	$ 1,880,000
21	GRAVITY SEWER MAIN, 8"	LF		29,410	$ 107	$ 3,132,165
22	SEWER MANHOLE	LF		120	$ 4,258	$ 510,960

23	SANITARY LATERAL CONNECTIONS, 6"	EA		200	$ 5,000	$ 1,000,000
24	POWER AND TELECOMMUNICATION DUCT BANK	LF		17,950	$ 190	$ 3,410,500
25	TRANSFORMERS	EA		70	$ 2,000	$ 140,000
26	POWER AND TELECOMMUNICATION SERVICE CONNECTIONS	EA		30	$ 1,500	$ 45,000
27	SWITCH CABINETS	EA		20	$ 75,000	$ 1,500,000
28	MISC. EQUIPMENT (JUNCTION BOX, MANHOLES, HANDHOLES, ETC.)	LS		1	$ 500,000	$ 500,000
			SUB-TOTAL	SUB-TOTAL		$ 33,079,887
			20% CONTINGENCY	20% CONTINGENCY		$ 6,615,977
			TOTAL	**TOTAL**		**$ 39,695,865**
			COST PER CENTERMILE	**COST PER mi Street**		**$ 4,135,700**

5 CONCLUSIONS AND RECOMMENDATION

This document provides selected Green Infrastructure strategies for the OLF-8 project based on the Hybrid Plan developed by DPZ Codesign in May 2021. Initial assessment of project site conditions and design considerations of the project site was conducted to determine potential constraints that may limit on-site retention of stormwater runoff and implementation of stormwater quality control measures. Six types of green infrastructure components are implemented.

For stormwater treatment a series of interconnected lakes and green areas are proposed (wet and dry ponds). The urban plan introduced 11 lakes (with a total area of 24 acres ranging between 0.3 and 4 acres in size) and additional dry ponds. The proposed wet and dry ponds are interconnected with overland and subsurface conveyances to distribute and treat water storage within the site. Based on the urban plan configuration, the stormwater system for the Hybrid Plan provides enough storage to attenuate post-development 100-year, 24-hour peak discharge rate to pre-development rates. On a block and parcel scale, smaller green infrastructure components (with a total area of 32 acres ranging in size between 0.1 to 2 acres) are proposed, which include stormwater planters, rain gardens, stormwater trees and vegetated swales.

To reduce the impact of introducing impervious roads, two strategies are proposed. Thoroughfare medians with total length of nearly 25,000 feet are used to provide stormwater storage runoff from the roads. Additionally, for semi-impervious road cover and medians are proposed for light vehicular and for pedestrian traffic. For green building practices, either solar roofs or green roofs are proposed to cover the proposed 95 acre of building roofs. Using solar power has initial costly investment, however it has the potential to reduce the overall use of energy within the site.

As an alternative to solar roofs, green roofs can be used to capture the runoff by a layer of vegetation and soil installed on top of a conventional flat or sloped roof. The rooftop vegetation allows evaporation and evapotranspiration processes to reduce the volume and discharge rate of runoff entering the conveyance system.

Geothermal Heat Pumps are poposed to reduce the overall energy demand of the site and to reduce noise generated by air conditioning system. In Zones Z1 to Z4 Closed loop systems are recommended based on using a thermal fluid, (typically water), to circulate through underground pipes to a building's heat exchange system. In the winter, the heat pump extracts heat from the ground to heat the building through space heating or to heat water.

The plan follows the topography and will not require significant modifications or grading. Best considerations of topographic features include placing the residential areas at the highest. The location of the industrial area is in proximity to the retention areas on the east side which is the most optimal for environmental purposes.

Distributed open space within the plan and preservation of large open space area at the southwest section provides the most optimal approach to protecting open space and use within the urbanized areas. The plan will provide the required flood protection capacity based on the minimized fraction of directly connected impervious areas which include multiple green corridors to provide storage and interrupt flow over such areas.

All potable water for the site will be municipally supplied, no on-site potable water wells are located on or utilized by the property. Wastewater generated at the site is currently managed on-site via a sanitary septic system connected to existing buildings' plumbing systems. The plan will include a sewer system that will be built in phases and which will connect to a regional wastewater treatment plant managed by Emerald Coast Utilities Authority (ECUA). Surface water runoff infiltrates or is discharged eventually to Eleven Mile Creek with no NPDES Permits requirements. Solid waste managed by ECUA. Electricity is provided by Gulf Power and electricity.

The initial review of available data indicates that the proposed location of the lakes could be favorable in terms of topography and soil and subsurface properties. Additional investigations may be needed at the location of the proposed lakes. The soil type and geologic conditions of the project site should be additionally evaluated to estimate the potential for infiltration and to identify suitable as well as unsuitable locations for retention-based stormwater quality control measures.

A field exploration program should be designed using suitable and reliable drilling equipment with the goal of retrieving representative and undisturbed soil samples for an adequate characterization of the soil materials. A laboratory testing program should be designed with the goal of quantifying the strength and deformability characteristics of the soil materials. The laboratory equipment should meet ASTM standards and be properly calibrated. All slopes should be properly designed and protected from rainfall erosion. Two basic methods include drainage and use of vegetation.

As a part of future Green Infrastructure submittal, a detailed geotechnical report must be prepared by a geotechnical engineer. Infiltration can cause geotechnical issues, including settlement through collapsible soil, expansive soil movement, and slope instability due to a temporary increase in groundwater levels near retention-based stormwater quality control measures. Increased water pressure in soil pores reduces soil strength, which can make foundations more susceptible to settlement and slopes more susceptible to failure. In general, retention-based stormwater quality control measures must be set back from building foundations or steep slopes. Recommendations for each block must be determined by a licensed geotechnical engineer based on soils boring data, drainage patterns, and current requirements for stormwater treatment. Even though no issues may be expected with the current location of the lakes, further field and laboratory geotechnical investigation should confirm this preliminary result. A geotechnical engineer's recommendations are essential to reduce damage from increased subsurface water pressure on surrounding properties, public infrastructure, and sloped banks.

Slopes can be affected by the temporary rise in groundwater level. The presence of a water surface near a slope can reduce the stability of the slope compared to a dry condition. A groundwater modeling analysis is recommended to evaluate the potential increase in groundwater levels around a retention-based stormwater quality control measure. If the potential increase in groundwater level approaches nearby slopes, a slope stability evaluation should be conducted to determine the implications of the temporary groundwater surface. The geotechnical and groundwater mounding evaluations can identify the duration of the elevated groundwater level and provide safety factors consistent with the duration (e.g., temporary or long-term conditions).

Considering that concentrated flows from off-site drainage may cause extensive erosion if not properly conveyed through or around the project site or otherwise managed, the locations and sources of off-site drainage have been identified, and future design of the stormwater system can provide estimates of the volume of stormwater and factored into the siting and sizing of stormwater quantity and quality control measures.

The presence of Protected Ecological Areas may limit the siting of certain stormwater quality control measures, such as facilities that do not provide sufficient treatment of pollutants of concern. The OLF-8 project will aim for zero stormwater discharge which will be fulfilled by integrating stormwater infrastructure within the stormwater system.

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