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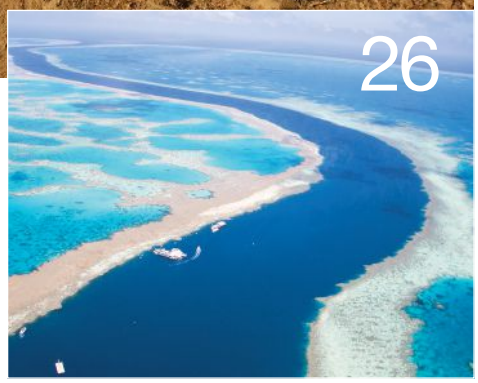

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Strong Foundation

By Rachel Sim

To those outside the stormwater and sediment control industries, the work done to preserve surface water quality and reduce erosion and sedimentation can appear rather opaque. Stormwater capture and treatment often occur underground, street sweeping can feel like just a schedule to move your car, and very few people admire a stable slope with the same intensity as they curse one that erodes. As is true with many things, the prevention gets less attention than the failure.

However, sediment control and surface water quality experts know there's more to the job than a beautifully vegetated slope, an unflooded street, or even a healthy stream. The nitty-gritty behind-the-scenes work yields the results—as unnoticed by the general public as it may be.

This month, we're bringing you stories exploring some of the background work that goes into maintaining surface water quality and controlling sediment. In our lead feature, "**Keeping Compliant during a Pandemic**," (**pg. 16**), David Renfrew discusses EPA's reporting requirements during the pandemic and the challenges it presents for water regulation entities.

Up in Canada, in order to meet the Alberta Environment and Parks TSS and TP loading objectives, the City of Calgary created a city-wide stormwater model. Check out "**A City of Stormwater**" (**pg. 12**) for more on how the model was developed and then applied to evaluate scenarios as far into the future as 2078 while considering new development and redevelopment conditions.

Although each site is unique, some need a little more personalized attention than others. In "**Designed Drainage**" (**pg. 28**), 100-year-old streets received custom stormwater infrastructure to help alleviate flooding. In "**Steep Slope? No Problem!**" (**pg. 22**) a 70-degree slope on the shore of Lake Wisconsin needed serious stabilization, but with native plants and pre-vegetated blankets, the results were quick and impressive.

How do you protect one of the world's greatest national treasures, the Great Barrier Reef? For the city of Cairns, Australia, it starts with understanding your impact. Cairns Regional Council commissioned a network of sensors to better understand what they were discharging to the Reef and alert them to when loads got too high. Check out "**Caring for Coral**" (**pg. 26**) for more.

Finally, don't miss our **Guest Editorial** (**pg. 20**), which offers an overview of PFAS and the state of the practice. What do we know and what questions still need to be answered? With PFAS already on the radar for soils, sediments, and groundwater, surface water quality standards will likely soon follow.

The work that goes on largely out of public view—to find the best solution, to understand all the variables—is the bulk of the work of stormwater managers and erosion control experts. It's also the foundation that supports everything else, whether that's water quality, shoreline stability, or pollutant reduction. As we grapple with changing procedures and the economic fall out of the global COVID-19 pandemic, this strong foundation is what will carry this industry through.

Cover photo: NV5

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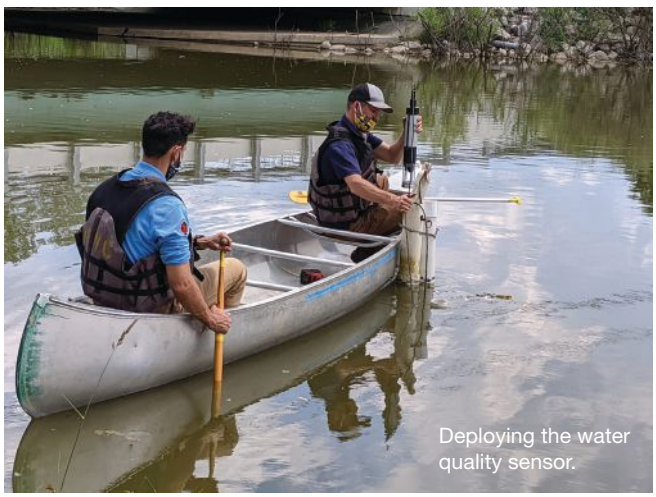
EPA Provides Additional Funding to Reduce Excess Nutrients in Gulf of Mexico Watershed

EPA recently announced it will provide an additional $840,000 to the 12 state members of the Mississippi River/Gulf of Mexico Hypoxia Task Force (HTF) in addition to the $1.2 million the Agency announced in August 2019. Collectively, EPA's funding of over $2 million is helping HTF states implement plans that accelerate progress on reducing excess nutrients and improving water quality in the Mississippi/Atchafalaya River Basin (MARB).

Süleyman ahan from Pexels

HTF is a partnership composed of 12 states, five federal agencies, and a representative for tribes working collaboratively to reduce nutrient pollution in the (MARB) and the extent of the hypoxic zone in the Gulf of Mexico at the mouth of the Mississippi River.

Excess nutrients in surface waters can contribute to algae blooms, hypoxic zones, and other water quality concerns. The HTF provides direction and support for federal and state initiatives to improve water quality in local waterways and the Gulf of Mexico.



Deploying the water quality sensor.

Everyday Sensors to Monitor Water Quality into Lake Erie

A project between the Cleveland Water Alliance, the Ohio Department of Natural Resources (ODNR), and Michigan-based LimnoTech will show how inexpensive sensor technology used in everyday products can monitor water quality in Lake Erie.

Staff from ODNR are being trained on how to use and monitor the sensor technology, which will provide real-time results and remote-accessible data. This will reduce the time and cost in collecting reliable data. The project is taking place along a 3-mile stretch of Old Woman Creek, which flows into Lake Erie. Approximately 30 sensors will be installed at four different sites. These low-cost sensors will potentially do the work of legacy sensors at roughly 10% of the cost.

They will measure and collect data on wind speed, air temperatures, solar energy (how much sun is hitting the water), water temperature, water levels and flow, and turbidity. The project is funded by ODNR's Office of Coastal Management.

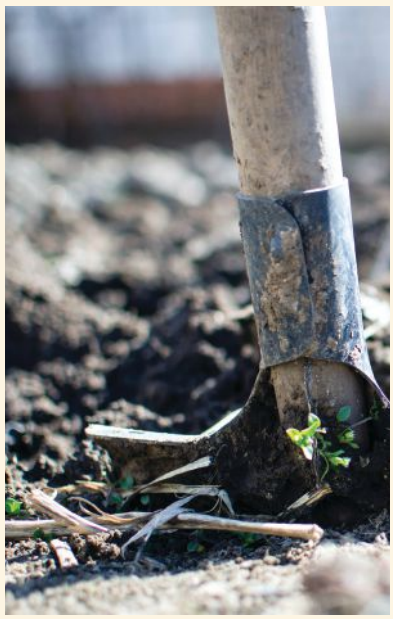
Unusual Dark Wetland Soil Identified on California's Central Coast

A team of researchers has recently investigated and classified areas of soil along the central coast of California with some unusual characteristics.

The experiment examined how dark the soil was, its water content, vegetation, and chemical composition. Looking at how wet the soils seemed, the vegetation that grew there, and microbes that lived in the soil, a scientist would think they were wetland soils. But characteristics such as its dark color confused the researchers because it was so similar to the surrounding, drier soil.

The surrounding landscape provided classification clues. The steep slopes in the region where the team worked are prone to landslides, which deposit soil in different areas and can result in depressions where soil is wetter than might be expected, given the surroundings.

When combined with the wetland hydrology and water-loving vegetation the researchers found, the area could be classified as hydrologically isolated wetlands.



Lukas from Pexels

Coal-Tar-Based Sealants on Pavements Are the Primary Source of PAHs in Great Lakes Tributaries

According to a recent study from USGS, EPA, and the University of Helsinki, runoff from pavement with coal-tar-based sealant is the most likely primary source of polycyclic aromatic hydrocarbons, or PAHs, found in the majority of streambed sediments of Great Lakes tributaries. PAHs are a group of chemicals found in crude oil and coal. They occur as a byproduct of burning and can have harmful effects to organisms in the environment under certain conditions.

Scientists collected sediment samples from 71 streambed sites throughout the US portion of the Great Lakes Basin. Based upon relative concentrations of the particular PAHs found in the sediments, dust from coal-tar-sealant was most likely the dominant PAH source for 57 of the sites. PAHs from coal-tar sealants are transported to streams through stormwater runoff. Concentrations in 62% of the samples exceeded screening criteria for aquatic life. Further analysis is needed to determine the potential effects of PAHs on aquatic life in that area in order to improve habitat for aquatic organisms.

Wes Hicks on Unsplash

Petra Boekhoff from Pixabay

Historical Research Shows Wetlands Protect Coastlines

A research team led by scientists from the Royal Netherland Institute for Sea Research (NIOZ), Delft University of Technology, Deltares, and Antwerp University has examined salt marshes performance during extreme real-world storms by digging into major historic records of flooding disasters.

By examining historic data from the well-documented 1717 and 1953 floods in Northwestern Europe, the researchers showed that salt marshes reduced the number of breaches of engineered defenses. The data also showed that salt marshes lower flood magnitude by limiting the size of breaches when engineered defenses like dikes fail during severe storms.

The researchers say the findings provide insight into the mechanisms and benefits of nature-based flood mitigation. Supplementing engineered defensive structures with coastal wetlands and salt marshes could offer better protection during storms and help safeguard coastal regions from the most extreme effects of sea-level rise and coastal erosion.

Southern Environmental Law Center Files Petition to Protect Popular North Carolina Fishing Creek

The Southern Environmental Law Center (SELC) has filed a petition with the North Carolina Supreme Court arguing that a state permit failed to protect Blounts Creek in eastern North Carolina from Martin Marietta's plan to discharge up to 12 million gallons of open-pit mine wastewater a day into the creek.

In 2017, Carteret County Superior Court found that the state permit failed to protect the biological integrity of the creek as required by state law. The altered creek would no longer support its existing diversity of fish species or be considered swamp waters due to the increased flow and pH and other changes to the creek. It would be unlike any creek naturally found in the region. Under federal and state law, North Carolina cannot authorize discharges that will violate water quality standards by changing the natural mix of wildlife in a water body.

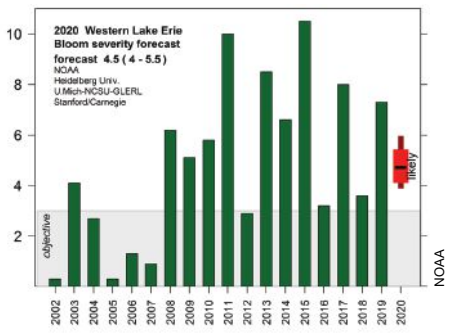
Tim Marshall on Unsplash

NOAA Predicts Moderate Harmful Algae Bloom in Western Lake Erie

NOAA and its research partners are forecasting that western Lake Erie will experience a moderate harmful algal bloom this summer. This year's bloom is expected to measure 4.5 on the severity index but could possibly range between 4 and 5.5, compared to 7.3 last year. An index above 5 indicates a more severe bloom.

The severity index is based on the bloom's biomass over a sustained period. The largest blooms occurred in 2011 (with a severity index of 10) and 2015 (a severity of 10.5). NOAA, EPA, Environment and Climate Change Canada, and other partners have set a goal of 3, which was last seen in 2012.

The size of a bloom isn't necessarily an indication of how toxic it is—toxins in a large bloom may not be as concentrated as in a smaller bloom. Each algal bloom is unique in terms of size, toxicity, and its impact on local communities. NOAA is developing tools to detect and predict how toxic blooms will be.



NOAA


Dreamstime/Owen Aucoin

Louisiana Reduces Planned State Funding for Costal Restoration and Protection

Louisiana's House Appropriations Committee recently approved the state's Capital Outlay bill (HB-2), which annually provides the funds for constructing projects across the state, with an amendment that removed $117 million of 2018–19 surplus funds for the state's Coastal Trust Fund. With those dollars, the state planned to help fund 13 flood protection and coastal restoration projects across the coast and a number of restoration projects.

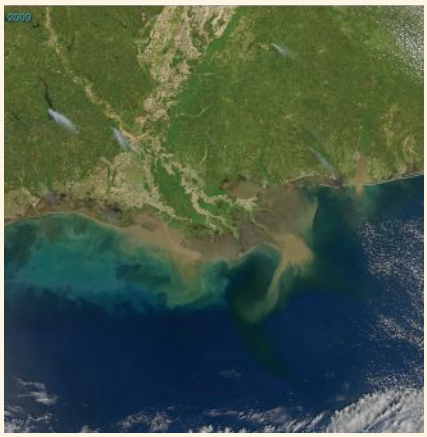
According to a recent analysis by Dr. Loren C. Scott & Associates Inc., the construction of two restoration projects alone would support nearly 4,000 jobs, deliver $56.6 million in revenues to the State of Louisiana, and increase regional business sales by $3.1 billion. A statewide poll of high-frequency Louisiana voters found that over 95% of respondents want their elected officials to protect funding for coastal restoration and protection and to prioritize coastal restoration and protection while in office.

A National Institutes of Building Sciences study found that every $1 invested in disaster mitigation saves $6 in disaster recovery.

Gulf of Mexico's Annual Hypoxic Area Expected to Be Larger than Average

This year's annual summer hypoxic area or "dead zone" in the Gulf of Mexico is forecast to be approximately 6,700 square miles, scientists from NOAA are forecasting. This is larger than the long-term average measured size of 5,387 square miles but less than the record of 8,776 square miles set in 2017. The annual prediction is based on US Geological Survey river-flow and nutrient data.

Major factors contributing to this year's above-average hypoxic zone are the high river flows and nutrient loads delivered to the Gulf this spring, primarily from the Mississippi and Atchafalaya rivers. In May 2020, discharge in the Mississippi and Atchafalaya rivers was about 30% above the long-term average between 1980 and 2019. USGS estimates this river discharge carried 136,000 metric tons of nitrate and 21,400 metric tons of phosphorus into the Gulf of Mexico in May alone. These nitrate loads were about 2% above the long-term average, and phosphorus loads were about 25% above the long-term average.



NASA image courtesy Norman Kuring, Ocean Color Team

State of Montana and United States Lodge $150M Settlement to Clean Up Mining Contamination

EPA and the Justice Department have announced the lodging of a proposed consent decree in federal District Court requiring the Atlantic Richfield Company (ARCO) conduct over $150 million of clean-up work at the Butte Priority Soils Operable Unit site in Montana.

The cleanup activities required include removing contaminated tailings at the Northside and Diggings East Tailings areas along with contaminated sediments and additional floodplain contamination from Silver Bow and Blacktail Creeks. It also requires more extensive treatment of contaminated stormwater before it flows into the creeks and the capture and treatment of additional contaminated groundwater.

Joanne Francis on Unsplash

The Silver Bow Creek/Butte Area site is in and around Butte, MT, and includes 26 miles of stream and streamside habitat. Since the late 1800s, mining wastes have been dumped into the area, as well as into streams and wetlands near mining operations, and smelters and mills produced aerial emissions contaminated with arsenic and heavy metals. These activities contaminated soil, groundwater, and surface water with heavy metals.

Binyamin Mellish from Pexels

EPA Settles Alleged Stormwater Violations in Idaho Ski Area

EPA and the Bogus Basin Recreational Association Inc. have settled a Clean Water Act enforcement case stemming from alleged violations of construction stormwater permit requirements at the ski area and recreation complex northwest of Boise, ID. Bogus Basin is a 501(C)(3) non-profit organization that operates by a Special Use Permit on the Boise National Forest under the USDA.

EPA alleges violations took place at Bogus Basin's Stabilization Project. Construction included installing a retention dam, creating an in-stream 42-acre-foot water storage pond for snowmaking, and chair lift replacement.

Concluded under an Expedited Settlement Agreement, the action included a penalty of $52,680. Expedited Settlement Agreements offer business and industry a faster, more streamlined process to resolve permit violations with monetary penalties commensurate to the severity of the violations.

The alleged violations were observed during an unannounced facility inspection conducted by the Idaho Department of Environmental Quality, on EPA's behalf in June and September 2019.

$1.45M Awarded for Environmental Resilience by Southeast Michigan Resilience Fund

Seven projects have been selected by Southeast Michigan Resilience Fund partners to receive $1.45 million in grant funding to benefit communities and wildlife habitats in southeast Michigan. These community-driven investments will strengthen regional resilience by installing green infrastructure and reducing the threat of flooding and other intensifying environmental stressors. Additionally, projects will restore critical habitat for wildlife and create or enhance public access to and use of natural areas and parks across four counties.

The Southeast Michigan Resilience Fund is a public-private partnership that increases the resilience of communities and natural resources in Southeast Michigan by reducing the impact of stormwater, improving water quality, enhancing habitat, and increasing the accessibility and usability of public green space and natural areas. These actions help communities prepare for intensifying environmental stressors related to development, climate, invasive species, nonpoint source pollution, and other factors.

David Mark from Pixabay

A City of Stormwater

Calgary develops city-wide stormwater loading targets with an eye to the future

BY STACEY ZHAO, SEN BAI

Dreamstime/Ronniechua/Fish Creek

Calgary is situated at the confluence of Bow and Elbow River about 80 kilometers (50 miles) east of the Front Ranges of the Canadian Rockies. With a population of 1.27 million, Calgary is Canada's third-largest municipality and fourth-largest Canadian census metropolitan area. Calgary encompasses six watersheds: Nose Creek, Elbow River, Fish Creek, Pine Creek, Western Irrigation Canal, and Bow River. The majority of the city area, except for a small portion of irrigation canal area, eventually drains into Bow River. Bow River is a world-famous river for fly fishing brown and rainbow trout. To protect fish in Bow River, Alberta Environment and Parks (AEP) has set total suspended solids (TSS) and total phosphorous (TP) loading objectives for Calgary. To ensure the City meets the AEP TSS objective and as part of the Stormwater Management Strategy, the City has committed to keeping TSS loadings to the Bow River at the 2005 level, in spite of ongoing population growth and city development.

In order to provide technical support for the Stormwater Management Strategy update and ensure the City is continuously meeting the AEP objectives, Tetra Tech was retained and conducted a "City-wide Stormwater Loading Targets Development" study in 2015. A city-wide stormwater model was developed using a SWMM-SUSTAIN framework. The model was also applied to evaluate future 2028 and 2078 scenarios considering new-development and redevelopment conditions.

Table 1. Buildup Rate Sequence for Phosphorus

Organic Phosphorus	Inorganic Phosphorus
Industrial	Industrial
Transportation	Transportation
High/medium density residential	Gravel surface
Low density residential	High/medium density residential
Commercial	Low density residential
Gravel surface	Commercial
Other	Other

Setting Up the Model

Due to its location near the Rocky Mountain Foothills, Calgary's rainfalls are localized. More than 30 rain gauges within the city area have been installed since 1980s to monitor rainfall from May to September. To save computational time, the city area is divided into seven rain zones. The Thiessen polygon method was used to generate seven rain zone time series from the City's 32 rain gauges and Calgary airport data. For other weather data such as wind speed, airport data were used.

EPA's Storm Water Management Model (SWMM) was used to simulate the runoff and loadings of the hydrological response units (HRUs) from specific land surfaces. A total of 24 HRUs were generated based on land use, soil type, and imperviousness to represent the land surfaces. TSS was modeled using build-up and wash-off in warm weather and Event Mean Concentrations (EMCs) for snowmelt events from December to April. TP was modeled as the sum of inorganic phosphorus and organic phosphorus from the land surface using the buildup and wash-off method.

The System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) model contains the catchments and pond routing network and summarizes the runoff and loading for a catchment or outfall. The City's stormwater catchments and wet ponds are shown in Figure 1. A total of 471 catchments and 178 wet ponds and wetlands were configured in the SUSTAIN model. When routing through the wet ponds, TSS was distributed to sand, silt, and clay with different settling velocities; first-order decay was used for inorganic and organic phosphorus to represent the removal of TP.

Event Mean Concentrations were applied for winter TSS representation instead of buildup and wash off, since winter TSS load in Calgary is mainly driven by winter sanding.

Stormwater Monitoring and Model Calibration

The City has been monitoring its stormwater flow and quality since 2001. The water quality of baseflow, rain, and snowmelt events for residential, commercial, industrial land uses were monitored at 16 locations from 2001 to 2005. Since 2015, the flow- and event-based water quality data have been collected year-round at land use catchment outlets, outfalls, and wet pond inlets/outlets to better understand the stormwater flow and quality.

Fourteen monitoring sites were used to calibrate the hydrology and eight sites to calibrate TSS and TP loadings.

For hydrology calibration, infiltration parameters and depression storage were adjusted iteratively until model results agreed well with monitoring data. The hydrology calibration errors for 14 sites were within -26% and +28% with an overall relative error of less than 1.0%.

For TSS calibration, the buildup rates, in order from high

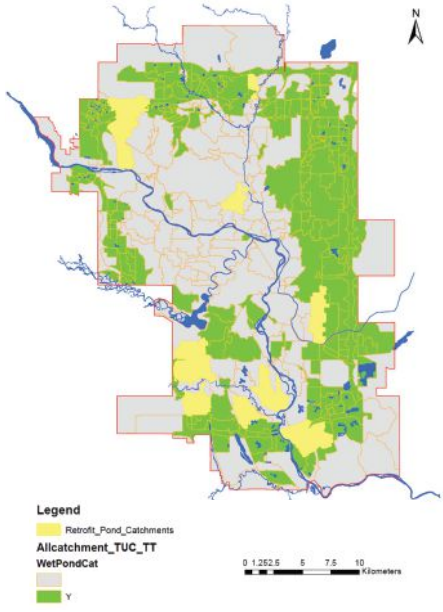
to low, are gravel surface, industrial, transportation, high-density residential, commercial, low-density residential, and other land surfaces.

The wash-off parameters were set to be identical for all the HRUs with the assumption that the same runoff depth on the surface of the HRUs will have the same wash-off power. The actual wash off from different land surfaces will vary because the runoff depth varies on the surfaces of different HRUs. In the SUSTAIN model, TSS were separated into three categories: sand, silt, and clay, with three settling velocities in wet ponds. Buildup parameters and settling velocities were calibrated. The TSS calibration errors at eight sites were within -18% to +37% with an overall relative error of 0.2%.

The buildup rate, from high to low, for organic and inorganic phosphorus are listed in Table 1.

The first-order decay rates for organic and inorganic through wet ponds were also calibrated. The TP calibration errors at eight sites were within -9% to +49% with an overall relative error of 0.2%.

Figure 1. Calgary Catchments and Wet Ponds



The City-Wide Model

The parameters from calibration were applied to the city-wide model. To be conservative, all impervious area was treated as effective imperviousness. HRU TSS and TP simulated loading results are shown in Figures 2 and 3.

Construction Loadings

Calgary experienced rapid growth from 2006 to 2014 as a result of the oil industry boom. The growth rate peaked in 2014, as did construction. The construction loading calculation was based on 2014 conditions, which is conservative.

Daily TSS loadings from the construction sites were calculated using an estimated average annual construction site TSS yield—2 tons per hectare per year with a downstream pond removal rate of 65% and a green space removal rate of 60%. The annual average TSS yield was distributed to daily TSS loadings based on daily precipitation data. The TSS loading from construction sites was added to the SWMM-SUSTAIN model results as a post-processing step. The average daily TSS loadings from construction sites were calculated as 5,427 kilograms (12,000 pounds) per day.

Future Scenarios

The timeline for the next renewal of provincial approval is 2028. The City's long-term planning scenario is for 2078, which aligns with the City's Municipal Development Plan. The new development area information was obtained from the City Planning Division. For the redevelopment, it was assumed all inner-city areas will be redeveloped by 2078 and one-sixth of the inner-city will be redeveloped by 2028. It was assumed that redevelopment imperviousness percentage will increase from the current 50% to 70% for residential and 85% for commercial.

With current Calgary's stormwater policy, Nose Creek, West Nose Creek, and Pine Creek have runoff volume control targets. For other watersheds, wet ponds are required to attenuate 100-year floods in Calgary's Stormwater Design Manual. With most newly designed wet ponds, TSS removal efficiency could reach 90%. To be conservative, it is assumed that future wet ponds will remove 80% of TSS.

It was assumed that stormwater ponds will reduce 40% of TP and the volume control measures will reduce 50% of TP for future scenarios; the construction loading will be the same as the 2014 level.

Project Findings

More than half of the City's future greenfield development is in Nose Creek, Pine Creek, and West Nose Creek where volume control targets are already in place. The Bow River direct watershed has 36% of greenfield development where the wet ponds (but no assumed volume control) were applied for future scenarios.

This study showed that the average wet pond treatment efficiencies within the City are 81% for TSS and 58% for TP. Newer ponds have higher TSS removal efficiencies as a result of better pond design. Usually, the volume control approach adds 5 to 8% higher efficiency for TSS removal compared with wet pond treatment alone.

With stormwater retrofit ponds and current stormwater management

Table 2. Recommended TSS Loading Rates by Watersheds

Watershed	Selected Loading (kg/day)	Recommended Target (kg/day)	Unit Area Loading Target (kg/day/ha)
Bow River	14,710	15,160	0.559
Elbow River	4,867	5,016	0.773
Fish Creek	1,322	1,362	0.260
Irrigation Canal	2,688	2,770	0.790
Nose Creek	5,997	6,180	0.330
Pine Creek	944	973	0.302
Shepard Ditch	5,457	5,624	0.433
Shepard Slough	837	863	0.517
West Nose Creek	2,962	3,053	0.524
Total	39,784	41,000	0.548

policies (e.g., Interim Stormwater targets requirement), the annual stormwater TSS loading increase has been reduced from 112 kg/day (247 lbs/day) (as shown in Golder's 2007 modeling results) to 56 kg/day (123 lbs/day) for the present condition during the clear flow period.

Based on present controls and the addition of three retrofit ponds (Bowmont East pond was completed in 2017, Ogden and Highfield ponds are scheduled for construction), the modeling results showed that the City will continue to meet the TSS Council commitment of 41,000 kg/day (90,000 lbs/day) beyond 2028 and is projected to only slightly exceed the TSS Council commitment 58 years from now, in 2078.

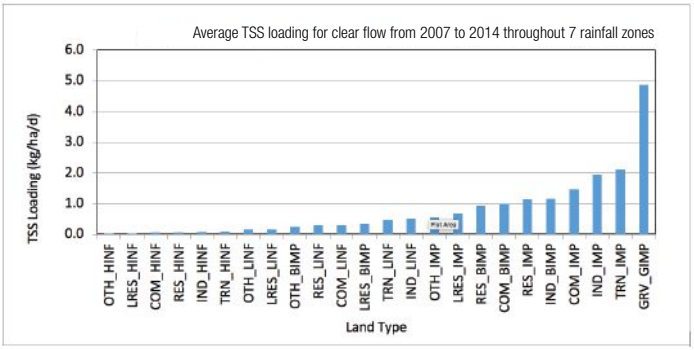
Modeling results showed gravel surfaces (gravel lanes and parking lots) and construction sites are disproportionately high TSS contributors. Gravel surfaces were estimated to contribute 22% of TSS loading to the Bow River from only 3% of the city's area. Construction sites contribute 13% of TSS loading from only 4% of the area. Together, a total of 35% of all TSS is being generated by only 7% of the City's land area.

Model runs showed that if gravel surfaces are eliminated in new development and redevelopment in the near future, the TSS loading would remain below the Council commitment beyond 2078.

Watershed-Level TSS Control Targets

To better manage the TSS load entering the Bow River, Tetra Tech recommended that the City manage the TSS loading rates by watersheds. Different watersheds have different drainage areas, land uses, soil types, impervious covers, and future developments, resulting in different contributions of TSS from different watersheds under current and future conditions. The recommended targets were based on the loading rates from the watersheds in scenario 2028 and scenario 2078 without gravel lane and the council commitment of 41,000 kg/day. The recommended TSS loading targets by watersheds are listed in Table 3.

Figure 2. Land Use TSS Loading Model Results

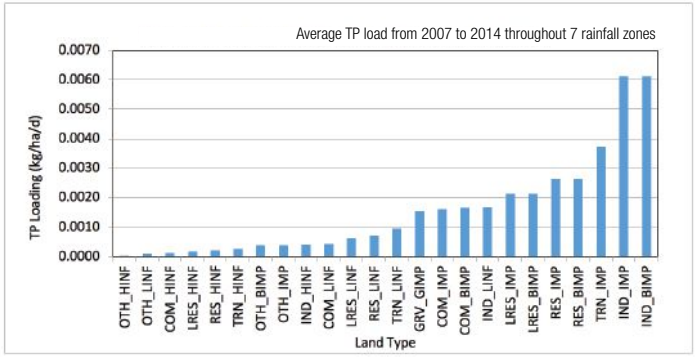


Recommendations

The study and modeling resulted in the following recommendations to the city:

- For redevelopment areas without any stormwater treatment,

Figure 3. Land Use TP Model Results



to improve stormwater quality and better maintain pipe capacity, investigate alternatives to erodible gravel surfaces and apply source/volume control measures to achieve TSS loading reduction.

- For new development, investigate alternatives to erodible gravel surfaces based on Triple Bottom Line analysis including life cycle cost.
- A new study—Gravel Lane Sediment Abatement Study—was initiated last year as a result of the above recommendations. The study is using the TBL approach to evaluate gravel lane, paved lane, and alternatives. Three alternatives will be chosen as pilot projects.
- Investigate opportunities to further reduce construction site TSS loadings, through enhanced Sediment Erosion Control measures, refining standards for sedimentation pond performance during construction periods, assessing enforcement and incentive techniques, developing a policy for stripping and grading practices or related measures.
- Work with Roads to optimize winter salting and sanding operations to further reduce TSS loading and other environmental impacts.

Stacey Zhao *is a water resources engineer for the City of Calgary with more than 20 years of experience in river and stormwater quality monitoring and modeling, watershed and stormwater management, and planning and project management.*

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Keeping Compliant during a Pandemic

COVID-19 and the new reality of stormwater permit compliance

BY DAVID RENFREW

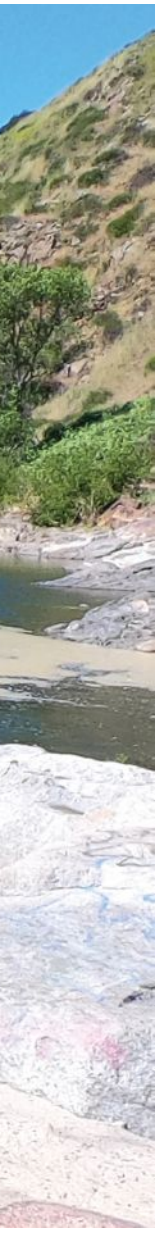
Receiving water sampling during the COVID-19 pandemic.

NV5

Providing stormwater permit compliance services has its everyday challenges. These range from dealing with changing site conditions, changes to Storm Water Pollution Prevention Plans (SWPPPs), incorporating changes or maintaining best management practices (BMPs), or dealing with regulatory changes and reporting requirements that might impact one's operations and budgets. They all have their unique requirements and the permits, and the science associated with them are always evolving. There is one common theme that all stormwater industry personnel from field staff to managers of municipal, industrial, and construction general permit projects can count on: it will rain again, and stormwater will runoff and have the potential to carry pollutants downstream that will need to be managed. However, no one could have imagined having to deal with the global wrench-in-the-spokes stopping that the COVID-19 pandemic has presented.

As this article is being written—and after being in lockdown for several months under work from home orders, learning new technology skills, and seeing essential businesses modifying their operations—society is beginning to

open up non-essential businesses, even as COVID-19 cases are increasing in many states. It is not a pretty picture, and we have a long way to go to get back to any sense of normalcy. Businesses and business managers need to stay diligent about following good practices to avoid problems down the road. This is much like implementing BMPs to prevent downstream pollution from rain events—they only work if the procedures are followed and the BMPs are maintained.



Most people working in the environmental industry know about risks associated with environmental hazards and personal protective equipment (PPE) needed to prevent risks to individual safety, good hygiene, and sample cross-contamination. Knowing this makes those in the environmental industry slightly more aware of our surroundings and how to protect ourselves and our workers from getting ill or from contaminating samples or work environments. A good example is preparing to sample for asbestos or for bacterial DNA in beach water quality samples. This experience makes us more aware of the potential for spreading COVID-19. On the other hand, the general population may not be quite as adept at knowing why we are wearing masks, taking temperatures, and wiping nearly everything down every time someone touches something, even as this becomes our new normal.

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Inspection protocols during the pandemic mean the addition of masks and physical distancing as much as possible.

The new normal operating conditions have been observed at most essential businesses including grocery stores, hardware stores, and other commercial, industrial construction, or government offices (if open). There is typically a controlled entrance, controlled spacing, and procedures are explained for persons walking into a facility. While many municipal, construction, and industrial businesses are operating, stormwater permit compliance remains important. People are just operating in a new manner and need to consider what actions might cause pollution if changes to operations occur because of COVID-19 related impacts.

The US Environmental Protection Agency (EPA) and many state environmental regulatory agencies recognized that with COVID-19, permit compliance might go by the wayside and issued clear guidance to permit holders that monitoring and reporting efforts are still required. The only way permittees can reduce their efforts is by providing a written justification as to why any permit requirements could be halted, delayed, or modified. Without express written consent, permit holders run the risk of violations or monetary penalties for non-compliance.

On March 26, 2020, EPA provided a Memo entitled "COVID-19 Implications for EPA's Enforcement and Compliance Assurance Program." The document stipulated two main points in the general conditions. All enforcement discretion set forth in the temporary policy was conditioned on the following:

1. Entities should make every effort to comply with their environmental compliance obligations.
2. If compliance is not reasonably practicable, facilities with environmental compliance obligations should:
   a. Act responsibly under the circumstances in

Casarsa Guru/Getty Images

order to minimize the effects and duration of any noncompliance caused by COVID-19;
b. Identify the specific nature and dates of the noncompliance;
c. Identify how COVID-19 was the cause of the noncompliance, and the decisions and actions taken in response, including best efforts to comply and steps taken to come into compliance at the earliest opportunity;
d. Return to compliance as soon as possible; and
e. Document the information, action, or condition specified in a. through d.

EPA also provided guidance for the following:

- Routine compliance monitoring and reporting by regulated entities
- Settlement agreement and consent decree reporting obligations and milestones
- For facility operations, the EPA expects all regulated entities to continue to manage and operate their facilities in a manner that is safe and that protects the public and the environment.
- Public water systems regulated under the Safe Drinking Water Act; and Critical infrastructure

Further, the EPA clarified expectations for states, writing that they "should consider the safety and health of their inspectors and facility personnel and use discretion when


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making decisions to conduct routine inspections, notwithstanding any applicable compliance monitoring strategy." EPA will continue to conduct enforcement and "would focus its resources largely on situations that may create an acute risk or imminent threat to public health or the environment, to ensure protection against such risks or threats." Lastly, EPA stated nothing in the policy "relieves any entity from the responsibility to prevent, respond to, or report accidental releases of oil, hazardous substances, hazardous chemicals, hazardous waste, and other pollutants, as required by federal law, or should be read as a willingness to exercise enforcement discretion in the wake of such a release."

Many state entities such as California's State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCB) issued several notices and emails to permittees that compliance with essential Permit conditions is still expected (SWRCB, 2020). It should be noted that RWQCB staff have been conducting drive-by or spot inspections to verify that permitted facilities, construction sites, and municipal activities are still complying with Permit requirements. Additionally, with RWQCB staff working remotely, there has been an enhanced focus on performing reviews of electronic database submittals. California uses the Stormwater Multiple Application and Report Tracking System (SMARTS) to provide publicly available and transparent regulatory data. Many RWQCBs are sending out reminder emails to ensure data is being reported in a timely manner and in accordance with permit requirements.

Permit managers, Legally Responsible Persons (LRPs), Duly Authorized Representatives (DARs), and Pollution Prevention Team Members (PPTs), all need to recognize that stormwater permit requirements and standard provisions are mostly still intact and required. This means that routine inspections still need to be conducted, BMPs still need to be implemented and maintained, training still needs to be conducted, and sampling, reporting, and record keeping are still required. It just might take a bit more effort under the

new normal to implement these procedures. Technology has improved to the point where some operations have become more common. The use of tough books to avoid paper handling; the use of meeting applications such as Zoom, Microsoft Teams, or Skype; and the use of GoTo Webinar to conduct training have all been used to overcome many of the remote work challenge environments.

We have been seeing many clients continue to operate with modified conditions. The most common practices are to employ the five-tiered NIOSH safety approach which includes elimination (working from home or remotely, preventing access to certain areas), substitution (changing a practice to prevent worker risk), engineering controls (barriers, thermometers, and sanitizers), administrative controls (written procedures and protocols), and lastly, the use of personal protective equipment (everyone should be wearing a mask, gloves when needed, and hand sanitizer or wash stations should be readily available).

Stormwater permitting requirements and standard provisions are mostly still intact and required.

Most permit managers can handle operating and controlling their own facilities or permit conditions. Where it gets more difficult is when contractors or subcontractors, shipping, and waste handling folks come on-site and have different protocols than those employed by the specific facility they are working at. Or worse, when the supply chain becomes disrupted. One of the biggest impacts on most operations has been the interruption in safety supplies needed to perform the job. Most facilities make do, but the message has been loud and clear—future supply management and planning is needed to ensure operations can continue unimpeded, with adequate safety supplies to do the job.

We all recognize that activities and accidents that generate pollution can happen. The biggest challenge that facility and permit managers will face will be to ensure they have staff available to do the job; with COVID-19 still looming, the safety of all staff is the main concern. With municipal budgets and supply chains in the still yet-to-be-determined phase, planning and adaptation will be the skills most needed to ensure operations continue and permit compliance is maintained. However, as previously mentioned, there is one thing we can all count on: it will rain again. When stormwater runs off, it has the potential to carry pollutants downstream—and those will still need to be managed.

David Renfrew is a vice president, Water Resources at NV5 Inc. NV5, a national engineering firm, has experts who have been working with industries and regulated water entities to maintain compliance and mitigate risk from COVID-19.

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PFAS in Surface Water

The state of the practice

BY BRANDON STEETS, ADAM QUESTAD, JENNIFER ARBLASTER, AND RULA DEEB

Stormwater has recently gained increasing attention as a potential migration pathway for perfluorooctanoic acids (PFAS). For example, stormwater has been shown to wash off and transport Aqueous Film Forming Foam (AFFF), PFAS from other PFAS sources, and/or impacted surface soils to surface water bodies at PFAS-impacted sites. In instances where these stormwater discharges are covered under National Pollutant Discharge Elimination System (NPDES) permits, receiving water limits often require discharges not cause or contribute to water quality standards (WQS) exceedances. However, the applicable WQS depend on the receiving water type (e.g., marine versus freshwater) and beneficial use (e.g., municipal supply versus aquatic life). In most US states, formal, enforceable WQS have not yet been developed for PFAS.

Several states have been active in developing drinking water notification, advisory, or reporting levels for PFAS, and some states have also developed fish consumption advisory levels. However, few enforceable WQS have been established, especially for aquatic life and human health (consumption of organisms). In California, environmental screening levels from the San Francisco region have been developed recently and have the potential to be referenced by other regions for setting cleanup levels for soil, groundwater, and, potentially, surface waters discharges as well. WQS and screening levels differ in that WQS must go through a public comment process and are typically the basis of NPDES water quality-based effluent limits.

As of May 2020, the State Water Resources Control Board (SWRCB) in California has issued investigative orders to various types of facilities with high potential for PFAS presence (i.e., "high risk"), including landfills, airports, and chrome platers. The orders to chrome platers were the first in the state to include stormwater and aerial deposition sampling. Geosyntec Consultants also recently supported the SWRCB on the development of statewide guidance for stormwater dry wells, which included a literature review on PFAS in stormwater and an assessment of risks to groundwater contamination from stormwater infiltration through dry wells. Based on this guidance, it is expected that the SWRCB will require "high risk" facilities with potential PFAS sources to coordinate with regional water boards and potentially sample stormwater for PFAS prior to installing new dry wells.

Lessons learned from ongoing Geosyntec stormwater PFAS treatment projects and research provide key takeaways:

Anticipated WQS Magnitudes: Ecological risk-based thresholds for aquatic life protection are increasingly being reported, such as through recent research for the Department of Defense (DoD). These aquatic life values are higher than many state's drinking water thresholds. This is not likely to be true of human health thresholds for consumption of organisms, therefore future WQS applicable to non-municipal supply receiving waters (both surface and groundwaters) may not be less stringent than drinking water standards.

Abundance of PFAS in Urban Stormwater: Perfluorooctanoic acid (PFOA)/PFOS are typically detected in urban stormwater runoff, with residential runoff unlikely to exceed EPA drinking water thresholds, but with the potential to exceed California's notification levels, and commercial/industrial runoff likely to exceed both EPA and California levels. Therefore, there is potential for stormwater discharges to present a risk of WQS exceedance, particularly to receiving waters with minimal dilution (e.g., ephemeral drainages).

Stormwater Treatment Selection and Performance: Despite a lack of performance data for conventional structural Best Management Practices (BMPs) for PFAS, based on the physiochemical properties of PFAS, these BMPs are expected to have limited effectiveness. An exception may be if the BMP includes effective pretreatment, carbon media amendment (with frequent maintenance), and outlet control (for increased contact time).

- At PFAS cleanup sites where stormwater remediation is required, active treatment systems are often needed. These systems are powered, provide equalization storage, robust pretreatment (e.g., chemical-flocculant addition or microfiltration), granular activated carbon (GAC), and/or ion exchange.
- Because of the range of organic-carbon partitioning coefficient (K_{oc}) values of different PFAS (e.g., PFOS has medium-high Koc and PFOA has low K_{oc}), the average fractions of PFAS that are attached to suspended solids—and are therefore more controllable via erosion/sediment control and conventional natural treatment BMPs such as those found in most municipal stormwater BMP design manuals—are highly variable. As a result, treatment efficacy will vary by PFAS. For low K_{oc} PFAS (like PFOA), erosion/sediment control and conventional natural treatment control BMPs are expected to have marginal effectiveness and infiltration BMPs could present a risk for ground water contamination (due to their mobility through the vadose zone). Therefore, active treatment systems, such as GAC-based systems, may be preferred. However, the low capture efficiency and rapid break through could translate to a high replacement frequency and high O&M cost that should be factored in during treatment option comparison.

- Research on conventional stormwater treatment controls is ongoing and needed. For example, Geosyntec is collaborating with Texas Tech University and Stanford researchers on stormwater treatment BMP performance testing for the DoD for various less-studied pollutants including PFAS, with an emphasis on reducing risk of recontaminating sediment cleanup sites. More such studies are needed, and the data should be made public through inventories like the International Stormwater BMP Database (*www.bmpdatabase.org*).
- More performance data are needed on the effectiveness of source controls—such as roof coating, pavement resurfacing, and surface soil stabilization—as a means of controlling legacy PFAS residues that reside on surfaces and soils.

Much of this material is taken from Geosyntec presentations on PFAS in Stormwater at the 2019 California Stormwater Quality Association (CASQA) Conference and a 2020 California Groundwater Resources Association (GRA) webinar series on PFAS. These presentations can be made available to our professional colleagues upon request.

***Brandon Steets**, **Adam Questad**, **Jennifer Arblaster**, and **Dr. Rula Deeb** are with Geosyntic Consultants. **Steets** is a senior principal engineer specializing in NPDES and TMDL regulations, pollutant source investigation, water quality modeling and monitoring, stormwater BMP planning and design, and Clean Water Act litigation. **Questad** is a senior engineer specializing in stormwater regulations and treatment, watershed management and planning, and industrial stormwater permitting and litigation. **Arblaster** is a project scientist with experience in bioaccumulation modeling, ecological and human health risk assessment, sediment site characterization, and evaluation of environmental quality criteria. **Dr. Deeb** is a senior principal with experience focused on private practice and academia addressing the cross-media fate and transport of emerging contaminants including PFAS and the remediation of complex soil and groundwater sites.*

Steep Slope? No Problem!

Pre-vegetated blanket helps stabilize 70-degree slope at the end of a watershed

BY CARLY CARIS

All photos: GreenLine Synergy

Any landscape designer will tell you steep slopes can present some interesting challenges. Robert Livingston of Creative Edge Landscapes was contracted for a shoreline restoration and landscape design project along Lake Wisconsin in Merrimac, Sauk County, WI. The slope? Plunging 70-degrees to the shoreline. Not only that, but the site was also located at the end of the Lake Wisconsin watershed, which meant the site was susceptible to erosion issues. His goal was to create a natural patio/firepit area surrounded by plantings with a more permanent way to access the water while maintaining drainage patterns and securing the site from erosion. All of this was done with a three-person crew within three weeks.

The Lake Wisconsin watershed region is located mostly in Sauk and Columbia counties with the southernmost tip extending into Dane County in south-central Wisconsin. It consists of three municipalities—Poynette, Lodi, and Merrimac. It is a beautiful area that is well known for its sport fishery, extensive recreation, and scenic winding roads. The population growth in the area is high, as it is located just north of Madison. Lake Wisconsin is a major feature and covers 6.5% of the watershed's area (WDNR, *Lake Wisconsin*).

This project was at the client's vacation home in Merrimac. They were interested in a space that would provide for outdoor seating featuring a firepit overlooking the lake and new stairs leading down to boats docked along the shore. The existing wooden stairs had been compromised by excessive erosion and the existing shoreline protection was inadequate. Like many shorelines, concrete and other debris had been dumped along the shore to prevent wave erosion and protect it from ice pressure, but the lake had pulled much of it out from the bank over the years. The client desired something that would be easy to maintain, hold up to the pressure of erosive energy such as stormwater runoff, wind, and waves while being attractive. The slope was barely being held in place by a few mature trees and some sparse, low-quality vegetation comprised of invasive species like crown vetch, black locust, and poison ivy.

Pre-construction, the lake-side slope was overrun with invasive species.

The soil was comprised of a brown sandy loam with many intermittent rocks. Sandy loam soil is normally made up of sand along with varying amounts of silt and clay. Loamy soil is ideal for most garden plants, at least in a flat area, because it holds plenty of moisture

The slope being cleared and prepared for construction

but also drains well so sufficient amounts of air can reach the roots (Lerner, 2017). However, the steep slope and presence of rocks made the hillside unstable, with the added complication of drying out quickly.

"I knew that the slope would present several challenges. Every time I took a step the soil would move under my feet making it extremely difficult to walk up and down the hill. I felt like I was constantly going to fall. I needed a plan that would not only address erosion but also provide a sturdy base for plantings to become established," says Livingston. "I wanted to create an aesthetic that suited the natural beauty of the site's surroundings. The hardest part would be striking a balance between sustainability and practicality."

Effective erosion control involves minimizing the duration of soil exposure to erosive conditions. Using multiple best management practices, protection can occur on many levels. Livingston proposed two options to the client, along with the pros, cons, and cost of each. The options consisted of using a product called a pre-vegetated blanket instead of traditional native seeding options or using turf sod. Whichever method was used to restore vegetation to the site, boulder cropping, retaining walls, mulch, and supplemental shore protection would be required to provide enough support for the plants to become established.

After reviewing the options, the client chose to go with the pre-vegetated blanket because even though pre-vegetated blanket is more costly than the alternatives, it rendered the most benefits and chances for success. It can take up to five years for native plants to establish from seed. Intense maintenance is often needed in those first years and many seeded projects wash out in the early stages when the site is most vulnerable to erosion. While turf sod provides instant results aesthetically, it does not have a deep root system, which would comprise the longevity of the project in this application. A pre-vegetated

The immediate post-construction slope with the pre-vegetated blankets, boulders, and native plants

Vegetation developing on the slope after construction

blanket, on the other hand, utilizes a coir fiber erosion control mat that has proven effective on slopes of this caliber, provides instant results, and is less likely to be washed out even immediately after installation (WDNR, *Wisconsin Construction*).

Pre-vegetated blankets use customized native seed mixes, providing flexibility for its use on any site. Native plants offer the most sustainable habitat for a given site as they have formed symbiotic relationships with native wildlife over thousands of years. Native plants thrive in the soils, moisture, and weather of their native region (NWF, *Native Plants*). This generally means they need less maintenance as they require less watering and use of pesticides.

"Herbaceous native plants, whether by themselves or within pre-vegetated blankets, improve soil stabilization because they have extensive root systems that can grow up to 16 feet in depth depending on the species," says Livingston. "They also have larger root mass when compared to trees and shrubs or even their ornamental counterparts. This gives them the advantage of improving the soil conditions they are growing in, which makes them ideal for planting tough sites and increasing infiltration rates in areas prone to holding water or overly compacted. Letting nature do the work is the most sustainable thing I can do as a landscaper."

GreenLine Synergy

The finished zero-edge view firepit patio overlooking Lake Wisconsin.

The project kicked off with site preparation and demolition. This entailed cutting and chemically treating the existing vegetation on the slope, pulling concrete chunks and cinder blocks out of the shoreline, and separating existing rock for use later. Silt fence was also put in place for extra temporary erosion control during construction. Restoration of the site began at the shoreline by supplementing existing stone salvaged from the demolition with 43 tons of fractured mica per the Wisconsin Department of Natural Resources standards. This stone was placed on top of a fabric underlayment that is used to prevent soil movement through the stone application. Once the bank was secured from collapse, manufactured step units were used to create a more permanent way to access the water and reduce future structure maintenance. As the staircase was constructed, 12- to 36-inch granite boulders were used to retain the slope on each side of the staircase and at the top of the slope where a fire pit patio created a zero-edge view of Lake Wisconsin set under the canopy of large existing trees. An additional short retaining wall was used in place of boulders to support the edge of the patio.

The slope was barely held in place by a few mature trees and some sparse, low-quality vegetation comprised of invasive species.

Even with the staircase and boulders creating an easier way to get up and down the 70-degree slope, installation of the pre-vegetated blanket would pose an even greater challenge as the 4-foot, 1-inch by 7-foot, 11-inch sheets had to be carried across the slope to their final destination, overlapping to prevent scour and avoiding damaging blanket that had already been set. "It is definitely a balancing act on that steep of a slope with nothing to hang on to," says Livingston, who adds jokingly, "I almost felt like I was in the circus."

A total of 610 square feet of pre-vegetated blanket was installed on the slope. "GreenLine Synergy's pre-vegetated blanket allowed us to continuously cover this steep slope with native plants to not only help with erosion and stabilization but also to provide a simplistic look with a pop of color in a natural area that had previously been overrun with messy looking invasive plants. Pre-vegetated blanket quickly stabilizes the steep slope because its basal root systems are already actively growing and take root quickly into the soil much like turf sod. Nature, in that way, is pretty amazing," adds Livingston. The seed mix used for the pre-vegetated blanket consisted of 50% black-eyed Susan, 25% little bluestem, and 25% prairie dropseed.

Once the blanket was in place, natives in containers were used in an ornamental way to complete the project. Planting started at the shore with 60 blue flag iris' installed amongst the riprap near the waterline along the length of the shore. Planting continued up the slope along either side of the stairs to a band along the top of the slope. Plantings consisted of 24 junegrass, 36 wild geraniums, 96 stout blue-eyed grass, 24 wild lupine, and 36 butterfly weeds planted every 18 inches on center. Natives used in an ornamental way not only secure slopes with their deep root systems but achieve a more controlled look with swatches of color.

The results were stunning. "Not only were we able to stabilize the slope, but we also made it visually appealing. Just as the client can enjoy a much more balanced, natural look while looking out over the lake, boaters on the lake can enjoy it as well. Native plants attract local wildlife adding another level of interest to the site. An added bonus!" says Livingston. However, Mother Nature would offer the true test.

Not even a week after the project was complete, there were multiple, substantial rain events averaging 2 inches or more every few days for the next month. Runoff pummeled the stairs, scouring out the sides of the step units and boulders as the ornamental style planting had not been given enough time to form a root matrix; however, only minimal repair work needed to be done to restore the project.

"I had a gut feeling Mother Nature walloped the area and I was concerned about the site. On my drive to the project site, I was bracing myself for the worst possible scenario. I was almost pleasantly surprised that there was minimal damage, considering the sheer amount of rain we had received and only a small amount of over-seeding had to be done," says Livingston. "The basal root structures in the pre-vegetated blanket had already taken hold on the slope, so that saved us in the end. If the client would have gone with the seeding or sod option, the result would have been catastrophic."

Looking back on the project Livingston says, "If I had to do it over, I'm not sure I would change anything. Well, except maybe the amount of rain we got. The pre-vegetated blanket already has an established root system when installed, allowing it to take hold quickly. Letting nature do what it's intended to do is the best option possible. You learn quickly in this business that Mother Nature always has the upper hand. You just have to learn how to work with her and not against her."

Carly Caris *writes on behalf of GreenLine Synergy LLC. She holds a Bachelor of Communication from Clarke University in Iowa.*

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Caring for Coral

Monitoring, analyzing, and sharing urban runoff data is the first step to reducing environmental impacts on the Great Barrier Reef BY NICOLE NALLY

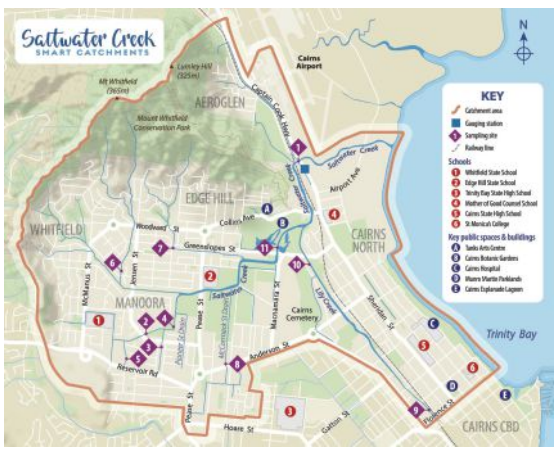
Australia's Great Barrier Reef is the world's largest coral reef system supporting a wide diversity of life. It is a World Heritage Site, has been named one of the seven natural wonders of the underwater world, and contributes $6.5 billion a year to the Queensland economy. To build resilience against the impacts felt on the reef due to climate changes, coastal communities are finding ways to improve water quality by reducing and removing pollutants that enter waterways before discharging into the Great Barrier Reef Lagoon.

Saltwater Creek catchment is north of Cairns Central Business District and is an urban catchment primarily consisting of residential and commercial estates and public open space. Cairns Regional Council (CRC) manages stormwater in the catchment primarily using concrete drains which stretch across the suburbs before discharging through Saltwater Creek, south of the Barron River. CRC recently undertook a Smart Cities project to help improve the knowledge of water quality impacts from Saltwater Creek on the GBR lagoon. The long-term objective is to improve urban water quality.

The catchment is in a low-lying area of Cairns, the creek is estuarine well into the catchment and it is subject to flooding during storm events on high tide. Intense rainfall events result in significant runoff from the suburbs. Furthermore, like most water utilities, CRC gets infiltration into its sewer network during intense rainfall events in the wet season, emergency wet weather overflows at pump stations relieve pressure on the sewer network. Discharge from emergency wet weather overflows is used to prevent surcharge into residential dwellings.

Dr. Lynne Powell, strategic policy and compliance coordinator for Cairns Regional Council, says, "During storm events, we have multiple factors that can impact water quality discharge so our goal for this project was to investigate the contributing factors to water quality during these events, so we can influence the outcome for the better."

If you can't measure it, you can't manage it, so CRC collaborated with James Cook University and other partners to commission a network of environmental sensors in Saltwater Creek to obtain real-time water quality and flow data. The monitoring sites include a permanent gauging station with sensors for nitrate, pH, temperature, conductivity, dissolved oxygen, and chlorophyll-a. Grab samples are also collected throughout the catchment and analyzed at CRCs laboratory, with data being stored in the Laboratory Information Systems.



The map shows the sampling sites and gauging stations within the Saltwater Creek catchment

All photos: Cairns Regional Council

The Saltwater Creek live-data dashboard on Cairns Regional Council's website allows members of the public to see a variety of water quality metrics.

In a short time, there was a lot of data accumulating from the gauging station at 30-minute intervals. All this data needed to be managed. "We looked for a robust analytics program to turn the data into actionable intelligence and help us plan and improve stormwater infrastructure and water treatment processes, and in so doing, ensure our urban water run-off was not harming marine life," says Powell.

CRC selected Aquarius to deliver water quality data in real-time and, in turn, inform better water management processes by sending alerts to internal stakeholders when indicators (like pH, dissolved oxygen, chlorophyll-*a*, or nitrates) reach a setpoint. "By establishing baseline indicators, we are able to measure the efficiency and effectiveness of the environmental programs to be developed and set benchmarks for better managing, not only our own catchment but also other urban and rural catchments along the Great Barrier Reef," says Powell.

The software manages Salt-


The Cairns water team

water Creek's telemetered and grab-sampled data, transforming this data into information that is shared through a publicly accessible website that is easy for the community to understand through a user-friendly interface. Data is automatically uploaded into the system with minimal manual intervention, so operators can have greater confidence in data integrity.The entire system is run in the Aquarius Cloud which provides CRC with the assurance of high up-time and relieves the burden on internal IT. The ease of providing publicly accessible data through a web portal, building customized dashboards and the flexible data analytics built into Aquatic Informatics are some of the advantages of this data management platform.

Residents are encouraged to visit the web portal (see "Resources") to learn more about the water quality of their local catchment and identify how they can avoid and reduce pollutants that are entering the waterways. The system goes further than simply informing council staff and the general public, it also alerts users to critical events and provides advice to take appropriate actions to encourage and support sustainable, healthy waterways.

By having the data visible, and sharing insights with stakeholders and citizens through their online portal, CRC is committed to involving their entire community as part of the solution. Through the Wet Tropics Waterways Partnership, CRC has collaborated with other industries, including the agricultural industry to improve water quality monitoring tools. Wet Tropics Waterways is a collection of 50 organizations that work together to advocate for improving the health of waterways in Queensland. They generate an annual Wet Tropics Report Card that tracks trends in catchment conditions and the health of estuaries, freshwater, and marine environments. This report contributes to Reef 2050, a long-term sustainability plan for protecting the Great Barrier Reef. The findings from the 2017 report card were used to help CRC formulate the scope of this project.

CRC is also working with schools to educate students and the wider community on what is being done to improve stormwater quality management, and how they can play their part in protecting the Great Barrier Reef lagoon. In addition, CRC is sharing the interpreted data with James Cook University for the development of IoT tools.

Aquarius gives CRC flexible, functional tools to make evidence-based decisions using automated up-to-date environmental data like nutrients, sediments, and flow to determine water quality. By monitoring surface water quality and hydrology at sampling sites, CRC can calibrate stormwater quality modeling and hydrological flood modeling. The project started in early 2018 and was fully operational, with gauging stations sending near real-time data to the platform for analysis and interpretation, by early June 2019. The web portal was also up and running for all stakeholders to access at that time.

"Good water quality is important for sustaining the health of our aquatic communities, the wellbeing of our community, and has an important economic value in the Cairns region. When everyone can see and make sense of the data—we can all be part of the solution," concludes Powell.

Nicole Nally *is the Oceana regional manager for Aquatic Informatics. Nally has over 15 years of experience in the Australian water sector working in resource management, design, and sustainability. She holds a Bachelor of Engineering from Sydney University and a Masters in Business Administration from La Trobe University, Melbourne.*

Resources

Cairns Regional Council.
"Live data – Saltwater Creek." www.cairns.qld.gov.au/water-waste roads/water/smartcatchments/live-data-saltwater-creek2.

Designed Drainage

Custom stormwater infrastructure alleviates flooding in Florida

BY BOB SIMONE

In August of 2019, the Cypress Street Outfall project broke ground near downtown Tampa, FL after nearly three years of planning, measuring, calculating, and negotiating—which is the nature of this type of job. The Design-Build project, composed of Woodruff & Sons Inc. and Tetra Tech, collaborated with Oldcastle Infrastructure to design a series of custom infrastructure solutions, with the goal to create drainage relief in a neighborhood where it previously did not exist. Historically, this area floods several times per year and up to 3 feet of water sits in the street with nowhere to run off, in addition to disrupting local businesses and residents, this is both dangerous and unsanitary.

This project elevates the neighborhood up to 2020 standards and provides the locals with fresh, cityscape streets that will ease and promote pedestrian travel for many years to come. Oldcastle Infrastructure expected a few challenges to be thrown in the mix, especially during a project of this scale. A manufacturer's job is to be nimble, prepare for the unexpected, and evolve to stay on track with timelines. One thing that simply could not have been anticipated was the impact of the novel coronavirus and the global COVID-19 pandemic we are all currently experiencing.

Fortunately, the impact of the pandemic on the Cypress Street Outfall project has not affected timelines as severely as it could have. COVID-19 has proven to be a moving target and it has been difficult for all industries to adapt. With construction and infrastructure considered essential, those involved in this project had to take precautions in every way possible to protect employees and contractors and stay on schedule. Woodruff & Sons Inc. has a strong crew manning the project onsite, and during this time of uncertainty, their expertise and determination have shone through. Despite the unexpected challenge of the pandemic, they have made sure the project doesn't fall behind on deadlines and showed a commitment to the city while striking a balance of still prioritizing the health and safety of the team.

Installation of Oldcastle's custom stormwater infrastructure

All photos: Oldcastle Infrastructure

Project Materials and Progress

Prior to breaking ground in August 2019, the custom framework Oldcastle Infrastructure created was well underway for a few years. Structures for this project consist of a variety of custom precast catch basins and curb/throat inlets, dual vortex separators, filtration structures, box culverts, area drains, and reinforced concrete pipes to name a few. Precast curb inlet tops are also being utilized for the first time in the city of Tampa. These specially designed inlets will be responsible for directing stormwater from the curb-line of the road into the underground box culverts, which then empty nearby into the Hillsborough River.

The process of mapping out the groundwork is known for being tedious and lengthy. With each drainage system, the team must consider the size and makeup of the underground structure, as well as the connection to the water management portion of the individual project. With dozens of structures in a single

The Cypress Street Outfall project during construction.

project, this part of the project is not simple. A while ago, the City of Tampa installed a box culvert from the Hillsborough River to provide future flooding relief, with the goal to one day connect it to an updated water drainage system. That box culvert is the cornerstone of this project: all of Oldcastle's solutions were created to reach it in the most efficient way possible while resolving numerous issues at the same time. The custom culverts

Historically, the area of the Cypress Street Outfall project has flooded several times per year, with up to 3 feet of water sitting in the street with nowhere to run off.

were decided on in order to facilitate design by the engineers of record that would carry heavy rainfall water into the culvert and away from the previously flooding neighborhood. The previous system is outdated, and with these new culverts, it will allow the drainage system to empty into the nearby Hillsborough River.

Once submissions were attentively reviewed by the City of Tampa and Tetra Tech (the engineer of record) to be sure no additional changes were needed, production began. The structures were created over the course of several months and stored in climate-controlled spaces to ensure quality and stability.

For the past eight months, since breaking ground, Woodruff & Sons has staffed the project with a crew of about 20 employees, consisting of road crews, pipe crews, and supervisors, and they have been hard at work assembling and installing this utility storm drainage project. Categorized loosely as a complete gut job, the project itself is enticing to work on because of the nature of an urban project in an old-fashioned neighborhood. The streets are over 100 years old and the accessibility of the area is limited. Along with the installation of the precast filtration

Oldcastle supplied over 7,300 feet of box culvert pieces in a range of sizes.

structures, box culverts, area drains, and other complex pieces of the puzzle, Woodruff & Sons is also updating the neighborhood with wheelchair accessible sidewalks and ramps, bike lanes, and other pedestrian-friendly features.

This design-build project is providing the residents and business owners with not only a more accessible community to live, work, and play in, but a safer environment for when the inevitable Florida rainfall passes through. At the heart of each project is public safety; understanding that flooding is a serious danger to communities, these infrastructure products will provide locals with a new level of comfort and reassurance.

The Cypress Street Outfall project is jointly funded by the City of Tampa and

The project is an interesting urban installation in an old neighborhood. The streets are over 100 years old and the accessibility of the area is limited.

by the Southwest Florida Water Management District (SWFWMD), ensuring that the end result will yield better drainage and pretreatment management in the underground waterways. A benefit to all, this will contribute to a healthier environment and a cleaner Tampa Bay area.

Looking Ahead

A slow-moving style project by nature, the Cypress Street Outfall project has proven to be an excellent example of a city, engineering firm, manufacturer, and construction crew working together seamlessly toward a common goal. Soon, Oldcastle will be supplying a first for the City of Tampa's stormwater system: a custom-made top section for the city-style curb inlets, that has never been done before in the history of the city. The effort for this precast piece was made possible with very close work by all involved—Woodruff & Sons, City of Tampa Engineering, and the Oldcastle Infrastructure sales, engineering, and production teams. It is custom-designed, tailored, formed, and above all, meets the City of Tampa specifications. The piece will not only add a unique look to the road and sidewalk city landscape, but it will also provide the City of Tampa with the benefits of a high-quality precast piece providing many years of service to their stormwater system.

A true example of teamwork from all involved, this design-build project is built for life, solving the problems of today and transforming the community for tomorrow.

Bob Simone *is a precast sales executive for Oldcastle Infrastructure. Simone has been in the industry for over 28 years and specializes in custom stormwater solutions to combat flooding in American cities.*

ADVERTISER'S INDEX

SHOWCASE

JENSEN PRECAST

Jensen Precast's StormVault Biofiltration System with engineered Sierra Blend bio soil media has been tested and verified by the New Jersey Corporation for Advanced Technology (NJCAT) as a Stormwater Manufactured Treatment Device for Green Infrastructure. The StormVault Biofiltration System is a nonmechanical, self-operating unit that will function anytime there is flow within the drainage system. The bridging stone, Sierra Blend bio soil media, and plant stabilization media are arranged in layers within the chamber, with stormwater flowing downward through the layers.

www.jensenprecast.com/water-resources/stormwater

FECON

Fecon introduces the Bull Hog Mulcher Head, which operates with standard hydraulic flow. It is ideal for most standard skid steers, some smaller articulated wheel loaders, and other carriers with adequate hydraulic flow, enclosed cabs that can be properly protected with polycarbonate guarding, and the ability to lift the 1300-pound attachment. The new mulcher head features 22 knife or carbide-type cutting tools and has a 50-inch working width and can shred brush and small trees up to 4-inches in diameter.

www.fecon.com

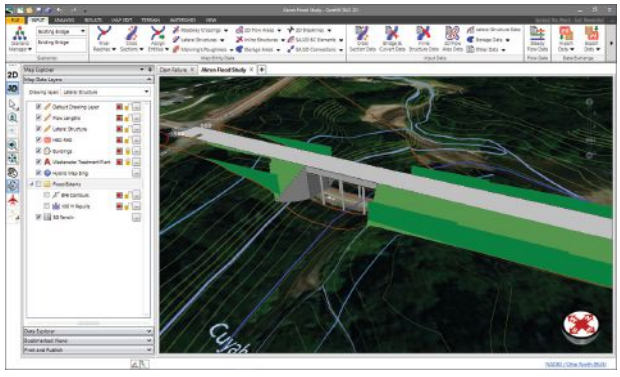
STORMWATERX

In partnership with Frog Creek Partners, StormwaterRX announces the availability of the new Frontline family of drain inlet inserts. Frontline is available in two common industrial configurations, the Frontline CBI (Catch Basin Insert) and the Frontline TDI (Trench Drain Insert), both of which offer simple installation, operation, and high performance. Frontline is easy to install—just insert the frame and pollutant filtration devices into your existing storm drain inlet. Its super-duty, stainless-steel construction is designed for years of rugged industrial use.

www.stormwaterx.com

CIVILGEO

CivilGEO's GeoHECRAS Version 3.0 utilizes an improved and easier to operate FlexNet software licensing technology from Flexera Software. GeoHECRAS is an AutoCAD, Bentley MicroStation, and ESRI ArcGIS compatible interactive 2D/3D graphical user interface data wrapper to US Army Corps of Engineer's HEC-RAS software. It computes water surface profiles for steady and unsteady flow conditions, analyzes and designs bridge and culvert roadway crossings, generates floodplain and flood hazard maps, performs river and stream restorations and realignments, computes flood inundation maps for possible dam and levee failures, and more.



www.civilgeo.com

LG SONIC

LG Sonic's new water quality Monitoring Buoy system allows users to monitor water quality at low cost before deciding upon the best path for water treatment. The system continuously monitors water quality in real-time and delivers data on Chlorophyll a, Phycocyanin, pH, Turbidity, Dissolved Oxygen, and Temperature via radio, GPRS, or 3G to web-based software. Solar panels provide power all year round and a wiper mechanism automatically cleans the sensor, keeping maintenance to a minimum.

www.lgsonic.com

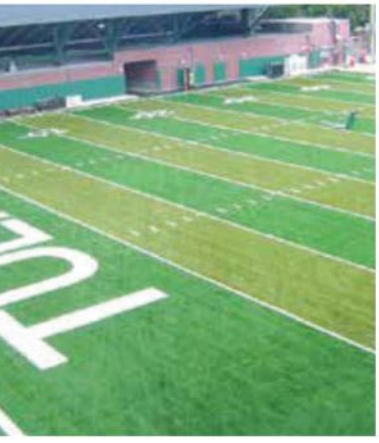
GRUNDFOS

Grundfos SL wastewater pumps were designed for raw water intake, commercial wastewater, municipal wastewater, industrial wastewater, process water, and stormwater runoff applications. Innovative technologies bring together intelligence, motors, hydraulics, and functionality to meet the challenges of modern wastewater—maximizing the hydraulic, electrical, and mechanical efficiency of your pumps. The solids-handling SL pump series ranges from 1.5 to 15 horsepower and is available with either the SLV/SuperVortex Impeller or the SL1/S-Tube Impeller.

www.grundfos.com

RAINSTORE3
BY INVISIBLE STRUCTURES™

Underground Water Storage System



Stormwater Solutions

Rainstore3 is a modular, stackable structure used to manage stormwater. Made from 100% Recycled Plastic, Rainstore3 exceeds H-20 loading, has 94% void space and does not require any gravel fill.

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