Keeping New Orleans Dry

16 June 2024

by Frank Vicidomina, PE, CVS

Since Hurricane Katrina, the New Orleans Area has been very lucky …. But we don't have to rely on luck to keep dry in the future

New Orleans hasn't had a major flood event since Katrina. Others, not too far away, have not been so lucky. A big hurricane and/or rainfall that will once again exceed our flood protection capability looms.

Significant levee and drainage improvements have only been implemented ***after*** major flood events (Mississippi River Flood of 1927, Hurricanes Betsy and Katrina, and rainfalls of May 3rd, 1979, and May 8th, 1995). There still, however, exists the potential for major flooding. Should we wait for the next big flood to make improvements? Or can we make necessary changes ***before*** we get flooded again? The latter will be a big and expensive undertaking but, with some innovation, is both possible and feasible.

We can learn from others here in the United States and the rest of the world on what can work to address flooding issues. Such measures are considered below in discussing the status and potential innovative and standard improvements to our flood protection systems. The East Bank of Jefferson and Orleans Parishes (not including New Orleans East) are specifically addressed below but note that the proposed measures may be utilized throughout the metro area as appropriate.

River floods, and hurricane storm surges and winds

The news here is actually pretty good. In response to the 1927 Mississippi River flood, the US Army Corps of Engineers (Corps) was authorized to build a flood control system from Minnesota to the Gulf of Mexico. Levees and floodwalls on the Mississippi River have been constructed and can contain what is called the 'Project Maximum Flood (PMF)' in densely populated areas, including New Orleans. The PMF is an event even greater than a 500-year flood. Levees and floodwalls on the river were built to very high standards, are well maintained, and have been put to the test several times over the years. With the inclusion of the Bonne Carre and Morganza Spillways, flooding from the Mississippi River, while still possible, has very little probability.

Similarly, the Corps has recently constructed $15 billion of hurricane risk reduction projects via post Katrina authorization and funding. Given failures of the past system in Katrina, this upgrade was built to higher standards and was closely scrutinized. Hurricane protection is now 100-year level certified. It has proven its performance containing high surge levels of Hurricanes Issac and Ida. The Corps has recently completed an evaluation addressing further federal work on the metro hurricane protection system. This study has determined that it is in the federal interest for the Corps to address settlement and other factors. Work will likely be authorized to allow

the Corps to perform continuous levee and floodwall raising and strengthening such that the entire system maintains at least 100-year protection over the next 50-years. The report did state, however, that additional protection would not result in higher net benefits. So, we are in good shape with regards to direct flooding. However, in some locations in the metro area, hurricane storm surge has an impact on our current ability to pump rainfall that may be extreme during such an event (see discussion below).

Unfortunately, major hurricanes bring very high winds that result in widespread roof damage. This causes significant water damage to homes and businesses that can often be more extensive than direct flooding. The State has just recently initiated a 'Roof Reinforcement Program' where funds are available for homeowners to upgrade roofs to a level that can withstand very high winds. This program, if properly implemented, seems quite promising and its expansion could serve an important role in comprehensive hurricane protection.

Major rainfall events

Almost Every drop of rain in the New Orleans Area must be pumped out of our large 'bowl'. The system currently has many issues but nearly all stem from just two overarching reasons: 1) The fact that the system was never really planned; population spread into drained swampland without consideration of long-term needs. 2) The age of the system; 100-years plus in the City of New Orleans proper and 30 to 50-years or more in adjacent parishes. Old pumping equipment, power supply, broken pipes and damaged culverts are problems that hamper system performance.

In general, if everything is working at full capability, we can handle a 10-year rainfall event without flooding homes and businesses. This quickly changes with higher events with widespread structure flooding in many sub-basins occurring with a 100-year rainfall. This has been widely accepted as 'the best we can do' given the limited conveyance capacity of existing canals and the long-standing ***perception*** that increasing the system capacity is not feasible. (Widening and/or constructing new canals in developed areas is not considered a viable option).

Let me directly state that a drainage system for any urban population center should be capable of preventing flooding from at least a 100-year rainfall. We should not accept the status quo.

A 10-year rainfall here is plus or minus 10-inches depending on its duration. We recently had a 7-inch rainfall that flooded most streets and a few homes and businesses. Any additional rain would have certainly flooded more structures. Note some examples of recent nearby flood event 24-hour rainfall amounts: (2012) 15-inches near Opelousas, LA, (2016) 31-inches in Livingston Parish, LA, (2017) 30-inches throughout the Houston, TX Area.

Still feeling lucky?

The actual design and construction of pump stations and canal improvements throughout the last 30-40 years is of very high quality and performs well within its design parameters. Performance is constrained, however, by the conveyance capacity of existing canals, the apparent lack of redundant pumps, and in some areas the inability to pump against a high hurricane surge level.

The 100-year-old part of the City of New Orleans system has reached far beyond its useful life and needs major upgrading. Major pump stations still use the original pumps. The Sewerage and Water Board of New Orleans (S&WB) supplies much of the power for these stations via an antiquated electrical generation and transmission grid. The system currently is not performing at capacity given the overwhelming repair and replacement needs. The 'newer' 50-year-old systems in adjacent areas will also have potential reliability needs in the not-too-distant future.

The combination of a hurricane and major rainfall event

For most of the East Bank of Jefferson Parish there exists a significant pumping capability shortfall. Most of the system capacity is provided by large, 1,000 cubic feet per second flow horizontal pumps. These pumps were designed for rainfall events under normal tide conditions. They have performed well, are well maintained and will likely do their intended job in the future.

Horizontal pump output is affected by any increase in discharge head. For East Jeff, lake surge levels expected during a major hurricane will significantly diminish system capacity at a time when it will be most needed. Given the high probability of concurrent copious rainfall associated with hurricanes, this must be fixed.

It is important to note that this is ***not*** the case for most of the West Bank of Jefferson and the older section of the City of New Orleans. As part of the above-mentioned post Katrina hurricane projects, the Corps has constructed new pump stations (West Closure Complex in West Jeff and the Permanent Canal Closure Project (PCCP) in New Orleans). These stations re-pump water supplied by interior pumps and are designed to pump at or very near full capacity under 100-year hurricane surge conditions.

Elmwood Pump Station – Jefferson Parish

Proposed fixes

(For hurricane protection)

Our goals should be to maintain at least a 100-year level of levee protection and strengthen as many roofs as possible to withstand hurricane force winds. We should support Corps efforts to maintain this protection and the State's proper development and implementation of the recently initiated Roof Reinforcement Program.

(For drainage)

Our goal here should be to improve drainage in every sub-basin where needed such that a 100-year rainfall does not flood any homes and businesses. Note that this is far less stringent than upgrading the entire system to fully contain a 100-year event. Street flooding is OK but not houses.

Let's first address the City of New Orleans.

As stated above, the drainage system has surpassed its useful life and should be replaced to the extent possible. Snapshot – time of this writing, S&WB is struggling to complete the installation of a large new generator unit to provide power that existing old units cannot reliably supply. Completing installation of this unit will only buy time until one of the next major antique features fails. There is, however, an alternative already identified that will replace three of the major outfall pump stations.

The new PCCP pump stations recently constructed in the Corps' Katrina work are designed to pump flow from three existing S&WB stations when lakefront floodgates are closed for a hurricane. These stations (17th St., Orleans and London Ave Canals) have also been constructed at a sufficient depth to accept flow via gravity from the three existing S&WB pump locations. The plan, identified as 'Option 2', currently calls for the replacement of the existing outfall canal with much deeper and larger open culvert structures. The construction of these new culverts will be difficult and very expensive for reasons including, but not limited to, the need for large temporary bracing structures, roadway and other utility relocations and the continuous ability to bypass pump station discharge during construction. The cost of this work is far beyond the means of S&WB and there are currently no federal and/or state funds authorized for such a project. There is, however, a potential innovation that may greatly reduce the cost of this project and can be the key to improving drainage in the entire New Orleans Area.

Tunnels……. More specifically, 'soft-earth' tunnels.

We have looked to the Dutch for many flood control methods. They do indeed have engineered a very impressive system that we have obtained much knowledge from. The really cool stuff, however, can be found in Japan. Tokyo has an enormous and elaborate underground drainage system complete with storage, pump stations and conveyance tunnels. Like New Orleans, development in flood prone areas occurred. Surface solutions were not practical given the need to relocate many homes and structures. So, underground they went.

Their subsurface facilities dwarf those of our drainage system. As far as conveyance tunnels are concerned, we only need much smaller ones to accomplish our system improvement needs. It should be noted that tunnels are hydraulically more efficient versus open canal given their near round cross-section and pool-to-pool water pressure. This means that tunnel equivalent hydraulic size can be smaller than an open surface canal.

Harris County (Houston), Texas. Houston is a physically huge, densely populated urban landscape and like the New Orleans Area, has major drainage problems in numerous locations. They have resolved to improve the drainage system to 100-year capacity where possible. Again, like New Orleans, enlarging existing conveyance streams, bayous and man-made channels would require massive residential and commercial relocations and not be feasible.

Houston is aware of the potential of drainage tunnels. They are currently starting the third phase of a three-phase study to determine their feasibility and identify a master implementation plan. Results through Phase 2 indicate that large diameter drainage tunnels appear feasible in flood-prone areas with high-density development. It should be noted that this study is being performed under federal guidelines (alternatives analysis, environmental impact statement, etc.) with the intent of ultimately gaining federal authorization and funding for construction. Their Phase 2 report, which contains extensive design and cost information, can be found at https://www.hcfcd.org/Z-08. It should also be noted that the drainage tunnels needed for the New Orleans Area would be only a fraction of what is currently under

consideration in Harris County. We should follow their lead and 'lessons learned' and develop such a drainage plan to meet our needs.

Deep soil conditions in New Orleans are similar to that in Houston, so, can we build tunnels in our poor soil conditions? Yes. First, consider that at tunnel depth there is enough soil strength to allow boring and tunnel wall construction. There have been several soft-earth tunnels and structures constructed (San Diego Wastewater Ocean Outfall, Houston Underground, and the Washington, DC Metro). The DC Metro was built in soft soils and serves as a good example of how tunnels could be constructed here: easy boring with the construction of the tunnel structure via pre-cast panels. Not cheap, but very doable and likely a far better option versus new surface drainage canals through existing development.

As stated above, tunnels can be constructed to gravity-connect the existing main outfall pumps stations. This will allow taking the existing pump stations out of service which will provide a tremendous amount of relief for the power supply needs of S&WB. This in turn will greatly improve total system reliability over the current situation.

So how do we address the parts of the city that have chronic flooding? Tunnels and increased outfall pumping capacity. It appears that two or three moderately sized drainage tunnels can be constructed to serve low-lying locations. Their location would generally follow major streets as existing culverts and other utilities allow. Inflow to these tunnels would be limited to the problem areas only such that there would be an 'express lane' conveyance to a pump station. New tunnel flows would be pumped either by expanded PCCP stations, or additional new ones.

Given the presence of the Gentilly Ridge right across the middle of the city, and the fact that problem sub-basins exist on both sides of this ridge, these tunnels would likely have two inlets – one on each side of the ridge. Taking this water out of the existing canal/culvert system will also improve overall system performance.

For East Jefferson:

First, in my opinion, there should be a priority to upgrade pumping stations to fully perform under major hurricane conditions. To that end, additional higher-head pumps should be added to at least two of the four outfall stations. It may be possible to increase power to horizontal pumps in lieu of adding said pumps and associated structures.

As proposed above for the City of New Orleans, one or two drainage tunnels can be constructed to reduce flooding in low-lying areas. Unlike the City, East Jefferson is a fairly symmetric bowl with low-lying areas located across the middle of the basin. Tunnel inlets may be limited to just the chronically flooded zone with the possibility of the West Napoleon Canal as a flow inlet to one or two entrance shafts. As presented above, tunnel flow would be directed to and pumped by either expanded existing stations of new pump station locations. Also, per above, removing this flow from the main system will improve overall rainfall removal performance.

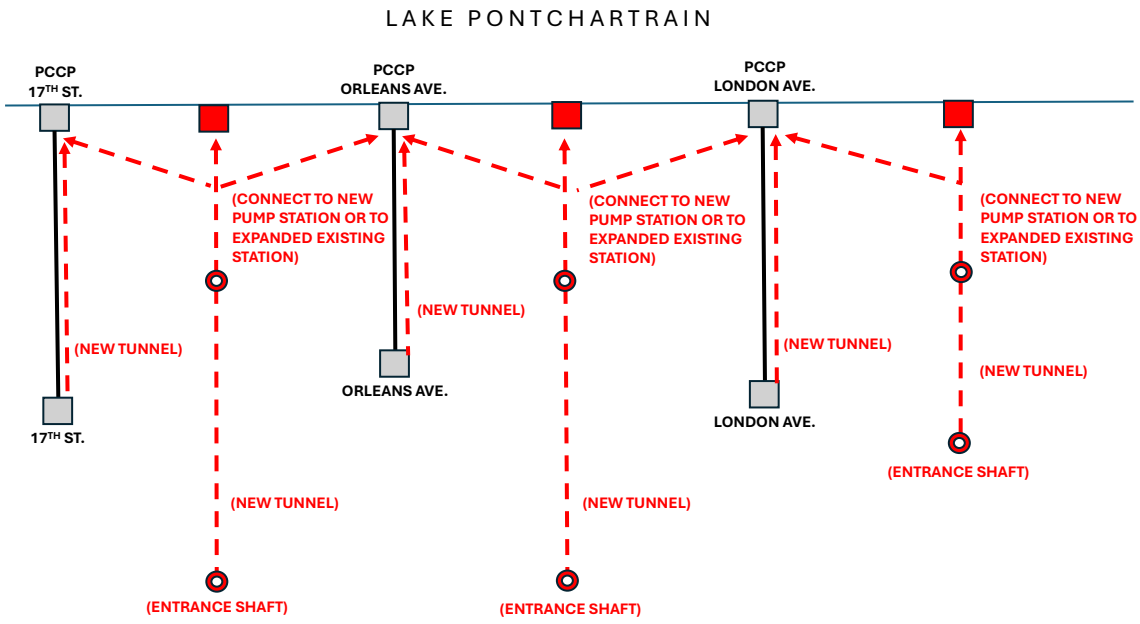
Tokyo Drainage Tunnel Under Construction

Washington DC Metro - Underground Station

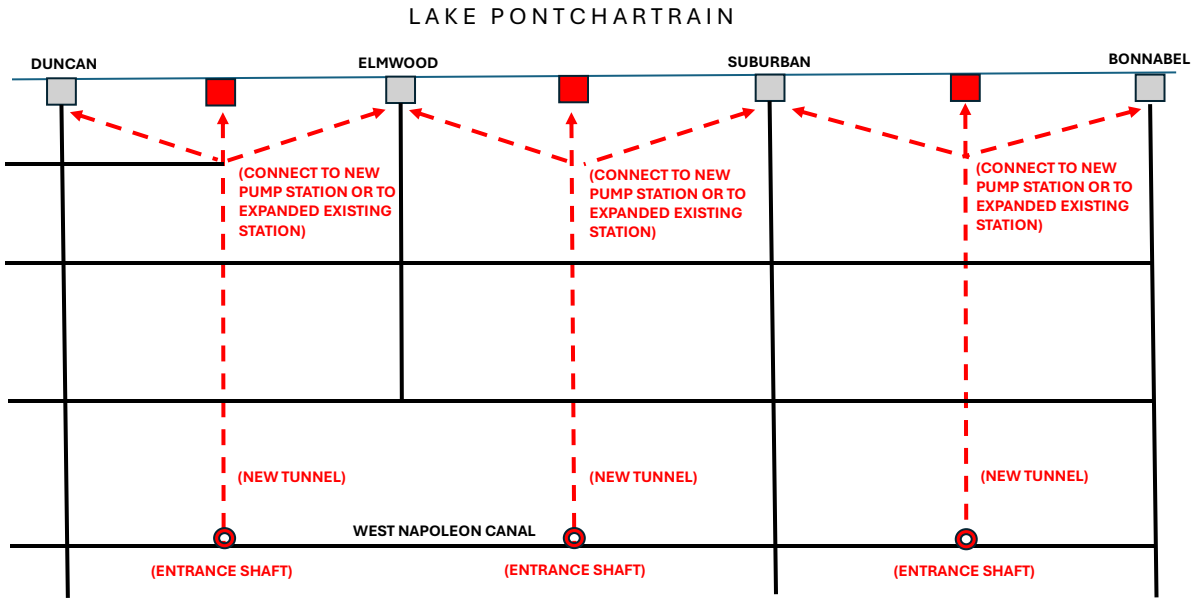
Washington DC Metro – Single Track Tunnel

Washington DC Metro – Tunnel Construction

Completed Tunnel Section with Pre-Cast Concrete Structural Panels



Schematic Plan of New Orleans Drainage System with Possible New Tunnel and Pump Station Locations



Schematic Plan of East Jefferson Drainage System with Possible New Tunnel and Pump Station Locations

Expand the use of more conventional measures

Tunnels may not be the best solution in some low-lying areas. In more recent years less radical measures have been successfully implemented. Such include, but are not limited to:

- Using greenspace as storage basins (ex., Pontiff Playground)
- Pumping from low-lying areas to nearby culverts or canals (ex., current construction of pump stations at the east end of Veterans Blvd to 17th St. Canal)
- Pump to the River (ex., East Jeff Pump to the River Pump Station and force mains)
- Adjusting street grade near culvert or canal to allow street-flow into the system (no known examples)
- House elevation and/or buyout of frequently flooded homes (ongoing FEMA program)

A specific possible example may be constructing storage compartment areas in Lafreniere Park with pumping from the West Napoleon Canal during high rainfall events. This could possibly be done in lieu of one of the above proposed conveyance tunnels.

Use of the above measures should, however, still be included to the extent practical as part of a comprehensive drainage improvement plan.

How can we implement this plan?

Will this plan cost millions? No. Billions? Yes. Tens of billions? No. This appears to be doable but still obviously well beyond our local financial means. Federal dollars will be needed.

Can the Government sponsor this drainage project? Yes. There is recent precedent of the Southeast Louisiana Flood Control Project (SELA) where federal funds were authorized and appropriated for numerous local drainage projects in response to the May 1995 flood. It should also be noted that as part of the $15 billion post Katrina Hurricane and Storm Damage Risk Reduction System Project (HSDRRS) new pump station designs were upgraded to pump near or at full capacity under 100-year hurricane storm surge conditions. Hence, the above cited East Jefferson pump station upgrades may be considered and included as part of ongoing hurricane risk reduction measures.

What needs to happen to get federal funds? The standard process for getting a project funded by the Government basically is done as follows:

- Request Congress to authorize and fund a feasibility study to identify if there is a federal interest (positive benefit-to-cost)
- If approved, the Corps conducts the feasibility study
- If the project is determined to be in the federal interest, Congress authorizes it and appropriates funds for implementation.

To get things started we must identify and commit to a master plan. Specific components of this plan can be left open for optimization (e.g., tunnels versus storage sites, etc.). Regardless of the federal funding process, we should independently develop the master plan and identify the

best means of accomplishing our goals. This can proceed to the actual design of some features such that if there is a future federal infrastructure authorization we can be shovel ready for at least some of these sub-projects.

The required planning and engineering effort for this plan will be enormous and quite challenging. Note that the cost pf planning and design is only a fraction of total project cost and we should proceed with such regardless of federal participation. Professional engineering expertise can be supplemented with university involvement. Such can perform preliminary studies on the feasibility of major plan features.

In summary we have 500-year plus protection from flooding from the river; 100-year, potentially more, hurricane surge protection but only 10-year rainfall event protection provided by our drainage system. The latter greatly reduces the effectiveness of hurricane protection as there is a high probability of rainfall exceeding 10-year frequency as part of any hurricane strike. Also, the need to fortify roofs appears necessary to complete hurricane protection. The money needed to fortify roofs and upgrade our drainage system is substantial but appears feasible and doable with state and federal assistance. So, for once in our history can we make this investment ***before*** the next big flood and not in response to it?

Frank Vicidomina is a semi-retired professional civil engineer and certified value specialist. He has over 40-years of experience in the planning, design and construct of numerous water and flood control projects. He can be contacted at FrankVicidominaLLC@Yahoo.com .