Technical Concerns That Support a Recommendation for the Re-evaluation of the Minimum Flows Recovery Strategy for the Lower Hillsborough River

Report Submitted to:

The Southwest Florida Water Management District

and

The Florida Department of Environmental Protection

By:

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EXECUTIVE SUMMARY

In the development of recovery strategies for rivers that are not meeting their minimum flows, caution should be used to avoid causing potentially adverse impacts to other natural resources. This report provides a review and analysis of the minimum flows recovery strategy for the Lower Hillsborough River. The report presents a series of recommendations for components of the recovery strategy that should be re-evaluated before construction of either the Blue Sink project or the Morris Bridge Sink project is pursued.

The minimum flows for the Lower Hillsborough River that were adopted in 2007 are 20 cubic feet per second (cfs) freshwater equivalent for the months July through March and 24 cfs freshwater equivalent for the months April through June. Four water sources in the following priority of use are identified in the recovery strategy to provide minimum flows to the lower river - Sulphur Springs, Blue Sink, the Tampa Bypass Canal and Morris Bridge Sink. The priority of use between the Tampa Bypass Canal (TBC) and Morris Bridge Sink is based on water levels in the lower pool of the TBC.

The District has been providing minimum flows from the Tampa Bypass Canal to the lower river since 2008 and modifications to the diversion facilities at Sulphur Springs were completed in the spring of 2012. Diversions from these two sources have either met or come close to meeting the adopted minimum flows for the lower river on many days since the spring of 2012.

The recovery strategy for the lower river contains a stipulation that minimum flow diversions from the TBC that are routed through the Hillsborough River Reservoir be subject to a 25% loss term before release to the lower river. A scientific review panel that reviewed the efficiency of a water transmission pipeline identified in the recovery strategy concluded that previous water loss estimates for potable water supply diversions from the TBC were large overestimates. As a result of that finding, the transmission pipeline is not going to be built. The scientific rationale presented by the review panel indicates that the 25% loss term that is applied to minimum flow diversions from the TBC is an even larger overestimate. It is therefore the conclusion of this report that the 25% loss term for minimum flow diversions from the TBC should be greatly reduced or eliminated from the recovery strategy. Eliminating the loss term would make 2.75 cfs available for meeting the minimum flows, increasing the number of days the minimum flows could be met with the existing diversion facilities.

During the time that flow to the Lower Hillsborough River has been identified as a regulatory and ecological issue of concern, there has been a dramatic increase in the amount of water supply permitted from the Hillsborough River / Tampa Bypass Canal system. As part of the renewal of the City of Tampa's water use permit for withdrawals from the reservoir/canal system in 1991, the City's maximum average annual withdrawal quantity was increased from 62 to 82 million gallons per day (mgd). The 1991 permit renewal also required a extensive study of the freshwater flow relationships of the Lower Hillsborough River and the tidal reach of the Tampa Bypass Canal.

In 1999, a water use permit was issued to Tampa Bay Water to also withdraw water from the Hillsborough Reservoir / Tampa Bypass Canal system. As part of a modification of that permit in 2007, the withdrawal rate from the TBC was changed from 80 percent to 100 percent of the flow at structure S160 on the TBC. In addition, a condition that withdrawals be restricted to flows above 11 cfs was removed so that withdrawals by Tampa Bay Water can continue when flows at S160 reach zero cfs. The maximum annual average withdrawal quantity currently permitted to Tampa Bay Water from the reservoir/canal system is 85 mgd.

Corresponding to these increases in permitted water use, the combined actual water use from the reservoir/canal system has increased from an average rate of 62.1 mgd for the period 1991 to 2001 to an average rate of 104.9 mgd for the years 2003 - 2012. The water use permits for both the City of Tampa and Tampa Bay Water include special conditions that deal with the potential effects of reduced flows to the Lower Hillsborough River and specify that these permits may be subject to modification to address minimum flows.

Given the large increases in permitted water use from the reservoir/canal system and regulatory conditions of that use, it is the conclusion of this report that the Tampa Bypass Canal should be the second source in priority for meeting the minimum flows for the Lower Hillsborough River. If necessary, the 11 cfs limit for minimum flow diversions from the TBC could be subject to a small increase in order to meet minimum flows of the lower river when water levels in the TBC are at suitable levels.

Blue Sink is natural sinkhole located in a densely populated area of the Tampa metropolitan area. Previous studies have shown that water from Blue Sink used to flow to the Lower Hillsborough River via Sulphur Springs. However, Blue Sink has become clogged due to debris, which has contributed to reduced flows in Sulphur Springs. A 30-day pumping test of Blue Sink conducted by the District indicated that the sink can provide up to 2 mgd for minimum flows to the Lower Hillsborough River. The City of Tampa then conducted a feasibility analysis that indicated the most effective way to convey minimum flows diversions from Blue Sink to the lower river is to pipe water from Blue Sink to an existing pipeline that runs from Sulphur Springs to the base of the Hillsborough River Dam. The District reviewed and approved this finding, then in 2013, the City applied for and was granted a water use permit by the District to utilize Blue Sink for minimum flows at a peak month rate not to exceed 2 mgd (equivalent to 3.1 cfs).

Based upon information generated within the last two years, this report raises technical concerns about the Blue Sink project or the necessity of its use. A great deal of caution should used in placing a 2 mgd withdrawal in an urban/residential setting due to potential sinkhole risks. Given it current priority of use after Sulphur Springs, pumping from Blue Sink could occur over 200 days in the dry seasons of some years and be near 300 days in very dry years. Although the clogging of Blue Sink has resulted in some increase in water levels near the sink, this excess water is removed after relatively short periods of pumping, with additional withdrawals lowering water levels in the surrounding groundwater system. The City of Tampa has expressed the view that the risk of sinkholes from Blue Sink is very small, but opinions differ and there is uncertainty involved, so it is the conclusion of this report that reducing the duration of pumping from Blue Sink should reduce any sinkhole risks.

There is also a risk of prolonged withdrawals from Blue Sink reducing the flow and increasing the salinity of Sulphur Springs. In contrast to stated views that the Blue Sink project is returning flow to the way nature had it, withdrawals from Blue Sink will act to pull groundwater away from Sulphur Springs. Sulphur Springs provides most of the minimum flow to the Lower Hillsborough River and its flow must be carefully managed. With regard to Blue Sink, the following options are suggested to reduce the risks associated with prolonged withdrawals from Blue Sink: (1) Not construct the project, for Sulphur Springs and the Tampa Bypass Canal can likely provide all of the adopted minimum flows; (2) put minimum flow diversions from Blue Sink last in priority for minimum flows; (3) consider revisiting the option of routing diversions from Blue Sink to Jasmine or Orchid Sinks, which will act to increase flow to Sulphur Springs; and (3) if Blue Sink is constructed in the proposed design, it use be limited to be limited to providing emergency potable supplies during periods of water shortage. At a construction cost of near $10,000,000, I suggest the feasibility of using Blue Sink only for emergency potable water supply should be considered before the project is pursued.

Morris Bridge Sink is another natural sinkhole that is located on District owned lands in a rural area east of Tampa near the upper pool of the Tampa Bypass Canal. In 2009, the District conducted a 30-day pumping test that indicated that Morris Bridge Sink can produce a withdrawal rate of 3.9 mgd (equivalent to 6 cfs) that is specified in the recovery strategy. Minimum flow diversions from Morris Bridge Sink will be routed to the lower river via the upper and middle pools of the Tampa Bypass Canal and the Hillsborough River Reservoir. Most diversions from Morris Bridge Sink will be based on water levels in the lower pool of the TBC. When water levels in the lower pool are at or below 9.0 feet NGVD, water will be diverted from Morris Bridge Sink to the middle pool of the TBC for minimum flows. Data collected in the TBC since 2008 indicate that during wet years there will be either zero or relatively few days of withdrawals from Morris Bridge Sink. However, during dry years, diversions from Morris Bridge Sink could be on the order of 150 to 172 days.

Morris Bridge Sink represents a unique geologic and ecological feature that lies on District owned lands designated as the Lower Hillsborough Wilderness Preserve. The aquatic biological communities within Morris Bridge Sink will likely be impacted by the proposed diversions from the sink. In addition to riverine wetlands associated with the Hillsborough River and Cowhouse Creek, three isolated wetlands comprising a total of 69 acres occur near Morris Bridge Sink. Two of these wetlands are in near pristine condition, comprising an important component of one of largest and most intact wildlife corridors in the region. Given their high resource value, a high degree of protection should be afforded to these wetlands, especially in a minimum flows recovery strategy for which the goal is to provide net environmental benefit.

As part of a re-evaluation of the minimum flows recovery strategy, consideration should be given to limiting diversions from Morris Bridge Sink to periods when water levels in the lower pool of the TBC fall below 6.0 feet, rather than 9.0 feet as specified in the recovery strategy. Since 2008, minimum flow waters were diverted from the lower pool of the TBC at elevations between 6.0 and 9.0 feet, so such a revision would simply continue this practice rather than switching to diversions from Morris Bridge Sink at 9.0 feet. This revision would greatly reduce the amount of days that diversions from Morris Bridge Sink could affect hydroperiods in the nearby wetlands and reduce the frequency and duration of impacts to biological communities within the sink. However, as with Blue Sink, probably the most appropriate alternative for Morris Bridge Sink would be to use it as was used in the past - to provide emergency potable supplies during times of water shortage.

Different minimum flow recovery scenarios should be modeled to determine their effects on the dependable water supply yield of the Hillsborough Reservoir / Tampa Bypass Canal system. The effects of different recovery scenarios should be examined in the context of an integrated water supply plan for the region that utilizes other water supply sources to make up any changes in the yield from the reservoir/canal system.

In March 2012, a letter was sent from the Florida Department of Environmental Protection (FDEP) to the state's five water management districts that provided guidance on groundwater augmentation of surface waters. The letter cited a passage in the Florida Administrative Code that states "*In implementing consumptive use permitting programs, the Department and Districts shall strive to prevent harm to natural systems without the need for artificial maintenance of natural systems by pumped groundwater augmentation*." The letter also states *"These same principles should be applied in the development and implementation of recovery and prevention strategies for minimum flows and levels."* It also states *"Long-term augmentation of wetlands or other surface waters with pumped groundwater should be avoided. When long-tem augmentation is the only feasible alternative, augmentation with the use of reclaimed water or recycled stormwater is encouraged....."*

Blue Sink and Morris Bride Sink are geologic openings to the Upper Floridan aquifer and withdrawals from these sinks are in effect direct withdrawals from groundwater resources. It is also clear that Blue Sink and Morris Bridge Sink are not the only feasible alternatives for meeting the minimum flows for the Lower Hillsborough River. Given the direction from FDEP, the technical information that is now available and the management experience gained using the existing minimum flow sources since 2008, the recovery strategy for the Lower Hillsborough River should be re-evaluated to assess ways to reduce the risks associated with the Blue Sink and Morris Sink projects or determine if these projects are even necessary. Not constructing these projects would save roughly $11,600,000.

A recent report by the District examined the effectiveness of the minimum flows that have been implemented to date. That report concluded that minimum flow rates in the range of the adopted minimum flows will create a low salinity zone in the lower river below the dam, but problems with low dissolved oxygen concentrations will remain in much of river between Hannahs Whirl and Sulphur Springs. As part of a re-evaluation of the recovery strategy, the feasibility of installing circulation devices to improve aeration of the river above Sulphur Springs could be investigated. If it is concluded that the Blue Sink or Morris Bridge Sink projects are not necessary to meet minimum flows, the costs savings from those projects could be used to install and operate circulation devices if they are shown to be feasible and effective.

1 The technical approach of this report

This report provides a review and analysis of the adopted minimum flow recovery strategy for the Lower Hillsborough River (LHR). The report concludes with recommendations for components of the recovery strategy that should be re-evaluated before construction either of the Blue Sink and Morris Bridge Sink projects is pursued.

I worked at the Southwest Florida Water Management District between February 1985 and August 2014, first as an Environmental Scientist IV and then as a Chief Environmental Scientist. During this period, I was the District's lead environmental scientist concerning the evaluation of environmental aspects of water use permits for withdrawals from the Hillsborough River and the Tampa Bypass Canal and the determination of minimum flows for the LHR. In some cases, this report is written in the first person to describe my participation in those processes. Though not described in this report, at several meetings within the District during my last two years there I made the case that the minimum flow recovery strategy for the Lower Hillsborough River should be re-evaluated. This report presents the technical basis for that perspective

Much of the information discussed in this report is presented in more detail in reports or other documents prepared for or by the Southwest Florida Water Management District (the District), the City of Tampa (the City), the City's consultants, or other parties. Some results, figures, and tables from those reports are reprinted below. However, for the sake of brevity, discussion of those results is concise and the referenced reports should be consulted for more detailed information.

2 Overview of the adopted minimum flows for the Lower Hillsborough River

Minimum flows for the Lower Hillsborough River have been adopted twice. A minimum flow rate of 10 cfs was adopted in 1999, but as part of a settlement agreement with the Friends of the River, that minimum flow rule was to be re-evaluated based on five years of additional study. Based on the findings of that re-evaluation, revised minimum flows for the LHR were adopted in August 2007. Those minimum rates, which are currently in effect, are 20 cubic feet per second (cfs) freshwater equivalent for the nine months from July through March and 24 cfs for the three months from April through June. The adopted minimum flow rule for the Lower Hillsborough River is included as Attachment A to this report.

The freshwater equivalent factor is based on hydrodynamic salinity modeling of the LHR, in that the effect of the minimum flows from all sources should be as effective at creating a volume of water less than 5 psu salinity between the dam and Sulphur Springs as would releasing 20 or 24 cfs of fresh water from the reservoir during those respective months. Based on a result presented in the minimum flows report for the Lower Hillsborough River (SWFWMD 2007), adding a value of 3 cfs to the 20 or 24 cfs value can be used to roughly estimate a total minimum flow rate that should be achieved if diversions from Sulphur Springs are used to provide part of the minimum flow. This factor could be refined based on additional salinity modeling, but that is not critical at this time. It is important to recognize that diversions from Sulphur Springs have, and are expected to, provide a substantial proportion of the minimum flows for the LHR on all days.

The minimum flow rule for the LHR also specifies that minimum flow rates may be reduced when daily flows at the Hillsborough River near Zephyrhills gage are less than 58 cfs. Figure 1 below shows the minimum flow rates that would have been in effect for the period January 1, 2002 through June 8, 2013 if the currently adopted minimum flow rates were in effect during that period, not adjusted for the freshwater equivalent factor. No minimum flows are shown for days when flows over the dam were in excess of the minimum flow rate. Blue bars are shown on days when flows from the dam would have partially met the minimum flow.

The switch from 20 to 24 cfs in the springtime is apparent during most years. Also noted is the periodic reduction in either of these values due low flows at the Zephyrhills gage. During this nearly 12-year period, reduction of the minimum flows due to low flows at the Zephyrhills would have occurred on 19% of the days. The lowest minimum flow rates that would have been required were 15 cfs on a few days during the month of March in the years 2007 and 2009.

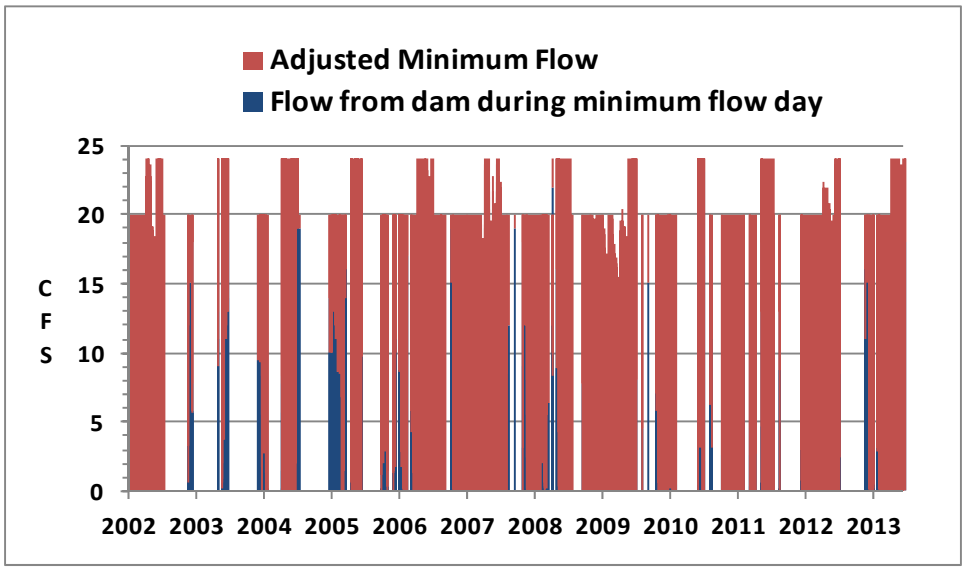

Figure 1. Daily minimum flow rates for the LHR that would have been in effect during the period Jan. 1, 2002 through June 8, 2013, adjusted for low flows at the Zephyrhills gage. Values not adjusted for the freshwater equivalent (reprinted from SWFWMD 2015).

Minimum flows are generally required for some duration in the dry season, which typically begins in the early fall and extends through the late spring in west-central Florida. Table 1 lists the beginning and ending dates for when the current minimum flows would have been in effect in each yearly dry season. Also listed are the number of days within each period that minimum flows would have been in effect and the percentage of days within each period. On average, minimum flows would have been needed 196 days during each dry season. The lowest number of days that minimum flows would have been required was 38 days in the dry season spanning 2002 and 2003. The maximum number of days that minimum flows would have been in effect (303 days) was in the dry season spanning 2006 and 2007. Minimum flow values would also have been in effect over 200 days in six other dry season intervals. These results are important for assessing how often diversions from the various water sources identified in the recovery strategy would be needed to meet the minimum flows for the LHR.

Table 1 Beginning and ending dates for minimum flow periods spanning the dry seasons of years between the fall of 2001 and the spring of 2013. The number of days that minimum flows would have been required and the percentage of minimum flows days within each period are listed (reprinted from SWFWMD 2015).

Beginning Date	Ending Date	Number of minimum flow days	Percent of days within period
October 28, 2001	July 3, 2002	249	100%
November 12, 2002	June 17, 2003	38	17%
November 26, 2003	July 1, 2004	131	60%
December 13, 2004	June 3, 2005	125	72%
September 18, 2005	August 31, 2006	277	80%
October 4, 2006	August 2, 2007	303	100%
October 19, 2007	July 16, 2008	207	76%
September 8, 2008	June 26, 2009	283	97%
October 11, 2009	June 24, 2010	123	48%
September 29, 2010	July 8, 2011	225	80%
November 28, 2011	June 23, 2012	205	98%
November 13, 2012	June 8, 2013	185	89%

3 Status of the minimum flows recovery strategy for the Lower Hillsborough River

Diversions from four water sources are identified in the recovery strategy to provide minimum flows to the LHR. Those sources are Sulphur Springs, the Tampa Bypass Canal, Blue Sink and Morris Bridge Sink. When fully implemented, the recovery strategy describes the priority and diversion rates at which these sources will be used. The minimum flows recovery strategy is included as Attachment B to this report.

Diversions from Sulphur Springs up to 18 cfs are to be utilized first, followed by diversions from Blue Sink at rates up to 3.1 cfs. Diversions from the Tampa Bypass Canal (TBC) to the Hillsborough River Reservoir are then to be implemented at rates up to 11 cfs, although only 75% this water (8.3 cfs) is to released from the reservoir to the LHR for minimum flows. If additional water is needed for minimum flows, diversions of up to 6 cfs will be obtained from Morris Bridge Sink. Also, if water levels in the lower pool of the TBC fall below an elevation of 9.0 feet NGVD, diversions of water from Morris Bridge Sink up to 6 cfs will be implemented to replace diversions from the Tampa Bypass Canal.

As will be discussed in Section 3.2 and 3.3, implementation of the recovery strategy has begun, but has not been fully completed. The facilities at Sulphur Springs have been completed and minimum flow diversions from the spring have been fully implemented. Using temporary pumping facilities, minimum flow diversions from the Tampa Bypass Canal have been implemented since 2008. Diversions from Blue Sink and Morris Bridge Sink have not yet been implemented, as these facilities have not yet been constructed. The recovery strategy requires that the minimum flows for the LHR be fully met by October 1, 2017.

3.1 Costs for construction of the projects identified in the recovery strategy

The costs to construct the four water sources to provide the minimum flows identified in the recovery strategy are listed in Table 2. This includes costs that were spent on projects that have been completed and estimated costs for projects that have yet to be constructed. The total cost for construction of the facilities to implement the recovery strategy is $22,701,235. For each project, the percent of total cost and the maximum rate of minimum flow diversion is also listed. The maximum diversion rate is then divided by the costs of each project to calculate an average cost per cfs.

Table 2. Costs for construction of the projects to provide minimum flows to the Lower Hillsborough River. The values in parentheses for the new pumps on the TBC and reservoir do not include the 25% loss term for water from the TBC to the reservoir.

Lower Hillsborough Recovery Costs				
	Cost	Percent of cost	Max CFS	Cost Per CFS
Sulphur Springs Lower Weir	$493,546	2%		
Sulphur Springs Upper Weir and Pumps	$5,276,759	23%	18	$293,153
Morris Bridge Sink	$1,623,000	7%	6	$270,500
New pumps on TBC and Reservoir	$4,422,430	19%	8.3 (11)	$532,822 ($402,039)
Blue Sink	$10,785,500	48%	3	$3,595,167
Additional Sources study	$100,000	0%		
Total	$22,701,235			

The total costs for the two Sulphur Springs projects, which have been completed, represent 25% of the total construction costs of the recovery strategy. The construction of the Sulphur Springs facilities was co-funded by the City and the District, but all operating costs are incurred by the City. Since the amount of minimum flows that can be obtained from Sulphur Springs is high (18 cfs), the cost per cfs is relatively low ($293,153). It is expected that Sulphur Springs will be used all days when minimum flows are needed, as diversions from the spring are a critical component of the recovery strategy.

The construction cost for the Morris Bridge Sink project ($1,623,000) is estimated because a contract to construct this facility has not yet been developed. The construction and operation costs for the Morris Bridge Sink project will be incurred solely by the District. Although the average cost per cfs is the lowest ($270,500) among the four water sources, Morris Bridge Sink will be used the least often of the water sources that are identified in the recovery strategy.

The pumps that are currently operating on the middle and lower pools of the Tampa Bypass Canal to provide minimum flows are temporary diesel powered pumps that are operated by the District. The District also operates a similar pump at the Hillsborough River Dam to provide minimum flows to the lower river.

According to the recovery strategy, permanent pumping facilities on the TBC middle pool and at the Hillsborough River dam will be constructed and operated by the City. The City and the District are currently developing a cooperative funding agreement to co-fund the construction of permanent pumping facilities at these two locations, with a budgeted cost of $4,422,430, which represents 19% of the total cost of the recovery strategy. Since only 75% of the water diverted

from the TBC to the reservoir is released to the lower river, the average cost per cfs is $532,822. However, if the 25% loss term was eliminated and the full 11 cfs that is diverted from the TBC is released to the lower river, the costs per cfs would be $402,039, which is listed in parentheses in Table 1. The possible elimination of the 25% loss term is discussed in Sections 4.2 of this report.

The District will continue to operate the pumping facility on the lower pool of the TBC that is used to replenish the minimum flow diversions from the lower pool on a one-to-one basis. Since this pump is currently in place, it was not included the table of total costs for the recovery plan listed in Table 1.

The remaining water source listed in Table 1 is Blue Sink. The District and the City have entered into a cooperative agreement to co-fund the Blue Sink project. The total cost of the Blue Sink project is $10,785,500, which represents 48% of the total cost of the recovery strategy. The cost per cfs for Blue Sink is $3,479,194 (calculated for a minimum flow diversion of 3.1 cfs), which is by far the highest of the four water sources. According to the priority of sources identified in the recovery strategy, it is expected that diversions from Blue Sink will be used every day that minimum flows are needed.

However, as discussed in Chapter 6 of this report, I suggest that the utilization of Blue Sink per this priority schedule poses some risks and strong consideration should be given to not constructing the project. If the Blue Sink project is constructed, it's priority for use for minimum flows should be modified. As an alternative, the use of Blue Sink could be limited to provide emergency potable supplies during times of water shortage.

The remaining project listed in Table 1 is for an ongoing study that will identify any other sources that may be necessary if the four water sources that have been identified are insufficient to meet the minimum flows. A contract with a consultant for a total cost $100,000 is in effect, but so far, the need for additional sources has been determined not to be necessary.

3.2 Minimum flow diversions that have been implemented from Sulphur Springs and the Tampa Bypass Canal

The status of the minimum flows that have been implemented to date are briefly summarized below. As previously described, minimum flow diversions are now in effect from Sulphur Springs and the Tampa Bypass Canal.

A hydrograph of diversions from Sulphur Springs to the LHR at the base of the Hillsborough River Dam is shown in Figure 2. Minimum flow diversions from Sulphur Springs began in the spring of 2002, when the adopted minimum flow was 10 cfs. After the revised minimum flows for the LHR were adopted in 2007, modifications were made to the weirs and pumping facilities at Sulphur Springs to allow for greater minimum flow diversions to the base of the dam. These modifications were completed in the spring of 2012, which allowed for greater diversions of spring water to the base of the dam. Since the spring of 2012, diversions of spring water at a rate of 18 cfs or slightly greater (maximum 20.6 cfs) have been implemented when minimum flows to the lower river were needed.

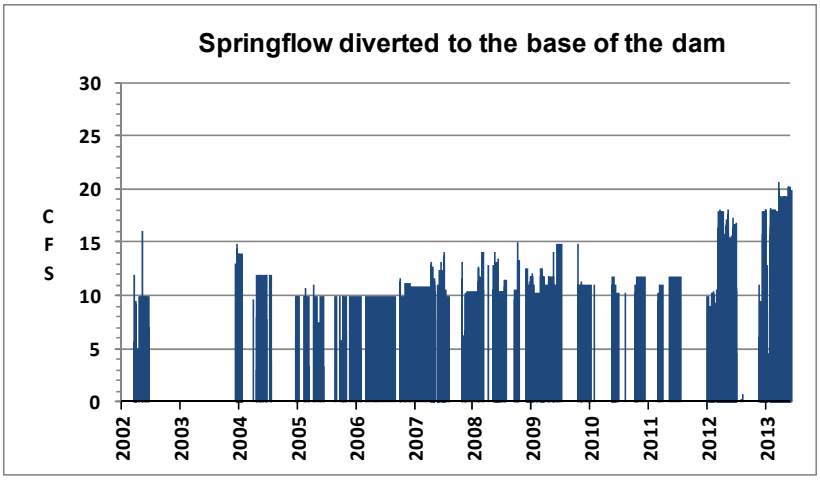

Figure 2. Daily quantities of water diverted from Sulphur Springs to the base of the dam for minimum flows (reprinted from SWFWMD 2015).

Minimum flows for the spring run that receives flow from Sulphur Springs have also been established. Only water that is above the minimum flow rate for the spring run can be diverted to the base of the dam for minimum flows for the LHR. However, the minimum flows for the spring run are flexible in that in the increased diversions from the spring can be implemented as long as brackish water from the LHR does not migrate into the spring run. Since 2002, springflow rates as little as 10 to 11 cfs have prevented the incursion of river water into the spring run. However, mats of filamentous algae have developed in the spring run during these low flows, and management of the algal mats, including manual harvesting, may be investigated as part of the minimum flows plan for the spring run. Also, in order to maintain thermal refuge for manatees in the LHR near mouth of the spring run, a flow of 18 cfs must be maintained to the spring run when water temperatures in the river fall below 20 degrees Celsius.

Diversions from the Tampa Bypass Canal have been implemented since December 31, 2007, which for brevity is referred to as since 2008 in this report. Using temporary pumping facilities operated by the District, diversions of up to 11 cfs have been diverted from the middle pool of the TBC to the Hillsborough River Reservoir. In order to address concerns expressed by the of City of Tampa about losses of canal water pumped into the reservoir, only 75% of this water is released to the lower river as minimum flows. The lack of a scientific basis for the magnitude of this loss term is discussed in Section 4.2 of this report.

Minimum flows to the LHR that have resulted from diversions from the TBC, after application of the 25% loss term, are shown in Figure 3. These releases were usually at a rate of 8.3 cfs, except when that much water was not needed to meet the minimum flows (e.g., spring of 2013). Although minimum flows were needed below the dam, diversions from TBC were discontinued for a 52-day period in the spring of 2012, which essentially is shown as zero flows in Figure 3. Using a pump currently operated by the District, minimum flow diversions from the middle pool of the TBC to the reservoir are replaced on a one-to-one basis (no loss term) by pumpage from the TBC lower pool into the middle pool. However, as specified in the recovery strategy, when water levels in the lower pool fall below 6.0 feet NGVD, pumpage from the lower pool is to cease and not resume until water levels in the lower pool rebound to 9.0 feet and remain above

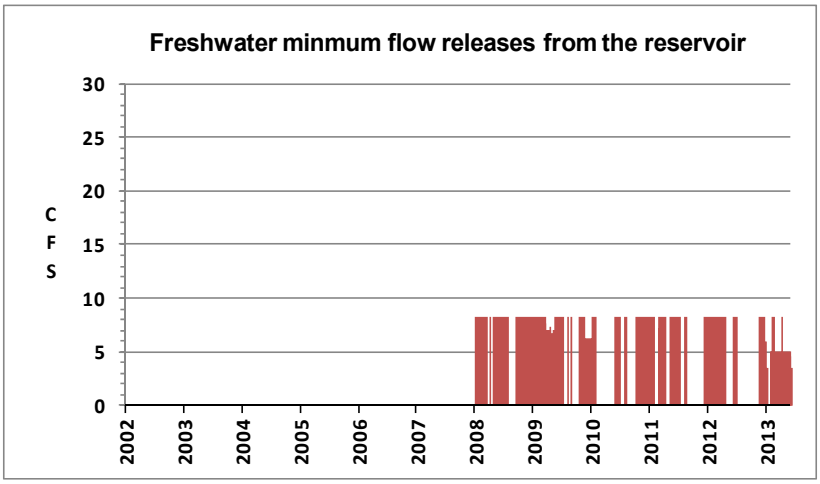

Figure 3. Daily quantities of water released from the Hillsborough River Reservoir for minimum flows (reprinted from SWFWMD 2015).

that level for 20 days. Such an occurrence happened in the spring of 2012. During this interval, diversions of minimum flows from the TBC middle pool to the reservoir and releases of reservoir water to the LHR ceased, as these do not occur if replenishment from the lower pool cannot occur. If the Morris Bridge Sink facilities had been in place during this period, diversions of up to 6 cfs would have continued, with 75% of this water released as minimum flows to the Lower Hillsborough River.

The combined minimum flows that were provided to the lower river from 2002 to early June, 2013 are shown in Figure 4. The increase in minimum flows with the implementation of diversions from the TBC in 2008 is apparent. A second increase in minimum flows occurred in the spring of 2012, when increased diversions from Sulphur Springs were first implemented.

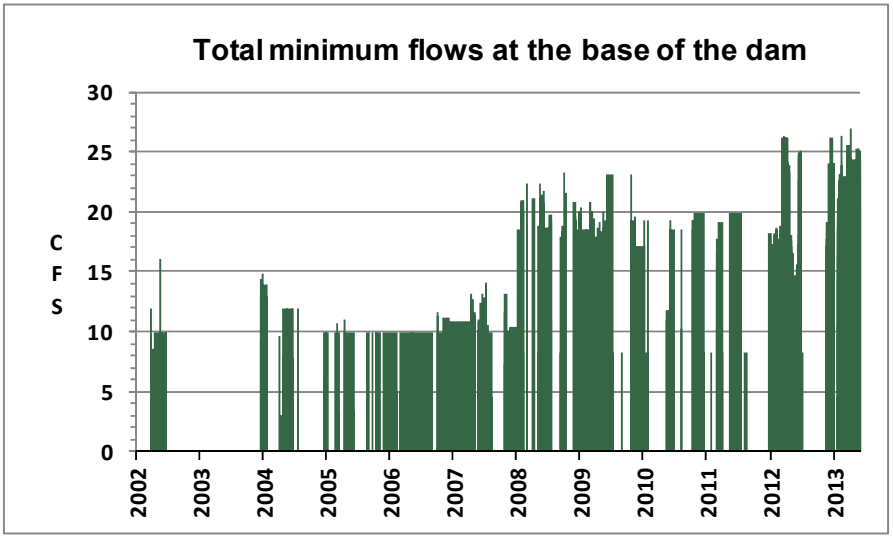

Figure 4. Daily values for total minimum flow rates delivered to the base of the dam comprised of diversions from Sulphur Springs and releases from the reservoir that originated from pumpage from the TBC (reprinted from SWFWMD 2015).

Since March 2012, the combined diversions of flows from Sulphur Springs and the Tampa Bypass Canal have either met or come close to meeting the adopted minimum flows for the LHR on many days. With the exception of the 52-day period when diversions from the TBC were discontinued, there were 237 days between March 1, 2012 and May 31, 2013 when minimum flows for the LHR were required. The combined minimum flows that were implemented during this period met the minimum flow requirements of the river for 76% of those days if there was no adjustment for the freshwater equivalent. If the freshwater equivalent was applied by adding 3 cfs to the required minimum flows, the minimum flows that were implemented would have met the minimum flows on 34% of the days. If the freshwater equivalent was not applied to the months April through June, when the minimum flow rate increases to 24 cfs, the total minimum flows would have met the minimum flow requirements on 57% of the days. On most days when the minimum flows were not fully achieved, addition of relatively small amounts of water would have met the minimum flows.

3.3 Status of the Blue Sink and Morris Bridge Sink projects

Construction of the Blue Sink project is being co-funded by the City and the District. A cooperative funding agreement between the District and the City to design and construct the project began in October 2010. Prior to initiation of the Blue Sink project, consultants for the City conducted a feasibility analysis that examined various alternatives for transmitting water from Blue Sink to the Hillsborough River (MWH 2009). That report discussed the findings of previous studies that examined the relationships of groundwater flow between Blue Sink with other features in the area including Jasmine Sink, Orchid Sink, and Sulphur Springs. The study also summarized the results of a month-long pumping test conducted by the District in the spring of 2009 that concluded that Blue Sink could reliably produce up to 2 million gallons per day (mgd) for minimum flows (SWFWMD 2009).

The feasibility analysis considered four general alternatives for the utilization of Blue Sink that included: Piping water from Blue Sink to Jasmine or Orchid Sink and letting the water travel through the underground aquifer from there to Sulphur Springs; Piping the water to the Sulphur Springs pump station or to the pipeline that extends from the Sulphur Springs to the base of the dam; and two modifications of these plans which involved first routing the water through the large stormwater wetland that lies south of Blue Sink.

Factors that were evaluated for each alternative included cost, regulatory considerations, dredging and grading difficulty, pubic use benefit, and the reliability of the quantity and quality of water source with the reliability factors given the greatest weight. The feasibility report concluded that the best alternative was to construct a pipe from Blue Sink to the pipeline that extends from Sulphur Springs to the base of the Hillsborough River Dam. Staff from District, including myself, reviewed the feasibility report and approved this finding, as it represented the most effective way to get the water pumped from Blue Sink to the Lower Hillsborough River.

In July 2013, the City applied to the District for a water use permit to withdraw up to 2 mgd from Blue Sink, which is equivalent to the rate of 3.1 cfs that has been cited elsewhere in document. The District's analysis concluded the requested withdrawals from Blue Sink met the conditions of issuance, and a water use permit that allows a peak month withdrawal rate of 2 mgd was issued to the City in December 2013. The design of the Blue Sink project has been completed and bids for construction of the project were to have been issued late in 2014.

The Morris Bridge Sink project is to be constructed on lands owned by the District that are part of the Lower Hillsborough River Flood Detention Area. Morris Bridge Sink is a natural sinkhole that is approximately 135 feet in diameter and over 200 feet deep. In the drought during the year 2000, there were withdraws from Morris Bridge Sink by Tampa Bay Water to provide emergency potable supplies. Water from the sink was pumped into the upper pool of the Tampa Bypass Canal, from where it was pumped into the middle pool of the TBC and then to the Hillsborough River Reservoir for water supply.

In keeping with the directives of the adopted recovery strategy for the LHR, the District conducted a pumping test of Morris Bridge Sink in the spring of 2009. The District concluded from the pumping test that Morris Bridge Sink could reliably produce a sustained diversion of 3.9 mgd.

Similar to Blue Sink, it has been concluded that withdrawals from Morris Bridge Sink will require a water use permit. Because the District cannot issue a water use permit to itself, the District applied to the Florida Department of Environmental Protection (FDEP) for a water use permit to utilize Morris Bridge Sink at a maximum daily rate of 3.9 mgd, which is equivalent to the 6 cfs quantity cited elsewhere in this report. In simulations that did not include any minimum flow diversions from Blue Sink, it was projected that during a very dry year, water would be needed from Morris Bridge Sink at an average rate of 2.8 mgd for 270 days. Groundwater modeling was conducted to examine the effects of these withdrawals on groundwater levels and water levels on 69 acres of isolated wetlands located near Morris Bridge Sink. The issuance of a water use permit from FDEP is still pending at the time of this report.

4 Technical concerns - There should be a greater reliance on the Tampa Bypass Canal to provide minimum flows

The following section provides a rationale for why there should a greater reliance on using the Tampa Bypass Canal to provide minimum flows. Recommendations regarding re-evaluation of the use of the TBC are presented below and also in Section 10 of this report.

4.1. The minimum flows rates that have been achieved to date with existing facilities are close to meeting the adopted minimum flows

As described in on page 8, since the completion of the new the pump and weir facilities at Sulphur Springs in the spring of 2012, the minimum flow rates that have been achieved have routinely exceeded 20 cfs and have been as high as 26 cfs on some days. These minimum flow rates have been achieved soley with diversions from Sulphur Springs and the Tampa Bypass Canal. Depending on how the freshwater equivalent factor is handled, these minimum flow rates either met or came close to meeting the adopted minimum flows for the LHR on many days, without any new facilities to divert water from Blue Sink or Morris Bridge Sink.

In a recent report that evaluates effectiveness of the minimum flows that have been implemented to date (SWFWMD 2015), the District reports that total minimum flows in the range of 23 to 26 cfs appear to be more effective at reducing salinity and improving water quality than a minimum flow rate of 20 cfs. This conclusion takes a different approach to the freshwater

equivalent factor, but again the minimum flows that have been implemented to date have often been close to or within this range of minimum flows.

One issue that has arisen is that the diversion of greater quantities of flow from Sulphur Springs to the base of the dam has contributed to the increased coverage of filamentous algae in Sulphur Springs Run. The District is currently monitoring the amount of algae in spring run and examining relationships between the biomass of algae and rate of springflow and current velocities in the spring run (SWFWMD 2015). If the management of filamentous algae in the spring run becomes a criterion for minimum flow management, it could affect the quantity of spring water that can be diverted to the base of the Hillsborough River dam. However, if necessary, the manual removal of the algae is one option that could be examined that would reduce amount of algae while allowing greater diversions spring water to the base of the dam.

4.2. The lack of scientific basis for the twenty-five percent loss term for minimum flows diverted from the TBC

As described on page 6, the recovery strategy requires that only 75% of the water that is diverted into the Hillsborough River Reservoir from the Tampa Bypass Canal will be released to the LHR for minimum flows. This loss term is based on concerns expressed by the City of Tampa that there is a loss of water pumped from the canal into the reservoir. As will be discussed further in Section 4.4, the City has used the TBC to augment potable water supplies in the reservoir since 1985. Using a separate pump, the diversions from the TBC into the reservoir for minimum flows since 2008 are in addition to pumpage from the canal into the reservoir for potable supply.

Because of the City's concerns about this possible loss term, the recovery strategy includes a discussion of the construction of a water transmission pipeline that would extend from the middle pool of the TBC to the City's water treatment plant, which lies on the south shore of the reservoir, with a spur extending to the dam for minimum flows. The construction of this pipeline would serve to eliminate these water losses and was estimated to result in a water savings, which was estimated at 1.9 mgd (2.9 cfs).

This pipeline would have been very expensive and there was not consensus about the rate of any water loss that was occurring, so the District and the City agreed that the water savings that might result from the pipeline be subject to technical peer review. A three-person review panel was formed that included faculty from the University of Florida, the University of South Florida, and a consultant from the Tampa Bay area who had considerable experience with the Hillsborough Reservoir / Tampa Bypass Canal system. The primary objective of the peer review was to determine the projected water saving that might be expected to result from the construction of a pipeline to convey augmentation water pumped from the TBC to the reservoir based on previous studies.

The peer review panel published their findings in a letter report submitted to the District and the City (Motz et al. 2008). The panel concluded that previous studies to calculate water loss terms did not make the distinction between water lost to evaporation and water that is recirculated in the groundwater system between the reservoir and the TBC. Water that flows from the reservoir back to the TBC can be returned by simply pumping the water back into the reservoir. The panel thus concluded that the only water lost to the system is from evaporation, and that

any increased water loss would be the increased evaporation due to the addition of the augmented water pumped from the TBC, which would slightly raise the water level and increase the surface area of the reservoir.

The panel concluded that the increased evaporation losses that would result from augmentation using the TBC are less than a few tens of thousands or few hundreds of thousands of gallons of water per day, and that the projected water savings that could be expected from the pipeline would be small. Based on this conclusion, the water transmission pipeline was dropped from consideration in the recovery strategy.

It is important to note the peer review panel's conclusion was based on the much greater rates of augmentation from the TBC that are used for potable supply. Potential loss terms due to minimum flow pumpage, which is capped at 11 cfs, would be much smaller. The findings of the review panel can thus be applied to conclude that the 25% loss term that is applied to minimum flows that are delivered from the TBC to the reservoir is a very large overestimate

Based on the 25% loss term specified in the recovery strategy, of the 11 cfs of minimum flow water that is to come from the Tampa Bypass Canal, 2.75 cfs is currently not released to the lower river. This rate of water loss is much greater than the potential loss terms discussed by the review panel, which again were estimated for much larger augmentation rates from the TBC. It is therefore the conclusion of this document that the 25% loss term specified in the recovery strategy should be re-evaluated and probably eliminated.

As previously discussed, the minimum flows that have been implemented to date have either met or come close to meeting the adopted minimum flows of the LHR on many days. If the 25% loss term was eliminated from the recovery strategy, the number of days that the minimum flows that could be fully met using diversions solely from Sulphur Springs and the Tampa Bypass Canal would increase considerably. It is also worth noting that the 2.75 cfs that is represented by the 25% loss term is only slightly less than the 3.1 cfs that is to be achieved from construction of the Blue Sink pumping facility. Elimination of the 25% loss term, which is not supported scientifically, could possibly alleviate the need to construct the Blue Sink project.

4.3 The documented success of using the Tampa Bypass Canal as a primary source for providing minimum flows

Diversions from the Tampa Bypass Canal have been used to provide minimum flows to the Lower Hillsborough River since December 31, 2007. This has provided over seven years of record demonstrating that the TBC can be successfully used as a primary source to provide minimum source to the LHR.

A hydrograph of diversions from the TBC middle and lower pools for minimum flows for the period January 1, 2008 through the spring of 2013 is shown in Figure 5. Also shown are water levels in the lower pool of the TBC and a reference line at an elevation of 9.0 feet NGVD. These diversion rates are before the 25% loss term is applied to releases to the lower river. The period shown includes some very dry years, including the springs months of 2009 and 2012.

As described on in more detail in the District report (SWFWMD 2015), diversions from the TBC continued in 2009 when water levels in the lower pool fell below 6.0 feet. This was done by variance, as the recovery strategy specified that diversions from the TBC lower pool are to cease when water levels go below 6.0 feet and not resume until water levels rebound to 9.0 feet and remain above that level for 20 days. Under a temporary variance to their water use permit, water supply withdrawals from the TBC lower pool by Tampa Bay Water also continued during this period of low water levels in the spring of 2009.

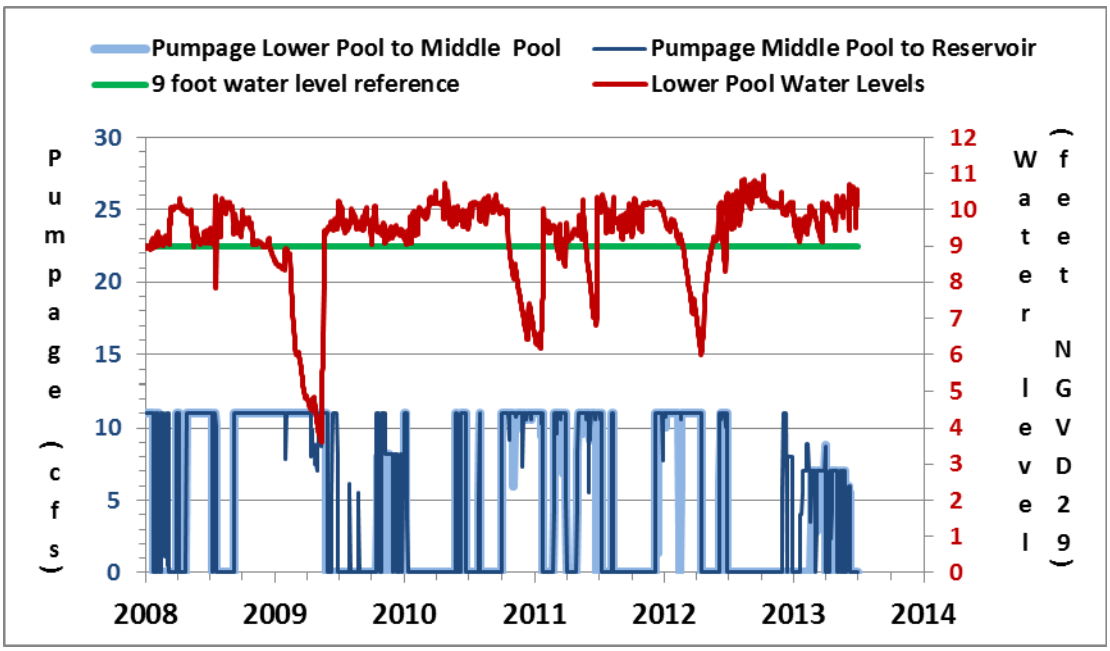

Figure 5. Minimum flow diversion rates from the lower pool to the middle pool of the TBC, from the middle pool of the TBC to the Hillsborouh River resevoir, water levels in the lower pool of the TBC, and a refernce line at 9.0 feet for water levels in the lower pool of the TBC

As described on pages 6 and 7, the specifications of the recovery strategy were followed in the spring of 2012, when water levels in the lower pool fell to 6.0 feet and diversions from both pools of the TBC were discontinued for 52 days.

In viewing Figure 5, it is useful to consider how diversions from Blue Sink and Morris Bridge Sink would have replaced or supplemented these diversions from the TBC had those projects been in place. In all cases, diversions from Blue Sink at a rate of 3.1 cfs would have occurred prior to any diversions from the TBC. Diversions from Morris Bridge Sink to the TBC middle pool (via routing through the TBC upper pool) would have occurred prior to minimum flow diversions from the lower pool when water levels in the lower pool fell below 9.0 feet. Diversions into the reservoir that originate from Morris Bridge Sink would also have been subject to the 25% loss term before release to the LHR.

Because the Blue Sink and Morris Bridge Sink projects had not yet been constructed, the period since 2008 demonstrates how the TBC was successfully used as a primary source to provide minimum flows to the LHR, used only in conjunction with Sulphur Springs. During this period, which again included very dry years, potable supplies for the region were met using the integrated water supply system available to Tampa Bay Water and the City of Tampa. As previously discussed, the minimum flows to the LHR that were implemented after the spring of 2012 either met or came close to meeting the minimum flows for the LHR on many days.

In my opinion, these results indicate use the TBC should be moved up in the priority of minimum flow sources for the LHR**,** which is presented as a recommendation in Chapter 10 of this report. As described below, the District should have strong regulatory justification for this modification to the recovery strategy given the technical information and permit conditions that have accompanied large increases in permitted water supplies from the combined Hillsborough River / Tampa Bypass Canal system that have been granted in recent years.

4.4 Increases in permitted water supplies from the Hillsborough River Reservoir / Tampa Bypass Canal system in relation to the requirements for minimum flows

During the time that the District has known that minimum flows for the Lower Hillsborough were needed, there has been a dramatic increase in the amount of permitted water supplies granted from the Hillsborough River / Tampa Bypass Canal system. It should be pointed out that the legislative directive to establish minimum flows dates to the Florida Water Resources Act of 1972, and the District has had an active minimum flows research program since the early 1980s. As described below, extensive studies of the freshwater flow relationships of the LHR have been required by the conditions of water use permits issued to the City of Tampa or Tampa Bay Water since the early 1990s.

It is a now a routine standard condition in water use permits that permitted water supply withdrawals may have to be modified to comply with minimum flows. Given the recent increases in permitted water supplies and the large size, hydraulic characteristics, and the management capabilities of the combined reservoir/canal system, it is my opinion that the District should have strong regulatory justification to require minimum flows be provided to the LHR within the context of the existing water use permits from the Hillsborough River Reservoir and the Tampa Bypass Canal.

While allowing for the replacement of some existing pumping facilities, the minimum flows to the LHR could be largely or completely met with the existing water control infrastructure on the combined reservoir/canal system. A summary of scientific studies and permit conditions that have pertained to the management of freshwater flow to the Lower Hillsborough River and water use from the reservoir/canal system is presented below. Some important dates, permitted quantities, and special conditions that have been part of water use permits for withdrawals from the Hillsborough River Reservoir and the Tampa Bypass Canal are listed in Table 3.

Table 3. Important dates, permitted quantities, and special conditions of water use permits for withdrawals from the Hillsborough River Reservoir and the Tampa Bypass Canal. The following abbreviations are used: CoT = City of Tampa; TBW = Tampa Bay Water; WUP = Water Use Permit; HRR = Hillsborough River Reservoir; TBC = Tampa Bypass Canal; mgd = million gallons per day; S160 = Structure 160 on Tampa Bypass Canal

1983 - CoT issued WUP from HRR or annual average withdrawal of 62 mgd and maximum day withdrawal of 104 mgd. TBC first used to augment water supplies in HRR in 1985.

1991 - CoT WUP renewed. Annual average rate increased from 62 mgd to 82 mgd.
- Under a separate WUP, the TBC can be used for reservoir augmentation when water levels in HRR fall to 19 or 21 NGVD feet depending on the month. Permitted augmentation rates from TBC are 20 mgd annual average and 40 mgd maximum day.
- As a special permit condition, a three-year hydrobiological study is conducted of freshwater flow relationships of the LHR and the tidal reach of the TBC. Goals of study include the development of optimal reservoir/canal operations plan to minimize environmental impacts while meeting water supply needs.
- While the study is being conducted, mitigation augmentation from the TBC is required when flows at the dam are less than 25 cfs and daily withdrawals from the HRR are greater than previous average monthly rates.

1996 - WUP for augmentation from TBC modified so that augmentation of HRR can occur when water levels in HRR fall below the spillway elevation of 22.5 feet

1999 - WUP issued to TBW for withdrawals from the TBC and for diversion of high flows from the HRR to TBC for withdrawal
- Average annual withdrawals from HRR and TBC by TBW permitted at 60 mgd
- Withdrawals from TBC limited to 80% of flow over Structure 160 when flows over S160 are greater than 11 cfs
- Hydrobiolgical monitoring program of LHR and tidal reach of TBC is required

2004 - WUP to CoT for withdrawals from HRR modified to increase maximum day withdrawal from 104 to 120 mgd to allow for Aquifer Storage Recovery

2007 - WUP to TBW modified to increase annual average rate from 60 to 85 mgd
- Withdrawals from TBC modified so that 100% of flow over S160 can be withdrawn
- 11 cfs low flow requirement at S160 removed, so flow at S160 can go to zero cfs
- Apart from permit, District commits to diverting 11 cfs from TBC to HRR
- Hydrobiological Monitoring Program of LHR and tidal reach of TBC continued

4.4.1 Permitted water use from the reservoir/canal system for the City of Tampa

The City of Tampa was the principal water user from the Hillsborough River for many years. In 1983, the City was issued a water use permit to use the Hillsborough River Reservoir at an annual average rate not to exceed 62 mgd and a maximum day withdrawal rate of 104 mgd. In 1985, augmentation of water supplies in the reservoir from the middle pool of the Tampa Byapss Canal began using a temporary pumping facility.

In 1989, as part of the renewal of their water use permit, the City of Tampa requested that the annual average withdrawal rate from the reservoir be increased from 62 to 82 mgd. A separate water use permit was issued that was jointly held by the City of Tampa and the West Coast Regional Water Supply Authority that allowed for augmentation of the HRR from pumpage from the TBC. This WUP allowed reservoir augmentation at an average annual rate of 20 mgd and maximum daily rate of 40 mgd. Augmentation water that is pumped into the Hillsborough River Reservoir from the TBC is included in withdrawal limits from the reservoir. In other words, withdrawals from the reservoir cannot exceed an annual average rate of 82 mgd, including water that originates from the TBC. The WUP for augmentation withdrawals from the TBC is now solely held by Tampa Bay Water, but water is augmented into the reservoir on a daily basis at the City of Tampa's request.

The renewal of the City of Tampa's water use permit for withdrawals from the Hillsborough River Reservoir and TBC was issued in January 1991. Due to concerns about the effects the increased permitted water use of the ecology of the LHR, a special condition was included in the permit that dealt with assessment of potential environmental impacts that could result from the increased withdrawals. That special condition required that an extensive three-year study be conducted of the freshwater flow relationships of Lower Hillsborough River below and the tidal reach of the Tampa Bypass Canal below Structure 160 (S160). The study included data collection for salinity, water quality, phytoplankton, benthic invertebrates and fishes.

The final report for that project documented that biological characteristics of the LHR changed during periods of no flow at the dam. During periods of flow from the dam, there was a complete salinity gradient in the lower river ranging from freshwater to polyhaline waters. The ecological characteristics of the TBC were less sensitive to the effects of freshwater flow, and the report concluded that due its highly modified morphology, the TBC represented a habitat bottleneck for estuarine dependent species and reductions of flow there should have not adverse impacts in the tidal reach of the TBC below S160.

The condition also required that a mathematical model of the reservoir/canal system be constructed. The ultimate goal of the ecological study and the application of the model was to determine an optimal withdrawal/augmentation schedule for the reservoir, TBC, and Sulphur Springs that minimizes downstream impacts while meeting the City's water supply needs. The condition also stated that if the final study report or District staff's analyses indicate that unacceptable adverse impacts are occurring or are anticipated to occur due to increased withdrawals from the reservoir, the City would be required to limit withdrawals from the reservoir to an acceptable impact.

The final report required by the special condition was prepared by Water and Air Research Inc, which conducted the ecological study, and SDI Environmental Services Inc., which developed and applied the hydrologic model of the reservoir/canal system. The report was published in 1995 and is commonly referred to as the WAR report (WAR/SDI 1995). The report concluded that if the TBC is used for increased reservoir augmentation, then the permitted increase in withdrawals should not cause unacceptable impacts in either the LHR or the tidal reach of the TBC.

The 1991 permit renewal also contained a special condition that applied during the course of the three-year study. In order to limit an increase in the number of no-flow days at the dam, any withdrawals from reservoir that were in excess of previous average rates for each month had to be made up by augmentation from the Tampa Bypass Canal. This mitigation plan was discontinued after the WAR/SDI study was published.

Based on these findings, the schedule by which the TBC could be used to augment the reservoir was gradually expanded. The 1991 permit stipulated that augmentation could not occur until water levels in the reservoir fell to 19.0 feet NGVD during the months July through December and to 21.0 feet during the months March through June. In 1993 this schedule was changed to allow augmentation when water levels fell to 21.0 feet year-round. In order to allow maximum augmentation from the TBC, the permit was again modified in 1996 to allow augmentation from the canal when water levels in the reservoir fell below the dam spillway elevation of 22.5 feet.

In 2004, the City's water use permit was renewed to include a modification that increased the maximum daily quantity from 104 mgd to 120 mgd to allow for the storage of surface water underground using Aquifer-Storage-Recovery (ASR). Recharge to the ASR wells could only occur when flows at the dam spillway were greater than 35 cfs.

When the City's WUP was being renewed in 2004, the District was conducting a study to re-evaluate a minimum flow rate of 10 cfs that was adopted for the Lower Hillsborough River in 1999. Accordingly, the WUP contained a special condition that required the City to maintain a minimum flow of 10 cfs to the LHR, allowing for diversions from Sulphur Springs or other alternative sources to be used to provide this flow.

However, since a re-evaluation of that minimum flow rule was ongoing, another special condition stated that "upon approval or modification of any of the Minimum Flows or Levels for the Sulphur Springs, the Tampa Bypass Canal, or the lower Hillsborough River, the City shall comply with the terms of the approved or modified Minimum Flows and Levels." This type of condition is now routinely contained in water use permits for surface water withdrawals from rivers, and in my opinion, means that the withdrawal schedules and/or permitted quantities can be adjusted to comply with required minimum flows. However, the utilization of alternative water sources is also an option that can be used to provide part or all of the minimum flows.

4.4.2 Permitted water use from the reservoir/canal system for Tampa Bay Water

Due in large cutbacks in permitted water use from the its central wellfield network, Tampa Bay Water (TBW) applied for water use permits to utilize surface waters from the Tampa Bypass Canal and the Hillsborough and Alafia Rivers in the late 1990s. Withdrawals for these three sources can be conveyed directly to the TBW's water treatment facility located near the Tampa Bypass Canal or to the C. W. "Bill" Young Reservoir in southern Hillsborough County.

In 1999, Tampa Bay Water was issued a water use permit to withdraw water from the Tampa Bypass Canal and the Hillsborough River. Intakes for withdrawals were installed on both the middle and lower pools of the TBC. Withdrawals from the Hillsborough River are implemented by diverting water from the Hillsborough River Reservoir through the Harney Canal and then withdrawal at the intake sites on the TBC.

Diversions from the river reservoir to the TBC for water supply were regulated under a sliding diversion schedule contained in the permit. When flows to the LHR at the dam spillway were less than 100 cfs, no diversions to the TBC could occur. At flow rates between 100 and 150 cfs, ten percent of the flow over the dam could be diverted to the TBC for water supply. At flows between 150 and 215 cfs, a sliding scale was employed that gradually increased the allowable diversions from ten to thirty percent. The thirty percent diversion rate remained in effect up to a flow rate of 1,000 cfs, above which diversions were limited to a maximum rate of 300 cfs.

Withdrawals directly from the TBC (not including diversions from the Hillsborough River Reservoir), were regulated under a schedule that was based on ranges of water levels in the TBC and flows at Structure 160 (S160), which separates the freshwater and tidal reaches of the TBC. When flows at S160 were below 11 cfs, no withdrawals from either the lower of middle pools of the TBC were allowed. When flows at S160 were above 11 cfs, 80% of the flow at S160 could be withdrawn up to a maximum withdrawal rate of 100 cfs. However, withdrawals from the middle pool could not occur until water levels in the middle pool were over 14 feet, or the District was maintaining a water level less than 14 feet and the flows at S160 were greater than 100 cfs.

Combined withdrawals directly from the middle and lower pools could not exceed a total withdrawal rate of 100 cfs. Combined with diversions from the Hillsborough River Reservoir, total withdrawals could not exceed a rate of 400 cfs, equivalent to 258 mgd. There were other restrictions related to head differences in water levels between the reservoir and the pools in the TBC that are not summarized in this document.

The 1999 permit did not specify an annual average combined withdrawal rate from the reservoir/canal system, but the 400 cfs diversion capacity served a maximum daily withdrawal limit. The permit did contain a table that listed average yearly quantities that could be diverted from the Hillsborough River Reservoir and directly from the Tampa Bypass Canal for the period 1975 though 1995. The average withdrawal rates for these two sources for this 21-year period were 31.0 mgd for the diversions from the Hillsborough River Reservoir and 29.5 mgd directly from the TBC, which combined total an average of 60.5 mgd. However, as will be discussed further, this value is somewhat misleading because the water supply yield from the reservoir/canal system is much less in dry years.

The 1999 permit also required that a hydrobiological monitoring program (HBMP) be conducted to assess potential impacts to the LHR and tidal reach of the TBC and McKay Bay due to the permitted withdrawals. The HBMP was very extensive and continues today, although some of the major monitoring components have been discontinued in recent years. The HBMP has produced a very extensive data base for the water quality and biological characteristics of the affected downstream water bodies and analyses conducted for the HBMP have not found any adverse impacts that can be attributed to withdrawals by Tampa Bay Water.

As will be discussed further in the next section of this report, the District in 2007 established a minimum flow of zero cfs for the Tampa Bypass Canal at S160. Largely in response to this development, the permit issued to Tampa Bay Water for withdrawals from the reservoir/canal system was modified during that same year. This 2007 permit modification established a average daily withdrawal limit of 85 mgd from the combined reservoir/canal system and retained the maximum day withdrawal limit of 400 cfs.

The 2007 permit modification increased the maximum diversion rate from the Hillsborough River Reservoir from 30 percent to 40 percent at mid-range flows. The withdrawal limit from the lower pool was also changed from 80 percent to 100 percent of the flow at S160 as long as water levels in the lower pool were above 9.0 feet NGVD. The low flow cutoff of 11 cfs was eliminated from the permit, but it was understood the District would divert up to 11 cfs from the TBC to the Hillsborough River to meet minimum flows for the LHR. In addition, 100 percent of flow could be withdrawn from the middle pool as long as water levels in the middle pool were over 14.0 feet and flows at S160 were above 100 cfs.

Both the 1997 permit and the 2007 permit modification contained a special condition that pertained to the establishment of minimum flows for both the LHR and the Tampa Bypass Canal. Special condition number 17 in the 2007 permit modification states that it was anticipated that minimum flows for the LHR and the TBC would be established during the term of that water use permit. The special condition states "Once minimum flows are established, this water use permit may be subject to additional comprehensive review by the District during the term of this permit. The decision as to the need for further modification or review of the permit shall be made by the District after adoption of minimum flows for the Hillsborough River and TBC systems."

4.4.3 Chronology of minimum flows analyses and adoption for the Lower Hillsborough River and Tampa Bypass Canal

A brief chronology of key developments in the establishment of minimum flows for the Lower Hillsborough River and the Tampa Bypass Canal is provided in the following section. In addition to the conditions and restrictions applied in water use permitting, the establishment of minimum flows is a legislatively mandated tool employed by the District to establish the environmental flow requirements of streams and rivers. In response to legislative action in 1996, the District accelerated its efforts for the technical evaluation and adoption of minimum flows in the region.

In October 1996, the District requested that the Tampa Bay National Estuary Program (TBNEP) convene a technical advisory group to provide recommendations for criteria for setting minimum flows on the Lower Hillsborough River and tidal reach of the Tampa Bypass Canal. The

advisory group met on approximately a monthly basis and provided summary recommendations to the District on July 10, 1997.

Minimum flows for the Lower Hillsborough River

The District conducted analyses of existing data and the results of hydrodynamic modeling of salinity distributions in the LHR. Based on my analyses of the data and review of the modeling results, I initially suggested that the minimum flow be 30 cfs when water levels in the reservoir were greater than 19.0 feet NGVD and 20 cfs when water levels in the reservoir were less than 19.0 feet, with diversions from Sulphur Springs used to provide half of each of these minimum flows. Based on internal discussions at the District, I revised my proposal to 10 cfs of freshwater release from the reservoir, with the amount diversion available from Sulphur Springs to be determined at a future date subject to additional study of the spring system.

This proposal was later revised by the District to allow Sulphur Springs to be used to provide the 10 cfs minimum flow to the LHR. In February 1999, the District Governing Board adopted a minimum flow rule for the Lower Hillsborough River of 10 cfs, but because the storage of water in the reservoir was critical to public health, safety and welfare, the minimum flow could be met with the diversion of water from other sources (i.e., Sulphur Springs).

The 10 cfs minimum flow that was adopted in 1999 was not widely accepted by the public, particularly the Friends of the River, a citizen group that was concerned with the establishment of minimum flows for the LHR. The Friends of the River filed an administrative challenge to the rule, but an agreement was reached in which the District agreed to conduct a five-year study and re-evaluate the minimum flows for the lower river. Similarly, the scientific review panel that reviewed the District report that proposed the 10 cfs minimum flow with alternative sources did not find this minimum flow rate to be well justified, and suggested that it be a place holder to be used in adaptive management strategy in which other minimum flow rates were investigated.

The District, with much work done by a local consultant (Janicki Environmental, Inc.), analyzed data from the five-year re-evaluation study, and in August 2006, produced a report that proposed a revised minimum flow for the LHR of 20 cfs freshwater equivalent (SWFWMD 2006). However, the scientific panel that reviewed that report suggested that the minimum flow be increased to a rate of 24 cfs freshwater equivalent in the months of April, May, and June due to high utilization of low salinity habitats by estuarine species during those months (Montagna et al. 2006) Accordingly, in August 2007, the District adopted minimum flows of 20 and 24 cfs freshwater equivalent at the base of the dam that vary by month. These minimum flows are currently in effect.

Minimum flows legislation that was enacted by the Florida Legislature in 1997 specified that if a river is not meeting its minimum flows, then a recovery strategy must be developed to achieve the minimum flows as soon as practicable. Accordingly, in 2007 along with the adoption of the current minimum flows, the District Governing Board also adopted the recovery strategy for the Lower Hillsborough River that is described in Chapter Three of this report.

Minimum flows for the Tampa Bypass Canal

As part of a larger effort to establish minimum flows and levels for the Northern Tampa Bay area, the District conducted a minimum flow analysis of the Tampa Bypass Canal, and in 1999, produced a report that recommended a minimum flow of zero cfs for the Tampa Bypass Canal at S160. However, the scientific review panel that reviewed this report found that the data utilized in the District's analysis were very limited at low flows and the District's analysis did not account for the frequency and duration of that a flow rate of zero cfs could occur. The panel recommended that the District develop a mechanistic model that could be used to evaluate the effects of different minimum flow strategies on salinity distributions in the TBC/McKay Bay system.

In response to the peer review panel's comments, the District began a more comprehensive analysis minimum flows for the TBC, including the use of a three-dimensional hydrodynamic model of the system that was used to evaluate changes in salinity distributions in relation to freshwater flow at S160. The District produced a report in 2005 that included assessments of relationships of flows from S160 with salinity distributions in the estuary and potential effects on the biological communities in the estuary (SWFWMD 2005). The District's report concluded that because of the dramatic physical alteration of the former Six Mile Creek/ Palm River system that was excavated to form the Tampa Bypass Canal, the estuarine resources in the tidal reaches of the TBC and McKay Bay were insensitive to the effects of freshwater flow and that a minimum flow for the Tampa Bypass Canal should not be adopted.

The scientific panel that reviewed this report supported the District's findings and agreed with the conclusion to not the establish minimum flows on the TBC (Powell et al. 2005). In response to this peer review report, the District adopted a minimum flows of zero cfs for the Tampa Bypass Canal in 2006. However, the potential impacts of reduced flows to the TBC have continued to be evaluated as part of the Hydrobiological Monitoring Program conducted as part of the special conditions of the water use permit issued to Tampa Bay Water for withdrawals from the TBC. As described on page 18, the HBMP has not documented any adverse impacts to the resources of the TBC/McKay Bay system as a result of the permitted withdrawals.

4.4.4 Comparison of minimum flow requirements and permitted and actual water use from the reservoir / canal system

Along with documenting the chronology of changes in the issuance of water user permits from and the development of minimum flows for the LHR and TBC, it is useful to examine changes in permitted and actual water use from the Hillsborough River Reservoir / Tampa Bypass Canal system and compare these values to the requirements of the adopted minimum flows.

In the time that the District first expressed concern about decreases in flow to the LHR and required permit conditions that dealt with this matter, the annual average permitted withdrawals from the reservoir/canal system have increased from 62 mgd to 167 mgd. The permitted maximum day quantities have increased for 104 mgd to 378 mgd. These values correspond to the increase in permitted withdrawals beginning with the City of Tampa permit renewal in 1991 to the sum of the permitted withdrawals included in the City of Tampa's 2004 permit renewal and Tampa Bay Water's 2007 permit modification.

This increase in permitted withdrawal rates is misleading, however, because the yield of the reservoir/canal system varies dramatically between wet and dry years. During prolonged dry periods, water use from the system is largely restricted to water use by the City of Tampa, as the water levels in the reservoir are below the dam spillway and there is augmentation of the reservoir by pumpage from the middle pool of the TBC. During months when there is extensive reservoir augmentation, Tampa Bay Water typically does not withdraw much water from either the lower of middle pool of the TBC. Thus, in years with prolonged dry periods, the yield of the reservoir/canal system is most limited. These are also the years in which minimum flows will most often be in effect.

Conversely, during wet years the yield of reservoir/canal system can be much greater. When there is flow over the dam spillway, the City does not augment the water supplies in the reservoir with pumpage from the TBC. When flows at the dam are over 100 cfs, Tampa Bay Water can divert flows from the reservoir into the TBC for additional withdrawal and use.

Figure 6 shows the combined average monthly withdrawals rates from the reservoir/canal system by the City of Tampa and Tampa Bay Water for the years 1991 though 2012. Augmentation rates of the reservoir by pumpage from the TBC are not included in these values, as they accounted for in withdrawals from the reservoir by the City. Withdrawal rates prior to 2002 were relatively stable as they were comprised solely by withdrawals by the City of Tampa. Withdrawals by the City were low in 2000 and 2001 due to a prolonged drought in the region and low water levels in the reservoir.

Monthly withdrawals from the reservoir/canal system began to increase dramatically late in the summer of 2002 when Tampa Bay Water began to utilize water from the system. High flows in the river began in the fall of 2002 and continued through much of 2003 and 2004, which allowed for relatively large withdrawals from the reservoir/canal system. However, during dry periods, such as during 2007, 2009 and 2012, combined monthly withdrawals by the City and Tampa Bay Water were occasionally below 50 mgd due to low water levels in the reservoir and the TBC.

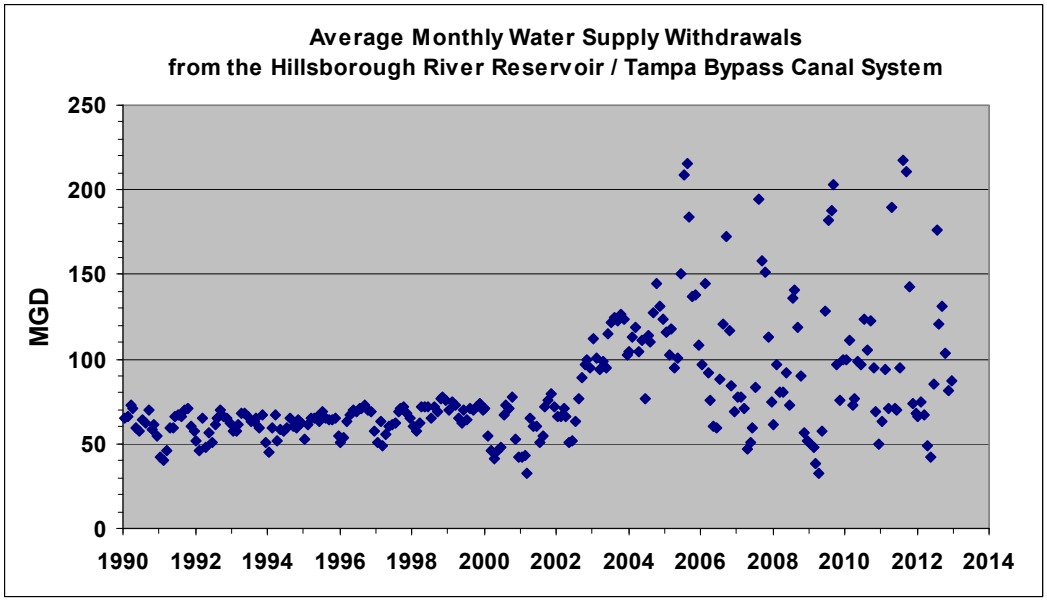

Figure 6. Average monthly combined water supply withdrawals from the Hillsborough River Reservoir / Tampa Bypass Canal system by the City of Tampa and Tampa Bay Water for the years 1991 - 2012.

Figure 7 shows the average yearly combined withdrawals from the reservoir/canal system for the City and Tampa Bay Water. As previously discussed for monthly withdrawals, average yearly withdrawals were relatively stable between 1991 and 2001 due to the City of Tampa being the sole water user on the system. The overall average with withdrawal rate was 62.3 mgd for this eleven-year period, with the highest yearly rate of 69.7 mgd occurring in 1999 and the lowest yearly withdrawal rate of 57.5 mgd occurring in the drought year of 2000.

Large increases in yearly withdrawals began in 2003, which was the first full year in which withdrawals from the system by Tampa Bay Water were implemented. The overall average withdrawal rate for period 2003 to 2012 was 104.9 mgd. As previously discussed for monthly withdrawals, the highest yeary withdrawals occurred from 2003 to 2005 due to high flows in the Hillsborough River, peaking with a yearly withdrawal rate of 139.8 mgd in 2005. The lowest average yearly withdrawal rate since 2003 was 89.9 mgd in 2008.

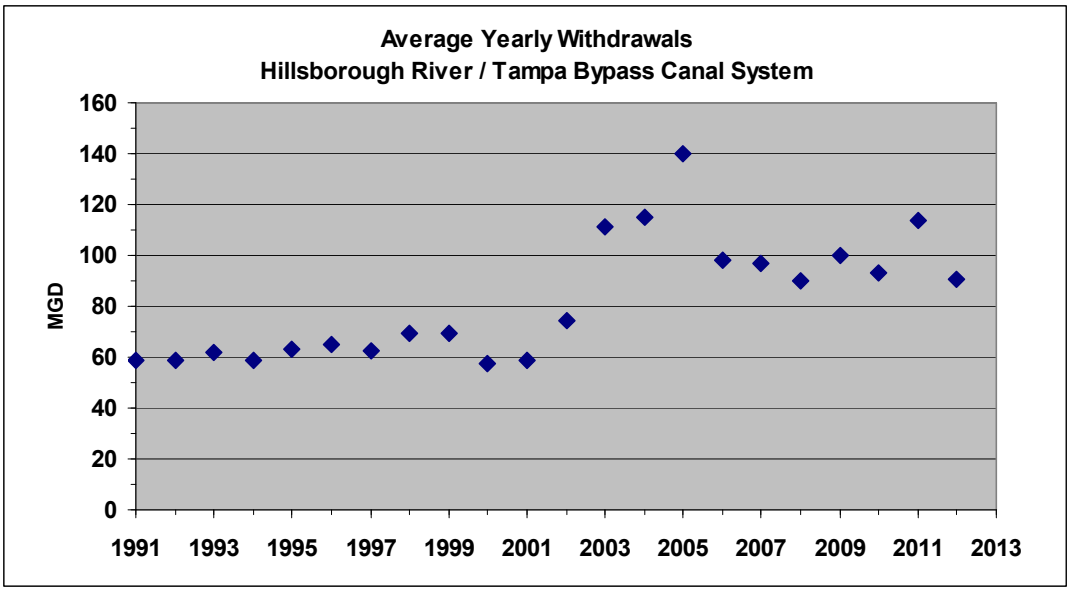

Figure 7. Average yearly combined water supply withdrawals from the Hillsborough River Reservoir / Tampa Bypass Canal System by the City of Tampa and Tampa Bay Water for the years 1991 - 2012.

These data illustrate the large increases water use that has been permitted by the District during the period when it was recognized that minimum flows were needed for the Hillsborough River below the dam. The average withdrawal rate of 104.9 mgd for the 2003-2012 period represents a sixty-eight percent increase in water use compared to the 1991-2001 period. The year 2002 is left out of this comparison because Tampa Bay Water implemented their withdrawals late in that year.

By contrast, the water that would have been released from the Tampa Bypass Canal to the LHR for minimum flows had the current minimum flows been in effect can be estimated for this same period. The recovery strategy specifies that 7.1 mgd (11 cfs) of water will be diverted from the TBC to the reservoir for minimum flows, with 75% of this water released to the lower river, which

equals a release rate of 5.3 mgd or 8.3 cfs. Minimum flows would have been needed for 53.7 percent of days during 2003 to 2012 Multiplying this release rate by 53.7 % yields an average minimum flow rate obtained from the reservoir/canal system of 2.9 mgd or 4.4 cfs. This average minimum flow release is equivalent to 2.7 percent of the water that was withdrawn for water supply from the combined reservoir/canal system during the 2003-2012 period.

However, it can be argued that minimum flows will be in effect during the drier times of the year, when water supplies available from the reservoir/canal system are more limited. Figure 8 shows the combined average yearly withdrawals from the reservoir/canal system with the average calculated only for days in which minimum flows would have been required within each calendar year. The number of days that minimum flows would have been required varied considerably between years, from 65 days in 2003 to 334 days in 2000. Different colored symbols are used in Figure 7 to denote years in which minimum flows would have been needed either less than or greater than 200 days per year.

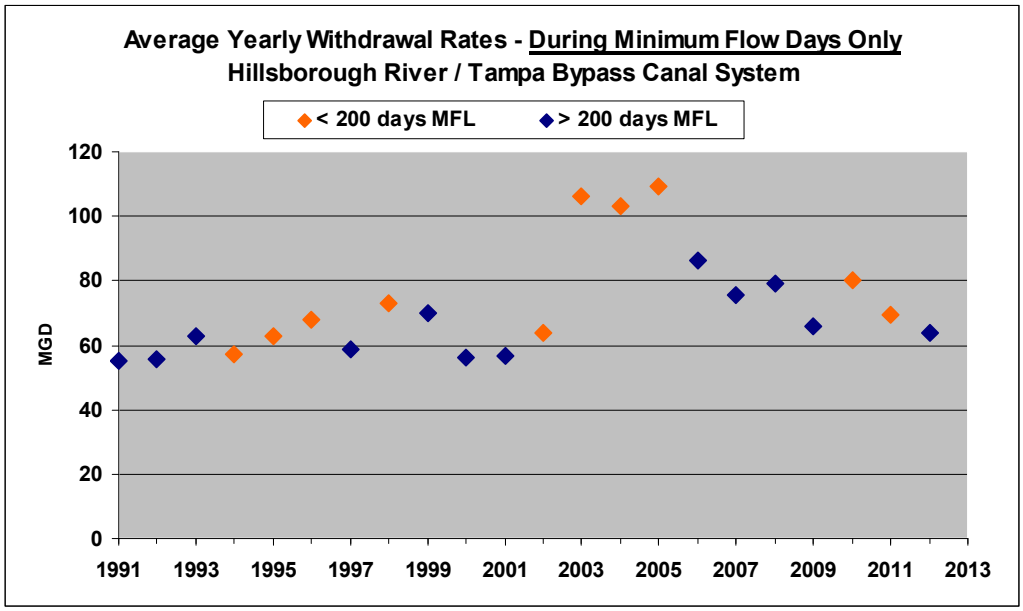

Figure 8. Average yearly combined water supply withdrawals from the Hillsborough River Reservoir / Tampa Bypass Canal System by the City of Tampa and Tampa Bay Water for the years 1991 - 2012 on days when the currently minimum flows for the LHR would have been in effect. Blue symbols represent years with greater than 200 days with minimum flows in effect for the lower river.

The average yearly combined withdrawal rates for days when minimum flows would have been in effect ranged from 55.1 mgd in the year 2000 to 109.0 mgd in 2005. For the period 1991-2001 when the City of Tampa was the sole water user on the system, average withdrawals during minimum flow days averaged 60.6 mgd. For the years 2003-2012, when Tampa Bay Water was also untilizing the reservoir/canal system, withdrawals during minimum flow days averaged 80.5 mgd. The 80.5 mgd value for 2003-2012 is 30 percent greater than the 62 mgd average annual permitted rate that was increased to 82 mgd in the 1991, when flows below the Hillsborough River dam first became a regulatory and scientific issue of concern.

It is also useful to examine the years 2008 to 2012, for this is when minimum flow water was diverted from the TBC to the lower river via the Hillsborough River Reservoir. This minimum flow usage produced additional demand from the TBC which could have affected water supply yields from this system. For this five-year period, water supply withdrawals from the reservoir/canal system during minimum flow days averaged 71.3 mgd. It is reiterated this value does not include the water diverted from the TBC for minimum flows.

4.5 Conclusion - The Tampa Bypass Canal should be a primary water source for providing minimum flows to the LHR

These findings from 2008 to 2012 demonstrate that the Hillsborough Reservoir / Tampa Bypass Canal system is capable of providing considerable quantities of water supply when the TBC is being used to provide minimum flows to the LHR. Secondly, given the history of permit conditions and technical studies conducted on the resources associated with the reservoir/canal system, it is my opinion that the District would have strong regulatory justification to require that the TBC be the primary, if not the only, water source used to provide minimum flows to the LHR other than diversions from Sulphur Springs.

Permit conditions that pertained to the potential effects of reductions of freshwater flow to the LHR were first initiated in 1991 when the City of Tampa's permit annual average quantity was increased from 62 to 82 mgd. Since that time, combined water use from reservoir/canal system has risen dramatically, with an average withdrawal of 104.9 mgd occurring during the years 2003-2012 when Tampa Bay Water' s withdrawal facilities were also in operation on the system.

The water use permits for both the City of Tampa and Tampa Bay water contain special conditions that state the permits may be subject to modification in order to comply with minimum flows. Given these conditions, both of these water use permits could be modified to provide water for minimum flows, even though the City and Tampa Bay Water are existing legal users of the water resource. This would be particularly justified since the large permitted increases in withdrawals were relatively recent and were granted when minimum flows investigations were underway.

However, modification of the water use permits may not be necessary as long as minimum flows are provided from the system. This in effect has been occurring since 2008, as the District has diverted up to 7.1 mgd (11 cfs) from the TBC to the reservoir for minimum flows. This has had minimal effects on the City of Tampa's augmentation of water supplies in the reservoir, because minimum flow diversions from the TBC middle pool are replaced by pumpage from the TBC lower pool. Tampa Bay Water is permitted to withdraw water from the lower pool, but this can happen as long as minimum flows are provided. I think the safeguard that minimum flows diversions from the TBC cease when water levels in the lower pool fall to 6.0 feet is justified. This restriction was implemented for 52 days in the spring of 2012.

The period since 2008 clearly shows that the TBC can be used along with Sulphur Springs to be a primary source for providing minimum flows. As discussed on pages 12 and 13, the minimum flows that have been achieved since 2008 have either met or come close to meeting the

minimum flows on many days. Secondly, as described in Section 4.2, the 25% loss term that is applied to minimum flows that are diverted from the TBC is not scientifically justified and greatly reducing or eliminating this loss term could bring more days into minimum flow compliance.

In some ways the TBC is an optimal source to provide both minimum flows and water supply. It is a very large highly modified system that was built for flood control, and due to the extensive network of structures and pumps on it, has very high management capabilities. If necessary to meet minimum flows on some days, the 11 cfs limit to diversions from the TBC specified in the recovery strategy could be increased if water levels in the TBC are not low.

Because of the highly modified nature of the TBC and the zero cfs minimum flow that was adopted for S160, the potential adverse environmental impacts of using the TBC are virtually non-existent. As will be described in Chapters 6 and 7, this in contrast to the Blue Sink and Morris Bridge Sink projects, which in my opinion both have significant potential for environmental impacts. As will be discussed in the recommendations, at a minimum, the TBC should be ranked ahead of Blue Sink in the priority of sources used for minimum flows.

5 A balanced approach is needed regarding the role of the Hillsborough Reservoir / Tampa Bypass Canal system in an integrated water supply plan for the use of surface water and groundwater resources in the region and the availability of alternative supplies

One of the most promising and effective strategies for meeting water supply needs in west-central Florida is the integrated use of surface water and groundwater resources. During high flows in the wet season, relatively large quantities of water may be available from rivers without causing unacceptable environmental impacts. During these wet periods a greater proportion of the water supplies can be obtained from surface water sources, thus alleviating demands on groundwater resources. Conversely, during periods of low flow, the amount of water that may be available from rivers can be very limited if environmental resources are to be protected.

The Hillsborough River / Tampa Bypass Canal system is used in such an integrated manner along with the regional water supply system that is operated by Tampa Bay Water. During times of high flow in the Hillsborough River, Tampa Bay Water is able to obtain substantial water supplies from the reservoir/canal system, thus relieving demands on regional groundwater resources. Along with withdrawals from the Alafia River, surface waters from the reservoir/canal system in excess of immediate water supply needs can be stored in the C.W. "Bill" Young reservoir, which is located in southern Hillsborough County, and withdrawn for later use.

Conversely, during dry periods, there is greater reliance by Tampa Bay Water on its central wellfield network or water can be withdrawn from storage in the C.W. Bill Young reservoir. If necessary, Tampa Bay Water can also utilize the desalination plant on Hillsborough Bay. If water supplies in the reservoir/canal system become low, the City of Tampa can purchase water from Tampa Bay Water. However, the City tries to rely on the reservoir/canal system as much as possible to minimize these purchases and hold down their yearly water production costs. In my opinion, that is a principal reason the City wants to build the Blue Sink project.

The development of water supplies from the Hillsborough River / Tampa Bypass Canal system by Tampa Bay Water has acted to reduce the impacts of groundwater withdrawals on the groundwater resource and natural systems such as lakes, wetlands and streams in the Northern Tampa Bay region. As part of the Recovery Strategy for Paso, Northern Hillsborough, and Pinellas Counties, it was required that the permitted 12-month moving average for withdrawals from the central wellfiled network be reduced from 150 mgd to 90 mgd. This has been successfully accomplished, as groundwater withdrawals from the wellfiled network have been reduced from an average of 151.8 mgd for a five-year period from 1997 to 2001 to an average value of 83.3 mgd during the five-year period from 2009 to 2013.

Given this cutback in groundwater use, it was necessary for Tampa Bay Water to develop alternative supplies, which included the construction of a desalination plant located on Hillsborough Bay and the development of surface water supplies from the Tampa Bypass Canal and the Hillsborough and Alafia Rivers. Withdrawals from the Alafia River, which were first implemented in 2001, are managed under a separate water use permit.

As with groundwater resources, the development of water supplies from surface water resources must account for potential environmental impacts and compliance with minimum flows and levels. Because of the highly urbanized character of the Lower Hillsborough River and it longstanding use as a water supply source from an impounded river, the District took a "bottom up " approach to determining minimum flows for the LHR. This approach simulated adding water to a no-flow condition to determine if there are breakpoints in the improvement of environmental conditions below the dam. This is fundamentally different than the approach the District takes on less impacted, unimpounded rivers such as the Alafia, in which environmentally safe withdrawal schedules are determined based on simulations of taking water away from the natural flow regime of the river.

The bottom up approach that was employed on the Hillsborough poses much less impact to water supply yields than would the application of a top down approach. In my opinion, the 20 and 24 cfs minimum flows for the LHR are very reasonable and achievable, especially since they allow for rerouting of water from Sulphur Springs. As discussed in Section 3.2, diversions from Sulphur Springs provide a majority of the minimum flows to the LHR.

As previously discussed, large increases in water use from the Hillsborough River / Tampa Bypass Canal have been granted during the time that is was known that minimum flows for the Lower Hillsborough River were needed. Accordingly, there are conditions in the permits for both the City of Tampa and Tampa Bay Water that if necessary, those permits can be modified to comply with minimum flows. In one way this has already happened, as the recovery strategy specifies that water from the TBC will be diverted into the Hillsborough River Reservoir to provide minimum flows to the LHR. However, these diversions are to occur after diversions from Blue Sink, and when water levels in the lower pool are less than 9.0 feet, diversions from Morris Bridge Sink are to be utilized before diversions from the TBC lower pool.

As will be discussed in later sections, it is my opinion is there some potential to use both Blue Sink and Morris Bridge Sink for minimum flows, but a better option would be to use them solely for emergency potable water supplies during times of water shortage.

Given the large quantities of water that have been permitted from the Hillsborough River / Tampa Bypass Canal system, it is my opinion that the District has clear regulatory authority and justification to require that the Tampa Bypass Canal be a primary source to be used along with Sulphur Springs to provide the required minimum flows to the Lower Hillsborough River. As previously discussed, the TBC has been used to provide minimum flows since 2008, and since the spring of 2012, the minimum flow rates that have been implemented have either met or come close to meeting the adopted minimum flows on many days.

5.1 The effects of various minimum flow recovery scenarios on the water supply yield of the reservoir/canal system need to be assessed

It has long been my position that minimum flows for the Lower Hillsborough River should be realistic and take into account impacts to the water supply yields from the reservoir/canal system. With my participation, in the late 1990s engineering staff at the District simulated the effects of different minimum flows rates on the water supply yields of the reservoir canal/system. These simulations included different augmentation rates of the reservoir from the TBC and Sulphur Springs. These results were not published in a District report, and I don't suggest revisiting them now, as they are outdated and contain some assumptions that may no longer apply.

To my knowledge, since that time there have not been simulations of the effects of the adopted minimum flows on the water supply yield of the reservoir/canal system. Tampa Bay Water has excellent modeling capabilities and may have performed such simulations, but if so, I do not know if these results were made available to the District or if they were considered in the development of the adopted LHR recovery strategy. However, my knowledge is limited, for I was not involved in the development of the LHR minimum flows recovery strategy.

At this time, I suggest that as part of a re-evaluation of the LHR recovery strategy, simulations be performed of the effects of different minimum flow recovery scenarios on the water supply yield of the reservoir/canal system. These scenarios should include the recovery strategy as it is currently adopted and scenarios which involve elimination of the 25% loss term and less reliance on Blue Sink and Morris Bridge Sink, including not using those sources for minimum flows. These results should be published and reviewed by the District, and if requested, made available to stakeholders on the system.

The review of such modeling results would be very valuable to assess how the reservoir/canal system could be used along with other water supply sources in the region, while maintaining environmentally sound minimum flows to the LHR that avoid impacts to other natural resources. During times of low water in the reservoir/canal system, water could be obtained from the regional water supply system, whether it is the central wellfield network, surface water stored in the Bill Young Reservoir, the City's aquifer-storage-recovery system, or from the Tampa Bay Water desalination plant.

It is my expectation that the effects of any modifications to the recovery strategy on the need for alternative water supply resources would be very small and well justified in an integrated water supply plan. Not all minimum flows that originate from the TBC would need to be replaced. In

many years, minimum flow water released early in the dry season is replaced by moderate to high flows in the river that occur between October and June that fill up the water storage in the reservoir and canal. However, in years with prolonged low flows in the dry season, a greater reliance on the TBC will result in slightly lower water levels in the reservoir/canal system than under the current strategy, which incorporates use of Blue Sink and Morris Bridge Sink.

Even if modifying the recovery strategy slightly lowers the yield of the reservoir/canal system, this may well be acceptable within the context of a integrated water supply plan for the region. At present, there is more water permitted and being used from the reservoir/canal system than from the entire Tampa Bay Water central wellfield network. Furthermore, the water that is required for minimum flows is very small compared to the water use from the reservoir/canal system. As described on page 23, if 8.3 cfs from the TBC was released to the lower river on all days that minimum flows were required during 2003 - 2012, it would have equaled 2.7 percent of the water used from the reservoir/canal system during that period. Given the heavy reliance on the Hillsborough River / Tampa Bypass Canal system and the low minimum flow requirements for the LHR, it may be that some small, increased reliance on alternative water supply sources is reasonable and well justified.

6 There is an over-reliance on diversions from Blue Sink with a potential for adverse impacts

As described in the overview of the recovery strategy in Chapter Three, diversions from Blue Sink are to be used second in priority after diversions from Sulphur Springs. Because the minimum flows are expressed in freshwater equivalents and the flow from Sulphur Springs is slightly brackish, diversions from Blue Sink will be in effect on all days that minimum flows are required.

As will be described further below, I suggest there is an over-reliance in Blue Sink in the recovery strategy and the strategy should be re-evaluated before the Blue Sink facility in constructed. As described on page 4, Blue Sink is the most expensive component in the recovery strategy, representing 48% of the total construction costs identified for the recovery strategy. Secondly, as discussed in Section 3.2, diversions from Sulphur Springs and the Tampa Bypass Canal are either meeting or coming close to meeting the minimum flows for the lower river on many days. There is an issue with regard to the growth of filamentous algae in Sulphur Springs Run, which may or may not, affect the amount of minimum flows that can be diverted from Sulphur Springs. However, as discussed in Section 4.2, the 25% loss term for diversions from the TBC is not scientifically justified and elimination of this loss term would make an additional 2.75 cfs of water available for minimum flows, which is close to quantity to be obtained from Blue Sink (3.1 cfs).

Accordingly, I suggest it would be preferable to put a greater reliance on diversions from the TBC and reduce or eliminate the need for diversions from Blue Sink. As previously discussed, diversions from the TBC have been successfully implemented since 2008. Diversions from the TBC or other alternative sources pose much less risk of adverse impacts than do diversions from Blue Sink. However, as discussed below, others believe the risks of diversions from Blue Sink are small.

6.1 Previous investigations of the history, water supply yield, and potential effects diversions from Blue Sink

The hydrologic and water supply characteristics of Blue Sink have been the subject of several previous investigations. These studies contain extensive information regarding the hydrologic characteristics of the sink, and in some cases, the results of previous pumping episodes from the sink. Consultants for the City of Tampa presented a review of previous hydrologic istudies for the Blue Sink in a feasibility assessment of using Blue Sink for minimum flows (MWH Inc. 2009). In a subsequent water use permit application to the District, the City's consultants also presented groundwater modeling scenarios that simulated the effects of withdrawing the projected 2 mgd of water from Blue Sink on nearby water resources (MWH 2013). These previous studies are all very informative and well written and it is beyond the scope of this report to do a thorough review of those findings. However, a chronology of those studies and some of their principal findings are described briefly below.

Stewart and Mills (1984) produced a USGS map series report that described the hydrogeology of the Sulphur Springs area, including the area around Blue Sink. In 1958, City of Tampa Water Department Staff conducted dye studies that found that water readily moved through the groundwater system from the Curiosity Creek / Blue Sink area to Sulphur Springs. In 1987, staff from the City of Tampa's stormwater division tried to recreate this test and the dye did not arrive at Sulphur Springs, thus a plugging of the sink by debris was surmised. However, there was connection observed between Ochid Sink and Sulphur Springs, with a travel time of 20 hours. Additional dye testing was done in 1989 by Environmental Engineering Consultants with similar conclusions (Environmental Engineering Consultants 1989).

Subsequent studies have also confirmed that that previous groundwater connection between Blue Sink and the flow path to Sulphur Springs has become clogged. Schreuder Inc. (1999) conducted hydraulic tests in 1999 that examined changes in water levels in nearby sinks and mointor wells in response to changes in water levels in Sulphur Springs. That study confirmed there remained good connection between Jasmine, Orchid, and Alaska Sinks with Sulphur Springs, but blockage was present downgradient from Blue Sink. Schreuder suggested that the blockage occured between 1974 and 1985. A subsequent data collection effort in 2001 indicated there was hydraulic connection between Sulphur Springs and a sink east of Florida Ave. near Northgage Lincoln Mercury, indicating the zone of plugging from Blue Sink was west of that location (Schreuder Inc. 2001). Later testing at a sink complex near the HondaLand automobile dealership on the west side of Florida Avenue indicated that the plugging was west of that sink complex (Schreuder Inc. 2004).

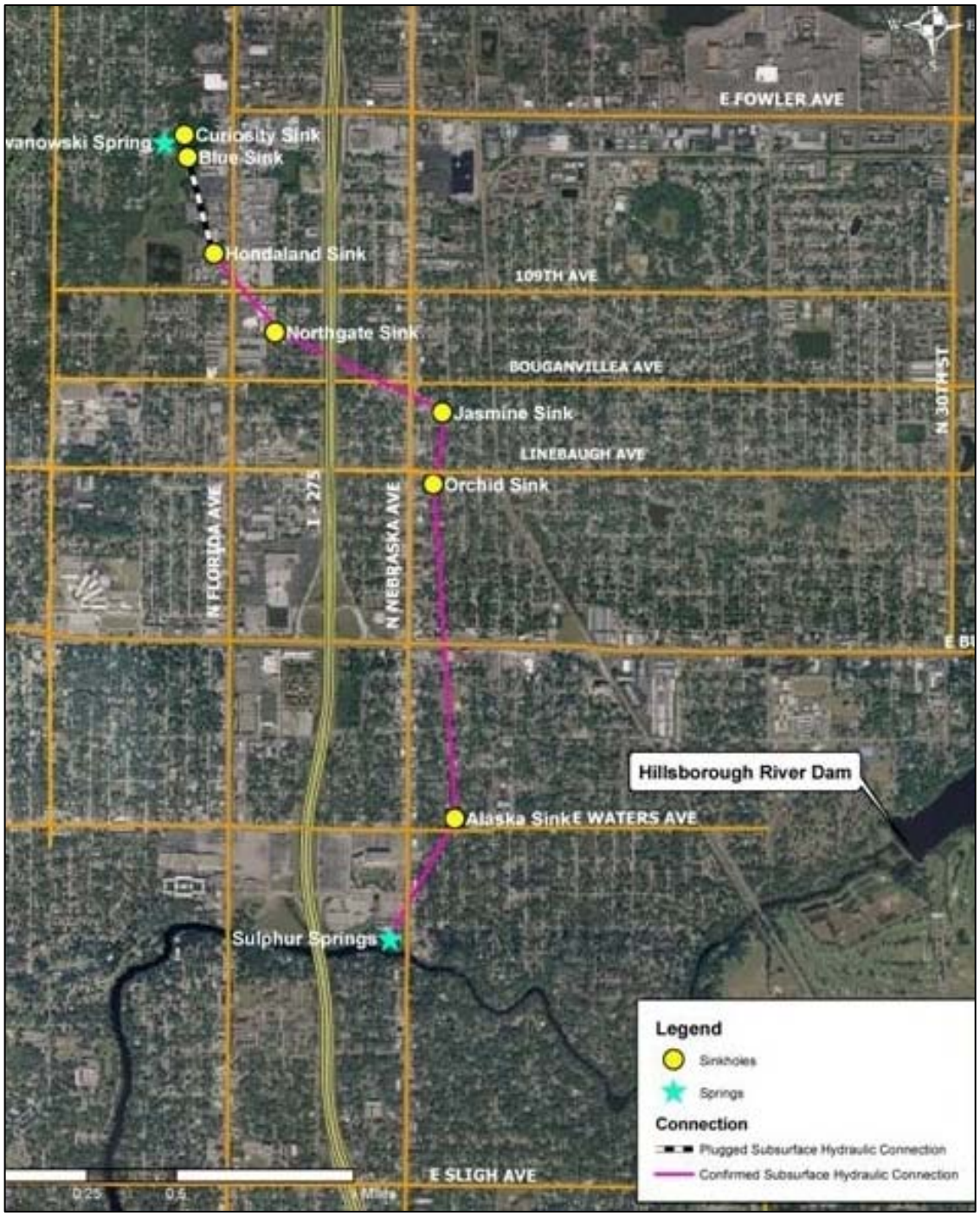

Figure 9. Map of the general groundwater flow path from Blue Sink to Sulphur Springs including other sinks and the area of plugging upgradient from Hondaland Sink (reprinted from MWH Inc. 2013).

Based on the findings of these studies, a map of the general groundwater flow path from Blue Sink to Sulphur Springs, including the intermediate sinks and the area of blockage is shown in Figure 9 above, which is reprinted from the water use application submitted by the City of Tampa for the use of Blue Springs for minimum flows (MWH 2013).

The studies of Blue Sink have also included three periods during which withdrawals were made from the sink, providing valuable data for the repsonse of the water resources in the vicinity of the sink during these pumping episodes. In 1997, the City of Tampa conducted a 10-day pumping test under the direction of Schreuder Inc. Withdrawal rates from the sink fluctuated between 4.3 and 4.6 mgd and resulted in a lowering of water levels in the sink from 23 feet to 18.5 feet NGVD. Water was pumped to a Florida Department of Transportation discharge point on the Hillsborough River via an existing pipe and ditch system (Scheuder Inc. 2001, MWH Inc. 2009).

The most prolonged pumping of Blue Sink occurred for 100 days from April 24th to August 2nd, 2000. This pumping was done to enhance emergency water supplies to the City of Tampa during the severe drought of that year. The City of Tampa used a series of existing pipes and new piping to convey withdrawals from Blue sink to Jasmine Sink in order to increase the groundwater flow from Jasmine Sink to Sulphur Springs. During this drought, water from Sulphur Springs was being diverted to the Hillsborough River Reservoir via a pipeline that runs from Sulphur Springs to the dam (Hydro-Services 2000, MWH Inc. 2009).

Pumping rates from Blue Sink started at 4 mgd in late April, then declined to 1.6 mgd in mid-June, then increased again to 2.5 mgd when summer rains provided recharge to the groundwater system. Water levels in five lakes and a number of monitor wells were monitored during this emergency pumping episode. The City concluded that no lakes were impacted by the pumping, but water levels in Sulphur Springs showed a positive response to the diversions from Blue Sink, as there was increased flow to Sulphur Springs from Jasmine Sink. The specific conductance and chloride concentrations in Sulphur Springs also showed a lowering of concentrations due to the increased flow of water from Jasmine Sink.

This emergency pumping episode was a very useful exercise as it demonstrated how diversions from Blue Sink could be used to enhance the flow and water quality of Sulphur Springs. Over recent decades, there has been a declining flow trend in Sulphur Springs (Schreuder Inc. 2001, SWFWMD 2004). Schreuder Inc. (2001) suggested the plugging of flow from Blue Sink has contributed to the observed flow decline for Sulphur Springs, thus the diversion of water from Blue Sink to Jasmine or Orchid Sink could act to counteract this decline in flows to some degree.

As described in more detail by Schreuder Inc. (2004) and the District minimum flows report for Sulphur Springs (SWFWMD 2004), exploration of the cave network that contributes flow to Sulphur Springs has shown that water higher in specific conductance flows from the Alaska tunnel, while water lower in specific conductance (and total dissolved solids) flows from the Orchid tunnel that comes from Jasmine and Orchid Sinks (Figure 10). Thus, the supplementation of flow in Jasmine or Orchid Sink can act to lower specific conductance of discharge from Sulphur Springs, as was observed during the emergency pumping episode in the year 2000.

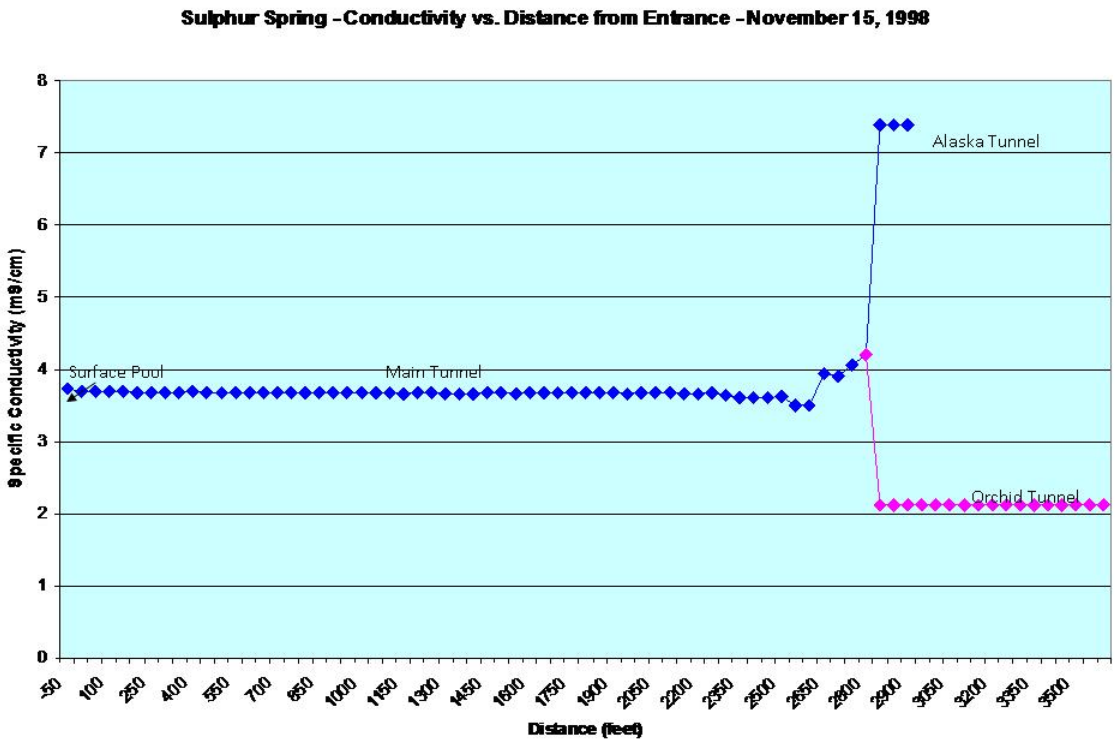

Figure 10. Specific conductance values in the main tunnel, the Alaska tunnel and the Orchid Tunnels that contribute flow to Sulphur Springs, recorded by scuba divers in 2004 (reprinted from SWFWMD 2004)

The District also performed two pumping tests of Blue Sink to test its ability to provide minimum flows to the Lower Hillsborough River. The first test was conducted in the months of May and early June in 2008. The water that was pumped from the sink was diverted to the F100C stormwater pond located directly south of the sink. During the pumping test, water levels were recorded in Blue Sink, Ewanowski Spring, and number of lakes and monitor wells in the area. Ewanowski Spring is a small spring that discharges to Curiosity Creek about 375 feet upstream of Blue Sink.

A mechanical failure interrupted the 2008 pumping for more than 36 hours in late May, which did not allow for the 30 days of continual pumping from the sink that was the goal of the test. As a result of this mechanical failure, the pumping test was repeated in the spring of 2009.

The 2009 pumping test for Blue Sink was conducted between March 2 and April 1, 2009. The pumping rate from the sink was maintained at a near constant rate of 2 mgd, since this is the quantity of minimum flow water to be provided from Blue Sink that is specified in the recovery strategy. Water levels were again monitored Blue Sink, Ewanowski Spring, and in a number of lakes and monitor wells in the vicinity. The spring of 2009 was very dry and there was only very small rainfall amounts during the pumping test and during the two weeks prior.

The full details of the data collection network and findings of the 2009 pumping test are provided in a report published by the District (SWFWMD 2009). The background water level trend for each monitoring site was determined by the difference in water level at the beginning of the pump test and water level the morning of April 12th, or 11 days after the pumping from Blue Sink had ceased. The selection of April 12th was based on examination of Blue Sink's recovery after pumping was terminated. Water level rise in the sink has slowed to just 0.01 feet per day after 11 days of recovery (Figure 11). A rainfall event of 1.4 inches was recorded at a nearby rainfall site on April 14th.

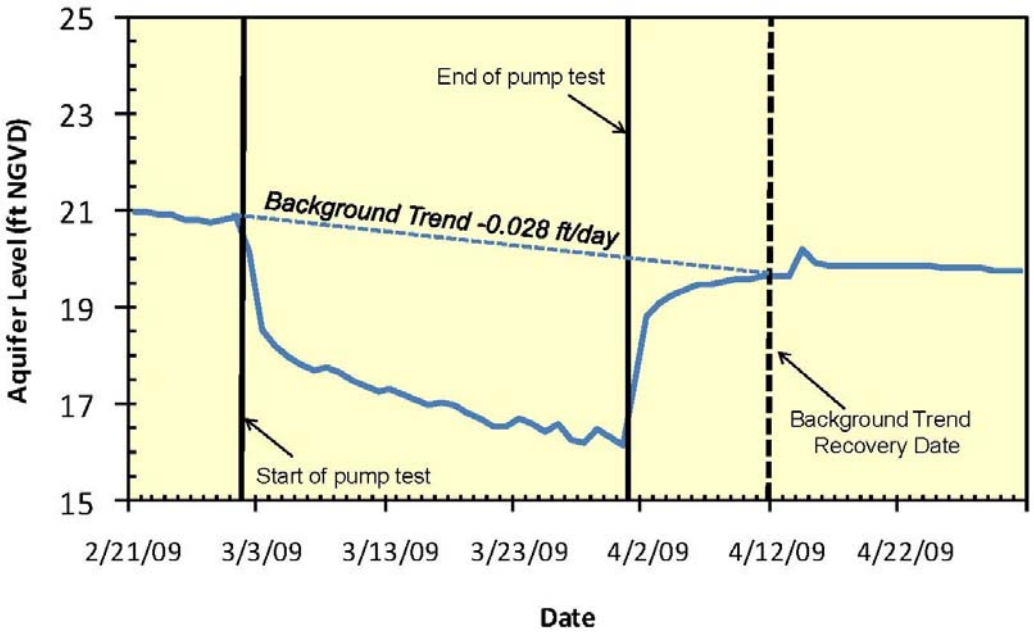

Figure 11. Hydrograph of water levels in Blue sink with background trend illustrated, reprinted from SWFWMD (2009).

The drawdown in Blue Sink reached a quasi steady state condition after about 25 days of withdrawal, as the amount of drawdown remained relatively stable at 3.7 feet. The drawdown in Ewanowski Spring after the 3-day test was approximately 3.9 feet. When withdrawals are not being made from Blue Sink, water from Curiosity Creek normally covers Ewanowski Spring, which likely retards discharge from the spring vent. During the pumping test, when water levels over the spring vent were lower, water was observed to flow from Ewanowski Spring into Blue Sink, which resulted in an apparent increase in water clarity in Blue Sink.

The District report also contains information on predicted drawdowns for a number of lakes and monitor wells in the area, as well as estimates of aquifer transmissivity and storage coefficients within the Upper Floridan aquifer that were derived from the drawdown results. The District report concluded that the pumping test indicates that Blue Sink can likely provide up to 2 mgd (3.1 cfs) of water to assist in meeting the minimum flows for the Lower Hillsborough River. Impacts to nearby lakes were not significant during the duration of the pumping test and drawdown with in the Upper Floridan aquifer mostly varied 0.5 to 2.5 feet within one-half mile of Blue Sink.

6.2 Water use permit application for withdrawals from Blue Sink

Following publication of the District's pumping test report, the City of Tampa submitted an application for a water use permit to withdraw water from Blue Sink for use in the minimum flows recovery strategy for the Lower Hillsborough River (MWH 2013). In keeping with the 2 mgd withdrawal rate from Blue Sink that was identified in the recovery strategy and subsequently implemented in the pumping test conducted by the District, the City requested a peak withdrawal rate of 2 mgd from Blue Sink.

As part of the permit application process, the City and their consultant (MWH Inc.) interacted with the District to develop a groundwater modeling procedure to be used for evaluating the potential effects of the requested withdrawals. The model simulations utilized the most recent version of the SWFWMD District-Wide Regional Model Version 2 (DWRMW2) numerical groundwater model. The City's consultants created a more localized groundwater model derived from DWRM2, referred to as a Focus Telescopic Mesh Refinement Mode (FTMR), to refine the District model in the area near Blue Sink and incorporate the findings of the 2009 pump test.

The City also interacted with the District to identify how often withdrawals from Blue Sink would be needed on a worst case basis. Based on analyses conducted by the City's consultants and myself, it was concluded that the longest periods of pumpage would be either 287 to 288 days in either calendar year 2006 or in the dry season spanning the period from the fall of 2006 to the spring of 2007.

As a check on the maximum days that diversions from Blue Sink would be needed, MWH examined withdrawals that would be needed from the sink over any rolling 12-month period and concluded that, at most, Blue Sink would be needed for 318 days either between April 2006 to May 2007 or May 2006 to April 2007. Thus, to simulate a worst case condition in the permit application, the City presented groundwater modeling results for 318 consecutive days of pumpage from Blue Sink. Because it was a very dry year, rainfall during water year 2006-2007 was used for the simulation. To very conservative, the permit application also presented results for 365 days of pumpage. Those results did not differ significantly from the 318-day simulations and the 365-day simulations are not discussed in this report.

A graphic that shows the spatial distribution of predicted incremental drawdowns in the Upper Floridan Aquifer as a result of withdrawing 2 mgd from Blue Sink for 318 days is shown in Figure 12. The predicted drawdowns were approximately symmetric around Blue Sink. The 0.1 foot drawdown contour extends outward roughly three miles and the one-foot drawdown contour extends approximately 1.5 miles. For reference, I have inserted symbols to show location of Sulphur Springs and Jasmine sink in relation to the predicted drawdown contours.

The City also presented results for predicted drawdowns for 30 days of diversions from the Blue Sink and found that the differences in drawdowns between the 30-day and 318-day simulations were on the order of less than 0.2 feet. This corresponds to the District's conclusion that drawdowns associated with Blue Sink reach steady state condition after 25 to 30 days of

pumping. The City's permit application therefore concluded that "minimal Florida aquifer impacts in close proximity to Blue Sink will occur related to long term use of Blue Sink water to augment the Lower Hillsborough River."

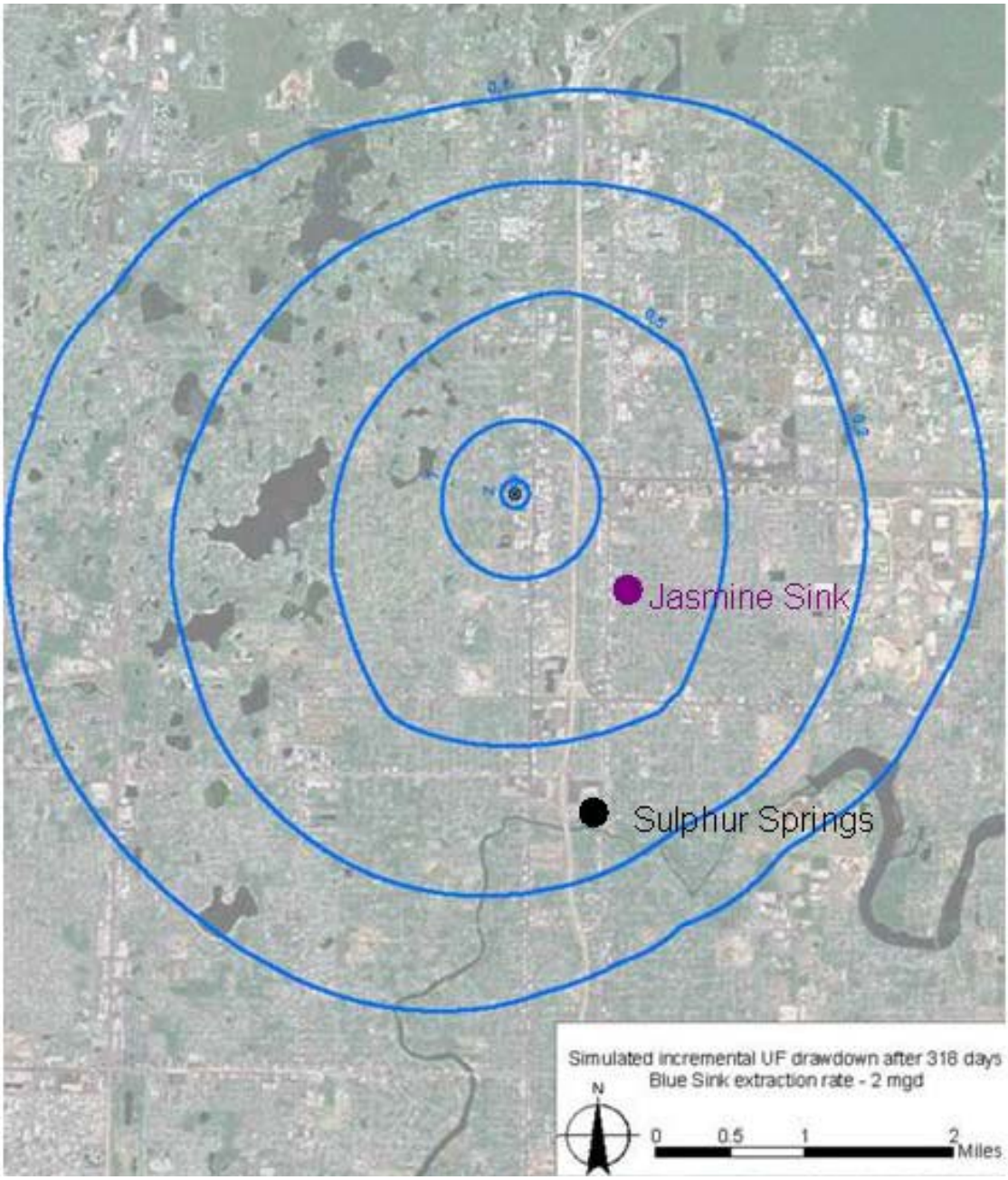

Figure 12. Predicted incremental drawdowns in the Upper Florida Aquifer for withdrawals of 318 consecutive days from Blue Sink showing the approximate location of Jasmine Sink and Sulphur Springs. Adapted from MWH Inc. (2013).

Based on the information presented of the City's permit application, the District concluded the City's request met the conditions for issuance, and in December 2013 issued a water use permit to the City for withdrawals from Blue Sink at a peak month quantity of 2 mgd and an annual average quantity of 1.74 mgd. The annual average quantity corresponds to a withdrawal rate of 2 mgd for 318 days prorated over a 12 month period. The water use permit contains a series of standard and special conditions, including that withdrawals from Blue Sink will be metered and the City shall address any water resource complaints associated with the withdrawals.

Special condition number eight specifies that the permit authorizes that withdrawals necessary for the environmental benefit of the lower Hillsborough River below the dam to assist in meeting the established minimum flow in Rule 40D-8.041(1)(b). The condition also states that "The Governing Board may amend the recovery strategy and minimum flow at any time. Therefore, this Permit is subject to modification to comply with new rules regarding the amended recovery strategy or minimum flow for the Lower Hillsborough River. "

6.3 Technical concerns with regard to the Blue Sink project

I have two general concerns with the use of the Blue Sink as it specified in the minimum flows recovery strategy for the Lower Hillsborough River. Those are: (1) Increasing the risk of sinkholes in the neighborhoods and urban areas near Blue Sink, and a (2); impacting the flow and water quality of discharge from Sulphur Springs.

6.3.1 Potential for increased sinkhole risk

In general, there should be a great deal of caution considered in placing a 2 mgd withdrawal in a densely populated urban/residential area such as that surrounding Blue Sink. I am not an expert on sinkhole risk by any means, for I am not a hydrogeologist by training. However, some general principals are worth considering with regard to the extensive use of Blue Sink that is expected given the requirements of the recovery strategy.

Sinkhole risk is significant factor in some areas of Florida and it has been well documented that large groundwater withdrawals can contribute to sinkholes (Tihanksy 1999). At two public workshops about the Blue Sink project that were conducted by the City of Tampa, there was large public attendance and repeated concerns voiced about the potential for sinkholes that could result from the project. The City of Tampa staff and their consultants told the crowd that sinkholes typically result from much greater and more sudden groundwater withdrawals, such as those that result from frost-freeze protection for crops, and that the risk of increased sinkholes from the Blue Sink project is very small.

A counter opinion regarding sinkhole risk was expressed in a letter to the Tampa Bay Times by retired hydrogeologist who lives in the area (Miller 2013). According to that letter, the area near Blue Sink contains many relict sinks, which are dormant features that are filled with sand that could be reactivated by groundwater pumping.

It should be noted that the area near Blue Sink contains a large number of karst sinkhole features. Blue Sink itself is located in a complex of sinks, plus there are the aforementioned major sinks in the area (e.g., Jasmine, Orchid, Hondaland) that are described in reports about Blue Sink that have been previously discussed (Schreuder Inc. 1999, 2001, 2004, SWFMWD 2009, MWH Inc. 2009). Due to its natural geologic characteristics, it appears that the area near Blue Sink is susceptible to sink formation.

It should be noted that pumping from Blue Sink has occurred in the past, most notably for over 100 days in the drought of 2000, and to my knowledge, no sinkholes were reported. However, the recovery strategy will call for much more extended pumpage from Blue Sink, with the most prolonged and continuous pumping occurring in the driest of years. The groundwater modeling analysis that was submitted for the water use permit indicates that the size of the drawdowns extending from Blue Sink will not expand greatly due to prolonged pumpage. However, it is reasonable to conclude that greater drawdowns will occur over time as pumpage continues. Similarly, even if the risk of sinkholes from the Blue Sink project may be small, it is likely the risk will increase as pumpage continues for long periods of time.

As previously discussed, it is my opinion the District has clear regulatory authority and justification to require that diversions from the Tampa Bypass Canal be a primary source for providing minimum flows to the LHR. Placing the TBC ahead of diversions from Blue Sink, and eliminating the 25% loss term for TBC withdrawals, could greatly reduce the quantities and duration that withdrawals would be needed from Blue Sink and any associated sinkhole risks.

6.3.2 Potential to reduce flow and increase the salinity of flow from Sulphur Springs

Sulphur Springs provides most of the minimum flows to the LHR and is the cornerstone of the minimum flows recovery strategy. Because of its central role in the minimum flows recovery strategy, both the flow and water quality of Sulphur Springs should be carefully managed. Because the goal of the minimum flow recovery strategy is to maintain a low salinity zone in the Lower Hillsborough River, it is important to try to maintain as much flow from Sulphur Springs as possible and also keep the salinity of the spring water as low as practicable.

If used as specified in the recovery strategy, the Blue Sink project has the potential to decrease the flow and increase the salinity of water discharging from Sulphur Springs. The groundwater model results presented in the City of Tampa's permit application indicate there will be drawdowns in the Upper Floridan aquifer at Jasmine Sink of between 0.5 and 1 feet (see Figure 12). It has been well established that groundwater readily flows from Jasmine and Orchid Sinks to Sulphur Springs. Although the predicted drawdowns at these sinks are relatively small, it is my opinion that prolonged withdrawals from Blue Sink could act to reduce flows to Sulphur Springs.

At the Governing Board meeting at which the water use permit for Blue Sink was issued to the City, a board member asked if the project was basically putting the system back the way nature had it. The representative for the City of Tampa said that was correct. Actually, the opposite is true. Water used to flow from Blue Sink toward Sulphur Springs. The Blue Sink project as it is now designed will pull water towards Blue Sink, opposite of the direction it used to flow.

As suggested by Schreuder Inc. (2001), the plugging of Blue Sink has created a mounding condition in both surface water and groundwater levels near the sink. However pumping water from the sink at a rate of 2 mgd lowers water in the sink and surrounding wells fairly rapidly, which likely removes this accumulated water. Prolonged pumpage from Blue Sink pulls additional water from the surrounding groundwater system, with increased potential to reduce flows in Sulphur Springs as the pumping continues through time.

Also, as shown in Figure 11, low salinity water (which can be calculated from specific conductance) flows from Orchid Sink and Jasmine sinks through the tunnel network that flows to Sulphur Springs. Higher salinity water flows in further downgradient from the Alaska tunnel. As a result, any reduction of flows from the contributing zone near Orchid and Jasmine Sinks also could act to increase the salinity of water discharging from Sulphur Springs.

As discussed by Schreuder Inc. (2001), the clogging of the aquifer downgradient of Blue Sink has likely contributed to flow declines that have been observed for Sulphur Springs. The diversion of water from Blue Sink to either Jasmine or Orchid Sinks, as was done during the emergency pumping during the year 2000, bypasses this blockage and enhances the flow of Sulphur Springs. Pumping water from Blue Sink to Jasmine or Orchid Sink does return the system to more natural flow, as was asked by the Governing Board member at the December 2013 meeting. The Blue Sink project as it is now designed does the opposite.

6.4 A reconsideration of options for Blue Sink

As described on page 8, consultants for the City of Tampa published a feasibility analysis in 2009 that examined a range of options for the Blue Sink project, including diverting water from Blue Sink to Jasmine or Orchid Sink (MWH 2009). However, for several reasons, the City concluded this was not the best plan for conveying minimum flow water to the base of the dam. Included in these reasons was that either Jasmine or Orchid sink could be subject to future clogging. The analysis concluded that the most effective and certain way to convey the 2 mgd to the base of the dam would be to pump it directly from the sink to pipeline that extends from Sulphur Springs to the base of the dam. Stated another way, if you pump 2 mgd of fresh water from Blue Sink, this plan best ensures that all or nearly all of that water will make it to the river below the dam.

The District reviewed a draft of the feasibility analysis and concurred with this conclusion. I was part of the District review team and agreed with this finding, as it represented the most feasible way to get the 2 mgd of water to the base of the dam. Based on this feasibility analysis and the issuance of the water use permit for withdrawals from Blue Sink, the City has designed the pump station at Blue Sink and a route for the pipeline from Blue Sink that extends to the pipeline that runs from Sulphur Springs to the Hillsborough River dam.

Upon further review of the findings and modeling results presented in water use permit application, it is my conclusion that the Blue Sink project as it is now designed is not a good plan for it will likely affect the flow and water quality of Sulphur Springs. Also, although the potential for increased sinkhole risk may be small, caution should be utilizing a 2 mgd

withdrawal in an urban/residential setting, and its would be best to use Blue Sink only when it is truly necessary, after utilizing other water sources.

As mentioned on page 1 of this report, I have made the case at meetings within the District that the minimum flows recovery strategy for the Lower Hillsborough River be re-evaluated before any new projects are constructed. The Blue Sink project is very expensive, and I think it is only prudent that all information collected to this point in time be considered before construction of the project is begun. At this juncture, I suggest the options described below be considered before for Blue Sink project is constructed. Any of these options could be considered within the context of a re-evaluation of the minimum flows recovery strategy for the Lower Hillsborough River, which should be the first step in the process.

6.4.1 Reconsider the option to divert water from Blue Sink to Jasmine or Orchid Sinks

As a first option, the plan to transfer diversions from Blue Sink to Jasmine or Orchid Sink should be reconsidered. Given the flow declines that have already occurred in Sulphur Springs and the critical role that Sulphur Springs plays in achieving the minimum flows, diverting water from Blue Sink to Jasmine or Orchid Sink could be very valuable in helping restore flow to Sulphur Springs. I realize this would be backtracking to some extent, as the feasibility analysis and design of the pipeline to connect with the Sulphur Springs pipeline has been largely completed. However, much of the design would largely be the same, including the pump house and much of the pipeline route.

The 2009 feasibility analysis found that ending the pipeline from Blue Sink at Jasmine or Orchid Sink saves considerable costs, as the total pipeline distance is much shorter (see Figure 9 for approximate distances). The current design that links to the Sulphur Springs pipeline goes very close to Jasime and Orchid Sinks and modification of this plan to end at one of these two sinks would use much of the current design. Considering the high cost of the Blue Sink project and the relatively small costs for any redesign work, a reconsideration of this option could be very valuable as it has real advantages with regard to managing the overall water resource.

6.4.2 Prioritize the use of Blue Sink after utilization of the Tampa Bypass Canal

In my opinion, the most problematic aspect of the recovery strategy is that diversions from Blue Sink are second in priority of use ahead of the Tampa Bypass Canal. Moving the TBC up in the priority schedule ahead of Blue Sink would greatly alleviate the need for diversions from Blue Sink and reduce any risks associated with diversions from the sink.

As previously discussed, the potential for adverse impacts from utilizing the Tampa Bypass Canal is negligible and the TBC has been successfully used to provide minimum flows since 2008. Also, considering the quantity of water that has been permitted from the reservoir/canal system in recent years and the conditions of that use, the District should have clear regulatory authority and justification to make the TBC a primary source for providing minimum flows, second in priority to diversions from Sulphur Springs. Also, reducing or eliminating the 25% loss term for minimum flow transfers from the TBC, would help achieve the adopted minimum flows.

6.4.3 Restrict the use of Blue Sink to emergency potable supply during water shortage

Given the alternatives sources that are available to provide minimum flows, I believe a more appropriate use for diversions from Blue Sink are to use them the way they were in the past - to provide emergency potable water supplies for the City of Tampa in times of water shortage. As was done in the year 2000, water that is diverted to Jasmine or Orchid Sinks supplements the flow of Sulphur Springs, which by permit can be diverted into the Hillsborough River Reservoir during times of water shortage.

This would employ the same pumping facilities as minimum flow option described above which diverts water from Blue Sink to Jasmine or Orchid Sink. However, compared to use for minimum flows, the pumping that would be for emergency potable supply would be much less frequent. If this type of facility was used for minimum flows and problems were encountered, its use for minimum flows could be discontinued with diversions limited to periods of water shortage, with less associated risk.

In my opinion, the currently designed system that diverts water from Blue Sink to the pipeline that runs from Sulphur Springs to the dam is best suited to be used as source of emergency potable supply during water shortage conditions. Fresh water from Blue Sink could be diverted directly to the reservoir, alleviating the problems with highly mineralized water that discharges from Sulpur Springs. As in the year 2000 drought, periods of pumpage from Blue Sink for emergency potable supply would be much less frequent and of shorter duration than is currently planned for minimum flows, with less associated risk. In my opinion, the current design for the Blue Sink project should not be constructed unless restricting it use to it for emergency potable supply is considered a viable option given the cost of the project.

6.4.4. Not construct the Blue Sink Project

As previously discussed, elimination of the scientifically unsupported 25% loss term for diversions from the TBC to the lower river and the increased use of the TBC could meet the minimum flows of the lower river. Thus, the Blue Sink project would not be needed. Not constructing the Blue Sink project would save approximately $10,000 and eliminate any increased risk for sinkholes or reductions in flow or increased in salinity in Sulphur Springs.

6.4.5 Relation of various options to restoration plans for Blue Sink

Some citizens would like to see water levels in Blue Sink and nearby reach of Curiosity Creek returned to what are more of a natural, historic condition. This would allow the discharge point for Ewanowski Spring to flow again and improve the aesthetic qualities of the creek and adjacent lands near Blue Sink. I appreciate the perspective of these people and believe that a restoration of lower water levels could a legitimate goal, if other adverse impacts can be avoided. However, I personally don't think the current situation is all that bad, as the aesthetic issues are limited to a very small area. The dead trees and stumps near Blue Sink could be removed and the area near the sink viewed more as a pond. Secondly, with regard to minimizing sinkhole risk, the most conservative thing to do with Blue Sink is to leave it alone.

Again, a restoration plan to lower water levels around Blue Sink could be suitable goal if other impacts can be avoided. In that regard, any plan to divert water from Blue Sink for restoration purposes should be done carefully with the frequent checking off water level data, adjustment of pumpage rates as needed, and contingency plans if problems develop.

The diversion of water from Blue Sink to Jasmine or Orchid Sink could be part of restoration plan for Blue Sink, but I suggest that any such diversions be managed very carefully on a short-term basis in response to water levels in and near Blue Sink. If these water levels become too low, these diversions should be temporarily discontinued. Also, if any problems with sinkholes arise, use of this facility should be discontinued or limited to times of water shortage, as was done in the year 2000 drought. As previously discussed, I do not support the current plan to divert water from Blue Sink to the Sulphur Spring pipeline for minimum flows for prolonged periods of time, as it may negatively affect the flow and water quality of Sulphr Springs.

Peter Schreuder of Schreuder Inc. has suggested that excess water in Blue Sink could be diverted a short distance south to the F100C storm drainage pond. By supplementing the pond's hydroperiod, a large viable wetland could be created which would serves as valuable wildlife habitat that could possibly include recreational fishing from the pond edge. An advantage of this plan is that the capital costs would be much less than the other options, because the distance to transport the water is much shorter. Using temporary pumping facilities, the District diverted water to the F100C pond during the 2008 and 2009 pumping tests. Since the capital costs of this plan are much less, any need to discontinue this plan would pose much less financial loss.

A Blue Sink restoration plan that involves diverting water to the F100C pond would do nothing to provide minimum flows to the Lower Hillsborough River. However, as previously discussed, I don't think that is critical that Blue Sink be used to provide minimum flows to the LHR given the availability of the TBC. Similar to diverting water from Blue Sink to the Sulphur Springs pipeline, diverting flow from Blue Sink to the F100C pond could possibly reduce flows to Sulphur Springs. Even though water is being transported only a short distance and there is likely some groundwater recharge through the F100C pond, I suspect there would be very high evapotranspiration losses from the F100C pond compared to Blue Sink. In sum, as a restoration plan for Blue Sink, I don't that routing excess water to the F100C pond is as desirable as routing excess water from Blue Sink to Jasmine or Orchid Sink, but it does involve much less financial investment and does have the benefit of creating wildlife habitat in an urban setting.

7 Technical concerns with the projected use of Morris Bridge Sink

Morris Bridge Sink is a natural sinkhole that is located about 0.6 miles south of the Hillsborough River in a predominantly rural area near Interstate 75 east of the cities of Tampa and Temple Terrace (Figure 13). The sink lies on land owned by the District that is part of the Lower Hillsborough Wilderness Preserve, which is part of the Lower Hillsborough River Flood Detention Area. The District lands are undeveloped, but there is some low density residential development between the District land and Morris Bridge Road. The upper reaches of the Tampa Bypass Canal lie about 3,400 feet southwest of Morris Bridge Sink.

Morris Bridge Sink is approximately 135 feet in diameter and 200 feet deep. Another sink, called Nursery Sink, lies about 750 feet east of Morris Bridge Sink. There are three isolated wetland systems near Morris Bridge Sink that total about 69 acres between the floodplains of the Hillsborough River and Cowhouse Creek.

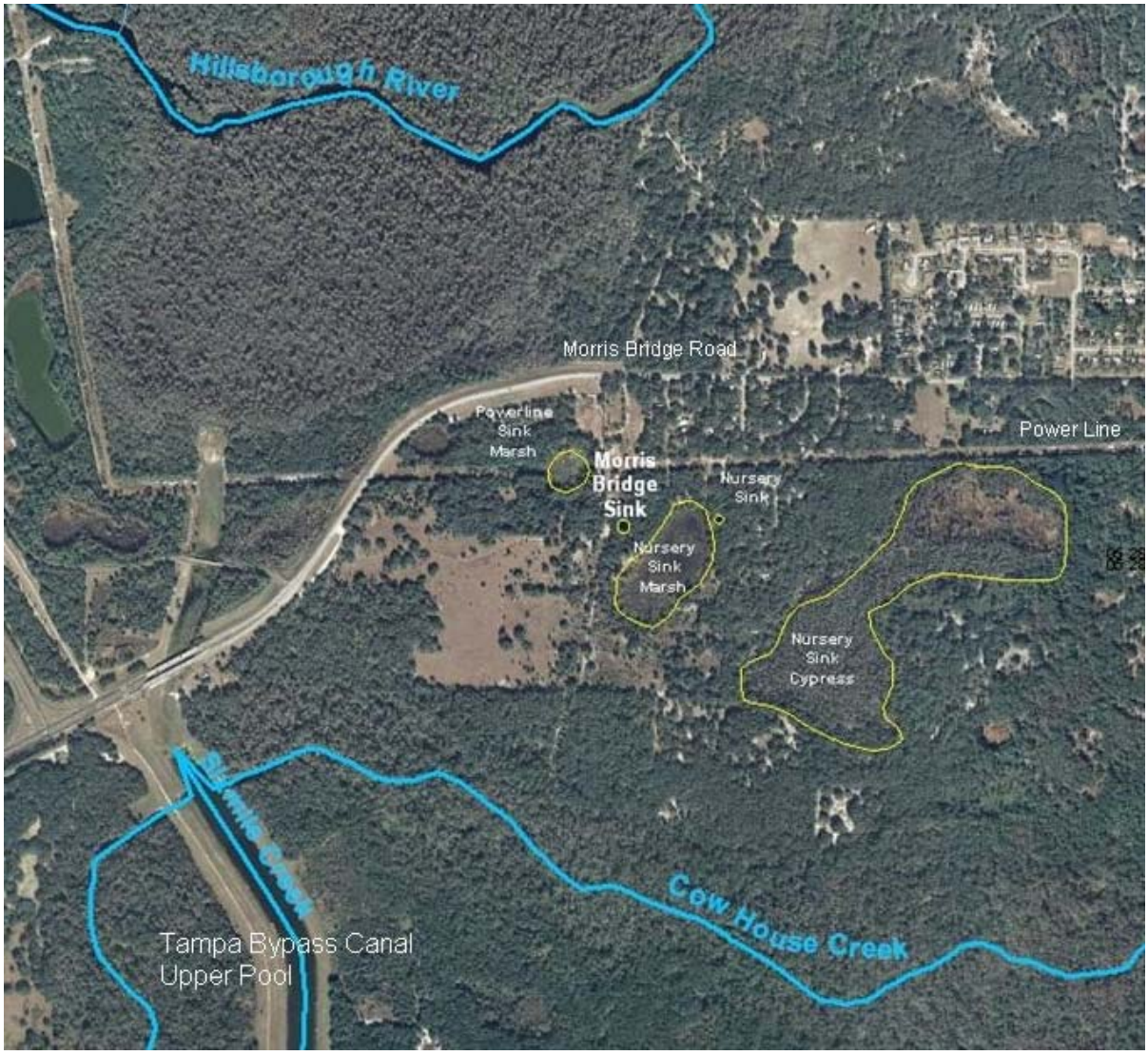

Figure 13. Location of Morris Bridge Sink also showing Nursery Sink, the Hillsborough River, Cowhouse Creek, the uppermost reach of the TBC, Morris Bridge Road and three isolated wetlands located near Morris Bridge Sink.

Morris Bridge Sink is the fourth source identified in the recovery strategy to be used minimum flows. The recovery strategy species that the District will own and operate the pumping facility at Morris Bridge Sink at rates up to 3.9 mgd. As described on page 9, the Morris Bridge Sink project has not yet been constructed, but the District has submitted a water use application to the Florida Department of Environmental Protection to use Morris Bridge Sink for minimum flows.

Minimum flow diversions from Morris Bridge Sink will be routed via pipeline to the upper pool of the Tampa Bypass Canal, then via a gravity drain to the middle pool of the TBC. Once in the middle pool, any water that originates from Morris Bridge Sink will be pumped into the Hillsborough River Reservoir for release to the lower river. However, as with minimum flow diversions from the TBC, water in the reservoir that originates from Morris Bridge Sink will be subject to a 25% loss before it is released to the lower river.

In some passages, the language of the recovery strategy indicates that diversions from Morris Bridge Sink are third in priority after diversions from Sulphur Springs and Blue Sink. However, in paragraph 40-D80.073(8)(a)(ii), the recovery strategy states that on days when Tampa Bay Water does not draw the TBC lower pool down to 9.0 feet NGVD for water supply purposes, and supplemental flow is needed for minimum flows beyond that which can be provided from Sulphur Springs, Blue Sink, and the 1.9 million gallons of water savings each day from the transmission pipeline *(comment - which will not be built)*, the District shall divert up to 3.9 mgd from the TBC lower pool to the TBC middle pool prior to diverting flows from Morris Bridge Sink to the TBC middle pool. The rate of 3.9 mgd specified in the recovery strategy is equivalent to a rate of 6 cfs discussed elsewhere in this report.

Given this passage, there are two conditions under which minimum flow diversions from Morris Bridge Sink up to a rate of 6 cfs will occur.

1. If water levels in the lower pool are over 9.0 feet and the combined diversions from Sulphur Springs, Blue Sink, and the TBC remain below the required minimum flow rate, the remainder of the minimum flow will be provided from Morris Bridge Sink.

2. If water levels in the TBC lower pool are at 9.0 feet or lower, any minimum flow water that is needed from the TBC middle pool will be replaced at a rates up to 6 cfs from Morris Bridge Sink prior to diverting water from the TBC lower pool to the middle pool.

7.1 Previous investigations of the yield of Morris Bridge Sink

Withdrawals from Morris Bridge Sink have been conducted on three previous occasions during the years 1972, 2000, and 2009. In June and July 1972, the City of Tampa conducted a pumping test to evaluate Morris Bridge Sink as a future water supply source for public supply. The sink was pumped at a rate of that averaged 6.05 mgd (equivalent to 9.4 cfs) for 17 days during June and at an average rate of 5.76 mgd (8.9 cfs) for eight days in July. Water was discharged to a lined ditch to nearby Cowhouse Creek. Water levels were measured in Morris Bridge Sink, nearby Nursery Sink, the Hillsborough River and three wells. The results of this pumping test were published in a report by the U.S. Geological Survey (Stewart 1977).

The most extensive pumpage from Morris Bridge Sink occurred in the year 2000 in response to the extreme drought during that year. In order to augment potable water supplies in the Tampa Bypass Canal and Hillsborough River Reservoir, Tampa Bay Water installed pumps on the sink to divert water to the TBC for augmentation of the Hillsborough River Reservoir. Pumping began on May 30th and continued for 76 days until August 14th at an average rate of 6.7 mgd (10.4 cfs). Tampa Bay Water's consultant analyzed water level data from a number of surface

and groundwater sites in the area and published a report (Leggete, Brashears and Graham, Inc. 2001). The maximum drawdown in Morris Bridge Sink was 7 feet and 2.6 feet in Nursery Sink. The maximum drawdowns observed in Upper Floridan aquifer wells was 4 feet at a distance from the sink of 50 feet, 2 feet at a distance of 870 ft., and 1.4 feet at a distance of 2,500 feet. Domestic well complaints from a one-mile radius around the sink were received with 15 out of 23 complaints attributed to a lack of water. Tampa Bay Water replaced 13 of these wells with deeper wells. Drawdown data indicated that the Upper Florida aquifer levels were lowered from 1.4 to 2.7 feet in the vicinity of these wells.

The third pumping episode from the Morris Bridge Sink occurred in the spring of 2009 as part of a pumping test conducted by the District to investigate the feasibility of the sink for use in providing minimum flows to the Lower Hillsborough River (SWFWMD 2010). The pumping test extended for 30 days from April 13th to May 13th, 2009. The pumping rate was maintained near at a near constant rate of 4 mgd, very close to the 3.9 mgd pumping rate specified in the recovery strategy. Water from the sink was routed through a 14-inch pipe approximately 4,500 feet to the upper pool of the TBC, from where it was routed to the middle pool of the TBC. Because the spring of 2009 was very dry, Tampa Bay Water pumped from Morris Bridge Sink at rates between 4 and 6 mgd for nine days after the District pumping test ceased in order to augment potable water supplies in the TBC/Hillsborough River Reservoir system. This pumpage was discontinued after nine days due to unusually heavy rains that occurred in mid-May which raised water levels in the Tampa Bypass Canal.

The findings of the District's pumping test are published in a District report (SWFWMD 2009). Results are presented in the report for water levels that were monitored a number of surface and groundwater sites during the test. The drawdown in Morris Bridge Sink over the course of the test was 2.16 feet. Drawdowns in the Upper Floridan and surficial aqufers were calculated extending out from Morris Bridge Sink. Hydraulic parameters (e.g., transmissivity, storage) in the Upper Florida aquifer were calculated from the pumping test results.

The District concluded that Morris Bridge Sink could likely provide up to 6 cfs of minimum flow water. It was suggested, however, that numerical modeling of the proposed minimum flows withdrawals be conducted prior to implementation of the Morris Bridge Sink project to better predict wetland and surficial aquifer response during withdrawals. The report also suggested that a well inventory also be conducted to determine well construction details and the types of pumping equipment near Morris Bridge Sink prior to implementation of the project.

7.2 Expected durations of use of Morris Bridge Sink

The amount of time that minimum flow diversions would be needed form Morris Bridge Sink can be estimated based on water levels in the TBC. The period after January 1, 2008 is valuable for this assessment because minimum flow water was being diverted to the Lower Hillsborough River from the TBC while the middle and lower pools of the TBC were being used for water supply by the City of Tampa and Tampa Bay Water. The post-2008 period includes all the demands that could affect water levels in the TBC, and thus the amount that minimum flow water would have been pumped from Morris Bridge Sink had in been online.

As previously discussed, minimum flow diversions from Morris Bridge Sink will be employed when water levels in the lower pool of the TBC are 9.0 feet or lower. Some diversions from Morris Bridge Sink may also be needed when water levels are above 9.0 feet, but frequency of those diversions are more difficult to estimate. So, as a general number, the amount of time that water levels in the lower pool of the TBC were below 9.0 feet since 2008 can be examined to assess how often diversions from Morris Bridge Sink would have been in effect, although this may be a slight underestimate.

Using a water year breakdown that runs from October 1st through September 30th of the following year, the number of days that diversions would have been needed from Morris Bridge were calculated. Those results are presented in below in Table 3. The first year of results begin in October 1, 2008, for that is the first complete water year in which minimum flow diversions were obtained from the TBC. The final water year that was accessed for this analysis ended September 30, 2013. A time series of when the daily diversion from Morris Bridge Sink would have occurred during this period can be interpreted from Figure 5 on page 12, which shows a hydrograph of daily water levels in the TBC lower pool relative to 9.0 feet.

Table 3. Number of days in four water years that water levels in the lower pool of the Tampa Bypass Canal were at 9.0 feet or below and minimum flow diversions from Morris Bridge Sink would have been implemented had that project been in place.

Water year	Number of days water levels in lower pool of TBC less than 9.0 feet and diversions from Morris Bridge Sink would have been implemented
Oct. 1, 2008 to Sep. 30, 2009	172
Oct. 1, 2009 to Sep. 30, 2010	2
Oct. 1, 2010 to Sep. 30, 2011	150
Oct. 1, 2011 to Sep. 30, 2012	94
Oct. 1, 2012 to Sep. 30, 2013	0

The number of days that diversions from Morris Bridge Sink would have been needed varied considerably between years, ranging from zero days in water year 2013 to 172 days in water year 2009. It is important to note that water year 2009 and 2011 were very dry, with 2009 representing near worst case conditions. During wet years, there will be very little demand on Morris Bridge Sink for minimum flows.

In contrast, in dry years the duration of minimum flow diversions from Morris Bridge Sink will excess of what was pumped for emergency water supply in the year 2000, when pumping from the sink continued for 76 days. The average pumping rate during 2000 (10.7 cfs) was greater than what is planned for minimum flows, but the minimum flow diversions will begin earlier in dry years. In 2009, minimum flow diversions from Morris Bridge Sink would have started in late November 2008 and extended with only a six-day break until mid-May 2009. During water year 2011, diversions from the sink would have started in mid-October with periodic diversions occurring until late June 2009.

This seasonal pattern of minimum flow diversions is fundamentally different that what was previously conducted for emergency water supplies or the 2009 pump test, both of which started in the spring. It was documented that the wetlands near Morris Bridge Sink were dry during the 2009 pump test and this was also likely the case when the emergency pumping began in the year 2000. In dry years, the minimum flow diversions will have a greater potential to affect wetland hydroperiods, as any associated groundwater drawdowns will begin earlier in the year when there is likely to be standing water in the wetlands.

7.3 The need to protect the high quality natural resources in and near Morris Bridge Sink

Morris Bridge Sink lies on lands owned by the District that are designated as the Lower Hillsborough River Wilderness Preserve (LHRWP), which is part of the Lower Hillsborough River Flood Detention Area. According to the Recreation Guide to Southwest Florida Water Management District Lands (SWFWMD, undated), natural resource conservation is an important purpose of the LHRWP. Furthermore, the recreation guides states that significant ecological features on the LHRWP "include a wood stork rookery, a sawgrqass marsh, a sphagnum bog and two sinkholes." Without a doubt, Morris Bridge Sink and nearby Nursery Sink are unusual geologic and ecological features that deserve a high degree of protection.

Although there are no biological data for within Morris Bridge Sink, the biological communities in the sink are probably somewhat like those of a pond, although the sink is much deeper with a much more limited benthic community. However, there are probably viable planktonic and littoral communities in the sink and it reasonable to conclude that the high rate of withdrawal specified by the recovery strategy (6 cfs) would, at a minimum, impact lower trophic level communities that support fish and wildlife use of the sink.

In addition, the three isolated wetlands located near Morris Bridge Sink also deserve a high degree of protection (Figure 16). As part of the network of public lands associated with the Hillsborough River Flood Detention Area / Green Swamp system, these wetlands at part of one of the largest and most intact wildlife corridors remaining in the District. Two of the three isolated wetlands near Morris Bridge Sink are in near pristine condition. There are also river floodplain wetlands associated with the Hillsborough River and Cowhouse Creek located within 0.6 miles of Morris Bridge Sink, but it is expected that any impacts of withdrawals from Morris Bridge Sink would be first be manifested in the three isolated wetland systems.

7.4 Recommendation for use of the Tampa Bypass Canal ahead of Morris Bridge Sink at water levels between 6.0 and 9.0 feet in the TBC lower pool

Since 2008, because the Morris Bridge Sink facilities had not yet been constructed, minimum flow diversions from the lower pool of the Tampa Bypass Canal continued when water levels in the lower pool went below 9.0 feet. As described on page 10, variances were granted so that minimum flow diversions and withdrawals for water supply by Tampa Bay Water continued down to elevations below 4.0 feet in the spring of 2009. In the spring of 2012, minimum flow diversions ceased when water levels in the lower pool reached 6.0 feet did not resume until water levels rebounded to 9.0 feet and remained above that level for 20 days.

I believe the requirement in the recovery strategy to cease minimum flow diversions from the TBC when water levels in the lower pool reach 6.0 feet is a very reasonable and acts to protect the water supplies in the TBC during times of water shortage. However, as has been implemented in the years since 2008, minimum flow diversions from the lower pool at elevations between 6.0 and 9.0 feet could act to greatly reduce the demands on Morris Bridge Sink and lessen the impact on biological communities in the sink and the wetlands located near the sink.

Given the high quality of the ecological features in and near Morris Bridge Sink and the documented success of using the TBC for minimum flows since 2008, a recommendation is presented in Section 10 that diversions from Morris Bridge Sink should not be implemented for minimum flows until water levels in the TBC fall to 6.0 feet and rebound to over 9.0 feet for 20 days as specified in the recovery strategy. This would greatly reduce the frequency and duration that withdrawals would affect the natural resources within and near Morris Bridge Sink.

7.5 Restrict the use of Morris Bridge Sink to emergency potable water supply during water shortage conditions

Alternately, withdrawals from Morris Bridge Sink could be used as they have been used in the past - for emergency potable supplies during times of water shortage. Such a use for emergency potable supply was also suggested as one option for Blue Sink. Given the availability of the Tampa Bypass Canal to provide minimum flows to the Lower Hillsborough River, plans to use Blue Sink or Morris Bridge Sink for emergency potable supply are justifiable and may represent the best use of these resources in a balanced regional water resource plan.

8 Direction from the Florida Department of Environmental Protection regarding groundwater augmentation of surface waters

In March 2012, a letter was sent from the Deputy Secretary for Water Policy and Ecosystem Restoration at the Florida Department of Environmental Protection to the Executive Directors and Chairs of the Governing Boards of the State's five Water Management Districts that provided guidance on groundwater augmentation of surface waters (Munson 2012). That letter is provided as Attachment C to this report.

The letter states that balancing the use of surface and groundwater resources without imperiling natural systems is critical to good water management, particularly when using groundwater to augment surface waters that have been or could be impacted by withdrawals. The letter says that the FDEP conducted a series of stakeholder sessions that identified a need for additional consistency across Water Management Districts on the use of groundwater to augment surface waters.

The letter cites Rule 62-40.410(7), Florida Administrative Code that states in part: *"In implementing consumptive use permitting programs, the Department and Districts shall strive to prevent harm to natural systems without the need for artificial maintenance of natural systems by pumped groundwater augmentation*." The letter also states: *"These same principles should be applied in the development and implementation of recovery and prevention strategies for minimum flows and levels. Development of long-term recovery solutions that are self-*

sustaining and do not involve ongoing operation and maintenance costs, should be the goal of plan development. Long-term augmentation of wetlands or other surface waters with pumped groundwater should be avoided. When long-tem augmentation is the only feasible alternative, augmentation with the use of reclaimed water or recycled stormwater is encouraged, as provided in Rule 62-40.4107(7)(b), F.A.C., when consistent with water quality standards."

Although Blue Sink and Morris Bride Sink are surface water features, they are geologic openings to the Upper Floridan Aquifer and it is clear that withdrawals from these sinks are direct withdrawals from groundwater resources. Secondly, as specified in the recovery strategy for the Lower Hillsborough River, the sinks are being used to augment a surface water body to help meet its minimum flows.

It should be clear from the information presented in this report that diversions from Blue Sink and Morris Bridge Sink are not the only feasible alternatives for meeting the minimum flows for the Lower Hillsborough River. Minimum flows recovery strategies should be oriented to achieving some degree of net environmental improvement. As such, a primary goal of any recovery strategy should be to not cause adverse impacts to other natural systems or the water resource. In my opinion, by allowing for prolonged withdrawals of significant water quantities from Blue Sink and Morris Bridge Sink, the recovery strategy for the Lower Hillsborough River poses unnecessary risks to natural systems near those sinks, and in the case of Blue Sink, poses some degree of increased sinkhole risk to nearby neighborhoods and urban settings.

The attached letter from the FDEP was sent almost six years after the recovery strategy for the Lower Hillsborough River was adopted in 2007. Based on over six years of implementing the parts of the recovery strategy that been completed or operable, it is clear that the minimum flows of the Lower Hillsborough River can be met without construction of the Blue Sink or Morris Bridge Sink projects. As described in this report, there could be options for reducing the use of these sinks in a revised recovery strategy, or alternately, a more balanced resource management strategy could be to use the sinks as they were in the past - as sources of emergency water supplies during times of water shortage.

Given the direction from FDEP and the recent management experience with Hillsborough River / Tampa Bypass Canal system, the fundamental recommendation of this report is that the recovery strategy for the Lower Hillsborough River should be re-evaluated to achieve a higher degree of resource protection while meeting water supply needs. The construction of either the Blue Sink project or the Morris Bridge Sink project should not be pursued until such a re-evaluation is completed.

9 Recent findings regarding the effectiveness of the minimum flows implemented to date and the possible use of funds for other strategies to improve the Lower Hillsborough River

As part of the requirements of the recovery strategy, the District recently published a report that examines the hydrologic, water quality, and biological conditions in the Lower Hillsborough River that have resulted from the implementation of the minimum flows that have been

implemented to date (SWFWMD 2015). This study was mandated by paragraph 9(h) in the recovery strategy that states:

In 2013, and for each five-year period through 2023, the District shall evaluate the hydrology, dissolved oxygen, salinity, temperature, pH and biologic results achieved from implementation of the recovery strategy for the prior five years, including the duration, frequency, and impacts of the adjusted minimum flow as described in paragraph 40D-8.041(1)(b), F.A.C. As part of the evaluation, the District will assess the recording systems used to monitor these parameters. The District shall also monitor and evaluate the effect the Recovery Strategy is having on water levels in the Hillsborough River above the City's dam to at least Fletcher Avenue. The District will evaluate all projects described in this Recovery Strategy relative to their potential to cause unacceptable adverse impacts prior to their implementation.

This study assessed minimum flow rates that ranged from 10 cfs that were first implemented in 2002 to minimum flow rates in 2012 and 2013 that were very close to the currently adopted minimum flow rates for the Lower Hillsborough River. The report concludes that minimum flow rates in the range of 23 to 26 cfs are more effective at creating a low salinity zone below the dam and improving water quality than a minimum flow rate of 20 cfs. Depending on how the freshwater equivalent factor is handled, the report thus concludes that in a bottom up approach, the adopted minimum flows are within a range that serves as a reasonable breakpoint for improving the water quality and biological conditions in the river below the dam.

However, the results of the study indicate that with the adopted minimum flows, the river will continue to have problems with low dissolved oxygen concentrations (hypoxia) in the target area for water quaity and ecological improvement between the dam and Sulphur Springs that is identified in the minimum flow rule. The hypoxia is due to a salt wedge that persists in the river between Hannah's Whirl and Sulphur Springs. This zone of hypoxia degrades the environmental quality and biological untilization of the low salinity zone that was created upstream of Sulphur Springs and it would take considerably higher minimum flow rates to alleviate this problem.

There may be other options to a at least partially remedy the hypoxia problems in this reach of the river. Circulaltion devices that could vertically mix the salt wedge between Hannah's Whirl and Sulphur Springs could be considered to determine if they could improve the aeration of deeper waters and dissolved oxygen concentrations in the river. It is not clear at this time if such devices would be sufficent because of the large tidal exchange in the lower river, but preliminary analyses or water quality modleing could be done to asses the feasiblity of such circulation devices or other means to improve dissolved oxygen concentrations.

Paragraph 9(h) of the recovery strategy also states that the District shall evaluate all projects described in the recovery strategy relative to their potetial to casue unacceptable adverse impacts prior to their implementation. In the last two years at the District, I have maintined that after completion of the report specifed in the recovery strategy, the minimum flow recovery strategy should be re-evaluated to assess the necessity, cost effectiveness, and risk of adverse impacts from the projects identififed in the strategy and the strategy's overall effectiveness.

This report has made the case that there are extensive hydrolgic data, managment experience, and regulatory justification to have the Tampa Bypass Canal play a greater role in achieving the adopted minimum flows for the Lower Hillsborough River. If the 25% loss term for TBC diversions was eliminated and there was greater reliance on the TBC, the adopted minimum flows for the lower river could largely be met tomorrow. With greater reliance on the Tampa Bypass Canal, the Blue Sink and Morris Bridge Sink projects could be modified to pose less risk of impacts to nearby resources or the projects to withdraw water from those sinks may not be necessary.

If the Blue Sink and Morris Bridge Sink projects are not constructed, it would free up nearly twelve million dollars of funds that could be used for other managment strategies to improve the water quality and biological chacteristis of river between the dam and Sulphur Springs. It is not known at this time how effective circulation devices above Sulphur Springs might be for improving the hypoxia problem in the river, but evaluation of such options could be considered as part of a re-evaluation of the minmum flows recovery strategy for the lower river.

The timeline for having the minimum flows for the Lower Hillsborough River that is specifed in the reccovery strategy is October 1, 2017, and the staff of the District and the City have been working dilagently to meet that deadliine. However, due to the design and financial and regulatroy complexity of the recovery strategy, some of the projects have been behind their respective schedules for implementation dentified in the recovery 4strategy. Even with that being the case, the October 2017 timeline looks to be achievable, and as previoiusly discussed, the minimum flows are largely being met right now using Sulphur Springs and the Tampa Bypass Canal.

At this time, the most important step is to re-evaluate the minimum flow recovery strategy to ensure that it meets the minimum flows of the lower river while being cost effective and minmizing the risk of adverse impacts to other resources. Pending the conclusions of such a re-evalatuion, the goals of fully meeting the minimum flows may not have to be delayed and could even be expedited.

10 Conclusions and Recommendations

The principal conclusions and recommendations of this report are listed below.

1. The minimum flow recovery strategy for the Lower Hillsborough River should be re-evaluated and the construction of either the Blue Sink project or the Morris Bridge Sink project should not be pursued until such a re-evaluation in completed.

2. Using temporary pumping facilities operated by the District, the Tampa Bypass Canal has been used to provide minimum flows to the Lower Hillsborough River since 2008. Since 2012, when the diversion facilities at Sulphur Springs were completed, the minimum flows for the lower river have either been met or come close to being met on many days using diversions from Sulphur Springs and the Tampa Bypass Canal

3. The recovery strategy includes a 25% loss term for minimum flow diversions that are diverted from the Tampa Bypass Canal through the Hillsborough River Reservoir. Based on much higher rates of pumpage from the TBC than are used for minimum flows, a scientific review panel evaluated potential losses of water that are diverted from the TBC. That panel found that some previous estimates were large overestimates of any true water losses from the reservoir. Accordingly, there is strong technical justification for greatly reducing or eliminating the 25% loss term that is applied to minimum flows that are diverted from the TBC. Eliminating this term would make available 2.75 cfs that could be used for minimum flows, thus increasing the number of days that minimum flows are met by diversions from Sulphur Springs and the Tampa Bypass Canal.

4. During the time that freshwater flow to the Lower Hillsborough River has been identified as a regulatory issue of concern, there has been a dramatic increase in the quantity of permitted water supply granted from the Hillsborough River Reservoir / Tampa Bypass Canal system. An extensive study of the flow relationships of the Lower Hillsborough River was required as part of the City of Tampa's permitted increased in average annual withdrawals from 62 to 82 mgd in 1991. The City was also required to develop an optimal management plan for the reservoir/canal system that minimizes downstream impacts while meeting water supply needs.

   In 1999, Tampa Bay Water was issued a water use permit to withdraw potable supplies from the reservoir/canal system. In 2007, their permit was modified so that a flow of 0 cfs can be maintained at the most downstream structure on the TBC and the diversion rate from the canal during low flows was changed from 80 percent to 100 percent of flow. The average annual quantity currently permitted to Tampa Bay Water for withdrawals from the reservoir/canal system is now 85 mgd. Combined with the City of Tampa's water use permit, the combined authorized annual average withdrawal from the canal/reservoir system is now 167 mgd. The actual combined water use from the reservoir/canal system for the years 2003 to 2012 was 104.9 mgd.

   The water use permits for both the City of Tampa and Tampa Bay Water contain special conditions that stipulate those permits may be subject to modification to comply with minimum flows. Given the large quantities of water that have been permitted from the reservoir/canal system and the documented use of the Tampa Bypass Canal for providing part of the minimum flows, the District has strong regulatory authority and justification for requiring increased use of the Tampa Bypass Canal for meeting the minimum flows of the Lower Hillsborough River.

5. The recovery strategy should be amended so that the Tampa Bypass Canal is used second in priority after Sulphur Springs. Combined with the reduction of elimination of the 25% loss term for minimum flows from the TBC, the maximum limit of 11 cfs for minimum flow diversions from the TBC could also be increased during suitable water levels in the TBC.

6. Minimum flows for the Lower Hillsborough River that minimize risk to other resources need to be viewed in an integrated water supply plan for the Tampa Bay Region. Using the currently adopted minimum flow rates, the effects of different recovery strategies on the

dependable yield of the Hillsborough River Reservoir/ Tampa Bypass Canal system need to be simulated with the need for any alternative water supplies quantified. The effects of different minimum flow scenarios on the need for alternative supplies is probably very small and would be available from other water supply sources in the region including the regional wellfield network, surface water stored in the C.W. "Bill" Young Reservoir, Aquifer-Storage-Recovery, or the Tampa Bay Water desalination plant.

Given the large water use from the reservoir/canal system and the small minimum flow requirements of the Lower Hillsborough River, an evaluation of different minimum flow recovery scenarios that minimize risk to other resources is warranted and should be conducted as part of a re-evaluation of the recovery strategy for the Lower Hillsborough River.

7. Blue Sink is sinkhole that lies in a heavily developed urban/residential area of Tampa. In 2009 the City of Tampa conducted a feasibility analysis that concluded the best plan for using Blue Sink for minimum flows was to pump water from Blue Sink directly to the pipeline that extends from Sulphur Springs to the base of the Hillsborough River dam. The District reviewed and approved this conclusion.

8. Based on the design recommended by the feasibility analysis, the estimated construction cost for the Blue Sink project is $10,785,500, which represents 48% of the total costs of minimum flows recovery strategy. The cost per cfs for Blue Sink diversions is much greater than for the other water sources.

9. As the recovery strategy is now written, Blue Sink is used immediately after diversions from Sulphur Springs. This will frequently result in withdrawals from Blue Sink of over 200 days per year, with maximum durations near 300 days in drought years.

   Previous investigations have been conducted on the yield of Blue Sink. Blue Sink has become clogged and water levels in the sink and nearby aquifer are somewhat elevated. However, this excess water can be removed after relatively short periods of pumpage, with extended withdrawals lowering groundwater levels in the surrounding area.

   As part of a water use application to use Blue Sink for minimum flows, the City of Tampa simulated groundwater drawdowns that would result by continuous pumping from Blue Sink at rate of 2 mgd for 318 days in a dry year. The District reviewed these findings and concluded that such withdrawals meet the conditions of issuance and has granted the City a water use permit to use Blue Sink at a peak monthly rate of 2 mgd.

10. Opinions differ, but I believe that extending pumping of Blue Sink at 2 mgd poses some degree of increased sinkhole risk in the neighborhoods and urban areas near the sink.

11. Prolonged diversions from Blue Sink may also result in a reduction of flow and increase in salinity in Sulphur Springs. Sulphur Springs provides most of the minimum flows to the Lower Hillsborough River and any impacts to the flow or water quality of the spring should be avoided.

12. Based on the combined information that has been generated relative to the recovery strategy in recent years, I suggest that the Blue Sink project be re-evaluated with three possible options:

    ● Not construct the Blue Sink project, for with small regulatory adjustments, Sulphur Springs and the Tampa Bypass Canal will likely meet the minimum flows of the lower river. Not constructing Blue Sink will save approximately ten million dollars.

    ● Reconsider the option of routing water from Blue Sink to Jasmine or Orchid Sinks to supplement the flow of Sulphur Springs. Although this would involve some re-design work, it is a shorter route that the current plan and is less expensive.

    ● If the current design for Blue Sink is constructed, its use should be limited to providing emergency potable water supplies during times of water shortage.

13. Morris Bridge Sink is to provide minimum flows primarily when water levels in the lower pool of the Tampa Bypass Canal are at or below 9.0 feet NGVD. With Morris Bridge Sink not yet constructed, the lower pool of the TBC has been used to provide minimum flows when water levels were between 6.0 and 9.0 feet in the lower pool of the TBC.

14. Data collected since 2008, when the TBC was being used for both water supply and minimum flows, indicate that diversions from Morris Bridge Sink will be used infrequently during wet years. However, during dry years, diversions from Morris Bridge Sink can be in the range of 150 to 172 days. Previous diversions from Morris Bridge Sink for emergency potable water supplies or pumping tests were of much shorter duration.

15. Morris Bridge Sink and nearby Nursery Sink lie on District owned lands that are designated as the Lower Hillsborough River Wilderness Preserve (LHRWP). Natural resource conservation is a stated purpose of the LHRWP, and Morris Bridge Sink and Nursery Sink are described as significant ecological features in the published recreational guide to District owned lands. These sinkholes are unique geologic and ecological features that deserve a high degree of protection.

16. Riverine wetlands and 69 acres of isolated wetlands occur near Morris Bridge Sink. Two of these isolated wetlands are in near pristine condition and are part of one of the most intact and extensive wildlife corridors remaining in the District

17. Given the high quality of the natural resources associated with Morris Bridge Sink and its nearby wetlands, consideration should be given to reducing the frequency and duration that withdrawals from Morris Bridge Sink are required. Utilizing the lower pool of the TBC to provide minimum flows ahead of Morris Bridge Sink when water levels in the lower pool are between 6.0 and 9.0 feet, which has been the operating procedure since 2008, would greatly reduce the frequency and duration of withdrawals from Morris Bridge Sink with much less impact on nearby natural resources.

18. Given the options available from providing minimum flows, the most appropriate option for Morris Bridge Sink would be to provide emergency potable water supplies during water shortage conditions

19. In 2012, the Florida Department of Environmental Protection sent a letter to the State's five Water Management Districts that suggested that the District's strive to prevent significant harm to natural systems without groundwater augmentation of surface waters. With regard to minimum flows and levels, the letter states that "*Long-term augmentation of wetlands or other surface waters with pumped ground waters should be avoided*". The letter also discussed using reclaimed or recycled stormwater "*When long-term augmentation is the only feasible alternative*...."

    Withdrawing water from Blue Sink and Morris Bridge Sink for minimum flows of the Lower Hillsborough River is a case of pumping groundwater sources to meet minimum flows in a surface water. Also, utilizing these sinks is clearly not the only feasible alternative to meeting the minimum flows for the Lower Hillsborough River.

    Considering all factors discussed in this report and the direction of the FDEP, the most appropriate use for both Blue Sink and Morris Bridge Sink would be to use them as they were used in the past - as emergency potable water supply sources during times of water shortage.

20. As specified in the recovery strategy, the District recently completed a report that examined the effectiveness of the minimum flows that have been implemented to date. That report indicates that minimum flows rates in the range of the adopted minimum flows create a low salinity zone below the dam, but problems with low dissolved oxygen concentrations will persist in the lower river, impacting the water quality and biological utilization of much of the target area for minimum flows between the dam and Sulphur Springs.

    As part of a re-evaluation of the minimum flows recovery strategy, the feasibility of installing circulation devices to improve the aeration of the river between Hannah's Whirl and Sulphur Springs should be considered. If such a plan is feasible, cost savings from not constructing the Blue Sink and Morris Bridge projects could be considered to pay for their installation and operation.

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Attachment A
Minimum Flow Rule for the Lower Hillsborough River

Excerpt From:

CHAPTER 40D-8
WATER LEVELS AND RATES OF FLOW

40D-8.041 Minimum Flows.

(1) Minimum Flows for the Lower Hillsborough River.

(a) For the purposes of Minimum Flows, the Lower Hillsborough River is defined as the River downstream of Fletcher Avenue. A tributary of the Lower Hillsborough River is Sulphur Springs, an artesian spring which enters the River via a short spring run at a point 2.2 miles downstream of the City's dam.

(b) The Minimum Flows for the Lower Hillsborough River are based on extending a salinity range less than 5 ppt from the Hillsborough River Dam toward Sulphur Springs. The Minimum Flows for the Lower Hillsborough River are 20 cubic feet per second ("cfs") freshwater equivalent from July 1 through March 31 and 24 cfs fresh water equivalent from April 1 through June 30 at the base of the dam as adjusted based on a proportionate amount that flow at the United States Geological Survey Gauge No. 0203000 near Zephyrhills, Florida ("Gauge") is below 58 cfs. The adjustment is that for each one cfs that Hillsborough River flow at the Gauge is below 58 cfs, when 20 cfs freshwater equivalent is otherwise required, the Minimum Flow is adjusted by reducing it by 0.35 cfs; when 24 cfs freshwater equivalent is otherwise required, the Minimum Flow is adjusted by reducing it by 0.40 cfs. For purposes of this paragraph 40D-8.041(1)(b), F.A.C., freshwater equivalent means water that has a salinity concentration of 0.0 ppt for modeling purposes.

Attachment B
Minimum Flow Recovery Strategy for the Lower Hillsborough River

Excerpts From: 40D-80.073 Comprehensive Environmental Resources Recovery Plan for the Northern Tampa Bay Water Use Caution Area, and the Hillsborough River Strategy.

Rules of the Southwest Florida Water Management District, Florida Adminstrative Code

(8) Hillsborough River Strategy.

Beginning November 25, 2007, the Minimum Flow for the Lower Hillsborough River shall be as provided in subsection 40D-8.041(1), F.A.C., to be achieved on the time schedule as set forth below. The District and the City of Tampa (City) shall measure the delivery of water to the base of the dam relative to their respective elements as described below. The City shall report this information to the District monthly on the 15th day of the following month. In addition, the City shall submit a quarterly written report of all activities and all progress towards timely completion of its elements of the recovery strategy. Such reports will be submitted to the District within 15 calendar days after each calendar year quarter.

(a) The District and the City have entered into the Joint Funding Agreement Between The Southwest Florida Water Management District and The City of Tampa For Implementation of Recovery Projects To Meet Minimum Flows of The Lower Hillsborough River, dated October 19, 2007, (the Funding Agreement), which is incorporated herein by reference. A copy of the Funding Agreement is available from the District upon request. The Funding Agreement and subsection 40D-80.073(8), F.A.C., constitute the District's recovery strategy for the Lower Hillsborough River required by Section 373.0421(2), F.S., and shall not compromise public health, safety and welfare.

(b) The schedule to achieve the Minimum Flows for the Lower Hillsborough River is as follows:

1. Sulphur Springs.

Beginning on November 25, 2007, the City shall be required to provide ten cubic feet per second (cfs) of water to the base of the City's dam each day, provided such use will not compromise public health, safety and welfare.

2. Tampa Bypass Canal Diversions.

By January 1, 2008, provided that any permit that may be required is approved, the District shall divert up to 7.1 million gallons of water on any given day from the District's Tampa Bypass Canal (TBC) to the Hillsborough River at the District's Structure 161. The District shall then deliver water from the Hillsborough River immediately above the City's dam to the base of the City's dam to help meet the minimum flow requirements of the Lower Hillsborough River. Such diversions shall not occur if public health, safety or welfare will be compromised.

a. The District shall complete a comprehensive analysis of these diversions within 90 days of the first year of operation to identify and subsequently make any mechanical or efficiency adjustments that may be necessary. The District shall use its best efforts to expedite obtaining any permit that may be needed to undertake these actions.

b. By October 1, 2013, provided that the transmission pipeline has been constructed and is operational, all of the water diverted from the TBC middle pool under this provision to help meet the minimum flow shall be provided to the Lower Hillsborough River per subparagraph 40D-80.073(8)(b)7., F.A.C.

c. These diversions shall be prioritized as follows:

(i) Priority Source One – Diversions From the TBC Middle Pool When the TBC Middle Pool is Above 12.0 feet NGVD (1929 or its 1988 equivalent), and There is Flow of at Least 11 cfs Over the District's Structure 162.

On days when the TBC middle pool is above 12.0 feet NGVD (1929 or its 1988 equivalent), as measured by the downstream gauge at the District's Structure 161, and there is flow of at least 11 cfs over the District's Structure 162, the District shall divert water from the TBC middle pool to the Hillsborough River.

A. The District shall then deliver 75 percent of any water diverted from the TBC to the Hillsborough River under this provision to the Lower Hillsborough River. Delivery of 75 percent of the water diverted from the TBC addresses concerns about potential losses due to subsurface leakage, evaporation and transpiration. This delivery shall be from the Hillsborough River just above the City's dam to the base of the City's dam, and shall supplement diversions from Sulphur Springs, Blue Sink and Morris Bridge Sink, as they are implemented, and as described in subparagraphs 40D-80.073(8)(b)1., 3., 6. and 8., F.A.C.

B. The TBC middle pool diversions will be limited to the quantity needed to achieve the minimum flow requirements of the Lower Hillsborough River set forth in subsection 40D-8.041(1), F.A.C., but will not exceed 7.1 million gallons on any given day.

C. Such diversions shall cease from the TBC middle pool if the elevation difference between the TBC middle and lower pools exceeds 7.0 feet.

D. On days when flow over the Hillsborough River Dam naturally exceeds 20 cfs during the months of July through March, or 24 cfs during the months of April through June and when diversions from the TBC middle pool are not needed to replenish the supply from Storage Projects described in paragraphs 40D-80.073(8)(c) and (d), F.A.C., diversions from the TBC middle pool shall not occur and any flows in the TBC lower pool above elevation 9.0 feet NGVD (1929 or its 1988 equivalent), shall be available for water supply.

E. Prior to October 1, 2013, and during the months of March through June, on days when some water is needed from the TBC middle pool to help meet the minimum flow for the Lower Hillsborough River, all available water from the TBC middle pool not needed to be diverted in accordance with SWFWMD Water Use Permit No. 20006675 but not exceeding 7.1 million gallons on any given day will be diverted to the Hillsborough River. Water delivered to the Hillsborough River in excess of that needed to help meet the minimum flow of the Lower Hillsborough River shall remain in the Hillsborough River above the dam. Keeping this water in the Hillsborough River above the dam will reduce the time and quantities of supplemental flow needed to help meet the minimum flow requirements.

F. During the months of July through February, on days when water is needed from the TBC middle pool to help meet the minimum flow of the Lower Hillsborough River, only that amount of water needed to help meet the minimum flow but not in excess of 7.1 million gallons on any given day shall be diverted from the TBC middle pool to the Hillsborough River, and any water in the TBC middle and lower pools above elevations 12.0 and 9.0 feet NGVD (1929 or its 1988 equivalent), respectively, shall be available for water supply.

(ii) Priority Source Two – Diversions When the TBC Middle Pool is Above 12.0 feet NGVD (1929 or its 1988 equivalent), and the Flow Over the District's Structure 162 is Less Than 11 cfs.

On days when the TBC middle pool is above 12.0 feet NGVD (1929 or its 1988 equivalent), as measured by the downstream gauge at the District's Structure 161, and the flow over the District's Structure 162 is less than 11 cfs, the District shall divert water from the TBC middle pool to the Hillsborough River.

A. The District shall then deliver 75 percent of any water diverted from the TBC middle pool to the Hillsborough River under this provision to the Lower Hillsborough River. Delivery of 75 percent of the water diverted from the TBC addresses concerns about potential losses due to subsurface leakage, evaporation and transpiration. This delivery shall be from the Hillsborough River just above the City's dam to immediately below the City's dam, and shall supplement diversions from Sulphur Springs, Blue Sink and Morris Bridge Sink, as they are implemented, and as described in subparagraphs 40D-80.073(8)(b)1., 3., 6. and 8., F.A.C.

B. The TBC middle pool diversions will be limited to the quantity needed to achieve the minimum flow requirements of the Lower Hillsborough River, but will not exceed 7.1 million gallons on any given day.

I. On days such diversions occur, the District will divert from the TBC lower pool to the TBC middle pool quantity equivalent to that diverted by the District from the TBC middle pool to the Hillsborough River.

II. Such diversions shall cease from both the TBC middle and lower pool when the stage of the TBC lower pool reaches 6.0 feet NGVD (1929 or its 1988 equivalent), as measured by the gauge at the District's Structure 160, or the elevation difference between the TBC middle and lower pools exceeds 7.0 feet.

C. Once the stage in the TBC lower pool is below 8.7 feet NGVD (1929 or its 1988 equivalent), withdrawals from this priority source to help meet the minimum flow for the lower Hillsborough River are considered withdrawals from the storage of the TBC lower pool. When the stage in the TBC lower pool is below 8.7 feet NGVD (1929 or its 1988 equivalent), the following restrictions apply:

I. At no time shall withdrawals from the lower pool to help meet the minimum flow for the lower Hillsborough River cause the stage in the lower pool to go below 6.0 feet NGVD (1929 or its 1988 equivalent), or cause the elevation difference between the TBC middle and lower pools to exceed 7.0 feet, as measured on either side of the District's Structure 162.

II. If supplemental flows are required to help meet the lower Hillsborough River minimum flow from this Priority Source, once withdrawals begin from storage they will continue until the TBC lower pool reaches an elevation of 6.0 feet NGVD (1929 or its 1988 equivalent). At such time as either of the conditions set forth in sub-sub-sub-subparagraph 40D-80.073(8)(b)2.(ii)C.I., F.A.C., above, are met, the District shall cease withdrawals from the TBC lower pool. The District shall only reinitiate withdrawals from the TBC lower pool when its elevation equals or exceeds 9.0 feet NGVD (1929 or its 1988 equivalent), for 20 consecutive days, which is defined as the TBC lower pool replenishment.

III. The total withdrawn from storage on any given day shall not exceed 7.1 million gallons on any given day.

IV. Withdrawals from storage will be limited to the quantity needed to help achieve the minimum flow requirements of the Lower Hillsborough River after utilizing the quantity diverted from all other sources, as they are implemented, and as described in paragraphs 40D-80.073(8)(b), (c) and (d), F.A.C.

(iii) Priority Source Three – Diversions When TBC Middle Pool Elevations are Between 10.0 and 12.0 Feet NGVD (1929 or its 1988 equivalent).

The District will make all reasonable efforts to obtain authorization from the United States Army Corps of Engineers to allow the withdrawals of up to 7.1 million gallons on any given day from the TBC middle pool to aid in the Lower Hillsborough River minimum flow requirements when the TBC middle pool is below 12.0 feet and above 10.0 feet NGVD (1929 or its 1988 equivalent).

A. These diversions will only occur when the stage of the TBC lower pool has reached 6.0 feet NGVD (1929 or its 1988 equivalent), or the TBC lower pool is in a state of replenishment as described in sub-sub-sub-subparagraph 40D-80.073(8)(b)2.(ii)C.II., F.A.C. These diversions will be limited to the quantity needed to help achieve the minimum flow requirements of the Lower Hillsborough River after utilizing the quantity diverted from all other sources, as they are implemented, and as described in paragraphs 40D-80.073(8)(b), (c) and (d), F.A.C., but will not exceed 7.1 million gallons on any given day.

B. These diversions shall cease if the elevation difference between the Hillsborough River and TBC middle pool exceeds 9.5 feet, if approved by the United States Army Corps of Engineers, as measured on either side of the District's Structure 161, or if the elevation difference between the TBC middle and lower pools exceeds 7.0 feet, as measured on either side of the District's Structure 162.

C. Diversions associated with this provision will not occur until the water transmission pipeline as set forth in subparagraph 40D-80.073(8)(b)7., F.A.C., is completed or by October 1, 2013, whichever is sooner. Once the stage in the TBC middle pool is below 12.0 feet NGVD (1929 or its 1988 equivalent), withdrawals to help meet the minimum flow for the Lower Hillsborough River are considered withdrawals from the storage of the TBC middle pool. When the stage is below 12.0 feet NGVD (1929 or its 1988 equivalent), the following restrictions apply:

I. At no time shall withdrawals from the TBC middle pool to help meet the minimum flow for the Lower Hillsborough River cause the stage in the middle pool to go below 10.0 feet NGVD (1929 or 1988 equivalent), or cause the elevation difference between the TBC middle pool and Hillsborough River to exceed 9.5 feet, as measured on either side of the District's Structure 161, or cause the elevation difference between the TBC middle and lower pools to exceed 7.0 feet, as measured on either side of the District's Structure 162.

II. If supplemental flows are required to help meet the Lower Hillsborough River minimum flow from this Priority Source, once withdrawals begin from storage they will continue until the TBC middle pool reaches an elevation of 10.0 feet NGVD (1929 or its 1988 equivalent). At such time as either of the conditions set forth in sub-sub-sub-subparagraph 40D-80.073(8)(b)2.c.(iii)C.I., F.A.C., above, are met, the District shall cease withdrawals from the TBC middle pool. The District shall only reinitiate withdrawals from the TBC middle pool when its elevation equals or exceeds 12.0 feet NGVD (1929 or its 1988 equivalent), for 20 consecutive days, which is defined as the TBC Pool Replenishment, and there is less than 11 cfs of flow over the District's Structure 162.

III. The total withdrawn from storage on any one day shall not exceed 7.1 million gallons.

IV. Withdrawals from storage will be limited to the quantity needed to help achieve the minimum flow requirements of the Lower Hillsborough River after utilizing the quantity diverted from all other sources, as they are implemented, and as described in paragraphs 40D-80.073(8)(b), (c) and (d), F.A.C.

3. Sulphur Springs Project.

a. By October 1, 2009, and as specified in the Funding Agreement incorporated in paragraph (8)(a) above, the City shall complete the modification of the lower weir to provide to the base of the dam all available flow from Sulphur Springs not needed to maintain the minimum flow for manatees as set forth in paragraph 40D-8.041(2)(b), F.A.C.

b. By October 1, 2010, the City shall complete the construction of the upper gates and the pump station to provide to the base of the dam all available flow from Sulphur Springs not needed to maintain the minimum flow for manatees as set forth in paragraph 40D-8.041(2)(b), F.A.C.

c. By October 1, 2012, and as specified in the Funding Agreement incorporated in paragraph (8)(a) above, the City is to provide to the base of the dam, all available flow from Sulphur Springs not needed to maintain the minimum flow for Sulphur Springs as set forth in paragraph 40D-8.041(2)(a), F.A.C.

(i) These diversions shall not exceed 11.6 million gallons on any given day.

(ii) The City is authorized to use any remaining quantities at Sulphur Springs for water supply purposes consistent with SWFWMD Water Use Permit No. 20002062.

d. Additionally, beginning on October 1, 2010, on days when the minimum flow requirements are being adjusted for the Lower Hillsborough River, as described in paragraph 40D-8.041(1)(b), F.A.C., and there is flow at Sulphur Springs in excess of the quantity needed to help meet the adjusted flow as described in paragraph 40D-8.041(1)(b), F.A.C., and the minimum flow requirements in paragraph 40D-8.041(2)(b), F.A.C., and the City is not using such flow to augment the Hillsborough River above the dam, the City shall move such quantity to the base of the City's dam up to the unadjusted quantities described in paragraph 40D-8.041(1)(b), F.A.C.

4. Blue Sink Analysis.

By October 1, 2010, and as specified in the Funding Agreement incorporated in paragraph (8)(a) above, the City in cooperation with the District shall complete a thorough cost/benefit analysis to divert all available flow from Blue Sink in north Tampa to a location to help meet the minimum flow or to the base of the City's dam.

5. Transmission Pipeline Evaluation.

By October 1, 2010, and as specified in the Funding Agreement incorporated in paragraph (8)(a) above, the City shall complete a thorough design development evaluation to construct a water transmission pipeline from the TBC middle pool to the City's David L. Tippin Water Treatment Facility, including a spur to just below the City's dam.

6. Blue Sink Project.

By October 1, 2011, and as specified in the Funding Agreement incorporated in paragraph (8)(a) above, the City will provide all available flow from Blue Sink project to help meet the minimum flow provided that all required permits are approved, and it is determined that the project is feasible. Once developed, all water from this source shall be used to the extent that flow is available to help meet the minimum flow for the Lower Hillsborough River.

7. Transmission Pipeline Project.

By October 1, 2013, and as specified in the Funding Agreement incorporated in paragraph (8)(a) above, the City shall complete the water transmission pipeline described in subparagraph 40D-80.073(8)(b)5., F.A.C., and move the

water the District will move as specified in subparagraphs 40D-80.073(8)(b)2. and 8., F.A.C., to the Lower Hillsborough River directly below the dam as needed to help meet the minimum flow or to transport water in accordance with SWFWMD Water Use Permit No. 20006675.

a. This transmission line will eliminate all adjustment for losses described in subparagraphs 40D-80.073(8)(b)2. and 8., F.A.C.

b. Additionally, the City will provide an additional flow of 1.9 million gallons each day to the base of the dam from the TBC middle pool provided that water is being transported in accordance with SWFWMD Water Use Permit No. 20006675. This additional 1.9 million gallons each day is anticipated to be part of the water savings associated with this transmission pipeline.

c. Once the pipeline is completed, the 1.9 million gallons each day of additional flow provided by the City as part of the water savings associated with the pipeline will be used in preference to all other sources except Sulphur Springs and Blue Sink to help meet the minimum flow for the Lower Hillsborough River.

d. In the event that this pipeline is not substantially completed by October 1, 2013, or that the City did not provide the District with a minimum ninety (90) days notice prior to October 1, 2013, of the delay of completion of the pipeline due to circumstances beyond its control, then, the City will be responsible for delivering the flows the District was previously obligated to divert from the TBC middle pool to the Hillsborough River and then to immediately below the City's dam under subparagraphs 40D-80.073(8)(b)2. and 8., F.A.C.; except that the District shall continue to be responsible to pump water from the TBC lower pool to the middle pool as described in sub-subparagraph 40D-80.073(8)(b)2.b., F.A.C., and from Morris Bridge Sink to the TBC middle pool as described in subparagraph 40D-80.073(8)(b)8., F.A.C.

e. The City shall also provide the 1.9 million gallons each day if needed to help meet the flow described in this provision, from some other permitable source and is obligated to do so pursuant to sub-subparagraph (8)(b)2.d. above.

8. Morris Bridge Sink Project (see sub-paragraph ii below).

a. By October 1, 2012, or earlier, and upon completion of the project, provided that any permit that may be required is approved, the District shall divert up to 3.9 million gallons of water on any given day from the Morris Bridge Sink to the TBC middle pool.

(i) The Morris Bridge Sink diversions will be limited to the quantity needed to achieve the minimum flow requirements of the Lower Hillsborough River, after utilizing the quantity diverted from Sulphur Springs, Blue Sink and the 1.9 million gallons of water savings each day anticipated from the transmission pipeline, as they are implemented, and as described in subparagraphs 40D-80.073(8)(b)1., 3., 6. and 7., F.A.C.

(ii) However, on days when Tampa Bay Water does not draw the TBC lower pool down to 9.0 feet NGVD (1929 or its 1988 equivalent) for water supply purposes, and supplemental flow is needed for the Lower Hillsborough River minimum flow requirements beyond water that can be delivered from Sulphur Springs, Blue Sink and the 1.9 million gallons of water savings each day anticipated from the transmission pipeline described in subparagraphs 40D-80.073(8)(b)1., 3., 6. and 7., F.A.C., the District shall divert up to 7.1 million gallons on any given day from the TBC lower pool to the TBC middle pool prior to diverting flows from the Morris Bridge Sink to the TBC middle pool.

(iii) The District shall cease to divert water from the TBC lower pool under this provision once the elevation of the TBC lower pool reaches 9.0 feet NGVD (1929 or its 1988 equivalent).

b. Prior to the completion of the pipeline described in subparagraph 40D-80.073(8)(b)7., F.A.C., the District shall transfer any water delivered to the TBC middle pool from the Morris Bridge Sink or the TBC lower pool under this provision to the Hillsborough River near the District's Structure 161.

(i) These deliveries shall be made on the same day the District delivers water from the Morris Bridge Sink or the TBC lower pool.

(ii) The District shall then deliver 75 percent of any water diverted to the Hillsborough River under this provision to the Lower Hillsborough River. This delivery shall be from the Hillsborough River just above the City's dam to immediately below the City's dam.

(iii) The deliveries of the water from the Morris Bridge Sink to the TBC middle pool then on to the Hillsborough River are in addition to any other diversions from the TBC middle pool to the Hillsborough River described in subparagraphs 40D-80.073(8)(b)2. and 8., F.A.C.

c. Once the City completes the water transmission pipeline described in subparagraphs 40D-80.073(8)(b)5. and 7., F.A.C., or as may be otherwise responsible for delivering the flows the District was previously obligated to divert pursuant to subparagraph 40D-80.073(8)(b)7., F.A.C., the City shall move any water the District delivers to the TBC middle pool from Morris Bridge Sink or the TBC lower pool under this provision to the Lower Hillsborough River directly below the dam. Such delivery by the City will occur on the same day the District delivers the water from the Morris Bridge Sink or the TBC lower pool to the TBC middle pool.

d. At no time shall withdrawals from the TBC under this provision cause:

(i) The elevation difference between the TBC middle pool and Hillsborough River to exceed 9.5 feet as measured on either side of the District's Structure 161; or

(ii) The elevation difference between the TBC middle and lower pools to exceed 7.0 feet as measured on either side of the District's Structure 162.

9. Beginning October 1, 2017, the City shall be required to meet the minimum flows at the base of the dam as set forth in subsection 40D-8.041(1), F.A.C.

(c) The City and the District shall, as specified in the Funding Agreement incorporated in paragraph (8)(a) above, cooperate in the evaluation of options for storage of water (Storage Projects) such as aquifer storage and recovery and additional source options (e.g., diversions from Morris Bridge Sink greater than those described in subparagraph 40D-80.073(8)(b)8., F.A.C.), in sufficient permitable quantities, that upon discharge to the base of the dam, together with the other sources of flow described in paragraph 40D-80.073(8)(b), F.A.C., will meet the minimum flows beginning October 1, 2017, or earlier.

(d) The City may propose for District approval additional source or storage projects that when completed may be used in lieu of all or part of one or more sources described in subparagraphs 40D-80.073(8)(b)2.-8., F.A.C.

(e) Any District sponsored project, which shall include evaluation of up to 3.9 million gallons per day of additional quantities other than those identified in subparagraph 40D-80.073(8)(b)8., F.A.C., from the Morris Bridge Sink, shall be implemented by the District no later than October 1, 2017, provided that it is deemed feasible by the District, to eliminate or reduce the need to divert water from the TBC middle and lower pool storage as described in subparagraph 40D-80.073(8)(b)2., F.A.C. Such projects shall be implemented only after receiving any required permits.

(f) Each spring, beginning in 2008, the District shall review the recovery strategy to assess the progress of implementation of the recovery strategy and report that progress to the Governing Board. This annual review and report shall include identification of the Storage Projects or other additional source options that will be operational by October 1, 2017. If and when developed, Storage Projects or other additional source options to supply supplemental flows to meet the minimum flow will be used in preference to removal of water from storage in either the middle or lower pools of the TBC as described in paragraph 40D-80.073(8)(b), F.A.C.

(g) The City and the District shall continue the existing monitoring and analysis of the water resources within the Lower Hillsborough River and the District shall provide this information to the Governing Board as part of the annual review and report described in paragraph (8)(d), above.

(h) In 2013, and for each five-year period through 2023, the District shall evaluate the hydrology, dissolved oxygen, salinity, temperature, pH and biologic results achieved from implementation of the recovery strategy for the prior five years, including the duration, frequency and impacts of the adjusted minimum flow as described in paragraph 40D-8.041(1)(b), F.A.C. As part of the evaluation, the District will assess the recording systems used to

monitor these parameters. The District shall also monitor and evaluate the effect the Recovery Strategy is having on water levels in the Hillsborough River above the City's dam to at least Fletcher Avenue. The District will evaluate all projects described in this Recovery Strategy relative to their potential to cause unacceptable adverse impacts prior to their implementation.

(i) In conjunction with recovery of the Lower Hillsborough River and to enhance restoration of McKay Bay and Palm River estuary, the District intends to undertake a wetland restoration project adjacent to McKay Bay. The City agrees to contribute to the project by providing up to 7.1 million gallons on any given day of reclaimed water, as needed for the project. Within five years of completion of this wetland project, and for two subsequent five-year periods thereafter, the District shall review the hydrologic, dissolved oxygen, salinity, temperature, pH and biologic results achieved from the implementation of the restoration project and other similar District projects that may occur.

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TO: George Roberts, Chair, NWFWMD
Douglas E. Barr, Executive Director, NWFWMD
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Charlie Houder, Acting Executive Director, SRWMD
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Paul Senft, Chair, SWFWMD
Blake Guillory, Executive Director, SWFWMD
Joe Collins, Chair, SFWMD
Melissa Meeker, Executive Director, SFWMD

THROUGH: Herschel T. Vinyard Jr. HTV
Secretary

FROM: Greg Munson
Deputy Secretary for Water Policy and Ecosystem Restoration

DATE: March 23, 2012

SUBJECT: Guidance on Groundwater Augmentation of Surface Waters

Groundwater and surface water remain critical water supply sources for Floridians. Balancing the use of these sources to provide water supply without imperiling our natural systems is critical. This balance becomes particularly important when using groundwater to augment surface water that has been or could be impacted by withdrawals. This memo provides guidance to address that balance.

The Department recently conducted stakeholder sessions around the state with water users and environmental interests seeking input on ways to improve the consistency and effectiveness of the consumptive use permitting program. The stakeholders identified a need for additional consistency across the Water Management Districts (Districts) on the use of groundwater to augment surface waters.

Guidance related to the augmentation of surface waters with pumped groundwater is provided in Rule 62-40.410(7), Florida Administrative Code (F.A.C.) (Attachment 1). That section states, in part:

> *In implementing consumptive use permitting programs, the Department and Districts shall strive to prevent harm to natural systems without the need for artificial maintenance of natural systems by pumped groundwater augmentation.*

The rule further provides factors that the Districts should consider in the adoption and implementation of consumptive use permitting rules regarding the use of pumped groundwater to artificially maintain natural systems that otherwise would be adversely affected by an applicant's proposed withdrawal for water supply.

These same principles should be applied in the development and implementation of recovery and prevention strategies for minimum flows and levels. Development of long-term recovery solutions that are self sustaining and do not involve ongoing operation and maintenance costs, should be the goal of plan development. Long-term augmentation of wetlands or other surface waters with pumped groundwater should be avoided. When long-term augmentation is the only feasible alternative, augmentation with the use of reclaimed water or recycled stormwater is encouraged, as provided in Rule 62-40.410(7)(b), F.A.C., when consistent with water quality standards. Further, when long-term augmentation is the only feasible alternative, short-term pilot projects using groundwater to test the efficacy of augmentation may be allowable, but should be limited in duration.

The use of groundwater for augmentation of small aesthetic or recreational surface water bodies may be requested by homeowners or other entities, unrelated to any request by the applicant for water supply withdrawals. Such uses need to be reviewed on an individual basis to determine if the use meets the conditions of issuance for a consumptive use permit. It is anticipated that such a use would only rarely meet the conditions of issuance. Further, the use of groundwater during times of drought or normal climactic variability to augment surface waters is generally not consistent with the public interest.

This memo is not applicable to the use of pumped groundwater to be discharged to surface waters for purposes other than those described above, such as augmentation of aquaculture ponds or for mixing with other waters for salinity adjustment. Such proposed uses should be reviewed on a case by case basis for compliance with the conditions for permit issuance.

If there are any questions or concerns regarding a proposal to use pumped groundwater to augment a surface water body, the District should contact the Office of Water Policy to discuss the proposed augmentation.

HTV/GM/as

Attachment

cc: Ann B. Shortelle, Ph.D., Director, Office of Water Policy, FDEP

Attachment 1

Rule 62-40.410(7), F.A.C

(7) In implementing consumptive use permitting programs, the Department and Districts shall strive to prevent harm to natural systems without the need for artificial maintenance of natural systems by pumped groundwater augmentation. If groundwater augmentation is authorized, reasonable assurance must be provided that such augmentation will not cause harm to natural systems.

(a) In the adoption and implementation of consumptive use permitting rules regarding use of pumped ground water to artificially maintain natural systems that otherwise would be adversely affected by withdrawals for water supply, consideration shall be given to the following factors:

1. Whether there are other economically, environmentally, and technically feasible means to avoid the impacts, including the use of alternative water sources, that would reduce or eliminate the impact. In determining economic feasibility, the Department and Districts shall consider costs and benefits;

2. The current condition of the natural system, and whether the system would be enhanced over the current condition through augmentation;

3. The geographic extent of the system to be augmented; and

4. The amount of water made available for water supply compared to the amount required for augmentation.

(b) The use of reclaimed water and recycled stormwater is encouraged in situations when the augmentation of wetlands is conducted, where practical and consistent with water quality protection.

(c) This paragraph is not intended to exclude other means to avoid or mitigate adverse impacts to natural systems.