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HANI MICHEL, P.E.
Texas No. 60763 JANUARY 25, 2008

City of Austin

Water Treatment Plant No. 4

VOLUME II
TECHNICAL MEMORANDUM NO. 17
WATER QUALITY ENVIRONMENTAL COMMISSIONING

DRAFT
January 2008

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CITY OF AUSTIN

WATER TREATMENT PLANT NO. 4

VOLUME II
TECHNICAL MEMORANDUM
NO. 17

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WATER QUALITY ENVIRONMENTAL COMMISSIONING

1.0 INTRODUCTION

1.1 Background

The City of Austin (City) plans to design and construct a new water treatment facility, Water Treatment Plant No. 4 (WTP 4). The existing WTP 4 site lies within the upper headwaters of Bull Creek, and is surrounded by the Balcones Canyonlands Preserve (BCP). The protection of the valuable habitat for native flora and fauna, as well as the Northern Edwards Aquifer formation, which underlies the site, is a critical component of the project. As such, the process of Environmental Commissioning (EC) was implemented to help achieve the highest level of protection possible while allowing for construction of the WTP 4 facilities.

1.2 Scope

The purpose of this Technical Memorandum (TM) is to describe alternatives and recommendations for achievement of several of the environmental goals associated with the construction and operation of WTP 4 at the Bull Creek site. Greater detail of the Best Management Practices (BMPs) and mitigation strategies developed to achieve the environmental goals is provided in a report prepared by the Mitigation Working Group entitled *Environmental Goals and Recommendations for Mitigation, Best Management Practices, Monitoring, and Environmental Commissioning*.

In order to minimize the environmental impacts due to construction of WTP 4, the storm water quality and flood control system will be installed prior to construction of the WTP 4 process facilities. The storm water facilities will be designed to maintain the existing hydrologic regime and will be installed before the construction of the WTP 4 facilities to ensure their proper operation. Other mitigation strategies to limit the impact that the construction and operation of WTP 4 may have on the surrounding environment, and in particular, to preserve the natural site hydrology and hydrogeology, include:

- Minimizing the depth of excavation
- Rainwater harvesting and groundwater recharge
- Excavation fines mitigation
- Shaft and tunnel mitigation
- Process leak/overflow protection

- Chemical containment
- “Moat”

The environmental benefits and associated costs of each mitigation strategy are described in subsequent sections of this TM.

2.0 GOALS

Goals of the mitigation strategies outlined in this TM parallel those of the *Environmental Goals and Recommendations for Mitigation, Best Management Practices, Monitoring, and Environmental Commissioning* report, and include:

- Achieve non-degradation of water quality.
- Achieve non-degradation of hydrologic regimes.
- Prevent discharge of pollutants from the site.
- Reduce impacts to BCP.
- Protect habitat for native flora and fauna, including the Jollyville Plateau Salamander (JPS).
- Strive toward energy efficiency and resource conservation.

3.0 MINIMIZING THE DEPTH OF EXCAVATION

3.1 Purpose

Drinking water treatment facilities are typically constructed to maintain gravity flow through the facilities, which can require deep excavating often in excess of 25 feet. The Northern Edwards Aquifer, which underlies the site, is primarily composed of carbonate rocks, such as limestone and dolomite. When these carbonate rocks weather by dissolution, they become honeycombed and cavernous, forming what is called “karst” topography. When this type of formation is exposed to the surface, it allows the underlying aquifer to be recharged by the infiltration of rainfall and storm water runoff. However, the excavation required to construct WTP 4 could potentially sever some of these natural conduits, reducing the amount of water available to recharge the aquifer. Therefore, the protection of karst features and void spaces are important to maintaining the existing groundwater flow paths and avoiding habitat fragmentation. It is difficult to quantify the impact excavation activities and the installation of permanent structures within the limestone strata will have. However, it is assumed that any WTP 4 design that reduces the amount of excavation within the limestone will directly lessen the impacts on karst voids and conduits, helping to maintain the existing groundwater pathways.

3.2 Description and Implementation

Reducing the excavation depth of the WTP 4 facilities was examined as a potential mitigation strategy to maintain the existing groundwater flow regimes. Boring logs, provided by HVJ Associates, indicate that in general the site has an upper strata of alluvial soils, including fat/lean clay underlain by completely weathered limestone consisting of clayey sand and gravelly clay. These boring logs also provide a means to estimate the depth the limestone strata lies below the ground surface. On average, the limestone strata are expected to be approximately 2 to 7 feet below the ground surface. For additional information, see the Geotechnical Investigation Report prepared by HVJ & Associates included in Appendix F. In order to preserve these strata, fill will need to be imported and compacted to raise the site. In addition to importing fill, raising the facilities also affects foundation requirements for each structure. The project structural engineer, Jose I. Guerra, Inc., evaluated the foundation requirements and subsequent cost for a range of excavation depths. This evaluation is included as part of the structural design Technical Memorandum (TM No. 14). This assessment notes that three basic structure types will be used, and each has different foundation requirements depending upon the depth of excavation (Table 17.3.1). Each of the proposed foundation types are more robust than those required if the limestone strata need not be preserved below a specified depth baseline, resulting in cost increases.

Table 17.3.1 Foundation Requirements[1]
TM17 — Water Quality Environmental Commissioning
City of Austin Water Treatment Plant No. 4

Structure Type	Baseline Foundation [2]	Raised Facility Foundation [3]
Liquid Containing Structures	2-ft thick perimeter walls on strip footings ranging from 2 - 3 feet thick that bear on limestone (i.e., Ullrich clarifiers (Figure SD-2 in Appendix A.17.1))	Construction of a 2-ft thick concrete mat with lean concrete between the mat and the surface of the limestone (Figure SD-1 in Appendix A.17.1)
Lightly Loaded Buildings	Stiffened slab on grade (Figure SD-4 in Appendix A.17.1)	Structural foundation slab on concrete-drilled piers bearing on the limestone (Figure SD-3 in Appendix A.17.1)

Table 17.3.1 Foundation Requirements[1]
TM17 — Water Quality Environmental Commissioning
City of Austin Water Treatment Plant No. 4

Structure Type	Baseline Foundation [2]	Raised Facility Foundation [3]
Heavily Loaded Buildings	Stiffened slab on grade supported by concrete-drilled piers (i.e. Ullrich lime building)	Construction of a thick concrete mat (2 - 4 feet, depending on the structure) with lean concrete between the mat and the surface of the limestone (Figure SD-5 in Appendix A.17.1)

Notes:
1. Based on information provided in Appendix A.17.1.
2. Foundations used in the absence of implementing karst protection measures.
3. Lean concrete/piers need only be placed between the concrete mat/slab and limestone if the mat/slab does not bear on the limestone.

3.3 Implementation Issues

Depending on the depth of excavation, several implementation issues exist:

- Increased Construction Time. Taller structures will require larger and thicker foundations and fill will need to be placed and compacted to raise the site. The increased time that would be required for the construction of the foundation, importing off-site backfill, grading, and compaction would only be partially offset by a reduction in the time required for excavation.

- Settlement in Areas Between the Major Structures. Despite implementation of even the best compaction techniques, the placement of deep layers of imported fill across the site may result in settlement in areas between the structures. The major facility structures (such as the upflow clarifiers (UFCs), filters, buildings, etc.) will be constructed with substantial foundations, and therefore should not be affected. However, roadways and other construction in the areas between the major structures on the imported fill may be subject to differential settlement problems (i.e. movement and cracking).

- Maintenance of Hydraulic Profile. Because the elevations of each process structure are related by the hydraulic profile of the plant, raising the structures that require the deepest excavation (i.e., the UFCs and clearwells), results in raising all of the structures upstream as well.

3.4 Alternative Evaluation

The UFC basins are potentially a major source of excavation within the limestone strata due to their large footprint and conical shaped bottom. Therefore, the UFC excavation served as the baseline for examining the impact decreasing the excavation depth had on disturbance of limestone strata. In addition to the UFC basins, the clearwells may also require a significant amount of excavation. According to the hydraulic profile and the ground surface elevations at the proposed locations of the UFC basins and the clearwells, the excavation depths at both structures are similar. The environmental benefits of decreasing the excavation depth while minimizing cost were studied by examining four different cases:

- Case 1. The "baseline" scenario representing the proposed hydraulic profile, if karst void features were not an issue (excavation of approximately 23 feet below grade)
- Case 2. UFC excavation to approximately 18 feet below grade (raising the facilities 5 feet above "baseline")
- Case 3. UFC excavation to approximately 13 feet below grade (raising the facilities 10 feet above "baseline")
- Case 3.2. UFC excavation to approximately 10 feet below grade (raising the facilities 13 feet above "baseline")
- Case 4. Import fill, thus no excavation is required near UFC basins (raising the facilities 23 feet above "baseline")

These cases span the range of excavation requirements from that required if karst void features were not an issue (Case 1), to raising the facilities completely above the ground surface elevation (Case 4). Figure 17.1 presents a schematic showing the UFCs in each case along with the approximate existing ground and limestone strata elevation. In each case, imported fill will be needed for grading purposes. In Cases 1, 2, and 3, the majority of the imported fill will be required for grading the area of the proposed electrical substation. However, in Case 4, a significant amount of imported fill will also be required to raise the facilities throughout the site. Appendix A.17.2 contains individual site plans and hydraulic profiles detailing the limits of grading, location of retaining walls, and the location of other treatment plant components for each case.

3.5 Cost Estimate

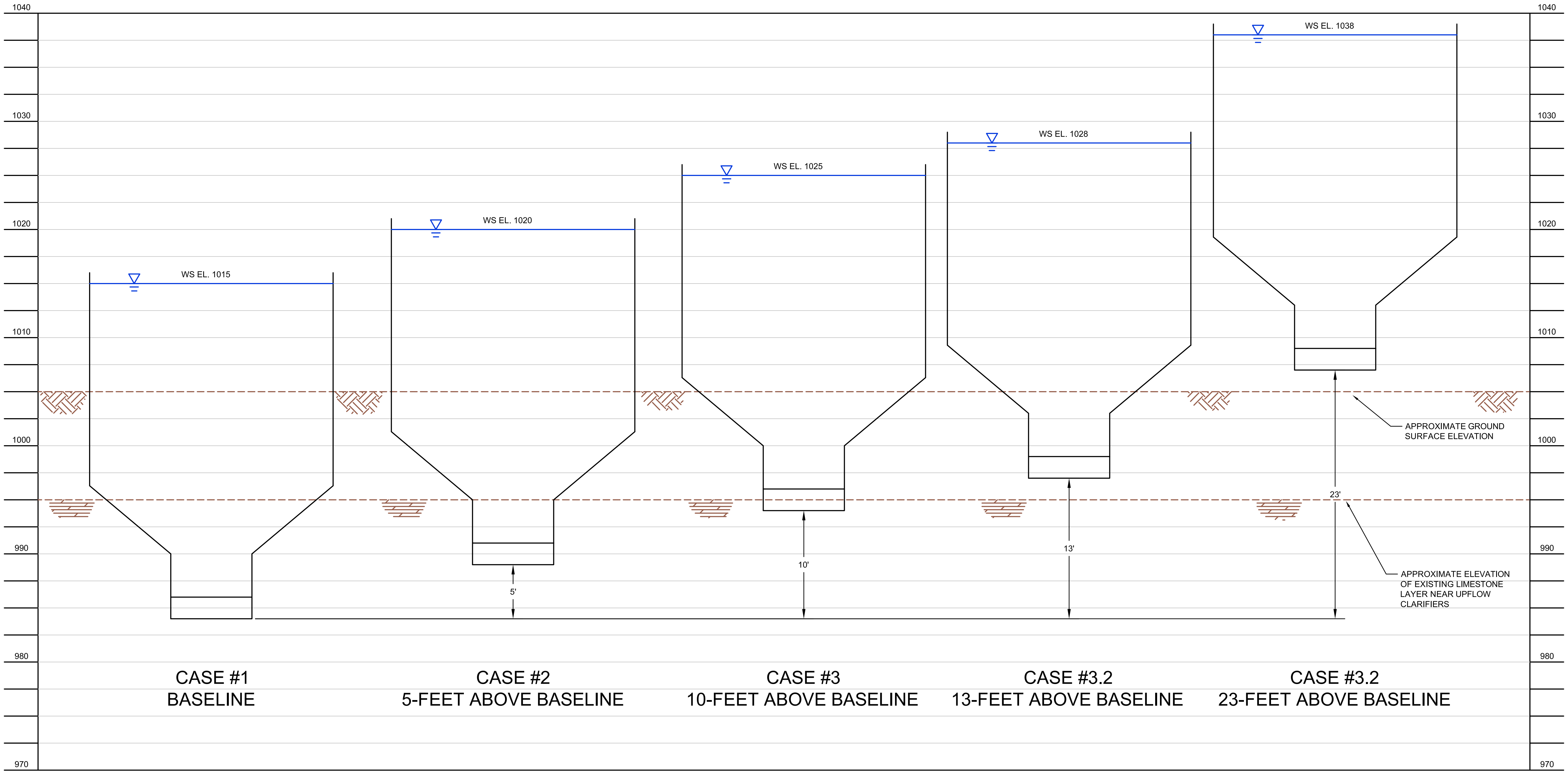
Budgetary estimates of the differential construction costs versus the "baseline" (Case 1) were developed for each of the alternative cases based on consultation with, Jose I. Guerra, Inc. and using the appurtenant site plans and profiles in Appendix A.17.2. The differential construction costs include the contractor's labor, materials, overhead, and profit. A contingency of 15 percent was assumed to account for unforeseeable elements of cost within the defined project scope as well as known elements that could not be identified at this stage of progress. Items such as variations in basin configuration developed during the detailed design phase and reasonable project changes during construction are included in the contingency.

The level of accuracy for construction cost estimates varies depending upon the level of detail to which the project has been defined. The American Association of Cost Engineers (AACE) International publishes guidelines that define the class of estimate and the expected accuracy range. Based on these guidelines, the construction cost estimate presented herein is a Class 4 estimate, which should be considered a cbudget estimate. The expected range of accuracy for this type of estimate is +30 percent to –15 percent of the actual project cost.

The costs presented in Table 17.3.2 represent the differential costs for raising the various facilities. The estimate includes the cost of foundations, excavation, imported fill, increased head tank volume, and retaining wall structures.

3.6 Recommendation

Construction of the UFC basins will require significant excavation due to their shape and large size. The approximate elevation of the limestone layer in the proposed area of the clarifiers is approximately 10 feet below grade. Given the City's desire to limit the impact of WTP 4 facilities on the environment, and in particular, the preservation of the natural hydrology, it is recommended that the excavation be limited to 10 feet in the area near the proposed UFC basins (Case 3.2). Limiting the excavation to a maximum of 10 feet will raise the UFC basins and required process piping above the existing limestone strata, resulting in minimal disturbance. This alternative provides a trade-off between limiting environmental impact and minimizing costs. The preliminary fill plan for this case (Figure 17.2) illustrates the areas of the site that imported fill and retaining wall structures will be required. Further raising the facilities increases costs because of greater imported fill volumes and larger and thicker foundation requirements. Raising the UFC basins will dictate the other major structures also be raised (Figure 17.3), minimizing the disturbance of limestone strata that may have resulted from their construction as well.



NOTES:
1. BASELINE PROFILE BASED ON PRELIMINARY HYDRAULIC CALCULATIONS.
2. ALL ELEVATIONS ARE APPROXIMATE.
3. JUNE 6, 2007.

SCALE:
VERT. 0 2.5' 5' 10'
HORZ. 0 20' 40' 80'

Figure No. 17.1
WTP 4
RAISING FACILITIES
(UPFLOW CLARIFIERS)
CITY OF AUSTIN

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Table 17.3.2 Impact of Limiting Excavation on Total Cost
TM 17 — Water Quality Environmental Commissioning
City of Austin Water Treatment Plant No. 4

Scenario	Comment	Excavation Depth (ft) [1]	Differential Foundation Cost	Differential Retaining Wall Cost	Differential Excavation/ Imported Fill/Head Tank Cost	Total Cost Differential [2]
Case 1	**Engineer's Baseline**	**23**	**---**	**---**	**---**	**$0**
Case 2	Raise 5 ft	18	$160,000	$0	($1,200,000)	($1,040,000)
Case 3	Raise 10 ft	13	$4,210,000	$740,000	($980,000)	$3,970,000
Case 3.2	Raise 13 ft	10	$5,320,000	$2,470,000	($460,000)	$7,330,000
Case 4	Raise 23 ft	0	$18,300,000	$5,460,000	$2,490,000	$26,250,000

Notes:
1. Estimated excavation depth below natural ground elevation required for UFC basins.
2. Costs include 15-percent contingency.
3. Costs estimated in June 2007.

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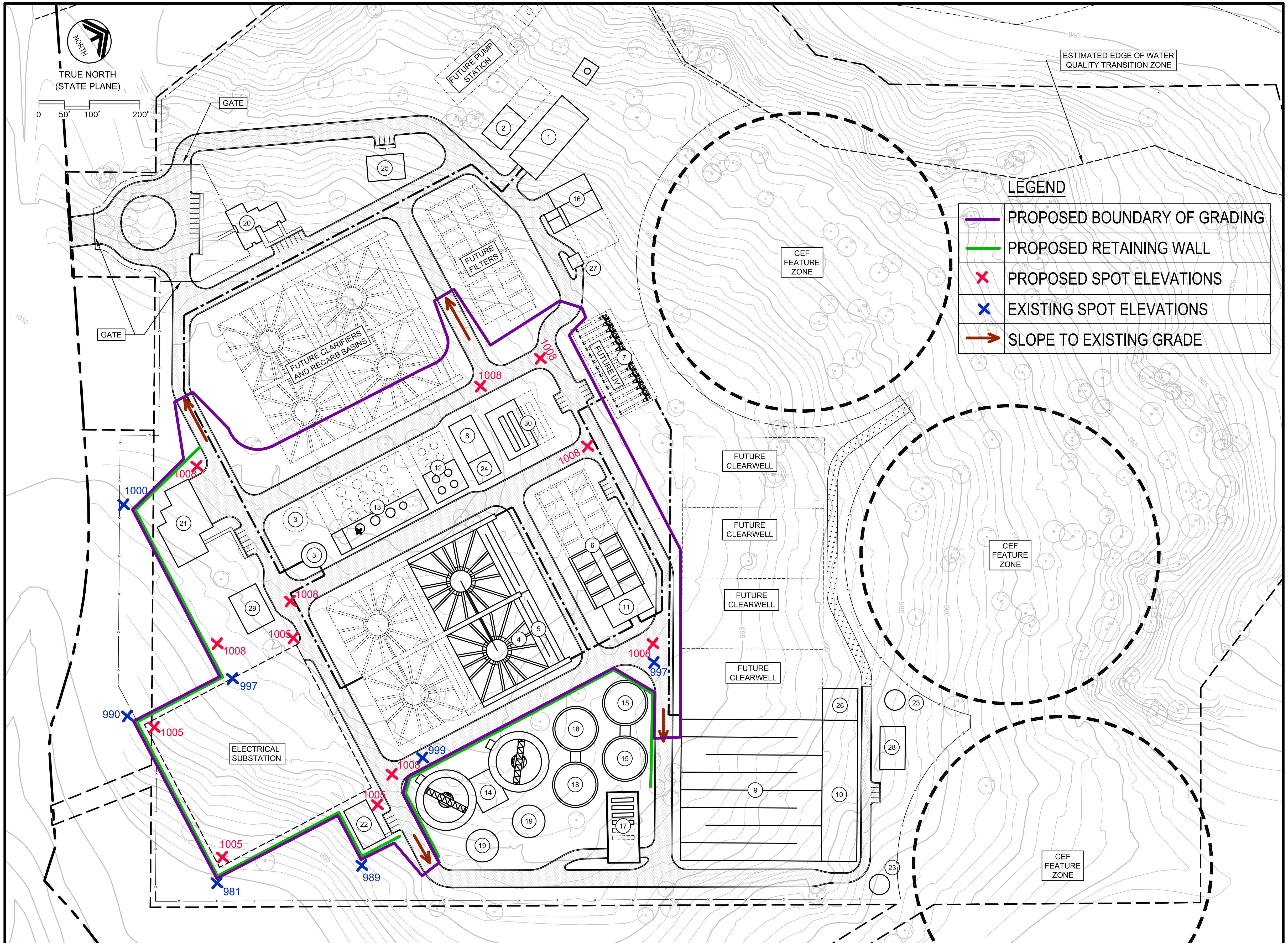

FACILITY LEGEND

1. RW PUMP STATION
2. RW ELECTRICAL BUILDING
3. INLET FLOW SPLIT STRUCTURE
4. UPFLOW CLARIFIERS
5. RECARBONATION BASIN
6. FILTERS
7. UV DISINFECTION (OPTIONAL)
8. CHEMICAL/PRETREATMENT ELECTRICAL BUILDING
9. CLEARWELLS / CT CONTACT BASINS
10. FW PUMP STATION
11. ELECTRICAL & BLOWER BUILDING
12. LIME BUILDING
13. CHEMICAL BUILDING
14. GRAVITY THICKENERS
15. FILTER RECYCLE EQUALIZATION
16. CHLORINE BUILDING
17. PLATE & FRAME PRESS
18. FILTER RECYCLE CLARIFICATION
19. RESIDUALS STORAGE
20. ADMINISTRATION BUILDING
21. MAINTENANCE BUILDING
22. MAIN ELECTRICAL BUILDING
23. TUNNEL ACCESS SHAFT
24. OPERATIONS BUILDING
25. PAC FACILITY
26. WASH WATER PUMP STATION
27. SALT STORAGE
28. FW ELECTRICAL BUILDING
29. AMMONIA BUILDING
30. CO_2 STORAGE

PAVED ROAD
GRASSPAVE POROUS PAVING
PROPERTY BOUNDARY
FACILITY BOUNDARY (APPROXIMATE)
INDEX CONTOUR
INTERMEDIATE CONTOUR
MAJOR PROCESS PIPING
EXISTING TREE (19"Ø AND LARGER)

Figure No. 17.2
WTP 4
PRELIMINARY FILL PLAN
(CASE 3.2)
CITY OF AUSTIN

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WTP4 Plant-Alternate

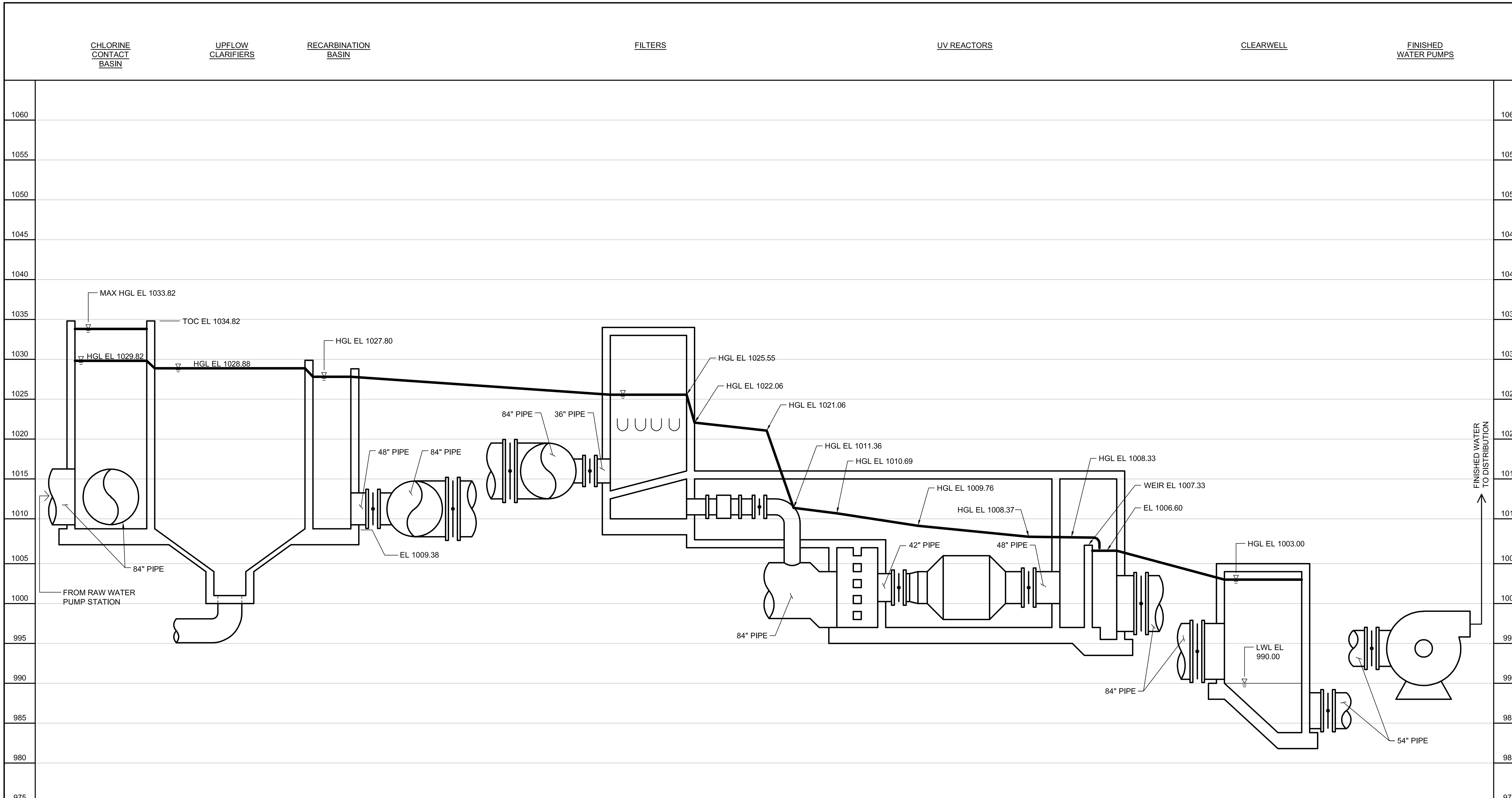

Figure No. 17.3
WTP 4
PRELIMINARY
HYDRAULIC PROFILE
CITY OF AUSTIN

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4.0 RAINWATER HARVESTING AND GROUNDWATER RECHARGE

4.1 Purpose

Effective management of storm water runoff is essential to maintaining the pre-developed surface water runoff and groundwater recharge characteristics. A component of the strategy to maintain the pre-development hydrology is the minimization of impervious areas on the site and the implementation of rainwater capture where feasible. The captured rainwater may be used as a source of artificial groundwater recharge, thus serving as a groundwater flow mitigation strategy.

4.2 Description and Implementation

According to the memorandum, Water Treatment Plant No. 4 Groundwater Flow Path Mitigation, dated May 7, 2007 and issued by David Johns, P.G., with the City's Watershed Protection and Development Review Department (WPDRD), the site geology, soils, and karst development at the WTP 4 site is expected to be similar to the Barton Springs segment of the Edwards Aquifer, in which recent studies indicate that approximately 32 percent of the rainfall in upland areas recharges this aquifer either through direct or diffuse recharge. Therefore, the Environmental Commissioning team set a goal of capturing 32 percent of the rainwater that falls over the impervious areas on the WTP 4 site to mitigate the recharge of the aquifer. Potential areas for rainwater collection include:

- Maintenance and operations buildings
- Clearwells
- Other buildings (chemical buildings, electrical buildings, finished water pump station, and dewatering building)
- Covering parking areas

4.3 Implementation Issues

The issues and constraints towards a successful installation of a rainwater harvesting system at WTP 4 are described below.

4.3.1 <u>Roofing Material</u>

The choice of roofing material is an important consideration for rainwater harvesting systems. The Texas Commission on Environmental Quality (TCEQ) published a report in January 2007 entitled, *Harvesting, Storing, and Treating Rainwater for Domestic Use*. The authors of this report recommend:

- The use of a smooth, nonporous material because it improves the efficiency of the harvesting system by absorbing less water and reducing the chance that microbes and debris will collect in the pores and seams of the roof.
- Avoid using composite or asphalt-coated shingles.
- Do NOT use any roofing material that contains fungicides, algaecides, or any other biocide compound. As these products age and decay they release a variety of organic and inorganic chemicals that can pose a health threat if consumed.

According to the Texas Manual on Rainwater Harvesting published by the Texas Water Development Board (TWDB), Galvalume®, a 55-percent aluminum/45-percent zinc alloy-coated sheet steel, is a commonly used roofing material for rainwater harvesting. Galvalume® is also available with a baked enamel coating, or it can be painted with epoxy paint.

If rainwater harvesting is implemented, all roofs used for harvesting will be upgraded from shingles to a standing seam metal roof, which will result in a cost increase. According to R.S. Means Square Foot Costs 28th Annual Addition, Class A shingles cost approximately $1.88 per square foot, while a standing seam metal roof costs approximately $7.45 per square foot.

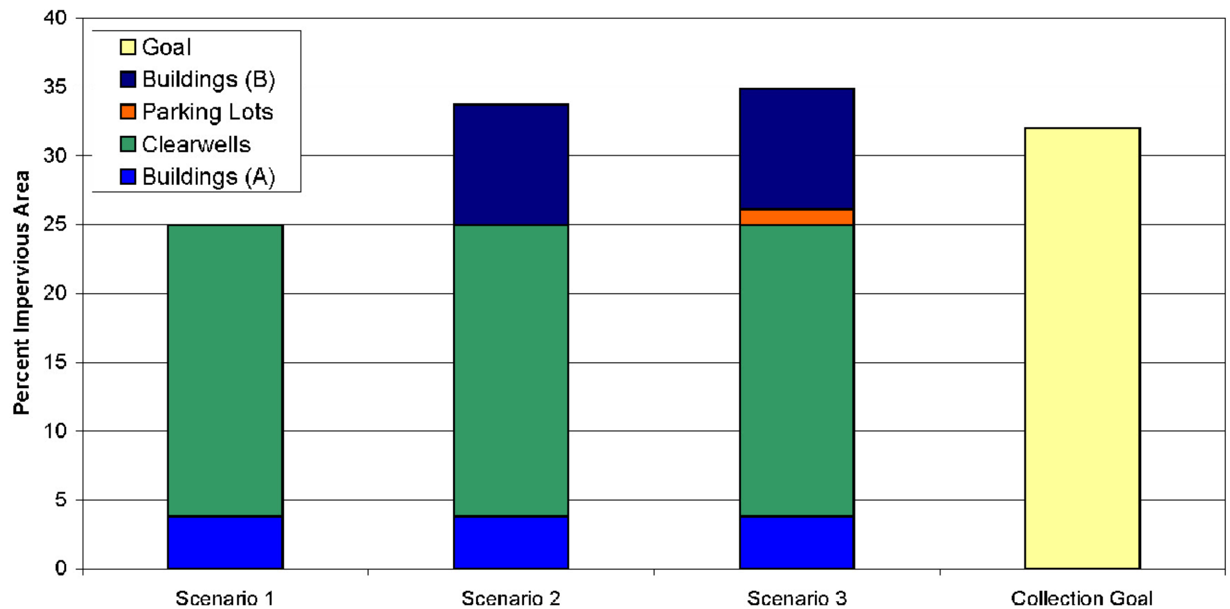
4.3.2 Injection Well Permitting

The state requires a permit for injection wells. This permit is from the Underground Injection Control Unit of the Industrial and Hazardous Waste Permits Section of the Waste Permits Division of TCEQ.

4.4 Alternative Evaluation

Figure 17.4 illustrates the contribution each proposed structure provides towards attainment of the 32-percent collection goal. The collection areas were divided into three scenarios based on ease of rainwater capture and cost (Scenario 1 is the simplest to implement; and Scenario 3 is more difficult and costly). The 32-percent attainment goal is exceeded by Scenario 2, which will achieve almost 34 percent attainment. Collecting rainwater on the UFCs is unattractive because of the cost associated with covering the large spans, the need for a removable cover to allow for maintenance, and that sufficient sunlight is required to be able to visually observe the amount of lime at the bottom of the clarifier while standing on the walkway at the top of the structure.

The rainwater harvesting system will consist of guttered buildings, clearwells, and parking covers that will collect rainwater (Figure 17.5). The water will then be conveyed to a sump and pumped into a collection tank, where it will be stored and fed to recharge wells spaced around areas of the site where a majority of the impervious cover is located, particularly in the plateau region of the site. The recharge wells will be completed at a depth below deep foundations but above geologic contact between the Edwards and Walnut formations,



Notes:
1. Buildings A include the Maintenance and Operations Buildings.
2. Buidings B include the remaining buildings.
3. The Colleciton Goal represents the volume of rainwater from a 2-year, 3-hour storm from the total impervious area on the WTP 4 site.

FIGURE No. 17.4
WTP 4
RAINWATER HARVESTING OPTIONS
CITY OF AUSTIN

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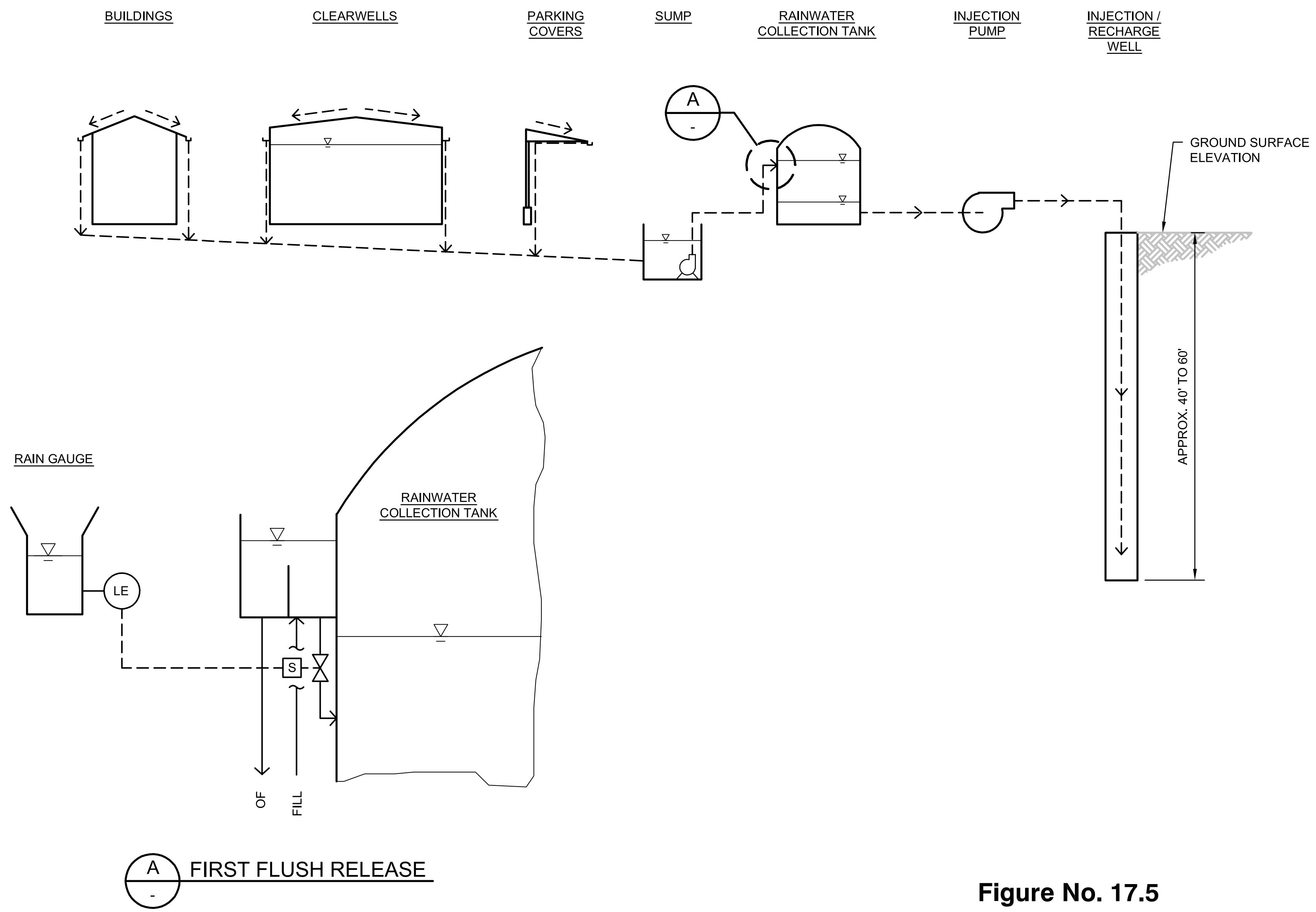

NOTES:
1. INJECTION WELLS TO BE CONTINUOUSLY ENCASED AND PERFORATED AT MULTIPLE DEPTHS.
2. TANK FILL VALVE TO OPEN BASED ON RAINFALL RECEIVED AND TRAVEL TIME TO TANK.

Figure No. 17.5
WTP 4
RAIN WATER HARVESTING SCHEMATIC
CITY OF AUSTIN

DRAWING NOT TO SCALE

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which is expected to be between 40 and 60 feet below the ground surface elevation. In addition, a first flush release mechanism, also depicted in Figure 17.5, will be used to help ensure the quality of the collected rainwater is optimal. The system is sized to contain a two-year, three-hour rain event. The layout of the collection system for each scenario is shown in Figure 17.6. Each scenario is cumulative. For example, the structures for which rainwater is captured and necessary from collection system in Scenario 1 are also included in Scenario 2. In addition, the required tank volumes were determined for each scenario (Table 17.4.1). The volume in each tank will be returned to the aquifer via injection wells over a two-day period. It is expected that the injection wells will be able to convey approximately 45 gpm with gravity feed; therefore, pumps will not be required for injection if the wells are located at lower elevations than the collection tanks.

Table 17.4.1 Required Collection Tank Volumes [1,2]
TM 17 — Water Quality Environmental Commissioning
City of Austin Water Treatment Plant No. 4

	Scenario 1 [3]	Scenario 2 [4]	Scenario 3 [5]
Tank 1 (gal)	20,000	24,000	32,000
Tank 2 (gal)	131,000	148,000	150,000
Tank 3 (gal)	4,000	37,000	40,000

Notes:
1. Tank and building numbers correlate to Figure SD-3 in Appendix A.17.1.
2. System is sized to capture a two-year; three-hour storm (0.773 inches per hour; 2.32 inches) event.
3. Buildings 18, 19; Clearwells.
4. Buildings 7, 8, 9, 10, 11, 12, 16, 18, 19, 21; Clearwells.
5. Buildings 7, 8, 9, 10, 11, 12, 16, 18, 19, 21; Clearwells; Parking.
6. gal = gallon.

4.5 Cost Estimate

Budgetary estimates of the construction costs were developed for each of the alternatives based on the layouts presented in Figure 17.6.

Table 17.4.2 summarizes the estimated construction costs for each scenario. A more detailed analysis of the costs for each option is provided in Appendix A.17.3.

Table 17.4.2 Opinion of Probable Construction Costs [1] – Rainwater Harvesting System [2,3] TM 17 — Water Quality Environmental Commissioning City of Austin Water Treatment Plant No. 4		
Scenario 1 [4]	**Scenario 2 [5]**	**Scenario 3 [6]**
$646,000	$789,000	$1,198,000

Notes:
1. Estimated cost of construction (including contractor fees and contingency) in June 2007 dollars
2. Tank and building numbers correlate to Figure SD-3 in Appendix A.17.1
3. System is sized to capture a two-year; three-hour storm (0.773 inches per hour; 2.32 inches) event.
4. Buildings 18, 19; Clearwells.
5. Buildings 7, 8, 9, 10, 11, 12, 16, 18, 19, 21; Clearwells.
6. Buildings 7, 8, 9, 10, 11, 12, 16, 18, 19, 21; Clearwells; Parking.

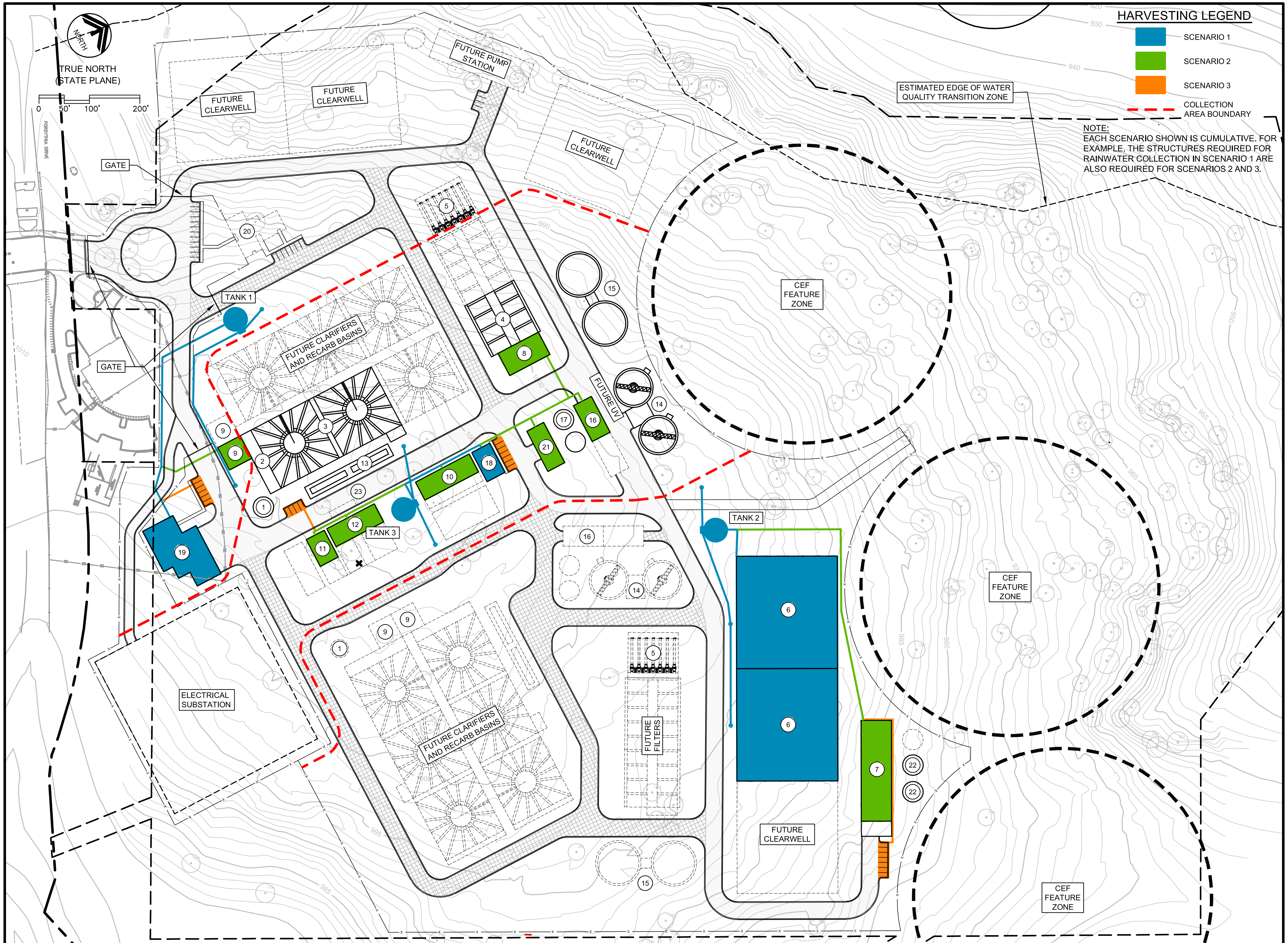
4.6 Recommendations

Scenario 2, which captures the rainwater from the clearwells and buildings that may be guttered is recommended because it will provide enough surface area to capture 32 percent of rainfall that falls over the impervious area of the proposed treatment plant. The location of artificial recharge points (injection wells) should be based on the results of groundwater tracing to ensure that the benefit on the springs from the introduced water is maximized.

5.0 EXCAVATION MITIGATION

5.1 Purpose

The Northern Edwards Aquifer, which underlies the site, is recharged by storm water through surface features. Groundwater then naturally flows through subterranean conduits and recharges the aquifer. Mitigation may be required during excavation to preserve voids and water flow features. The required excavation for construction of WTP 4 may also produce fine particulate matter, which has the potential to block subterranean conduits (i.e., if transported into a conduit by a rain event), reducing the amount of water available to recharge the aquifer. Therefore, mitigation strategies may be implemented to both reduce and remove the fine particulate matter produced by excavation.



FACILITY LEGEND

1. RW TUNNEL ACCESS SHAFT
2. CHLORINE CONTACT CHAMBER
3. UPFLOW CLARIFIERS / RECARBONATION
4. FILTERS
5. UV DISINFECTION (FUTURE)
6. CLEARWELLS / CT CONTACT BASINS
7. FW & BW PUMP STATION
8. ELECTRICAL & BLOWER BUILDING
9. LIME BUILDING
10. CHEMICAL BUILDING
11. AMMONIA BUILDING
12. CHLORINE BUILDING
13. CO_2 STORAGE
14. GRAVITY THICKENERS
15. FILTER RECYCLE EQUALIZATION / CLARIFICATION
16. DEWATERING
17. RESIDUALS STORAGE
18. OPERATIONS BUILDING
19. MAINTENANCE BUILDING
20. ADMINISTRATION BUILDING (FUTURE)
21. MAIN ELECTRICAL BUILDING
22. FW TUNNEL ACCESS SHAFT
23. SALT STORAGE (FUTURE)

NOTE:
DASHED FACILITIES ARE PROPOSED FUTURE EXPANSIONS.

PAVED ROAD
FUTURE ROADS
PROPERTY BOUNDARY
FACILITY BOUNDARY (APPROXIMATE)
PROPOSED PERIMETER FENCE
INDEX CONTOUR
INTERMEDIATE CONTOUR
EXISTING TREE (19"Ø AND LARGER)

DRAFT

Figure No. 17.6
WTP 4
RAIN WATER HARVESTING
CITY OF AUSTIN

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WTP4 Plant-Alternate

5.2 Void Mitigation

The City proposed void and water flow mitigation strategies (proposed Section 1.12.0 of the Environmental Criteria Manual, City of Austin Standard Specification Item No. 658S, and Standard Details 658 S-1 through S-7) are provided in Appendix A.17.4. These strategies describe the criteria for notification requirements and guidance for furnishing and installing mitigation measures for voids and water flow anomalies discovered during excavation.

The proposed measures require a geologist or geologist representative to inspect excavation operations within the Edwards Aquifer Recharge Zone or within 500 feet of a spring or seep. Upon observance of a void or water feature, all excavation activities must be stopped within 25 feet of the outer edge of the void until the appropriate mitigation strategies are approved.

The selection of the appropriate void and water flow mitigation measure is dependent on:

- The size of the void
- The amount of water flowing
- The biological characteristics observed

Temporary and permanent mitigation measures are used to protect the void during construction. The Class I temporary protection measures and Class II-V permanent void mitigation measures are described in detail in Appendix A.17.4. These measures will preserve the voids and groundwater flow patterns while maintaining utility integrity and preventing pollution. In general, these techniques require the void to be filled with gravel type media and sealed in a manner to ensure the natural hydrologic regimes remain intact.

5.3 Tunnel Shaft Mitigation

Raw water will be pumped to the WTP 4 site by a conveyance tunnel from the raw water pump station. The tunnel will be constructed below the Edwards Formation, and an access shaft will be used to connect the tunnel to the WTP 4 facilities. A significant amount of excavation will be required to construct the tunnel, access shafts, and pump station. Mitigation of the access shaft will be required to ensure that groundwater flow paths remain open and connected. Severed and disturbed conduits will be repaired in accordance with the City’s proposed void mitigation specifications described in Section 5.2 and illustrated in Figure 17.7. Dye tracing studies may be undertaken to determine probable groundwater flow paths. Access shafts will then be located away from these flow paths if possible. In addition, additional access shafts that may be constructed as part of future expansion phases will be located perpendicular to the groundwater water flow contours, if possible, so they are in the “shadow” of each other, further limiting possible interference to natural groundwater flow.

5.4 French Drains

French drains (Figure 17.8) consist of perforated Polyvinyl Chloride (PVC) pipe embedded in drain rock, and may be used around building foundations to collect rainwater and convey it to the stormwater collection ponds for irrigation. The drain rock will consist of an open material with minimal amounts of fine aggregate and is free from organic matter, clay, or other deleterious material. To prevent fine material from the surrounded soil from migrating into the open pores of the drain rock, the drain rock will be encapsulated with filter fabric. This will allow the drain rock to remain porous and drain rainwater into the French drain system.

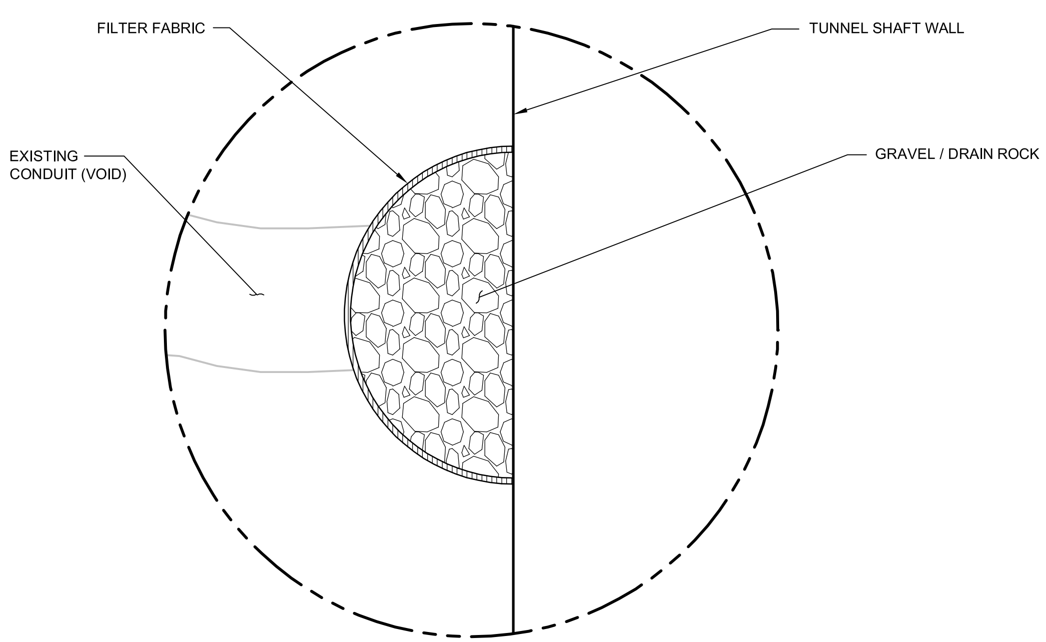
5.5 Fines Mitigation

As described in Section 3 of this TM, protection of karst features and void spaces are important to maintain the existing groundwater flow pathways. The main component to mitigate potential impact to these groundwater flow paths is through minimization of excavations by raising the WTP 4 facilities (also described in Section 3). Part of any excavation is the generation of fines (small soil and rock particles) and dust as a result of removing the soil and rock layers during construction. Regardless of the effort to minimize the disturbance of the soil-rock layers from excavation activities, generation of fines and dust will still occur. The generated fines have to be handled as they have the potential to migrate, accumulate, and potentially clog void spaces and karst features. As such, inquiries were made to research potential solutions to this problem. The use of a mechanical broom and/or vacuum type vehicle for suction of fines was identified as the most promising option. In essence, such a vehicle would be part of a daily “cleaning” routine to capture fines generated during each work day during the construction of foundation work.

5.5.1 Implementation Issues

Theoretically, fines mitigation is possible, however to our knowledge it has never previously been done. As such, practical experience, means and methods, and equipment (designed for this specific objective) may not exist. Three issues with implementing fines mitigation are described below:

1. Existing “street sweeper” equipment for removal of fines and dust are not designed for the inconsistent uneven terrain of a major construction site. It is not clear if such equipment or combination of equipment will effectively accomplish the desired objectives. A myriad of models and attachments exist for different types of potential equipment. It is possible that the available equipment is not able to produce the desired results.
2. General and excavation contractors have never performed any type of fines mitigation as envisioned by the City (described in Section 1.5.5) and will need to be trained, especially if it requires that the contractors purchase new equipment or develop their own means and methods.



A VOID MITIGATION

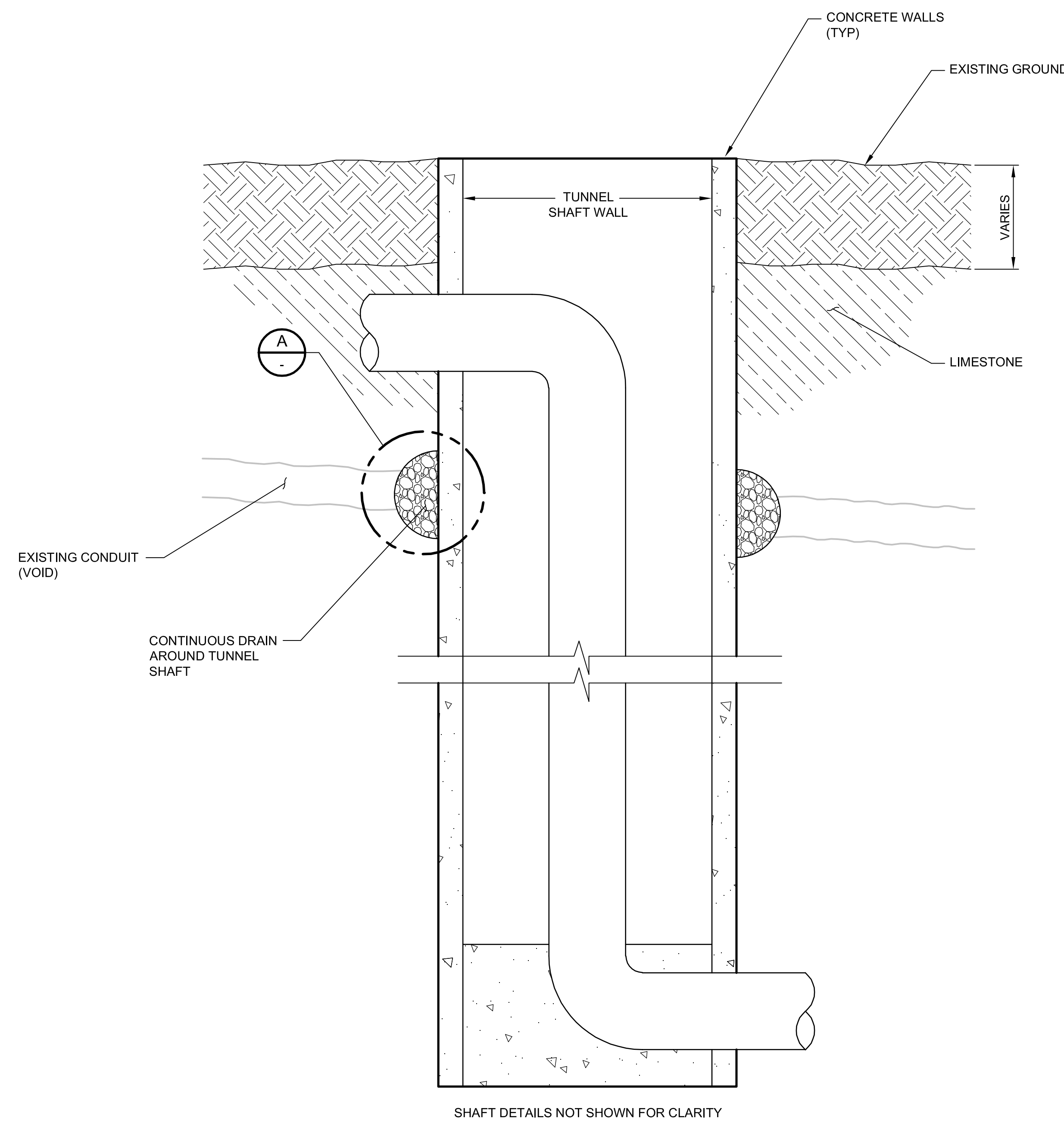


Figure No. 17.7
WTP 4
TUNNEL SHAFT MITIGATION
CITY OF AUSTIN

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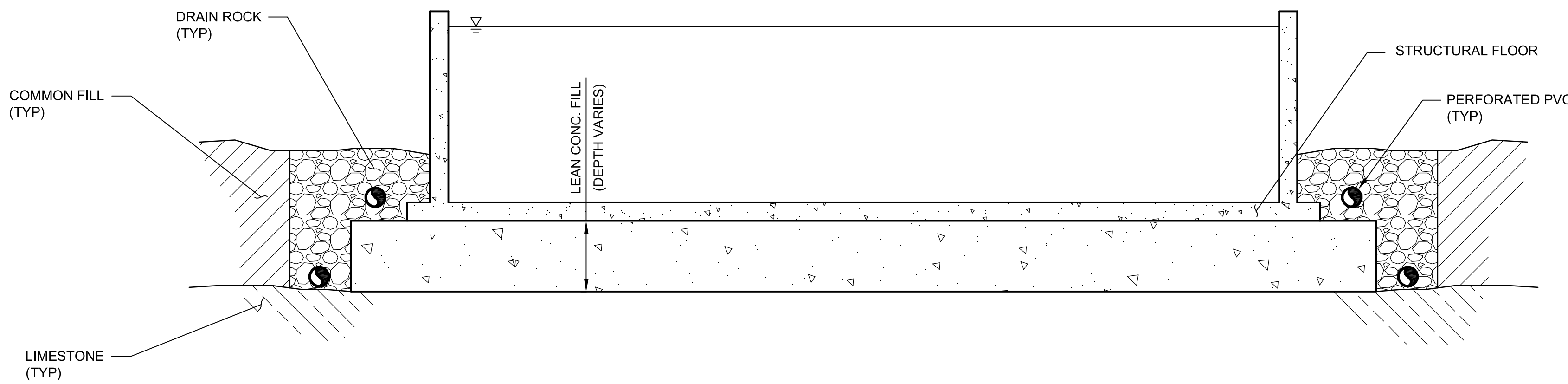
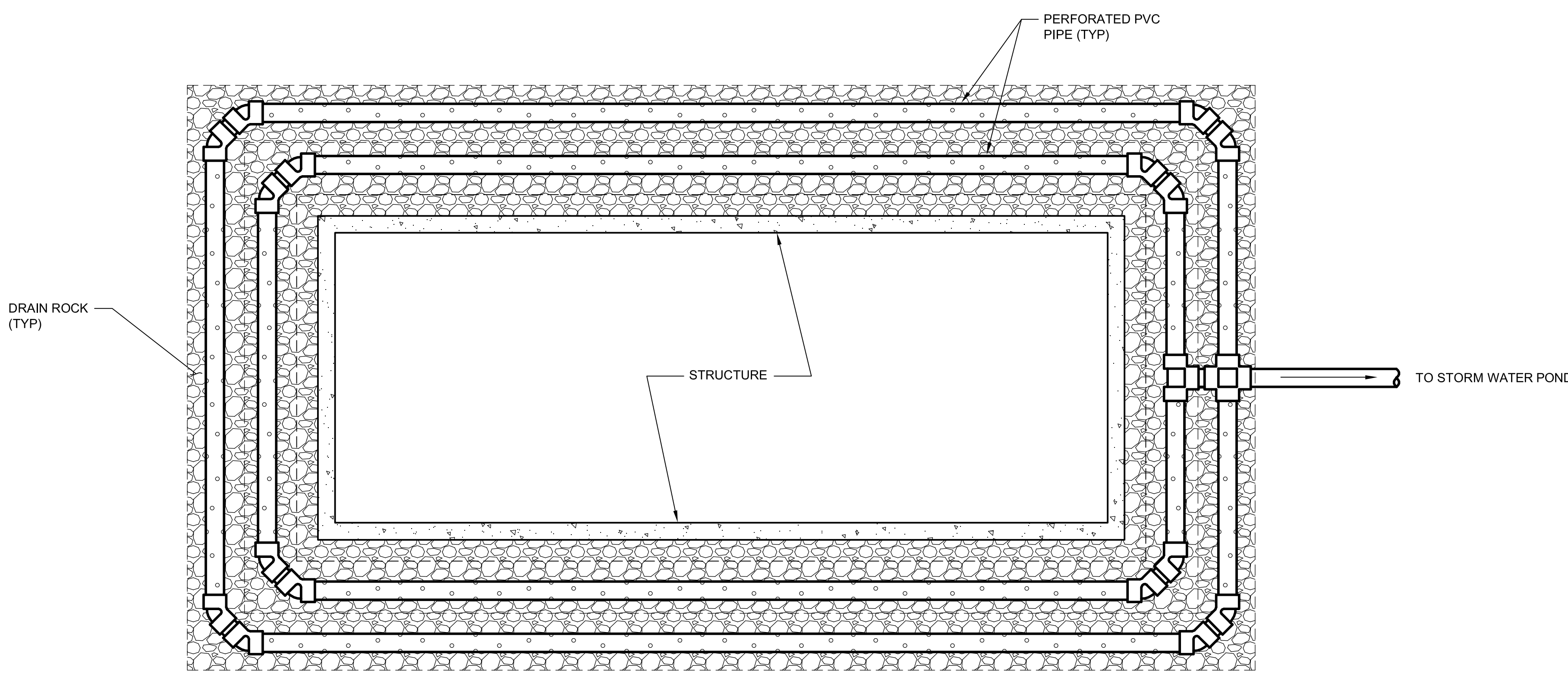


SECTION



PLAN

Figure No. 17.8
WTP 4
FRENCH DRAIN
CITY OF AUSTIN

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3. In order for any fines mitigation effort to be successful, standard contract language may need to be changed to provide financial motivation for performing the fines mitigation along with establishing the metrics to be used for judging the quality of the work (and any equipment requirements).

Tractor-mounted mechanical brooms (rotary brush), street sweepers with rotary brushes, and/or vacuum type equipment are employed by municipalities and construction contractors to clean up roadways during utility construction, prior to line stripping and litter control, etc. A mechanical broom type device is used to push fines into piles and then they are collected manually or in combination with a front-end loader. A strictly mechanical broom-type set-up is problematic as they are known to broadcast fines and dust.

A vacuum sweeper uses an air blast and suction to lift the fines and convey it into a collection hopper. Some models are able to filter the exhaust air to very small particulates. This method offers some potential for fines mitigation, however its chassis and body are not specifically designed to collect fines generated on a major construction site with very uneven terrain. In discussion with contractors, operation of such equipment on the WTP 4 construction site may result in frequent breakdown of the equipment from hitting protruding limestone, overturning of the vehicle and/or broadcasting of fines and dust as a result of the vehicle pitching and yawing back and forth. The last issue would defeat the whole purpose of using such a machine for capturing and removing fines.

While construction contractors are familiar with soil erosion and airborne dust control measures, similar means and methods for keeping fines from clogging void spaces and karst features have, to our knowledge, never been attempted and would be required at a large scale for the construction of WTP 4. Therefore, it is highly likely that a contractor will need to be educated about the importance of the fines mitigation and the City’s expectation that new means and methods may need to be developed and implemented to minimize the clogging of karst features. It is important that measurable metrics be established to determine the contractors payment and/or penalties for fines mitigation activities.

5.5.2 Cost Estimate

Two potential vacuum-type air sweeper manufacturers have been identified (Tymco of Waco, Texas) and (Schwarze Industries of Hunstville, Alabama) each with an array of models. The two models that may potentially achieve the fines mitigation goals are the Schwarze model 348-I and the Tymco model HSP.

The budget price to purchase a Schwarze model 348-1 is $82,200. It is expected that the budget price to purchase of the Tymco HSP is of similar value. It has been estimated that renting similar equipment over a five-month period of excavation will cost approximately $160,000. However, with little practical experience at performing fines mitigation a contractor may increase this cost in the bid in order to compensate for the perceived extra risk (See Implementation Issue No. 2 in Section 5.5.1).

5.5.3 Recommendations

In summary, fines and dust collection to prevent clogging of void spaces and karst features during a major construction project has, to our knowledge, never been attempted. Consultation with local contractors and queries with vendors confirms this conclusion. As such, the potential equipment available to accomplish the fines mitigation is designed for use on paved, even surfaces. The possibility exists that this equipment may perform reasonably well or not at all under the conditions of a major construction site.

It is recommended that, prior to the bidding and start of the main WTP 4 construction project, a small pilot (demonstration) project be performed to test the practicality of fines mitigation with a vacuum-type street sweeper. The construction of the storm water detention facilities; which is to be built prior to the WTP 4 project, is a good opportunity to test the effectiveness of the equipment on a smaller scale. It can also serve as a useful way to educate contractors and establish reasonable metrics to be used to judge the quality of the fines mitigation work performed under the main WTP 4 project.

6.0 PROCESS LEAK/OVERFLOW PROTECTION

6.1 Purpose

Partially treated and finished water from WTP 4 will contain disinfectant (chlorine or chloramines) concentrations that are toxic to aquatic and benthic organisms. Therefore, secondary containment of leaks, spills, or overflow of treated water will be provided by a Structural Underdrain Collector (SUC) system and overflow collection and routing structures.

6.2 Implementation Issues

6.2.1 SUC System

In addition to the installation of the SUC system under the necessary structures and pipe lines, implementation of this mitigation strategy would also require additional piping and control mechanisms to route any water collected for proper disposal.

6.2.2 Overflow Structures

The water collected from the overflow structures must be routed to the storm water detention ponds where could be contained and then pumped to the sewer for disposal. Implementation of this mitigation strategy will require control mechanisms to ensure the overflow water collected is routed to the sewer.

6.3 SUC Process Description

The SUC system will collect leakage from the treatment structures. This system will be located under each structure that contains process water and all process piping that convey it. A schematic of this system is provided in Figure 17.9. Due to the need to raise the facilities, a pad of lean concrete will need to be constructed beneath each water-containing structure. Before pouring the lean concrete, channels will be formed from styrofoam in a grid-like pattern, and then filled with a drain rock mixture to allow the conveyance of any water collected. The collection system will also be lined on the bottom and sides with impermeable PVC liner to prevent the release of treated water. The water collected by the SUC system will be piped by gravity to collection sumps prior to discharge to the sewer. In addition to the SUC system, each hydraulic structure will be constructed using ACI 350 standards and will undergo leak performance testing.

6.3.1 <u>Cost Estimate</u>

The cost of implementing the SUC system as a mitigation strategy was determined by the difference between the construction costs with the SUC system and without it. Therefore, the cost of excavation, fill, and collection piping were estimated for each case. A more detailed analysis of the costs is provided in Appendix A.17.3. These costs represent the costs associated with the collection systems placed under the structures as well as the cost of placing the SUCs under the process piping. The costs the SUC installation under the process piping, also shown in detail in Appendix A.17.3, were developed by determining the cost per linear foot for each option, including the cost of the process piping itself. The cost of the overflow facilities is not included in the analysis because they are required regardless of the mitigation strategies utilized. The estimated additional cost of installing the SUC system is approximately $930,000.

6.4 Process Overflow Structures System Description

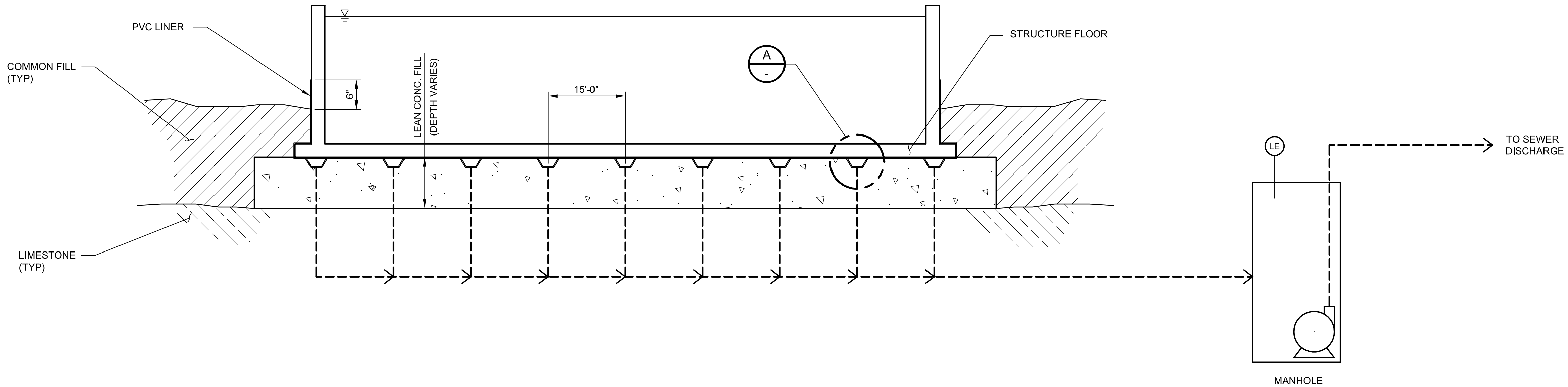
Overflow weir structures will be provided upstream of the filters to provide overflow for all pre-filtered processes and downstream of the filters to provide overflow for finished water from the clearwells. A schematic of this system is provided in Figure 17.10. Overflow structures will be sized to accommodate the maximum process flow to WTP 4 for 5 minutes. This duration will allow ample time for the overflow to be corrected and will prevent uncontrolled spilling of process flows into areas surrounding the plant. Overflow piping will route process overflows (treated or partially treated water) directly to the storm water collection ponds. A control system will be provided to isolate the detention pond to prevent the release of process water to the environment and pump the overflow water from the detention ponds to the sanitary sewer during dry conditions. In the event of an overflow during a significant rain event when the detention ponds are full, the control system will allow the combined storm water and overflow water to be discharged in a diffused manner (sheet flow). The conceptual design of the storm water quality and flood control is described in detail in the *Environmental Goals and Recommendations for Mitigation, Best Management Practices, Monitoring, and Environmental Commissioning* report prepared by the Mitigation Working Group.

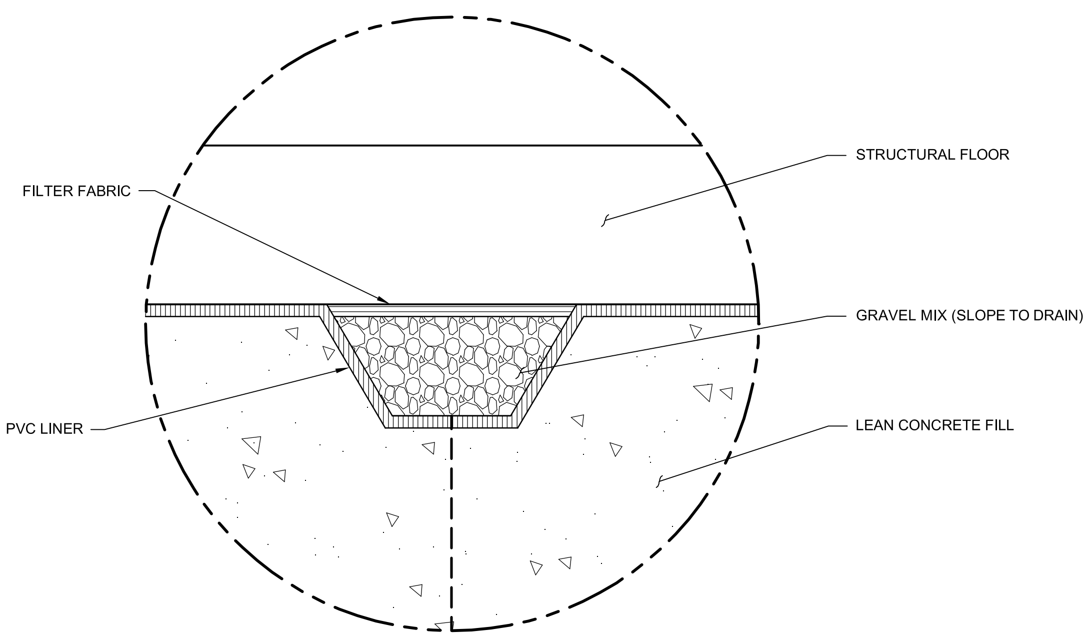
6.4.1 <u>Dechlorination</u>

The potential presence of chlorine, chloramines, and ammonia in the overflow water is of particular importance due to their known toxicity to aquatic organisms. Therefore, it is necessary to ensure that any water released to the environment from the overflow protection system contains low enough concentrations of chemicals of concern to be non-toxic to local organisms. Several feasible options for dechlorination/ammonia removal exist:

- Breakpoint chlorination/dechlorination with calcium thiosulfate
- Dechlorination with Granular Activated Carbon (GAC)/carbon dioxide (CO_2) addition for pH depression/ammonia removal with ion exchange (cliniptilolite)
- Natural attenuation by overland flow prior to discharge to the storm water detention ponds

However, because the overflow system will be used infrequently, a system that requires minimal operation is desired. Therefore, discharge of any process overflows to the storm water detention ponds is recommended. In order to ensure the feasibility of this option, the fate of each chemical of concern must be determined. As previously described, if the ponds are empty, the overflow water will be pumped to the sanitary sewer. Therefore, process water will only be discharged during a rain event when the detention ponds are full of storm water. Laboratory studies will be performed to determine the fate of the disinfectants in the presence of soil and rocks collected from the WTP 4 site to ensure adequate disinfectant degradation. In the event of a process overflow when the detention ponds are full of storm water, any remaining disinfectant residual should be significantly diluted by the storm water present in the detention facilities. The concentrations presented in Table 17.6.1 represent the greatest concentration of the chemicals of concern that would be discharged. However, the disinfectant concentrations are expected to be significantly less because of continued oxidation of Natural Organic Matter (NOM) present in the storm water, and if discharged, any remaining chlorine or chloramine residual should quickly be degraded from reactions with NOM in soil and rocks. In addition, any ammonia that remains should also be converted to nitrate nitrogen by organisms that are naturally present in the soil environment, taken up by plants, and dissipated by volatilization.





A STRUCTURAL UNDERDRAIN COLLECTOR

Figure No. 17.9
WTP 4
STRUCTURAL UNDERDRAIN
COLLECTION SYSTEM SCHEMATIC
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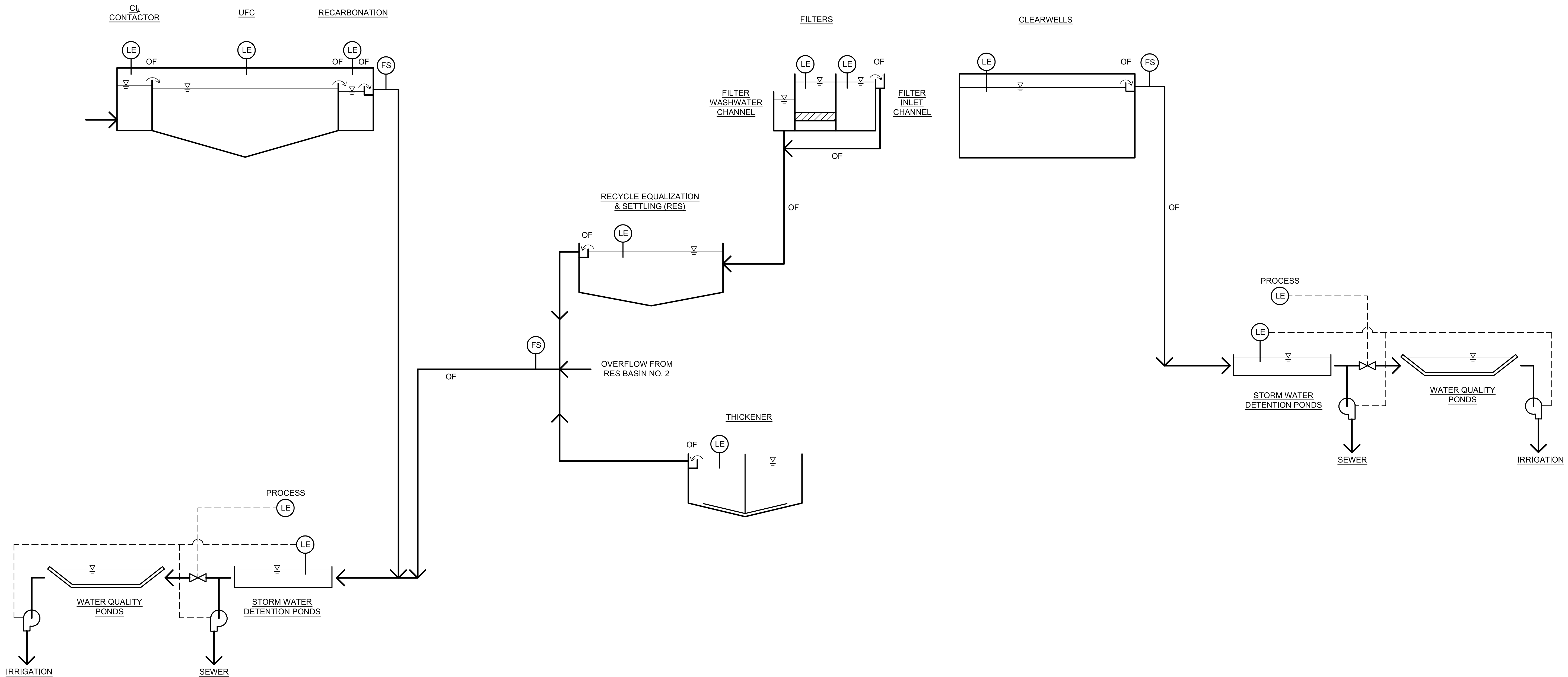

LEGEND

OF = OVERFLOW

LE = LEVEL INDICATION

FS = FLOW SWITCH

NOTES:

1. RAW WATER WILL BE CHLORINATED AT BEGINNING OF CHLORINE CONTACTOR. AMMONIA WILL BE INJECTED AT END OF CONTACTOR TO FORM CHLORAMINES.
2. HYDRAULIC CONVEYANCE AND OVERFLOW TREATMENT FACILITIES WILL BE SIZED FOR MAXIMUM POTENTIAL OVERFLOW RATE FROM EACH FACILITY.
3. WHEN STORM WATER DETENTION POND IS EMPTY AND OVERFLOW OCCURS, VALVE WILL CLOSE AND OVERFLOW WILL BE PUMPED TO SEWER.
4. IF IRRIGATION PUMPS ARE ON AND PONDS CONTAIN STORM WATER, VALVE WILL REMAIN OPEN AND OVERFLOW WATER WILL BE COMBINED WITH STORM WATER AND IRRIGATED.

Figure No. 17.10
WTP 4
OVERFLOW SCHEMATIC
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Table 17.6.1 Effect of Dilution on Concentrations of Chemicals of Concern
TM 17 — Water Quality Environmental Commissioning
City of Austin Water Treatment Plant No. 4

Chemical	Process Water	Detention Pond 1[1]	Detention Pond 2[2]	Detention Pond 3[3]	All Detention Ponds[4]
Chlorine (mg/L as Cl_2)	2.5	0.45	0.50	0.30	0.15
Chloramine (mg/L as Cl_2)	2.2	0.40	0.44	0.27	0.13
Fluoride (mg/L)	1	0.18	0.20	0.12	0.06
Free Ammonia (mg/L as N)	0.1	0.02	0.02	0.01	0.01

Notes:
1. Calculation assumes a 50-mgd release for 5 minutes; Basin 1 volume is 104,720 ft^3 (783,000 gallons).
2. Calculation assumes a 50-mgd release for 5 minutes; Basin 2 volume is 92,242 ft^3 (690,000 gallons).
3. Calculation assumes a 50-mgd release for 5 minutes; Basin 3 volume is 167,706 ft^3 (1,254,000 gallons).

6.4.2 Redundancy

The overflow protection process will be designed with significant redundancy to ensure process water is not released to the environment untreated. The redundancy incorporated into the design includes:

- Three level alarms on each water-containing process; when the third alarm is triggered, the raw pumps will automatically shut down.
- An overflow that occurs for 5 minutes at an initial flow rate of 50 mgd will result in approximately 175,000 gallons; however, the three storm water detention ponds as currently designed will hold approximately 2.6 million gallons combined, providing ample storage.
- Should the overflow occur when the detention ponds are empty, the overflow water will be collected in the detention ponds and pumped to the sanitary sewer.
- Should the overflow occur when the detention ponds are full (i.e., during a rain event), oxidation of NOM present in the storm water, and dilution should sufficiently reduce the chemicals of concern to concentrations non-toxic to local organisms.

6.5 Recommendation

Due to the necessity to protect the local environment, both the proposed SUC and overflow protection systems are recommended.

7.0 CHEMICAL CONTAINMENT

7.1 Purpose

Conventional water treatment involves the application of various chemicals in the process to improve the raw water quality to meet the United States Environmental Protection Agency (EPA) drinking water quality regulations. The conceptual plan developed during the Preliminary Site Assessment and Conceptual Design phases assumed that lime softening would be used at WTP 4 to match operations at the other City plants. WTP 4 is expected to fundamentally match the other existing Water Treatment Plants (WTPs) in terms of all chemicals used. The overall WTP 4 treatment process is fundamentally identical to the Ullrich WTP process, treating the same Colorado River source water (albeit from Lake Travis, rather than Lake Austin). The chemicals to be used at WTP 4 include:

- Chlorine (chlorination)
- Liquid Ammonium Sulfate (LAS) (chloramination)
- Ferric sulfate (primary coagulant)
- Quick lime (softening)
- Sodium Hexametaphosphate (SHMP) (anti-scalant)
- Fluorosilicic acid (fluoridation)
- Powdered Activated Carbon (PAC) (used occasionally for taste and odor treatment)

The chemical storage and feed facilities will have to meet regulations defined in TCEQ Chapter 290.42.f.1 and 2. A summary of these regulations as they pertain to chemical containment is outlined below.

- The materials used to construct containment structures must be compatible with the chemicals stored in the tanks. Incompatible chemicals shall not be stored within the same containment structure.
- Containment facilities for a single container or for multiple interconnected containers must be large enough to hold the maximum amount of chemical that can be stored with a minimum freeboard of six vertical inches or to hold 110 percent of the total volume of the container(s), whichever is less.

- Common containment for multiple containers that are not interconnected must be large enough to hold the volume of the largest container with a minimum freeboard of six vertical inches or to hold 110 percent of the total volume of the containers, whichever is less.

7.2 Process Description

A description of each chemical, safety considerations, storage requirements, and use is described in detail in TM No. 11. Some of these chemicals, if released to the environment, may cause adverse effects; therefore, secondary containment will be provided to ensure accidental chemical spills are contained for proper disposal. In general, bulk chemical storage tanks will be located within a secondary containment area large enough to store the contents of the largest single tank plus 20 minutes of fire sprinkler discharge. A spill will be contained and pumped into a tank trailer for proper disposal. Water resulting from washdown of the containment areas would be pumped to the sewer.

7.3 Recommendation

Providing secondary chemical containment is required by TCEQ, and therefore will be constructed for all proposed chemical storage areas at WTP 4.

8.0 MOAT

8.1 Purpose

Some of the existing groundwater pathways potentially flow laterally across the site. Construction of WTP 4 facilities may disrupt some of these existing lateral groundwater flow pathways. In an effort to mitigate this effect, one option proposed was to construct a “moat” like structure to intercept the lateral groundwater flow prior to it crossing into the WTP 4 site. Once in the “moat,” the flow would be diverted around the WTP 4 site where it would ideally reconnect and continue on in its natural flow pathways. This would be accomplished by excavating an approximately 10-foot deep 5-foot wide trench that would be filled with drainage rock. A layer of top soil would cover the drainage rock. The soil and rock layer would be separated with filter fabric to keep the rock layer from silting up. The “moat” structure would encircle the entire plant with the upstream faces of the trench coated with a 3-inch shotcrete liner to prevent premature seepage out of the trench.

8.2 Implementation Issues

The construction of the “moat” is relatively simple, but presents two main issues that need to be addressed. Although the “moat” may accomplish its intended goal to maintain the lateral flow of groundwater, the depth required to construct this may result in the actual disruption of lateral and vertical karst features. In addition, due to the topography of the site, the “moat” may unintentionally change the flow regime. During high groundwater levels in combination with large storm events, it is possible that “manmade” springs may form at the low elevation points of the “moats” and under a worst case scenario may be silt laden overland flow.

8.3 Cost Estimate

The estimated cost for construction of a drainage rock-filled moat that encircles the site is approximately $1.4 million dollars.

8.4 Recommendations

Although, construction of the moat is straightforward and simple, the implementation as well as maintenance issues are sufficiently problematic to question the cost effectiveness and utility of this option. It is therefore recommended that this option not be pursued.

9.0 NEXT STEPS

The concepts presented herein for implementing EC measures relative to water quality protection require additional evaluation and investigation prior to implementation. If the City ever decided to return to the Bull Creek site, the EC process would need to be re-engaged to further define the goals, evaluate the concepts, and develop specific requirements for implementing the strategies.