Appendix H | **2022 City of New Braunfels Reports**

Appendix H1 | **Native Aquatic Vegetation Restoration in the Comal River System**

2022 Native Aquatic Vegetation Restoration and Maintenance in the Comal River

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1 Introduction

As part of the Edwards Aquifer Recovery Implementation Program (EARIP) Habitat Conservation Plan (HCP), scientists at BIO-WEST, Inc., (BIO-WEST) have conducted native aquatic plant restoration activities to improve habitat for the federally listed, endangered Fountain Darter (*Etheostoma fonticola*) and native aquatic fauna. This year marked the ninth consecutive year for restoration and maintenance activities. The continued intent of this HCP measure is to increase the cover and distribution of target native aquatic plant species, subsequently benefiting the Fountain Darter by increasing available native habitat and improving the quality of existing habitat. This 2022 Native Aquatic Vegetation Restoration and Maintenance report summarizes the activities and restoration results within the project areas.

1.1 Project Areas Overview

The project area generally covers the upper two kilometers of the Comal River but is divided into multiple Restoration and Long-Term Biological Goal (LTBG) Reaches (**Figure 1**). The LTBG Reaches are the sampling sites in which routine biological monitoring is conducted. Fountain Darter sampling, water quality, discharge, and various other data are collected specifically in the LTBG Reaches to support the HCP long-term monitoring program. The Restoration Reaches are included to expand restoration and habitat improvement to the system. This project area encompasses Bleiders Creek through a spring run channel, referred to as Upper Spring Run, into Landa Lake and extending into the Mill Race, effectively ending at the first low-head dam. The project area also extends into the Old Channel and downstream approximately 1,100 meters. The Upper New Channel Long-Term Biological Goal Reach is disjunct from the rest of the project area. Each project reach has its own restoration timeline and goals as directed by annual work plans provided by the City of New Braunfels.

In 2022, significant effort was focused on the Landa Lake LTBG Reach. This included maintaining previously restored areas and creating new areas for plantings of *Ludwigia repens* and *Cabomba caroliniana*. Restoration plantings in the Old Channel were focused entirely on the Restoration Reach, with gardening activities occurring at the LTBG Reach. Although the Old Channel

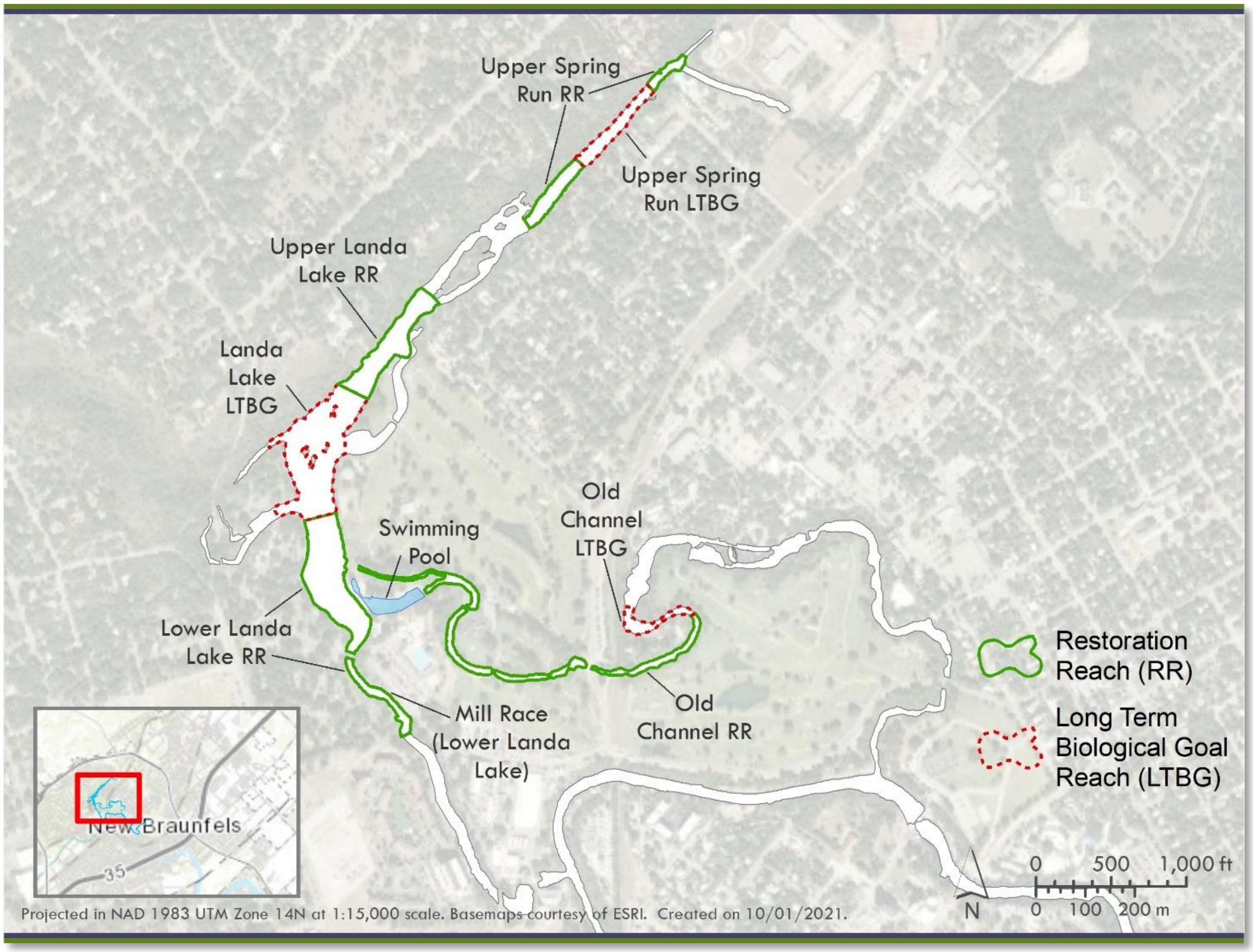


Figure 1 Location of the Landa Lake, Upper Spring Run and Old Channel Long Term Biological Goal (LTBG) Reaches (outlined in red). Green outlines the restoration areas.

Restoration Reach was not originally a target for restoration plantings this year, plans were modified to include reestablishment of *Ludwigia repens* and *Cabomba caroliniana*. The coverage of both species has declined significantly over the last 2 years due to competition from other native aquatic plant species. Upper and Lower Landa Lake continue to maintain their minimal vegetation goals. The Upper Spring Run Reaches were greatly impacted by low flows this year. Recreational impacts appeared to be minimal. As is common each year, general maintenance, such as vegetation mat removal, tree trimming and clearing of debris, was conducted as needed across the project area to enhance habitat quality for native aquatic vegetation.

2 Spring / River Conditions in 2022

This project year was dominated by below-average flows. Comal River discharge maintained a steady but lower-than-average rate during the first quarter of 2022. After spring rains failed to materialize, Comal spring discharge began to depart drastically from the historical mean (**Figure 2**). Precipitation recorded for March, April, and May at the San Antonio International Airport totaled 3.46 inches. As of September 30, rainfall totaled 8.5 inches.

By July, Comal spring discharge dropped below 130 cfs, enacting Provision M of the Habitat Conservation Plan. At this time all large-scale restoration activities were halted including large scale plantings, plant removal as well as relocating benthic barriers. Although late-summer rain provided a small boost to discharge, Provision M remained in place through November 2022 and the submittal of this report.

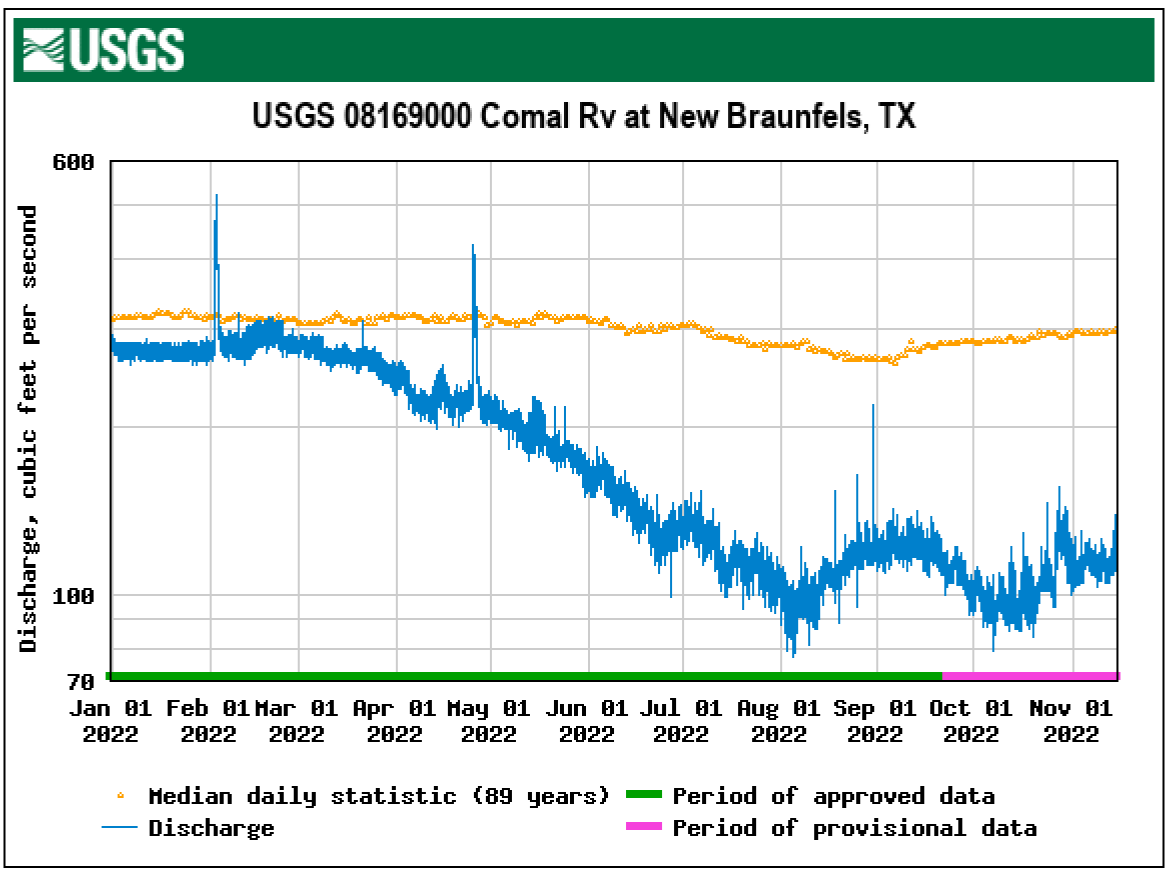


Figure 2 Discharge in the Comal River from January through November 2022 (USGS 2022).

3 Plant Propagation Methods

The native aquatic plant species targeted for this project are *Ludwigia repens* (Ludwigia), *Cabomba caroliniana* (Cabomba), *Sagittaria platyphylla* (Sagittaria), *Potamogeton illinoensis* (Potamogeton) and *Vallisneria neotropicalis* (Vallisneria). In recent years, only Ludwigia and Cabomba were propagated and planted because all other species have either met the target goals in their respective reach or are deemed not appropriate for a specific area. The methods for aquatic plant propagation in 2022 remained comparable to methodologies employed in previous years. Mobile underwater plant propagation trays (MUPPTs) were utilized to propagate the majority of the Ludwigia necessary for the project. This procedure was supplemented with sprigging from trimmed stem fragments because the efforts of the past several years have demonstrated this to be a reliable way to supplement Ludwigia colonies, and the Ludwigia colonies also benefit from the occasional trimming. As in previous years, Cabomba was sprigged into the planting site from mother colonies located at other locations of the Comal River. Plant production in the MUPPTs began in April. Over the course of 2022, the MUPPTs were harvested as needed and restocked accordingly until July, when Provision M conditions were reached, at which time the MUPPTs were removed from Landa Lake. Detailed background information regarding plant-propagation methods can be found in previous reports (BIO-WEST 2013b, 2014, 2015, 2016).

4 Aquatic Vegetation Restoration Program

Aquatic habitat-restoration field efforts in the project areas consist of the following three main activities: (1) removal of invasive *Hygrophila polysperma* (Hygrophila); (2) planting of native aquatic plants; and (3) monitoring, mapping, and gardening of restored areas. Each activity is covered in detail in sections 4.1–4.3.

4.1 Hygrophila Removal

From 2013 to 2018, significant effort was put into removing and eliminating Hygrophila from Bleiders Creek, Upper Spring Run, Landa Lake, and the first kilometer of the Old Channel Restoration Reach. Since 2019, the presence of Hygrophila has been greatly reduced. It is now found only in a few locations in the project area and continues to decline. Typical occurrences of Hygrophila are now limited to sprigs or small clumps, less than 1 meter in diameter, and usually along the stream edges (**Figure 3**).

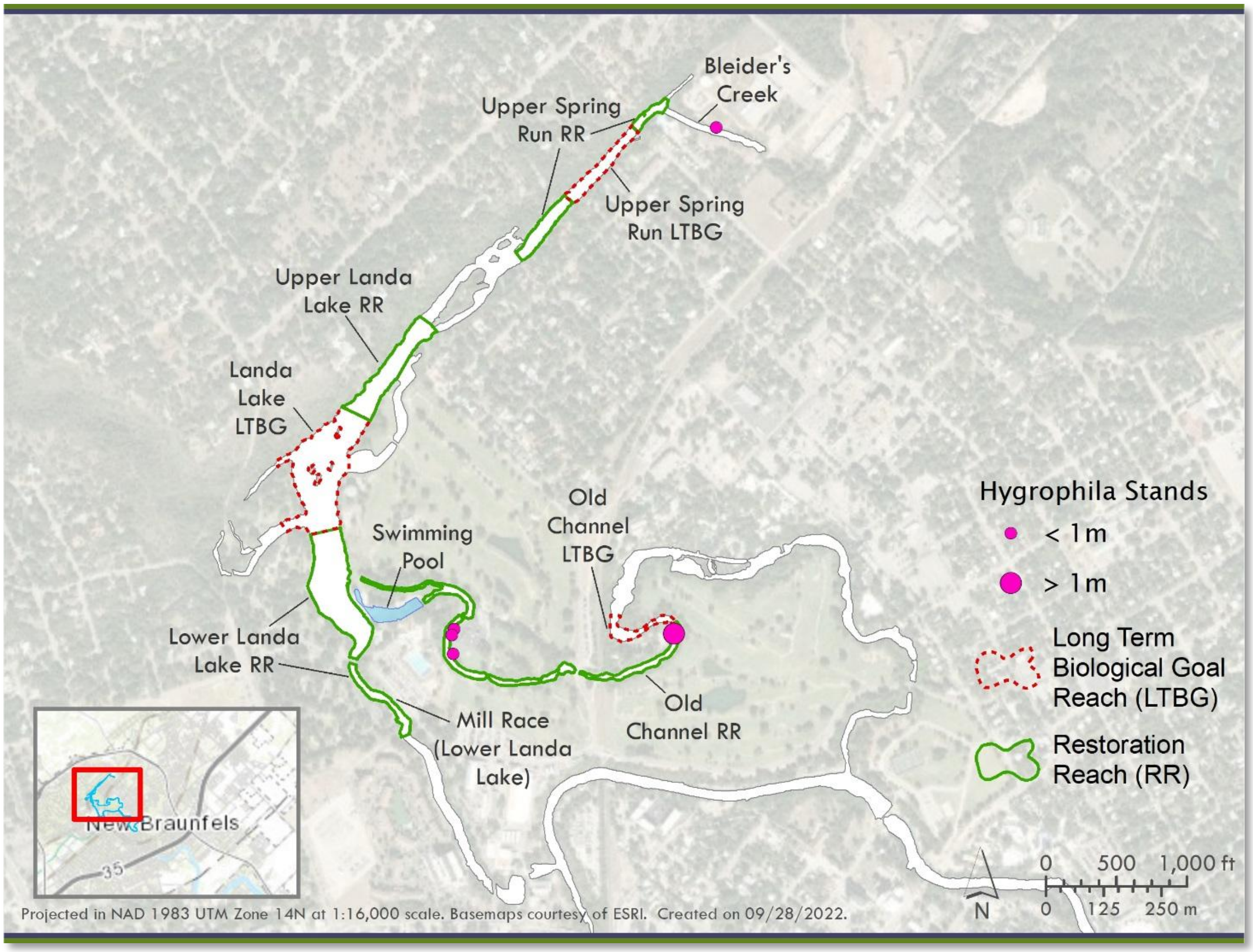


Figure 3 The 2022 distribution of Hygrophila in the study area.

To continue to combat Hygrophila, the project team routinely conducted visual snorkel surveys from Bleiders Creek to the end of the Old Channel LTBG Reach, and any Hygrophila observed was removed. Greater effort was focused on the Old Channel river sections adjacent to the golf course because these areas tend to support recurring Hygrophila population fragments. The amount of Hygrophila removed from the entire project area in 2022 totaled approximately 7 m^2 (**Table 1**). A single patch slightly larger than 2 m^2 appeared during the spring monitoring period and was subsequently removed in 2022. No further patches were observed in this section through the year, only sprigs. In Bleiders Creek, a single reoccurring plant was covered with a benthic barrier mat. Thus far, containment has proven successful. The likelihood of Hygrophila re-infestation into restored areas is possible, but ongoing maintenance and gardening should prevent Hygrophila from reestablishing and dominating the areas where it has been removed.

Table 1 Amount of Hygrophila removed in 2022 per work section.

Location/Section	Area Removed (m²)	Period of Work
Landa Lake (outside of LTBG Reach)	0	Gardened as needed
Old Channel Restoration Reach	<0.5	Gardened as needed
Old Channel LTBG Reach	6	Gardened as needed
Swimming Pool	0	Gardened as needed
Upper Spring Run LTBG Reach	0	Gardened as needed
Upper Spring Run Restoration Reach and Bleiders Creek	< 1	Gardened as needed
Landa Lake Spillway	0	Gardened as needed

4.2 Native Aquatic Plant Restoration

Over the course of 2022, the Comal aquatic restoration project planted 3,114 native aquatic plants. Ludwigia plantings consisted of 1,455 sprigged Ludwigia and 732 Ludwigia from MUPPTs, all of which were planted in Landa Lake. Cabomba plantings consisted of 883 sprigged plants placed in the Old Channel Restoration Reach. To date, the project has planted 85,518 aquatic plants for Fountain Darter habitat restoration. During a routine year, we complete as many as three MUPPT plantings; however, because Provision M conditions halted most work in July, we only completed one MUPPT planting in 2022. As such the team relied predominantly on Ludwigia sprigs for planting work because these are less intrusive to plant. Ludwigia also benefits from regular trimmings, which is carried out as a routine gardening and maintenance procedure, and so these sprigs are available in ample supply. Cabomba is acquired only via collecting trimmings from parent plants and thus planted as sprigs.

4.3 Aquatic Gardening and Monitoring

As previously discussed, no large-scale removal of Hygrophila was necessary during 2022. Instead, only routine gardening trips were conducted at the Bleiders Creek, Old Channel Restoration, and LTBG reaches to search for Hygrophila sprigs or patches. With Hygrophila mostly absent, aquatic gardening focused on other objectives, including regular trimming of immersed Ludwigia stands in Landa Lake, clearing floating vegetation mats, clearing algae, and removing fallen trees and other debris. Trimming the Ludwigia provides sprigs for supplemental plantings as well as propagative material for MUPPTs, while also promoting persistence of individual patches by reducing the top growth of the Ludwigia plants and in turn decreasing the buoyancy of the patches (**Figure 4**). Ludwigia stands that have a large amount of top growth, which can extend 3–4 feet into the water column, tend to be uprooted by water currents over time. Therefore, removal of top growth aids in persistence of these patches. These trimmings are then replanted as sprigs.

Other gardening in these reaches entailed hand removal of Vallisneria and Sagittaria around the perimeter of Ludwigia and Cabomba patches to control encroachment.

Figure 4 Vegetation mats were more problematic around restored vegetation in Landa Lake early in 2022. Removal and maintenance through the year helped improve site conditions.

The gardening activities discussed above were conducted throughout Provision M conditions. Activities that were halted during Provision M included producing and planting MUPPT-grown plants, moving benthic barrier mats, and removing large areas of Vallisneria or Sagittaria to prepare planting plots. Clearing vegetation mats in the immediate vicinity of restored vegetation continued, although vegetation mats became less of a problem later in the year despite a continuing decrease in spring discharge. One contributing factor to this may have been the decreasing growth rate of Vallisneria and Sagittaria as flows continued to drop. Similar observations in reduced growth rate were noted based on how slowly these two species grew back into the buffer areas that are maintained around restored Ludwigia and Cabomba patches. As flows decreased and stayed consistently low, clearing these buffer areas was required less frequently.

Vegetation mats are rarely a problem in the Old Channel, and immersed Ludwigia growth is also not an issue because water depth is lower and current velocities are greater there than in other reaches. These two factors keep Ludwigia stems short and sprawling. Aquatic gardening activities in the Old Channel typically focus on removing fallen trees or tree limbs, which block the channel and facilitate the accumulation of debris. Excessive buildup of thick bryophyte beds can be problematic for Old Channel aquatic vegetation because thick bryophyte beds can smother Cabomba and Ludwigia. Sagittaria is less affected by such factors. Accordingly, steps are taken to routinely dislodge epiphytic bryophytes on susceptible restored plantings. These activities were conducted again in 2022 until Provision M was enacted, at which point we no longer focused on tree removal or bryophyte clearing. We did continue to remove any clogging debris as well as gardening activities for Hygrophila.

Monitoring and mapping of LTBG and Restoration Reaches is an important measure within restoration strategies because it provides data useful in gauging the progress of the project and allows the team to reassess and enhance methodologies for future success. Four mapping events were conducted in 2022 to evaluate the restoration project and assess native plant coverage. The first was a baseline-mapping event conducted in March, before 2022 restoration activities commenced. Subsequent mapping occurred in April and September as regularly scheduled. Two additional mapping events occurred in June and August as part of low flow-triggered monitoring for the Edwards Aquifer Habitat Conservation Plan. Vegetation mapping is conducted by encircling the perimeter of plant patches with a kayak while collecting GPS coordinates with a Trimble GPS unit. Once a patch is mapped, it is identified to species, and the density of each species within the patch is estimated to produce a final area coverage estimate in square meters. These methods are used to quantitatively evaluate the spatial expansion of plant species and qualitatively evaluate the density and health of restored and natural stands. The results of these mapping events are discussed in detail in the respective site results sections below.

4.4 2022 Restoration Results

4.4.1 Old Channel Restoration Results

The Old Channel Long Term Biological Goal Reach has been shown to be self-sustaining over the past several years, with Ludwigia and Cabomba expanding or maintaining growth sufficiently without plantings. Instead, general maintenance and aquatic gardening was carried out to keep the area free of debris and improve natural expansion. Aquatic gardening for Hygrophila was also conducted. The continued challenge to vegetation establishment in this reach is the formation of extensive bryophyte beds and epiphytic growth, which must be cleared occasionally in order for rooted species to thrive.

The Old Channel Restoration Reach still requires manipulation to promote Cabomba and Ludwigia and meet coverage goals. Because of the activation of Provision M, only a short window of time was available for progress to be made in the reach. Only one new restoration plot was added for the year (**Figure 5**). This plot was created by placing a benthic barrier over Sagittaria in 2021, where it remained for 8 months. Once the barrier was removed, the area was planted with Cabomba. This area was planted with Cabomba in 2015, but Sagittaria had out-competed it. All the Cabomba and some Ludwigia planted in the early years of restoration efforts has been lost due to competition from Sagittaria. This year, the project team resumed efforts to reestablish these two species in areas where they were once prominent. This is anticipated to continue into next year.

A total of 883 Cabomba plants covering 181 m^2 were planted in a new plot in the Old Channel Restoration Reach (**Table 2**). An additional 44 sprigs of Ludwigia were planted across multiple plots as supplemental plantings.

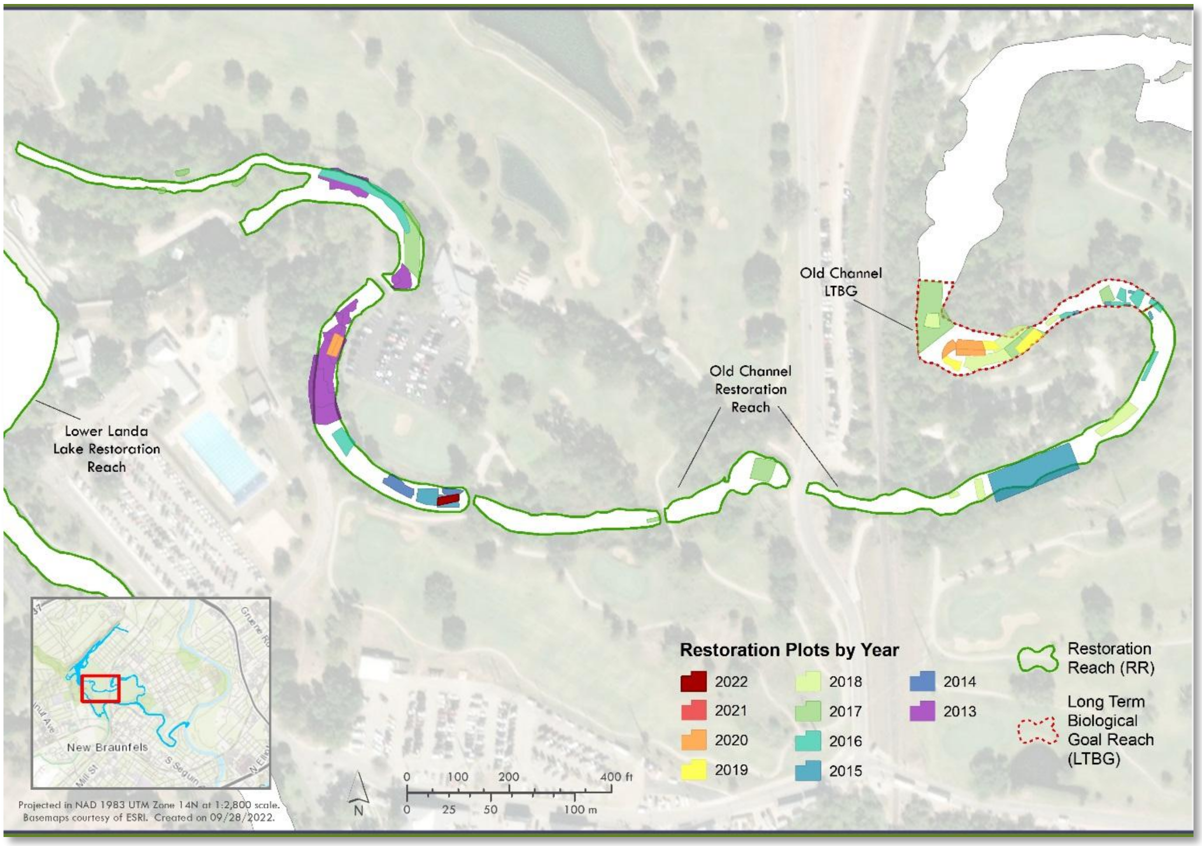


Figure 5 Restoration plots in the Old Channel LTBG and Restoration reaches.

Table 2 Planting dates and number of target species planted within the Old Channel.

2022 Old Channel Restoration Plantings			
Old Channel Restoration Reach			
Date Planted	Plot	Ludwigia	Cabomba
5/26	22A	0	500
6/1	22A	0	75
6/2	22A		50
6/10	21B	44	
6/10	22A		64
6/20	22A		150
Total		44	883

Table 3 shows a baseline, spring, June, August, and fall coverage (in m²) of the target species and other plants within the Old Channel Restoration and LTBG reaches. As noted in previous reports, Ludwigia and Cabomba often fluctuate between mapping events throughout the year, while the coverage of other species such as Vallisneria tends to stay consistent. Inter-year and intra-year fluctuations result from both natural losses and expansion in addition to restoration plantings. No floods or other disturbance events caused any scouring effects in 2022.

Table 3 Seasonal cover (m²) of target restoration species in the Old Channel LTBG and Restoration Reaches from GIS mapping from September 2021 to September 2022.

Species	Sept. 2021	March 2022	April 2022	June 2022	August 2022	Sept. 2022
Old Channel LTBG Reach						
Ludwigia	397	257	331	270	208	290
Sagittaria	0	0	0	0	0	0
Cabomba	340	396	370	437	461	495
Hygrophila	0	0	0	0	0	0
Bryophyte	211	245	309	412	366	568
algae	n/d	0	18	0	0	54
Old Channel Restoration Reach						
Ludwigia	933	722	818	597	596	605
Sagittaria	807	961	856	786	786	785
Cabomba	142	8	18	107	107	132
Potamogeton	622	512	515	530	533	540
Vallisneria	1,081	1047	1051	768	791	847
Hygrophila	2	6	0.46	0	0	0
Bryophyte	108	438	35	567	570	726

In the Old Channel LTBG Reach, Ludwigia coverage trended downwards over the course of the year. Based on observations, this was partially a result of prolonged shading from the thick bryophyte mats that tend to settle in this reach, especially during periods of reduced flows. Bryophyte coverage expanded over some of the same area where Ludwigia occurs in the reach. Cabomba experienced a steady increase over the year, from 340 m^2 to 495 m^2 (**Table 3**). Cabomba generally appreciates lower flows and is also positioned in areas where bryophytes are less likely to accumulate. Small Cabomba colonies have also appeared on their own throughout the restoration reach below Elizabeth Street.

In the Old Channel Restoration Reach, Ludwigia coverage trended downward over the course of the year, while Cabomba trended upward. However, healthy stands of both plants were present throughout the year (**Figure 6**). Some other plant species also lost coverage. Observations indicate

Figure 6 The aquatic vegetation in the Old Channel Restoration Reach in October.

that lower flows lead to reduced health in Sagittaria, Vallisneria, and Potamogeton. Notable biomass loss of these species was seen in colonies of each. Bryophytes settled onto large sections of Sagittaria, resulting in thinner coverage.

Planted Cabomba expanded well and Cabomba reappeared below the outlet of the spring-fed pool, which is a location where Cabomba naturally occurs and naturally waxes and wanes. Now that the project team is aware of the dynamics between mixed stands of Sagittaria/Potamogeton and Ludwigia/Cabomba, efforts can be made to maintain and protect Ludwigia/Cabomba patches from competition in order to preserve desired cover, encourage expansion, and strive towards meeting HCP goals.

Maps highlighting the species distribution between all five mapping events are shown below (**Figures 7, 8, 9, 10, and 11**).

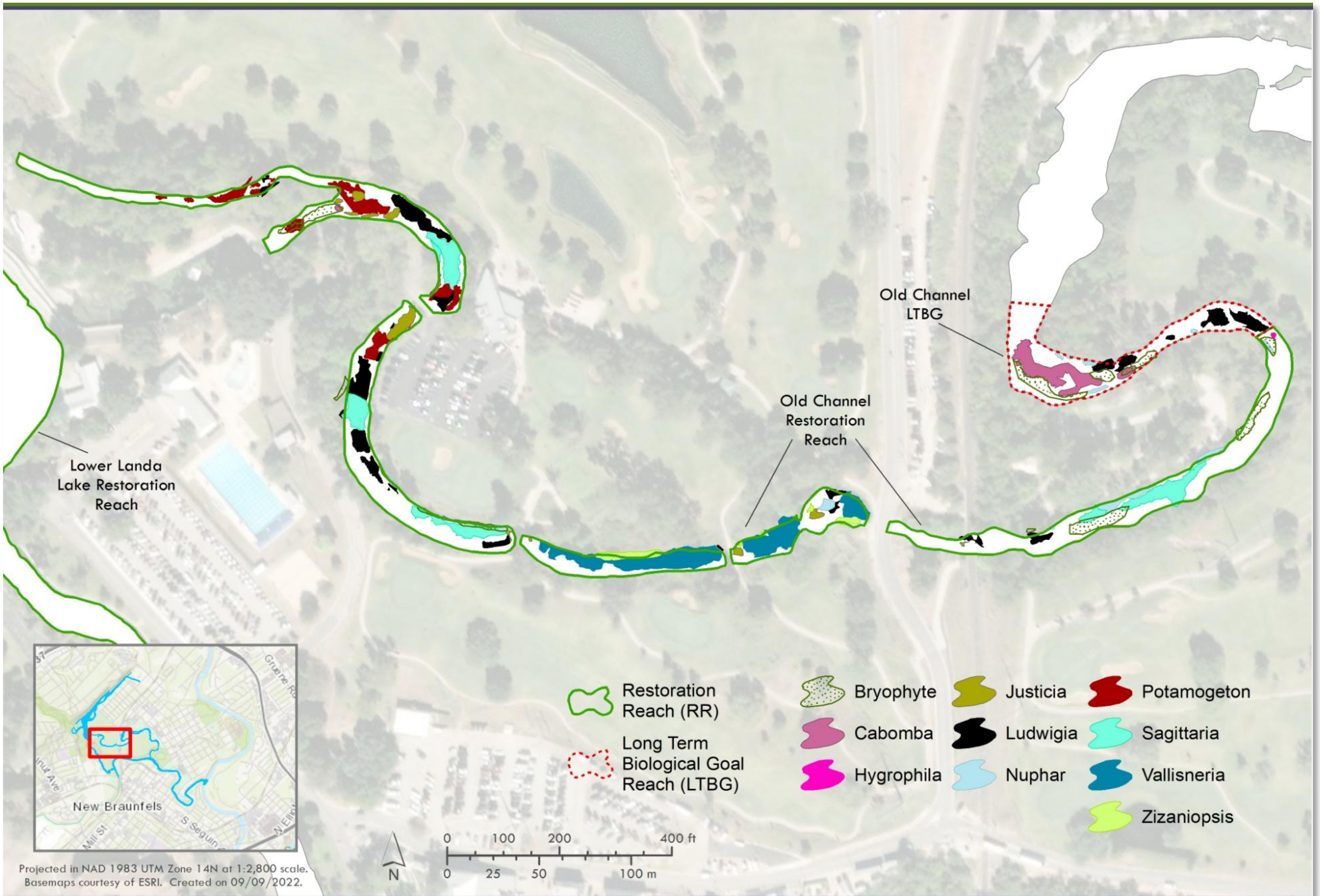


Figure 7 Restored aquatic vegetation in the Old Channel in February 2022.

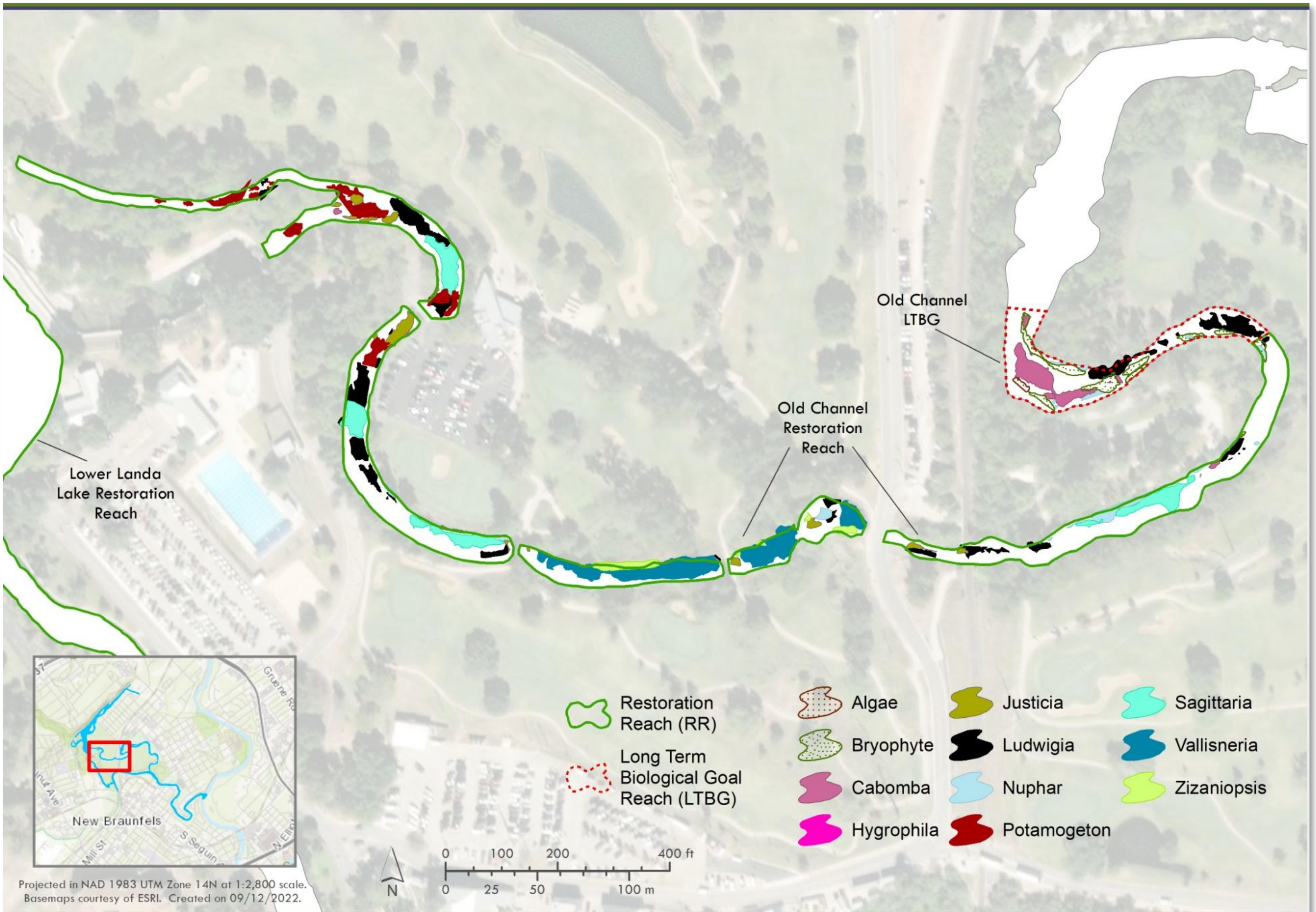


Figure 8 Restored aquatic vegetation in the Old Channel in April 2022.

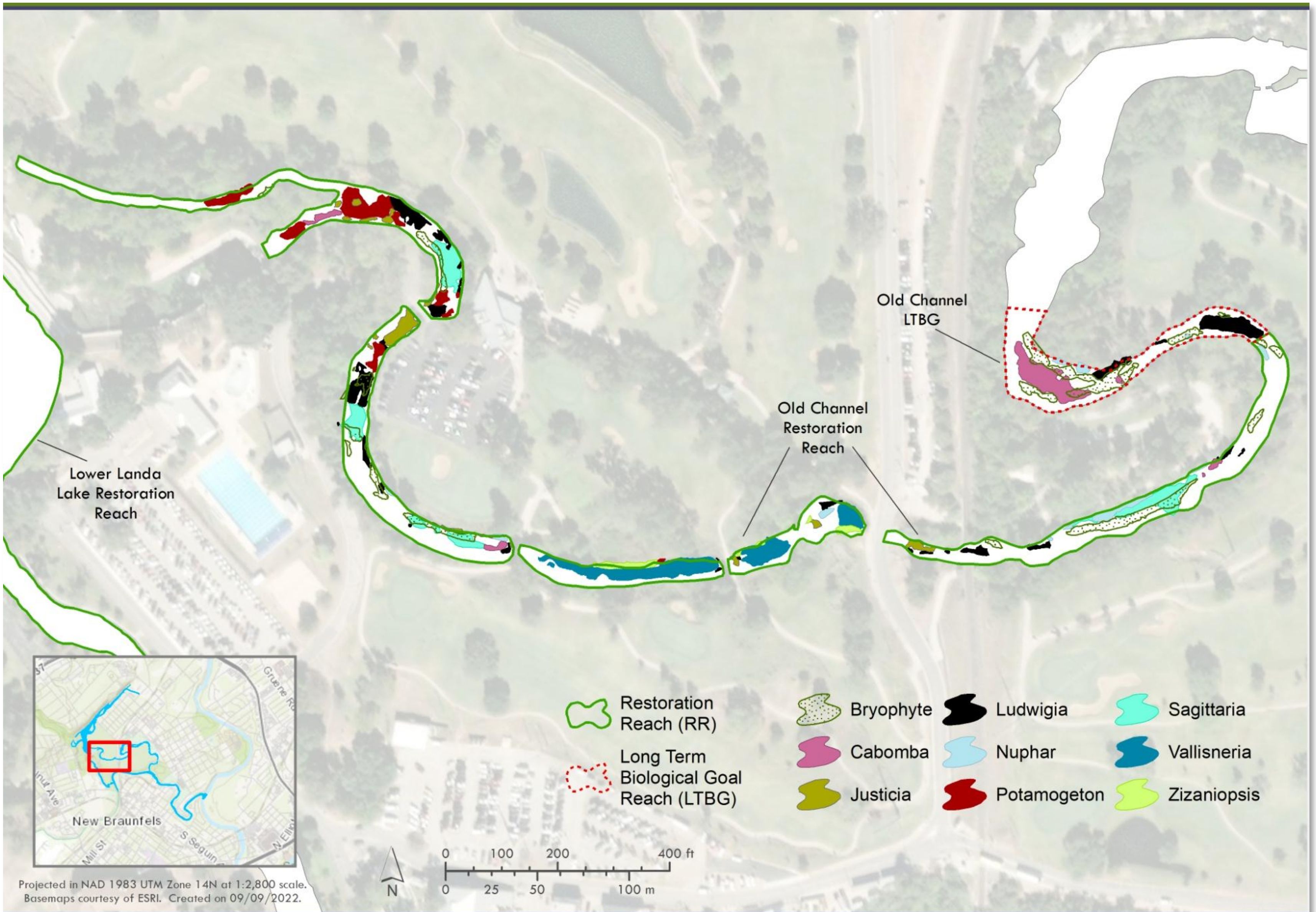


Figure 9 Restored aquatic vegetation in the Old Channel in June 2022.

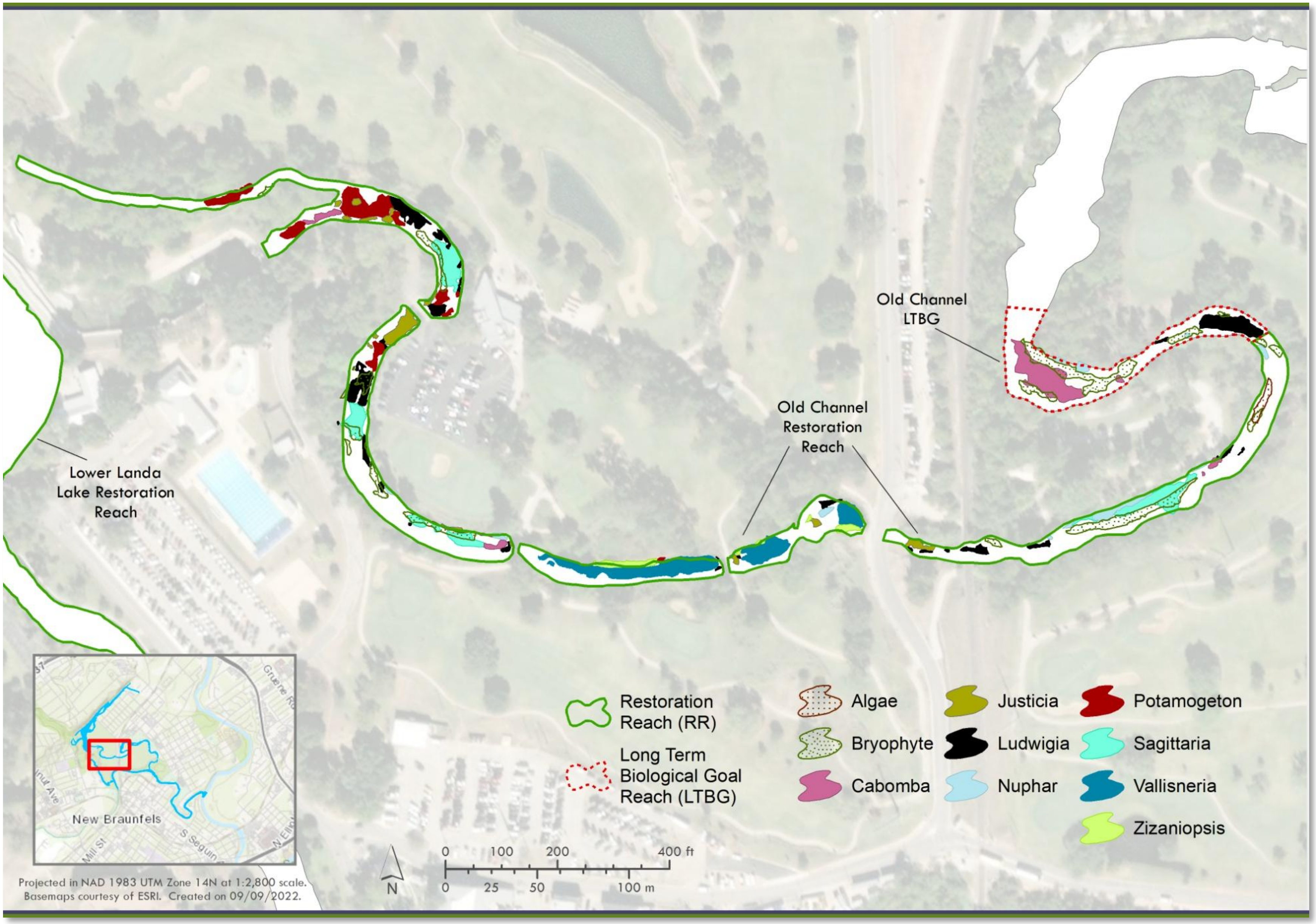


Figure 10 Restored aquatic vegetation in the Old Channel in August 2022.

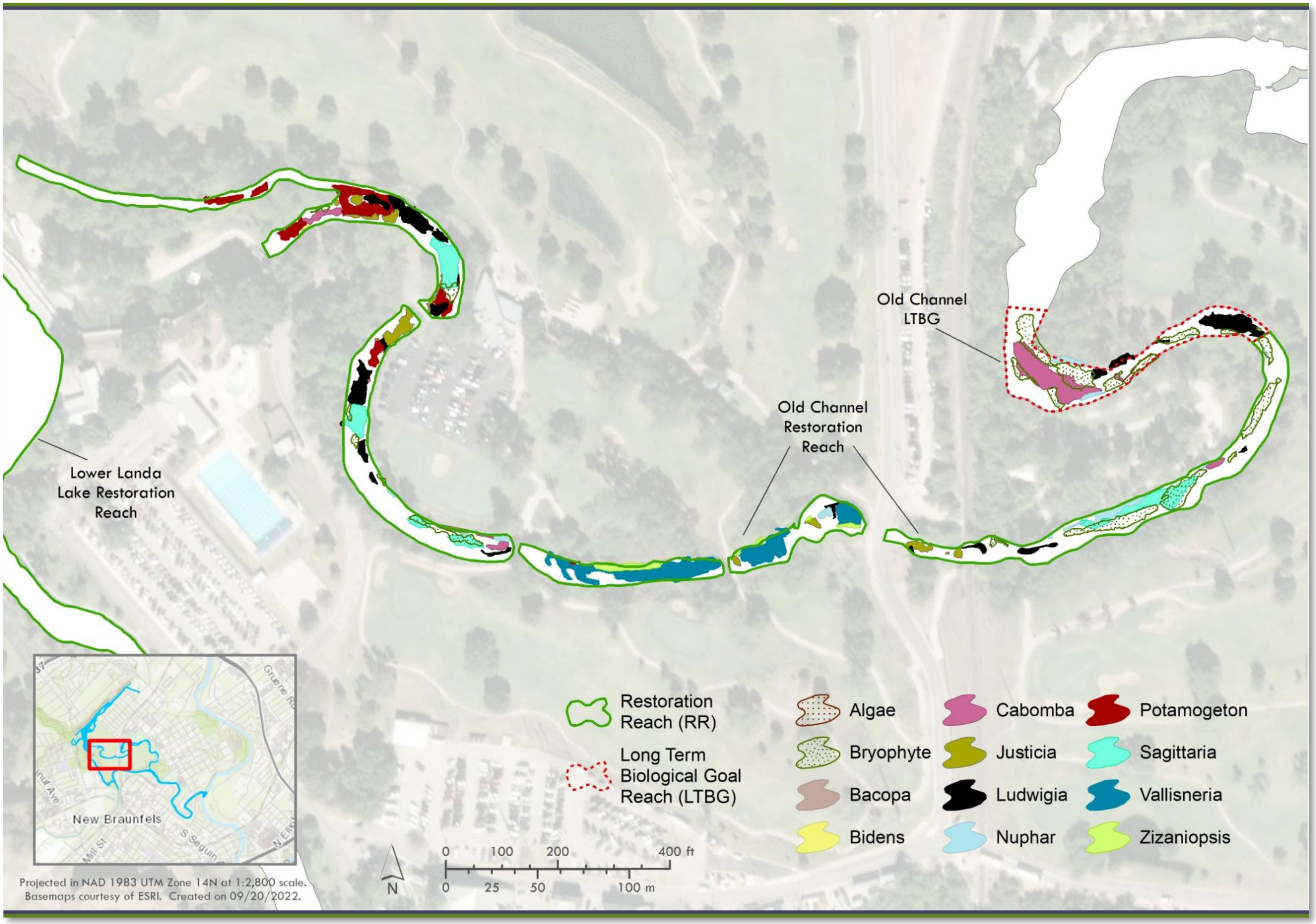


Figure 11 Restored aquatic vegetation in the Old Channel in September 2022.

4.4.2 Landa Lake Restoration Results

This year's plantings were limited to the Landa Lake LTBG Reach and resulted in a total of 2,187 plants installed into the reach (**Table 4**). A portion of those were planted as supplements to older plots. A combined area of 1,440 m² was planted in two new restoration plots cleared with benthic barriers (**Figure 12**). Provision M limited the window for planting site preparation and large-scale plantings. No Cabomba was planted as a result. Only one MUPPT planting occurred (the average for a year is three) and those plants were dedicated to the new plots. Before Provision M was enacted, 732 Ludwigia plants were provided by MUPPTs. Once Provision M went into effect, Ludwigia plantings consisted of sprigs used to improve density of new plots and fill in thinning areas of old plots. Regular trimming and sprigging of Ludwigia was a major activity in 2022 because of the drought and reduced lake depths. Trimming is necessary to keep Ludwigia in a sprawling growth phase, which is especially beneficial during lower water levels, with trimmings then planted by hand as sprigs. After July, activities in all the Landa Lake Reaches were limited to gardening and maintenance. This included clearing vegetation mats, cleaning algae from newly planted plots, and removing limbs and branches to prevent buildup of floating debris. Filamentous and epiphytic algae in Landa Lake remained minimal. The large swathes of algae covering Ludwigia that were prominent last year were not observed in 2022.

Table 4 Planting dates and number of native specimens planted within Landa Lake LTBG. Shaded numbers indicate supplemental plantings in pre-existing plots.

Date	Plot	Ludwigia
5/18	18A	80
6/15	22A	432
6/24	18R	200
7/5	22A	300
7/9	22B	200
7/11	16M	200
7/12	16M	100
7/13	14P	100
7/15	15G	300
8/1	15G	50
8/2	15G	50
8/5	16J	75
8/6	15G	80
8/12	16M	112
9/6	20D	250
9/8	20D	300
9/27	20D	90
Total		**2,187**

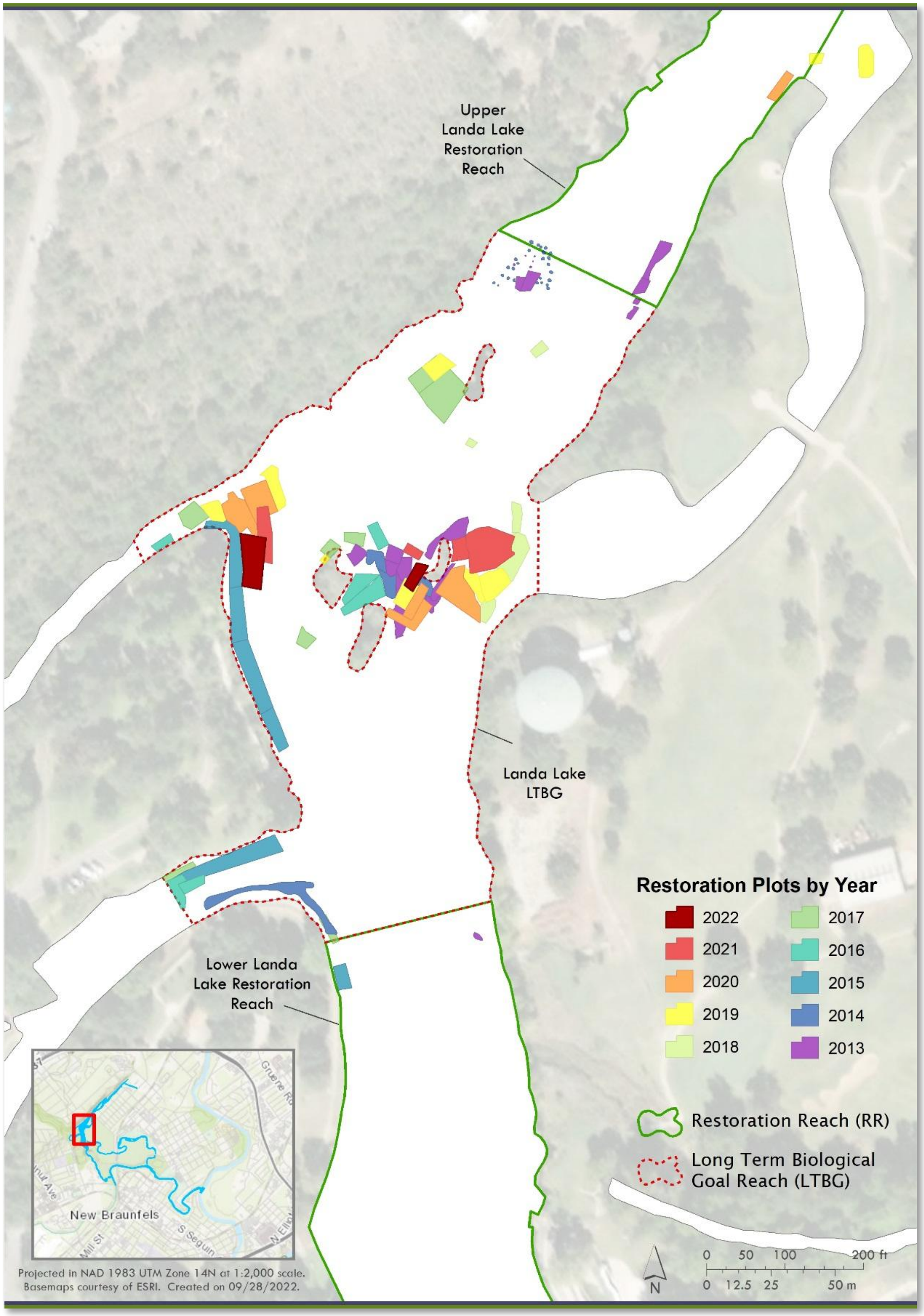


Figure 12 Restoration plots in the Landa Lake LTBG and Landa Lake Upper and Lower Restoration Reaches.

Low-flow events this year impacted Vallisneria the most. Plants were observed to be shorter and thinner. Furthermore, bare and sparse patches appeared where the flow was diverted away, though the main channels of current remained unaffected. The Ludwigia in deeper areas, such as around Spring Run 3, remained healthy due to the incoming current and flow. In the past several years, the area around Spring Run 3 was targeted for Ludwigia plantings specifically because this area would provide ideal growing conditions, and subsequently prime Fountain Darter habitat, for the longest period of time during low-flow events. In shallower areas, such as around Three Islands, Ludwigia continually emerged into large surface mats. These were regularly trimmed to prevent the surface matting from uprooting the plants entirely. Cabomba did not seem impacted by reduced flows; most of the Cabomba remained in adequate flow east of the three islands.

Table 5 shows the coverages in square meters of selected species per reach during each mapping event. In the LTBG Reach Ludwigia stayed above 1,000 m^2 until June, when summer senescence caused biomass to be lost as the plants thinned out. Loss of cover was also a result of vegetation matting covering areas of Ludwigia. Through late summer the Ludwigia regrew and expanded and by September was back over 1,000 m^2. Cabomba remained relatively steady throughout the year. The area where Cabomba is distributed remained within an area of current and was never impacted by vegetation mats. Although Cabomba was not planted this year, it did expand into adjacent buffer areas, and by September it increased to its second highest coverage since 2013. Vallisneria coverage decreased in 2022, as discussed previously. Because the project team did not remove Vallisneria this year, this loss is attributed to inadequate growth conditions. Large open areas appeared within Vallisneria below the Three Islands area as well as locations where vegetation mats accumulated over several months. Although Sagittaria was also impacted by low flows, it remained healthy where flows were consistent. Because Sagittaria can also grow as an emergent plant, it continued to expand upstream and along the muddy banks into previously unvegetated areas. Bryophytes remained minimal compared to historical patterns. Over the last 3 years, bryophyte coverage has been trending downward and bryophytes are becoming uncommon, even in their historically prime locations in Landa Lake.

In the Upper Landa Lake Restoration Reach, vegetation coverage shifted dramatically in 2022. Bryophytes and algae typically dominate this reach along with some established Sagittaria. Because of the water depth and cobble substrate, as well as persistent summer algae (*Spirogyra*), only specific locations of this reach are suitable for restoration plantings. Ludwigia and Cabomba were planted in 2019 in a side-embayment where the reach diverts into the Pecan Island slough. This area has soft sediment for planting and is relatively shallow. In 2022, filamentous and epiphytic algae were commonly observed growing over bryophyte as well as vascular plants in this reach. Overall, this impacted the health of most vegetation, with Ludwigia eventually declining to 0 m^2 and Cabomba similarly reduced.

Ludwigia and Cabomba located in the Lower Landa Lake Restoration Reach remained stable. Floating vegetation mats were common in this reach through much of the year and tended to accrue around the boat house, where water currents were minimal. Although these mats sometimes covered Cabomba stands, the affected plants rebounded quickly.

As expected, floating vegetation mats were common in Landa Lake throughout the year. Although vegetation mats are almost always present in some part of Landa Lake, as the water currents in the lake slowed, the mats of algae, leaf litter, and dead vegetation accrued and expanded. Areas where vegetation mats were persistent included around and below the Three Islands, along the western shoreline and in the lower area of Landa Lake in front of the boat house (**Figure 12**). However, improved management of floating vegetation mats at strategic locations allowed restored areas of Ludwigia and Cabomba to remain healthy despite reduced flows (**Figure 13**). If it were not for this activity, plant health would have been poor. Vegetation mats sometimes became so thick, navigating the kayak during mapping was problematic. In certain areas where thick mats accrue, the Vallisneria and Sagittaria have thinned, contributing to better water flow, and if thinning continues, this may create space for restoration plantings.

Figures 14, 15, 16, 17, and 18 show the mapped coverage of aquatic vegetation in the Landa Lake LTBG and Upper and Lower Landa Restoration reaches throughout 2022.

Figure 13 Vegetation mat buildup in Lower Landa Lake Restoration Reach.

Table 5 Seasonal cover (m²) of target restoration species in the Landa Lake LTBG and Restoration Reaches from GIS mapping from September 2021 to September 2022.

Species	September 2021	March 2022	April 2022	June 2022	August 2022	September 2022
Landa Lake LTBG Reach						
Ludwigia	1,129	1,125	1,015	695	892	1,076
Sagittaria*	3,625	3,985	4,011	3,412	3,767	3,306
Cabomba*	432	535	429	387	425	512
Potamogeton	0	2	2	7	0	2
Vallisneria*	12,531	11,468	11,529	11,489	11,854	10,913
Bryophyte	427	359	314	99	70	192
algae	*	0	605	437	300	808
Upper Landa Lake Restoration Reach						
Ludwigia	70	22	6	0	0	0
Sagittaria	929	536	350	754	739	1,092
Cabomba	115	31	0	0	0	47
Bryophyte	555	0	0	8	0	937
Lower Landa Lake Restoration Reach						
Ludwigia	36	4	29	3	2	39
Sagittaria	19	21	24	19	19	20
Cabomba	123	3	93	39	39	104

* These numbers combine naturally occurring and planted Sagittaria, Cabomba and Vallisneria in Landa Lake.

Figure 14 Ludwigia in the Landa Lake Long Term Biological Goal Reach.

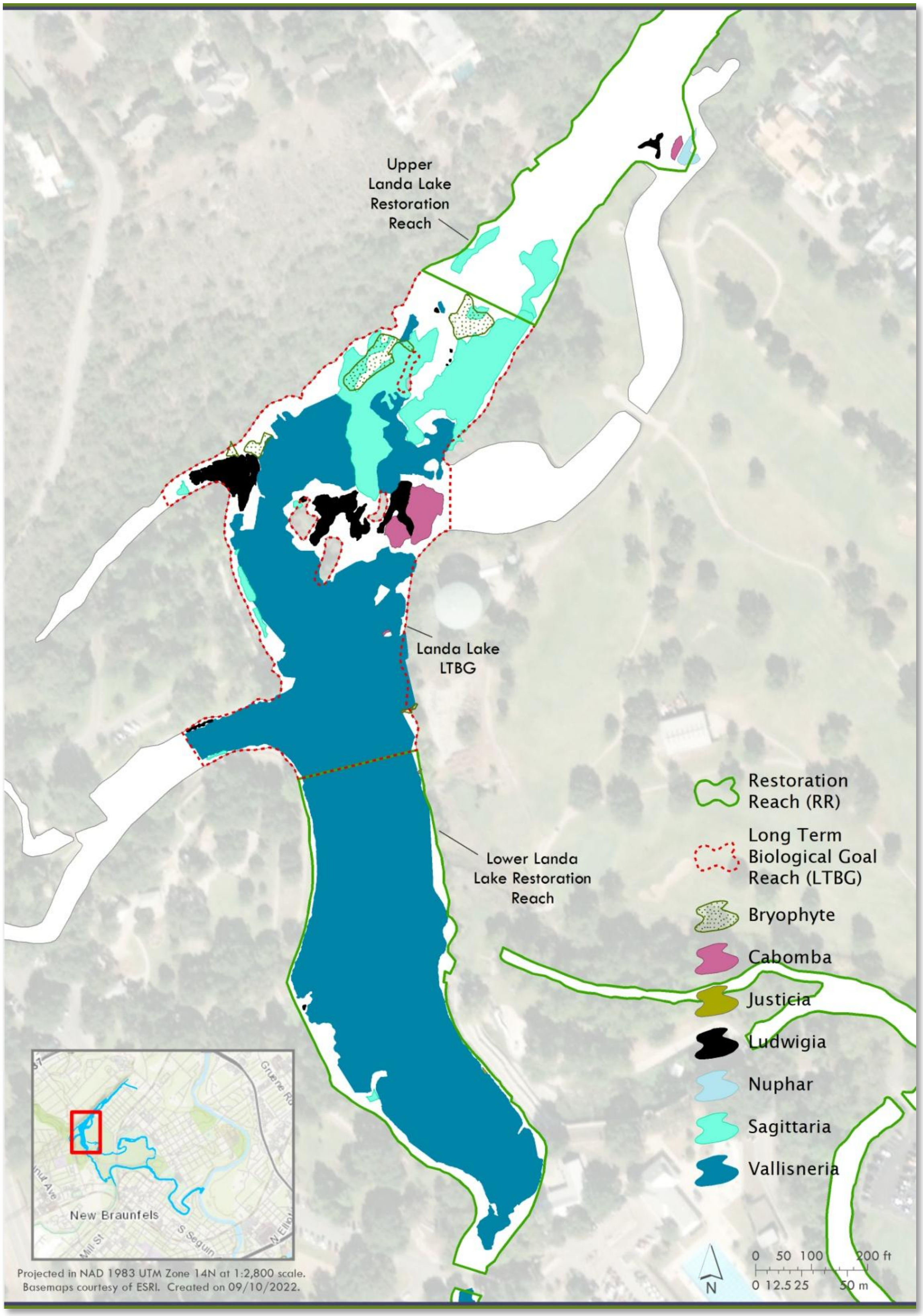


Figure 15 Cover of aquatic vegetation in Landa Lake in February 2022.

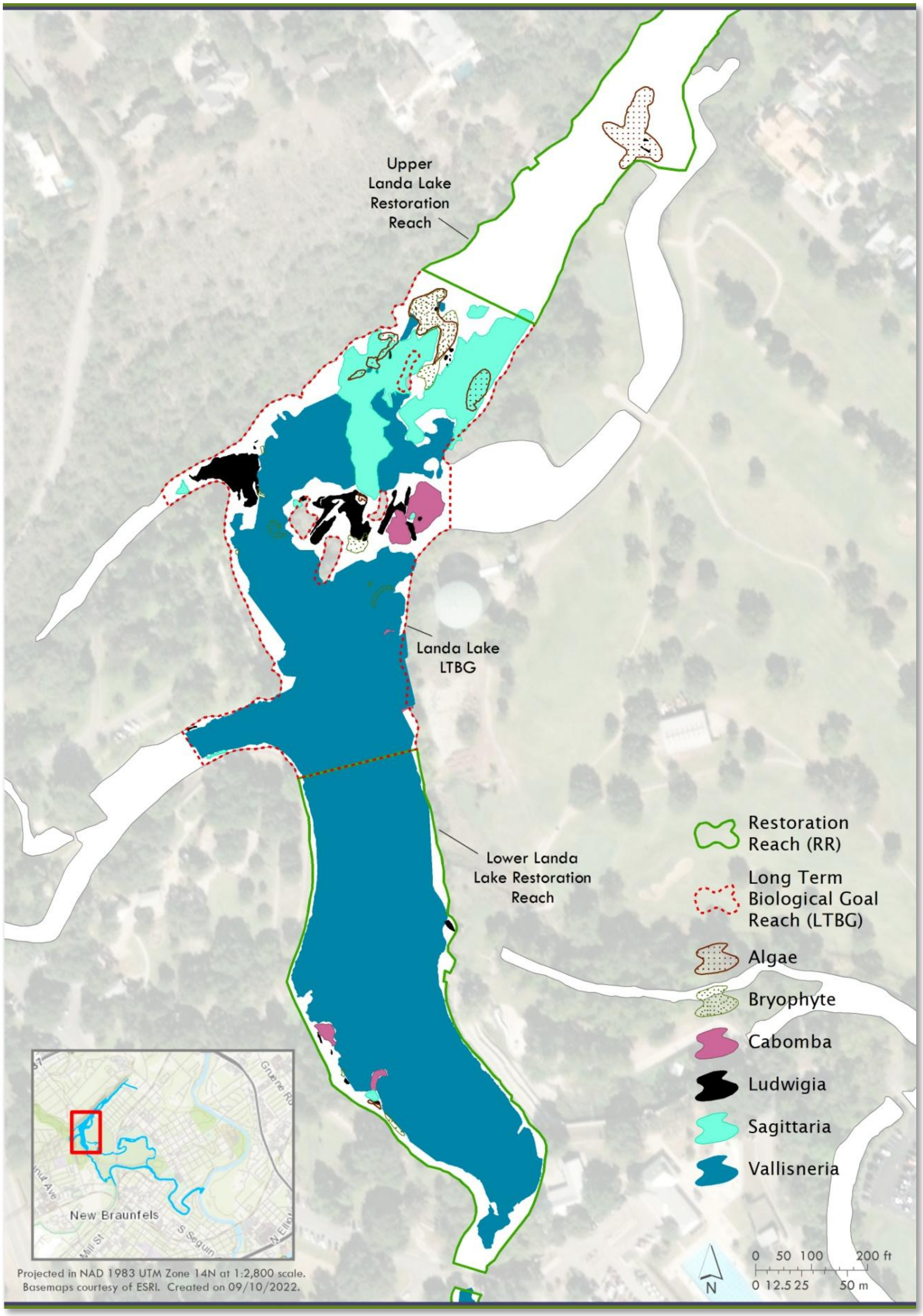


Figure 16 Cover of aquatic vegetation in Landa Lake in April 2022.

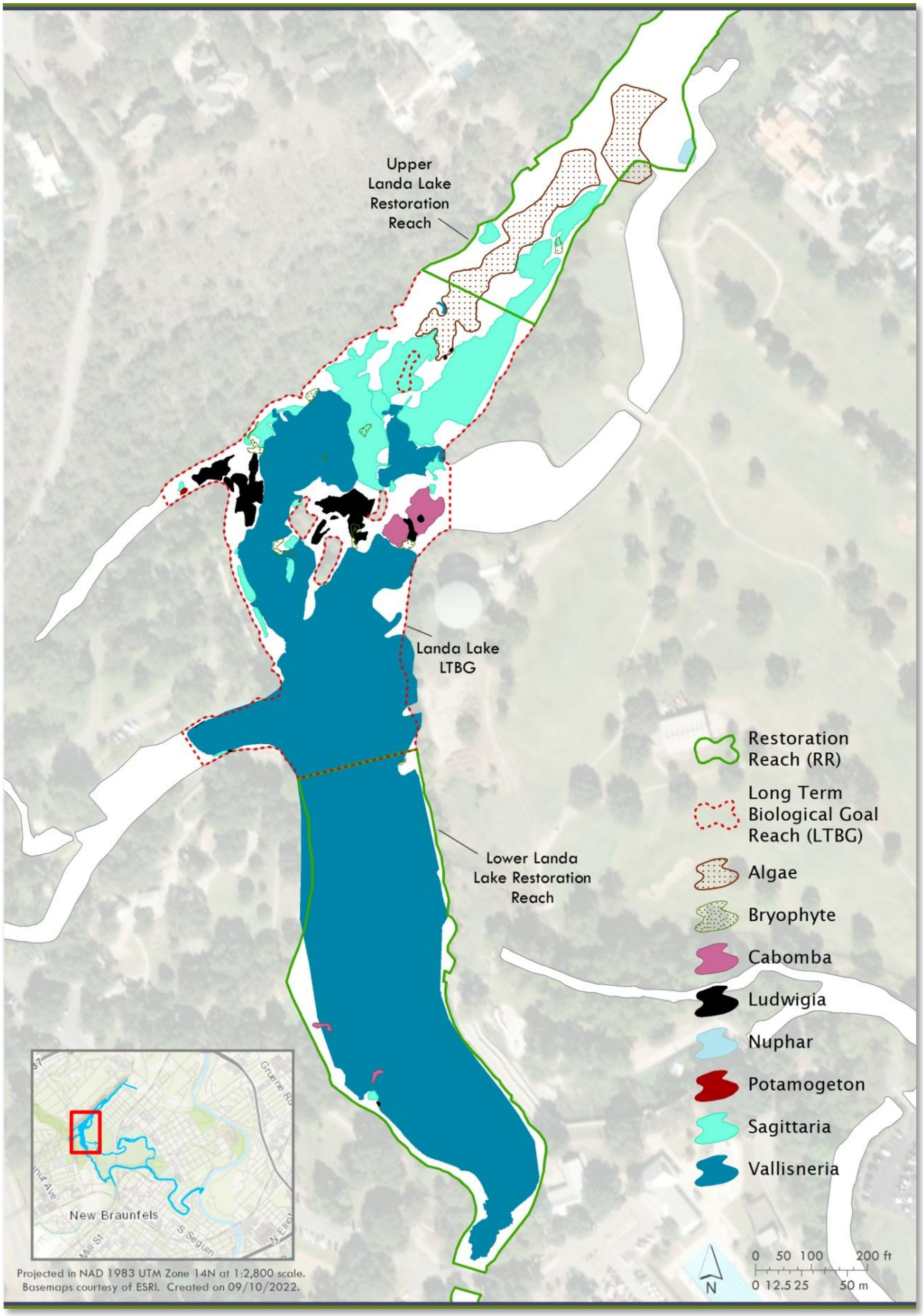


Figure 17 Cover of aquatic vegetation in Landa Lake in June 2022.

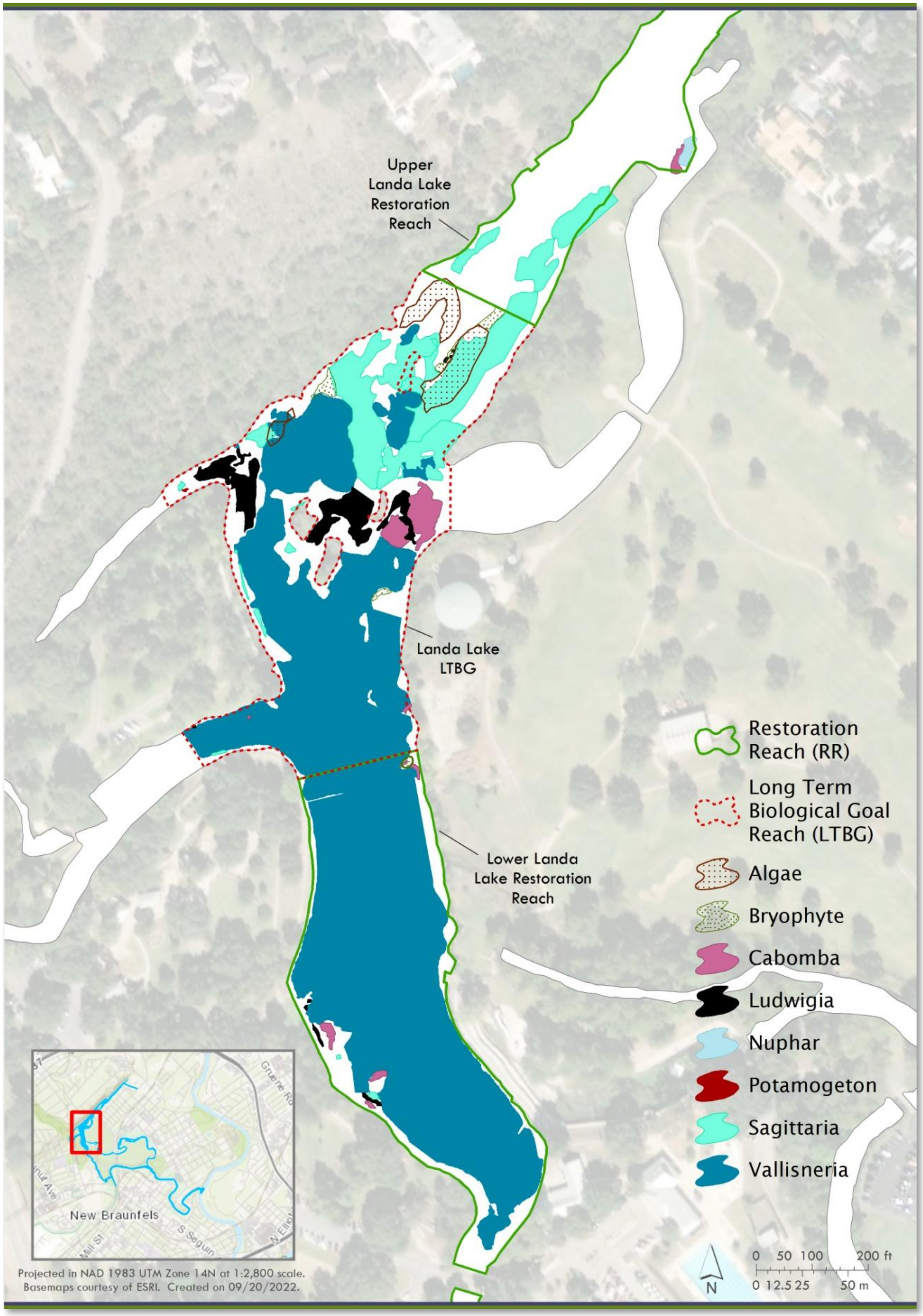


Figure 18 Cover of aquatic vegetation in Landa Lake in August 2022.

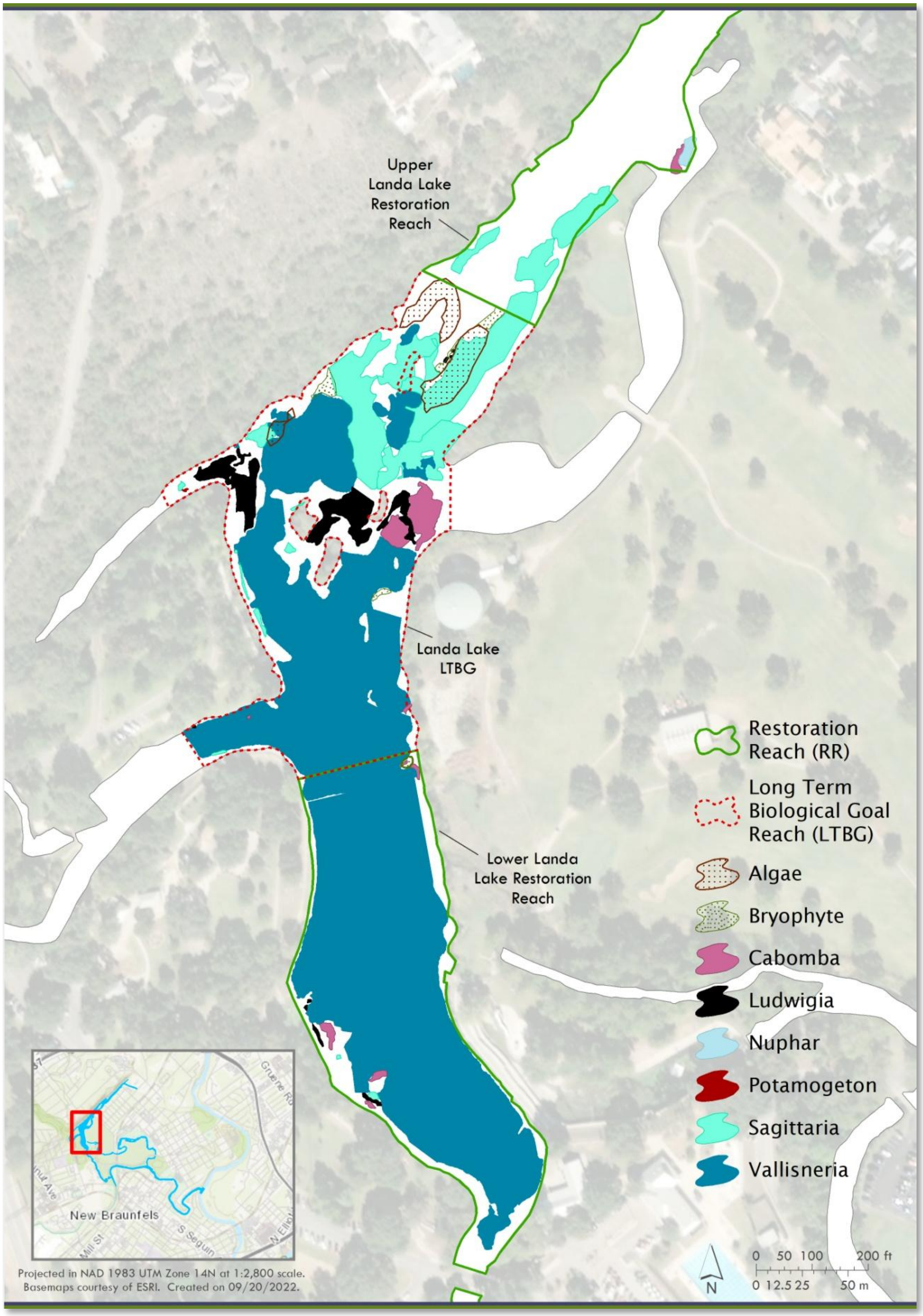


Figure 19 Cover of aquatic vegetation in Landa Lake in September 2022.

4.4.3 Upper Spring Run Restoration Results

No active restoration plantings occurred in the Upper Spring Run Restoration Reach in 2022. As the drought persisted, the water level in this reach dropped significantly, such that Sagittaria in most of the reach began emerging (**Figure 20**). The emergent stems created catch points for floating algae and detritus. During multiple observations, large areas of Upper Spring Run were covered in floating algal mats and leaf debris, and the water flow in this area diminished.

Figure 20 Vegetation mats in the Upper Spring Run Long Term Biological Goal Reach.

Baseline mapping in February 2022 showed conspicuous amounts of Ludwigia in both the Upper Spring Run LTBG Reach and Restoration Reach. As the year progressed, Ludwigia coverage decreased in the Upper Spring Run LTBG Reach but remained mostly intact in the Restoration Reach (**Table 6**). Cabomba appeared voluntarily in the Upper Spring Run LTBG Reach in multiple patches along the run. Those patches expanded slightly over the course of the year, and Cabomba continues to do very well in the upper locations of the Upper Spring Run Restoration Reach at the confluence with Bleiders Creek. It is persistent year over year and showed a notable increase at fall mapping despite almost a complete lack of spring inflow in the reach. Sagittaria remained steady in both reaches this year despite low flows. Anecdotally, it appeared that recreation pressure was less than normal in the reach and therefore lessened the impact on this species.

Table 6 Seasonal cover (m²) of target restoration species in the Upper Spring Run LTBG and Restoration reaches from September 2021 to September 2022.

Species	September 2021	February 2022	April 2022	June 2022	August 2022	September 2022
USR LTBG Reach						
Ludwigia	38	33	0	0	0	0
Sagittaria	1,576	1,161	1,537	1,602	1,578	1,625
Cabomba	<1	4	4	4	11	27
Bryophyte	171	49	0	0	0	0
Algae	*	1529	1119	1311	1300	314
Restoration Reach						
Ludwigia	43	13	15	40	42	0
Sagittaria	1,324	1,055	1,219	1,107	1,066	1,152
Cabomba	178	145	131	177	180	217
Bryophyte	103	382	195	0	0	58
Algae	*	93	1766	183	175	289

In response to the reduced spring flows and lower water depths much of the Sagittaria emerged above the waterline. This access to atmospheric carbon dioxide (CO^2) allows the plant to remain healthy despite poor growing conditions under water. As a result, the plants were able to persist and even expand in some areas of this reach.

Bryophytes in both reaches decreased significantly through the year, continuing a trend from past years with average flows. Conversely, filamentous algae such as *Spirogyra* increased as the year progressed and replaced bryophytes as those died off. Filamentous algae also covered and attached to Sagittaria.

The Upper Spring Run stretch is dominated by rocky substrate with some pockets of silt and clay. Due to the sustained low flows in 2022, silt accumulation along the bottom was noticeable, which allowed plants like Cabomba to spread voluntarily. However, during normal flow rates, the cobble and gravel sediments tend to hamper growth for Ludwigia and Cabomba. Shallow and wadable areas are also prone to recreational disturbances. **Figures 21, 22, 23, 24, and 25** show the baseline, spring, and fall maps of aquatic vegetation in the Upper Spring Run LTBG and Restoration reaches.

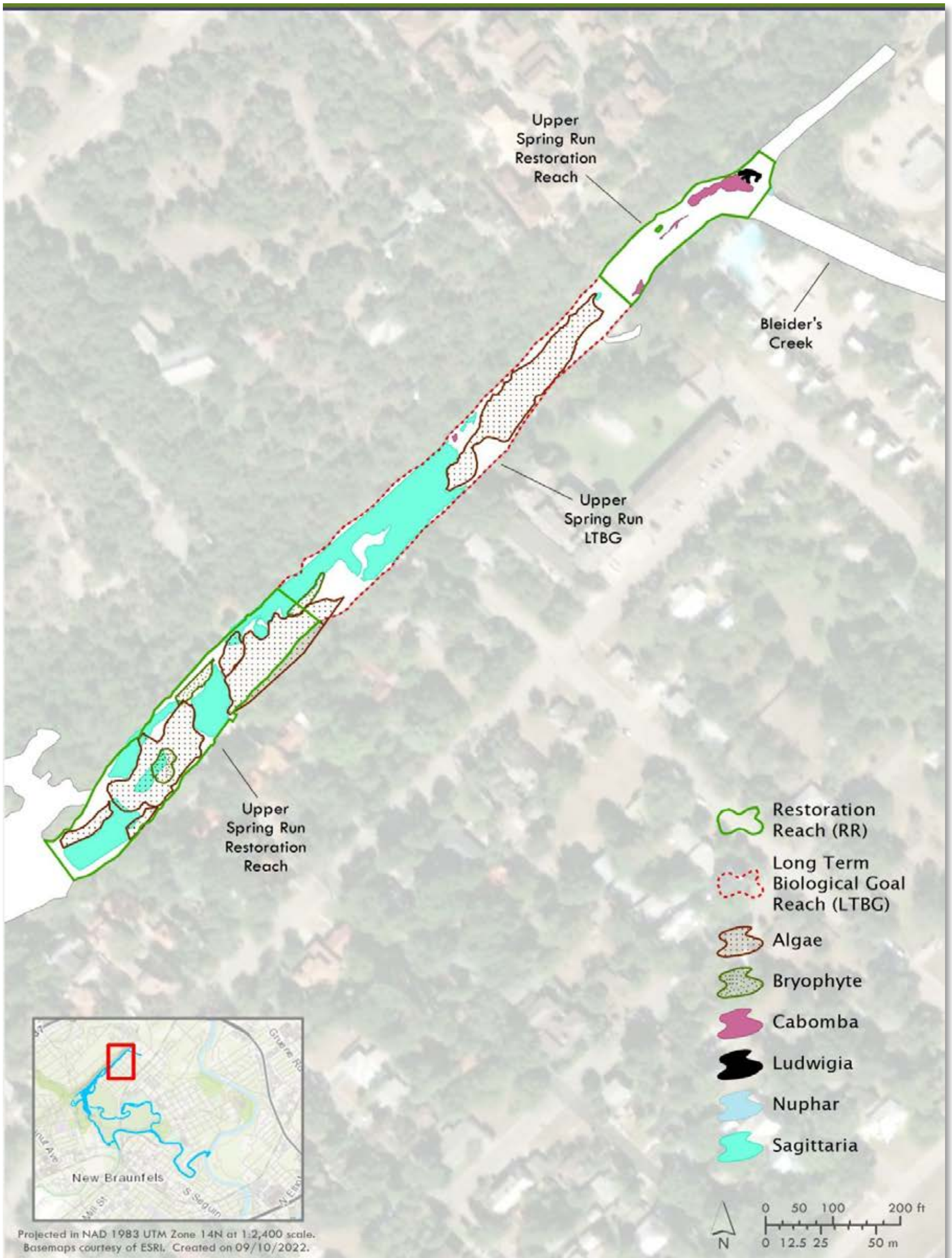


Figure 21 Cover of aquatic vegetation in the USR reaches in March 2022.

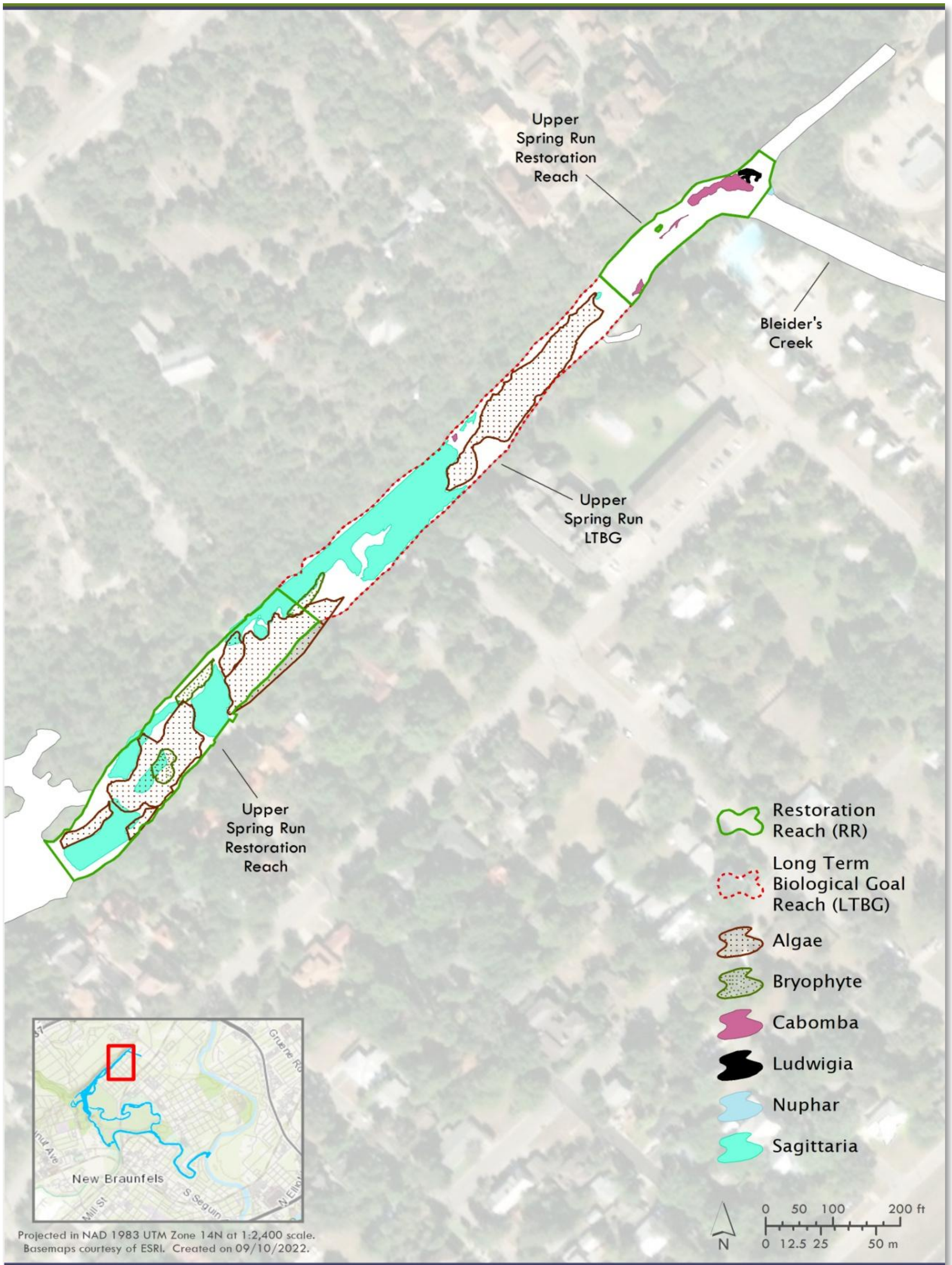


Figure 22 Cover of aquatic vegetation in the USR reaches in April 2022.

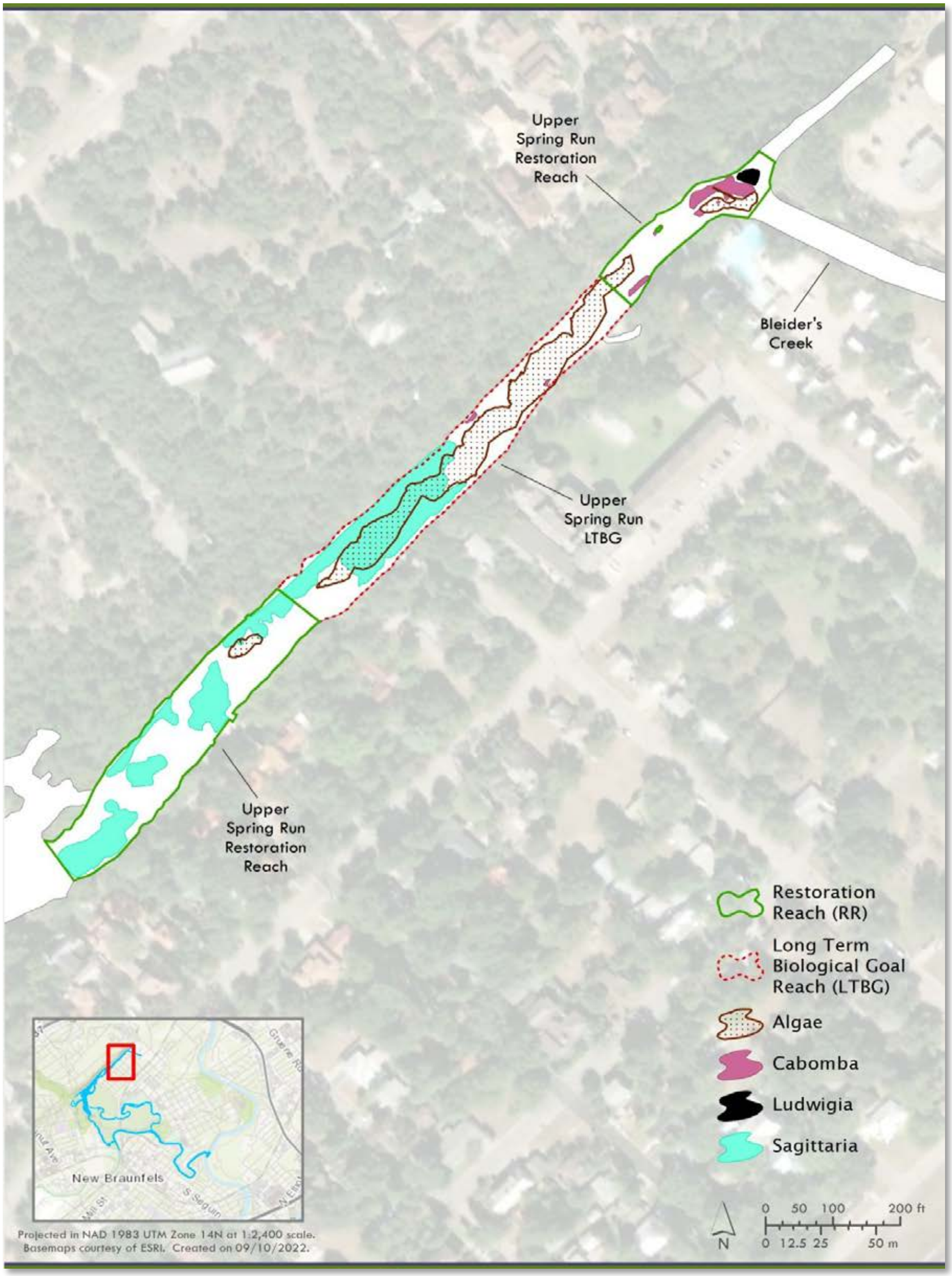


Figure 23 Cover of aquatic vegetation in the USR reaches in June 2022.

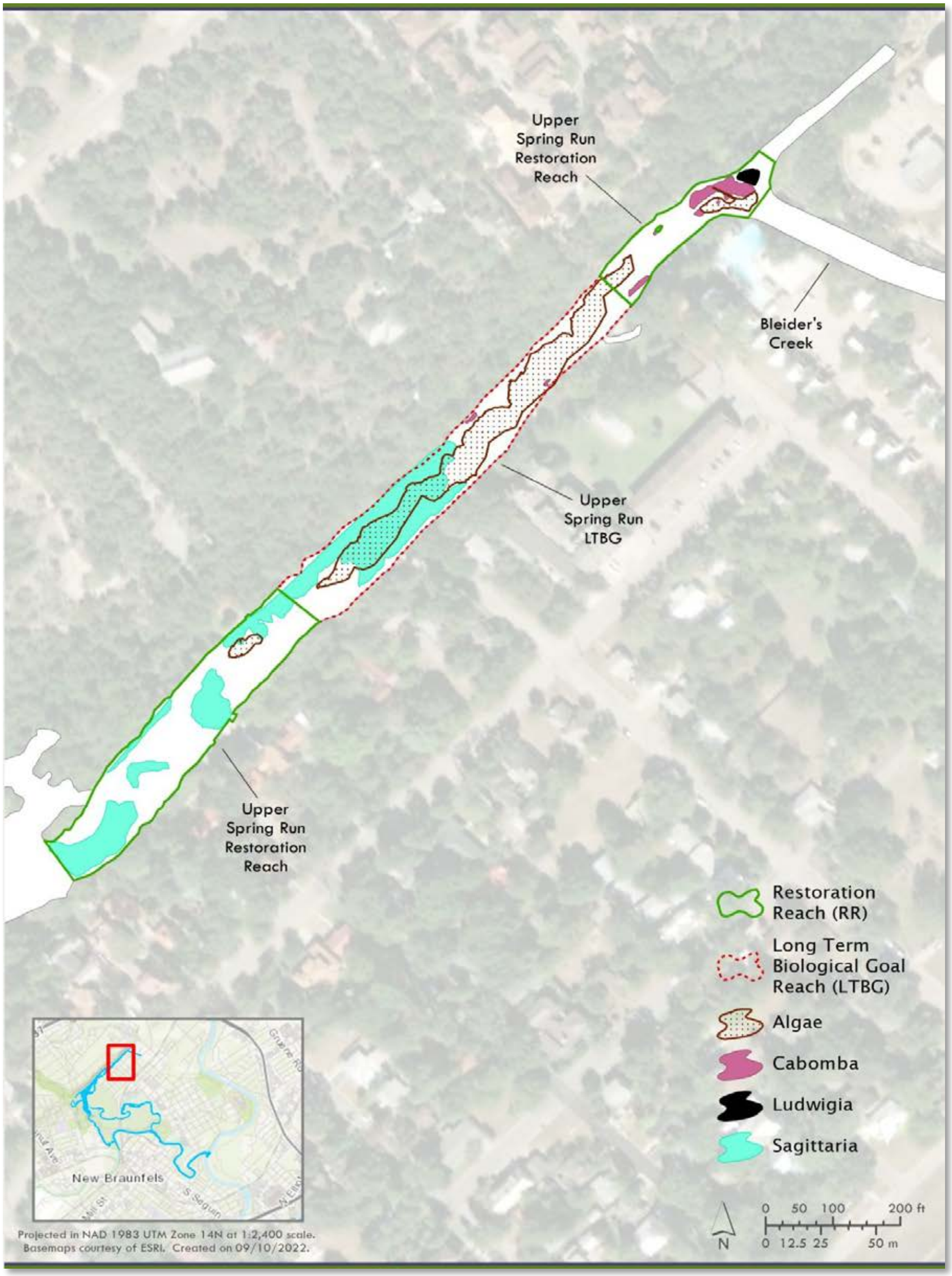


Figure 24 Cover of aquatic vegetation in the USR reaches in August 2022.

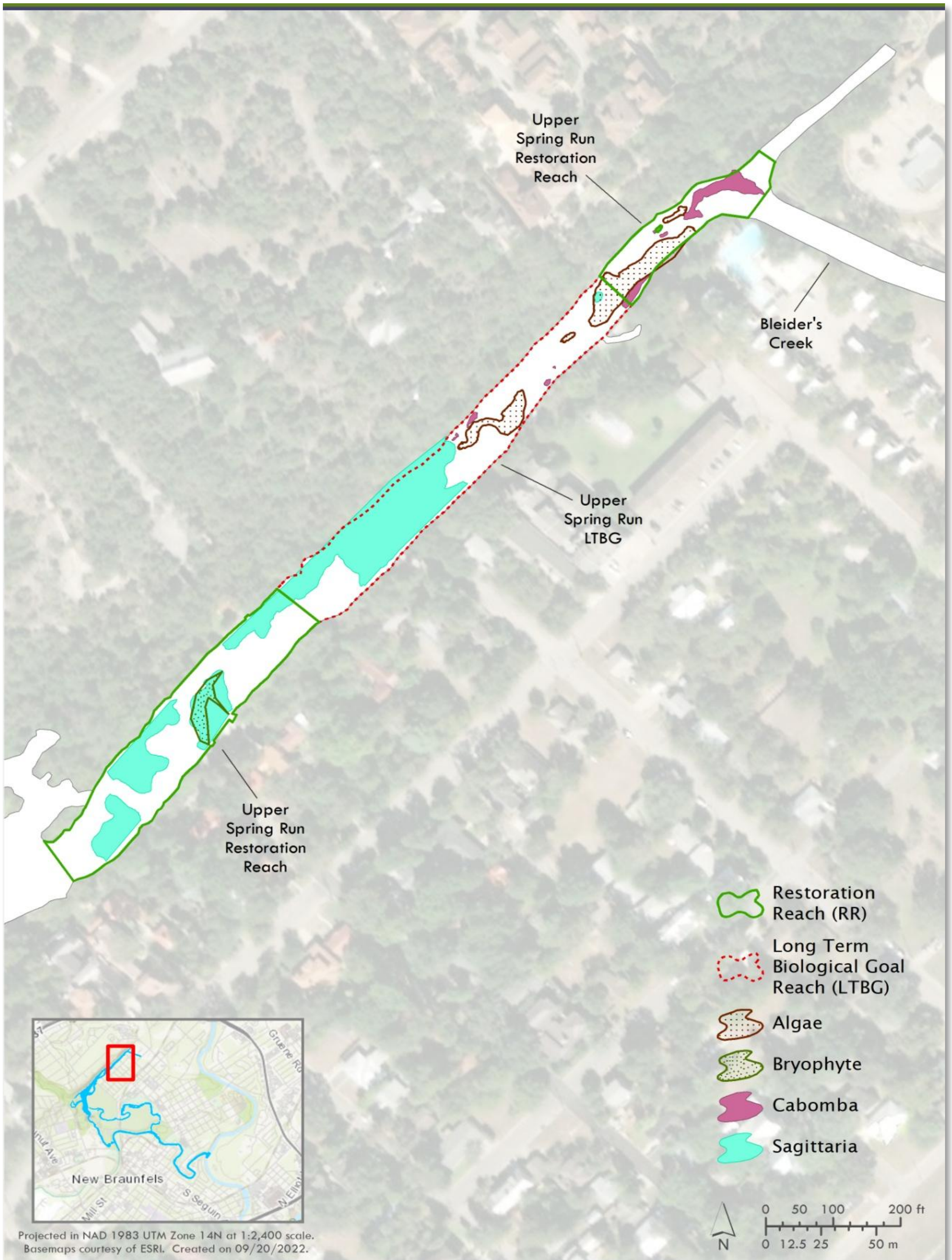


Figure 25 Cover of aquatic vegetation in the USR reaches in September 2022.

4.4.4 Upper New Channel Restoration

No work was conducted in the Upper New Channel Restoration Reach in 2022, per discussions with the City of New Braunfels. This reach is subject to high recreational activity as well as occasional, but significant, scouring flood events, which can drastically alter the growing conditions. The few plantings conducted in this reach to date have not succeeded. These planting efforts have either been overtaken by Hygrophila or presumably scoured away by flow pulses or recreation. Naturally established Ludwigia has persisted in this reach, although it is commonly intermixed with Hygrophila. A few naturally occurring Cabomba patches have developed, expanded, and then disappeared within a year as the riverbed changes from accumulated silt to gravel. It is our professional opinion that this reach should no longer be considered in future restoration plans because of its volatility and the limited potential for success as defined by meeting HCP goals for coverage. The project team will continue to monitor conditions in this reach through the HCP biological monitoring program. If opportunities become available to improve the habitat in this reach, then planned activities will be adjusted accordingly.

5 Restoration Summary

The purpose of aquatic vegetation restoration in the Comal River is to improve Fountain darter habitat not only during times of normal flow, but to ensure usable habitat persists during droughts. As such, restoration efforts have been conducted with drought in mind. In 2022, persistent drought conditions led to decreased discharge in the Comal springs, yet high-quality habitat consisting of Ludwigia and Cabomba remained in Landa Lake and the Old Channel. The activation of Provision M of the EAA HCP limited the timeframe for most restoration activities to just 4 months. Within those four months the project team focused on large-scale plantings of Ludwigia in Landa Lake LTBG Reach and planting Cabomba in the Old Channel Restoration Reach. By the time these major activities were completed, Provision M was enacted, after which restoration was limited to maintenance and aquatic gardening. Maintenance and gardening activities became integral for the continued health of restoration plots as low flow conditions promoted epiphytic algae buildup and floating vegetation mats.

In the Old Channel Restoration Reach, the 2022 focus was to return some coverage of Ludwigia and Cabomba, which had been lost to the expansion of other species. Sagittaria and Potamogeton, both of which exceed their coverage goals in this reach, were removed and replaced with Ludwigia or Cabomba.

In the Old Channel LTBG Reach, no active planting was conducted, and Cabomba expanded on its own. Ludwigia declined and will be planted if it does not recover. This reach increasingly exhibits a sustainable aquatic plant community.

In the Landa Lake LTBG Reach, removal of Vallisneria via benthic barriers added another 1,440 m^2 of potential Ludwigia coverage. Ludwigia has not yet covered the entirety of this area. Despite drought conditions, Ludwigia remained above the overall goal of 900 m^2. Although no Cabomba was planted because of Provision M, the species expanded on its own. In some areas of Landa Lake Vallisneria has died back or slowed its growth. This is due to slower water flow through the lake, which in turn reduces CO^2 availability necessary for submerged plant growth. This phenomenon was observed in early applied research trials conducted for the HCP (BIO-WEST 2013c). Sagittaria remained healthy as this species can grow emergent despite reduced CO^2 levels, and it remained the primary competitor to more-desirable species. Due to the strategic location for Ludwigia and Cabomba plantings and ongoing improvements in native aquatic vegetation coverage, Landa Lake has a much-improved, deep-water habitat for Fountain darters compared to years past.

Table 7 shows changes in annual coverage by reach and highlights the current status of project goals. With some exceptions, goals are being met on an annual basis (square meters planted). Final goals for some species per their locations are presently exceeded. For other species or locations, the final goals are very approachable depending on the growing conditions for the year. Goals for Sagittaria and Potamogeton in certain reaches may require amendments based on observed results of previous years' restoration attempts and available on-site habitat conditions.

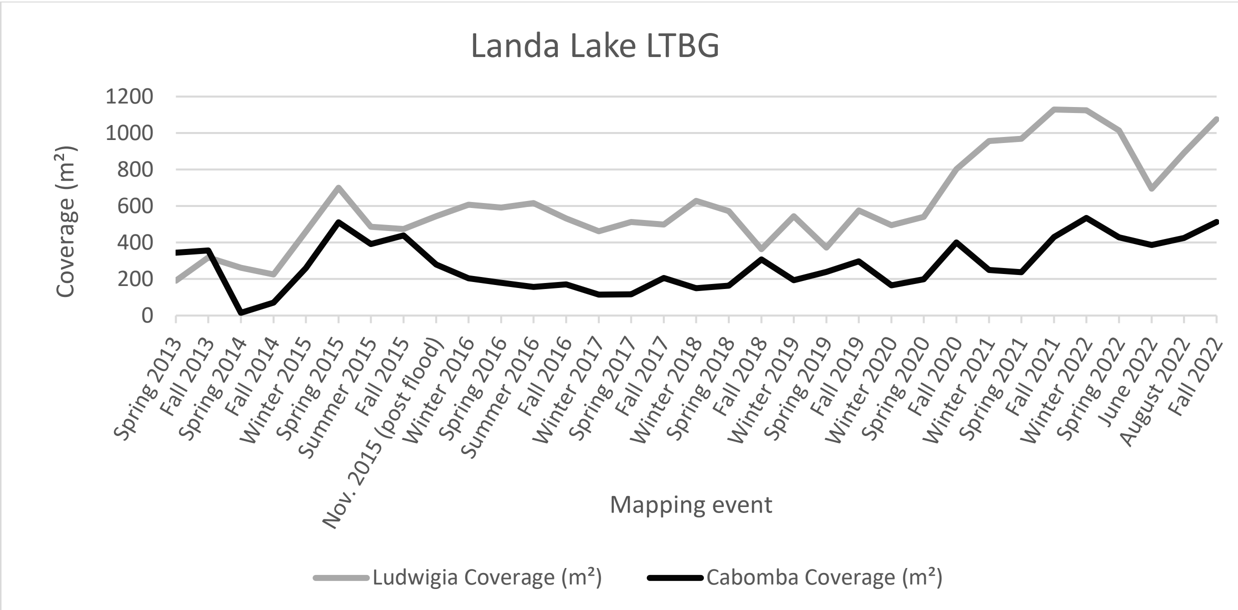
An important caveat regarding **Table 7** is that Sagittaria and Vallisneria are no longer planted in any reach as part of the current restoration regime, but they are still considered target species for habitat. Instead, these two species are allowed to expand on their own in areas where they were originally planted or where they already exist naturally. Currently, we are refraining from planting more Sagittaria in the Old Channel LTBG Reach to prevent competition with more-desirable Ludwigia and Cabomba. Future strategies entail removing some Sagittaria and possibly Potamogeton from the Old Channel Restoration Reach to create increased planting space for Ludwigia and Cabomba.

Table 7 Summary of 2022 native aquatic vegetation restoration efforts in the Comal system.

Reach	Aquatic Vegetation Species	Native Aquatic Vegetation Coverage (m^2)					
		Fall 2021	Fall 2022	Gain / (Loss)	Total Planted Area (2022)	Annual Restoration Goal 2022	HCP Long-term Program Goal
LTBG Reaches							
Old Channel	Ludwigia	397	290	(107)	0	50	425
	Cabomba	340	495	155	0	15	180
	Sagittaria	0	0	0	0	50	450
Landa Lake	Ludwigia	1,129	1,076	(53)	1,440	35	900
	Cabomba	432	512	80	0	30	500
	Vallisneria	12,531	10,913	(1,618)	0	75	12,500
	Potamogeton	0	2	2	0	5	25
New Channel	Ludwigia	N/D			0	15	100
	Cabomba	N/D			0	20	2500
Upper Spring Run	Ludwigia	38	0	(38)	0	5	25
	Cabomba	1	27	26	0	5	25
	Sagittaria	1,576	1,625	49	0	5	850
Restoration Reaches							
Landa Lake Upper	Ludwigia	70	0	(70)	0	n/a	25
	Cabomba	115	47	(68)	0	20	250
	Sagittaria	929	1,092	163	0	50	250
Landa Lake Lower	Ludwigia	36	39	3	0	10	50
	Cabomba	123	104	(19)	0	5	125
	Sagittaria	19	20	1	0	25	100
Old Channel	Ludwigia	933	605	(328)		n/a	850
	Cabomba	142	132	(10)		n/a	200
	Sagittaria	807	785	(22)	0	n/a	750
	Vallisneria	1,081	847	(234)	0	n/a	750
	Potamogeton	622	540		0	n/a	100

N/D – No data available

Figure 26 tracks the long-term changes in Ludwigia and Cabomba coverage since restoration began in 2013. These graphs highlight the inherent fluctuation in coverage of these two species. There are several explanations for this pattern. First, senescence is a natural process in which plants undergo a reduction in biomass as a seasonal reaction (e.g., reduced daylight, cooler water temperatures) or a life cycle change (e.g., maturation, post-blooming). Senescence can also be a response to changes in growing conditions.



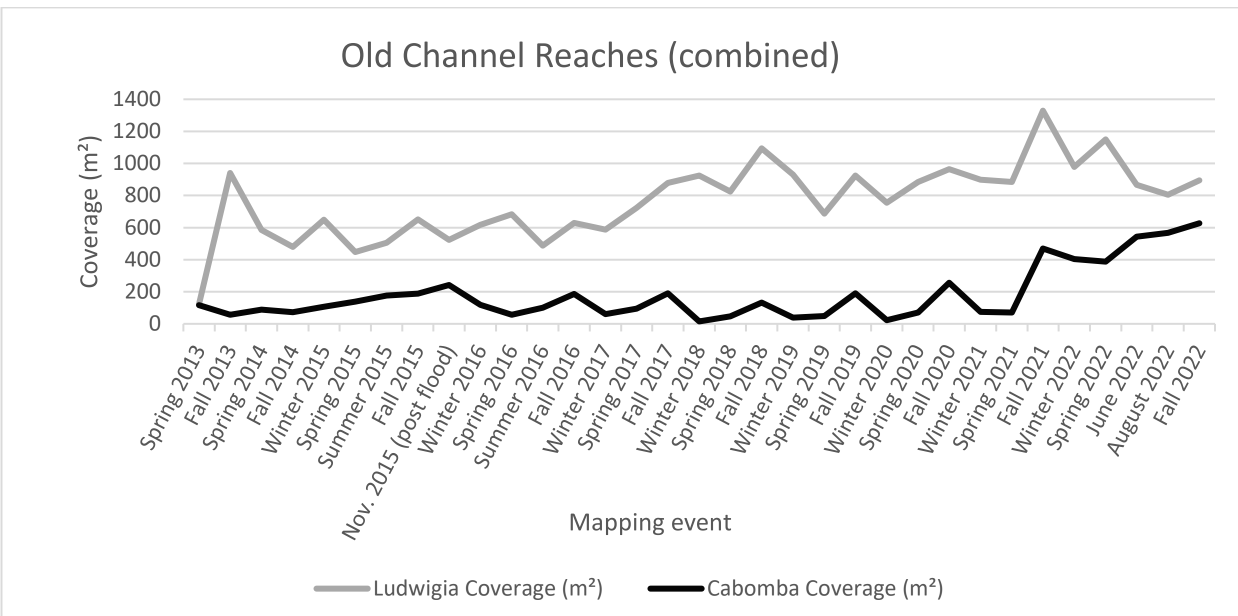


Figure 26 The 9-year trend for coverage of Ludwigia and Cabomba in the Landa Lake LTBG Reach (top) and the combined reaches of the Old Channel (bottom).

A strong senescence period was seen in June when low flow conditions set in. This inevitably caused a reduction in plant biomass. Sometimes the plants habituate to the changing conditions and they may recover, while at other times senescence leads to death as the plant has entered its final life stage and lacks the energy to recover. Second, loss of cover can be caused by competition and later complete exclusion due to the expansion of other more aggressive native species, as previously detailed in this report. These two factors together commonly lead to a reduction in cover that is equal to or higher than the amount planted, making consistent year-to-year coverage difficult. Despite the fluctuation, coverage is generally increasing. The alteration in methodology toward creating larger contiguous patches of Ludwigia and Cabomba is anticipated to reduce losses and improve sustainability. Expectations are that the coverage trend will show a more consistent pattern within the next year and annual gains will be greater than achieved in the past. The native aquatic plant restoration and maintenance activities conducted in 2022 continue to enhance the aquatic ecosystem of the Comal River and provide valuable lessons. Additionally, the continued decline and subsequent rarity in nonnative aquatic vegetation in the Comal system has been an incredible success story in this ongoing habitat restoration project.

Appendix A includes maps of 2022 plots overlaid with the fall 2022 vegetation distribution to gauge planting area versus resulting plant coverage discussed in the body of the report.

6 References

BIO-WEST 2013a. 2013 Restoration Plan for Aquatic Vegetation in Landa Lake and Old Channel Reach. May 13, 2013. Prepared for City of New Braunfels, TX, 72pp.

BIO-WEST 2013b. 2013 Aquatic Vegetation Restoration in Landa Lake and the Old Channel of the Comal River. November 20, 2013 Prepared for City of New Braunfels, TX 80pp.

BIO-WEST 2013c. 2013 Edwards Aquifer Authority Habitat Conservation Plan(HCP) Applied Research. November 20, 2013 Prepared for Edwards Aquifer Authority, San Antonio, TX 110pp.

BIO-WEST 2014. 2014 Aquatic Vegetation Restoration in Landa Lake and the Old Channel of the Comal River. November 20, 2014 Prepared for City of New Braunfels, TX 68pp.

BIO-WEST 2015. 2015 Aquatic Vegetation Restoration in Landa Lake and the Old Channel of the Comal River. November 20, 2015 Prepared for City of New Braunfels, TX 72pp.

BIO-WEST 2016. 2016 Aquatic Vegetation Restoration in Landa Lake and the Old Channel of the Comal River. November 10, 2016 Prepared for City of New Braunfels, TX 72pp.

(USGS) United States Geological Survey. 2019. National Water Information System: Web Interface for USGS Gage No. 08169000 for the period January 1, 2019 to October 1, 2019. [http://waterdata.usgs.gov]

7 Appendix A

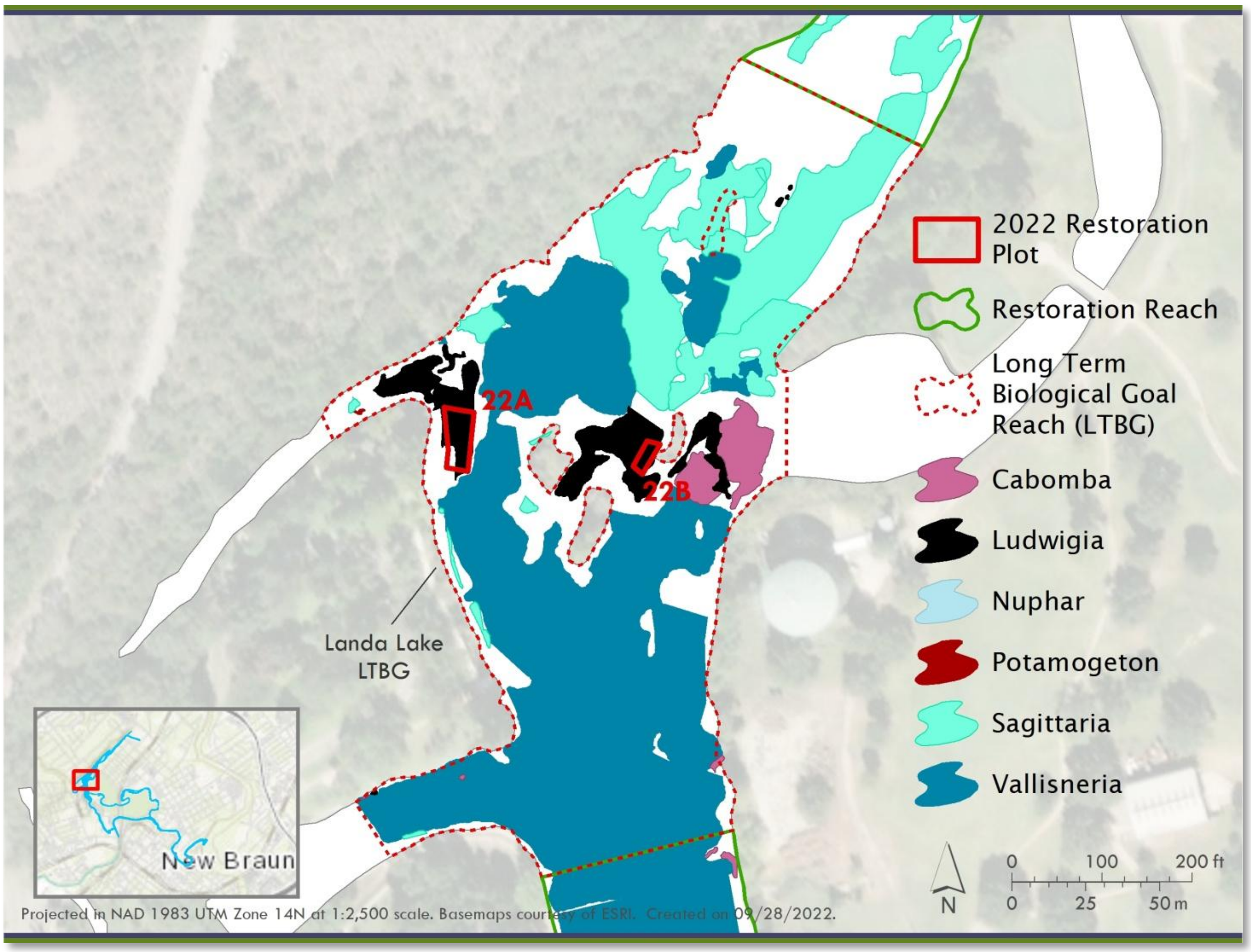


Figure A1 Plots planted in Landa Lake LTBG in 2022 and their resulting vegetation cover in fall 2022.

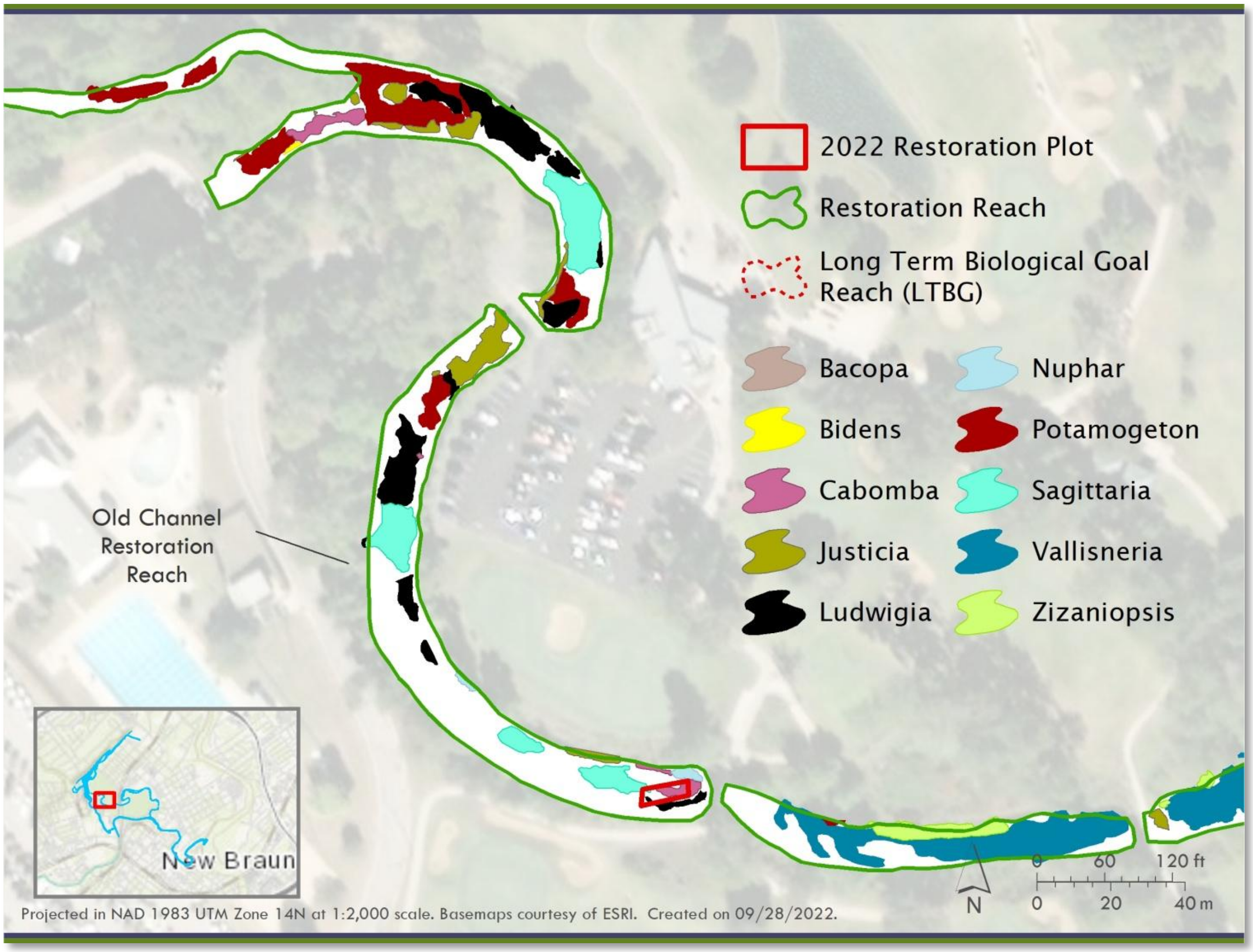


Figure A2 Plots planted in Old Channel Restoration Reach in 2022 and their resulting vegetation cover in fall 2022.

Appendix H2 | **Dissolved Oxygen Monitoring**

MEMORANDUM

TO:	Phillip Quast (City of New Braunfels)
FROM:	Ed Oborny (BIO-WEST)
DATE:	**November 30, 2022**
SUBJECT:	BIO-WEST Dissolved Oxygen Management Plan 2022 Activities

EXECUTIVE SUMMARY

This memorandum summarizes BIO-WEST's 2022 activities associated with the City of New Braunfels Dissolved Oxygen Management Plan (Plan). BIO-WEST's involvement in 2022 centered around the Low spring flow conditions triggered monitoring as outlined below in the 2022 scope of work:

1) Deploy near-continuous DO monitoring sensors at six strategic locations within the Comal River system upon the onset of low-flow conditions (<100cfs) at Comal Springs. Monitoring shall be focused in monitoring locations within prime Fountain Darter habitat in Landa Lake. Other strategic monitoring locations may be considered upon consultation with and approval by the City.
2) Maintain and service DO monitoring sensors.
3) Off-load DO data from sensors on a routine basis. Evaluate and analyze collected DO data;
4) Inform City of New Braunfels staff of low-dissolved oxygen conditions as measured by sensors or other method and recommend mitigation actions based on the Landa Lake Dissolved Oxygen Management Plan.
5) Assess the linkage between DO concentrations as measured at the six sensors and observed Fountain Darter data collected as part of the Edwards Aquifer Habitat Conservation Plan (EAHCP) Biological Monitoring Program;
6) Compile data and update the Landa Lake Dissolved Oxygen Management Plan to include 2022 monitoring activities and data. Include any additional DO mitigation measures that may need to be further evaluated and/ or implemented to effectively mitigate DO levels.
7) Attend and present at EAHCP Committee Meetings, as needed, to support EAHCP activities and provide updates on findings.
8) All work to be conducted in accordance with the City of New Braunfels' approved 2022 EAHCP Work Plan.

In summary, compilation and analysis of 2022 data collection revealed that dissolved oxygen (DO) suitable for Fountain Darters was maintained in key Fountain Darter areas consistent with both the EAA near-continuous sonde monitoring in Comal Springs as well as the EAHCP biological monitoring data collected during drop net sampling. Although periodic observances of DO below 4.0 mg/L were observed, these were typically only exhibited for short durations of time mostly associated with early morning hours. Fountain Darters have been and were again collected in 2022 in all these areas through the EAHCP biological monitoring program drop net, dip net and fish community sampling. Our conclusion based on the additional DO sampling performed in 2022 is that no revisions to the existing City of New Braunfels Dissolved Oxygen Management Plan regarding the Low spring flow conditions triggered monitoring is recommended at this time. The project team supports the DO Low spring flow monitoring Work Plan components in place and recommends the City of New Braunfels continue implementation in 2023.

2022 FIELD SAMPLING

Six strategic locations were selected in 2022 based on previous years sampling and continuously monitored when total system discharge declined below 100 cfs during summer 2022. The six sites include one in the Upper Spring Run, four in Landa Lake, and one in the Old Channel (**Figure 1**).

Figure 1. **S**ix Dissolved Oxygen continuous monitoring Low flow sites in the Comal System.

With coordination and approval from the City of New Braunfels, BIO-WEST deployed all six MiniDOT sondes on August 3, 2022. Figure 2 shows a MiniDot sonde deployed at the Landa Lake (Three Islands) site. Per recommendations in 2018, a more solid anchoring device was used in 2022. The sensors were purposely installed off the bottom to examine the portion of water column utilized directly by the Fountain Darter. Unlike 2018, there were no probes that were tampered with or stolen during 2022 deployment.

Figure 2. MiniDOT sonde deployed at Landa Lake (Three Islands) Study Site.

During the August 3rd through September 12th deployment period, MiniDots were downloaded multiple times and cleaned approximately once per week in between downloads. All sondes were downloaded, retrieved, cleaned and stored in mid-September following an increase in Comal Total System Discharge above 100 cfs (**Figure 3**).

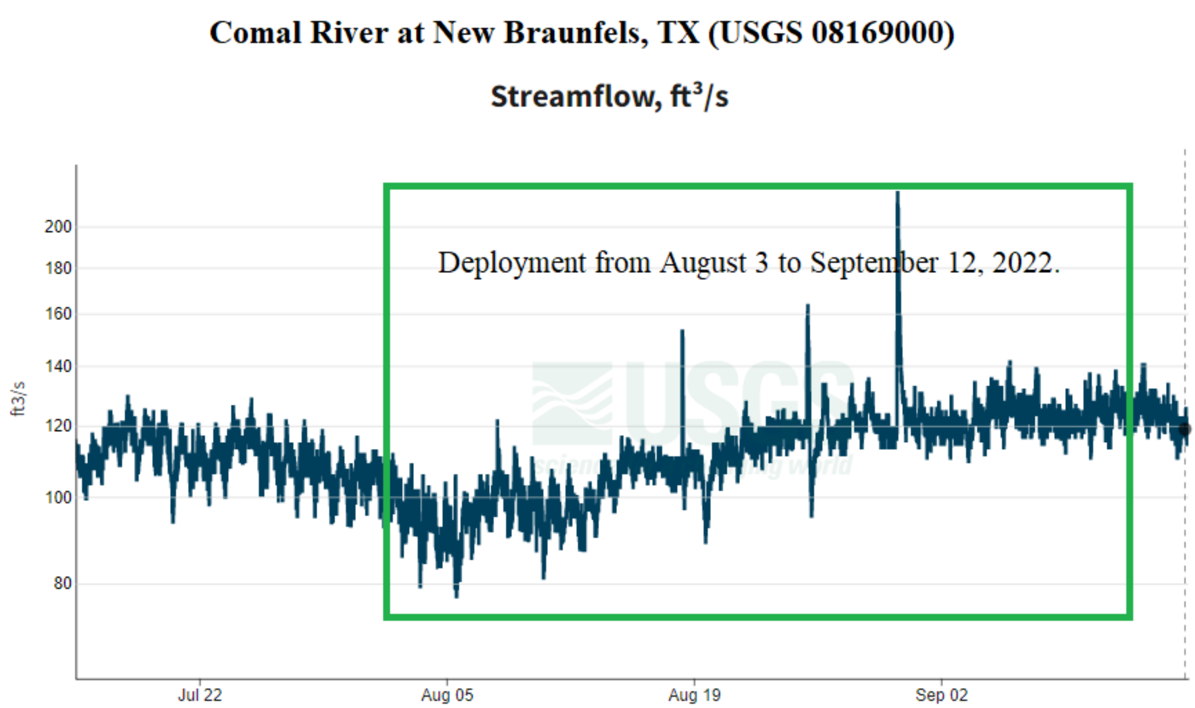


Figure 3. USGS recorded Total System Discharge at Comal River at the New Braunfels USGS gage over the MiniDOT deployment.

Table 1 highlights some summary statistics for both the DO and water temperature data collected over the summer deployment period.

Table 1. Dissolved Oxygen and Water Temperature data collected from August 3 to September 12, 2022 at six monitoring sites in the Comal System using MiniDOT sondes.

Site	Dissolved Oxygen (mg/L)			Water Temperature (°C)		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Upper Spring Run	3.09	7.87	14.26	23.17	26.26	30.18
Landa Lake (MUPPTs)	3.10	6.48	14.66	23.54	24.22	26.16
Landa Lake (Three Islands)	3.44	5.92	12.43	23.48	24.24	26.18
Landa Lake (Spring Run 3)	4.10	5.32	8.40	23.45	23.68	24.93
Landa Lake (Pecan Island)	3.42	6.25	12.25	23.36	24.30	26.85
Old Channel	3.49	7.26	10.26	23.39	24.76	27.12

Although, Total System Discharge in the Comal System dipped below 100 cfs for a brief period in early October, it was mutually agreed upon by the field biologists and City of New Braunfels that there was not a need to re-deploy the sondes. This decision was based on the cooler ambient air temperatures in October and quality Fountain Darter habitat that was present in the system at that time. As October progressed, rainfall and subsequent recharge occurred that resulted in increases to Total System Discharge in the Comal River.

Dissolved oxygen levels reported by the MiniDOTs during the deployment period were variable across locations, but exhibited similar results to what has been observed historically through EAHCP biological monitoring. The stations closest to the main spring openings (both major spring runs and lake upwellings) maintained a more consistent water temperature and less daily fluctuation of DO. Sensors in swift moving water in Landa Lake (Spring Run 3) and the Old Channel exhibited typical and consistent diel fluctuations in DO and water temperature. The sites in the slowest moving (Upper Spring Run) and shallow areas exhibited the warmest water temperatures and corresponding lowest DO values.

Although periodic observances of DO below 4.0 mg/L were observed in the MiniDOT data at the majority of stations, these values were typically reported only for short durations of time. These occurrences were mostly associated with early morning hours and/or the onset of biofouling on the probes. It is important to reiterate that Fountain Darters have been routinely collected over the years at each of these locations via drop net, dip net and fish community sampling, and were again documented in 2022 in these areas through the EAHCP biological monitoring program. Overall, there was no cause for concern with respect to DO or water temperature at any of the six study sites during the summer 2022 deployment period. As of this memorandum (November 2022), Total System Discharge is above 100 cfs and Fountain Darter habitat in both Landa Lake and the Old Channel maintain high quality condition.

Our conclusion based on the additional Low flow triggered DO sampling performed in 2022 is that no revisions to the existing City of New Braunfels Dissolved Oxygen Management Plan regarding the Low spring flow conditions triggered monitoring is recommended at this time. The project team supports the DO Low spring flow monitoring Work Plan components in place and recommends the City of New Braunfels continue implementation in 2023.

Appendix H3 | **Control of Harmful Non-Native Animal Species**

CoNB Control of Harmful Non-Native Animal Species (EAHCP § 5.2.5)

The CONB continued to implement a non-native fish and animal species management program focused on the removal of tilapia (*Oreochromis sp.*), nutria (*Myocastor coypus*) and vermiculated sailfin catfish (family Loricariidae). In 2022, divers utilized primarily polespears and spearguns for capture of non-native fish species and baited box traps to capture nutria. Tilapia were targeted primarily in the main body of Landa Lake, near the confluence of Blieders Creek/ Landa Lake and in the Upper Spring Run while sailfin catfish were targeted primarily in the downstream portion of Landa Lake. Efforts to capture nutria were focused primarily around Landa Lake, in the Upper Spring Run area and along Blieders Creek. **Table 1** summarizes the number of non-native fish and animal species removed from the Comal River system in 2022.

Table 1. Summary of Non-Native Fish & Animal Species Removal (January – December 2022)

Species	Number Removed	Biomass (lbs.)	Average Biomass (lbs./individual)
Vermiculated Sailfin Catfish	195	430.03	2.2
Tilapia	874	2275.83	2.6
Nutria	11	90.26	8.2

Appendix H4 | **Gill Parasite Monitoring in the Comal River System**

BIO-WEST, Inc.
1405 United Drive, Suite 111
San Marcos, Texas 78666

MEMORANDUM

TO:	**Phillip Quast, City of New Braunfels**
FROM:	BIO-WEST, Inc.
DATE:	November 30, 2022
SUBJECT:	**2022 Gill Parasite Monitoring in the Comal River**

Introduction

To benefit populations of the federally-endangered Fountain Darter *Etheostoma fonticola*, the Edwards Aquifer Habitat Conservation Plan (EAHCP) proposed to conduct studies aimed at monitoring and reducing concentrations of the non-native gill parasite *Centrocestus formosanus* in the Comal River. BIO-WEST was contracted to conduct these studies in 2013. Studies initially included data collection targeted at identifying the current distribution, abundance, and density of the free-swimming cercariae of *C. formosanus* as well as its host snail, *Melanoides tuberculatus*. They also included studies to document current prevalence of *C. formosanus* in host snails and Fountain Darters, and pilot studies to evaluate host snail removal as a means of potentially reducing *C. formosanus* concentrations. Additionally, during this time period, data was also collected on the abundance and density of the cercariae of another exotic trematode parasite, *Haplorchis pumilio*, which has the potential to negatively impact Fountain Darter populations. Lastly, repeat monitoring was implemented to track host snail (2013-2018) and parasite cercariae concentration (2013-2022) through time.

From 2014 through 2018, parasite cercariae monitoring was conducted three times per year (Winter, Spring, and Summer seasons) at three transects (Landa Lake [LL], Old Channel Reach [OCR], and RV Park [RVP]; **Figure 1**). In 2019, at the request of the City of New Braunfels and Edwards Aquifer Authority, monitoring efforts were decreased to one event per year, and a fourth sampling transect was added at Pecan Island (PI) due to concerns of potentially high parasite concentrations at this location (**Figure 1**). Since 2019, BIO-WEST biologists have conducted a single summer-season parasite monitoring event at these four transects in the Comal River system. In 2022, this data collection took place on August 15-16, and included quantification of cercariae densities for both *C. formosanus* and *H. pumilio* at each transect. This data was combined with previously collected data from 2014-2021 and the full dataset was analyzed with updated statistical techniques to examine the relationship between multiple predictor variables (discharge, year, season, and site) and parasite concentrations. Details of the methods utilized, a summary of the results and subsequent analyses, a discussion on the utility of this information, and recommendations for further research and monitoring are provided below.

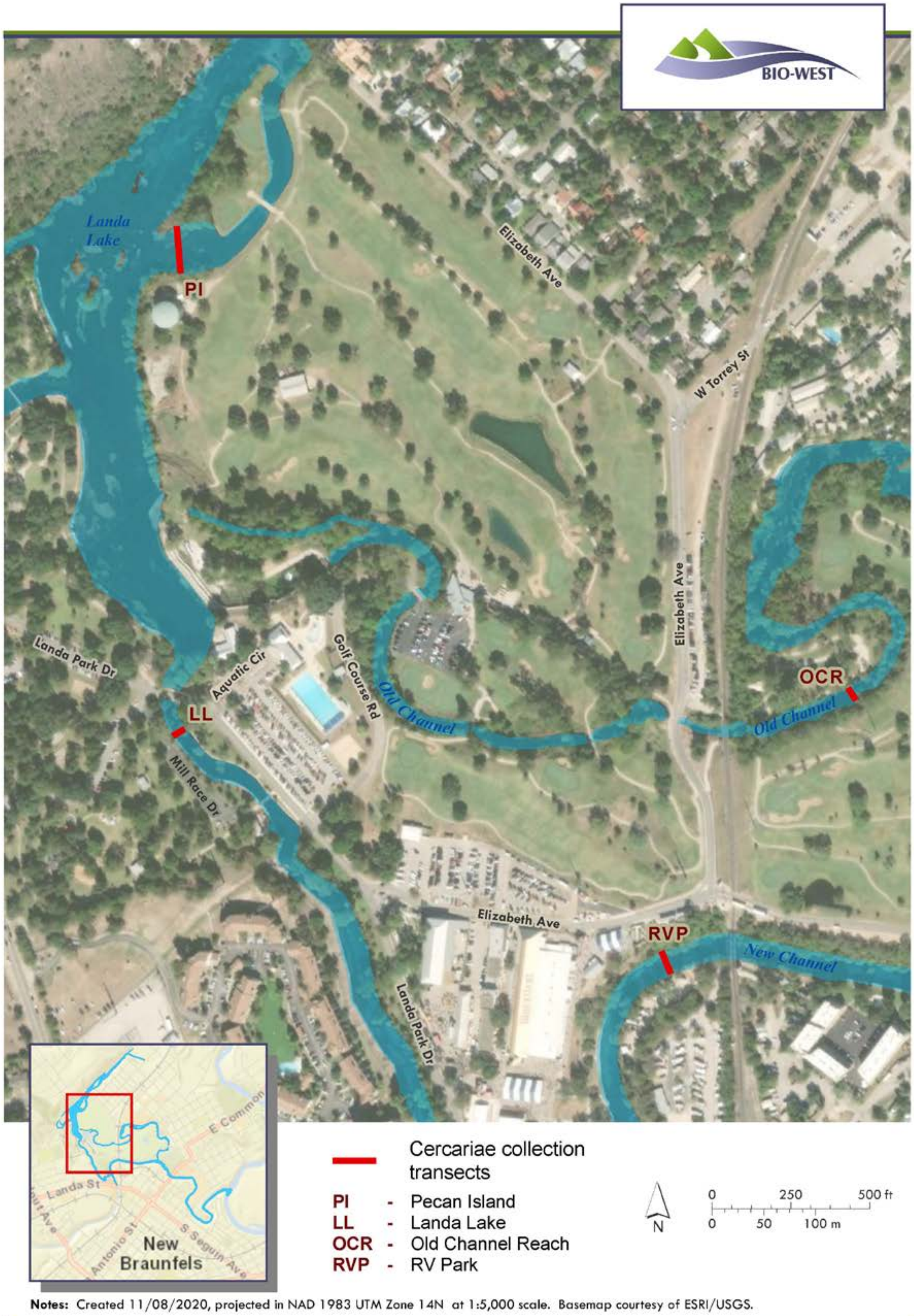


Figure 1. Map of cercariae collection transects in the Comal River system.

Methods

Data Collection

At each transect, 5-Liter (L) water samples were collected from six points evenly distributed throughout the water column both vertically and horizontally. Three evenly spaced sampling stations were established across the stream channel, perpendicular to flow. At each station, two 5-L samples were collected, one at 60% stream depth, and one approximately 5 centimeters (cm) below the water surface, totaling six samples per site. Cercariae were collected using a modified live-well pump attached to an incremental wading rod which pumped water through clear acrylic tubing to collection buckets. At time of collection, each water sample was immediately treated with 5 milliliters (ml) of formaldehyde to kill all parasite cercariae. Each sample was then filtered using a specialized filtration device consisting of three progressively finer nylon filters, with the final filter having pores of 30 microns (µm). After filtration of each sample, the 30-µm filter containing cercariae was removed from the filtration device and placed in a Petri dish. Each sample was then stained with a Rose Bengal solution and fixed with 10% formalin, at which point the Petri dish was closed and sealed with Parafilm for storage. After fixation and staining, the samples were then observed using high-power microscopy (40-100 X magnification) and all cercariae were identified to species and enumerated in the BIO-WEST laboratory.

Data Analysis

Random forest regression models were used to examine relationships between river discharge and density of *C. formosanus* and *H. pumilio* cercariae in the water column. In 2020, general additive models were used for this analysis; however, analysis conducted in 2021 demonstrated that random forest models yielded similar or higher predictive performance. Random forest regression is a type of ensemble decision tree model that generates a large number of trees via bootstrapping that are combined to make predictions. These types of models are advantageous for assessing ecological data, due to their ability to depict nonlinear trends and better generalize to new data (Breiman 2001; Prasad et al. 2006).

For all sampling events, discharge values (cfs) specific to each site were taken or calculated from USGS gaging stations on the Comal River (USGS gages 08168913, 08168932, 08169000) at 10:00 am on the day of collection. Specifically, discharge data for LL and PI were taken from the Comal River New Channel gage (08168932), data for OCR were taken from the Comal River Old Channel gage (08168913), and data for the RVP site were calculated as the difference of the total system gage (08169000) and Old Channel gage (08168913). Discharges were then standardized by median discharge (discharge(x)/Q50) for the study duration to make observations comparable between sites. In addition to standardized discharge; year, season, and site were included as predictor variables to provide more information for the models and potentially identify any temporal or spatial variation in cercariae densities.

Random Forest models were fit using 500 trees and tuned to maximize predictive performance (Breiman 2002). Statistics calculated to assess each model's performance included mean of squared residuals, percent variation explained, and correlation between observed and predicted cercariae densities. Percent increase in mean squared error (MSE) was also calculated for each predictor variable, which represents the magnitude of feature influence relative to prediction error (Breiman 2002). Lastly, partial dependence plots are provided to display cercariae density trends as a function of the most influential predictor variables. All analyses were conducted using R (4.1.1) packages ‘randomForest’ (Liaw 2018), ‘pdp’ (Greenwell 2019), and ‘ggplot2’ (Lin Pedersen 2021).

Results

In 24 individual five-liter samples collected in 2022, 44 total *C. formosanus* and 91 *H. pumilio* cercariae were detected, resulting in an overall system wide mean (±SE) of 0.37 (±0.07) and 0.76 (±0.16) cercariae/L, respectively (**Table 1)**. These densities represent a slight increase from the last few years. However, *C. formosanus* densities are still considerably lower than mean densities from monitoring events early in the study, which were as high as 4.80 (±0.50) cercariae/L in 2014. *H. pumilio* densities in 2022 have breached their highest overall average since 2014, which was 0.60 (±0.09). The highest mean density of *C. formosanus* and *H. pumilio* were observed at LL (0.63 and 1.03 cercariae/L, respectively) and RVP (0.73 and 1.80 cercariae/L, respectively) (**Table 1**).

Random Forest Models were fit based on 468 observations in PI (n = 24), LL (n = 144), OCR (n = 150) and RVP (n = 150). Temporal trends in standardized discharge throughout the duration of cercariae monitoring were similar in the New Channel near Landa Lake and downstream of Dry Comal Creek, increasing from 2014 (~0.14) to 2017 (~1.50) and decreasing from 2017 to 2022 (~0.20). In the Old Channel, standardized discharge was also lower in 2014 (~0.70 in winter), but remained stable for most of the study duration, displaying slight to moderate variation from Q50 (**Figure 2**). Both models performed well with correlations between observed and predicted values ≥0.70, though model correlation and percent variation explained was much higher for *C. formosanus* (0.92 and 83.98%, respectively) than *H. pumilio* (0.70 and 48.89%, respectively) (**Table 2**).

Based on percent increase in MSE, standardized discharge (58.23%) and year (52.91%) were the most influential predictors of *C. formosanus* density. Standardized discharge (27.18%) was also an influential predictor of *H. pumilio* density and had a much higher percent increase MSE than year (10.49%) (**Figure 3**). Partial dependence plots visualizing relationships between parasite density and standardized discharge displayed a nonlinear relationship for both species and showed that density sharply decreased with increasing standardized discharge from about 0.10 to 0.80 units. The partial dependence plots of *C. formosanus* annual trends show that density has decreased from 2014 to 2022. In contrast, trends in *H. pumilio* density display a decrease in density from 2014 to 2017, followed by an increase from 2021 to 2022 (**Figure 4**).

Table 1. Mean cercariae/liter (±SE) collected during parasite monitoring events from 2014-2022.

C. formosanus						*H. pumilio*					
Transect	**Year**	**Season**				**Transect**	**Year**	**Season**			
		Winter	**Spring**	**Summer**	**OVERALL**			**Winter**	**Spring**	**Summer**	**OVERALL**
LL						**LL**					
	2014	4.4 (±0.4)	6.1 (±0.5)	13.3 (±0.6)	**7.9 (±1.0)**		2014	0.2 (±0.09)	0.3 (±0.08)	0.9 (±0.24)	**0.5 (±0.11)**
	2015	2.6 (±0.3)	2.6 (±0.3)	3.4 (±0.3)	**2.9 (±0.2)**		2015	0.5 (±0.09)	0.3 (±0.06)	0.2 (±0.03)	**0.3 (±0.04)**
	2016	0.8 (±0.9)	2.3 (±0.8)	1.9 (±0.8)	**1.6 (±2.2)**		2016	0.03 (±0.03)	0.3 (±0.08)	0.2 (±0.08)	**0.2 (±0.04)**
	2017	1.3 (±0.1)	1.4 (±0.3)	1.0 (±0.2)	**1.2 (±0.1)**		2017	0.06 (±0.04)	0.03 (±0.03)	0.03 (±0.03)	**0.04 (±0.02)**
	2018	0.8 (±0.1)	1.5 (±0.2)	1.6 (±0.4)	**1.3 (±0.2)**		2018	0.1 (±0.07)	0.1 (±0.04)	0.1 (±0.04)	**0.1 (±0.03)**
	2019			0.4 (±0.1)			2019			0.0 (±0.0)	
	2020			0.3 (±0.1)			2020			0.03 (±0.03)	
	2021			0.2 (±0.07)			2021			0.07 (±0.04)	
	2022			0.63 (±0.06)			2022			1.03 (±0.09)	
OCR						**OCR**					
	2014	0.4 (±0.1)	1.0 (±0.2)	2.0 (±0.3)	**1.1 (±0.2)**		2014	0.1 (±0.04)	0.1 (±0.07)	0.2 (±0.09)	**0.1 (±0.04)**
	2015	1.4 (±0.2)	1.9 (±0.2)	2.4 (±0.2)	**1.9 (±0.1)**		2015	0.2 (±0.06)	0.3 (±0.07)	0.1 (±0.03)	**0.2 (±0.03)**
	2016	2.0 (±1.1)	1.2 (±0.9)	1.8 (±1.2)	**1.7 (±1.1)**		2016	0.1 (±0.07)	0.1 (±0.07)	0.1 (±0.07)	**0.1 (±0.04)**
	2017	0.7 (±0.1)	0.6 (±0.2)	0.5 (±0.1)	**0.6 (±0.1)**		2017	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	**0.0 (±0.0)**
	2018	0.6 (±0.1)	0.3 (±0.1)	0.2 (±0.1)	**0.4 (±0.1)**		2018	0.0 (±0.0)	0.0 (±0.0)	0.03 (±0.03)	**0.01 (±0.01)**
	2019			0.4 (±0.1)			2019			0.2 (±0.06)	
	2020			0.4 (±0.1)			2020			0.2 (±0.1)	
	2021			0.1(±0.04)			2021			0.03 (±0.03)	
	2022			0.06(±0.06)			2022			0.23 (±0.08)	
RVP						**RVP**					
	2014	3.8 (±0.3)	7.8 (±0.9)	4.8 (±0.4)	**5.6 (±0.2)**		2014	0.7 (±0.11)	0.9 (±0.25)	1.6 (±0.50)	**1.0 (±0.20)**
	2015	4.5 (±0.7)	3.1 (±0.3)	3.6 (±0.3)	**3.7 (±0.2)**		2015	0.4 (±0.06)	0.4 (±0.07)	0.2 (±0.06)	**0.3 (±0.04)**
	2016	2.1 (±1.1)	2.5 (±0.8)	2.3 (±0.8)	**2.3 (±0.6)**		2016	0.2 (±0.10)	0.2 (±0.10)	0.1 (±0.07)	**0.2 (±0.05)**
	2017	2.0 (±0.6)	2.3 (±0.2)	1.5 (±0.2)	**1.9 (±0.2)**		2017	0.2 (±0.16)	0.2 (±0.08)	0.1 (±0.07)	**0.2 (±0.06)**
	2018	1.6 (±0.2)	1.5 (±0.3)	2.1 (±0.2)	**1.7 (±0.2)**		2018	0.1 (±0.07)	0.2 (±0.10)	0.2 (±0.07)	**0.2 (±0.05)**
	2019			0.9 (±0.1)			2019			0.1 (±0.06)	
	2020			0.6 (±0.2)			2020			0.1 (±0.1)	
	2021			0.2 (±0.08)			2021			0.5 (±0.13)	
	2022			0.73 (±0.04)			2022			1.8 (±0.3)	
Pecan Island						**Pecan Island**					
	2019			0.03 (±0.03)			2019			0.0 (±0.0)	
	2020			0.1 (±0.1)			2020			0.0 (±0.0)	
	2021			0.1 (±0.07)			2021			0.03 (±0.03)	
	2022			0.03 (±0.03)			2022			0.0 (±0.0)	
OVERALL						**OVERALL**					
	2014	2.9 (±0.5)	4.9 (±0.8)	6.7 (±1.2)	**4.8 (±0.5)**		2014	0.3 (±0.08)	0.4 (±0.12)	0.9 (±0.22)	**0.6 (±0.09)**
	2015	2.9 (±0.3)	2.5 (±0.2)	3.2 (±0.2)	**2.9 (±0.1)**		2015	0.4 (±0.04)	0.3 (±0.04)	0.2 (±0.03)	**0.3 (±0.02)**
	2016	1.6 (±0.2)	2.0 (±0.2)	1.9 (±0.1)	**1.9 (±0.1)**		2016	0.1 (±0.04)	0.2 (±0.05)	0.1 (±0.04)	**0.1 (±0.03)**
	2017	1.3 (±0.2)	1.4 (±0.2)	1.0 (±0.1)	**1.2 (±0.1)**		2017	0.1 (±0.06)	0.07 (±0.03)	0.04 (±0.03)	**0.07 (±0.02)**
	2018	1.0 (±0.1)	1.1 (±0.2)	1.3 (±0.2)	**1.1 (±0.1)**		2018	0.07 (±0.03)	0.1 (±0.04)	0.1 (±0.03)	**0.09 (±0.02)**
	2019			0.4 (±0.1)			2019			0.1 (±0.02)	
	2020			0.3 (±0.1)			2020			0.1 (±0.03)	
	2021			0.2 (±0.05)			2021			0.2 (±0.04)	
	2022			0.6 (±0.37)			2022			0.75 (±0.16)	

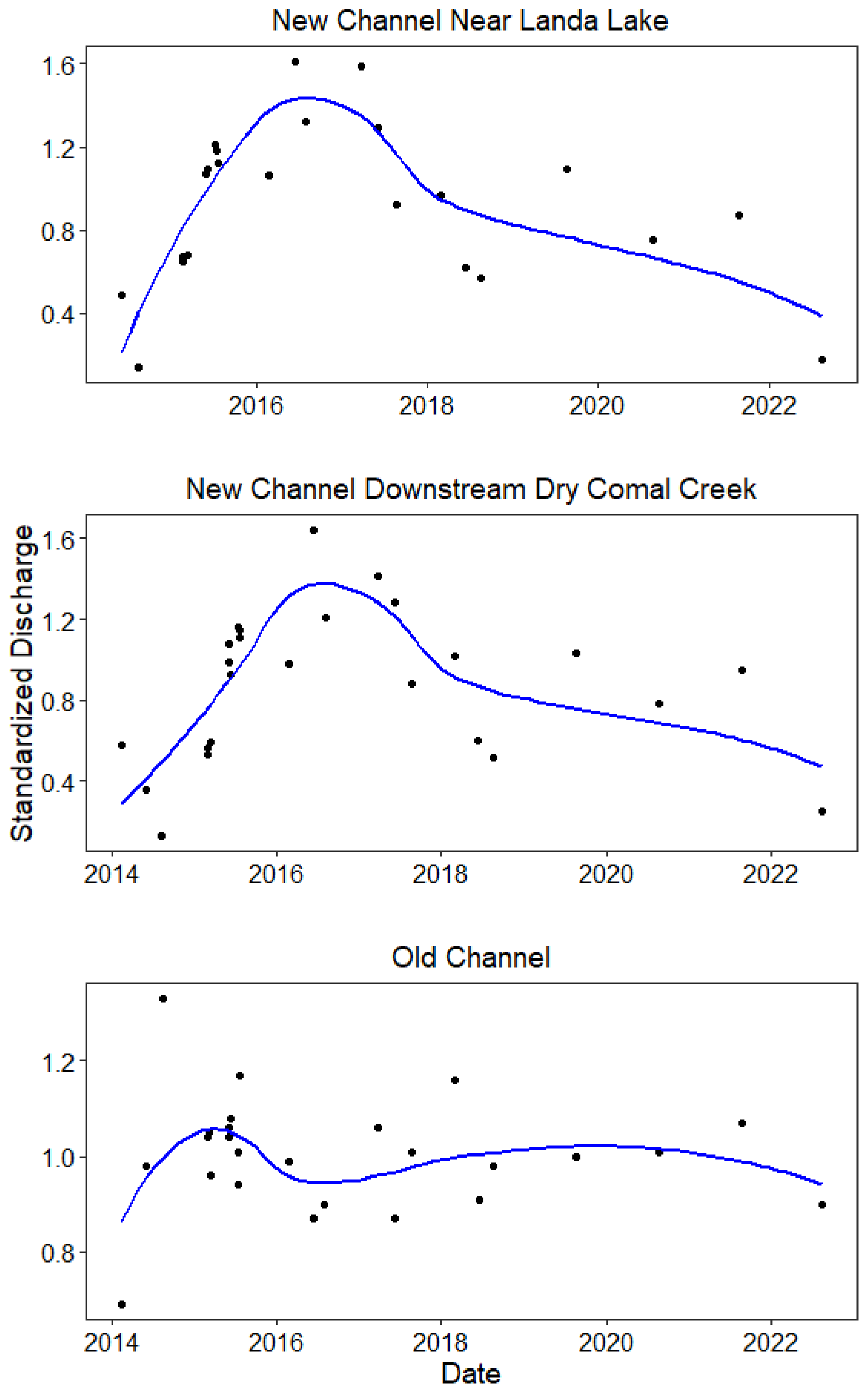


Figure 2. Times series displaying trends in standardized discharge during parasite monitoring. The blue line denotes LOESS smoothed regression fitted to observed standardized discharge values (black dots).

Table 2. Summary of optimal hyperparameters and predictive performance for random forest regression models used to examine trends in cercariae density in the Comal Springs/River System.

	C. formosanus	***H. pumilio***
Model Hyperparameters		
# of trees	500	500
# of variables tried per split	3	2
node size	5	5
Model Performance Statistics		
mean of squared residuals	0.78	0.08
% variation explained	83.98	48.89
correlation	0.92	0.70

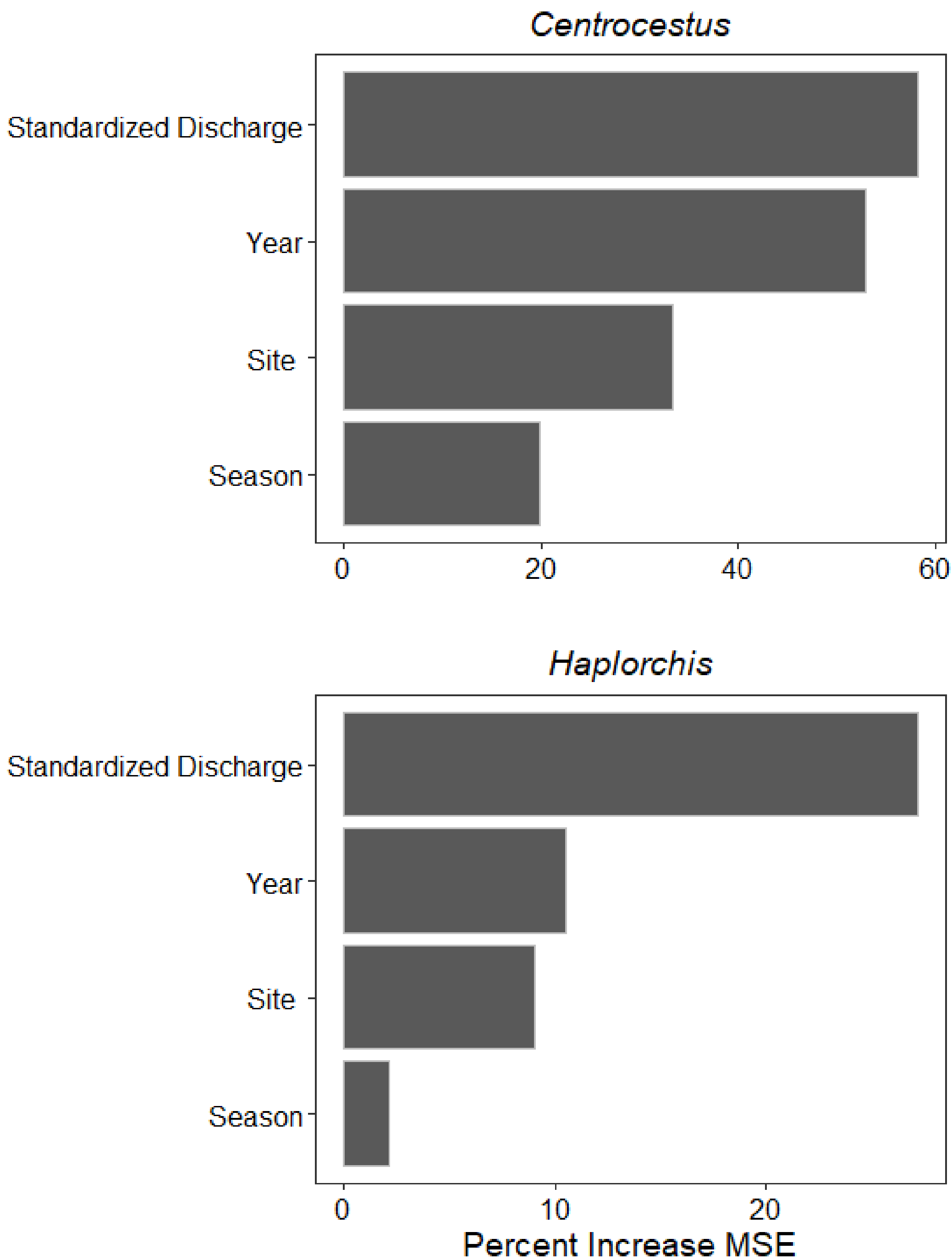


Figure 3. Bar graph displaying the percent increase in mean squared error (MSE) of variables used to predict *Centrocestus formosanus* and *Haplorchis pumilio* density in the Comal Springs/River system.

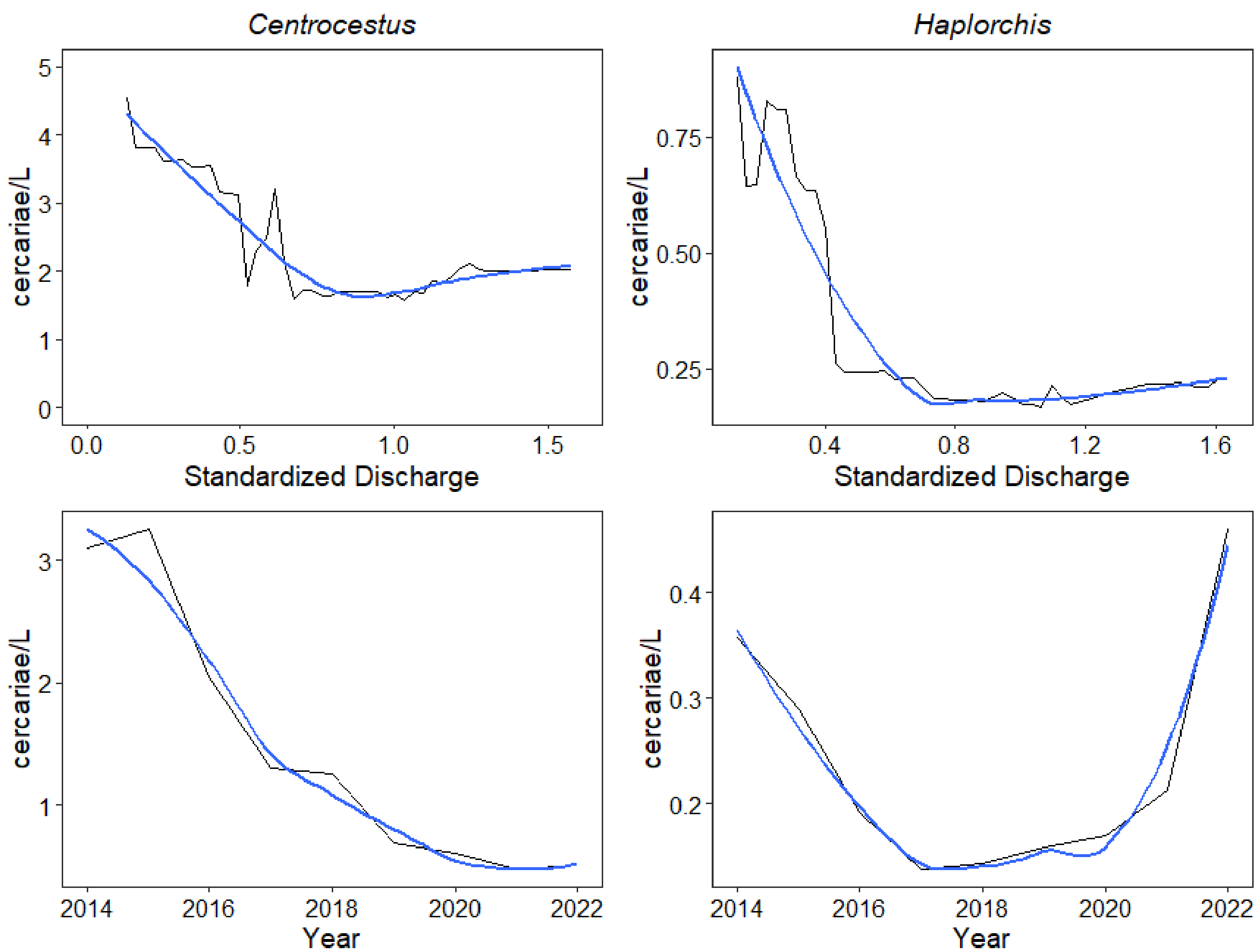


Figure 4. Partial dependence plots displaying the response of cercariae density as a function of standardized discharge and year for *Centrocestus formosanus* and *Haplorchis pumilio* in the Comal Springs/River system. The blue line denotes a loess smoothed regression of the fitted function. Note differences in y-axis scales for each panel.

Discussion and Recommendations

Parasite monitoring from 2014-2022 suggests that overall cercariae concentrations of *C. formosanus* have generally declined over the course of the study duration. Specifically, mean concentrations at each site decreased from 2014 to 2018 and generally stabilized at lower concentrations from 2019 to 2022. Relative trends in *H. pumilio* cercariae density generally aligned with *C. formosanus* until 2022, where *H. pumilio* density increased to concentrations similar to 2014.

Random forest models used to predict parasite concentrations varied in performance. The strong correlation between observed and predicted values supports that there is an association between parasite concentration and model covariates. However, lower percent variation explained for *H. pumilio* suggests that other important covariates may be missing, though may instead be due to low sample sizes for higher parasite concentrations where predictive error was highest or a result of lower magnitudes in density variation compared to *C. formosanus*. Similar to 2021 results, both models also supported that standardized discharge was the most influential predictor of parasite concentration, demonstrating a nonlinear, inverse relationship. If cercariae production is assumed constant, concentrations naturally become diluted under high flow conditions and concentrations logically increase under low flow conditions. That being said, year had a substantial influence on predictive performance of *C. formosanus* concentrations, indicating a temporal component influencing cercariae densities.

Using Landa Lake as an example, *C. formosanus* density decreased as discharge increased from less than 0.80 in 2014 to greater than 0.80 from 2015 to 2018, corroborating a discharge effect. However, despite a decline in discharge from 2018 to 2022, density remained lower even when standardized discharge decreased to 0.18 in 2022, although minor increases did occur from 2019 to 2021. Based on this, results from this analysis provide new insights into explaining trends in *C. formosanus* concentrations and suggest that confounding temporal factors unaccounted for by the model are likely affecting this observed decline.

Recent declines in *C. formosanus* concentration could be related to recent trends in population dynamics of the host-snail *M. tuberculata*. In 2018, BIO-WEST collected data on snail distribution and densities throughout the study reaches, which showed large densities of *M. tuberculata* upstream of the LL and RVP transects (**Figure 5**). However, this data is not available from 2019 to 2022. Collecting current data on snail distribution and density could help elucidate whether recent declines in *C. formosanus* concentration align with recent *M. tuberculata* population trends. Additionally, long-term data on snail infection rates would be valuable to understand the relationship between snail populations and cercariae concentrations. Lastly, no current data is available on the number and intensity of infected fish in the system, or on definitive host (i.e., bird) infection rates. Data collection on infection rates in all three of the parasites hosts would allow a more thorough understanding of parasite population dynamics.

In summary, parasite monitoring show that *C. formosanus* concentrations showed a slight increase from 2021 to 2022. Concentrations in *H. pumilio* remained less than 1 cercariae/L overall, despite an increase from 2021. Results from this analysis show that Random Forest regression models can be used to better inform the EAHCP process specific to *C. formosanus*. Incorporating additional data, as described above, could provide better ecological insight on mechanisms driving parasite population dynamics for both species, including recent declines in *C. formosanus* despite lower discharge in 2022, and could also enhance the utility of the *H. pumilio* model. At a minimum, continued monitoring of parasite concentrations in the Comal Springs/River system is important to provide data at flow levels not yet observed, as well as to assess how *C. formosanus* concentrations respond to future low-flow scenarios and confirm that other confounding mechanisms are influencing parasite concentrations.

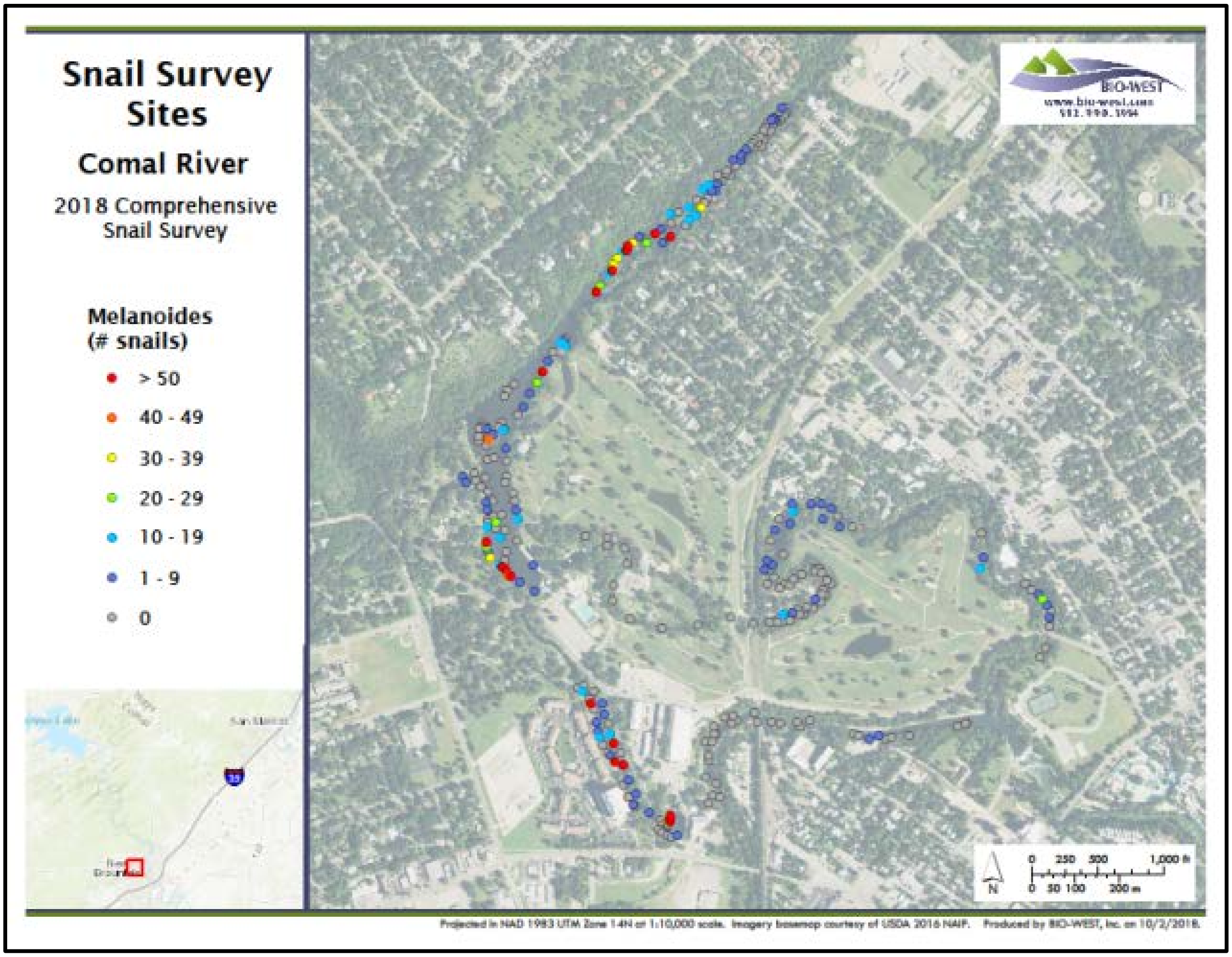


Figure 5. 2018 comprehensive survey of *M. tuberculata* in the Comal River**.**

Appendix H5 | **Riffle Beetle Riparian Habitat Restoration**

City of New Braunfels
Native Riparian Habitat Restoration (Riffle Beetle) (EAHCP § 5.2.8) - 2022

Native riparian habitat restoration along Spring Run 2 consisted of installing additional sediment capture devices on the hillside to slow down storm water runoff coming from Landa Park Drive. Sediment capture devices consisted of Coconut coir wattles and gabion baskets filled with mulch.

The focus of 2022 native habitat restoration was creating a vegetated buffer along spring run 2. The work area consisted of the upper flat embankment and the slope leading down to the water edge. On the upper embankment, planting beds were installed with an improved soil mix with a limestone border (Figure 1 and Figure 2). These areas were then planted with native upland plants, shrubs, and grasses (Table 1). On the slope, degradable erosion control blankets were laid down and sediment control logs were placed strategically along the slope to capture any loose material. Native riparian plants were planted within the erosion fabric. Nine non-native Ligustrum trees larger than 4 caliper inches were injected with herbicide mixture and left in place to be removed at a later date.

Figure 1. Photograph of project area along Spring Run 2 prior to the installation of the planting beds.

Figure 2. Photographs of project area along Spring Run 2 after the installation of the planting beds.

Table 1. Riparian vegetation planted as part of the Riffle Beetle restoration along the Spring Runs.

Species	Quantity
Fall aster	40
Fragrant mistflower	20
Turk’s cap	20
Tx Lantana	5
Skeleton Leaf goldeneye	15
Agarita	10
Aromatic sumac	6
Elbow bush	10
Native grasses	40
Fragrant mimosa	10
Bear grass	10
River fern	20
Spiderwort	20
Mexican plum	1
American beautyberry	1
Red buckeye	1
Total Plants and Grasses	229

Appendix H6 | **Native Riparian Habitat Restoration**

CoNB Native Riparian Habitat Restoration (EAHCP § 5.7.1)

The primary riparian restoration activities conducted in 2021 include: 1) removal and control of non-native riparian vegetation along Landa Lake on Comal County Water Recreation District property near Spring Island, near the Landa Park Golf Course, near Pavilion 16 in Landa Park, and on Wurstfest property downstream from the Dry Comal Creek and Comal River confluence, 2) planting of native vegetation in areas where non-native vegetation was previously treated/ removed, 3) establishment of erosion/ sediment control berms and, 4) maintenance of previously restored areas within the riparian zone of Landa Lake and the Old Channel for the Comal River. **Figure 1, Figure 2, and Figure 3** illustrate the areas where riparian restoration activities occurred for the first time in 2022.

Figure 1. Map of 2022 restoration areas along the Landa Lake shoreline. Restoration in these areas included removal of non-native vegetation and planting of native plants.

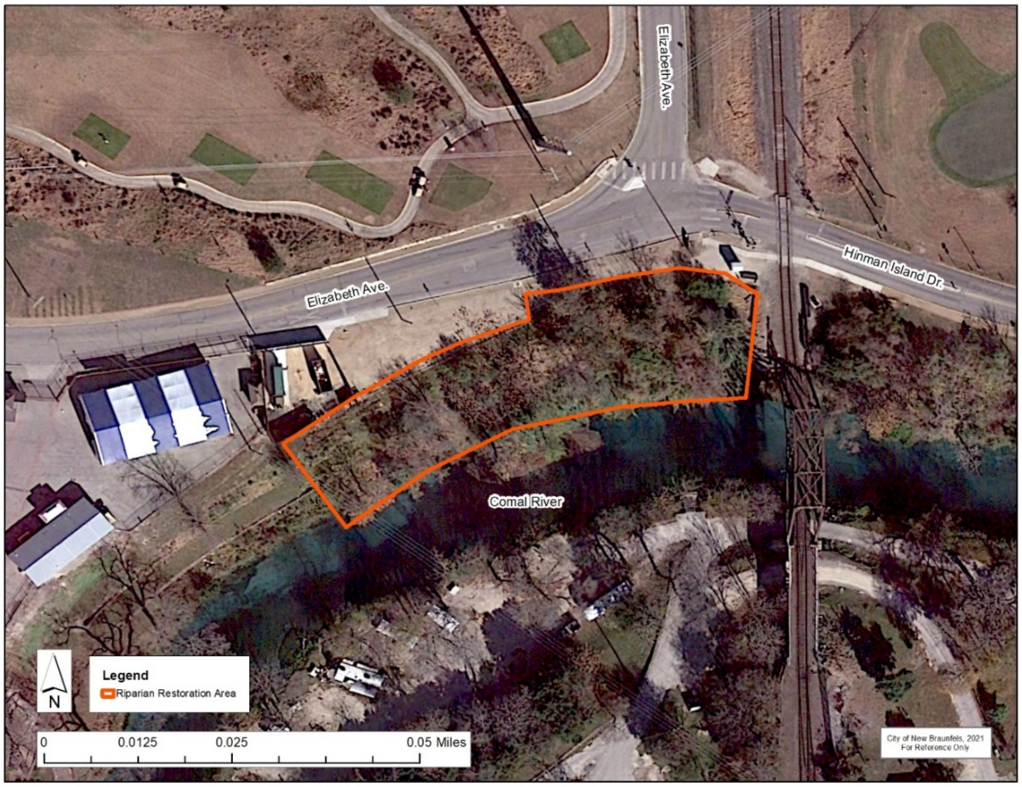


Figure 2. Map of 2022 restoration area along the New Channel of the Comal River on Wurstfest property. Restoration in this area to include removal of non-native vegetation, installation of erosion/ sediment control berms, and planting of native plants.

Figure 3. Map of 2022 restoration area along the New Channel of the Comal River near Pavilion 16 in Landa Park. Restoration in this area to include removal of non-native vegetation, installation of erosion/ sediment control berms, and planting of native plants.

The non-native vegetation species targeted in 2022 include, but were not limited to, elephant ear (*Colocasia* sp.), privet (*Ligustrum* sp.), Chinese tallow (*Triadica sebifera*), giant cane (*Arundo donax*), and chinaberry (*Melia azedarach*). Approximately 585 Ligustrum (including 138 large trees and 447 small trees/ saplings), 2,011 Chinese tallow (including 17 large trees and 1994 small trees/ saplings) and 210 Chinaberry (including 99 large trees and 111 small trees/ saplings) were removed/ treated throughout the riparian zone in 2022, primarily along the shores of Landa Lake and the bank of the new channel of the Comal River.

Maintenance activities, including the re-treatment of re-emergent non-native vegetation and supplemental planting, occurred within previously restored areas extending from the upstream portion of Landa Lake through the Old Channel of the Comal River to the end of the Old Channel LTBG reach.

In 2022, approximately 1,131 native plants were planted and 5lbs. of native grass seed distributed within the riparian zone along Landa Lake primarily within and adjacent to the Pecan Island area where extensive non-native vegetation removal occurred in 2022. The species and the total number of plants introduced into riparian areas in 2022 is shown in **Table 1**.

Table 1. Native Plants Planted within Riparian Zones Throughout the Comal River System in 2021

Native Plants	
American Beauty Berry	3
Antelope Horns Milkweed	20
Big Muhly	64
Black-eyed Susan	10
Brushy Bluestem	115
Chile Petin	20
Common Tree Senna	1
Corralberry	5
Dwarf Palmetto	2
Eastern Gamagrass	5
Elbow Bush	2
Flame Red Anisacanthus	3
Four Nerve Daisy	15
Frogfruit	100
Gregg's Mist Flower	20
Indiangrass	21
Inland Sea Oats	93
Lindheimer Muhly	129
Little Bluestem	60
Lyre Leaf Sage	15
Mealy Blue Sage	15
Nolina	53
Purple Coneflower	20
Rockrose	4
Roughleaf Dogwood	2
Sideoats Grama	38
Straggler Daisy	12
Sumac, Aromatic	2
Sumac, Evergreen	5
Switchgrass	34
Texas Lantana	37
Texas Mountain Laurel	23
Texas Persimmon	1
Texas Sage/ Cenizo	26
Tropical Sage	15

Table 1. Native Plants Planted within Riparian Zones Throughout the Comal River System in 2021	
Turk's Cap	63
Woodland Creek Sedge	65
Yaupon Holly	1
Yucca, Red	1
Yucca, Twist Leaf	6
Zexmenia	5
Native Plant Seed Distributed	
Green Sprangletop	1 lb.
Native Turf Blend – Blue Grama and Buffalograss	4 lbs.
Total # of native plantings: 1131 (plus approx. 5 lbs. seed distributed)	

Photo Log

Photo 1 Photo of erosion control berms being installed along the Landa Lake shoreline in the area where non-native trees were removed (Figure 1). The sediment control berms were constructed using trunks and slash from removed non-native trees.

Photo 2. Photo of elephant ears being treated with aquatic herbicide near Spring Island (Figure 1).

Photo 3. Photo of the Wurstfest property showing the area where non-native trees were removed, erosion control berms built using the slash, and native plants were planted (Figure 2).

Photo 4. Photo of the Wurstfest property showing the area where non-native trees were removed and native plants were planted (Figure 2).

Photos 5. Photo of the Wurstfest property showing the area where non-native trees were removed, erosion control berms built using the slash, and native plants were planted (Figure 2).

Appendix H7 | **Impervious Cover and Water Quality Protection**

City of New Braunfels
Impervious Cover and Water Quality Protection (EAHCP § 5.7.6) – 2022

Excerpt from Landa Park Aquatic Center Water Quality Retrofit Technical Memorandum:

“The existing Aquatic Center parking lot is proposed to be retrofitted with a bioretention basin to treat stormwater runoff from the entire parking lot. Currently, the approximate 2-acre parking lot drains directly to the Comal River. The proposed bioretention basin will use a concrete wall (height = 2 feet) with a form liner to have the appearance of a stacked rock wall. In addition, native plants and trees will be planted in the basin to enhance appearance, improve water quality management, and provide parking lot shade. Wheel stops are proposed along with a ribbon curb so that parking lot runoff will sheet flow into the basin, thus, avoiding concentrated discharge points and the potential for sediment accumulation that can impeded flow. Existing trees will be preserved and the bioretention outlet will use a 24” reinforced concrete pipe to connect to an existing stormwater inlet and pipe that currently discharges to the Comal River.

The bioretention basin water quality component was designed per the TCEQ Edwards Aquifer Protection Program, RG-348 Manual. Bioretention soil media per the TCEQ guidance is proposed to promote infiltration and support long-term pollution management. Upgradient of the biofiltration component, a bioswale is proposed at a slope of 0.6% to promote filtering and nutrient uptake.

Key project statistics:
Drainage area = 1.91 acres
Impervious area = 1.59 acres (83%)
Water quality volume provided = 3,241 cubic feet at elevation 624.5.
Biofiltration media elevation = 623.1
Total suspended sediment managed per year = 1,427 pounds”

Technical Memorandum prepared for the City of New Braunfels by Tom Hegemier, P.E., D.WRE, CFM and Oscar Flores, EIT, December 29, 2020

CITY OF NEW BRAUNFELS
LANDA PARK AQUATIC COMPLEX

WATER QUALITY RETROFIT

PLANS PREPARED AND RECOMMENDED FOR APPROVAL BY:

DOUCET & ASSOCIATES, INC. Date

ACCEPTED FOR CONSTRUCTION:

CITY OF NEW BRAUNFELS DATE

NBU DATE

CITY OF NEW BRAUNFELS, OWNER DATE

FLOODPLAIN NOTE:

THE PROPERTY IS LOCATED WITHIN ZONE "AE". AREAS DETERMINED TO BE INSIDE OF THE 100-YEAR FLOODPLAIN AS SHOWN ON F.I.R.M. PANEL NO. 48091C0435F OF COMAL COUNTY, TEXAS DATED SEPTEMBER 2, 2009.

EDWARDS AQUIFER JURISDICTIONAL BOUNDARY NOTE:
THE SITE IS LOCATED WITHIN THE EDWARDS AQUIFER TRANSITION ZONE.

*NOTE:

ALL INSPECTIONS ARE TO BE CALLED IN AT 830.221.4068, OR FAXED IN AT 830.608.2117 OR EMAILED AT INSPECTION@NBTEXAS.ORG

SURVEY CONTROL:

BASIS OF BEARING IS THE TEXAS COORDINATE SYSTEM, SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM 1983 (NAD83), 2011 ADJUSTMENT (EPOCH 2010) AND A VERTICAL DATUM OF NAVD88, GEOID 12B. ALL COORDINATE VALUES AND DISTANCES SHOWN ARE GRID VALUES .
UNITS: US SURVEY FEET.

THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A TITLE COMMITMENT. EASEMENTS OR OTHER MATTERS OF RECORD MAY EXIST WHERE NONE ARE SHOWN.

BENCHMARK #2
NORTHING = 13,806,936.57
EASTING = 2,243,390.53
ELEVATION = 626.87
BM = MAGNL

VICINITY MAP

SCALE: 1" = 1,000'

Sheet List Table	
Sheet Number	Sheet Title
1	COVER SHEET
2	GENERAL NOTES
3	EXISTING SITE, DEMOLITION, AND EROSION CONTROL PLAN
4	OVERALL SITE PLAN
5	GRADING PLAN
6	WATER QUALITY POND CROSS SECTIONS
7	WATER QUALITY POND PLAN AND CALCULATIONS
8	LANDSCAPING PLAN
9	DETAILS SHEET

NOTE:

1. ALL CONSTRUCTION ACTIVITIES SHALL MEET THE CITY OF NEW BRAUNFELS AND/OR TXDOT CONSTRUCTION STANDARDS.
2. ALL RESPONSIBILITY FOR THE ADEQUACY OF THESE REMAINS WITH THE ENGINEER WHO PREPARED THEM. IN ACCEPTING THESE PLANS, THE CITY OF NEW BRAUNFELS MUST RELY ON THE ADEQUACY OF THE WORK OF THE DESIGN ENGINEER.
3. PROJECT IS A TYPE 3 DEVELOPMENT.
4. IF CONSTRUCTION HAS NOT COMMENCED WITHIN ONE-YEAR OF CITY APPROVAL FOR CONSTRUCTION INSPECTION, THAT APPROVAL IS NO LONGER VALID.
5. THIS PROJECT IS FUNDED BY THE EDWARDS AQUIFER HABITAT CONSERVATION PROGRAM (EAHCP) AND THE CITY OF NEW BRAUNFELS.

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COVER SHEET

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AQUATICS CENTER
CITY OF NEW BRAUNFELS
350 AQUATIC CIRCLE, NEW BRAUNFELS, TEXAS 78130

STATE OF TEXAS
THOMAS EDWARD HEGEMIER
62216
LICENSED
PROFESSIONAL ENGINEER
Thomas Edward Hegemier
12/28/2020

Scale:	1"=
Designed:	GP/OF
Drawn:	GP/OF
Reviewed:	TEH
Date:	12/28/2020

SHEET

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Project No.:
(PW) 1757-004

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CONSTRUCTION PLAN NOTES

IF CONSTRUCTION HAS NOT COMMENCED WITHIN ONE-YEAR OF CITY APPROVAL FOR CONSTRUCTION INSPECTION, THAT APPROVAL IS NO LONGER VALID.

THE MOST CURRENT EDITIONS OF THE CITY OF SAN ANTONIO STANDARD SPECIFICATIONS AND THE TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION OF HIGHWAYS, STREETS AND BRIDGES SHALL BE FOLLOWED FOR ALL CONSTRUCTION EXCEPT AS AMENDED BY THE CITY OF NEW BRAUNFELS STANDARD DETAILS.

ALL RESPONSIBILITY FOR THE ADEQUACY OF THESE PLANS REMAINS WITH THE ENGINEER OF RECORD. IN ACCEPTING THESE PLANS, THE CITY OF NEW BRAUNFELS MUST RELY UPON THE ADEQUACY OF THE WORK OF THE ENGINEER OF RECORD.

PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL CONTACT THE CITY OF NEW BRAUNFELS TO SCHEDULE A PRECONSTRUCTION MEETING.

FOR PUBLIC INFRASTRUCTURE PERMIT (SC) OR SITE PREP PERMIT (SD) PROJECTS:
- ALL INSPECTIONS ARE TO BE CALLED IN AT 830-221-4068.
- YOU MUST CALL BEFORE 12:00 P.M., 24 TO 48 HOURS PRIOR TO YOUR INSPECTION REQUEST.
- IF YOU LEAVE INCOMPLETE INFORMATION, YOUR REQUEST FOR INSPECTION WILL NOT BE ACCEPTED/SCHEDULED.
- EACH INSPECTION WILL BE ALLOTTED 1 HOUR UNLESS YOU REQUEST FOR MORE TIME.
- ONCE YOUR REQUEST HAS BEEN ACCEPTED, YOU WILL RECEIVE A CALL FROM THE ENGINEERING INSPECTOR.

FOR COMMERCIAL PERMIT (CP) PROJECTS:
- ALL INSPECTIONS ARE TO BE CALLED IN AT 830-221-4068 OR,
- FAXED IN AT 830-608-2117 OR,
- E-MAILED AT INSPECTIONS@NBTEXAS.ORG.

IT IS THE CONTRACTOR'S RESPONSIBILITY TO SEE THAT ALL TEMPORARY AND PERMANENT TRAFFIC CONTROL DEVICES ARE PROPERLY INSTALLED AND MAINTAINED IN ACCORDANCE WITH THE PLANS AND LATEST EDITION OF THE TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES. IF, IN THE OPINION OF THE ENGINEERING REPRESENTATIVE AND THE CONSTRUCTION INSPECTOR, THE BARRICADES AND SIGNS DO NOT CONFORM TO ESTABLISHED STANDARDS OR ARE INCORRECTLY PLACED OR ARE INSUFFICIENT IN QUANTITY TO PROTECT THE GENERAL PUBLIC, THE CONSTRUCTION INSPECTOR SHALL HAVE THE OPTION TO STOP OPERATIONS UNTIL SUCH TIME AS THE CONDITIONS ARE CORRECTED. IF THE NEED ARISES, ADDITIONAL TEMPORARY TRAFFIC CONTROL DEVICES MAY BE ORDERED BY THE ENGINEERING REPRESENTATIVE AT THE CONTRACTOR'S EXPENSE.

A TXDOT TYPE II B-B BLUE REFLECTIVE RAISED PAVEMENT MARKER SHALL BE INSTALLED IN THE CENTER OF THE ROADWAY ADJACENT TO ALL FIRE HYDRANTS. IN LOCATIONS WHERE HYDRANTS ARE SITUATED ON CORNERS, BLUE REFLECTIVE RAISED PAVEMENT MARKERS SHALL BE INSTALLED ON BOTH APPROACHES WHICH FRONT THE HYDRANT. THE RAISED PAVEMENT MARKER SHALL MEET TXDOT MATERIAL, EPOXY AND ADHESIVE SPECIFICATIONS.

GROUNDWATER

IT SHALL BE THE RESPONSIBILITY OF THE DEVELOPER, CONTRACTOR, SUBCONTRACTORS, BUILDERS, GEO-TECHNICAL ENGINEER, AND PROJECT ENGINEER TO IMMEDIATELY NOTIFY THE OFFICE OF THE CITY ENGINEER AND PROJECT ENGINEER IF THE PRESENCE OF GROUNDWATER WITHIN THE SITE IS EVIDENT. UPON NOTIFICATION THE PROJECT ENGINEER SHALL RESPOND WITH PLAN REVISIONS FOR THE MITIGATION OF THE GROUNDWATER ISSUE. THE CITY ENGINEER SHALL RESPOND WITHIN TWO (2) BUSINESS DAYS UPON RECEIPT OF THE MITIGATION PLAN. ALL CONSTRUCTION ACTIVITY, IMPACTED BY THE DISCOVERY OF GROUNDWATER, SHALL BE SUSPENDED UNTIL THE CITY ENGINEER GRANTS A WRITTEN APPROVAL OF THE GROUNDWATER MITIGATION PLAN.

RECORD DRAWINGS

AS PER PLATTING ORDINANCE SECTION 118-38M.: WHEN ALL OF THE IMPROVEMENTS ARE FOUND TO BE CONSTRUCTED AND COMPLETED IN ACCORDANCE WITH THE APPROVED PLANS AND SPECIFICATIONS AND WITH THE CITY'S STANDARDS, AND UPON RECEIPT OF ONE SET OF "RECORD DRAWING" PLANS, AND A DIGITAL COPY OF ALL PLANS (PDF COPY) THE CITY ENGINEER SHALL ACCEPT SUCH IMPROVEMENTS FOR THE CITY OF NEW BRAUNFELS, SUBJECT TO THE GUARANTY OF MATERIAL AND WORKMANSHIP PROVISIONS IN THIS SECTION.

CONSTRUCTION NOTE

ENGINEER OF RECORD IS RESPONSIBLE TO ENSURE THAT EROSION CONTROL MEASURES AND STORMWATER CONTROL SUFFICIENT TO MITIGATE OFF SITE IMPACTS ARE IN PLACE AT ALL STAGES OF CONSTRUCTION.

DRAINAGE NOTE

DRAINAGE IMPROVEMENTS SUFFICIENT TO MITIGATE THE IMPACT OF CONSTRUCTION SHALL BE INSTALLED PRIOR TO ADDING IMPERVIOUS COVER.

FINISHED FLOOR ELEVATIONS

THE ELEVATION OF THE LOWEST FLOOR SHALL BE AT LEAST 10 INCHES ABOVE THE FINISHED GRADE OF THE SURROUNDING GROUND, WHICH SHALL BE SLOPED IN A FASHION SO AS TO DIRECT STORMWATER AWAY FROM THE STRUCTURE. PROPERTIES ADJACENT TO STORMWATER CONVEYANCE STRUCTURES MUST HAVE FLOOR SLAB ELEVATION OR BOTTOM OF FLOOR JOISTS A MINIMUM OF ONE FOOT ABOVE THE 100-YEAR WATER FLOW ELEVATION IN THE STRUCTURE. DRIVEWAYS SERVING HOUSES ON THE DOWNHILL SIDE OF THE STREET SHALL HAVE A PROPERLY SIZED CROSS SWALE PREVENTING RUNOFF FROM ENTERING THE GARAGE.

SOILS TESTING

PROCTORS SHALL BE SAMPLED FROM ON-SITE MATERIAL (ON-SITE IS DEFINED AS LIMITS OF CONSTRUCTION FOR THIS -PLAN SET) AND A COPY OF THE PROCTOR RESULTS SHALL BE DELIVERED TO THE CITY OF NEW BRAUNFELS STREET INSPECTOR PRIOR TO ANY DENSITY TESTS.

ROADWAY

ALL ROADWAY COMPACTION TESTS SHALL BE THE RESPONSIBILITY OF THE DEVELOPER'S GEOTECHNICAL ENGINEER. FLEXIBLE BASE OR FILL MATERIAL SHALL BE PLACED IN UNIFORM LAYERS NOT TO EXCEED EIGHT-INCHES (8") LOOSE. EACH LAYER OF MATERIAL, INCLUSIVE OF SUBGRADE, SHALL BE COMPACTED AS SPECIFIED AND TESTED FOR DENSITY AND MOISTURE IN ACCORDANCE WITH TEST METHODS TEX-113-E, TEX-114-E, TEX-115-E. THE NUMBER AND LOCATION OF REQUIRED TESTS SHALL BE DETERMINED BY THE GEOTECHNICAL ENGINEER AND APPROVED BY THE CITY OF NEW BRAUNFELS STREET INSPECTOR. AT A MINIMUM, TESTS SHALL BE TAKEN EVERY 200 LF FOR EACH LIFT. UPON COMPLETION OF TESTING, THE GEOTECHNICAL ENGINEER WILL PROVIDE THE CITY OF NEW BRAUNFELS STREET INSPECTOR WITH ALL TESTING DOCUMENTATION AND A CERTIFICATION STATING THAT THE PLACEMENT OF FLEXIBLE BASE, AND FILL MATERIAL, AND SUBGRADE, HAS BEEN COMPLETED IN ACCORDANCE WITH THE PLANS. ADDITIONAL DENSITY TESTS MAY BE REQUESTED BY THE CITY OF NEW BRAUNFELS STREET INSPECTOR.

ITEM 340

ASPHALTIC CONCRETE PAVEMENT SHALL BE TYPE "D" HOT MIX ASPHALT AS DEFINED IN TXDOT'S STANDARD SPECIFICATIONS FOR CURRENT TXDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION OF HIGHWAYS, STREET AND BRIDGES.

THE CITY OF NEW BRAUNFELS WILL NOT ACCEPT THE USE OF RECYCLED ASPHALT PAVEMENT (RAP) OR RECYCLED ASPHALT SHINGLES (RAS) IN ASPHALT MIXTURES FOR NEW ROADWAYS. ANY DEBRIS INCLUSIONS WITHIN NEW ASPHALT PAVEMENTS WILL RESULT IN ASPHALT REMOVAL AND REPLACEMENT FROM CURB TO CURB FOR LIMITS TO BE DETERMINED BY THE CITY OF NEW BRAUNFELS.

THE ASPHALTIC CONCRETE SURFACE COURSE SHALL BE PLANT MIXED, HOT LAID TYPE "D" MEETING THE SPECIFICATION REQUIREMENTS OF TXDOT ITEM 340. THE MIX SHALL BE DESIGNED FOR A STABILITY OF AT LEAST 35 AND SHALL BE COMPACTED TO BETWEEN 91 AND 95 PERCENT OF THE MAXIMUM THEORETICAL DENSITY AS DETERMINED BY TXDOT TEST METHOD TEX-227-F. THE ASPHALT CEMENT CONTENT BY PERCENT OF TOTAL MIXTURE WEIGHT SHALL FALL WITHIN A TOLERANCE OF $\pm$0.5 PERCENT FROM A SPECIFIC MIX DESIGN.

UTILITY TRENCH COMPACTION (ADDED TO THE CONSTRUCTION PLANS ON ALL UTILITY PLAN SHEETS).

ALL UTILITY TRENCH COMPACTION TESTS WITHIN THE STREET PAVEMENT SECTION SHALL BE THE RESPONSIBILITY OF THE DEVELOPER'S GEOTECHNICAL ENGINEER. FILL MATERIAL SHALL BE PLACED IN UNIFORM LAYERS NOT TO EXCEED TWELVE INCHES (12") LOOSE. EACH LAYER OF MATERIAL SHALL BE COMPACTED TO A MINIMUM 95% DENSITY AND TESTED FOR DENSITY AND MOISTURE IN ACCORDANCE WITH TEST METHODS TEX-113-E, TEX-114-E, TEX-115-E. THE NUMBER AND LOCATION OF REQUIRED TESTS SHALL BE DETERMINED BY THE GEOTECHNICAL ENGINEER AND APPROVED BY THE CITY OF NEW BRAUNFELS STREET INSPECTOR. AT A MINIMUM, TESTS SHALL BE TAKEN EVERY 200 LF FOR EACH LIFT AND EVERY OTHER SERVICE LINE. UPON COMPLETION OF TESTING THE GEOTECHNICAL ENGINEER SHALL PROVIDE THE CITY OF NEW BRAUNFELS STREET INSPECTOR WITH ALL TESTING DOCUMENTATION AND A CERTIFICATION STATING THAT THE PLACEMENT OF FILL MATERIAL HAS BEEN COMPLETED IN ACCORDANCE WITH THE PLANS. ADDITIONAL DENSITY TESTS MAY BE REQUESTED BY THE CITY OF NEW BRAUNFELS STREET INSPECTOR.

CURB CUT DUE TO CONSTRUCTION OF NEW RIGHT-OF-WAY CONSTRUCTION

(INDICATE THE 2 OPTIONS ON THE CONSTRUCTION PLANS).
1. SAWCUT EXISTING STREET AND MATCH TO NEW CONSTRUCTION.
2. SAWCUT EXISTING CURB TO TIE INTO EXISTING CONSTRUCTION.

CONSTRUCTION STABILIZED ENTRANCE

SAWCUT CURB FOR CONSTRUCTION ENTRANCE.

STABILIZED CONSTRUCTION AREA SHALL BE CONSTRUCTED OF 3"X5" ROCK TO BE PLACED A MINIMUM LENGTH OF 25-FT. AND MAINTAINED SO THAT CONSTRUCTION DEBRIS DOES NOT FALL WITHIN THE CITY RIGHT-OF-WAY. RIGHT-OF-WAY MUST BE CLEARED FROM MUD, ROCKS, ETC. AT ALL TIMES.

(NOTES TO BE PLACED ON ALL WW PLAN & DETAIL SHEETS)

ENSURE ALL DRIVEWAY APPROACHES ARE BUILT IN GENERAL ACCORDANCE WITH A.D.A. SPECIFICATIONS.

NO VALVES, HYDRANTS, ETC. SHALL BE CONSTRUCTED WITHIN CURBS, SIDEWALKS, OR DRIVEWAYS.

SIGNING AND PAVEMENT MARKING PLAN NOTES

THE CONTRACTOR SHALL FURNISH AND INSTALL ALL REGULATORY AND WARNING SIGNS, STREETS NAME SIGNS AND SIGN MOUNTS IN ACCORDANCE WITH APPROVED ENGINEERING PLANS. THE CITY WILL INSPECT ALL SIGNS AT FINAL INSPECTION.

THE CONTRACTOR SHALL INSTALL ALL PAVEMENT MARKINGS IN ACCORDANCE WITH APPROVED ENGINEERING PLANS. THE CONTRACTOR SHALL NOTIFY THE CITY AT LEAST TWENTY-FOUR (24) HOURS PRIOR TO THE INSTALLATION OF ALL SEALER AND FINAL MARKINGS. THE CITY WILL INSPECT ALL MARKINGS AT FINAL APPLICATION.

SEEDING AND ESTABLISHMENT OF VEGETATION WITHIN EARTHEN CHANNELS, STORMWATER BASINS AND DISTURBED AREAS

SEEDING FOR THE PURPOSE OF ESTABLISHING VEGETATION WITHIN CONSTRUCTED EARTHEN CHANNELS, BASINS AND DISTURBED AREAS SHALL BE CONDUCTED IN ACCORDANCE WITH ITEM 164 (SEEDING FOR EROSION CONTROL) OF TXDOT'S STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MAINTENANCE OF HIGHWAYS, STREETS AND BRIDGES MANUAL. ONLY SEED TYPES AND MIXES SPECIFIED FOR THE SAN ANTONIO DISTRICT (DISTRICT 15) IN TABLES 1 AND 2 UNDER ITEM 164 SHALL BE UTILIZED. DURING THE COOL SEASON (SEPT 1-NOV 30), CEREAL RYE AND SEED SPECIES SPECIFIED FOR THE SAN ANTONIO DISTRICT IN TABLE 3 MAY BE USED. FOR COOL SEASON SEEDING APPLICATIONS, COOL SEASON SEED MIXES SHALL BE USED IN CONJUNCTION WITH SEED MIXES FOR THE SAN ANTONIO DISTRICT AS SPECIFIED IN TABLE 1 AND 2 UNDER ITEM 164.

IT MAY BE DEEMED NECESSARY TO INCORPORATE TOPSOIL AND SOIL AMENDMENTS (I.E. COMPOST/ FERTILIZER) INTO EXISTING SOIL IN ORDER TO FACILITATE VEGETATION GROWTH. TOPSOIL, COMPOST AND FERTILIZER ADDITIONS SHALL BE CONDUCTED ACCORDING TO ITEMS 160, 161 AND 166 OF TXDOT'S STANDARD SPECIFICATIONS MANUAL, RESPECTIVELY.

WATERING MAY ALSO BE NECESSARY TO FACILITATE AND EXPEDITE THE SPROUTING AND GROWTH OF VEGETATION. ITEM 168 OF TXDOT'S STANDARD SPECIFICATIONS MANUAL SHALL BE ADHERED TO FOR VEGETATIVE WATERING.

IF EXTENDED DROUGHT CONDITIONS EXIST THAT HINDER OR PROHIBIT THE GROWTH AND ESTABLISHMENT OF VEGETATION, THE CONTRACTOR/ DEVELOPER SHALL PROVIDE A PLAN TO THE CITY OF NEW BRAUNFELS DESCRIBING THE MEASURES THAT WILL BE TAKEN TO STABILIZE EARTHEN DRAINAGE INFRASTRUCTURE UNTIL A TIME WHEN GROWING CONDITIONS BECOME MORE FAVORABLE.

<u>GENERAL NOTES:</u>

1. ALL MATERIALS AND CONSTRUCTION PROCEDURES WITHIN THE SCOPE OF THE PROJECT SHALL BE APPROVED BY NEW BRAUNFELS UTILITIES AND COMPLY WITH THE CURRENT "NEW BRAUNFELS UTILITIES WATER SYSTEMS CONNECTION/CONSTRUCTION POLICY".
2. CONTRACTOR SHALL NOT PROCEED WITH ANY PIPE INSTALLATION WORK UNTIL THEY OBTAIN A COPY OF THE PLANS FROM THE CONSULTANT OR ENGINEER AND NOTIFY NBU WATER SYSTEMS ENGINEERING AT 830-608-8971 WITH AT LEAST TWO (2) WORKING DAYS (48 HOURS) NOTICE. WORK COMPLETED BY THE CONTRACTOR, WHICH HAS NOT RECEIVED A NOTICE TO PROCEED FROM NEW BRAUNFELS UTILITIES WATER SYSTEMS ENGINEERING WILL BE SUBJECT TO REMOVAL AND REPLACEMENT BY AND AT THE EXPENSE OF THE CONTRACTOR.
3. THE DEVELOPER DEDICATES THE WATER / WASTEWATER MAINS UPON COMPLETION BY THE CONTRACTOR AND ACCEPTANCE BY THE NEW BRAUNFELS UTILITIES WATER SYSTEM. NBU WILL OWN AND MAINTAIN SAID WATER / WASTEWATER MAINS WHICH ARE LOCATED WITHIN PLATTED UTILITY EASEMENTS OR PUBLIC ROW OF PROPOSED DEVELOPMENTS. (AS APPLICABLE).
4. CONTRACTOR AGREES TO ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE CONSTRUCTION OF THE PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS. THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE OWNERS AND THE ENGINEER AND HIS EMPLOYEES, PARTNERS OFFICERS, DIRECTORS, OR CONSULTANTS HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF THE WORK ON THIS PROJECT, EXCEPTING FROM LIABILITY ARISING FROM SOLE NEGLIGENCE OF THE OWNER OR ENGINEER, ENGINEER'S DIRECTORS, OFFICERS, EMPLOYEES, OR CONSULTANTS.
5. CONTRACTOR TO CONTACT THE ENGINEER-OF-RECORD (EOR) FOR ANY FIELD CHANGES. ANY REVISIONS OR CHANGES TO THE APPROVED CONSTRUCTION PLANS WILL REQUIRE ADDITIONAL APPROVAL BY NBU IN WRITING.
6. CONTRACTOR AND / OR CONTRACTOR'S INDEPENDENTLY RETAINED EMPLOYEE OR SAFETY CONSULTANT SHALL IMPLEMENT A TRENCH SAFETY PROGRAM IN ACCORDANCE WITH OSHA STANDARDS GOVERNING THE PRESENCE AND ACTIVITIES OF INDIVIDUALS WORKING IN AND AROUND TRENCH EXCAVATION.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR RESTORING TO ITS ORIGINAL OR BETTER CONDITION, ANY DAMAGES DONE TO EXISTING FENCES, CURBS, STREETS, DRIVEWAYS, LANDSCAPING AND STRUCTURES, AND EXISTING UTILITIES (NOT ADJUSTED ON PLANS). COST OF RESTORATIONS, IF ANY, SHALL BE THE CONTRACTOR'S ENTIRE EXPENSE.
8. THE CONTRACTOR SHALL AVOID CUTTING ROOTS LARGER THAN ONE INCH IN DIAMETER WHEN EXCAVATING NEAR EXISTING TREES. EXCAVATION IN VICINITY OF TREES SHALL PROCEED WITH CAUTION.
9. CONTRACTOR SHALL PROCURE ALL PERMITS AND LICENSES, PAY ALL CHARGES, FEES AND TAXES AND GIVE ALL NOTICES NECESSARY AND INCIDENTAL TO THE DUE AND LAWFUL PROSECUTION OF THE WORK.
10. NO EXTRA PAYMENT SHALL BE ALLOWED FOR WORK CALLED FOR ON THE PLANS BUT NOT INCLUDED ON THE BID SCHEDULE. THIS INCIDENTAL WORK WILL BE REQUIRED AND SHALL BE INCLUDED UNDER THE PAY ITEM TO WHICH IT RELATES.
11. CONTRACTOR IS RESPONSIBLE FOR REMOVAL OF ALL WASTE MATERIALS UPON PROJECT COMPLETION. THE CONTRACTOR SHALL NOT PERMANENTLY PLACE ANY WASTE MATERIALS IN THE 100-YEAR FLOOD PLAIN WITHOUT FIRST OBTAINING AN APPROVED FLOOD PLAIN DEVELOPMENT PERMIT.
12. THE CONTRACTOR SHALL NOT PLACE ANY MATERIALS ON THE RECHARGE ZONE OF THE EDWARDS AQUIFER WITHOUT AN APPROVED WATER POLLUTION ABATEMENT PLAN FROM THE TCEQ 31 TAC 313.4 AND 31 TAC 313.9.
13. BARRICADES AND WARNING SIGNS SHALL CONFORM TO THE "TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" AND SHALL BE LOCATED TO PROVIDE MAXIMUM PROTECTION TO THE PUBLIC AS WELL AS CONSTRUCTION PERSONNEL AND EQUIPMENT WHILE PROVIDING CONTINUOUS TRAFFIC FLOW AT ALL TIMES DURING CONSTRUCTION. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING ALL DEVICES DURING CONSTRUCTION.
14. CONTRACTOR IS REQUIRED TO VERIFY PROJECT ELEVATIONS. THE TERM "MATCH EXISTING" SHALL BE UNDERSTOOD TO SIGNIFY BOTH HORIZONTAL AND VERTICAL ALIGNMENT.
15. THE LOCATION OF UTILITIES, EITHER UNDERGROUND OR OVERHEAD, SHOWN WITHIN THE RIGHT OF WAY ARE APPROXIMATE AND SHALL BE VERIFIED BY THE CONTRACTOR BEFORE BEGINNING CONSTRUCTION OPERATIONS.
16. OSHA REGULATIONS PROHIBIT OPERATIONS THAT WILL BRING PERSONS OR EQUIPMENT WITHIN 10 FEET OF AN ENERGIZED LINE. WHERE WORKMEN AND/OR EQUIPMENT HAVE TO WORK CLOSE TO AN ENERGIZED ELECTRICAL LINE, THE CONTRACTOR SHALL NOTIFY THE ELECTRICAL POWER COMPANY INVOLVED AND MAKE WHATEVER ADJUSTMENTS NECESSARY TO ENSURE THE SAFETY OF THOSE WORKMEN.
17. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO LOCATE UTILITY SERVICE LINES AS REQUIRED FOR CONSTRUCTION. CONTRACTORS SHALL CALL THE ONE CALL SYSTEM FOR WATER/WASTEWATER LOCATION.
18. DUE TO FEDERAL REGULATIONS TITLE 49, PART 192 (8), GAS COMPANIES MUST MAINTAIN ACCESS TO GAS VALVES AT ALL TIMES. THE CONTRACTOR MUST PROTECT AND WORK AROUND ANY GAS VALVES THAT ARE IN THE PROJECT AREA.
19. THE CONTRACTOR IS FULLY RESPONSIBLE FOR THE TRAFFIC CONTROL AND WILL BE RESPONSIBLE FOR FURNISHING ALL TRAFFIC CONTROL DEVICES, AND FLAGGERS. THE CONSTRUCTION METHODS SHALL BE CONDUCTED TO PROVIDE THE LEAST POSSIBLE INTERFERENCE TO TRAFFIC SO AS TO PERMIT THE CONTINUOUS MOVEMENT OF THE TRAFFIC IN ONE DIRECTION AT ALL TIMES. THE CONTRACTOR SHALL CLEAN UP AND REMOVE FROM THE WORK AREA ANY LOOSE MATERIAL RESULTING FROM CONTRACT OPERATIONS AT THE END OF EACH WORKDAY.
20. PRIOR TO ORDERING MATERIALS TO BE USED IN CONSTRUCTION, CONTRACTOR SHALL PROVIDE THE ENGINEER WITH FOUR (4) COPIES OF THE SOURCE, TYPE, GRADATION, MATERIAL SPECIFICATION DATA AND / OR SHOP DRAWINGS, AS APPLICABLE, TO SATISFY THE REQUIREMENTS OF THE FOLLOWING ITEMS AND ALL MATERIAL ITEMS REFERRED TO IN THESE LISTED ITEMS:
    a. WATER MAINS AND SERVICES
    b. WASTEWATER MAINS AND SERVICES
21. THRUST BLOCKS WILL NOT BE ALLOWED ON THE SYSTEM WITHOUT SPECIAL APPROVAL. JOINTS WILL BE RESTRAINED WITH RESTRAINING SYSTEMS APPROVED BY NBU AND RESTRAINT LENGTH SHALL BE SUBMITTED TO NBU AT THE TIME OF PLAN SUBMITTAL.
22. WATER JETTING THE BACKFILL WITHIN A STREET WILL NOT BE PERMITTED. WASTEWATER TRENCHES SUBJECT TO TRAFFIC SHALL CONFORM TO NBU CONNECTION AND CONSTRUCTION POLICY MANUAL.
23. WHERE THE MINIMUM 9 FOOT SEPARATION DISTANCE BETWEEN WASTEWATER LINES AND WATER LINES / MAINS CANNOT BE MAINTAINED, THE INSTALLATION OF WASTEWATER LINES SHALL BE IN STRICT ACCORDANCE WITH 30 TAC 217.
24. CONTRACTOR AND/OR CONTRACTOR'S INDEPENDENTLY RETAINED EMPLOYEE OR STRUCTURAL DESIGN/GEOTECHNICAL/SAFETY/EQUIPMENT CONSULTANT, IF ANY, SHALL REVIEW THESE PLANS AND AVAILABLE GEOTECHNICAL INFORMATION AND THE ANTICIPATED INSTALLATION SITE(S) WITHIN THE PROJECT WORK AREA IN ORDER TO IMPLEMENT CONTRACTOR'S TRENCH EXCAVATION SAFETY PROTECTION SYSTEMS, PROGRAMS AND/OR PROCEDURES. THE CONTRACTOR'S IMPLEMENTATION OF THE SYSTEMS, PROGRAMS AND/OR PROCEDURES SHALL PROVIDE FOR ADEQUATE TRENCH EXCAVATION SAFETY PROTECTION THAT COMPLIES WITH AS A MINIMUM, OSHA STANDARDS FOR TRENCH EXCAVATIONS. SPECIFICALLY, CONTRACTOR AND/OR CONTRACTOR'S INDEPENDENTLY RETAINED EMPLOYEE OR SAFETY CONSULTANT SHALL IMPLEMENT A TRENCH SAFETY PROGRAM IN ACCORDANCE WITH OSHA STANDARDS GOVERNING THE PRESENCE AND ACTIVITIES OF INDIVIDUALS WORKING IN AND AROUND TRENCH EXCAVATION.
25. <u>UTILITY TRENCH COMPACTION WITH STREET R.O.W.</u>
    a. ALL UTILITY TRENCH COMPACTION TEST WITHIN THE STREET PAVEMENT SECTION SHALL BE THE RESPONSIBILITY OF THE DEVELOPER'S GEO-TECHNICAL ENGINEER.
    b. FILL MATERIAL SHALL BE PLACED IN UNIFORM LAYERS NOT TO EXCEED TWELVE INCHES (12") LOOSE.
    c. EACH LAYER OF MATERIAL SHALL BE COMPACTED AS SPECIFIED AND TESTED FOR DENSITY AND MOISTURE IN ACCORDANCE WITH TEXT METHODS TEX-113-E, TEX-114-E, TEX-115-E.
    d. THE NUMBER AND LOCATION OF REQUIRED TESTS SHALL BE DETERMINED BY THE GEO-TECHNICAL ENGINEER AND APPROVED BY THE CITY OF NEW BRAUNFELS STREET INSPECTOR.
    e. UPON COMPLETION OF TESTING THE GEO-TECHNICAL ENGINEER SHALL PROVIDE THE CITY OF NEW BRAUNFELS STREET INSPECTOR WITH ALL TESTING DOCUMENTATION AND A CERTIFICATION STATING THAT THE PLACEMENT OF FILL MATERIAL HAS BEEN COMPLETED IN ACCORDANCE WITH THE PLANS.

<u>WATER NOTES:</u>

1. ALL WATER MAINS SHALL BE AWWA C900 (CLASS 150 OR GREATER).
2. WATER SERVICES SHALL BE SINGLE 1" COPPER TUBING.
3. WATER LINE IS TO BE CONSTRUCTED IN ACCORDANCE WITH THE NBU SYSTEMS CONNECTION & CONSTRUCTION POLICY.
4. WATER MAIN SHALL HAVE A MINIMUM OF 42 INCHES OF COVER, OTHERWISE CONCRETE ENCASEMENT WILL BE REQUIRED.
5. EACH UNIT IN A DUPLEX, TRIPLEX, FOURPLEX, OR CONDOMINIUM SHALL BE PROVIDED WITH AN INDIVIDUAL WATER METER. A MASTER METER CAN BE CONSIDERED FOR SEPARATE BUILDINGS, HOWEVER, THOSE BUILDINGS MUST BE PLUMBED TO ALLOW SEPARATE METERS FOR FUTURE CONSIDERATION.
6. CONTRACTOR WILL KEEP THE AREA ON TOP OF AND AROUND THE WATER METER BOX FREE OF ALL OBJECTS AND DEBRIS.
7. INITIAL BACKFILL OF WATER LINES SHALL BE MANUFACTURED SAND OR PEA GRAVEL AS PER NBU SYSTEMS CONNECTION & CONSTRUCTION POLICY.
8. SECONDARY BACKFILL OF WATER LINES SHALL GENERALLY CONSIST OF MATERIAL REMOVED FROM THE TRENCH AND SHALL BE FREE FROM BRUSH, DEBRIS AND TRASH OR STONES HAVING ANY DIMENSION LARGER THAN 6" INCHES AT THE LARGEST DIMENSION.
9. HYDROSTATIC TESTING IS DONE FROM VALVE TO VALVE.
10. NO METER BOXES TO BE SET IN DRIVEWAYS OR SIDEWALKS. ANY METER BOXES SET IN DRIVEWAYS OR SIDEWALKS WILL BE RELOCATED AT CONTRACTOR'S AND/OR DEVELOPER'S EXPENSE.
11. METER BOXES MUST BE SET AT THE PROPOSED GRADE. ANY METER BOXES THAT ARE NOT SET AT THE FINAL GRADE WILL BE ADJUSTED AT CONTRACTOR'S AND/OR DEVELOPER'S EXPENSE.
12. ACCEPTABLE METER BOXES ARE D13-BAMR AND D15-BAMR. <u>NEW RESIDENTIAL LOTS ARE REQUIRED TO USE THE D15-BAMR METER BOXES (DOUBLE AMR).</u> COMMERCIAL LOTS SHOULD CHOOSE WHICH BOX APPLIES TO THE DOMESTIC AND/OR IRRIGATION METER LAYOUT.
13. THRUST BLOCKS WILL NOT BE ALLOWED ON THE SYSTEM WITHOUT SPECIAL APPROVAL. JOINTS WILL BE RESTRAINED WITH RESTRAINING SYSTEMS APPROVED BY NBU AND RESTRAINT LENGTH SHALL BE SUBMITTED TO NBU AT THE TIME OF PLAN
    SUBMITTAL.
14. CONTRACTOR SHALL PLACE TRACER WIRE ON TOP OF THE WATER MAINS. TRACER WIRE SHOULD RUN FROM VALVE TO VALVE AND EXIT AT THE VALVE BOX. THE TRACER WIRE SHOULD BE ATTACHED TO THE TOP OF THE PIPE USING TAPE. EXCESS WIRE SHOULD BE LEFT WITHIN VALVE BOXES TO BE PLACED WITHIN LID OF COVER.

<u>WASTEWATER NOTES:</u>

1. THE CONTRACTOR SHALL MAINTAIN SERVICE TO EXISTING WASTEWATER SYSTEM AT ALL TIMES DURING CONSTRUCTION.
2. A MINIMUM OF 8" WASTEWATER PIPE AND FITTINGS (P.V.C. SDR-26, ASTM, D-3034, D-3212, F-477) ARE REQUIRED ON NEW INSTALLATION.
3. ALL RESIDENTIAL WASTEWATER SERVICE LATERALS SHALL BE EXTENDED TO THE PROPERTY LINE AND A CLEANOUT SHALL BE INSTALLED AT THE PROPERTY LINE. SERVICES TO LOTS WILL EXTEND FOUR (4) FEET PAST THE UNDERGROUND ELECTRIC CONDUIT IF ELECTRIC IS INSTALLED IN THE FRONT EASEMENT.
4. PIPE BEDDING OF WASTEWATER LINES SHALL BE MANUFACTURED SAND OR PEA GRAVEL AS PER NBU SPECIFICATIONS.
5. SECONDARY BACKFILL OF WASTEWATER LINES SHALL GENERALLY CONSIST OF MATERIALS REMOVED FROM THE TRENCH AND SHALL BE FREE FROM BRUSH, DEBRIS AND TRASH, NO ROCKS OR STONES HAVING ANY DIMENSION LARGER THAN 6 INCHES AT THE LARGEST DIMENSION.
6. ALL WASTEWATER PIPES SHALL HAVE COMPRESSION OR MECHANICAL JOINTS AS PER 30 TAC §217.53 (C) (2).
7. FOR WASTEWATER LINES LESS THAN 24" IN DIAMETER, SELECT INITIAL BACKFILL MATERIAL SHALL BE PLACED IN TWO LIFTS.
    a. THE FIRST LIFT SHALL BE SPREAD UNIFORMLY AND SIMULTANEOUSLY ON EACH SIDE AND UNDER THE SHOULDERS OF THE PIPE TO THE MID POINT OR SPRING LINE OF THE PIPE.
    b. THE SECOND LIFT SHALL BE PLACED TO A DEPTH AS SHOWN ON THE PIPE BACKFILL DETAIL. FOR PIPES LARGER THAN 24", 12" MAXIMUM LIFTS SHALL BE USED.
8. ALL MANHOLES MUST BE WATER TIGHT, EITHER MONOLITHIC, CAST-IN-PLACE CONCRETE STRUCTURES OR PREFABRICATED MANHOLES SPECIFICALLY APPROVED BY NBU. THE MANHOLES SHALL HAVE WATER-TIGHT RINGS AND COVERS. WHEREVER THEY ARE WITHIN THE 100 YEAR FLOODPLAIN, THE MANHOLE COVERS SHALL BE BOLTED. EVERY THIRD MANHOLE IN SEQUENCE SHALL HAVE AN ALTERNATE MEANS OF VENTING. 30 TAC §213.5 (C) (3) (A) AND 30 TAC §217.55 (O).
9. ALL MANHOLES SHALL BE CONSTRUCTED SO THAT THE TOP OF THE RING IS TWO INCHES (2") ABOVE SURROUNDING GROUND EXCEPT WHEN LOCATED IN PAVED AREAS. IN PAVED AREAS, THE MANHOLE RING SHALL BE FLUSH WITH PAVEMENT.
10. ALL NEW MANHOLES, UNLESS APPROVED BY NBU ENGINEERING, ARE TO HAVE COVERS WITH 32" OPENINGS.
11. WASTEWATER PIPE CONNECTIONS TO PRE-CAST MANHOLES WILL BE COMPRESSION JOINTS OR MECHANICAL "BOOT TYPE" JOINT AS APPROVED BY NBU.
12. WASTEWATER LINES SHALL BE TESTED FROM MANHOLE TO MANHOLE.
13. IN AREAS WHERE A NEW WASTEWATER MANHOLE IS TO BE CONSTRUCTED OVER AN EXISTING WASTEWATER SYSTEM, IT SHALL BE THE CONTACTOR'S RESPONSIBILITY TO TEST THE EXISTING MANHOLES BEFORE CONSTRUCTION. AFTER THE PROPOSED MANHOLE(S) HAS BEEN BUILT, THE CONTRACTOR SHALL RE-TEST THE EXISTING SYSTEM TO THE SATISFACTION OF THE CONSTRUCTION INSPECTOR. (NO SEPARATE PAY ITEM).
14. WHERE THE MINIMUM 9 FOOT SEPARATION DISTANCE BETWEEN WASTEWATER LINES AND WATER LINES / MAINS CANNOT BE MAINTAINED, THE INSTALLATION OF WASTEWATER LINES SHALL BE IN STRICT ACCORDANCE WITH TCEQ. THE WASTEWATER LINE SHALL BE CONSTRUCTED OF CAST IRON, DUCTILE IRON OR PVC MEETING THE ASTM SPECIFICATION FOR BOTH PIPES AND JOINTS OF 150 PSI AND SHALL BE IN ACCORDANCE WITH 30 TAC §217.53 (D) (3) (A) (I).
15. NO TESTING WILL BE PERFORMED PRIOR TO 30 DAYS FROM COMPLETE INSTALLATION OF THE WASTEWATER LINES. THE FOLLOWING SEQUENCE WILL BE STRICTLY ADHERED TO:
    a. PULL MANDREL
    b. PERFORM AIR TEST
    c. CLEANING OF ANY DEBRIS
    d. FLUSHING OF SYSTEM
    e. TV INSPECTION (WITHIN 72 HOURS OF FLUSHING)
16. A MINIMUM OF 3 FEET OF COVER IS TO BE MAINTAINED OVER THE WASTEWATER MAIN AND LATERALS AT SUBGRADE, OTHERWISE CONCRETE ENCASEMENT WILL BE REQUIRED.
17. WASTEWATER MAIN CONNECTIONS MADE DIRECTLY TO EXISTING MANHOLES WILL REQUIRE SUCCESSFUL TESTING OF THE MANHOLE IN ACCORDANCE WITH NBU CONNECTION & CONSTRUCTION POLICY MANUAL.
18. TCEQ AND EPA REQUIRE EROSION AND SEDIMENTATION CONTROL FOR CONSTRUCTION OF WASTEWATER COLLECTION SYSTEMS. DEVELOPER OR AUTHORIZED REPRESENTATIVE SHALL PROVIDE EROSION AND SEDIMENTATION CONTROL AS NOTES ON THE PROJECT'S PLAN AND PROFILE SHEETS. ALL TEMPORARY EROSION AND SEDIMENTATION CONTROLS SHALL BE REMOVED BY THE CONTRACTOR AT FINAL ACCEPTANCE OF THE PROJECT BY NBU WATER SYSTEMS.
19. ALL MANHOLES NOT WITHIN PAVED STREETS SHALL HAVE LOCKING CONCRETE COLLAR TO SECURE RING AND COVER TO MANHOLE CONE PER NBU DETAIL DRAWING #329.
20. ALL MANHOLES OVER THE EDWARDS AQUIFER RECHARGE ZONE SHALL HAVE LOCKING CONCRETE COLLAR TO SECURE RING AND COVER TO MANHOLE CONE PER NBU DETAIL DRAWING #329.

<u>STANDARD SEQUENCE OF CONSTRUCTION</u>

1. TEMPORARY EROSION AND SEDIMENTATION CONTROLS ARE TO BE INSTALLED AS INDICATED ON THE APPROVED SITE PLAN OR SUBDIVISION CONSTRUCTION PLAN AND IN ACCORDANCE WITH THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP) THAT IS REQUIRED TO BE POSTED ON THE SITE. INSTALL TREE PROTECTION AND INITIATE TREE MITIGATION MEASURES.
2. THE ENVIRONMENTAL PROJECT MANAGER OR SITE SUPERVISOR MUST CONTACT THE CITY OF NEW BRAUNFELS TO SET A PRECONSTRUCTION MEETING. FOR PUBLIC INFRASTRUCTURE PERMIT (SC) OR SITE PREP PERMIT (SD) PROJECTS:
    - ALL INSPECTIONS ARE TO BE CALLED IN AT 830-221-4068.
    - YOU MUST CALL BEFORE 12:00 P.M., 24 TO 48 HOURS PRIOR TO YOUR INSPECTION REQUEST.
    - IF YOU LEAVE INCOMPLETE INFORMATION, YOUR REQUEST FOR INSPECTION WILL NOT BE ACCEPTED/SCHEDULED.
    - EACH INSPECTION WILL BE ALLOTTED 1 HOUR UNLESS YOU REQUEST FOR MORE TIME.
    - ONCE YOUR REQUEST HAS BEEN ACCEPTED, YOU WILL RECEIVE A CALL FROM THE ENGINEERING INSPECTOR.
3. THE ENVIRONMENTAL PROJECT MANAGER, AND/OR SITE SUPERVISOR, AND/OR DESIGNATED RESPONSIBLE PARTY AND THE GENERAL CONTRACTOR WILL FOLLOW THE STORM WATER POLLUTION PREVENTION PLAN (SWPPP) POSTED ON THE SITE. TEMPORARY EROSION AND SEDIMENTATION CONTROLS WILL BE REVISED, IF NEEDED, TO COMPLY WITH CITY INSPECTORS' DIRECTIVES, AND REVISED CONSTRUCTION SCHEDULE RELATIVE TO THE WATER QUALITY PLAN REQUIREMENTS AND THE EROSION PLAN.
4. ROUGH GRADE THE POND(S) AT 100% PROPOSED CAPACITY. EITHER THE PERMANENT OUTLET STRUCTURE OR A TEMPORARY OUTLET MUST BE CONSTRUCTED PRIOR TO DEVELOPMENT OF EMBANKMENT OR EXCAVATION THAT LEADS TO PONDING CONDITIONS. THE OUTLET SYSTEM MUST CONSIST OF A SUMP PIT OUTLET AND AN EMERGENCY SPILLWAY MEETING THE REQUIREMENTS OF THE DRAINAGE CRITERIA MANUAL AND/OR THE ENVIRONMENTAL CRITERIA MANUAL, AS REQUIRED. THE OUTLET SYSTEM SHALL BE PROTECTED FROM EROSION AND SHALL BE MAINTAINED THROUGHOUT THE COURSE OF CONSTRUCTION UNTIL INSTALLATION OF THE PERMANENT WATER QUALITY POND(S).
5. TEMPORARY EROSION AND SEDIMENTATION CONTROLS WILL BE INSPECTED AND MAINTAINED IN ACCORDANCE WITH THE STORM WATER POLLUTION PREVENTION PLAN (SWPPP) POSTED ON THE SITE.
6. BEGIN SITE CLEARING/CONSTRUCTION (OR DEMOLITION) ACTIVITIES.
7. PERMANENT WATER QUALITY PONDS OR CONTROLS WILL BE CLEANED OUT AND FILTER MEDIA WILL BE INSTALLED PRIOR TO/CONCURRENTLY WITH REVEGETATION OF SITE.
8. COMPLETE CONSTRUCTION AND START REVEGETATION OF THE SITE AND INSTALLATION OF LANDSCAPING.
9. UPON COMPLETION OF THE SITE CONSTRUCTION AND REVEGETATION OF A PROJECT SITE, THE DESIGN ENGINEER SHALL SUBMIT AN ENGINEER'S LETTER OF CONCURRENCE TO THE CITY INDICATING THAT CONSTRUCTION, INCLUDING REVEGETATION, IS COMPLETE AND IN SUBSTANTIAL CONFORMITY WITH THE APPROVED PLANS. AFTER RECEIVING THIS LETTER, A FINAL INSPECTION WILL BE SCHEDULED BY THE APPROPRIATE CITY INSPECTOR.
10. UPON COMPLETION OF LANDSCAPE INSTALLATION OF A PROJECT SITE, THE LANDSCAPE ARCHITECT SHALL SUBMIT A LETTER OF CONCURRENCE TO THE CITY INDICATING THAT THE REQUIRED LANDSCAPING IS COMPLETE AND IN SUBSTANTIAL CONFORMITY WITH THE APPROVED PLANS. AFTER RECEIVING THIS LETTER, A FINAL INSPECTION WILL BE SCHEDULED BY THE APPROPRIATE CITY INSPECTOR.
11. AFTER A FINAL INSPECTION HAS BEEN CONDUCTED BY THE CITY INSPECTOR AND WITH APPROVAL FROM THE CITY INSPECTOR, REMOVE THE TEMPORARY EROSION AND SEDIMENTATION CONTROLS AND COMPLETE ANY NECESSARY FINAL REVEGETATION RESULTING FROM REMOVAL OF THE CONTROLS. CONDUCT ANY MAINTENANCE AND REHABILITATION OF THE WATER QUALITY PONDS OR CONTROLS.

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TBPLS Firm Number: 10105800

GENERAL NOTES

LANDA PARK
AQUATICS CENTER
CITY OF NEW BRAUNFELS
350 AQUATIC CIRCLE, NEW BRAUNFELS, TEXAS 78130

STATE OF TEXAS
THOMAS EDWARD HEGEMIER
62216
LICENSED
PROFESSIONAL ENGINEER
Thomas Edward Hegemier
12/28/2020

Scale:	1"=
Designed:	GP/OF
Drawn:	GP/OF
Reviewed:	TEH
Date:	12/28/2020

SHEET
2
2 OF 9

Project No.:
(PW) 1757-004

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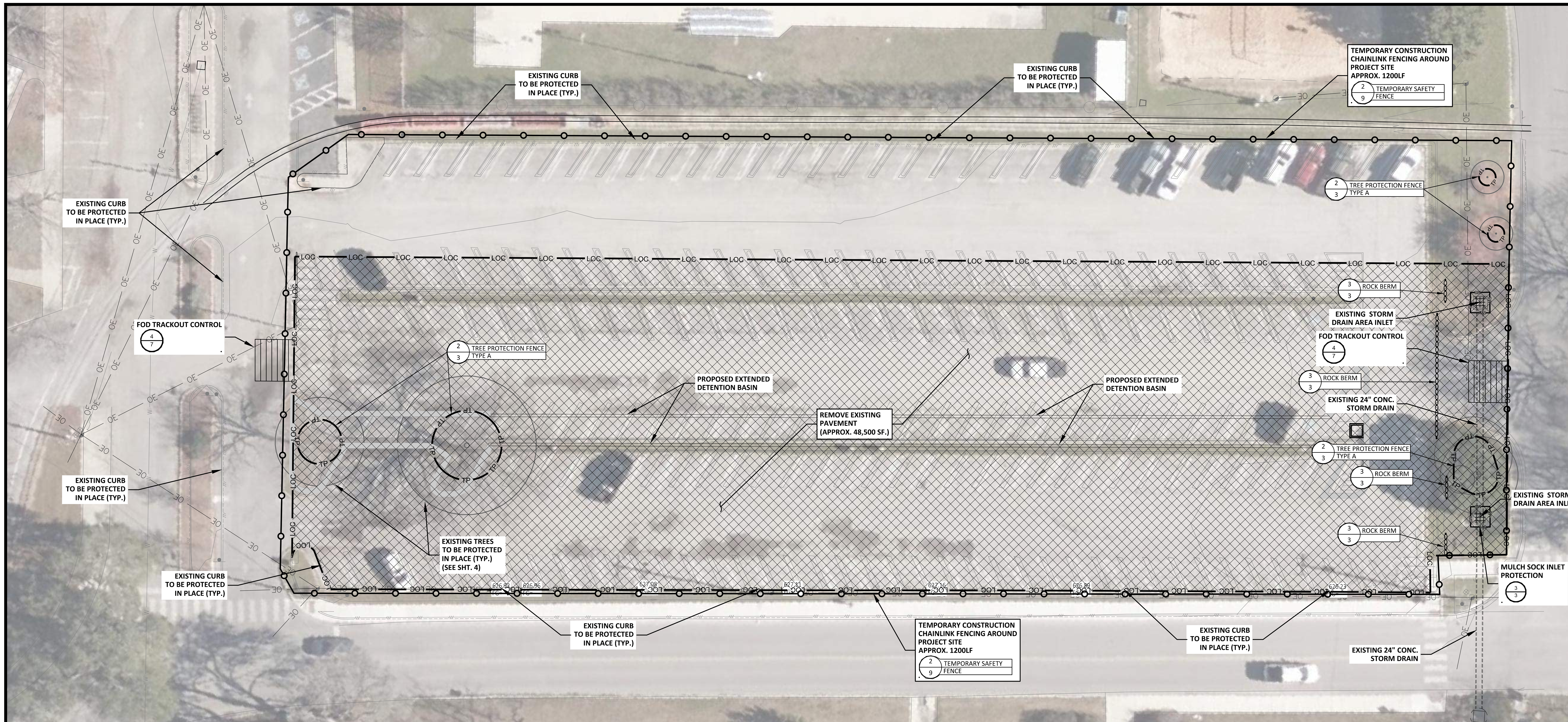

GRAPHIC SCALE 1"=20'

PLAN LEGEND

- FIRE HYDRANT
- SIGN (AS NOTED)
- POWER POLE
- DOWN GUY
- PAVEMENT
- PAVEMENT TO BE REMOVED
- BUILDING
- LOC — LIMITS OF CONSTRUCTION
- BOUNDARY LINE
- PROPERTY LINES
- EASEMENTS
- WIRE FENCE
- WOOD FENCE
- CHAIN LINK FENCE
- OE — OVERHEAD ELECTRIC
- EDGE OF EXISTING ASPHALT
- SIDEWALK TO BE INSTALLED
- CURB & GUTTER
- 1000 — EX MAJOR CONTOURS (5FT)
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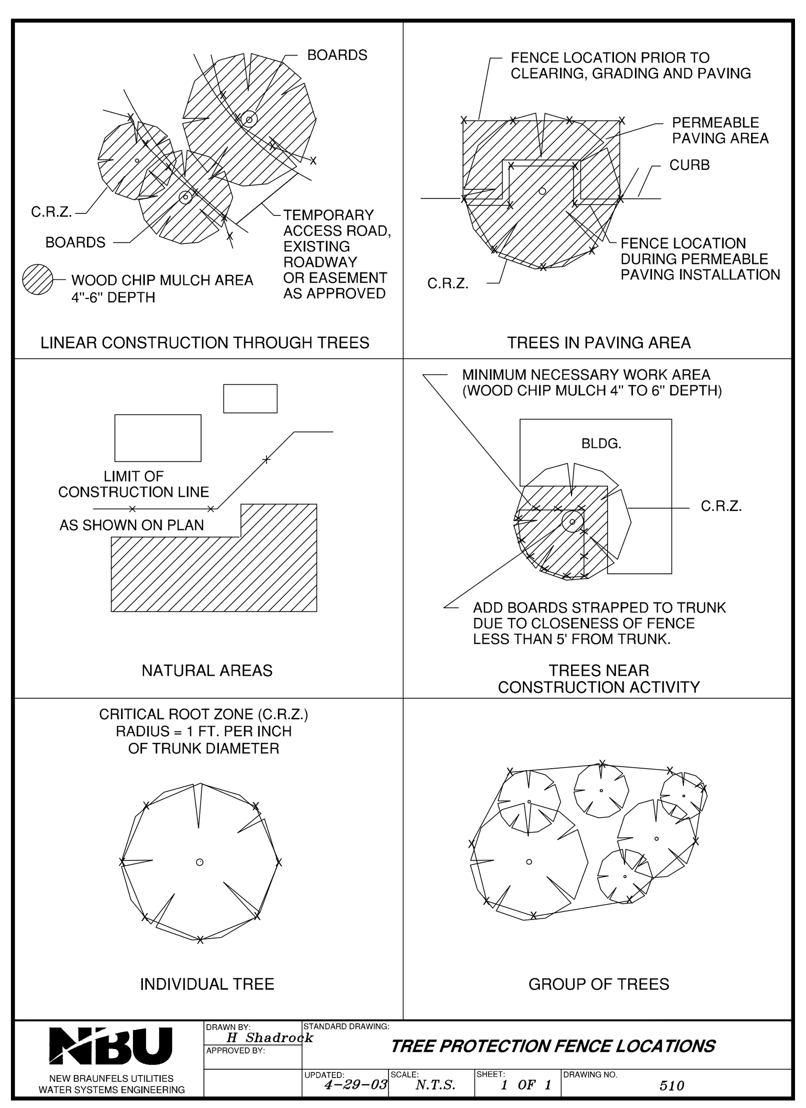
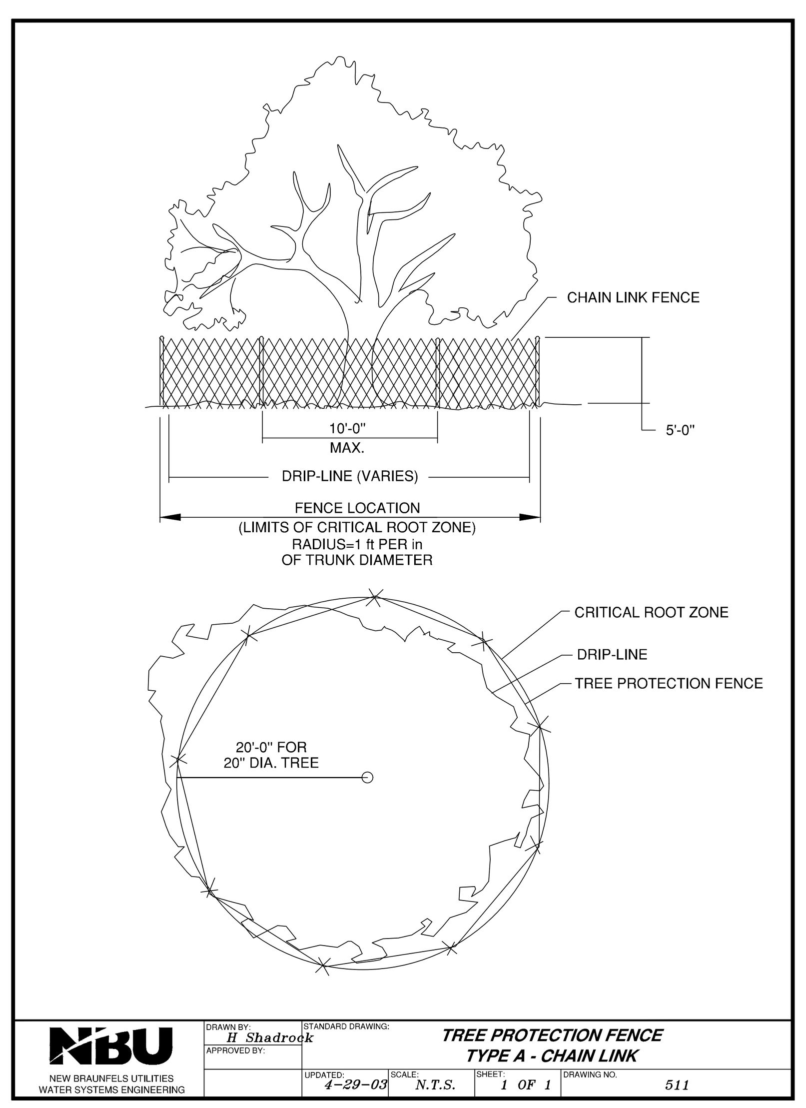
- 1000 — PR MAJOR CONTOURS (5FT)
- PR MINOR CONTOURS (1FT)
- STORM SEWER LINE
- WATER LINE
- PROPOSED WASTEWATER LINE
- EXISTING TREE TO REMAIN
- EXISTING TREE TO BE REMOVED/RELOCATED
- TP — TREE PROTECTION FENCE
- MS — FILTER DIKE CURB INLET PROTECTION
- REINFORCED ROCK BERM

TREE LIST

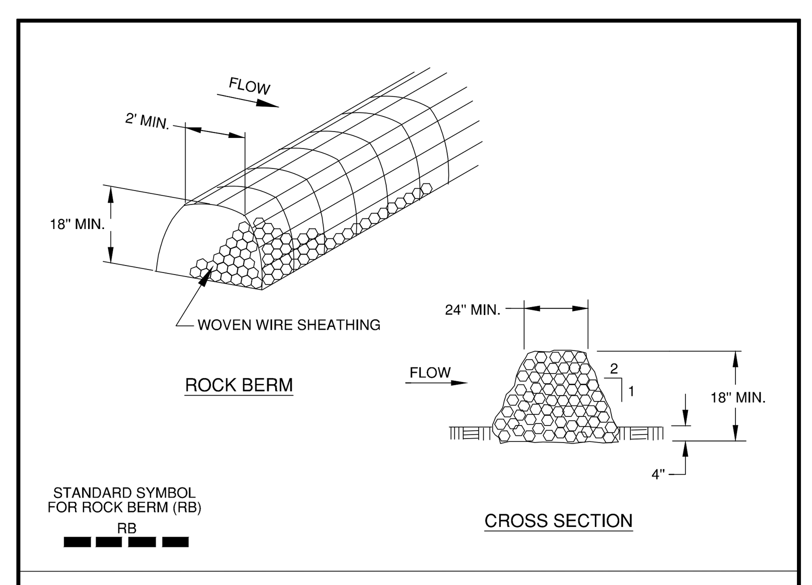
Point #	Trunk Dia. & Species
3000	16" CEDAR ELM
3001	25" CEDAR ELM
3002	14" UNKNOWN
3003	14" UNKNOWN
3004	5" UNKNOWN
3005	6" UNKNOWN
3006	6" UNKNOWN



1/3 TREE PROTECTION FENCE LOCATIONS
SCALE: NONE



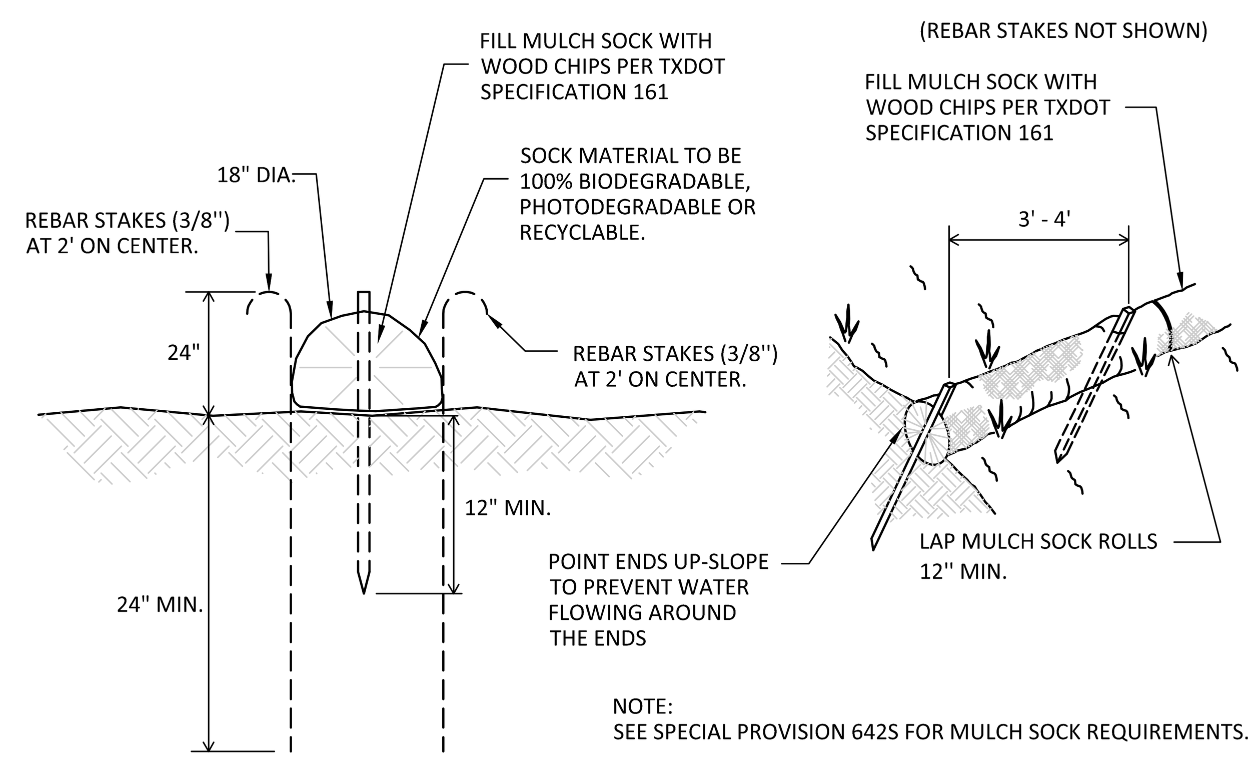
1/3 TREE PROTECTION FENCE TYPE A - CHAINLINK
SCALE: NONE



NOTES:

1. USE ONLY OPEN GRADED ROCK 4" to 8" DIAMETER FOR STREAM FLOW CONDITIONS. USE OPEN GRADED ROCK 3" to 5" DIAMETER FOR OTHER CONDITIONS.
2. THE ROCK BERM SHALL BE SECURED WITH A WOVEN WIRE SHEATHING HAVING MAXIMUM 1" OPENING AND MINIMUM WIRE DIAMETER OF 20 GAUGE. ROCK BERMS IN CHANNEL APPLICATIONS SHALL BE ANCHORED FIRMLY INTO THE SUBSTRATE A MINIMUM OF 6" WITH T-POSTS OR WITH #5 OR #6 REBAR, WITH MAXIMUM SPACING APART OF 48" ON CENTER.
3. THE ROCK BERM SHALL BE INSPECTED WEEKLY OR AFTER EACH RAIN, AND THE STONE AND/OR FABRIC CORE-WOVEN SHEATHING SHALL BE REPLACED WHEN THE STRUCTURE CEASES TO FUNCTION AS INTENDED, DUE TO SILT ACCUMULATION AMONG THE ROCKS, WASHOUT, CONSTRUCTION TRAFFIC DAMAGE, ETC.
4. WHEN SILT REACHES A DEPTH EQUAL TO ONE-THIRD THE HEIGHT OF THE BERM OR 6", WHICHEVER IS LESS, THE SILT SHALL BE REMOVED AND DISPOSED OF ON AN APPROVED SITE AND IN A MANNER THAT WILL NOT CREATE A SILTATION PROBLEM.
5. DAILY INSPECTION SHALL BE MADE ON SEVERE-SERVICE ROCK BERMS; SILT SHALL BE REMOVED WHEN ACCUMULATION REACHES 6".
6. WHEN THE SITE IS COMPLETELY STABILIZED, THE BERM AND ACCUMULATED SILT SHALL BE REMOVED AND DISPOSED OF IN AN APPROVED MANNER.

2/3 ROCK BERM DETAIL
SCALE: NONE



NOTE:
SEE SPECIAL PROVISION 642S FOR MULCH SOCK REQUIREMENTS.

3/3 MULCH SOCK DETAIL
SCALE: NONE CUST - 314

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EXISTING SITE, DEMOLITION, AND EROSION CONTROL PLAN

LANDA PARK AQUATICS CENTER
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350 AQUATIC CIRCLE, NEW BRAUNFELS, TEXAS 78130

STATE OF TEXAS
THOMAS EDWARD HEGEMIER
62216
LICENSED PROFESSIONAL ENGINEER
Thomas Edward Hegemier
12/28/2020

Designed:	GP/OF
Drawn:	GP/OF
Reviewed:	TEH
Date:	12/28/2020

SHEET
3
3 OF 9

Project No.:
(PW) 1757-004

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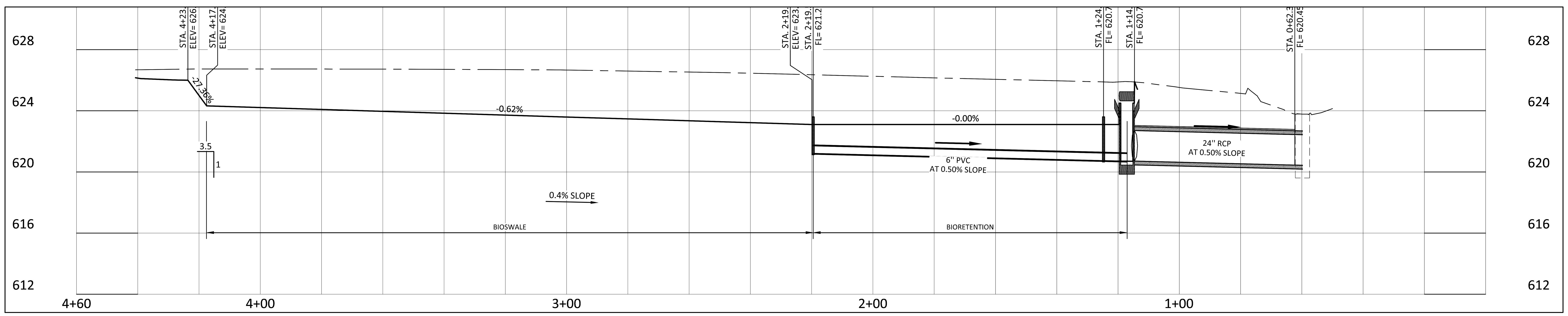

GRAPHIC SCALE 1"=20'

PLAN LEGEND

- FIRE HYDRANT
- SIGN (AS NOTED)
- POWER POLE
- DOWN GUY
- CONCRETE
- BUILDING
- BOUNDARY LINE
- PROPERTY LINES
- EASEMENTS
- WIRE FENCE
- WOOD FENCE
- CHAIN LINK FENCE
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- EXISTING TREE TO REMAIN
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OVERALL SITE PLAN

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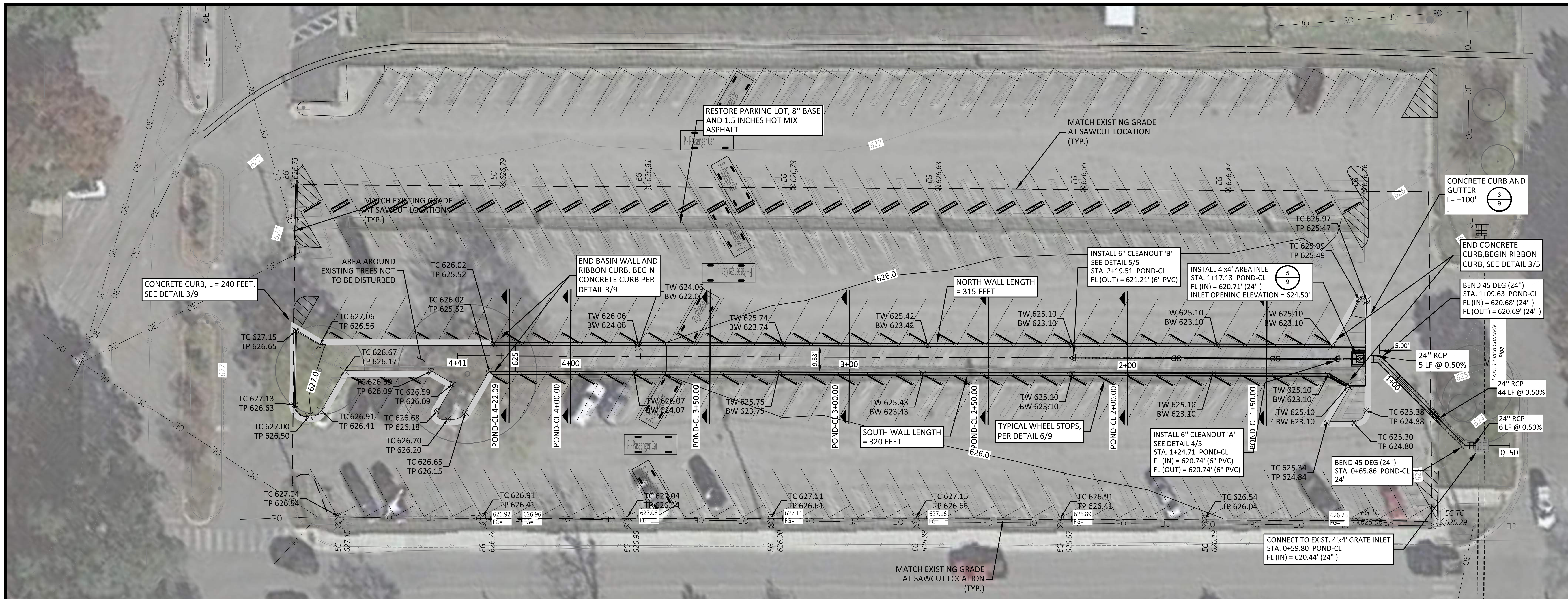
SHEET
4
4 OF 9

Project No.: (PW) 1757-004



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- FIRE HYDRANT
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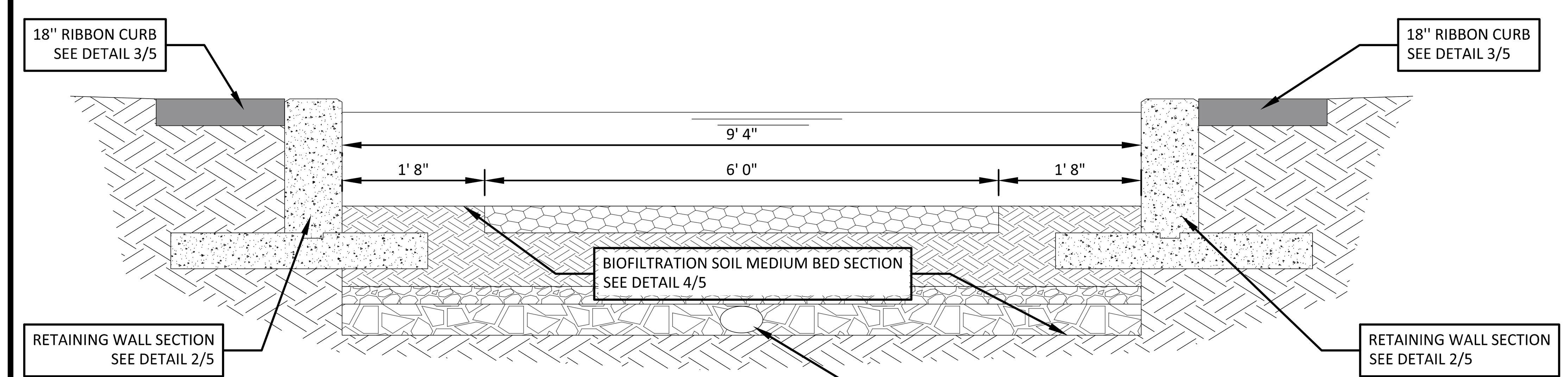
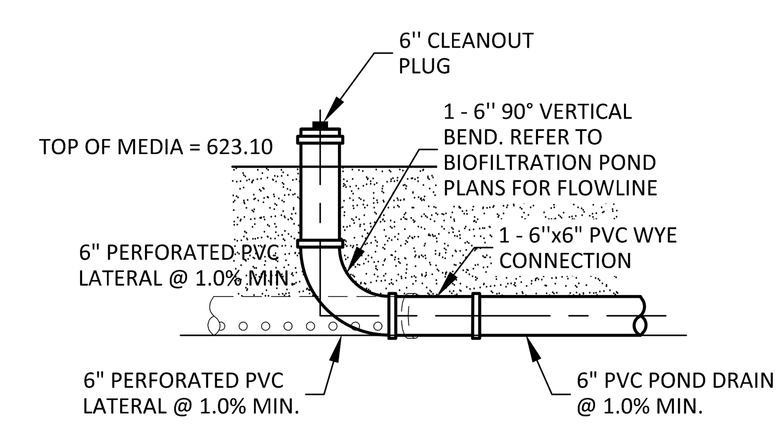
GRAPHIC SCALE 1"=20'



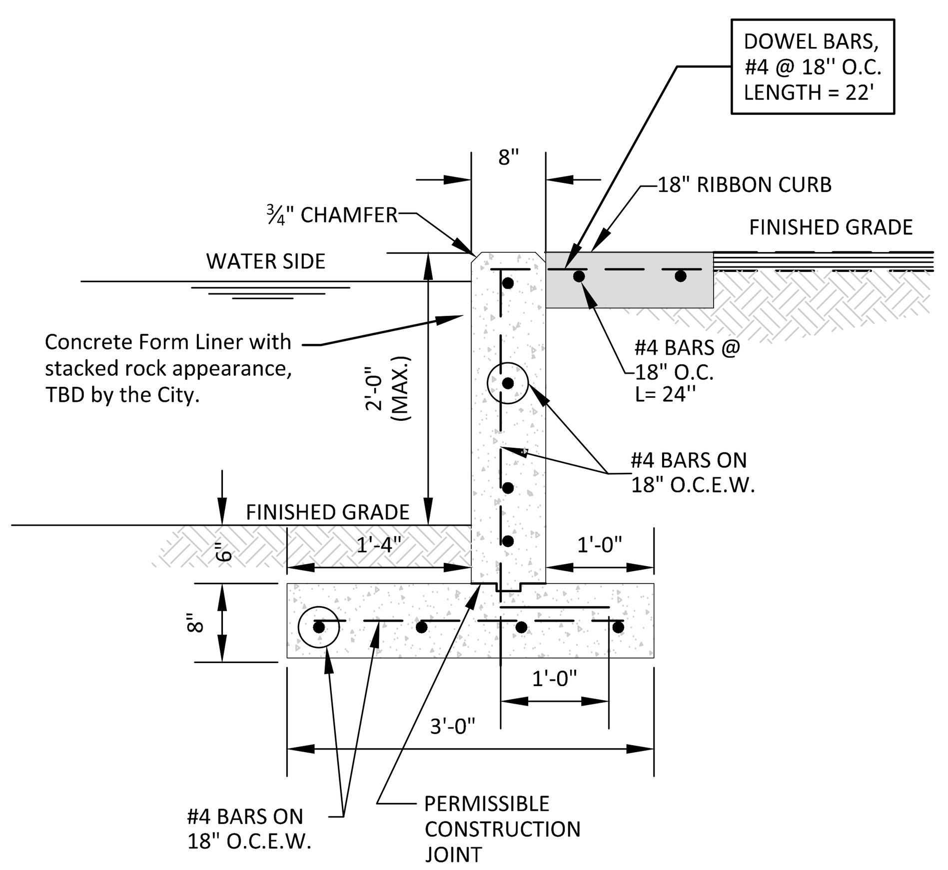
1/5 TYPICAL SECTION

SCALE: NONE



4/5 CLEANOUT 'A'

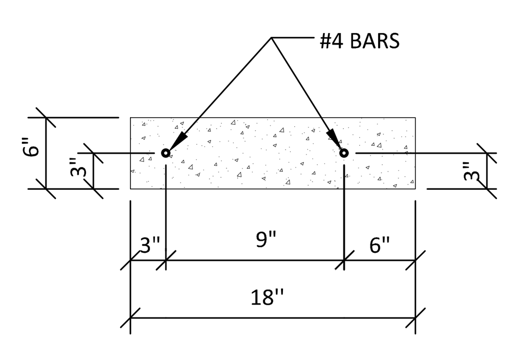
SCALE: NONE



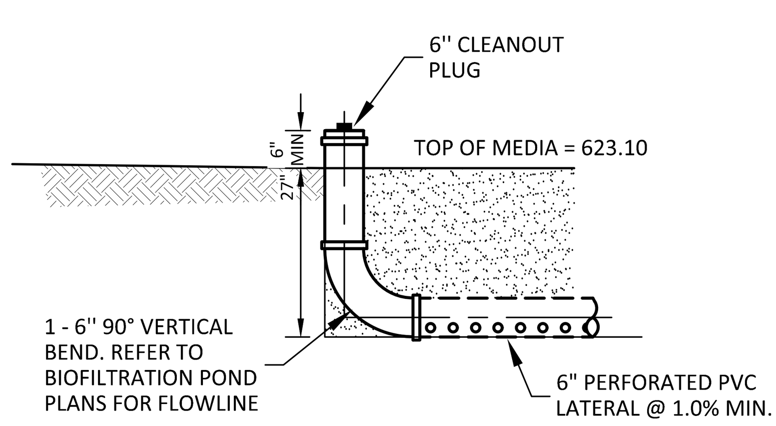
2/5 RETAINING WALL SECTION (2.0' MAX. HEIGHT)

CUST-139

SCALE: NONE



3/5 18'' RIBBON CURB



5/5 CLEANOUT 'B'

SCALE: NONE

SOIL MEDIA BED & GEOTEXTILE FABRIC

SOIL MEDIA TO MEET THE FOLLOWING PERFORMANCE CRITERIA:

FIRST LAYER: TEXAS BLEND COBBLESTONE, BROWNS AND TANS, NATURAL FINISH, 3" TO 6" SIZE, KELLER MATERIAL OR APPROVED EQUAL

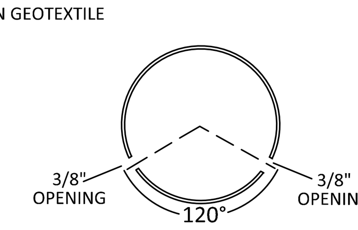
SECOND LAYER:
* 75-90% 0.02-0.04 INCH DIA. SAND WHICH CORRESPONDS WITH ASTM C-33 CONCRETE SAND OR ASTM C-144 MASONRY SAND(SMALLER SIZE IS NOT ACCEPTABLE)
* 10-25% SCREEN BULK TOPSOIL
* <5% CLAY BY VOLUME
* PERCENT ORGANIC MATTER (BY WEIGHT) OF 0-4%. ORGANIC MATTER SHOULD NOT INCLUDE COMPOST.

THIRD LAYER - GRAVEL, 3/8'' CLEAN WASHED PEA GRAVEL LAYER

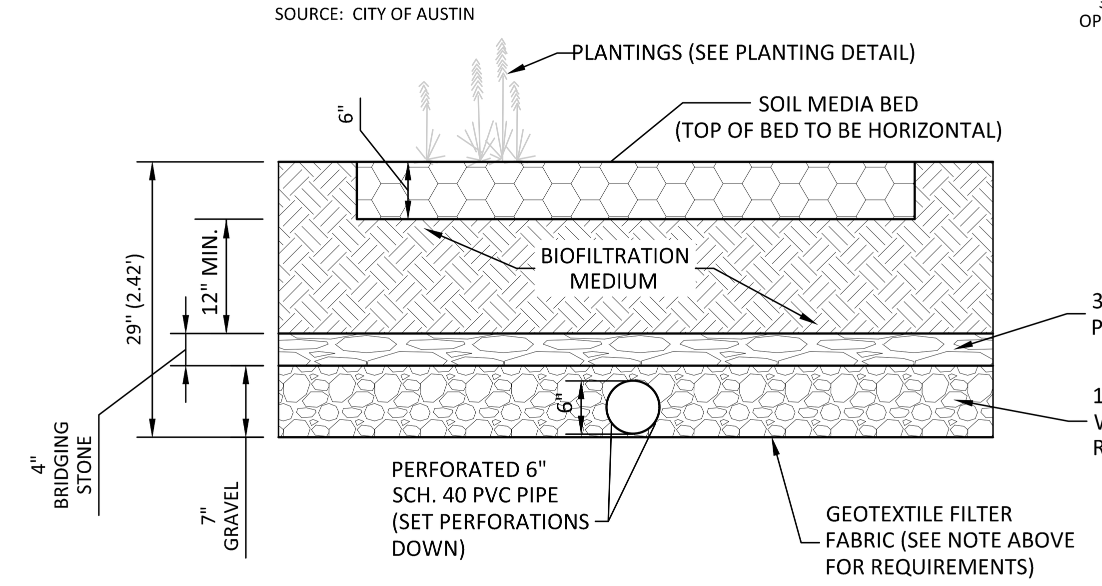
FOURTH LAYER - GRAVEL, ½ TO 1-½ INCH WASHED RIVER GRAVEL, AT LEAST 3 TO 5 INCH DEPTH SURROUNDING UNDERLAIN PIPING, THE TWO LAYERS MUST BE SEPARATED FROM EACH OTHER USING GEOTEXTILE FILTER FABRIC THAT COMPLIES WITH CITY OF AUSTIN SPECIFICATION 620S, TABLE 2, HIGH FLOW FILTER FABRIC REQUIREMENTS AND THE FOLLOWING SPECIFICATIONS:

	TEST METHOD	UNIT	SPECIFICATION
			NONWOVEN GEOTEXTILE
		OZ./SQ. YD.	8 (MIN.)
		IN./SEC.	0.08 (MIN.)
	ASTM D-1682	LB.	400 (MIN.)
PUNCTURE STRENGTH	ASTM D-751(MODIFIED)	LB.	125 (MIN.)
MULLEN BURST STRENGTH	ASTM D-751	PSI.	400 (MIN.)
TENSILE STRENGTH	ASTM D-1682	LB.	200 (MIN.)
EQUIV. OPENING SIZE	US STANDARD SIEVE	NO.	80 (MIN.)

SOURCE: CITY OF AUSTIN



PERFORATION LAYOUT



4/5 BIOFILTRATION SOIL MEDIUM BED SECTION (WITHOUT IMPERMEABLE LINER)

CUST-252

SCALE: NONE

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GRADING PLAN

LANDA PARK AQUATICS CENTER
CITY OF NEW BRAUNFELS
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STATE OF TEXAS
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5
5 OF 9

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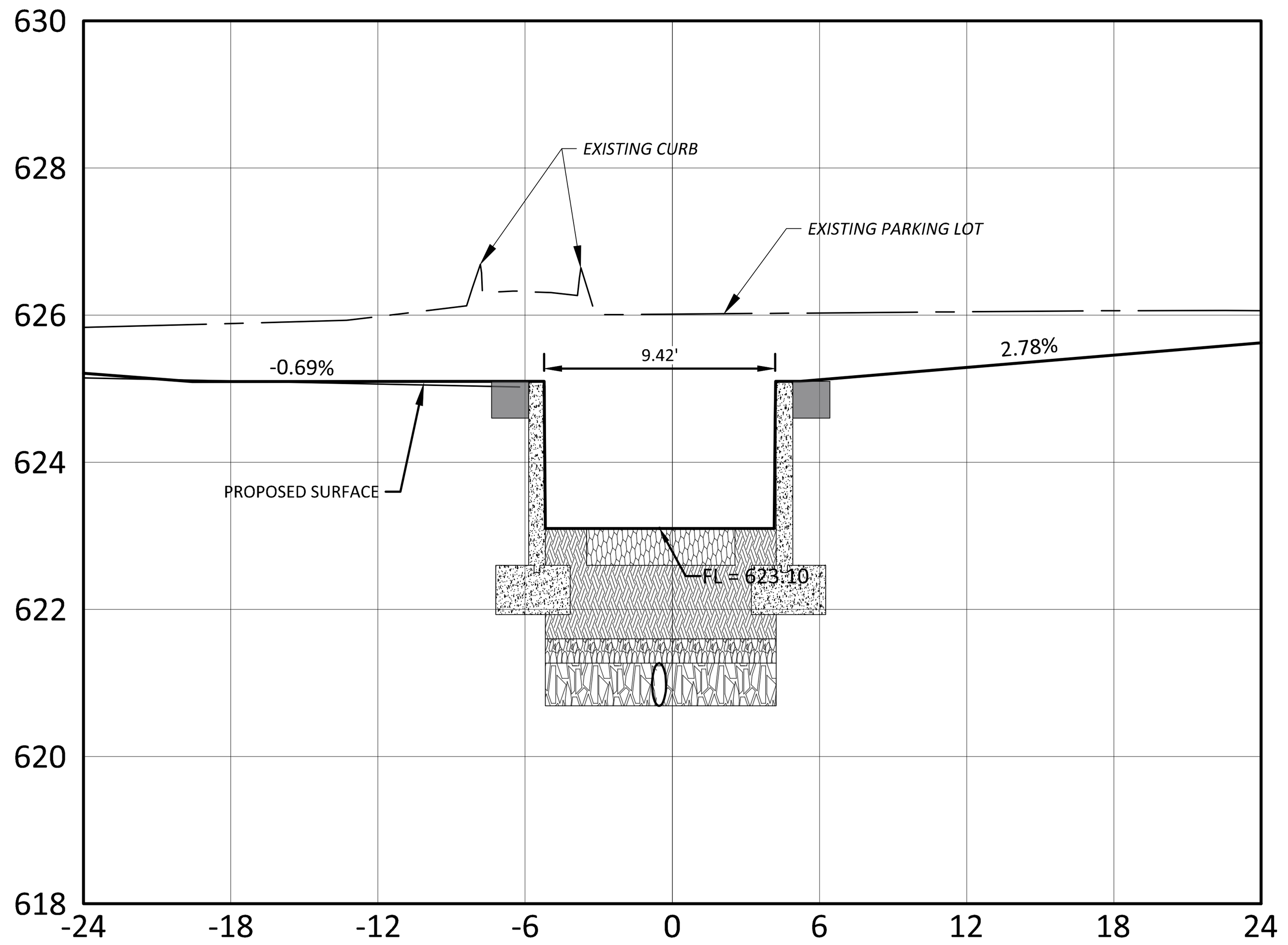
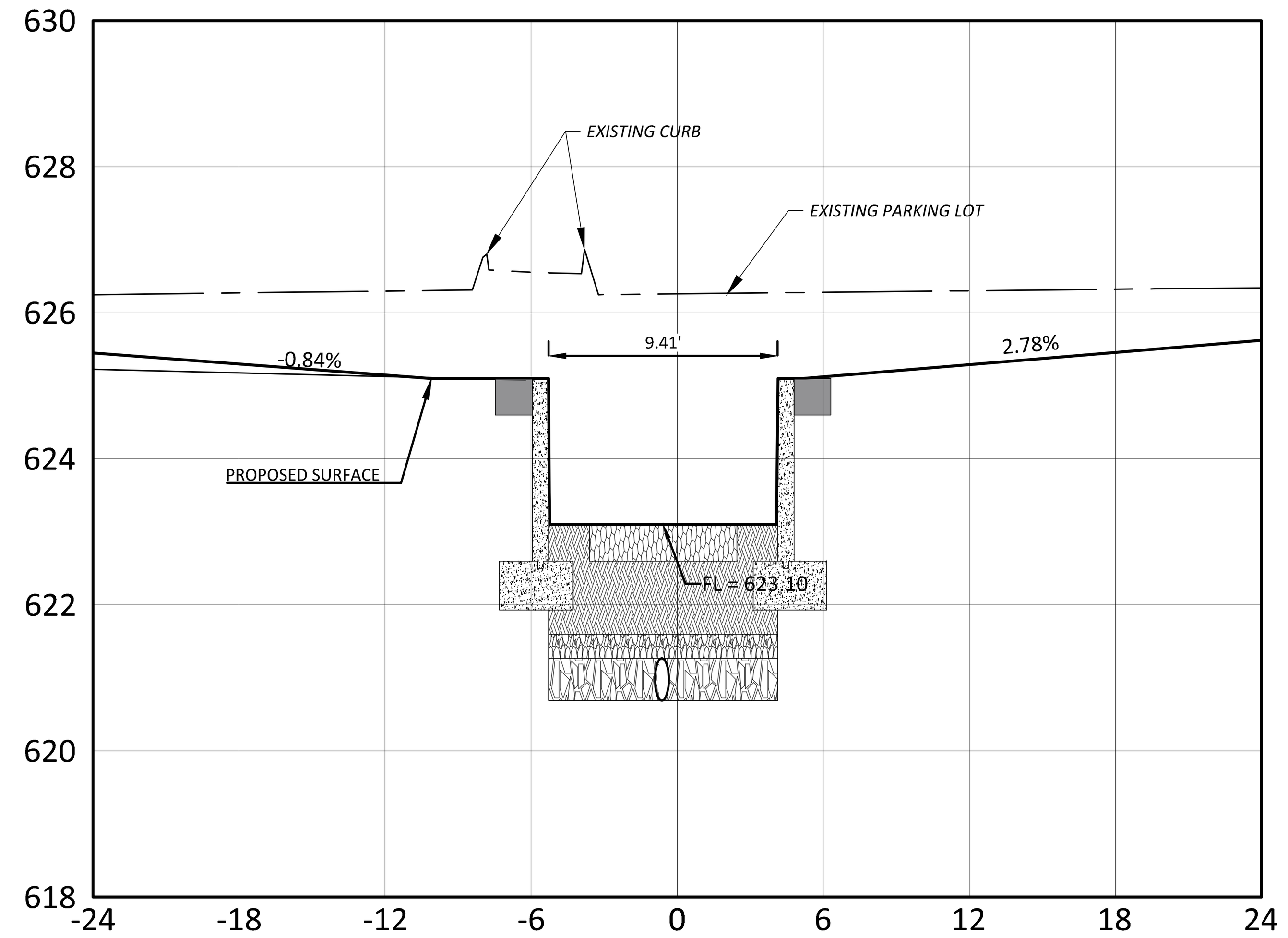


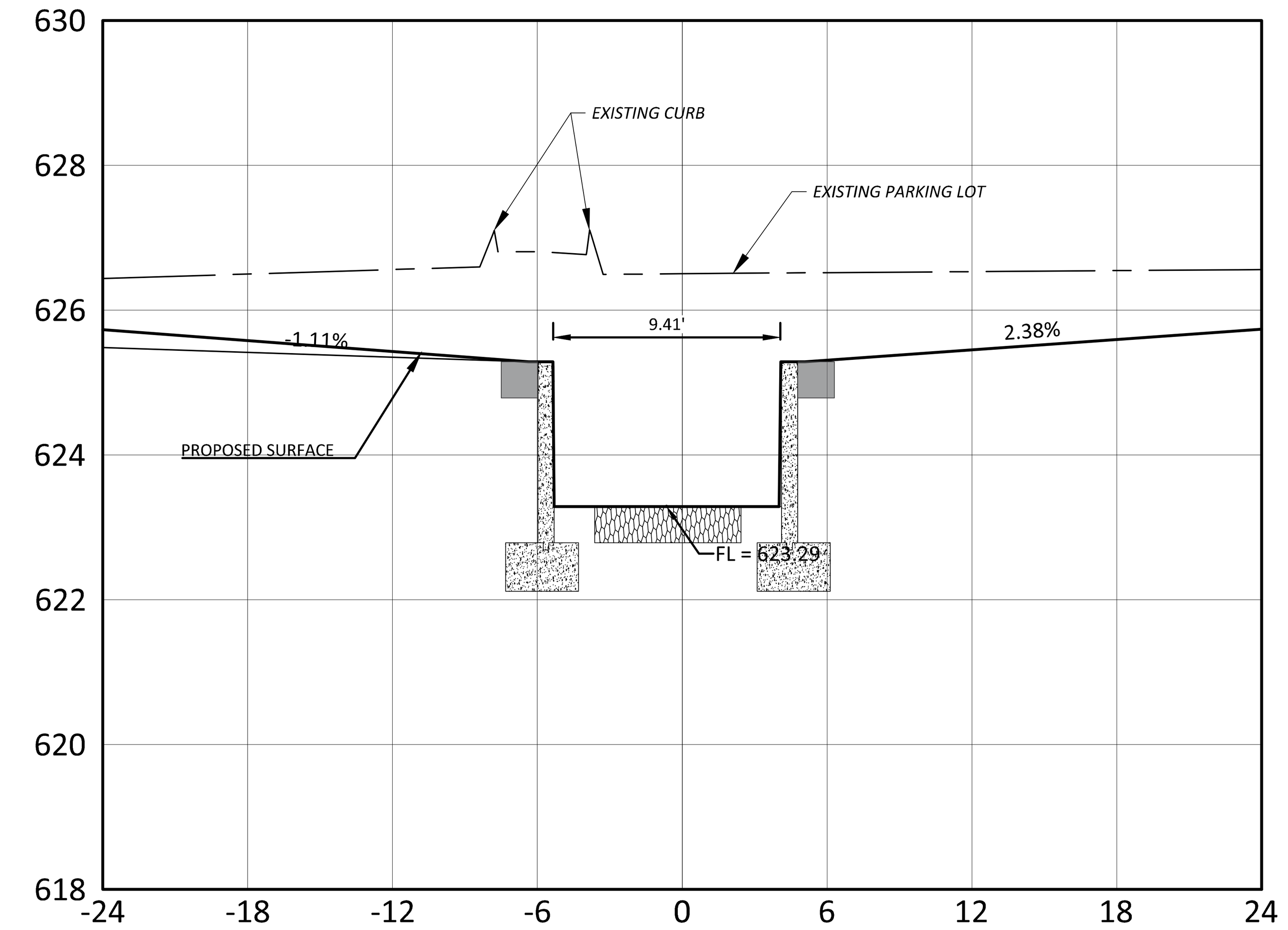
POND-CL STA. 1+50

1" = 6' HORZ. - 1" = 2' VERT.



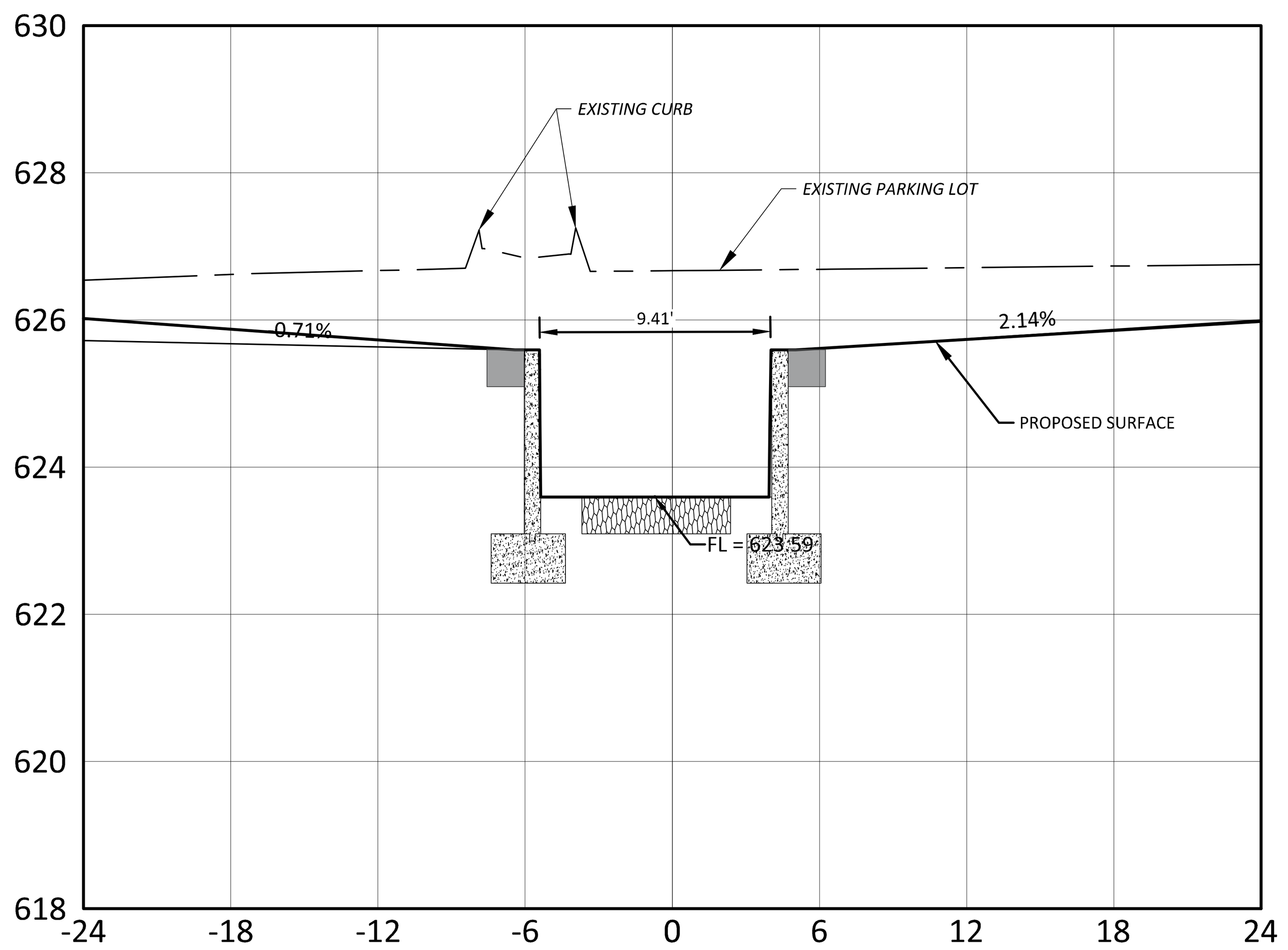
POND-CL STA. 2+00

1" = 6' HORZ. - 1" = 2' VERT.



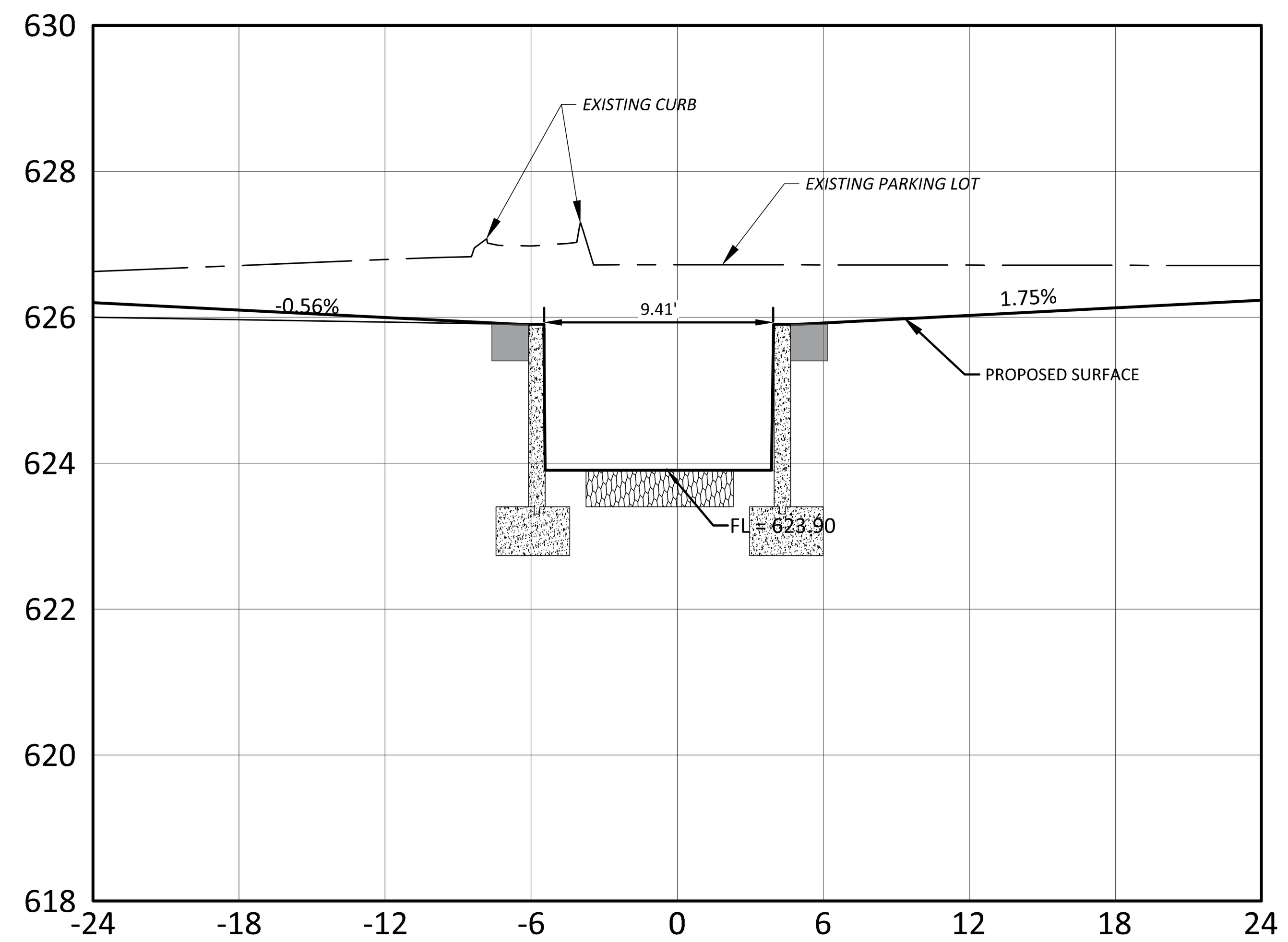
POND-CL STA. 2+50

1" = 6' HORZ. - 1" = 2' VERT.



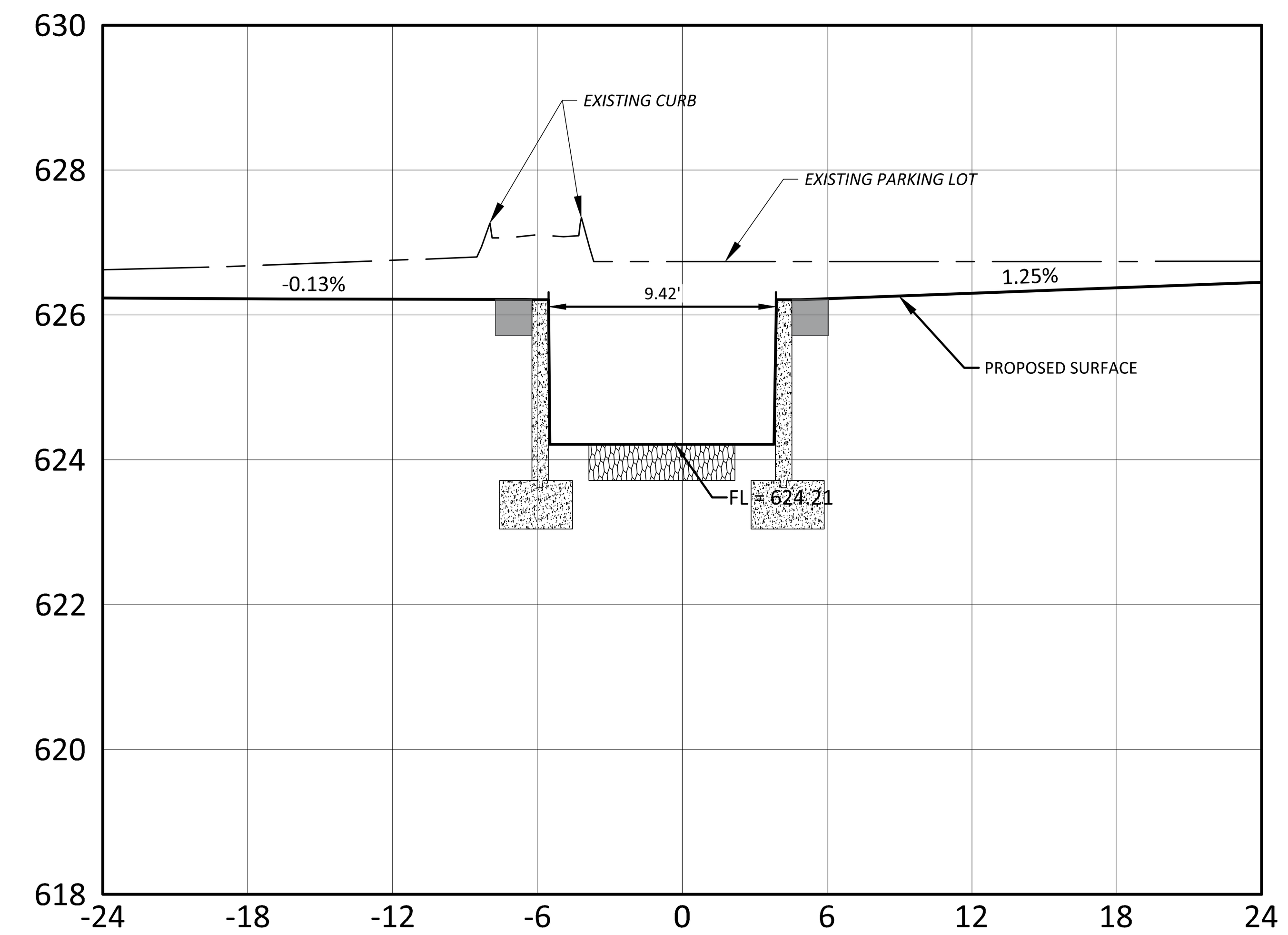
POND-CL STA. 3+00

1" = 6' HORZ. - 1" = 2' VERT.



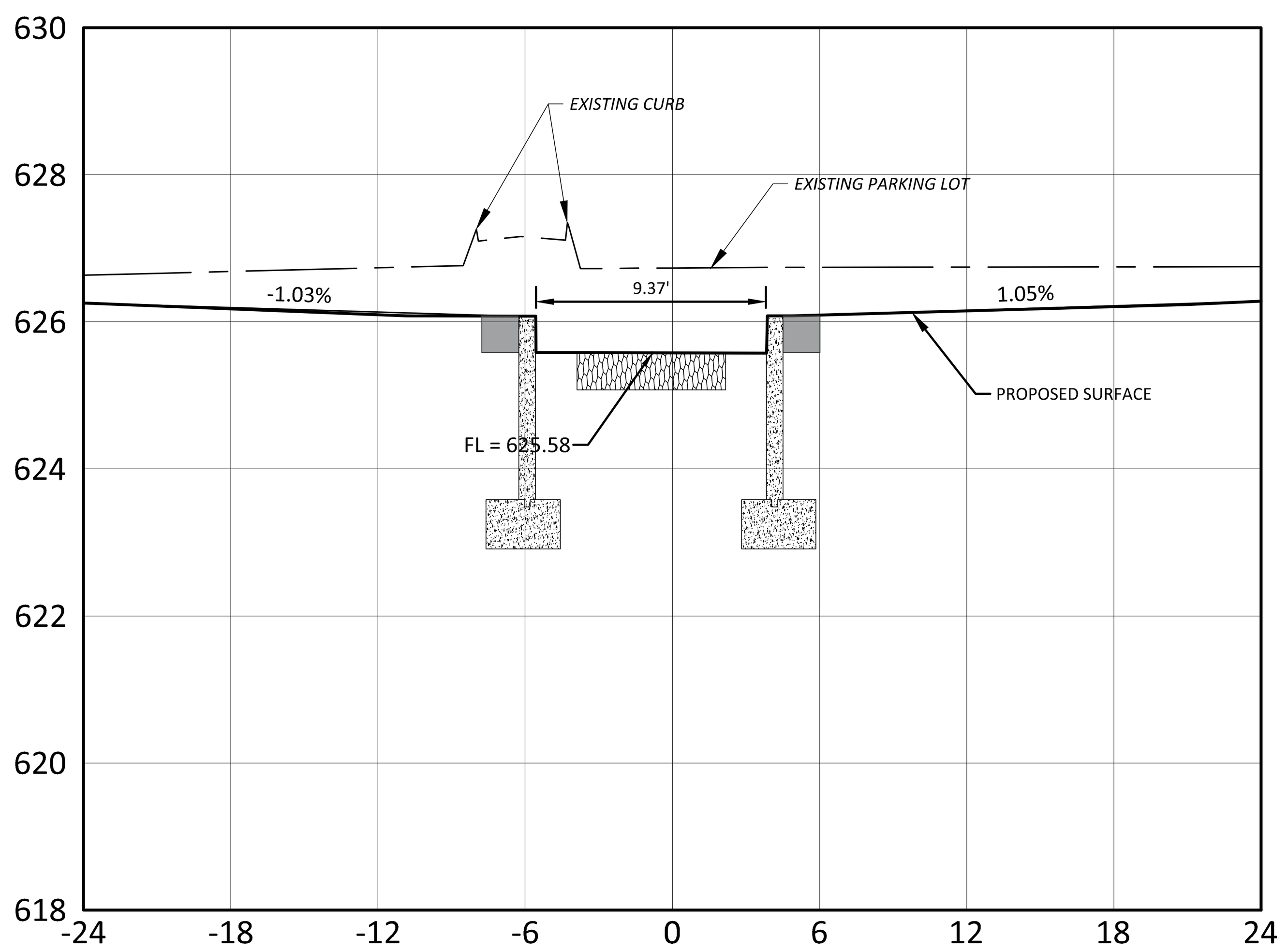
POND-CL STA. 3+50

1" = 6' HORZ. - 1" = 2' VERT.



POND-CL STA. 4+00

1" = 6' HORZ. - 1" = 2' VERT.



POND-CL STA. 4+22

1" = 6' HORZ. - 1" = 2' VERT.

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TBPE Firm Number: 3937
TBPLS Firm Number: 10105800

WATER QUALITY POND CROSS SECTIONS

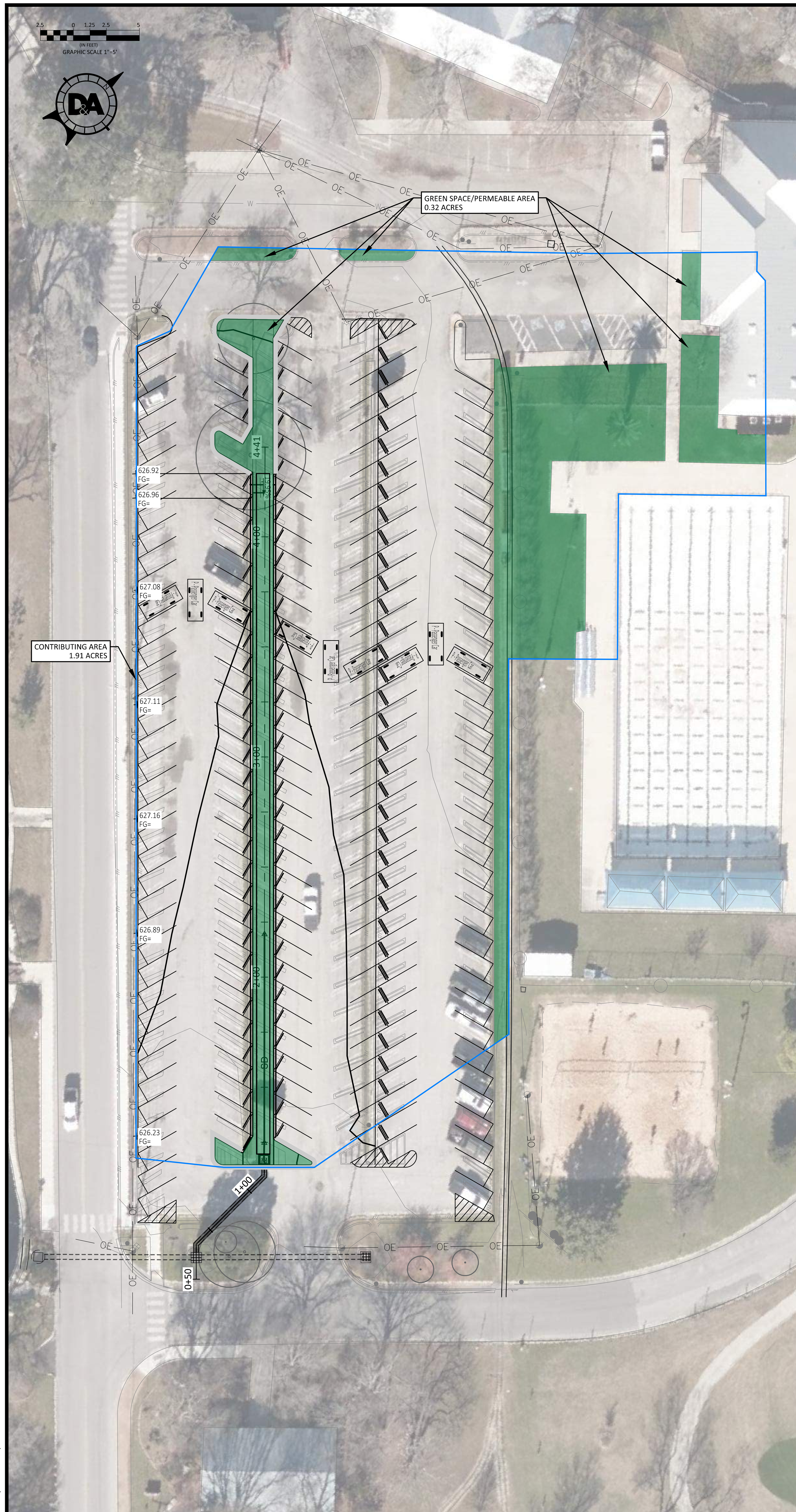
LANDA PARK AQUATICS CENTER
CITY OF NEW BRAUNFELS
350 AQUATIC CIRCLE, NEW BRAUNFELS, TEXAS 78130

STATE OF TEXAS
THOMAS EDWARD HEGEMIER
62216
LICENSED PROFESSIONAL ENGINEER
12/28/2020

Designed:	GP/OF
Drawn:	GP/OF
Reviewed:	TEH
Date:	12/28/2020

SHEET
6
6 OF 9

Project No.:
(PW) 1757-004



LANDA PARK AQUATIC COMPLEX - WATER QUALITY RETROFIT

Water Quality Pond 1 Summary - Extended Detention

Date: 12/22/2020
Project No: 1757-004
Pond: 1

BASIN DATA		
Parameter	**Pre-Project**	**Post-Project**
Basin ID	Greenfield	1
Basin Area (Acres)	1.91	1.91
Impervious (Acres)	0.00	1.59
Permeable (Acres)	1.91	0.32
IC (%)	0.0%	83.2%
DESIGN DATA		
County	Comal	
P_1	33	
Treatment Level	80%	
Load Managed - LM (lbs) $_2$	1,427	

BMP DATA	
BMP	Bioretention
BMP Efficiency $_3$	89%
TSS CALC DATA	
Load Removed - LR (lbs) $_4$	1,621
LM (lbs) Desired	980
F_5	0.60
Rainfall Depth (in) $_6$	0.58
Runoff Coefficient $_7$	0.67
WATER QUALITY VOLUME DATA	
WQV (CF) $_8$	2,694
Capture Vol. (120% WQV)	3,232

Post-Project Impervious Cover Calculations			
Post-Project Area:		1.91	Ac.
IC Type	**Sq. Ft**	**Acres**	**Site Percent**
Structures	0	0.00	0.0%
Parking	67,657	1.55	81.3%
Other Paved	1,604	0.04	1.9%
		1.59	**83.2%**

VOLUME PROVIDED			
STAGE STORAGE DATA			
Elevation	**Area (SF)**	**Volume (CF)**	**∑ Vol. (CF)**
623.1	2,893	-	0
623.5	1,605	900	900
624	2,365	993	1,892
624.32	2,850	834	2,727
624.5	**2,861**	**514**	**3,241**
625.1	*2,918*	*1,734*	*4,975*

RG-348 References
1 - P -Table 3-3
2 - LM -Equation 3.2
3 - BMP Eff - Table 3-4
4- LR - Equation 3.8
5 - F - Equation 3.9
6 - Rainfall Depth - Table 3-5
7 - Runoff Coeff. - Eq. 3.11
8 - WQV - Eq. 3.10

Texas Commission on Environmental Quality

TSS Removal Calculations 04-20-2009

Project Name: LPAC-Retrofit
Date Prepared: ########

Additional information is provided for cells with a red triangle in the upper right corner. Place the cursor over the cell.
Text shown in blue indicate location of instructions in the Technical Guidance Manual - RG-348.
Characters shown in red are data entry fields.
Characters shown in black (Bold) are calculated fields. Changes to these fields will remove the equations used in the spreadshee

1. The Required Load Reduction for the total project: Calculations from RG-348 Pages 3-27 to 3-30

Page 3-29 Equation 3.3: $L_M = 27.2(A_N \times P)$

where:
$L_{M\ TOTAL\ PROJECT}$ = Required TSS removal resulting from the proposed development = 80% of increased l
A_N = Net increase in impervious area for the project
P = Average annual precipitation, inches

Site Data: Determine Required Load Removal Based on the Entire Project
County = **Comal**
Total project area included in plan * = **1.91** acres
Predevelopment impervious area within the limits of the plan * = **0.00** acres
Total post-development impervious area within the limits of the plan* = **1.59** acres
Total post-development impervious cover fraction * = **0.83**
P = **33** inches

$L_{M\ TOTAL\ PROJECT}$ = **1427** lbs.

*** The values entered in these fields should be for the total project area.**

Number of drainage basins / outfalls areas leaving the plan area = **1**

2. Drainage Basin Parameters (This information should be provided for each basin):

Drainage Basin/Outfall Area No. = 1

Total drainage basin/outfall area = **1.91** acres
Predevelopment impervious area within drainage basin/outfall area = **0.00** acres
Post-development impervious area within drainage basin/outfall area = **1.59** acres
Post-development impervious fraction within drainage basin/outfall area = **0.83**
$L_{M\ THIS\ BASIN}$ = **1427** lbs.

3. Indicate the proposed BMP Code for this basin.

Proposed BMP = **Bioretention**
Removal efficiency = **89** percent

Aqualogic Cartridge Filter
Bioretention
Contech StormFilter
Constructed Wetland
Extended Detention
Grassy Swale
Retention / Irrigation
Sand Filter
Stormceptor
Vegetated Filter Strips
Vortechs
Wet Basin
Wet Vault

4. Calculate Maximum TSS Load Removed (L_R) for this Drainage Basin by the selected BMP Type.

RG-348 Page 3-33 Equation 3.7: $L_R = (\text{BMP efficiency}) \times P \times (A_I \times 34.6 + A_P \times 0.54)$

where:
A_C = Total On-Site drainage area in the BMP catchment area
A_I = Impervious area proposed in the BMP catchment area
A_P = Pervious area remaining in the BMP catchment area
L_R = TSS Load removed from this catchment area by the proposed BMP

A_C = **1.91** acres
A_I = **1.59** acres
A_P = **0.32** acres
L_R = **1621** lbs

5. Calculate Fraction of Annual Runoff to Treat the drainage basin / outfall area

Desired $L_{M\ THIS\ BASIN}$ = **980** lbs.

F = **0.60**

6. Calculate Capture Volume required by the BMP Type for this drainage basin / outfall area. Calculations from RG-348 Pages 3-34 to 3-36

Rainfall Depth = **0.58** inches
Post Development Runoff Coefficient = **0.67**
On-site Water Quality Volume = **2694** cubic feet

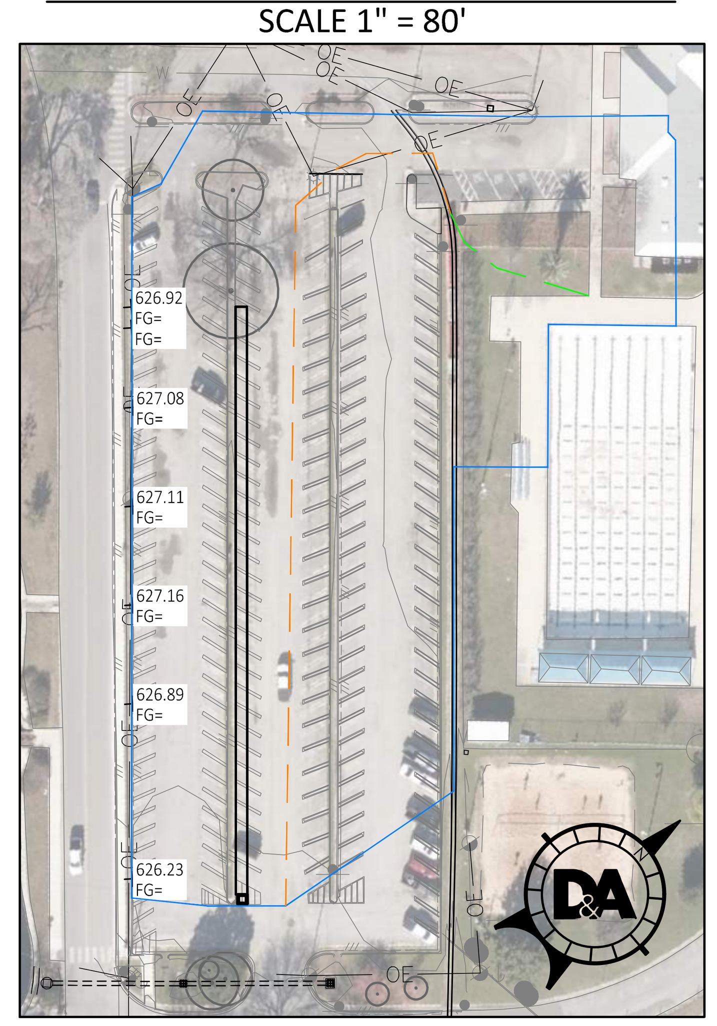
Calculations from RG-348 Pages 3-36 to 3-37

Off-site area draining to BMP = **0.00** acres
Off-site Impervious cover draining to BMP = **0.00** acres
Impervious fraction of off-site area = **0**
Off-site Runoff Coefficient = **0.00**
Off-site Water Quality Volume = **0** cubic feet

Storage for Sediment = **539**
Total Capture Volume (required water quality volume(s) x 1.20) = 3232 cubic feet

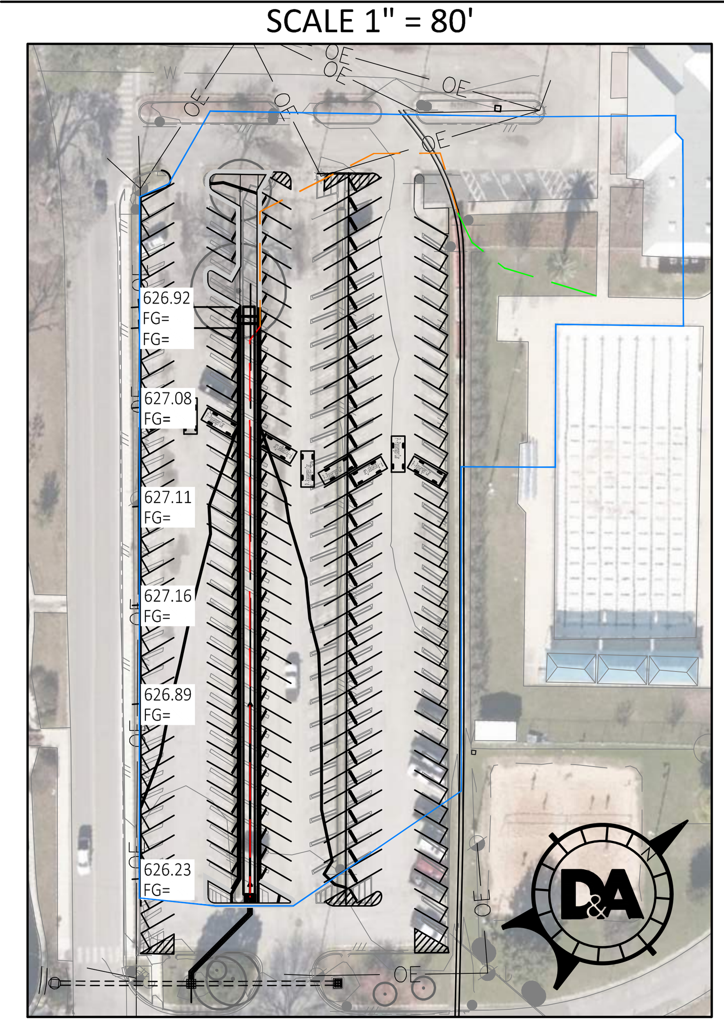
EXISTING DRAINAGE AREA MAP

SCALE 1" = 80'



POST-PROJECT DRAINAGE AREA MAP

SCALE 1" = 80'



LEGEND

- SHEET FLOW
- SHALLOW CONCENTRATED FLOW
- CHANNEL FLOW

Drainage Area	Overland Sheet Flow							Shallow Concentrated Flow								TC TOTAL
	Length	n-Value	E_{START}	E_{END}	Slope	TC_{SHEET}	TC_{SHEET}	Length	Paved(P)/ Unpaved(U)	E_{START}	E_{END}	Slope	Velocity	$TC_{SHALLOW}$	$TC_{SHALLOW}$	
EX	89.3	0.240	628.5	627.5	1.12%	**14.56**	**14.56**	482.7	P	627.5	625.85	0.50%	1.44	**5.59**	**5.59**	***20.15***
PR	89.3	0.240	628.5	627.5	1.12%	**14.56**	**14.56**	195.6	P	627.5	626.33	0.60%	1.57	**2.08**	**7.01**	***21.57***
								301.92	U	621.96	620.75	0.40%	1.02	**4.93**		

DA CHARACTERISTICS				INTENSITY (IN/HR)						COMPOSITE C-VALUE							RUNOFF FLOW - Q					
ID	Area (AC)	IC %	Tc (Min)	2	5	10	25	50	100	2	5	10	25	50	100	500	2	5	10	25	50	100
EX	1.91	84.6%	20.15	3.64	4.55	5.34	6.43	7.28	8.20	0.67	0.71	0.74	0.79	0.83	0.88	0.92	4.7	6.2	7.6	9.7	11.6	13.8
PR	1.91	83.1%	21.57	3.52	4.40	5.16	6.20	7.02	7.90	0.66	0.70	0.73	0.78	0.82	0.87	0.91	4.4	5.9	7.2	9.3	11.0	13.2

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TBPLS Firm Number: 10105800

WATER QUALITY POND PLAN AND CALCULATIONS

LANDA PARK
AQUATICS CENTER
CITY OF NEW BRAUNFELS
350 AQUATIC CIRCLE, NEW BRAUNFELS, TEXAS 78130

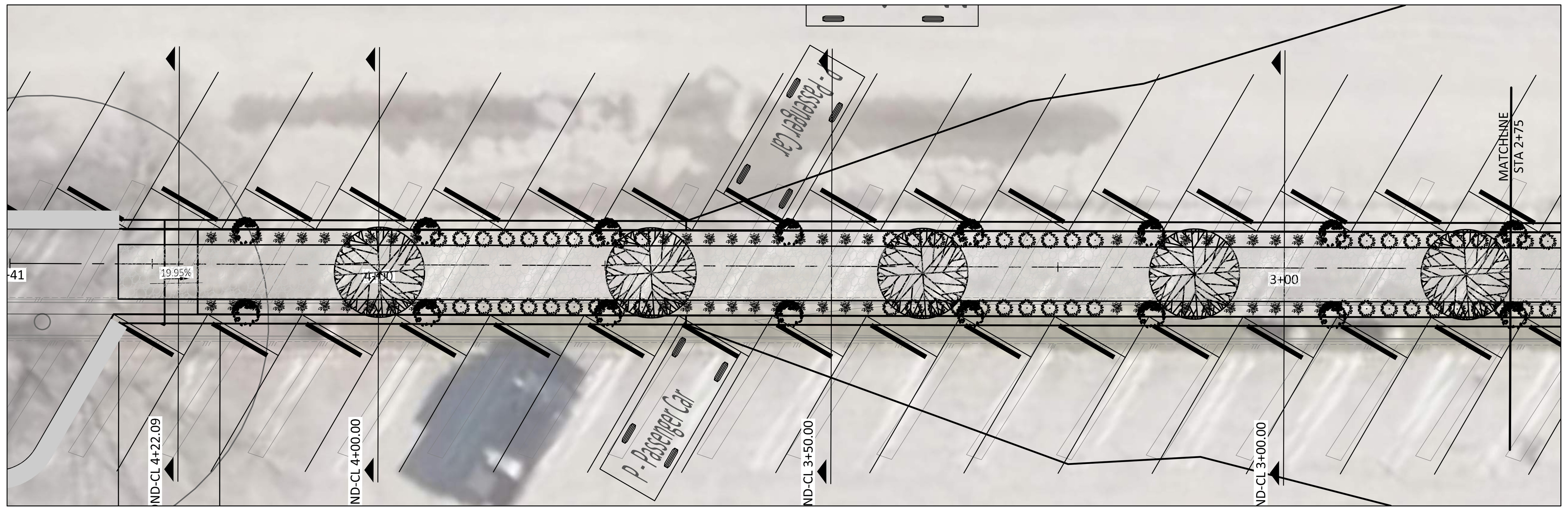
STATE OF TEXAS
THOMAS EDWARD HEGEMIER
62216
LICENSED PROFESSIONAL ENGINEER
Thomas Edward Hegemier
12/28/2020

Designed: GP/OF
Drawn: GP/OF
Reviewed: TEH
Date: 12/28/2020

SHEET
7

Project No.: (PW) 1757-004

Last Modified: Dec. 28, 20 - 16:11
Plot Date/Time: Dec. 28, 20 - 16:31:20



GRAPHIC SCALE 1"=10'

PLANTING LEGEND

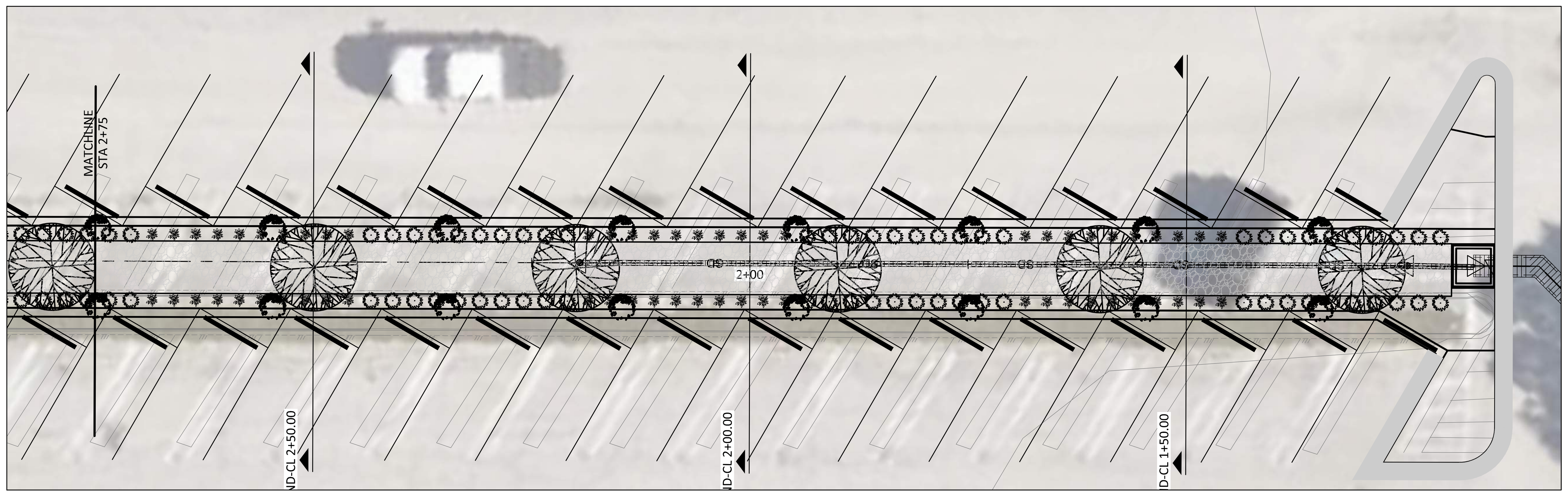
BALD CYPRESS -
30' O.C. LOCATED IN THE MIDDLE OF THE BASIN;
- 4" CALIPER, 15' HEIGHT, 10' SPREAD, SINGLE TRUNK, STRAIGHT LEADER, UNIFORM CANOPY

TEXAS SAGE -
20' O.C. ALONG BASE OF WALL, BOTH SIDES; STAGGERED FROM BALD CYPRESS (APPROX. 5');
- 5 GAL, 3' HT, 3' SPREAD

GULF MUHLY -
2.5' O.C. 9" OFF FACE OF WALL, PLAN IN 25 FOOT GROUPINGS ALONG BASE OF WALL ON EACH SIDE;
- 5 GAL, 2' HEIGHT

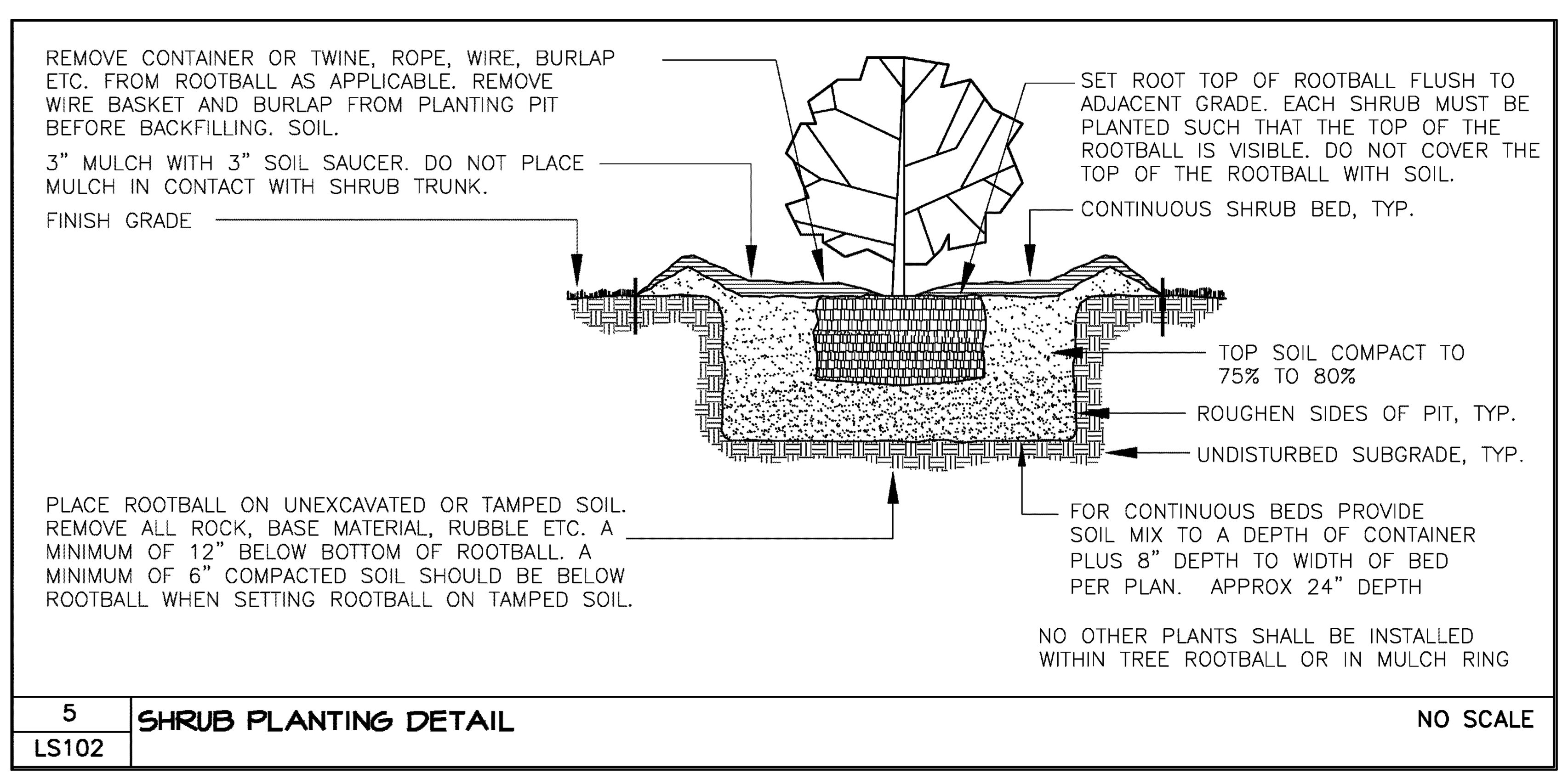
SALVIA -
2.5' O.C. 9" OFF FACE OF WALL, PLAN IN 25 FOOT GROUPINGS ALONG BASE OF WALL ON EACH SIDE;
- 5 GAL, 1.5' HEIGHT

TEXAS BLEND COBBLESTONE, BROWNS AND TANS, NATURAL FINISH, 3" TO 6" SIZE, KELLER MATERIAL OR APPROVED EQUAL". PLACE THE COBBLE STONE TO A WIDTH OF 6 FEET ACROSS THE MIDDLE OF THE POND.

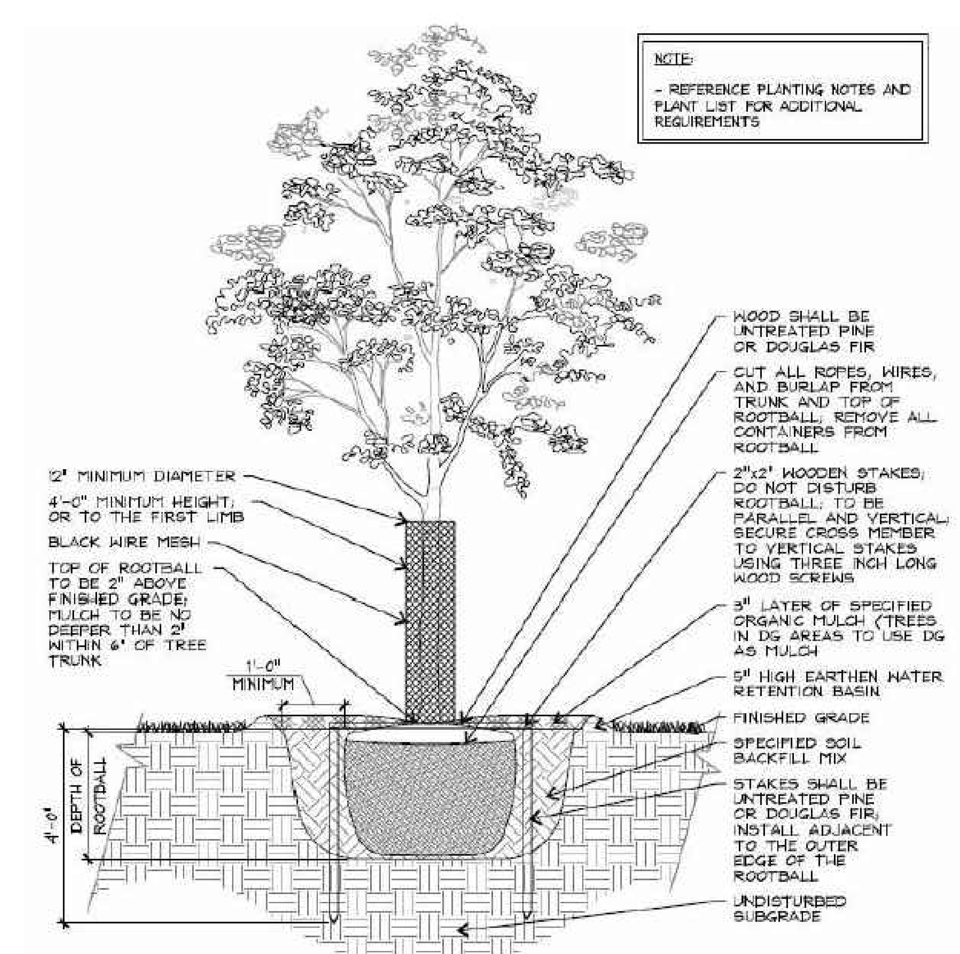


GRAPHIC SCALE 1"=10'

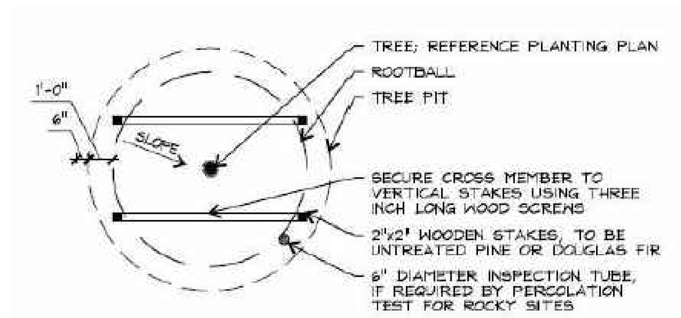
PLANTING SCHEDULE		
TYPE	SIZE	QUANTITY
BALD CYPRESS	4'' CALIPER	10
TEXAS SAGE	5-GAL	30
GULF MUHLY	5-GAL	120
SALVIA	5-GAL	120



1/8 SHRUB PLANTING DETAIL
SCALE: 1" = NONE



2/8 AT GRADE TREE STAKING
CROSS SECTION NOT TO SCALE



AT GRADE TREE STAKING
PLAN VIEW NOT TO SCALE

NOTE:
LANDSCAPING DETAILS 2
SOURCE: NEW BRAUNFELS RECREATION CENTER, TGB PARTNERS

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LANDSCAPING PLAN

LANDA PARK
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CITY OF NEW BRAUNFELS
350 AQUATIC CIRCLE, NEW BRAUNFELS, TEXAS 78130

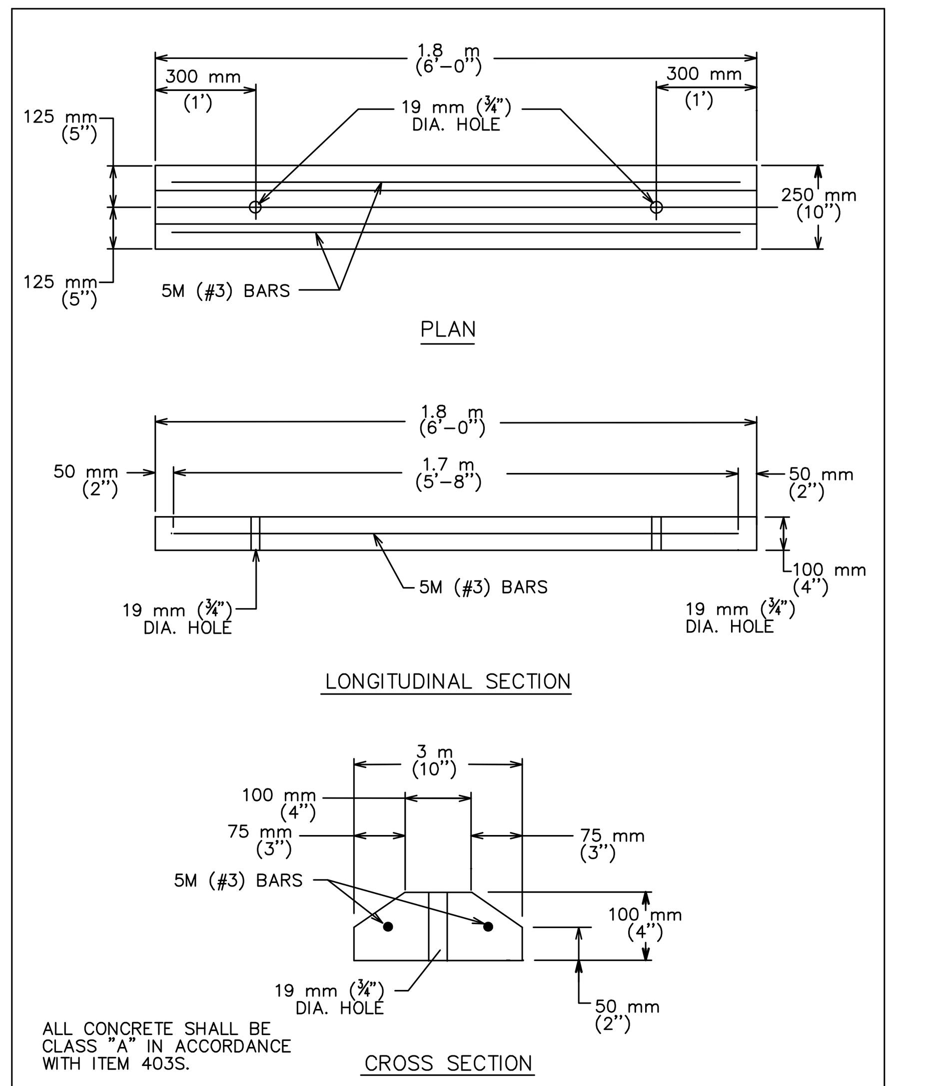
STATE OF TEXAS
THOMAS EDWARD HEGEMIER
62216
LICENSED PROFESSIONAL ENGINEER
Thomas Edward Hegemier
12/28/2020

Designed: GP/OF
Drawn: GP/OF
Reviewed: TEH
Date: 12/28/2020

SHEET
8

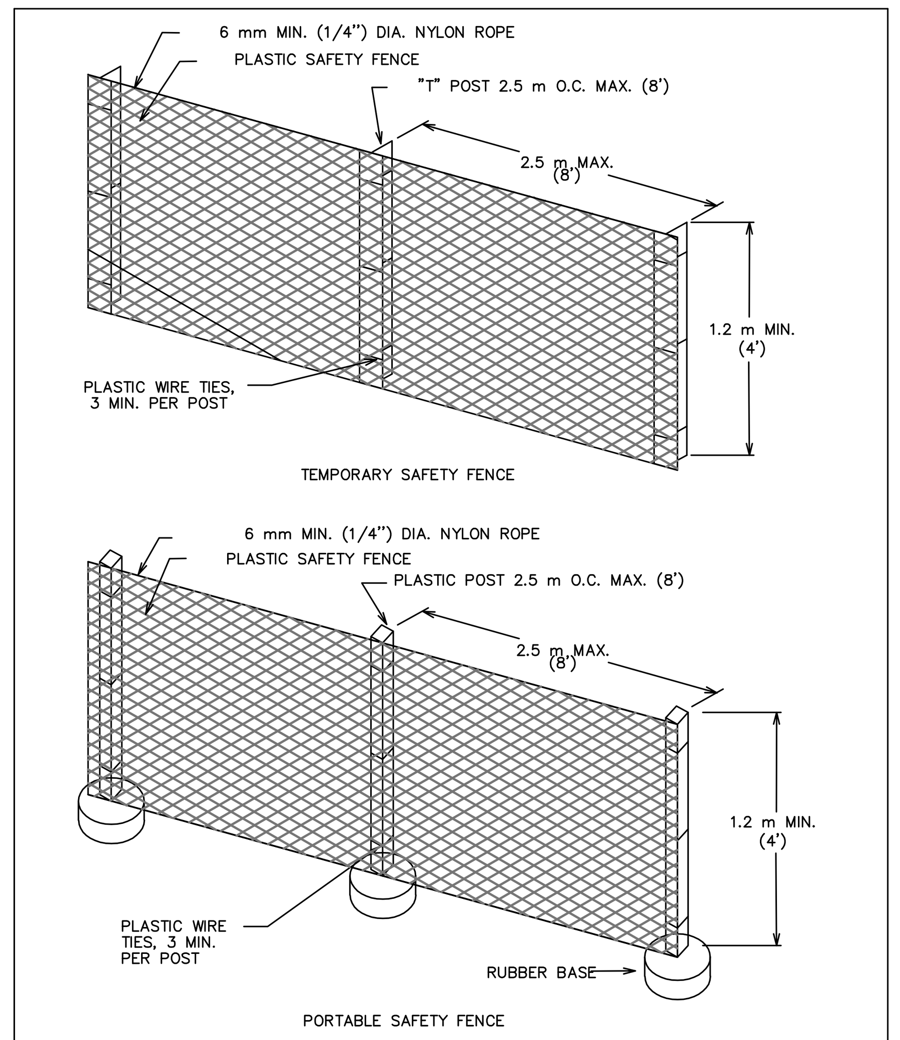
Project No.:
(PW) 1757-004

Drawing: C:\pw_working\...\1757-004 CD PD.dwg
Last Modified: Dec. 28, 20 - 16:11
Plot Date/Time: Dec. 28, 20 - 16:31:33



CITY OF AUSTIN DEPARTMENT OF PUBLIC WORKS		PARKING LOT BUMPER CURB	
RECORD COPY SIGNED BY BILL GARDNER	3/15/05	THE ARCHITECT/ENGINEER ASSUMES RESPONSIBILITY FOR APPROPRIATE USE OF THIS STANDARD.	STANDARD NO. 439S–1
APPROVED	ADOPTED		

1/9



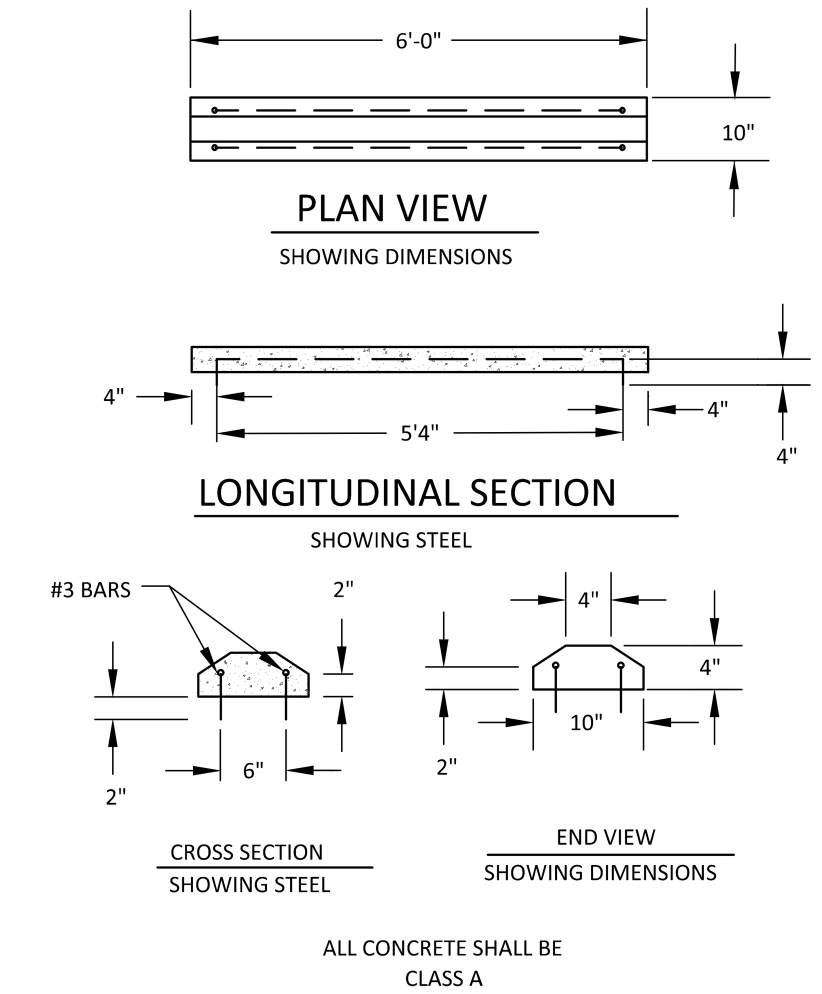
CITY OF AUSTIN DEPARTMENT OF PUBLIC WORKS		SAFETY FENCE	
RECORD COPY SIGNED BY SAM ANGOORI	04/03/09	THE ARCHITECT/ENGINEER ASSUMES RESPONSIBILITY FOR APPROPRIATE USE OF THIS STANDARD.	STANDARD NO. 804S–4 1 OF 9
	ADOPTED		

2/9

1. SAFETY FENCE SHALL BE USED TO PROTECT ALL EXCAVATIONS IN THE RIGHT–OF–WAY.
2. SAFETY FENCES SHALL BE USED TO SEPARATE CONSTRUCTION ACTIVITIES FROM PEDESTRIAN.
3. ALL SAFETY FENCING SHALL BE PLASTIC, 1,200 mm (48") MINIMUM HEIGHT AND ORANGE IN COLOR.
4. SAFETY FENCE USED WITHIN THE ROADWAY SHALL BE REFLECTORIZED WITH A MINIMUM OF TWO (2) STRIPS OF RETROREFLECTIVE MATERIAL, A MINIMUM OF 25 mm (1') WIDE, THE LENGTH OF THE FENCE OR DELINEATED BY CHANNELIZING DEVICES.
5. SAFETY FENCE USED TO SEPARATE SIDEWALKS FROM CONSTRUCTION ACTIVITIES SHALL HAVE MINIMUM ENCROACHMENT TO THE SIDEWALK.
6. AS A MINIMUM, SAFETY FENCING IS REQUIRED IN AREAS ADJACENT TO EXCAVATIONS GREATER THAN OR EQUAL TO 150 mm (6").
7. SAFETY FENCING SHALL BE PAID FOR UNDER ITEM 803S, "BARRICADES, SIGNS AND TRAFFIC HANDLING", PAY ITEM NO. 803S–SF.
8. PORTABLE SAFETY FENCE MOUNTS SHALL BE APPROVED BY THE TRANSPORTATION DIVISION PRIOR TO CONSTRUCTION.

CITY OF AUSTIN DEPARTMENT OF PUBLIC WORKS		SAFETY FENCE	
RECORD COPY SIGNED BY SAM ANGOORI	04/03/09	THE ARCHITECT/ENGINEER ASSUMES RESPONSIBILITY FOR APPROPRIATE USE OF THIS STANDARD.	STANDARD NO. 804S–4 2 OF 9
	ADOPTED		

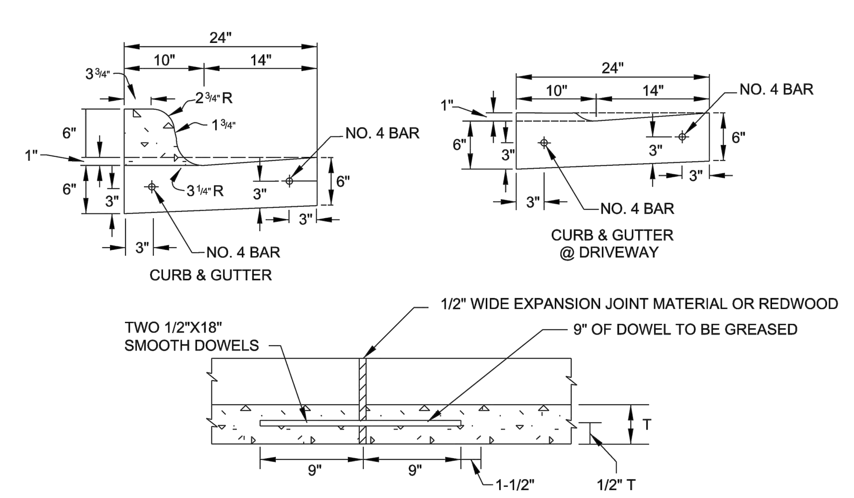
2/9



6/9 PARKING LOT BUMPER CURB

SCALE: NONE CUST-161

CURB AND GUTTER



LONGITUDINAL SECTION THRU CURB AND GUTTER
SHOWING TYPICAL EXPANSION JOINT DETAILS.
REINFORCING STEEL SHALL NOT CROSS EXPANSION JOINTS.
STEEL SHALL BE TERMINATED 3" (+ OR -) 1" FROM FACE OF THE JOINT.

NOTES:

1. REINFORCING BARS SHALL BE LAPPED A MINIMUM OF 18".
2. CURB AND GUTTER SHALL HAVE FORMED TOOLED OR SAWED CONTRACTION JOINTS AT ± 10'. THE DEPTH OF THESE JOINTS SHALL BE SUFFICIENT TO ENSURE CRACKING AT THE JOINTS.
3. CURB OR CURB AND GUTTER SHALL HAVE EXPANSION JOINTS AT POINTS OF CURVATURE, AT INTERVALS NO GREATER THAN 100' AND AT ALL ADJACENT STRUCTURES.
4. UNLESS OTHERWISE SHOWN, TRANSITIONS BETWEEN CURBS OR CURBS AND GUTTER OF DIFFERING CROSS SECTION SHALL BE ACCOMPLISHED OVER A 10' LENGTH OR AS APPROVED BY THE CITY ENGINEER.
5. ALL CONCRETE TO BE CLASS "A" 3000 PSI CONCRETE.
6. ALL EXPOSED CONCRETE SURFACES TO BE BRUSHED SMOOTH AND UNIFORM.

DATE APPROVED: 07/2008	DWG. NO: ST-013	SCALE: N.T.S.	City of New Braunfels	ENGINEERING DEPARTMENT
DRAWN BY: RAS	SHEET: 1 OF 1			
FILENAME: CURB & GUTTER				

3/9

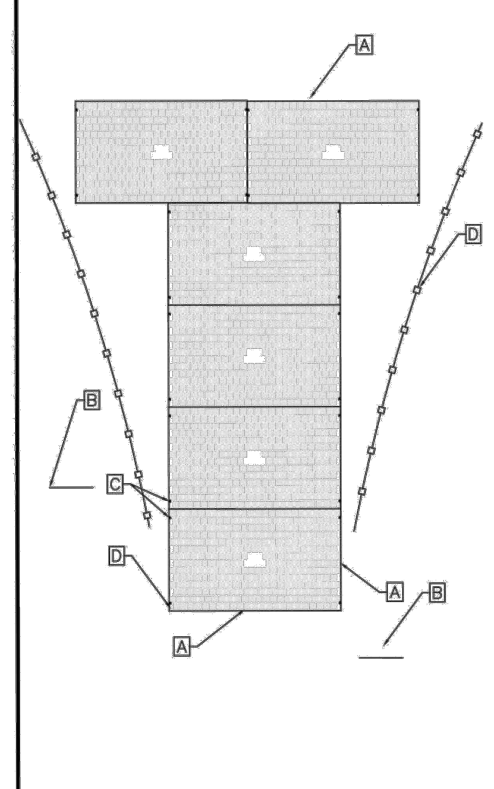
FODS TRACKOUT CONTROL SYSTEM

THE PURPOSE AND DESIGN OF THE FODS TRACKOUT CONTROL SYSTEM IS TO EFFECTIVELY REMOVE MOST SEDIMENT FROM VEHICLE TIRES AS THEY EXIT A DISTURBED LAND AREA ONTO A PAVED STREET. THIS A GENERAL GUIDE FROM WHICH TO INSTALL A FODS TRACKOUT CONTROL SYSTEM. (NOTE: THIS IS NOT A ONE SIZE FITS ALL GUIDE.) THE INSTALLATION MAY NEED TO BE MODIFIED TO MEET THE EXISTING CONDITIONS, EXPECTATIONS, OR DEMANDS OF A PARTICULAR SITE. THIS IS A GUIDELINE. ULTIMATELY THE FODS TRACKOUT CONTROL SYSTEM SHOULD BE INSTALLED SAFELY WITH PROPER ANCHORING AND SIGNS PLACED AROUND THE ENTRANCE AND EXIT TO CAUTION USERS AND OTHERS.

KEY NOTES:

A. FODS TRACKOUT CONTROL SYSTEM MAT.
B. FODS SAFETY SIGN.
C. ANCHOR POINT.
D. SILT OR ORANGE CONSTRUCTION FENCE.

CALL UTILITY NOTIFICATION CENTER
811
CALL 3-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.



TYPICAL ONE–LANE LAYOUT

FIG. 1

INSTALLATION:

1. THE SITE WHERE THE FODS TRACKOUT CONTROL SYSTEM IS TO BE PLACED SHOULD CORRESPOND TO BEST MANAGEMENT PRACTICES AS MUCH AS POSSIBLE. THE SITE WHERE FODS TRACKOUT CONTROL SYSTEM SHOULD ALSO MEET OR EXCEED THE LOCAL JURISDICTION OR STORM WATER POLLUTION PREVENTION PLAN (SWPPP) REQUIREMENTS.
2. CALL FOR UTILITY LOCATES 3 BUSINESS DAYS IN ADVANCE OF THE FODS TRACKOUT CONTROL SYSTEM INSTALLATION FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES. CALL THE UTILITY NOTIFICATION CENTER AT 811.
3. ONCE THE SITE IS ESTABLISHED WHERE FODS TRACKOUT CONTROL SYSTEM IS TO BE PLACED, ANY EXCESSIVE UNEVEN TERRAIN SHOULD BE LEVELED OUT OR REMOVED SUCH AS LARGE ROCKS, LANDSCAPING MATERIALS, SUDDEN ABRUPT CHANGES IN ELEVATION, AND SIMILAR. FODS WILL SPAN AND SUPPORT OVER MOST OBSTACLES, BUT THE FLATTER AND SMOOTHER THE TERRAIN UNDER THE FODS TRACKOUT CONTROL SYSTEM WILL BE MORE EFFICIENT AND SAFER.
4. NEXT THE INDIVIDUAL MATS CAN START TO BE PLACED IN POSITION. THE FIRST MAT SHOULD BE PLACED NEXT TO THE PAVED SURFACE AND/OR CURB AT THE CLOSEST POINT OF EGRESS. THIS WILL ENSURE THAT THE VEHICLE WILL EXIT STRAIGHT FROM THE SITE TO THE PAVED SURFACE. FROM THE SITE TO THE PAVED SURFACE.
5. AFTER THE FIRST MAT IS PLACED DOWN IN ITS PROPER LOCATION, AN H BRACKET SHOULD BE PLACED AT THE END OF THE FIRST MAT, BEFORE ANOTHER MAT IS POSITIONED ADJACENT TO THE FIRST MAT.
6. ONCE THE SECOND MAT IS PLACED ADJACENT TO THE FIRST MAT, MAKE SURE THE H BRACKET IS CORRECTLY SITUATED BETWEEN THE TWO MATS.
7. NEXT, THE CONNECTOR STRAP SHOULD BE INSTALLED TO CONNECT THE TWO MATS TOGETHER.
8. AFTER THE FIRST MAT IS PLACED DOWN IN ITS PROPER LOCATION, IT SHOULD BE ANCHORED TO PREVENT THE POTENTIAL MOVEMENT WHILE THE ADJOINING MATS ARE INSTALLED NEXT. ANCHORS SHOULD BE PLACED AT EVERY ANCHOR POINT (IF FEASIBLE) TO HELP MAINTAIN THE MAT IN ITS CURRENT POSITION.
9. ONCE THE FIRST MAT IS ANCHORED DOWN, THE SUCCESSIVE MATS CAN THEN BE PLACED TO CREATE THE FODS® TRACKOUT CONTROL SYSTEM.
10. UPON PLACEMENT OF EACH NEW MAT IN THE SYSTEM, THAT MAT SHOULD BE ANCHORED AT EVERY ANCHOR POINT TO HELP STABILIZE THE MAT AND ENSURE THE SYSTEM IS CONTINUOUS WITH NO GAPS IN BETWEEN THE MATS.
11. AFTER INSTALLATION OF THE FODS TRACKOUT CONTROL SYSTEM, FODS SAFETY SIGNS SHOULD BE PLACED AT THE ENTRANCE AND EXIT SIDES OF THE FODS TRACKOUT CONTROL SYSTEM.
12. A SILT FENCE OR ORANGE CONSTRUCTION FENCE SHOULD ALSO BE INSTALLED ON THE SIDES OF THE FODS TRACKOUT CONTROL SYSTEM TO DIRECT VEHICLES DOWN THE MATS AND BARRICADE PEDESTRIANS FROM CROSSING THE MATS. PEDESTRIANS SHOULD ALSO USE EXTREME CAUTION WHEN CROSSING THE MATS AS THE SURFACE IS UNEVEN AND MAY BE DIFFICULT TO WALK ON.

USE AND MAINTENANCE

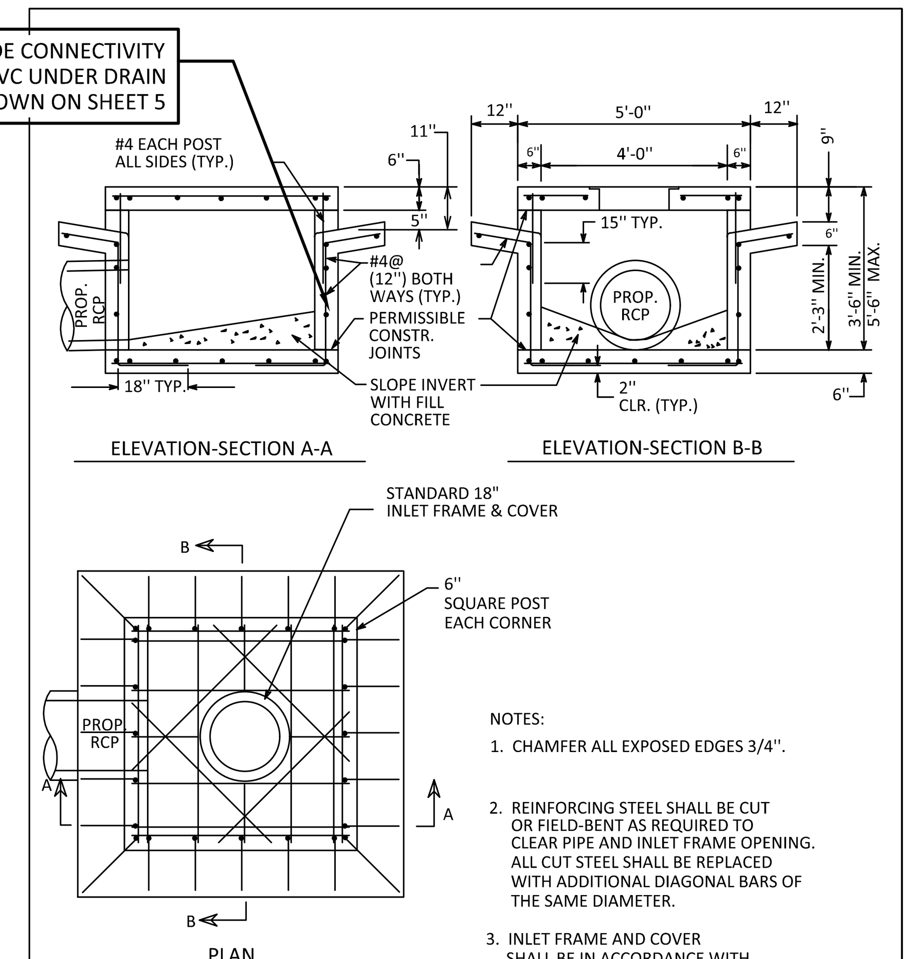
1. VEHICLES SHOULD TRAVEL DOWN THE LENGTH OF THE FODS TRACKOUT CONTROL SYSTEM AND NOT CUT ACROSS THE MATS.
2. DRIVERS SHOULD TURN THE WHEEL OF THEIR VEHICLES SUCH THAT THE VEHICLE WILL TAKE A SERPENTINE ROUTE DOWN THE LENGTH OF THE FODS TRACKOUT CONTROL SYSTEM.
3. MATS SHOULD BE CLEANED ONCE THE VOIDS BETWEEN THE PYRAMIDS BECOME FULL OF SEDIMENT. TYPICALLY THIS TASK WILL NEED TO BE PERFORMED WITHIN TWO WEEKS AFTER A STORM EVENT. BRUSHING IS THE PREFERRED METHOD OF CLEANING, EITHER MANUALLY OR MECHANICALLY.
4. THE USE OF ICE MELT, ROCK SALT, SNOW MELT, DEICER, ETC. SHOULD BE UTILIZED AS NECESSARY DURING THE WINTER MONTHS AND AFTER A SNOW EVENT.

REMOVAL

1. REMOVAL OF FODS TRACKOUT CONTROL SYSTEM IS THE REVERSE ORDER OF THE INSTALLATION.
2. STARTING WITH THE LAST MAT, THE MAT THAT IS PLACED AT THE INNERMOST POINT OF THE SITE OR THE MAT FURTHEST FROM THE EXIT OR PAVED SURFACE SHOULD BE REMOVED FIRST.
3. THE CABLE ANCHORS SHOULD BE CUT WITH WIRE ROPE CUTTERS.
4. THE CONNECTOR STRAPS SHOULD BE UNBOLTED AT ALL LOCATIONS IN THE FODS TRACKOUT CONTROL SYSTEM.
5. STARTING WITH THE LAST MAT IN THE SYSTEM, EACH SUCCESSIVE MAT SHOULD THEN BE MOVED AND STACKED FOR LOADING BY FORKLIFT OR EXCAVATOR ON TO A TRUCK FOR REMOVAL FROM THE SITE.

4/9

PROVIDE CONNECTIVITY FOR 6" PVC UNDER DRAIN AS SHOWN ON SHEET 5



NOTES:

1. CHAMFER ALL EXPOSED EDGES 3/4".
2. REINFORCING STEEL SHALL BE CUT OR FIELD-BENT AS REQUIRED TO CLEAR PIPE AND INLET FRAME OPENING. ALL CUT STEEL SHALL BE REPLACED WITH ADDITIONAL DIAGONAL BARS OF THE SAME DIAMETER.
3. INLET FRAME AND COVER SHALL BE IN ACCORDANCE WITH CITY OF AUSTIN STANDARD 503S-1.
4. CONCRETE COVERAGE OF STEEL SHALL BE 2" MIN. AT ALL SURFACES.

	4-SIDED AREA INLET	
	THE ARCHITECT/ENGINEER ASSUMES RESPONSIBILITY FOR APPROPRIATE USE OF THIS STANDARD.	STANDARD NO. 508S-9

5/9 4.0' X 4.0' AREA INLET

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DETAILS

LANDA PARK AQUATICS CENTER
CITY OF NEW BRAUNFELS
350 AQUATIC CIRCLE, NEW BRAUNFELS, TEXAS 78130

STATE OF TEXAS
THOMAS EDWARD HEGEMIER
62216
LICENSED PROFESSIONAL ENGINEER
12/28/2020

Designed:	GP/OF
Drawn:	GP/OF
Reviewed:	TEH
Date:	12/28/2020

SHEET
9
9 OF 9

Project No.:
(PW) 1757-004

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