Exhibit 1
Project Background and Published Articles

- Project Background shows the dates and subject matter for public meetings in which the reuse water project was a topic for discussion.

- Articles in the Newspaper provides the dates and headlines of articles published on the subject of the reuse water project.

Project Background

April 15, 2013 –Presentation to EIC on storage pond concept as requested by board

June 17, 2013 – Presentation on Reuse Pond Feasibility Study scope of work.

June 25, 2013 – City Council authorization to apply for funding through the EIC for Reuse Pond Feasibility Study

July 22, 2013 – Presentation to EIC for the funding application.

September 10, 2013 – City Council authorized Professional Services Agreement for the Reuse Pond Feasibility Study

June 10, 2014 – Freese Nichols Inc. presented results of the Reuse Pond Feasibility Study to the City Council

June 23, 2014- Staff presented the results of the Reuse Pond Feasibility Study to the EIC

July 22, 2014 – City Council considered and approved the Reuse Pond Design funds during the Capital improvement project budget process

October 28, 2014 – City Council authorized Professional Services Agreement for the Reuse Pond Design

May 12, 2015 – City Council authorized Professional Services Agreement for the Direct Potable Reuse Contract

November 10, 2015 – City Council created an Ad Hoc Committee to evaluate the Reuse Pond project

December 15, 2015 – City Council appoints members to the Ad Hoc Committee

January 7, 2016 – Ad Hoc Committee meeting – Water 101 Presentation

January 21, 2016 – Ad Hoc Committee meeting – Tours

January 28, 2016 – Ad Hoc Committee meeting – Project Overview

February 4, 2016 – Ad Hoc Committee unanimously approves recommendation for city to continue with effluent project

March 22, 2016 – Joint meeting between the Kerrville City Council and KPUB regarding Proposal for a loan for the City of Kerrville water reuse project in an amount not to exceed $8,500,000

May 10, 2016 – City Council consideration of construction and funding for reuse distribution lines.

July 26, 2016 – City Council confirms amount of funding from Kerrville Public Utility Board pursuant to Loan Agreement, with proceeds to be used for construction of reuse water pond.

Articles in the Newspaper

03/15/02 – Treated wastewater may be good option

4/17/13 – Feeling Flushed

6/14/13 – EIC to look at effluent ponds

6/18/13 – Effluent pond gets EIC blessing

8/29/14 – City moves toward pond construction

10/28/15 – City looks to use reuse

11/19/15 – City forms reuse advisory committee

12/10/15 – Treated effluent water is valuable

12/16/15 – 9 names to city's water reuse ad hoc committee

1/04/16 – First meeting on tap for water reuse committee

1/08/16 – Reuse committee evaluates Kerrville water system

1/11/16 – Big night planned Tuesday at City Hall

1/13/16 – Sparks fly during city council water talks

1/22/16 – Committee, city officials tour site for $21M water project

1/30/16 – Committee reviews City water plan

2/5/16 – Committee approves effluent project

03/22/16 – City ponders $8.5M loan from KPUB

05/10/16 – Effluent pond funding tops city agenda

05/11/15 – Council votes to pursue funding for effluent lines

07/27/16 – City fields questions about water project loan

07/29/16 – City breaks down costs, funding for effluent water project; rate increase on the table

Exhibit 2
Effluent Discharge Chart for September 30, 2016
And
Pump Run Chart for August 6, 2016

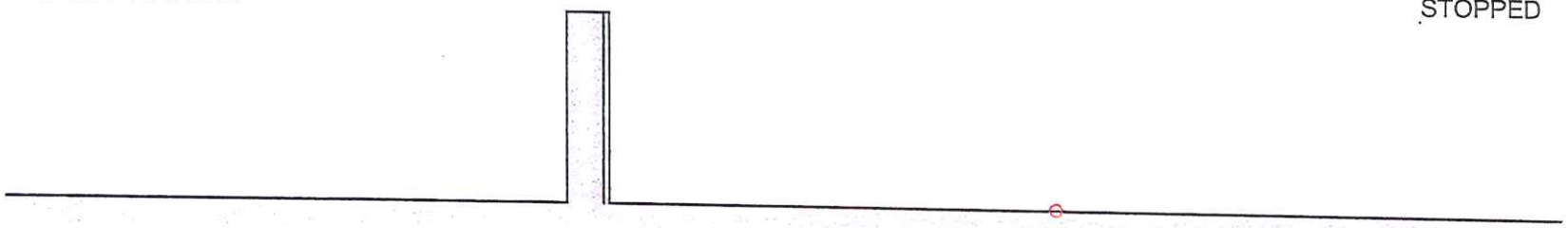
- Effluent Discharge from Contact Chamber for September 30, 2016
  - Shows a typical day of effluent discharge from the sewer plant.
  - Total volume discharged was 2.097 million gallons.
  - Discharge rate varies from a low 450 gpm to a high of 2,180 gpm.
  - There was no measurable precipitation for this day.

- Pump Run Chart for August 6, 2016
  - Shows a peak day where all pumps were running.
  - Approximately 1.78 million gallons of effluent was distributed.
  - Approximately 1.99 million gallons of effluent generated.
  - Shows 15 hours of pump run time.
  - Shows 5.5 hours of down time for refill of contact chamber.
  - Shows 3.5 hours of down time for plant operations.

-1 days 00:00:00 WWTP-2 (Fri Sep 30 16:14:35 CDT 2016) Sat Oct 01 00:00:02 CDT 2016

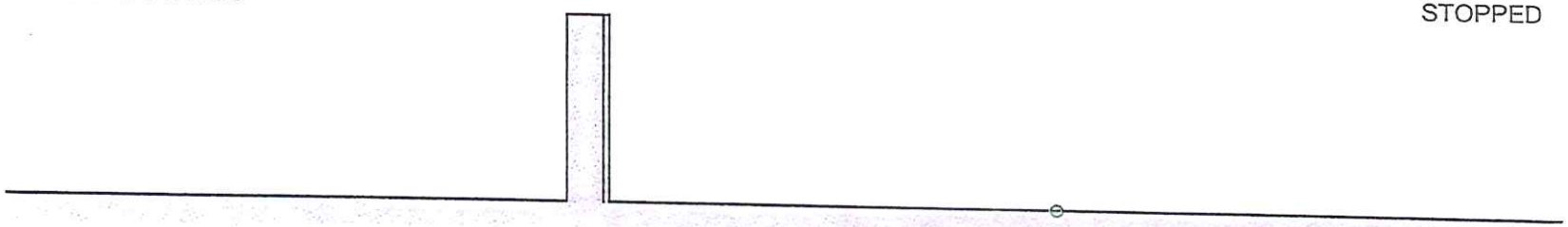
REUSE P1 STATUS

STOPPED



REUSE P2 STATUS

STOPPED



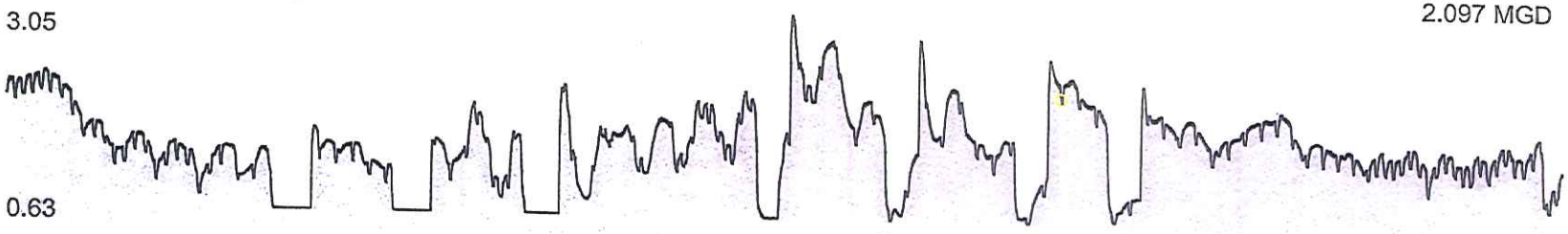
REUSE P3 VFD STATUS

STOPPED

TOTAL PLANT OUTFALL

3.05

2.097 MGD



0.63

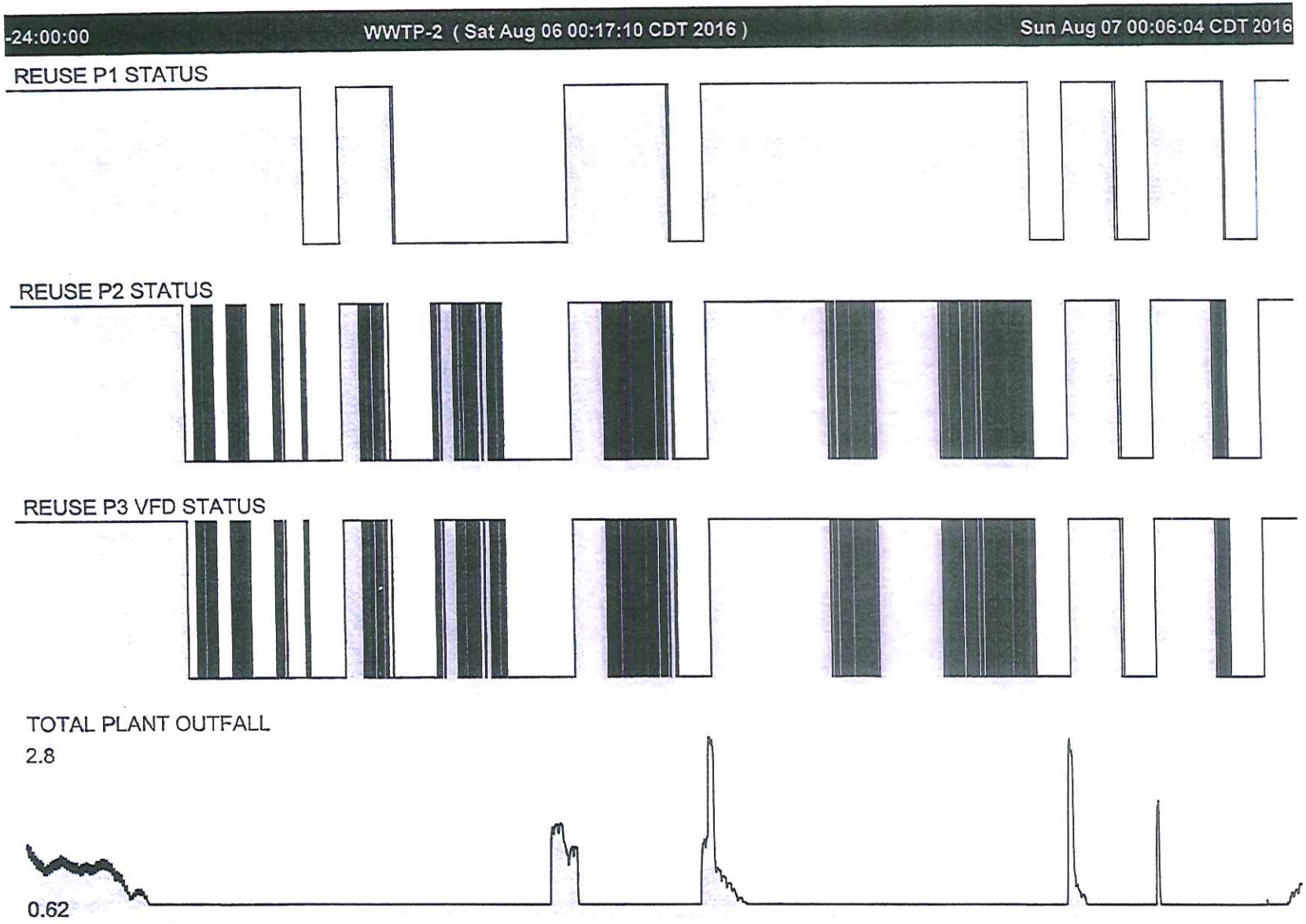

-24:00:00
WWTP-2 (Sat Aug 06 00:17:10 CDT 2016)
Sun Aug 07 00:06:04 CDT 2016
REUSE P1 STATUS
REUSE P2 STATUS
REUSE P3 VFD STATUS
TOTAL PLANT OUTFALL
2.8
0.62

Exhibit 3
Reuse Water Data - FY2011 and FY2016

- Daily information provided for the entire fiscal year.
- FY2011 data shows information for a hot, dry year.
- FY2016 data shows information for a wet year with moderate temperatures.
- Influent Totals show the total inflow of wastewater into the plant (millions).
- Reclaimed Totals show the amount of effluent distributed to customers (millions).
- Tailwater Totals show the amount of effluent discharged into Third Creek (millions).
- Percent ReUse Water Sold shows the percentage of water pumped to customers as a percentage of actual effluent produced.
- Percent ReUse Water Lost shows the percentage of water released to Third Creek as a percentage of actual effluent produced.
- Weekly Water Resources Report for months of June, July, August, and September shows daily precipitation.

Water Reclamation Facility Flows
FY 2011

	Influent	Reclaimed Water Sold	Tailwater
Oct-10	65.52300	23.24567	44.05316
Nov-10	61.27832	20.76365	41.03213
Dec-10	62.14395	15.11575	49.50517
Jan-11	62.18234	10.78738	54.35935
Feb-11	59.13220	10.23234	55.63753
Mar-11	63.67346	15.46258	45.67758
Apr-11	59.80384	24.43624	35.38502
May-11	60.90704	27.34454	32.60034
Jun-11	59.59640	36.05709	16.01398
Jul-11	61.97528	40.08740	14.83779
Aug-11	60.15343	41.54080	10.79032
Sep-11	59.31176	38.34708	10.72170
Totals	735.68102	303.42052	410.61406
Total MG Treated in FY 2011			735.68102
Total MG Reclaimed Water sold in FY 2011			303.42052
Total MG to 3rd Creek in FY 2011			410.61406

*All volumes are MG (million gallons)

Day	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11
1	2.068062	2.093939	2.008060	1.845763	2.120185	2.069255	2.012264	1.904801	1.997925	2.034111	1.937398	1.924407
2	1.985994	2.023829	2.065116	1.902808	2.220560	2.035002	1.975764	1.978575	1.928720	1.948219	2.025494	1.892367
3	2.093707	2.096700	2.008696	2.054372	2.357529	2.024572	1.954078	2.003204	1.913855	1.903938	2.036697	1.931878
4	2.118044	1.982457	1.944536	2.011596	2.389007	2.018203	2.038265	2.012849	1.901810	1.978099	2.012032	1.850988
5	2.115742	1.996390	1.936802	1.990836	2.333347	1.943534	1.943059	1.992519	1.816408	2.099540	2.014491	2.036353
6	2.109462	1.950825	2.083210	2.034447	2.105543	1.989634	2.020829	1.960557	1.972915	2.097627	1.963198	1.934282
7	2.061477	1.993393	1.976262	1.983028	2.141921	2.017678	2.026508	1.920166	1.933927	2.097204	1.936243	1.937962
8	2.069523	2.080385	2.031052	1.937421	2.098054	2.020056	2.022195	1.925985	1.953961	2.042448	2.020773	1.925000
9	2.003732	2.033593	2.002253	2.306508	2.196702	2.031330	1.928607	2.017308	1.964049	1.906473	1.973295	1.912407
10	1.980140	2.010818	2.009785	2.030461	2.312763	2.358895	1.991635	1.972309	2.032756	1.931687	1.988095	1.903567
11	2.103580	2.083967	1.980023	2.050814	2.254231	2.008369	2.079213	1.960931	1.887553	2.041492	1.903436	1.839134
12	2.103811	1.979471	2.018189	2.050121	2.098585	1.983944	2.046829	2.240639	1.828053	2.026094	1.985815	1.930789
13	2.047447	1.977600	2.136892	2.058270	2.031997	1.995882	2.056589	2.002034	1.915559	2.025119	1.912593	1.960960
14	3.522795	2.020556	2.051016	1.966401	2.110349	2.078021	1.997602	1.883000	1.992670	2.054921	1.882248	1.935838
15	2.001239	2.076508	2.055254	1.929665	2.118225	1.975477	2.008737	1.875507	1.956978	2.082500	1.938383	1.999036
16	2.001609	2.083556	2.004136	1.967351	2.076041	2.047212	1.942951	1.957874	2.040213	1.913903	1.929870	1.955161
17	1.979043	2.039874	2.039427	2.043468	2.081565	2.100447	1.981908	1.967852	2.019739	1.846742	1.883377	1.865414
18	2.159586	2.157615	1.934289	2.022474	2.042063	2.143417	2.049299	1.959508	1.934772	2.012028	1.931009	1.954047
19	2.034688	2.050814	1.931710	2.046343	1.933160	2.033775	2.038627	1.930668	1.914707	2.007886	1.891673	2.013081
20	2.056859	2.022714	2.071551	2.027797	1.892104	2.086540	2.044336	1.958301	2.060781	2.011959	1.791931	1.963790
21	2.102329	2.048452	2.042702	2.128167	2.066283	2.147320	2.018223	1.817459	2.018485	2.036373	1.911791	2.152096
22	2.085045	2.171282	1.952918	2.010051	2.017919	2.095119	2.100708	1.878601	2.166085	2.062548	2.003331	2.073715
23	2.069706	2.122834	1.968727	1.961475	2.081164	2.119912	1.742209	1.967423	2.060552	1.927510	1.968718	2.050116
24	2.056073	2.132996	2.027280	2.070220	2.038300	2.102276	1.877426	2.005637	2.106976	1.924819	1.940443	1.953628
25	2.120981	1.945628	1.703397	1.990898	2.015428	2.134094	1.988072	1.960320	2.045411	1.995197	1.948143	1.956630
26	2.069556	2.026169	1.873045	1.950902	1.915475	2.012179	2.020815	1.970232	1.944355	1.982978	1.844484	2.067347
27	2.146488	1.973515	2.065959	2.013158	2.001191	1.995793	2.010782	1.996914	2.058485	1.982532	1.823518	2.123967
28	2.067332	2.046421	2.027727	1.953950	2.082508	2.084623	1.966932	1.977771	2.081694	1.968137	1.863003	2.156249
29	2.112902	2.075327	2.092168	1.882108		2.018581	2.014467	1.916912	2.055387	1.987721	1.985007	2.067941
30	2.063981	1.980693	2.023339	1.967886		1.991188	1.904906	1.976845	2.091623	2.017849	1.944171	2.043611
31	2.012070		2.078430	1.993583		2.011127		2.014339		2.027629	1.962767	
Monthly Total (MG)	65.523003	61.278321	62.143951	62.182342	59.132199	63.673455	59.803835	60.907040	59.596404	61.975283	60.153427	59.311761
Daily Average (MG)	2.113645	2.042611	2.004644	2.005882	2.111864	2.053982	1.993461	1.964743	1.986547	1.999203	1.940433	1.977059

FY 2011 Total (MG)	735.681021	→	In Thousand of Gallons	735681.02
FY 2011 Daily Avg. (MG)	2.016173	→	In Thousand of Gallons	2016.17

Influent Totals

Day	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11
1	0.252805	0.753838	0.765264	0.190918	0.187842	0.126745	0.769967	0.916906	1.409518	1.220487	1.235196	1.522373
2	0.331961	0.135680	0.892114	0.927309	0.184121	0.145345	0.943067	0.160174	1.319601	1.437122	1.370806	1.573117
3	0.926803	0.357015	0.781948	0.210691	0.498634	0.147514	1.629177	0.942707	1.153850	1.225714	1.130278	1.504053
4	0.290457	1.342259	0.119841	0.317885	0.210981	0.122480	0.651366	0.555254	1.068789	1.327399	1.223815	1.444051
5	1.030842	1.015695	0.103606	0.204516	0.215455	0.078448	0.821257	1.348616	0.960906	1.026817	1.432361	1.477322
6	1.203243	0.652328	0.845208	0.503447	0.204208	0.396574	0.304494	1.070652	1.219574	1.228340	1.294430	1.416578
7	1.436977	1.080995	1.039658	0.203322	0.438725	0.082496	0.416912	0.868662	1.379566	1.242350	1.274126	1.479320
8	0.439176	1.428582	0.818956	0.261436	0.225551	1.098712	0.940497	1.088083	1.313419	1.122556	1.317605	1.522803
9	0.143702	1.425992	0.665355	0.182740	0.198108	0.629757	1.183710	1.229707	1.407429	1.344896	1.233551	1.494284
10	0.179032	0.253263	0.153410	0.529646	2.357851	1.341179	0.776435	1.730609	1.434286	1.207205	1.311879	1.016212
11	0.978812	0.825164	0.287524	0.699716	0.355742	0.177575	0.269606	0.145020	1.301655	1.524683	1.314003	1.261618
12	1.278251	0.389761	0.088828	0.253501	0.259540	0.070165	0.448326	0.134366	1.335288	1.540453	1.431629	1.502900
13	0.865847	0.207021	0.729297	0.290942	0.231624	1.030967	1.013687	0.146767	1.042689	1.399868	1.252686	1.525445
14	1.037713	0.663056	1.131813	0.188219	0.267370	0.959025	1.325198	0.290299	0.755561	1.241187	1.308347	1.499600
15	2.501051	0.215389	0.811351	0.171730	0.323832	0.822675	0.680936	0.316210	0.572569	1.005846	1.276230	1.410593
16	0.194809	0.890156	1.188340	0.193913	0.301226	0.132021	0.881455	0.915273	1.435949	0.778815	1.493281	1.527855
17	0.118382	1.021358	0.957628	0.260078	0.332604	0.846448	0.547205	1.085647	1.576227	1.177474	1.332273	1.448472
18	0.197299	0.600517	0.430530	0.236421	0.287282	0.135478	1.113100	0.567913	1.002733	1.605808	1.349168	1.513110
19	0.492587	0.196813	0.211328	0.318090	0.295994	0.227398	1.113294	1.201269	1.039142	1.373284	1.343998	1.354222
20	1.157058	1.332217	0.484148	0.303579	0.229707	0.101987	0.542940	0.471498	1.521791	1.332924	1.308933	1.080640
21	1.460330	0.369655	0.346761	0.214627	0.491981	0.229422	0.657618	1.014760	1.507429	1.373119	1.195798	0.871567
22	1.443040	0.488428	0.233067	0.269885	0.309387	1.349118	1.123220	1.273598	1.200173	1.316571	1.485746	1.034432
23	0.964704	1.682737	0.237419	0.181554	0.373447	1.162513	0.118735	0.734820	0.604289	1.350594	1.287781	1.030448
24	0.082020	0.158100	0.200734	0.740747	0.416596	0.806025	0.853504	1.257739	0.979431	1.438213	1.315580	0.967070
25	0.124774	0.235653	0.194646	0.233996	0.281662	0.238651	0.090863	0.855924	1.052020	1.280213	1.385675	1.416790
26	1.221057	1.168270	0.190915	0.217302	0.221685	0.114527	1.256912	1.308431	0.521184	1.388765	1.456817	1.665226
27	0.741685	0.534817	0.291299	0.236182	0.285696	1.085293	0.991859	1.070817	1.305730	1.312008	1.367078	1.340996
28	1.279329	0.853718	0.188645	0.200597	0.245487	0.121553	1.507829	1.376575	1.602480	1.432237	1.481289	1.007138
29	0.557600	0.238286	0.262290	0.884406	0.000000	0.334178	0.640570	0.168859	1.550523	1.321339	1.442735	0.173622
30	0.232056	0.246888	0.289982	0.295497		0.533490	0.822502	1.563043	1.483287	1.488659	1.465021	0.265221
31	0.082268		0.173852	0.864488		0.814824		1.534340		1.022457	1.422689	
Monthly	23.245669	20.763651	15.115755	10.787381	10.232338	15.462582	24.436239	27.344536	36.057085	40.087403	41.540802	38.347079
Daily Av	0.749860	0.692122	0.487605	0.347980	0.352839	0.498793	0.814541	0.882082	1.201903	1.293142	1.340026	1.278236

FY 2011	303.420520	→	In Thousand of Gallons	303420.52
FY 2011	0.828261	→	In Thousand of Gallons	828.26

Reclaimed Totals

Day	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11
1	1.913088	1.340128	1.242752	1.927739	1.743592	1.722488	1.242296	0.987864	0.312952	0.735144	0.361152	0.134704
2	1.224256	1.726192	1.173032	0.945485	2.817840	2.230888	1.032664	1.790056	0.224384	0.144664	0.333856	0.050112
3	1.166904	1.302632	1.659712	1.858184	1.858880	1.736256	0.324880	1.060480	0.677200	0.476560	0.653352	0.111400
4	2.372368	0.640248	1.843776	1.352616	2.592296	1.929616	1.386928	1.457648	0.640392	0.277968	0.536736	0.160784
5	1.084912	0.980656	1.881160	1.699688	2.034352	1.563440	1.129808	0.643904	0.885936	0.481152	0.392520	0.231528
6	0.893384	1.298544	1.238008	1.530960	2.506560	1.473480	1.809024	0.889912	0.265424	1.144720	0.395912	0.191056
7	0.624536	0.912352	0.936592	1.710024	1.703160	1.754192	1.609648	1.051520	0.470728	0.613920	0.392736	0.133032
8	1.746464	0.651760	1.242096	2.226072	1.796728	0.693800	1.081736	0.837880	0.414752	0.800864	0.301456	0.132240
9	1.621480	0.607624	1.336880	2.550408	2.310792	1.249048	0.744912	0.787600	0.172880	0.195176	0.547832	0.077848
10	2.110664	2.195048	1.856296	1.717368	2.011576	0.749544	1.215168	0.241720	0.154224	0.462192	0.545416	0.721984
11	1.147900	1.258776	1.692512	1.670936	2.376896	1.280872	1.769496	2.156688	0.113072	0.122712	0.395536	0.520800
12	0.881540	1.540344	2.275024	2.230832	1.796120	2.080570	1.598536	1.303656	0.047368	0.219072	0.317744	0.089544
13	1.581616	1.543005	1.407584	1.750448	2.054504	0.842502	1.042896	2.315400	0.523472	0.366872	0.469944	0.122856
14	0.963912	1.357491	0.919192	1.720440	1.729952	1.118984	0.672368	1.592736	0.552176	0.546544	0.277808	0.188032
15	0.992792	1.674608	1.243944	2.225528	1.783824	1.152824	1.327760	1.559280	1.389848	1.070416	0.347168	0.250152
16	1.263440	1.193392	0.815760	2.210216	2.156912	2.091968	1.061536	1.042592	0.569440	1.036648	0.172608	0.193008
17	1.950064	1.002216	1.081848	1.703744	1.697632	1.254024	1.434720	0.882208	0.136328	0.680584	0.441128	0.204240
18	1.944168	1.557084	2.178016	1.670344	1.654384	1.806320	0.936216	1.391600	0.719808	0.237680	0.248448	0.085936
19	1.542056	1.854012	1.873528	2.198768	2.142952	1.410672	0.911456	0.729352	0.876888	0.284752	0.360064	0.181456
20	0.899840	0.690480	1.587400	1.640416	2.159360	1.473792	1.501416	1.486760	0.199832	0.432552	0.304232	0.743648
21	0.641992	1.678792	1.710576	2.265776	1.574336	1.661560	1.347920	0.802720	0.223288	0.395932	0.458888	0.550616
22	1.104968	1.682808	1.674848	1.745048	1.730536	0.745984	0.973440	0.604976	0.763744	0.499852	0.252816	0.275408
23	2.310944	0.434056	1.472152	2.018472	2.239456	0.957360	1.996888	1.232568	1.146216	0.314864	0.286376	0.484448
24	1.656408	2.873240	2.306648	1.329736	1.747304	1.294168	1.166744	0.747936	1.163768	0.223744	0.449192	0.640008
25	2.248416	1.695456	1.495552	1.580688	2.145832	2.209256	1.177200	1.104360	0.601112	0.433752	0.283440	0.188264
26	0.848520	0.857872	2.096128	2.229848	1.594952	2.087464	0.763936	0.661776	1.208464	0.415448	0.375520	0.228400
27	1.404784	1.438744	1.123672	1.634248	2.152296	0.910504	1.210008	0.926112	0.925272	0.452728	0.159282	0.271624
28	0.787952	1.192696	1.899792	1.375976	1.524504	1.857640	0.459088	0.601240	0.189952	0.317208	0.116382	0.910864
29	1.555344	2.204152	1.654936	0.937712		1.684360	1.373888	0.816008	0.289480	0.433896	0.199560	1.039040
30	2.121576	1.647720	2.878976	1.572520		1.457664	1.082440	0.413752	0.155576	0.206816	0.182736	1.608664
31	1.446872		1.706776	1.129112		1.196344		0.480040		0.813360	0.230480	
Monthly	44.053160	41.032128	49.505168	54.359352	55.637528	45.677584	35.385016	32.600344	16.013976	14.837792	10.790320	10.721696
Daily Av	1.421070	1.367738	1.596941	1.753527	1.987055	1.473470	1.179501	1.051624	0.533799	0.478638	0.348075	0.357390

FY 2011	410.614064	→	In Thousand of Gallons	410614.06
FY 2011	1.129069	→	In Thousand of Gallons	1129.07

Tailwater Totals

Day	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11
1	12%	36%	38%	10%	9%	6%	38%	48%	71%	60%	64%	79%
2	17%	7%	43%	49%	8%	7%	48%	8%	68%	74%	68%	83%
3	44%	17%	39%	10%	21%	7%	83%	47%	60%	64%	55%	78%
4	14%	68%	6%	16%	9%	6%	32%	28%	56%	67%	61%	78%
5	49%	51%	5%	10%	9%	4%	42%	68%	53%	49%	71%	73%
6	57%	33%	41%	25%	10%	20%	15%	55%	62%	59%	66%	73%
7	70%	54%	53%	10%	20%	4%	21%	45%	71%	59%	66%	76%
8	21%	69%	40%	13%	11%	54%	47%	56%	67%	55%	65%	79%
9	7%	70%	33%	8%	9%	31%	61%	61%	72%	71%	63%	78%
10	9%	13%	8%	26%	102%	57%	39%	88%	71%	62%	66%	53%
11	47%	40%	15%	34%	16%	9%	13%	7%	69%	75%	69%	69%
12	61%	20%	4%	12%	12%	4%	22%	6%	73%	76%	72%	78%
13	42%	10%	34%	14%	11%	52%	49%	7%	54%	69%	65%	78%
14	29%	33%	55%	10%	13%	46%	66%	15%	38%	60%	70%	77%
15	125%	10%	39%	9%	15%	42%	34%	17%	29%	48%	66%	71%
16	10%	43%	59%	10%	15%	6%	45%	47%	70%	41%	77%	78%
17	6%	50%	47%	13%	16%	40%	28%	55%	78%	64%	71%	78%
18	9%	28%	22%	12%	14%	6%	54%	29%	52%	80%	70%	77%
19	24%	10%	11%	16%	15%	11%	55%	62%	54%	68%	71%	67%
20	56%	66%	23%	15%	12%	5%	27%	24%	74%	66%	73%	55%
21	69%	18%	17%	10%	24%	11%	33%	56%	75%	67%	63%	40%
22	69%	22%	12%	13%	15%	64%	53%	68%	55%	64%	74%	50%
23	47%	79%	12%	9%	18%	55%	7%	37%	29%	70%	65%	50%
24	4%	7%	10%	36%	20%	38%	45%	63%	46%	75%	68%	50%
25	6%	12%	11%	12%	14%	11%	5%	44%	51%	64%	71%	72%
26	59%	58%	10%	11%	12%	6%	62%	66%	27%	70%	79%	81%
27	35%	27%	14%	12%	14%	54%	49%	54%	63%	66%	75%	63%
28	62%	42%	9%	10%	12%	6%	77%	70%	77%	73%	80%	47%
29	26%	11%	13%	47%		17%	32%	9%	75%	66%	73%	8%
30	11%	12%	14%	15%		27%	43%	79%	71%	74%	75%	13%
31	4%		8%	43%		41%		76%		50%	72%	
Monthly Total (MG)	35%	34%	24%	17%	17%	24%	41%	45%	61%	65%	69%	65%
Daily Average (MG)	35%	34%	24%	17%	17%	24%	41%	45%	61%	65%	69%	65%
FY 2011 Total (MG)	41%											
FY 2011 Daily Avg. (MG)	41%											

% ReUse Water Sold

Day	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11
1	93%	64%	62%	104%	82%	83%	62%	52%	16%	36%	19%	7%
2	62%	85%	57%	50%	127%	110%	52%	90%	12%	7%	16%	3%
3	56%	62%	83%	90%	79%	86%	17%	53%	35%	25%	32%	6%
4	112%	32%	95%	67%	109%	96%	68%	72%	34%	14%	27%	9%
5	51%	49%	97%	85%	87%	80%	58%	32%	49%	23%	19%	11%
6	42%	67%	59%	75%	119%	74%	90%	45%	13%	55%	20%	10%
7	30%	46%	47%	86%	80%	87%	79%	55%	24%	29%	20%	7%
8	84%	31%	61%	115%	86%	34%	53%	44%	21%	39%	15%	7%
9	81%	30%	67%	111%	105%	61%	39%	39%	9%	10%	28%	4%
10	107%	109%	92%	85%	87%	32%	61%	12%	8%	24%	27%	38%
11	55%	60%	85%	81%	105%	64%	85%	110%	6%	6%	21%	28%
12	42%	78%	113%	109%	86%	105%	78%	58%	3%	11%	16%	5%
13	77%	78%	66%	85%	101%	42%	51%	116%	27%	18%	25%	6%
14	27%	67%	45%	87%	82%	54%	34%	85%	28%	27%	15%	10%
15	50%	81%	61%	115%	84%	58%	66%	83%	71%	51%	18%	13%
16	63%	57%	41%	112%	104%	102%	55%	53%	28%	54%	9%	10%
17	99%	49%	53%	83%	82%	60%	72%	45%	7%	37%	23%	11%
18	90%	72%	113%	83%	81%	84%	46%	71%	37%	12%	13%	4%
19	76%	90%	97%	107%	111%	69%	45%	38%	46%	14%	19%	9%
20	44%	34%	77%	81%	114%	71%	73%	76%	10%	21%	17%	38%
21	31%	82%	84%	106%	76%	77%	67%	44%	11%	19%	24%	26%
22	53%	78%	86%	87%	86%	36%	46%	32%	35%	24%	13%	13%
23	112%	20%	75%	103%	108%	45%	115%	63%	56%	16%	15%	24%
24	81%	135%	114%	64%	86%	62%	62%	37%	55%	12%	23%	33%
25	106%	87%	88%	79%	106%	104%	59%	56%	29%	22%	15%	10%
26	41%	42%	112%	114%	83%	104%	38%	34%	62%	21%	20%	11%
27	65%	73%	54%	81%	108%	46%	60%	46%	45%	23%	9%	13%
28	38%	58%	94%	70%	73%	89%	23%	30%	9%	16%	6%	42%
29	74%	106%	79%	50%		83%	68%	43%	14%	22%	10%	50%
30	103%	83%	142%	80%		73%	57%	21%	7%	10%	9%	79%
31	72%		82%	57%		59%		24%		40%	12%	
Monthly Total (MG)	67%	67%	80%	87%	94%	72%	59%	54%	27%	24%	18%	18%
Daily Average (MG)	67%	67%	80%	87%	94%	72%	59%	54%	27%	24%	18%	18%
FY 2011 Total (MG)	56%											
FY 2011 Daily Avg. (MG)	56%											

% ReUse Water Lost

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / June 2011

	Water Pumped, Treated & Sent to Distribution												
Date	Surface Water (MG) High Service Pump	Well Water (MG)	ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Holliman Dr. Monitor Well
1-Jun	2.5	2.6	1.0	0.0	0.0	5.1	85	86	Stage 2	13	No Rain	1621.29	1369'
2-Jun	2.4	1.6	1.1	0.0	0.0	4.0	66	85	Stage 3	14	No Rain	1621.29	
3-Jun	3.6	0.8	0.5	0.0	0.0	4.4	73	86	Stage 3	12	No Rain	1621.26	
4-Jun	3.9	1.0	0.8	0.0	0.0	5.0	83	85	Stage 3	12	No Rain	1620.26	
5-Jun	3.8	1.8	1.0	0.0	0.0	5.5	93	85	Stage 3	12	No Rain	1621.23	
6-Jun	3.1	2.3	0.2	0.0	0.0	5.4	91	84	Stage 3	13	No Rain	1621.22	
7-Jun	3.7	2.3	0.9	0.0	0.0	5.9	99	84	Stage 3	14	No Rain	1621.21	
8-Jun	2.8	1.4	0.0	0.0	0.0	4.1	69	82	Stage 3	14	No Rain	1621.20	
9-Jun	3.5	1.0	0.5	0.0	0.0	4.5	75	83	Stage 3	14	No Rain	1621.23	
10-Jun	3.4	0.7	0.3	0.0	0.0	4.1	62	82	Stage 3	14	No Rain	1621.21	
11-Jun	4.4	1.2	1.3	0.0	0.0	5.6	86	82	Stage 3	15	No Rain	1621.14	
12-Jun	4.1	0.8	1.3	0.0	0.0	5.0	76	80	Stage 3	13	No Rain	1621.03	
13-Jun	4.1	2.1	1.2	0.0	0.0	6.2	94	80	Stage 3	13	No Rain	1620.95	1361'
14-Jun	3.3	2.3	0.5	0.0	0.0	5.6	86	78	Stage 3	14	No Rain	1620.91	
15-Jun	3.7	0.7	0.8	0.0	0.0	4.4	70	78	Stage 3	14	No Rain	1620.82	
16-Jun	3.4	0.7	0.7	0.0	0.0	4.1	64	77	Stage 3	14	No Rain	1620.80	
17-Jun	3.6	0.7	0.7	0.0	0.0	4.3	67	78	Stage 3	14	No Rain	1620.75	
18-Jun	3.7	1.8	1.3	0.0	0.0	5.5	87	78	Stage 3	14	No Rain	1620.60	
19-Jun	3.7	1.6	1.1	0.0	0.0	5.2	82	79	Stage 3	14	No Rain	1620.58	
20-Jun	3.6	2.1	0.8	0.0	0.0	5.7	90	78	Stage 3	14	No Rain	1620.48	
21-Jun	3.4	1.9	0.7	0.0	0.0	5.3	84	78	Stage 3	14	No Rain	1620.42	
22-Jun	2.7	0.9	0.0	0.0	0.0	3.7	58	76	Stage 3	16	0.6	1620.46	
23-Jun	2.7	0.8	0.2	0.0	0.0	3.5	56	75	Stage 3	17	No Rain	1620.40	
24-Jun	2.9	0.7	0.3	0.0	0.0	3.5	56	73	Stage 3	20	No Rain	1620.45	
25-Jun	3.5	1.6	0.8	0.0	0.0	5.0	79	72	Stage 3	21	No Rain	1620.40	
26-Jun	3.7	1.4	1.1	0.0	0.0	5.0	79	72	Stage 3	18	No Rain	1620.22	
27-Jun	3.3	1.8	0.5	0.0	0.0	5.0	79	70	Stage 3	16	No Rain	1620.19	
28-Jun	3.8	1.9	1.2	0.0	0.0	5.7	90	71	Stage 3	15	No Rain	1620.14	
29-Jun	4.0	1.0	1.1	0.0	0.0	5.0	79	74	Stage 3	13	No Rain	1620.10	
30-Jun	2.8	1.1	0.3	0.0	0.0	4.0	62	75	Stage 3	14	No Rain	1620.08	
Totals	102.9	42.3	22.3	0.0	0.0	145					0.60		
Average	3.4	1.4	0.7	0.0	0.0	4.8	77	79		15			
NOTES	562 MG for the year pumped out of 1,983 MG annually allowed by permit(s) from the River.	207 MG for the year pumped out of 1,356 MG annually allowed by Groundwater permit.	740 MG stored in the ASR system.			Daily average water produced for June is 4.9 MGD. (5 year average)	The Safe Operating Capacity was changed from 6.527 to 6.340 on 06/15/11.	Between 85%-95%SOC we remain in Stage 3	Stage 3	Monthly mean flow for June is 199 CFS. (23 year average)	Monthly average rain fall for June is 3.97". (30 year avg.)	Normal Water Level in Lake is 1621.45 Feet above MSL	Monthly average water level for June is 1402' Mean Sea Level. (5 year avg.)

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / July 2011

	Water Pumped, Treated & Sent to Distribution												
Date	Surface Water (MG) High Service Pump	Well Water (MG)	ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Holliman Dr. Monitor Well
1-Jul	3.3	0.7	0.7	0.0	0.0	4.0	63	76	Stage 3	13	No Rain	1619.99	1350'
2-Jul	3.8	1.5	1.1	0.0	0.0	5.3	83	77	Stage 3	13	No Rain	1619.95	
3-Jul	3.8	1.7	1.3	0.0	0.0	5.5	87	78	Stage 3	13	No Rain	1619.97	
4-Jul	3.7	0.9	1.0	0.0	0.0	4.6	73	77	Stage 3	10	No Rain	1619.85	
5-Jul	3.9	1.7	1.2	0.0	0.0	5.6	88	77	Stage 3	9.8	No Rain	1619.75	
6-Jul	3.7	1.4	1.2	0.0	0.0	5.1	80	77	Stage 3	9.8	No Rain	1619.73	
7-Jul	2.8	1.4	0.3	0.0	0.0	4.2	66	77	Stage 3	9.2	No Rain	1619.67	
8-Jul	2.8	1.1	0.2	0.0	0.0	3.9	61	77	Stage 3	8.9	No Rain	1619.66	
9-Jul	3.6	2.4	1.0	0.0	0.0	6.0	95	79	Stage 3	8.9	No Rain	1619.63	
10-Jul	3.6	2.1	0.9	0.0	0.0	5.6	89	79	Stage 3	8.7	No Rain	1619.59	
11-Jul	3.7	0.9	1.3	0.0	0.0	4.6	72	79	Stage 3	8.4	No Rain	1619.52	
12-Jul	3.8	1.2	1.0	0.3	0.0	5.4	85	78	Stage 3	8.2	No Rain	1619.49	
13-Jul	3.7	2.4	1.3	0.0	0.0	6.1	96	81	Stage 3	8.2	No Rain	1619.47	
14-Jul	2.6	1.0	0.1	0.0	0.0	3.6	56	79	Stage 3	7.9	No Rain	1619.40	
15-Jul	2.9	1.2	0.4	0.0	0.0	4.2	66	80	Stage 3	7.7	No Rain	1619.38	1347'
16-Jul	3.9	1.8	1.2	0.0	0.0	5.8	91	79	Stage 3	7.3	No Rain	1619.34	
17-Jul	3.9	1.6	1.3	0.0	0.0	5.5	87	79	Stage 3	7.6	No Rain	1619.31	
18-Jul	3.7	1.0	0.9	0.0	0.0	4.7	74	79	Stage 3	7.4	No Rain	1619.25	
19-Jul	3.7	1.5	1.2	0.0	0.0	5.2	82	79	Stage 3	7.3	No Rain	1619.20	
20-Jul	3.7	1.6	1.1	0.1	0.0	5.5	87	78	Stage 3	12	No Rain	1619.22	
21-Jul	2.9	1.0	0.5	0.0	0.0	4.0	63	78	Stage 3	13	No Rain	1619.26	
22-Jul	3.3	0.9	0.8	0.0	0.0	4.2	67	79	Stage 3	12	No Rain	1619.36	
23-Jul	3.3	2.0	1.2	0.0	0.0	5.3	83	78	Stage 3	12	No Rain	1619.48	
24-Jul	3.6	2.1	1.1	0.0	0.0	5.7	90	78	Stage 3	12	No Rain	1619.57	
25-Jul	3.4	1.4	1.2	0.0	0.0	4.8	76	78	Stage 3	12	No Rain	1619.68	
26-Jul	3.2	2.3	1.0	0.0	0.0	5.6	88	79	Stage 3	14	No Rain	1619.68	
27-Jul	3.6	2.1	0.7	0.0	0.0	5.7	89	79	Stage 3	14	No Rain	1619.72	
28-Jul	3.2	0.8	0.9	0.0	0.0	4.0	63	79	Stage 3	13	No Rain	1619.72	
29-Jul	2.9	0.9	0.6	0.0	0.0	3.8	60	78	Stage 3	11	No Rain	1619.67	
30-Jul	3.3	1.6	1.2	0.0	0.0	4.8	76	77	Stage 3	12	No Rain	1619.66	
31-Jul	3.8	1.7	1.1	0.0	0.0	5.4	85	77	Stage 3	13	No Rain	1619.65	
Totals	107.2	45.9	28.9	0.4	0.0	154					0.00		
Average	3.5	1.5	0.9	0.0	0.0	5.0	78	78		10			
NOTES	677 MG for the year pumped out of 1,983 MG annually allowed by permit(s) from the River.	256 MG for the year pumped out of 1,356 MG annually allowed by Groundwater permit.	705 MG stored in the ASR system.			Daily average water produced for July is 3.4 MGD. (5 year average)	The Safe Operating Capacity was changed from 6.527 to 6.340 on 06/15/11.	Between 85%-95%SOC we remain in Stage 3	Stage 3	Monthly mean flow for July is 197 CFS. (25 year average)	Monthly average rain fall for July is 2.82". (30 year avg.)	Normal Water Level in Lake is 1621.45 Feet above MSL	Monthly average water level for July is 1400' Mean Sea Level. (5 year avg.)

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / August 2011

	Water Pumped, Treated & Sent to Distribution												
Date	Surface Water (MG) High Service Pump	Well Water (MG)	ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Holliman Dr. Monitor Well
1-Aug	3.7	0.7	1.1	0.0	0.0	4.4	70	76	Stage 3	13	No Rain	1619.64	1345'
2-Aug	3.7	1.7	1.1	0.1	0.0	5.5	86	76	Stage 3	13	No Rain	1619.65	
3-Aug	3.6	1.7	1.3	0.0	0.0	5.3	84	75	Stage 3	12	No Rain	1619.61	
4-Aug	2.8	1.3	0.2	0.0	0.0	4.1	74	76	Stage 3	12	No Rain	1619.57	
5-Aug	3.2	1.3	0.7	0.0	0.0	4.5	80	79	Stage 3	11	No Rain	1619.51	
6-Aug	3.9	1.9	1.2	0.0	0.0	5.8	103	83	Stage 3	11	No Rain	1619.44	
7-Aug	3.7	1.9	1.1	0.0	0.0	5.6	100	85	Stage 3	10	No Rain	1619.42	
8-Aug	3.4	1.6	0.9	0.0	0.0	5.0	90	88	Stage 3	9.6	No Rain	1619.31	
9-Aug	3.8	1.7	1.2	0.0	0.0	5.5	98	90	Stage 3	9.3	No Rain	1619.23	
10-Aug	3.5	1.9	1.1	0.1	0.0	5.5	98	92	Stage 3	8.9	No Rain	1619.18	
11-Aug	3.2	1.2	0.7	0.0	0.0	4.4	78	92	Stage 3	8.4	No Rain	1619.10	
12-Aug	3.1	0.8	0.4	0.0	0.0	3.9	70	91	Stage 3	10	0.29	1619.17	
13-Aug	3.7	1.4	1.3	0.0	0.0	5.1	90	89	Stage 3	11	No Rain	1619.15	
14-Aug	3.5	1.6	0.9	0.0	0.0	5.2	92	88	Stage 3	12	No Rain	1619.12	
15-Aug	3.7	0.8	1.0	0.0	0.0	4.5	80	87	Stage 3	14	No Rain	1619.10	1342'
16-Aug	3.5	1.0	1.1	0.4	0.0	4.9	87	85	Stage 3	13	No Rain	1619.07	
17-Aug	3.5	1.2	1.1	0.8	0.0	5.5	98	85	Stage 3	12	No Rain	1619.01	
18-Aug	3.0	0.8	0.4	0.6	0.0	4.5	80	85	Stage 3	11	No Rain	1618.98	
19-Aug	3.5	0.6	1.0	0.0	0.0	4.1	73	86	Stage 3	11	No Rain	1618.91	
20-Aug	3.7	0.9	1.2	0.4	0.0	5.1	91	86	Stage 3	11	No Rain	1618.81	
21-Aug	3.7	1.3	1.1	0.8	0.0	5.8	109	88	Stage 3	10	No Rain	1618.69	
22-Aug	3.6	0.9	1.2	0.2	0.0	4.7	88	89	Stage 3	10	No Rain	1618.58	
23-Aug	3.8	1.7	1.1	0.0	0.0	5.5	102	92	Stage 3	11	No Rain	1618.52	
24-Aug	3.7	1.9	1.1	0.2	0.0	5.8	108	93	Stage 3	11	No Rain	1618.48	
25-Aug	3.4	0.6	1.0	0.0	0.0	4.0	74	92	Stage 3	10	No Rain	1618.37	
26-Aug	3.4	0.6	0.9	0.0	0.0	4.0	74	92	Stage 3	9.5	No Rain	1618.29	
27-Aug	3.7	0.7	1.2	0.0	0.0	4.4	82	91	Stage 4	8.9	No Rain	1618.25	
28-Aug	3.7	1.2	1.1	0.0	0.0	4.9	92	88	Stage 4	8.4	No Rain	1618.20	
29-Aug	3.8	0.6	1.1	0.0	0.0	4.4	81	88	Stage 4	9.6	No Rain	1618.17	
30-Aug	3.4	0.6	1.0	0.0	0.0	4.0	75	84	Stage 4	9.2	No Rain	1618.11	
31-Aug	3.5	0.6	1.0	0.0	0.0	4.1	77	79	Stage 4	9.2	No Rain	1618.07	
Totals	109.4	36.8	30.6	3.6	0.0	150					0.29		
Average	3.5	1.2	1.0	0.1	0.0	4.8	87	86		11			
NOTES	815 MG for the year pumped out of 1,983 MG annually allowed by permit(s) from the River.	298 MG for the year pumped out of 1,356 MG annually allowed by Groundwater permit.	672 MG stored in the ASR system.			Daily average water produced for August is 4.7 MGD. (5 year average)	The Safe Operating Capacity was changed from 5.606 to 5.346 on 08/21/11.	7 day SOC between 95% and 100% SOC we remain in Stage 4.	Stage 4	Monthly mean flow for August is 106 CFS. (25 year average)	Monthly average rain fall for August is 1.67". (52 year avg.)	Normal Water Level in Lake is 1621.45 Feet above MSL	Monthly average water level for August is 1386' Mean Sea Level. (5 year avg.)

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / September 2011

	Water Pumped, Treated & Sent to Distribution												
Date	Surface Water (MG) High Service Pump	Well Water (MG)	ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Holliman Dr. Monitor Well
1-Sep	3.5	0.6	0.0	0.0	0.0	4.0	75	80	Stage 4	9.0	No Rain	1618.00	1340"
2-Sep	3.3	0.6	0.8	0.0	0.0	3.9	73	79	Stage 4	9.5	No Rain	1617.93	
3-Sep	3.3	0.6	0.8	0.0	0.0	4.0	74	78	Stage 4	9.5	No Rain	1617.85	
4-Sep	3.7	0.6	1.0	0.0	0.0	4.3	80	77	Stage 4	11	No Rain	1617.77	
5-Sep	3.3	0.6	0.8	0.0	0.0	3.9	73	75	Stage 4	10	No Rain	1617.73	
6-Sep	3.4	0.6	0.9	0.0	0.0	3.9	73	75	Stage 4	9.5	No Rain	1617.47	
7-Sep	2.7	1.2	1.1	0.0	0.0	3.9	85	76	Stage 4	8.4	No Rain	1617.35	
8-Sep	2.4	1.1	1.1	0.0	0.0	3.5	76	76	Stage 4	6.4	No Rain	1617.36	
9-Sep	2.4	0.6	1.0	0.4	0.0	3.3	72	76	Stage 4	7.1	No Rain	1617.34	
10-Sep	2.6	0.6	1.2	0.4	0.0	3.5	77	77	Stage 4	7.4	No Rain	1617.29	
11-Sep	2.5	1.0	1.0	0.3	0.0	3.8	82	77	Stage 4	10	No Rain	1617.35	
12-Sep	2.5	1.2	1.1	0.0	0.0	3.7	79	78	Stage 4	11	No Rain	1617.29	
13-Sep	2.3	1.0	1.1	0.9	0.0	4.3	92	80	Stage 4	11	No Rain	1617.30	
14-Sep	2.5	0.6	1.2	0.3	0.0	3.3	72	79	Stage 4	11	No Rain	1617.28	
15-Sep	2.7	1.1	1.2	0.4	0.0	4.3	92	81	Stage 4	11	No Rain	1617.25	1339'
16-Sep	2.4	1.1	1.0	0.6	0.0	4.1	88	83	Stage 4	13	0.05	1617.20	
17-Sep	2.5	1.0	1.1	0.0	0.0	3.6	77	83	Stage 4	13	No Rain	1617.13	
18-Sep	2.8	1.3	1.0	0.0	0.0	4.1	89	84	Stage 4	14	0.34	1617.06	
19-Sep	2.6	0.5	1.1	0.0	0.0	3.1	67	82	Stage 4	20	No Rain	1617.25	
20-Sep	2.4	0.8	1.0	0.3	0.0	3.5	75	80	Stage 4	20	No Rain	1617.18	
21-Sep	2.7	0.6	1.1	0.4	0.0	3.7	81	81	Stage 4	21	0.77	1617.13	
22-Sep	2.0	0.6	0.8	0.0	0.0	2.6	56	76	Stage 4	24	No Rain	1617.75	
23-Sep	2.3	1.0	0.9	0.0	0.0	3.3	71	74	Stage 4	20	No Rain	1618.14	
24-Sep	2.6	0.6	1.1	0.0	0.0	3.2	69	73	Stage 4	18	No Rain	1618.43	
25-Sep	2.7	1.2	1.1	0.0	0.0	3.9	84	72	Stage 4	15	No Rain	1618.53	
26-Sep	2.5	1.1	0.7	0.0	0.0	3.6	78	74	Stage 4	14	No Rain	1618.68	
27-Sep	2.3	0.9	1.0	0.0	0.0	3.2	70	73	Stage 4	14	0.38	1618.84	
28-Sep	2.3	0.7	0.9	0.0	0.0	3.0	65	71	Stage 4	12	0.02	1619.03	
29-Sep	2.3	0.7	0.9	0.0	0.0	2.9	64	72	Stage 4	14	0.01	1619.12	
30-Sep													
Totals	77.5	23.9	28.0	3.9	0.0	105					1.57		
Average	2.7	0.8	1.0	0.1	0.0	3.6	76	77		13			
NOTES	892 MG for the year pumped out of 1,983 MG annually allowed by permit(s) from the River.	309 MG for the year pumped out of 1,356 MG annually allowed by Groundwater permit.	639 MG stored in the ASR system.			Daily average water produced for September is 4.01 MGD (5 year average)	The Safe Operating Capacity was changed from 5.346 to 4.614 on 09/07/11.	7 day SOC between 95% and 100% SOC Stage 4.	Stage 4	Monthly mean flow for September is 110 CFS. (25 year average)	Monthly average rain fall for September is 3.65". (52 year avg.)	Normal Water Level in Lake is 1621.45 Feet above MSL	Monthly average water level for September is 1379' Mean Sea Level. (5 year avg.)

Water Reclamation Facility Flows
FY 2016

	Influent	Reclaimed Water Sold	Tailwater
Oct-15	60.01132	17.49418	47.00406
Nov-15	83.64466	2.61242	61.66885
Dec-15	84.30811	3.53696	62.07280
Jan-16	81.75511	3.51819	62.92474
Feb-16	80.44274	11.52035	52.53426
Mar-16	88.64081	4.68239	66.07070
Apr-16	69.79754	5.17660	70.29606
May-16	89.54351	4.96141	94.12038
Jun-16	92.07546	18.50954	85.86354
Jul-16	63.07908	31.64895	32.64652
Aug-16	65.18535	24.01104	44.80898
Sep-16	26.48215	6.69933	20.48032
Totals	884.96583	134.37137	700.49123
Total MG Treated in FY 2016			884.96583
Total MG Reclaimed Water sold in FY 2016			134.37137
Total MG to 3rd Creek in FY 2016			700.49123

*All volumes are MG (million gallons)

Day	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
1	1.916019	2.304935	2.857637	2.509102	2.725918	2.744599	2.254434	2.132287	4.618061	2.248272	2.008844	2.072794
2	1.880115	2.236799	2.830149	2.803884	2.675284	2.691221	2.054788	2.146960	5.274406	2.192719	2.001158	2.100066
3	1.873880	2.913903	2.758340	3.004803	2.715175	2.716276	2.090990	2.151590	4.993088	2.147523	1.929985	2.038020
4	0.993695	2.461592	2.691921	2.925645	2.675001	2.653489	2.120186	2.111027	4.510927	2.156690	1.961401	2.018223
5	2.398373	2.530412	2.626436	2.897104	2.664413	2.565682	2.060783	2.106034	4.156255	2.169236	1.996364	2.091875
6	1.173725	2.631945	2.696668	2.850808	2.608548	2.589686	2.057810	2.075678	3.909416	2.087094	1.926405	2.066004
7	1.837600	2.534726	2.577493	2.207335	2.696798	2.676870	2.062432	2.035325	3.652314	2.118615	1.906402	2.038050
8	2.064543	2.564072	2.736052	2.088923	2.734209	2.718260	2.008811	2.013414	3.519310	2.120832	1.944335	2.042160
9	2.266341	2.741610	2.704964	2.050848	2.673526	2.921676	1.949814	2.812378	3.358082	2.018267	1.913112	2.026286
10	1.877546	3.321791	2.599014	2.124030	2.629522	3.390003	2.024739	2.769225	3.229602	1.992968	1.946762	1.983345
11	1.879956	2.876761	2.587239	1.823457	2.683757	3.399412	2.057786	2.710335	3.076620	2.033433	1.927324	1.979105
12	1.989960	2.982554	2.505020	2.707320	2.670651	3.107182	2.323169	2.161462	2.981430	1.985235	1.974101	2.061701
13	1.947301	3.060014	3.490878	2.720351	2.644710	2.913150	2.424207	2.090119	2.994835	2.017016	1.976058	1.964516
14	1.986698	2.967928	2.876831	2.818486	2.579784	3.009457	2.108466	2.049191	2.883487	2.072826	2.565349	
15	1.919765	2.998327	3.145881	2.692512	2.798448	2.919717	2.122753	2.127274	2.803440	2.027783	2.302464	
16	1.930161	2.575061	2.749363	2.673306	2.713110	2.940711	2.052027	2.164790	2.746786	1.973454	2.556423	
17	1.883407	2.475191	2.767033	2.697176	2.719613	2.859771	2.524098	3.819025	2.685809	1.982565	2.142033	
18	0.479394	2.412935	2.655971	2.852861	2.638725	2.937115	3.148733	3.112018	2.551842	2.031440	2.093042	
19	1.648047	2.592568	2.658938	2.758185	2.586047	2.787748	2.753442	4.500328	2.444084	1.952813	2.051080	
20	1.866681	2.523508	2.533850	2.702319	2.531206	2.827637	2.568912	3.420379	2.518221	1.988657	2.524734	
21	1.870121	2.489744	2.716438	2.761818	2.531748	2.848482	3.176639	3.047389	2.281026	1.945185	2.141587	
22	1.796315	2.616156	2.663919	2.768400	2.665115	2.872489	2.695049	2.928532	2.429691	2.018450	2.377409	
23	3.239152	2.642498	2.719271	2.636804	5.552048	2.816775	2.549908	2.910537	2.435264	1.952255	2.190125	
24	2.628002	2.909164	2.663739	2.712306	2.710008	2.909384	2.511672	2.759612	2.378494	1.958595	2.191989	
25	2.004457	2.591667	2.282681	2.728525	2.695472	2.849247	2.478583	2.647122	2.251552	1.986222	2.116617	
26	1.973346	2.513280	2.478348	2.707634	2.735484	2.764715	2.382935	2.748715	2.330281	1.993420	2.078807	
27	1.828786	3.766187	2.758489	2.706576	2.707733	2.743262	2.568080	2.865783	2.325494	1.968698	2.033168	
28	1.926276	4.016389	2.746021	2.759807	2.671757	2.836197	2.266363	2.999104	2.256081	1.972247	2.077406	
29	2.604952	3.403420	2.776153	2.758710	2.808925	3.824829	2.246517	6.108390	2.255391	2.019970	2.178762	
30	2.119572	2.989523	2.695434	2.617566		2.736523	2.153416	5.514147	2.224175	1.988141	2.083699	
31	2.207134		2.757939	2.688506		2.069249		4.505340		1.958456	2.068404	
Monthly Total (MG)	60.011320	83.644660	84.308110	81.755107	80.442735	88.640814	69.797542	89.543510	92.075464	63.079077	65.185349	26.482145
Daily Average (MG)	1.935849	2.788155	2.719616	2.637262	2.773887	2.859381	2.326585	2.888500	3.069182	2.034809	2.102753	2.037088

FY 2013 Total (MG)	884.965833	→	In Thousand of Gallons	884965.83
FY 2013 Daily Avg. (MG)	2.514422	→	In Thousand of Gallons	2514.42

Influent Totals

City of Kerrville Wat lamation Division

Reclaimed Water Sold

Day	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
1	0.837722	0.051000	0.001240	0.017788	0.463161	0.182017	0.115607	0.087900	0.005900	1.365541	0.422144	0.397227
2	1.048207	0.002700	0.001150	0.118193	0.226774	0.222825	0.001000	-0.082000	0.003100	0.540498	0.641361	0.107392
3	1.281035	0.199565	0.056525	0.000000	0.258257	0.313834	0.029250	0.171326	0.191996	1.173875	1.132209	0.336362
4	1.099786	0.059133	0.060900	0.000000	0.594171	0.064545	0.100765	0.040692	0.094668	1.083839	1.563613	0.377105
5	1.033729	0.000000	0.116122	0.108629	0.053671	1.072143	1.018061	0.057101	0.171339	0.460019	1.423452	0.361492
6	1.246454	0.002000	0.068900	0.000110	0.073095	0.850065	0.868012	0.272595	0.029940	1.435287	1.777981	0.098290
7	0.770643	0.000000	0.196459	0.043268	0.497087	0.055633	0.218113	0.118179	0.080136	0.729999	1.833772	0.239102
8	0.094354	0.038592	0.127249	0.003410	0.723320	0.046537	0.902705	0.275485	0.038235	1.353953	1.588192	1.368570
9	0.279729	0.000100	0.480098	0.049027	0.153560	0.000100	0.316857	0.091545	0.121717	1.155417	1.370274	0.357218
10	0.403975	0.004300	0.302285	0.034973	0.336341	0.012400	0.125311	1.207716	0.451107	0.429497	1.200264	1.473780
11	1.457317	0.001500	0.051200	0.001168	0.983691	0.001020	0.065333	0.204455	1.009502	0.453341	1.143558	0.551606
12	0.318704	0.156382	0.065800	0.065460	0.533429	0.001100	0.091681	0.027950	0.154163	1.263341	1.195623	0.546234
13	0.920287	0.388856	0.128525	0.176776	1.774442	0.000000	0.303378	0.027200	0.602749	1.183380	0.952879	0.484950
14	0.978008	0.270614	0.066120	0.260627	1.345716	0.002000	0.029360	0.001000	1.305309	0.562212	1.218168	
15	0.578423	0.311211	0.001830	0.036673	0.375768	0.045700	0.007990	0.029100	1.251674	1.430077	0.863436	
16	0.082020	0.021800	0.057000	0.474643	0.613465	0.030930	0.036465	0.143850	0.464385	1.322461	0.077614	
17	1.427799	0.048100	0.099848	0.029019	0.153898	0.170740	0.001000	1.241839	0.279690	1.346820	0.081119	
18	0.914934	0.034400	0.072480	0.065457	0.006300	0.281950	0.001000	0.106200	0.531635	1.054014	1.008272	
19	0.740115	0.047900	0.151511	0.118813	0.071751	0.108334	0.001100	0.023643	1.209150	0.965306	0.124448	
20	0.824833	0.205337	0.443262	0.337802	0.087069	0.187748	0.065058	0.159960	1.588746	1.096090	0.087170	
21	0.242128	0.051241	0.025220	0.474703	0.296700	0.037450	0.291270	0.046871	1.044650	1.362604	0.184341	
22	0.105164	0.000000	0.027940	0.440424	0.001240	0.165624	0.249911	0.114110	1.336525	1.458745	0.053236	
23	0.020100	0.385498	0.257806	0.142057	0.044200	0.070350	0.240303	0.000040	0.307077	1.371586	0.005248	
24	0.046500	0.066700	0.262684	0.057360	0.071472	0.037210	-0.999090	0.401192	1.040186	1.127530	0.113252	
25	0.000700	0.022900	0.028500	0.027820	0.044149	0.177156	1.001300	0.033538	1.539731	1.335213	0.147006	
26	0.003500	0.046100	0.167961	0.040399	0.516581	0.049631	0.056381	0.048161	0.774365	0.963568	0.274704	
27	0.048302	0.148090	0.001000	0.046100	0.568779	0.034800	0.001390	0.023330	0.461596	0.744404	1.306606	
28	0.057802	0.045800	0.000000	0.059132	0.594614	0.076880	0.001170	0.001100	0.462058	0.495745	0.667026	
29	0.396975	0.001100	0.144667	0.036939	0.057651	0.112114	0.035622	0.033600	0.481085	1.195192	1.273166	
30	0.234936	0.001500	0.045570	0.046790		0.195487	0.000300	0.024900	1.477133	1.159030	0.109041	
31	0.000000		0.027111	0.204629		0.076072		0.028830		0.030370	0.171866	
Monthly Total (MG)	17.494180	2.612418	3.536962	3.518189	11.520352	4.682393	5.176603	4.961406	18.509544	31.648952	24.011040	6.699327
Daily Average (MG)	0.564328	0.087081	0.114096	0.113490	0.397254	0.151045	0.172553	0.160045	0.616985	1.020934	0.774550	0.515333

FY 2013 Total (MG)	134.371366	→	In Thousand of Gallons	134371.37
FY 2013 Daily Avg. (MG)	0.390641	→	In Thousand of Gallons	390.64

Reclaimed Totals

Day	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
1	46%	103%	99%	41%	69%	69%	117%	93%	131%	40%	35%	78%
2	52%	85%	70%	86%	59%	80%	97%	128%	106%	75%	64%	119%
3	26%	55%	96%	95%	78%	63%	126%	91%	124%	67%	57%	78%
4	66%	95%	64%	70%	41%	87%	87%	124%	93%	49%	17%	104%
5	30%	81%	63%	65%	87%	32%	64%	93%	92%	76%	32%	77%
6	30%	93%	87%	93%	71%	49%	46%	110%	120%	40%	12%	88%
7	57%	68%	67%	91%	68%	66%	55%	95%	107%	61%	11%	109%
8	89%	91%	66%	90%	16%	66%	62%	111%	123%	36%	13%	28%
9	107%	64%	68%	90%	63%	101%	82%	63%	97%	48%	19%	75%
10	73%	53%	58%	152%	64%	65%	116%	30%	121%	68%	44%	90%
11	118%	82%	87%	95%	27%	98%	89%	107%	93%	93%	37%	92%
12	76%	59%	69%	68%	63%	71%	81%	99%	118%	41%	44%	63%
13	49%	57%	82%	94%	85%	93%	134%	129%	92%	38%	50%	0%
14	64%	74%	68%	55%	63%	73%	85%	95%	78%	63%	57%	
15	73%	44%	59%	90%	55%	63%	134%	125%	121%	46%	62%	
16	82%	70%	91%	62%	64%	90%	86%	94%	80%	51%	97%	
17	65%	72%	67%	89%	62%	75%	120%	49%	124%	32%	131%	
18		96%	91%	65%	70%	77%	98%	137%	78%	48%	96%	
19	65%	72%	81%	87%	90%	70%	114%	96%	67%	51%	122%	
20	45%	60%	58%	59%	72%	86%	131%	150%	30%	45%	91%	
21	103%	94%	66%	49%	79%	65%	78%	102%	62%	30%	96%	
22	102%	61%	24%	67%	68%	67%	117%	124%	44%	28%	119%	
23	72%	76%	77%	67%	38%	89%	92%	93%	89%	30%	91%	
24	100%	59%	82%	86%	88%	72%	130%	97%	67%	42%	121%	
25	118%	88%	67%	70%	73%	87%	99%	130%	30%	33%	90%	
26	80%	100%	88%	91%	87%	69%	97%	94%	46%	52%	116%	
27	93%	57%	67%	63%	70%	93%	126%	125%	101%	62%	34%	
28	120%	88%	71%	69%	85%	69%	103%	85%	75%	75%	78%	
29	55%	63%	61%	87%	68%	48%	127%	124%	106%	41%	38%	
30	112%	82%	93%	68%		86%	98%	115%	34%	42%	87%	
31	113%		92%	61%		96%		125%		98%	116%	
Monthly Total (MG)	78%	74%	74%	77%	65%	75%	101%	105%	93%	52%	69%	77%
Daily Average (MG)	78%	74%	74%	77%	65%	75%	101%	105%	93%	52%	69%	84%
FY 2011 Total (MG)	79%											
FY 2011 Daily Avg. (MG)	80%											

Percent of ReUse Water Lost

City of Kerrville Wat lamation Division

Effluent Discharged

Day	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
1	0.886568	2.380824	2.842488	1.037648	1.888304	1.897624	2.631960	1.993304	6.062000	0.905376	0.707272	1.626832
2	0.970680	1.898704	1.974864	2.414096	1.587032	2.157264	2.003144	2.751968	5.597624	1.638536	1.284128	2.509280
3	0.488496	1.595352	2.653896	2.851208	2.116632	1.708440	2.633320	1.963832	6.190128	1.441248	1.109104	1.594912
4	0.659736	2.327216	1.720056	2.045008	1.105528	2.308952	1.852848	2.618000	4.200400	1.063312	0.339912	2.103584
5	0.729512	2.054544	1.653440	1.873232	2.326744	0.824450	1.326256	1.960104	3.811264	1.649464	0.647184	1.608560
6	0.354136	2.450472	2.335064	2.643624	1.853560	1.275414	0.938312	2.286776	4.707888	0.838592	0.232336	1.813920
7	1.042792	1.735848	1.730784	2.004664	1.830872	1.769240	1.127408	1.935480	3.907112	1.288144	0.206792	2.224088
8	1.841256	2.330896	1.806880	1.884136	0.431792	1.803032	1.251008	2.230250	4.344224	0.759560	0.244688	0.576472
9	2.430577	1.758736	1.834984	1.836616	1.694654	2.957144	1.592800	1.762342	3.269504	0.962304	0.372000	1.512496
10	1.362119	1.751400	1.519856	3.224864	1.694654	2.197848	2.354904	0.839032	3.894520	1.352832	0.860351	1.778816
11	2.226552	2.363504	2.256408	1.735624	0.728248	3.335000	1.827336	2.901520	2.873616	1.897200	0.717057	1.828958
12	1.509336	1.755712	1.717272	1.852488	1.675296	2.199976	1.877384	2.131744	3.527488	0.815752	0.872176	1.302402
13	0.952672	1.748104	2.851872	2.547248	2.253880	2.712571	3.245224	2.699096	2.769208	0.764072	0.983016	
14	1.262696	2.182878	1.961072	1.544304	1.636144	2.200101	1.798264	1.947720	2.237176	1.306648	1.471800	
15	1.399472	1.307730	1.851680	2.430528	1.544048	1.845520	2.847960	2.660504	3.400032	0.941208	1.438970	
16	1.583104	1.798496	2.497896	1.651736	1.745528	2.649328	1.765576	2.040680	2.209488	1.011376	2.478810	
17	1.231536	1.791440	1.846184	2.405008	1.698712	2.138016	3.041184	1.852304	3.319920	0.635745	2.811088	
18	1.192416	2.313256	2.426520	1.866400	1.837984	2.275896	3.097056	4.271664	1.983392	0.977426	2.009264	
19	1.065264	1.875880	2.164688	2.404088	2.324016	1.949912	3.150960	4.313312	1.630920	0.987508	2.495856	
20	0.835912	1.510240	1.457960	1.596656	1.820856	2.424400	3.375600	5.127160	0.762792	0.892567	2.300912	
21	1.923744	2.338960	1.782008	1.362560	1.995528	1.856795	2.480280	3.120904	1.404264	0.582581	2.066048	
22	1.839376	1.602152	0.644240	1.843672	1.822704	1.914789	3.154440	3.640456	1.069816	0.559705	2.832400	
23	2.334072	2.004920	2.099832	1.759152	2.117424	2.504128	2.337528	2.718056	2.165520	0.580669	1.997888	
24	2.630152	1.728808	2.173832	2.327736	2.389352	2.100496	3.263512	2.666784	1.602624	0.831065	2.644032	
25	2.359568	2.286216	1.540224	1.902168	1.960936	2.469200	2.460640	3.449776	0.673688	0.651010	1.903880	
26	1.584240	2.510600	2.177752	2.450838	2.385720	1.899976	2.322808	2.585904	1.060504	1.029852	2.413504	
27	1.693096	2.147776	1.853672	1.716562	1.884600	2.562856	3.231576	3.583664	2.350048	1.224294	0.691696	
28	2.309504	3.515160	1.962648	1.903184	2.279680	1.944648	2.342496	2.561144	1.693896	1.476502	1.614952	
29	1.436176	2.158480	1.682168	2.408352	1.903832	1.852368	2.852808	7.556440	2.381344	0.824778	0.837640	
30	2.376528	2.444544	2.517200	1.769616		2.350248	2.111472	6.319008	0.763144	0.829111	1.819352	
31	2.492768		2.535360	1.631728		1.985072		5.631456		1.928086	2.404872	
Monthly Total (MG)	47.004056	61.668848	62.072800	62.924744	52.534259	66.070704	70.296064	94.120384	85.863544	32.646522	44.808980	20.480320
Daily Average (MG)	1.516260	2.055628	2.002348	2.029830	1.811526	2.131313	2.343202	3.036141	2.862118	1.053114	1.445451	1.706693

FY 2016 Total (MG)	700.491225	→	In Thousand of Gallons	700491.23
FY 2016 Daily Avg. (MG)	1.999469	→	In Thousand of Gallons	1999.47

Tailwater Totals

Day	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
1	44%	2%	0%	1%	17%	7%	5%	4%	0%	61%	21%	19%
2	56%	0%	0%	4%	8%	8%	0%	-4%	0%	25%	32%	5%
3	68%	7%	2%	0%	10%	12%	1%	8%	4%	55%	59%	17%
4	111%	2%	2%	0%	22%	2%	5%	2%	2%	50%	80%	19%
5	43%	0%	4%	4%	2%	42%	49%	3%	4%	21%	71%	17%
6	106%	0%	3%	0%	3%	33%	42%	13%	1%	69%	92%	5%
7	42%	0%	8%	2%	18%	2%	11%	6%	2%	34%	96%	12%
8	5%	2%	5%	0%	26%	2%	45%	14%	1%	64%	82%	67%
9	12%	0%	18%	2%	6%	0%	16%	3%	4%	57%	72%	18%
10	22%	0%	12%	2%	13%	0%	6%	44%	14%	22%	62%	74%
11	78%	0%	2%	0%	37%	0%	3%	8%	33%	22%	59%	28%
12	16%	5%	3%	2%	20%	0%	4%	1%	5%	64%	61%	26%
13	47%	13%	4%	6%	67%	0%	13%	1%	20%	59%	48%	25%
14	49%	9%	2%	9%	52%	0%	1%	0%	45%	27%	47%	
15	30%	10%	0%	1%	13%	2%	0%	1%	45%	71%	38%	
16	4%	1%	2%	18%	23%	1%	2%	7%	17%	67%	3%	
17	76%	2%	4%	1%	6%	6%	0%	33%	10%	68%	4%	
18		1%	3%	2%	0%	10%	0%	3%	21%	52%	48%	
19	45%	2%	6%	4%	3%	4%	0%	1%	49%	49%	6%	
20	44%	8%	17%	13%	3%	7%	3%	5%	63%	55%	3%	
21	13%	2%	1%	17%	12%	1%	9%	2%	46%	70%	9%	
22	6%	0%	1%	16%	0%	6%	9%	4%	55%	72%	2%	
23	1%	15%	9%	5%	1%	2%	9%	0%	13%	70%	0%	
24	2%	2%	10%	2%	3%	1%		15%	44%	58%	5%	
25	0%	1%	1%	1%	2%	6%	40%	1%	68%	67%	7%	
26	0%	2%	7%	1%	19%	2%	2%	2%	33%	48%	13%	
27	3%	4%	0%	2%	21%	1%	0%	1%	20%	38%	64%	
28	3%	1%	0%	2%	22%	3%	0%	0%	20%	25%	32%	
29	15%	0%	5%	1%	2%	3%	2%	1%	21%	59%	58%	
30	11%	0%	2%	2%		7%	0%	0%	66%	58%	5%	
31	0%		1%	8%		4%		1%		2%	8%	
Monthly Total (MG)	29%	3%	4%	4%	14%	5%	7%	6%	20%	50%	37%	25%
Daily Average (MG)	29%	3%	4%	4%	14%	5%	7%	6%	20%	50%	37%	25%
FY 2011 Total (MG)	15%											
FY 2011 Daily Avg. (MG)	16%											

Percent of ReUse Water Sold

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / June 2016

	Water Pumped, Treated & Sent to Distribution												
Date	Treated Surface Water. Includes *ASR 1 Recovered Water (MG) High Service Pump	Well Water (MG)	*ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Hollman Dr. Monitor Well
1-Jun	1.3	1.5	1.2	0.0	0.0	2.8	32	33	Year Round	807	1.67	1622.43	1393
2-Jun	1.5	1.5	1.5	0.0	0.0	3.0	34	33	Year Round	1240	0.45	1623.35	
3-Jun	1.7	1.1	1.4	0.0	0.0	2.8	32	33	Year Round	667	0.10	1622.17	
4-Jun	1.4	1.1	1.4	0.0	0.0	2.5	29	32	Year Round	571	0.02	1622.33	
5-Jun	1.7	1.3	1.5	0.0	0.0	3.0	35	32	Year Round	492	No Rain	1622.22	
6-Jun	1.4	1.5	0.4	0.0	0.0	2.8	33	33	Year Round	437	No Rain	1621.95	
7-Jun	3.8	0.1	0.0	0.0	0.5	3.5	40	33	Year Round	398	No Rain	1621.89	
8-Jun	3.9	0.0	0.0	0.0	0.8	3.1	35	34	Year Round	370	No Rain	1621.93	
9-Jun	4.0	0.0	0.0	0.0	0.5	3.6	41	35	Year Round	309	No Rain	1621.79	
10-Jun	4.0	0.0	0.0	0.0	0.5	3.5	40	36	Year Round	292	No Rain	1621.86	
11-Jun	3.9	0.0	0.0	0.0	0.2	3.7	42	38	Year Round	275	No Rain	1621.82	
12-Jun	3.8	0.0	0.0	0.0	0.5	3.3	37	38	Year Round	254	No Rain	1621.79	
13-Jun	3.6	0.0	0.0	0.0	0.4	3.2	37	39	Year Round	243	No Rain	1621.61	
14-Jun	4.0	0.0	0.0	0.0	0.1	3.9	44	39	Year Round	230	No Rain	1621.61	
15-Jun	4.2	0.1	0.3	0.0	0.0	4.2	48	41	Year Round	215	No Rain	1621.56	1399'
16-Jun	4.2	0.0	0.3	0.0	0.0	4.2	48	42	Year Round	199	No Rain	1621.73	
17-Jun	4.0	0.0	0.0	0.0	0.3	3.7	42	43	Year Round	186	No Rain	1621.48	
18-Jun	4.3	0.0	0.5	0.0	0.0	4.3	49	44	Year Round	176	No Rain	1621.69	
19-Jun	3.8	0.0	0.1	0.0	0.0	3.8	44	45	Year Round	169	No Rain	1621.68	
20-Jun	3.7	0.0	0.0	0.0	0.0	3.7	42	45	Year Round	162	No Rain	1621.53	
21-Jun	4.5	0.0	1.3	0.0	0.0	4.5	52	47	Year Round	155	No Rain	1621.63	
22-Jun	5.1	0.0	1.5	0.0	0.0	5.1	59	48	Year Round	147	No Rain	1621.62	
23-Jun	4.5	0.0	0.6	0.0	0.2	4.3	49	48	Year Round	139	No Rain	1621.62	
24-Jun	3.9	0.0	0.0	0.0	0.0	3.9	45	49	Year Round	134	No Rain	1621.58	
25-Jun	4.7	0.0	1.0	0.0	0.0	4.7	54	49	Year Round	130	0.07	1621.61	
26-Jun	4.5	0.0	0.4	0.0	0.4	4.1	47	50	Year Round	144	0.80	1621.59	
27-Jun	3.2	0.0	0.0	0.0	0.4	2.8	33	48	Year Round	139	No Rain	1621.62	
28-Jun	4.5	0.0	0.5	0.0	0.2	4.2	48	48	Year Round	125	No Rain	1621.59	
29-Jun	4.8	0.0	0.8	0.0	0.0	4.8	55	47	Year Round	118	No Rain	1621.59	
30-Jun	4.0	0.0	0.0	0.0	0.0	4.0	46	47	Year Round	111	No Rain	1621.55	
Totals	107.9	8.1	14.6	0.0	4.9	111					3.11		
Average	3.6	0.3	0.5	0.0	0.2	3.7	42	41		301			
NOTES	642 MG for the year pumped out of 2,221 MG annually allowed by permit(s) from the River	50 MG for the year pumped out of 1,441 MG annually allowed by Groundwater permit	651 Million Gallons stored in the ASR system.			Daily average water produced for June is 4.16 MGD (5 year average)	The Safe Operating Capacity was changed from 6.120 to 8.738 on 06/10/15.	7 day SOC Less than 65% Year Round	Year Round	June Mean flow is 172 cfs (30 year average) Median is 74 cfs	Monthly average rain fall for June is 3.53" 30 year avg.)	Normal Water Level in Lake is between 1621.35 - 1621.45 Feet above MSL	Monthly average water level for June is 1364' Mean Sea Level. (5 year avg.)

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / July 2016

	Water Pumped, Treated & Sent to Distribution												
Date	Treated Surface Water. Includes *ASR 1 Recovered Water (MG) High Service Pump	Well Water (MG)	*ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Holliman Dr. Monitor Well
1-Jul	4.3	0.0	0.5	0.0	0.0	4.3	50	47	Year Round	110	No Rain	1622.55	1399'
2-Jul	4.2	0.5	0.1	0.0	0.2	4.5	52	47	Year Round	104	No Rain	1623.55	
3-Jul	4.1	0.9	0.0	0.0	0.2	4.8	55	48	Year Round	101	No Rain	1622.55	
4-Jul	4.0	1.1	0.2	0.0	0.2	4.9	56	52	Year Round	99	No Rain	1622.48	
5-Jul	4.1	0.9	0.0	0.0	0.4	4.7	53	52	Year Round	93	No Rain	1622.54	
6-Jul	4.6	0.9	0.4	0.0	0.4	5.1	58	53	Year Round	86	No Rain	1621.46	
7-Jul	4.7	1.0	0.0	0.0	1.0	4.7	54	54	Year Round	80	No Rain	1621.46	
8-Jul	4.9	0.1	0.5	0.0	0.3	4.7	54	55	Year Round	76	No Rain	1621.45	
9-Jul	5.6	0.2	0.9	0.0	0.4	5.4	62	56	Year Round	74	No Rain	1621.44	
10-Jul	4.4	0.0	0.5	0.0	0.0	4.4	50	55	Year Round	73	No Rain	1621.51	
11-Jul	4.6	0.0	0.2	0.0	0.0	4.6	53	55	Year Round	70	No Rain	1621.44	
12-Jul	5.3	0.0	1.0	0.0	0.0	5.3	60	56	Year Round	64	No Rain	1621.44	
13-Jul	5.5	0.3	1.0	0.0	0.0	5.8	66	57	Year Round	66	No Rain	1621.42	
14-Jul	4.7	0.6	0.3	0.0	0.0	5.3	60	58	Year Round	61	No Rain	1621.42	
15-Jul	4.1	1.3	0.0	0.0	0.6	4.8	55	58	Year Round	54	No Rain	1621.42	
16-Jul	5.0	1.3	0.7	0.0	0.6	5.7	65	58	Year Round	54	No Rain	1621.41	1391'
17-Jul	4.4	1.5	0.7	0.0	0.0	5.9	68	61	Year Round	54	No Rain	1621.32	
18-Jul	4.7	0.0	0.9	0.0	0.0	4.7	54	61	Year Round	52	No Rain	1621.46	
19-Jul	5.6	0.3	1.2	0.0	0.0	5.9	68	62	Year Round	51	No Rain	1621.35	
20-Jul	4.9	0.7	0.8	0.0	0.1	5.5	62	62	Year Round	50	No Rain	1621.46	
21-Jul	5.1	0.6	0.0	0.0	0.2	5.4	62	62	Year Round	47	No Rain	1621.45	
22-Jul	4.8	0.0	0.7	0.0	0.0	4.8	55	62	Year Round	44	No Rain	1621.42	
23-Jul	5.3	0.4	1.4	0.0	0.0	5.8	66	62	Year Round	45	No Rain	1621.42	
24-Jul	4.5	1.0	1.4	0.0	0.0	5.5	63	62	Year Round	43	No Rain	1621.42	
25-Jul	4.1	0.9	0.5	0.0	0.0	5.0	57	62	Year Round	41	0.06	1621.45	
26-Jul	4.8	0.4	0.5	0.0	0.0	5.1	59	61	Year Round	41	0.01	1621.44	
27-Jul	4.6	0.9	0.4	0.0	0.0	5.5	63	61	Year Round	46	No Rain	1621.43	
28-Jul	4.8	0.5	0.8	0.0	0.3	5.0	58	60	Year Round	136	No Rain	1621.52	
29-Jul	5.4	0.2	1.0	0.0	0.0	5.5	63	61	Year Round	84	No Rain	1621.52	
30-Jul	5.2	0.5	0.8	0.0	0.0	5.6	64	61	Year Round	60	No Rain	1621.49	
31-Jul	5.0	0.7	0.0	0.0	0.0	5.7	65	61	Year Round	50	No Rain	1621.32	
Totals	147.2	17.5	17.5	0.0	4.7	160					0.07		
Average	4.7	0.6	0.6	0.0	0.2	5.2	59	58		68			
NOTES	789 MG for the year pumped out of 2,221 MG annually allowed by permit(s) from the River	68 MG for the year pumped out of 1,441 MG annually allowed by Groundwater permit	637 Million Gallons stored in the ASR system			Daily average water produced for July is 4.7 MGD (5 year average)	The Safe Operating Capacity was changed from 6.120 to 8.738 on 06/10/15.	7 day SOC Less than 65% Year Round	Year Round	July Mean flow is 168 cfs (30 year average) Median is 57 cfs	Monthly average rain fall for July is 2.75" 30 year avg.)	Normal Water Level in Lake is between 1621.35 - 1621.45 Feet above MSL	Monthly average water level for July is 1359' Mean Sea Level. (5 year avg.)

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / August 2016

	Water Pumped, Treated & Sent to Distribution												
Date	Treated Surface Water. Includes *ASR 1 Recovered Water (MG) High Service Pump	Well Water (MG)	*ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Holliman Dr. Monitor Well
1-Aug	4.3	0.6	0.6	0.0	0.0	4.9	56	61	Year Round	79	No Rain	1621.28	1389'
2-Aug	5.2	0.7	1.2	0.0	0.0	5.8	67	62	Year Round	72	No Rain	1621.28	
3-Aug	5.7	0.7	1.4	0.0	0.0	6.4	73	64	Year Round	68	No Rain	1621.28	
4-Aug	4.9	0.6	1.2	0.0	0.0	5.5	63	64	Year Round	66	No Rain	1621.43	
5-Aug	4.3	0.6	0.8	0.0	0.0	4.9	56	63	Year Round	64	No Rain	1621.42	
6-Aug	5.0	0.6	1.0	0.0	0.0	5.6	64	63	Year Round	62	No Rain	1621.42	
7-Aug	5.1	0.6	1.4	0.0	0.0	5.7	65	63	Year Round	60	No Rain	1621.43	
8-Aug	4.5	0.6	0.6	0.0	0.0	5.1	58	64	Year Round	58	No Rain	1621..40	
9-Aug	4.9	1.1	0.5	0.0	0.0	6.0	68	64	Year Round	57	No Rain	1621.38	
10-Aug	5.7	1.0	1.4	0.0	0.0	6.7	76	64	Year Round	58	No Rain	1621.40	
11-Aug	4.8	0.6	1.0	0.0	0.0	5.4	62	64	Year Round	58	No Rain	1621.40	
12-Aug	4.7	0.5	0.9	0.0	0.0	5.2	59	65	Year Round	52	0.05	1621.40	
13-Aug	4.3	0.6	0.3	0.0	0.0	4.9	56	63	Year Round	66	0.35	1621.40	
14-Aug	4.0	0.7	0.4	0.0	0.2	4.5	52	62	Year Round	288	2.93	1621.57	
15-Aug	4.1	0.0	0.0	0.0	0.7	3.4	39	59	Year Round	276	0.57	1621.93	1383'
16-Aug	4.1	0.0	0.0	0.0	0.0	4.1	47	56	Year Round	269	1.83	1621.79	
17-Aug	3.8	0.0	0.0	0.0	0.2	3.5	40	51	Year Round	255	0.48	1621.87	
18-Aug	4.7	0.0	0.0	0.0	1.0	3.7	42	48	Year Round	207	No Rain	1621.87	
19-Aug	4.0	0.0	0.0	0.0	0.9	3.1	35	45	Year Round	172	No Rain	1621.85	
20-Aug	4.4	0.0	0.0	0.0	0.9	3.6	41	42	Year Round	190	1.18	1621.85	
21-Aug	4.0	0.0	0.0	0.0	0.8	3.2	37	40	Year Round	208	0.06	1621.82	
22-Aug	4.1	0.0	0.0	0.0	1.0	3.1	35	40	Year Round	276	0.50	1621.64	
23-Aug	4.3	0.0	0.0	0.0	0.7	3.6	41	39	Year Round	260	No Rain	1622.22	
24-Aug	4.7	0.0	0.0	0.0	0.8	3.9	45	39	Year Round	197	No Rain	1621.87	
25-Aug	4.7	0.0	0.0	0.0	0.6	4.1	47	40	Year Round	170	No Rain	1621.57	
26-Aug	4.6	0.0	0.0	0.0	0.8	3.8	44	41	Year Round	156	No Rain	1621.57	
27-Aug	4.6	0.1	0.0	0.0	0.8	4.0	45	42	Year Round	148	No Rain	1621.53	
28-Aug	4.3	0.0	0.0	0.0	0.7	3.6	41	43	Year Round	141	No Rain	1621.56	
29-Aug	4.3	0.2	0.0	0.0	0.4	4.0	46	44	Year Round	137	0.27	1621.46	
30-Aug	4.0	0.2	0.0	0.0	0.8	3.5	40	44	Year Round	136	No Rain	1621.56	
31-Aug	4.4	0.4	0.0	0.0	0.5	4.4	50	45	Year Round	138	No Rain	1621.56	
Totals	140.2	10.5	12.9	0.0	11.6	139					8.22		
Average	4.5	0.3	0.4	0.0	0.4	4.5	51	53		143			
NOTES	929 MG for the year pumped out of 2,221 MG annually allowed by permit(s) from the River	79 MG for the year pumped out of 1,441 MG annually allowed by Groundwater permit	636 Million Gallons stored in the ASR system.			Daily average water produced for August is 4.9 MGD (5 year average)	The Safe Operating Capacity was changed from 8.738 to 9.758 on 08/08/16.	7 day SOC Less than 65% Year Round	Year Round	August Mean flow is 90 cfs (30 year average) Median is 49 cfs	Monthly average rain fall for August is 1.75" 30 year avg.)	Normal Water Level in Lake is between 1621.35 - 1621.45 Feet above MSL	Monthly average water level for August is 1350' Mean Sea Level. (5 year avg.)

CITY OF KERRVILLE WEEKLY WATER RESOURCES REPORT / September 2016

	Water Pumped, Treated & Sent to Distribution												
Date	Treated Surface Water. Includes *ASR 1 Recovered Water (MG) High Service Pump	Well Water (MG)	*ASR 1 Recovered Water (MG)	ASR 2 Recovered Water (MG)	ASR Wells Surface Water Stored (MG)	Total Water Produced (MG)	% Safe Operating Capacity (SOC)	% SOC 7 Day Running Average	Water Stage	Daily Average River Flow (CFS)	Precipitation (Inches)	Lake Level (Feet Above MSL)	Aquifer Level @ Mac Holliman Dr. Monitor Well
1-Sep	4.4	0.1	0.8	0.0	0.0	4.5	52	61	Year Round	135	No Rain	1621.54	1387'
2-Sep	4.4	0.2	0.9	0.0	0.0	4.6	52	62	Year Round	209	0.04	1621.73	
3-Sep	4.2	0.2	1.0	0.0	0.0	4.4	51	64	Year Round	165	No Rain	1621.61	
4-Sep	4.4	0.2	0.9	0.0	0.0	4.6	53	64	Year Round	147	No Rain	1621.39	
5-Sep	4.2	0.0	1.0	0.0	0.0	4.2	48	63	Year Round	141	No Rain	1621.56	
6-Sep	4.3	0.4	0.5	0.0	0.0	4.7	54	63	Year Round	132	No Rain	1621.36	
7-Sep	5.0	0.1	0.5	0.0	0.0	5.1	59	53	Year Round	125	No Rain	1621.54	
8-Sep	4.7	0.3	0.9	0.0	0.0	5.0	57	53	Year Round	120	No Rain	1621.53	
9-Sep	4.6	0.1	0.7	0.0	0.0	4.7	53	54	Year Round	115	No Rain	1621.52	
10-Sep	4.6	0.3	0.8	0.0	0.0	4.9	56	54	Year Round	112	No Rain	1621.52	
11-Sep	4.4	0.5	0.8	0.0	0.0	5.0	57	55	Year Round	108	No Rain	1621.50	
12-Sep	4.3	0.2	0.8	0.0	0.0	4.6	52	55	Year Round	106	No Rain	1621.48	
13-Sep	4.4	0.5	0.7	0.0	0.0	4.9	56	56	Year Round	106	0.07	1621.48	
14-Sep	4.4	0.4	0.0	0.0	0.3	4.5	51	55	Year Round	107	No Rain	1621.48	
15-Sep	4.6	0.2	0.0	0.0	0.5	4.3	49	54	Year Round	106	No Rain	1621.50	1389'
16-Sep	4.4	0.6	0.0	0.0	0.8	4.2	48	53	Year Round	106	No Rain	1621.48	
17-Sep	4.2	0.4	0.0	0.0	0.3	4.3	49	52	Year Round	102	No Rain	1621.48	
18-Sep	4.2	0.4	0.0	0.0	0.5	4.0	46	50	Year Round	100	No Rain	1621.48	
19-Sep	4.1	0.4	0.3	0.0	0.0	4.5	51	50	Year Round	99	No Rain	1621.45	
20-Sep	4.0	0.6	0.0	0.0	0.0	4.7	53	50	Year Round	94	No Rain	1621.47	
21-Sep	4.7	0.4	0.0	0.0	0.0	5.0	58	51	Year Round	88	No Rain	1621.47	
22-Sep	4.4	0.3	0.0	0.0	0.4	4.3	49	51	Year Round	87	No Rain	1621.42	
23-Sep	4.7	0.0	0.0	0.0	0.7	3.9	45	50	Year Round	86	No Rain	1621.41	
24-Sep	4.5	0.3	0.0	0.0	0.9	3.9	44	50	Year Round	84	No Rain	1621..41	
25-Sep	4.2	0.4	0.0	0.0	0.5	4.0	46	50	Year Round	116	0.72	1621.46	
26-Sep	4.0	0.0	0.0	0.0	0.6	3.3	38	48	Year Round	171	0.54	1621.59	
27-Sep	4.0	0.3	0.0	0.0	1.1	3.2	36	45	Year Round	153	No Rain	1621.59	
28-Sep	4.4	0.3	0.0	0.0	0.9	3.8	44	43	Year Round	128	No Rain	1621.54	
29-Sep	5.0	0.3	0.0	0.0	0.7	4.5	52	44	Year Round	127	No Rain	1621.53	
30-Sep	4.5	0.1	0.0	0.0	0.8	3.8	43	43	Year Round	113	No Rain	1621.54	
Totals	132.0	8.6	10.5	0.0	9.1	131							
Average	4.4	0.3	0.4	0.0	0.3	4.4	50	53		120	1.37		
NOTES	**1061 MG** for the year pumped out of **2,221 MG** annually allowed by permit(s) from the River	**90 MG** for the year pumped out of **1,441 MG** annually allowed by Groundwater permit	**654 Million Gallons** stored in the ASR system.			Daily average water produced for **September** is **4.0 MGD** (5 year average)	The Safe Operating Capacity was changed from **8.738 to 9.758** on 08/08/16.	**7 day SOC Less than 65%** Year Round	Year Round	**September** Mean flow is **95 cfs** (30 year average) Median is **72 cfs**	Monthly average rain fall for **September** is **3.83"** (30 year avg.)	Normal Water Level in Lake is between **1621.35 - 1621.45** Feet above MSL	Monthly average water level for **September** is **1346'** Mean Sea Level. (5 year avg.)

Exhibit 4
Texas Historical Commission Documents

- Texas Historical Commission Final Letter – August 17, 2015
- Submission to Texas Historical Commission – January 7, 2015

TEXAS HISTORICAL COMMISSION
real places telling real stories

RECEIVED
AUG 22 2015
Prewitt and Associates, Inc.

August 17, 2015

Karl Kibler
Prewitt & Associates, Inc.
2105 Donley Dr., Ste 400
Austin, TX 78758

Re: Draft report review under the Antiquities Code of Texas: *Archeological Survey for the Kerrville Water Reuse Project, City of Kerrville, Kerr County* (City of Kerrville; Track #201511136; TAC 7294)

Dear Mr. Kibler:

Thank you for allowing us to review the report referenced above. This letter serves as comment from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission.

The review staff, led by Tiffany Osburn, has completed its review. We concur that site 41KR501 is ineligible for inclusion in the National Register of Historic Places or designation as a State Archeological Landmark due to the lack of data potential and disturbance. We also concur with the recommendation that no further archeological investigation is needed within the area surveyed unless cultural resources are encountered during construction. In addition, please submit a cover letter with future draft report submissions that summarizes your recommendations.

Thank you for your cooperation in this review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If we may be of further assistance, please call Tiffany Osburn of our staff at 512/463-8883.**

Sincerely,

for
Mark Wolfe
State Historic Preservation Officer
MW/to

ARCHEOLOGICAL SURVEY FOR THE KERRVILLE WATER REUSE PROJECT, CITY OF KERRVILLE, KERR COUNTY, TEXAS

by

Karl W. Kibler

and

John E. Dockall

Principal Investigator: Ross C. Fields

TECHNICAL REPORTS, NUMBER 100

submitted to

Freese and Nichols, Inc.
Austin, Texas

and

City of Kerrville, Texas

by

Prewitt and Associates, Inc.
Cultural Resources Services
Austin, Texas

PAI No. 215006

September 2015

TEXAS ANTIQUITIES PERMIT NO. 7294

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ABSTRACT

Personnel from Prewitt and Associates, Inc. conducted archeological investigations in two phases (June 3–5 and 22–24, 2015) for the City of Kerrville's proposed water reuse project along Third Creek in Kerr County, Texas. The investigations consisted of pedestrian survey and excavation of 5 shovel tests and 29 backhoe trenches. The pedestrian survey did not observe any artifacts or cultural features and noted a number of disturbances across the surface of the project area. The survey identified four surfaces (one bedrock and three alluvial) within the project area, two of which (T_2 and T_1) warranted shovel testing and trenching. Five shovel tests were excavated on the T_1 surface, where disturbances appeared to be minimal and the deposits appeared to be less than 1 m thick. Other than modern items (e.g., wire nails), no artifacts were found. The broader T_1 surface on the east side of the Third Creek was not shovel tested due to extensive disturbance and modifications. Twenty-nine backhoe trenches were excavated, two on the higher T_2 surface and 27 on the T_1 surface. Four allostratigraphic units probably dating to the late Pleistocene, late Pleistocene/early Holocene, late Holocene, and late Holocene/Historic were defined below these two surfaces. All but the earliest unit have the potential to contain buried intact archeological sites, but none were encountered in the trenching. One previously recorded site, 41KR501, is mapped within the project area, but no evidence of it was found. Site 41KR501 appears to have a low artifact density, lacks buried cultural features, and has been disturbed by construction activities. Based on these attributes, it is recommended that the site be judged ineligible for listing in the National Register of Historic Places and designation as a State Antiquities Landmark. For the overall project area, it is recommended that the project proceed without any additional archeological investigations based on the lack of cultural materials encountered during the pedestrian survey, shovel testing, and trenching.

ACKNOWLEDGMENTS

Several individuals aided the authors of this report, helping them to successfully complete this project. They are Charles Kucherka, P.E., of Freese and Nichols, Inc., Malcolm Matthews, Parks and Recreation director for the City of Kerrville, and Tom Calderon of San Antonio, who provided backhoe services. Karl Kibler served as the project archeologist. John Dockall and Aaron Norment served as assistant project archeologists. Ross Fields served as principal investigator. Sandy Hannum and Brian Wootan produced the figures for this report.

INTRODUCTION

On June 3–5 and 22–24, 2015, personnel with Prewitt and Associates, Inc., conducted an archeological survey for the City of Kerrville's proposed water reuse project (Figure 1). The proposed project includes the construction of a 24-inch gravity-fed reuse line running from the city's existing wastewater treatment plant overlooking Third Creek to a proposed ca. 25-acre detention pond (Figure 2). The detention pond will be bound by earthen berms using soil materials from a ca. 30-acre borrow area north of the proposed pond. The project also includes a 12-inch pressurized reuse distribution line running from the detention pond and connecting to the existing reuse system. The 24-inch gravity-fed reuse line is ca. 3,000 ft long (ca. 915 m), and the 12-inch pressurized reuse distribution line is ca. 1,200 ft long (ca. 365 m). A 100-ft wide corridor centered on both reuse lines, totaling ca. 9.6 acres, was examined, as were the 25-acre detention pond and 30-acre borrow area, for a total of ca. 65 acres.

The archeological investigations were authorized by the State of Texas Antiquities Code (Texas Natural Resource Code of 1977, Title 9, Chapter 191, VTCS 6145-9) and conducted under Texas Antiquities Permit No. 7294. The work was conducted for the City of Kerrville, Texas, under a subcontract with Freese and Nichols, Inc.

ENVIRONMENTAL SETTING

The project area is in east-central Kerr County, Texas, within the city limits of Kerrville. This portion of the county is part of the Balcones Canyonlands, which represents the highly dissected and eroded eastern and southern margins of the Edwards Plateau. The Balcones Canyonlands is a transitional zone between the Edwards Plateau and the Gulf Coastal Plain to the east and south consisting of deeply incised and faulted lower Cretaceous carbonate rocks. Because it is a transitional zone, its floral and faunal communities and other characteristics tend to consist of a mix of Edwards Plateau, Blackland Prairie, and South Texas Plains elements.

Faunas of the Balcones Canyonlands belong to the Balconian biotic province (Blair 1950), although very few are endemic to the province, as it contains a mix of species from the adjacent Texan (to the east) and Tamaulipan (to the south) biotic provinces. The Balcones Canyonlands also represents the easternmost limits of a number of species from the more-western Chihuahuan biotic province. The ecotonal nature of the region has resulted in the presence of a large number of faunal species, some from more-arid western and southern regions and some from more-humid eastern regions (Blair 1950:113–114). Therefore, the area represents the geographical limits of distribution for many species (Neck 1986). Faunal diversity is also due to the diverse habitats and microenvironments within the ecotone (Lundelius 1967:309–310). The present-day faunal community consists of 57 mammals, 36 species of snakes, 16 lizard species, 15 frog and toad species, and 7 species of salamanders (Blair 1950:113–115). Five of the salamander species

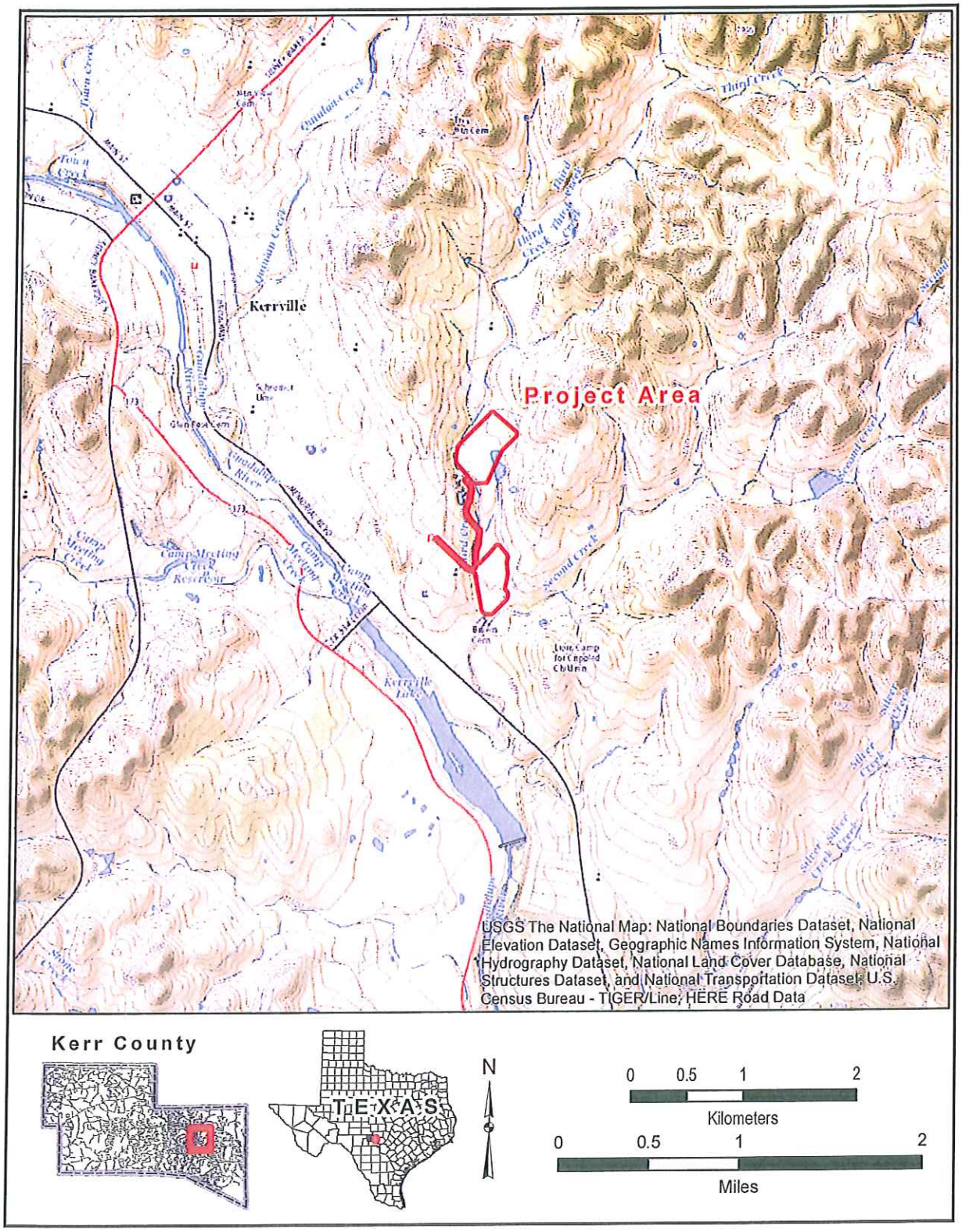

Figure 1. Project location map.

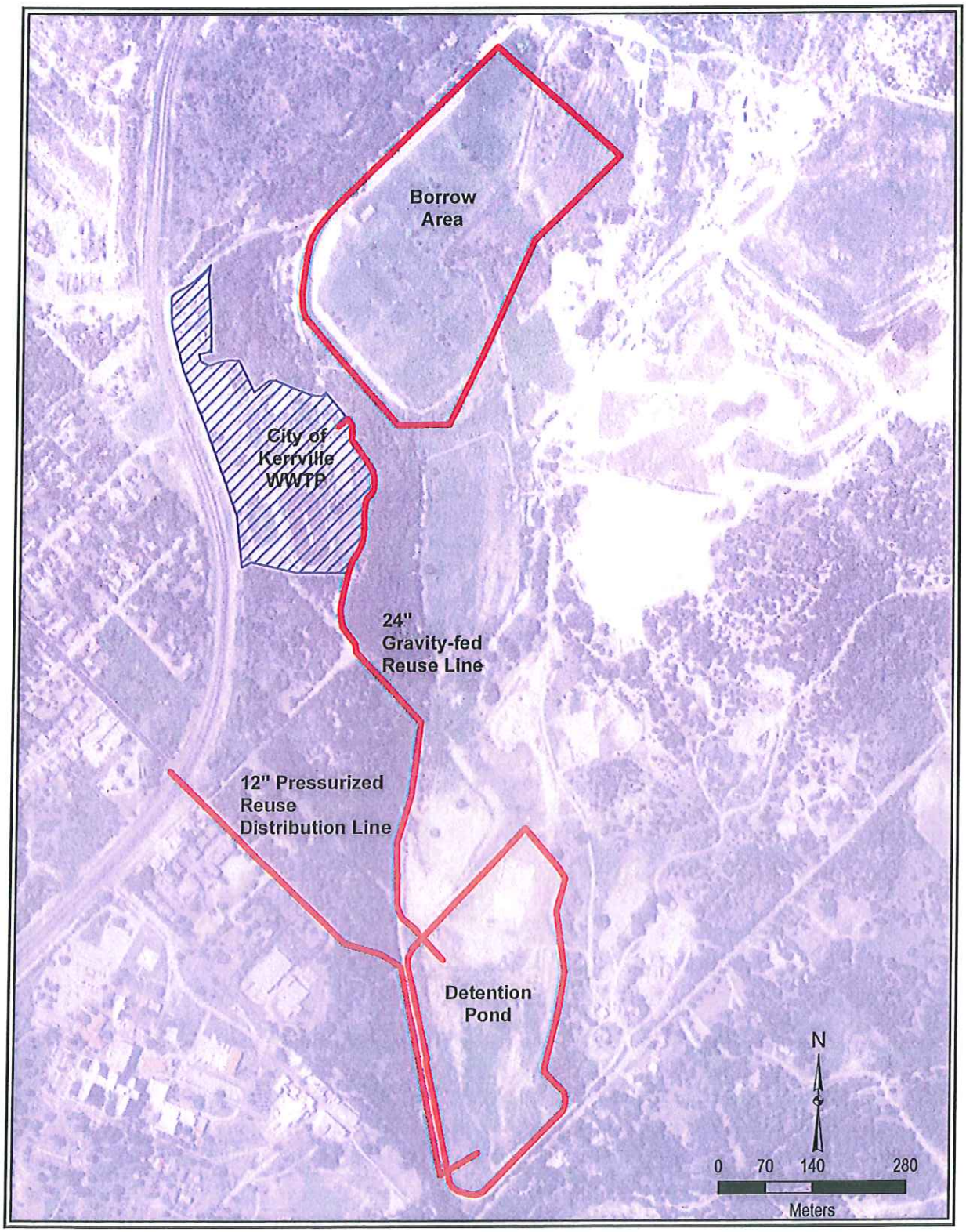

Figure 2. Project area depicting proposed distribution lines, detention pond, and borrow area.

represent the only vertebrate fauna endemic to the Balconian province (Blair 1950:115). Extirpated species include bison, pronghorn antelope, gray wolf, mountain lion, and black bear.

Like the fauna, plant communities of the Balconian biotic province are a mix a species from adjacent provinces. Early historic accounts of the Balcones Canyonlands' floral communities describe upland grassland savannas with dense forests along the stream valleys (Bonnell 1840:94; Roemer 1935:118). Due to development, overgrazing, and suppression of range fires starting in the nineteenth century, vegetation patterns have been severely altered. The effect of overgrazing and fire suppression resulted in the spread of woody species, such as juniper and mesquite, from protected canyons and erosional breaks (Harris 1966; Smeins 1980).

Today the vegetation pattern is a complex mosaic of communities of endemic species and elements from adjacent biotic provinces (for an overview of floral communities, see Gehlbach [1988] and Van Auken [1988]). Evergreen woodlands and deciduous forests that owe much of their origin to the Sierra Madre Oriental (Riskind and Diamond 1986:24) dominate the steep slopes, high-gradient streams, and canyons. Grasslands are primarily present in the form of savannas or open woodlands along drainage divides (Riskind and Diamond 1986:25). Dominant grass species include little bluestem, Texas wintergrass, tall dropseed, Texas grama, and sideoats grama. Communities within the more-mesic canyons along the eastern margin of the Balcones Canyonlands contain elements typical of the eastern (Austroriparian) deciduous forests and tall grass prairies (Texan). The plant communities along the southern margin of the area are strongly influenced by yet another community: the Tamaulipan brush country. Overall floral community composition and structure are influenced by exposure, soils, and slope (Van Auken 1988:55), with at least three major community types (streamsides, floodplains, and steep slopes) identifiable (Riskind and Diamond 1986:25).

Perennial streamside communities are dominated by bald cypress, sycamore, and to a lesser extent black willow (Riskind and Diamond 1986:25). Dry intermittent streamside communities are dominated by sycamore and cedar elm.

Oak-elm-hackberry gallery forests dominate floodplain communities. Species such as pecan, chinkapin oak, and black walnut are more common in the more-eastern bottomlands, while live oak, cedar elm, and sugarberry are more common in more-western bottomlands. Floodplain shrub communities consist of deciduous holly, roughleaf dogwood, elderberry, Mexican plum, and hoptree.

Arboreal communities on steep slopes vary due to exposure. The drier south- and west- facing slopes typically support stands of juniper and juniper-oak woodlands (Riskind and Diamond 1986:25). Dense stands of junipers, known locally as "cedar breaks," also contain live oak, scrub oak, Texas persimmon, and Texas mountain laurel. These more-xeric woodlands commonly contain few understory woody plants and are less diverse in woody species than the woodlands on the more-mesic northern and eastern slopes. Mixed deciduous-oak woodlands cover northern and eastern exposures. Texas oak is the dominant species but is replaced by Lacey oak farther west toward the Nueces River (Riskind and Diamond 1986:25). Understory

vegetation includes yaupon, American beautyberry, hoptree, Mexican buckeye, red or yellow buckeye, deciduous holly, and roughleaf dogwood. The composition of slope communities dramatically changes west of the Frio River (Riskind and Diamond 1986:28). Woodlands are limited to valley bottoms and north- and east-facing slopes. Juniper decreases in frequency, and species with a Mexican affinity become more common. Xeric shrub species, such as cenizo, Spanish dagger, sotol, agarito, and *Acacia* spp., are dominant.

GEOLOGY, GEOMORPHOLOGY, AND SOILS OF THE PROJECT AREA

The project area occupies the valley slopes, terraces, and narrow floodplain of Third Creek, a perennial tributary of the Guadalupe River. Third Creek is an underfit stream that incises lower Cretaceous limestones and dolomites of the Fort Terrett member of the Edwards Formation and the upper Glen Rose Formation (Bureau of Economic Geology 1981). The former is exposed in the headwaters of Third Creek, while the upper Glen Rose unit forms the valley walls in the vicinity of the project area. Late Quaternary alluvium in the form of low terraces that flank the Third Creek channel are mapped on the valley floor, although the investigations reported here revealed that the geomorphic surfaces and underlying alluvial units are more complex than what is depicted on the 1:250,000-scale *Geologic Atlas of Texas, Llano Sheet*. This complexity is discussed in greater detail later in the report.

Soils mapped within the project area hint at this greater geomorphic complexity on the valley floor of Third Creek, where Krum and Nuvalde series soils are mapped on the terraces and floodplain (Dittemore and Coburn 1986). Both soils are thick Mollisols that form on calcareous clayey and silty alluvium, but horizonation and secondary carbonate morphological differences between them suggest they formed on different allostratigraphic units and landforms of different ages.

Eckrant and Comfort series soils are mapped in the adjacent upland areas of exposed Edwards Formation limestone (Dittemore and Coburn 1986). Both soils are thin or shallow Mollisols that form on weathered limestone. In the upland and valley wall areas of exposed Glen Rose Formation, soils of the Doss, Kerrville, Real, and Tarpley series are mapped. These soils, except for the Kerrville soils, are shallow Mollisols that form on limestones, marls, and chalks. The Kerrville soils are Inceptisols and tend to be thicker and occupy lower segments of valley walls.

ARCHEOLOGICAL BACKGROUND AND PREVIOUS INVESTIGATIONS

Culture History

The prehistoric archeology of the project area is typical of the eastern and southern Edwards Plateau and central Texas in general and has been subdivided into three periods: Paleoindian, Archaic, and Late Prehistoric. The cultural sequence and characteristics of each period have been defined and refined by Collins (1995, 2004) and Johnson and Goode (1994).

Paleoindian Period

Collins (1995, 2004) dates the Paleoindian period from ca. 11,500 to 8,800 years B.P. Collins (2004:116–119) proposes a two-part subdivision into early and late subperiods or horizons characterized by distinct styles of projectile points and stone tool technologies. The early subperiod is characterized by two stone tool technologies known as Clovis and Folsom. Clovis horizon data from central Texas and elsewhere strongly suggest a generalized hunting and gathering life supported by technology to exploit larger game. In contrast, sites with Folsom components indicate a subsistence system and associated technology strongly oriented to large game (e.g., bison).

Also significant is evidence for an onset of an Archaic way of life within the terminus of the Late Paleoindian period (Collins 2004:118–119; Masson and Collins 1995). This transition is readily observed in the technological differences between projectile point styles such as Wilson, Golondrina-Barber, and St. Mary's Hall. The presence of other point styles, such as Angostura, within Late Paleoindian and Early Archaic contexts indicates the existence of a defined transition between these periods (Collins 2004:118; Dockall and Pevney 2005; McKinney 1981; Thoms 1992, 1995; Thoms et al. 1996).

Archaic Period

The Archaic is recognized as a period of intensification of subsistence patterns that began during the Late Paleoindian period and is marked by increased diversity in material culture and ground stone technology (Collins 2004:119). In central Texas, the extensive use of various types of burned rock features for the preparation of root foods is a significant hallmark. The Archaic period of central Texas is divided into early, middle, and late subperiods (Collins 2004; Johnson and Goode 1994; Prewitt 1981, 1985).

The Early Archaic subperiod dates from ca. 8000 to 6000 B.P. and is divided into three point style intervals: Angostura, Early Split Stem, and Martindale-Uvalde (Collins 2004:119). Human groups were loosely organized into small mobile hunter-gatherer band units (Weir 1976:115–122). Sites of this subperiod are often small, broadly scattered, and isolated on prominences or terraces. Site distributions and greater technological diversity suggest a high degree of group mobility. Point styles included Angostura, Gower, Jetta, Martindale-Uvalde, and other split-stem forms. Other artifact types include Clear Fork and Guadalupe bifaces, Waco sinkers, grooved bola stones, and a wide diversity of unifacial and unretouched stone implements. Early Archaic components have been documented principally along the southern and eastern margins of the Edwards Plateau (Collins 2004:119; Johnson and Goode 1994; Kibler and Scott 2000; McKinney 1981). This distribution pattern may represent a response to various environmental or climatic factors and the use of better-watered areas within the live oak savannas (Collins 2004:120). The Early Archaic components at the Gatlin site (41KR621) and other sites contain burned rock features such as middens, hearths, and pits, and the technological diversity suggests exploitation of a range of resources, especially roots, nuts, and bulbs. The specialized cooking and

processing facilities at many sites represent precursors of the larger burned rock middens that have become the hallmark of the Middle and Late Archaic in central Texas and the Edwards Plateau (Collins 2004:120).

The Middle Archaic subperiod has an age range from ca. 6000 to 4000 B.P. and is further subdivided into three projectile point style intervals: Bell-Andice-Calf Creek, Taylor, and Nolan-Travis (Collins 2004:120). Commonly, sites of this time are larger and more abundant and exhibit a broader geographic distribution, implying increased populations (Prewitt 1981:73; Weir 1976:124–126). These characteristics could also suggest larger hunter-gatherer group size or increasing sedentism. A documented shift from a mesic environment to drier conditions and a possible expansion of the ranges of succulent plant foods like sotol and lechuguilla may explain some of the changes in cooking and food processing technologies evident during the Middle Archaic. A reliance on hunting and extensive processing of plant foods are indicated by changes in both chipped and ground stone technologies.

The Late Archaic subperiod extends from ca. 4000 to 1300 or 1200 B.P. (Collins 2004:121) and was associated with a gradual return to more-mesic conditions from the more-xeric setting at the end of the Middle Archaic. Collins (2004) proposes six projectile point style intervals for this portion of the Archaic: Bulverde, Pedernales-Kinney, Lange-Marshall-Williams, Marcos-Montell-Castroville, Ensor-Frio-Fairland, and Darl. With the exception of Bulverde, all intervals are represented by well-dated components at a number of sites. The subsistence economy of the Late Archaic represents a continuance of Middle Archaic practices involving the use of heated rock cooking facilities (Collins 2004:121). In general, the trends that emerge for the Late Archaic include increased population, continued and intensified use of various burned rock features, further diversification of projectile point styles, and participation of central Texas groups within an interregional exchange system involving much of southeastern North America.

Late Prehistoric Period

The Late Prehistoric period is divided into early and late subperiods and two projectile point style intervals (Collins 2004:113, 122–123) and spans a period of time from ca. 1200 B.P. to the Historic period. A date of A.D. 1600 is often used as a terminus for the Late Prehistoric period (Black 1989:32). The early subperiod (Austin) is associated with Scallorn arrow points, and the Late subperiod (Toyah) with Perdiz arrow points. The most distinctive break from the Late Archaic is the technological shift from dart points to arrow points. Otherwise, there was a continuation of the basic pattern of hunting and gathering subsistence from the Late Archaic, but coupled with the appearance of the bow and arrow and later in the Toyah period, the use of ceramics.

Previous Investigations and Research in Kerr County

Archeological investigations in Kerr County have contributed much to our understanding of prehistoric lifeways across the Edwards Plateau and central Texas. In particular, investigations at two sites, Camp Pearl Wheat (41KR243) and

Gatlin (41KR621), have provided insights into past subsistence economies and the technologies used to successfully procure and process resources for thousands of years.

The Camp Pearl Wheat site is north of the City of Kerrville along Town Creek, a tributary of the Guadalupe River (Collins et al. 1990). Investigations at the site revealed a discrete Early Archaic component representing brief use of the locality by a small group of hunting and gathering people. Site activities included hunting and processing of game and possibly cooking of plant foods in open burned rock hearths and small earth ovens. The suite of tools and features reflects a generalized rather than specialized subsistence economy.

More-recent investigations at the nearby Gatlin site (41KR621), ca. 10 km up the Guadalupe River from its confluence with Third Creek, recovered significant data on four distinct occupation zones representing Early Archaic, Middle Archaic, and mixed Middle and Late Archaic subperiods (Houk et al. 2008). The lowermost occupation zone (OZ1) represents the Early Archaic period and was radiocarbon dated to 6600–6060 B.P.; it was associated with Early Barbed, Martindale, and Gower dart point types. Occupation Zone 2 also represented the Early Archaic period but was dated on the basis of projectile point styles like Gower, Martindale, Bandy, and Baker. Occupation Zone 3 appears to span the transition between the Early and Middle Archaic periods based on dart point styles like Early Triangular, Nolan, and Bell/Andice. Radiocarbon assays from this zone range from 4500 to 3850 B.P. The youngest component (OZ4) represents a considerably mixed occupation record from the Middle and Late Archaic periods associated with an extensive burned rock midden and nine other features. Radiocarbon dates span the interval from 3900 to 1290 B.P. The Early and Middle Archaic materials, one of the largest excavated assemblages from the southern Edwards Plateau, provide insights into human adaptation and basic lifeways at the site and surrounding region. The recovered materials indicate the Gatlin site was primarily used by small foraging groups for brief periods of time to acquire and process game, procure raw materials for the manufacture of tools, and prepare and plan for future foraging activities. Like the riparian setting at Camp Pearl Wheat, the Guadalupe River riparian zone provided the occupants of the Gatlin site with abundant game, plant foods, fuel, and other raw materials that met the needs of an adaptive strategy that remained largely unchanged for thousands of years.

Similar prehistoric sites, although not investigated to the same extent as the Camp Pearl Wheat and Gatlin sites, occur in and around the project area. A search of the Texas Historical Commission's Archeological Sites Atlas revealed one previously recorded site within the project area and nine other sites within 1 km. The site within the project area (41KR501) is a large prehistoric site that occupies much of the east side of Third Creek within the proposed borrow area and south of there. When first recorded in 1995, lithic artifacts (flakes, dart points, a core, and a chopper) were observed on the surface, and three burned rock hearths were noted at depths of 4–5 ft and 10–12 ft in drainages associated with the soccer fields that are situated within the proposed borrow area. Based on the distribution of artifacts and features, the site was limited to a small area adjacent to and west and southwest of

a large earthen berm associated with a pond situated in the south-central portion of the proposed borrow area.

When the site was revisited in 2008, the site boundary was expanded based on shovel testing results, surface artifact evidence, and cultural materials encountered in three of four backhoe trenches (Butler 2009). Of the 14 shovel tests excavated, cultural materials were recovered from only 7, which yielded a total of 14 prehistoric and historic artifacts. Nine of these artifacts, including a .22-caliber shell casing, were recovered from 0–20 cm below the ground surface. Four of the remaining five artifacts were found at 20–40 cm, and the fifth was from 40–60 cm. Three of the four backhoe trenches, all which encountered bedrock, indurated K horizons, or thick basal gravels at depths of 100 to 360 cm, yielded 4 chert flakes up to 200 cm deep from alluvial deposits. Two of the trenches and 2 shovel tests were excavated in the vicinity of the hearths noted when the site was first recorded, but no features were encountered. One of the trenches did encounter a series of discrete gravel beds that may have been mistaken for hearths in 1995. Regardless, based on the 2008 investigations it was suggested that intact buried archeological deposits could be present, despite the extensive surface disturbance from the construction of the soccer fields and adjacent city landfill expansion.

Of the nine known sites within 1 km, two are in upland settings just east of the project area. One of these (41KR672) is a twentieth-century farmstead, and the other (41KR673) is a surface lithic scatter. Site 41KR106, just south of the project area, is a burned rock midden on a terrace above Second Creek. Site 41KR566, just south of the proposed 12-inch pressurized reuse distribution line corridor, is an upland lithic scatter. The other five sites are on a high terrace along the Guadalupe River south the project area. Two of these (41KR119 and 41KR559) are burned rock middens disturbed by looting and other factors, and the other three (41KR556, 41KR569, and 41KR582) are lithic scatters, at least two of which probably represent occupational areas associated with middens.

METHODS OF INVESTIGATION

The archeological investigations for the current project consisted of pedestrian survey, shovel testing, and backhoe trenching. These investigations were carried out in two phases. The first was conducted on June 3–5, 2015, and the second phase was carried out on June 22–24, 2015. During the first phase, the project area was walked over at intervals of 20-30 m across the borrow area and detention pond and intervals of 10-20 m within the 100 ft wide corridors of the reuse lines. The survey examined the surface for cultural materials, focusing on areas where ground surface visibility was high. In addition, areas of disturbance where intact archeological sites are unlikely to occur and areas where thick (more than 1 m) Holocene alluvial deposits that could contain intact archeological sites were noted. A limited amount of shovel testing was conducted in areas were Holocene deposits were believed to be less than 1 m thick and largely undisturbed. The shovel tests were ca. 30 cm in diameter and excavated in 20-cm increments. Sediments from each 20-cm level were screened through 1/4-inch mesh. Coordinates for each shovel test were recorded using a hand-held GPS receiver for mapping purposes.

The shovel tests were terminated when stony subsoil horizons or gravelly deposits were reached.

Backhoe trenching was done during the second phase of the field investigations. Areas to be trenched were identified during the earlier phase based on geologic and geomorphic characteristics conducive to the occurrence of deeply buried (greater than 1 m) intact archeological sites. Trenching is a more effective and productive means of site detection than shovel testing in such settings. Within these selected areas, trench placement was not random. The placement of trenches avoided areas that were disturbed (e.g., thick deposits of artificial fill, deep erosional gullies, gravel roads, natural gas lines). Trenching within the proposed borrow area at the northern end of the project was limited to the margins of the area at the request of the city because several soccer fields are currently in use there. Excavation of the trenches was closely monitored. Once excavation of a trench was finished, its length, depth, width, and orientation were recorded. Coordinates for both ends of trenches were recorded using a handheld GPS unit for mapping purposes. Trench walls were examined for cultural materials. Photographs of selected trenches were taken and recorded on a photographic log. Observations regarding the stratigraphy, soil horizons, and sedimentological nature of the deposits exposed in the trench walls were noted. Trenches were backfilled at the end of each work day.

RESULTS OF INVESTIGATIONS

The pedestrian survey did not encounter any artifacts on the surface. It revealed that the project area is situated on multiple bedrock and alluvial surfaces (Figure 3). The northern ca. 390 m of the 12-inch pressurized reuse distribution line will cross the highest surface, which is just outside the Third Creek valley. This surface stands ca. 10–18 m above the Third Creek channel and consists of exposed limestone of the Glen Rose Formation. This portion of the reuse distribution line is within the right of way of Legion Drive (Figure 4). A short segment of the 24-inch gravity-fed reuse line, approximately 180 m in length, also occupies this surface before it turns southeast to parallel an existing natural gas line and cross Third Creek. Given the geomorphic and geologic setting (i.e., lack of appreciable sediments, a high degree of ground surface visibility) and presence of existing disturbances (e.g., Legion Drive) these segments of the pressurized reuse distribution line and the gravity-fed reuse line did not warrant shovel testing or trenching.

The second-highest surface within the project area is an alluvial or constructional surface of late Quaternary age and is limited to the southeastern corner of the proposed borrow area (Figure 5). This surface, designated T_2, stands ca. 6–9 m above the Third Creek channel, although it is eroded and beveled. Because of its age and nature, the T_2 surface warranted trenching to search for buried archeological sites and further delineate the age and nature of its underlying deposits. Shovel testing on the T_2 was not warranted given the eroded and disturbed nature of its surface.

At elevations below the T_2 surface is another late Quaternary alluvial surface, designated T_1. It stands ca. 3–5 m above the Third Creek channel and makes up

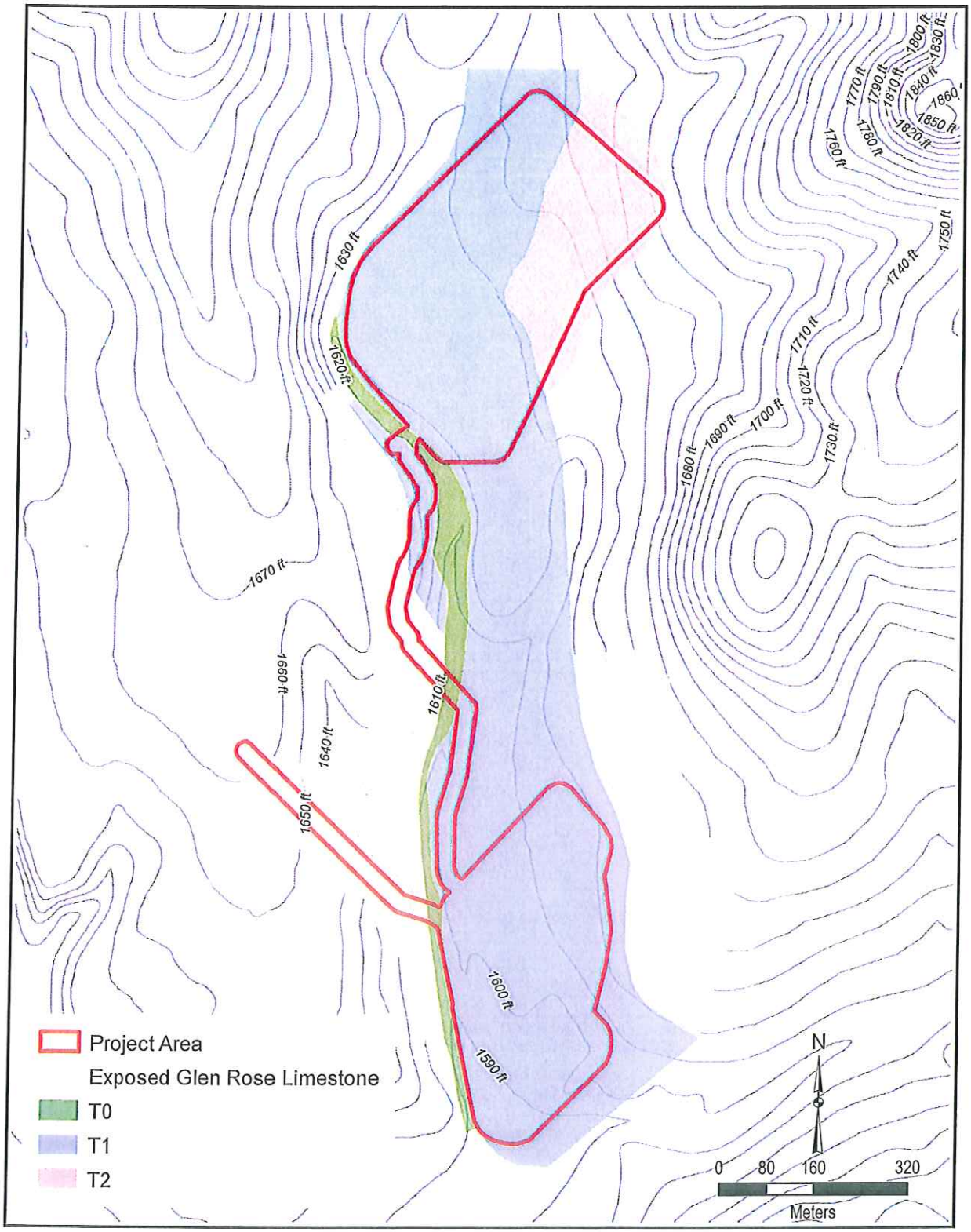

Figure 3. Map of surfaces across the project area.

Figure 4. Photograph of the 12-inch pressurized reuse distribution line corridor along Legion Drive with Third Creek in the background.

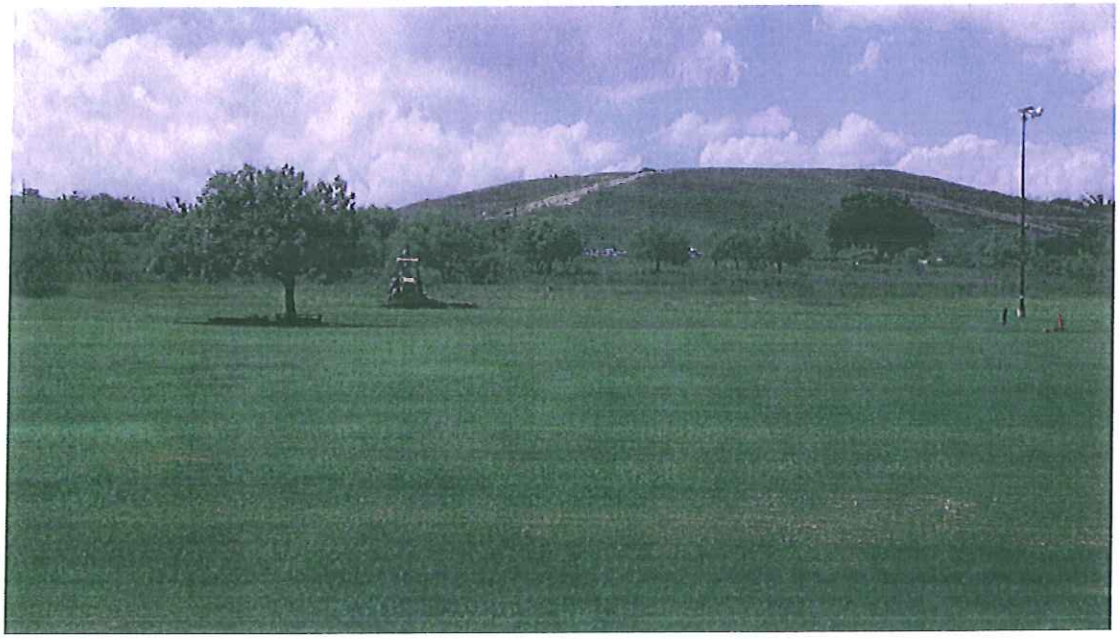

Figure 5. Photograph of the T_2 surface (between the backhoe and the hillside).

most of the project area (Figure 6). Observations made during the pedestrian survey suggested that the T_1 surface caps evidence of a complex history of channel incision, channel migration, and floodplain aggradation in this portion of the Third Creek valley. Like the higher T_2 surface, the age and nature of the T_1 surface warranted trenching to search for buried sites and further define the age and characteristics of its underlying alluvium. The Third Creek channel runs along the far west side of the valley in the project area, so the T_1 surface is widest on the east side of the valley. The broad T_1 surface east of the creek is extensively disturbed by landscape modifications (e.g., soccer fields) and dumping of fill materials (e.g., concrete and asphalt rubble). Because of this, it was determined that trenching would be more effective and productive than shovel testing on this landform.

Figure 6. Photograph of the T_1 surface on the east side of the Third Creek valley.

Between the proposed borrow area and the northernmost ca. 180 m of the 24-inch gravity-fed reuse line, the narrow Third Creek floodplain is flanked by strath or bedrock terraces mantled by ca. 1 m of Holocene alluvium (Figure 7). Downstream, the alluvium-mantled strath terraces are not present on the east side of the channel, and where the channel is up against the T_1 terrace, alluvium is exposed from the top to the bottom of the ca. 2–4-m-high profile of the bank. Regardless of whether a strath terrace or thick alluvial deposits underlie the T_1 surface, both are mantled by alluvium that aggraded to the same elevation and merged to form a broad T_1 surface. Four shovel tests (Shovel Tests 1–4; Table 1) were excavated

where the northernmost ca. 180 m of the 24-inch gravity-fed reuse lines traverses the alluvium-mantled strath terrace on the west side of Third Creek, an area of about 1.4 acres. This equates to 2.9 shovel tests per acre, a density just less than the Texas Historical Commission's survey standard of 3 shovel tests per acre for project areas ≤ 2 acres in size. The shovel tests ranged from 25 to 70 cm deep. None yielded cultural materials, other than a few modern pieces of glass and a wire nail from Shovel Test 2. A fifth shovel test (Shovel Test 5) was excavated downstream of the other four, ca. 20–30 m west of the project corridor. It was on the T_1 surface near the confluence of Third Creek and an unnamed tributary, primarily to assess the nature of the alluvial deposits below the surface but also because such settings are likely to contain sites. No cultural materials were encountered, and the dark loamy sediments gave way to a muddy sandy gravel deposit at 50-70+ cm below the surface where the excavation was terminated.

Figure 7. Strath terrace (highlighted between the white lines) on the east side of the Third Creek valley.

The lowest surface in the project area, designated T_0, is the narrow floodplain of Third Creek; the 24-inch gravity-fed reuse line and the 12-inch pressurized reuse distribution line both cross it (Figure 8). It stands ca. 1 m above the channel. Bank exposures of the deposits underlying the floodplain surface display gravelly alluvium with interstitial dark muds (Figure 9). Of the four surfaces observed during the pedestrian survey, the T_0 surface constitutes the least amount of area that will be impacted by the project. Both reuse lines will parallel natural gas lines

Table 1. Shovel test data

Shovel Test	Depth (cm)	Cultural Materials	Stratigraphy
1	0–25	none	0–20 cm: Dark brown stony silty clay loam
			20–25+ cm: Brown stony silty clay
2	0–20	none	0–30 cm: Dark brown silty clay loam
	20–40	1 wire nail, 1 piece of clear glass	30–60+ cm: Brown stony silty clay loam
	40–60	1 piece of clear glass	
3	0–20	none	0–30 cm: Dark brown silty clay loam
	20–40	none	30–60 cm: Brown silty clay loam
	40–60	none	60–70+ cm: Brown stony silty clay loam
	60–70	none	
4	0–20	none	0–25: cm Dark brown silty clay loam
	20–40	none	25–45 cm: Brown silty clay loam
	40–50	none	45–50+ cm: Brown stony silty clay loam
5	0–20	none	0–15 cm: Dark borwn silty clay loam
	20–40	none	15–50 cm: Brown silty clay loam
	40–60	none	50–70+ cm: Brown muddy sandy gravel
	60–79	none	

that cross Third Creek within corridors that are already disturbed. Because of this disturbance and the gravelly nature of the deposits and their recent age (less than ca. 200 years), it was determined that shovel testing and trenching were not warranted on this surface.

The second phase of the survey consisted of excavating 29 backhoe trenches on the T_1 and T_2 surfaces east of Third Creek, an area of about 58 acres (Figure 10). This equates to 1 trench per 2 acres, a density that is equivalent to the Texas Historical Commission's survey standard for shovel testing areas >11 to 100 acres in size, however since trenches provide large windows into the deposits the density can be viewed as exceeding the survey standards. Two trenches were on the T_2 surface, and 27 trenches were on the T_1 surface. All but 4 of the trenches were excavated to the top of thick basal gravel deposits, bedrock, or the water table, whichever came first. The trenches were 0.8 cm wide and varied in length from 5.1 to 7.6 m and in depth from 0.7 to 2.4 m (Table 2).

Based on the stratigraphic, sedimentological, and pedogenic characteristics of the alluvial deposits observed in these trenches, four allostratigraphic units were defined. Although radiocarbon ages are not available to provide absolute dates for these units, their stratigraphic and geomorphic contexts, along with the features of their respective soil imprints, are compared to units defined and dated by Abbott (2008) on the Guadalupe River.

Backhoe Trenches 22 and 26 were on the T_2 surface, which is present in the form of an eroded terrace only in the southeastern corner of the proposed borrow area. The profiles of both trenches revealed loamy to clayey sediments of 5YR and

a

b

Figure 8. Photographs of where the 24-inch gravity-fed reuse line (a) and the 12-inch pressurized reuse distribution line (b) will cross Third Creek.

Figure 9. Gravelly alluvium exposed along Third Creek below the T_0 surface.

7.5YR hues imprinted with well-structured Bk horizons exhibiting Stage II carbonate morphology (Figure 11). The Bk horizons overlie deposits of muddy sandy gravels displaying Stage III carbonate morphology. The top of the carbonate-cemented gravels are 100 to 120 cm below the beveled surface of the T_2 terrace. Although not conclusive, this suggests that the cemented gravels mantle impervious bedrock, which in turn suggests that the alluvium below the T_2 surface rests on a buried bedrock strath terrace that is at least a few meters above the current bedrock floor of the valley. The color of the sediments, pedogenic expression, carbonate morphology, and geomorphic context of the deposits in these two trenches suggest the unit correlates to Abbott's (2008) Unit 2. Abbott (2008:20) states that the deposition of Unit 2 ceased by 18,000 to 15,000 years ago, based on broadly similar sedimentological, pedogenic, and geomorphic characteristics of dated allostratigraphic units from other stream valleys in central Texas. Based on this, the alluvium below the T_2 surface predates the presence of human beings in North America. Although the T_2 surface could host archeological materials of various ages, the eroded nature of the T_2 surface makes it unlikely that sites with good contextual integrity exist on this surface, and none were observed during the survey. Shovel testing on this surface on an adjacent property by Butler (2009:Figure 5) noted its disturbed nature and did not recover any artifacts.

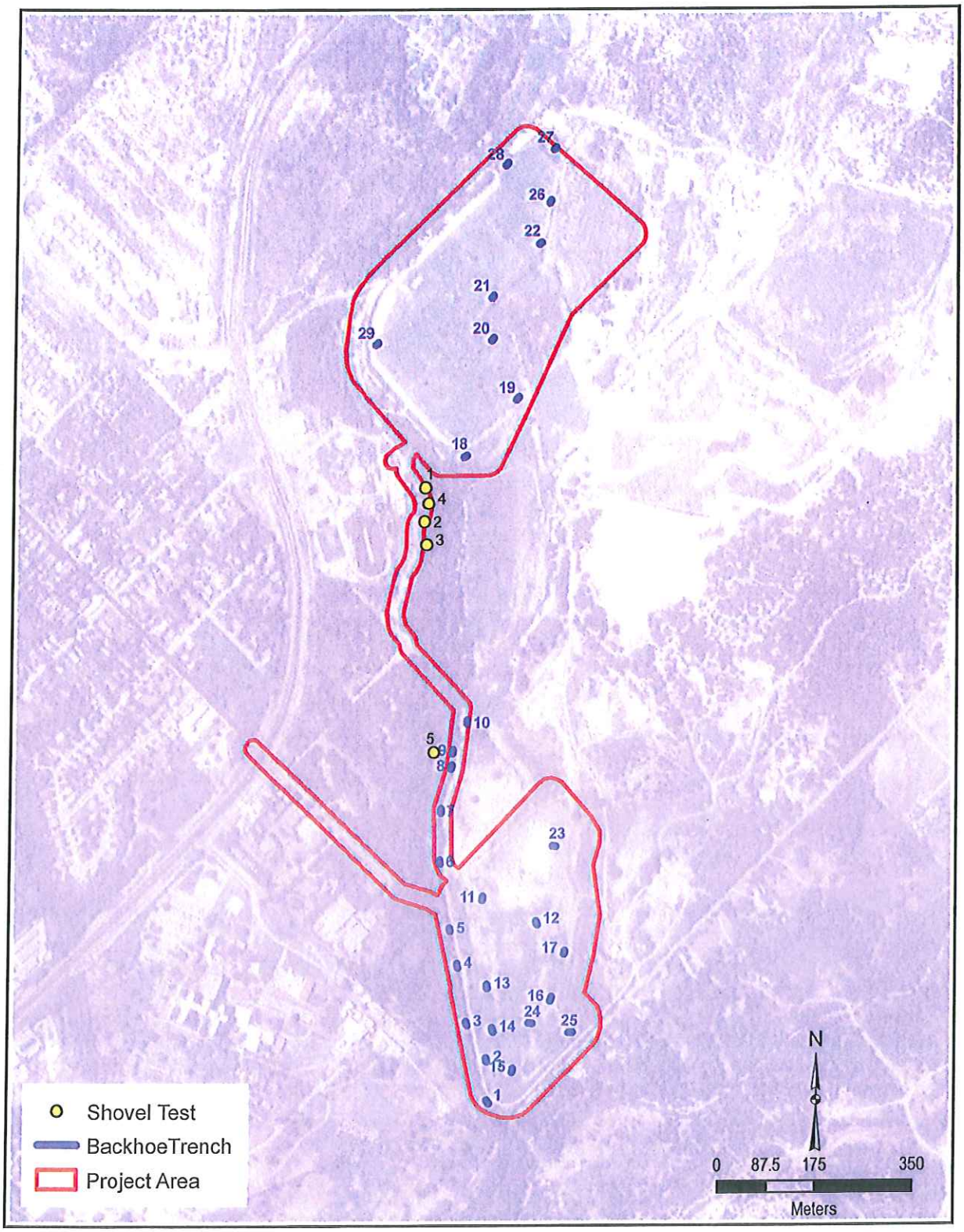

Figure 10. Map of backhoe trench and shovel test locations.

Table 2. Backhoe trench descriptions

BHT	Length	Width	Depth	Orientation	Surface	Profile Description	Allostratigraphic Unit
1	7	0.8	1.7	324	T1	0–20 cm: very dark grayish brown loamy alluvium	recent
						20–50 cm: artificial fill	recent
						50–170 cm: very dark grayish brown loamy alluvium with 2% gravel	late Holocene/Historic
						170+ cm: limestone bedrock	
2	7	0.8	1.5	343	T1	0–125 cm: yellowish brown loamy alluvium	late Holocene
						125–150+ cm: moderately–sorted rounded gravels	late Holocene
3	7.5	0.8	1.9	344	T1	0–190+ cm: yellowish brown loamy alluvium	late Holocene
4	7.3	0.8	0.9	344	T1	0–90 cm: very dark grayish brown loamy alluvium	late Holocene/Historic
						90+ cm: moderately–sorted rounded gravels	late Holocene/Historic
5	5.4	0.8	1.2	348	T1	0–100 cm: very dark grayish brown loamy alluvium	late Holocene/Historic
						100–120+ cm: brown msG, gravels are rounded and moderately–sorted	late Holocene
6	6.5	0.8	1.6	355	T1	0–50 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						50–160 cm: yellowish brown loamy alluvium with Bw horizon imprint	late Holocene
						160+ cm: moderately–sorted rounded gravels	late Holocene
7	7.5	0.8	0.7	360	T1	0–25 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						25–70+ cm: yellowish brown msG	late Holocene
8	6.2	0.8	0.9	11	T1	0–25 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						25–70+ cm: yellowish brown msG	late Holocene
9	6.4	0.8	1.6	9	T1	0–160 cm: very dark grayish brown loamy to clayey alluvium	late Holocene/Historic
						160+ cm: limestone bedrock	
10	6.4	0.8	1.3	360	T1	0–20 cm: artificial fill	recent
						20–130 cm: yellowish brown loamy alluvium with A–Bw soil imprint	late Holocene
						130+ cm: yellowish brown msG, gravels are rounded and moderately–sorted	late Holocene
11	6.7	0.8	1.9	6	T1	0–120 cm: artificial fill	recent
						120–190 cm: brown loamy alluvium	late Holocene
						190+ cm: brown clayey alluvium with well–structured Bk horizon imprint displaying Stage II carbonate morphology	late Pleistocene/early Holocene
12	7.2	0.8	0.7	340	T1	0–70+ cm: yellowish brown msG, gravels are rounded and moderately–sorted	late Holocene
13	6.3	0.8	1.6	346	T1	0–40 cm: artifical fill	recent
						40–160 cm: yellowish brown loamy alluvium	late Holocene
						160+ cm: gravels with Stage III carbonate morphology	late Pleistocene/early Holocene

Table 2, continued

BHT	Length	Width	Depth	Orientation	Surface	Profile Description	Allostratigraphic Unit
14	7.3	0.8	1	345	T1	0–100 cm: artificial fill	recent
						100+ cm: yellowish brown msG, gravels are rounded and moderately–sorted	late Holocene
15	6.6	0.8	2.1	18	T1	0–40 cm: artificial fill	recent
						40–210 cm: yellowish brown loamy alluvium	late Holocene
						210+ cm: yellowish brown msG with Stage II carbonate morphology	late Holocene
16	7.6	0.8	2	15	T1	0–30 cm: artificial fill	recent
						30–150 cm: yellowish brown loamy alluvium	late Holocene
						150–200 cm: brown to yellowish brown clayey alluvium with well–structured Bk horizon imprint displaying a Stage II carbonate morphology	late Pleistocene/early Holocene
						200+ cm: yellowish brown msG with Stage II carbonate morphology	late Pleistocene/early Holocene
17	6.5	0.8	2	20	T1	0–20 cm: artificial fill	recent
						20–100 cm: yellowish brown loamy alluviun	late Holocene
						100–170 cm: pale brown loamy alluvium	late Holocene
						170–200+ cm: pale brown msG with Stage II carbonate morphology	late Holocene
18	5.7	0.8	1.2	63	T1	0–50 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						50–120 cm: brown loamy alluvium with Bw horizon imprint	late Holocene
						120+ cm: yellowish brown msG, gravels are rounded and moderately–sorted	late Holocene
19	6.3	0.8	1.1	45	T1	0–50 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						50–100 cm: brown loamy alluvium with Bw horizon imprint	late Holocene
						100–110+ cm: yellowish brown msG, gravels are rounded and moderately–sorted	late Holocene
20	6.2	0.8	1.9	43	T1	0–40 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						40–190+ cm: yellowish brown loamy alluvium with Bw horizon imprint	late Holocene
21	5.6	0.8	1.6	44	T1	0–160 cm: yellowish brown loamy alluvium	late Holocene
						160+ cm: yellowish brown msG, gravels are rounded and moderately–sorted	late Holocene
22	5.3	0.8	1.1	55	T2	0–100 cm: yellowish to reddish brown loamy to clayey alluvium with well–structured Bk horizon imprint displaying a Stage II carbonate morphology	late Pleistocene
						100–110+ cm: gravels with Stage III carbonate morphology	late Pleistocene
23	6.2	0.8	2.4	104	T1	0–240+ cm: artificial fill	recent
24	6.7	0.8	1.8	100	T1	0–100 cm: yellowish brown loamy alluvium	late Holocene
						100–180 cm: pale brown loamy alluvium	late Holocene
						180+ cm: yellowish brown msG, gravels are rounded and moderately–sorted	late Holocene
						0–180+ cm: yellowish brown msG laterally inset to profile above	late Holocene

Table 2, continued

BHT	Length	Width	Depth	Orientation	Surface	Profile Description	Allostratigraphic Unit
25	7.2	0.8	2	84	T1	0–60 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						60–180 cm: yellowish brown loamy alluvium with Bw horizon imprint	late Holocene
						180–200 cm: yellowish brown clayey alluvium with well–structured 2Bt horizon	late Pleistocene/early Holocene
						200+ cm: yellowish brown msG with Stage III carbonate morphology	late Pleistocene/early Holocene
26	6	0.8	1.4	28	T2	0–40 cm: dark brown loamy alluvium with A horizon imprint	late Pleistocene
						40–120 cm: brown loamy alluvium with well–structured Bk horizon imprint displaying Stage II carbonate morphology	late Pleistocene
						120–140+ cm: gravels with Stage III carbonate morphology	late Pleistocene
27	5.6	0.8	1.8	48	T1	0–50 cm: very dark grayish brown loamy alluvium with A horizon imprint	late Holocene
						50–170 cm: brown loamy alluvium with well–structured Bk horizon imprint displaying Stage II carbonate morphology	late Pleistocene/early Holocene
						170–180+ cm: gravels with Stage III carbonate morphology	late Pleistocene/early Holocene
28	6.3	0.8	2.4	40	T1	0–130 cm: artificial fill	recent
						130–240 cm: dark brown loamy alluvium	late Holocene/Historic
						240+ cm: dark brown sG, gravels are rounded and moderately–sorted	late Holocene/Historic
29	5.1	0.8	1.2	45	T1	0–40 cm: very dark grayish brown loamy alluvium and artificial fill	late Holocene/Historic
						40–120+ cm: limestone bedrock with slightly cemented lag gravel cap that dips westward	

Notes: msG = muddy sandy gravel; sG = sandy gravel

Figure 11. Truncated Bk horizon on late Pleistocene alluvium in Backhoe Trench 22 profile.

The remaining trenches (1–21, 24, 25, and 27–29) were on the T_1 surface and reveal a complex history of channel incision, floodplain aggradation, and channel migration across the Third Creek valley. The three allostratigraphic units defined appear to represent late Pleistocene/early Holocene, late Holocene, and late Holocene/Historic alluviums, based on comparisons to units defined by Abbott (2008).

The late Pleistocene/early Holocene unit was observed in Backhoe Trenches 11, 13, 16, 25, and 27; all of these are within the detention pond at the southern end of the project area, except for Backhoe Trench 27 in the borrow area. The unit is not exposed on the T_1 surface but underlies the late Holocene unit. The top of this unit is 150 to 190 cm below the surface, except in Backhoe Trench 27 where it is at 50 cm. It is at least 130 cm thick. The unit consists of gravelly and fine-grained facies. The fine-grained facies consist of a yellowish brown to reddish brown (10YR and 7.5YR hues) clayey to loamy alluvium imprinted with truncated but well-structured Bk or Btk horizons exhibiting Stage II carbonate morphology, whereas the gravelly facies consist of moderately sorted rounded to subrounded cemented (Stage III carbonate morphology) gravels (Figure 12). No artifacts or cultural features were observed in this unit. The secondary carbonate morphology—nodules and cementation—indicate a late Pleistocene to early Holocene age for this unit. It is likely that this unit correlates to Abbott's (2008:20–21) Unit 3. By 10,000 years ago, the Guadalupe River had deposited an extraordinary amount of Unit 3 sediment. Aggradation of Unit 3 had significantly slowed and ceased altogether when the Guadalupe channel incised around 5,000 years ago. It appears that, by 5,000 years ago or slightly earlier, the Guadalupe River and Third Creek valleys were out of synch regarding cycles of aggradation and erosion. Whereas the Guadalupe River incised its channel and abandoned its floodplain around 5,000 years ago, it appears that Third Creek underwent an erosional phase much earlier, one that truncated the late Pleistocene/early Holocene unit. It started filling its valley again sometime in the late Holocene (less than 5,000 years ago). This is based on the absence of any recognizable middle Holocene unit, although this conclusion is speculative in the absence of radiocarbon ages.

Figure 12. Photograph of truncated Bk horizon imprint on late Pleistocene/early Holocene unit near the bottom of Backhoe Trench 11.

The late Holocene unit was observed in Backhoe Trenches 2, 3, 5–8, 10–21, 24–25, and 27. The unit is

exposed on the T_1 surface in Backhoe Trenches 2, 3, 6–8, 12, 18–21, 24, 25, and 27. In Backhoe Trenches 10, 11, and 13-17, the unit is buried by 20 to 120 cm of artificial fill. These trenches are near or within the footprint of the detention pond, where large volumes of fill and rubble (e.g., road asphalt, concrete, topsoil) have been dumped, particularly in and around the northern portion of the pond. In the northeast corner of the detention pond, the fill is at least 240 cm thick as evidenced in Backhoe Trench 23, which did not reach the original ground surface. In Backhoe Trench 5, the unit is buried by the late Holocene/Historic unit. The unit is at least 190 m thick. It appears that the late Holocene deposits make up the bulk of the alluvial fill below the T_1 surface. The unit consists of coarse-grained channel fill facies and finer-grained overbank facies (Figure 13). The coarse-grained channel fill facies consist of yellowish brown to brown (10YR hues) muddy sandy gravels. The fine-grained facies generally consist of very dark grayish brown and yellowish brown to brown (10YR hues) loamy sediments imprinted with A-Bw soil profiles. The moderately-developed soils suggest a late Holocene age (less than 5,000 years old) for this unit. No artifacts or cultural features were observed in the trenches that exposed this unit.

a b

Figure 13. Photographs of the late Holocene allostratigraphic unit beneath the T_1 surface. (a) Fine-grained facies in Backhoe Trench 6; (b) gravelly facies at bottom of Backhoe Trench 7.

The late Holocene/Historic unit was observed in Backhoe Trenches 1, 4, 5, 9, 28, and 29. The unit is exposed on the T_1 surface capping the late Holocene unit or bedrock, or laterally inset to the late Holocene unit. It is at least 160 cm thick. It consists of gravelly and finer-grained facies that typically display weakly developed A-C soil profiles (Figure 14). The gravelly facies consist of moderately sorted rounded gravels representing channel fills. The fine-grained facies consist of very dark grayish brown to dark brown (10YR hues) loamy and clayey alluvium with gravel percentages of up to 2 percent. No artifacts or cultural features were observed in the trenches that exposed the late Holocene/Historic unit.

Figure 14. Photograph of late Holocene/Historic unit in Backhoe Trench 1.

The four allostratigraphic units below the T_2 and T_1 surfaces along Third Creek were defined based on stratigraphic and geomorphic contexts and sedimentological/soil characteristics observed in 29 trench profiles. A comparison of these attributes to the work of Abbott (2008) on the Guadalupe River provides a chronological framework for at least for the older units (Figure 15). Late Pleistocene alluvium below the T_2 surface is in excess of ca. 18,000 to 15,000 years old and appears to rest on a strath terrace. This surface was abandoned around ca. 18,000 to 15,000 years ago when the Third Creek channel downcut and scoured the bedrock floor of the valley to a depth of at least a few meters below the top of the strath terrace. Incision of the bedrock however was not valley wide, as a bedrock strath remains in place at the northern end of the project area between the modern channel and the three later allostratigraphic units below the T_1 surface.

The three allostratigraphic units deposited after Third Creek incised and abandoned the T_2 surface, are late Pleistocene/early Holocene, late Holocene, and late Holocene/Historic in age. Truncated Bt and Btk soils imprinted on the late Pleistocene/early Holocene alluvium suggest that the Third Creek valley once again underwent an erosional phase, although incision of the bedrock valley floor did not occur. This erosional period appears to have lasted several centuries, if not for a couple of millennia, given the apparent absence of middle Holocene deposits. Sometime in the late Holocene, the valley floor aggraded again burying the strath terrace remnant in the northern

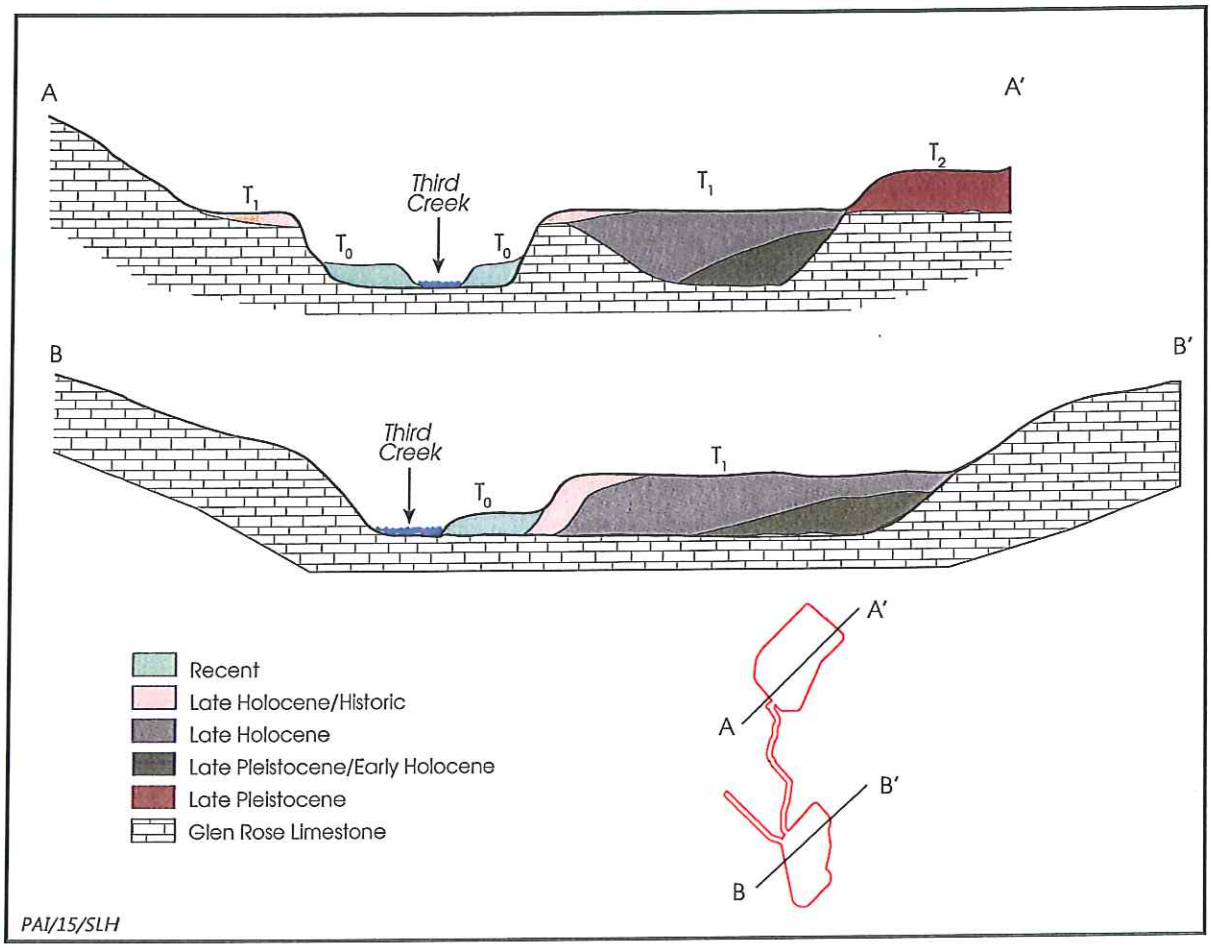

Figure 15. Generalized cross sections of the Third Creek valley.

part of the project area, as seen in Backhoe Trench 29 and the alluvium-mantled strath on the west side of Third Creek, and forming the broad T_1 surface on the eastern side of the valley. Abandonment of this surface probably occurred within the recent past (less than 200 years ago), after which the narrow modern floodplain of Third Creek formed.

As noted, one previously recorded archeological site (41KR501) is in the project area. The Texas Archeological Sites Atlas shows 41KR501 as extending across much of the proposed borrow area, except for the T_2 surface portion, and about 500 m south along the T_1 surface between Third Creek and the valley wall (Figure 16). Seven of the 29 backhoe trenches were within the boundaries of the site, and none encountered any artifacts or cultural features. Butler (2009), who expanded the boundaries to their current extent, excavated 4 trenches and 14 shovel tests at the site and found only a small number of prehistoric artifacts from near-surface deposits and no cultural features. Two of Butler's shovel tests (one positive and one

negative) and 2 of his trenches were in the area of the site where the site's original recorder observed three burned rock features, one as deep as 10–12 ft, in drainages associated with the adjacent soccer fields. Two trenches in the current investigations, Backhoe Trenches 19 and 20, also were in this area. Given the lack of archeological materials in these trenches and the sparse remains in Butler's excavations, it is speculated that the three burned rock features reported in 2005 actually were segments of thin gravel beds exposed in these drainages. This interpretation is supported by the fact that Butler (2009:18) noted gravel beds at depths similar to those of the three burned rock features in two of his trenches. He also commented on the presence of deeply disturbed deposits in the same vicinity and speculated that they may represent disturbances related to the construction of the adjacent stock pond. Expanding this line of reasoning further, it is possible that the artifacts observed on the surface (flakes, dart points, a core, and a chopper) by the original recorder might have washed out of the earthen berm associated with the stock pond. Regardless, it is apparent that 41KR501 has a very low artifact density, lacks buried cultural features, and has been disturbed by activities related to the construction of the stock pond and adjacent soccer fields. Given these attributes, it is believed that 41KR501 retains no important information. Hence, it is recommended that the site be judge ineligible for listing in the National Register of Historic Places and designation as a State Antiquities Landmark.

ASSESSMENTS AND RECOMMENDATIONS

Archeological investigations conducted for the City of Kerrville's proposed water reuse project along Third Creek consisted of pedestrian survey and the excavation of 5 shovel tests and 29 backhoe trenches. The pedestrian survey did not observe any artifacts or cultural features across the surface of the project area and noted a number of disturbances, particularly in and around the proposed borrow area and detention pond and where the 24-inch gravity-fed reuse and the 12-inch pressurized reuse distribution lines cross Third Creek. The survey identified four surfaces (one bedrock and three alluvial) within the project area, two of which (T_2 and T_1) warranted shovel testing and trenching. Four shovel tests were excavated on the T_1 surface on the west side of Third Creek near the northern end of the 24-inch gravity-fed reuse line, and one shovel test was excavated just outside the gravity-fed reuse line corridor at the confluence of Third Creek and an unnamed tributary. Other than modern items (e.g., wire nails), no artifacts were found. The broader T_1 surface on the east side of the Third Creek was not shovel tested due to extensive disturbances and landscape modifications to the surface. Twenty-nine backhoe trenches were excavated, two on the higher T_2 surface and 27 on the T_1 surface. Four allostratigraphic units probably dating to the late Pleistocene, late Pleistocene/early Holocene, late Holocene, and late Holocene/Historic were defined below these two surfaces. All but the earliest unit have the potential for buried archeological sites, but none were encountered through trenching. One previously recorded site, 41KR501, is present within the project area, but no evidence of it was observed. Along with the information from previous investigations at this site, it appears that 41KR501 has a low artifact density, lacks buried cultural features, and has been disturbed. Based on the results of the survey, it appears that the proposed

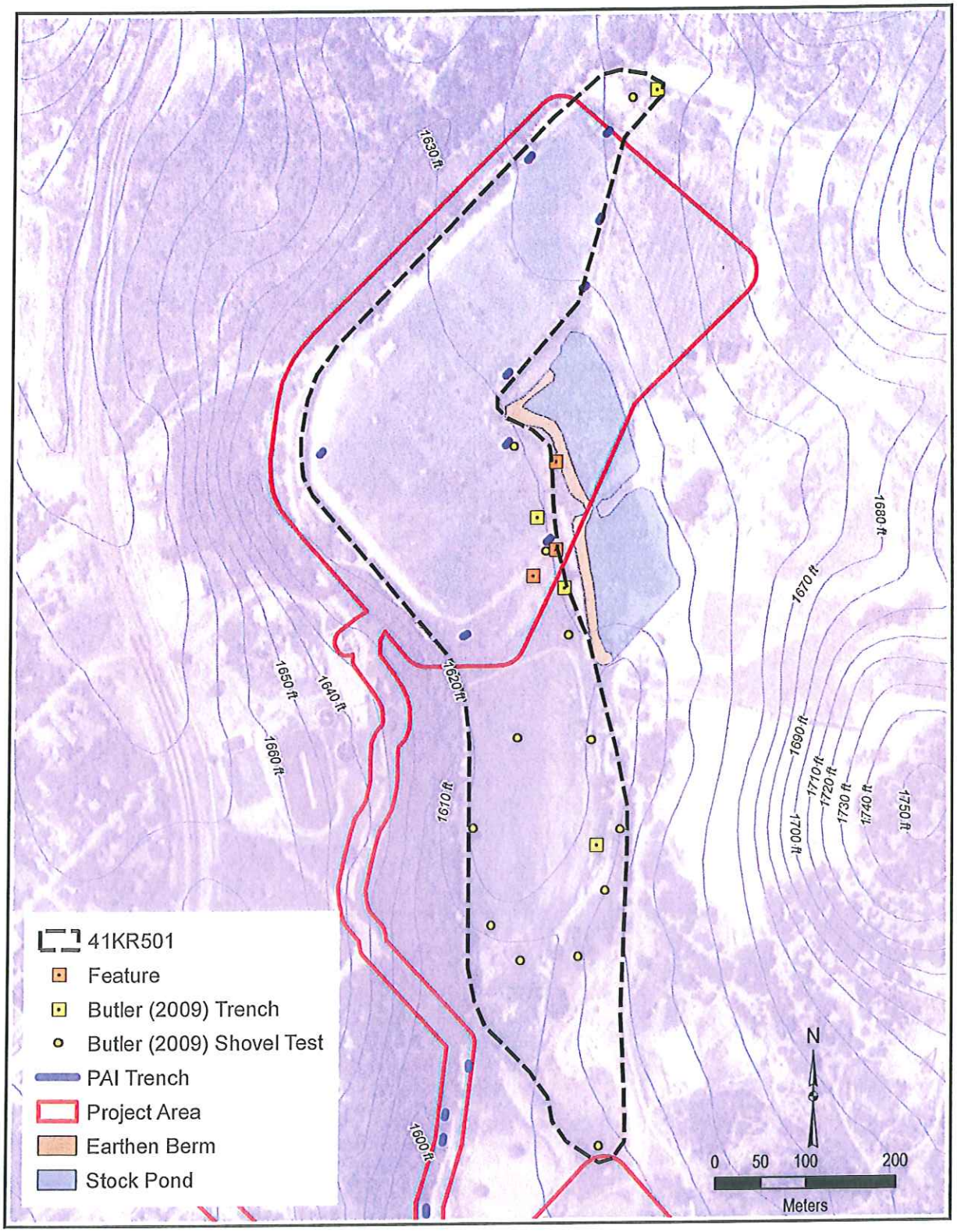

Figure 16. Map of 41KR501 with locations of shovel tests and trenches from all phases of work and reported features.

reuse project will not affect any archeological sites that are eligible for listing in the National Register of Historic Places and designation as State Antiquities Landmarks. No further archeological work is recommended.

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1/7/2015

Mark Wolfe
State Historic Preservation Officer
Texas Historical Commission
P.O. Box 12276
Austin, TX 78711-2276

Re: City of Kerrville Reuse Facility

Dear Mr. Mark Wolfe:

The City of Kerrville is proposing to improve their existing water reuse program and Water Resources Recovery Facility (Wastewater Treatment Plant). Included in this document are the following items:

- Request for SHPO Consultation Form
- Proposed Ground Disturbing Activities
- Project Description
- Maps
- Photographs

Please review the proposed project to identify issues relative to any cultural resources that should be considered by the City of Kerrville in the development of this project. If possible, we would like to receive your comments in 30 days. If you have any questions or need additional information, please feel free to contact me at (512) 617-3106 or meredith.heather@freese.com.

Sincerely,

Meredith Heather

Meredith Heather
Environmental Scientist

TEXAS HISTORICAL COMMISSION

REQUEST FOR SHPO CONSULTATION:
Section 106 of the National Historic Preservation Act and/or the Antiquities Code of Texas

Please see instructions for completing this form and additional information on Section 106 and Antiquities Code consultation on the Texas Historical Commission website at http://www.thc.state.tx.us/crm/crmsend.shtml.

☒ This is a new submission.

☐ This is additional information relating to THC tracking number(s): _____

Project Information

PROJECT NAME
Kerrville Reuse Facility

PROJECT ADDRESS	PROJECT CITY	PROJECT ZIP CODE(S)
0.4 miles northeast of HWY 27 and Spur 100 intersection	**Kerrville**	**78028**

PROJECT COUNTY OR COUNTIES
Kerr County

PROJECT TYPE (Check all that apply)

- ☐ Road/Highway Construction or Improvement
- ☐ Site Excavation
- ☐ Utilities and Infrastructure
- ☒ New Construction
- ☐ Repair, Rehabilitation, or Renovation of Structure(s)
- ☒ Addition to Existing Structure(s)
- ☐ Demolition or Relocation of Existing Structure(s)
- ☐ None of these

BRIEF PROJECT DESCRIPTION: Please explain the project in one or two sentences. More details should be included as an attachment to this form.
The Kerrville Reuse Facility proposed project involves the construction of a 105 MG reuse water pond, pump station, and associated improvements to expand the City's reuse capacity.

Project Contact Information

PROJECT CONTACT NAME	TITLE	ORGANIZATION	
Meredith Heather	**Environmental Scientist**	**Freese and Nichols, Inc.**	
ADDRESS	CITY	STATE	ZIP CODE
10431 Morado Circle, Suite 300	**Austin**	**Texas**	**78759**
PHONE	EMAIL		
512-617-3106	**meredith.heather@freese.com**		

Federal Involvement (Section 106 of the National Historic Preservation Act)

Does this project involve approval, funding, permit, or license from a federal agency?

☐ Yes (Please complete this section) ☒ No (Skip to next section)

FEDERAL AGENCY	FEDERAL PROGRAM, FUNDING, OR PERMIT TYPE
CONTACT PERSON	PHONE
ADDRESS	EMAIL

State Involvement (Antiquities Code of Texas)

Does this project occur on land or property owned by the State of Texas or a political subdivision of the state?

☒ Yes (Please complete this section) ☐ No (Skip to next section)

CURRENT OR FUTURE OWNER OF THE PUBLIC LAND
City of Kerrville

CONTACT PERSON	PHONE
Dieter Werner, P.E.	**830-258-1415**
ADDRESS	EMAIL
200 Sidney Baker N. **Kerrville, TX 78028**	

Identification of Historic Properties: Archeology

Does this project involve ground-disturbing activity?

☒ Yes (Please complete this section) ☐ No (Skip to next section)

Describe the nature of the ground-disturbing activity, including but not limited to depth, width, and length.

See attachments.

Describe the previous and current land use, conditions, and disturbances.

There is an existing Water Resource Recovery Facility (Wastewater Treatment Plant) on the project site. A portion of the site where the pipelines are proposed is undisturbed. The majority of the proposed site has previously disturbed and used as a borrow area for cover material at the adjacent municipal landfill. The site contains some unimproved roads, culverts, and small storage structures. There is an existing reuse line and existing landfill.

Identification of Historic Properties: Structures

Does the project area or area of potential effects include buildings, structures, or designed landscape features (such as parks or cemeteries) that are 45 years of age or older?

☐ Yes (Please complete this section) ☒ No (Skip to next section)

Is the project area or area of potential effects within or adjacent to a property or district that is listed in or eligible for listing in the National Register of Historic Places?

☐ Yes, name of property or district: ☐ No ☒ Unknown

In the space below or as an attachment, describe each building, structure, or landscape feature within the project area or area of potential effect that is 45 years of age or older.

ADDRESS	DATE OF CONSTRUCTION	SOURCE FOR CONSTRUCTION DATE
ADDRESS	DATE OF CONSTRUCTION	SOURCE FOR CONSTRUCTION DATE
ADDRESS	DATE OF CONSTRUCTION	SOURCE FOR CONSTRUCTION DATE

Attachments

Please see detailed instructions regarding attachments.

Include the following with each submission:

☒ Project Work Description
☒ Maps
☐ Identification of Historic Properties
☒ Photographs

For Section 106 reviews only, also include:

☐ Consulting Parties/Public Notification
☐ Area of Potential Effects
☐ Determination of Eligibility
☐ Determination of Effect

Submit completed form and attachments to the address below. Faxes and email are not acceptable.

Mark Wolfe
State Historic Preservation Officer
Texas Historical Commission
P.O. Box 12276, Austin, TX 78711-2276 (mail service)
108 W. 16th Street, Austin, TX 78701 (courier service)

For SHPO Use Only

Ground Disturbing Activity

The project involves the construction of a storage pond with 105 million gallon (MG) capacity and a footprint of approximately 15 acres. The pond is estimated to be about 26 feet deep, 1800 feet long, and 810 feet wide. Fill for the construction of the earthen embankment will be obtained from onsite excavation of the pond and a borrow area at the north end of the property. The potential soil borrow area is shown in Figure 1. Ground disturbance will also occur with the installation of a new 24-inch gravity pipeline. Approximately 2,560 linear feet of 24-inch gravity line will be installed from the new pond to the existing treatment facility. Two transmission mains will be installed, approximately 2,000 linear feet in length from the proposed pump station to the existing reuse distribution system. The proposed project activities and locations are shown in Figure 1. The project location is shown in Figure 2 on a United States Geological Survey (USGS) 7.5 minute topographic map.

Exploratory borings will occur within the vicinity of the proposed improvements:

- 105 MG holding pond – 4 borings to a depth of 50 feet; 5 borings to a depth of 40 feet and 2 borings to a depth of 15 feet. Boring holes will have a diameter of approximately 8 inches.
- Pump station – 2 borings to a depth of 40 feet; one boring to depth of 20 feet for the flow meter vault
- 24- inch gravity pipeline, 12-inch transmission pipeline, other miscellaneous lines – 2 borings to a depth of 45 feet at the creek crossing.
- Onsite or offsite borrow area – 3 borings to a depth of 15 feet

The boring holes are anticipated to have a diameter of approximately 8 inches. The pipelines are proposed to be installed at a depth ranging from 4 feet to 15 feet. The pipelines are proposed to cross Third Creek either by open cutting the creek or boring under, depending on further environmental studies.

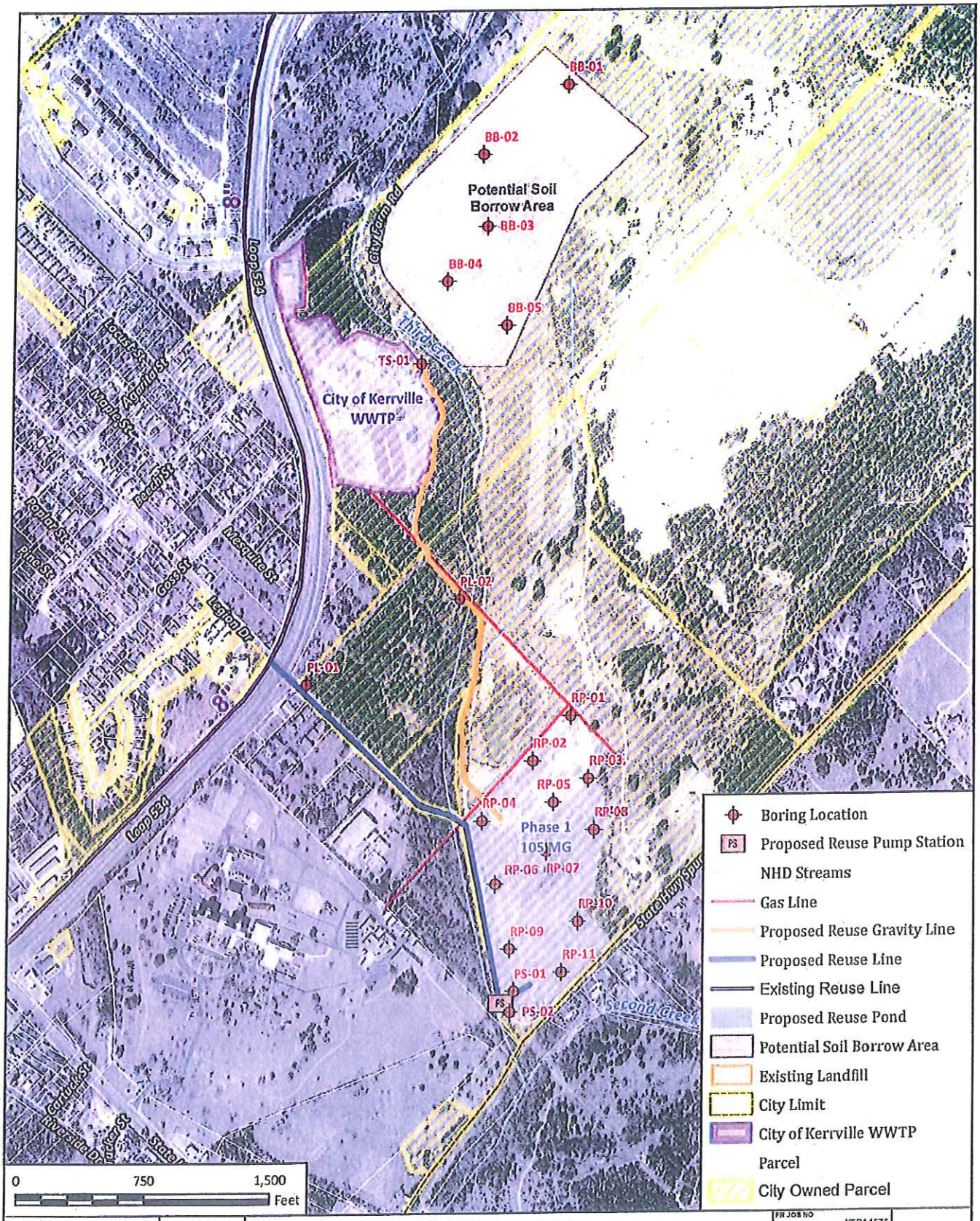
Project Description

The City of Kerrville has a successful water reuse program which provides reclaimed water from its Water Resources Recovery Facility (Wastewater Treatment Plant – WWTP) to various customers for irrigation of golf courses, recreational areas and landscape, as well as other non-potable uses. In order to expand the available usage of this resource, the City is seeking to construct reclaimed water storage ponds to increase the flexibility of matching water supply and demand. The City is also interested long-term in the potential to convert some of its treated effluent into a supplemental source of domestic supply for the City. The project location and activities are shown in Figures 1 and 2.

Kerrville Reuse Facility improvements consist of the following main components:

- New storage pond – With a 105 million gallon (MG) capacity of reuse water, the pond will consist of a new soil cement and HDPE-liner with 3H:1V of flatter side slopes and a footprint of approximately 15 acres.
- New pump station – the approximate location of the proposed pump station will be at the southwestern corner of the proposed reuse storage pond. The proposed pump station will be capable of serving two pressure planes within the city's proposed reuse system
- New 24-inch gravity pipeline from the WWTP – approximately 2,560 linear feet of 24-inch gravity line will be installed from the new pond to the existing treatment facility.
- New transmission pipelines (2 total, one for each pressure plane) – two transmission mains will be installed, approximately 2,000 linear feet in length from the proposed pump station to the existing reuse distribution system adjacent to Legion Dr. to Veterans Hwy (534). It is assumed that the transmission mains will be constructed adjacent to each other.

The pipelines are proposed to cross Third Creek, either by open cutting the creek or boring under, depending on further environmental studies.



FREESE AND NICHOLS, INC
10431 Morado Circle, Suite 100
Austin, TX 78759
Phone - 512-617-3100

CITY OF KERRVILLE

Kerrville Reuse Facility

Location on Aerial

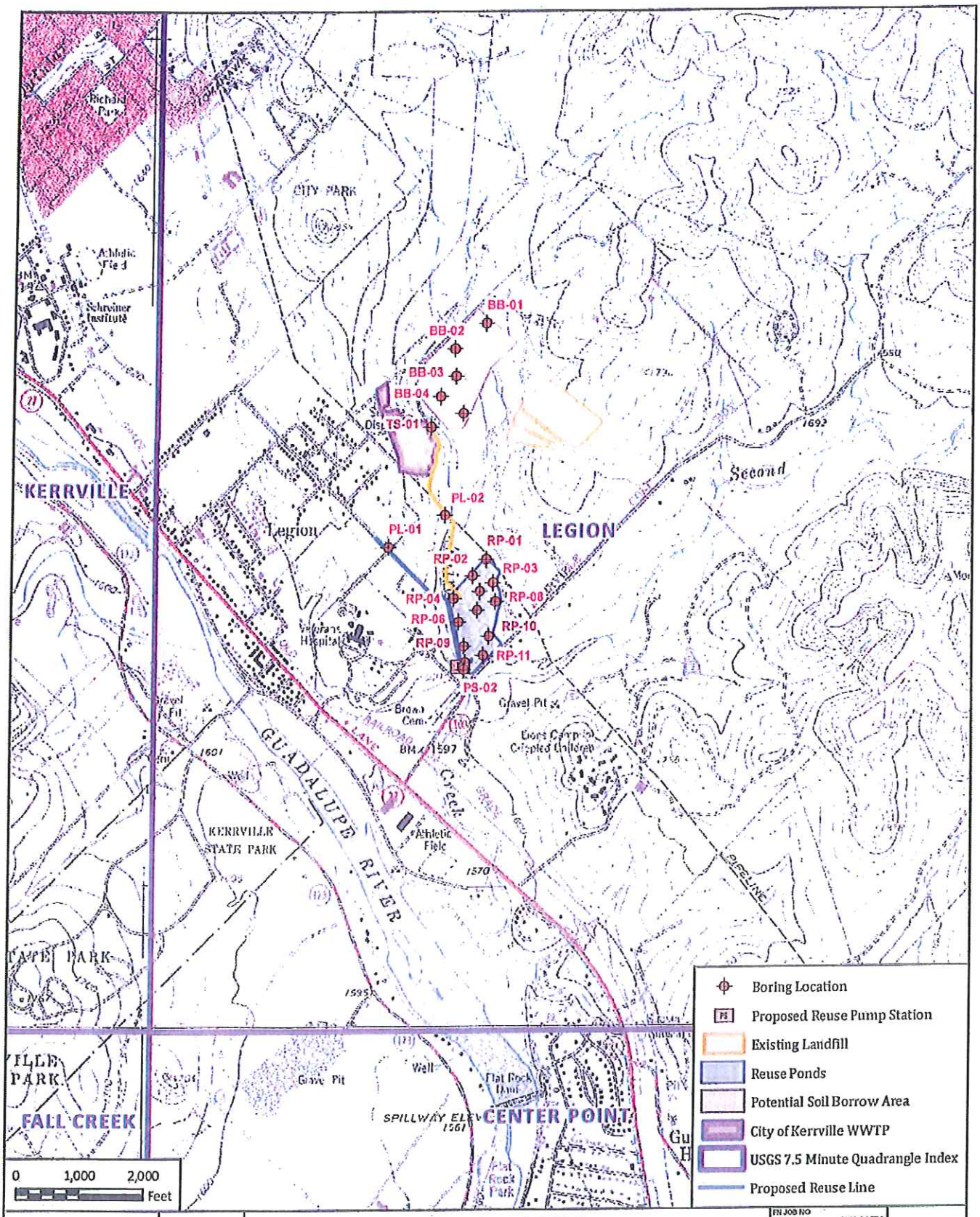
FN JOB NO	KER14576
FILE NAME	1_Aerial.mxd
DATE	1/7/2015
SCALE	1:9,000
DESIGNED	SSJ
DRAFTED	02218

1

FIGURE

Path: T:\ES\THC Coordination\1_Aerial.mxd

NAD 1983 StatePlane Texas South Central FIPS 4204 Feet



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10431 Morado Circle, Suite 100
Austin, TX 78759
Phone - 512-617-3100

CITY OF KERRVILLE

Kerrville Reuse Facility

Location on USGS 7.5 Minute Topographic Quadrangles

FN JOB NO	KER14576
FILE NAME	2_Topo_01_05_14.mxd
DATE	1/6/2015
SCALE	1:24,000
DESIGNED	SSJ
DRAFTED	SSJ

2

FIGURE

Path: H:\ENVIRONMENTAL\Final_Exhibits\THC\2_Topo_01_05_14.mxd

NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

Photographs

Photo 1. Project area; soccer fields adjacent to project area

Photo 2. Existing building on project site

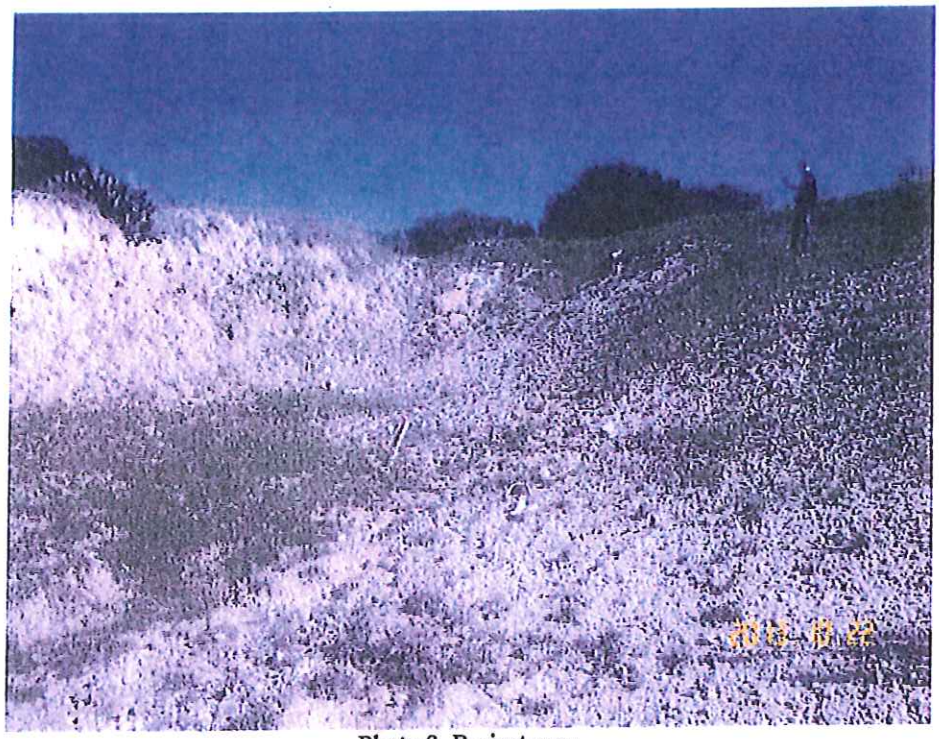

Photo 3. Project area

Photo 4. Wetland to the north of the proposed pond area

Photo 5. Proposed pond area

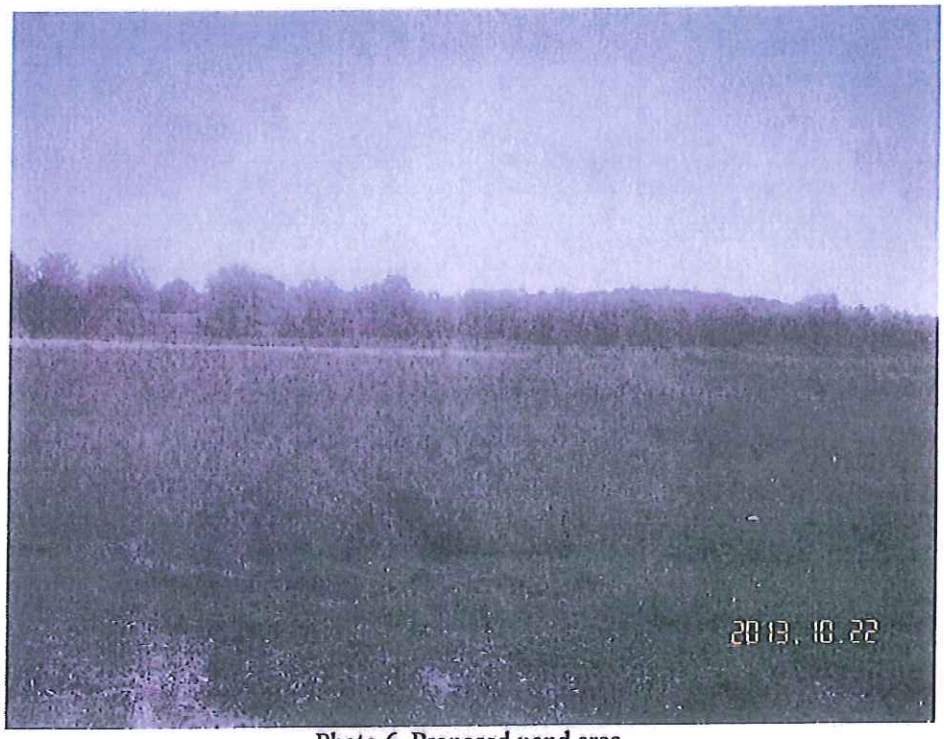

Photo 6. Proposed pond area

Photo 7. Proposed pond area

Photo 8. Proposed pond area

Photo 9. Existing pipeline crossing

Photo 10. Existing outfall to Third Creek

TEXAS HISTORICAL COMMISSION
real places telling real stories

February 3, 2015

Meredith Heather
Freese and Nichols
4040 Broadway St., Ste 600
San Antonio, Texas 78209

Re: Project review under the Antiquities Code of Texas: Kerrville Wastewater Treatment Plant Improvements County (City of Kerrville; Track #201504550)

Dear Ms. Heather:

Thank you for your correspondence describing the above referenced project. This letter serves as comment on the proposed undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission.

The review staff, led by Tiffany Osburn, has examined our records. Several archeological sites have been previously recorded within and adjacent to proposed project area. A professional archeologist must survey the areas of new ground disturbance, including the proposed new pond and pump station, as well as the proposed reuse gravity line between the new pond and existing treatment facility. In addition, previously recorded archeological site 41KR501 is located in the area of the potential soil borrow area. as indicated on the map submitted. This site will require archeological testing and further survey for delineation by a professional archeologist.

This work should meet the minimum archeological survey standards posted on-line at www.thc.state.tx.us. A report of investigations should be produced in conformance with the Secretary of the Interior's Guidelines for Archaeology and Historic Preservation, and submitted to this office for review. You may obtain lists of most professional archeologists in Texas on-line at: www.councilof texasarcheologists.org or www.rpanet.org. Please note that other potentially qualified archeologists not included on these lists may be used.

Since the survey is being performed on public land or within a public easement your contract archeologist must obtain an Antiquities Permit from our office before any investigations are undertaken. An Antiquities Permit can be issued as soon as we have a completed permit application.

Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Tiffany Osburn at 512/463-8883 or tiffany.osburn@thc.state.tx.us.**

Sincerely,

for
Mark Wolfe, State Historic Preservation Officer

MW/to

TECHNICAL MEMORANDUM

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TO: Dieter Werner, P.E.

CC: Randall Howard; John New, PE; Richard Weatherly, PE

FROM: Patrick Garnett, CWB, CPESC

SUBJECT: City of Kerrville, TX: Water Reuse Site Feasibility

DATE: June 4, 2014

PROJECT: KER13488

On Tuesday, October 22, 2013, Freese and Nichols, Inc. (FNI) environmental scientist, Patrick Garnett and Professional Engineer, Matt Ewald, performed a pedestrian site visit to the City of Kerrville's wastewater treatment plant and land adjacent to the City's sanitary landfill.

The proposed site is approximately 80 acres located along the eastern bank of Third Creek in Kerrville. The property to the southeast is the Kerrville Sanitary Landfill. To the northwest is the City's wastewater treatment plant. The property proposed for the reuse water storage facility is currently used as recreational sports fields, numerous borrow pits for the sanitary landfill, storage of empty refuse containers, and a remote controlled aircraft airfield. The airfield and sports complex are currently irrigated with reuse water from the wastewater treatment plant. Vegetation along the segment of stream 1, an unnamed tributary of Third Creek is typical of an ephemeral upland water course. Stream 1 exhibits an ordinary high water mark (OHWM) width of on foot as it exits the sediment ponds on the northern end of the complex. These ponds appear to be constructed to detain some of the stormwater from the adjacent sanitary landfill. Stream 1 and the open water impounded below the sanitary landfill is mapped on the USGS 7.5 minute Legion, TX quadrangle. Near the confluence with Third Creek, this unnamed tributary exhibits an OHWM of 1.5 feet as it exits a culvert from the sanitary landfill borrow pits.

Third Creek is an intermittent stream mapped on the USGS 7.5 minute Legion, TX quadrangle. There was water observed in the stream, downstream of the wastewater outlet (Photo 1). Upstream of the outlet no water was observed despite the recent two-inch rainfall approximately four days prior to the site visit.

Vegetation throughout the project area was comprised of common mullein (*Verbascum Thapsus),* greenbriar (Smilax bona-nox), mealy blue sage (Salvia farinacea), ashe juniper (Juniperus ashei), pecan (*Carya illinoinensis*), mesquite (Prosopis glandulosa), sugarberry (Celtis laevigata), giant reed (Arundo donax), Bermuda grass (Cynodon dactylon), Texas persimmon (Diospyros texana), ligustrum (Ligustrum lucidum), Johnsongrass (Sorghum halepense), sideoats grama (*Bouteloua curtipendula*), verbena (Verbena spp.), Texas wintergrass (*Nassella leucotricha*), buffalo grass(*Bouteloua dactyloides*), American sycamore (*Platanus occidentalis*), thistle (*Cirsium horridulum)*, prickly pear (Opuntia engelmannii), and twisted leaf yucca (Yucca rupicola).

The vegetation within the potential herbaceous wetland includes spikerush (Eleocharis palustris), bushy bluestem (Andropogon glomeratus), Roosevelt weed (Baccharis neglecta), and sumpweed (Iva annua).

According to the U.S. Fish and Wildlife Service (USFWS), the golden-cheeked warbler (Dendroica chrysoparia) and black-capped vireo (Vireo atricapilla) are listed as endangered species in Kerr County. Tobusch fishhook cactus

(Ancistrocactus tobuschii) is listed as an endangered flowering plant in Kerr County. No Tobusch fishhook cactus was seen along the proposed pipeline route. Black-capped vireos prefer habitat with young, semi-open stands of small trees and shrubs separated by open grasslands. This type of habitat was not observed within the project site. The golden-cheeked warbler resides in habitats consisting mainly of dense, mature Ashe juniper mixed with various oak species. This woodland habitat grows on limestone hills, canyons, and adjacent canyons. Habitat suitable for the golden-cheeked warbler has not been observed within the project site. In reference to the USFWS critical habitat mapper, there is no designated critical habitat in Kerr County.

Potential Section 404 impacts for the proposed project include: stream impacts to stream 1 and Third Creek, herbaceous wetland impacts, and open water impacts. All of these potential impacts would be avoided in the conceptual reuse pond project proposed in this report.

In 2001, a critique of compensatory mitigation by the National Research Council (NRC) concluded that third-party compensatory mitigation such as mitigation banks offer advantages over permittee-responsible mitigation in the fulfillment of regulatory goals. One such advantage identified by NRC is the consensus-driven, interagency review process used to approve banks. NRC noted that banks are more likely than traditional compensatory mitigation to achieve desired long-term outcomes and to create mitigation sites that are protected in perpetuity by organizations dedicated to resource conservation.

If the proposed impacts to Third Creek would require temporarily dewatering any portion of the waterway a Aquatic Resource Protection Plan is required to be approved by Texas Parks and Wildlife Department. This plan would detail the limits of dewatering (temporal and geographic), techniques for aquatic vertebrate removal and relocation, and habitat restoration.

Coordination with the Texas Historic Commission (THC) would be required if greater than 5,000 cubic yards of material were moved or more than five acres of area were disturbed. A letter with the project description and location could be sent to THC requesting their opinion as to the archeological requirements for the project. THC will respond with information concerning whether or not an archeological survey will need to be performed. Due to the existing disturbance and history of extensive use within the area the project may receive a "Project may proceed, no additional survey required" for the proposed activities.

Photo 1. Looking upstream on Third Creek, wastewater outfall to the left.

Photo 2. Looking north into the dammed drainage area, upgradient of Stream 1.

Photo 3. Looking south breached or blown out area of diversion above sports fields

Photo 4. Looking north, across open water located above water diversion berm.

Photo 5. Riprap and grouted swale down gradient of sanitary landfill.

Photo 6. Looking east, from grouted swale, toward wastewater treatment plant.

Photo 7. Looking south, along potential water of the U.S., Stream 1

Photo 8. Active borrow pit located north of herbaceous wetland.

Photo 9. Active borrow pit, herbaceous wetland in back right corner.

Photo 10. Southern extent of project area, upland vegetation.

Photo 11. Herbaceous wetland, sanitary landfill in the distance.

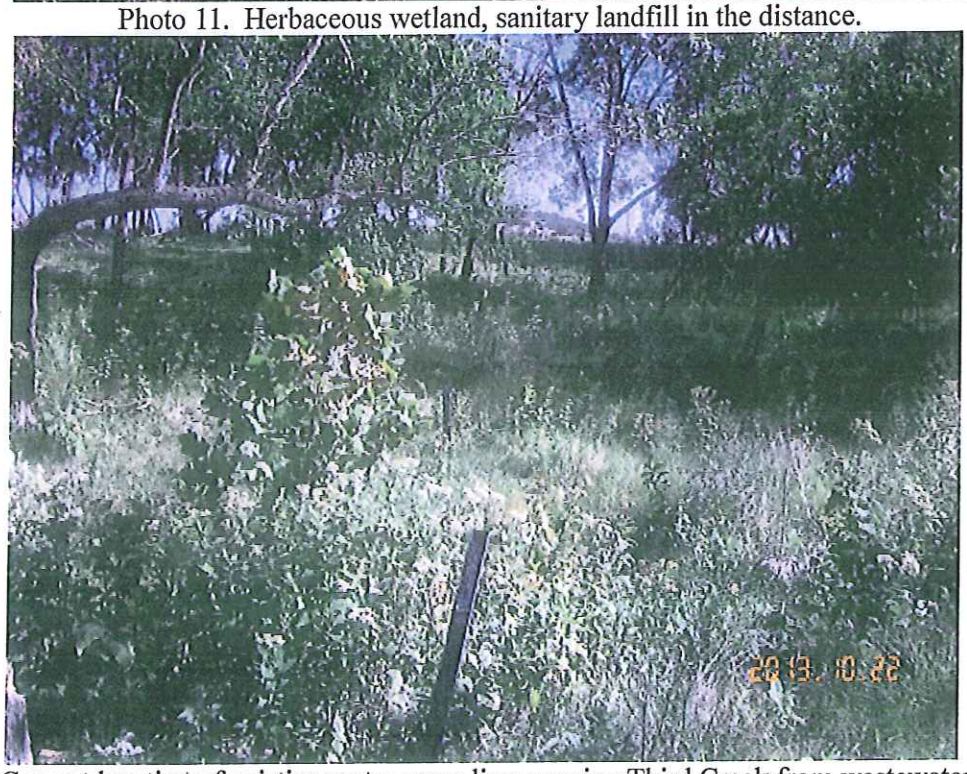

Photo 12. Current location of existing water reuse line crossing Third Creek from wastewater treatment plant.

Photo 13. Third Creek channel upstream of sanitary sewer outfall.

Exhibit 5
TCEQ Documents Regarding Dam Safety

- Response Letter Submitted to TCEQ – September 23, 2016
- Submission Letter to TCEQ – July 1, 2016

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September 23, 2016

Mr. Dustin Jennings, P.E., Engineer
Dam Safety Section
Critical Infrastructure Division, MC-177
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Re: Kerrville Reuse Pond and Pump Station Dam
Construction Plans/Specification Review
Kerr County

Dear Mr. Jennings:

We have received your comments regarding the construction plans and specifications for the Kerrville Reuse Pond and Pump Station Dam. We have summarized our responses below and look forward to discussing any questions with you in order to finalize the documents. The TCEQ comments are provided below with our responses in italics.

General Comments

1. The Information Sheet (TCEQ Form 20345 should be signed by the owner or responsible official.
   The signed form is attached to this letter.
2. Is there a written plan for the first reservoir filling (including procedures for emergency conditions)? Please include this in the specifications.
   Monitoring during filling will be the responsibility of the Owner rather than the contractor. Therefore, a filling plan will not be included in the specifications. Recommendations on monitoring filling will be provided to the Owner. Emergency procedures are documented in the Emergency Action Plan.
3. Section 31_23_10 titled "Structural Excavation and Backfill" has a field quality control section (Page 32_23_10-6), which specifics that in-place density tests shall be conducted at a rate of one test per 1,500 ft^2 for each lift. However, Section 31_23_23.16 titled "Compacted Earth Fill" does **not** specify a testing frequency for compacted earth fill. What testing frequencies are proposed for material placed according to the Compacted Earth Fill Sections.
   Section 3.06 Field Quality Control, was added to 31 23 23.16 "Compacted Earth Fill". The in-place density testing will be provided by the owner rather than the contractor and therefore does not need to be a part of the specifications. The owner will test approximately once per every 5,000 square feet per lift, per material type but may adjust the frequency based upon production.
4. The geotechnical analysis [Page 16] recommends crumb dispersion tests to be performed at a frequency of 1 test per 10,000 cubic yards placed per material type. Was this provisions incorporated plans or specifications.
   A material properties table was added to sheet P-9, indicating that the soil must not be dispersive. Testing requirements were added to 31 23 23.16.

Design Comments

5. The 24 inch pipe will discharge into the reservoir at an approximate elevation of 1,598.0 ft-msl, which means the pipe will be submerged by about 27 feet of water when the reservoir is at normal capacity. According to sheet P-13, the pipe will be sealed in the headwall using an "ADEKA ULTRASEAL MC-2005T". Please provide a description and manufacturers information for this product in the specifications. Further, how will the soil cement be anchored/attached to the headwall.
   The Adeka waterstop was added to 03 30 00 "Cast-In-Place Concrete", 2.04.B.1.b. The subgrade will be held 9-inches below the top of headwall. The HDPE liner will be anchored to the headwall per detail 5 on sheet P-10 or with embedded polyethylene channel. The soil cement will be placed adjacent to the headwall but will not be anchored/attached to the headwall.
6. The geotechnical report states that the topsoil within the embankment footprint should be stripped to a depth of 6-12 inches and be proof rolled to identify loose or soft spots (which are then excavated and replaced). Also note that some borings identified poorly graded gravel. Since the bedrock is shallow, and the clay core will be keyed into the bedrock, has consideration been given to excavating down the bedrock to start compaction of embankment material?
   We did consider this and determined that the 6-12 inch stripping is sufficient. The HDPE liner and underdrain will provide protection for seepage purposes.
7. Is there a vehicle weight limit for the soil cement access ramp? How will the soil cement joints be sealed?
   There is no weight limit specified. The ramp will support typical construction equipment. The HDPE liner is the water barrier to reduce seepage from the pond. The soil cement is a protective layer for the HDPE liner and does not need to be watertight. Therefore, the joints will not be sealed.
8. The geotechnical report states that 4 observation wells will be located in the embankment and to refer to Sheet P-2 for the proposed locations. Please clarify the locations of the observation wells on Sheet P-2.
   The observation wells are shown in plan view on P-2 with this symbol: P–X. *Additional details of the observation wells are given on P-14, including northing, easting and depth.*
9. What is the maximum discharge capacity in cubic feet second (cfs) of the pump station?
   North Plane = 625 gpm (Two pumps but should only run one at a time)
   River Hills/Schreiner University = 870 gpm
   Comanche Trace = 700 gpm
   Total = 2,195 gpm (4.9 cfs)

Hydrology and Hydraulics (H&H) Analysis

10. The H&H analysis assumed an inlet flow from the 24 inch pipe during the design storm event. The flow was converted from a maximum daily flow of 10 million gallons per day, to 15.5 cfs. Was the 10 MGD number based on the maximum possible cfs flowrate of the pipe? In other words, a maximum daily flow might not be representative of a maximum hourly flow, unless the daily flow assumes a maximum hourly flow for all 24 hrs. Please clarify/confirm the maximum hourly flowrate for the 24 inch pipe.
    The 15.5 cfs is the maximum possible flowrate of the pipe. This discharge assumes that the gate directing flow from the treatment plant to the pond is wide open, the pond is at the level of the overflow spillway, the water level in the treatment plant chlorine contact basin is at the top of the basin walls, and that there is sufficient inflow into the treatment plant to fill the chlorine contact basin to this level. The 15.5 cfs is 43% higher than the plant's permitted peak flow.
11. The H&H analysis was reviewed, and appears to be in accordance with Title 30, Texas Administrative Code, S4ection 299.15. Note that hydraulic adequacy will not be official until the

construction plans and specifications are approved and the requested information regarding the 24 inch pipe flow is provided and considered.
The response has been noted.

EAP and Inundation Map

12. The EAP, inundation map, and hazard classification (represented as a High Hazard Dam) were not reviewed during this project and will be reviewed separately.
The response has been noted.

Two changes have been made to the pond design since the preliminary set of plans was submitted to TCEQ. The first change is that the soil cement thickness has been changed from 12-inch to 9-inch. The 9-inch thickness will provide sufficient protection to the HDPE liner.

The second change is an alternate bid item to install a geotextile and soil cover over the HDPE on the pond bottom rather than an HDPE liner. The soil cover will provide protection to the HDPE liner.

Sincerely,

Dustin Mortensen

Dustin Mortensen, P.E.
Engineer

Attachments

Texas Commission on Environmental Quality

HYDROLOGIC AND HYDRAULIC (H&H) EVALUATION SUMMARY

(Please complete **all** sections, unless otherwise specified)

Name of Dam: Reuse Pond Dam

TCEQ Dam Safety Project No.: _____

County: Kerr

Year to Build: 2017

Maximum Record Precipitation (in): 35

Record Area (county or city): Kerr

Duration (hr): 36

Date of Record (MM/DD/YY): 06/30/32 – 07/2-32

Source Ref. (FEMA, National Weather Service, etc.): http://floodsafety.com/texas/

Downstream Dam Toe 1600 (ft-MSL) Normal Reservoir Capacity 308.5 (ac-ft)

Normal Pool 1625.0 (ft-MSL) Maximum Reservoir Capacity 362.2 (ac-ft)

Principal Spillway N/A (ft-MSL) Reservoir Surface Area 13 (ac)

Emergency Spillway 1626.0 (ft-MSL) Drainage Area 14 (ac)

Top of Dam 1629.0 (ft-MSL) Outlet Diameter or Cross-Section 40ft bottom width

Storm Duration	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Stage (ft-MSL)	% PMF Passing	Comments (if needed)
1 hr	263	55	1626.6	100	
2 hr	199	86	1626.7	100	
3hr	198	87	1626.8	100	
6 hr	155	69	1626.6	100	
12 hr	122	98	1626.8	100	Critical Storm
24 hr	91	81	1626.7	100	
48 hr	72	55	1626.6	100	
72 hr	46	44	1626.5	100	

To the best of my knowledge, I certify the above data are correct. I will supply the hydrologic and hydraulic reports to the Texas Commission on Environmental Quality upon request.

(Signature)

7-1-2016

(Date)

STATE OF TEXAS
J. BLAINE LAECHELIN
103616
LICENSED
PROFESSIONAL ENGINEER

Bryan W. Shaw, Ph.D., P.E., *Chairman*
Toby Baker, *Commissioner*
Jon Niermann, *Commissioner*
Richard A. Hyde, P.E., *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

August 9, 2016

Mr. Dustin Mortensen, P.E.
Freese and Nichols
10431 Morado Circle, Suite 300
Austin, Texas 78759

RE: **Kerrville Reuse Pond and Pump Station Dam**
Construction Plans/Specifications Review
Kerr County

Mr. Mortensen,

On July 6, 2016 TCEQ Dam Safety received a preliminary set of plans and specifications for the proposed construction of the Kerrville Reuse Pond and Pump Station Dam.

The TCEQ understands that the dam will consist of a ring levee with a maximum embankment height of 29 ft and a maximum impoundment of 362.2 acre-ft. That the reservoir does not collect runoff (except for what falls directly over the 14 acre reservoir surface area) and will be filled by a gravity fed 24 inch pipe from the onsite Kerrville Water Reclamation Plant. The dam will have a clay core, which will be keyed into the limestone bedrock, the key cut will be at least 10 ft wide and 2 ft deep. The inner and outer face will have a slopes of 3 horizontal to 1 vertical. The inner face of the embankment will be armored with a high density polyethylene (HDPE) liner and a soil cement protective cover. The outer face of the embankment will have grass cover established, except for areas that may be damaged by channelized runoff or flood flow from Third Creek (which will be armored with a permanent turf reinforcing mat). The dam will have a 3 ft deep trapezoidal emergency spillway that has a 40 ft bottom width and 100 ft top width. A under drain system will be placed beneath the reservoir area, and water captured by the drain will be pumped into the reservoir.

Additional information is needed to complete our review. Please refer to the following comments and concerns:

General Comments

1. The Information Sheet (TCEQ Form 20345) should be signed by the owner or responsible official.

2. Is there a written plan for the first reservoir filling (including procedures for emergency conditions)? Please include this in the specifications.

RE: Kerrville Reuse Pond and Pump Station Dam (TX80472)

3. Section 31_23_10 titled "Structural Excavation and Backfill" has a field quality control section (Page 31_23_10-6), which specifics that in-place density tests shall be conducted at a rate of one test per 1,500 ft^2 for each lift. However, Section 3_23_23.16 titled "Compacted Earth Fill" does **not** specify a testing frequency for compacted earth fill. What testing frequencies are proposed for material placed according to the Compacted Earth Fill section?

4. The geotechnical analysis [Page 16] recommends crumb dispersion tests to be performed at a frequency of 1 test per 10,000 cubic yards placed per material type. Was this provision incorporated plans or specifications?

Design Comments

5. The 24 inch pipe will discharge into the reservoir at an approximate elevation of 1,598.0 ft-msl, which means the pipe will be submerged by about 27 ft of water when the reservoir is at normal capacity. According to sheet P-13, the pipe will be sealed in the headwall using an "ADEKA ULTRASEAL MC-2005T". Please provide a description and manufactures information for this product in the specifications. Further, how will the soil cement be anchored/attached to the headwall?

6. The geotechnical report states that the topsoil within the embankment footprint should be stripped to a depth of 6-12 inches and be proof rolled to identify loose or soft spots (which are then excavated and replaced). Also note that some borings identified poorly graded gravel. Since the bedrock is shallow, and the clay core will be keyed into the bedrock, has consideration been given to excavating down the bedrock to start compaction of embankment material?

7. Is there a vehicle weight limit for the soil cement access ramp? How will the soil cement joints be sealed?

8. The geotechnical report states that 4 observation wells will be located in the embankment and to refer to Sheet P-2 for the proposed locations. Please clarify the locations of the observation wells on Sheet P-2.

9. What is the maximum discharge capacity in cubic feet second (cfs) of the pump station?

Hydrology and Hydraulics (H&H) Analysis

10. The H&H analysis assumed an inlet flow from the 24 inch pipe during the design storm event. The flow was converted from a maximum daily flow of 10 million gallons per day, to 15.5 cfs. Was the 10 MGD number based on the maximum possible cfs flowrate of the pipe? In other words, a maximum daily flow might not be representative of a maximum hourly flow, unless the daily flow assumes a maximum hourly flow for all 24 hrs. Please clarify/confirm the maximum hourly flowrate for the 24 inch pipe.

RE: Kerrville Reuse Pond and Pump Station Dam (TX80472)

11. The H&H analysis was reviewed, and appears to be in accordance with Title 30, Texas Administrative Code, Section 299.15. Note that hydraulic adequacy will not be official until the construction plans and specifications are approved and the requested information regarding the 24 inch pipe flow is provided and considered.

EAP and Inundation Map

12. The EAP, inundation map, and hazard classification (represented as a High Hazard Dam) were not reviewed during this project and will be reviewed separately.

After receipt of all the additional information in conjunction with finalized (signed and sealed) plans and specifications, we will continue the review of your plans. If the information furnished in response to this notice results in the need for further clarification or additional information, we will communicate that need as soon as possible.

Thank you for your cooperation in this matter. If you have any questions, please contact me at (512) 239-1268 or my supervisor for this project Johnny Cosgrove, P.E. at (512) 239-4307.

Sincerely,

Dustin Jennings, P.E., Engineer
Dam Safety Section
Critical Infrastructure Division, MC-177

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July 1, 2016

Warren D. Samuelson, P. E
Manager, Dam Safety Section
Texas Commission on Environmental Quality
MC-177
P.O. Box 13087
Austin, TX 78711-3087

Re: Kerrville Reuse Facility Storage Pond

Dear Mr. Samuelson:

We are completing design of a 100-million-gallon pond for the City of Kerrville. The design reports are complete while the plans and specifications are at the 90 percent complete stage. I am submitting the drafts to you now for your review. We plan to complete the design and issue the project for bid on July 21, 2016.

Enclosed, please find the following:

1. Form 20345—Information Sheet: Proposed New Construction, Modification, Repair, Alteration, or Removal of a Dam
2. Form 20346—Hydrologic and Hydraulic (H&H) Evaluation Summary
3. Emergency Action Plan
4. Reuse Pond Design Report
5. Geotechnical Data Report
6. Geotechnical Analysis Report
7. 90% Review Specifications – 2 Volumes
8. 90% Review Plans – Half-size of the entire set, including all sheets for the pipelines and pump station
9. 90% Review Plans – Full-size of the pond drawings only

Sincerely,

Dustin Mortensen

Dustin Mortensen

Attachments

EMERGENCY ACTION PLAN

KERRVILLE REUSE FACILITY STORAGE POND TX#####

1. INTRODUCTION

1.1. Purpose

The purpose of this Emergency Action Plan (EAP) is to identify emergency situations that could threaten the Kerrville Reuse Facility Storage Pond dam and to plan for an expedited, effective response to prevent failure of the dam and warn downstream residents of impending danger. This plan defines the notification procedures to be followed in the event of a potentially hazardous situation. The procedures are intended to protect lives and prevent property damage from an uncontrolled release of water from the reservoir.

1.2. Basic Information

The Kerrville Reuse Facility Storage Pond is located in the City of Kerrville in the hill country of south-central Texas. The City of Kerrville is in Kerr County, 68 miles northwest of the City of San Antonio. The Kerrville Ruse Facility Storage Pond dam creates a 100-million-gallon storage pond 0.5 miles south-southwest of the City of Kerrville Water Reclamation Facility (wastewater treatment plant) and due south of the existing landfill. A vicinity map is presented in Tab 1.

1.3. Directions to the Dam

The only public road access to the dam is via Highway 27 (Memorial Blvd) to Spur 100.

- Spur 100 is 0.6 miles southeast of the intersection of Highway 27 and TX-537 Loop S (Veterans Highway)
- Turn northeast onto Spur 100, continue for 0.6 miles.
- The dam is on the left (east) side of Spur 100.

Alternate access is from the City of Kerrville Water Reclamation Facility by crossing Third Creek and following the City's private road with locked gates.

2. DAM INFORMATION

2.1. General

The Kerrville Reuse Facility Storage Pond was built in 2017 and impounds treated effluent from the City of Kerrville Water Reclamation Plant. The dam is an off channel facility and has no drainage area except for the reservoir surface of approximately 13.9 acres. The normal pool elevation of the reservoir is 1625 feet NAVD88, and the storage capacity of the reservoir at normal pool is 308.5 acre-feet, or 100 million gallons.

The dam is a ring-dike with embankment entirely surrounding the reservoir. The dike is a 3,244-foot long, earthfill embankment with a maximum height of 29 feet. The top of the dam is at elevation 1629 feet NAVD88, and the crest of the dam is approximately 12 feet wide with a flexible base road surface. The upstream and downstream slopes are approximately 3H:1V (3-ft horizontal to every 1-ft vertical) with natural vegetation on the slopes. The bottom of the pond is up to 10 feet below the original ground surface.

The dam does not have a principal spillway. The emergency spillway, located on the south side of the dam, is a soil-cement lined channel measuring 40 feet in width with a crest elevation of 1626 feet NAVD88 with 10H:1V side slopes. Flood releases from the reservoir are uncontrolled since the spillway automatically passes flow when the reservoir water elevation reaches the spillway crest elevation. The dam is designated as high hazard by TCEQ criteria.

A summary of the dam information is provided in Table 1. Additional information is provided in Tab 3.

Table 1 – Information for Kerrville Reuse Facility Storage Pond

Drainage Area:	13.9 acres – Pond surface only. There is no inflow.		
Type of Dam:	Earthfill embankment		
Length:	3,244 feet		
Maximum Height:	29 feet above natural ground		
Top of Dam Elevation:	1629 feet NAVD88	**Maximum Capacity:**	362.2 acre-feet
Normal Pool:	1625 feet NAVD88	**Capacity at Normal Pool:**	308.5 acre-feet
Emergency Spillway:	40-ft wide soil cement channel on south side	**Emergency Spillway Elevation:**	1626 feet NAVD88

2.2. Reservoir Operations

The reservoir is filled through a pipeline from the Kerrville Water Reclamation Facility. Water is released through the reservoir through the pump station into the reuse distribution system. In an emergency, the inflow to the reservoir could be shut off at the reclamation facility. The reservoir could be lowered using the pump station, provided that the reuse customers have capacity to store the discharged water or if a temporary discharge location from the distribution system is allowed by Texas Commission on Environmental Quality, Water Quality Division.

3. RESPONSIBILITIES

3.1. Dam Owner's Responsibilities

The first point of contact for dam safety issues is the Water Reclamation Superintendent with the City of Kerrville. The Water Reclamation Superintendent is also listed as the EAP Coordinator in the Notification Flowchart, and as such, is responsible for implementing this EAP if conditions warrant. The Water Reclamation Superintendent will coordinate with the Public Works Director who will coordinate directly with the City's Emergency Management Coordinator. The Notification Flowchart (page 3) and Distribution List (page 5) contain the names and job descriptions of those City personnel and others who will need to be contacted in the event of an emergency at the dam. These EAP components will need to be updated as personnel changes occur within the City and other organizations. The remaining portions of the EAP will make reference to job descriptions only, and will thus not need to be updated.

City personnel responsible for maintenance of the dam, specifically the Water Reclamation Superintendent or his designee, are the first line of dam observers, and are the people responsible for initiating implementation of the EAP protocols. The Water Reclamation Superintendent, or his designee, is responsible for conducting integrity inspections, and notifying the Public Works Director of any situation which could lead to an emergency. The Public Works Director is responsible for notifying emergency personnel of any emergency. The Public Works Director is also responsible for contacting appropriate emergency personnel if a dam failure is imminent. The Water Reclamation Superintendent is responsible for coordination of maintenance and inspection activities, and annual updates of the EAP.

3.2. Responsibilities for Notification

The Water Reclamation Superintendent shall make initial notifications per the Notification Flowcharts. The Kerrville Emergency Management Coordinator will coordinate the response (contact information provided in organization flow charts on pages 3 and 4). Downstream residents should be notified of possible evacuation during a Possible Dam Failure condition. The Kerrville Emergency Management Coordinator shall issue news releases. Sample news releases appear in Tab 4.

3.3. Responsibilities for Evacuation

Downstream residents and businesses should be evacuated during an Imminent Dam Failure condition. City of Kerrville Police will be responsible for the warning and evacuation of people in the threatened areas.

3.4. Responsibilities for Duration, Security, Termination, and Follow-up

The Water Reclamation Superintendent or his designated representative is responsible for monitoring of emergency situations at the dam and keeping authorities informed, based on the Notification Flowchart.

The Public Works Director and the Kerrville Emergency Management Coordinator (contact information provided in organizational flow chart on page 4) are responsible for declaring that an emergency at the dam is terminated. Applicable authorities will be notified based on the Notification Flowchart.

The Water Reclamation Superintendent will ensure that a follow-up evaluation is completed by all participants after the emergency. The results of the evaluation should be documented in a written report and filed with the EAP.

3.5. Communications

Local officials and downstream residents will be notified by landline telephone, if available; otherwise via cell phones or emergency personnel (in person or using their radios).

Sample public announcements appear in Tab 4. Verification or authentication of the situation can be made by contacting the Water Reclamation Superintendent and City of Kerrville emergency management officials. Television and radio can be used as much as possible to notify area residents of the possible dangers. Public announcements are to be issued by the City of Kerrville Emergency Management Coordinator.

4. POSSIBLE EMERGENCY CONDITIONS

4.1. Situations

Daily surveillance at the site and during an event will be the normal method of detecting potential emergency situations. The following events could lead to an emergency and may necessitate the implementation of the Emergency Action Plan.

- **Severe storms with excessive rains:** Although generally not in themselves a threat to the dam, severe storms cause a rise in water level above the spillway and the uncontrolled release of floodwater. Severe storms increase flow in already rain-swollen areas and can also contribute to an existing problem and hinder remediation efforts.
- **Tornadoes:** Tornadoes occur in the area and could cause structural damage to the dam which could possibly result in its failure. If a tornado has struck in the area, an inspection of the dam for any signs of damage should be performed.

- **Earthquakes:** Kerrville Reuse Facility Storage Pond is located in a seismic zone with low activity; however, an earthquake is still a possibility. If one should occur, appropriate post-earthquake inspection should be performed.
- **Sabotage:** A threat to damage the dam has been made. Appropriate actions must be taken to protect the dam.

4.2. Signs of Failure

The following paragraphs describe some signs of failure which could eventually lead to a dam breach. The Emergency Action Plan should be implemented if any of these signs are evident.

- **Excessive Seepage:** All earthen embankments allow some minor seepage through the dam or the foundation. However, excessive, uncontrolled seepage can result in piping which is the movement of embankment material in the seepage flow and can lead to failure. Piping can occur for years at a slow rate.

  If the piping has progressed to a dangerous level, it will be evident by increased flow or the discharge of muddy water (or both). At that stage, immediate action to stop the piping is needed. Fully developed piping is difficult to handle and is very likely to result in failure. A whirlpool in the reservoir is a sign of uncontrollable piping and necessitates immediate emergency action.
- **Embankment or Foundation Sliding:** Sliding is usually first apparent when cracks or bulges in the embankment appear. Slides with progressive movement can cause failure of the embankment.
- **Overtopping Failure:** Overtopping of the embankment results in erosion of the dam crest. Once erosion begins, it is very difficult to stop and can lead to breach of the dam.

4.3. Emergency Identification and Classification

Early identification of potentially dangerous conditions can allow time for implementation of the emergency action plan. With appropriate action, distress need not lead to a catastrophic failure of the dam. Early identification, close monitoring, planned action and remedial measures will help alleviate a potentially dangerous situation.

The following sections describe some of the different signs of distress which may be used to classify the emergency level. The conditions listed are summarized in Tab 5, along with recommended actions.

A. "Abnormal" Conditions

The following conditions are not normal occurrences.

- piping or boils on or near the dam, as evidenced by muddy water
- slides or sloughs in the embankment
- a significant increase in seepage quantities

- unusual movement or cracking of the embankment
- small sinkholes or subsidence within 500 feet of the embankment or spillway
- a severe storm, earthquake, or tornado

In the event that any of these items are observed, a licensed engineer should be contacted to inspect the dam to document the distress and determine whether remedial action is necessary. Notification of local authorities is not necessary for "abnormal" conditions.

B. "Watch" Condition

A "watch" indicates that a significant problem that may potentially progress to a dangerous situation has been detected, but that a breach is considered unlikely and no flooding is imminent. The following is a list of conditions which constitute "watch" conditions:

- small boils if conditions are muddy on the downstream slope of the embankment or downstream from the toe, or if there is flowing muddy water downstream from the embankment
- large sinkholes with corresponding seepage anywhere on the embankment or downstream from the toe
- any slide that degrades the crest of the embankment or that is progressively increasing in size
- significantly increasing seepage or flow

In the event that any of these items are observed, notifications should be made following the "Watch Condition" Notification Flowchart on page 3.

C. Possible Dam Failure

A "possible dam failure" warning is issued when a "watch" condition is becoming progressively worse and a dam failure is considered possible. The existence of any of the following conditions constitutes possible dam failure:

- large boils, increasing in size and flow rate, especially if there is flowing muddy water
- significantly increasing seepage, especially flowing muddy water
- slides involving a large mass of material that impairs the crest of the dam and is continuing to move
- sinkholes with seepage flowing muddy water
- an increase in the reservoir level to near the top of the dam

If any of these items are observed, notifications should be made following the "Possible/Imminent Dam Failure Notification Flowchart on page 4. Downstream residents should be notified that evacuation may be necessary.

D. Imminent Dam Failure

"Imminent dam failure" is the determination that a "possible dam failure" condition will most likely progress to a failure of the dam and the reservoir will be uncontrollably released, regardless of the actions taken. The existence of any of the following conditions constitutes imminent failure:

- overtopping of the dam
- rapidly increasing boils or the presence of new, significantly flowing boils, particularly muddy ones near previously identified ones
- rapidly increasing seepage, especially flowing muddy water
- slides involving a large mass of material or which have degraded the crest of the embankment to a level that approaches the water surface level, or if significant seepage is observed through the slide area
- settlement that is predicted to degrade to the reservoir level
- cracks that extend to the reservoir level

If any of these items are observed, notifications should be made following the Possible/Imminent Dam Failure Notification Flowchart on page 4. Downstream residents should be evacuated.

4.4. Previously Known Problems

There are no known problems with the dam.

5. PREPAREDNESS

Preparedness actions are to be taken both before and following the development of emergency conditions and should identify ways of preparing for an emergency, increasing response readiness in a uniform and coordinated manner, and helping to reduce the effects of a dam failure. The following are some steps that could prevent or delay failure after an emergency is first discovered.

Surveillance: The Water Reclamation Superintendent or his designee will monitor the dam during emergency situations such as a severe storm event.

Response during weekends and holidays: The Water Reclamation Superintendent or his designee will be available for emergency response during weekends and holidays.

Response during periods of darkness and adverse weather: The Water Reclamation Superintendent or his designee will arrange for access to generators and lights to adequately monitor the situation. The Water Reclamation Superintendent or his designee will be able to access the site during adverse weather conditions by trucks if Third Creek has not made the City's low water crossing or Spur 100 impassable.

Access to the site: Alternate access routes should be planned in the event of an emergency at the dam. The shortest access from the Water Reclamation facility is by crossing Third Creek. In the event flows in Third Creek block the access road, access is via Spur 100.

Preventive measures can be taken in an emergency to prevent the catastrophic failure of the dam, but such repairs should be undertaken with extreme caution. The repairs are only temporary, and a permanent repair should be designed by an engineer as soon as possible.

The following actions should only be undertaken under the direction of a professional engineer or contractor. In all cases, the appropriate Notification Flowchart must be implemented and the personnel of the TCEQ Dam Safety Section must be notified.

Consider the following preparedness actions if the dam's integrity is threatened by:

Overtopping by flood waters

1. Give erosion-resistant protection to the downstream slope by placing plastic sheets or other materials over eroding areas.

Slide on the upstream or downstream slope of the embankment

1. Lower the water level in the reservoir by pumping or siphoning to an elevation considered safe given the slide condition.
2. Stabilize any slide on the downstream slope by weighting the toe area below the slide with additional soil, rock, or gravel.

Seepage or Piping (Leakage) through the embankment, foundation, or abutments

1. Plug the flow with whatever material is available (hay bales, bentonite, or plastic sheeting) if the entrance to the leak is in the reservoir.
2. Lower the water level in the reservoir by pumping or siphoning until the flow decreases to a non-erosive velocity or until it stops.
3. Place an inverted filter (a protective layer of sand and gravel) on the exit area to hold the material in place.
4. Continue operating at a lower level until a repair is made.

Emergency spillway erosion threatening reservoir evacuation

1. Provide temporary protection at the point of erosion by putting in place sandbags, riprap materials, or plastic sheets weighted with sandbags.
2. Consider pumps and siphons to help reduce the water level in the reservoir.
3. When rainfall subsides, lower the water in the reservoir to a safe level; continue operating at a lower water level in order to minimize spillway flow.

Excessive settlement of the embankment

1. Lower the water level by pumping or siphoning.
2. If necessary, restore freeboard, preferably using sandbags.
3. Lower the water in the reservoir to a safe level; continue operating at a reduced level until repairs can be made.

6. SUPPLIES AND RESOURCES

6.1. Contracts

The City of Kerrville has access to emergency personnel, equipment, and resources throughout the various city departments. The City will also work with Kerr County to provide personnel and resources in the event of an emergency, as well as statewide mutual aid. Should Kerrville personnel and resources prove to be inadequate during an emergency, requests will be made for assistance from other local jurisdictions, other agencies and industry, as needed. Such assistance may include equipment, supplies, or personnel. All agreements will be entered into by authorized officials, and should be in writing whenever possible. The Public Works Director shall have the authority to enter into agreements as deemed necessary to prevent failure of the dam.

6.1. Equipment and Supplies

Equipment and supplies which may be needed for use in the event of an emergency includes the equipment listed in Tab 6.

6.2. Reports

Technical Data

Periodic inspections of the dam will be made to evaluate its structural safety and stability. These inspections will be documented in short reports with photographs. In the event of an "Abnormal" occurrence, reference to these reports, particularly the photographs, may be beneficial in the evaluation of a potential problem.

Technical records such as drawings and inspection reports should be stored and carefully maintained by the Water Reclamation Superintendent. Alternate personnel will be familiar with the location of the documents in the event of an emergency situation.

Emergency Operations Activity Log

Any unusual or emergency condition should be documented, including the following:

- activation or deactivation of emergency facilities
- emergency notifications to other local governments and to state and federal agencies
- significant changes in the emergency
- major commitments of resources or requests for additional resources from external sources
- telephone calls should be recorded in chronological order
- issuance of protective action recommendations to the public
- evacuations

- casualties
- termination of the incident

6.3. Costs of Emergency Operations

For major emergencies, the Water Reclamation Superintendent shall maintain detailed records of costs expended. These records may be used to recover costs from the responsible party or insurers, or as a basis for requesting financial assistance for certain allowable response and recovery costs from the state and/or federal government. These documented costs should include:

- Personnel costs, especially overtime costs;
- Costs for leased or rented equipment;
- Equipment operation costs;
- Costs for contract services to support emergency operations;
- Costs for specialized supplies expended for emergency operations.

7. INUNDATION AREA

The inundation map illustrates the areas subject to flooding from a failure of the dam, and can be found in Tab 2. The map was prepared using the results of a simplified breach analysis assuming the reservoir level is at the top of dam.

There are a significant number of structures that could be affected due to a dam breach. These structures are located along Spur 100 and Highway 27. Among the structures impacted would be the Kerrville Little League Baseball Field, Kerr County Fair Grounds, Kerrville National Cemetery, and the businesses along Riverside Drive.

7.1. Local Evacuation Plan

If imminent failure of the dam with uncontrolled downstream flooding is anticipated, local emergency management and law enforcement personnel should notify those downstream to evacuate in the most expedient manner possible. The organizations and personnel on the Notification Flowchart should be contacted immediately. Local law enforcement officials, along with radio and television stations, can best spread the notice for evacuation. The immediate impact will be to areas along Third Creek downstream of the dam. For sunny-day and design flood breaches, the following actions should be taken:

- Barricading all roads that could possibly be flooded to prevent access to the affected area. These roads include the Spur 100 and Highway 27 near Spur 100. See the Inundation Map in Tab 2 to determine appropriate barricade locations.
- The Department of Public Safety District Coordinator office can assist with the notification of all persons and agencies involved, with the possibility of additional support—including contacting others not accessible by radio or telephone.

8. IMPLEMENTATION

8.1. Development

The draft Emergency Action Plan will be sent to TCEQ for review after review by the City of Kerrville. Comments received will be incorporated into this document prior to the final approval by the City of Kerrville. Copies of this document will be on file with TCEQ.

8.2. Updating

Copies of the EAP have been provided to the appropriate individuals and the EAP has been approved and signed by the owner and emergency management coordinator, as shown on the Distribution List and Approval and Implementation sheets at the front of the report. This plan will be reviewed and updated annually by Water Reclamation Superintendent and the City of Kerrville Emergency Management Coordinator in conjunction with City's annual maintenance inspection of the dam. The Water Reclamation Superintendent will review and complete all items on the Annual EAP Evaluation Checklist in Tab 7. After the annual update is complete, a new Approval and Implementation sheet will be attached and the annual update will be documented on the Plan Review and Update sheet in Tab 8.

If revisions to the EAP are made as a result of the annual update, such changes will be recorded on the Log Sheet of Changes form at the front of the report. A copy of the updated portions of the EAP will be sent to TCEQ. If the EAP was reviewed and revisions were not required, the Water Reclamation Superintendent will submit written notification to the TCEQ that no updates to the EAP have been adopted or implemented.

8.3. Testing

A table top exercise will be conducted at least once every five years. The table top exercise involves a meeting of the Water Reclamation Superintendent and Emergency Management Coordinator with local and state emergency management officials in a conference room. The exercise begins with a description of a simulated event and proceeds with discussions by the participants to evaluate the EAP and response procedures, and to resolve concerns regarding coordination and responsibilities. Any problems identified during an exercise should be included in revisions to the EAP. Records of training and testing exercises will be resolved and maintained in Tab 9.

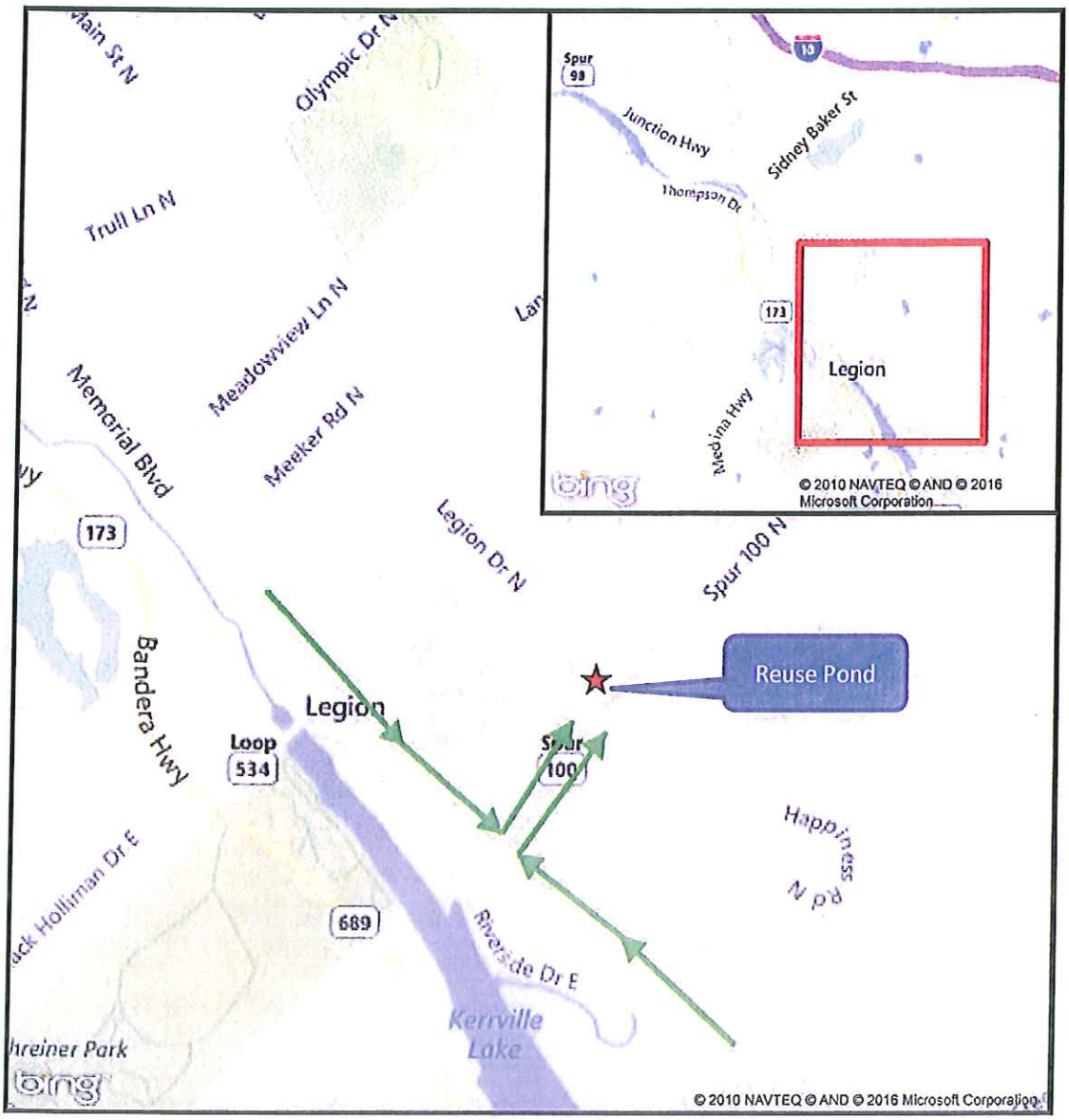
8.4. Training

All people involved in the EAP will be trained to ensure that they are thoroughly familiar with its elements, the availability of equipment, and their responsibilities and duties under the plan. Personnel will be trained in problem detection, evaluation, and appropriate corrective measures. This training is essential for proper evaluation of developing situations at all levels of responsibility. Training records will be maintained in Tab 9.

8.5. Distribution

Copies of this Emergency Action Plan have been supplied to all parties shown on the distribution list shown on page 5.

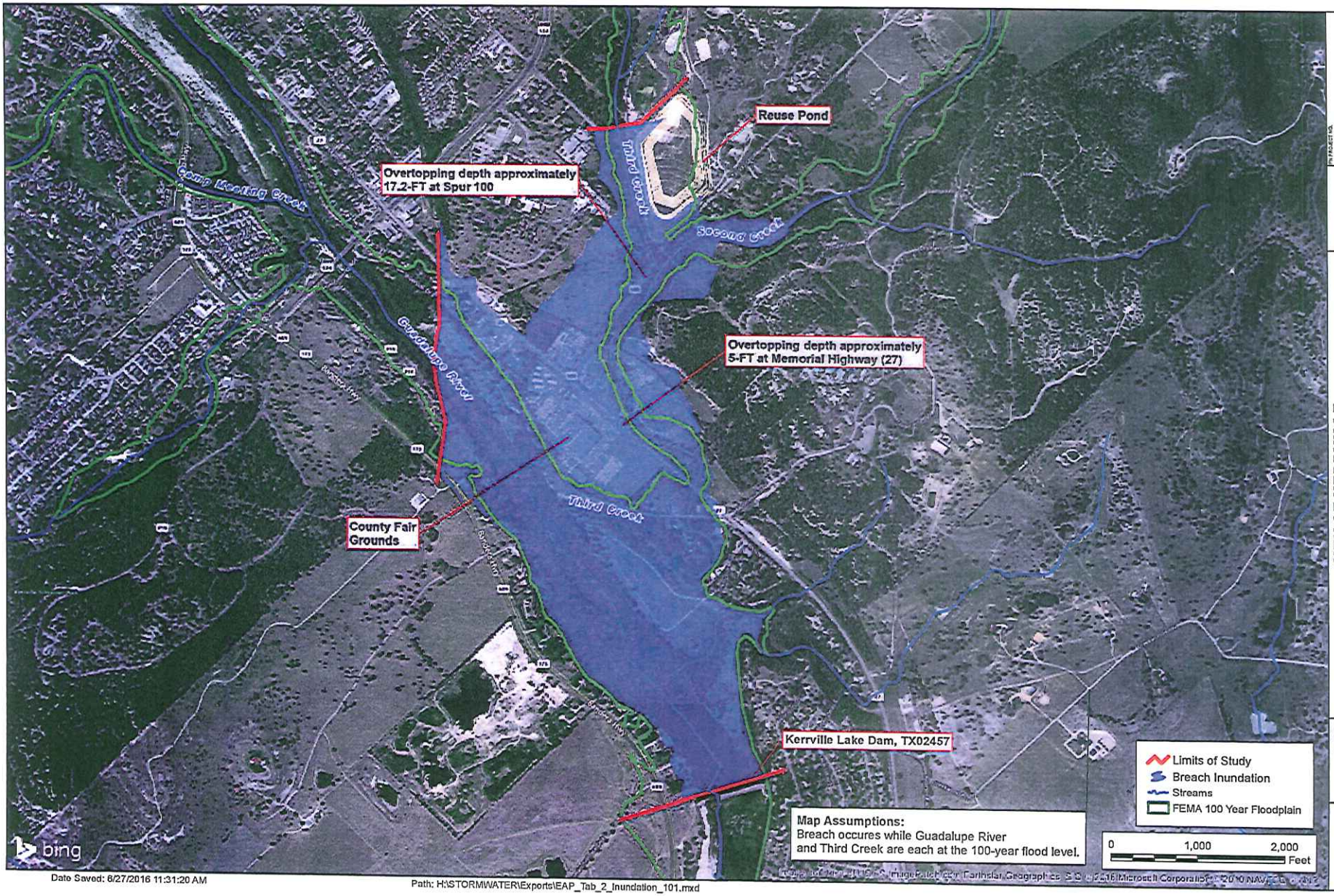
TAB 1. LOCATION MAP AND ACCESS ROUTES



TAB 2. INUNDATION MAP

Notes:

Because of the method, procedures, and assumptions used to determine the flooded areas; the limits of flooding shown are approximate and should be used only as a guideline for establishing evacuation zones. Areas inundated in an actual event will depend on actual failure conditions and may differ from areas shown on the maps.



CITY OF KERRVILLE
REUSE FACILITY

BREACH INUNDATION MAP

FREESE AND NICHOLS, INC.
10431 MORADO CIRCLE
SUITE 800
AUSTIN, TEXAS 78759
PHONE: 512-617-3100
FAX: 512-617-3101

TAB
2

Date Saved: 6/27/2016 11:31:20 AM

Path: H:\STORMWATER\Exports\EAP_Tab_2_Inundation_101.mxd

TAB 3. DAM DESCRIPTION

Official Dam Name: Kerrville Reuse Facility Storage Pond Dam

Stream: Off-Channel, adjacent to Third Creek

Dam Location: On Spur 100, 0.6 miles northeast of the intersection of Spur 100 and Memorial Blvd

Latitude/Longitude: 30.016592, -99.108793

Dam Owner: City of Kerrville

Embankment

Type	Earthen Embankment
Year Constructed	2017
Length	3,244 feet
Maximum Height	29 feet
Top Width	12 feet
Top of Embankment Elevation	1629 feet NAVD88
Drainage Area	13.9 acres

Principal Spillway

Type	None. Normal releases through pump station

Emergency Spillway

Type	Soil Cement Lined Broad-Crested Weir
Location	East Embankment
Crest Length	40 feet
Crest Elevation	1626.0 feet NAVD88

Reservoir

Elev. Top of Conservation Pool	1625.0 feet NAVD88
Capacity Conservation Pool (Normal Pool)	308 acre-feet
Capacity at Top of Dam (Maximum)	362 acre-feet
Surface Area	13.0 acres

TAB 4. SAMPLE PUBLIC ANNOUNCEMENTS

Note: *These messages are communicated to downstream residents to altert the public of impending danger. The Water Reclamation Superintendent should coordinate with the National Weather Service and the Kerrville Emergency Management Coordinator prior to release. Messages developed with the assistance of the National Weather Service may be used instead, which can be communicated via radio, television and other media outlets.*

Announcement for a Slowly Developing "Watch Condition"

The City of Kerrville has declared a "Watch" condition for Kerrville Reuse Facility Storage Pond Dam (TX#####) as of *(time and date).*

(Briefly describe the problem or condition.)

There is no immediate danger of the dam failing; however the potential does exist.

(Describe what actions are being taken to monitor and control the situation.)

Additional news will be made available as soon as it is received.

Announcement for a Possible Dam Failure

This is an emergency message. The City of Kerrville has declared a possible dam failure at Kerrville Reuse Facility Storage Pond Dam (TX#####) as of *(time and date).*

(Briefly describe the problem or condition.)

It is possible the dam could fail. Attempts to save the dam are under way, but their success cannot yet be determined.

(Describe what actions are being taken to monitor and control the situation.)

Additional news will be made available as soon as it is received.

Announcement for an Imminent Dam Failure

Urgent! This is an emergency message. The City of Kerrville has announced that Kerrville Reuse Facility Storage Pond Dam (TX#####) is in imminent danger of failing.

(Describe what actions are being taken to monitor and control the situation.)

It is possible that the dam will fail in *(##)* hours. Residents along Spur 100 from the Kerrville National Cemetery to Highway 27, the Kerrville Little League Baseball Fields, and the Kerr County Fair Grounds should prepare for immediate evacuation. Additional news will be made available as soon as it is received.

Announcement of a Dam Failure

Emergency! This is an emergency message. Kerrville Reuse Facility Storage Pond Dam (TX#####) failed at *(time and date)*. Residents along Spur 100 from the Kerrville National Cemetery to Highway 27, the Kerrville Little League Baseball Fields, and the Kerr County Fair Grounds should evacuate immediately. Additional news will be made available as soon as it is received.

TAB 5. EVIDENCE OF DISTRESS

General Observation	Specific Observation	Condition	Emergency Action	Equipment Material and Supplies	Data to Record
Boils	Small boils, no increase of water flow, flowing clear water	Abnormal	Closely check all of downstream toe, especially in the vicinity of boil for additional boils, wet spots, sinkholes, or seepage. Closely monitor entire area for changes or flow-rate increases	None	Site and location, approximate flow
	Large or additional boils near previously identified ones, without increasing flow rate, but carrying small amount of soil particles	Watch	Initiate 24-hour surveillance. Monitor as described above. Construct sandbag ring dikes around boils to cover them with water to retard the movement of soil particles. Filter cloth may be used to retard soil movement, but do **not** retard the flow of water.	Sandbags, filter cloth	Site and location, approximate flow
	Large or additional boils near previously identified ones, increasing flow rate, carrying soil particles	Possible Failure	Continue 24-hour surveillance. Continue monitoring and remedial action as described above. Initiate emergency lowering of the reservoir. Issue a warning to downstream residents and businesses.	Sandbags, pump	Site and location, approximate flow
	Rapidly increasing size of boils and flow increasing and muddy water	Imminent Failure	Downstream evacuation. Employ all available equipment to attempt to construct a large ring dike around the boil area.	Dozer, shovels, source of earthfill	Site and location, approximate flow

General Observation	Specific Observation	Condition	Emergency Action	Equipment Material and Supplies	Data to Record
Seepage	Minor seepage of clear water at toe, on slope of embankment, or at the abutments	Abnormal	Closely check entire embankment for other seepage areas. Use wooden stakes or flagging to delineate seepage area. Try to channel and measure flow. Look for upstream whirlpools.	Wooden stakes, flagging	Site, location, approximate flow
	Additional seepage areas observed flowing clear water and/or increasing flow rate.	Watch	Initiate 24-hour surveillance. Monitor as described above. Construct measuring weir and channel all seepage through weir. Attempt to determine source of seepage.	Dozer, shovels	Site, location, approximate flow
	Seriously or rapidly increasing seepage, underseepage, or drain flow.	Possible Failure	Continue 24-hour monitoring and remedial action as described above. Initiate emergency lowering of the reservoir. Construct a large ring dike around the seepage area. Issue a warning to downstream residents and businesses.	Dozer, shovels, source of earthfill	Site location, approximate flow
	Additional seepage areas with rapid increase in flow and muddy water.	Imminent Failure	Downstream evacuation. Employ all available equipment to attempt to construct a large ring dike around the seepage area.	Dozer, shovels, source of earthfill	Site location, approximate flow

General Observation	Specific Observation	Condition	Emergency Action	Equipment Material and Supplies	Data to Record
Slides or severe erosion	Skin slide or slough on slope of embankment. No further movement of slide and embankment crest not degraded.	Abnormal	Examine rest of embankment for other slides. Place stakes in slide material and adjacent to it for determining if further movement is taking place.	Stakes, tape measure	Distance between stakes
	Slide or erosion involving large mass of material, crest of embankment is degraded, no movement or very slow continuing movement.	Watch	Initiate 24-hour surveillance. Mobilize all available resources and equipment for repair operations to increase freeboard and to protect the exposed embankment material. Start filling sandbags and stockpile near slide area.	Dozer, shovels, sources of earthfill, sandbags.	Distance between stakes
	Slide or erosion involving large mass of material, crest of embankment is degraded, progressively increasing in size.	Possible Failure	Continue monitoring and remedial actions as described above. Place additional material at the toe of slope to stop the slide. Initiate emergency lowering of the reservoir. Issue a warning to downstream residents and businesses.	Dozer, shovels, source of earthfill, pump.	Distance between stakes
	Slide or erosion involving large mass of material, crest of embankment is severely degraded, movement is continuing and may reach pool.	Imminent Failure	Downstream evacuation. Utilize all available equipment and personnel to sandbag the degraded slide area to prevent it from overtopping.	Dozer, shovels, sandbags, pump.	Distance between stakes

General Observation	Specific Observation	Condition	Emergency Action	Equipment Material and Supplies	Data to Record
Sinkholes	Sinkholes anywhere on the embankment or within 500 feet downstream from the toe.	Abnormal	Carefully walk the entire embankment and downstream area looking for additional sinkholes, movement, or seepage.	Stakes, flagging	Size, location
	Sinkholes with corresponding seepage anywhere on the embankment or downstream from the toe.	Watch	Initiate 24-hour surveillance. Monitor as above. Construct sandbag dike around the seepage exit point to reduce the flow rate. Start filling sandbags and stockpile near sinkhole.	Dozer, shovels, pump	Size, location
	Large sinkholes with corresponding seepage anywhere on the embankment or downstream from the toe.	Possible failure	Continue monitoring and remedial action as described above. Utilize sandbags to increase the freeboard on the dam if necessary. Initiate emergency lowering of the reservoir. Issue a warning to downstream residents and businesses.	Sandbags, dozer, pump	Size, location
	Sinkholes rapidly getting worse, seepage flowing muddy water and increasing flow.	Imminent failure	Downstream evacuation. Utilize all available equipment and personnel to attempt to construct a large ring dike around the area.	Dozer, shovels, pump	Size, location

General Observation	Specific Observation	Condition	Emergency Action	Equipment Material and Supplies	Data to Record
Settlement	Obvious settlement of the crest of the embankment, especially adjacent to concrete structures.	Abnormal	Look for bulges on slope or changes in crest alignment.	None	Size, location
	Settlement of crest of embankment that is progressing, especially adjacent to concrete structures or if any corresponding seepage is present.	Watch	Initiate 24-hour surveillance. Mobilize all available resources for repair operations to increase freeboard. Fill and stockpile sandbags. Identify any boils near settlement points for flowing material and pursue action for boils.	Sandbags, dozer, shovels, source of earthfill.	Size, location
	Settlement of crest of embankment that is rapidly progressing especially adjacent to concrete structures or if any corresponding seepage is flowing muddy water or increasing flow.	Possible failure	Continue monitoring and remedial actions as described above. Use sandbags to increase the freeboard on the dam if necessary. Initiate emergency lowering of the reservoir. Issue a warning to downstream residents and businesses.	Sandbags, shovels, dozer, source of earthfill.	Size, location
	Progressing settlement that is expected to degrade the embankment to reservoir level.	Imminent failure	Downstream evacuation. Utilize all available equipment and personnel to build up the crest in the area that is settling. Identify any boils near settlement points for flowing material and pursue action for boils.	Dozer, shovels, source of earthfill, sandbags.	Size, location

General Observation	Specific Observation	Condition	Emergency Action	Equipment Material and Supplies	Data to Record
Cracking	Cracks in the embankment crest or on slopes.	Abnormal	Walk on entire crest and slope and check for additional cracking.	Stakes, tape measure	Size, location
	Numerous cracks in crest that are enlarging, especially those perpendicular to the centerline of the dam.	Watch	Initiate 24-hour surveillance. Carefully monitor and measure cracking to determine the speed and extent of the problem. Mobilize to fill cracks. Cracks parallel to the centerline indicate a slide. Follow remedial action for slides.	Stakes, tape measure, dozer, shovels, source of earthfill.	Size, location
	Large cracks in the crest that are rapidly enlarging, especially those perpendicular to the centerline of the dam.	Possible failure	Continue monitoring and remedial action as described above. Initiate emergency lowering of the reservoir. Issue a warning to downstream residents and businesses.	Dozer, shovels, source of earthfill.	Size, location
	Cracking that extends to pool elevation.	Imminent failure	Downstream evacuation. Continue remedial actions as described above.	Dozer, shovels, source of earthfill.	Size, location

General Observation	Specific Observation	Condition	Emergency Action	Equipment Material and Supplies	Data to Record
Upstream Whirlpool	Whirlpool in the lake in the vicinity of the embankment	Imminent Failure	Downstream evacuation. Attempt to plug the entrance of the whirlpool with riprap from the slope of the embankment. Search downstream for an exit point and construct a ring dike to retard the flow of soil particles. Initiate emergency lowering of the reservoir. Issue a warning to downstream residents and businesses.	Dozer, source of earthfill, sandbags, filter cloth, straw, rocks	Size, location, flow rate
Rapidly rising lake	Lake level rising and rain continuing	Watch	Initiate 24-hour surveillance of lake level and rainfall.		Lake level, rainfall
Dam being overtopped	Water flowing over the dam and lake continuing to rise	Possible failure	Downstream evacuation. Continue monitoring.		Lake level, rainfall

TAB 6. SUPPLIES AND RESOURCES

The following equipment and supplies may be necessary for use during a dam emergency. The City of Kerrville Public Works Department owns equipment and supplies and will be the first resource during an emergency.

Equipment/Supplies
Backhoes
Dump trucks
Portable welding equipment
Generators
Bulldozers
Excavators
Loaders
Motor graders
Sandbags
Rock riprap
Fill Material

TAB 7. ANNUAL EAP EVALUATION CHECKLIST

Do the Notification Flowcharts require revision?	□ Yes □ No	If yes, date revised Contact Information pages were distributed: (Note that revision of the Contact Information will not require EAP approval; however, the revised Contact Information pages will need to be redistributed as a replacement pages.)
Was training or an exercise conducted?	□ Yes □ No	Circle: training exercise Date conducted:
Are inspection and training records included in the EAP?	□ Yes □ No	
Was the EAP reviewed?	□ Yes □ No	If yes, review date:
Were changes required to the EAP?	□ Yes □ No	If yes, date of revised EAP approval:

Signature of Owner: _____ Date: _____

TAB 8. PLAN REVIEW AND UPDATE

This plan will be reviewed and updated annually and tabletop exercises will be conducted at least once every five years. Document these reviews below.

Date of review: _____ Participants: _____

_____

_____

_____

Date of review: _____ Participants: _____

_____

_____

_____

Date of review: _____ Participants: _____

_____

_____

_____

Date of review: _____ Participants: _____

_____

_____

_____

Date of tabletop exercise: _____ Participants: _____

_____

_____

_____

TAB 9. TRAINING RECORD

Use this form to record training sessions. File the completed form in the appropriate Tab of the EAP. All items in the EAP should be thoroughly reviewed during training. Appropriate City of Kerrville employees and EAP team members should attend a training session annually (or participate in a simulated exercise).

TRAINING LOCATION:	
DATE: TIME: INSTRUCTOR:	
CLASS SIGN-IN:	
Type of Simulation Conducted:	**Circle Emergency Type:** Emergency water release Watch condition Possible dam failure Imminent dam failure Actual dam failure
Comments, Results of Exercise:	
Revisions Needed to EAP Based on Results of Exercise? ☐ **Yes** ☐ **No** If yes, list revisions required:	

Exhibit 6
TCEQ Documents Regarding Design and Environmental

- Submission Letter to TCEQ – August 29, 2016
- Environmental Report to Freese and Nichols – April 22, 2105
- Environmental Report to City of Kerrville – June 4, 2014

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August 29, 2016

Louis C. Herrin III, P.E.
TCEQ – MC 148
P.O. Box 13087
Austin, Texas 78711-3087

Re: Chapter 210/217 Summary Transmittal Letter
Permittee: City of Kerrville
Reclaimed Water Authorization No. R10576001
RN100844802; CN600522858
Project Name: Kerrville Reuse Pond and Pump Station
County: Kerr

Mr. Herrin:

The purpose of this letter is to provide the Texas Commission on Environmental Quality (TCEQ) with the information necessary to comply with the requirements of §210 of the TCEQ's rules entitled, "USE OF RECLAIMED WATER" for the City of Kerrville (City) "Kerrville Reuse Pond and Pump Station Project."

Also included with this summary letter are the following Design Reports:

- Water Reuse Feasibility Study – June 4, 2014
- Water Reuse Facility Reuse Pond Design Report – June 30, 2016
- Reuse System Modeling Technical Memorandum
- FNI submitted preliminary plans and specifications for the proposed construction of the Reuse Pond and Pump Station Dam to Warren D. Samuelson, P. E, Manager of the Dam Safety Section of TCEQ on July 1, 2016. Mr. Dustin Jennings, P.E. (TCEQ) responded with comments to the submittal on August 9, 2016. Attached is TCEQ's comment letter dated August 9, 2016. FNI is currently working to address the comments.

The following is the necessary information for this submittal:

1. Engineering firm:
   Freese and Nichols, Inc.
   1920 Corporate Dr.,
   Suite 207B
   San Marcos, Texas 78666

2. Design Engineer contact information:
   Engineer: Charles Kucherka, P.E.
   Phone: 210-298-3814
   Fax: 210-298-3801
   E-mail: cak@freese.com

3. Name of the entity that proposes to own, operate and maintain the project through its design life:
   City of Kerrville
   701 Main Street
   Kerrville, TX 78028

4. Request a variance from Chapter 210 which is a part of the design:
   No variances from Chapter 210 are part of this design.

5. If applicable, disclose any innovative or nonconforming technologies which are proposed as part of the project identified in this letter:
   There are no innovative or nonconforming technologies proposed as part of this project.

6. The plans and specifications which describe the project identified in this letter are in substantial compliance with all the requirements of Chapter 210.

7. Project Description and Scope:

   This project shall consist of:
   - Construction of a reuse pump station
   - Construction of a reuse pond
   - Installation of approximately 2,800 lf of 24-inch effluent main from the City's existing treatment facility to the proposed reuse storage pond
   - Modifications to the chlorine contact basin to direct flow to the proposed reuse pond
   - Construction of three reuse distribution mains that will connect the proposed reuse pump station to the existing reuse distribution system (the actual connection to the existing system will be made in a future project)
   - Other appurtenant work associated with these items

We would appreciate your review of the attached plans and specifications, as well as our response letter. If there is anything we can do or if you need any additional information to complete your review, please do not hesitate to contact us.

Sincerely,

Charles A. Kucherka, P.E.
Freese and Nichols, Inc.

STATE OF TEXAS
CHARLES A KUCHERKA
98388
LICENSED
PROFESSIONAL ENGINEER
8/29/2016

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

cc: Kyle Burow, P.E., City of Kerrville
TCEQ Region 13 Office, attachments

Attachments
1. TCEQ Construction Plans/Specifications Review Letter dated August 9, 2016
2. Water Reuse Feasibility Study
3. Water Reuse Facility Reuse Pond Design Report
4. Reuse System Modeling Technical Memorandum
5. One (1) CD with PDF plans and specifications

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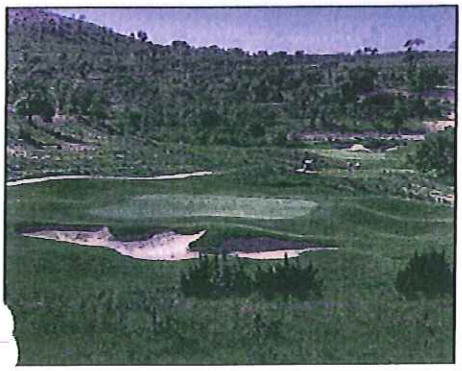

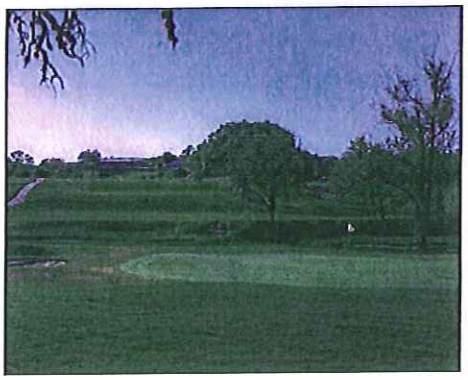

Water Reuse Feasibility Study

Prepared for:

City of Kerrville

Prepared by:

FREESE AND NICHOLS, INC.
4040 Broadway, Suite 600
San Antonio, Texas 78209
210-298-3800

FNI Project No.: KER13488

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

Water Reuse Feasibility Study

Prepared for:

City of Kerrville

STATE OF TEXAS
JOHNNY M. NEW
96330
LICENSED
PROFESSIONAL ENGINEER

6-04-14

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

STATE OF TEXAS
RICHARD WEATHERLY
100211
LICENSED
PROFESSIONAL ENGINEER

6/4/14

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F-2144

Prepared by:

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4040 Broadway, Suite 600

San Antonio, Texas 78209

210-298-3800

FNI Project No.: KER13488

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Appendix B Environmental Permitting Technical Memorandum
Appendix C Geotechnical and Landfill Investigation Technical Memorandum
Appendix D Floodplain Analysis Technical Memorandum
Appendix E Water Reuse Regulatory Requirements

1.0 INTRODUCTION

The City of Kerrville currently has a successful water reuse program which provides reclaimed water from its Water Resource Recovery Facility (Wastewater Treatment Plant) to various customers for irrigation of golf courses, recreational areas and landscape, as well as other non-potable uses. In order to expand the available usage of this resource, the City is seeking to construct reclaimed water storage ponds to increase the flexibility of matching water supply and demand. This study evaluated two separate pond locations: a North Pond and a South Pond. The location of the proposed ponds evaluated for this study are shown in **Figure 1.1**. The City is also interested long-term in the potential to convert some of its treated effluent into a supplemental source of domestic supply for the City.

Freese and Nichols, Inc. (FNI) was retained in 2013 by the City of Kerrville to investigate the feasibility of adding additional reuse storage capacity and prepare a Reuse Feasibility Study. The goals of the Reuse Feasibility Study were to investigate necessary environmental permitting, geotechnical conditions, hydrologic and hydraulic analyses and regulatory requirements for the implementation of this future reuse project. This report has been prepared to provide the City of Kerrville with an assessment of the feasibility of short-term and long-term improvements to the reuse system infrastructure. The recommended improvements will serve as a basis for the design, construction, and financing of facilities required to implement the reuse options investigated.

The major elements of the scope of this project include:

- Surveying
- Environmental Services
- Geotechnical and Landfill Investigations
- Flood Plain Analysis
- Water Reuse Pump Station Requirements
- Water Reuse Regulatory Requirements
- Cost Development and Report Preparation

As part of this project, FNI gave a series of presentations to the City Council and EIC, which are included in **Appendix A**.

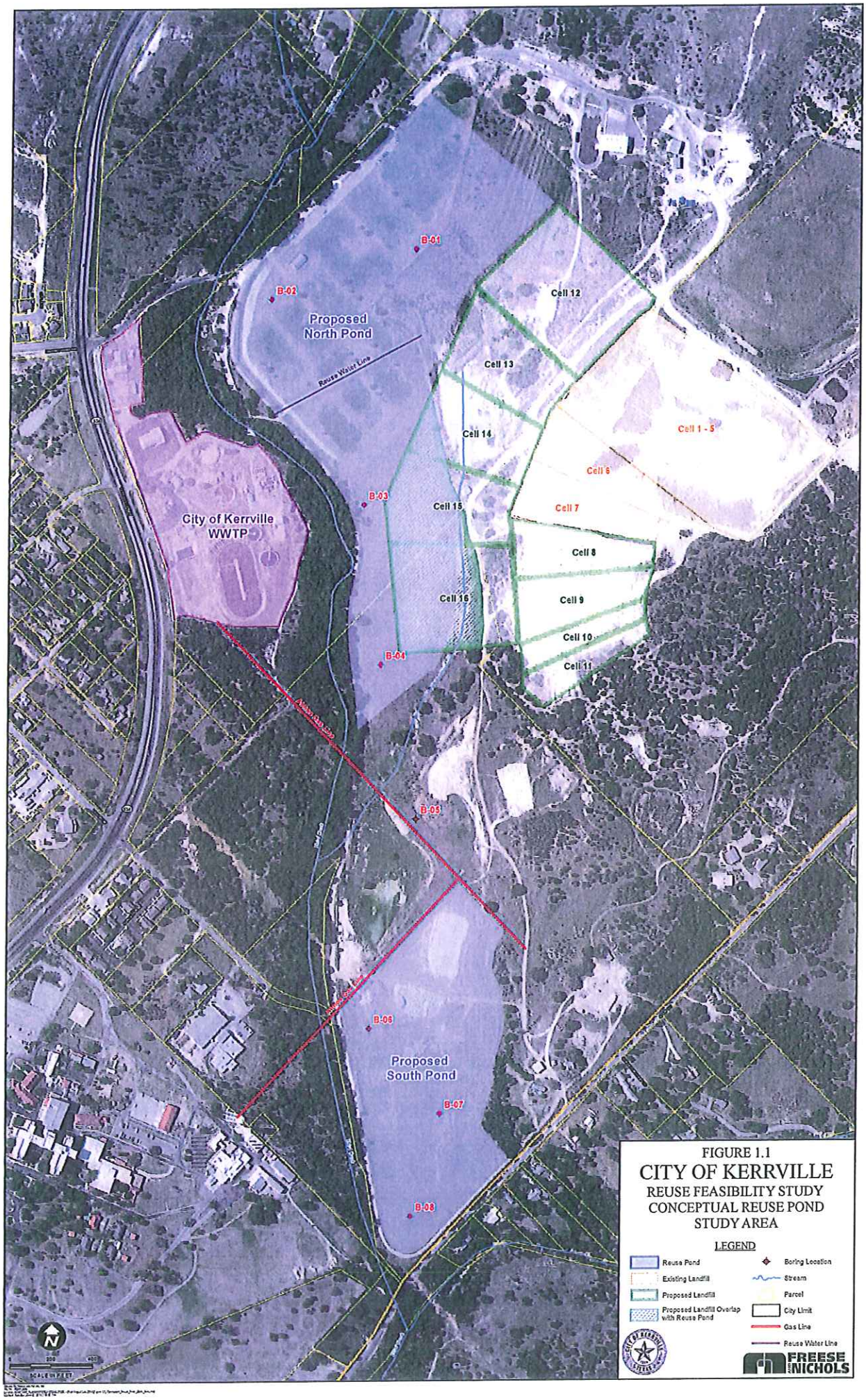


FIGURE 1.1
CITY OF KERRVILLE
REUSE FEASIBILITY STUDY
CONCEPTUAL REUSE POND
STUDY AREA

2.0 ENVIRONMENTAL SITE INVESTIGATION

FNI conducted a pedestrian site visit of the City of Kerrville's wastewater treatment plant and land adjacent to the City's sanitary landfill proposed as the future location of the City's reuse storage ponds and associated facilities to assess site conditions. FNI prepared an environmental permitting technical memorandum summarizing the field observations described above which is included in **Appendix B** of this report. The property proposed for the reuse water storage facility is currently used as recreational sports fields, numerous borrow pits for the sanitary landfill, storage of empty refuse containers and a remote controlled aircraft airfield. Within the study area, there appears to be approximately 2,400 feet of an unnamed tributary of Third Creek. The vegetation types noted in the study area are described in the technical memorandum.

FNI investigated whether any Section 404 permitting would be required to construct the proposed reuse infrastructure. Potential Section 404 impacts include stream impacts to the unnamed tributary to Third Creek and to Third Creek itself, herbaceous wetland impact and open water impacts. All of these potential impacts would be avoided in the conceptual reuse project proposed in this report.

FNI conducted a reconnaissance-level field survey within the area of the proposed water reuse ponds to identify potential habitat and document any federally listed or Texas Parks and Wildlife Department threated or endangered (T&E) species. There is no United States Fish and Wildlife Services (USFWS) critical habitat designated in Kerr County. The type of habitats needed for the endangered species that might be encountered in Kerr County were not observed within the project site. In addition, no endangered flowering plants were seen within the project site.

FNI provided a desktop review of the Texas Archaeological Research Laboratory (TARL) to determine the likelihood and potential extent of coordination with the Texas Historical Commission (THC). Coordination with the THC would be required if greater than 5,000 cubic yards of material were moved or more than five areas of area were disturbed. FNI recommends drafting a letter to THC with the project description and location requesting their opinion as to the archeological requirement for the project.

The following is a summary of the environmental site investigation:

- The conceptual reuse pond project, as proposed in this report, would avoid any Section 404 impacts and therefore, could be constructed under a USACE Nationwide Permit.
- The type of habitats needed for the endangered species that might be encountered in Kerr County were not observed within the project site.
- No endangered flowering plants were seen within the project site.
- FNI recommends drafting a letter to the Texas Historical Commission with the project description and location requesting their opinion as to the archeological requirement for the project.

3.0 GEOTECHNICAL & LANDFILL INVESTIGATION

Geotechnical and landfill investigations were performed to investigate the feasibility of siting the reuse ponds in the proposed location. FNI prepared a technical memorandum summarizing the geotechnical investigation and landfill issues which is included in **Appendix C** of this report.

Geotechnical Investigation

The purpose of the geotechnical investigation was to explore subsurface conditions and determine if suitable material is available for use in constructing the proposed pond embankments. FNI selected locations for a total of 8 (eight) exploratory borings to a depth of 25 feet. The locations are shown on Figure 2 in Appendix C. Samples were collected intermittently using continuous flight augers and a split-spoon sampler in conjunction with the Standard Penetration Test (SPT). FNI provided an engineer who directed the drilling, logged the borings, recorded field test data, handled and transported the samples. FNI selected samples for laboratory testing, assigned tests, delivered samples to Holt Engineering, Inc. for laboratory testing and reviewed test results. Testing included classification and moisture content tests. The subsurface soils encountered during drilling primarily consisted of lean clays (CL), lean clays with sand (CL) and fat clays with sand (CH). Based on laboratory testing, the CL and CH material meets soil classification criteria for foundation and embankment material. However, FNI identified dispersive soils onsite which will need to be used selectively.

Since the reuse ponds will hold wastewater effluent, a low permeability liner will be required to limit the release of potential contaminants into the groundwater and surface water bodies. Due to the type of effluent being stored in the ponds, it will be necessary to clean the ponds of solids periodically. For this reason, a hard surface layer such as concrete or soil cement is recommended. Various liner options can be evaluated and slope stability analyses can be performed as part of the design phase.

Landfill Investigation

The City of Kerrville operates a Type I municipal solid waste landfill located to the east of the proposed reuse pond location. FNI reviewed landfill documents in order to identify potential issues that may impact the operation of the reuse ponds. Based on the existing groundwater conditions, liner and cap system for the landfill and the anticipated liner system for the reuse ponds, FNI believes issues of contaminate release from the landfill or reuse ponds to be minimal or non-existent.

The following is a summary of the subsurface investigation and landfill documents review:

- Suitable soils are available onsite for construction of the pond embankments
- Dispersive soils were found onsite and will need to be used selectively
- Quantity of soils available onsite is yet to be determined until the flood study is complete and a crest elevation can be established.
- Some rock will likely need to be excavated for pond development but is likely soft enough to be excavated with conventional construction equipment.
- Water was encountered in some of the borings and is likely perched above or between rock layers but should be manageable during construction.
- Issues are not anticipated with contaminant release from the landfill or pond with liner systems in place.
- Potential conflict with potential reuse pond locations and future expansion of landfill. This will need to be explored further when pond layout design options are finalized.

4.0 FLOODPLAIN ANALYSIS

The floodplain analysis study, included in this report as **Appendix D**, provides a detailed hydrologic and hydraulic evaluation of Third Creek based on existing and proposed conditions for the 1.0% annual chance event. The limits of the hydraulic analysis is defined by Spur 100 to the south and 1,500-feet upstream of Landfill Road to the north. The following provides a brief summary of the analyses.

General information

1. This reach is designated as Zone A by the Federal Emergency Management Agency, which indicates that the area is subject to flooding during the 1.0% annual chance flood event (1% AC), but no detailed hydraulic analysis has been performed; therefore no base flood elevation exists.
2. The project area parallels city, county and privately owned property that fronts Third Creek.
3. The hydrologic modeling was based on non-calibrated conditions.
4. The hydraulic analysis was developed using two-foot topography and field measurements and based on non-calibrated conditions.

Existing Conditions Evaluation

1. The peak 1% AC discharge for Third Creek is approximately 15,800 cfs based on existing land use conditions, which was assumed to be the same as future land use conditions.
2. The project area, as well as City and private land parcels adjacent and upstream of the project area are inundated by flood water for existing conditions during the 1% AC. One publicly-owned structure and six privately-owned structures are potentially affected during the subject event; however a finished floor elevation survey will need to be obtained to confirm the inundation.
3. For the project area to be developable, floodplain modifications will be necessary to remove the area from the 1% floodplain.

Proposed Conditions Evaluation

1. Three alternatives were developed to prevent flood water from the 1% AC from inundating the project area. Each alternative is based on constructing an earthen levee(s) along the eastern side of the existing maintenance road on the east side of the creek.
2. **Alternative 1** consists of constructing a levee around the designated South Pond area to the east of Third Creek. Results for this alternative are as follows:
    a. Maximum flood stage increase of 2.37 feet as compared to existing conditions.

b. Causes adverse impact from Spur 100 to approximately 3,600 feet upstream of the road.

c. The increase in water surface elevation is confined to City and County properties, so no additional floodplain modifications will be required to implement Alternative 1 as long as the City and County approve of the flood water increases on their property.

d. As in the existing conditions analysis, one publicly-owned structure and six privately-owned structures are potentially affected by the one-percent storm. No additional structures are inundated by this alternative. In order to determine potential adverse impact to the structures, a finished floor elevation survey will need to be performed.

3. **Alternative 2** consists of constructing a levee around the designated North Pond area to the east of Third Creek. Results for this alternative are as follows:

   a. Maximum flood stage increase of 2.73 feet as compared to existing conditions.

   b. Causes adverse impact from the upstream study limit to just south of the City wastewater treatment plant.

   c. The increase in water surface elevation affects City and County land as well as private property north of Landfill Road, thus additional floodplain modifications will likely be required to implement Alternative 2.

   d. As in the existing conditions analysis, one publicly-owned structure and six privately-owned structures are potentially affected by the one-percent storm. No additional structures are inundated by this alternative. In order to determine potential adverse impact to the structures, a finished floor elevation survey will need to be performed.

4. **Alternative 3** consists of constructing two levees along the eastern edge of the maintenance drive around the North and South Ponds on the east side of Third Creek. Results for this alternative are as follows:

   a. Maximum flood stage increase of 2.73 feet as compared to existing conditions.

   b. Causes adverse impact throughout the study limits.

   c. The increase in water surface elevation affects City and County land as well as private property north of Landfill Road, thus additional floodplain modifications will likely be required to implement Alternative 3.

   d. As in the existing conditions analysis, one publicly-owned structure and six privately-owned structures are potentially affected by the one-percent storm. No additional

structures are inundated by this alternative. In order to determine potential adverse impact to the structures, a finished floor elevation survey will need to be performed.

Floodplain Analysis Recommendations

Due to the potential adverse impact to private property owners at the upstream end of the study reach, Alternative 1 results in the most feasible alternative since the flood stage increases are limited to City and County property. The following items shall be considered for future modeling effort if the project moves into final design.

1. As this analysis is based on non-calibrated conditions and City available base data, the models shall be revised to reflect calibrated conditions and design survey, including finished floor elevation information.
2. The models shall be revised to represent proposed flow patterns through the project area that could affect the location and time of contributing runoff to Third Creek.

5.0 WATER REUSE REGULATORY REQUIREMENTS

The water reuse regulatory requirements review, included in this report as **Appendix E,** provides discussion of regulatory issues associated with the use of reclaimed water, including the addition of storage ponds and the potential future implementation of potable reuse and/or incorporating reclaimed water into the City's program of aquifer storage and recovery (ASR).

The following is a summary of the reuse regulatory requirements review:

1. Pond storage of reclaimed water can be provided without revising the City's reclaimed water authorization (Chapter 210 approval). However, standard plans and specification approval is required.
2. Pond storage can be anticipated to result in some level of algae growth and dissipation of chlorine residual which should be considered in the final design of pumping facilities.
3. Direct potable reuse projects have been approved by TCEQ, with the first (CRMWD's Big Spring project) in operation since April 2013, and the second (Wichita Falls) anticipating imminent approval to begin production. Direct potable reuse requirements are evaluated on a case by case basis, as confirmed by discussion with TCEQ staff. The City could expect a 2-3 year interval which would include a treatment feasibility study, pilot testing and final design. This would involve continuous coordination with TCEQ throughout this period. This same time period would also represent an opportunity for public education.
4. Recent testing of Kerrville's reclaimed water indicates it may be a good candidate for a potable reuse treatment sequence which does not include reverse osmosis. This could significantly improve the economics and reduce implementation hurdles by avoiding creation of a brine byproduct stream.
5. Aquifer storage and recovery is likely to have similar treatment requirements as direct potable reuse, but has not been recently considered in detail at TCEQ.

6.0 WATER REUSE INFRASTRUCTURE REQUIREMENTS

Due to the floodplain analysis determining that the North Pond was not a feasible location as proposed, FNI evaluated the infrastructure necessary to construct a reuse system that would convey treated effluent from the City's WWTP to the South Pond and then deliver reuse water from that pond to connect to the City's existing reuse system. The conceptual reuse system infrastructure that would be required include the following items:

- Reuse storage pond at the South Pond location
- Reuse gravity pipeline to convey reuse water from existing WWTP to future reuse pond
- Reuse Pump Station located at the South Pond
- Reuse Distribution pipeline to connect to existing City reuse system

Figure 6.1 shows the conceptual reuse pond proposed reuse system.

Reuse Pond

FNI evaluated the construction of the reuse storage pond with the goal of maximizing reuse water storage volume while minimizing the costs to the City. **Figure 6.2** shows the proposed typical embankment section for the reuse storage pond. The crest elevation for the embankment was established based on the conclusions reached in the flood study. This crest elevation was determined to be 1628 ft and will be constant around the entire pond. The maximum water elevation inside the reuse pond would be 1625 ft to provide a recommended 3-foot of freeboard. The embankment sections, pond areas and excavation depths were determined based on the embankment crest elevations and geotechnical investigations. Cut and fill quantities required for the embankment were calculated based on the recommended embankment slope of 3H:1V or flatter. The volume of soil needed to construct the embankment exceeds the amount of soil recoverable during excavation and, therefore, and estimated 149,920 cubic yards of offsite fill material would need to be delivered to the site for construction. The proposed reuse storage pond is estimated to hold 105 million gallons.

Since the reuse ponds will hold wastewater effluent, a low permeability liner will be required to limit the release of potential contaminants into the groundwater or surface water bodies (i.e. nearby Third Creek). Soil liners, geo-membrane liners and bentonite mats are all examples of low permeability liners. The cost developed for this study assumed an HDPE geo-membrane liner.

The cost estimate provided as part of this study includes additional items such as an under-drain system, aeration equipment, inlet/outlet vaults, emergency spillway outfall, berm armoring and access road improvements.

Reuse Gravity Pipeline Analysis

FNI evaluated the ability to convey reuse water from the existing WWTP to the proposed Reuse Ponds by developing a hydraulic grade line profile. **Figure 6.3** shows the hydraulic grade line profile for the proposed reuse gravity line for a potential route that could allow for gravity flow to the reuse pond. Based on the hydraulic analysis, FNI determined that a 24" pipeline would be able to deliver the peak WWTP flow of 8 MGD to the reuse storage pond. This line size allows for gravity flow which eliminates the need to pump the flow from the WWTP to the reuse pond.

Preliminary Reuse Pump Station Configuration

FNI recommends that the reuse pump station be located below the embankment on the southwest corner of the South Pond. A 16" suction pipe encased in concrete would be installed during the embankment construction. The suction line could also serve as a line to drain the ponds for maintenance if needed. The suction line will run to a header pipe outside of the embankment. The header pipe will feed two or three cans that will house vertical turbine pumps. Each pump will have a discharge line and associated valves and piping coming together into a common discharge header. The pumps may be located outside with a slab poured under the piping and valves for improved access and maintenance. A driveway should be located adjacent to the slab to allow a small crane to remove pumps and valves for maintenance. An electrical and control room would be located off to the side of the pump station to house the electrical and SCADA equipment. Due to the limited amount of room at the proposed site, some fill and perhaps a retaining wall may be needed to develop a suitable workspace out of the floodplain.

Reuse Transmission Pipeline

A hydraulic model was used to evaluate the reuse transmission pipeline from the reuse pump station at the pond to the existing reuse pipeline at the City's WWTP. The reuse transmission pipeline route follows the same route as the gravity pipeline. The analysis concluded that a 12" line would be required to deliver the required flow rate and not exceed the City's existing 8" reuse pipeline pressure rating.

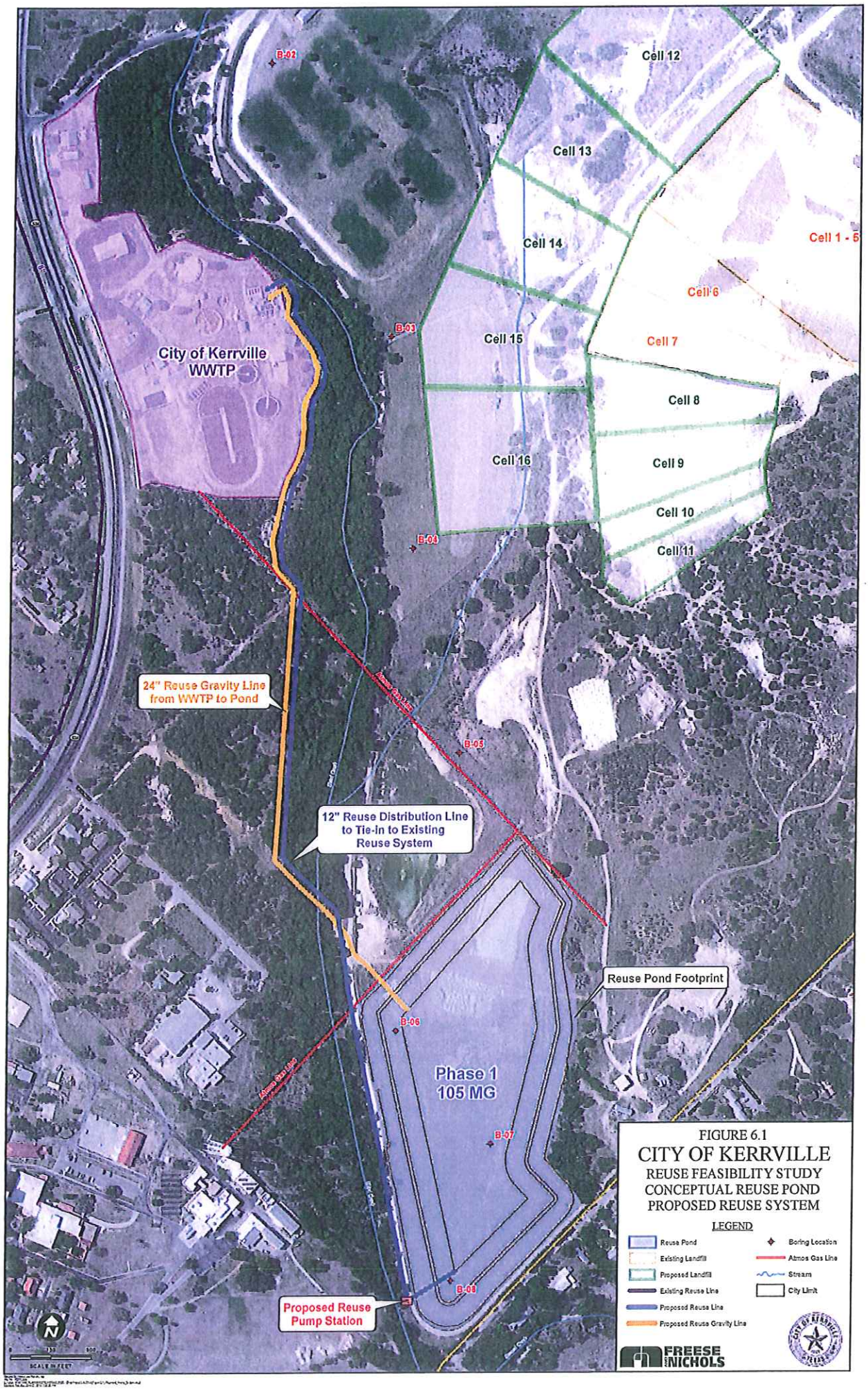
Summary of Infrastructure Costs

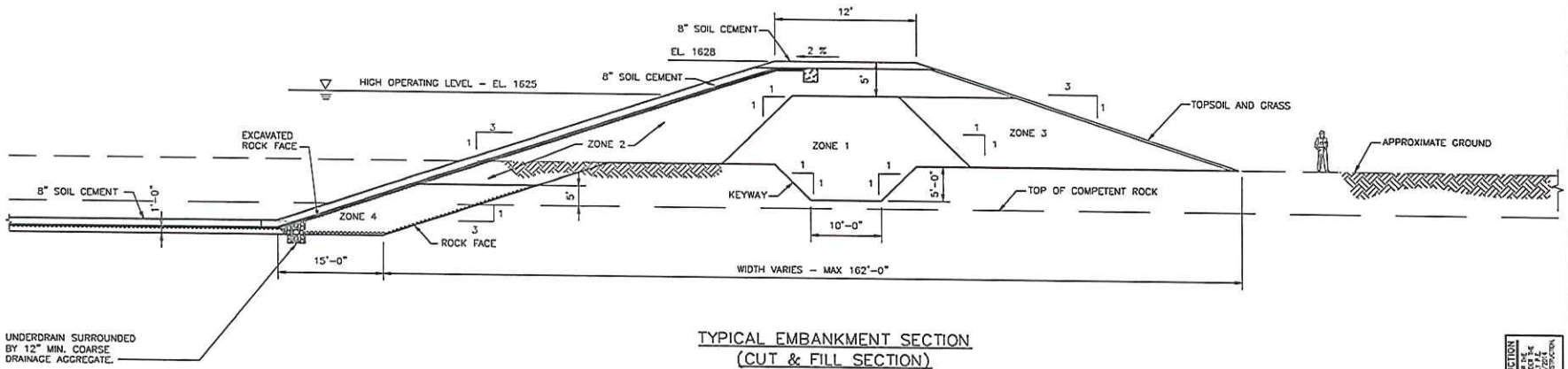
The recommended projects for the water distribution system are presented on **Table 6.1**. Locations shown for new reuse infrastructure were generalized for this analysis. Specific alignments and sites will

be determined as part of the design process. **Table 6.1** summarizes the project cost of the conceptual reuse system for the City of Kerrville. A detailed cost estimate is shown in **Table 6.2**.

Table 6.1 Summary of Reuse Pond Project Costs

Item	Description	Cost
1	105 MG Reuse Pond	$7,775,000
2	Gravity Line from WWTP	$635,000
3	Reuse Pump Station	$1,334,000
4	Pipeline to Existing Reuse System	$513,000
	Subtotal:	$10,257,000
	Mobilization @ 5%:	$513,000
	Subtotal:	$10,770,000
	Contractor Overhead & Profit @ 15%:	$1,616,000
	Subtotal:	$12,386,000
	Contingency @ 20%:	$2,477,000
	Project Total:	$14,863,000


Cell 12
Cell 13
Cell 14
Cell 1 - 5
Cell 6
Cell 7
Cell 15
Cell 8
Cell 16
Cell 9
Cell 10
Cell 11
City of Kerrville WWTP
B-02
B-03
B-04
B-05
B-06
B-07
B-08
24" Reuse Gravity Line from WWTP to Pond
12" Reuse Distribution Line to Tie-In to Existing Reuse System
Reuse Pond Footprint
Phase 1 105 MG
Proposed Reuse Pump Station
FIGURE 6.1
CITY OF KERRVILLE
REUSE FEASIBILITY STUDY
CONCEPTUAL REUSE POND
PROPOSED REUSE SYSTEM
LEGEND
Reuse Pond
Existing Landfill
Proposed Landfill
Existing Reuse Line
Proposed Reuse Line
Proposed Reuse Gravity Line
Boring Location
Atmos Gas Line
Stream
City Limit
FREESE AND NICHOLS



TYPICAL EMBANKMENT SECTION
(CUT & FILL SECTION)
N.T.S.

NOT FOR CONSTRUCTION

Freese and Nichols, Inc.
Texas Registered Engineering Firm F-2144

CITY OF KERVILLE
REUSE FEASIBILITY STUDY

TYPICAL CROSS SECTION
OF PROPOSED REUSE POND EMBANKMENT

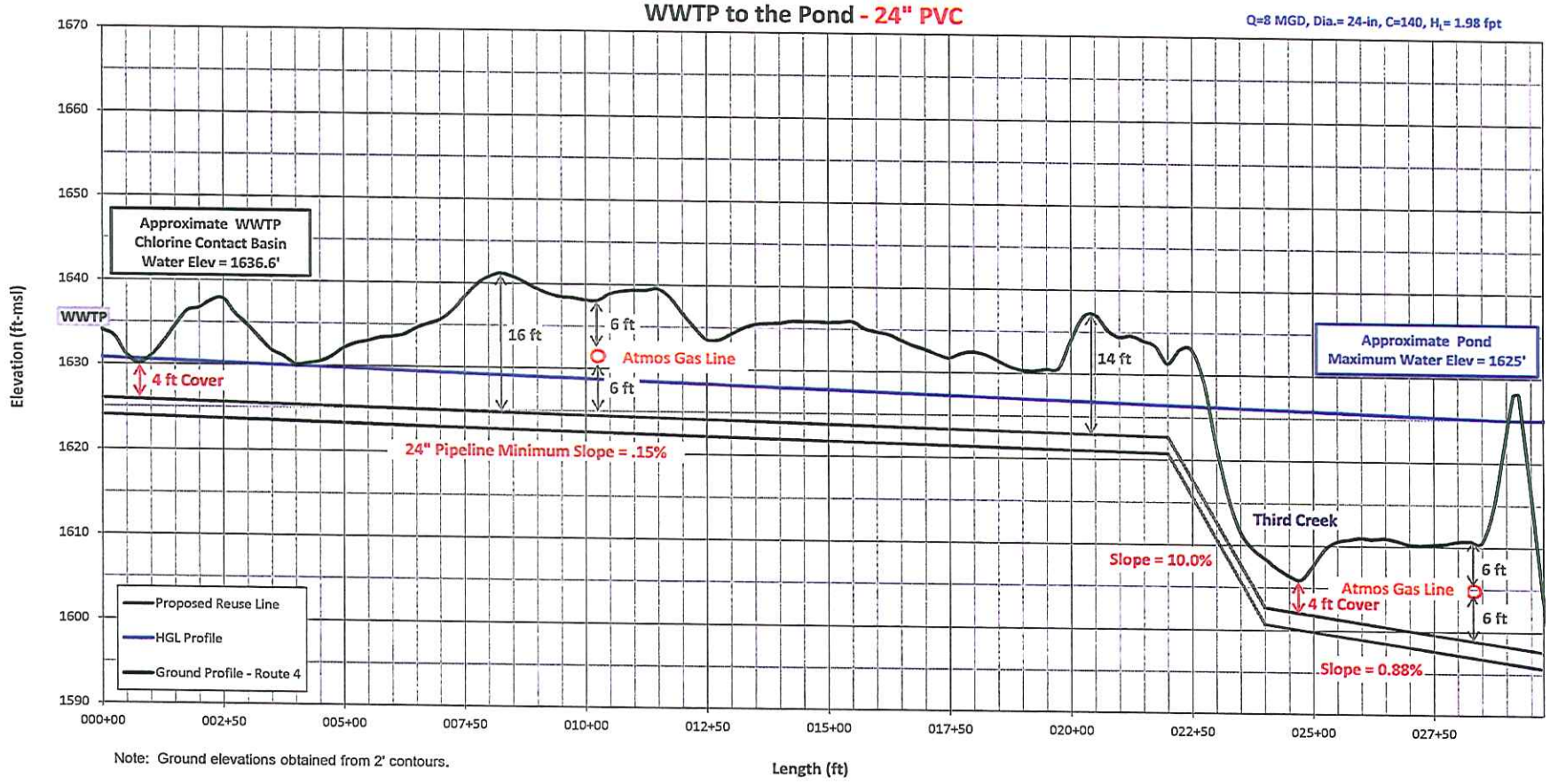
F&N JOB NO.	KER13488
DATE	JUNE 2014
SCALE	AS SHOWN
DESIGNED	RW
DRAFTED	WFA
FILE	CROSS SECTION EXHIBIT.dwg

FREESE NICHOLS
4040 Broadway Street, Suite 600
San Antonio, Texas 78209-6350
Phone - (210) 298-3800
Fax - (210) 298-3801

6.2
FIGURE

Date: Jun 03, 2014 - 1:56pm User: 02139 File: N:\UTIL\Report\Prelim\Feasibility Reuse\Cut and Fills\Alternatives\Pond Alternatives\REV 3 1626\CROSS SECTION EXHIBIT.dwg

Figure 6.3
City of Kerrville
Reuse Water Gravity Pipeline Profile
WWTP to the Pond - 24" PVC



Note: Ground elevations obtained from 2' contours.

Table 6.2 Detailed Opinion of Probable Construction Cost

105 MG REUSE POND
CITY OF KERRVILLE
REUSE FEASIBILITY STUDY

OPINION OF PROBABLE CONSTRUCTION COST June 4, 2014

ESTIMATOR	CHECKED BY	ACCOUNT NO
MKE	JMN	KER13488

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	REUSE POND				**$7,775,000**
1	CLEARING, GRUBBING AND STRIPPING OF TOPSOIL	104,444	SY	$1	**$104,000**
2	GENERAL EXCAVATION	76,685	CY	$4	**$307,000**
3	ROCK EXCAVATION	45,625	CY	$10	**$456,000**
4	COMPACTED FILL	226,605	CY	$3	**$680,000**
5	OFF-SITE FILL MATERIAL	149,920	CY	$15	**$2,249,000**
6	8" SOIL CEMENT	18,637	CY	$100	**$1,864,000**
7	HDPE GEOMEMBRANE WITH GEONET	83,864	SY	$12	**$1,006,000**
8	UNDERDRAIN SYSTEM	1	LS	$352,000	**$352,000**
9	CIRCULATION / AERATION EQUIPMENT	1	LS	$100,000	**$100,000**
10	INLET / OUTLET VAULTS	2	EA	$100,000	**$200,000**
11	EMERGENCY SPILLWAY OUTFALL	1	LS	$100,000	**$100,000**
12	BERM ARMORING	1,167	SY	$80	**$93,000**
13	ACCESS ROAD IMPROVEMENTS	1	LS	$100,000	**$100,000**
14	SWPPP, TOPSOIL, EROSION CONTROL MATS, SEEDING	23,407	SY	$7	**$164,000**
	GRAVITY PIPELINE FROM WWTP				**$635,000**
15	TIE-IN AT TREATMENT PLANT	1	LS	$50,000	**$50,000**
16	24" C905 PVC PIPE	3,000	LF	$130	**$390,000**
17	CONCRETE ENCASED PIPE THROUGH DAM	200	LF	$200	**$40,000**
18	6' PRECAST MANHOLES	8	EA	$7,500	**$60,000**
19	36" BORE UNDER CREEK	100	LF	$750	**$75,000**
20	PAVEMENT REPAIR	1	LS	$20,000	**$20,000**
	PUMP STATION				**$1,334,000**
21	CONCRETE ENCASED PS SUCTION 16" PIPE	250	LF	$250	**$63,000**
22	PUMP STATION STRUCTURE	1	LS	$550,000	**$550,000**
23	VERTICAL TURBINE PUMPS	3	EA	$65,000	**$195,000**
24	PUMP STATION MECHANICAL	1	LS	$151,000	**$151,000**
25	ELECTRICAL AND INSTRUMENTATION	1	LS	$275,000	**$275,000**
26	SITE IMPROVEMENTS	1	LS	$100,000	**$100,000**
	PIPELINE TO REUSE SYSTEM				**$513,000**
27	12" C900 PVC PIPE	4,500	LF	$85	**$383,000**
28	24" BORE UNDER CREEK	100	LF	$500	**$50,000**
29	ISOLATION AND AIR RELEASE VALVES	1	LS	$50,000	**$50,000**
30	PAVEMENT REPAIR	1	LS	$20,000	**$20,000**
31	SYSTEM TIE-IN	1	LS	$10,000	**$10,000**
		SUBTOTAL:			$10,257,000
		MOBILIZATION:		5%	$513,000
		SUBTOTAL:			$10,770,000
		OVERHEAD & PROFIT:		15%	$1,616,000
		SUBTOTAL:			$12,386,000
		CONTINGENCY:		20%	$2,477,000
		PROJECT TOTAL:			**$14,863,000**

APPENDIX A:
Presentations

APPENDIX B:
Environmental Permitting Technical Memorandum

APPENDIX C:
Geotechnical and Landfill Investigation Technical Memorandum

APPENDIX D:
Floodplain Analysis Technical Memorandum

APPENDIX E:
Water Reuse Regulatory Requirements Technical Memorandum

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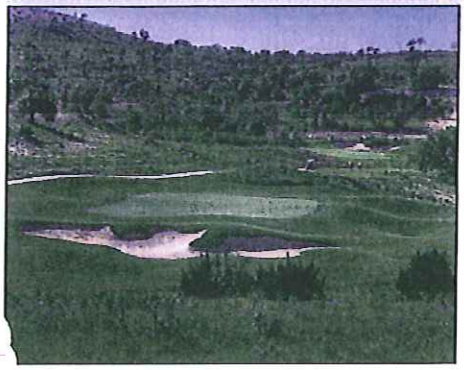
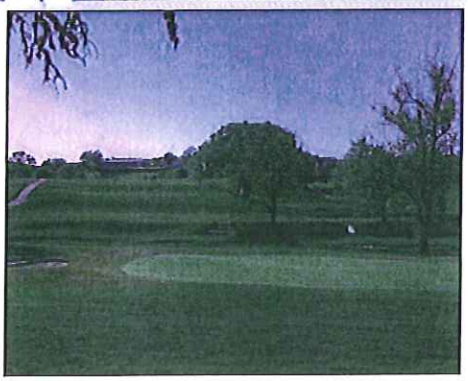
Practical results
Outstanding service





Water Reuse Facility
Reuse Pond Design Report

Prepared for:

City of Kerrville

Prepared by:
FREESE AND NICHOLS, INC.
4040 Broadway, Suite 600
San Antonio, Texas 78209
210-298-3800
FNI Project No.: KER14576

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

Water Reuse Facility Reuse Pond Design Report

Prepared for:

City of Kerrville

STATE OF TEXAS
DUSTIN G. MORTENSEN
100000
LICENSED
PROFESSIONAL ENGINEER
6/10/16

Prepared by:
FREESE AND NICHOLS, INC.
TBPE F-2144
4040 Broadway, Suite 600
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210-298-3800

FNI Project No.: KER14576

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1.0 INTRODUCTION

1.1 BACKGROUND

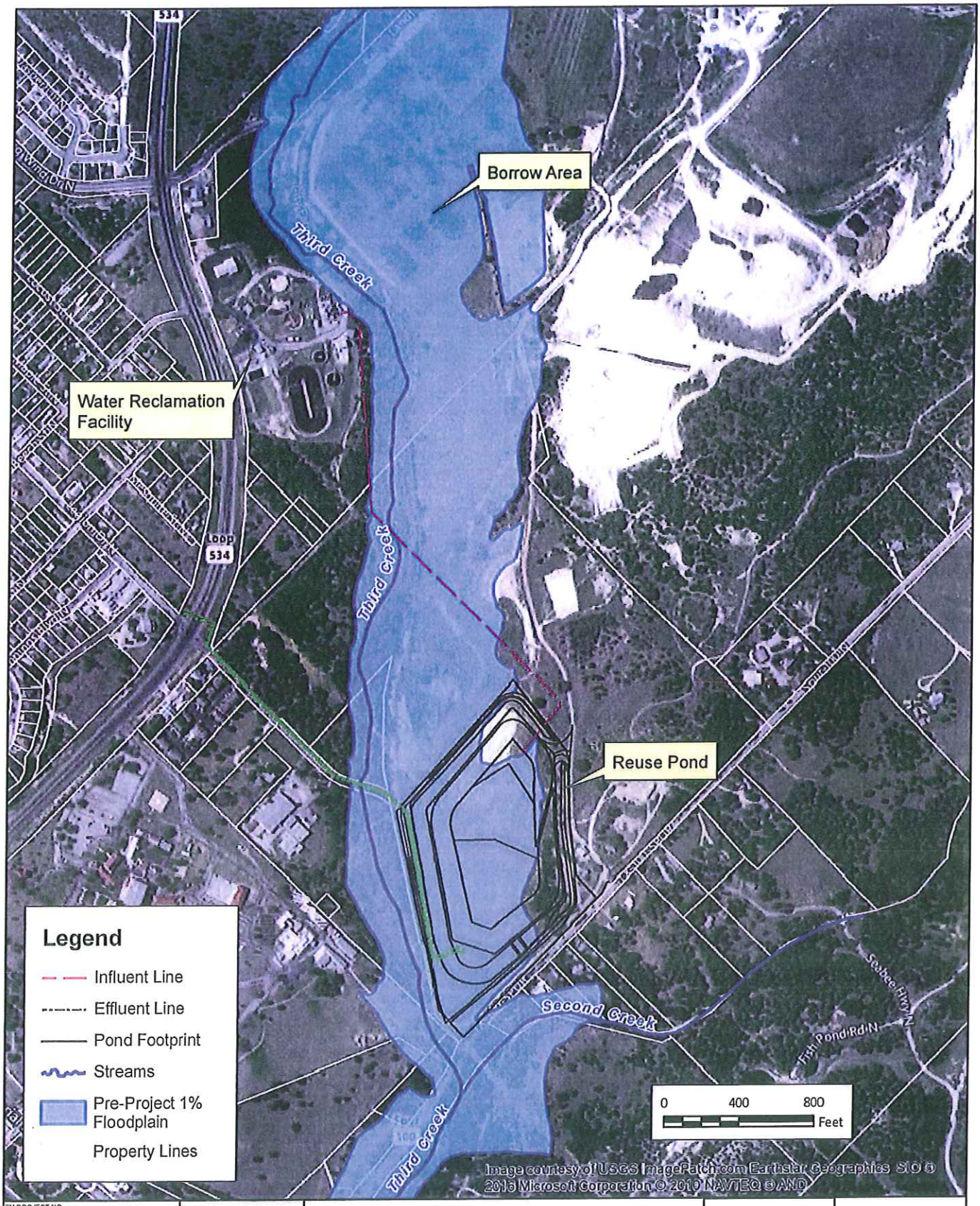
The City of Kerrville currently has a successful water reuse program which provides reclaimed water from its Water Reclamation Facility (Wastewater Treatment Plant) to various customers for irrigation of golf courses, recreational areas and landscape, as well as other non-potable uses. In order to expand the available usage of this resource, the City plans to construct a reclaimed water storage pond to increase the flexibility of matching water supply and demand.

In June 2014, Freese and Nichols (FNI) completed a feasibility study for the implementation of the reuse project [7.0]. During the study, FNI investigated necessary environmental permitting, geotechnical conditions, hydrologic and hydraulic analyses and regulatory requirements. The feasibility study evaluated two separate pond locations: a North Pond and a South Pond. The study provided the City of Kerrville with an assessment of short-term and long-term improvements to the reuse system infrastructure and served as a basis for the design, construction, and financing to implement the preferred reuse option.

Freese and Nichols was retained in November 2014 by the City of Kerrville to design the reuse pond and associated influent, effluent and pump station to expand the water reuse program. The South Pond location was selected for final design. This report documents the design of the reuse pond.

1.2 LOCATION

The reuse pond is located in the southeast side of Kerrville, east of the South Texas Veterans Health Care System. The selected site is currently owned by the City of Kerrville and is accessible from the City's water reclamation facility and from Spur 100. The west side of the site is bounded by Third Creek. Much of the site lies within an area designated by the Federal Emergency Management Agency (FEMA) as an area subject to flooding during the 1.0% annual chance flood event. Figure 1-1 shows the location of the reuse pond and the influent and effluent water lines. The potential borrow site for the pond embankment material is also shown on Figure 1-1.



FN PROJECT NO. KER14576	FREESE AND NICHOLS, INC. 4040 BROADWAY ST. SUITE 600 SAN ANTONIO, TEXAS 78209 P: 210-298-3800 F: 210-298-3801	Kerrville Reuse Facility	N	FIGURE
DATE CREATED Date: 6/23/2016				1-1
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central		Reuse Facility Overview Map		
FILE NAME Name: Fig1_1Location				
PREPARED BY BCK				

Date Saved: 6/23/2016 5:40:54 PM Path: H:\STORMWATER\Exports\Fig1_1Location.mxd

1.3 APPLICABLE REGULATIONS AND HAZARD CLASSIFICATION

The reuse pond is subject to regulation by multiple agencies. The embankment creating the pond is considered a dam and is subject to dam safety regulations [8]. The embankment will also function as a levee on Third Creek and may be subject to FEMA levee regulations [9]. The reuse pond facility must also meet requirements of the Texas Commission on Environmental Quality (TCEQ) permit authorizing reuse of the reclaimed water [2].

1.3.1 Dam Safety

Dam safety in Texas is regulated and administered by the TCEQ under Texas Administrative Code Title 30, Chapter 299 – Dams and Reservoirs [8]. TCEQ classifies dams based on two criteria: size and hazard classification. A small size dam is one with a height greater than 6 feet and less than 40 feet and/or a maximum storage greater than 15 acre-feet and less than 1,000 acre-feet. With a maximum height of 29 feet and a maximum storage of 362 acre-feet, the Kerrville Reuse Pond will be classified as a small sized dam. A high hazard dam is one in which failure would likely cause loss of life or excessive economic loss, including damage to main highways. As demonstrated in a breach analysis described in Section 5.7, the dam has the potential to impact homes adjacent to the pond as well as State Highway 27 (Memorial Blvd). Therefore, the pond will be classified as a high hazard dam.

1.3.2 National Flood Insurance Program

The reuse pond embankment will remove the area in the pond footprint from the FEMA floodplain, and the embankment will act as a levee to Third Creek. In order to be accredited as a levee, the pond facility must meet the regulations given in the Code of Federal Regulations Title 44, Chapter 1, Section 65.10 (44 CFR Section 65.10) [9]. If the levee were certified by FEMA, the area inside the levee would be removed from the regulated floodplain. If the City of Kerrville does not pursue levee certification, the area will continue to be shown as part of the regulated floodplain. The pond is designed to comply with the levee criteria.

1.3.3 Reclaimed Water Reuse

Use of reclaimed water in Texas is governed by the TCEQ under Texas Administrative Code Title 30, Chapter 210 – Use of Reclaimed Water [10]. TCEQ authorized the City of Kerrville to reuse water under Reclaimed Water Authorization No. R10576001 [2]. This authorization includes requirements for the water storage that the pond must meet. The provisions applicable to the pond are listed below. The

authorization allows for the use of soil or a synthetic pond liner. As the final design uses a synthetic liner, only the synthetic liner requirements are listed in this report.

I.(e). Reclaimed water managed in ponds for storage must be prevented from discharge into waters in the state, except for discharges directly resulting from rainfall events or in accordance with a permit issued by the commission.

I.(g). Signs in both English and Spanish shall be posted at storage areas, hose bibs and faucets reading "Reclaimed Water, Do Not Drink" or similar warnings. Alternately, the area may be secured to prevent access by the public.

II.(a).(1) The ponds, whether constructed of earthen or other impervious materials, shall be designed and constructed so as to prevent groundwater contamination.

II.(a).(5) Synthetic membrane linings shall have a minimum thickness of 40 mils with a leak detection system.

II.(a).(6) Certification shall be furnished by a Texas Registered Professional Engineer that the pond lining meets the appropriate criteria prior to utilization of the facilities.

II.(a).(7) Soil embankment walls shall have a top width of at least five feet. The interior and exterior slopes of soil embankment walls shall be no steeper than one foot vertical to three feet horizontal unless alternate methods of slope stabilization are utilized. All soil embankment walls shall be protected by a vegetative cover or other stabilizing material to prevent erosion. Erosion stops and water seals shall be installed on all piping penetrating the embankments;

2.0 GENERAL PROJECT INFORMATION

2.1 EXISTING SITE CONDITIONS

The reuse pond is located at approximately 99.108793° N, 30.016592° W, approximately one half mile east of the intersection of Memorial Blvd and Spur 100. The pond site is within the floodplain of Third Creek but is not located on the creek channel.

The existing topography of the reservoir site is relatively flat and slopes from the northeast to the southwest. There are few trees or significant vegetation within the site. A gravel access road is present

along the east, south and west side of the pond site. The site has been used for other purposes in the past and a 200-foot wide concrete weir is located on the west side of the site.

According to the U.S. Department of Agriculture soil survey map of Kerr County, the surface soils at the pond site consist predominately of Nuvalde silty clay. Hydrologic soil classifications include predominately Type B soils. The site is part of the Glen Rose formation according to the Llano Sheet of the Geologic Atlas of Texas [12].

2.2 DESIGN TECHNIQUES WITH ASSOCIATED DESIGN COMPUTATIONS AND DATA

The reuse pond embankment and spillway were generally designed and analyzed using design criteria and standards from such agencies as The United States Army Corps of Engineers (USACE), the United States Department of Agriculture Natural Resources Conservation Service (NRCS), and the United States Bureau of Reclamation (Reclamation).

2.3 ENVIRONMENTAL PROTECTION MEASURES

Standard best management practices (BMPs) for erosion and sedimentation control during construction and the disposal of wastes are incorporated into the design. It will be the Contractor's responsibility to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) in accordance with local, state, and federal requirements.

2.4 QUALITY CONTROL DURING CONSTRUCTION

The technical specifications provide requirements regarding the quality control throughout the duration of construction. It will be the sole responsibility of the contractor to maintain a quality control plan, following the provided technical specifications.

3.0 REUSE POND

3.1 RESERVOIR FOOTPRINT AND EMBANKMENT

The reuse pond was designed to store 100 million gallons (MG). A single cell design was chosen to maximize the storage volume of the site. The interior footprint of the pond is approximately 14 acres. The interior and exterior slopes will be 3H:1V to provide adequate slope stability and to comply with the reuse authorization. The east side of the pond incorporates an existing hillside to reduce the amount of fill required for the embankment. The pond bottom has a change in grade near the center to follow the

approximate top of rock surface to minimize rock excavation. The pond slopes to a minimum elevation of 1590.1 feet at the pump station to allow the pond to drain.

The top of embankment elevation is 1629 feet while the minimum elevation on the outside of the pond is 1600 feet. The minimum elevation inside the pond is 1590.1 feet, which is ten feet below existing grade. The dam height is 29 feet, as height is measured from the crest to the lowest point on the downstream toe rather than the deepest point in the pond. The embankment crest is 12-feet wide with a flexible base roadway. This crest width exceeds the water reuse authorization requirements.

The pond footprint is constrained by gas lines on the north and east sides of the site. The west side is constrained by Third Creek, overhead electric transmission lines, the City's property line, and the proposed reuse line. The south side of the site is bounded by a public utility easement and Spur 100. The pond footprint is as large as practical given these constraints.

3.2 INLET STRUCTURE

The inlet consists of a 24-inch diameter gravity pipeline from the Water Reclamation Plant. The flowline of the inlet is near the bottom of the pond. The portion of the pipeline beneath the reuse pond embankment will be welded steel pipe prior to the reuse pond. A hydrophilic waterstop will be provided between the steel pipe and concrete headwall to limit seepage from the pond. The pond liner will also be bonded to the headwall to limit seepage.

3.3 OVERFLOW WEIR DESIGN

The reservoir includes an overflow spillway for excessive rainfall and emergency events. A 40-foot wide overflow weir, with a crest elevation of 1626.0, is located on the south side of the embankment to handle these flows. The spillway will discharge into the south ditch for conveyance to Third Creek. The spillway crest and chute will be protected with 12 inches of soil cement. The soil cement extends 30 feet beyond the chute to reduce erosion near the embankment. Some erosion of the south ditch should be anticipated due to spillway discharges.

The reclaimed water authorization states that reclaimed water must be prevented from discharge into waters in the state, except for discharges directly resulting from rainfall events or in accordance with a permit issued by the commission. The spillway crest is one foot above the maximum operating level of 1625.0. Thus, if the influent line is closed during the 100-year storm event, the 12-inch freeboard could contain the storm and the spillway will not engage and reclaimed water will not be discharged into Third

Creek. The spillway will discharge during larger storm events, and discharge during storm events is allowed by the reuse authorization. The spillway was sized to accommodate malfunction or mis-operation of the influent pipeline during the probable maximum flood (PMF). This is described in more detail in Section 5.4.

3.4 EMBANKMENT PROTECTION

The interior bottom and slopes of the reservoir will be protected with a 12-inch layer of soil cement. The exterior slope of the embankment will be grass-covered, sloping at 3H:1V, tying into the natural ground. Due to the drainage ditches and Third Creek running along the toe of the dam, an evaluation of erosion potential was performed to determine where additional slope protection is required.

FEMA requires that the downstream slope of the embankment have no appreciable erosion during the base flood event. The western slope of the embankment was analyzed to determine erosion potential due to the base flood of Third Creek since encroachment up the slope is expected during this base storm. This analysis was performed in HEC-RAS as part of the hydraulic impact analysis described in Section 5.6. There are two factors that need to be considered in order to choose channel linings to ensure a stable channel design – velocity and shear stress. These parameters were calculated at each HEC-RAS cross section through the embankment. Velocities less than 6 ft/s are considered acceptable for grass-lined channels, but more than 6 ft/s requires hard armoring. Shear stresses less than 1 lb/ft^2 are considered acceptable for grass-lined sod channels overlaid by average grained soil (0.1 in), but more than 1 lb/ft^2 requires hard armoring. Based on the results provided in Table 3-1, armoring is required along the slope west slope.

Table 3-1 Shear Stress on West Embankment due to Third Creek

Dam Centerline Station	4+60	2+00	31+20	28+00
HEC RAS Section (Figure 5-2)	5346	5092	4743	4397
Max Shear (lb/ft^2)	4.10	2.61	2.88	0.80
Max Velocity (ft/s)	9.81	8.50	9.43	5.45
Max Creek Level (ft)	1612.68	1610.94	1608.13	1607.72

The 1 percent annual exceedance event, also known as the base flood, will also inundate a portion of the northern and southern slopes but the velocities will be minor and not pose a threat since the inundation will be a result of backwater from Third Creek.

At the toe of each slope, drainage swales were designed to divert 100-year surface runoff around the facility to be compliant with TCEQ criteria. It was also important to determine the erosion potential of the drainage swales since they are located at the toe of the embankment. In designing the swales, no backwater influence from Third Creek was assumed since the creek would inundate the channels during basin wide storm events. Therefore, the channels were designed based on a localized storm condition.

Velocity and shear stress were calculated for each ditch at each grade change and every change in horizontal alignment. As with the west embankment, velocities less than 6 ft/s are considered acceptable for grass-lined channels, but more than 6 ft/s requires hard armoring. Shear stresses less than 1 lb/ft^2 are considered acceptable for grass-lined sod channels overlaid by average grained soil (0.1 in), but more than 1 lb/ft^2 requires hard armoring.

Table 3-2 summarizes the maximum velocity, shear stress, and whether hard armoring is necessary for each ditch section. This information was used as the basis of selecting the channel lining.

Permanent turf reinforcement mat (PTRM) is provided in the areas noted for hard armoring and the west embankment due to Third Creek. The PTRM was selected using Erosion Control Materials Design Software Version 5.0.

Table 3-2: Drainage Swale Results

South Ditch						
Stationing	16+85.21 to 14+00.00	Bend Center 13+50.00	13+00.00 to 10+00.00	Bend Center 9+50.00	9+01.25 to 7+20.93	7+20.93 to 0+01.12
Max Shear (lb/ft^2)	0.49	0.51	0.49	0.72	2.53	0.16
Max Velocity (ft/s)	3.33	3.33	3.33	3.33	12.91	2.02
Lining	grass	grass	grass	grass	hard armor	grass
North Ditch						
Stationing	12+82.24 to 11+48.11	11+48.11 to 10+50.00	Bend Center 9+50.00	8+50.00 to 6+38.28	6+38.28 to 1+36.00	
Max Shear (lb/ft^2)	2.42	0.79	1.20	0.79	1.02	
Max Velocity (ft/s)	14.52	8.70	8.70	8.70	9.79	
Lining	hard armor	hard armor	hard armor	hard armor	hard armor	
West Ditch						
Stationing	12+39.04 to 11+76.39	11+76.39 to 9+26.52	9+26.52 to 8+00.00	8+00.00 to 5+85.00	5+85.00 to 1+00.00	
Max Shear (lb/ft^2)	0.34	0.35	0.05	0.06	0.06	
Max Velocity (ft/s)	2.90	2.93	1.24	1.34	1.34	
Lining	grass	grass	grass	grass	grass	

3.5 LINER AND UNDERDRAIN

The liner will consist of a 60 mil thick HDPE geomembrane over a HDPE geonet composite material with geotextile. An underdrain system consisting of 8-inch diameter perforated PVC pipe will be provided to collect leakage through the liner. Flow from the underdrain is collected in a wet well/sump and returned to the pond via a pump. The underdrain will also reduce potential uplift beneath the liner due to groundwater. The underdrain system is to remain operational even with the pond empty.

3.6 PUBLIC SAFETY

Signs will be provided at entrances to the pond to notify the public of the reclaimed water in accordance with item 1.g of the reclaimed water authorization. A fence is also provided around the downstream toe to prevent public access.

4.0 GEOTECHNICAL ANALYSIS

A geotechnical analysis of the site was performed by Freese and Nichols, Inc. The analysis is documented in the Geotechnical Data Report and the Geotechnical Analysis Report and summarized below.

- A geotechnical report titled "Geotechnical Data Report - Kerrville Reuse Facility" (dated June 2, 2015) describing the field investigation and laboratory testing program [3].
- A geotechnical report titled "Geotechnical Analysis Report - Kerrville Reuse Facility" (dated June 29, 2016) describing the site geology, seepage, slope stability, settlement analysis as well as design recommendations [4].

The geotechnical reports document the geology and stratigraphy of the site, discuss the development of geotechnical design parameters, provide the results of the embankment slope stability, seepage, and settlement analyses, and provide foundation recommendations for the structures planned for the site. Key conclusions from the analysis are repeated in this design report to document compliance with applicable criteria and regulations.

4.1 STABILITY ANALYSIS

The interior and exterior slopes were analyzed for slope stability for steady state, rapid drawdown, end of construction, and fully softened conditions. The analyses were performed in general accord with USACE's EM 1110-2-1913 [13], as specified by 44 CFR 65.10 for levees. This method also meets TCEQ dam safety criteria. The slopes will meet or exceed the minimum allowable values for all conditions analyzed. The results of the slope stability analysis are summarized in Table 4-1.

Table 4-1: Summary of Slope Stability Analysis

Loading Condition	Slope Analyzed	Factor of Safety	
		Calculated	TCEQ Minimum [11]
Steady State	Interior	2.2	1.5
	Exterior	1.6	1.5
Rapid Drawdown	Interior	1.5	1.2
End of Construction	Interior	1.5	1.25
	Exterior	1.5	1.25
Fully Softened	Exterior	1.2	NA

4.2 SETTLEMENT ANALYSIS

A settlement analysis was performed to comply with the levee criteria in 44 CFR 65.10. Settlement of the foundation material as well as the embankment material were considered. The analysis included potential settlement of these materials due to embankment loads, embankment soil compressibility and construction compaction methods. The maximum total settlement at any location after construction will be approximately 8.5 inches or less. These values are based on conservative assumptions and represent a maximum calculated total settlement. Assuming a functioning underdrain, the expected settlement after construction is estimated to range from 3 to 5 inches.

4.3 SEEPAGE ANALYSIS

Seepage from the pond will be controlled through the use of a HDPE geomembrane and soil cement protective cover. An underdrain system has been designed to collect and convey the seepage due to leakage through the HDPE liner, as well as groundwater that may enter from outside the pond. For stability modeling purposes, a straight line phreatic surface is assumed to develop from the maximum water surface elevation within the pond to the outside embankment toe elevation. This scenario conservatively assumes the underdrain is not functioning.

4.4 SEISMIC ANALYSIS

The historical seismicity since 1900 was reviewed within a 100 km (62 mile) radius from the site. The analysis found that the horizontal acceleration at the site would be approximately 0.036 g, which would be generally unperceivable at the site. Therefore, a seismic analysis was not performed.

5.0 HYDROLOGIC AND HYDRAULIC ANALYSIS

The reuse pond will be classified as a small size, high hazard dam and will be required to safely pass a minimum of 75 percent of the critical Probable Maximum Flood (PMF) by Texas Administrative Code [8].

In the event of high water levels, the pond was designed with an overflow spillway to convey flows away from the reservoir, without the embankment being overtopped. The spillway, as previously described, will consist of a 40-foot wide overflow weir, with 10H:1V side slopes. Discharges through the spillway will overflow into the south ditch.

The remainder of this chapter will discuss the analysis and results of the hydrologic and hydraulic analysis for the reuse pond.

5.1 ELEVATION – CAPACITY

The reuse pond was designed for a total capacity of 100 MG, at a "high" operating elevation of 1625 feet. The reuse pond will typically be operated in a 30-foot elevation range of empty at 1595 feet to maximum operating level at 1625 feet. The top of embankment elevation is 1629 feet, which will provide four feet of additional storage capacity in the event of an extreme storm event. The elevation-capacity for the reuse pond is provided in Figure 5-1 and Table 5-1.

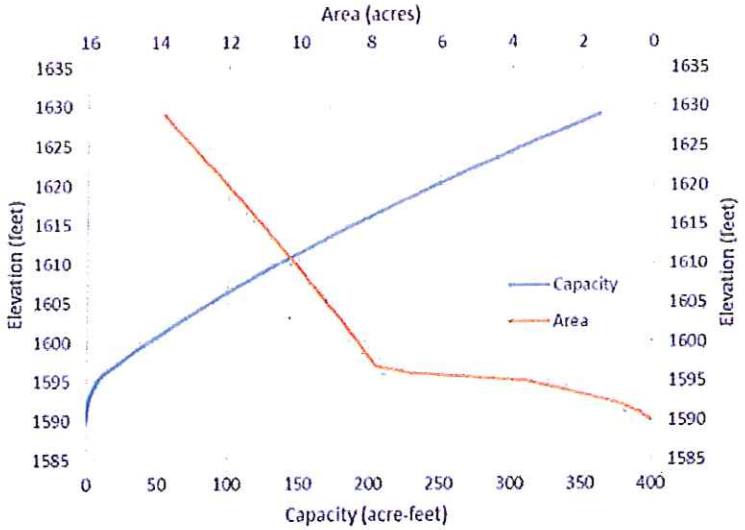


Figure 5-1 Elevation-Area-Capacity

Table 5-1 Elevation-Area-Capacity

Elevation (ft)	Area (acres)	Capacity (ac-ft)	Capacity (MG)
1590	0.0	0	0
1591	0.3	0.1	0.0
1592	0.9	0.7	0.2
1593	1.6	1.9	0.6
1594	2.5	3.9	1.3
1595	3.6	7.0	2.3
1596	6.9	12.1	3.9
1597	7.8	19.4	6.3
1598	8.0	27.3	8.9
1599	8.1	35.4	11.5
1600	8.3	43.6	14.2
1601	8.5	52.0	16.9
1602	8.7	60.6	19.7
1603	8.8	69.3	22.6
1604	9.0	78.2	25.5
1605	9.2	87.3	28.5
1606	9.4	96.6	31.5
1607	9.5	106.0	34.6
1608	9.7	115.7	37.7
1609	9.9	125.5	40.9
1610	10.1	135.5	44.2
1611	10.3	145.7	47.5
1612	10.5	156.0	50.8
1613	10.7	166.6	54.3
1614	10.8	177.4	57.8
1615	11.0	188.3	61.4
1616	11.2	199.4	65.0
1617	11.4	210.7	68.7
1618	11.6	222.3	72.4
1619	11.8	234.0	76.2
1620	12.0	245.9	80.1
1621	12.2	258.0	84.1
1622	12.4	270.3	88.1
1623	12.6	282.8	92.2
1624	12.8	295.5	96.3
1625	13.0	308.5	100.5
1626	13.2	321.6	104.8
1627	13.4	334.9	109.1
1628	13.6	348.5	113.5
1629	13.9	362.2	118.0

5.2 OUTLET STRUCTURES

Water will be conveyed from the reuse pond via distribution mains that will exit from the reuse pump station located on the southwest side of the reservoir. Normal operations will occur via the pump station and into the distribution mains. No discharge through the pump station was assumed for the hydrologic analysis.

5.3 WEIR AND SPILLWAY DESIGN

Emergency discharges will occur via the previously described spillway located on the west embankment. Since the spillway is effectively an overtopping roadway functioning as a broad-crested weir, CulvertMaster was used to determine the discharge through the spillway for various headwater elevations [14]. CulvertMaster implements the overtopping roadway methodology presented in Federal Highway Administration HDS-5 [15]. The spillway width is 40 feet, with 10H:1V side slopes. The discharge rating curve is provided in Table 5-2.

Table 5-2 Spillway Discharge Rating Curve

Elevation (ft)	Discharge (cfs)
1626.0	0
1626.25	16
1626.50	45
1626.75	87
1627.0	139
1627.5	272
1628.0	445
1628.5	656
1629.0	907

5.4 HYDROLOGIC ANALYSIS

The criteria for hydrologic and hydraulic analysis of dams in Texas is documented in Hydrologic and Hydraulic Guidelines for Dams in Texas [7]. As a small size, high hazard dam, the reuse pond will be required to pass a minimum of 75 percent of the Probable Maximum Flood (PMF).

The Probable Maximum Flood (PMF) is defined as the greatest flood to be expected assuming complete coincidence of all factors that would produce the heaviest rainfall and maximum runoff. The Probable Maximum Precipitation (PMP) is theoretically the greatest depth of rainfall for a given duration that is physically possible over a given storm area at a particular geographic location. Generally, the rainfall depth is calculated for the ten square miles of the watershed which receive the highest intensity rainfall.

In order to determine the PMP, rainfall amounts were developed using Hydrometeorological Report No. 52 (HMR52). The contributing drainage area is less than 10sqmi; therefore, aerial reduction was not used and the maximum PMP values from HMR52 were used. Table 5-3 shows the resulting precipitation for the various storm durations.

Table 5-3 Probable Maximum Precipitation

Duration (hr)	Depth (in)
1	16.7
2	20.6
3	23.6
6	29.5
12	36.0
24	42.3
48	47.5
72	50.7

There is no contributing drainage area to the reuse pond other than the surface of the 14-acre pond. Due to this reason, precipitation that falls on the pond surface area will be immediately contributing to the pond and no losses would occur. Discharges would be routed through the pond via the spillway. The embankment crest is sloped to direct rainfall away from the pond. The drainage basin was assumed to have an Antecedent Runoff Condition (ARC) III soil curve number of 98.

The analysis was performed with inflow from the water reclamation plant. Preferably, the pipeline will be closed during large rainfall events. However, there is the possibility that the pipeline will remain open, therefore the spillway was sized to prevent overtopping during the PMF with inflow from the reclamation plant. The analysis assumed that the inflow from the reclamation plant will be 10 MGD (15.5 cfs). Discharge through the pump station and distribution mains were not included.

The PMF was applied to the reservoir for PMF events with durations of 1, 2, 3, 6, 12, 24, 48, and 72 hours. The peak elevation for each storm duration for the full (100 percent) PMF and 75% PMF for the critical storm is shown in Table 5-4.

Table 5-4 PMF Results

Duration (Hours)	Peak Stage (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)
1	1626.6	263	55
2	1626.7	199	86
3	1626.8	198	87
6	1626.6	155	69
12	1626.8	122	98
24	1626.7	91	81
48	1626.6	72	55
72	1626.5	46	44
75%PMF	1626.6	92	63

The critical duration for the pond is the 12-hour storm. The reuse pond is able to safely pass the critical PMF event without overtopping the embankment. The spillway will engage whether or not there is inflow from the reclamation plant.

The pond was also analyzed for the 10-, 50-, 100-, and 500-year storm events. If there is no inflow from the reclamation plant, there will be no discharge from the reuse pond into Third Creek for up to the 100-year event. The results for each storm event is shown in Table 5-5.

Table 5-5 Frequency Event Results

Frequency Event (Year)	Peak Stage (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)
10	1625.6	129	0
50	1625.8	167	0
100	1625.9	186	0
500	1626.1	275	4.2

5.5 FREEBOARD

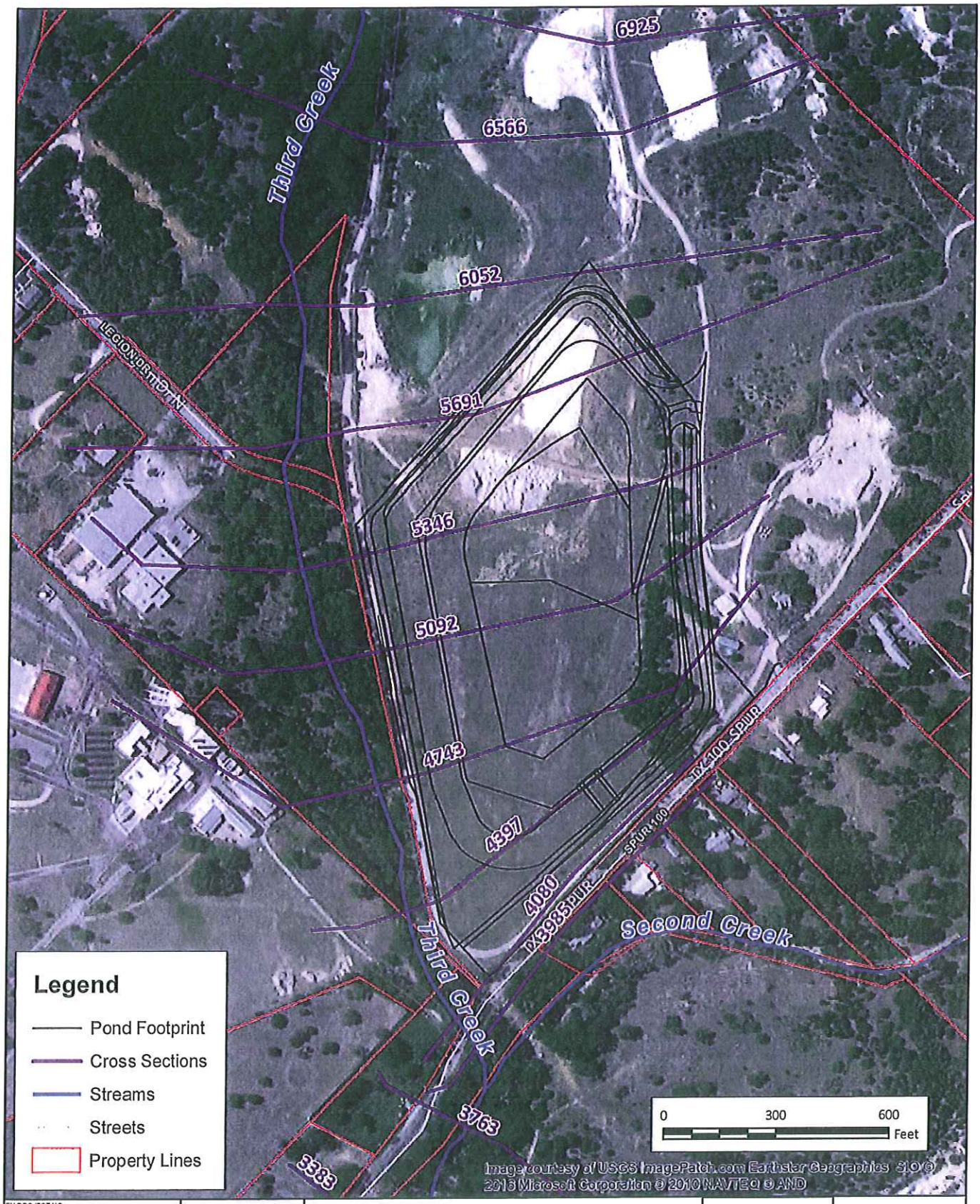
TCEQ requires that new dams have appropriate freeboard. Overtopping from wave action due to design wind loads is generally not allowable. Freeboard was evaluated according to Section 3.2 in the TCEQ H&H Guidelines using an overland design wind speed of 77 miles per hour. The anticipated wave run-up is 2.33 feet. The crest of the dam was set to contain the wave run-up during a 75% PMF event.

FEMA requires that levees provide freeboard over the Base Flood Elevation (1.0 percent storm, i.e. 100-year storm) to prevent floods from entering the leveed area. The minimum freeboard for the reuse pond is 3-feet above the FEMA Base Flood Elevation (BFE) around the entire levee, 3.5-feet at the upstream end of the pond and 4-feet at the Spur 100 Bridge. There are no BFEs on Third Creek at the reuse pond site since a detailed study has not been completed by FEMA. However, a detailed analysis, described in Section 5.6, was completed as part of this project which indicates that the 1.0 percent storm levels in Third Creek will be approximately 1615 feet at the upstream end and 1606 feet near Spur 100. The pond crest elevation of 1629 exceeds the FEMA freeboard requirements, even after consideration of the potential settlement.

5.6 HYDRAULIC IMPACT ANALYSIS

For the final design impact analysis, FNI built hydrologic and hydraulic models to develop the 10-, 50-, 100-, and 500-year flow rates and compare hydraulic conditions between pre-project conditions and the proposed pond conditions. Lateral structures were used on the west side of Third Creek in the hydraulic model to represent the flow leaving the Third Creek watershed.

USACE HEC-HMS version 3.5 was used for the hydrologic analysis and USACE HEC-RAS version 4.1.0 was used in the hydraulic analysis. The models were not calibrated or validated as part of this effort since gage data or historic water marks were not available. Figure 5-2 provides the location of the HEC-RAS cross sections for the area around the proposed facility.



FN PROJECT NO. KER14576	FREESE AND NICHOLS	Kerrville Reuse Facility	N	FIGURE
DATE CREATED Date: 6/23/2016	FREESE AND NICHOLS, INC. 4040 BROADWAY ST. SUITE 600 SAN ANTONIO, TEXAS 78209 P: 210-298-3800 F: 210-298-3801	Cross Sections Within Project Area		5-2
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central				
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5.6.1 Pre-Project Conditions Hydraulic Analysis

The purpose of analyzing the "pre-project" condition is to establish the floodplain elevation and limits before the project is built. This condition is compared to project conditions to assess the potential impact the project could have on the floodplain limits.

The pre-project hydraulic model was developed using design survey and two-foot topography from the City. The resultant flood stage for pre-project conditions is provided in Table 5-6. A depiction of the pre-project conditions floodplain for the one-percent storm event is shown in Figure 5-3. During this event, the proposed location of the reuse facility as well as City and private land parcels adjacent and upstream of the project area are inundated by flood water. One publicly-owned structure and six privately-owned structures are potentially affected between Spur 100 and the end of the study reach.

5.6.2 Project Conditions Hydrologic and Hydraulic Analyses

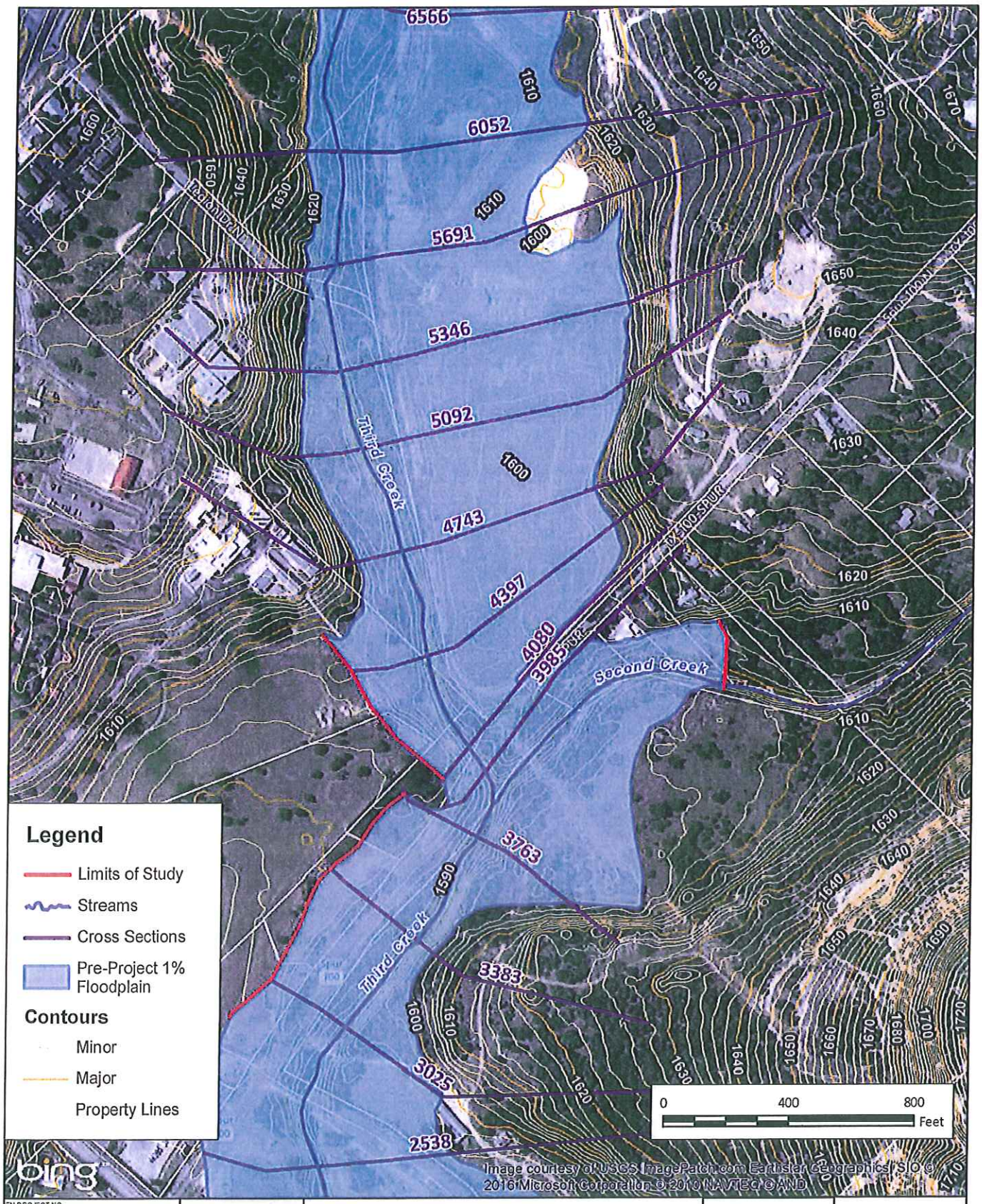
The "pre-project" condition hydrologic model was revised to reflect the change in flow patterns based on the proposed reuse facility. A reservoir with a corresponding outlet structure was added to the model to reflect the proposed facility.

The "pre-project" condition hydraulic model was revised to reflect the location of the proposed reuse facility with respect to Third Creek. This model was combined with the revised flows from the hydrologic model to establish the "project" conditions. This condition is compared to the "pre-project" condition to determine if the project causes an adverse floodplain impact. This comparison is summarized in Table 5-6.

The project conditions result in a maximum flood stage increase of 0.44 feet, stretching across city property at cross section 6566. The increased water surface elevation extends downstream approximately 180-ft before equaling or subsiding the pre-project water surface elevation on city property. Since the increase in water surface elevation is on City owned property and recedes below pre-project conditions before reaching county property, floodplain mitigation will not be required based on the proposed project conditions. Figure 5-4 shows the project floodplain.

Table 5-6 Project v. Pre-Project Conditions 1.0% Storm Results

River Sta	Location of Section	Pre-Project		Project		Δ W.S. Elev
		Discharge (cfs)	W.S. Elevation (ft)	Discharge (cfs)	W.S. Elevation (ft)	Project - Pre
11183	private	16000	1649.1	16000	1649.1	0.00
10912	private, city	16000	1647.8	16000	1647.8	0.00
10407	private, city	16000	1643.4	16000	1643.4	0.00
9990	city	16000	1641.4	16000	1641.4	0.00
9629	city	16000	1640.4	16000	1640.4	0.00
9569	Culvert					
9508	city	16000	1638.7	16000	1638.7	0.0
9092	city	16000	1637.7	16000	1637.7	0.0
8682	city	16000	1635.2	16000	1635.2	0.0
8285	city	16000	1631.9	16000	1631.9	0.0
8014	city	16000	1629.6	16000	1629.6	0.0
7694	city	16000	1627.7	16000	1627.7	0.0
7407	city	16000	1625.2	16000	1625.2	0.0
6925	city	16000	1621.6	16000	1621.6	0.0
6566	city	16000	1619.8	16000	1620.3	0.4
6052	city, county	16000	1616.8	16000	1615.9	-0.9
5691	city, county	16000	1614.6	16000	1614.3	-0.4
5346	city, county	16000	1611.6	16000	1611.1	-0.5
5092	city, county	16000	1609.6	16000	1609.6	0.0
4811	Lateral Structure					
4743	city, county	16151	1607.0	13604	1607.0	0.0
4397	city, county, private	16016	1606.4	13604	1606.3	-0.1
4080	city, county, private	13651	1605.2	13604	1605.2	0.0
4040	Culvert					
3985	private	13651	1605.3	13604	1605.3	0.0
3763	KISD, private	22910	1603.0	22856	1602.8	-0.2
3762	Lateral Structure					
3383	KISD, city	22821	1600.6	21570	1600.5	-0.1
3025	KISD, private	22241	1598.8	21570	1598.8	0.0
2538	KISD, county	21703	1594.9	21570	1594.9	0.0
2117	KISD, county	19327	1591.1	19309	1591.1	0.0
1796	KISD, county	19327	1589.6	19309	1589.6	0.0
1255	private, county	19327	1587.4	19309	1587.4	0.0
498	private	19327	1583.7	19309	1583.7	0.0



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DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central		Pre-Project 1% Floodplain		
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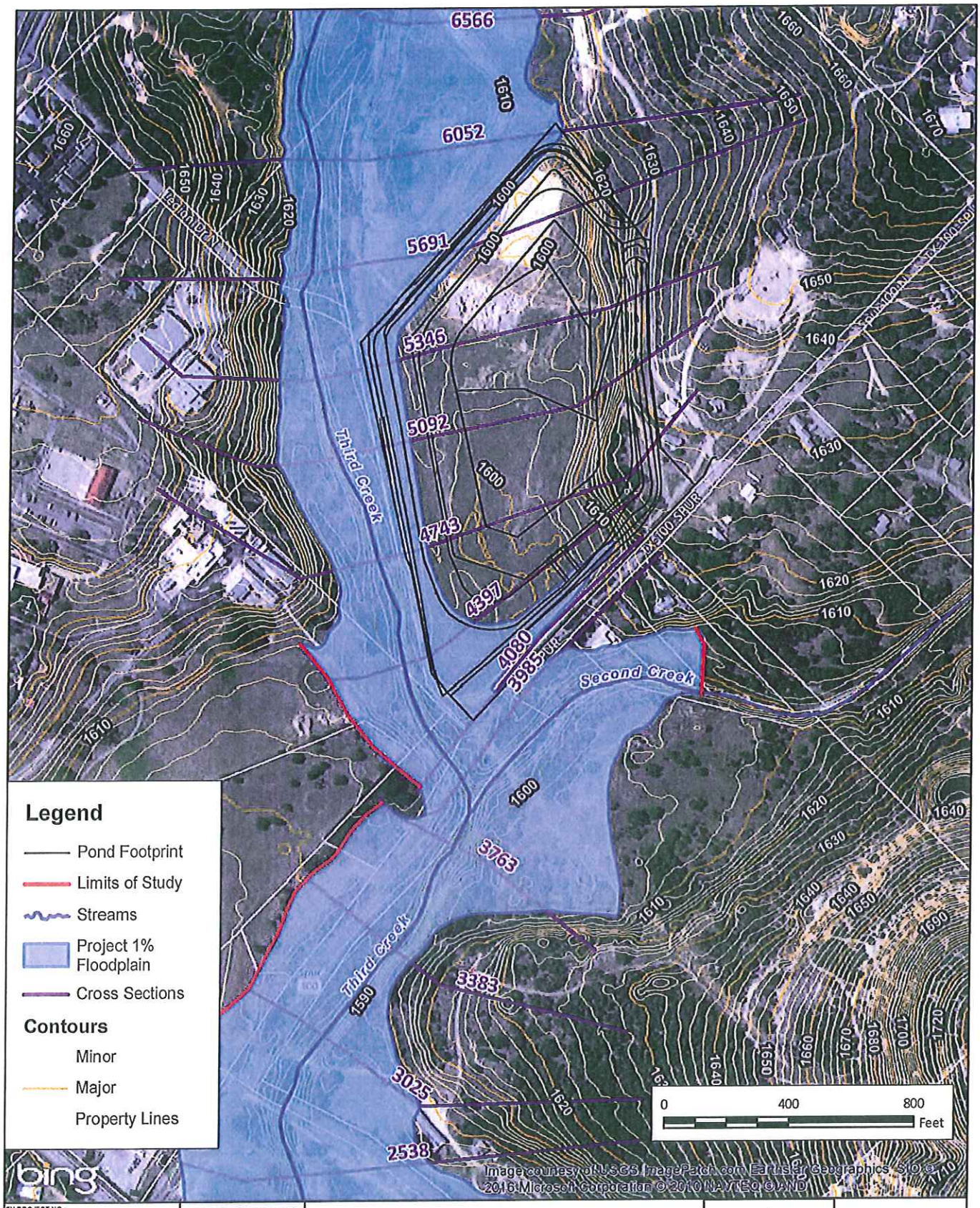

FN PROJECT NO. KER14576	FREESE AND NICHOLS, INC. 4040 BROADWAY ST. SUITE 600 SAN ANTONIO, TEXAS 78209 P: 210-298-3800 F: 210-298-3801	Reuse Feasibility Study	FIGURE 5-4
DATE CREATED Date: 6/23/2016		Project Floodplain 1% Floodplain	
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central			
FILE NAME Name: Fig5_4_ProjFP_101			
PREPARED BY BCK			

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5.7 BREACH ANALYSIS

The impacts due to a breach of the reuse pond embankment were calculated using the simplified breach methodology documented in Hydrologic and Hydraulic Guidelines for Dams in Texas [7]. Total peak flow from the dam and inundation length were determined to be approximately 50,700 cfs and 3.6 miles, respectively. In addition to the breach flows from the dam, the influence of Third Creek and the Guadalupe River was assessed since it can be assumed that some amount of runoff is in the creeks when a breach of the dam occurs. Multiple hydrologic conditions along the downstream receiving streams were assessed to determine their impact on the breach inundation area, including 10-, 50-, and 100-year flows in Third Creek combined with 10, 50, and 100-year flows in the Guadalupe River, and combinations in between. Each combination resulted in less than one foot of elevation difference. Therefore, the worst case condition using the 100-year flows combined with the breach flows was mapped. The breach inundation area is shown in Figure 6-1.

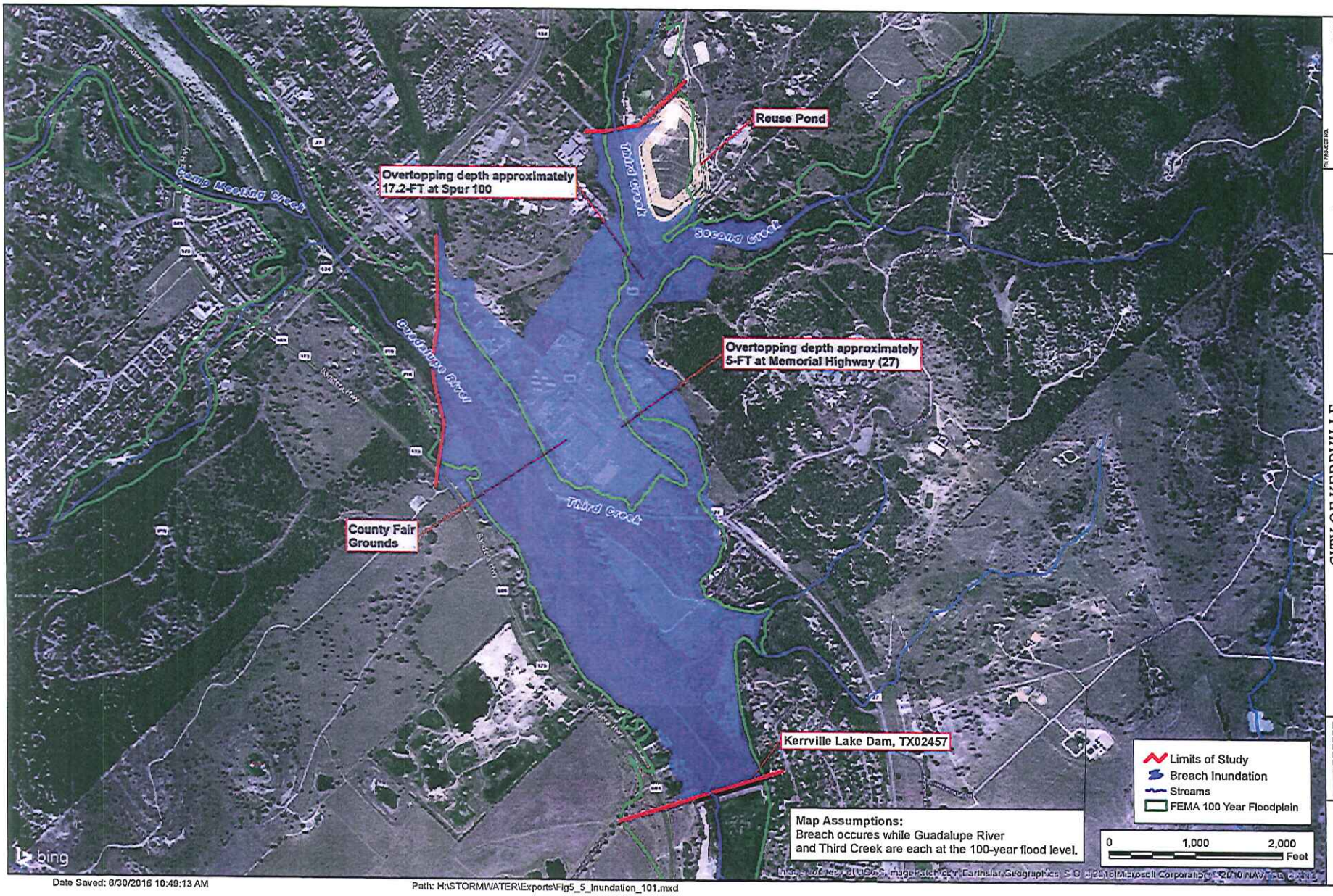
The inundation mapping stops at Kerrville Lake Dam, TX02457 since the inundation area is within the 100-year floodplain at that location. Kerrville Lake Dam is a channel dam that is overtopped frequently. A breach of the reuse pond would not impact Kerrville Lake Dam. A breach will impact Spur 100, several homes on Spur 100 directly across from the pond, Kerrville National Cemetery, the County Maintenance Yard, the Little League Fields, the County Fair Grounds, Memorial Highway near Spur 100 and several homes on Riverside Dr. Since the breach will impact a main highway and more than three habitable structures, the dam is considered high hazard by TCEQ's Chapter 299 – Dams and Reservoirs.

5.8 INTERIOR DRAINAGE

The levee criteria in Code of Federal Regulations Title 44 require an analysis of the interior drainage of the levee and the extent of interior flooding. Since the pond is designed to store water, rather than function as a levee, the interior drainage analysis is not applicable. The PMF analysis showed that the spillway provides sufficient interior drainage to prevent overtopping of the embankments.

6.0 CONCLUSION

The reuse pond has been designed to meet the applicable requirements of TCEQ Dam Safety, TCEQ Reclaimed Water Usage and the National Flood Insurance Program. The pond will contain the 100-year storm event without discharging water from the pond.



CITY OF KERRVILLE
REUSE FACILITY

BREACH INUNDATION MAP

FREESE AND NICHOLS, INC.
10431 MORADO CIRCLE
SUITE 300
AUSTIN, TEXAS 78759
PHONE: 512-617-3100
FAX: 512-617-3101

FIGURE
5-5

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MEMORANDUM

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TO: Charles Kucherka, P.E.

CC: Estella Cota; Randall Howard

FROM: Meredith Heather, AWB®; Patrick Garnett, CWB®

SUBJECT: Environmental Permitting Technical Memorandum

DATE: April 22, 2015

PROJECT: KER14576

On April 2, 2015 Freese and Nichols, Inc. (FNI) environmental scientists performed a pedestrian site visit to the Kerrville Reuse Facility project area, Figure 1. The site visit was to assess the conditions of the proposed site for potential environmental constraints and permitting.

The area southwest of the potential soil borrow area was surveyed for a possible drainage path from the borrow area to Third Creek. Third Creek displays an average ordinary high water mark (OHWM) of 14 feet and is currently dry in this area (Photo 1). Typical vegetation along the creek banks consists of American elm (*Ulmus americana*), ligustrum (*Ligustrum lucidum*), greenbriar (*Smilax bona-nox*), live oak (*Quercus virginiana)*, yaupon holly (*Ilex vomitoria*), possumhaw holly (*Ilex decidua*), cedar elm (*Ulmus crassifolia*), American sycamore (*Platanus occidentalis*), straggler daisy (*Calyptocarpus vialis*), and frostweed (*Verbesina virginica*). Upland of the right bank is a rocky hillslope dominated with mature Ashe juniper (*Juniperus ashei*) and live oak, which is potential golden-cheeked warbler (*Setophaga chrysoparia*) habitat. Adjacent to the left bank is an excavated side channel with the following vegetation (Photo 2): Roosevelt weed (*Baccharis neglecta*), shrub Ashe juniper, live oak, common mullein (*Verbascum Thapsus),* thistle (*Cirsium horridulum*), and prairie verbena (*Glandularia bipinnatifida*).

In the area where the pipeline route is proposed to traverse adjacent to the City of Kerrville Wastewater Treatment Plant (WWTP) (Photo 3), vegetation is primarily straggler daisy, prairie verbena, thistle, silverleaf nightshade (*Solanum elaeagnifolium*), opuntia (*Opuntia engelmannii*), mealy blue sage (*Salvia farinacea*), and rabbit tobacco (*Evax prolifera*).

Third creek continues to have an average OHWM of 14 feet where the reuse gravity line is proposed to cross. Water is currently present in this section of the creek (Photo 4). Vegetation adjacent to the creek consists of ligustrum, cedar elm, four o'clock (*Mirabilis jalapa*), frostweed, parietaria (*Parietaria pensylvanica*), and old man's beard (*Clematis drummondii*). Upland vegetation includes mature Ashe juniper, live oak, and greenbriar. Again, this represents potential golden-cheeked warbler habitat.

There is a dry channel with an OHWM of 2 feet where the proposed pipeline crosses the tributary to Third Creek. Vegetation along the channel consists of annual ragweed (*Ambrosia artemisiifolia*), Texas wintergrass (*Nassella leucotricha*), ryegrass (*Lolium spp.*), upright prairie coneflower (*Ratibida columnifera*), Bermudagrass (*Cynodon dactylon*), and Johnson grass (*Sorghum jalapense*). There is a nearby wetland comprised primarily of spikerush (*Eleocharis spp.*).

Third Creek continues to display an average OHWM of 14 feet at the proposed crossing location of the two reuse distributions lines (Photo 5). Vegetation along the creek is dominated by Spanish oak (*Quercus buckleyi*) and also contains frostweed, parietaria, cedar elm, and shrub Ashe juniper.

Section 404 Permitting

Nationwide permit (NWP) *12: Utiility Line Activities* authorizes activities required for the construction, maintenance, repair, and removal of utility lines and associated facilities in waters of the U.S. provided the activity does not result in the loss of greater than 1/2-acre of waters of the U.S. for each single and complete project. The proposed pipeline routes will cross Third Creek and a tributary to Third Creek, each displaying an OHWM, classifying them as waters of the U.S. At this time, it is in the opinion of FNI staff that the project will qualify for NWP 12 without pre-construction notification (PCN) to the U.S Army Corp of Engineers (USACE). A PCN is required if permanent impacts to waters of the U.S. are greater than 1/10 of an acre.

Threatened and Endangered Species

According to the U.S. Fish and Wildlife Service (USFWS), the golden-cheeked warbler and black-capped vireo (*Vireo atricapilla*) are listed as endangered bird species in Kerr County. Black-capped vireos prefer habitat with young, semi-open stands of small trees and shrubs separated by open grasslands. This type of habitat was not observed within the project site. The golden-cheeked warbler resides in habitats consisting mainly of dense, mature Ashe juniper mixed with various oak species. This woodland habitat grows on limestone hills, canyons, and adjacent canyons. Potential habitat suitable for the golden-cheeked warbler was observed within the project site. It is the opinion of FNI staff to perform a golden-cheeked warbler presence/absence survey, following USFWS survey protocol, or to perform necessary construction outside of nesting season, which is March through August.

Tobusch fishhook cactus (*Ancistrocactus tobuschii*) is listed as an endangered flowering plant in Kerr County. No Tobusch fishhook cactus was seen along the proposed pipeline route. In reference to the USFWS critical habitat mapper, there is no designated critical habitat in Kerr County.

Archeological Review

FNI coordinated with the Texas Historical Commission (THC) in regards to the proposed project. In response, THC required a professional archeologist to survey the areas of new ground disturbance, including the proposed new pond and pump station, as well as the proposed reuse gravity line between the new pond and existing treatment facility. In addition, the previously recorded archeological site 41KR501 located in the area of the potential soil borrow area will require archeological testing and further survey for delineation by a professional archeologist. Prewitt and Associates, Inc. has been contracted by FNI to perform the mentioned archeological surveys.

Photographs

Photo 1. Looking downstream, dry portion of Third Creek southwest of potential soil borrow area.

Photo 2. Excavated side channel adjacent to the left bank of Third Creek in Photo 1.

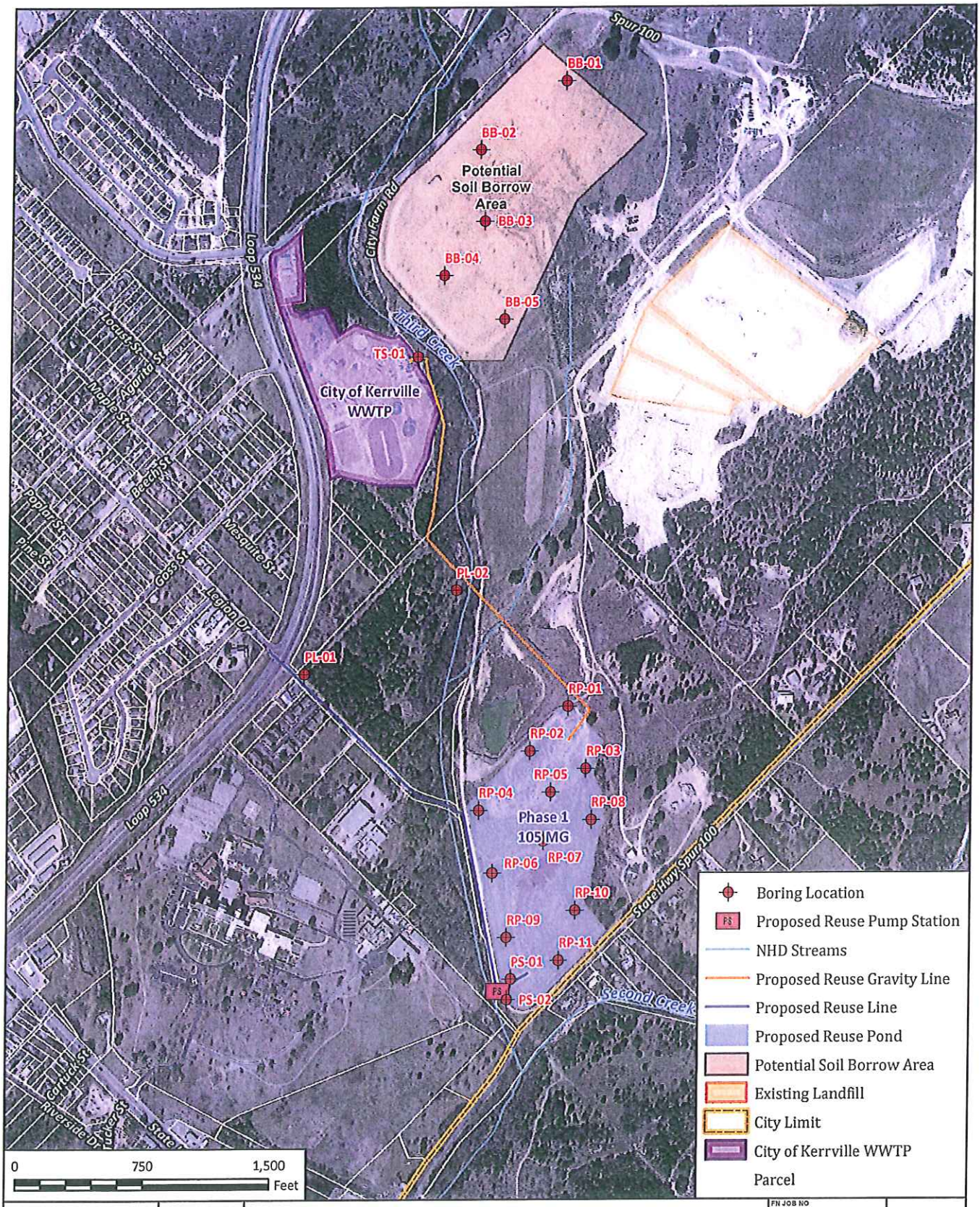
Photo 3. Proposed pipeline route adjacent to City of Kerrville WWTP.

Photo 4. Third Creek where the reuse gravity line is proposed to cross.

Photo 5. Third Creek continues at the proposed crossing location of the two reuse distributions lines.

Photo 6. Legion Drive adjacent to proposed route for the two reuse distribution lines.

Photo 6. View of proposed reuse pond area



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N W E S

CITY OF KERRVILLE

Kerrville Reuse Facility

Location on Aerial

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FILE NAME	1_Aerial_05152015.mxd
DATE	5/15/2015
SCALE	1:9,000
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FIGURE

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NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

TECHNICAL MEMORANDUM

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TO: Dieter Werner, P.E.

CC: Randall Howard; John New, PE; Richard Weatherly, PE

FROM: Patrick Garnett, CWB, CPESC

SUBJECT: City of Kerrville, TX: Water Reuse Site Feasibility

DATE: June 4, 2014

PROJECT: KER13488

On Tuesday, October 22, 2013, Freese and Nichols, Inc. (FNI) environmental scientist, Patrick Garnett and Professional Engineer, Matt Ewald, performed a pedestrian site visit to the City of Kerrville's wastewater treatment plant and land adjacent to the City's sanitary landfill.

The proposed site is approximately 80 acres located along the eastern bank of Third Creek in Kerrville. The property to the southeast is the Kerrville Sanitary Landfill. To the northwest is the City's wastewater treatment plant. The property proposed for the reuse water storage facility is currently used as recreational sports fields, numerous borrow pits for the sanitary landfill, storage of empty refuse containers, and a remote controlled aircraft airfield. The airfield and sports complex are currently irrigated with reuse water from the wastewater treatment plant. Vegetation along the segment of stream 1, an unnamed tributary of Third Creek is typical of an ephemeral upland water course. Stream 1 exhibits an ordinary high water mark (OHWM) width of on foot as it exits the sediment ponds on the northern end of the complex. These ponds appear to be constructed to detain some of the stormwater from the adjacent sanitary landfill. Stream 1 and the open water impounded below the sanitary landfill is mapped on the USGS 7.5 minute Legion, TX quadrangle. Near the confluence with Third Creek, this unnamed tributary exhibits an OHWM of 1.5 feet as it exits a culvert from the sanitary landfill borrow pits.

Third Creek is an intermittent stream mapped on the USGS 7.5 minute Legion, TX quadrangle. There was water observed in the stream, downstream of the wastewater outlet (Photo 1). Upstream of the outlet no water was observed despite the recent two-inch rainfall approximately four days prior to the site visit.

Vegetation throughout the project area was comprised of common mullein (*Verbascum Thapsus),* greenbriar (Smilax bona-nox), mealy blue sage (Salvia farinacea), ashe juniper (Juniperus ashei), pecan (*Carya illinoinensis*), mesquite (Prosopis glandulosa), sugarberry (Celtis laevigata), giant reed (Arundo donax), Bermuda grass (Cynodon dactylon), Texas persimmon (Diospyros texana), ligustrum (Ligustrum lucidum), Johnsongrass (Sorghum halepense), sideoats grama (*Bouteloua curtipendula*), verbena (Verbena spp.), Texas wintergrass (*Nassella leucotricha*), buffalo grass(*Bouteloua dactyloides*), American sycamore (*Platanus occidentalis*), thistle (*Cirsium horridulum)*, prickly pear (Opuntia engelmannii), and twisted leaf yucca (Yucca rupicola).

The vegetation within the potential herbaceous wetland includes spikerush (Eleocharis palustris), bushy bluestem (Andropogon glomeratus), Roosevelt weed (Baccharis neglecta), and sumpweed (Iva annua).

According to the U.S. Fish and Wildlife Service (USFWS), the golden-cheeked warbler (Dendroica chrysoparia) and black-capped vireo (Vireo atricapilla) are listed as endangered species in Kerr County. Tobusch fishhook cactus

(Ancistrocactus tobuschii) is listed as an endangered flowering plant in Kerr County. No Tobusch fishhook cactus was seen along the proposed pipeline route. Black-capped vireos prefer habitat with young, semi-open stands of small trees and shrubs separated by open grasslands. This type of habitat was not observed within the project site. The golden-cheeked warbler resides in habitats consisting mainly of dense, mature Ashe juniper mixed with various oak species. This woodland habitat grows on limestone hills, canyons, and adjacent canyons. Habitat suitable for the golden-cheeked warbler has not been observed within the project site. In reference to the USFWS critical habitat mapper, there is no designated critical habitat in Kerr County.

Potential Section 404 impacts for the proposed project include: stream impacts to stream 1 and Third Creek, herbaceous wetland impacts, and open water impacts. All of these potential impacts would be avoided in the conceptual reuse pond project proposed in this report.

In 2001, a critique of compensatory mitigation by the National Research Council (NRC) concluded that third-party compensatory mitigation such as mitigation banks offer advantages over permittee-responsible mitigation in the fulfillment of regulatory goals. One such advantage identified by NRC is the consensus-driven, interagency review process used to approve banks. NRC noted that banks are more likely than traditional compensatory mitigation to achieve desired long-term outcomes and to create mitigation sites that are protected in perpetuity by organizations dedicated to resource conservation.

If the proposed impacts to Third Creek would require temporarily dewatering any portion of the waterway a Aquatic Resource Protection Plan is required to be approved by Texas Parks and Wildlife Department. This plan would detail the limits of dewatering (temporal and geographic), techniques for aquatic vertebrate removal and relocation, and habitat restoration.

Coordination with the Texas Historic Commission (THC) would be required if greater than 5,000 cubic yards of material were moved or more than five acres of area were disturbed. A letter with the project description and location could be sent to THC requesting their opinion as to the archeological requirements for the project. THC will respond with information concerning whether or not an archeological survey will need to be performed. Due to the existing disturbance and history of extensive use within the area the project may receive a "Project may proceed, no additional survey required" for the proposed activities.