Ecological Resource Consultants, Inc.
5672 Juhls Drive ~ Boulder, CO ~ 80301 ~ (303) 679-4820

Date: April 25, 2014

To: Town of Erie, Community Development Department – Planning Division
645 Holbrook Street
PO Box 750
Erie, Colorado 80516

Project: **Development Report**
Threatened and Endangered Species, Habitat, and Wetlands Review
Flatiron Meadows Development Project, Preliminary Plat, Amendment No. 2
Erie, Colorado 80516

Ecological Resource Consultants, Inc. (ERC), on behalf of Calibre Engineering (Project Engineer), provides this summary letter to address Threatened and Endangered Species, Habitat, and Wetlands for the Flatiron Meadows Development, Preliminary Plat, Amendment No. 2 (Project) to ensure compliance with the subdivision standards and requirements set forth in Municipal Code, Title 10, Chapter 6, Subdivision Design and Improvements, of the Unified Development Code and in accordance with the Preliminary Plat-User's Guide (February 5, 2008) specifically, Section 10.f.

The Project is generally located southeast of the intersection of Erie Parkway and North 111th Street in Section 23 and 26, Township 1 North, Range 69 West, west of Erie, Boulder County, Colorado, (**Latitude 40.029756 ° North, Longitude -105.092345° West**) (Site). The Site is bound by Leyner Cottonwood #1 Ditch on the north, Prince Tributary to the east, agricultural fields and North 111th Street to the west and Prince Lake Reservoir to the south. The total area of the Site is approximately 50 acres (**Figures 1 and 2**).

The following is a summary of the studies completed for the Project that address threatened and endangered species, habitat, and wetlands.

Flatirons Meadows Filings 1-3 Screening Report for Federal and State Threatened and Endangered Species, ERC, April 26, 2012
ERC completed a Screening Report for Federal and State Threatened and Endangered Species (April 26, 2012) which specifically included the proposed 50 acre Site. The report detailed the results of a field inspection and screened the Site for potential habitat for both state listed and federally listed threatened and endangered species. The report concluded the following key items:

1. Current and historic land use practices have significantly limited the establishment of natural vegetation communities within the Site. The vegetation community specifically within the 50 acre Site appears to be entirely comprised of winter wheat agricultural land.

2. Some migratory birds likely utilize the Site. These birds are protected under the Migratory Bird Treaty Act (MBTA), and killing or possession of these birds is prohibited. Generally, the active nesting season for most migratory birds in this region of Colorado occurs between April 1 and

August 15. Any future land use changes that may occur within the Site that remove vegetation during the active nesting season should first ensure that active nests are not disturbed.

Raptor nest sites are further protected by the Colorado Parks and Wildlife (CPW). The CPW has established recommended buffer zones and seasonal activity restrictions for a variety of Colorado raptors. The April 26, 2012 screening report identified an active red-tailed hawk (*Buteo jamaicensis*) nest offsite but within the 1/3 mile recommended buffer of the nest. A follow-up nest clearance survey was completed by ERC and is summarized in a Technical Memorandum dated January 21, 2014 (Flatiron Meadows Project Site-Nest Clearance Survey). The survey was conducted in order to determine if the previously identified raptor nest on the Flatiron Meadows property is currently active or if any new active raptor nests are present. Specifically, two red-tail hawk nests were evaluated for evidence of active nest use. The survey determined that:

- No active raptor nests, specifically red-tail hawk, are located within the Site.
- Based on the CPW (2008) Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors, the time period that is critical to the nesting of red-tail hawks is between February 15 and July 15. Any vegetation removal should occur before February 15. A clearance survey should always be conducted within 1-2 weeks of removal of any nest (or vegetation) to ensure no activity is present.
- No further CPW review or clearance was obtained for the property as no active raptor nests or buffer zones were determined to be present at the time of the survey.

3. Federal or state listed threatened and endangered species and/or habitat protected under the Endangered Species Act (ESA) does not exist within the proposed 50 acre Site. The agricultural land within the Site was investigated as potential habitat for federal or state listed threatened and endangered species. Potential habitat was found to lack one or more habitat components critical for the federal or state listed species to likely occur in the area. Furthermore, connectivity to known populations was limited due to geographic, hydrologic, and other habitat constraints. No individuals or habitat for federally or state listed threatened and endangered species would likely be impacted by any future land use changes.

4. Any future project which may be water related or determined to be a water depletion to the South Platte River Basin may potentially be considered an adverse effect to water depletion species. Generally non-water dependent projects such as residential or commercial developments (which are supplied by municipal water) are not considered water depletions and is therefore not likely to adversely affect the continued existence or available habitat of these species. The specific details of a future project must be reviewed to determine water depletion status.

➨ In a letter dated May 18, 2012 the US Fish and Wildlife Service (USFWS) concurred that federally-listed threatened or endangered species are not likely to be present on or within the Site. Therefore, the proposed Project is not likely to directly affect federally-listed species (**Attachment A**).

Wetland Delineation Report for the Flatirons Meadows Filings 1-3, ERC, January 15, 2013

ERC completed a Wetland Delineation Report (January 15, 2013) which specifically included the proposed 50 acre Site (**Figure 3**). The report detailed the results of a field inspection that screened the Site (and adjoining land offsite) for potential waters of the US, including wetlands. The wetland conclusions were made specific to the Site:

1. A portion of one delineated feature (Wetland Area 4) is located within the 50 acre Site boundary. The delineated habitat within the Site comprises approximately 1.66 acres and is characterized as Palustrine emergent (PEM) wetland adjacent to Prince Tributary. Prince Tributary is located offsite however borders the eastern boundary of the Site flowing from south to north. Wetland Area 4 within the Site and the nearby Prince Tributary were determined to be likely jurisdictional under Section 404 of the Clean Water Act (CWA) based on connectivity to other downstream waters. All other land within the Site was determined to be upland.

    - Based on available mapping from the Project Engineer, the wetland area is located outside of the proposed development (**Figure 3**) therefore no impacts to waters of the US, including wetlands are anticipated to occur from the proposed Project.

2. Other potentially jurisdictional waters of the US including wetlands were delineated immediately outside of the Site boundary such as Leyner Cottonwood Ditch to the north of the Site and Prince Tributary to the east.

3. The wetland delineation report was submitted to the US Army Corps of Engineers (USACE) for verification of mapping and approved jurisdictional determination (JD).

➨ In a letter dated May 3, 2013 (USACE File No. 199880700), the USACE concurred with the ERC Wetland Delineation Report (January 15, 2013) which determined Wetland Area 4, specifically 1.66 acres within the Site, to be jurisdictional and regulated under Section 404 of the CWA. No other waters of the US including wetlands were identified within the Site. Other jurisdictional waters of the US were also identified offsite associated with Leyner Ditch to the north and Prince Tributary to the east. Refer to **Figure 3** for a map which depicts the jurisdictional wetland habitat within the Site based on the January 15, 2013 wetland delineation. A copy of the USACE approved JD letter (dated May 3, 2013) is provided in **Attachment B.**

SUMMARY OF FINDINGS

The occurrence of threatened and endangered species, habitat, and wetlands has been assessed at the Site in accordance within Section 10.f of the Preliminary Plat-User's Guide. Field investigations have found no threatened and endangered species, habitat, on the Site as confirmed by the USFWS (**Appendix A**). Moreover, further Site investigation has determined that no active raptor nests or buffer zones are present within the Site therefore no additional CPW clearance was obtained for the Site.

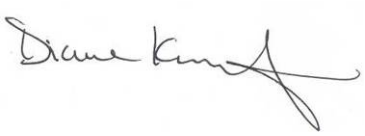
A portion of one wetland feature (1.66 acres total) that was determined to be jurisdictional waters of the US as part of the approved JD (USACE letter dated May 3, 2013) (**Attachment B**) appears to be located within the specific 50 acre Site boundary. Based on available mapping from the Project Engineer,

the wetland area is located outside of the proposed development therefore no impacts to waters of the US, including wetlands are anticipated to occur from the proposed project.

If you have any questions or require additional information please feel free to contact me.

Sincerely,

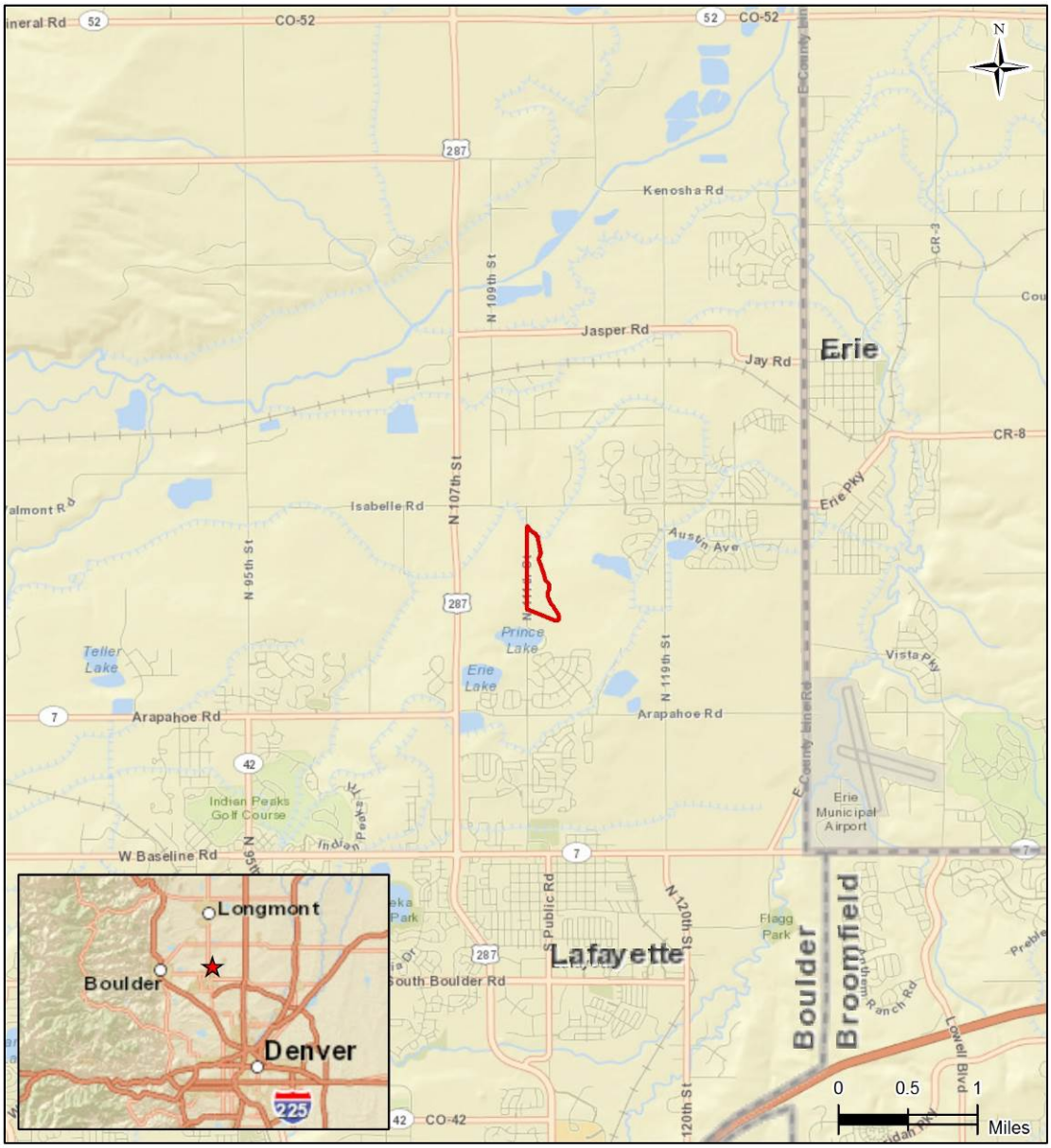
ECOLOGICAL RESOURCE CONSULTANTS, INC.



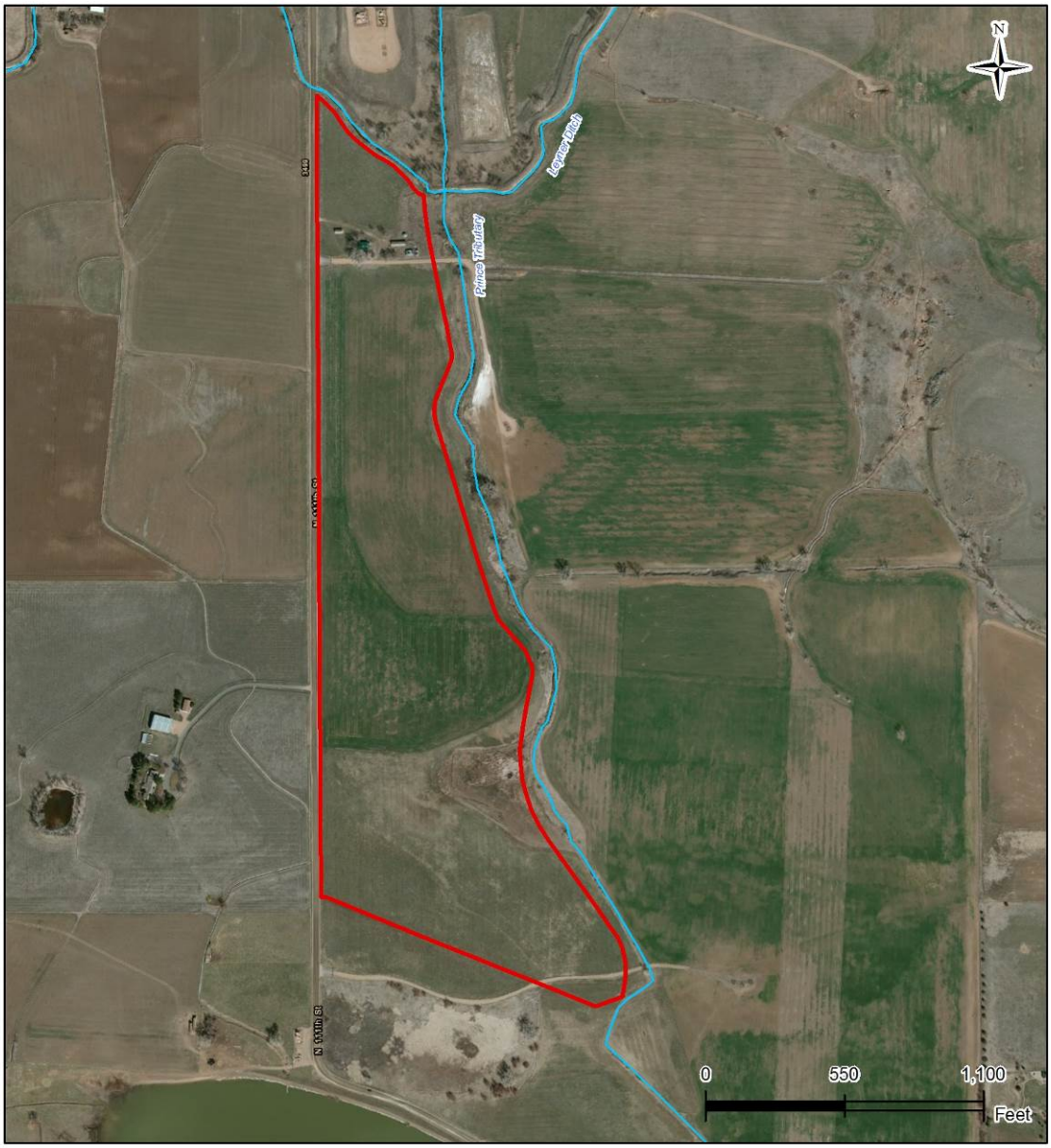
Diane Krzysztof, Ecologist, PWS

Reviewed and approved by:

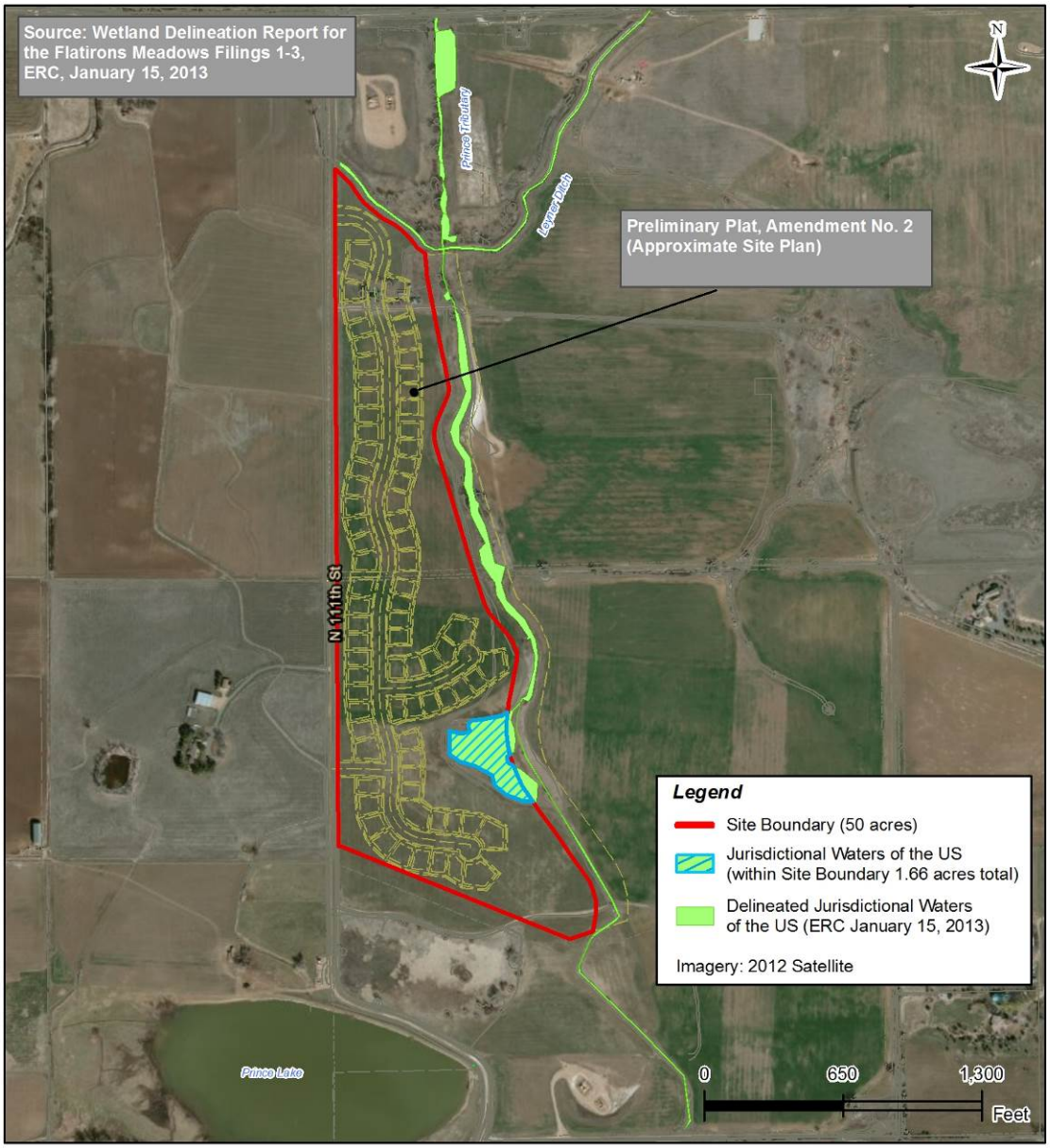
David J. Blauch, V.P., Senior Ecologist



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 1** **VICINITY MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Project Location Site Boundary *Prepared for:* *Calibre Engineering* *April 25, 2014*



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 2** **SITE MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Site Boundary Imagery: 2012 Satellite *Prepared for:* *Calibre Engineering* *April 25, 2014*



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 3** **WATERS OF THE US** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	*Prepared for:* *Calibre Engineering* *April 25, 2014*

ATTACHMENT A

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Colorado Field Office
P.O. Box 25486, DFC (65412)
Denver, Colorado 80225-0486

IN REPLY REFER TO:
ES/CO: T&E/Concurrence
TAILS: 06E24000-2012-TA-0488

MAY 18 2012

Dan Morta
Ecological Resource Consultants, Inc.
5672 Juhls Drive
Boulder, Colorado 80301

Dear Mr. Morta:

The U.S. Fish and Wildlife Service (Service) received your letter of May 9, 2012, and accompanying report of April 26, 2012, regarding the Flatirons Meadow, Filings 1-3 property located in Erie, Boulder County, Colorado (Sections 23 and 26, Township 1 North, Range 69 West). You requested concurrence that future land use changes on the property associated with a proposed residential development are not likely to adversely affect federally-listed threatened or endangered species. The following comments have been prepared based on the authority conferred to the Service by the Endangered Species Act of 1973 (ESA), as amended (50 CFR §402.14), and the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703).

The site of the proposed development covers approximately 369 acres, with 85 percent of the area in agricultural fields. Also present are a home site, the former Elmwood Reservoir (now decommissioned), the Leyner Ditch, an unnamed drainage, and low depressions that may support wetlands. Based on the information and analysis you have provided regarding the habitats present, the Service concurs with your conclusion that federally-listed threatened or endangered species are not likely to be present on the site and, therefore, the proposed project is not likely to directly affect federally-listed species.

However, as acknowledged on page 5 of your report, actions with a Federal nexus that result in depletions to flows in the Platte River system may require consultation under section 7 of the ESA, since they are likely to adversely affect listed species and designated critical habitat in the central Platte River in Nebraska. You conclude that "the proposed project is not anticipated to be considered a water deletion (*sic*) to the Platte River Basin and is therefore not likely to adversely affect the continued existence or available habitat of these species." Be aware that a wide range of project elements could be associated with depletions to the Platte River system, including, but not limited to, ponds (detention/recreation/irrigation storage), lakes (recreation/ municipal storage/power generation), reservoirs (recreation/ irrigation storage/ municipal storage/ power generation), pipelines, wells, diversion structures, and water treatment facilities. We have received no development plans for the site, do not know which if any of these elements may be proposed, and therefore have no basis to concur with your conclusion that

Approximate SITE BOUNDARY

TAKE PRIDE® IN AMERICA

depletions will not likely occur. If a Federal agency is associated with the proposed project (e.g., the U.S. Army Corps of Engineers (Corps) under section 404 of the Clean Water Act) and the Federal agency and the applicant determine that there are depletions associated with the project, the Federal agency should request initiation of formal section 7 consultation in a letter to this office.

Regarding wetlands on site, an 8-acre depression located in the southwest portion of the property in close proximity to Prince Lake #2 (which is just off of the site) and an area along the natural drainage just to the northeast appears to support significant area of wetlands. While these wetlands may or may not fall under Corps jurisdictional, we urge that development plans avoid adverse impact to wetlands and wildlife habitat present on this portion of the site.

Lastly, on pages 3 and 4 of your report you address MBTA concerns and cite Colorado Division of Parks and Wildlife (CPW) suggested buffer zones and seasonal restrictions for raptor nests. You further discuss "negotiations" with the Service to modify CPW-recommended buffers. To clarify our position, the Colorado Ecological Services Field Office is in general agreement with CPW over their raptor protection guidance. While we acknowledge that some human activities inside CPW recommended buffers may have no effect on nesting raptors, we can provide no assurance as to how individual raptors will respond or preclude potential liability under MBTA for human activities occurring near a nest.

If the Service can be of further assistance, please contact Peter Plage of this office at (303) 236-4750 or, for issues regarding Platte River depletions, Sandy Vana-Miller at 303-236-4748.

Sincerely,

Susan C. Linner
Colorado Field Supervisor

pc: COE, Littleton, CO
ec: Plage
Vana-Miller

Pplage:T&E\2012.09:051712

ATTACHMENT B

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
DENVER REGULATORY OFFICE, 9307 SOUTH WADSWORTH BOULEVARD
LITTLETON, COLORADO 80128-6901

May 3, 2013

Mr. Dan Morta
Ecological Resource Consultants, Inc.
35715 US Hwy 40, Suite D204
Evergreen, CO 80439

RE: Flatiron Meadows Filings 1-3 Area 5, Approved Jurisdictional Determination
Corps File No. 199880700

Dear Mr. Morta:

Reference is made to the above-mentioned project located at 40.024267; -105.0909005, Boulder County, Colorado.

This site has been reviewed in accordance with Section 404 of the Clean Water Act under which the U.S. Army Corps of Engineers regulates the discharge of dredged and fill material and certain excavation activities in waters of the United States. Waters of the U.S. may include ephemeral, intermittent and perennial streams, their surface connected wetlands and adjacent wetlands and certain lakes, ponds, drainage ditches and irrigation ditches that have a nexus to interstate commerce.

An approved jurisdictional determination (JD) has been completed for this project. The JD is attached to this letter. If you are not in agreement with the JD decision, you may request an administrative appeal under regulation 33 CFR 331, by using the attached Appeal Form and Administrative Appeal Process form. The request for appeal must be received within 60 days from the date of this letter. If you would like more information on the jurisdictional appeal process, contact this office. It is not necessary to submit a Request for Appeal if you do not object to the JD.

Wetland areas 1A, 1B, 2, 3 and 4, Including the Leyner Cottonwood No. 1 Ditch were determined to be jurisdictional and are regulated under Section 404 of the Clean Water Act. Isolated Wetland Area 5 was determined to be non-jurisdictional and is not regulated under Section 404 of the Clean Water Act.

Those aquatic resources that were determined to be jurisdictional are known as "Waters of the United States" and are regulated under Section 404 of the Clean Water Act. Any placement of fill material into these aquatic resources would require a Department of the Army permit prior to impacts.

If any work associated with this project requires the placement of dredged or fill material, and any excavation associated with a dredged or fill project, either temporary or permanent, in Wetland areas 1A, 1B, 2, 3 and 4, Including the Leyner Cottonwood No. 1 Ditch, this office should be notified by a proponent of the project for Department of the Army permits or changes in permit requirements pursuant to Section 404 of the Clean Water Act.

Work in jurisdictional aquatic sites should be shown on a map identifying the latitude, longitude and County of the work and the dimensions of work in each area. Any loss of wetlands may require mitigation. Mitigation requirements will be determined during the Department of the Army permitting

review.

This JD is valid for a period of five years from the date of this letter, unless new information warrants revisions of the JDs before the expiration date, or unless the Corps has identified, after a possible public notice and comment, that specific geographic areas with rapidly changing environmental conditions merit re-verification on a more frequent basis.

The Omaha District, Regulatory Branch is committed to providing quality and timely service to our customers. In an effort to improve customer service, please take a moment to complete our Customer Service Survey found on our website at http://per2.nwp.usace.army.mil/survey.html. If you do not have Internet access, you may call and request a paper copy of the survey that you can complete and return to us by mail or fax. (Completing the survey is a voluntary action)

If there are any questions call **Mr. Terry McKee** of my office at **303-979-4120** and reference **Corps File No. 199880700**.

Sincerely,

Timothy T. Carey
Chief, Denver Regulatory Office

tm

Ecological Resource Consultants, Inc.
5672 Juhls Drive ~ Boulder, CO ~ 80301 ~ (303) 679-4820

Date: April 25, 2014

To: Town of Erie, Community Development Department – Planning Division
645 Holbrook Street
PO Box 750
Erie, Colorado 80516

Project: **Development Report**
Cultural, Archeological, and Historical Review
Flatiron Meadows Development Project, Preliminary Plat, Amendment No. 2
Erie, Colorado 80516

Ecological Resource Consultants, Inc. (ERC), on behalf of Calibre Engineering (Project Engineer), provides this summary letter to address cultural, archeological, and historical resources for the Flatiron Meadows Development, Preliminary Plat, Amendment No. 2 (Project) to ensure compliance with the subdivision standards and requirements set forth in Municipal Code, Title 10, Chapter 6, Subdivision Design and Improvements, of the Unified Development Code and in accordance with the Preliminary Plat-User's Guide (February 5, 2008) specifically, Section 10.g.

The Project is generally located southeast of the intersection of Erie Parkway and North 111th Street in Section 23 and 26, Township 1 North, Range 69 West, west of Erie, Boulder County, Colorado, (**Latitude 40.029756 ° North, Longitude -105.092345° West**) (Site). The Site is bound by Leyner Cottonwood #1 Ditch on the north, Prince Tributary to the east, agricultural fields and North 111th Street to the west and Prince Lake Reservoir to the south. The total area of the Site is approximately 50 acres (**Figures 1 and 2**).

The following is a summary of the studies completed for the Project that address cultural, archeological, and historic resources at the Site:

Flatirons Meadows Regional Drainage Improvements, Cultural Resources Report, Boulder County, Colorado, A & B Cultural Consultants, LLC, March 2014
A&B Cultural Consultants, LLC completed a cultural resources survey (March 2014) which specifically included the proposed 50 acre Site (**Figure 3**). The survey comprised a file search, literature review and reconnaissance-level cultural resources investigation. The report concluded the following key items:

1. The records review indicated the presence of two potential historic sites in the vicinity of the proposed 50 acre Site: a segment of the Leyner-Cottonwood No. 1 Ditch (**5BL862.11**) the Meadow Sweet Farm (**5BL.6886**).

2. The evaluated Site **5BL.862.11** is located offsite, along the northern Site boundary, and comprises a segment the Leyner-Cottonwood No. 1 Ditch that extends from North 111th Street west to Erie Parkway. It represents and is associated with the early growth of irrigation in the region and is thus recommended eligible under Criteria a. On the whole, it appears that there is sufficient integrity for this segment to convey its significance as a representative element of a

significant irrigation system in northeastern Colorado. Therefore, the cultural resource report recommended that the Leyner-Cottonwood No. 1 Ditch segment (**5BL862.11**) be considered to retain sufficient integrity to support the eligibility of the entire ditch of which it is a part and for which there is no official determination, but which nonetheless appears to be eligible.

3. Site **5BL.6886** is located within the 50 acre Site (refer to **Figure 3**) and is comprised of the ruins of a farmstead that at the time of recordation in 1996 had four standing structures and a small shed remaining. These structures were still standing at the time of the current investigation, but have suffered significant deterioration in the intervening years. The site has been determined not eligible for listing in the National Register of Historic Places (NRHP) by the Bureau of Reclamation and the SHPO has concurred with this. A reconnaissance survey of the Site confirmed that no changes in the condition of the farmstead (site **5BL.6886**) were observed such that it would warrant a reevaluation. Therefore, the cultural resource report recommended the farmstead (site **5BL.6886**) as not eligible.

4. A reconnaissance survey of the entire 50 acre Site confirmed that no other above-ground historic or prehistoric resources were present.

5. The Cultural Resource Report (A&B Cultural Consultants, LLC 2014) was submitted to the SHPO for review and official determination of resource eligibility based on the report's recommendations. No official determination by the SHPO has been made to date.

6. The survey was completed in compliance with the provisions of Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 USC 470, as amended) and implementing regulations (36 CFR 800). The report complies in form and content with guidelines issued by the Colorado Historical Society, Office of Archaeology and Historic Preservation (CHS-OAHP) (2007).

SUMMARY OF FINDINGS

The occurrence of Cultural, Archaeological and Historical Resources has been assessed at the Site in accordance within Section 10.g of the Preliminary Plat-User's Guide. The Cultural Resource Report (A&B Cultural Consultants, LLC 2014) which specifically included the proposed 50 acre Site indicates that no eligible historic properties are located within the Site.

If you have any questions or require additional information please feel free to contact me.

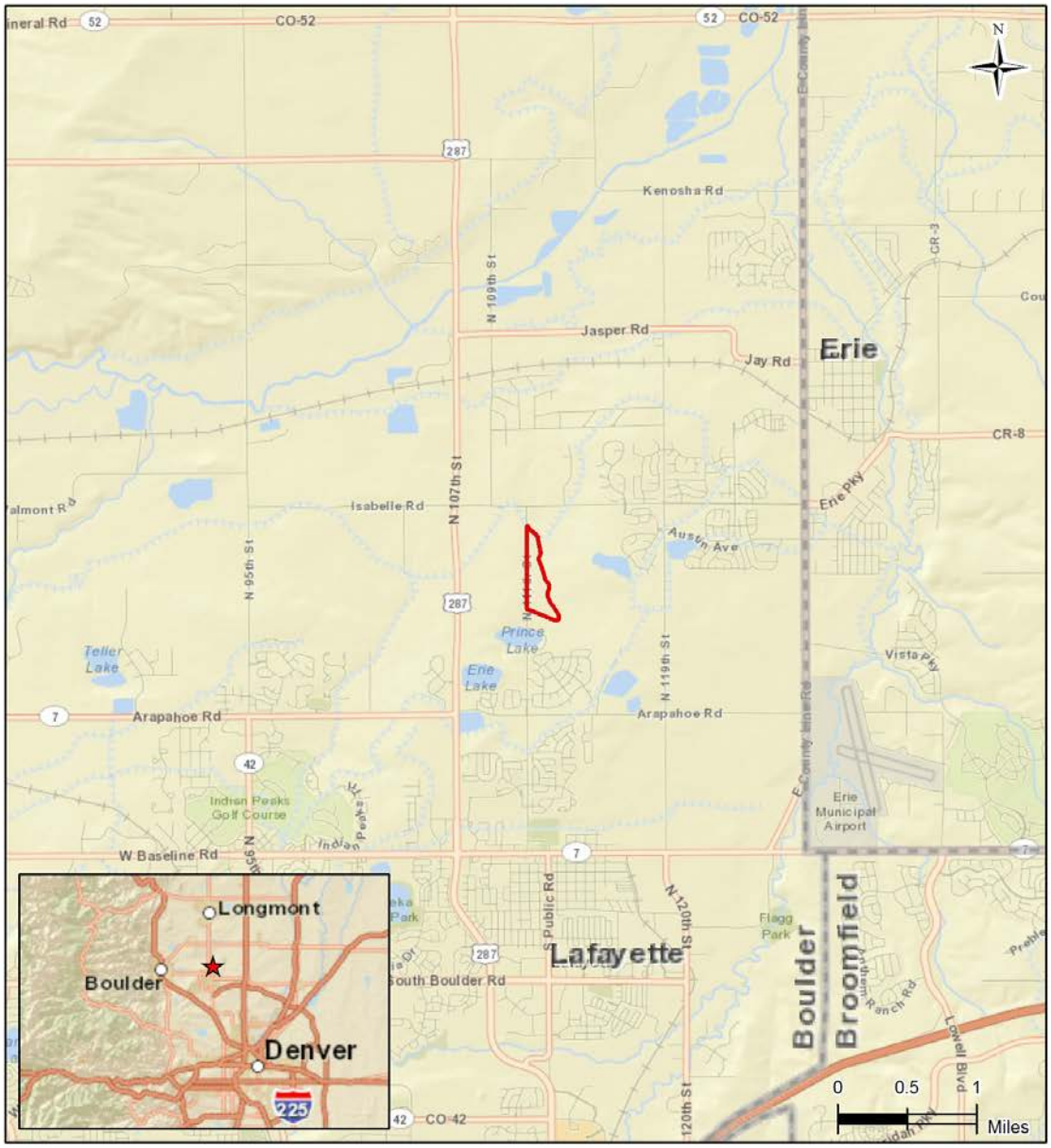
Sincerely,

ECOLOGICAL RESOURCE CONSULTANTS, INC.

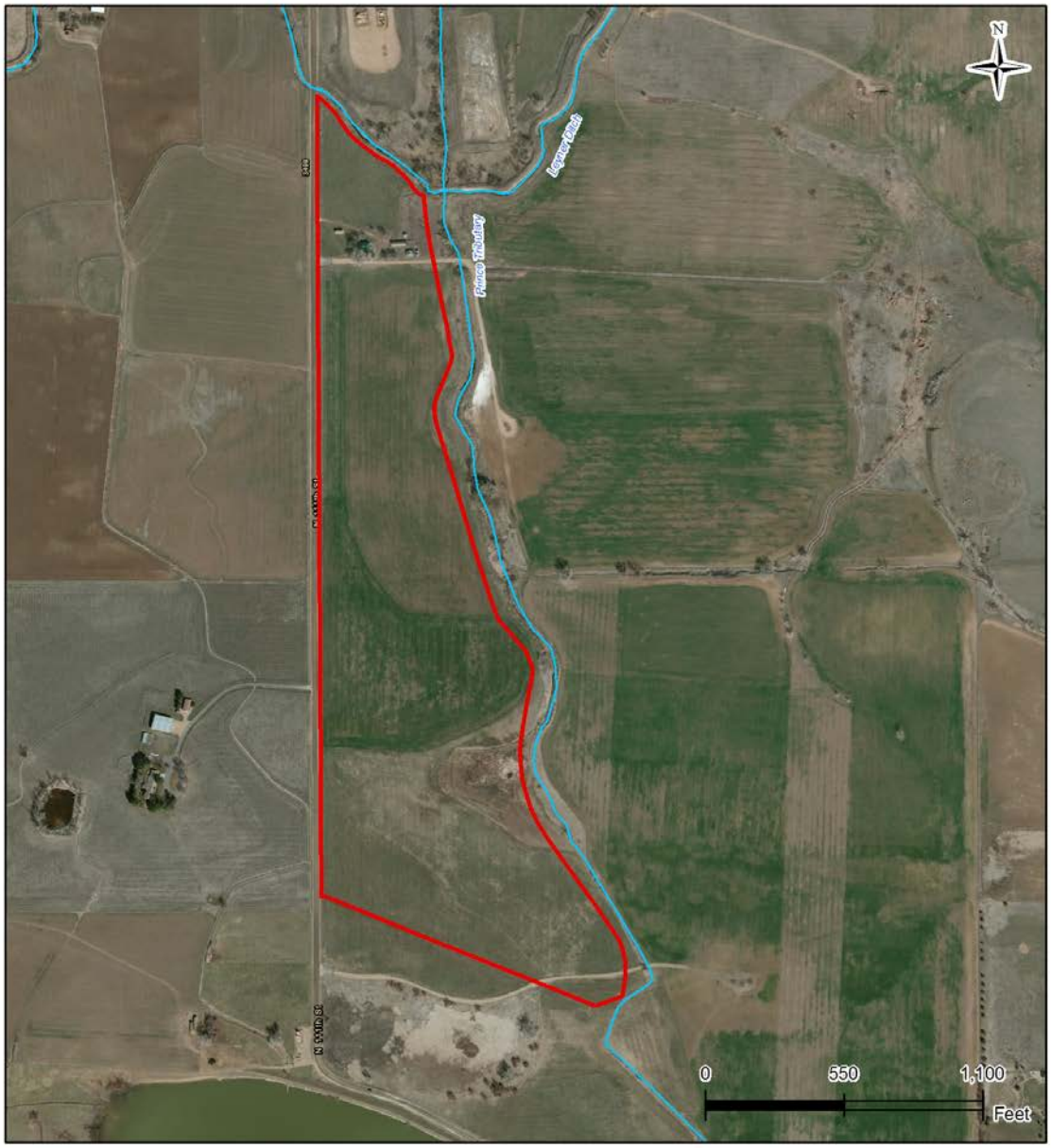
Diane Krzysztof, Ecologist

Reviewed and approved by:

David J. Blauch, V.P., Senior Ecologist



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 1** **VICINITY MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Project Location Site Boundary *Prepared for:* *Calibre Engineering* *April 25, 2014*



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 2** **SITE MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Site Boundary Imagery: 2012 Satellite *Prepared for:* *Calibre Engineering* *April 25, 2014*

Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 3** **CULTURAL RESOURCES PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Site Boundary (50 acres) Imagery: 2012 Satellite *Prepared for:* *Calibre Engineering* *April 25, 2014*

Ecological Resource Consultants, Inc.
5672 Juhls Drive ~ Boulder, CO ~ 80301 ~ (303) 679-4820

Date: April 25, 2014

To: Town of Erie, Community Development Department – Planning Division
645 Holbrook Street
PO Box 750
Erie, CO 80516

Project: **Development Report**
Native Tree and Vegetation Survey
Flatiron Meadows Development Project, Preliminary Plat, Amendment No. 2
Erie, CO 80516

Ecological Resource Consultants, Inc. (ERC), on behalf of Calibre Engineering (Project Engineer), has prepared this native tree and vegetation survey for the Flatiron Meadows Development Preliminary Plat, Amendment No. 2 (Project) to ensure compliance with the subdivision standards and requirements set forth in Municipal Code, Title 10, Chapter 6, Subdivision Design and Improvements, of the Unified Development Code and in accordance with the Preliminary Plat-User's Guide (February 5, 2008). Specifically per Section 4.b. the survey includes the following information:

1. The range of height and caliper of the trees on the site;
2. The predominant species within an area;
3. The general appearance of the trees with regard to health;
4. Identification and location of individual trees that are healthy and have a diameter at breast height ("DBH") of four inches or greater for deciduous trees, three inches or greater for ornamental trees and 8 feet high or greater for evergreen trees or that are otherwise noteworthy because of species, age, size, or rarity;
5. The species, size, and health of shrubs; and
6. Areas of native and specimen trees and vegetation.

The Project is generally located southeast of the intersection of Erie Parkway and North 111th Street in Section 23 and 26, Township 1 North, Range 69 West, west of Erie, Boulder County, Colorado, (**Latitude 40.029756 ° North, Longitude -105.092345° West**) (Site). The Site is bound by Leyner Cottonwood #1 Ditch on the north, Prince Tributary to the east, agricultural fields and North 111th Street to the west and Prince Lake Reservoir to the south. The total area of the Site is approximately 50 acres (**Figures 1 and 2**).

Method

ERC performed the tree inventory on April 17, 2014. Weather was warm and sunny and the trees were at the bud-break stage prior to leaf out. ERC inventoried each tree on the Site with a diameter of 4 inches and over by identifying the species, measuring the trunk DBH (at approximately 54 inches above the ground) using a 20 foot diameter tape, making a visual approximation of height, and evaluating the general condition of each tree. Trees that were less than 4 inches DBH were not included in the survey and are not represented on the Tree Survey Map.

Tree conditions were categorized into one of five groups: excellent, good, fair, poor or very poor. The tree condition categories are defined as follows:

Excellent – Healthy, vigorous tree.
No apparent signs of insect, disease or mechanical injury.
No corrective work required.
Form representative of the species.

Good – Better than average vigor.
Little corrective work needed.
Not quite perfect form.

Fair – Average condition and vigor for the area.
May be in need of some corrective pruning or repair.
May lack desirable form characteristics of the species.
May show minor insect injury, disease or physiological problem.

Poor – General state of decline.
May show severe mechanical, insect or disease damage.
Death not imminent.
May require major repair or renovation.

Very Poor – Includes "poor" above but is more extreme in that no amount of repair or renovation will lead to a desirable and sustainable tree. Costs would exceed any benefit.

Specific tree information is provided in **Table 1**. A Tree Survey Map (ERC April 18, 2014) was prepared on base mapping provided by the client and depicts the location of each tree and provides an identification number that corresponds to the tree described in **Table 1**. Photographs of the trees are provided in **Appendix A**.

Summary of Results

The vegetation within the Site is dominated by a variety of invasive species and grasses that are typical of fallow agricultural fields. Only one stand of trees is located within the northern portion of the Site near an abandoned farm house. No trees or shrubs occurred at any other location within the Site. In total, 10 individual trees, composed of two separate species, were identified. Species identified include: eastern cottonwood (*Populus deltoides*) and Siberian elm (*Ulmus pumila*). Most trees on the Site appear to be in fair to good condition. None of the trees appeared to be regularly maintained. Trees categorized as good were healthy with minor corrective maintenance required. Trees categorized as fair were generally healthy but exhibited pendulous branches, multiple trunks and dead branches requiring corrective pruning or repair. Trees categorized as poor displayed decay, significant dead limbs, broken limbs or substantial missing bark; in the long term, these trees may represent a potential threat to public safety or property.

The single native tree species present on the Site is eastern cottonwood. The Siberian elm is a non-native tree species.

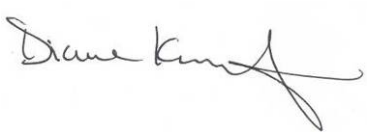
Table 1: Flatiron Meadows Development, ERC April 18, 2014 Tree Survey Results

ID #	Common Name	DBH (in)	Condition	Height	Comments or Recommendations
1	Eastern cottonwood	58.7	Good	50	- Native species - Recommend pruning
2	Eastern cottonwood	36.1	Good	50	- Native species - Recommend pruning
3	Siberian elm	5.5, 6, 8, 15, 4, 6.5	Fair	30	- Non-native species - Multiple trunks - Recommend pruning dead branches
4	Siberian elm	6, 7, 17, 8, 5.5, 5.5, 5, 5	Fair	30	- Non-native species - Multiple trunks - Recommend pruning dead branches
5	Siberian elm	6.1	Fair	20	- Non-native species - Growth constricted by abutting house (abandoned), may result in long-term tree mortality
6	Siberian elm	6, 7.8, 8, 8, 8.3, 5	Good	30	- Non-native species - Multiple trunks - Recommend pruning
7	Siberian elm	8, 7	Good	20	- Non-native species - Recommend pruning
8	Siberian elm	10.7	Good	30	- Non-native species - Recommend pruning dead branches
9	Siberian elm	8, 5, 7.5, 8, 6.5	Fair	30	- Non-native species - Multiple trunks - Recommend pruning
10	Siberian elm	5.5, 7, 15, 7.5, 17	Poor	30	- Non-native species - Multiple dead branches & decay - Recommend removal if development occurs nearby

*ID# refers to **Figure 3**: ERC Tree Survey Map in ERC Tree Survey Report (April 25, 2014).*
DBH refers to diameter at breast height measured at 54 inches above ground.
Multiple DBH values indicate tree trunk branching at measured height.
Species Names:
Eastern cottonwood *(Populus deltoides)*
Siberian elm *(Ulmus pumila)*

Report completed by:

ECOLOGICAL RESOURCE CONSULTANTS, INC.



Diane Krzysztof, Ecologist

Reviewed and approved by:

David J. Blauch, V.P., Senior Ecologist

Appendix A - Site Photos

Photo 1. Trees 1-4 from left to right. Looking northeast at abandoned residence.

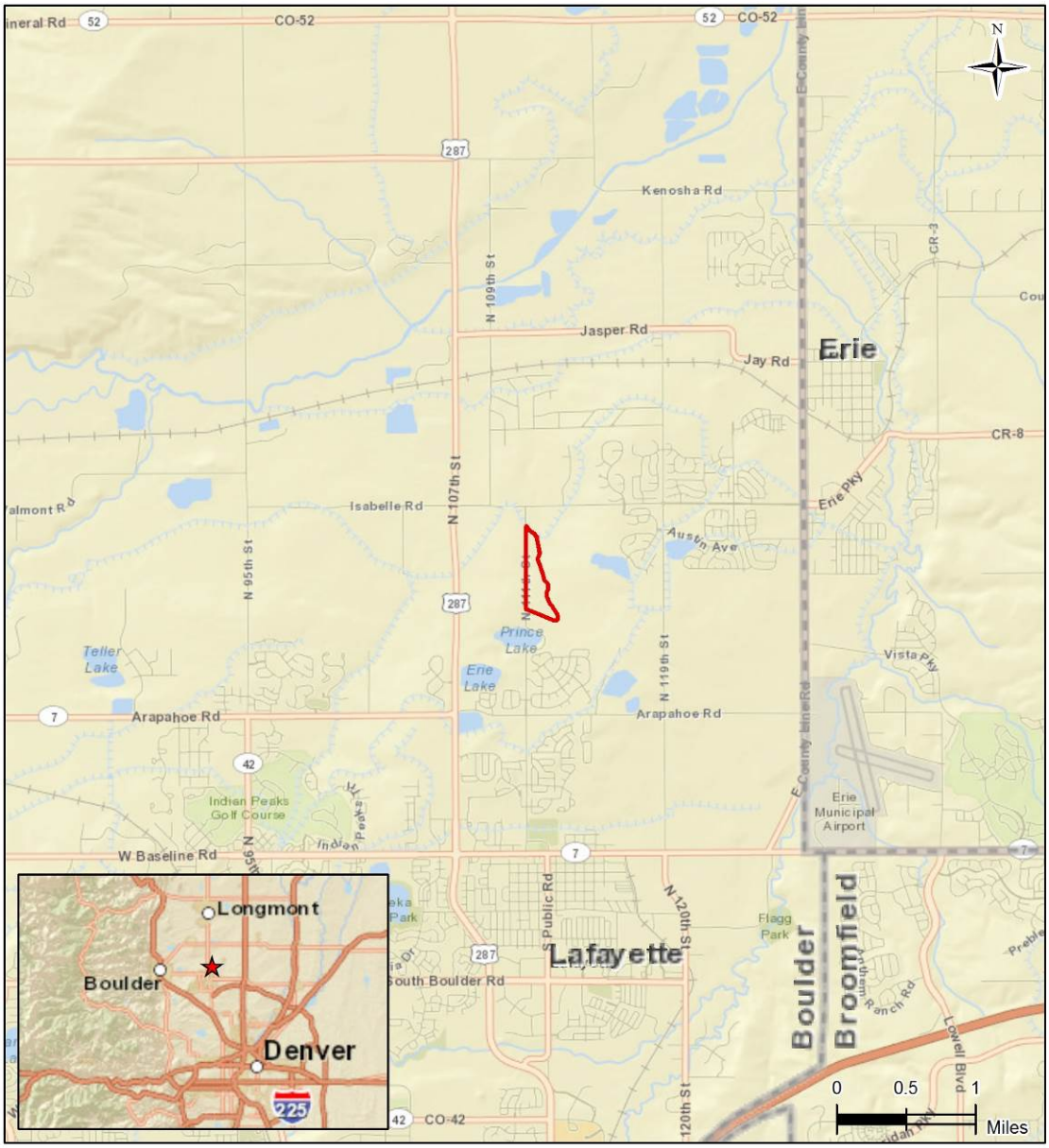
Photo 2. View west at tree 5. Growth is contricted by proximity to house.

Photo 3. View north at tree 6.

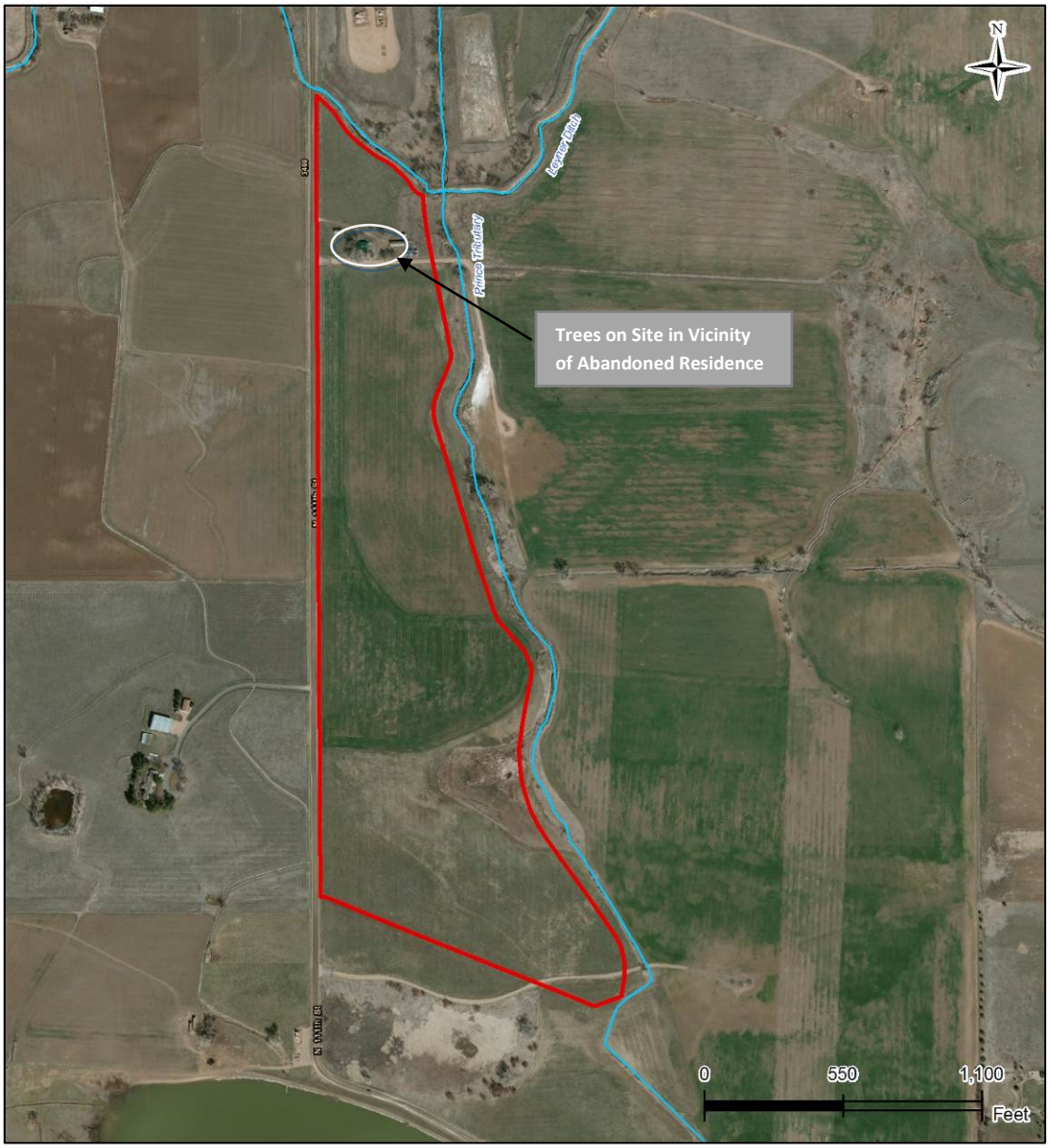
Photo 4. Looking south at trees 8-10 from left to right.

Photo 5. Tree 10. Discolored, peeling bark and dead branches indicative of decay.

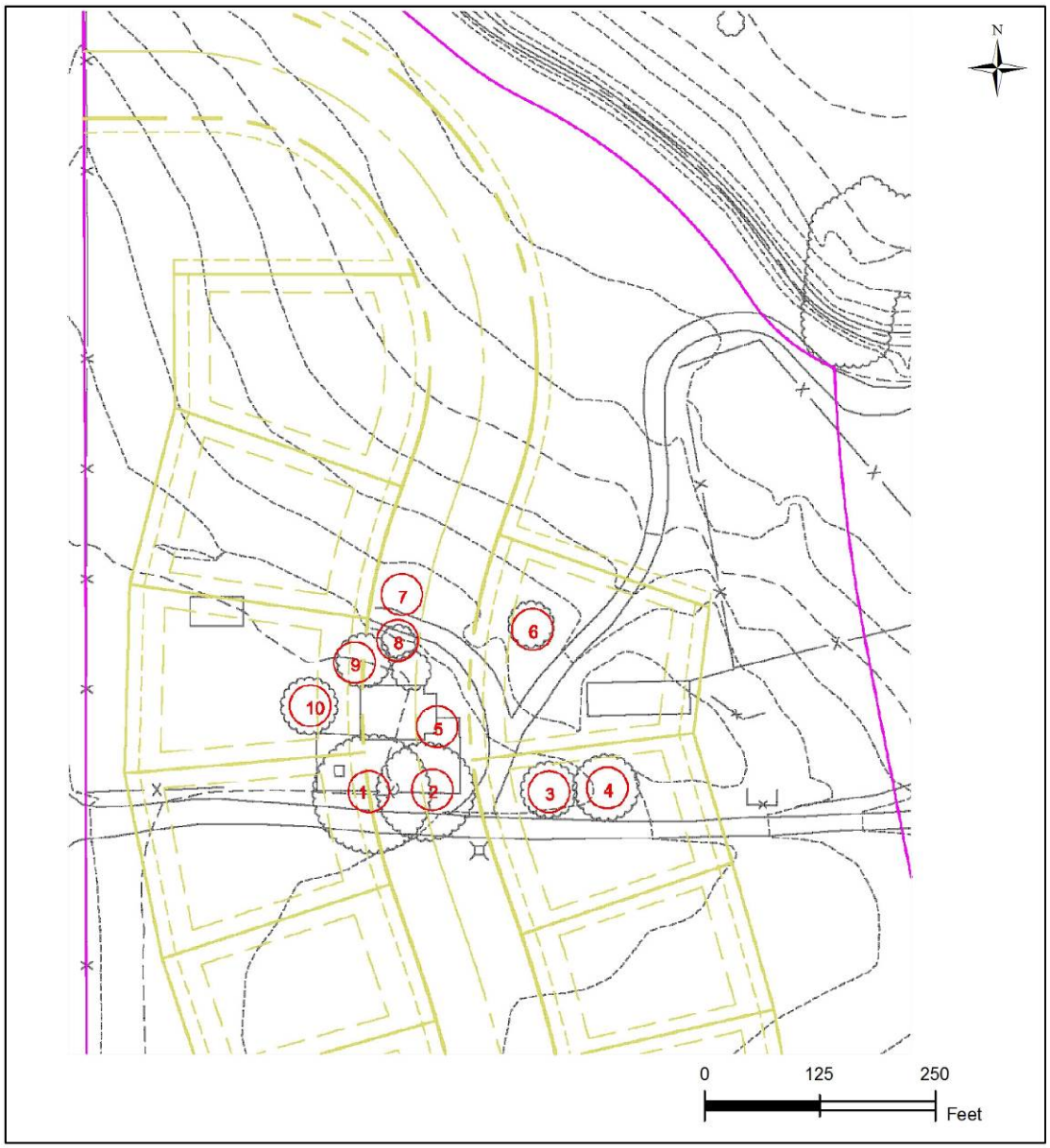
Photo 6. Tree 10. Multiple dead trunks with discoloration and insect burrows.



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 1** **VICINITY MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Project Location Site Boundary *Prepared for:* *Calibre Engineering* *April 25, 2014*



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 2** **SITE MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Site Boundary Imagery: 2012 Satellite *Prepared for:* *Calibre Engineering* *April 25, 2014*



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 3** **TREE SURVEY MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Site Boundary 1 Tree Location & ID *Prepared for:* *Calibre Engineering* *April 25, 2014*

Ecological Resource Consultants, Inc.
5672 Juhls Drive ~ Boulder, CO ~ 80301 ~ (303) 679-4820

Date: April 25, 2014

To: Town of Erie, Community Development Department – Planning Division
645 Holbrook Street
PO Box 750
Erie, Colorado 80516

Project: **Development Report**
Environmental Hazards
Flatiron Meadows Development Project, Preliminary Plat, Amendment No. 2
Erie, Colorado 80516

Ecological Resource Consultants, Inc. (ERC), on behalf of Calibre Engineering (Project Engineer), provides this summary letter to address environmental hazards for the Flatiron Meadows Development Preliminary Plat, Amendment No. 2 (Project) to ensure compliance with the subdivision standards and requirements set forth in Municipal Code, Title 10, Chapter 6, *Development and Design and Standards*, of the Unified Development Code and in accordance with the Preliminary Plat-User's Guide (February 5, 2008) specifically, Section 10(k).

The Project is generally located southeast of the intersection of Erie Parkway and North 111th Street in Section 23 and 26, Township 1 North, Range 69 West, west of Erie, Boulder County, Colorado, (**Latitude 40.029756 ° North, Longitude -105.092345° West**) (Site). The Site is bound by Leyner Cottonwood #1 Ditch on the north, Prince Tributary to the east, agricultural fields and North 111th Street to the west and Prince Lake Reservoir to the south. The total area of the Site is approximately 50 acres (**Figures 1 and 2**).

The following is a summary of the studies completed for the Project that address environmental hazards at the Site:

Limited Environmental Review, ATC Associates Inc., July 30, 2007
ATC Associates Inc. (ATC) completed a Limited Environmental Review (July 30, 2007) which included the proposed 50 acre Site (**Figure 3**). The scope of the review included a site visit, federal, state and local environmental records reviews, and a summary letter report of the findings. The Limited Environmental Review should not considered a Phase I Environmental Site Assessment as the report was not completed in accordance with ASTM E 1507-05 Standard Practice for Environmental Site Assessments: Phase I Site Assessment Process. The purpose of the Limited Environmental Review was to summarize findings at the Property since the previous Phase I Environmental Assessment conducted by ATC on February 6, 2006 and a Phase II Sub-Surface Investigation completed by ATC on March 6, 2006. The Limited Environmental Review concluded the following key items:

1. Background investigation determined that Site and adjacent land consists of a residence, outbuildings and oil production wells with associated equipment.

2. The Records Review, Section 3.0 of the report, provides a summary table of federal, state and tribal database findings. This table contains a discrepancy under the findings for two regulatory databases. The table identifies the "Property Listed" as "Yes" for State and Tribal Registered Leaking Underground Storage Tanks (LUST) (½ mile) and State and Tribal Registered Underground/Aboveground Storage Tanks (UST) / (AST) (property & adjoining). However, the corresponding column which identifies the "# Sites Listed" identifies "0" for both listings. Review of the complete regulatory agency database report in Appendix C of the Limited Environmental Review report confirms this was an error in the table and the Site was not identified in these databases.

3. Sections 3.1 and 3.2 of the Records Review summarize the databases searched stating that no sites were identified in the Federal, State and Tribal agency databases searched.

4. The Site reconnaissance (July 30, 2007) investigated all land except for the interior of the houses and sheds. The report did not note any signs of hazardous materials use or storage at the 50 acre Site during the site inspection.

5. The report noted oil production equipment (including tank batteries, pumps, high-pressure gas lines and associated piping) located offsite to the east (refer to **Figure 3**). ATC had previously performed sub-surface investigations in the vicinity of the oil production equipment to assess potential impacts. The laboratory results from the Phase II assessment conducted on March 6, 2006 indicated that the groundwater samples submitted did not contain detectable concentrations of the constituents analyzed, at the time of the sampling.

   ERC further evaluated the location of the oil production equipment in relation to the Site in a field inspection on April 17, 2014. The previously mapped oil production equipment is located offsite and downgradient thus determined not to be a potential impact to the Site.

6. ERC conducted a cursory overview of the Site (April 17, 2014) to evaluate any new changes in conditions. ERC did not identify any significant changes in landuse, obvious indications of new potential contamination, recognized environmental condition or hazardous waste on the Site.

7. The report summarized that ATC found no evidence of recognized environmental conditions at the Site. No further recommendations were offered by ATC based on the report.

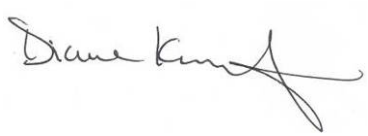
SUMMARY OF FINDINGS

A review of studies completed for the Site that address environmental hazards has been assessed in accordance with Section 10.k of the Preliminary Plat-User's Guide. The previous Limited Environmental Review report (ATC, July 30, 2007) included the entire proposed 50 acre Site. This report did not note any signs of previous or new hazardous materials use or storage within the 50 acre Site.

If you have any questions or require additional information please feel free to contact me.

Sincerely,

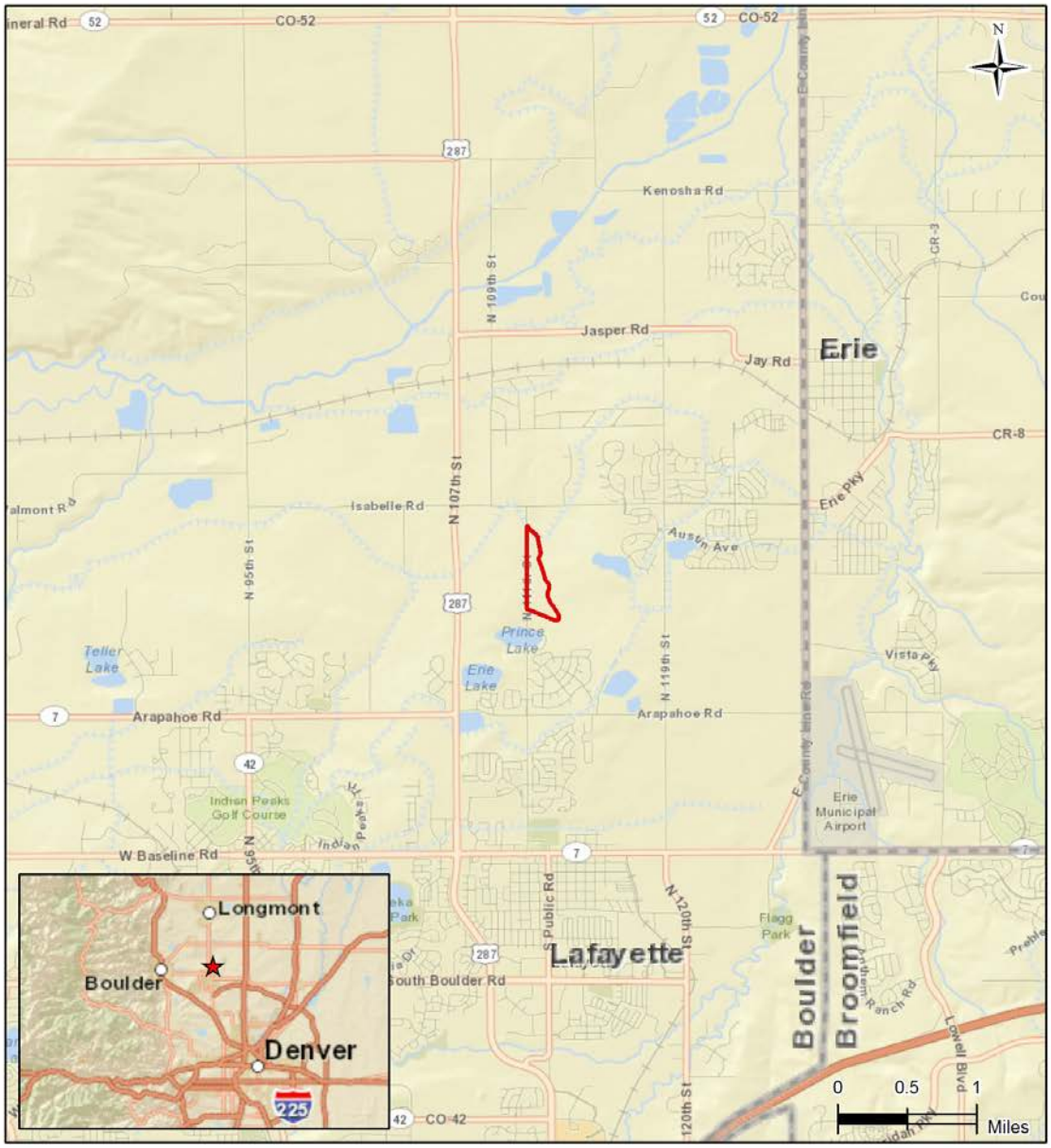
ECOLOGICAL RESOURCE CONSULTANTS, INC.



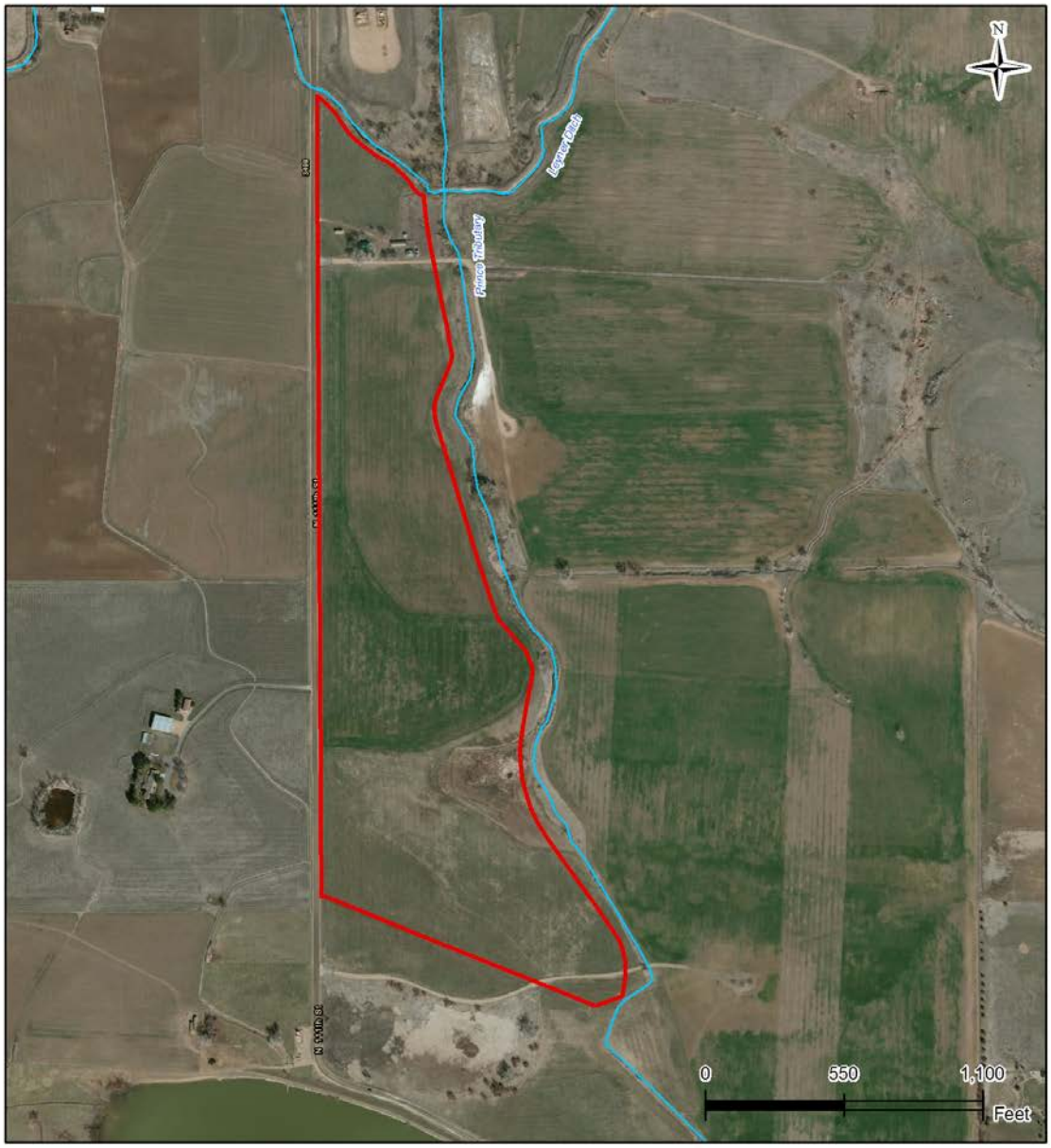
Diane Krzysztof, Ecologist

Reviewed and approved by:

David J. Blauch, V.P., Senior Ecologist

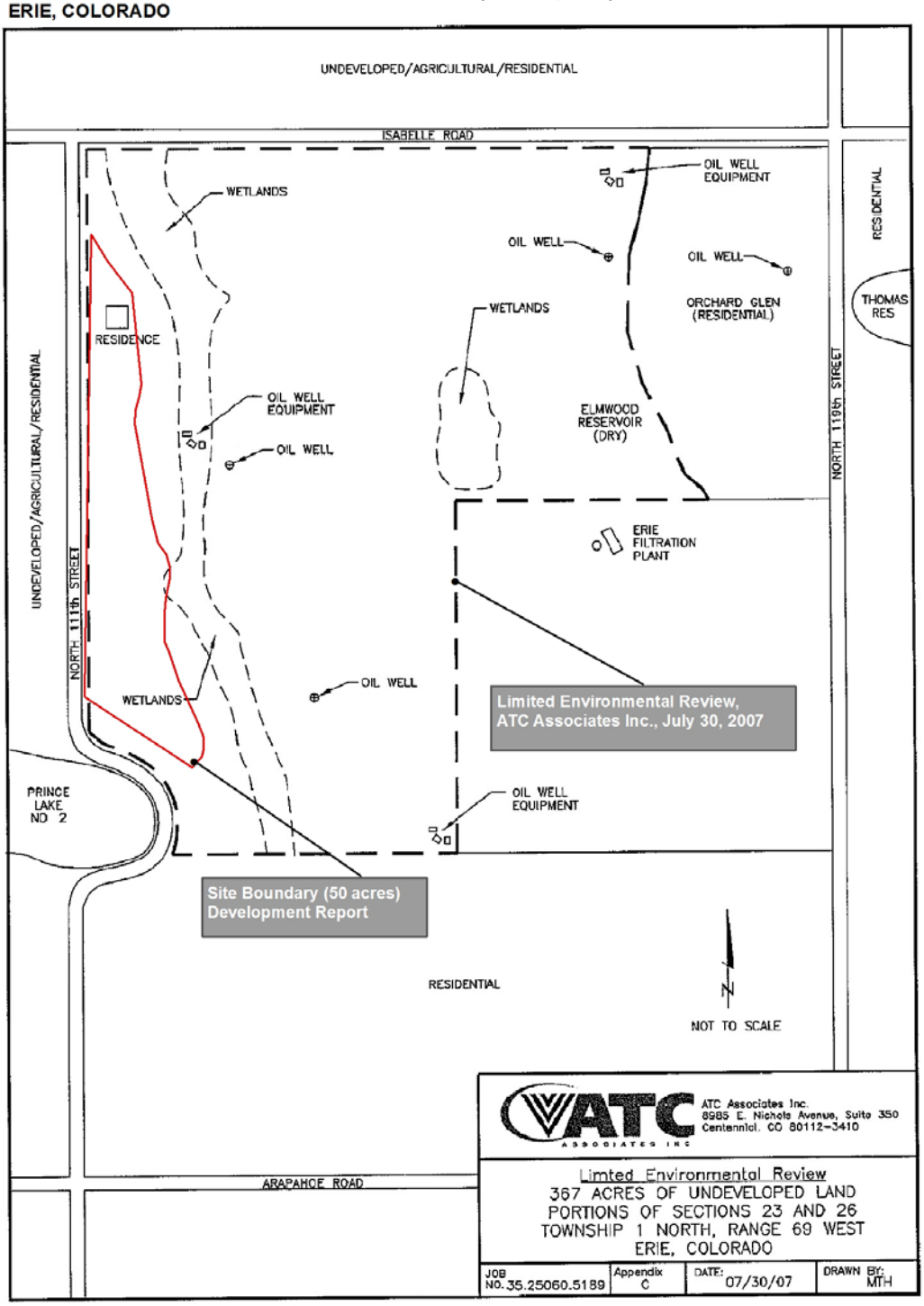


Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 1** **VICINITY MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Project Location Site Boundary *Prepared for:* *Calibre Engineering* *April 25, 2014*



Prepared By: ERC *5672 Juhls Drive* *Boulder, CO 80301* *(303) 679-4820*	**FIGURE 2** **SITE MAP** **PRELIMINARY PLAT, AMENDMENT NO. 2** **ERIE, COLORADO**	Site Boundary Imagery: 2012 Satellite *Prepared for:* *Calibre Engineering* *April 25, 2014*

FIGURE 3
SITE OVERLAY: LIMITED ENVIRONMENTAL REVIEW (JULY 30, 2007)
ERIE, COLORADO



CTL | THOMPSON INCORPORATED

PRELIMINARY GEOTECHNICAL INVESTIGATION FLATIRON MEADOWS SUBDIVISION PHASE 6A PLANNING AREAS A-H SOUTHEAST OF ERIE PARKWAY AND NORTH 111TH STREET ERIE, COLORADO

Prepared For:

HT FLATIRON LP
1515 Wynkoop Street, Suite 800
Denver, Colorado 80202

Attention: David Klebba
Chad Murphy

Project No. DN47,910-115

October 13, 2015

1971 West 12th Avenue | Denver, Colorado 80204 | Phone: 303-825-0777 | Fax: 303-825-4252 | www.ctlt.com

TABLE OF CONTENTS

SCOPE

This report presents the results of our Preliminary Geotechnical Investigation for the planned Phase 6A of development of the Flatiron Meadows Subdivision (431 single-family residences and park/drainage improvements) being considered on vacant parcels located southeast of Erie Parkway and North 111th Street in Erie, Colorado (Fig. 1). The subject areas are denoted as Planning Areas A through H. The purpose of our investigation was to evaluate the subsurface conditions to assist in due diligence and planning of site development and construction. The report includes descriptions of soil and bedrock strata and groundwater levels encountered in our exploratory borings, and discussions of site development and construction as influenced by geotechnical considerations. The scope was described in our Service Agreement (DN 15-0250) dated May 13, 2015. A Phase I Environmental Site Assessment was completed recently under our Project No. DN47,911-200 (report dated July 2, 2015). We also conducted a Limited Phase II Environmental Site Assessment under Project No. DN47,911-205 (letter dated August 3, 2015) and a Construction Dewatering Permit Application under Project No. DN47,911-210 (letter dated September 22, 2015).

This report is based on our understanding of the planned construction, subsurface conditions disclosed by exploratory drilling and sampling, site reconnaissance, results of field and laboratory tests, engineering analysis of field and laboratory data, previous investigation, and our experience with similar conditions and projects. It contains descriptions of the soil and bedrock conditions and groundwater levels found in our exploratory borings, preliminary discussions of site development, and preliminary design and construction criteria for foundations, floor systems, pavements, and surface and subsurface drainage. The discussions of foundation and floor system alternatives are intended for planning purposes only. Additional, site-specific investigations will be necessary to design

structures, pavements and other improvements. A brief summary of our conclusions and recommendations follows, with more detailed discussion in the report.

SUMMARY OF CONCLUSIONS

1. Most of the site is judged suitable for the planned development. The primary geotechnical concerns are shallow groundwater and soft/loose soils in the western portion of the site, and expansive soil and bedrock in the east-central area. We believe these concerns can be mitigated with proper planning, engineering, design and construction. We believe there are no geotechnical constraints at this site that would preclude development of the majority of the site. Planning Areas C and H appear to have shallow groundwater levels and measures will need to be taken in planning and design (such as raising site grades and/or installation of interceptor drains and grout/slurry walls) to properly develop. Because the site is zoned, we assume a mine subsidence hazard evaluation was conducted by others.

2. Strata found in our borings consisted of nil to about 7.5 feet of sandy clay fill and/or 4 to more than 35 feet of natural clay and sand underlain by weathered and comparatively unweathered claystone and sandstone bedrock. Most of the soils and bedrock samples tested were non-expansive or low swelling. Expansive claystone was found at shallow depths in TH-6 and TH-8 drilled in the east-central part of the site. Soft/loose soils were also identified in TH-2, TH-4, TH-7, TH-8, TH-9 and TH-11 through TH-21, and generally coincided with areas of shallow groundwater. Planning and design of the development should consider the impacts of expansive soil and bedrock, shallow groundwater and soft/loose soils.

3. Groundwater was encountered during drilling in nine borings at depths of about 4 to 26 feet. When the holes were checked on several occasions after drilling, water levels were measured at depths of about 2 to 23 feet or elevations 5108 to 5177.5 feet (Fig. 2). Groundwater appears to have risen significantly since AGW's 2013 investigation. Shallow groundwater will likely preclude basements in Planning Area C and possibly portions of nearby areas unless measures are taken to protect them during planning, design and construction. We recommend providing at least 3 feet, and preferably 5 feet, of separation between basement excavations and groundwater. Site grades should be raised as much as possible in shallow groundwater areas. Shallow groundwater will also compli-

cate utility installation and sub-excavation (if used), and require the use of subsurface drainage systems (interceptor drains and underdrains) to properly mitigate. Groundwater may fluctuate seasonally and rise in response to development, precipitation, landscape irrigation, and flow in nearby drainages and ditches.

4. We estimate total potential ground heave could range from less than 0.5-inch to about 5 inches considering a depth of wetting of 24 feet below existing grades. Most of the site is judged to have low risk of damage due to expansive soil and bedrock. The area of TH-8 is judged to have moderate risk and TH-6 is judged to be high risk. Drilled pier foundations bottomed in bedrock are typically recommended for sites with significant potential heave. Sub-excavation can be considered as a means to reduce potential heave and potentially allow use of shallow foundations. Fill subdrains, interceptor drains and sanitary sewer underdrains will likely be needed to control the water. We should perform additional investigation if sub-excavation is being considered. We judge potential movements for lightly loaded structures should be reduced to about 1 to 2 inches or less after sub-excavation. Settlement is possible in areas with soft/loose soils.

5. The near-surface clay soils are anticipated to possess relatively poor pavement support qualities. Sand is considered better subgrade material. Sub-excavation to depths up to 3 feet may be necessary below streets where swelling materials are present. Chemical stabilization may also be needed to reduce plasticity indices to less than 30. Local streets will need at least 6.5 inches of asphalt or an equivalent composite section of 4 inches of asphalt over 8 inches of base course. A design-level subgrade investigation should be done after site grading.

6. Control of surface drainage will be critical to the performance of foundations, slabs-on-grade and pavements. Overall surface drainage should be designed to provide rapid run-off of surface water away from structures and off pavements and flatwork. Water should not be allowed to pond near the crests of slopes, near structures or on pavements and flatwork. Conservative irrigation practices should be employed to reduce the risk of subsurface wetting.

SITE CONDITIONS

The site contains about 240 acres and is located southeast of Erie Parkway and North 111th Street in Erie, Colorado (Fig. 1 and Photo 1). According to the Boulder County Assessor, the legal description of the property is Flatiron Meadows Subdivision, Master Plat or Filing No. 4, Tracts I1, B and C. The site is bordered by Erie Parkway and residential lots on the north, vacant land and residential lots on the east, an access drive and residential development on the south, and North 111th Street on the west. Prince Lake No. 2 is across North 111th Street near the southwest corner of the site. Several drainages and ditches traverse various portions of the site. The predominant drainage (Prince Tributary) appears to initiate at the south-central end of the site via buried culvert, heads north and flows below Erie Parkway near the northwest corner of the site. A couple of small ponds or and areas with very moist soils and vegetation are present adjacent to the drainage. The Leyner Cottonwood Number 1 Ditch is present in the northwest part of the site and flows over the Prince Tributary and below Erie Parkway. Remnants of Elmwood Reservoir and a couple of ditches are present at the northeast corner of Planning Area F. Marfell Lakes and the South Boulder Canyon Ditch are about ¼-mile southeast. Erie Lake and Thomas Reservoir are about ½-mile southwest and east, respectively. Several other ponds and lakes are within about 1 mile. The ground surface is covered with grass, weeds, bushes and trees and slopes gently toward the central drainage. Overall, the terrain slopes gently to the north. Google Earth historical area photos dating back to 1993 indicate the site was used for farmland and livestock purposes. The ground surface on Planning Areas C and H (between North 111th Street and the central drainage) appear to be greener than the surrounding areas in most of the photos. An abandoned residence with two or three sheds is present in the northwest part of the site on the south side of the Leyner Cottonwood Number 1 Ditch. Oil/gas wells or facilities are present at the northwest and

southwest corners of the site and an easement traverses the central part of the site from west-to-east. We understand some water wells may also be present.

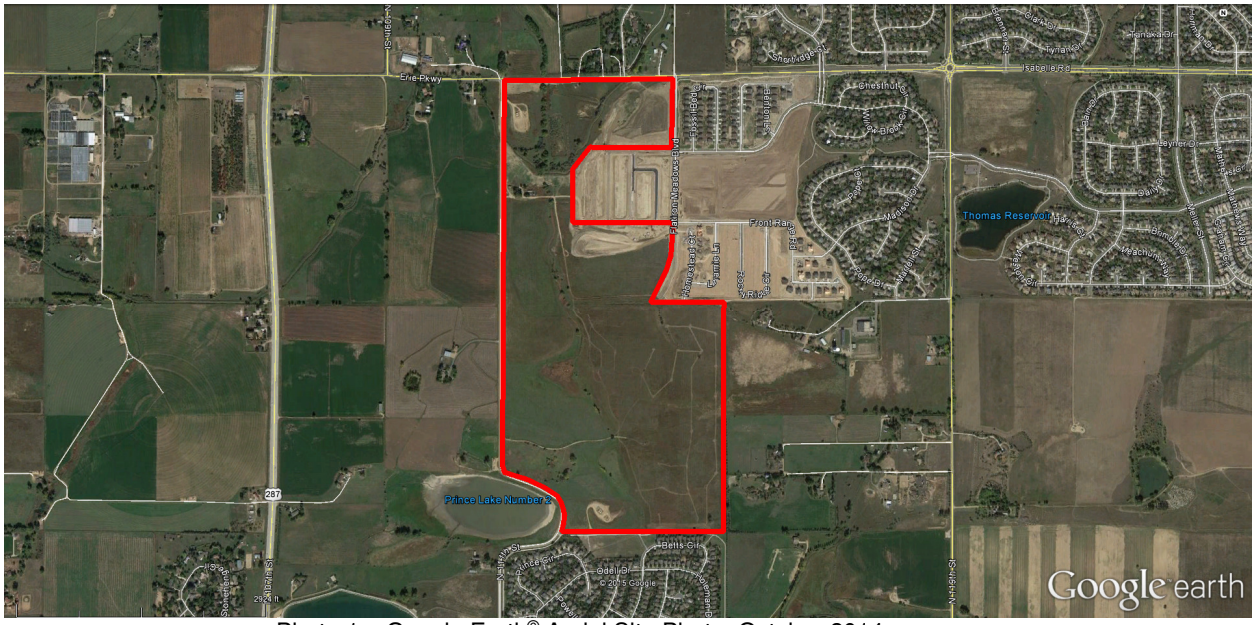


Photo 1 – Google Earth© Aerial Site Photo, October 2014

PROPOSED DEVELOPMENT

We were provided a conceptual site plan that indicates the development may consist of 431 single-family residences with attached garages serviced by buried utilities and paved roadways (Fig. 1) within Planning Areas A through H. We anticipate the residences will be one or two-story, wood-framed structures with basements or crawl spaces below the main floor levels. The residences may have partial brick or stone veneer exterior wall treatments. Regional pond and park improvements will be made in the northwestern and southwestern part of the site in Planning Area H and along the central drainage and irrigation ditch east and north of Planning Area C. Based on existing site grades, we anticipate the site grading will mostly consist of fills up to about 10 feet. Some tree removal and grubbing of existing drainages will be necessary. The existing residence and

sheds will be removed as part of construction. Water wells will need to be abandoned.

PREVIOUS INVESTIGATIONS

As part of our investigation, we reviewed a copy of a Geotechnical Site Development Study for Planning Area C prepared by A.G. Wassenaar, Inc. (AGW Project Number 133416; report dated November 12, 2013). AGW drilled and sampled 14 exploratory borings and generally found sand and clay over claystone and sandstone bedrock at depths ranging from about 18.5 to 32 feet below grade. Groundwater was measured at depths of about 3 to 20 feet. The subsurface conditions were generally consistent between our investigation and AGW's, except water levels appear to have risen significantly since 2013. Pertinent information from AGW's study were considered in preparation of this report. Their boring locations and summary logs are presented in Appendix C.

We performed a Due Diligence Geotechnical Investigation for Planning Area F under our Project No. DN47,987-115 (report dated August 24, 2015). We drilled 20 exploratory borings across the Planning Area to depths of 25 to 35 feet. We identified expansive soil and bedrock and shallow groundwater as the primary geotechnical concerns. We discussed sub-excavation of the majority the site as means to reduce potential heave and potentially allow use of footing foundations and slab-on-grade floors. It appeared the southeast corner of the Planning Area F had less potential heave risk than the remainder of the site. We recently conducted a Geotechnical Investigation for the regional pond and culvert improvements planned north of Planning Area C at the northwest corner of the site under our Project No. DN47,910-145 (report dated October 5, 2015). We drilled and sampled four exploratory borings in the pond area and found clay and sand soils, with claystone bedrock at 8 feet deep in one boring at the northeast corner

of the pond. We judged the clay and sand soils to be excavated as part of pond construction are suitable for re-use as site grading fill.

INVESTIGATION

We investigated subsurface conditions by drilling and sampling 21 widely spaced exploratory borings at the approximate locations shown on Fig. 1. Boring locations were staked and ground surface elevations provided by Calibre Engineering. Prior to drilling, we contacted the Utility Notification Center of Colorado and local sewer and water districts to identify locations of buried utilities. We drilled TH-1 through TH-10 between June 11 and 22, 2015 to depths of 17.5 to 35 feet below the existing ground surface. TH-11 through TH-21 were drilled on September 14, 2015 to depths of 15 to 20 feet and were all located within Planning Area C. All borings were drilled using 4-inch diameter, continuous-flight solid-stem auger and truck-mounted CME-45 and CME-55 drill rigs.

Samples of the soil and bedrock were obtained at approximate 5-foot intervals in TH-1 through TH-10 using a 2.5-inch diameter (O.D.) modified California barrel sampler driven by an automatic 140-pound hammer falling 30 inches. Only 4 feet samples were obtained in TH-11 through TH-21. Our field representatives were present during drilling to observe drilling operations, log the strata encountered and obtain samples for laboratory tests. After drilling was completed, we installed hand-slotted PVC pipe in the holes to allow delayed groundwater measurements. The annulus around the pipe was filled with cuttings and the tops of the holes/pipes were isolated by mounding cuttings around them to reduce infiltration of surface water. Summary logs of exploratory borings with results of field penetration resistance tests and a portion of the laboratory data are presented in Appendix A.

The samples were returned to our laboratory where they were examined and testing was assigned. Laboratory tests included dry density, moisture content, percent silt and clay-sized particles (passing the No. 200 sieve), gradation, Atterberg limits, unconfined compression, swell-consolidation, and water-soluble sulfate concentration. Swell-consolidation tests were performed by wetting the samples under overburden pressures (the weight of the overlying soil). Results of laboratory tests are presented in Appendix B and summarized in Table B-I.

SUBSURFACE CONDITIONS

Strata encountered in our exploratory borings generally consisted of nil to about 7.5 feet of sandy clay fill and 4 to more than 35 feet of natural clay and sand underlain by weathered and comparatively unweathered claystone and sandstone bedrock to the maximum explored depth of 35 feet. Practical drill refusal was encountered in cemented sandstone in TH-3 at a depth of about 17.5 feet. Some of the pertinent engineering characteristics of the soil and bedrock are described in the following paragraphs.

We found about 6 and 7.5 feet of fill at the ground surface in TH-6 and TH-1, respectively. The fill consisted of sandy, silty clay. The fill was very stiff based on results of field penetration resistance tests. Two fill samples swelled 1.5 and 1.7 percent when wetted under an applied pressure of 500 psf. These samples developed load-back swelling pressures of about 1,600 and 2,500 psf. We assume the fill is related to site development and grading. Fill compaction records would be helpful to judge the suitability of the fill for supporting improvements. If documentation is not available, the fill should be reworked or additional investigation performed (such as excavating test pits) to evaluate the condition of the fill.

Natural soils were encountered at the ground surface in eight borings and below fill in two borings, and consisted of sandy to very sandy, silty, clay and silty to very clayey sand. The soils became more gravelly with depth. The clay was soft to very stiff and the sand was loose to dense. Three clay samples compressed 0.2 percent and two swelled 0.1 and 1.4 percent when wetted. The highest swelling sample developed a load-back swell pressure of about 4,200 psf. A medium stiff clay sample exhibited an unconfined compressive strength of about 800 psf. A very sandy clay sample contained 54 percent silt and clay-sized particles and showed low plasticity with a liquid limit of 26 and a plasticity index of 13. A clayey sand sample did not swell when wetted. Seven sand samples had 18 to 47 percent fines and two had low plasticity with liquid limits of 20 and 25 and plasticity indices of 2 and 10. Soft/loose soils were identified in four borings, TH-2, TH-7, TH-8, TH-9 and TH-11 through TH-21, most of which were in Planning Area C and H along the west side of the site.

Bedrock was encountered in six borings at depths of about 4 to 19.5 feet below grade, or elevations 5123 to 5180.5 feet. The approximate surface elevation and depth to bedrock below existing grade are shown on Fig. 3. Bedrock was predominantly silty to clayey sandstone and siltstone, with claystone in TH-6 and TH-8 in the east-central part of the site in Planning Area F. Bedrock was shallow (less than 10 feet deep) in three borings, TH-3, TH-5 and TH-6, drilled in the central portion of the site. A sandstone sample did not swell when wetted. Four sandstone samples had 23 to 30 percent silt and clay-sized particles. One claystone sample did not swell and five swelled 1.4 to 5.4 percent when wetted. The two highest swelling samples showed load-back swelling pressures of about 6,800 and 7,800 psf. A hard claystone sample exhibited an unconfined compressive strength of approximately 14,800 psf, had 100 percent fines and had high plasticity with a liquid limit of 65 and a plasticity index of 44.

Groundwater

Groundwater was encountered during drilling in all except one boring at depths of about 4 to 26 feet below grade. When the holes were checked on multiple occasions after drilling, shallowest water levels were measured in the same nine borings at depths of about 1.8 to 23 feet or elevations 5108 to 5178.5 feet (Fig. 2). Shallow groundwater will likely preclude basement construction in Planning Area C and possibly portions of nearby Planning Areas D, E, F and G unless measures are taken to protect them and appropriate planning, design and construction are implemented. Shallow groundwater will also complicate utility installation and sub-excavation (if used), and require the use of temporary de-watering and permanent subsurface drainage systems (interceptor drains and underdrains) to properly mitigate. Groundwater may fluctuate seasonally and rise in response to development, precipitation, landscape irrigation, and flow in nearby drainages and ditches.

Our measured water levels in Planning Area C were shallower than AGW's measurements. We are unsure why the levels were shallower. AGW's investigation was performed about 2 months after historic rain occurred in Boulder County. Our investigation is also being performed during a relatively wet summer. The tops of our boreholes were sealed to reduce surface water from infiltrating the borehole. TH-7 was located at the base of a small hill, which may have influenced the water level measurement, although we judge this was not likely the case. Similarly, cattails and vegetation were observed near TH-16 and TH-17.

GEOLOGIC HAZARDS

Colorado is a challenging location to practice geotechnical engineering. The climate is relatively dry and the near-surface soils are typically dry and

comparatively stiff. These soils and related sedimentary bedrock formations react to changes in moisture conditions. Some of the soils swell as they increase in moisture and are referred to as expansive soils. Other soils can compress significantly upon wetting and are identified as compressible or collapsible soils. Most of the land available for development east of the Front Range is underlain by expansive clay or claystone bedrock near the surface. The soils that exhibit compressible behavior are more likely west of the Continental Divide; however, both types of soils occur throughout the state.

Covering the ground with structures, streets, driveways, patios, etc., coupled with lawn irrigation and changing drainage patterns, leads to an increase in subsurface moisture conditions. As a result, some soil movement due to heave or settlement is inevitable. Expansive soil and bedrock are present at this site, which constitutes a geologic hazard. There is risk that foundations and slab-on-grade floors will experience heave and damage. It is critical that precautions are taken to increase the chances that the foundations and slabs-on-grade will perform satisfactorily. Engineered planning, design and construction of grading, pavements, foundations, slabs-on-grade, and drainage can mitigate, but not eliminate, the effects of expansive soil and bedrock. Sub-excavation is a means to reduce potential heave and potentially allow wide use of shallow foundations and slab-on-grade floors. Shallow groundwater is also considered a geologic hazard and will require appropriate measures during planning, design and construction to control during construction and for long-term use. Additional investigation may reveal that the water cannot be controlled feasibly, and it may be determined that some areas are not economically practical for construction.

There are underground coal mines below parts of Boulder County. We reviewed the State of Colorado, Department of Natural Resources, Mined Land Reclamation Division, “Boulder County Subsidence Investigation,” Volumes IV and V prepared by Dames & Moore (1986). The maps do not show underground

coal mines below the site. If subsidence risk is present, we assume it was evaluated by others.

Seismicity

Based on available mapping, we found no active faults within or near the site. The soil and bedrock units are not expected to respond unusually to seismic activity. Based on methods described in Chapter 16 of the 2012 International Building Code (IBC), we judge the soil conditions justify Site Class D for seismic design. The Seismic Design Category would be “B” for structures such as schools and single-family residences.

Radioactivity

It is normal in the Front Range of Colorado and nearby eastern plains area to measure radon gas in poorly ventilated spaces (e.g., full depth residential basements) in contact with soil or bedrock. Radon 222 gas is considered a health hazard and is just one of several radioactive products in the chain of the natural decay of uranium into lead. Radioactive nuclides are common in the soil and bedrock underlying the subject site. Because these sources exist or will exist on most sites in the area, there is a potential for radon gas accumulation in poorly ventilated spaces. The concentration of radon that can develop is a function of many factors, including the radionuclide activity of the soil and bedrock, construction methods and materials, soil gas pathways, and accumulation areas. The only reliable method to determine if a hazard exists is to perform radon testing of completed residential structures. Typical mitigation methods consist of sealing soil gas entry areas, ventilation of below-grade spaces, and venting from foundation drain systems. Radon rarely accumulates to significant levels in above-grade living spaces. We recommend provision for ventilation of foundation drain systems to allow venting if a radon problem is discovered.

ESTIMATED POTENTIAL HEAVE

Based on the subsurface profiles, swell-consolidation test results and our experience, we calculated the potential heave at the ground surface for each test hole, as shown in the table below. We estimate potential ground heave may range from less than 0.5-inch to 1.7 inches for the majority of the site, with up to about 5 inches possible at TH-6. A depth of wetting of 24 feet relative to the existing grades was considered for the analysis. This depth of wetting is typically used for irrigated residential sites with basements. If the residences will not have basements, the depth of wetting may be less. Considering the depth to ground-water at this site, the influential depth of wetting will likely be significantly less than 24 feet, and therefore actual heave will likely be less than our estimates. Variations from our estimates should be anticipated. It is not certain whether the estimated heave will occur. Actual heave will likely be less. The planned grading will affect the potential heave estimates. Overall, we judge there is relatively low risk of problems due to expansive soil and bedrock for the majority of the site, with some isolated areas of moderate to high risk. Sub-excavation is a means to reduce potential heave and potentially allow use of shallow foundations and slab-on-grade floors. Groundwater may complicate sub-excavation and require sub-surface drainage systems to properly mitigate. Settlement is more likely than heave where soft soils are present (areas represented by TH-2, TH-4, TH-7, TH-8 and TH-9).

ESTIMATED POTENTIAL GROUND HEAVE AT
GROUND SURFACE BASED ON 24 FEET DEPTH OF WETTING

Boring	Estimated Potential Ground Heave (inches)	Risk Due to Expansive Soil and Bedrock
TH-1	1.5	LOW
TH-2	<0.5*	LOW
TH-3	<0.5	LOW
TH-4	<0.5*	LOW
TH-5	<0.5	LOW
TH-6	4.9	HIGH
TH-7	<0.5*	LOW
TH-8	1.7*	MODERATE
TH-9	<0.5*	LOW
TH-10	0.6	LOW

*Indicates soft/loose soils are present which implies settlement is more likely

SITE DEVELOPMENT

The primary geotechnical concerns that we believe will influence development and residential construction at this site are shallow groundwater and soft/loose soils, and localized areas with expansive soil and bedrock. These concerns can likely be mitigated with proper planning, engineering, design and construction. We believe there are no geologic or geotechnical constraints that would preclude development of the majority of the site. Appropriate planning, design and construction will be necessary to address the shallow groundwater below Planning Area C (and possibly others nearby). Site grading should be planned to avoid creating conditions where water would affect site development, utility installation and basements. The following sections discuss site development recommendations considering the current development plan.

Demolition

Existing fill presents risk of settlement to floor/pavement slabs and other surface improvements. We should be provided with fill compaction records which

demonstrate the fill was placed in a controlled manner, or perform additional investigation to evaluate the suitability of the fill. The existing residence and sheds in the northwest part of the site will be demolished. Foundations, slabs, utilities and other improvements should be removed or abandoned. Removal excavations should be replaced with moisture conditioned, compacted fill.

Excavation

We believe the soils and bedrock penetrated by our exploratory borings can be excavated with typical heavy-duty equipment. Hard bedrock may require heavy ripping for efficient removal (Fig. 3). We recommend the owner and the contractor become familiar with applicable local, state and federal safety regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Based on our investigation and OSHA standards, we anticipate the sand will classify as Type C soils, the clay as Type B or C, and the bedrock as Type A or B. Type A, B and C soils require maximum slope inclinations of ¾, 1:1 and 1½:1 (horizontal:vertical), respectively, for temporary excavations in dry conditions. Below groundwater or where any seepage is present, excavations will likely require flatter slopes, possibly as flat as 6:1. This could impact the efficiency of the contractor's work; they should be prepared to work in saturated and soft/loose soil conditions in shallow groundwater areas. Excavation side slopes specified by OSHA are dependent upon soil types and groundwater or seepage conditions encountered. The contractor's "competent person" should identify the soils encountered in the excavations and refer to OSHA standards to determine appropriate slopes. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to one-half the excavation depth, from the edge of the excavation. A professional engineer should design excavations deeper than 20 feet.

Stabilization, Dewatering and Shallow Groundwater Mitigation

Based on our measured water levels, groundwater appears to be manageable over the majority of the site. Shallow water levels were obtained in borings drilled within Planning Areas C, F and H. Based on current water levels, it is likely that deep sub-excavation and utility excavations will extend below groundwater in various parts of the site, mostly along North 111th Street.

Soft, very moist soils may be encountered in excavations and should be removed or stabilized. Removal is preferred to reduce settlement and seepage. Soft excavation bottoms can be stabilized by crowding crushed rock into the soils until firm. Acceptable rock materials include, but are not limited to, No. 2 and No. 57 rock. Crushed rock on a layer of geosynthetic grid or woven fabric can also be used, which should reduce the amount of aggregate needed to stabilize the subgrade. Typically, a biaxially woven fabric such as Mirafi 600x (or equal) or geogrid (such as Tensar BX1100 or equal) topped with 6 to 10 inches of 1 to 5-inch crushed rock will provide a stable working surface.

Temporary construction dewatering systems will probably be needed. We anticipate excavations can be dewatered using sumps, where the water is pumped down through the soils before being discharged. The Town of Erie, Boulder County and/or the Colorado Department of Public Health and Environment may require dewatering permits. Our experience indicates periodic environmental testing is usually required with these permits, with reporting. Permitting requirements may also influence the construction schedule. We provided a Construction Dewatering Permit Application under Project No. DN47,911-210 (letter dated September 22, 2015).

We believe it is prudent to protect basements (if used) from potential seepage. We believe installation of subsurface drain systems can be considered

as measures to possibly control shallow water. Drain systems include interceptor drain(s), underdrains, and foundation drains around basement or crawl space perimeters. A grout or slurry curtain wall can be considered to potentially "cut off" the shallow groundwater. Utilities may need to penetrate the curtain, making it less effective. We recommend additional investigation in Planning Area C to better evaluate the feasibility of subsurface systems. We can discuss potential permanent dewatering solutions once plans are more developed.

If sub-excavation is done, we recommend installation of fill subdrains along the slopes where sub-excavation exposes groundwater or seepage at shallow depths (Fig. 6). We expect this condition in Planning Area F. The fill subdrain should have a two-sided drainage board which extends at least 3 feet above any seepage and ties into the pipe. If sub-excavation is not done, an interceptor drain should be installed as shown on Fig. 7. The interceptor drain should also have a two-sided drainage board which ties into the pipe. The likely location for the interceptor drain is shown on Fig. 2. The drain should bottom at least 3 feet below adjacent basement excavations. We envision the drain can be connected to the sewer underdrain system; Fig. 8 shows a typical profile of this system. The drains should be provided with outlet(s).

Our firm generally advocates an underdrain system below sanitary sewer mains and services to control groundwater that may accumulate in response to development. The underdrain also helps to control shallow water and unusually deep wetting, which can lead to higher frequency of heave-related foundation problems and frequent pumping from basement foundation drain systems. If basements or below-grade areas are incorporated into the residences, we recommend an underdrain system. The underdrain can be "active" (perforated) where water is shallow to help with seepage.

The underdrain should consist of ¾ to 1½-inch clean, free-draining gravel surrounding a perforated PVC pipe (Fig. 9). We believe use of perforated pipe below sanitary sewer mains is the most effective approach to control groundwater and collect water from perimeter drains. The pipe should be sized for anticipated flow. The line should consist of smooth, perforated or slotted, rigid PVC pipe placed at a grade of at least 0.5 percent. A positive cutoff (concrete) should be constructed around the sewer pipe and underdrain pipe immediately downstream of the point where the underdrain pipe exits the sewer trench (Fig. 10). Solid pipe should be used down gradient of this cutoff wall. The underdrains should be designed to discharge to a gravity outfall and be provided with a permanent concrete headwall and trash rack. If the underdrain discharges into a detention pond area, the risk of flood water backflow through the underdrain into basements should be carefully evaluated. A check valve or backflow preventer can be considered. The underdrain should be provided with clean-outs and be maintained. Where feasible, the underdrain services should be installed deep enough so that the lowest point of foundation drains can be connected to the underdrain service as a gravity outlet (Fig. 8).

Sub-Excavation

We estimated potential ground heave of up to about 5 inches is possible. Long and heavily-reinforced drilled piers and structurally supported basement floors are normally recommended for sites with significant potential heave, such as at TH-6 in Planning Area F. Sub-excavation is a ground improvement method used to reduce the potential swell and mitigate impacts of swelling soils and bedrock. Additional investigation (including reviewing grading plans and drilling/sampling additional borings) is recommended to better delineate the sub-excavation areas and appropriate depths, if this approach is desired. More information will also allow us to evaluate groundwater levels and whether or not we believe it is necessary to extend sub-excavation below groundwater.

Sub-excavation has been used in the Denver area with satisfactory performance for the large majority of the sites where this ground modification method has been completed. We have seen isolated instances where settlement of sub-excavation fill has led to damage to houses supported on footings. In most cases, the settlement was caused by wetting associated with poor surface drainage or seepage, and/or poorly compacted fill placed at the horizontal limits of excavation. Wetting of the fill may cause softening and settlement. Groundwater will likely complicate sub-excavation. Installation of a fill subdrain is recommended along the slopes where excavation exposes groundwater or seepage at shallow depths. The subdrain should be provided with an outlet. Use of drilled pier foundations would be prudent if risk of footing movement is not tolerable.

There can be cases where the sub-excavation limits and depth are not adequate to encompass an entire building footprint including deck, patio and porch. As a result, the building has to be founded on deep foundations. Proper planning of the sub-excavation limits and depth based on the largest model plan, and as-built surveying of the limits and depth during the sub-excavation are important to reduce this risk.

The excavation slopes should meet OSHA, state, and local safety standards. The bottom of the sub-excavated area should extend laterally at least 5 feet, and preferably 10 feet, outside the largest possible foundation footprints to ensure foundations are constructed over moisture-conditioned fill. Conceptual sub-excavation profiles are shown on Figs. 11 and 12.

The excavation contractor should be chosen carefully to assure they have experience with fill placement at over-optimum moisture and have the necessary compaction equipment. The contractor should provide a construction disc to break down fill materials and anticipate use of push-pull scraper operations and dozer assistance. The operation will be relatively slow. In order for the procedure

to be performed properly, close contractor control of fill placement to specifications is required. Sub-excavation fill should be moisture-conditioned between 1 and 4 percent above optimum moisture content with an average test moisture content each day of at least 1.5 percent above optimum. Fill should be compacted as recommended in Fill and Backfill.

Special precautions should be taken for compaction of fill at corners, access ramps, and along the perimeters of the sub-excavation as large compaction equipment cannot easily reach these areas. Our representative should observe placement procedures and test compaction of the fill on a nearly full-time basis. The swell of the moisture-conditioned fill should be tested during and after the fill placement. Guideline sub-excavation grading specifications are presented in Appendix E.

If the fill dries excessively prior to construction, it may be necessary to rework the upper drier materials just prior to constructing foundations. We judge the fill should retain adequate moisture for about two years and can check moisture conditions in each excavation as construction progresses, if requested.

Sub-excavation and replacement with low swell fill will likely allow use of footing foundations for lightly loaded structures and enhance performance of slab-on-grade floors. Sub-excavation will also enhance performance of concrete flatwork (driveways and sidewalks) and pavements, potentially reducing maintenance costs.

Based on our experience, several problems have been encountered from the use of sub-excavation. The most common problem arises from placement of the structure outside of the sub-excavated area. The following suggestions should aid in planning and performing sub-excavation:

1. We recommend design of the treatment area and depth to satisfy the recommendations presented above, paying particular attention to lots on corners and lots that slope to the street. Consider the side setbacks for corner lots.

2. We recommend a surveyor document the actual limits of the treatment, and create "as-built" plans. These plans should be provided to the civil/surveyor who prepares plot plans so that they can verify that each residence is over the treated area. In the case of deep sub-excavation, the "treated area" stops at the toe of the deep sub-excavation slope. It would be prudent to show the horizontal limits and bottom elevation of treatment on the plot plans.

3. Land development staff must communicate with the building and sales division about the limitations of house locations.

Fill and Backfill

The ground surface in areas to be filled should be stripped of debris, vegetation/organics and other deleterious materials, scarified and moisture conditioned to between 1 and 4 percent above optimum moisture content for clay or within 2 percent of optimum for sand, and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). Imported fill should ideally consist of soil having a maximum particle size of 3 inches, less than 50 percent passing the No. 200 sieve, a liquid limit less than 30 and a plasticity index less than 15. Potential fill materials should be submitted to our office for approval prior to importing to the site. We recently investigated subsurface conditions in the regional pond area and determined the soils to be excavated are suitable for re-use as site grading fill.

The properties of fill will affect the performance of foundations, slabs-on-grade, utilities, pavements, flatwork and other improvements. The on-site soils are suitable for use as new fill provided they are substantially free of debris, vegetation/organics and other deleterious materials. Fill should be placed in thin loose lifts, moisture conditioned and compacted prior to placement of the next lift.

Our experience has shown clay fill moisture treated to optimum moisture content or above will exhibit lower swell than clay fill receiving the same compactive effort, but moisture treated below optimum moisture content. Clay fill should be moisture conditioned to between 1 and 4 percent above optimum moisture content and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). Sand fill should be moisture conditioned to within 2 percent of optimum moisture content and compacted similarly. The placement and compaction of new fill should be observed and density tested by our representative during construction. Guideline site grading specifications are presented in Appendix D.

Our experience indicates fill and backfill can compress, even if properly compacted to the criteria provided above. Settlement of the backfill on the order of 1 to 2 percent of the fill depth due to self weight of the fill should be anticipated. Fills composed of claystone may compress more. For utility installation, our experience indicates use of a self-propelled compactor results in more reliable performance compared to backfill "compacted" by a sheepsfoot wheel attachment on a backhoe or trackhoe. The upper portion of the trenches should be widened to allow the use of a self-propelled compactor. Special attention should be paid to backfill placed adjacent to manholes as we have seen instances where settlement in excess of 2 percent has occurred. Any improvements placed over backfill should be designed to accommodate movement. We recommend trench backfill be placed, moisture conditioned, and compacted as discussed above. The placement and compaction of utility trench backfill should be observed and tested by a representative of our firm during construction.

Slopes

We recommend permanent cut and fill slopes be designed with a maximum grade of 3:1 (horizontal to vertical). If site constraints (property boundaries

and streets) do not permit construction with recommended slopes, we should be contacted. Surface drainage should not be allowed to sheet flow across slopes or pond near the crest of slopes. All cut and fill slopes should be re-vegetated as soon as possible after grading to reduce potential for erosion problems. Erosion potential on the site is considered low to moderate, due to the gentle slopes. Uncontrolled and concentrated surface runoff has the potential to create damaging erosion. Erosion potential will increase during construction, particularly for the loose sands, but should return to pre-construction rates or less if proper grading practices, surface drainage design, and re-vegetation efforts are implemented. Construction sites within the Denver Metropolitan area are subject to the U.S. Environmental Protection Agency (EPA) regulations regarding the control of storm water discharge and soil erosion. Excavation contractors should evaluate ground conditions and control slopes in accordance with OSHA criteria. Fill placed on slopes of 20 percent or steeper should be benched as shown in Fig. 5.

Pavements

Pavement subgrade soils will likely consist of silty to clayey sand and sandy clay. Clay soils are considered to have relatively poor support characteristics, while sand is considered better subgrade material. Depending on the swell and plasticity of the subgrade, sub-excavation up to 3 feet may be necessary for expansive subgrade mitigation. Chemical stabilization may also be needed to reduce the plasticity index to less than 30. It may be advantageous to do street sub-excavation during or after utilities are installed. Local streets will need at least 6.5 inches of asphalt or an equivalent composite section of 4 inches of asphalt over 8 inches of base course. Both sections may need to be constructed over stabilized subgrade. A design-level subgrade investigation should be done prior to paving.

BUILDING CONSTRUCTION CONSIDERATIONS

The following discussions are preliminary and not intended for design or construction. After grading is completed, design-level investigations should be performed on a building-specific basis.

Foundations

Site soils mostly include non-expansive or low swelling soils at depths likely to affect foundation performance. Expansive claystone is present in TH-6 and TH-8 drilled within Planning Area F. Drilled piers bottomed in bedrock are typically used where relatively high swelling soil and bedrock are encountered. Drilled piers (if used) will likely require dewatering or underwater concrete placement by pumped methods. Groundwater and very hard bedrock may complicate drilled pier installation. At this time, we believe 20 percent or more of the houses will require pier foundations (Parcel F). We believe deep sub-excavation could allow use of footing foundations for lightly loaded structures. The planned grading will affect the sub-excavation depths, and groundwater levels. Further investigation is recommended to better delineate potential sub-excavation areas and depths, and whether or not it may be beneficial to extend sub-excavation below groundwater. Detailed soils and foundation investigations should be performed after overlot grading (and sub-excavation) to determine the appropriate foundation types and to provide design criteria on a lot-by-lot basis.

Floor Construction

The use of slab-on-grade floors should be limited to areas where potential movements are judged to be low to moderate. We judge slab performance risk will be low for about 75 percent of the site or more.

Sub-excavation may be considered to reduce the influence of expansive soil and bedrock on basement floors. Our experience suggests risk of poor slab performance can be reduced to low if the fill is moisture conditioned and compacted properly. The performance of garage floors, driveways, sidewalks, and other surface flatwork installed outside sub-excavated areas will likely be erratic at this site. Shallower sub-excavation can be considered in these areas.

The following precautions will be required to reduce the potential for damage due to movement of slabs-on-grade placed at this site:

1. Isolation of the slab from foundation walls, columns or other slab penetrations;

2. Voiding of interior partition walls to allow for slab movement without transferring movement to the structures;

3. Use of flexible water and gas connections to allow for slab movement. A flexible duct above furnaces will also be required; and

4. Proper surface grading and foundation drain installation to reduce water availability to sub-slab and foundation soils.

If basements are used, structurally supported basement floors are recommended for areas of high or very high risk. A structurally supported basement floor should also be used where a buyer cannot tolerate potential movement. Structurally supported floor systems should be anticipated in all non-basement finished living areas. Design and construction issues associated with structural floors include ventilation and lateral loads. Where structurally supported floors are installed in basements or over a crawl space, the required air space depends on the materials used to construct the floor and the potential expansion of the underlying soils. Building codes require a clear space of 18 inches between exposed earth and untreated wood floor components. For non-organic floor systems, we recommend a minimum clear space of 8 inches. This minimum clear space should be maintained between any point on the underside of the floor

system (including beams and floor drain traps) and the soils. If sub-excavation is not done, this clear space should be increased to allow for some heave.

Control of humidity in crawl spaces is important for indoor air quality and performance of wood floor systems. We believe the best current practices to control humidity involve the use of a vapor retarder (10 mil minimum) placed on the soils below accessible subfloor areas. The vapor retarder/barrier should be sealed at joints and attached to concrete foundation elements.

Basements and Crawl Spaces

Surface water can penetrate relatively permeable loose backfill soils located adjacent to residences and collect at the bottom of relatively impermeable basement or crawl space excavations, causing wet or moist conditions after construction. Basement and crawl space foundation walls should be designed to resist lateral earth pressures. Foundation drains should be constructed around the lowest excavation levels of basement or crawl space areas. These drains could be connected to an underdrain system (Fig. 8) to provide a gravity outlet. Sump pits should be provided so pumps can be installed as a backup if underdrains do not perform as intended.

Relatively shallow groundwater conditions may require limiting basement depths and/or the use of under-slab gravel layers, vapor retarders and deeper than normal drains. These types of systems are recommended where groundwater will be within 5 feet of the basement excavation. Site grades should be planned based on maintaining basement excavations at least 3 feet, and preferably 5 feet, above groundwater. Basements may not be suitable for residences within Planning Area C, and possibly others nearby unless subsurface drainage systems are implemented successfully. Builders should be made aware of the shallow groundwater and likelihood of limiting basement depths.

Concrete

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentrations of 0.01 to 0.35 percent in three samples from this site. For this level of sulfate concentration, ACI 332-08 *Code Requirements for Residential Concrete* indicates concrete shall be made with ASTM C150 Type V cement, or an ASTM C595 or C1157 hydraulic cement meeting high sulfate-resistant hydraulic cement (HS) designation and shall have a specified minimum compressive strength of 3,000 psi at 28 days. Alternative combination of cements and supplementary cementitious materials, such as Class F fly ash, shall be permitted with acceptable test records for sulfate durability.

Superficial damage may occur to the exposed surfaces of highly permeable concrete. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high water tables. Concrete should have a total air content of 6 percent +/- 1.5 percent. We recommend all foundation walls and grade beams in contact with the subsoils (including the inside and outside faces of garage and crawl space grade beams) be damp-proofed.

Surface Drainage

The performance of foundations, floors, pavements and other improvements is affected by moisture changes within the soil and bedrock. This is largely influenced by surface drainage. When developing an overall drainage scheme, consideration should be given to drainage around each residence. The ground surface around the residences should be sloped to provide positive drainage away from the foundations. We recommend a slope of at least 10 percent for the

first 10 feet surrounding each building, where practical. If the distance between buildings is less than 20 feet, the slope in this area should be 10 percent to the swale between houses. Variation from these criteria is acceptable in some areas. For example, for lots graded to direct drainage from the rear yard to the front, it is difficult to achieve the recommended slope at the high point behind the house. We believe it is acceptable to use a slope of about 6 inches in the first 10 feet at this location. Roof downspouts and other water collection systems should discharge well beyond the limits of all backfill around structures.

Proper control of surface runoff is also important to control the erosion of surface soils. Sheet flow should not be directed over unprotected slopes. Water should not be allowed to pond at the crest of slopes. Permanent slopes should be prepared to reduce erosion.

Attention should be paid to compaction of the soils behind curbs and gutters adjacent to streets and in utility trenches during the construction and development. If surface drainage between preliminary development and construction phases is neglected, performance of the roadways, flatwork and foundations may be poor.

RECOMMENDED FUTURE INVESTIGATIONS

We recommend the following investigations and services:

1. Additional monitoring of groundwater levels and recharge (pump) tests to better evaluate feasibility of dewatering systems;

2. We should review grading plans to better determine appropriate depths of sub-excavation. Additional drilling and testing to better delineate areas that would benefit from sub-excavation, if sub-excavation is considered;

3. Construction testing and observation during site development, sub-excavation, and building and pavement construction; including compaction testing of grading fill, utility trench backfill, and pavements, and observation and documentation of subsurface drainage systems;

4. Subgrade investigation and pavement design after grading;

5. Design-level Soils and Foundation Investigations after grading; and

6. Foundation installation observations.

LIMITATIONS

Our borings were widely spaced to provide a general picture of subsurface conditions for preliminary planning of development and residential construction. Variations from our borings should be anticipated. We should review grading plans once available. We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report or analysis of the influence of subsurface conditions on the project, please call.

CTL | THOMPSON, INC.

COLORADO LICENSED BENNY I. LUJAN 46531 10/13/15 PROFESSIONAL ENGINEER

Benny I. Lujan, P.E.
Project Engineer

Reviewed by:

Marc E. Cleveland, P.E.
Vice President

BIL:MEC/bg
(3 copies)

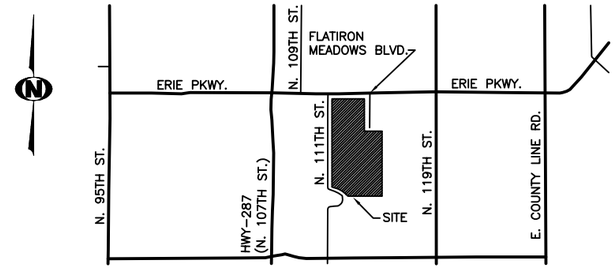
Via e-mail: david.klebba@hines.com
chad.murphy@hines.com

0 200 400

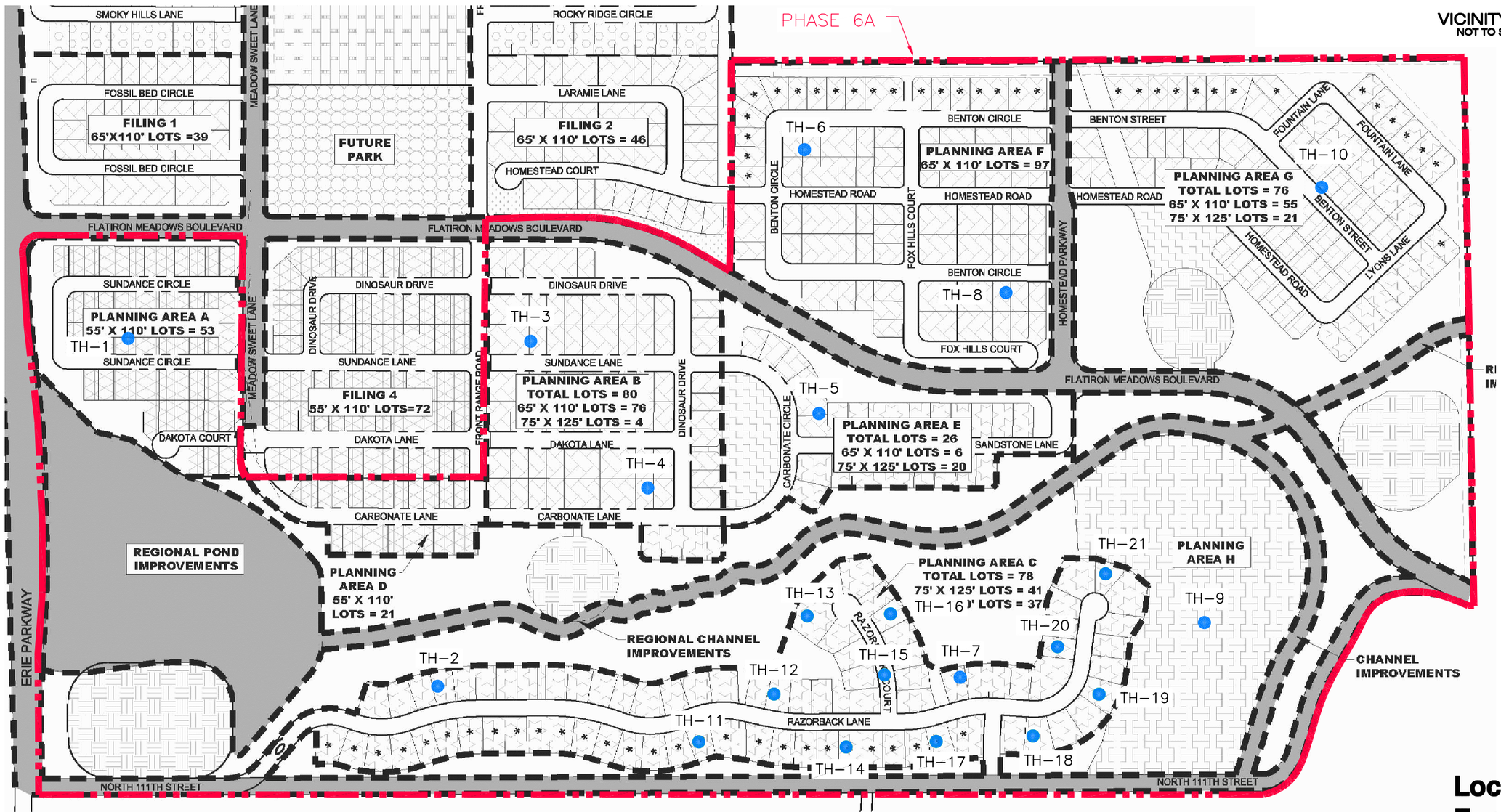
SCALE: 1" = 400'

LEGEND:

TH–1 APPROXIMATE LOCATION OF EXPLORATORY BORING



VICINITY MAP
NOT TO SCALE



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Project No. DN47,910-115

Locations of Exploratory Borings

Fig. 1

LEGEND:

0 200 400

SCALE: 1" = 400'

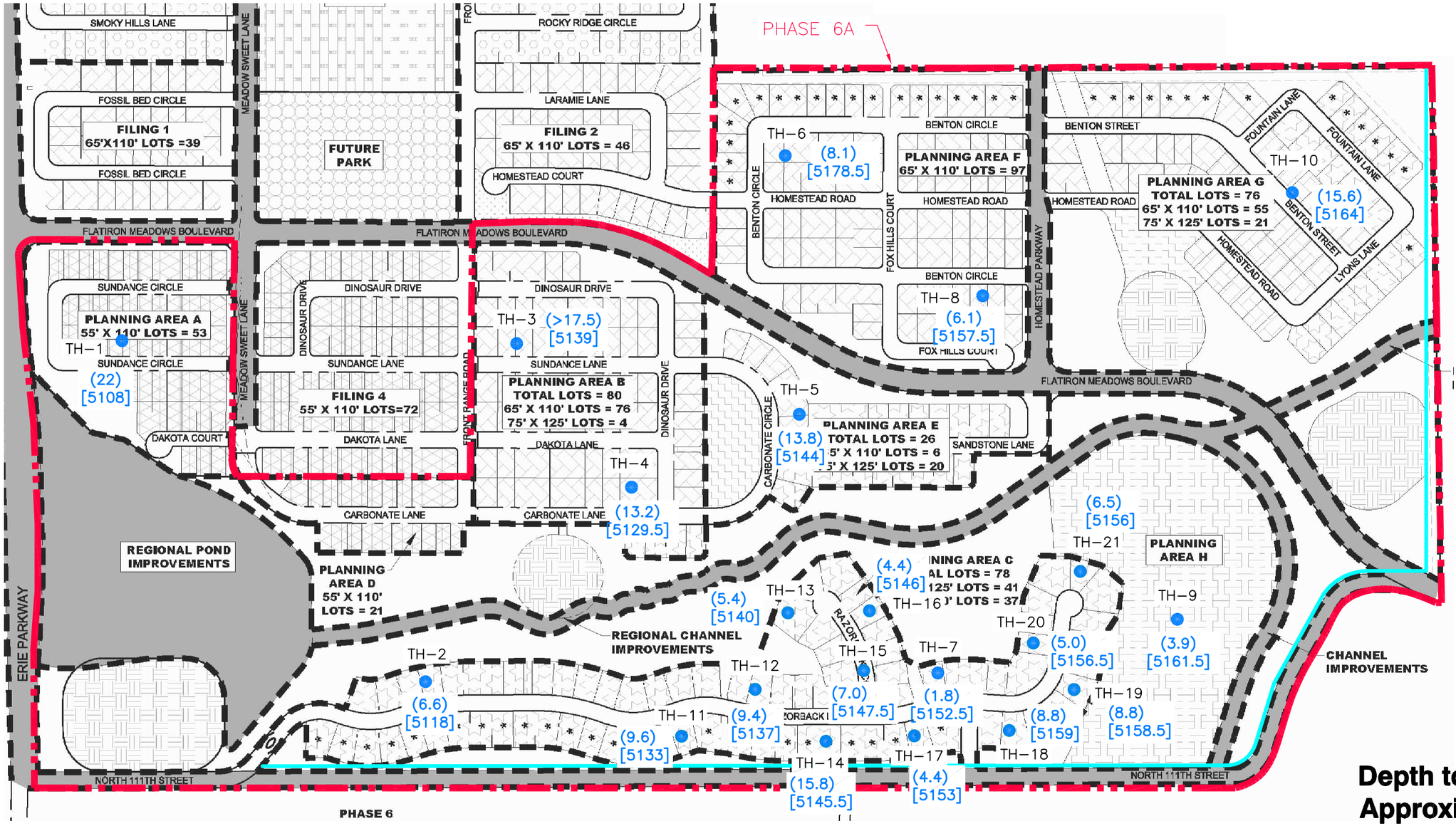
TH–1 APPROXIMATE LOCATION OF EXPLORATORY BORING

(22) INDICATES APPROXIMATE SHALLOWEST DEPTH TO GROUNDWATER IN BORING (FEET)

[5108] INDICATES APPROXIMATE SHALLOWEST GROUNDWATER SURFACE ELEVATION IN BORING (FEET)

INDICATES POSSIBLE LOCATION OF INTERCEPTOR DRAIN AND/OR GROUT CURTAIN OR SLURRY WALL

NOTE: WE RECOMMEND PROVIDING AT LEAST 3 FEET, AND PREFERABLY 5 FEET, OF SEPARATION BETWEEN BASEMENT EXCAVATIONS AND GROUNDWATER. BASEMENTS MAY NOT BE POSSIBLE IN PLANNING AREA C (AND POSSIBLY OTHERS NEARBY) UNLESS MEASURES ARE TAKEN SUCH AS RAISING SITE GRADES OR SUCCESSFULLY IMPLEMENTING INTERCEPTOR DRAIN(S) OR GROUT CURTAINS/SLURRY WALLS. REFER TO REPORT.



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Depth to Approximate Groundwater and Surface Elevation Fig. 2

LEGEND:

TH–1 APPROXIMATE LOCATION OF EXPLORATORY BORING

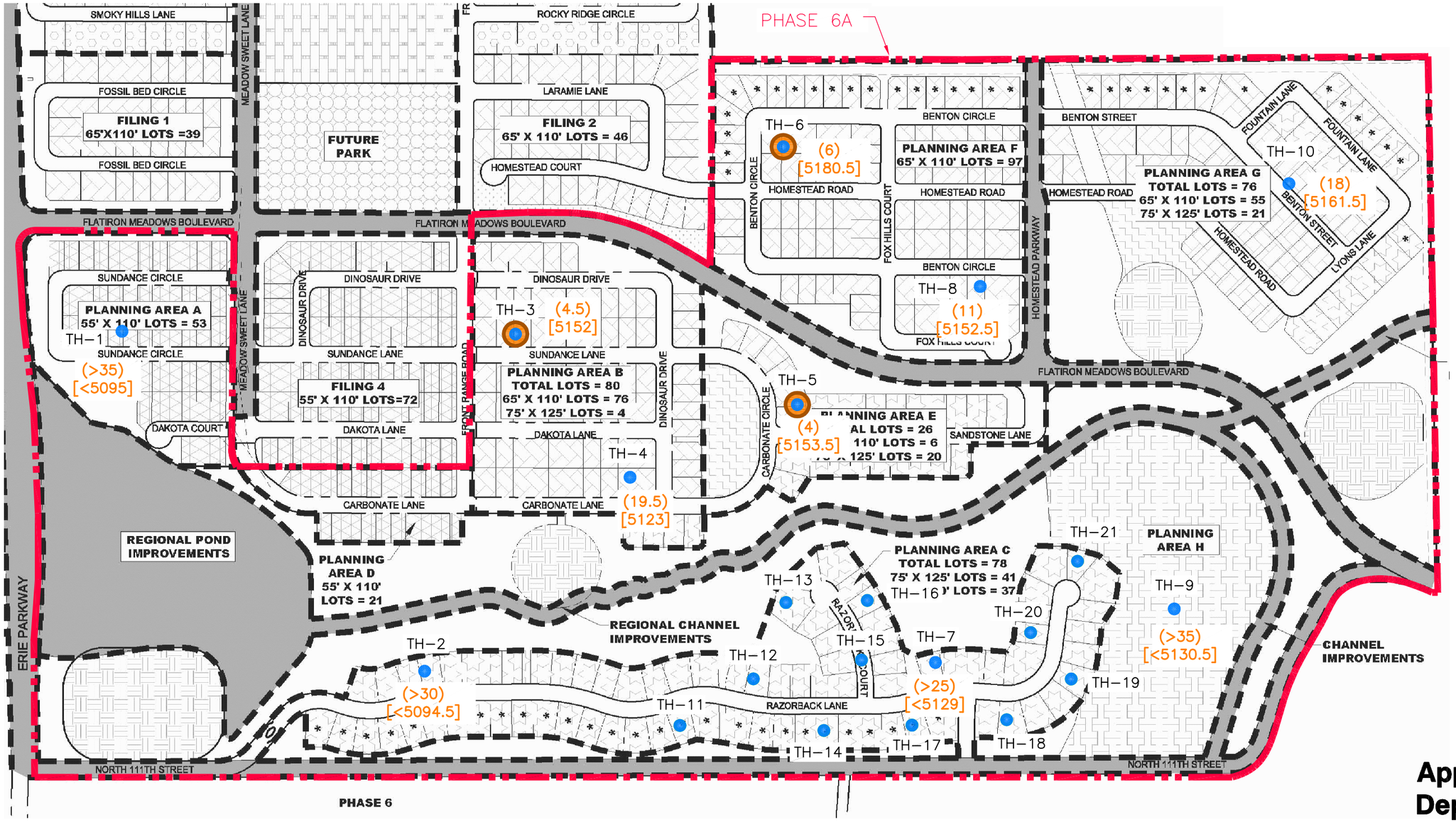
(4.5) INDICATES APPROXIMATE DEPTH TO BEDROCK IN BORING (FEET)

[5152] INDICATES APPROXIMATE BEDROCK SURFACE ELEVATION IN BORING (FEET)

INDICATES BORINGS WITH RELATIVELY SHALLOW BEDROCK WHICH MAY POSE DIFFICULTIES DURING BASEMENT AND UTILITY EXCAVATION.

0 200 400

SCALE: 1" = 400'



Approximate Depth to Bedrock and Surface Elevation

Fig. 3

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LEGEND:

TH–1 APPROXIMATE LOCATION OF EXPLORATORY BORING

LOW RISK

MODERATE RISK

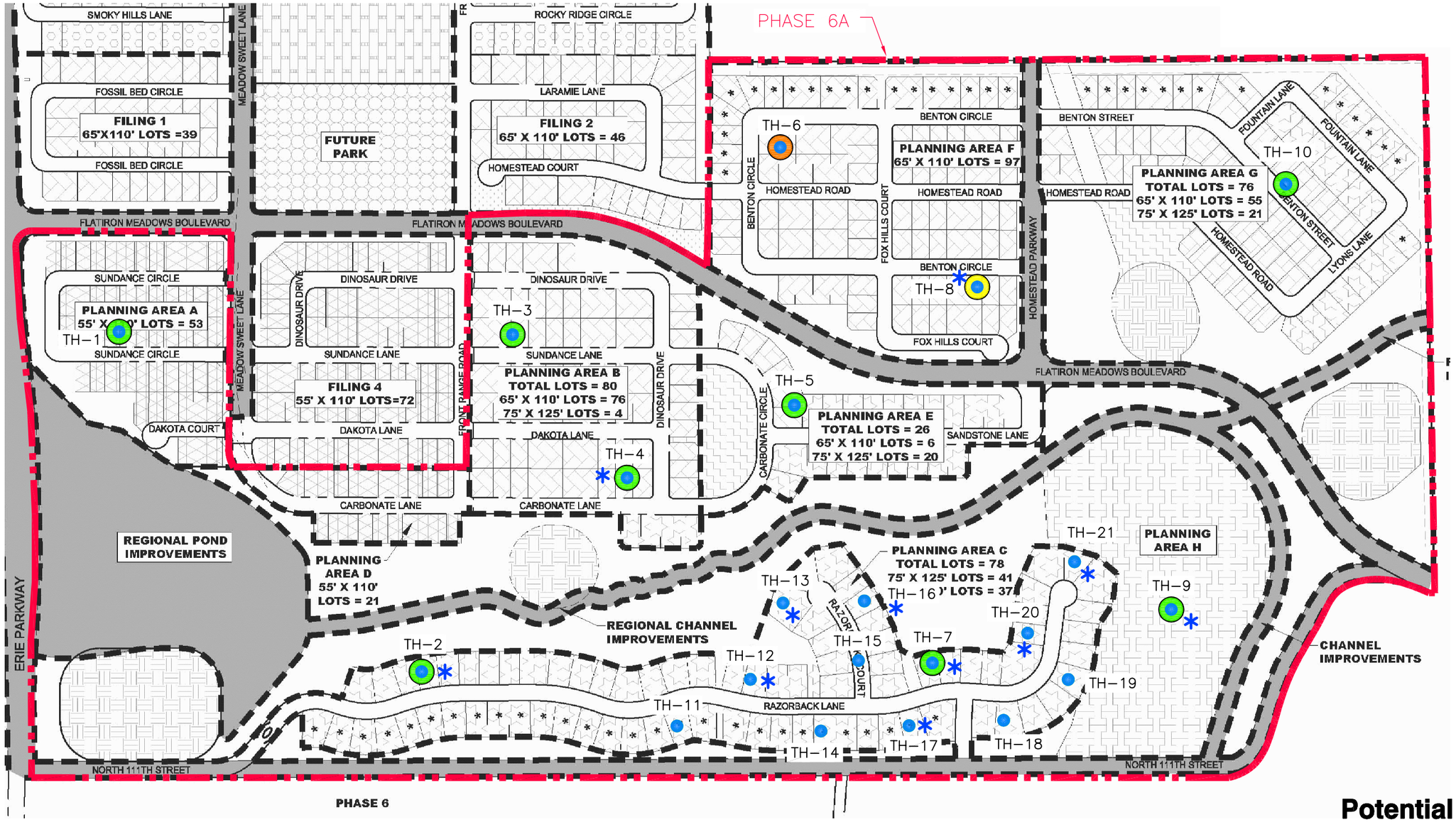
HIGH RISK

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF LABORATORY TEST RESULTS AND DRILL HOLE DATA.

* INDICATES BORINGS WHERE SOFT/LOOSE SOILS (AND SHALLOW GROUNDWATER) WERE ENCOUNTERED, IMPLYING SETTLEMENT IS MORE LIKELY THAN HEAVE

0 200 400

SCALE: 1" = 400'



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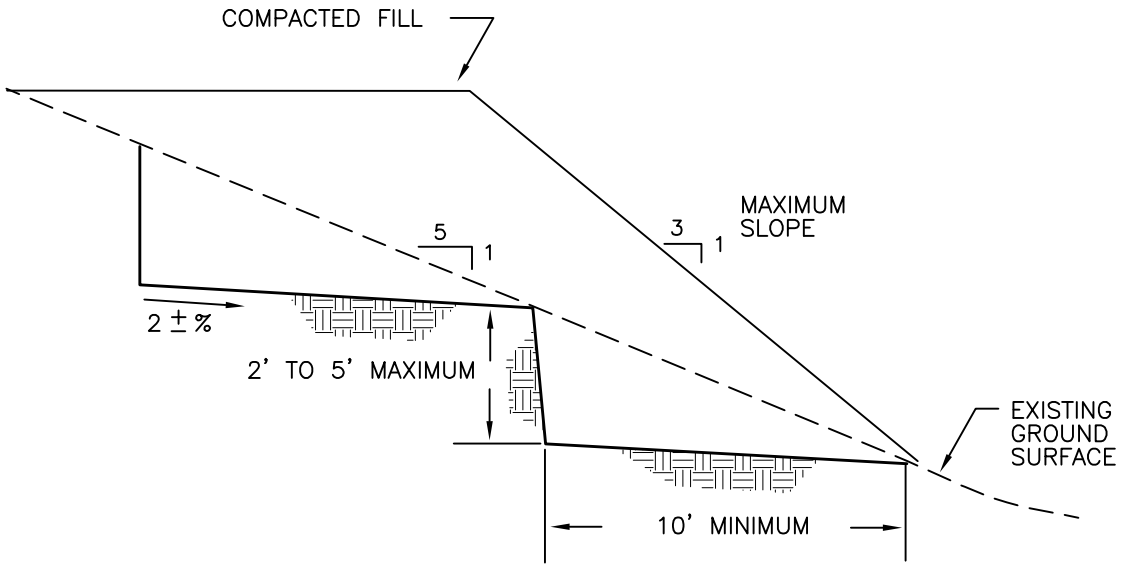
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
Project No. DN47,910-115

Potential Risk Due to Expansive Soil and Bedrock

Fig. 4

60-BENCHED-FILL_01



NOTES:

1) NATURAL SLOPES OF 20 PERCENT OR STEEPER ARE TO BE BENCHED PRIOR TO FILL PLACEMENT.

2) SLOPE BENCHES TO OUTSLOPE AT 2± PERCENT.

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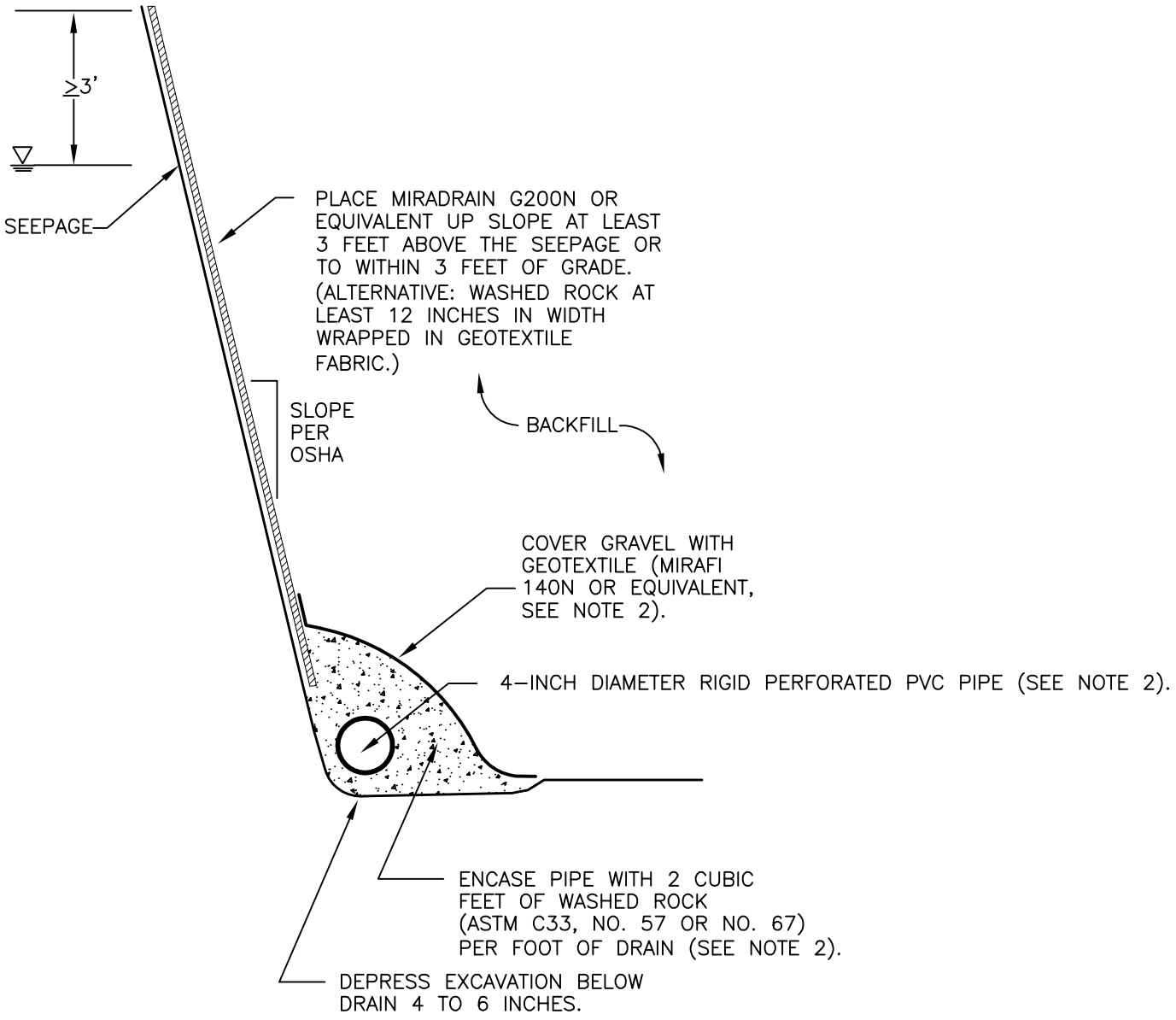
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
Project No. DN47,910-115

Benched Fill Detail

Fig. 5

20-INTERCEPTOR_08



NOTES:

1. THE BOTTOM OF THE DRAIN SHOULD SLOPE AT A MINIMUM SLOPE OF 0.5 PERCENT TO A POSITIVE GRAVITY OUTLET OR A MANHOLE PUMP STATION.

2. EZflow™ BY INFILTRATOR MAY BE USED IN LIEU OF PIPE, GRAVEL AND GEOTEXTILE.

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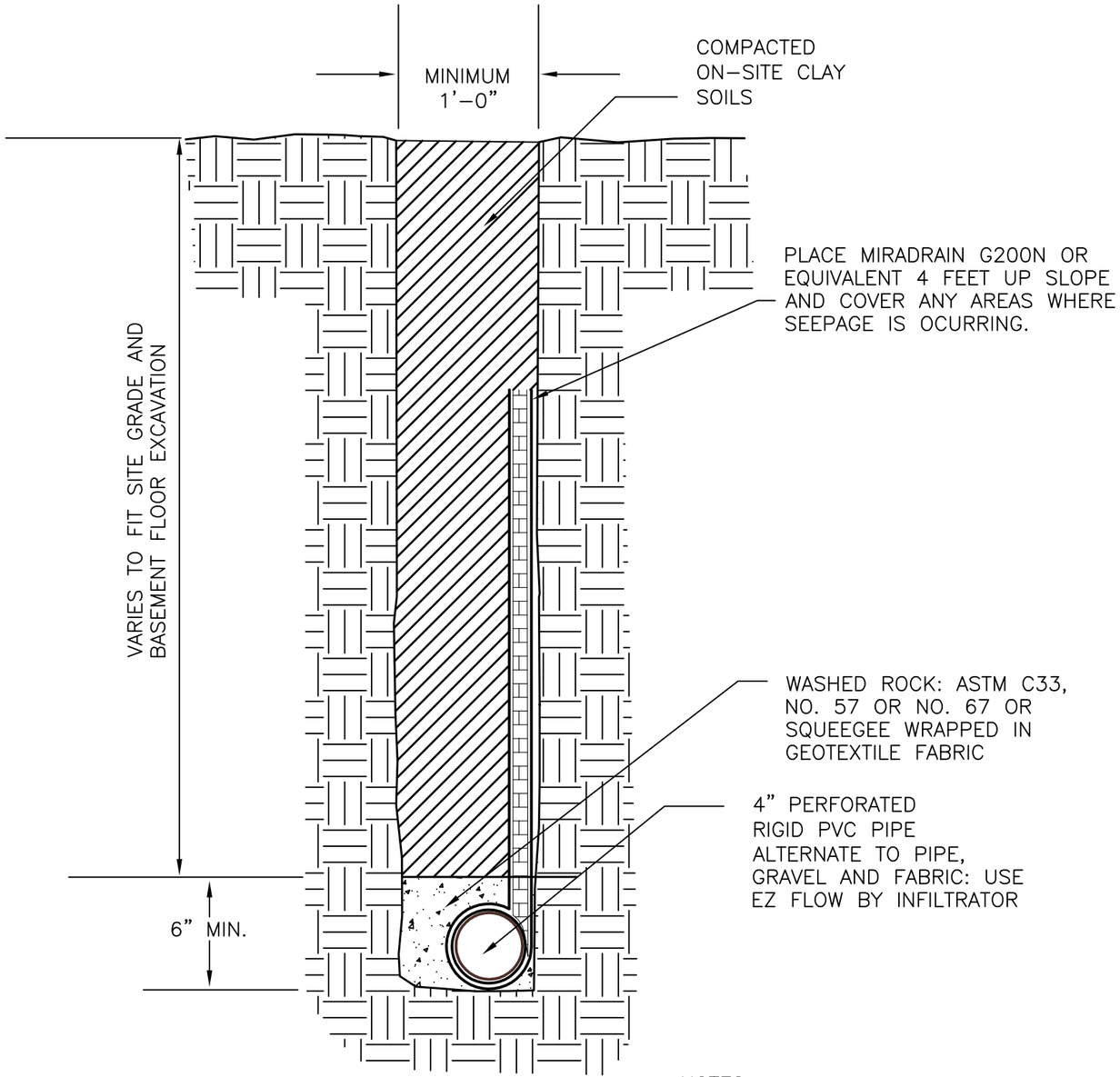
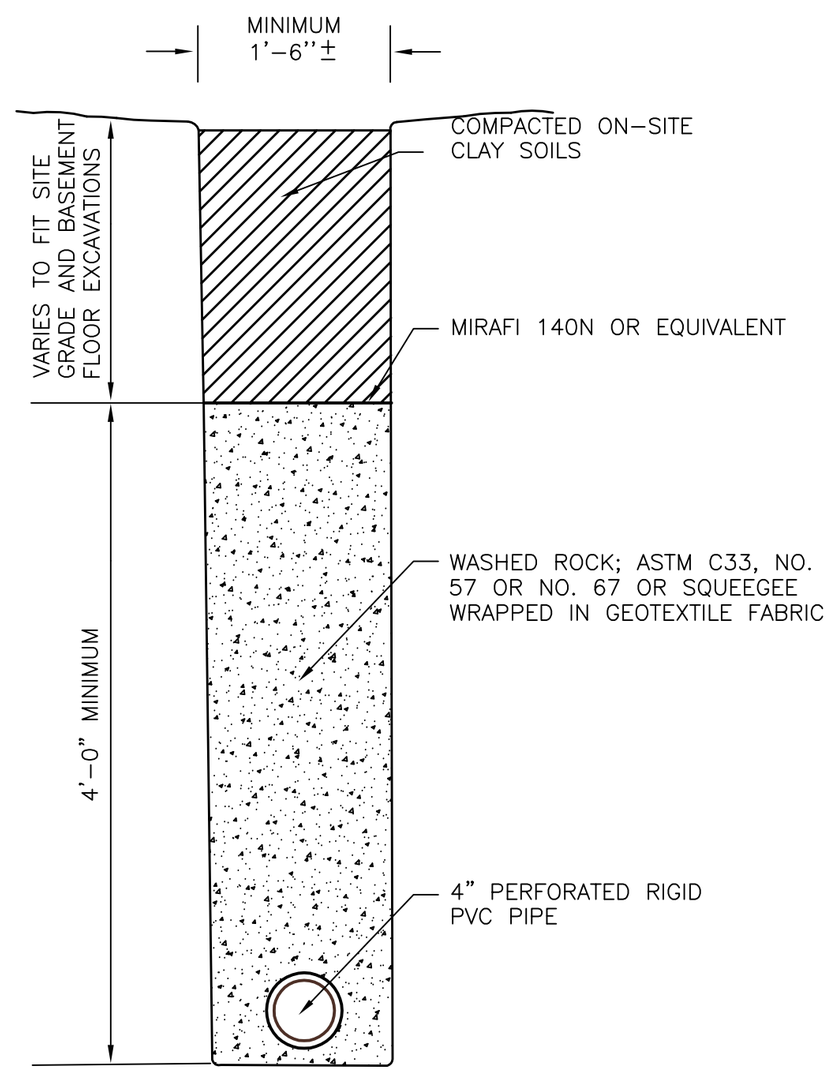
Project No. DN47,910-115

Fill Subdrain

Fig. 6





NOTES:

1) THE BOTTOM OF THE DRAIN SHOULD TO A POSITIVE GRAVITY WITH A MINIMUM SLOPE OF 0.5 PERCENT.

2) THE DRAIN CAN CONNECT AND DISCHARGE TO THE UNDERDRAIN, OUTFALL OR MANHOLE PUMP STATION.

NOT TO SCALE

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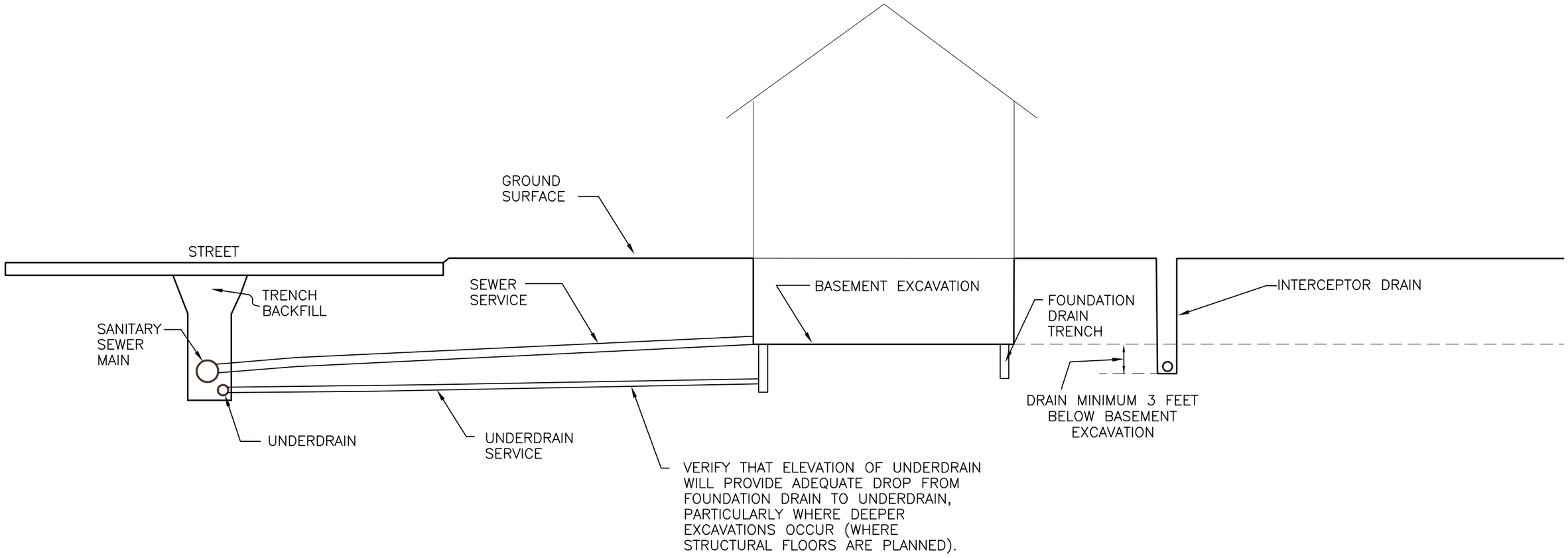
Project No. DN47,910-115

Typical Interceptor Drain

Fig. 7



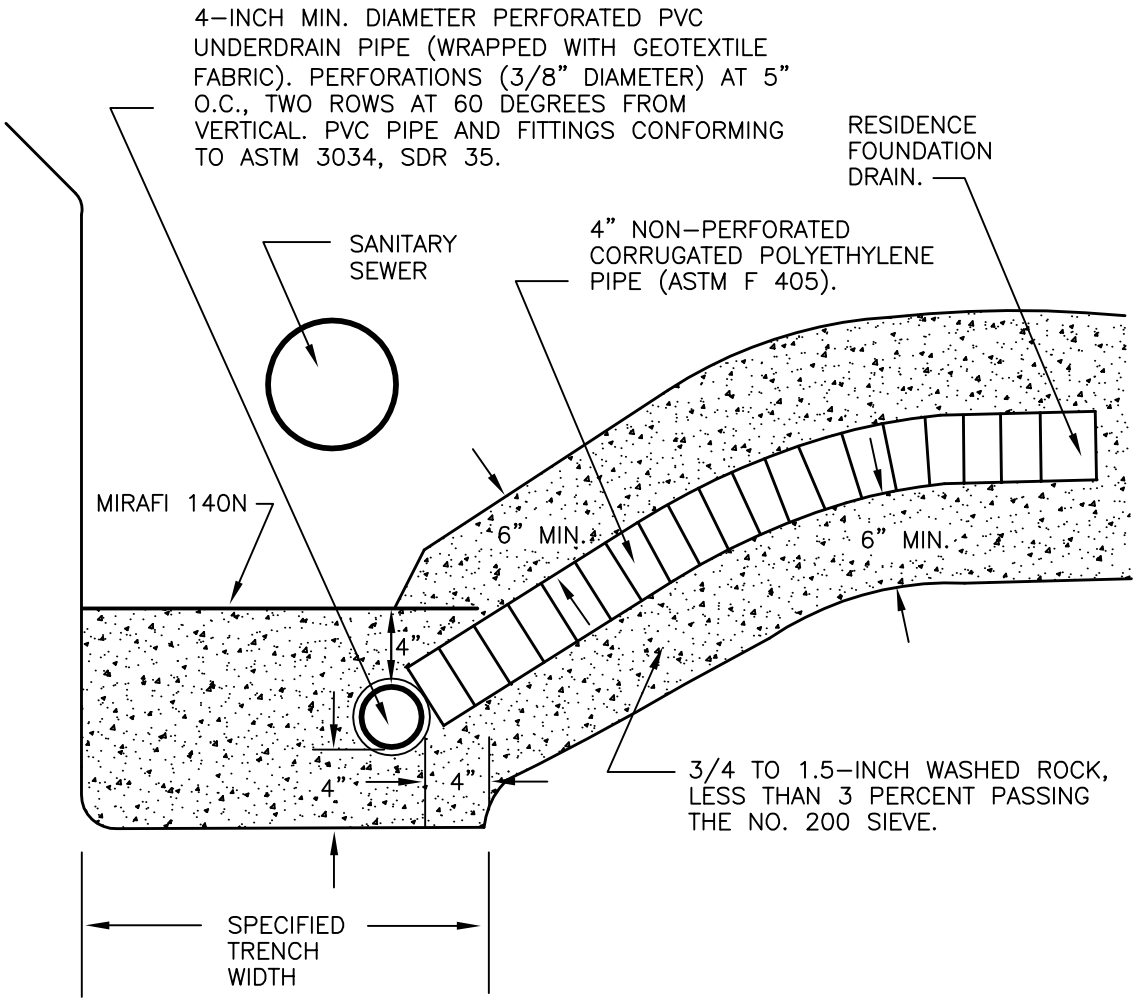
NOT TO SCALE

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
Project No. DN47,910-115

Conceptual Interceptor/Underdrain Profile

Fig. 8

50-UNDERDRAIN_02

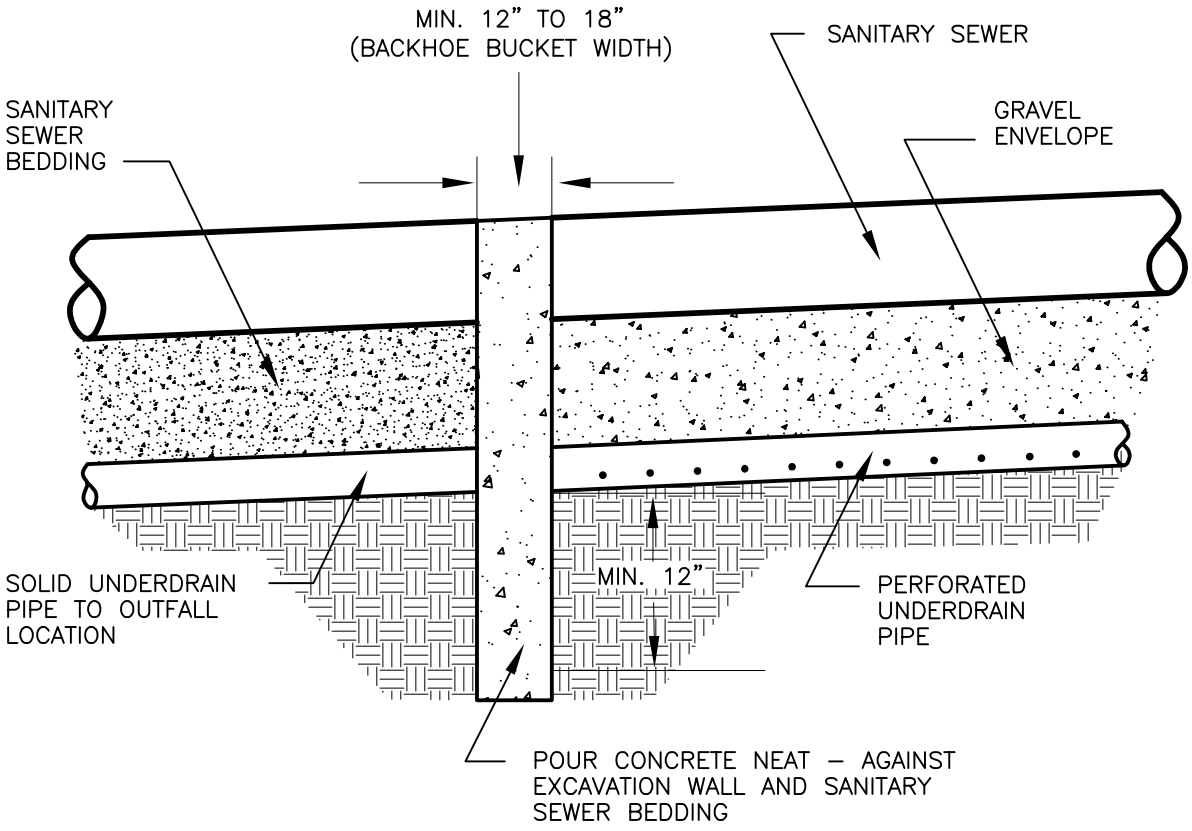


NOTE: NOT TO SCALE

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
Project No. DN47,910-115

Conceptual Sewer Underdrain Detail Fig. 9

50-UNDERDRAIN_05



NOTE:
THE CONCRETE CUTOFF WALL SHOULD EXTEND INTO THE UNDISTURBED SOILS OUTSIDE THE UNDERDRAIN AND SANITARY SEWER TRENCH A MINIMUM DISTANCE OF 12 INCHES.

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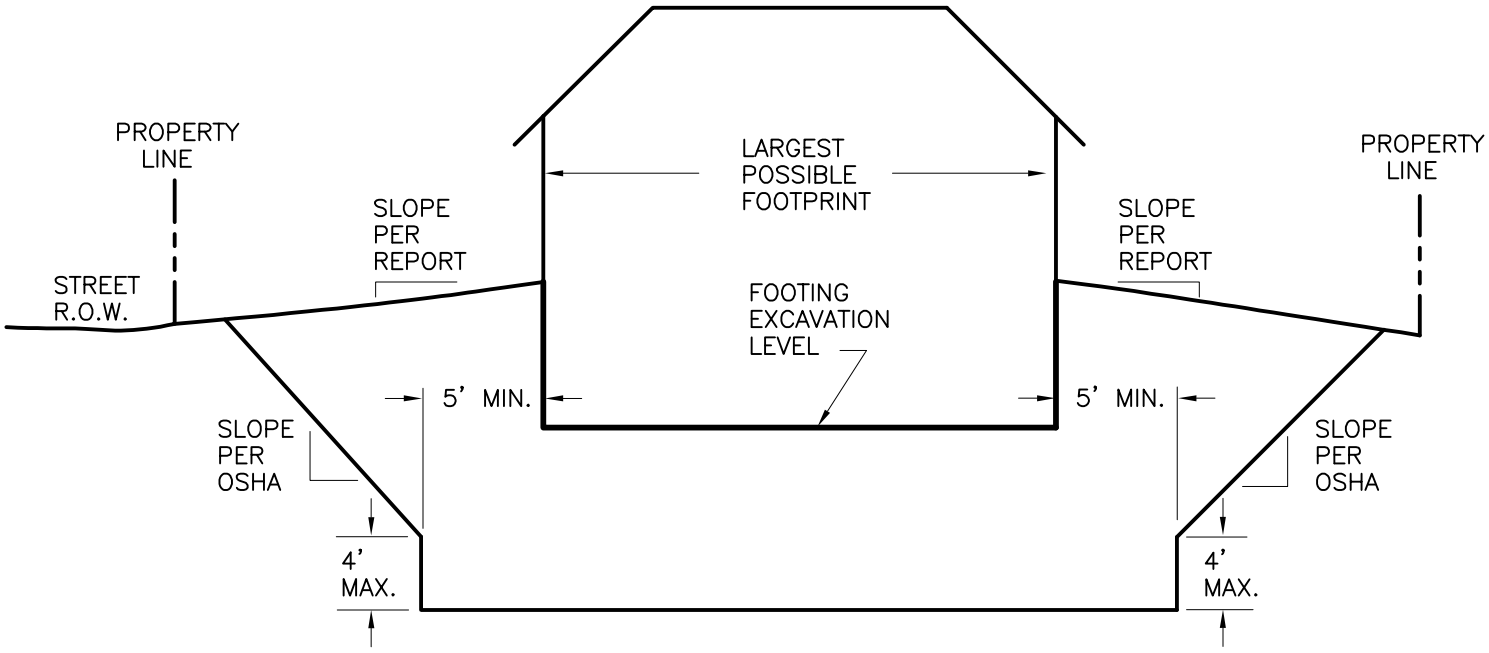
Project No. DN47,910-115

Underdrain Cutoff Wall Detail

Fig. 10

95-SUB-EXCAVATION_01



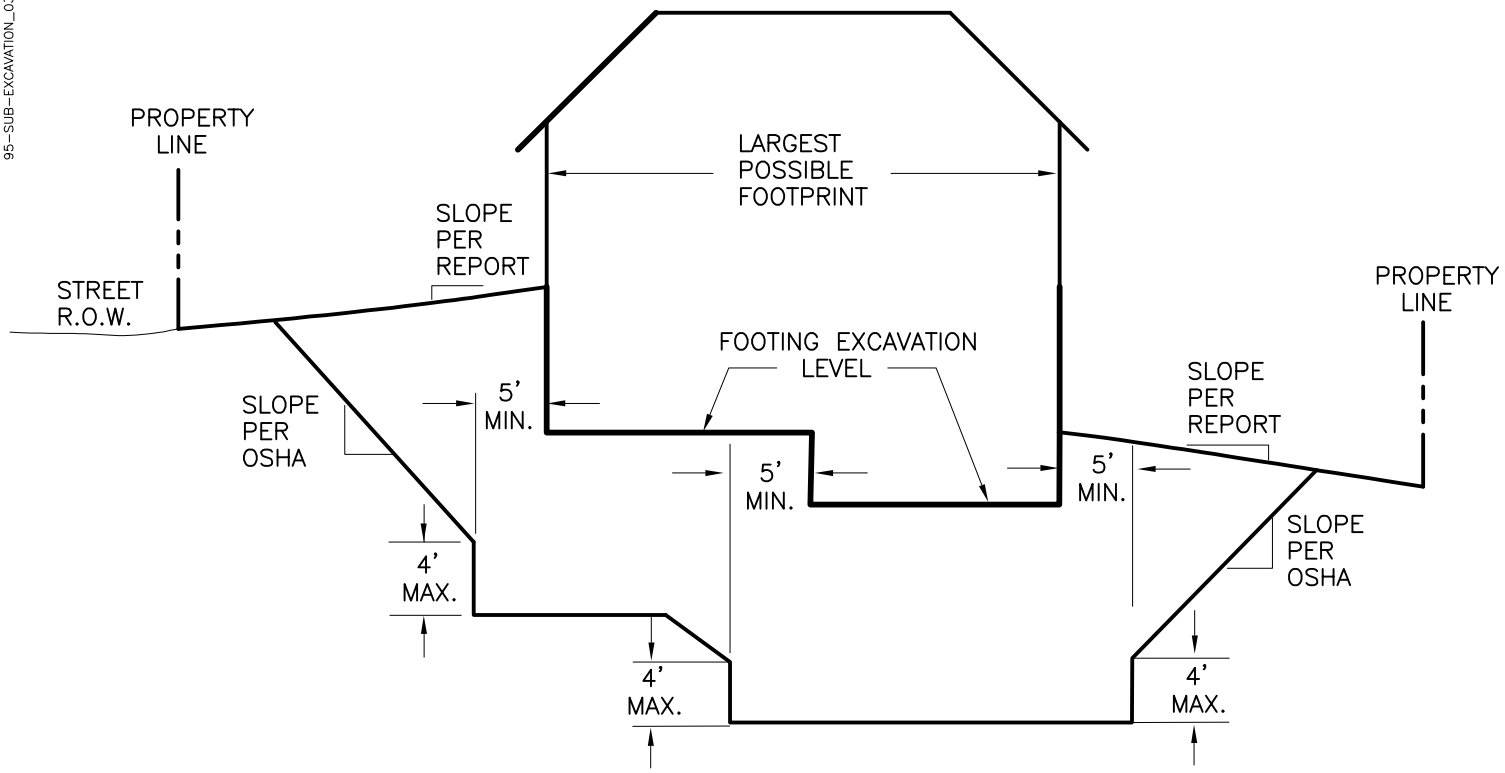
NOT TO SCALE

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
Project No. DN47,910-115

Conceptual Sub-excavation Profile

Fig. 11

95-SUB-EXCAVATION_03



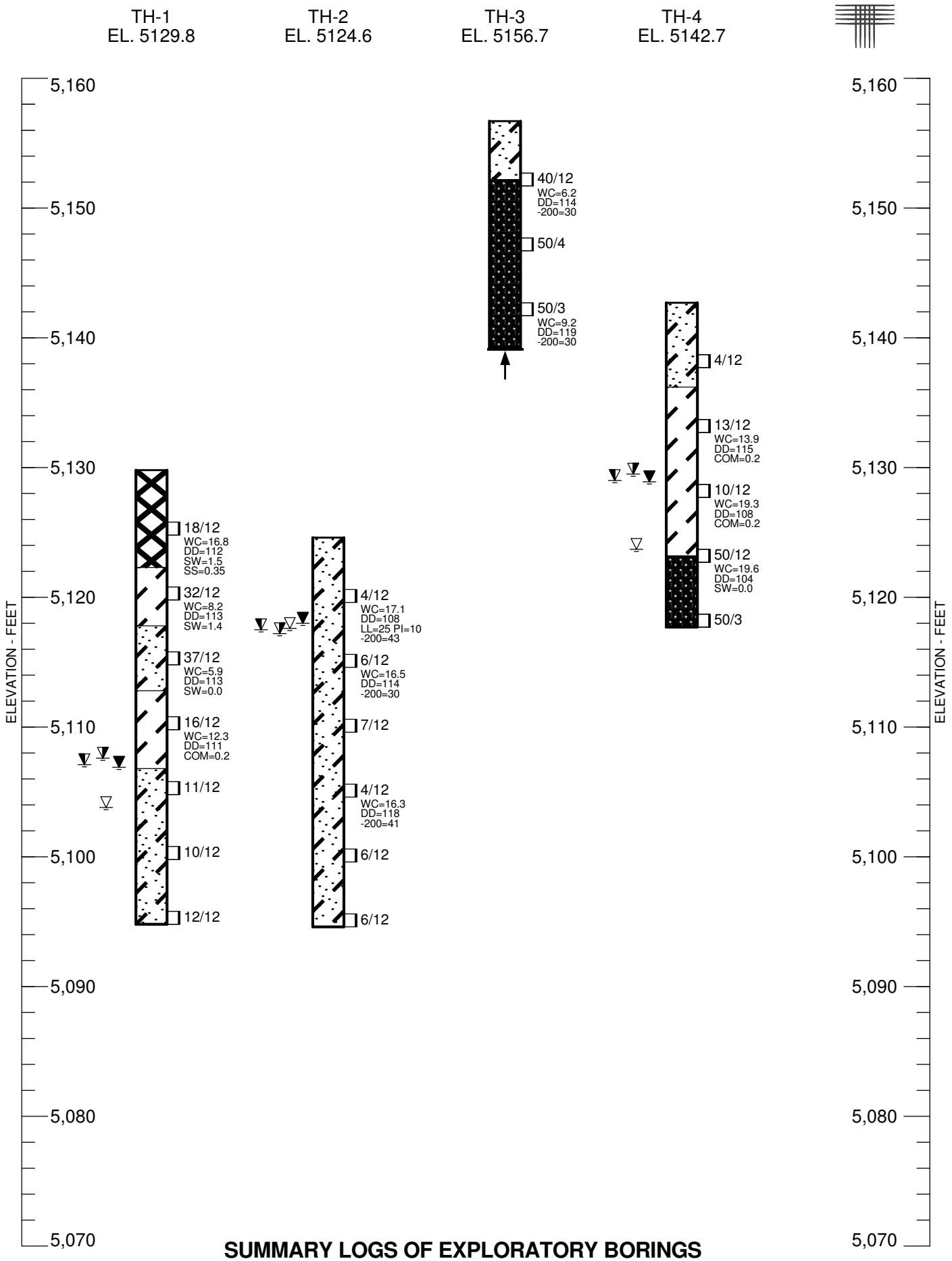
NOT TO SCALE

Conceptual Sub-excavation Profile

(Walk-out Basement) Fig. 12

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
Project No. DN47,910-115

APPENDIX A
SUMMARY LOGS OF EXPLORATORY BORINGS



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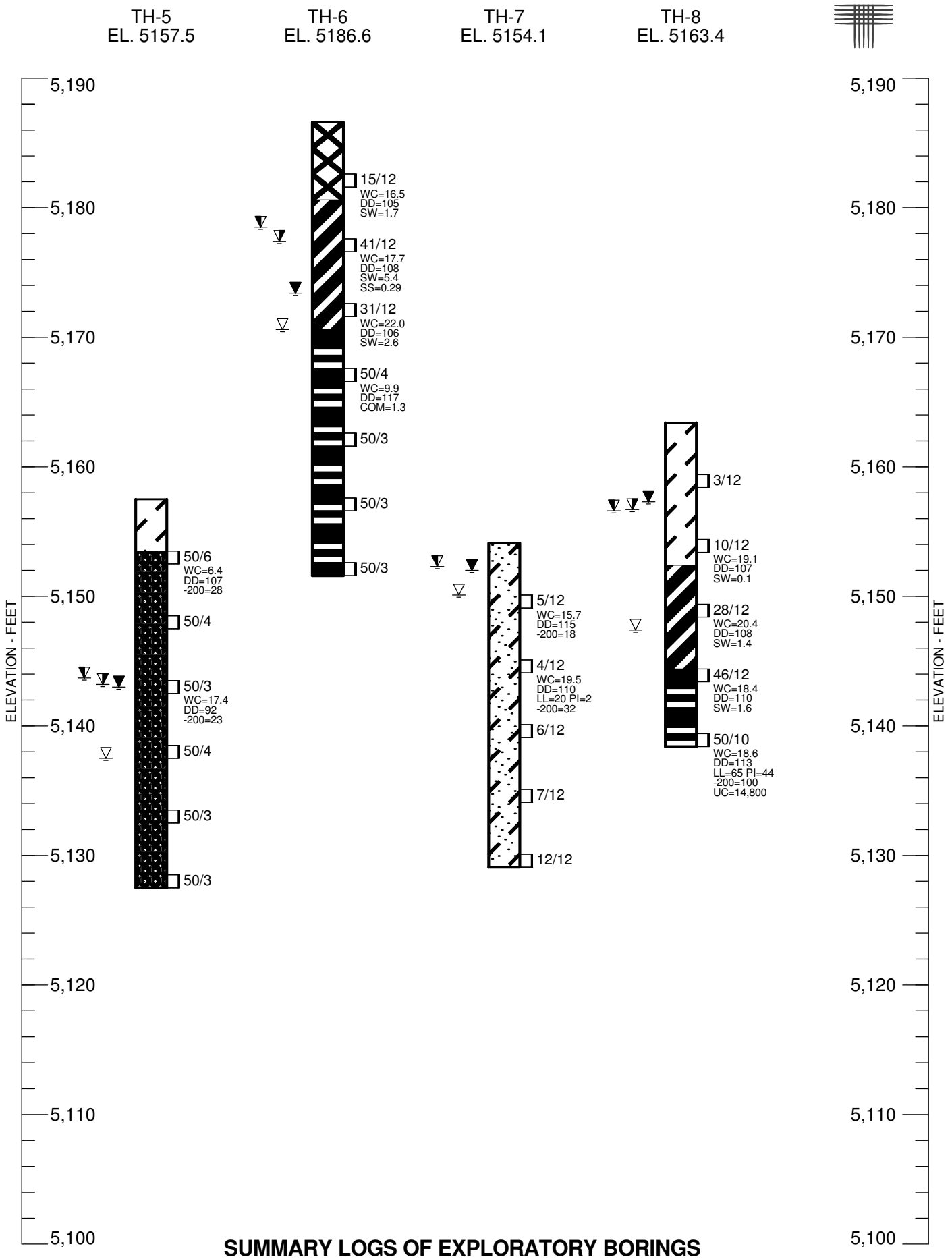
SUMMARY LOGS OF EXPLORATORY BORINGS

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115

FIG. A- 1



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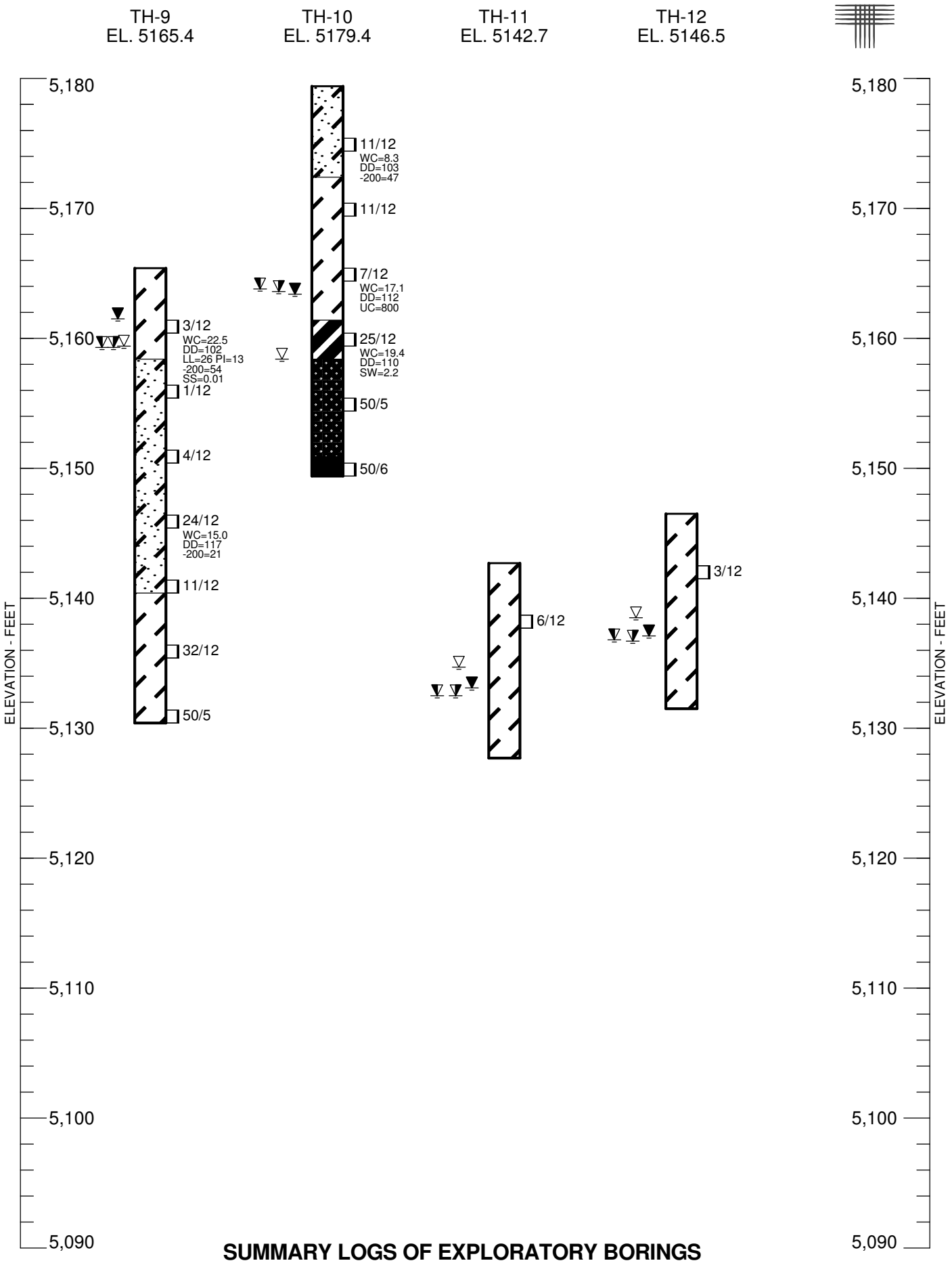
SUMMARY LOGS OF EXPLORATORY BORINGS

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115

FIG. A- 2



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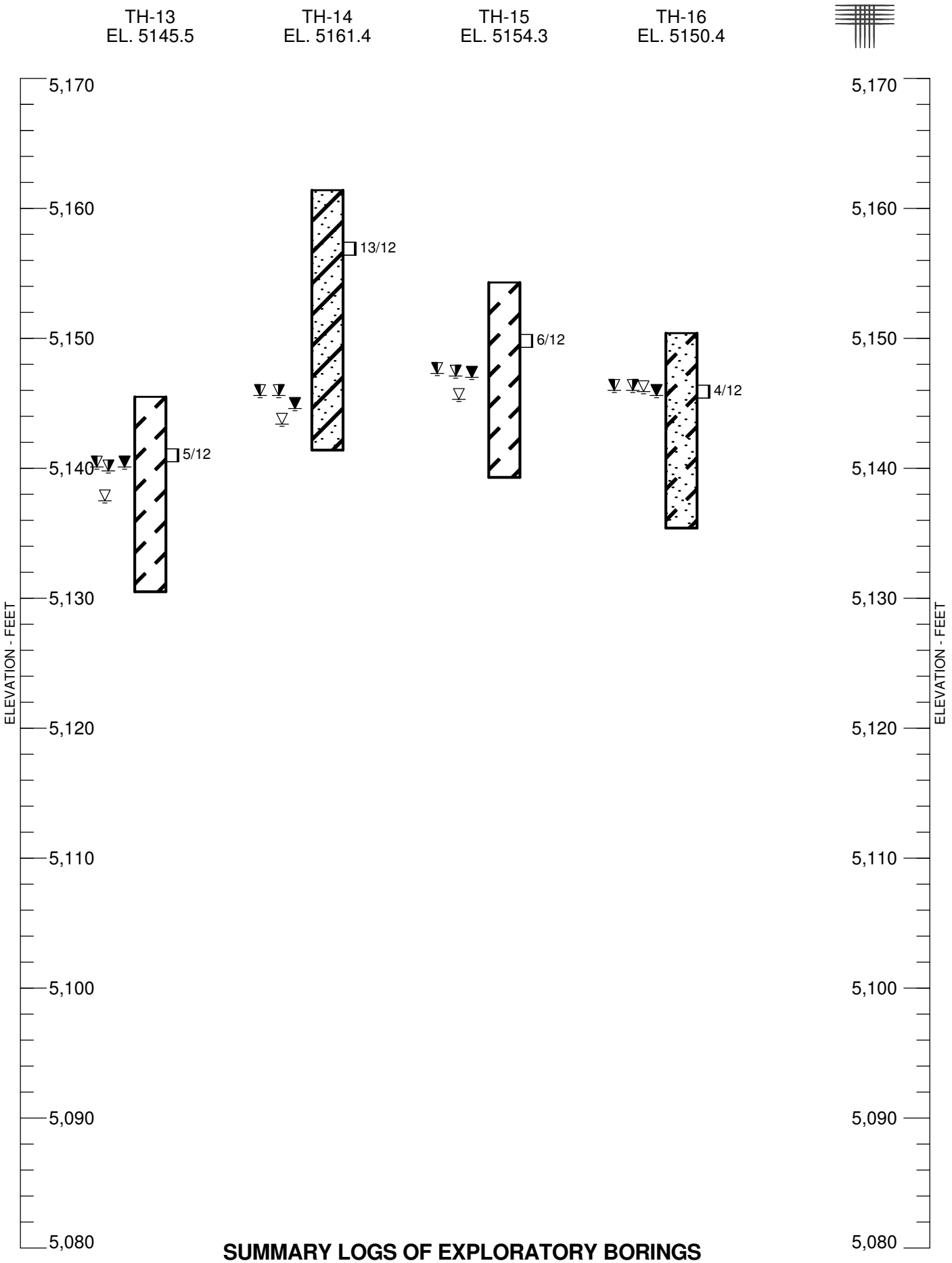
SUMMARY LOGS OF EXPLORATORY BORINGS

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115

FIG. A- 3



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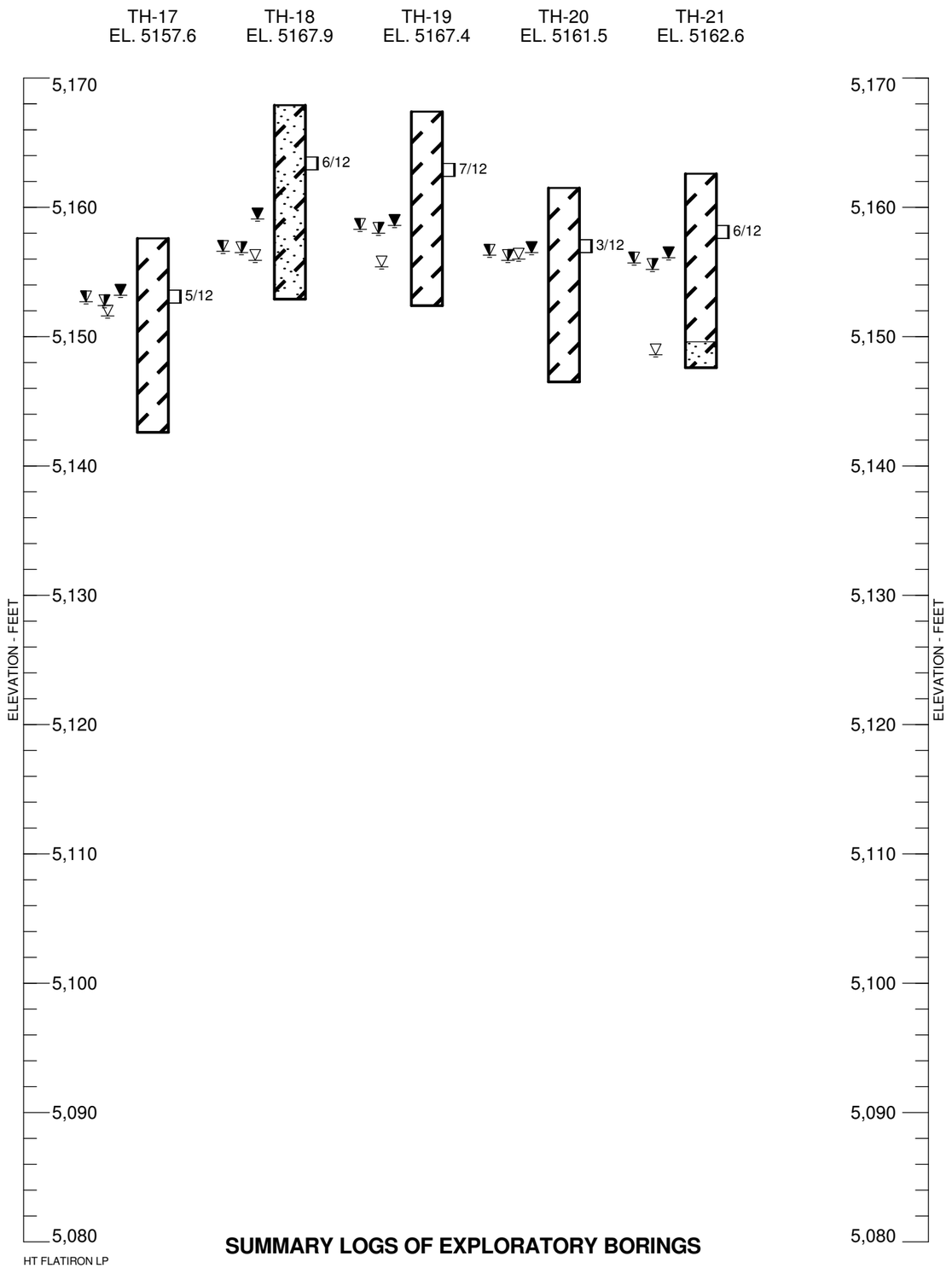
SUMMARY LOGS OF EXPLORATORY BORINGS

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115

FIG. A- 4



SUMMARY LOGS OF EXPLORATORY BORINGS

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115

LEGEND:

- FILL, CLAY, SANDY, SILTY, VERY STIFF, MOIST, BROWN, GRAY, TAN, RUST.
- CLAY, SANDY TO VERY SANDY, SILTY, GRAVELLY AT DEPTH, SOFT TO VERY STIFF, MOIST TO VERY MOIST, BROWN, TAN, GRAY, WHITE (CL).
- SAND, SILTY TO VERY CLAYEY, VERY LOOSE TO DENSE, SLIGHTLY MOIST TO WET, BROWN, LIGHT BROWN, TAN (SM, SC).
- WEATHERED CLAYSTONE, MOIST, GRAY, RUST, OLIVE.
- BEDROCK, CLAYSTONE, SILTY, SILTSTONE LAYERS, HARD TO VERY HARD, SLIGHTLY MOIST TO MOIST, GRAY, RUST, BROWN, LIGHT GRAY, TAN.
- BEDROCK, SANDSTONE, SOME SILTSTONE, SILTY TO CLAYEY, CEMENTED ZONES, VERY HARD, MOIST TO VERY MOIST, LIGHT GRAY, RUST, GRAY, BROWN, TAN.
- DRIVE SAMPLE. THE SYMBOL 18/12 INDICATES 18 BLOWS OF AN AUTOMATIC 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.
- WATER LEVEL MEASURED AT TIME OF DRILLING.
- WATER LEVEL MEASURED AFTER DRILLING ON JUNE 23, 2015 (TH-1 THROUGH TH-10) OR SEPTEMBER 16, 2015 (TH-11 THROUGH TH-21).
- WATER LEVEL MEASURED AFTER DRILLING ON JULY 2, 2015 (TH-1 THROUGH TH-10) OR SEPTEMBER 23, 2015 (TH-11 THROUGH TH-21).
- WATER LEVEL MEASURED AFTER DRILLING ON JULY 9, 2015 (TH-1 THROUGH TH-10) OR OCTOBER 8, 2015 (TH-11 THROUGH TH-21).
- PRACTICAL DRILL REFUSAL.

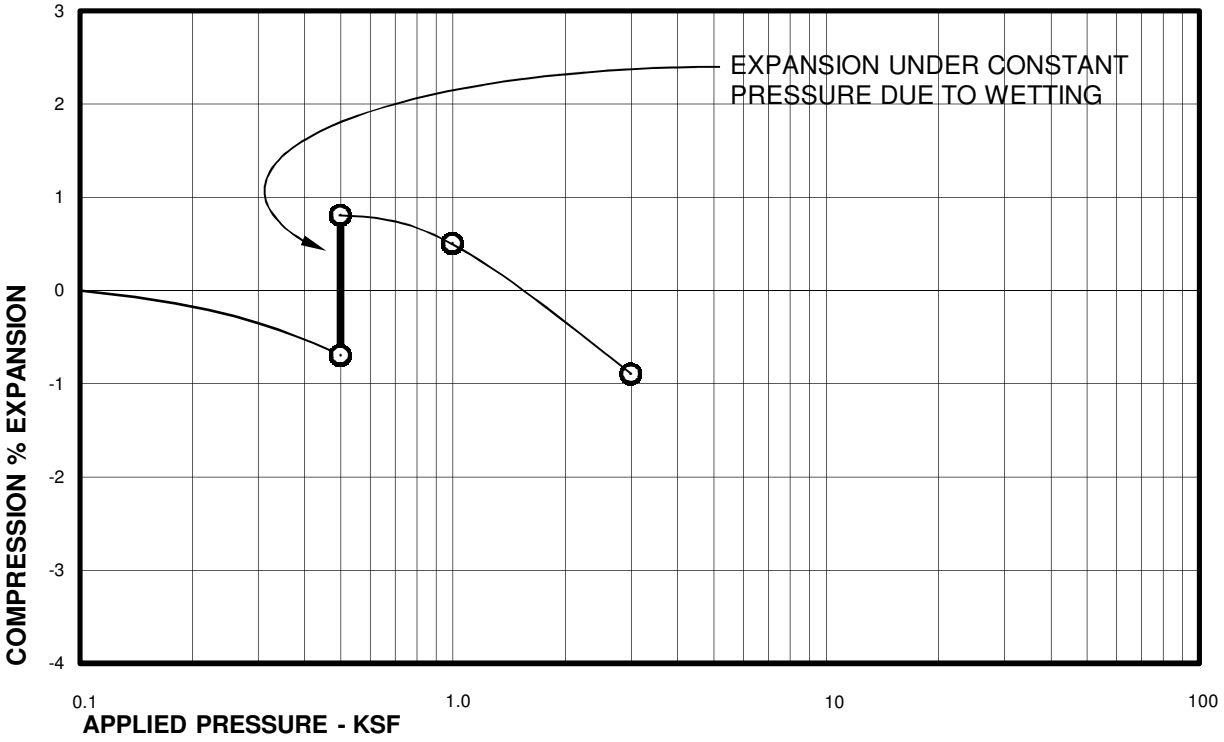
NOTES:

1. THE BORINGS WERE DRILLED USING 4-INCH DIAMETER, CONTINUOUS-FLIGHT SOLID-STEM AUGER AND TRUCK-MOUNTED CME-45 AND CME-55 DRILL RIGS.TH-1 THROUGH TH-10 WERE DRILLED ON JUNE 11, 17 AND 22, 2015 AND TH-11 THROUGH TH-21 WERE DRILLED ON SEPTEMBER 14, 2015.
2. BORING LOCATIONS WERE STAKED AND ELEVATIONS WERE PROVIDED BY CALIBRE ENGINEERING.
3. WC - INDICATES MOISTURE CONTENT (%).
   DD - INDICATES DRY DENSITY (PCF).
   SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE (%).
   COM- INDICATES COMPRESSION WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE (%).
   LL - INDICATES LIQUID LIMIT.
   PI - INDICATES PLASTICITY INDEX.
   -200 - INDICATES PASSING NO. 200 SIEVE (%).
   UC - INDICATES UNCONFINED COMPRESSIVE STRENGTH (psf).
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT (%).
4. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS CONTAINED IN THIS REPORT.

FIG. A- 5

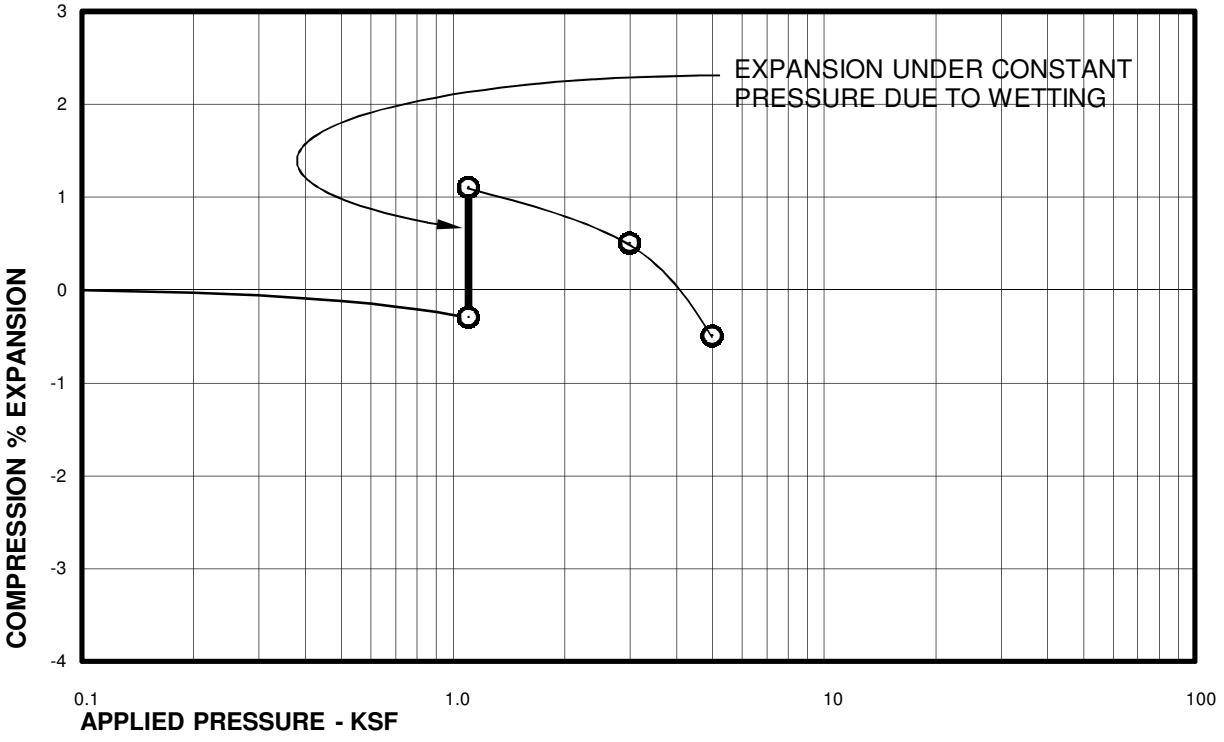
APPENDIX B

LABORATORY TEST RESULTS
TABLE B-I – SUMMARY OF LABORATORY TEST RESULTS



Sample of FILL, CLAY, SANDY
From TH-1 AT 4 FEET

DRY UNIT WEIGHT= 112 PCF
MOISTURE CONTENT= 16.8 %



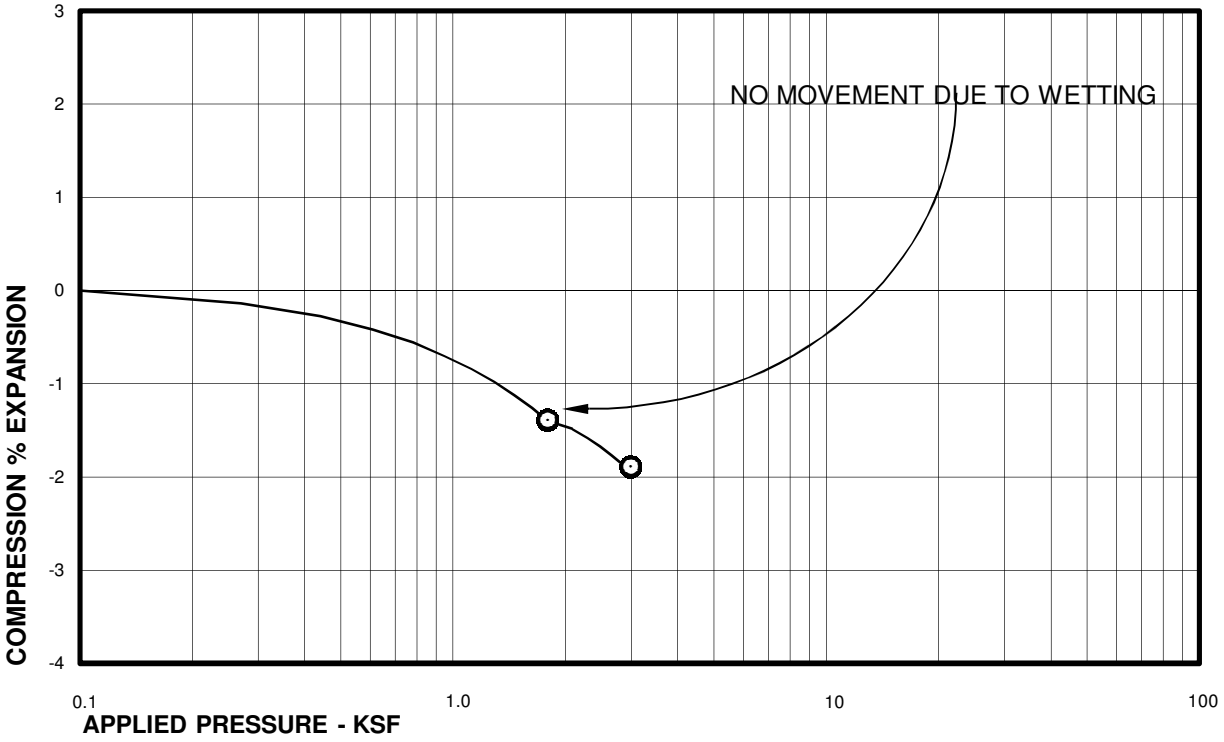
Sample of CLAY, SANDY (CL)
From TH-1 AT 9 FEET

DRY UNIT WEIGHT= 113 PCF
MOISTURE CONTENT= 8.2 %

Swell Consolidation Test Results

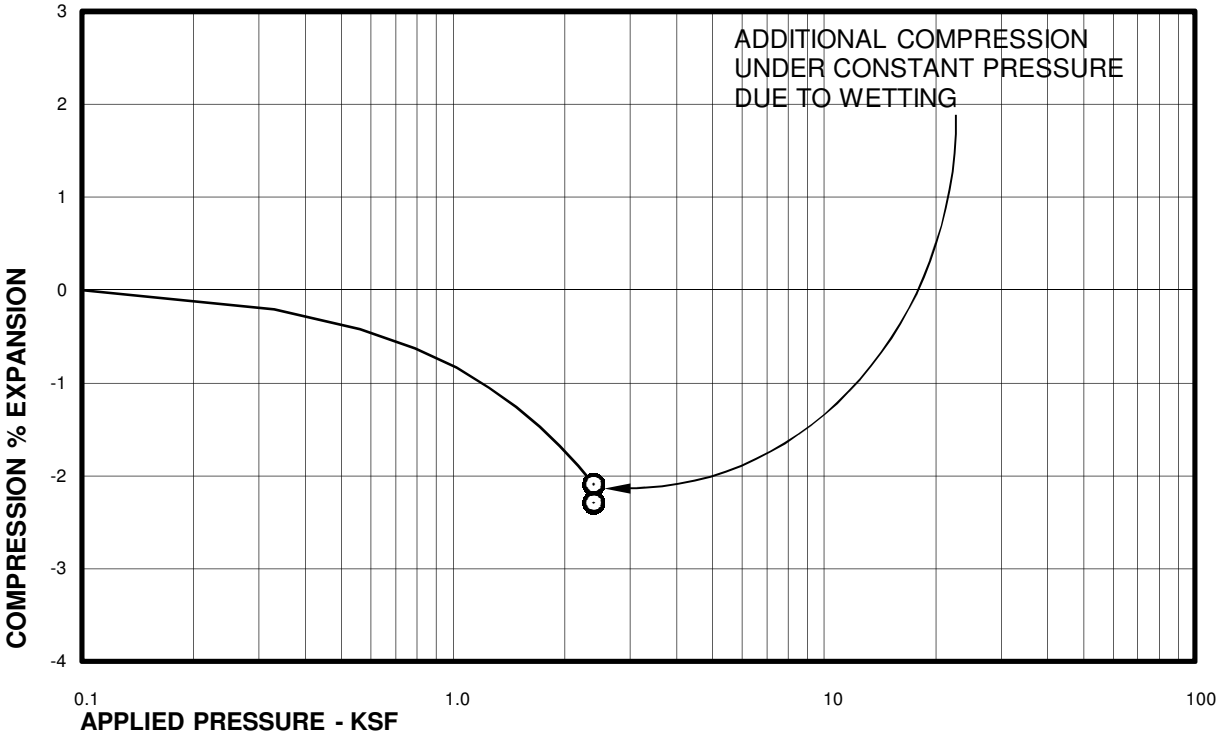
FIG. B-1

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)



Sample of SAND, CLAYEY (SC)
From TH-1 AT 14 FEET

DRY UNIT WEIGHT= 113 PCF
MOISTURE CONTENT= 5.9 %



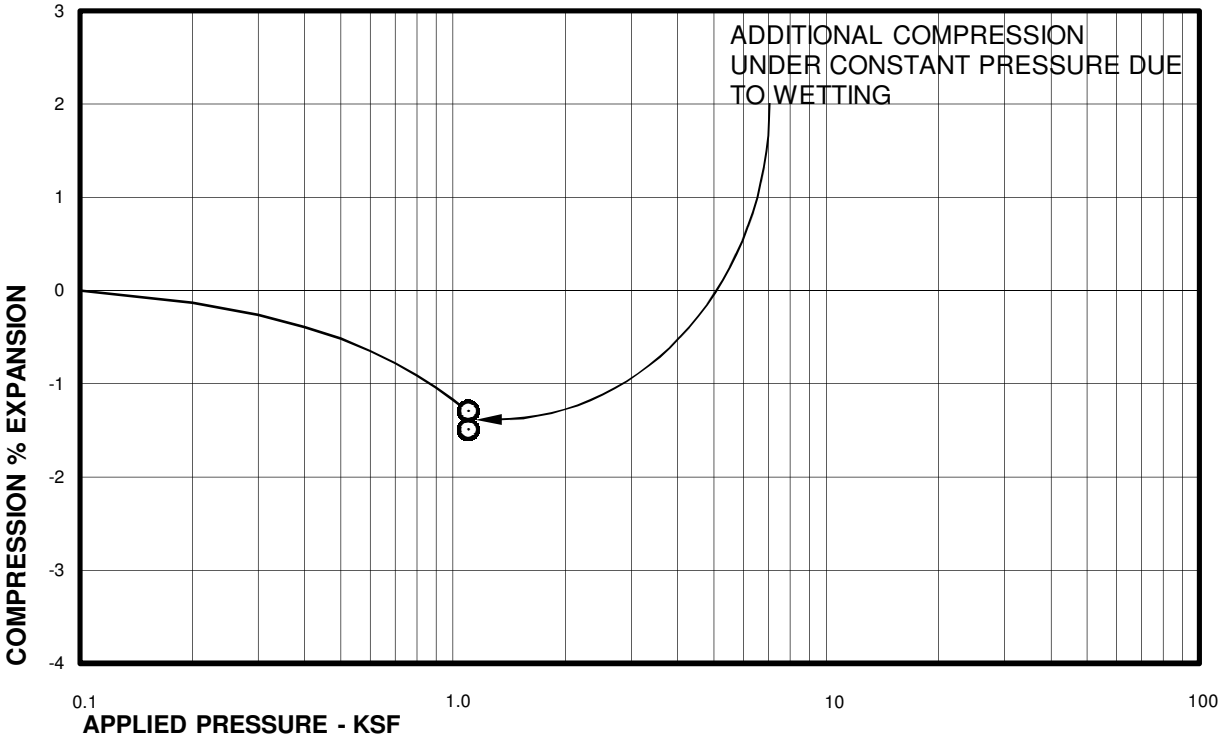
Sample of CLAY, SANDY (CL)
From TH-1 AT 19 FEET

DRY UNIT WEIGHT= 111 PCF
MOISTURE CONTENT= 12.3 %

Swell Consolidation Test Results

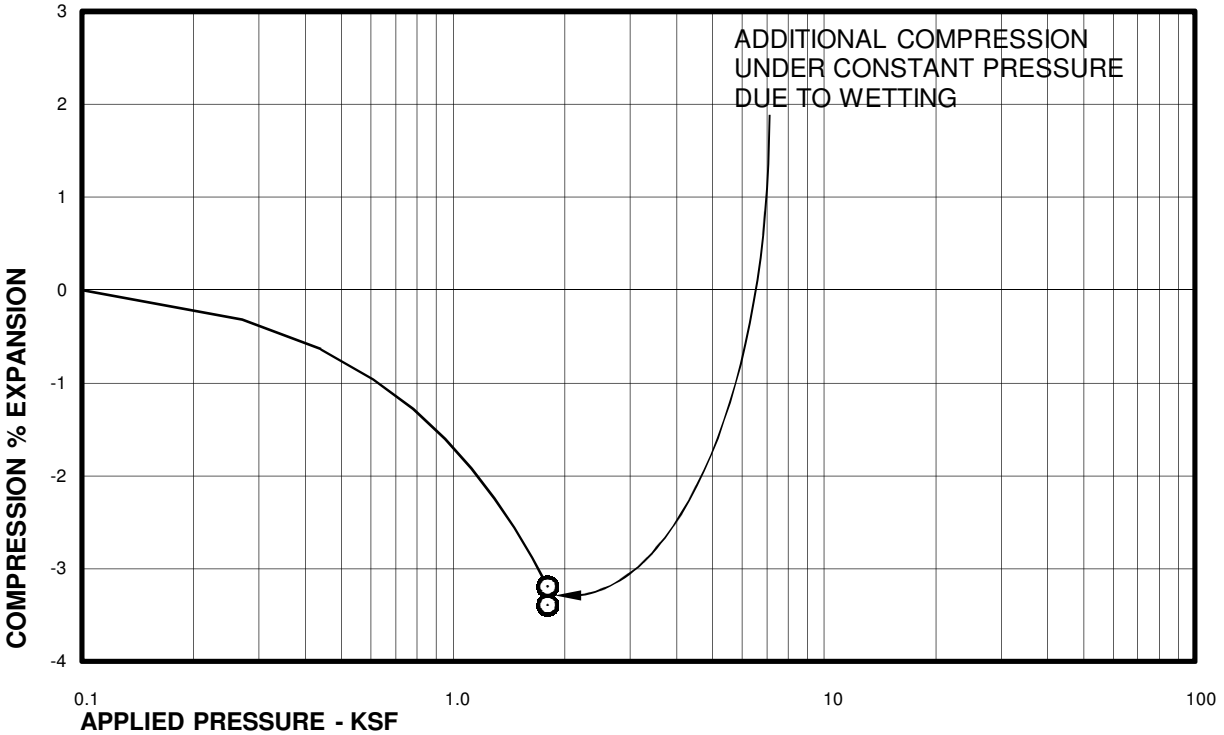
FIG. B-2

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)



Sample of CLAY, SANDY (CL)
From TH-4 AT 9 FEET

DRY UNIT WEIGHT= 115 PCF
MOISTURE CONTENT= 13.9 %



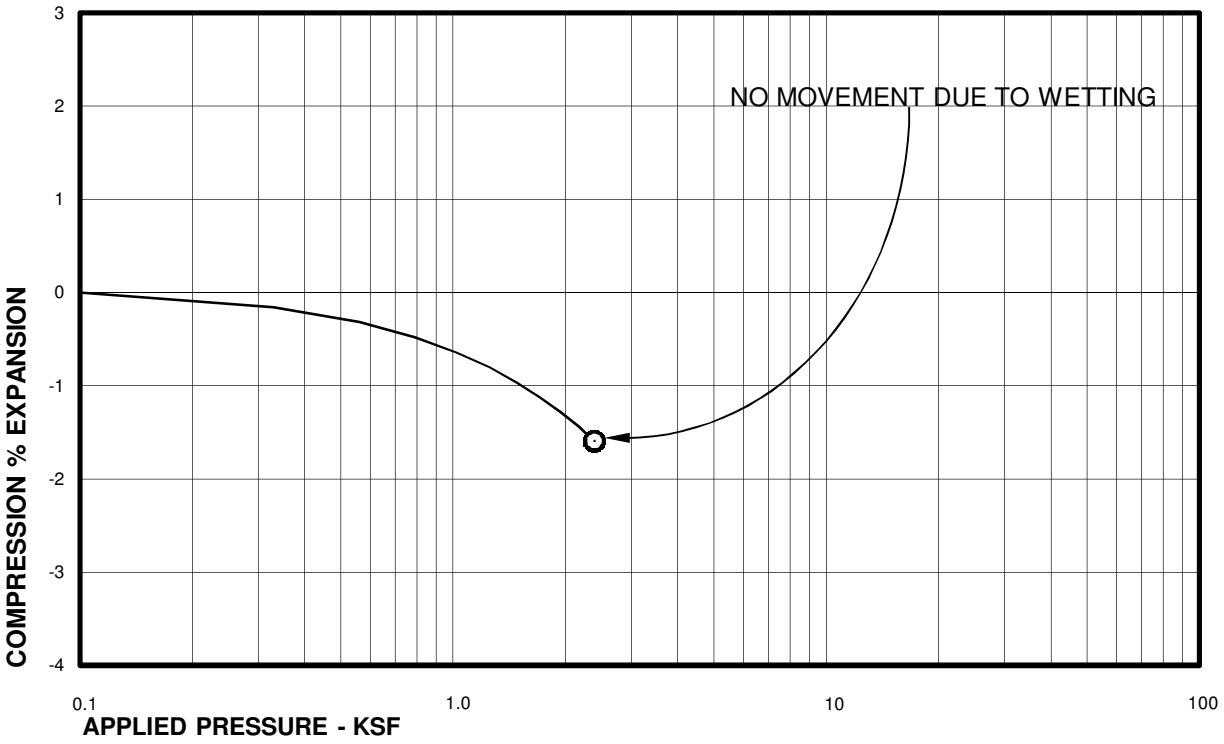
Sample of CLAY, SANDY (CL)
From TH-4 AT 14 FEET

DRY UNIT WEIGHT= 108 PCF
MOISTURE CONTENT= 19.3 %

Swell Consolidation Test Results

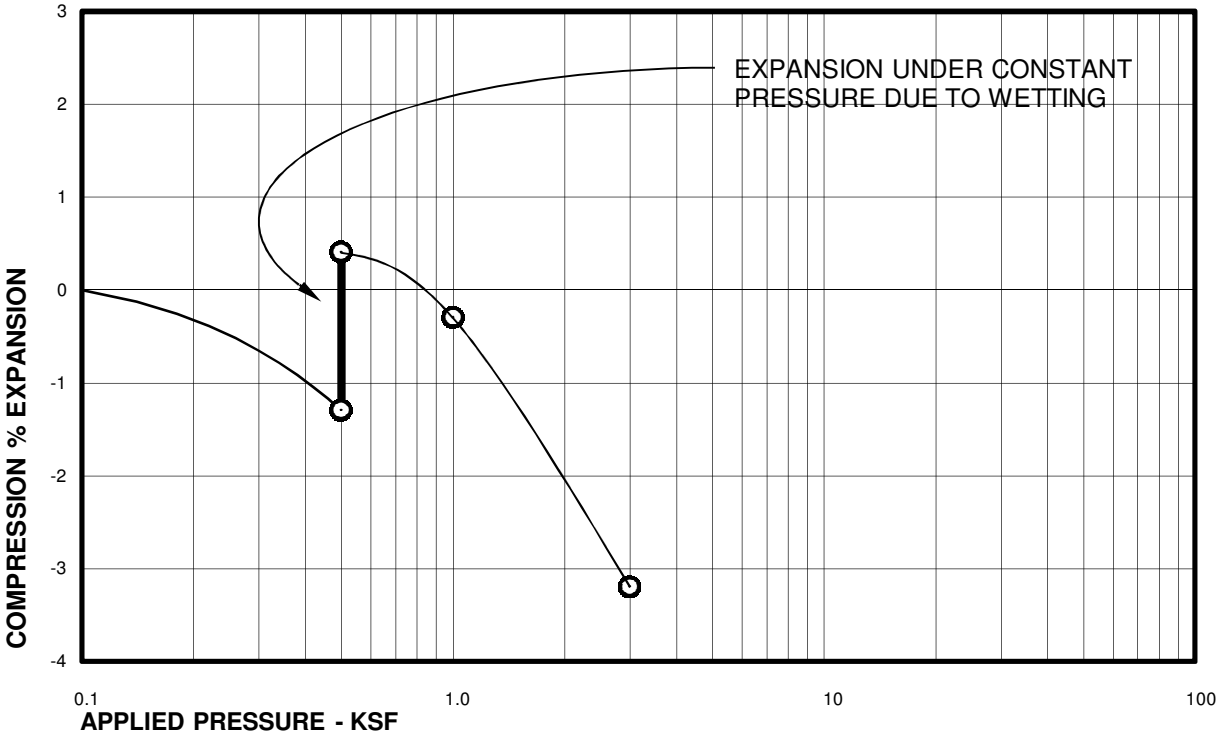
FIG. B-3

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)



Sample of SANDSTONE
From TH-4 AT 19 FEET

DRY UNIT WEIGHT= 104 PCF
MOISTURE CONTENT= 19.6 %



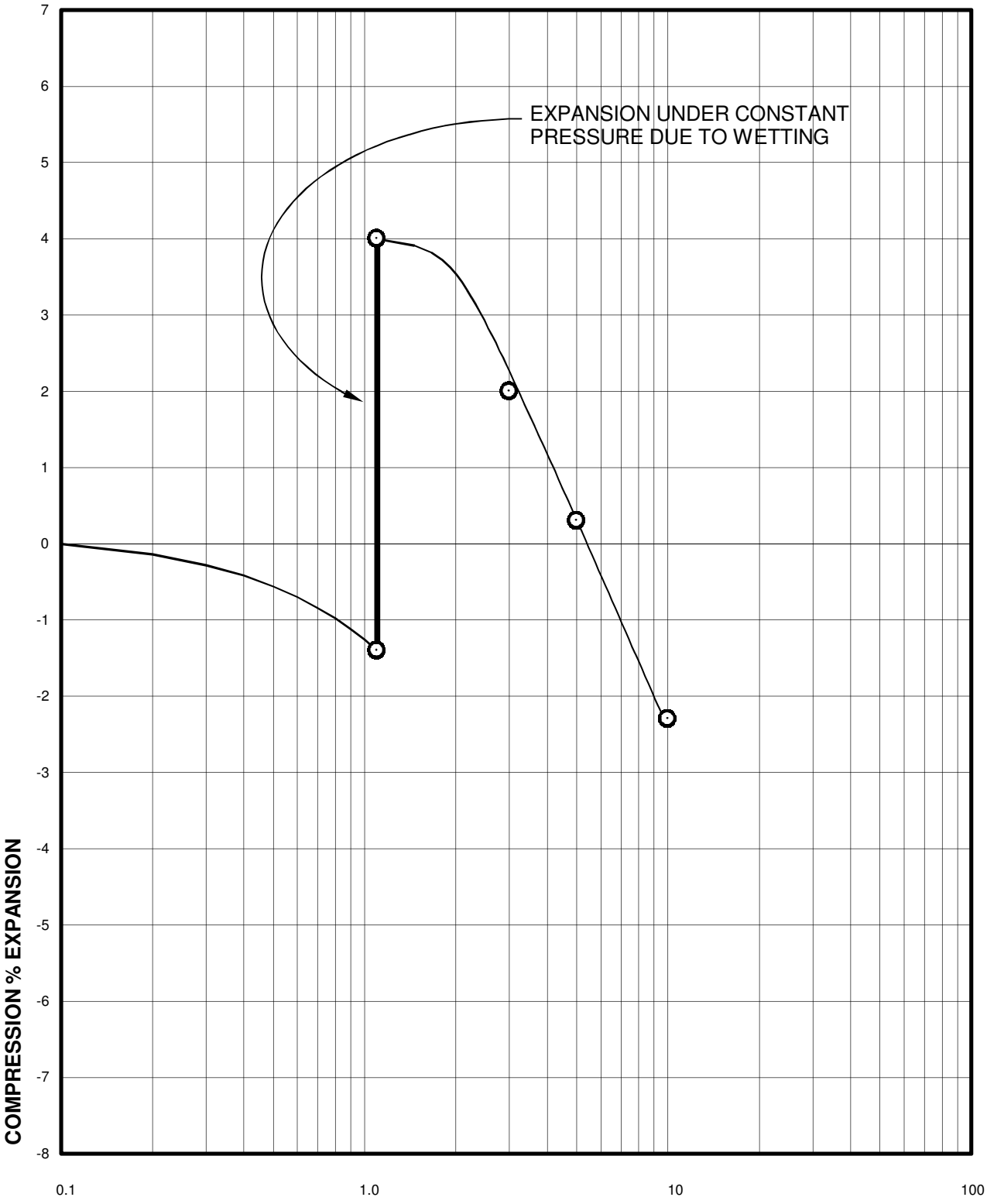
Sample of FILL, CLAY, SANDY
From TH-6 AT 4 FEET

DRY UNIT WEIGHT= 105 PCF
MOISTURE CONTENT= 16.5 %

Swell Consolidation Test Results

FIG. B-4

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)



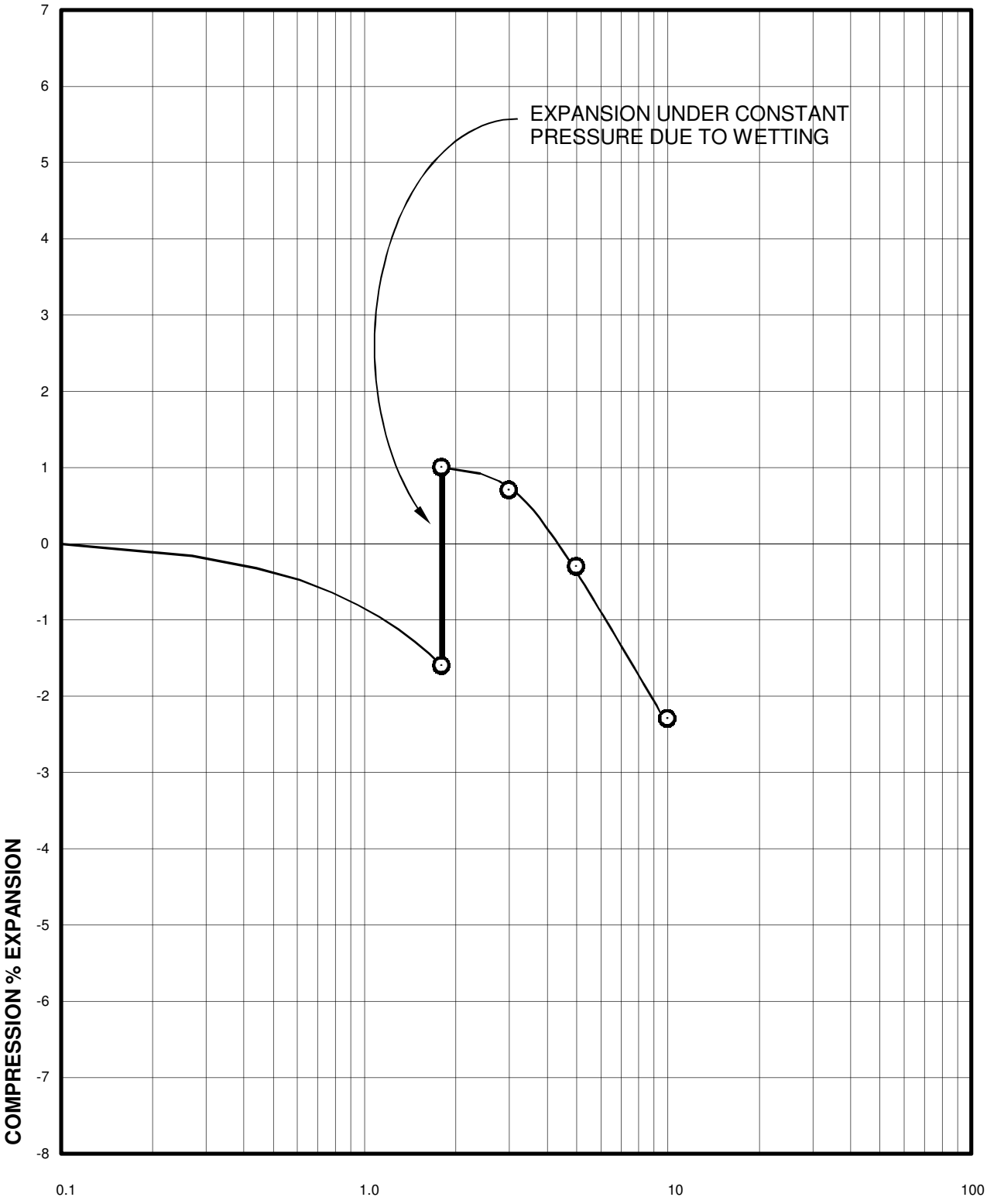
Sample of WEATHERED CLAYSTONE
From TH-6 AT 9 FEET

DRY UNIT WEIGHT= 108 PCF
MOISTURE CONTENT= 17.7 %

Swell Consolidation Test Results

FIG. B-5

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)



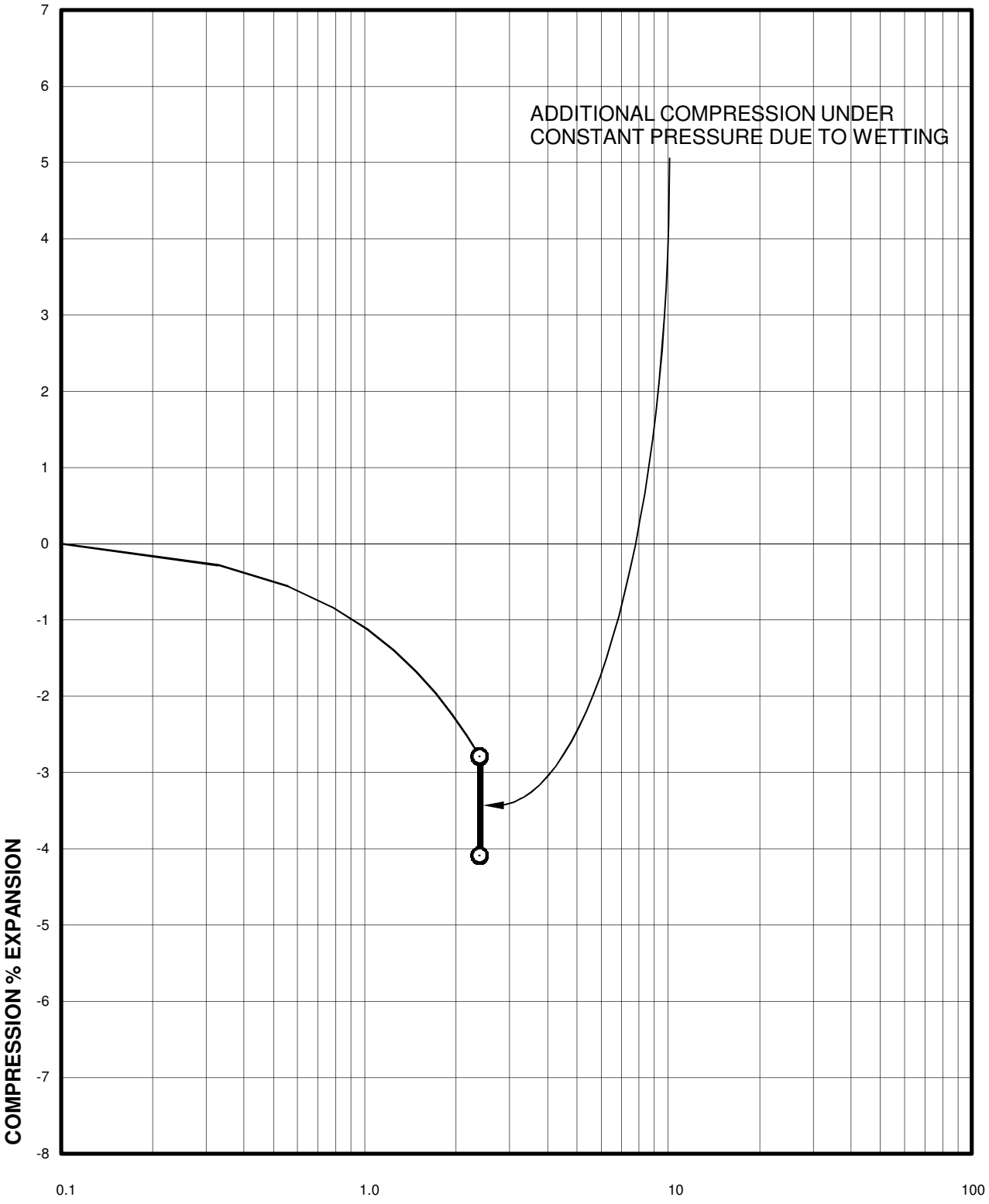
Sample of WEATHERED CLAYSTONE
From TH-6 AT 14 FEET

DRY UNIT WEIGHT= 106 PCF
MOISTURE CONTENT= 22.0 %

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)

Swell Consolidation Test Results

FIG. B-6



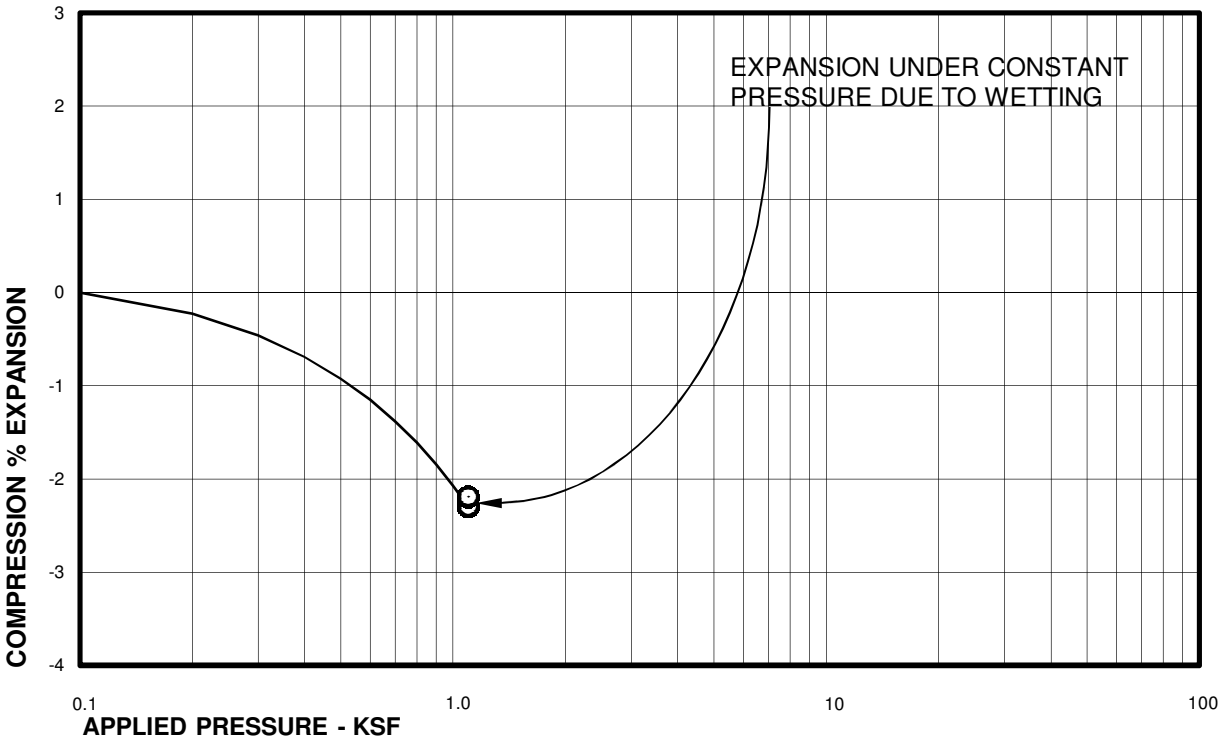
Sample of CLAYSTONE
From TH-6 AT 19 FEET

DRY UNIT WEIGHT= 117 PCF
MOISTURE CONTENT= 9.9 %

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)

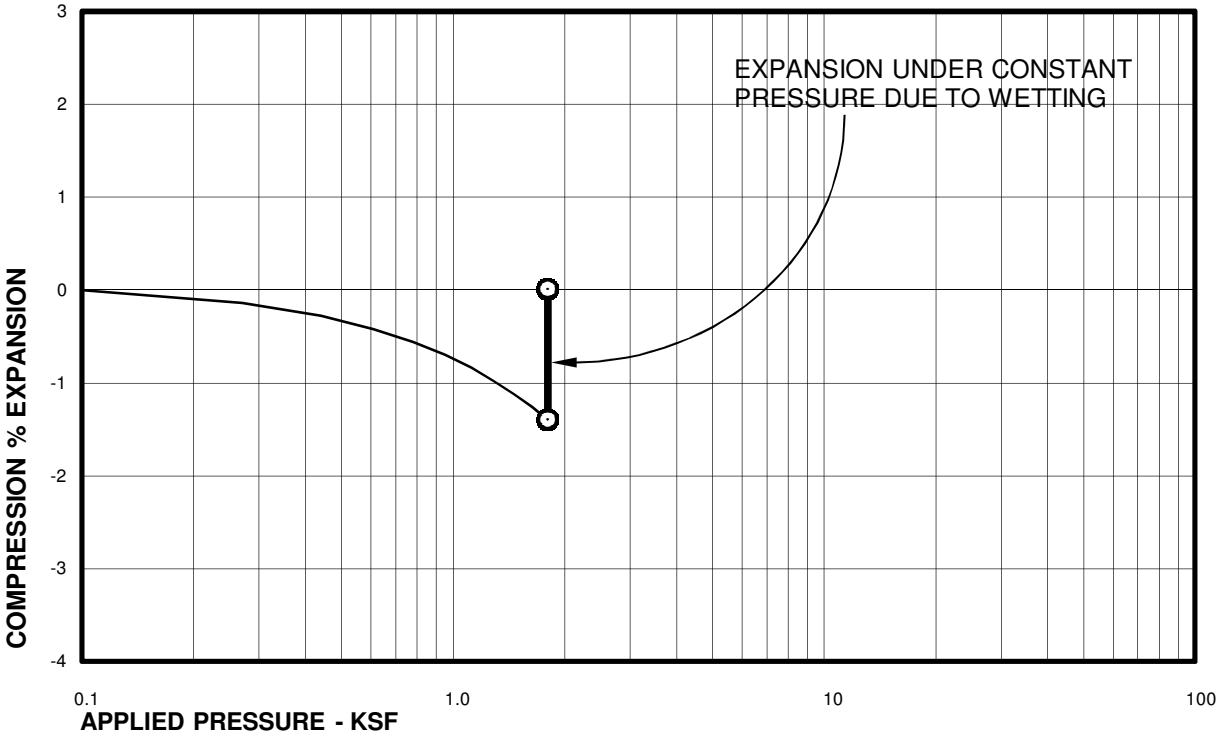
Swell Consolidation Test Results

FIG. B-7



Sample of CLAY, SANDY (CL)
From TH-8 AT 9 FEET

DRY UNIT WEIGHT= 107 PCF
MOISTURE CONTENT= 19.1 %



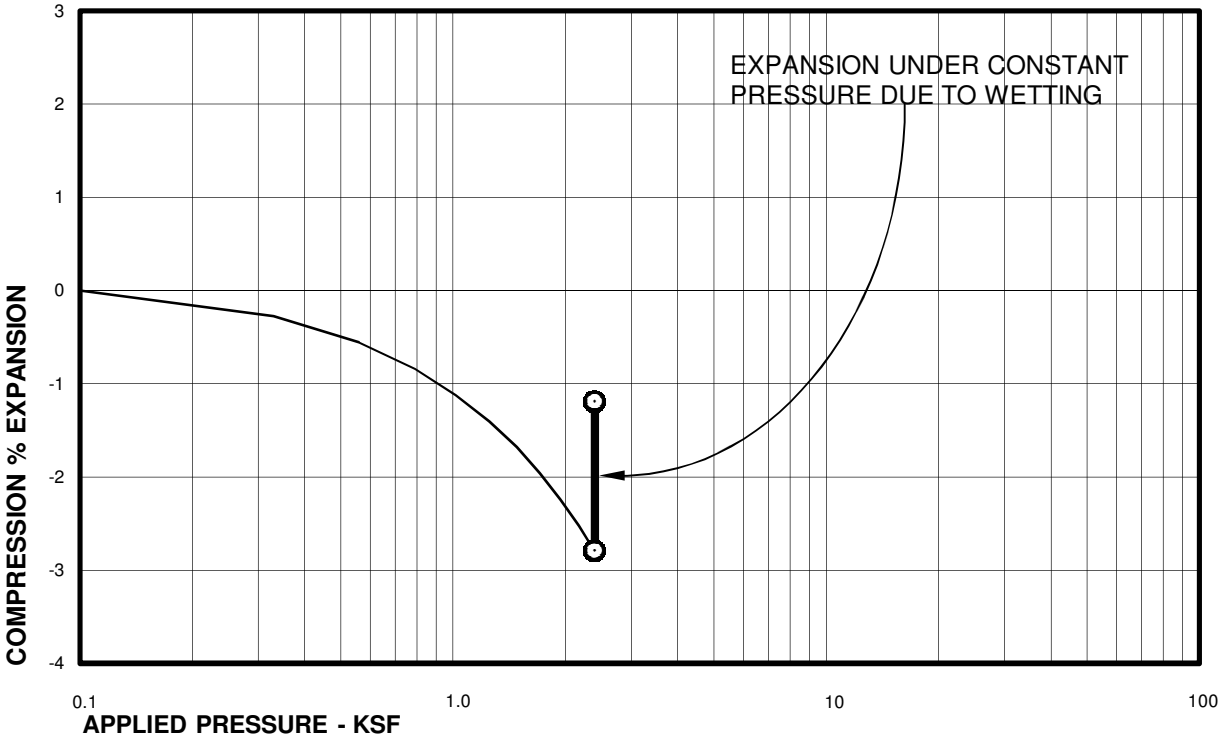
Sample of WEATHERED CLAYSTONE
From TH-8 AT 14 FEET

DRY UNIT WEIGHT= 108 PCF
MOISTURE CONTENT= 20.4 %

Swell Consolidation Test Results

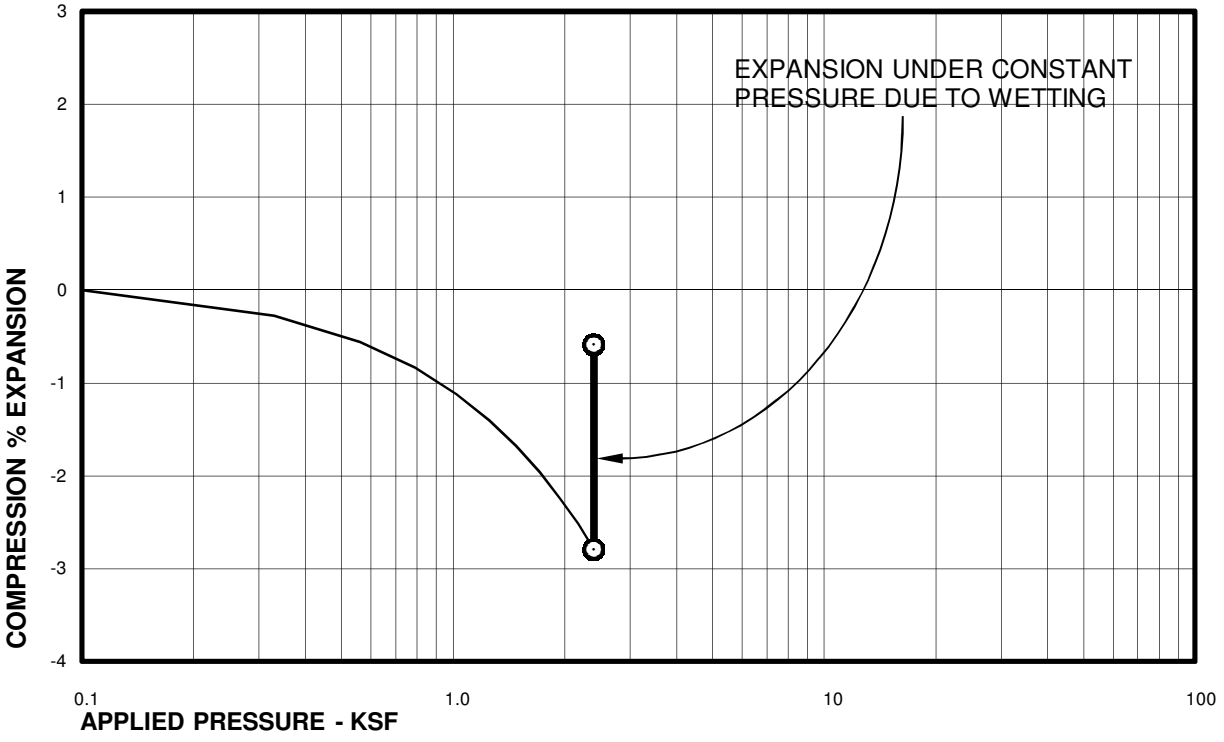
FIG. B-8

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)



Sample of CLAYSTONE
From TH-8 AT 19 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 18.4 %



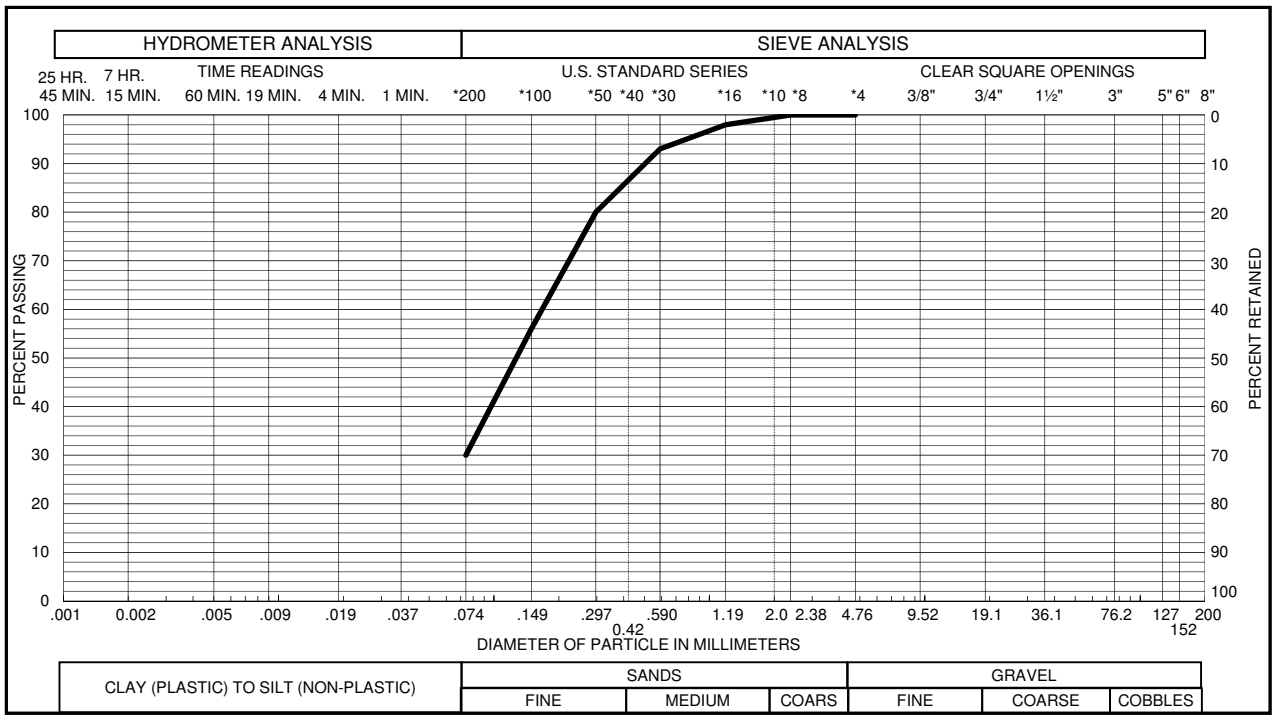
Sample of WEATHERED CLAYSTONE
From TH-10 AT 19 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 19.4 %

Swell Consolidation Test Results

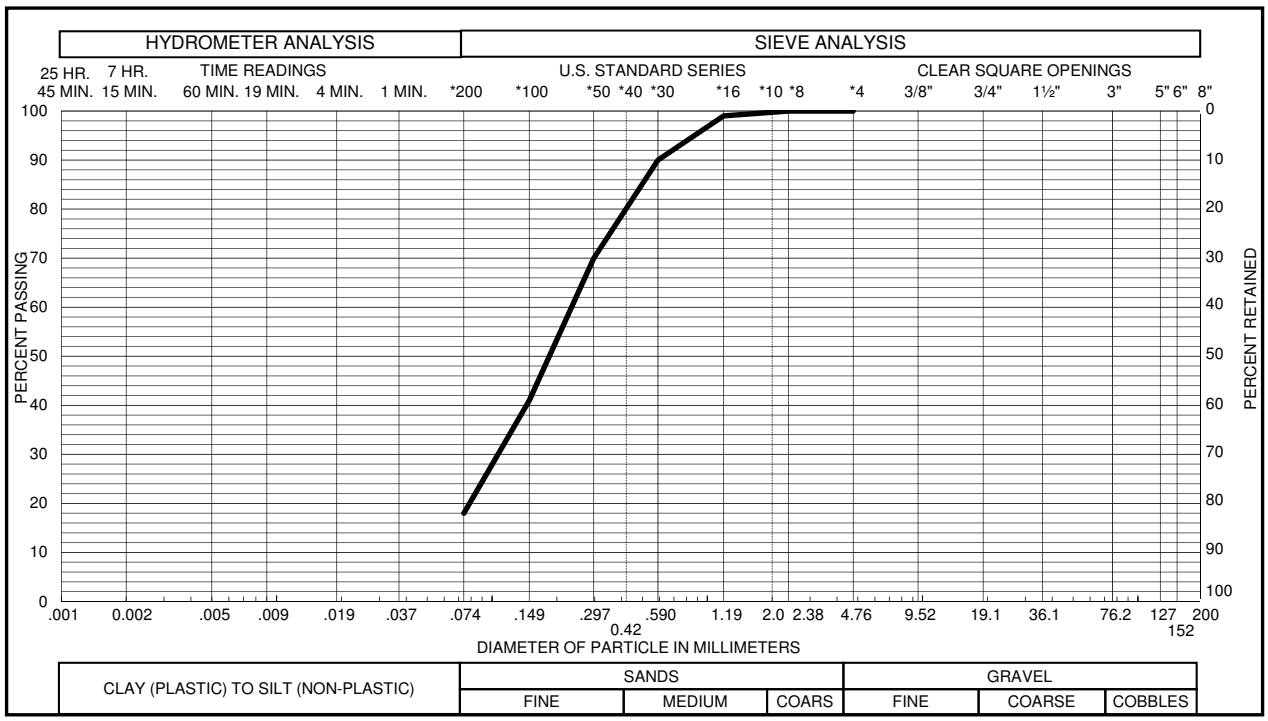
FIG. B-9

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X1(SWELL)



Sample of SAND, SILTY, SL. CLAYEY (SC)
From TH - 2 AT 9 FEET

GRAVEL 0 % SAND 70 %
SILT & CLAY 30 % LIQUID LIMIT
PLASTICITY INDEX



Sample of SAND, SILTY (SM)
From TH - 7 AT 4 FEET

GRAVEL 0 % SAND 82 %
SILT & CLAY 18 % LIQUID LIMIT
PLASTICITY INDEX

HT FLATIRON LP
FLATIRON MEADOWS SUBDIVISION, PHASE 6A
PROJECT NO. DN47,910-115
S:\PROJECTS\47900\DN47910.000\115\2. Reports\R1\DN47910-115-R1-X2(GRAD)

Gradation Test Results

FIG. B-10

TABLE B - I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	SWELL TEST DATA				ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (psf)	SOLUBLE SULFATE CONTENT (%)	PASSING NO. 200 SIEVE (%)	SOIL TYPE
				SWELL (%)	COMPRESSION (%)	APPLIED PRESSURE (psf)	SWELL PRESSURE (psf)	LIQUID LIMIT	PLASTICITY INDEX				
TH-1	4	16.8	112	1.5		500	2,500				0.35		FILL, CLAY, SANDY
TH-1	9	8.2	113	1.4		1,100	4,200						CLAY, SANDY (CL)
TH-1	14	5.9	113	0.0		1,800							SAND, CLAYEY (SC)
TH-1	19	12.3	111		0.2	2,400							CLAY, SANDY (CL)
TH-2	4	17.1	108					25	10			43	SAND, VERY CLAYEY (SC)
TH-2	9	16.5	114									30	SAND, SILTY, SL. CLAYEY (SC)
TH-2	19	16.3	118									41	SAND, CLAYEY (SC)
TH-3	4	6.2	114									30	SANDSTONE, SILTY, SL. CLAYEY
TH-3	14	9.2	119									30	SANDSTONE, SILTY, SL. CLAYEY
TH-4	9	13.9	115		0.2	1,100							CLAY, SANDY (CL)
TH-4	14	19.3	108		0.2	1,800							CLAY, SANDY (CL)
TH-4	19	19.6	104	0.0		2,400							SANDSTONE
TH-5	4	6.4	107									28	SANDSTONE, SILTY, SL. CLAYEY
TH-5	14	17.4	92									23	SANDSTONE, SILTY, SL. CLAYEY
TH-6	4	16.5	105	1.7		500	1,600						FILL, CLAY, SANDY
TH-6	9	17.7	108	5.4		1,100	7,800				0.29		WEATHERED CLAYSTONE
TH-6	14	22.0	106	2.6		1,800	6,800						WEATHERED CLAYSTONE
TH-6	19	9.9	117		1.3	2,400							CLAYSTONE
TH-7	4	15.7	115									18	SAND, SILTY (SM)
TH-7	9	19.5	110					20	2			32	SAND, SILTY, SL. CLAYEY (SC)
TH-8	9	19.1	107	0.1		1,100							CLAY, SANDY (CL)
TH-8	14	20.4	108	1.4		1,800							WEATHERED CLAYSTONE
TH-8	19	18.4	110	1.6		2,400							CLAYSTONE
TH-8	24	18.6	113					65	44	14,800		100	CLAYSTONE
TH-9	4	22.5	102					26	13		0.01	54	CLAY, VERY SANDY (CL)
TH-9	19	15.0	117									21	SAND, SILTY, SL. CLAYEY (SC)
TH-10	4	8.3	103									47	SAND, VERY CLAYEY (SC)
TH-10	14	17.1	112							800			CLAY, SANDY (CL)
TH-10	19	19.4	110	2.2		2,400							WEATHERED CLAYSTONE

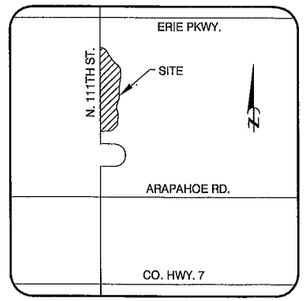
APPENDIX C

Geotechnical Site Development Study for Planning Area C

Prepared by A.G. Wassenaar, Inc.
(AGW Project Number 133416; report dated November 12, 2013)

FLATIRON MEADOWS
PHASE 6A

SCALE: 1" = 200'



VICINITY MAP
NOT TO SCALE

DRAINAGE CHANNEL

EXISTING DITCH

TEST BORING NO. 1

TEST BORING NO. 2

TEST BORING NO. 3

TEST BORING NO. 4

TEST BORING NO. 5

TEST BORING NO. 6

TEST BORING NO. 7

TEST BORING NO. 8

TEST BORING NO. 9

TEST BORING NO. 10

TEST BORING NO. 11

TEST BORING NO. 12

TEST BORING NO. 13

TEST BORING NO. 14

TEST BORING NO. 15

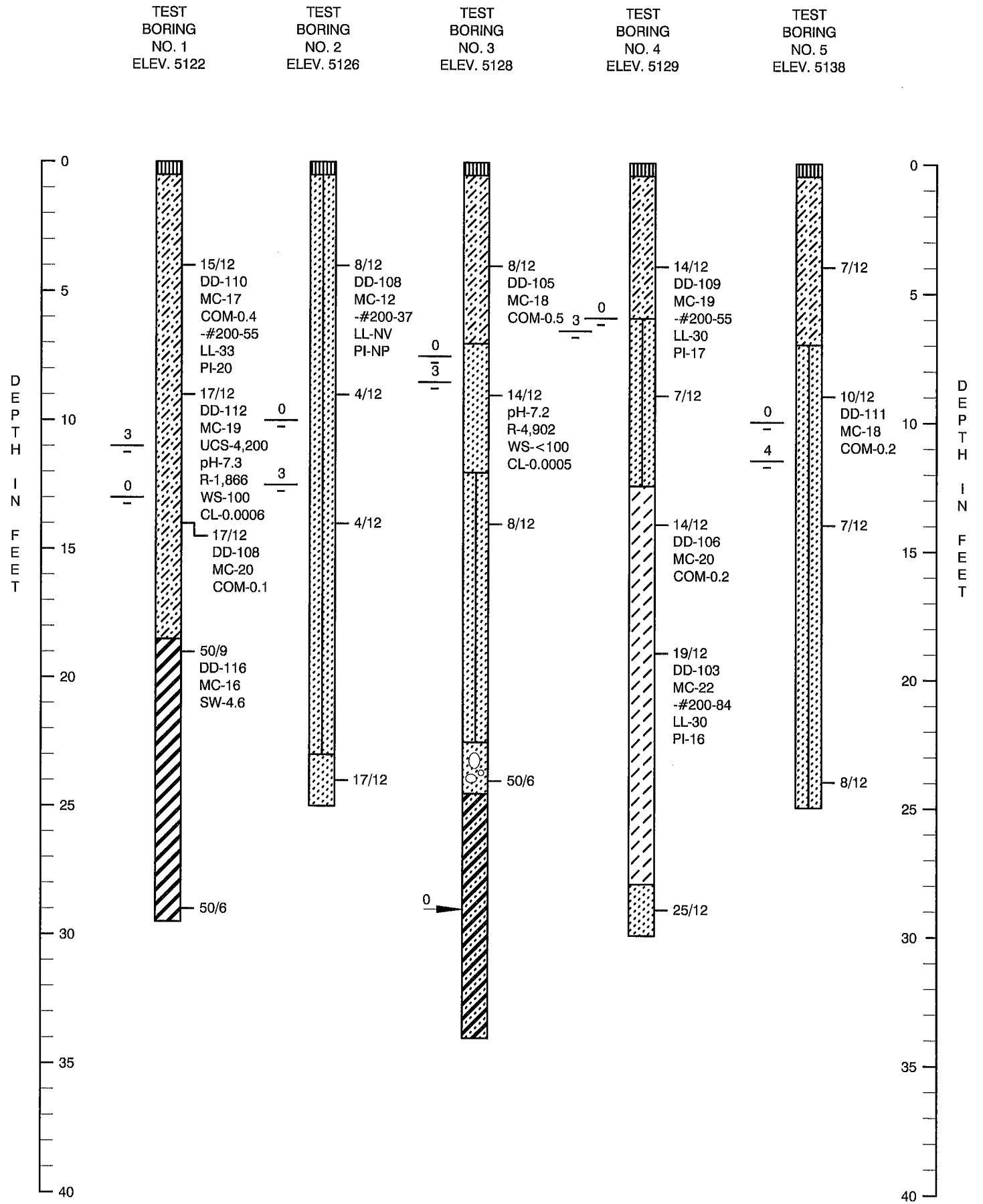
TEST BORING 14 WAS NOT ACCESSIBLE AT THE TIME OF DRILLING

N. 111TH STREET

NOTE: ALL LOCATIONS ARE APPROXIMATE

A.G. Wassenaar Inc.
Geotechnical and Environmental Consultants

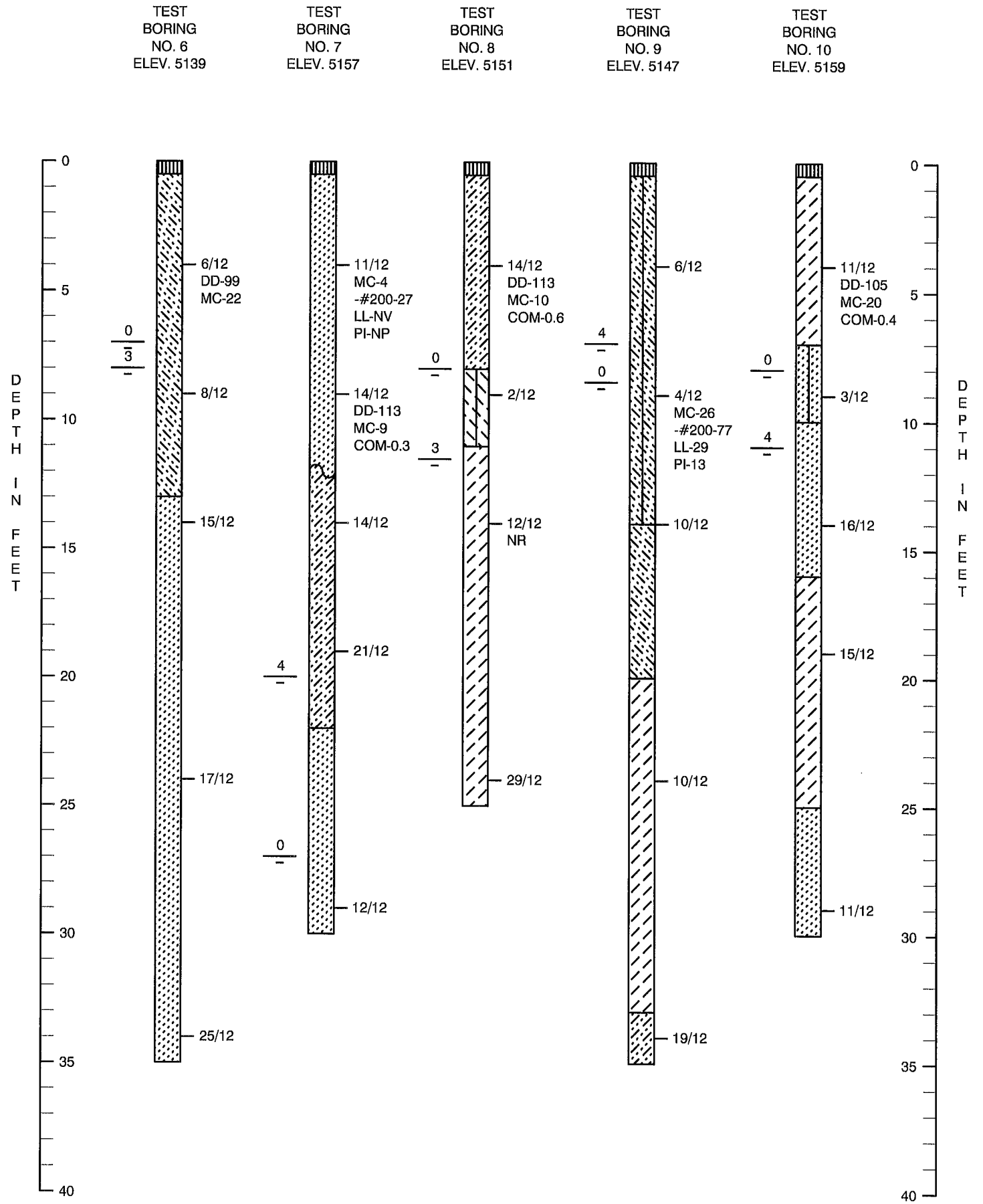
SITE PLAN AND VICINITY MAP	PROJECT NO. 133416 FIGURE 1



SEE FIGURE 4 FOR LEGEND AND NOTES TO EXPLORATORY BORINGS

EXPLORATORY BORING LOGS
FIGURE 2

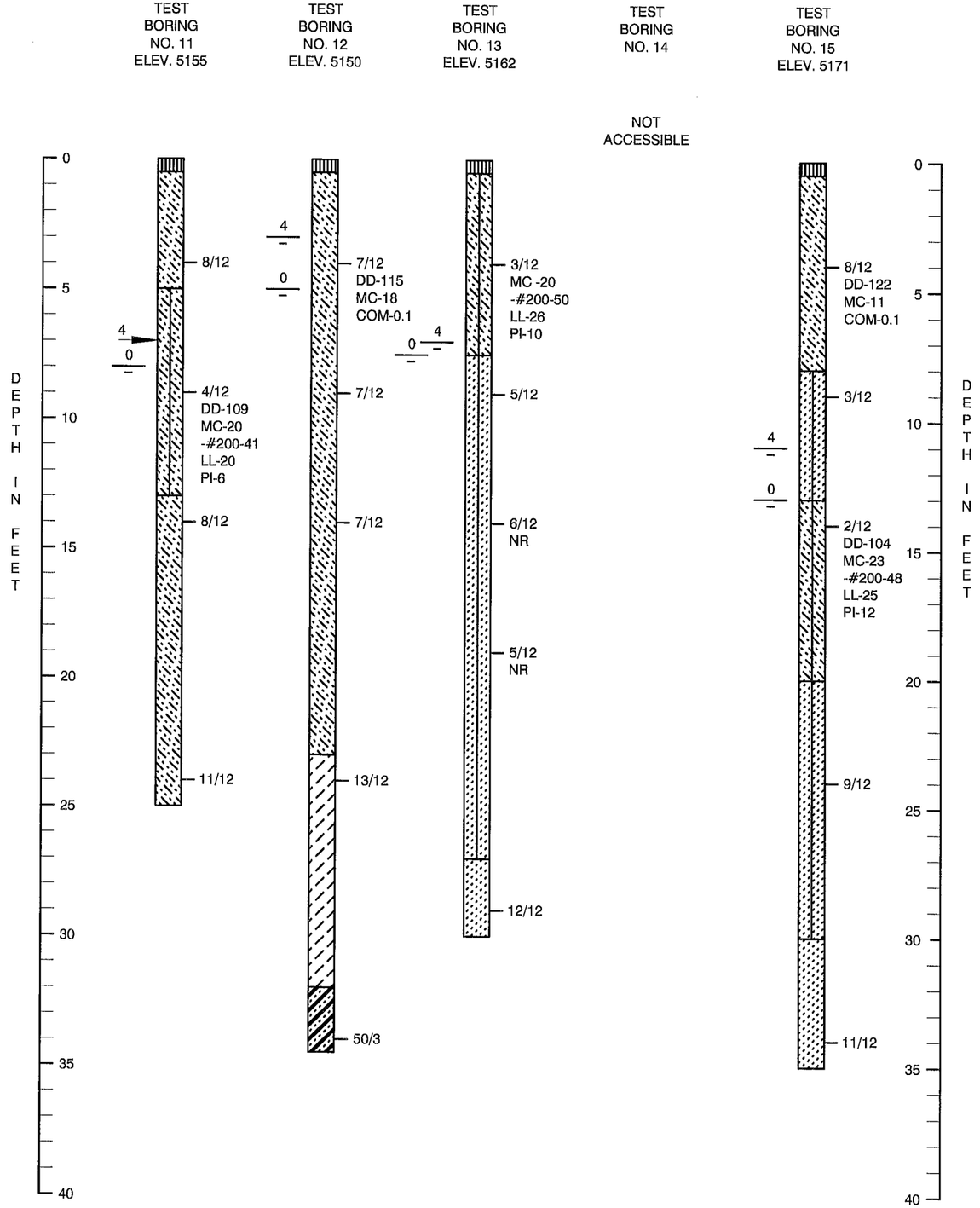
PROJECT NO. 133416



SEE FIGURE 4 FOR LEGEND AND NOTES TO EXPLORATORY BORINGS

EXPLORATORY BORING LOGS
FIGURE 3

PROJECT NO. 133416



LEGEND

- TOPSOIL, CLAY, SANDY, ORGANIC, MOIST, DARK BROWN
- CLAY, SOFT TO MEDIUM STIFF, SILTY, SANDY TO VERY SANDY, WITH SAND LENSES, MOIST TO VERY MOIST, BROWN (CL)
- CLAY, STIFF, SILTY, SANDY TO VERY SANDY, WITH SAND LENSES, MOIST TO VERY MOIST, BROWN (CL)
- SAND, VERY LOOSE TO LOOSE, SILTY TO VERY SILTY, MOIST TO WET, BROWN (SM)
- SAND, MEDIUM DENSE, SILTY, SCATTERED GRAVEL, MOIST TO WET, BROWN (SM)
- SAND, VERY CLAYEY TO CLAY, SANDY, VERY LOOSE / SOFT, MOIST TO VERY MOIST, SLIGHTLY CALCAREOUS, BROWN (SC, CL)
- SAND, VERY CLAYEY TO CLAY, SANDY, LOOSE / MEDIUM STIFF, MOIST TO VERY MOIST, SLIGHTLY CALCAREOUS, BROWN (SC, CL)
- SAND, VERY CLAYEY TO CLAY, SANDY, MEDIUM DENSE / STIFF, SLIGHTLY CALCAREOUS, MOIST TO WET, BROWN
- CLAYSTONE (BEDROCK), HARD TO VERY HARD, MOIST, OLIVE TO RUST BROWN TO GRAY
- SANDSTONE (BEDROCK), HARD TO VERY HARD, POORLY CEMENTED, SILTY, MOIST, BROWN TO GRAY

15/12	INDICATES THAT 15 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH OUTSIDE DIAMETER SAMPLER 12 INCHES.
0 ▽	INDICATES THE DEPTH TO THE FREE WATER TABLE AND THE NUMBER OF DAYS AFTER DRILLING WHEN THE MEASUREMENT WAS TAKEN.
	INDICATES GRADUAL CHANGE IN MATERIAL. LOCATION OF EXACT CHANGE NOT IDENTIFIED.
0 ▶	INDICATES THE DEPTH AT WHICH THE TEST BORING CAVED AND THE NUMBER OF DAYS AFTER DRILLING WHEN THE MEASUREMENT WAS TAKEN.
NR	INDICATES NO SAMPLE RECOVERED
DD	INDICATES DRY DENSITY OF SAMPLE IN POUNDS PER CUBIC FOOT
MC	INDICATES MOISTURE CONTENT AS A PERCENTAGE OF DRY WEIGHT OF SOIL
SW	INDICATES PERCENT SWELL UNDER A SURCHARGE OF 1000 PSF UPON WETTING
COM	INDICATES PERCENT COMPRESSION UNDER A SURCHARGE OF 1000 PSF UPON WETTING
-#200	INDICATES PERCENT PASSING THE NO. 200 SIEVE
LL	INDICATES LIQUID LIMIT
PI	INDICATES PLASTICITY INDEX
NP	INDICATES NON-PLASTIC
NV	INDICATES NO VALUE
UC	INDICATES UNCONFINED COMPRESSIVE STRENGTH IN POUNDS PER SQUARE FOOT
pH	INDICATES ACIDITY OR ALKALINITY OF SAMPLE IN pH UNITS
R	INDICATES RESISTIVITY IN OHMS.CM
WS	INDICATES WATER SOLUBLE SULFATES IN PARTS PER MILLION
CL	INDICATES CHLORIDES IN PERCENT

NOTES

1. TEST BORINGS WERE DRILLED SEPTEMBER 26, 27 AND 30, 2013 WITH A 4-INCH DIAMETER, CONTINUOUS FLIGHT POWER AUGER.
2. LOCATIONS OF TEST BORINGS WERE STAKED BY OTHERS AT LOCATIONS CHOSEN BY THIS FIRM.
3. ELEVATIONS AND CUT/FILL DEPTHS WERE OBTAINED FROM STAKING PROVIDED BY OTHERS AND HAVE BEEN ROUNDED TO THE NEAREST FOOT.
4. THE HORIZONTAL LINES SHOWN ON THE LOGS ARE TO DIFFERENTIATE MATERIALS AND REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIALS. THE TRANSITIONS BETWEEN MATERIALS MAY BE GRADUAL.
5. DRILL LOGS SHOWN IN THIS REPORT ARE SUBJECT TO THE LIMITATIONS, EXPLANATIONS, AND CONCLUSIONS OF THIS REPORT.

A.G. Wassenaar Inc.
Geotechnical and Environmental Consultants

EXPLORATORY BORING LOGS	PROJECT NO. 133416 FIGURE 4

APPENDIX D

GUIDELINE SITE GRADING SPECIFICATIONS

Flatiron Meadows Subdivision, Phase 6A, Planning Areas A-H
Erie, Colorado

GUIDELINE SITE GRADING SPECIFICATIONS

Flatiron Meadows Subdivision, Phase 6A, Planning Areas A-H
Erie, Colorado

1. DESCRIPTION

This item shall consist of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Engineer, as necessary to achieve preliminary street and overlot grade elevations. These specifications shall also apply to compaction of excess cut materials that may be placed outside of the development boundaries.

2. GENERAL

The Soils Representative shall be the Owner's Representative. The Soils Representative shall approve fill materials, method of placement, moisture contents and percent compaction, and shall give written approval of the completed fill.

3. CLEARING JOB SITE

The Contractor shall substantially remove all debris, vegetation, organics and other deleterious materials before excavation or fill placement. The Contractor shall dispose of the cleared material to provide the Owner with a clean, neat appearing job site. Cleared material shall not be placed in areas to receive fill or where the material will support structures of any kind.

4. AREA TO BE FILLED

Debris, vegetation, organics and other deleterious materials shall be substantially removed from the ground surface upon which fill is to be placed. The surface shall then be plowed or scarified until the surface is free from ruts, hummocks or other uneven features, which would prevent uniform compaction.

After the foundation for the fill has been cleared and scarified, it shall be disced or bladed until it is free from large clods, brought to the proper moisture content (between 1 and 4 percent above optimum moisture content and within 2 percent of optimum for sands) and compacted to at least 95 percent of maximum dry density as determined in accordance with ASTM D 698.

5. FILL MATERIALS

Fill soils shall be substantially free from debris, vegetation, organics and other deleterious materials, and shall not contain rocks or lumps having a diameter greater than six (6) inches. Claystone bedrock should be broken down to three (3) inches or smaller in size. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer.

On-site materials classifying as CL, CH, SC, SM, SW, SP, GP, GC and GM are acceptable.

6. MOISTURE CONTENT

Fill material classifying as CH, CL and SC shall be moisture conditioned to between optimum moisture content and 3 percent above optimum. Granular soils classifying as SM, SW, SP, GP, GC and GM shall be moisture conditioned to within 2 percent of optimum moisture content as determined from Proctor compaction tests. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas.

The Contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of the Soils Representative, it is not possible to obtain uniform moisture content by adding water on the fill surface. The Contractor may be required to rake or disc the fill soils to provide uniform moisture content through the soils.

The application of water to embankment materials shall be made with any type of watering equipment approved by the Soils Representative, which will give the desired results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are washed out.

Should too much water be added to any part of the fill, such that the material is too wet to permit the desired compaction from being obtained, rolling and all work on that section of the fill shall be delayed until the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework wet material in an approved manner to hasten its drying.

7. COMPACTION OF FILL AREAS

Selected fill material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density. Fill shall be compacted to at least 95 percent of the maximum density as determined in accordance with ASTM D 698. At the option of the Soils Representative, soils classifying as SW, GP, GC, or GM may be compacted to 95 percent of maximum density as determined in accordance with ASTM D 1557 or 70 percent relative density for cohesionless sand soils. Fill materials shall be placed such that the thickness of loose materials does not exceed 10 inches and the compacted lift thickness does not exceed 6 inches.

Compaction as specified above, shall be obtained by the use of sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment for soils classifying as CL, CH, or SC. Granular fill shall be compacted using vibratory equipment or other approved equipment. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient trips to ensure that the required density is obtained.

8. COMPACTION OF SLOPES

Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compaction operations shall be continued until slopes are stable, but not too dense for planting, and there is not appreciable amount of loose soils on the slopes. Compaction of slopes may be done progressively in increments of three to five feet (3' to 5') in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

9. PLACEMENT OF FILL ON NATURAL SLOPES

Where natural slopes are steeper than 20 percent in grade and the placement of fill is required, benches shall be cut at the rate of one bench for each 5 feet in height (minimum of two benches). Benches shall be at least 10 feet in width. Larger bench widths may be required by the Engineer. Fill shall be placed on completed benches as outlined within this specification.

10. DENSITY TESTS

Field density tests shall be made by the Soils Representative at locations and depths of his choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests shall be taken in compacted material below the disturbed surface. When density tests indicate that the density or moisture content of any layer of fill or portion thereof is not within specification, the particular layer or portion shall be reworked until the required density or moisture content has been achieved.

11. SEASONAL LIMITS

No fill material shall be placed, spread or rolled while it is frozen, thawing, or during unfavorable weather conditions. When work is interrupted by heavy precipitation, fill operations shall not be resumed until the Soils Representative indicates that the moisture content and density of previously placed materials are as specified.

12. NOTICE REGARDING START OF GRADING

The Contractor shall submit notification to the Soils Representative and Owner advising them of the start of grading operations at least three (3) days in advance of the starting date. Notification shall also be submitted at least 3 days in advance of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

13. REPORTING OF FIELD DENSITY TESTS

Density tests made by the Soils Representative, as specified under "Density Tests" above, shall be submitted progressively to the Owner. Dry density, moisture content, and percentage compaction shall be reported for each test taken.

14. DECLARATION REGARDING COMPLETED FILL

The Soils Engineer shall provide a written declaration stating that the site was filled with acceptable materials, and was placed in general accordance with the specifications.

APPENDIX E

GUIDELINE SITE GRADING SPECIFICATIONS (SUB-EXCAVATION)

Flatiron Meadows Subdivision, Phase 6A, Planning Areas A-H
Erie, Colorado

GUIDELINE SITE GRADING SPECIFICATIONS
(SUB-EXCAVATION)

Flatiron Meadows Subdivision, Phase 6A, Planning Areas A-H
Erie, Colorado

1. DESCRIPTION

This item shall consist of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Engineer, as necessary to achieve preliminary street and overlot elevations. These specifications shall also apply to compaction of materials that may be placed outside of the development boundaries.

2. GENERAL

The Soils Engineer shall be the Owner's representative. The Soils Engineer shall observe fill materials, method of placement, moisture content and percent compaction, and shall provide written opinions of the completed fill.

3. CLEARING JOB SITE

The Contractor shall remove all vegetation and debris before excavation or fill placement is begun. The Contractor shall dispose of the cleared material to provide the Owner with a clean, neat appearing job site. Cleared material shall not be placed in areas to receive fill where the material will support structures of any kind.

4. SCARIFYING AREA TO BE FILLED

All topsoil and vegetable matter shall be removed from the ground surface where fill is to be placed. The surface shall then be plowed or scarified until the surface is free from ruts, hummocks or other uneven features that would prevent uniform compaction.

5. COMPACTING AREA TO BE FILLED

After the foundation for the fill has been cleared and scarified, it shall be disked or bladed until it is free from large clods, brought to the proper moisture content, (1 to 4 percent above optimum) and compacted to not less than 95 percent of maximum density as determined in accordance with ASTM D 698.

6. FILL MATERIALS

Fill soils shall be free from vegetable matter or other deleterious substances, and shall not contain clay and claystone having a diameter greater than three (3) inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer.

On-site materials classifying as CL, CH, SC, SM, SP, GP, GC and GM are acceptable. Concrete, asphalt, and other deleterious materials or debris shall not be used as fill.

7. MOISTURE CONTENT

Fill materials shall be moisture-conditioned to within limits of optimum moisture content specified in "Moisture Content and Density Criteria". Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas or imported to the site.

The Contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of the Soils Engineer, it is not possible to obtain uniform moisture content by adding water on the fill surface. The Contractor will be required to rake or disc the fill to provide uniform moisture content throughout the fill.

The application of water to embankment materials shall be made with any type of watering equipment that will give the desire results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are washed out.

Should too much water be added to any part of the fill, such that the material is too wet to permit the desired compaction from being obtained, rolling and all work on that section of the fill shall be delayed until the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework wet material in an approved manner to hasten its drying.

8. COMPACTION OF FILL MATERIALS

Selected fill material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density given in "Moisture Content and Density Criteria". Fill materials shall be placed such that the thickness of loose material does not exceed 8 inches and the compacted lift thickness does not exceed 6 inches.

Compaction, as specified above, shall be obtained by the use of suitable equipment. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient trips to ensure that the required density is obtained.

9. MOISTURE CONTENT AND DENSITY CRITERIA

Fill material shall be substantially compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698, AASHTO T 99) dry density at 1 to 4 percent above optimum moisture content. Additional criteria for acceptance are presented in DENSITY TESTS.

10. DENSITY TESTS

Field density tests shall be made by the Soils Engineer at locations and depths of his choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests shall be taken in compacted material below the disturbed surface. When density tests indicate the density or moisture content of any layer of fill or portion thereof not within specifications, the particular layer or portion shall be reworked until the required density or moisture content has been achieved.

Allowable ranges of moisture content and density given in MOISTURE CONTENT AND DENSITY CRITERIA are based on design considerations. The moisture shall be controlled by the Contractor so that moisture content of the compacted earth fill, as determined by tests performed by the Soils Engineer, shall be within the limits given. The Soils Engineer will inform the Contractor when the placement moisture is less than or exceeds the limits specified and the Contractor shall immediately make adjustments in procedures as necessary to maintain placement moisture content within the specified limits, to satisfy the following requirements.

A. Moisture

1. The average moisture content of material tested each day shall not be less than 1.5 percent over optimum moisture content.

2. Material represented by samples tested having moisture lower than 1 percent over optimum will be rejected. Such rejected materials shall be reworked until moisture equal to or greater than 1 percent above optimum is achieved.

B. Density

1. The average dry density of material tested each day shall not be less than 95 percent of standard Proctor maximum dry density (ASTM D 698).

2. No more than 10 percent of the material represented by the samples tested shall be at dry densities less than 95 percent of standard Proctor maximum dry density (ASTM D 698).

3. Material represented by samples tested having dry density less than 95 percent of standard Proctor maximum dry density (ASTM D 698) will be rejected. Such rejected materials shall be reworked until a dry density equal to or greater than 95 percent of standard Proctor maximum dry density (ASTM D 698) is obtained.

11. OBSERVATION AND TESTING OF FILL

Observation by the Soils Engineer shall be sufficient during the placement of fill and compaction operations so that they can declare the fill was placed in general conformance with specifications. All observations necessary to test the placement of fill and observe compaction operations will be at the expense of the Owner.

12. SEASONAL LIMITS

No fill material shall be placed, spread or rolled while it is frozen, thawing, or during unfavorable weather conditions. When work is interrupted by heavy precipitation, fill opera-tions shall not be resumed until the Soils Engineer indicates the moisture content and density of previously placed materials are as specified.

13. REPORTING OF FIELD DENSITY TESTS

Density tests made by the Soils Engineer, as specified under “Density Tests” above, shall be submitted progressively to the Owner. Dry density, moisture content and percentage compaction shall be reported for each test taken.

ALDRIDGE TRANSPORTATION CONSULTANTS, LLC
Advanced Transportation Planning and Traffic Engineering

TRAFFIC IMPACT STUDY

for

Flatiron Meadows

ERIE, COLORADO

Prepared for:

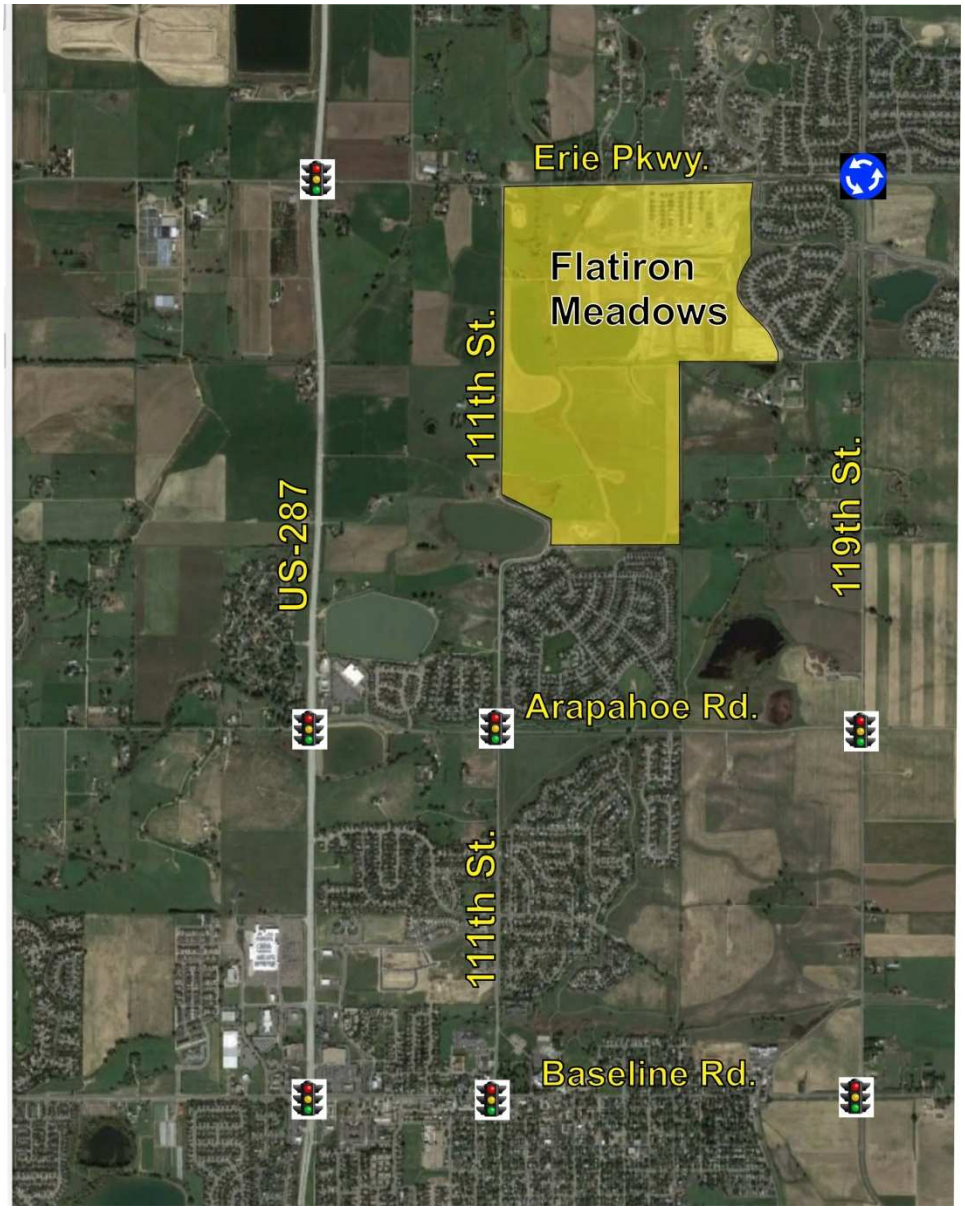
Calibre Engineering, Inc.
9090 S. RIDGELINE #105
HIGHLANDS RANCH, CO 80129

Prepared by:
JOHN M.W. ALDRIDGE, PE, PTOE, AICP
Aldridge Transportation Consultants, LLC
1082 CHIMNEY ROCK ROAD
HIGHLANDS RANCH, COLORADO 80120
303-703-9112

February 14, 2014

1. INTRODUCTION

This report examines the traffic impact associated with the construction of Flatiron Meadows in Erie, Colorado. The project is located on the south side of Erie Parkway between 111th Street and Meadow View Parkway. An aerial photo below shows the location and general vicinity of the project.



The proposed project is new residential featuring 809 single-family homes and 126 townhomes. In addition, plans include a 900-student K-8 school.

Two sections of the project, Planning Areas C and H, on the west side bordering 111th St. will access 111th St. only. All other planning areas will have access to Flatiron Meadows Blvd. Note that Flatiron Meadows Blvd. will connect to 111th St. where it curves around Prince Lake Number 2. 111th St provides a direct connection to Arapahoe Road and Baseline Road (both signalized intersections).

Erie Parkway is a two-lane roadway that carries approximately 8.800 ADT in this section of the roadway. Under CDOT definitions adopted by the Town for geometric design purposes, this is an NR-B classification. The intersection of 111th and Erie Parkway is two-way stop sign controlled, as are the intersections at Flatiron Meadows Blvd. and Meadow View Parkway. At US-287, the intersection is traffic signal controlled. To the east at 119th St., the intersection is a roundabout.

2. PROJECT TRIP GENERATION AND DESIGN HOUR VOLUMES

The project's trip generation calculates from rates and values found in the ***ITE Trip Generation Manual, 9th Edition.*** The PUD plan includes 818 residences, and a 900-student K-8 school. The chart shows the trip generation for average weekday (ADT) and AM and PM peak hours for each of the planning areas, school, and the total of them.

Trip Generation Worksheet for Flatiron Meadows

					Average Weekday			
					AM		PM	
ITE Code	Land Use	Unit	Quantity	ADT	In	Out	In	Out
210	Filing 1	DU	39	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**371**	**7**	**22**	**25**	**14**
210	Filing 2	DU	117	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**1,114**	**22**	**66**	**74**	**43**
210	Filing 3	DU	32	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**305**	**6**	**18**	**20**	**12**
210	Filing 4	DU	72	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**685**	**14**	**41**	**45**	**27**
210	PA-A	DU	53	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SDF			**505**	**10**	**30**	**33**	**20**
210	PA-B	DU	80	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**762**	**15**	**45**	**50**	**30**
210	PA-D	DU	21	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**200**	**4**	**12**	**13**	**8**
210	PA-E	DU	26	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**248**	**5**	**15**	**16**	**10**
210	PA-F	DU	97	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**923**	**18**	**54**	**61**	**36**
210	PA-G	DU	76	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**724**	**14**	**43**	**48**	**28**
520	School	Students	900	*1.29*	*0.25*	*0.20*	*0.07*	*0.08*
				1,161	**223**	**182**	**66**	**69**
Subtotal Unit/Trips			**613**	**6,997**	**338**	**527**	**452**	**296**
230	PA-H	DU	126	*5.81*	*0.07*	*0.37*	*0.35*	*0.17*
	TH/APT			**732**	**9**	**46**	**44**	**22**
210	PA-C	DU	79	*9.52*	*0.19*	*0.56*	*0.63*	*0.37*
	SFD			**752**	**15**	**44**	**50**	**29**
Total Units/Trips			**818**	**8,481**	**363**	**617**	**546**	**346**

Planning Areas C and H are separate so that the impact to 111th St. is clearly definable.

As the PM peak hour trips are higher on the adjacent streets than the AM peak hour, the PM peak hour is the design hour volume (DHV). An analysis of the AM peak hour impacts was prepared to review and check the proposed intersection design and traffic control.

3. TRIP DISTRIBUTION AND ASSIGNMENT

The locations of streets and highways, employment, and shopping in the surrounding area provide the basis for the trip distribution assumption. The assumption is that 30 percent will distribute to/from the south on 111th St. (Arapahoe and Baseline Roads), 40 percent to/from the west on Erie Parkway (US-287) and 30 percent to/from the east on Erie Parkway (Town of Erie). Of the 30 percent to/from the east, 10 percent will access Erie Parkway via Meadows View Parkway. Also assumed is that 50 percent of the K-8 school trips will remain internal to the development.

4. EXISTING AND PROJECTED TRAFFIC VOLUMES

Traffic counts at the intersections of 111th St. and Erie Parkway by All Traffic Data on January 16, 2014. The graphics show the counts for the existing AM and PM peak hours. The Synchro graphics in the appendix also show them.

Existing AM Peak Hour

Existing PM Peak Hour

The **Town of Erie Transportation Master Plan (2008)** provides forecasts for 2015, 2030, and 2060 (highly speculative full build-out of the Town and not used in this analysis). The forecast volumes in the master plan provided control points for this analysis. The current volume is approximately 8,800 ADT.

The 2015 forecast daily volume in the master plan is 9,000 AADT on a 2-lane roadway with a LOS D capacity of 16,200 AADT (assumes center turn lanes at the intersections). The 2030 forecast volume is 13,000 AADT. At that time, the master plan anticipates a 2-lane roadway with center turn lane that has an LOS D capacity again of 16,200 ADT.

Two growth scenarios, a short term (2019) and a long-term (2034), were developed to determine the anticipated traffic control and geometric design of the streets and intersections necessary to achieve an acceptable level of service. The following graphics show the projected AM and PM volumes for each scenario.

2019 AM Peak Hour

2019 PM Peak Hour

2034 AM Peak Hour

2034 PM Peak Hour

5. CAPACITY AND LEVEL OF SERVICE (LOS) ANALYSIS

A series of Synchro v8 traffic operations and SimTraffic simulation models were prepared to analyze the traffic operations of each scenario. The operations analysis is used to determine the veracity of access locations, type of traffic control, and intersection geometry. It also provides several key indicators on arterial traffic flow, level of service, signal coordination, and queuing data.

Synchro v8 is based on procedures and methodologies referenced from the **Highway Capacity Manual 2010 (HCM).** It rates intersection operations using a determination of level of service (LOS). LOS is letter rating from A to F. LOS A indicates free-flow traffic conditions and no delay at intersections. LOS F is heavy traffic congestion with significant delay. LOS is provided for the overall operations at signalized intersections. LOS D is generally the benchmark for acceptable signalized intersection operations during the weekday AM/PM peak hours. The LOS rating for unsignalized intersections is provided by the critical movement - not the overall -, which is generally a left turn out from the minor street. Caution must be used when evaluating the LOS at unsignalized

intersections particularly when LOS F is shown. In case of an LOS F, the HCM[1] suggests that other evaluation measures should be considered such as the control delay, volume over capacity ratio, and the 95th percentile queue length to make the most effective traffic control decision. LOS F at unsignalized intersections is normal during the weekday peak hour.

The table provides a Level of Service summary of the unsignalized and signalized intersections. Where an LOS F appears, the control delay in seconds per vehicle and the 95th percentile queue length in vehicles is shown as well.

Unsignalized Intersection Level of Service Summary

Intersection	Existing AM	Existing PM	2019 AM	2019 PM	2034 AM	2034 PM
Erie Parkway/Flatiron Meadows	C	C	F (87.3s) (7.1veh)	C	SIG	SIG
Erie Parkway/111th St.	C	C	C	D	E	E

Signalized Intersection Level of Service Summary

Intersection	Existing AM	Existing PM	2019 AM	2019 PM	2034 AM	2034 PM
Erie Parkway/Flatirons Meadows	UNSIG	UNSIG	UNSIG	UNSIG	B	B

The summary chart shows that intersections will operate acceptably including the 2019 AM peak hour at Flatiron Meadows Blvd. An animation of the traffic movement on the adjacent streets and intersections is available via the SimTraffic software.

[1] Highway Capacity Manual 2010 page 19-40

6. TRAFFIC SIGNAL WARRANT ANALYSIS

Traffic signal control is likely at the intersection of Flatiron Meadows Blvd and Erie Parkway in the long-term future. At the intersection of 111th St. and Erie Parkway, two-way stop sign control will be adequate for the short and long-term future. The MUTCD provides warrants for traffic signal control. In this situation, Warrants 1 (eight-hour) and 2 (four-hour) would prevail. Warrant 3 (peak hour) is not applicable as this is not an unusual case that attracts or discharges large numbers of vehicles over a short time.

The purpose of the following analysis of Warrants 1 and 2 is to determine the nth unit that would trigger the need for a traffic signal at the Flatiron Meadows Blvd. intersection with Erie Parkway.

Projected Signal Hourly Volume Warrants Based on Daily Volume

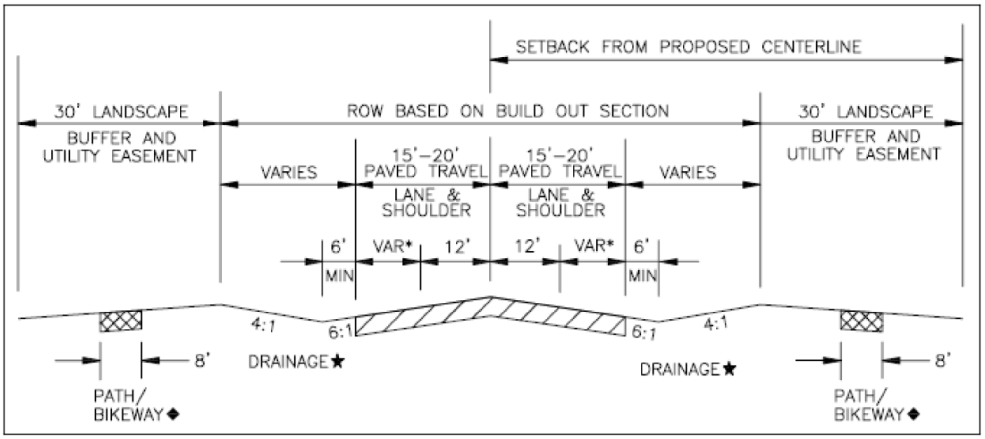
						Warrant 1				Warrant 2	
Daily Major Street Approaches			11000			Condition A		Condition B			
Daily Volume (In & Out)			2730								
		Distribution		Estimated Major Street Approaches	Total Applicable Volume	Major Street Volume	Minor Street Volume	Major Street Volume	Minor Street Volume	Major Street Volume	Minor Street Volume
TOD	Hourly Percent of Daily to find Factor for Warrant	Out (NB)	In (SB)	2014	Minor (NB)	(> = 350 vph)	(140 vph)	(> = 525 vph)	(70 vph)	Per Chart	(80 vph)
12:00 AM	0.58%	28.57%	71.43%	64	5	no	no	no	no	no	no
1:00 AM	0.37%	44.44%	55.56%	41	5	no	no	no	no	no	no
2:00 AM	0.08%	0.00%	100.00%	9	0	no	no	no	no	no	no
3:00 AM	0.04%	100.00%	0.00%	5	1	no	no	no	no	no	no
4:00 AM	0.21%	60.00%	40.00%	23	3	no	no	no	no	no	no
5:00 AM	1.40%	91.18%	8.82%	154	35	no	no	no	no	no	no
6:00 AM	3.18%	84.42%	15.58%	350	73	no	no	no	yes	no	no
7:00 AM	6.57%	83.02%	16.98%	722	149	yes	yes	yes	yes	yes	yes
8:00 AM	7.72%	75.40%	24.60%	850	159	yes	yes	yes	yes	yes	yes
9:00 AM	5.45%	65.15%	34.85%	600	97	yes	no	yes	yes	no	yes
10:00 AM	4.67%	54.87%	45.13%	513	70	yes	no	no	no	no	no
11:00 AM	5.62%	57.35%	42.65%	618	88	yes	no	yes	yes	no	yes
12:00 PM	6.03%	41.10%	58.90%	663	68	yes	no	yes	no	no	no
1:00 PM	4.83%	46.15%	53.85%	532	61	yes	no	yes	no	no	no
2:00 PM	5.62%	48.53%	51.47%	618	74	yes	no	yes	yes	no	no
3:00 PM	5.45%	38.64%	61.36%	600	58	yes	no	yes	no	no	no
4:00 PM	7.43%	39.44%	60.56%	818	80	yes	no	yes	yes	yes	yes
5:00 PM	9.46%	29.26%	70.74%	1040	76	yes	no	yes	yes	no	no
6:00 PM	8.84%	36.45%	63.55%	972	88	yes	no	yes	yes	yes	yes
7:00 PM	5.45%	29.55%	70.45%	600	44	yes	no	yes	no	no	no
8:00 PM	4.34%	37.14%	62.86%	477	44	yes	no	no	no	no	no
9:00 PM	2.93%	22.54%	77.46%	323	18	no	no	no	no	no	no
10:00 PM	2.31%	33.93%	66.07%	254	21	no	no	no	no	no	no
11:00 PM	1.40%	23.53%	76.47%	154	9	no	no	no	no	no	no
				Major Yes Minor Yes			**2**		**9**		**4**
				Warrant Met			**no**		**yes**		**yes**

The chart uses a typical hourly percent of daily volumes to determine the traffic each hour entering and exiting a residential development such as this. The major street hourly volumes factor similarly as a percent of daily volume. In this case, the intersection can apply the 70 percent factor on the warrants as it is in an area of less than 10,000 in population.

The analysis shows that Warrant 1 (Condition B) and Warrant 2 would be satisfied when Erie Parkway reaches 11,000 ADT (probably in two to three years) and the daily volume on Flatiron Meadows Blvd. is approximately 2,750 ADT. At full build out of the 613 homes and the K-8 school, the projected ADT on Flatiron Meadows Blvd. is 4,200. The 2,750 ADT is 65 percent or equivalent to approximately 400 homes. This assumes connection to 111th St. on the south end. If the connection is not made, then the warrants would be met with 40 percent of the development or an equivalent of 240 homes.

6. FINDINGS AND RECOMMENDATIONS

The analysis contained herein finds that the traffic generated by the project is consistent with the **Town of Erie Transportation Master Plan (2008)** particularly with respect to the projected short and long-range volumes on Erie Parkway and the proposed cross-section (Figure 22 from the Master Plan) shown below.



This cross-section with turn lanes has the capacity at LOS D to handle 16, 200 ADT. The projected 2034 ADT on Erie Parkway is 13,000 ADT.

The intersection of 111th St. and Erie Parkway is currently two-way stop sign controlled and should remain that way through the short and long-term future. The State Highway Access Code for an NR-B classified highway posted at 40 mph indicates turn lanes (right and left) from Erie Parkway for taper and storage only. Similar to the turn lanes at Flatiron Meadows Blvd., lanes with about 100 feet of storage and approximately 120 feet of taper are sufficient.

The intersection of Flatiron Meadows Blvd. and Erie Parkway is currently two-way stop sign controlled and should remain that way until approximately 65 percent or 400 units (not including Planning Areas C and H) are constructed assuming a connection on the south end to 111th Street. At that time, warrants for traffic signal control are probable. Should the connection to 111th St. not be in place, then warrants are probable with 40 percent or 250 homes.

For the internal streets, four of the cross-sections in the master plan are appropriate. A local street cross-section as illustrated in the master plan's Figure 21 would serve the streets internal to the planning areas that have residential driveways fronting the street. This section is specific to provide access to properties.

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FIGURE 21: STREET DESIGN STANDARD - LOCAL STREETS (2 LANES WITH PARKING)

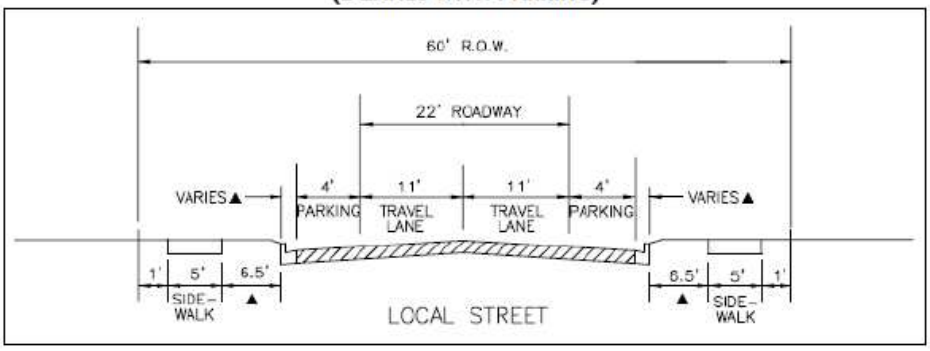
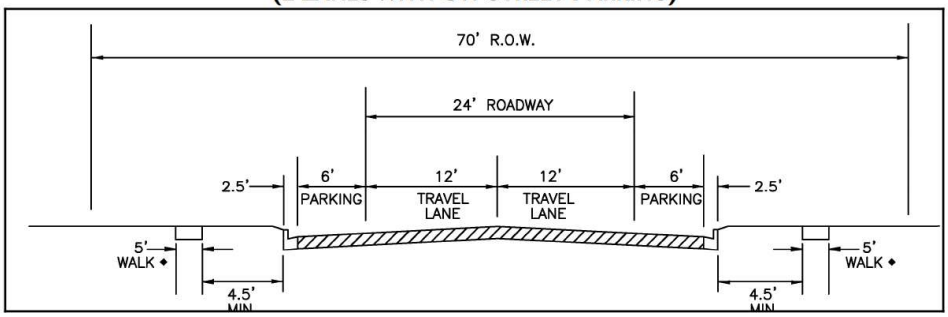


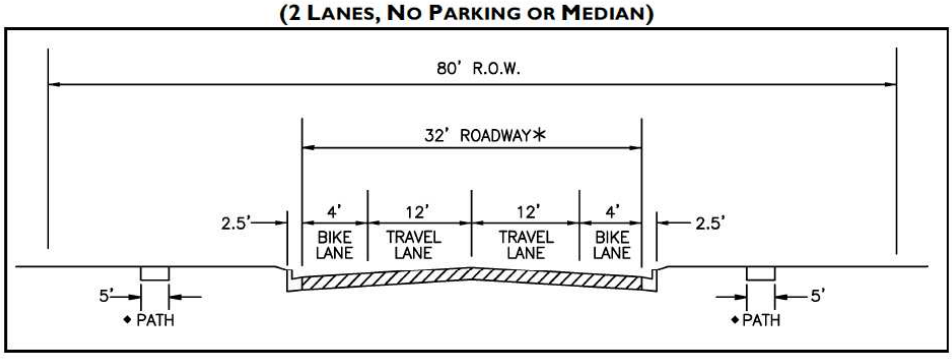
Figure 18 shows a residential collector type street that is appropriate for connectivity of the local streets to the entry streets. The cross-section features 12-foot travel lanes and on-street parking on both sides.

FIGURE 18: STREET DESIGN STANDARD - RESIDENTIAL COLLECTOR (2 LANES WITH ON-STREET PARKING)



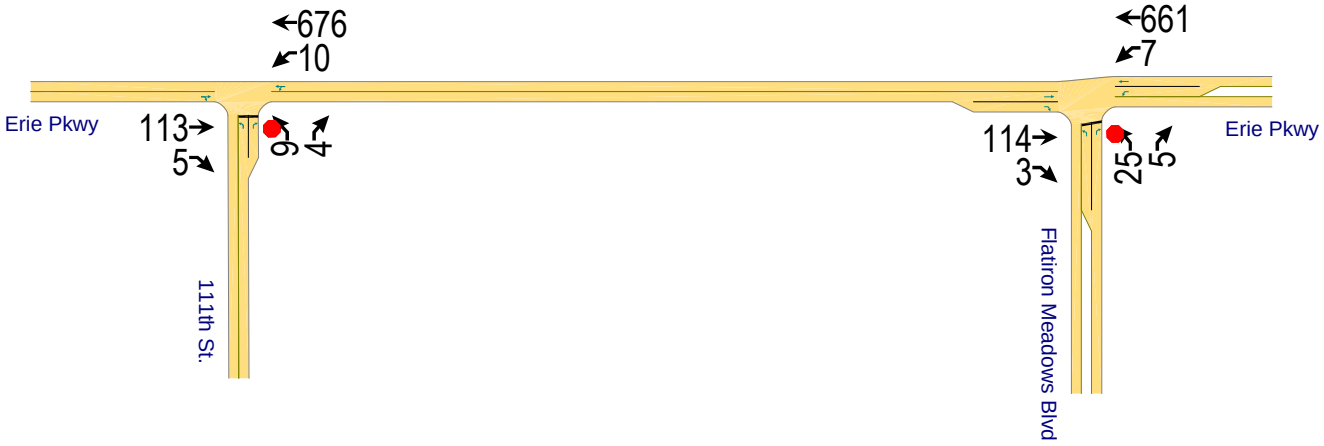
For the collector type streets, the cross-section in the master plan shown in Figure 17 below would serve as the connector between the arterial and local streets. This type of street is without parking and does not provide direct access to property.

FIGURE 17: STREET DESIGN STANDARD - COLLECTOR (2 LANES, NO PARKING OR MEDIAN)



In conclusion, this report finds that the roadway layout in the site plan and the recommended accesses will operate at an acceptable level of service and that overall traffic flow on the adjacent streets and intersections would be efficiently served by the proposed improvements.

APPENDIX


676
10
661
7
Erie Pkwy
113
5
9
4
114
3
25
5
Erie Pkwy
111th St.
Flatiron Meadows Blvd

Intersection	
Int Delay, s/veh	0.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	113	5	10	676	9	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	123	5	11	735	10	4

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	128	0	883	126
Stage 1	-	-	-	-	126	-
Stage 2	-	-	-	-	757	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1458	-	316	924
Stage 1	-	-	-	-	900	-
Stage 2	-	-	-	-	463	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1458	-	312	924
Mov Cap-2 Maneuver	-	-	-	-	312	-
Stage 1	-	-	-	-	900	-
Stage 2	-	-	-	-	457	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.1	14.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	312	924	-	-	1458	-
HCM Lane V/C Ratio	0.031	0.005	-	-	0.007	-
HCM Control Delay (s)	16.9	8.9	-	-	7.5	0
HCM Lane LOS	C	A	-	-	A	A
HCM 95th %tile Q(veh)	0.1	0	-	-	0	-

Intersection	
Int Delay, s/veh	0.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	114	3	7	661	25	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	100	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	124	3	8	718	27	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	124	0	858	124
Stage 1	-	-	-	-	124	-
Stage 2	-	-	-	-	734	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1463	-	327	927
Stage 1	-	-	-	-	902	-
Stage 2	-	-	-	-	475	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1463	-	325	927
Mov Cap-2 Maneuver	-	-	-	-	325	-
Stage 1	-	-	-	-	902	-
Stage 2	-	-	-	-	472	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.1	15.7
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	325	927	-	-	1463	-
HCM Lane V/C Ratio	0.084	0.006	-	-	0.005	-
HCM Control Delay (s)	17.1	8.9	-	-	7.5	-
HCM Lane LOS	C	A	-	-	A	-
HCM 95th %tile Q(veh)	0.3	0	-	-	0	-


171
3
164
10
Erie Pkwy
695
9
25
95
674
30
10
15
Erie Pkwy
111th St.
Flatiron Meadows Blvd

Intersection	
Int Delay, s/veh	0.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	695	9	3	171	2	9
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	755	10	3	186	2	10

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	765	0	952	760
Stage 1	-	-	-	-	760	-
Stage 2	-	-	-	-	192	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	848	-	288	406
Stage 1	-	-	-	-	462	-
Stage 2	-	-	-	-	841	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	848	-	287	406
Mov Cap-2 Maneuver	-	-	-	-	287	-
Stage 1	-	-	-	-	462	-
Stage 2	-	-	-	-	838	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	14.7
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	287	406	-	-	848	-
HCM Lane V/C Ratio	0.008	0.024	-	-	0.004	-
HCM Control Delay (s)	17.6	14.1	-	-	9.3	0
HCM Lane LOS	C	B	-	-	A	A
HCM 95th %tile Q(veh)	0	0.1	-	-	0	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	674	30	10	164	10	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	100	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	733	33	11	178	11	16

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	733	0	933	733
Stage 1	-	-	-	-	733	-
Stage 2	-	-	-	-	200	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	872	-	295	421
Stage 1	-	-	-	-	475	-
Stage 2	-	-	-	-	834	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	872	-	291	421
Mov Cap-2 Maneuver	-	-	-	-	291	-
Stage 1	-	-	-	-	475	-
Stage 2	-	-	-	-	823	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.5	15.5
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	291	421	-	-	872	-
HCM Lane V/C Ratio	0.037	0.039	-	-	0.012	-
HCM Control Delay (s)	17.9	13.9	-	-	9.2	-
HCM Lane LOS	C	B	-	-	A	-
HCM 95th %tile Q(veh)	0.1	0.1	-	-	0	-


744
20
727
90
Erie Pkwy
124
15
50
35
125
50
175
90
Erie Pkwy
111th St.
Flatiron Meadows Blvd

Intersection	
Int Delay, s/veh	1.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	113	15	20	676	50	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	0	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	135	16	22	808	54	38

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	135	0	987	135
Stage 1	-	-	-	-	135	-
Stage 2	-	-	-	-	852	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1449	-	274	914
Stage 1	-	-	-	-	891	-
Stage 2	-	-	-	-	418	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1449	-	270	914
Mov Cap-2 Maneuver	-	-	-	-	270	-
Stage 1	-	-	-	-	891	-
Stage 2	-	-	-	-	412	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	16.5
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	270	914	-	-	1449	-
HCM Lane V/C Ratio	0.201	0.042	-	-	0.015	-
HCM Control Delay (s)	21.7	9.1	-	-	7.5	-
HCM Lane LOS	C	A	-	-	A	-
HCM 95th %tile Q(veh)	0.7	0.1	-	-	0	-

Intersection	
Int Delay, s/veh	12.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	114	50	90	661	175	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	100	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	136	54	98	790	190	98

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	136	0	1122	136
Stage 1	-	-	-	-	136	-
Stage 2	-	-	-	-	986	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1448	-	228	913
Stage 1	-	-	-	-	890	-
Stage 2	-	-	-	-	361	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1448	-	213	913
Mov Cap-2 Maneuver	-	-	-	-	213	-
Stage 1	-	-	-	-	890	-
Stage 2	-	-	-	-	337	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.8	58.5
HCM LOS			F

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	213	913	-	-	1448	-
HCM Lane V/C Ratio	0.893	0.107	-	-	0.068	-
HCM Control Delay (s)	83.7	9.4	-	-	7.7	-
HCM Lane LOS	F	A	-	-	A	-
HCM 95th %tile Q(veh)	7.1	0.4	-	-	0.2	-


188
35
180
85
Erie Pkwy
765
50
20
30
741
170
55
105
Erie Pkwy
111th St.
Flatiron Meadows Blvd

Intersection	
Int Delay, s/veh	1.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	695	50	35	171	20	30
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	0	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	831	54	38	204	22	33

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	831	0	1112	831
Stage 1	-	-	-	-	831	-
Stage 2	-	-	-	-	281	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	801	-	231	370
Stage 1	-	-	-	-	428	-
Stage 2	-	-	-	-	767	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	801	-	220	370
Mov Cap-2 Maneuver	-	-	-	-	220	-
Stage 1	-	-	-	-	428	-
Stage 2	-	-	-	-	731	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.5	18.7
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	220	370	-	-	801	-
HCM Lane V/C Ratio	0.099	0.088	-	-	0.047	-
HCM Control Delay (s)	23.2	15.7	-	-	9.7	-
HCM Lane LOS	C	C	-	-	A	-
HCM 95th %tile Q(veh)	0.3	0.3	-	-	0.1	-

Intersection	
Int Delay, s/veh	3.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	674	170	85	164	55	105
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	100	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	806	185	92	196	60	114

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	806	0	1187	806
Stage 1	-	-	-	-	806	-
Stage 2	-	-	-	-	381	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	819	-	208	382
Stage 1	-	-	-	-	439	-
Stage 2	-	-	-	-	691	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	819	-	185	382
Mov Cap-2 Maneuver	-	-	-	-	185	-
Stage 1	-	-	-	-	439	-
Stage 2	-	-	-	-	613	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.2	23.6
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	185	382	-	-	819	-
HCM Lane V/C Ratio	0.323	0.299	-	-	0.113	-
HCM Control Delay (s)	33.5	18.4	-	-	10	-
HCM Lane LOS	D	C	-	-	A	-
HCM 95th %tile Q(veh)	1.3	1.2	-	-	0.4	-


1014
20
992
90
Erie Pkwy
170
15
50
35
171
50
175
90
Erie Pkwy
111th St.
Flatiron Meadows Blvd

Intersection	
Int Delay, s/veh	1.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	113	15	20	676	50	35
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	0	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	184	16	22	1102	54	38

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	184	0	1330	184
Stage 1	-	-	-	-	184	-
Stage 2	-	-	-	-	1146	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1391	-	171	858
Stage 1	-	-	-	-	848	-
Stage 2	-	-	-	-	303	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1391	-	168	858
Mov Cap-2 Maneuver	-	-	-	-	168	-
Stage 1	-	-	-	-	848	-
Stage 2	-	-	-	-	298	-

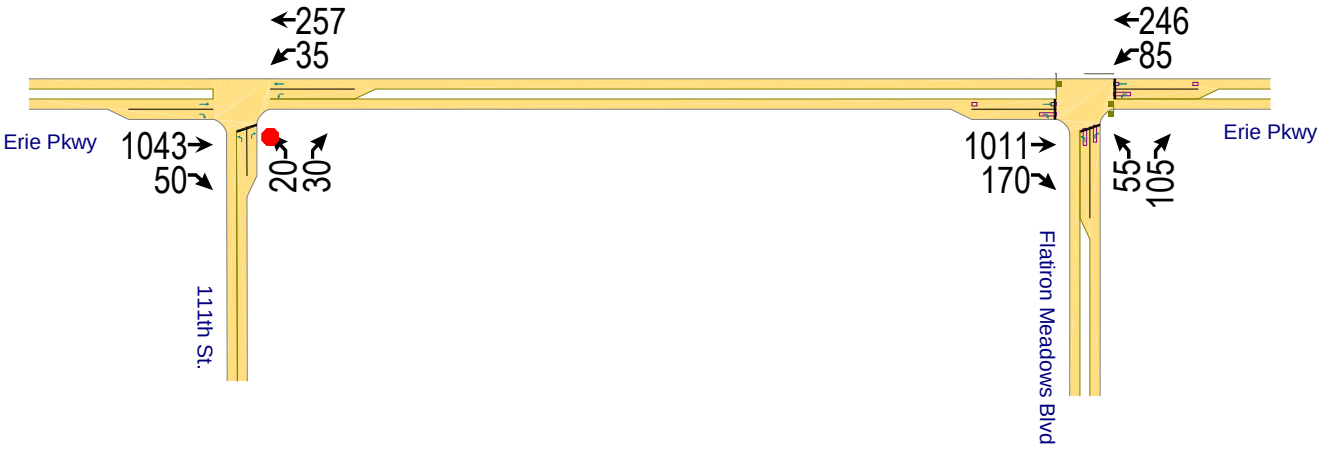
Approach	EB	WB	NB
HCM Control Delay, s	0	0.1	25.3
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	168	858	-	-	1391	-
HCM Lane V/C Ratio	0.323	0.044	-	-	0.016	-
HCM Control Delay (s)	36.4	9.4	-	-	7.6	-
HCM Lane LOS	E	A	-	-	A	-
HCM 95th %tile Q(veh)	1.3	0.1	-	-	0	-

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	114	50	90	661	175	90
Number	4	14	3	8	5	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	186	54	98	1078	190	98
Adj No. of Lanes	1	1	1	1	1	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1248	1061	811	1248	405	362
Arrive On Green	0.67	0.67	0.67	0.67	0.23	0.23
Sat Flow, veh/h	1863	1583	1135	1863	1774	1583
Grp Volume(v), veh/h	186	54	98	1078	190	98
Grp Sat Flow(s),veh/h/ln	1863	1583	1135	1863	1774	1583
Q Serve(g_s), s	2.9	0.9	2.7	35.7	7.3	4.0
Cycle Q Clear(g_c), s	2.9	0.9	5.6	35.7	7.3	4.0
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	1248	1061	811	1248	405	362
V/C Ratio(X)	0.15	0.05	0.12	0.86	0.47	0.27
Avail Cap(c_a), veh/h	1750	1487	1116	1750	405	362
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	4.8	4.4	5.8	10.2	26.3	25.0
Incr Delay (d2), s/veh	0.1	0.0	0.1	3.4	3.9	1.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	0.4	0.9	19.2	4.0	1.9
LnGrp Delay(d),s/veh	4.8	4.5	5.9	13.6	30.1	26.8
LnGrp LOS	A	A	A	B	C	C
Approach Vol, veh/h	240			1176	288	
Approach Delay, s/veh	4.7			13.0	29.0	
Approach LOS	A			B	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				8
Phs Duration (G+Y+Rc), s		22.0		56.8				56.8
Change Period (Y+Rc), s		4.0		4.0				4.0
Max Green Setting (Gmax), s		18.0		74.0				74.0
Max Q Clear Time (g_c+I1), s		9.3		4.9				37.7
Green Ext Time (p_c), s		0.6		17.9				15.1

Intersection Summary	
HCM 2010 Ctrl Delay	14.5
HCM 2010 LOS	B


257
35
246
85
Erie Pkwy
1043
50
20
30
1011
170
55
105
Erie Pkwy
111th St.
Flatiron Meadows Blvd

Intersection	
Int Delay, s/veh	1.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	695	50	35	171	20	30
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	0	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	1133	54	38	279	22	33

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	1133	0	1488	1133
Stage 1	-	-	-	-	1133	-
Stage 2	-	-	-	-	355	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	617	-	137	247
Stage 1	-	-	-	-	307	-
Stage 2	-	-	-	-	710	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	617	-	129	247
Mov Cap-2 Maneuver	-	-	-	-	129	-
Stage 1	-	-	-	-	307	-
Stage 2	-	-	-	-	666	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.3	28.5
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	129	247	-	-	617	-
HCM Lane V/C Ratio	0.169	0.132	-	-	0.062	-
HCM Control Delay (s)	38.5	21.8	-	-	11.2	-
HCM Lane LOS	E	C	-	-	B	-
HCM 95th %tile Q(veh)	0.6	0.4	-	-	0.2	-

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	674	170	85	164	55	105
Number	4	14	3	8	5	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	1099	185	92	267	60	114
Adj No. of Lanes	1	1	1	1	1	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	1459	1240	307	1459	177	158
Arrive On Green	0.78	0.78	0.78	0.78	0.10	0.10
Sat Flow, veh/h	1863	1583	429	1863	1774	1583
Grp Volume(v), veh/h	1099	185	92	267	60	114
Grp Sat Flow(s),veh/h/ln	1863	1583	429	1863	1774	1583
Q Serve(g_s), s	21.4	2.0	9.9	2.5	2.2	4.8
Cycle Q Clear(g_c), s	21.4	2.0	31.2	2.5	2.2	4.8
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	1459	1240	307	1459	177	158
V/C Ratio(X)	0.75	0.15	0.30	0.18	0.34	0.72
Avail Cap(c_a), veh/h	2068	1758	447	2068	415	370
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	3.9	1.8	12.2	1.9	28.7	29.9
Incr Delay (d2), s/veh	1.0	0.1	0.5	0.1	1.1	6.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.8	0.8	1.2	1.3	1.1	2.4
LnGrp Delay(d),s/veh	4.9	1.9	12.7	1.9	29.8	35.9
LnGrp LOS	A	A	B	A	C	D
Approach Vol, veh/h	1284			359	174	
Approach Delay, s/veh	4.5			4.7	33.8	
Approach LOS	A			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				8
Phs Duration (G+Y+Rc), s		10.8		57.6				57.6
Change Period (Y+Rc), s		4.0		4.0				4.0
Max Green Setting (Gmax), s		16.0		76.0				76.0
Max Q Clear Time (g_c+I1), s		6.8		23.4				33.2
Green Ext Time (p_c), s		0.3		22.2				20.4

Intersection Summary	
HCM 2010 Ctrl Delay	7.3
HCM 2010 LOS	A

FLATIRON MEADOWS – PLANNING AREA C

PHASE II DRAINAGE REPORT

JANUARY 2017

For:
HT FLATIRON LP
1515 WYNKOOP STREET, SUITE 800
DENVER, CO 80202

Calibre Engineering, Inc. 9090 S Ridgeline Blvd, Suite 105 Highlands Ranch, CO 80129 (303) 730-0434 www.calibre-engineering.com

ENGINEER'S STATEMENT:

I hereby state that this Phase II Drainage Report for Flatiron Meadows – Planning Area C was prepared by me (or under my direct supervision) in general accordance with the *Town of Erie Standards and Specifications* and the *Urban Storm Drainage Criteria Manual*.

Todd A. Johnson, P.E. Date
State of Colorado No. 37660
For and on behalf of Calibre Engineering, Inc.

TABLE OF CONTENTS

APPENDICES

SCOPE

The purpose of this report is to support the projected patterns of the Master Drainage Plan for the Flatiron Meadows – Planning Area C development. This report includes analysis and design of locations of proposed inlets and storm systems in general accordance with the standards and specifications of the Town of Erie and Urban Drainage Flood Control District (UDFCD).

The existing *Town of Erie Outfall Systems Plan (West of Coal Creek) Alternatives Analysis Report* (referred to as OSP in this report), is in the process of being updated by the Town of Erie and UDFCD.

I. INTRODUCTION

A. Location

- The site is bound to the west by North 111th Street, to the south by a future region of the Flatiron Meadows development, to the east by the Prince Tributary and to the north by the Leyner Cottonwood Ditch.
- Within the southwest quarter of Section 23, Township 1 North, Range 69 West of the 6th Principal Meridian, Town of Erie, County of Boulder, State of Colorado.
- The Prince Tributary is adjacent to the site, flowing from south to north.
- An existing oil/gas facility and the Regional Detention Pond 1029 are north of the site.
- All other Flatiron Meadows filings are east of the Planning Area C site.
- See the Vicinity Map and Filing Map in Appendix A.

B. Description of Property

- Flatiron Meadows – Planning Area C is approximately 49.3 acres of single family development.
- The existing ground cover is farmed land with agricultural soils.
- The drainage way is lined with shrubs, native grasses, and large cottonwood trees.
- The site has gentle to moderate slopes between 1% and 7%, sloping towards the northwest.
- According to the *Natural Resources Conservation Service Web Soil Survey* for the County of Boulder, the site is Hydrologic Soil Group B as Ascalon Sandy Loam (AcC).
- The Leyner Cottonwood Ditch is north of the site, flowing from west to east.
- The proposed Planning Area C development will consist of 79 single family residential units, open space and roadways.
- There are delineated wetland areas within the Prince Tributary; however no wetlands will be disturbed with the development of Planning Area C.

II. DRAINAGE BASINS

A. Major Basin Description

- Flatiron Meadows – Planning Area C is located within the limits of the *Town of Erie Outfall Systems Plan (West of Coal Creek) Alternatives Analysis Report* (OSP). Phase 5

is within the OSP major Basins 215 and 211. The OSP indicates both these basins will drain to the Prince Tributary and then to Regional Detention Facility 1029. Copies of applicable pages from the OSP are included in Appendix A.

- The site is found on FEMA Flood Insurance Rate Map (FIRM) panels 08013C0437J and 08013C0439J. A portion of the site is within Zone AE and the mapped 100-year floodplain. A CLOMR was approved in May 2008 for a modification of the floodplain.
- There are no lots within the existing FEMA floodplain.
- The ownership of all lakes and ponds will not influence or be influenced by the local drainage. There are no jurisdictional dams onsite.

B. Sub-Basin Description

- There are no Master Plan improvements designated for the site. The Regional Detention Pond will be constructed prior to Planning Area C improvements.
- Currently the site drains to the northeast towards the Prince Tributary.
- A small area of the adjacent Flatiron Meadows property is considered for off-site storm drainage onto the project.
- From west side of 111th will follow historic patterns.
- The increase in storm runoff due to the proposed development will be detained in the Regional Detention Pond 1029. The proposed development will not increase historic runoff and therefore downstream properties should not be adversely affected by the development of the proposed site.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference and Constraints

- Criteria and references used in the development of this Phase II Drainage Report include:
  - The Town of Erie Standards and Specifications for Design and Construction of Public Improvements.
  - The Urban Drainage and Flood Control District's *Urban Storm Drainage Criteria Manual* was also used as a reference and guide for criteria.
  - The Town of Erie Outfall Systems Plan (West of Coal Creek) Alternatives Analysis Report prepared by WRC Engineering, Inc., June 2013.
  - *Flatiron Meadows Master Drainage Study*, prepared by Calibre Engineering Inc.
- The delineated wetlands onsite will not be disturbed with the development of Planning Area C.

B. Hydrologic Criteria

- The Rational Method will be used for all hydrologic calculations.
- The minor event is the 2-year storm with a one-hour design rainfall depth of 1.01 inches per hour.

- The major event is the 100-year storm with a one hour design rainfall depth of 2.70 inches per hour.
- Per the *Town of Erie Standards and Specifications Storm Criteria*, Table 800-3 will be used to determine appropriate runoff coefficients.

C. Hydraulic Criteria

- Per *Town of Erie Standards and Specifications Storm Criteria*, Tables 800-7 and 800-8, allowable flow depths within the streets are:
  - To the top of curb, flow may spread to crown of street for the minor event.
  - Residential dwellings should be no less than 12 inches above the 100-year flood at the ground line or lowest water entry of the building. The depth of water over the gutter flow line will not exceed 18 inches for the major storm.
- A Hydraflow Storm Sewer model will be used to size storm pipes.
- The UDFCD Inlet Spreadsheet has been used to size inlets and was used to calculate street capacity. See Appendix C for street capacity calculations.
- Per the OSP, regional detention improvements will be constructed on the Flatiron Meadows Development, controlling the release rates before leaving the site. Design for the Regional Detention Pond 1029 is detailed in a separate report. Assumptions made in that report regarding Planning Area C will be confirmed.

D. Adaptations from Criteria

- No deviation from criteria is requested for this drainage design at this time.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

- The proposed drainage patterns will follow existing drainage patterns as closely as possible. Runoff will flow from the southwest to the northeast, either by the streets, natural drainage ways or the proposed storm sewer system.
- Runoff from all developed areas will be routed to the Regional Detention Pond. In accordance with the OSP and Flatiron Meadows *Master Drainage Study.*

B. Specific Details

- Proposed drainage basins have been broken down further on site to calculate street capacity, inlet capacity and size the storm system.
  - Basin A consists of single family uses, roadway and lawn. Runoff generated in this basin is routed via curb and gutter to a Type-R inlet in sump at Design Point (DP) 1. The minor and major events are captured and conveyed to Prince Tributary.
  - Basin B contains a portion of the improved N 111th Street and lawn. Runoff generated in this basin is routed via curb and gutter into the site (Basin C) at DP 2.
  - Basin C consists of single family uses, roadway and lawn. Runoff generated in this basin combines with runoff from Basin B and is routed via curb and gutter to an on-grade Type-R inlet at DP 3. The minor and major events are captured at this design point.

- Basin D consists of single family uses, roadway and lawn. Runoff generated in this basin is routed via curb and gutter to an on-grade Type-R inlet at DP 4. The minor and major events are captured at this design point.
- Basin E consists of single family uses, roadway and lawn. Runoff generated in this basin is routed via curb and gutter to two on-grade Type-R inlets on either side of the street. The entire minor and major events are captured at this point.
- Basins B-E utilize the same storm system, and outfall to Prince Tributary.
- Basin F consists of single family uses, roadway and lawn. Runoff generated in this basin is routed via curb and gutter to a Type-R inlet in sump at DP 6. The entire minor and major events are captured at this point. This storm system outfalls to Prince Tributary.
- Basin G contains a portion of the improved N 111th Street and lawn. Runoff generated in this basin is routed via curb and gutter to DP 7. The minor and major events are captured by one on-grade Type-R inlet within N 111th Street and one one-grade Type-R inlet within the site.
- Basin H consists of single family uses, roadway and lawn. Runoff generated in this basin is routed via curb and gutter to an on-grade Type-R inlet at DP 8. The entire minor and major events are captured at this point.
- Basin I consists of single family uses, roadway and lawn. Runoff generated in this basin is routed via curb and gutter to an on-grade Type-R inlet at DP 9. The entire minor and major events are captured at this point.
- Basin G-I utilize the same storm system, and outfall to Prince Tributary.
- Basin J consists of single family uses, roadway and lawn. Runoff generated in this basin is routed via curb and gutter to a sump Type-R inlet at DP 10. The entire minor and major events are captured at this point. This storm system outfalls to Prince Tributary.
- Basin ST-1 contains a portion of the improved N 111th Street and lawn. Runoff generated in this basin will be routed to a proposed Type-R inlet on grade at DP 11, which will be place on an existing storm line. The minor and major events are captured at this point.
- Basin ST-2 contains a portion of the improved N 111th Street and lawn. Runoff generated in this basin will be routed via curb and gutter to DP 12 to one Type R inlet in a sump and one Type-C inlet within the roadside swale. This storm system will outfall into the Prince Lake No. 2 dam breach channel. The minor and major events are captured at this point.

- Storm sewer systems will be accessed from the proposed roads onsite.
- Easements and tracts will be used for drainage purposes in specific locations where flooding in the 100-year storm may occur.
- Other storm sewer will be kept within the right-of-way to minimize special drainage easements and tracts.
- Downstream properties should not be affected by the development of the proposed site. The regional detention and water quality pond will provide the appropriate detention to

control the release from the Flatiron Meadows Development to the downstream properties to the north.

- All lots platted with Planning Area C are outside of the 100-year floodplain as shown on both the FEMA (FIRM) Map Number 0801810012E and the approved CLOMR for the site.

V. BEST MANAGEMENT PRACTICES

A. Construction BMP's

- Construction BMP's are discussed in a separate SWMP report.

B. Permanent BMP's

- Permanent stabilization BMP's are discussed in a separate SWMP report.
- Detention and water quality treatment will be provided by Regional Pond 1029.

VI. SUMMARY

A. Compliance with CRITERIA, MANUAL, and OSP

- This drainage report is in general compliance with the Town of Erie Standards and Specifications for Design and Construction of Public Improvements.
- The Urban Drainage and Flood Control District's *Urban Storm Drainage Criteria Manual* was also used as a reference and guide for criteria.
- Regional detention facilities will be constructed prior to this phase of development per the OSP recommendations.
- Construction and Permanent Best Management Practices will be utilized for the development of Flatiron Meadows Planning Area C.

B. Drainage Concept

- Runoff will flow from the southwest to the northeast, either by the streets, natural drainage ways or the proposed storm sewer system.
- Runoff from all developed areas will be routed to the Regional Detention Pond. In accordance with the OSP and Flatiron Meadows *Master Drainage Study.*

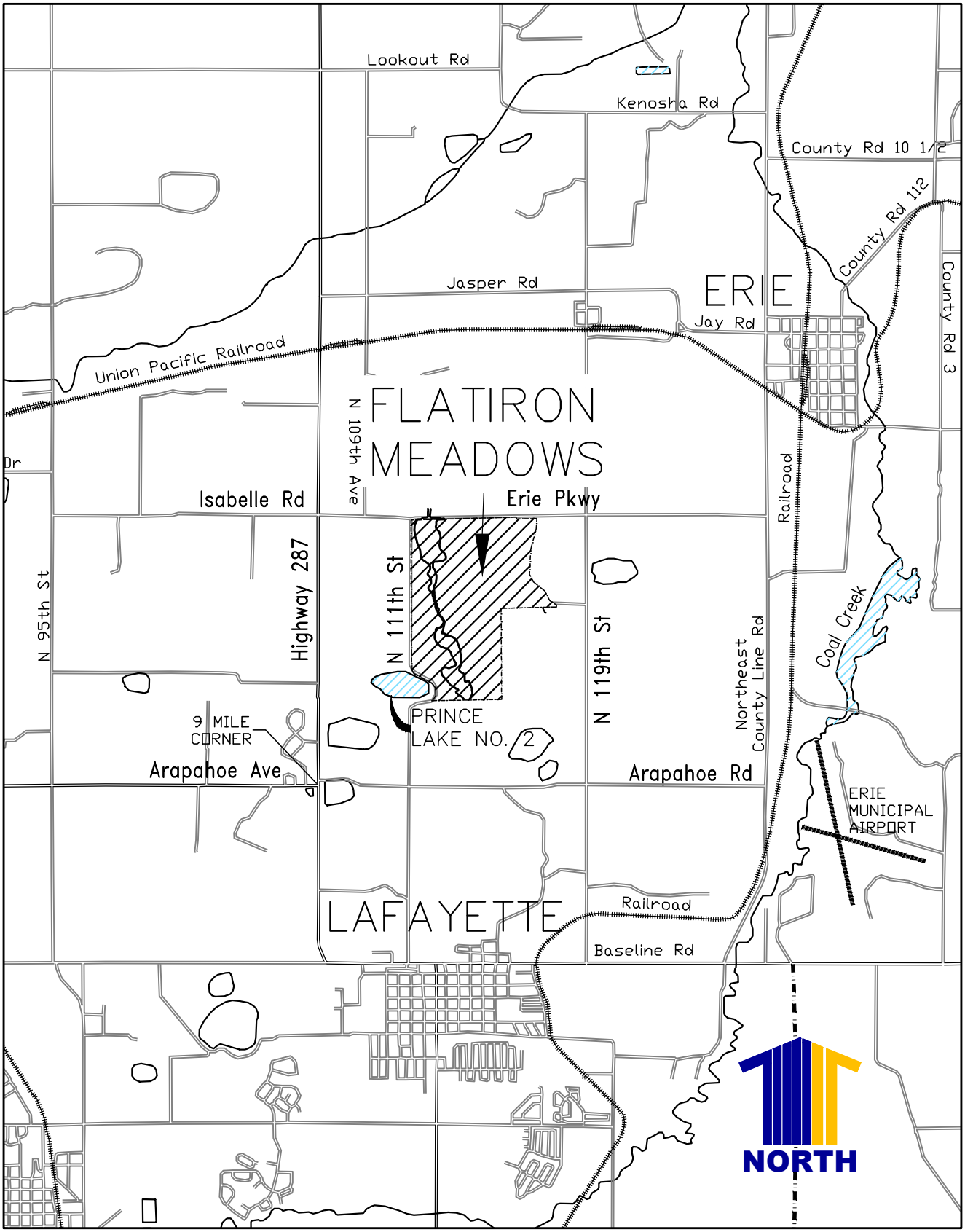
VII. LIST OF REFERENCES

All criteria and technical information used

1. *The Town of Erie, Standards and Specifications for Design and Construction of Public Improvements, Section 800, Storm Drainage Facilities,* 2012 Edition.
2. *Urban Storm Drainage Criteria Manuals,* Urban Drainage Flood Control District, Jan 2007.
3. *Town of Erie Outfall Systems Plan (West of Coal Creek) Alternatives Analysis Report (referred to as OSP in this report),* prepared by WRC Engineering, Inc., June 2013.
4. *Flood Insurance Rate Map, Map Numbers 08013C0437J and 08013C0439J,* Effective Date December 18, 2012, Federal Emergency Management Agency.

5. Hydrologic Group Rating for Adams County, CO, USDA Natural Resources Conservation Service.
6. *Flatiron Meadows Master Drainage Study,* Calibre Engineering Inc., September 2008
7. *Flatiron Meadows Phase III Drainage Report, Regional Drainage Improvements,* Calibre Engineering Inc., January 2014.
8. *Prince Lake No. 2 Dam Breach Analysis, Olsson Associates,* March 31, 2008.

APPENDIX A.
MAPS AND EXHIBITS



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DRAWING NAME: 10DR-VICINITY MAP.dwg PATH: P:\WORTH FLATIRON\CADD\Exhibits\ PLOTTED BY: KHouse XREFS:

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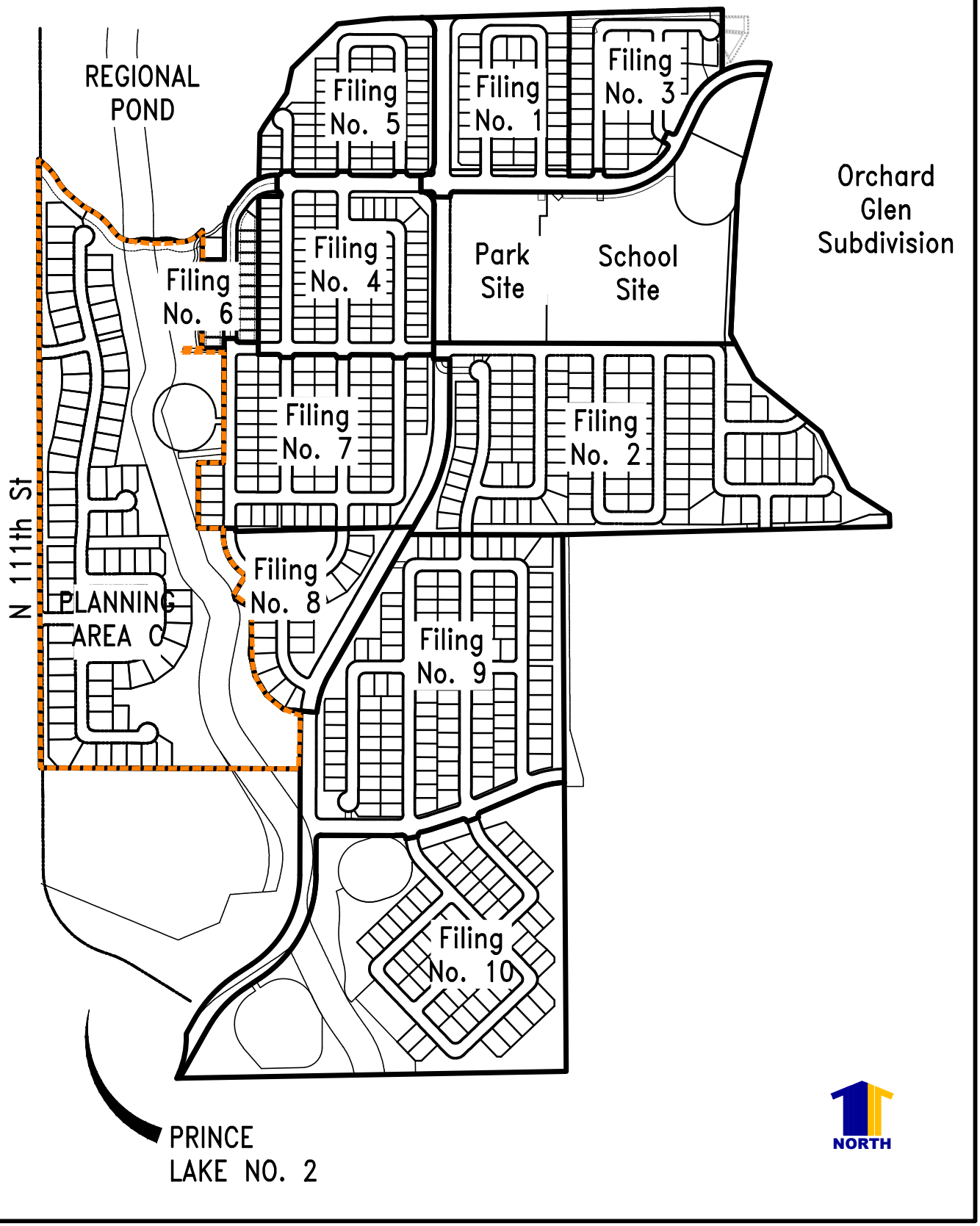
Highlands Ranch, CO 80129 (303) 730-0434
www.calibre-engineering.com
Construction Management Civil Engineering Surveying

FLATIRON MEADOWS
VICINITY MAP

SHEET
VM1

SCALE: N.T.S.

DATE: MAY 2016



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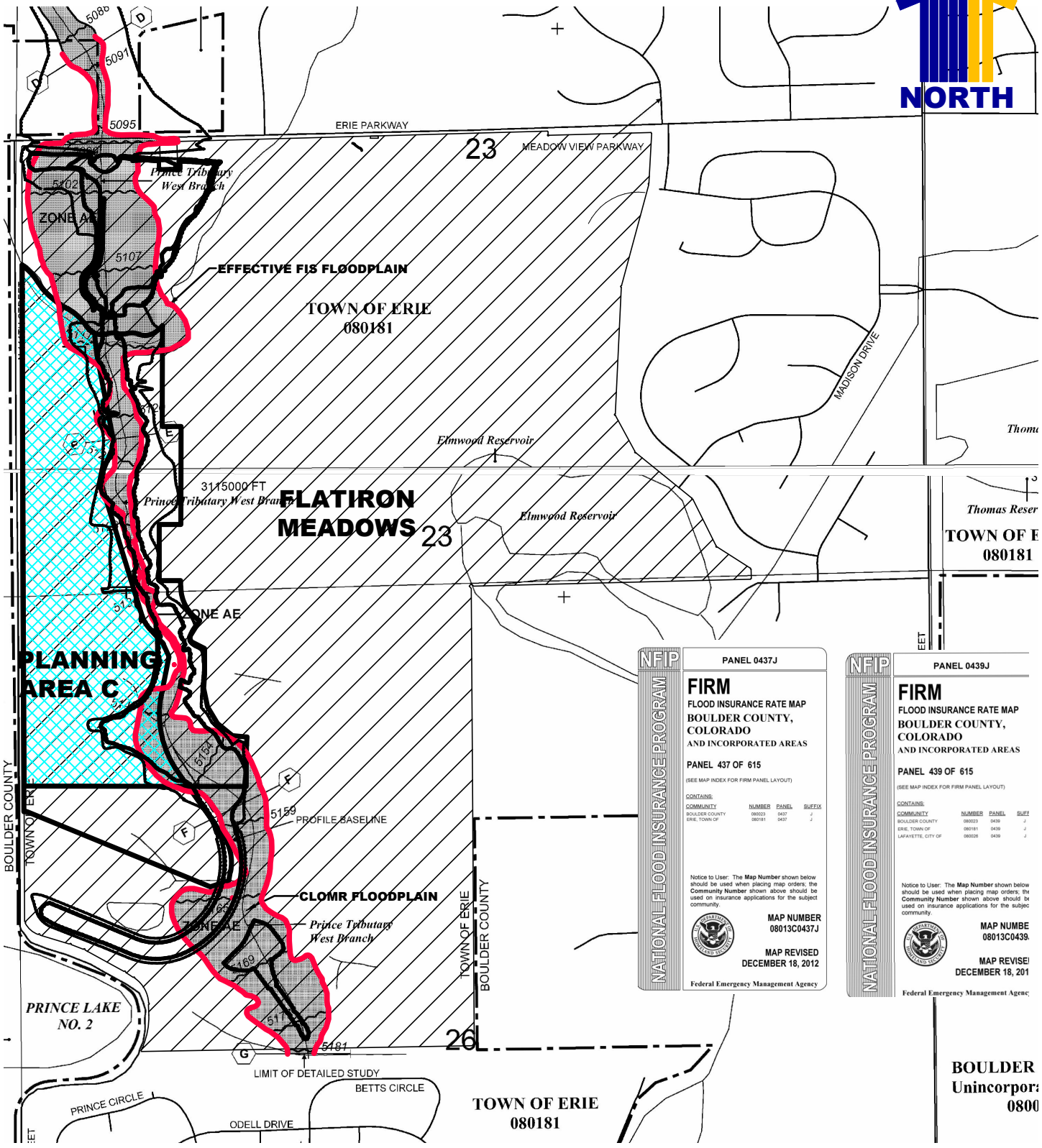
FLATIRON MEADOWS
FILING MAP

SHEET

SCALE: N.T.S.

DATE: JANUARY 2017



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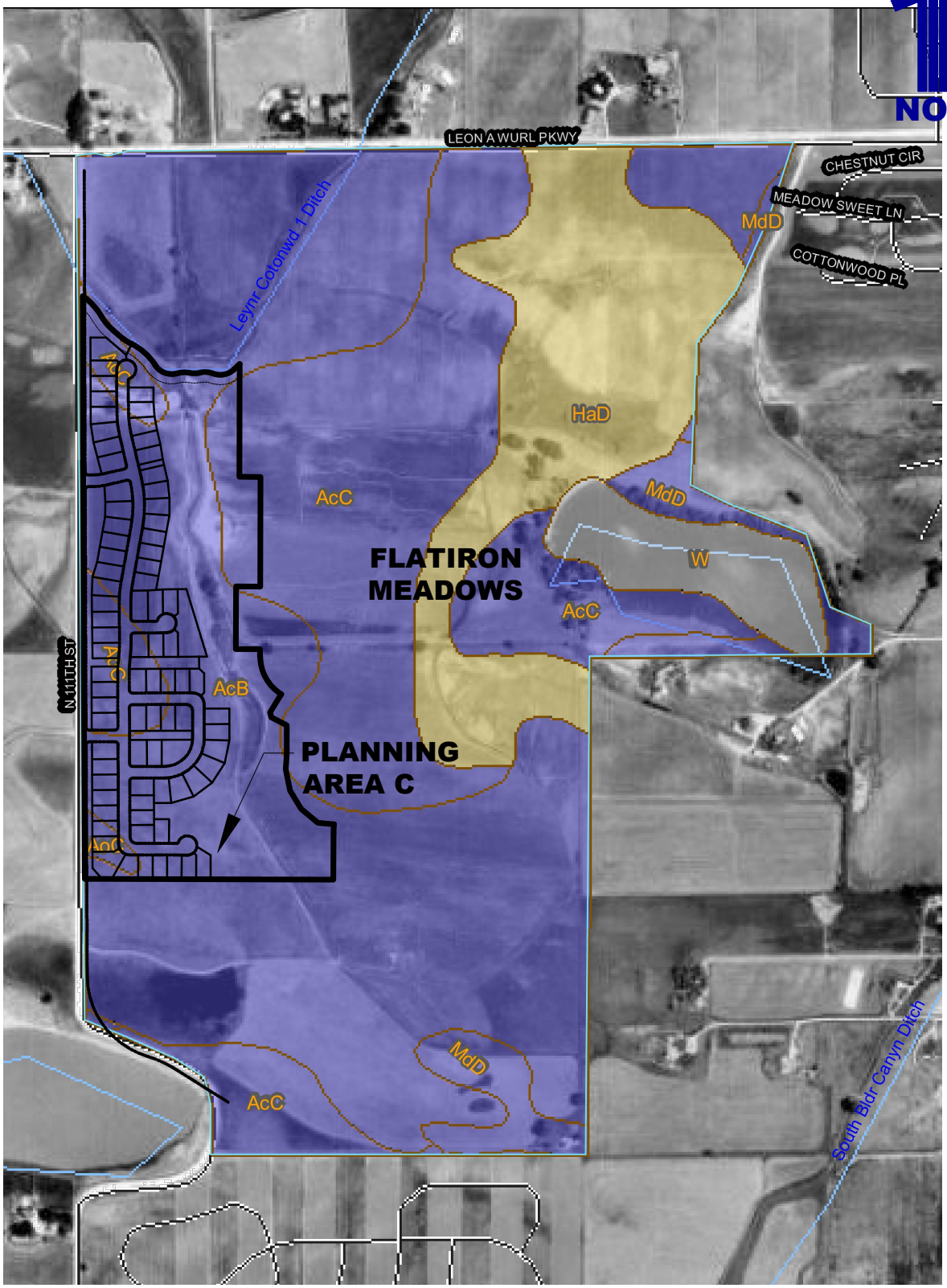
FLATIRON MEADOWS
PLANNING AREA C
FEMA MAP

SHEET
FM1

SCALE: 1" = 800'

DATE: MAY 2016



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FLATIRON MEADOWS
PLANNING AREA C
SOILS MAP

SHEET
SM1
SCALE: 1" = 800'
DATE: JANUARY 2017

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities
- PLSS Township and Range
- PLSS Section

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:3,590 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Boulder County Area, Colorado
Survey Area Data: Version 9, May 1, 2009

Date(s) aerial images were photographed: 8/6/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Boulder County Area, Colorado (CO643)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AcB	Ascalon sandy loam, 1 to 3 percent slopes	B	14.3	21.8%
AcC	Ascalon sandy loam, 3 to 5 percent slopes	B	46.8	71.1%
HaD	Hargreave fine sandy loam, 3 to 9 percent slopes	C	4.7	7.2%
Totals for Area of Interest			**65.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

PROPERTY BOUNDARY

75' IRRIGATION ESMT.

DRAINAGE EASEMENT

EX. FEMA FLOODPLAIN
PRINCE TRIBUTARY

PR. 100-YR FLOODPLAIN
PRINCE TRIBUTARY

WETLANDS

PROPERTY BOUNDARY

MATCHLINE 1
SEE VIEW 1

MATCHLINE 2
SEE VIEW 2

N 111TH ST

N 111TH ST

44' EASEMENT

FES

TYPE-R

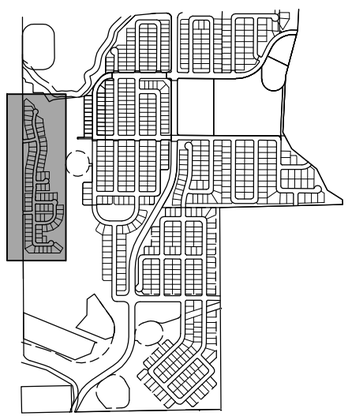
60' R.O.W.
34' F.L.-F.L.

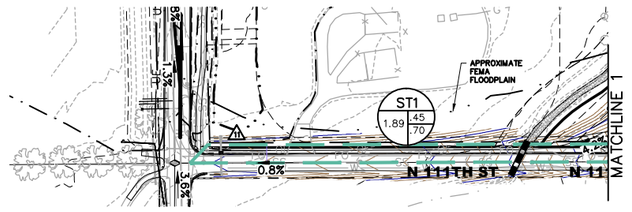
A	2.25	.40 / .67
B	1.22	.66 / .82
C	3.08	.36 / .65
D	1.39	.43 / .69
E	4.28	.36 / .65
F	1.82	.40 / .67
G	2.66	.71 / .84
H	5.24	.35 / .65
I	1.25	.46 / .70
J	3.18	.46 / .70
ST1	1.89	.45 / .70

NORTH

LEGEND

- PROPOSED MAJOR CONTOUR (5') — 5250
- PROPOSED MINOR CONTOUR (1')
- EXISTING MINOR CONTOUR (1')
- EXISTING MAJOR CONTOUR (5') — 5250
- PROPOSED STORM DRAIN PIPE
- PROPOSED STORM DRAIN INLET
- DIRECTIONAL FLOW ARROW
- BASIN LINE
- SWALE
- DESIGN POINT (1)
- PROPOSED BASIN LABEL
- A1 — BASIN DESIGNATION; AREA (AC.) 1.00 — .40 MINOR RUNOFF COEF., .60 MAJOR RUNOFF COEF.
- EMERGENCY OVERFLOW





VIEW 1
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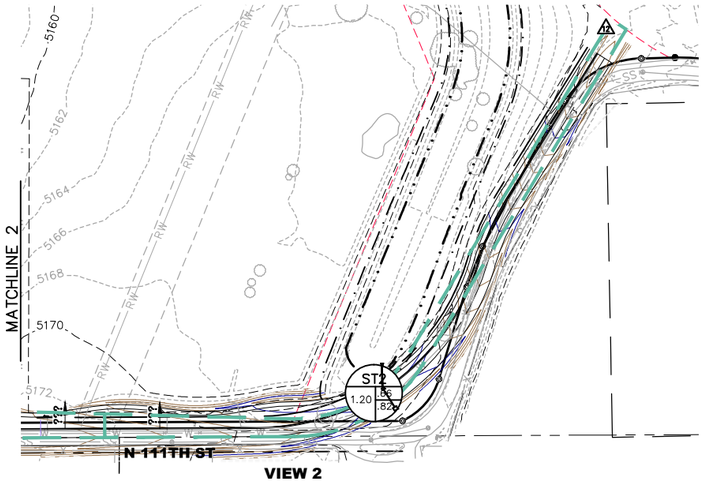

VIEW 2
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DATE	REVISION DESCRIPTION
.	.

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Job Number: HINES PA C PP
Prepared For: HT FLATIRON LP

0 50 100 200
1 inch = 100 ft. Horizontal

Designer	Drafter	Checked
MAS	MAS	BKM

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FLATIRON MEADOWS
PLANNING AREA C - IMPROVEMENT PLANS
PROPOSED DRAINAGE PLAN

Sheet DR1 — 1 of 1

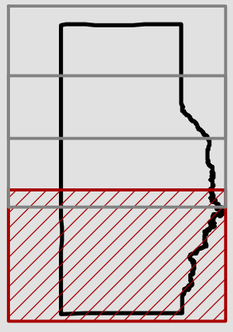
Date: JANUARY 27, 2017

LEGEND

- Study Area Boundary
- Town of Erie
- City of Lafayette
- Subbasin Boundary
- Major Watershed Boundary
- Regional Detention Ponds

XXX — Subbain ID
XX | X — % Impervious (Existing Land Use) | % Impervious (Future Land Use)
Area (Acres)

KEY MAP



N
W E
S

0 750 1,500 3,000 Feet

1 " = 1,500 FT

M:\2234\GIS\2234.MXD - 12/12/12 - NRT

WRC ENGINEERING, INC.
950 SOUTH CHERRY STREET, SUITE 404
DENVER, COLORADO 80246
PHONE: 303-757-8513
FAX: 303-758-3208

TOWN OF ERIE
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

TOWN OF ERIE OUTFALL SYSTEMS PLAN (WEST OF COAL CREEK)

SUBBASIN MAP

FIGURE B-2

APPENDIX B.
HYDROLOGIC COMPUTATIONS

Calibre

COMPOSITE 'C' FACTORS

LOCATION: TOWN OF ERIE DATE : 1/26/2017

BASIN						SOIL	PAVED			LAWNS			SINGLE FAMILY			WALK			COMP. C FACTOR		
DESIGNATION	PAVED	LAWNS	SINGLE FAMILY	WALK	TOTAL	TYPE	%I	2YR	100 YR	%I	2YR	100 YR	%I	2YR	100 YR	%I	2YR	100 YR	%I	2YR	100 YR
A	0.29	1.15	0.72	0.09	2.25	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	32	0.28	0.61
B	0.35	0.71	0.00	0.17	1.22	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	42	0.37	0.66
C	0.42	1.59	0.94	0.10	3.05	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	32	0.28	0.61
D	0.31	0.86	0.12	0.10	1.39	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	34	0.30	0.62
E	0.66	2.33	1.07	0.22	4.28	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	32	0.29	0.61
F	0.34	0.90	0.48	0.09	1.82	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	36	0.32	0.63
G	0.39	2.13	0.00	0.14	2.66	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	21	0.19	0.56
H	0.39	2.95	1.76	0.14	5.24	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	26	0.23	0.58
I	0.29	0.59	0.24	0.13	1.25	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	42	0.38	0.66
J	0.51	1.56	0.97	0.15	3.18	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	35	0.31	0.62
ST1	0.69	0.97	0.00	0.30	1.96	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	50	0.45	0.70
ST2	0.61	0.28	0.00	0.26	1.16	B	100	0.89	0.94	2	0.02	0.46	45	0.40	0.67	90	0.80	0.90	74	0.66	0.82

Calibre

TIME OF CONCENTRATION

LOCATION: PLANNING AREA C FLATIRON MEADOWS BY: MAS DATE: 1/26/2017

BASIN DATA				INIT./OVERLAND TIME (Ti)			TRAVEL TIME (Tt)					TOTAL	Tc Check		FINAL Tc
DESIGNATION	% Imperv	C5	AREA (AC)	LENGTH (FT)	SLOPE %	Ti (Min.)*	GRASS/ PAVED	LENGTH (FT)	SLOPE %	VEL. (FPS)**	Tt(Min.)	Ti+Tt(Min.)	LENGTH (FT)	Urbanized Basins Tc (min)***	(minutes)
A	32	0.30	2.25	266	2.0	19.1	PAVED	337	1.0	2.0	2.8	21.9	603	16.1	16.1
B	30	0.39	1.22	17	2.0	4.3	PAVED	1915	1.1	2.1	15.2	19.5	1932	29.3	19.5
C	32	0.29	3.05	215	2.0	17.2	PAVED	736	1.9	2.8	4.4	21.6	951	17.8	17.8
D	34	0.32	1.39	70	2.0	9.5	PAVED	673	2.1	2.9	3.9	13.4	743	16.8	13.4
E	32	0.30	4.28	56	2.0	8.7	PAVED	913	1.6	2.5	6.0	14.7	969	19.2	14.7
F	36	0.34	1.82	135	2.0	12.9	PAVED	241	6.6	5.2	0.8	13.7	376	13.3	13.3
G	21	0.19	2.66	17	2.0	5.4	PAVED	1240	2.6	3.2	6.4	11.9	1257	22.4	11.9
H	26	0.24	5.24	243	2.0	19.5	PAVED	1137	1.4	2.4	8.0	27.4	1380	22.8	22.8
I	42	0.39	1.25	63	2.0	8.1	PAVED	664	1.4	2.4	4.7	12.8	727	15.9	12.8

REMARKS

* V=Cv(Sw^1/2)

** Ti = 0.395 (1.1-C5)L^0.5/S^1/3

*** Tc = (18-15i)+L/[60*(24i+12)i*So^0.5} where Cv=15 for grassed waterways and 20 for paved areas

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

DESIGN STORM: 2-YEAR DEVELOPED

MAS
KLH
1/26/2017

LOCATION: PLANNING AREA C FLATIRON MEADOWS TOWN OF ERI

		DIRECT RUNOFF							TOTAL RUNOFF					REMARKS
STRUCTURE	DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (Min.)	C*A	I (in./ hr.)	Q (cfs)	SUM AREA	SUM Tc (min.)	I (in./hr.)	SUM CA	TOTAL Q (cfs)	
IN-1	1	A	2.25	0.28	16	0.64	2.22	1.4						A
-	2	B	1.22	0.37	19	0.46	2.01	0.9						B
IN-2	3	C	3.05	0.28	18	0.86	2.11	1.8	6.52	19.5	2.01	1.32	2.7	B+C
IN-3	4	D	1.39	0.30	13	0.42	2.41	1.0						
IN-4 & IN-5	5	E	4.28	0.29	15	1.23	2.31	2.9						
IN-12	6	F	1.82	0.32	13	0.59	2.42	1.4						
IN-6 & IN-7	7	G	2.66	0.19	12	0.50	2.55	1.3						
IN-8	8	H	5.24	0.23	23	1.22	1.85	2.2						
IN-9	9	I	1.25	0.38	13	0.47	2.46	1.2						
IN-10	10	J	3.18	0.31	17	0.99	2.18	2.1						
IN-11	11	ST1	1.96	0.45	17	0.87	2.13	1.9						
IN-12 & IN-13	12	ST2	1.16	0.66	17	0.76	2.18	1.7						

Notes: "Total Runoff" reflects total routed runoff using rational method. For total runoff plus carryover see "Storm Drainage System Design" sheet.

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

DESIGN STORM: 100-YEAR DEVELOPED

MAS
KLH

LOCATION: PLANNING AREA C FLATIRON MEADOWS TOWN OF ERIE 1/26/2017

		DIRECT RUNOFF							TOTAL RUNOFF					REMARKS
STRUCTURE	DESIGN POINT	BASIN	AREA (AC)	COEFF. (C)	Tc (Min.)	C*A	I (in./ hr.)	Q (cfs)	SUM AREA	SUM Tc (min.)	I (in./hr.)	SUM CA	Total Q (cfs)	
IN-1	1	A	2.25	0.28	16	0.64	5.93	3.8						
-	2	B	1.22	0.37	19	0.46	5.39	2.5						
IN-2	3	C	3.05	0.28	18	0.86	5.64	4.9	6.52	19.5	5.39	1.32	7.1	
IN-3	4	D	1.39	0.30	13	0.42	6.45	2.7						
IN-4 & IN-5	5	E	4.28	0.29	15	1.23	6.18	7.6						
IN-12	6	F	1.82	0.32	13	0.59	6.48	3.8						
IN-6 & IN-7	7	G	2.66	0.19	12	0.50	6.81	3.4						
IN-8	8	H	5.24	0.23	23	1.22	4.95	6.0						
IN-9	9	I	1.25	0.38	13	0.47	6.58	3.1						
IN-10	10	J	3.18	0.31	17	0.99	5.82	5.7						
IN-11	11	ST1	1.96	0.45	17	0.87	5.71	5.0						
IN-12 & IN-13	12	ST2	1.16	0.66	17	0.76	5.84	4.4						

Notes: "Total Runoff" reflects total routed runoff using rational method. For total runoff plus carryover see "Storm Drainage System Design" sheet.

STORM DRAINAGE SYSTEM DESIGN

Calc. by: MAS
Chk'd by: KLH
Date: 1/26/2017

LOCATION: PLANNING AREA C CITY OF: TOWN OF ERIE

						MINOR STORM EVENT (2YR)				MAJOR STORM EVENT (100YR)								
Design Point	Basin	Allowable Street Capacities				Q_2 (Direct) (cfs)	Q_2 (Routed) (cfs)	Captured Q_2 (cfs)	Q_2 Flow CO (cfs)	Q_{100} (Direct) (cfs)	Q_{100} (Routed) (cfs)	Q_{100} + CO (cfs)	Captured Q_{100} (cfs)	Q_{100} Flow CO (cfs)	Structure Label	Inlet Type (ft)	Design Event	Comments
		Slope (%)	Q_2 (CFS)	Q_{100} (CFS)	St. Crown													
1	A	2.8	5.6	26.9	19.4	1.4	1.4	1.4	0.0	3.8		3.8	3.8	0.0	IN-1	5 ' Type-R	100-year	Sump inlet, events captured
2	B	1.1	6.0	11.4	11.4	0.9	0.9	0.9	0.0	2.5		2.5	0.0	2.5	-	-	100-year	Street Capacity check, routed to Basin C/DP 3
3	C	3.1	5.9	26.1	19.2	1.8	2.7	2.7	0.0	4.9	7.1	7.1	7.1	0.0	IN-2	10 ' Type-R	100-year	On-grade inlet. In major event, crown overtopping; runoff split between both sides of street. Minor and major events captured
4	D	3.1	5.9	26.1	19.2	1.0	1.0	1.0	0.0	2.7		2.7	2.7	0.0	IN-3	10 ' Type-R	100-year	On-grade inlet. In major event, crown overtopping; runoff split between both sides of street. Minor and major events captured
5	E	3.1	5.9	26.1	19.2	2.9	2.9	2.9	0.0	7.6		7.6	7.6	0.0	IN-4 & IN-5	(2) 5 ' Type-R	100-year	On-grade inlets on both sides of street, events captured
6	F	1.9	4.6	30.2	16.0	1.4	1.4	1.4	0.0	3.8		3.8	3.8	0.0	IN-12	5 ' Type-R	100-year	Sump inlet, events captured
7	G	1.0	5.7	10.9	10.9	1.3	1.3	1.3	0.0	3.4		3.4	3.4	0.0	IN-6 & IN-7	(2) 5 ' Type-R	100-year	On-grade inlets, events captured
8	H	1.0	3.4	25.2	11.6	2.2	2.2	2.2	0.0	6.0		6.0	6.0	0.0	IN-8	10 ' Type-R	100-year	On-grade inlet, events captured
9	I	1.4	4.0	29.8	13.7	1.2	1.2	1.2	0.0	3.1		3.1	3.1	0.0	IN-9	10 ' Type-R	100-year	On-grade inlet, events captured
10	J	2.4	5.2	28.1	17.9	2.1	2.1	2.1	0.0	5.7		5.7	5.7	0.0	IN-10	10' Type-R	100-year	Sump inlet, events captured
11	ST1	0.8	5.1	9.7	9.7	1.9	1.9	1.9	0.0	5.0		5.0	5.0	0.0	IN-11	5 ' Type-R	100-year	On-grade inlet on existing storm line, events captured
12	ST2	0.8	5.1	9.7	9.7	1.7	1.7	1.7	0.0	4.4		4.4	4.4	0.0	IN-12 & IN-13	Type C & 5' - Type-R	100-year	Sump inlets, events captured

Notes:

1. Local Street: Allowable flow depth based on curb height or street crown for the minor event and spread at ROW for major event.
   Collector Street: Allowable flow depth based on 10' travel path in minor event, spread at ROW for major event.
2. Street capacities were calculated with UDFCDs UD-Inlet

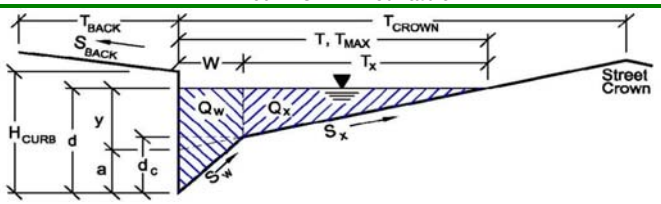
APPENDIX C.
HYDRAULIC COMPUTATIONS

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Flatirons Filing 10

Inlet ID: 60' R.O.W. - Mountable



Gutter Geometry (Enter data in the blue cells)			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	12.2	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.018	
Height of Curb at Gutter Flow Line	H_{CURB} =	4.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	17.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.009	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	17.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.0	6.9	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☑	check = yes

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**3.2**	**23.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

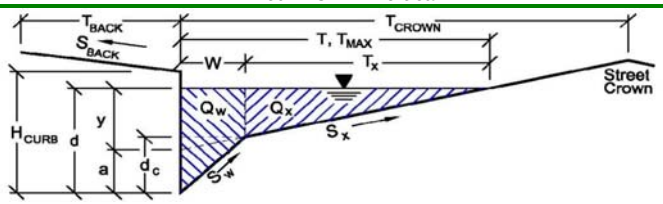
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Flatirons Filing 10

Inlet ID: 60' R.O.W. - Vertical



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	17.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.6	6.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
Q_{allow} =	**5.0**	**11.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

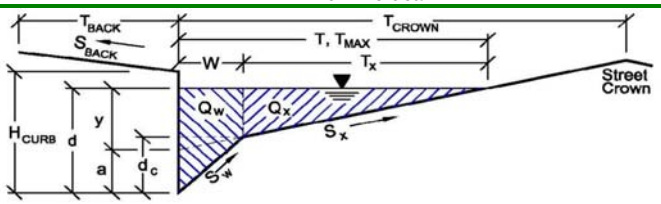
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Flatiron Filing 10

Inlet ID: N. 111th - Vertical



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	17.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	17.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	4.6	6.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**5.1**	**9.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

APPENDIX D.

COPIES OF GRAPHS, TABLES, AND NOMOGRAPHS USED

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential:	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

PROPERTY BOUNDARY

75' IRRIGATION ESMT.

DRAINAGE EASEMENT

EX. FEMA FLOODPLAIN
PRINCE TRIBUTARY

PR. 100-YR FLOODPLAIN
PRINCE TRIBUTARY

PROPERTY BOUNDARY

WETLANDS

FES

FES
TYPE-R

MATCHLINE 1
SEE VIEW 1

MATCHLINE 2
SEE VIEW 2

TYPE-R

34' F.L.-F.L.
60' R.O.W.

44' EASEMENT

A
2.25 | .40 | .67

B
1.22 | .66 | .82

C
3.08 | .36 | .65

D
1.39 | .43 | .69

E
4.28 | .36 | .65

F
1.82 | .40 | .67

G
2.66 | .71 | .84

H
5.24 | .35 | .65

I
1.25 | .46 | .70

J
3.18 | .46 | .70

ST1
1.89 | .45 | .70

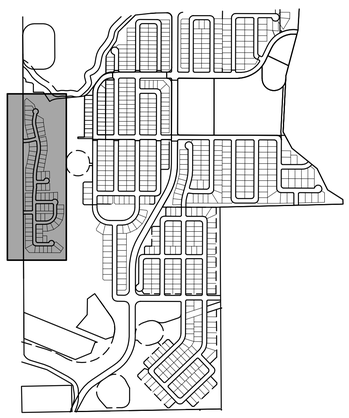
N 111TH ST

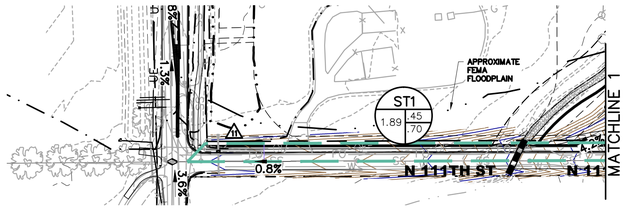
N 111TH ST

NORTH

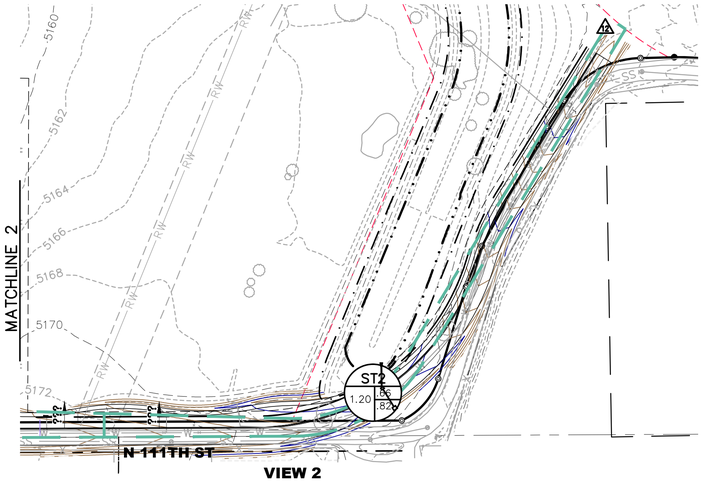
LEGEND

- PROPOSED MAJOR CONTOUR (5') — 5250
- PROPOSED MINOR CONTOUR (1')
- EXISTING MINOR CONTOUR (1')
- EXISTING MAJOR CONTOUR (5') — 5250
- PROPOSED STORM DRAIN PIPE
- PROPOSED STORM DRAIN INLET
- DIRECTIONAL FLOW ARROW
- BASIN LINE
- SWALE
- DESIGN POINT (1)
- PROPOSED BASIN LABEL
- A1 — BASIN DESIGNATION; AREA (AC.) 1.00 — .40 MINOR RUNOFF COEF., .60 MAJOR RUNOFF COEF.
- EMERGENCY OVERFLOW





VIEW 1
SCALE: 1"=150'



VIEW 2
SCALE: 1"=150'

PATH: P:\WORTH FLATIRON\CADD\EXHIBITS\60PDR.DWG
PLOTTED BY: COREY PETERSEN PLOT DATE: 1/26/2017 4:31 PM
XREFS: 10DR-Master, 36PPN, w-wetlands boundary, W-Water Surface, 10EUT, 10EPN, 10EMA, 60PUT, 60BASE, 60PPN,

DATE	REVISION DESCRIPTION
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.	.
.	.
.	.
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.	.

Drawing Name: 60PDR.dwg
Job Number: HINES PA C PP
Prepared For: HT FLATIRON LP

0 50 100 200
1 inch = 100 ft. Horizontal

Designer	Drafter	Checked
MAS	MAS	BKM

Calibre
Calibre Engineering, Inc.
9090 South Ridgeline Boulevard, Suite 105
Highlands Ranch, CO 80129 (303) 730-0434
www.calibre-engineering.com
Construction Management Civil Engineering Surveying

FLATIRON MEADOWS
PLANNING AREA C - IMPROVEMENT PLANS
PROPOSED DRAINAGE PLAN

Sheet DR1 — 1 of 1

Date JANUARY 27, 2017

CTL | THOMPSON

February 1, 2017

HT Flatiron LP
1515 Wynkoop Street, Suite 800
Denver, Colorado 80202

Attention: David Klebba
Chad Murphy
Jill Carlson, C.E.G., Colorado Geological Survey

Subject: Response to CGS' Comment Letter
Flatiron Meadows Preliminary Plat, Amendment No. 2 (Planning Area C)
Southeast of North 111th Street and Erie Parkway
Erie, Colorado
Project No. DN47,910-115

This letter presents our responses to a review letter dated December 13, 2016 prepared by the Colorado Geological Survey regarding Planning Area C and our letter dated October 25, 2016. We are in the process of preparing a report specific to Planning Area C with respect to the current grading plans and subsurface drainage systems. Our forthcoming report will have additional details regarding the discussions in this letter.

Soft/Loose, Wet, Settlement-Prone Soils

Because the materials are predominantly sandy and silty, we judge the majority of the consolidation will likely occur between 60 and 90 days. We believe the settlement risk for the residences is very low because basement excavations will remove the majority of the fill being placed during site grading, essentially unloading the soils or loading them to their preconstruction state. Nonetheless, we are working with the design team to specify construction sequencing processes to allow consolidation to occur within the estimated time frame with low risk of damaging sensitive improvements. Utility installation will be delayed to allow consolidation to occur after grading is completed and subsurface drains are activated. No sensitive utilities or improvements will be constructed before consolidation is allowed to occur.

Extremely Shallow Groundwater

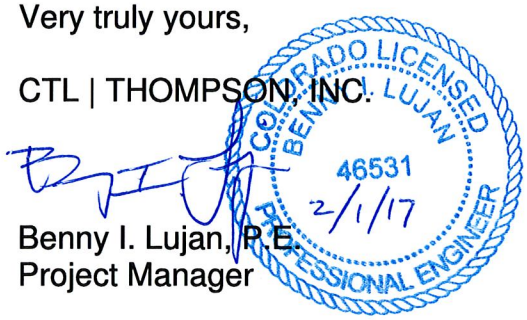
Calibre redesigned the proposed site grades to provide more site grading fill, however interceptor drains and underdrains will still be needed to effectively lower groundwater to at least 3 feet below basement levels. We are confident that interceptor drains and underdrains can lower the shallow groundwater, provided they are designed, constructed and maintained properly. The use of underdrains to collect individual foundation drain discharge should help reduce the risk of raising the groundwater levels

after construction. We believe our approach should eliminate problems associated with shallow groundwater causing risk of basement flooding. CTL has worked on several projects in the past where interceptor drains and underdrains were used to control shallow groundwater.

If you have questions regarding this letter or if we can be of further assistance, please call.

Very truly yours,

CTL | THOMPSON, INC.



Benny I. Lujan, P.E.
Project Manager

Reviewed by:

Marc E. Cleveland, P.E.
Vice President

BIL/bil
(2 copies)

Via e-mail: Dave.Klebba@hines.com
Chad.Murphy@hines.com
BMoss@calibre-engineering.com
carlson@mines.edu

CTL | THOMPSON

January 26, 2017

HT Flatiron LP
1515 Wynkoop Street, Suite 800
Denver, Colorado 80202

Attention: David Klebba
Chad Murphy
Jill Carlson, C.E.G., Colorado Geological Survey

Subject: Response to CGS' Comment Letter
Flatiron Meadows, Filing No. 10
Southeast of Future Flatiron Meadows Boulevard and Homestead Parkway
Erie, Colorado
Project No. DN47,910-115

This letter presents our responses to a review letter dated December 9, 2016 prepared by the Colorado Geological Survey regarding our Preliminary Geotechnical Investigation report dated September 22, 2016 for Flatiron Meadows, Filing No. 10. The CGS stated "The results of CTL's Preliminary Geotechnical Investigation indicate that shallow groundwater and soft, compressible soils and bedrock remain significant concerns within this filing." We address these concerns below.

Shallow Groundwater and Artesian Aquifer

CTL worked with Hines and Calibre to determine a solution to address the concerns with shallow groundwater and the presence of an aquifer. Consequently, Calibre redesigned the proposed site grades to eliminate all cuts and provide more site grading fill. Improvements will be raised above groundwater, and at least 3 feet of separation will be provided between basement floor levels and groundwater. This should eliminate problems associated with shallow groundwater causing risk of basement flooding. Because basements at least 3 feet above groundwater, an interceptor drain is no longer required. We continue to recommend an underdrain system for individual foundation drain discharge collection.

We concur with the CGS that it appears a confined aquifer is present within the bedrock below Filing No. 10, and that penetrating the confining layer may induce water issues for the development in the future. Based on our investigation, we believe the aquifer is at least 20 feet below existing grade (that was the depth lignite appeared and water began to rise in TH-241). The confining layer may be assumed to be the claystone between 12 and 20 feet. **Drilled piers used for residence foundations or deep foundations which may be used to underpin residence foundations in the future should not be allowed at Filing No. 10 to address this concern. Future builders and the Town should be aware of this.** Based on subsurface conditions disclosed by

our investigation, we do not believe any of the residences in Filing No. 10 will need drilled pier foundations. Future underpinning (if any) can be accomplished using compaction grouting, which does not penetrate bedrock. With the site grades being raised, sanitary sewer utilities and the underdrain will also be constructed at higher elevations, resulting in low likelihood that the confining layer will be penetrated by deep utility excavations.

Soft/Loose, Compressible, Settlement-Prone Soils

Based on revised grading plans, up to about 11 feet of fill will be placed on Filing No. 10, with the deepest fill in the southwestern and south-central portions. The majority of the site will receive less than 3 feet of fill. You have concerns that consolidation of the soft/loose materials will create damaging settlement to improvements. We performed calculations of estimated potential consolidation based on the worst-case scenario, such as at TH-238, where 11 feet of fill being placed on 10 feet of soft/loose material (materials below groundwater were neglected). We believe consolidation and settlement magnitude and timing will be similar to Planning Area C described in our Dewatering and Settlement/Consolidation Analysis letter dated October 25, 2016. Based on the consolidation measured during our previous investigation, we estimate theoretical settlements of about 3 to 6 inches and time for 90 percent consolidation ranging between 60 to 90 days.

Our estimates are conservative and probably represent the worst case scenario. In addition, most of the soils found were relatively sandy and silty compared to the clay samples the consolidation testing was performed on. These soils allow pore-water pressure to dissipate more rapidly than a clay, meaning the consolidation estimates above likely over-predict the actual consolidation. Our experience indicates that post-development settlement will likely be less than calculated. Much of the settlement will occur rapidly during or shortly after fill is placed. The consolidation should occur during site grading and prior to any improvements being built. We believe the settlement risk for the residences is very low because basement excavations will remove the majority of the fill being placed during site grading, essentially unloading the soils or loading them to their preconstruction state.

In regards to the 4.8 percent compression measured on a claystone sample from TH-238 at 19 feet, we do not believe the high compression is indicative of the claystone being compressible. The high compression was likely caused by sample disturbance. Bedrock is an overly consolidated material, meaning it has nil potential for compression.

If you have questions regarding this investigation or if we can be of further service, please call.

Very truly yours,

CTL | THOMPSON, INC.

Benny I. Lujan, P.E.
Project Manager

Reviewed by:

Marc E. Cleveland, P.E.
Vice President

BIL/
(2 copies)

Via e-mail: Dave.Klebba@hines.com
Chad.Murphy@hines.com
BMoss@calibre-engineering.com
carlson@mines.edu